

# Proceedings *of the*



12th LONDON SWINE CONFERENCE

## A Time For Change

Wednesday, March 28, 2012

Thursday, March 29, 2012

London, Ontario

[www.londonswineconference.ca](http://www.londonswineconference.ca)



UNIVERSITY  
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PROCEEDINGS

*of the*

**LONDON SWINE CONFERENCE**

**A TIME FOR CHANGE**

*Edited by*  
J.H. Smith

March 28<sup>th</sup> and 29<sup>th</sup>, 2012  
London, Ontario  
[www.londonswineconference.ca](http://www.londonswineconference.ca)

Proceedings of the London Swine Conference  
A Time For Change

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ISBN 978-1-927026-01-4

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## CHAIR'S MESSAGE

This year is a time for change, both in the redesign of the conference agenda for the 2012 London Swine Conference and the new paradigm for the Ontario hog industry. The London Swine Conference is the epicentre for technology transfer for Ontario. Since its inception, well over 2000 producers have attended this event and built on their skill sets.

Our industry has always been based on our breeding success and maximizing returns for our farm. So while our industry is changing, the key fundamentals to our prosperity have remained the same. This echoes French critic, journalist and novelist, Jean-Baptiste Alphonse Karr, who said “the more things change, the more they are the same.” My hope, as the Chair, is to have this event provide practical solutions to our farm challenges and for you to acquire ideas to improve your profitability.

As I look over the agenda, I feel confident that you will find many interesting topics and sessions to attend:

- Jack Tacoma will address a change in perspective and how to motivate and embrace change;
- Trent Loos will present pork production in a YouTube™ environment, a proactive approach to production in an increasingly connected world, and;
- Kilby Willenberg will discuss advancing reproductive technology to improve reproductive performance and genetics.

I challenge you to find at least one take away during this conference to assist you on your farm. If you achieve that goal then the committee will have succeeded in its program delivery. This event is created by a dedicated group of individuals who plan, coordinate and arrange all aspects of putting on a premiere conference. I wish to thank all of them for their commitment and dedication.

Stewart Cressman  
Chair,  
Steering Committee  
2012 London Swine Conference





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# **DAY 1: BREEDING SUCCESS**



# A CHANGE IN PERSPECTIVE

**D. Jack Tacoma**  
**Tacoma Engineers Inc.**  
**176 Speedvale Ave. West, Guelph, ON, N1H 1C3**  
**E-mail: [jacktacoma@sympatico.ca](mailto:jacktacoma@sympatico.ca)**

## ABSTRACT

The London Swine Conference is about change. Change is significantly affecting the swine industry. The number of swine producers is decreasing steadily. Market trends are becoming more diverse and less predictable. The quality of pork is increasing. On the other hand profitability, which in the past has seen regular and dramatic swings, has stopped swinging.

Every year, resolute producers unwaveringly cling to hope for the love of the business. We do know, however, that only those who most successfully prepare for and adapt to the changes in the industry will survive.

We will explore the nature of change – not in the usual philosophical sense – but in the context of a post modern world where the nature of the relationship between food and people is exhibiting some strange and contradictory behaviours. There are societal forces at work that are changing the way people perceive things and therefore how people behave.

We will see that in the current context there are exterior forces at work that are beyond our control, but perhaps within our power to anticipate – and perhaps even to take advantage of.

The swine industry is all too aware that there are also change forces at work within the swine industry that both bless and curse.

We will examine the nature of the human mind when confronted by change, and how it can make grievous errors. But there are things that the mind can do that allow it to make decisions smarter than a super-computer.

We will also examine how the “collective mind” of a group of people, like those involved in the swine industry, can work together to anticipate and shape change. The collective mind is a weird thing, very hard to define, understand and even trust. The collective mind, which understandably works more slowly than the human mind, can also exhibit moments of genius and insight. This can help producers more successfully anticipate and adapt to change.

This session will end with a tool box of change wisdom.

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# **CANADIAN PORK TRADE BALANCE, OUTLOOK AND OPPORTUNITY GAPS**

**Michael Young  
Canada Pork International**

## **INTRODUCTION**

Canada Pork International (CPI) was established in 1991 and is the export promotion organization of the Canadian pork industry. CPI is a joint initiative of the Canadian Meat Council, representing pork processors and trading companies, and the Canadian Pork Council, representing Canada's hog producers. CPI members include 32 allied and associate organizations, 24 processing plants, and 23 trading companies collectively representing almost 100% of Canada's pork processing industry.

CPI has four primary strategic priorities: Market Access, Market Development, Market Intelligence/Member Services, and Product Positioning/Promotion.

Market access remains a top priority for CPI and is a prerequisite for promotion, differentiation initiatives and market development investments. Market access cannot be taken for granted, trade disruption can happen anytime, anywhere; remember the impact of BSE and H1N1. Market access defines who is in the elite group of pork exporters (Canada, USA, Denmark). Brazil has yet to become a major threat because of market access issues. It is very important that improvements and progress continue regarding animal health, regionalization and biosecurity.

## **TRADE BALANCE**

In 2011 Canada's 7,000 hog farms produced 27 million pigs based on an inventory of 11.9 million pigs and 1.3 million sows. Manitoba, Ontario and Quebec represent 79% of Canada's hog production. Canadian federal slaughter volume is distributed across Canada: Western Canada 41%, Ontario 21%, and Quebec 38%. Downsizing and market access issues with the USA (COOL) have resulted in a 25% reduction of inventory over the last few years but slaughter capacity has maintained a solid momentum.

Canada accounts for over 20% of global pork exports and is the third largest exporter behind the USA and EU. The last five years Canada has exceeded 1 million tonnes of pork exports annually to over 130 countries and 2011 was another record breaking year for volume and value. In 2011 Canada exported over 64% of its pork production compared to beef declining to 38% and poultry holding at 13%.

Canada is also the most export dependent country compared to the top 9 pork-exporting countries in the world. This is the result of growing exports, declining domestic consumption and increased pork imported from the USA. Pork production has been growing exponentially in Canada since 1991 and represents the largest red meat sector in the country; in 2011: pork 1.9 million tonnes followed by beef at 1.1 million tonnes.

Canadian pork exports have also grown over the last 20 years, tripling in volume over the last 15 years. Major growth has come from Japan and other markets outside of the USA, which is still

Canada's largest export market by volume. In 1990 Canadian pork exports were worth 711 million compared to 3.2 billion in 2011.

Canadian pork quality, workmanship, carcass utilization and value optimization by Canada's meat packers and trading companies have been successful in marketing Canadian pork cuts to many countries around the world. Many of Canada's processors have been able to earn and achieve an export premium of \$19.00 - \$23.00/head compared to the same cuts marketed only in Canada and the USA. Canada's top value/unit export markets are Japan, Australia, New Zealand, USA, Russia, and South Korea.

Canada's domestic pork disappearance has been trending downwards for many years but not out of line with changes in many other developed countries. The most important concern is the increase in pork imports primarily from the USA. The combination of decreasing consumption and increasing imports must be addressed in Canada. In 2011 over 26% of the pork consumed in Canada was imported, primarily from the USA. This represents a 200,000 tonne opportunity for Canadian marketers to recapture domestic market share. However in 2011 the growth in exports out-performed imports resulting in an overall increase in trade balance. Canada is the fourth largest export market by volume for the USA but the second largest in value based on the product mix that is moving north.

## **OUTLOOK AND OPPORTUNITY GAPS**

Global consumer confidence is still a concern and still struggling to recover from pre-recession levels. Economic power is shifting to emerging markets. Average annual GDP growth rates in emerging markets from 2011 to 2016 is predicted to be 50% higher than developed markets.

Global meat consumption trends suggest that from 2010 – 2019 pork will increase by +23%, beef +15%, chicken +17%. Three billion people in the world will be trying to move into middle class economies and will drive meat demand.

The keys to growth in 2012:

1. **FAIR** and equitable market access
2. **TARGET** economically powerful end-user customer segments
3. **LEVERAGE** the redefinition of value, quality and emotion
4. **ENGAGE** the connected customer base in ways they understand and trust

What's driving consumer demand?

1. Quality, Value, Price
2. Taste, Tenderness, Flavour
3. Economic Climate
4. Brand Equity
5. Safe and Wholesome
6. Nutrition
7. Variety, Availability
8. Ethnic Influences
9. Convenience
10. Life Style Choices

What's driving the end-user customer?

ü **CONSUMER DEMAND**

1. Profitability
2. Sales and Distribution
3. Through-put
4. Competitive Position
5. Price/Value Balance
6. Differentiation
7. Quality
8. Brand Equity
9. Exclusivity
10. Availability

What's driving the Packer-Processor?

ü **CUSTOMER DEMAND**

1. Profitability
2. Through-put
3. Sales and Distribution
4. Carcass Utilization
5. Value Optimization
6. Livestock Supply Chain
7. Competitive Position
8. Differentiation
9. Quality
10. Brand Equity and Market Access

The Canadian pork industry faces many global marketing challenges that include the erosion of the domestic market, and continued growth and prosperity in the export marketplace.

ü **Right Product for the Right Market**

1. Price, value, service
2. Segment the market, identify the needs, serve them well
3. Change the “rules of the game” whenever possible

ü **Competitive Advantage**

1. Best In-class protein solution
2. Relevant and verifiable points of differentiation

Competing on price is easy, profitability is the challenge:

**Value = Benefits / Cost**

1. Establishing a credible value proposition
2. Adding value and growth to a commodity driven category
3. Knowledge to maintain or defend price points in a competitive protein market
4. Validation and communication of relevant points of differentiation



# **TOOLS, TECHNIQUES AND STRATEGIES TO IMPROVE REPRODUCTIVE PERFORMANCE AND GENETIC PROGRESS**

**Kilby Willenburg  
Reproquest Inc.  
6064 McKee Road, Fitchburg, WI 53719 USA  
E-mail: [willenburg@reproquest.com](mailto:willenburg@reproquest.com)**

**and**

**Michael Dyck\*, George Foxcroft, Jennifer Patterson  
Department of Agricultural, Food and Nutritional Sciences  
University of Alberta, Alberta, T6G 2P5, Canada  
\*E-mail: [michael.dyck@ualberta.ca](mailto:michael.dyck@ualberta.ca)**

## **INTRODUCTION**

The developing trends in the swine industry are to drastically reduce sperm cell numbers per insemination dose, decrease the number of working personnel on the farm, reduce boar numbers in the stud and deposit the majority of sperm cells in the uterus by bypassing the cervix. It is expected that this can be done without decreasing the impressive 90% farrowing rates (FR) and 13 total born (TB) production numbers, which have become the benchmark for the industry. To achieve this, we have to be flawless with all personnel and techniques at all times, in all seasons, in order to not see a reduction in fecundity. The swine industry is already a trimmed down version of its former self in terms of number of swine producers. Our market animals are leaner (3/4" of backfat compared to 3" in 1950s) and have impressive whole herd feed conversion ratios (3 lbs per 1 lb gain) but how much *can* we improve performance and at what cost?

### **Have we become greedy as an industry?**

There are a number of tools, techniques and strategies that can help improve performance and genetic progress, but as an industry we have to consider each farm individually and look at their respective goals because not every new technology is pertinent for every scenario. Depending on the farm, different levels of emphasis will be placed on fertility parameters and genetic progress. A farm that incorporates in-house multiplication of their breeding stock is going to have a different perspective on fertility and genetic traits than a farm that purchases their replacement stock. This former type of replacement herd system is interested in specific genetic traits and will prefer using the highest indexing boars with the greatest genetic superiority. They may be more willing to sacrifice some level of fertility by using single sire inseminations and thus lower fertility boars to achieve these desired traits. This type of farm might be more indicative of the dairy industry than the swine industry where it is common and acceptable to have 50% conception rates and a very low number of total born, but their goal is genetic progress and heritability, not fertility.

The other type of farm, and perhaps the most common, purchases semen from a local boar stud and buys replacement gilts from a genetic supplier. Pigs per sow per year and carcass traits are considered to be more important than genetic superiority so terminal boars are generally crossed with maternal line females. Pooled semen is generally used to reduce boar and seasonal

variation and has become standard practice in North American boar studs. In this case most doses range between 60-100 mL with 2-4 billion sperm (Knox et al., 2008).

### **Post-cervical AI (PCAI)**

In order for farms to reach their goals and maximize their potential whether it's genetic or fertility there are many commercially available tools such as PCAI (post cervical artificial insemination), low dose AI, boar fertility analysis, estrus characterization, and ovulation synchronization to name a few. These applications may not be applicable for every situation but should help reduce unwanted variation on the farm and allow producers to improve reproductive efficiency.

Post-cervical AI is not a new application (Hancock, 1959; Martinez et al., 2002) but the renewed interest and promotion of this technique has caused the industry to re-examine this method for sow insemination. This technique, also known as IUI (intrauterine insemination), bypasses the cervix and deposits the majority of the sperm cells directly in the uterine body. Bypassing the cervix reduces the amount of semen lost and therefore should require less sperm per insemination to achieve similar reproductive performance as with standard cervical AI. There are many limitations with PCAI such as the fact that it not easily applied in gilts, the catheter is more expensive, it requires retraining of personnel and it can be potentially harmful to the sow if not performed correctly. However, the benefits that can be achieved in labour reduction, decreased AI time and the ability to have more sows bred with semen from superior sires may outweigh those limitations. Perhaps the biggest factor behind the recent PCAI movement is a desire to reduce sperm cell numbers per dose volume so more sows can be inseminated with superior genetics. Sperm numbers of  $1 \times 10^9$  per 30 mL is a part of commonly described protocols for PCAI (Vazquez et al., 2008). One of the earliest trials (Watson and Behen, 2002) tested 3, 2 and  $1 \times 10^9$  sperm per dose both with conventional AI and PCAI and attained similar fertility results except for the  $1 \times 10^9$  dose with conventional AI which resulted in reduced litter size and farrowing rates ( $P < 0.001$ ). There have also been adequate fertility levels attained with  $0.5 \times 10^9$  sperm/doses (Mezalira et al., 2005), but some not so acceptable results in other reports at the same level of sperm (Roberts and Bilkei, 2005). This does cause one to question what are the causes of this variable success with PCAI and if this technique is applicable for all farms.

The commercial use of AI in swine has been available since the 1960s but little data was available on the optimal level for volume and concentration of semen until the work of Stratman and Self (1960), Hancock and Hovell (1961) and Baker et al., (1968). These experiments used non-extended semen, fresh semen extended in an egg yolk, phosphate, glucose extender and egg yolk bicarbonate extender, respectively, which questions how relevant the data is in today's industry with the use of long term extenders, data on weaned to estrus interval and AI timing, improved AI technique and catheters to name a few. The data reported above on PCAI using conventional AI as a control has shown that as a whole, the industry can decrease the sperm numbers per dose with a standard AI and achieve impressive fertility numbers, but the data is conflicting. A common theme of the data reported has been management. Farms that are managed properly will probably not have an issue with maintaining high fertility levels with PCAI whereas farms with poor management and low fertility might create more problems with the transition. Post cervical AI does have a place in this industry but it might not be as widespread as all of the excitement. New technologies that either reduce the number of available sperm or inhibit the longevity of the cell (frozen thawed sperm, sex sorted sperm etc) would benefit from PCAI.

## Identification of sub-fertile boars and sub-fertile ejaculates

As reviewed elsewhere in these proceedings (Dyck et al, 2012), identifying sub-fertile boars presents unique challenges to the swine industry. Quantitative analysis of physiological aspects of sperm function is currently used in boar studs but may not be the best indicator of boar fertility. One of the techniques employed by genetic companies to identify boars with chromosomal abnormalities is reciprocal translocations (RT). Specifically, it is a special type of chromosome abnormality caused by pieces of separate chromosomes breaking off from their original chromosome and forming with another. The result of such occurrence is a reduction in fertility and occurs in less than 1% of the boars but still could be of importance if single sired inseminations are used.

Fourier harmonic analysis (FHA) is another means to identify low fertility boars. This technique characterizes sperm nuclear shape and has been related to fertility in the bull (Ostermeier et al., 2001) and boar (not published). In a trial using single sired maternal line boars (n = 110) the head size and shape of sperm from an acceptable fertility boar (n = 105) and from unacceptable fertility boar (n = 5) were characterized and a model constructed. The acceptable boars had an average total born piglets (TB) of  $12.31 \pm 0.80$ , whereas an unacceptable boar had an average TB value of  $9.58 \pm 1.30$ . This model was tested on a new group of boars (n = 55) to validate the accuracy of the test. The results show that the model accurately characterized ~50% of the unacceptable fertility boars and ~85% of the acceptable boars. Although not perfect, this method is a justifiable means to reduce low fertility boars from a herd with minimal effort.

More pressing on a short-term basis is to screen for sub-fertile ejaculates. Boars can temporarily experience a reduction in fertility from acute and chronic stresses (Flowers, 1997) especially during the summer months (Cameron and Blackshaw, 1980). Most commercial AI studs have less than an hour to decide if an ejaculate should be processed or discarded (Knox et al., 2008), which does not allow time for many *in vitro* tests to be performed. Currently, a sperm motility analysis is conducted on every ejaculate and to a lesser extent sperm morphology to assess ejaculate quality (Knox et al., 2008). Therefore, it appears that there are procedures in place but the relevant question is how accurate are these routine evaluations (Flowers, 2009).

## Estrus characterization

Proper estrus characterization in the breeding herd is also an inexpensive method to improve reproductive performance and overall efficiency. Data has shown that around 95% of sows express estrus between 3 and 8 d after weaning and that sows mated between 3 and 6 d relative to estrus had increased farrowing rates and litter sizes compared to sows mated between day 7 and 15 (Tubbs, 1995). It has been reported that fertilization rates (Soede et al., 1995a) and litter size (Rozeboom et al., 1996) are lower if insemination occurs more than 24 h before ovulation. Therefore the best predictor of ovulation is frequency of estrus detection because ovulation occurs approximately 38-48 h after onset of estrus (Soede et al., 1995b; Knox et al., 2001) and animals ovulate 2/3 of the duration of estrus (Soede et al., 1995b; Knox and Zas, 2001). Proper herd characterization by monitoring duration of estrus in sows in special regards to parity and lactation length would improve AI timing, decrease the number of AI doses inseminated improve and overall herd fertility. This is true whether a producer is applying standard cervical AI or PCAI, but may be more critical when the sperm number per dose are reduced.

## **Synchronization of ovulation**

Currently, there is a new product seeking FDA approval in the US for synchronizing ovulation in weaned sows, which, in theory could facilitate a single timed AI with no heat checking. Data has shown that an intravaginal dose of 100 µg of a GnRH agonist (triptorelin) given at 96 h relative to estrus or at estrus advanced ovulation and when used with a timed AI resulted in farrowing rates and litter sizes comparable to sows mated based on estrus (Knox et al., 2011). This product could reduce labour and the cost of insemination doses saving the farm thousands of dollars assuming the product is priced competitively. In Canada, Zak et al. (2009) have demonstrated that administration of porcine Luteinizing Hormone (pLH) at the onset of behavioural estrus to control ovulation not only facilitated fixed-time insemination, but also resulted in reduced semen usage, less labour devoted to estrus detection, as well as improved sow productivity. These data demonstrate that administration of pLH at the time of estrus detection would allow for the application of a single fixed-timed administration 24-30 hours after pLH treatment. In situations in which the synchrony of estrus after weaning may not allow the effective application of either pLH or GnRH at a fixed time after weaning, the alternative strategy of using ovulation-induction after an initial treatment at weaning with eCG continues to be explored with acceptable results (Cassar et al., 2005). The eCG/pLH protocol has been successfully applied in combination with post-cervical AI with reduced sperm numbers per AI dose, without adversely affecting sow fertility. The results of these studies has prompted work to evaluate the application of pLH at the onset of estrus followed by a single, low semen dose, 24-30 hours later using post-cervical AI (studies on-going). These and other results suggest that the implementation of single fixed-time AI programs in a well managed sow herd can be a reality. Linked to the use of proven superior sires, post-cervical insemination catheters and lower doses of semen this fixed-time insemination will allow the pork production industry to apply the genetic value of elite boars to breeding programs that are competitive with other livestock species.

## **Equipment**

The last, and possibly the easiest, thing to ensure is that all equipment is adjusted and working properly. The swine industry has become very mechanized since the advent of AI and we have become very dependent on the equipment in our daily routine. Protocols should be implemented to reduce the inherent equipment variation. Microscopes should be checked monthly and the personnel at the stud should know how to adjust the scope. If you cannot see a proximal droplet then your scope needs adjustment. Photometers and CASA machines should be adjusted to achieve less than 5% variation between doses. Semen storage units should be kept in clean, dry, heated room so the unit can maintain a 16-18° C temperature range. Pipettors should be checked on a weekly basis and calibrated if needed. If the industry is pushing toward lower dose inseminations and single AIs then we have to make sure we are confident in the accuracy and consistency of the equipment.

## **CONCLUSIONS**

The swine industry is an exciting and progressive industry but there needs to be continued development if this industry is to improve and be more profitable. It is not uncommon for farms to average over 90% farrowing rates and 13 total born. In 2010, according to PigChamp (2011) the average Canadian FR and TB was 84.06% and 13.07, respectively, with 49 farms reporting data. In the US it was 81.46% and 12.86 with a total of 329 farms. This in comparison to the



data from 2001 for both Canada (74.9% and 11.5, 455 farms) and US (69.0% and 11.3, 786 farms) shows impressive strides in performance. The next decade will probably not produce another 10% increase in FR and greater than 1.5 pigs per litter but it wouldn't be unexpected to see improvement. On a short-term basis we should concentrate on identifying sub-fertile ejaculates especially during times of stress. We should also work towards identifying sub-fertile animals, both male and female, and working toward single sired inseminations to increase the genetic superiority of our herds. Single sired matings are taboo in our industry because of multiple AIs per pig, large numbers of sperm inseminated and significant boar variation but this would establish accurate reference points for male reproductive performance (Flowers, 2009). Then tools such as PCAI would be increasingly valuable since we would ideally be able to use the highest fertility and indexing boars across all of the sows.

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# **BENCHMARKING PRACTICES OF THE MOST PROFITABLE COMPANIES**

**Greg Bilbrey**  
**Agri Stats, Inc., Fort Wayne, Indiana, USA**

With today's volatile markets it has become increasingly more important to manage production costs and maintain margins. Keeping a pulse on your company's performance relative to the industry and knowing what opportunities exist in a system can translate to significant savings or earnings. One mechanism to improve overall performance and profitability is to benchmark or compare company or farm cost/performance data to data from individuals or groups of fellow producers. The most profitable companies in today's swine industry benchmark both their cost and performance and develop strategies to improve their relative position in key areas over time.

## **AGRI STATS**

Agri Stats is a privately held company providing professional benchmarking services to the commercial livestock industries. Services are currently provided for broiler, egg, turkey, and swine production companies as well as their harvest and processing plants. Since 1985, Agri Stats has been working with production companies in North and South America to help improve their profitability by identifying opportunities to lower cost and improve production efficiencies through comparative analysis or benchmarking.

Agri Stats collects participant financial and production data electronically each month. Internal auditors convert the data, prepare it for comparison and perform the monthly audits. Each company's financial data is reconciled to their general ledger to help ensure actual costs are reported. Raw numbers are used in Agri Stats' standardized calculations so all company numbers are calculated the same way.

## **BENCHMARKING**

Benchmarking is simply the act of comparing data to a contemporary group with the goal of improving performance or results. Modern formalized benchmarking is credited to the Rank Xerox Corporation though the practice dates back to ancient times. Japan sent teams to China in 607 AD to learn best practices for business, government and education (Zimmerman, 2003). Zimmerman also mentions that "economic Darwinism" (meaning business evolution) will lead to more companies participating in and utilizing benchmarking to improve production and profitability. Since modern agriculture and swine production should certainly be considered business enterprises, benchmarking should be a tool used by swine producers to improve their bottom line profitability and performance.

A key benefit of benchmarking is that it contributes to the ability to see outside personal or professional practices. The term "paradigm blindness" refers to the situation when individuals or businesses become so focused on or entrenched in the operation of their respective activities they fail to see what is going on outside their world. This blindness may be a source of stagnation and an impediment to progress. Benchmarking allows visualization of what individuals, companies

and/or competitors are doing and how one compares to them. Effective benchmarking breaks this paradigm blindness and leads to creation of practices or processes that improve performance.

### **What are those most profitable doing?**

The most profitable swine producers in the industry have made benchmarking a key focus in their organization. Not only are they benchmarking their production and performance but focusing on sales and cost benchmarks as well. By looking at the sales and production metrics as a whole the producer has the ability to see all facets of his/her organization and where focus should be directed. For benchmarking to be successful the entire team must be on board and committed to utilizing the information for improvement. It is imperative to have a good flow of data feeding the benchmark in an accurate and timely fashion with fellow team members exhibiting complete ownership. Oftentimes, benchmarking is viewed in a negative light with the perception that only “bad” areas are highlighted with those individuals responsible held accountable. The benchmarking exercise should be used as a tool for improvement and viewed as such.

The most profitable companies are reviewing benchmarking information on a routine basis, generally monthly. Incorporating regular meetings to review key opportunity areas and developing action plans or strategies to remedy improvement are commonplace with users of benchmarking. These companies monitor improvement over time and chart subsequent progress. Quantifying results and the economic impact of those results is a valuable measure in an organization, which benchmarking can provide.

While most producers can come up with and are more willing to compare performance measurements, the real strength of benchmarking comes from comparing profit, sales and cost data. Correctly recording actual cost data and ensuring the numbers are comparable between producers certainly requires more work but the effort is worth it. Best in performance (best ADG, best FC, etc.) does not necessarily mean best in cost or profit. Annual Agri Stats data on approximately 2,000,000 sows and 40,000,000 pigs has repeatedly shown operations with great advantages in performance but much higher production cost. Conversely, operations showing lower cost may or may not have superior performance.

### **CONCLUSION**

Benchmarking allows those most profitable swine producers to maximize advantageous areas and improve upon disadvantaged areas translating to an improved bottom line. While production/performance metrics are important to benchmark it is so much more valuable in today's industry to benchmark profit, sales and costs, developing strategies to improve the company's relative position in key areas over time. Oftentimes the most productive system does not necessarily translate to the most cost effective system. The ability to minimize the percentage of cull pigs out of a system as well as minimizing the percentage of pre-wean, nursery and finishing mortality are key drivers of the most profitable companies. Full commitment from the top of the organization down makes the benchmarking exercise a powerful and valuable tool to the company's overall success.

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# **DAY 1: WORKSHOP SESSIONS**



# ADVANCED SOW TROUBLESHOOTING

Kevin Vilaça<sup>1</sup>, Paul Ferreira<sup>2</sup> and Ryan Martin<sup>3</sup>

<sup>1</sup>South West Ontario Veterinarians, <sup>2</sup>Grand Valley Fortifiers, <sup>3</sup>RFW Farms

Sow production in the 21<sup>st</sup> century is at an unprecedented plateau of efficiency and performance. In conjunction with this new generation of finely-tuned animals, however, there is less tolerance for any challenges that may present themselves within a population. It is imperative, as never before, that management understands the level of sensitivity that is required to keep the operation functioning smoothly. Troubleshooting is a vital component of dealing with any issues – great or small – that have the potential to obstruct maximum production output. Rapid detection is the prerequisite for early intervention.

Troubleshooting can be roughly divided into two categories:

- 1. Dealing with Problems**
- 2. Preventative Maintenance**

A producer should never reserve his troubleshooting skills for the times when some obvious phenomenon is occurring in the sow-herd. He should always have his metaphoric antennae sending out signals and measuring the response of his environment. An ounce of prevention is worth a pound of cure! The principles that are presented in this article apply to both aspects of troubleshooting.

Albert Einstein once defined insanity as: “Doing the same thing over and over again and expecting different results”. Sow producers can settle into a deep groove where it concerns the status quo but are continually frustrated with the inability to take productivity and control to the next level of prosperity. Effective troubleshooting keeps one finger on the pulse of the latest technological advances while keeping the other firmly on “real life” in the barn. The process of exposing our system’s weaknesses and inefficiencies is a moving target; the answer may point one direction one minute but readjust its focus after exposure to the latest scientific release suggesting otherwise. This position cannot be justly accused to be indecisive shilly-shallying but prudent “moving with the times”!

Sometimes, one cannot “see the forest for the trees”! When a producer becomes burdened down with the same routine, animals, and barn everyday, he can lose sight of the big picture. It is a healthy exercise to step back and get glimpse of the panoramic view of the operation. As well, it is also good to get the 10,000-foot view and compare the position of one’s business with the rest of the industry. A detached system of troubleshooting can give a producer wide perspective as he prepares to deal with issues surrounding the farm.

Personal attitude can be a primary impediment to effective troubleshooting. The following points outline the most common mistakes that producers make:

- **Discipline to Face Reality:** Do I have a problem? In the daily, mundane routine of working in a swine facility, herds-people can be the most insensitive to subtle changes that may be exhibiting themselves in the sows. The process of second-guessing their own judgments can play tricks with their minds. The point of reference is usually the previous

day or the most recent chore-time. “Everything was okay yesterday so I must be imagining things” is a dangerous counter to a gut feeling that all is not well. It is a healthy exercise to lay aside our feelings from yesterday and deal with reality today. Action begins only when we concede that something is wrong.

- **Communication:** There must be a voluntary motivation to seek external confirmation and advice from other co-workers, supervisors or industry professionals. A second pair of eyes will bring clarity to a situation and nudge the producer into action. There is often a tendency to “hold the cards to their chest” and deny that outside influence may contribute a positive effect on the outcome. While there is no denying the extensive experience and sensitivity to details that an individual producer possesses, it may be a major deterrent to a partnership with other qualified voices. Humility is a personal choice that precedes the ability to pick up the phone, arrange the meeting or start the conversation that leads to a resolution!
- **Be Open-Minded:** Following the process of disciplining oneself to face reality and initiating communication, advice and opinions will freely flow! The producer or final decision-maker will need to filter out valid information from preconceived biases and notions. But never throw out the baby with the bathwater! The producer has the opportunity of a lifetime to be exposed to the information or research that may solve his problem and position his farm to a profitable future. They must put to rest their petty preferences and prejudices, replace them with an open mind, and honestly evaluate the results of their research.

Troubleshooting is the greatest friend to prosperity in the business of managing a sow herd and raising their progeny. Rather than viewing the processes as a necessary evil, embrace these principles and apply them to your farm. The inefficiencies that are uncovered, the troubles that are thwarted and the diseases that are eradicated will pay you great dividends as you move forward.



# MEASURING LAMENESS IN SOWS

Nicolas Devillers and Sabine Conte  
Swine Behaviour and Welfare  
Dairy and Swine R & D Centre, Agriculture and Agri-Food Canada  
Sherbrooke, QC J1M 0C8  
E-mail: [nicolas.devillers@agr.gc.ca](mailto:nicolas.devillers@agr.gc.ca)

## BACKGROUND

The movement away from sow gestation stalls to group housing presents several major welfare issues from the standpoints of facility design and sow management. In choosing the type of sow gestation housing, it will be important to adopt the system with the most advantages and to be able to assess factors that will impact on the sows' welfare, longevity in the herd and thereby the producer's economic sustainability. Group housed sows are exposed to various situations (conditions) that can reduce their state of well-being. In particular, lameness can be associated with the pen configuration, space allowance per animal, nature of the floor surface and feeding system.

Lameness in sows is one of the most important welfare issues. Indeed, studies in Europe and North America showed that lameness is the second major cause of culling after reproductive failure and represents between 8 and 15% of total culled sows (D'Allaire *et al.*, 1987; Anil *et al.*, 2005). Lameness accounts for up to 25% of culling reasons in gilts (Tarres *et al.*, 2006) and is an important criterion in gilt selection. Moreover, high prevalence of lameness is associated with higher mortality (Abiven *et al.*, 1998) with locomotive disorders being the main reason for euthanasia (Kirk *et al.*, 2005). However, detection and evaluation of lameness in sows have not been studied extensively. Most research on leg and foot problems are based on clinical and descriptive studies or genetic analyses. Lameness can have multiple origins: osteochondrosis, arthritis, arthroses, osteomyelitis, various foot lesions or overgrown hooves (Dewey *et al.*, 1993).

Until now, qualitative visual scores of gait, standing posture, difficulty in lying down and locomotion are the main methods used to measure lameness in pigs (Bonde *et al.*, 2004; Harris *et al.*, 2006). However, accuracy of these qualitative methods can vary among observers (Main *et al.*, 2000). Therefore, there is a need for more objective quantitative methods to assess lameness in pigs. Several approaches and methodologies may be used. Kinetics and kinematics have been largely used in horses and cows. Kinetics is often used in association with force plates to measure weight distribution. Kinematics consists in analysing movements from video recording where the subject's body is schematized with markers. Both of these methods have been used in pigs to evaluate gait and study the impact of floor friction level (Thorup *et al.*, 2007; von Wachenfelt *et al.*, 2008), but they have never been used to quantify lameness in sows yet. Footprint analysis using a high-resolution floor mat to record foot pressure has also been used to analyse gait in pigs, to compare different floor friction and identify which region of the claw is the most stressed (Carvalho *et al.*, 2009). Although these methods provide precise information on gait, they are quite expensive and technically complex. On the other hand, data loggers have been successfully used to study lameness in cows and horses and have been validated to measure postures and stepping in pigs (Ringgenberg *et al.*, 2010). Finally, postural changes such as lying down or standing up are also useful indicators of locomotor disorders (Bonde *et al.*, 2004).

These various quantitative methods proved their utility to evaluate gait, postures and lameness in cows, horses, and dogs, but none of them have been validated to quantify lameness in sows. Therefore, our objectives are:

1. to develop and compare several techniques to quantify lameness in ambulatory sows: gait analysis using kinematics, stepping and postural behaviour using accelerometers, standing up behaviour and back conformation observation. These methods are compared to a standardised visual assessment of lameness used as a reference
2. to validate the use of some indicators on farm

## **TECHNIQUES**

Fifty breeding sows were used at the Agriculture and Agri-Food Canada Dairy and Swine Research and Development Centre. Thirty-one sows were pregnant with a mean gestation day of 67.9 and 19 sows were not pregnant. They were housed in gestation stalls or individual pens with partially slatted floor. Measurements were taken on each sow within a period of 1 week to assess their gait and postural behaviour.

### **Visual gait scoring**

The visual gait scoring system used was adapted from the one of Main *et al.* (2000):

1. sow walks with even strides and there is no gait problem observed
2. abnormal stride length is detected; movements are no longer fluent but no obvious lameness is detected
3. stride is shortened and lameness is detected; swagger of caudal body is noticed as sow walks
4. sow does not place affected limb on the floor
5. sow is not able to move.

Only sows with a score of 3 or less were selected. Sows were classified in three different groups: non lame (score 1; n = 21), mildly lame (score 2; n = 18) and lame (score 3; n = 11).

### **Kinematics**

Kinematic measurements were taken on each side of each sow separately. Reflective markers were stuck on limb joints and sows were video recorded while walking at a steady pace and without stopping in a corridor (16 x 0.8 m) enlightened with spot lights to light up the reflective markers. Video were analysed using an automatic tracking program and several measurement were taken: walking speed, stride length, swing time, stance time, foot height and angle of carpal and tarsal joints.

### **Postural behaviour**

Several components of the postural behaviour were measured using accelerometers or visual observation:

- The standing posture of sows was recorded for 24 hours using one accelerometer fixed on a rear leg. The percentage of time spent standing over 24 hours was then estimated.
- Stepping was also recorded using two accelerometers fixed on both rear legs during one hour following the morning feeding. Acceleration data were thereafter converted in number of steps per minute while standing and latency to lie down after feeding.
- Back conformation (arched or not) was visually observed when the sows were standing.

- The standing up behaviour was observed using a behavioural test. An observer approached the sow, and talked to and touched her in order to incite her to get up. The observer scored the behaviour on a 2-level scale: 1: stands up or 2: refuses to stand up or stays in a sitting position

## COMPARISON BETWEEN TECHNIQUES

Table 1 presents the comparison between sows showing different degrees of lameness for gait measurements using kinematics, posture and stepping behaviour.

**Table 1. Degree of lameness using different measurements.**

		Limbs	Non lame (n = 21)	Mildly lame (n = 18)	Lame (n = 11)
<b>Kinematics</b>	Walking speed (m/s)		0.96 <sup>b</sup>	0.94 <sup>ab</sup>	0.83 <sup>a</sup>
	Stride length (cm)	All	98.8 <sup>ab</sup>	101.2 <sup>b</sup>	93.0 <sup>a</sup>
	Stance time (s)	All	0.69 <sup>a</sup>	0.70 <sup>a</sup>	0.83 <sup>b</sup>
	Angle amplitude (°)	Anterior	74.3	73.1	73.8
		Posterior	43.2	41.1	44.8
	Mean angle (°)	Anterior	169.2	167.0	169.8
		Posterior	139.6	136.3	138.8
	Foot height (cm)	Anterior	4.56	4.54	4.53
		Posterior	5.57	6.30	5.94
	Swing time (s)	Anterior	0.36	0.38	0.36
		Posterior	0.39	0.39	0.37
<b>Postural behaviour</b>	Stepping in the hour after meal (step/min)	Posterior	5.37 <sup>a</sup>	6.06 <sup>ab</sup>	10.12 <sup>b</sup>
	Latency to lie down after meal (min)		48.6 <sup>b</sup>	41.7 <sup>ab</sup>	33.4 <sup>a</sup>
	Time standing over 24 hrs (%)		14.5 <sup>b</sup>	13.7 <sup>b</sup>	6.3 <sup>a</sup>
	Standing up test (% sows that stood up)		57.1	82.4	54.6
	Back conformation (% sows with arched back)		14.3 <sup>a</sup>	35.3 <sup>b</sup>	63.6 <sup>c</sup>

Values with different superscripts differ significantly  $P < 0.05$

Several measurements are potential indicators of lameness in sows: gait components such as stride length, stance time, and walking speed, and postural components such as time spent standing, back conformation and stepping. Kinematics requires a complicated set up and expensive equipment and is too time consuming to be implemented on farm. On the other hand, indicators related to postural behaviour could be easily adapted to assess lameness on farm. These tools will be useful for further research on the influence of housing systems on lameness or the impact of the different types of foot lesions on lameness.

## ON-FARM VALIDATION

In order to validate the use of the previous indicators of lameness, an experiment was conducted on 311 sows from 10 commercial farms, 120 sows were housed in groups of 4 to 8 sows per pen (4 farms) and 191 sows were housed in individual stalls (6 farms). Among others, data collected were the 3-point gait score, walking speed and stride length calculated from the observation of sows simply walking a 5m-long distance, number of steps during 30s at feeding, latency to lie down after feeding, and the standing-up test.

Preliminary results on the effect of housing system on these indicators are presented in Table 2.

**Table 2. Effects of housing system on indicators of lameness.**

Indicator	Value	Group* (n = 120)	Stall* (n = 191)	Housing effect**
<b>Gait score</b>	Non lame	54.2	45.0	
	Mildly lame	33.1	37.3	<b>0.104</b>
	Lame	12.7	17.8	
<b>Walking speed</b>	≤ 0.8 m/s	27.1	27.5	
	≤ 1.25 m/s	47.5	28.8	<b>0.06</b>
	> 1.25 m/s	25.4	43.7	
<b>Stride length</b>	< 83 cm	39.8	31.1	
	< 100 cm	26.3	37.1	0.51
	≥ 100 cm	33.9	31.8	
<b>Stepping during feeding</b>	< 6 step/min	44.2	29.3	
	< 12 step/min	28.3	27.2	<b>0.002</b>
	≥ 12 step/min	27.5	43.5	
<b>Latency to lie down after feeding</b>	≤ 30 min	8.3	18.9	
	≤ 60 min	49.2	26.2	0.82
	> 60 min	42.5	55.0	
<b>Standing up test</b>	Moving freely	51.4	36.4	
	hesitancy	22.5	18.5	<b>0.0002</b>
	>5s to stand up	11.7	7.4	
	Refusal to stand up or dogsat	14.4	37.7	

\* Data are percentage of sow in each category within a housing system.

\*\* P-value from the Cochran-Mantel-Haenszel and Chi-squared tests.

Some indicators differ significantly between housing systems, however, association between the 3-point gait score and new indicators such as the walking speed and the stride length were seen for sows in stalls only ( $P < 0.05$ ). This suggests that methods used to detect lameness are not always applicable from one housing system to another. Therefore, other factors associated with housing system such as exercise level may interfere with the assessment and explain differences observed between housing systems.

## CONCLUSION

The lack of reliability of the gait scoring method, due to its subjective component, prompted the development of more accurate methods to assess lameness. Techniques such as kinematics and accelerometers proved their ability in the objective detection and evaluation of locomotor disorders in sows. Even if such techniques are hardly applicable on farm, they put forward new quantitative indicators of lameness like stride length, walking speed and stepping behaviour. These indicators appeared to be promising tools that can be used for on-farm assessment. However, because of a potential influence of the housing system on the validity of these measures, it seems necessary to investigate more precisely the conditions in which these indicators will be accurate.

## ACKNOWLEDGMENTS

The authors thank Julie Grégoire who collected the data presented during her M.Sc. in Animal Science at the University Laval (Qc). The authors would like to thank the Fédération des Producteurs de Porcs du Québec and the Agriculture and Agri-Food Canada Matching Investment Initiative for their financial support and MIC (Motion Imaging Corporation, Simi Valley, CA) and Intergrys (Mississauga, ON) for their technical support with kinematics technology.

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# IMPACT OF LAMENESS ON PRODUCTIVE POTENTIAL OF THE SOW

**Mark E. Wilson and Terry L. Ward**  
**Zinpro Corporation**  
**10400 Viking Drive, Suite 240, Eden Prairie, MN 55344**  
**Email: [mwilson@zinpro.com](mailto:mwilson@zinpro.com)**

## ABSTRACT

The quest for efficient production of pork protein to be able to feed a growing population is critical for the pork industry. A disease that causes a large impact on cost and efficiency of production is lameness. This disease is like a stealthy thief. The losses from this disease often go unnoticed or recognized. The consequences are larger in proportion than most producers are aware.

Lameness is one of the major reasons for culling in gilts and sows. There are several causes of lameness such as arthritis, osteochondrosis, disease and claw lesions to name a few. This article will focus on claw lesions as a cause of lameness. Claw lesions become problematic when the lesions are severe enough that they penetrate the horn wall into the corium causing inflammation and pain. When these conditions exist they impact productivity. A survey taken in 2007 showed that lameness accounts for greater than 15% of the animals that are culled. This number is likely underestimated because animals that are culled for reproductive reasons and for age are also often lame. Besides concerns for welfare of the animals, culling due to lameness impacts herd dynamics and reduces productivity.

Evaluation of many herds will show that the losses or removal due to lameness occur as a gilt and first parity. Generally, the value of herd replacement gilts is not paid for until they have had at least three litters. For each additional litter that a sow can have above the third litter dramatically reduces the fixed cost of piglet production. Factors that improve longevity such as prevention of claw lesions have a large economic impact on the production system. Data shows we can heal and reduce claw lesions by feeding organic minerals. The more important fact is to feed and attend to the management issues that help prevent claw lesions and lameness thus improving longevity. As replacement rates are reduced herds become immunologically more stable and productivity improves.

## INTRODUCTION

The level of productivity in a breeding herd is influenced by a number of factors including: genetics, nutrition, health status, housing gilt development, stockmanship and management. Depending on how these factors are managed, the resulting level of performance and productivity achieved by the sow herd can vary significantly. Consumer demand for ethical animal treatment and welfare, concerns for food safety, and interests in reducing the use of antibiotics and growth promoters all impact nutritional decisions. Often we measure the success of feeding programs by the changes to individual sow performance and forget about looking at changes in overall herd performance when altering a production stressor. In reproduction, it is usually not a single factor that drives significant change; several small factors in combination add up to significant impacts and the effect is often underestimated in the swine herds. One of the greatest factors to focus on with nutrition is to reduce the potential for inflammatory

responses in gilts and sows and thus increasing longevity of the sow herd. The greatest percentage of culling often occurs in gilts and parity 1 females. This is not only expensive (because of the cost of replacement gilts) but increases the number of gilts brought into the herd, which can increase the potential for a destabilization of health. These gilts' litters result in a decreased performance and increased post-weaning morbidity (Holyoake, 2006) of the offspring in grow finish performance and decrease herd feed conversion. Parity one litters have been shown to have lower IgG levels in their colostrum (Miller et al., 2009; Gealeet al., 2009) and milk. Improving longevity and increasing the number of sows in parity 3-6 has a large impact on overall productivity of the herd (Smits, 2011).

As we design nutritional programs to reduce claw lesions and lameness, and to improve reproductive performance and longevity, we need to consider consumer opinions and pressures. Factors such as markets, world economies, price of commodities, governmental regulations, and ethanol production alter our choices of food stuffs to supply nutrients for pork protein production.

## **LONGEVITY AND CULLING DECISIONS**

Removal of non-productive sows along with introduction of replacements is an essential part of maintaining herd productivity at a constant level. In commercial production 40-50% of the sows are removed prior to third and fourth parities (D'Allaire et al., 1987; Boyle et al., 1998). Increasing longevity or reducing sow attrition is an important consideration in commercial pork production because of the cost of gilt replacement.

Benefits from such a program include improvements in:

- litter size,
- life time productivity of sows,
- non-productive days,
- stability of immunity,
- biosecurity risks,
- salvage value of sows,
- production flows,
- welfare issues for the herd.

Faust et al. (1993)'s simulation model has shown that production systems with lower rates of culling are more profitable than farms with higher rates of culling.

Maximum productivity within a herd is generally parities 3 through 5. There is a significant loss of potential herd output, measured in pigs per sow per year, when young parity animals are culled at a high rate. Stalder et al. (2003) estimated that gilts must produce 3 or 4 litters to pay for the cost of replacement of an older sow. Other authors claim that economically optimal lifetime that sows spend in production is the fifth farrowing (Scholmann and Dijkhuizen, 1989; Rasmussen 2004). Balogh et al. (2007) quantified by an economic model how the production of a sow influences average cost of the piglets and these authors calculated that the fifth parity litter is the lowest cost per pig placed. High incidences of involuntary culling of the younger parities cause problems with the herd parity profile and minimize the ability to cull because of production parameters or age.



Sows leave the herd through death or culling. The goal is to reduce the number of bad culls, due to reproductive failure and lameness at a young age and to increase the number of good culls, culling for age and low productivity in the older sows. Greater focus needs to be placed on the factors that cause involuntary culling of the young parity sows. Correcting flow and performance of the herd when a bimodal distribution of the parity structure occurs is a difficult and expensive fix in commercial production.

A recent study showed that 23% of the culling reasons were judged as recorded inaccurately by the farm workers (Knauer et al., 2007). However, these listed surveys, and many others, do show trends and areas of emphasis that need to be investigated to see if we can develop management schemes to help prevent early sow removal and thus improve longevity. A trend in these surveys was that young sows (under parity 3) were culled largely due to feet and leg problems and reproductive failure, while parity 6 sows and older were culled mainly due to age and performance. There was a trend for larger farms to have a slightly higher rate of sow removal and death loss compared to smaller farms.

## **SOW LAMENESS**

Lameness has long been recognized as a problem in the reproductive herd. Removal of non-productive sows along with introduction of replacements is an essential part of maintaining herd productivity at a constant level. There are both economic and welfare impacts of a lower sow retention rate due to lameness.

Knowledge and understanding of lameness in swine is increasing as more research groups are reporting data. Odds ratios have been reported for sows with elongated claws, claw cracks, heel erosion and overgrowth and uneven toes has been shown to significantly impact the incidence of lameness (Vestergaard et al., 2006; Anil et al., 2008). Lameness increases odds ratios of early removal and has shown a highly significant decrease in sow productivity due to lameness (Anil et al., 2008).

One of the obvious consequences of lameness is pain and inflammation causing a reduction of feed intake. If a younger parity sow does not eat well they generally have reduced reproductive performance. The reduction in energy and protein consumption during lactation may disrupt or change the amount of signal from the hypothalamus of GnRH, which impacts the amount of release of LH and FSH and subsequently impacts steroidogenesis of the ovary. Often sows or gilts with low intakes in lactation are under conditioned with a body condition score of 1 on a 1-5 scale, with 5 being over conditioned. Sows with inadequate feed intake during lactation increased their odds of removal from the breeding herd (Anil et al., 2006). Inflammatory cytokine-driven responses of the neuroendocrine system are similar and resemble those seen in starvation: reduced thyroid function, reduced levels of GH-dependent peptides, and suppression of gonadal function (Reichlin, 1999). Metabolic response to starvation and severe inflammation essentially cause similar brain signalling and responses to metabolism within the animal. Australian researchers (King and Dunkin, 1986) were some of the first to demonstrate the linear relationship between daily feed intake during lactation and increased time required for sows to express estrus after weaning. Younger first litter gilts were more sensitive to negative effects of reduced feed intake during lactation than older gilts and multiparous sows (Eissenet et al., 2003). Lactation is one of the most energetically expensive and challenging activities that a female can undertake. The reproductive effects of inadequate lactation feed intake seems to be mediated, at

least in part, through LH secretion and embryo mortality (King and Martin, 1989). Sows with a body condition score (BCS) of 1 have a higher frequency of acyclic ovaries than sows with a BCS of 4. It is reasonable that some of the body weight loss was due to increased protein loss from these sows. Clowes et al. (2003) reported that body protein mass loss greater than 9 to 12% rapidly reduced ovarian function. Protein restriction throughout lactation alters circulating concentrations of somatotrophic hormones and insulin at the end of lactation and negatively impacts post weaning ovulation rate (Mejia-Guadarrama et al., 2002). Limited follicular development and incomplete recovery of the reproductive axis at weaning seem to be the most likely causes of decreased embryonic survival in second parity sows with earlier weaning age (Willis *et al.*, 2003). A low feed intake during lactation involves mobilization of body tissues and can lead to an excessive loss of body weight, reducing sow longevity (Gaughan et al., 1995) and reproductive performance (Quesnel, 2005). Prevention and early treatment of lameness and claw injuries will help maintain appetite and feed consumption.

## INFLAMMATORY RESPONSES

Severe tissue injury induced a relatively stereotypical pathophysiologic response manifested by fever, catabolism, and sickness behaviour. All organ systems are altered by acute and chronic inflammatory states. Activation of inflammatory cytokines by toxins or products of cell injury leads to a variety of metabolic and endocrine changes, mediated in part by the direct action of cytokines on tissue function and by changes in pituitary-endocrine end organ function (Reichlin, 1999). Many of the claw lesions and injuries fall into these inflammatory type wounds. Investigating the possible mechanisms for these lameness and foot injuries impacting reproduction becomes quite plausible when one sees how lack of nutrients cause some of the same responses as an inflammatory response due to cytokine release. Is it any wonder that we see more sows abort or absorb embryos, decreased litter sizes born, and a lack of return to estrus when sows are severely lame? Organ systems are altered by acute and chronic inflammatory states. In livestock production most recognize the dramatic changes to acute phase responses where dramatic changes occur in liver function such as suppression of albumin, transferrin and ceruloplasmin and increased synthesis of proteins such as fibrinogen and C-reactive protein (Dinarello and Wolff, 1993). When an animal gets an insult or injury most of the changes that happen in the body are mediated by a cascade of polypeptide molecules called inflammatory cytokines. These cytokines are released from immune barrier functioning cells such as endothelial cells, specialized immune cells such as lymphocytes, monocytes, macrophages and several other types of parenchymal cells. Examples of some of these cytokines that are released are interleukin (IL)-1, IL-2, IL-6 just to name some of the first ones identified. In addition, tumor necrosis factor-alpha (TNF- $\alpha$ ), interferon-gamma (INF- $\gamma$ ) and several other cytokines with anti-inflammatory activity such as IL-10, IL-1 receptor antagonist, transforming growth factor-B all work in a synergistic reaction to regulate body metabolism to get the animal to survive. One of the major impacts of cytokines is a profound change in neuroendocrine function during inflammatory disease (Reichlin, 1993; Wilder 1995).

The release of cytokines also causes a decrease in GnRH which reduces the amount of FSH and LH released from the pituitary. A severe inflammatory response from a wound may release large amounts of cytokines such as TNF $\alpha$  which cause a direct effect on the ovary. The effect on the ovary will cause a reduction in steroidogenesis and even apoptosis of the ovarian cells and the pregnancy will be lost. The most common reproductive anomaly found (9%) when harvesting

reproductive tracts from cull sows was acyclic ovaries (Knauer *et al.*, 2007). The occurrence of acyclic ovaries increased ( $P<0.05$ ) as Body Condition Score (BCS) of the sow decreased. Acyclic ovaries were also positively correlated ( $P<0.01$ ) with rear foot abscesses. Again we see a correlation between lameness and reproductive problems as acyclic ovaries increase in sows with rear foot abscesses. Not all sows with claw lesions will see changes in appetite and feed consumption. The injury must be inflammatory to see the responses described above.

## **NUTRITIONAL INTERVENTIONS TO REDUCE LAMENESS**

Tomlinson *et al.*, (2004) has written an excellent review of how the impact of nutrition, protein, energy, macro minerals, trace minerals and vitamins have been implicated in maintaining claw health. An eight trial summary shows an improvement in feet lesion scores, improved milk production and improved reproductive performance in dairy cattle (Siciliano-Jones *et al.*, 2008) with the addition of complexed organic minerals from Zinpro Corporation. Claw health is improved in the dairy cow by feeding complexed Zinpro minerals (Noceket *et al.*, 2000, Noceket *et al.*, 2006). Although further research is needed in sows, these examples suggest that nutrition may play an important role in supporting the immune system and improving lameness and reproductive performance.

When Zn, Mn and Cu as amino acid-complexed minerals were supplemented to sows in a controlled experiment, results showed a decrease in claw lesions of sows housed in gestation crates (Anil *et al.*, 2009). These sows were fed gestation and lactation diets that were identical except for the source of Zn, Mn and Cu where treated animals had a partial substitution with the amino acid-complexed minerals (50 ppm of Zn, 20 ppm Mn, 10 ppm of Cu) with the remainder of total added levels being supplied by sulfates used in control diet (Zn 125 ppm, 40 ppm Mn and 15 ppm of Cu). Results indicated that the sows fed trace minerals as amino acid complexes had less ( $P<0.05$ ) lesions on the hind limbs than control sows. These sows had fewer lesions on the lateral claws and fewer total number of lesions ( $P<0.07$ ). Analysis on prevalence of lameness was lower ( $P<0.05$ ) for the sow fed trace mineral amino acid complexes (34% vs. 51%) over sows fed inorganic trace minerals (Anil *et al.*, 2010a). In this same study, lesion scores were lower ( $P<0.05$ ) for total lesion score and for total later claw lesion score when sows were fed diets containing trace minerals as amino acid complexes. When reproductive performance was evaluated the treated sows had more ( $P<0.05$ ) pigs born alive ( $11.07 \pm 0.21$  vs.  $10.44 \pm 0.22$ ) and litter birth weight tended to be higher ( $P<0.07$ ) ( $16.99 \pm 0.31$  vs.  $16.16 \pm 0.33$ , kg) (Anil *et al.*, 2010b). In the second examination of side wall cracks of group housed sows in the same experiment, results showed that the sows fed trace mineral amino acid complexes had a higher ( $P<0.05$ ) proportion of sows with lesions that either improved or stayed the same than the controls (91% vs. 73%) (Anil *et al.*, 2010c).

## **CONCLUSION**

Claw health is crucial to the overall well-being of the sow. Claw lesions are an important cause of lameness in sows. Claw lesions that penetrate the corium increase the potential for inflammatory response and are associated with pain, lameness and decreased productivity. If not properly treated, negative claw conditions can lead to lameness and may result in further complications. This causes a devastating loss to swine producers by decreasing reproductive performance and longevity.

Lameness and reproductive failure are two of the most prominent reasons for early removal from the sow herd. Feeding and management to help prevent claw lesions and lameness should begin early in development and selection of gilts. Focusing efforts to improve longevity pay large economic dividends by directly and indirectly reducing whole herd feed conversion, improved pounds of pork per sow space, and growth performance of the offspring.

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# WHAT YOU SHOULD KNOW ABOUT YOUR FINANCIAL HEALTH

**Stephen R. Benedict**  
**Senior Relationship Manager, Farm Credit Canada**

My portion of the Workshop will help hog farmers look at and use their financial statements.

We will look specific key financial ratios, how they are calculated, why they are important to FCC and most importantly, why they're important to the hog farmer. As you know, borrowing properly can definitely help people realize their dreams, and reach their potential.

The 5 ratios we will look at are:

- 1) Debt service coverage ratio:** indicates the cash available for debt servicing interest, principal and lease payments. The higher the ratio, the better.

$$\text{DSCR} = \frac{(\text{Annual Net Income} + \text{Amortization/Depreciation} + \text{Interest Expense})}{(\text{Principal Repayment} + \text{Interest payments} + \text{Lease payments})}$$

A popular benchmark used in the measurement of an operation's ability to produce enough cash to cover its debt (including lease) payments.

- 2) Acceptable current ratio:** current ratio = current assets / current liabilities.  
This measures a business' ability to meet financial obligations without disrupting normal operations.
- 3) Debt to equity (leverage):** total debt / total equity.
- 4) Operating expense ratio:** total operating expenses / gross annual income.  
This is one indicator of an operation's efficiency.
- 5) Loan to security ratio (real property + all barn equipment):** the acceptable amount of debt that can be advanced as a percentage of the value of security offered.

## Guidelines for hog operators – that's you!

First I'll go over some of our portfolio numbers, such as:

FCC's National Portfolio

Canadian Swine Industry

Canadian Hog Operations as a glance

FCC's Hog Portfolio

Next, we'll go into the nitty gritty. That means exactly what we look for when reviewing credit applications if you're looking to expand your hog operation. A little "Lending 101". How does FCC make lending decisions?

**Character** – training and knowledge, experience, planning, financial skills, credit history, integrity

**Capacity** – past and projected financial performance, outside income, working capital

**Commitment** – financials and non-financials

**Collateral** – security available and offered, valuation comment, support for chattel security

**Conditions** – legislation, market, economy, environmental

Then head right into the next part – and that's crunching the numbers. Why do your numbers matter? What are the acceptable rules of thumb for various types of hog farming, such as:

- Operating expenses per unit
- Operating Expense ratio
- Acceptable current ratio
- Acceptable leverage ratio
- Debt per unit
- Debt service per unit
- Acceptable loan to security ratio.

**Ag Matters**, we know that. I'll share with you some of the reasons why we think the future of the industry is bright, despite its complexity.



# POST CERVICAL ARTIFICIAL INSEMINATION IN SOWS – WHAT, WHY, HOW?

**Egidijus Mickevicius**  
**Hypor Inc. – a Hendrix Genetics Company**  
**402 McDonald Street, Regina SK S4N 6E1**  
**Email: [egidijus.mickevicius@hendrix-genetics.com](mailto:egidijus.mickevicius@hendrix-genetics.com)**  
**[hyporontario@gmail.com](mailto:hyporontario@gmail.com)**  
**ph:519-535-2663**

## INTRODUCTION

As production costs continue to rise due to several factors, the swine industry is no different than any other and is turning to new and innovative ways to improve reproductive performance while decreasing cost of production in order stay competitive worldwide. Optimizing semen usage from superior sires combined with new breeding methods, Post-Cervical Artificial Insemination (PCAI) techniques and reduced sperm cell count may be some of the tools needed to achieve that goal. Visiting with many well respected and hard working Ontario farmers I am privileged to be able to present some experiences, observations and findings of this new way of breeding. In the literature about PCAI from different areas of the world and local farm trials, here are some of the questions listed below to which we are hoping to provide you some answers:

1. What value does PCAI bring to my operation?
  - a. What is your reason for choosing PCAI?
    1. ↓ Reduced labor cost
    2. ↓ Reduced semen cost
    3. ↑ Improved reproductive performance
    4. ↑ Improved grow-finish-carcass performance by optimizing genes of superior sires
  - b. Grow-finish-carcass opportunities
  - c. Sow herd opportunities
2. How is PCAI done?
3. What are the results?
4. Other questions

## WHAT VALUE DOES PCAI BRING TO MY OPERATION?

### Grow-Finish-Carcass

Some Genetic companies have recognized and provided some type of sire categorization to their customers for many years, while others are at the discovery and implementation stage. Producing and delivering the best of the best sires to Gene Transfer Centres (GTCs) does not come cheap. It requires large breeding herd populations to achieve the desired selection goals.

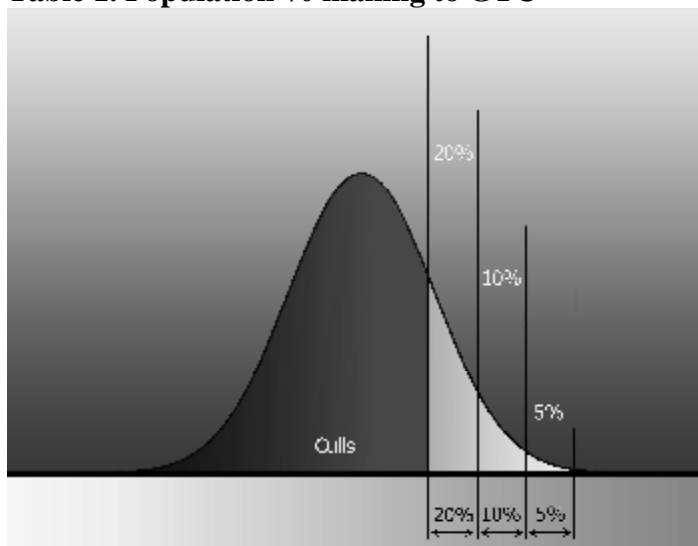
When speaking about this topic with local farmers some key question arise in the conversations:

1. What are the opportunities of using “The Superior Sires” Is there enough of them?
2. What are the financial implications we could expect using higher value sire on 1 sow vs. dividing the ‘Superior Genes’ on 2 or 3 sows? How does that change the grow finish population management and what are the realities of capturing economic opportunities?
3. What if we reduce the cell count and volume per insemination while increasing the value per piglet heading to N/G/F and packer?

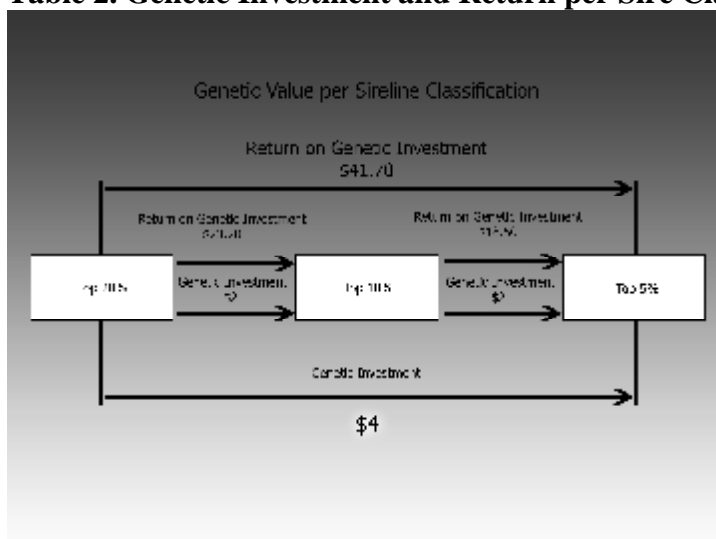
Let’s take a look at the following 3 diagrams:

1. What Sires make it to GTCs? (Table 1)
2. What is the return on genetic investment? (Table 2 and Table)

**Table 1. Population % making to GTC**



**Table 2. Genetic Investment and Return per Sire Classification**



**Table 3 Return on Genetic Investment**

	<b>Sireline Classification</b>		
	<b>Top 20%</b>	<b>Top 10%</b>	<b>Top 5%</b>
<b>Genetic Investment value per service</b>	<b>\$2</b>	<b>\$2</b>	<b>\$4</b>
<b>Genetic return per market hog</b>	<b>\$2.32</b>	<b>\$1.85</b>	<b>\$4.17</b>
<b>Total Genetic return per service</b>	<b>\$23.20</b>	<b>\$18.50</b>	<b>\$41.70</b>
<b>(ROI%) Return on Genetic Investment</b>	<b>1160%</b>	<b>925%</b>	<b>1043%</b>

### **Sow herd opportunities**

Heat-checking and timing of insemination **still the king.**

#### Time spent breeding:

Practical experience of European systems estimate improved PCAI efficiency of 1 person per 1000 sows. It is known that with Traditional Artificial Insemination (TAI) it can take 7 to 15 minutes to inseminate. PCAI takes 1-2 minutes. Six hundred sows breeding 32 sows per week gives a time savings of 4 hours, 26minutes per week. Some questions came from this time saving calculation: How consistently are these savings realised? Would this be a tool for batch farrowing farms? What benefit/value would a farm capture using time saved and time used in other production areas?

#### Semen cost savings:

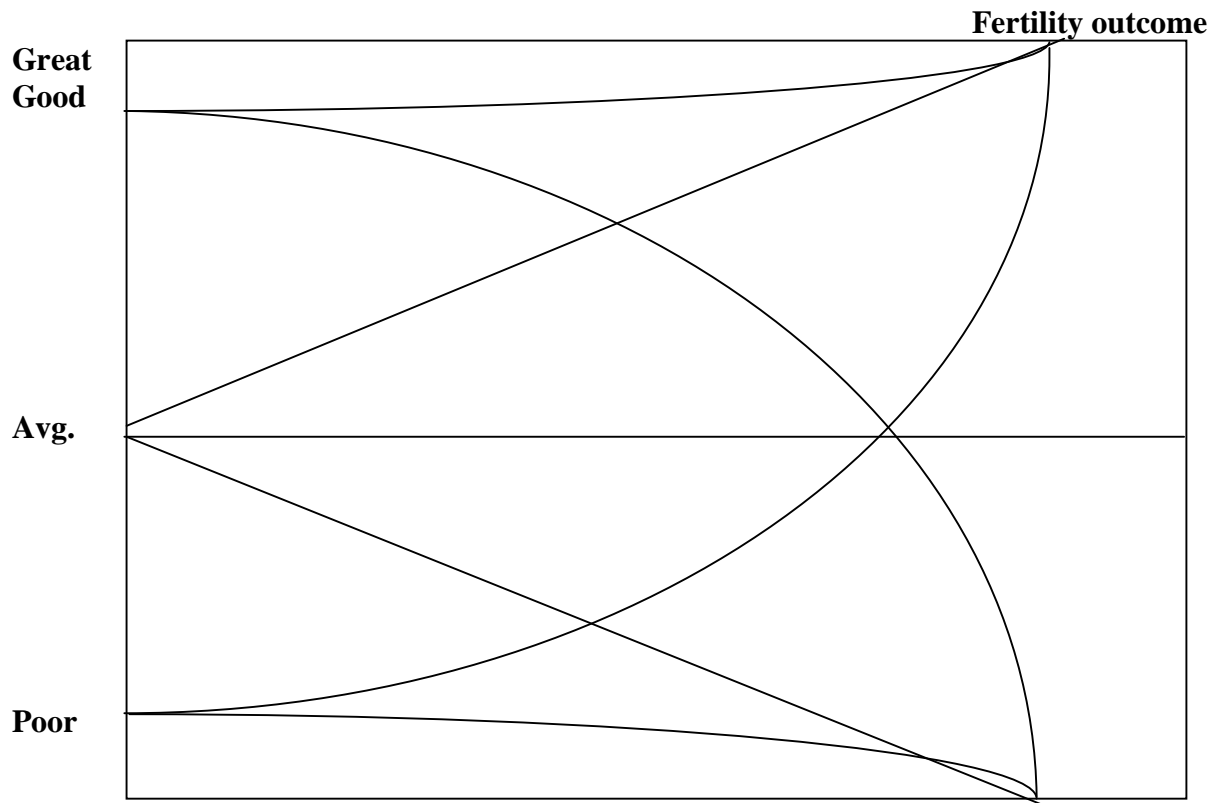
Semen cost per piglet weaned represents 3.7% of total cost while feed represents 43%. Per hog marketed it is less than 1% and 65 – 75% respectively. While looking and comparing known breeding techniques with what is around we should be looking at number of cells and volume used to produce a litter with increased piglet genetic value. Currently there are producers using 9Billion cells to produce a litter while others use 1.5Billion to achieve the same.

Farmers that know their herd performance well; that have consistent parity structures; predictable wean to service intervals; are applying best industry known management practices and work with very good breeding managers are currently capable of capturing savings. However, sometimes to get to that point is challenging but very much worth it.

### **IMPROVED REPRODUCTION PERFORMANCE:**

While learning about PCAI the assumption is that this type of process should improve reproductive performance: if anything the expectation should be to see performance equal to TAI. We have found results to be variable. Some producers noticed farrowing rate and litter size increases, some decreases and some saw no difference. (Schematic 1)

## Schematic. 1



## HOW IS PCAI DONE?

There is no boar present during insemination. It is all about giving time to allow reproductive organs to relax. Be patient and gentle (those that decide to learn, will learn with time and PCAI will become just as normal as TAI). This is not yet bullet proof system, it is still a technology that requires human feeling and, touch.

Heat-checking, identification and timing is **still the king.**

From industry meetings and research trials we understood that breeding gilts was not recommended. We excluded gilts from some trials, however in another instance we bred gilts with good success. We also found heavier body weight gilts 150-160 kg bred on 3<sup>rd</sup> known heat were easier to perform PCAI on. We also found that P1 are also challenging to breed PCAI due to intensity of uterine/smooth muscle contraction. (There are some interesting experiences being gained as this article is written.)

### Ontario Farm experience:

We set a goal of breeding only predictable sows

We agreed to breed only 10 sows per week

We agreed to breed sows that came to heat on day 4

We agreed to breeding single insemination with 75 ml and 3 billion cells.

### Option 1.

Heat-checking was performed according to farm's usual protocol (once per day in the morning). Sows found in heat on day 4 would be marked and then left in their location to be bred first thing next morning. After insemination we would go ahead and breed any day 5 sows immediately then 24 hours later. While day 5 sows are being bred the day 4 sows bred PCAI are getting additional stimulation.

### Option 2.

Heat-check sows routinely, mark the sows in heat, then go ahead and heat-check repeats and opportunity rows. Some managers also go ahead and heat-check and breed their gilts. Once all heat-checking is done then go back and breed sows found in heat earlier PCAI. "Relax" time given is recommended by industry professionals who have done this for a while - approx. 45 min to 1 hour. From our observations a good way to be sure when sows are ready to be bred PCAI is after the heat-checking is done to see sows lying down and relaxed. (We observed that behaviour after 30 min post boar exposure.)

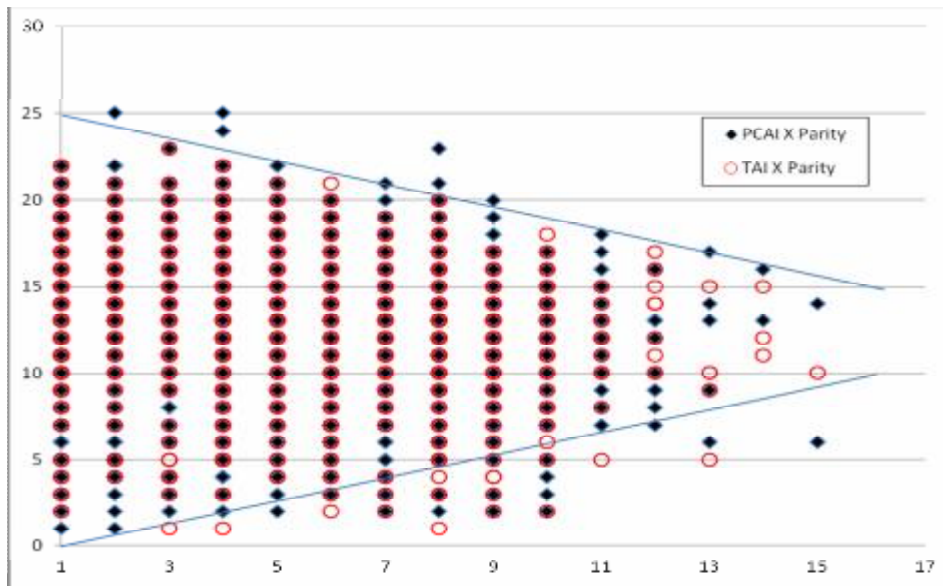
### Results

See Tables 4-6:

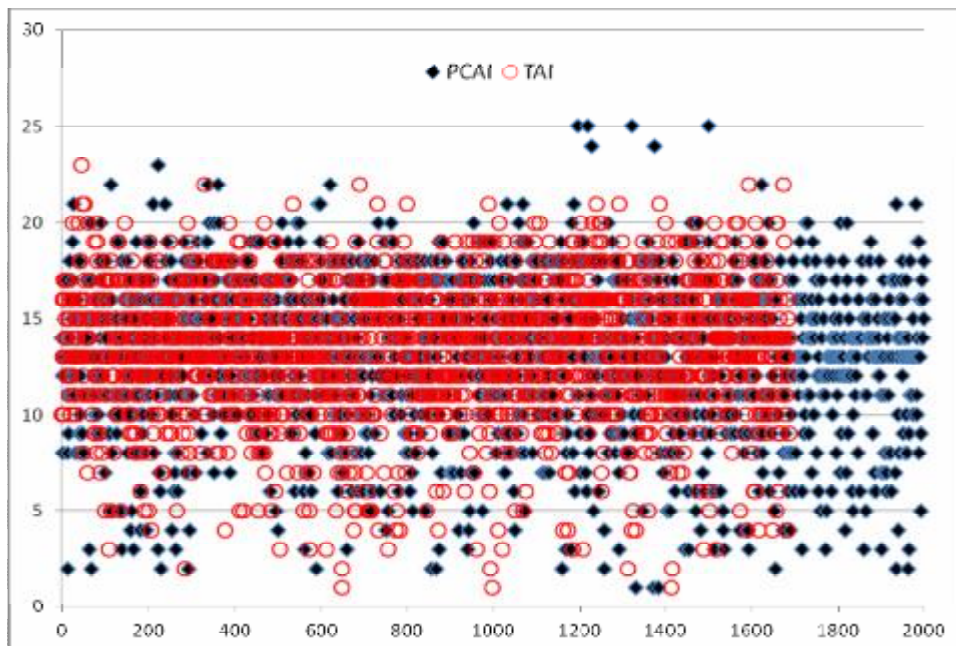
**Table 4 - Reproductive results**

	Traditional AI		PCAI	
	TB	FR	TB	FR
Farm 1	13.6	91.1	13	87.2
Farm 2	13.3	91.6	13.32	89.7
Farm 3	12.5	91.5	11.93	84.36

**Table 5 - Total Born distribution by parity by breeding method**



**Table 6 - Litter distribution ( variation) by breeding method**



### Other questions

What is the impact of stimulation after PCAI?

What are the differences in capacitation timing?

Who defines inner catheter length?

Influence of back-flow?

What are the differences in timing?

What is the optimum cell count and volume per insemination?

What impact does sire line fertility have when working with reduced cell counts?

What are the desired characteristics of a breeding technician willing to learn the breeding technique of PCAI:

- Patience
- Respect for animals
- Desire to learn
- Persistence
- Careful approach
- Monitoring and understanding progress

## **ACKNOWLEDGEMENTS**

University of Alberta - Dr. George Foxcroft, Dr. Michael Dyck, Jennifer Patterson (April - 2011 Alberta Swine Technology Workshop)

Inspiration: Dr. Julie Menard and Danbred NA( Dr. John Sondermans)

Producers:

- Farmer in Northern Ontario
- Dwight Davies and Production Manager of Greenwood Pork Lucio Leite
- Arnold Ypma(Producer)
- Stuart DeVries(General Manager, Total Swine Genetics)
- Greg Simpson(Swine Nutritionist, OMAFRA)
- Insem Inc.(Paul Chessman)
- Camera Crew for support and encouragement





# **DIFFERENCES IN MATING BETWEEN A BOAR, TRADITIONAL ARTIFICIAL INSEMINATION, AND POST CERVICAL INSEMINATION**

**Mark E. Wilson**  
**Zinpro Corporation**  
**10400 Viking Drive, Suite 240, Eden Prairie, MN 55344**  
**Email: [mwilson@zinpro.com](mailto:mwilson@zinpro.com)**

## **ABSTRACT**

As populations around the globe are growing the demand for pork protein in the human diet is increasing. Technologies utilized in 1990s such as artificial insemination have improved our capabilities to produce leaner carcasses. Utilizing superior genetics and breeding techniques as tools to improve growth rates, feed efficiency, and carcass quality is imperative for the swine industry to successfully meet today's economic challenges.

To capture the use of superior genetics an artificial insemination process called post cervical AI (PCAI) allows for lower sperm totals per dose. This gives the opportunity for the superior sires to breed many more sows. Understanding the physiology of what happens to sperm cells within a sow's reproductive tract is important. A comparison between an ejaculate from a boar to a dose of semen inseminated from traditional AI or PCAI catheters helps to make the new breeding techniques more successful. Data supports that PCAI allows the use of lower number of sperm cell in a dose of semen with successful results.

Advantages of PCAI are:

- Need fewer boars to service the same number of sows
- Able to select higher estimated breeding value (EBV) boars
- Production means are improved for finishing pigs
- Less extender used

Disadvantages of PCAI are:

- Sanitation may be more critical
- Catheters cost more money
- Does not reduce variation of performance
- Lower volume of extender causes more temperature fluctuation problems in semen dose
- Gilt's cervical canal too tight to pass the second catheter
- Will require additional training

The data shows that with training and attention to detail this method of insemination can be an effective tool in management and improving efficiency of pork protein production.

## **INTRODUCTION**

Prior to 1990 the US estimate on sows artificially inseminated was about 5%. By the year 2000 industry estimates were at 60% of the sows being bred artificially, which is a 12 fold increase in one decade (Singleton, 2000). Similar trends were being seen worldwide, but the European AI industry was ahead of North America. In 1980 approximately 7% of the sows in Europe were

bred artificially and by 2000 greater than 80% of the sows were artificially inseminated (Wagner and Thibier, 2000). Factors that contributed to the adoption and implementation of artificial insemination include: (1) larger and more specialized production systems, (2) improvements in AI-catheters, extenders and equipment, (3) genetic evaluation programs such as Best Linear Unbiased Prediction (BLUPP), and (4) packing industry paying premiums for lean carcasses (Singleton, 2000). We are at a turning point again with the European community being ahead of us by several years with the use of lower total sperm cells per dose. Advances in equipment and extenders as well as increased focus training and standardizing procedures for traditional AI have resulted incomparable results to natural mating.

Artificial insemination is at a new crossroads to utilize the highest genetic potential for rate of gain, feed efficiency and to produce lean pork protein. The scientific technique that is growing in attention is the use of post cervical artificial insemination (PCAI) which has been referred previously in the literature as trans-cervical AI or intrauterine AI. This must not be confused with the technique of running a catheter most of the way up the uterine horn called deep intrauterine AI. The development of PCAI will have a learning curve to perfect techniques to match success with the traditional AI methods.

The potential advantage of post cervical artificial insemination (PCAI) is the use of lower sperm numbers thus multiplying the number of matings from top indexing boars. Advantages of using the highest indexing sires are to capture improvements in rate of gain, feed efficiency and lean yield pork protein. However, advantages in genetic improvement may be diminished by epigenetic effects. There is an increased cost of the catheters involved in doing PCAI. It is also important to match reproductive performance of traditional AI at 3 billion cells from the performance of PCAI at 0.5-1.5 billion cells. Some misperceptions have occurred regarding the new technique concerning what it will accomplish. This paper is going to focus on the science of what happens with an ejaculate in comparison to traditional AI and PCAI so that producers better understand what technological changes are occurring so that they can quickly adapt to the new technology and implement superior genetics on their farm.

## **ANATOMY AND PHYSIOLOGY OF MATING IN SWINE**

### **Mating with boar**

Since the beginning of artificial insemination in swine it has always been the goal to match or exceed the performance achieved by the boar. There are some important and distinct differences of the ejaculate of the boar versus a neat ejaculate extended with a diluent (extender) and stored at 17°C. During the process of ejaculation the sperm cells are mixed with different seminal plasmas during the ejaculation process. There are three different phases to the process of ejaculation. When collecting a boar it is obvious that these phases exist. A mature boar collected on a regular frequency will take 5-10 minutes for a complete ejaculate of approximately 250-300 mL. A mature boar ejaculate will contain 70-110 billion sperm cells while younger boars (9 months) will produce 450-90 billion sperm per ejaculate (Flowers, 2008). The boar deposits the ejaculate near the mid-cervical canal. The ejaculate of a boar can be seen in distinct fractions: (1) pre sperm flush (PSF, mostly a clear seminal fluid with some gel with the purpose of removing contamination of cellular debris, urine and smegma from the urethra), (2) sperm rich fraction (SRF, easily recognized for its creamy-white color), and (3) post sperm-rich (PSRF, goes from a greyish color to watery with increasing amounts of flocula (gel) after

which penile erection fades (Rodriguez-Martinez et al., 2009). Some boars can cycle through these phases a couple of times and may be re-stimulated to a second ejaculation of much shorter duration.

Given the fact that boars ejaculate these different fractions is an important difference between mating with boar and delivering extended semen through an AI dose. Seminal plasma is not just a sperm vehicle for transport, but is also an important modulator for sperm function. Seminal plasma and sperms cells are also involved in the innate and adaptive immunological responses of the uterus to prepare for the arrival of fertilized oocytes in a few days. In addition, seminal plasma contains high levels of estrogens that induce the release of prostaglandin  $F_{2\alpha}$  from the endometrium of the uterus creating antiperistaltic muscle contractions of the uterus. Cervical peristaltic allows for mixing of the sperm suspension. The flocula creates a gelatinous plug in the cervix to prevent loss of the ejaculate from the cervix due to backflow. The antiperistalsis is greatly responsible for rapid sperm transport of a small population of the spermatozoa towards the sperm reservoir. It takes in the range of 5-60 minutes to reach a significant number (100-200 million) to populate the utero-tubal junction (UTJ) and oviduct with sperm (Hunter, 1990). Sperm cells that don't reach the oviduct are foreign body to the sow and are destroyed by white blood cells (Lovell and Getty, 1968; Rozeboom et al., 1999). White blood cells are found in large populations in the uterus as soon as 30 minutes after insemination and may be found for as long as 36 hours after insemination. Within 2 hours after a natural service less than 10% of the sperm cells can be recovered from the uterus.

Interestingly, the sperm cells from the sperm rich portion of the ejaculate, particularly the first 10-15 mL are the sperm cells that have the greatest population within the sperm reservoir and generally arrive at the reservoir within 5-20 minutes after mating (Rodriguez-Martinez et al., 2005, Rodriguez- Martinez et al., 2009). Sperm motility is suppressed in the sperm reservoir. The reservoir releases sperm gradually in restricted numbers towards the site of fertilization at the ampullary-isthmus junction (AIJ) (Rodriguez- Martinez et al., 2007). The number of sperm cell at the site of fertilization is in the hundreds at the AIJ which is extremely important to help maintain a physiological ratio of 1:1 sperm to oocyte during fertilization (Hunter and Rodriguez-Martinez, 2004). The tubal sperm reservoir is immunologically-privileged where sperm viability and fertilizing capacity are preserved. If given the possibility only sperm cells capable of fertilization will be selected to be released to the AIJ unless there are inadequate sperm numbers of morphologically normal sperm (Rodriguez-Martinez et al., 2001). Capacitation of sperm is a process that takes place in the oviduct where the sperm cell undergoes biochemical and membrane structural changes making the cells capable of fertilization. Sperm capacitation is thought to take 5-8 hours after mating unless ovulation is imminent and then it only takes about 2 hours (Hunter, 1990). Sperm cells are capable of fertilization for about 24 -28 hours and after that reproductive performance decreases. The egg has a much shorter lifespan for good reproductive results where the egg should be fertilized in less than eight hours and for maximum litter size generally four hours or less (Hunter, 1990).

### **Traditional AI mating**

Today most producers are detecting estrus once or twice daily and mating with 2-3 billion sperm cells suspended in 70-100 ml of extender and stored at 17 C. The insemination catheter for this method can either be aspirette or foam tip type which is locked into the cervix twisting the catheter in counter clockwise fashion. The catheter locks into the cervix slightly posterior to the position that the boar locks in. This process takes 3-5 minutes after inserting the catheter and

attaching the semen storage device onto the catheter and allowing the sow to take up the semen when she relaxes after 30-45 seconds after the insertion of the insemination catheter. The sperm extender solution is a homogenous mix, which is different than we described for the ejaculate of the boar. There is less seminal plasma in the AI dose and there is less estrogen to elicit the uterine contractions for movement of semen. The boar is generally left in front of sows when artificially inseminating with a tradition catheter. **Do estrous detection with a boar to optimize timing of insemination.** The mechanics of semen transport and the fertilization process are essentially the same as describe in a natural mating. You will find that leakage or loss of extended semen increases because there is not a plug to keep the cervix from pushing fluids back out. This peristalsis causes 30-40% of the total fluid and 25% of the sperm cells to be lost in the first hour after mating.

### **Post cervical artificial insemination**

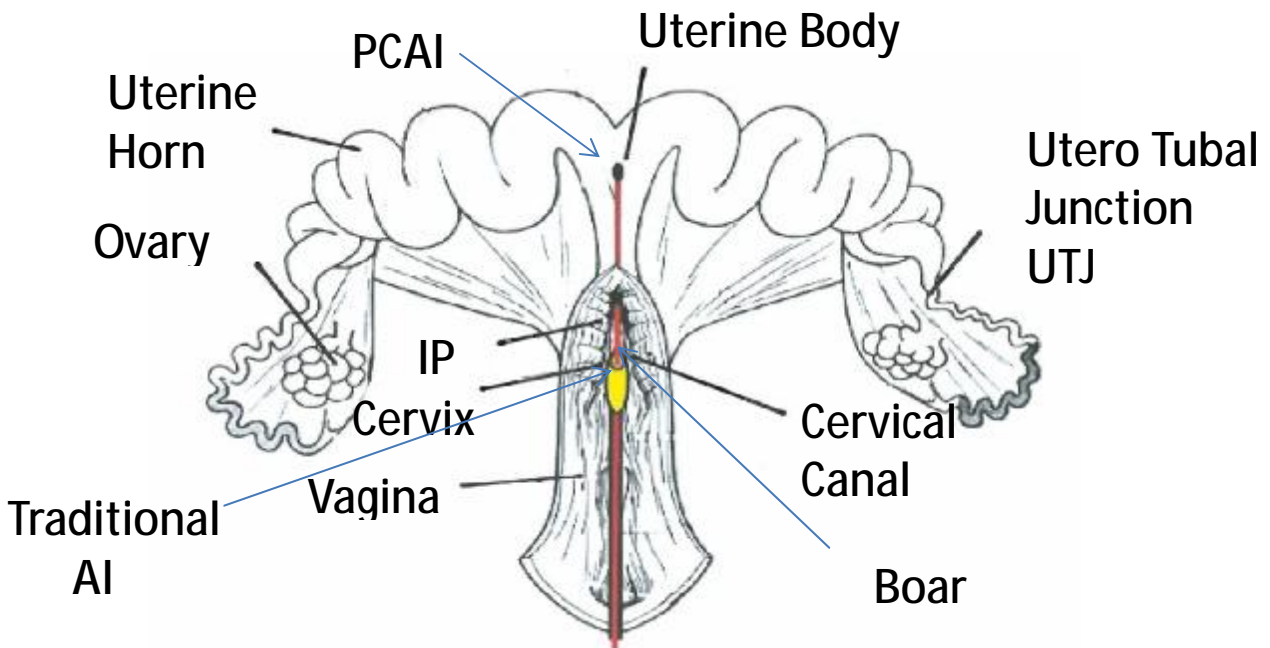
Now we have some major differences in this technique, but once they are understood the capability to make this insemination method effective is very reasonable. The first and major difference in this method is the traditional catheter, which has a smaller flexible tube that can be treaded through the cervical canal into the body of the uterus. The body of the uterus is only about 5 mm or close to 2 inches in length. The semen in this technique is deposited in the body of the uterus (see Figure 1). Heat check with a boar is imperative. After the sow is given 30-45 minutes rest from boar exposure it is time to insert the dual catheter system. Most catheter sets are enclosed in sterile wrap. Open this and put lubricant on the traditional catheter and insert this catheter into the cervix. Allow the sow to stand for a moment and try slowly with very gentle pressure push the inner catheter through the cervical canal. If one feels resistance wait another minute and try threading the inner catheter again. This insemination technique is not advisable for gilts as the cervix is too tightly closed unless the gilt is greater than 300 lb (136 kg) and is on their third estrus. Once the catheter is inserted then attach the tube or bag of semen and squeeze the extended semen into the body of the uterus. This should take only about 10-15 seconds. To summarize and simplify the differences between a boar, traditional AI and PCAI please refer to Table 1.

## **RESULTS**

Timing of insemination is still critical in all three of these methods of breeding sows. This is why the boar is so important in helping to determine when the female is truly in estrus. You will be able to see from the data that follows that there are details that need to be done with PCAI to maximize reproductive performance.

A comparison of traditional AI with 3.5 billion sperm cells to PCAI at 2.0, 1.0 and 0.5 billion sperm cells did not differ (Serret et al., 2005) for farrowing rate and litter size. In another trial results for farrowing rate and litter size were also the same for a traditional AI catheter compared to the post cervical AI catheter, however, reproductive performance was not par with industry standards for either trait (Fitzgerald et al., 2008). A comparison with the traditional AI catheter versus the PCAI catheters with either two and three billion sperm cells showed no difference in farrowing rate or born alive (Table 2, Watson and Behan, 2002). Notice that the only treatment that showed a difference was at 1 billion sperm cells in 80 mL for traditional AI, this was significantly lower than the other treatments. This suggests that as you increase dilution of

sperm cells, the risk of decreasing the amount of sperm transported to the UTJ and posterior isthmus may occur.



**Figure 1. Diagram of sow reproductive tract illustrating site of semen deposition for the boar, traditional AI and for PCAI.**

**Table 1. Comparison of different mating schemes in swine.**

	Mating with a boar	Traditional AI	Post Cervical AI
Volume fluid, ml	250-400	70-80	15-40
# sperm cells, billions	60-80	2-3	0.5 – 1.5
Location of sperm deposition	cervix	cervix	uterine body
Length of time	5-10 min	3-5 min	10-15 sec

Table 3 shows results of an experiment where traditional AI control at 4 billion sperm cells in 80 mL was compared with PCAI at three different sperm concentrations per 80 mL dose. The PCAI at 4 billion sperm cells favoured total pigs produced in 100 matings while the lower sperm concentrations showed a decline in piglet production from the services using the PCAI method. However, it must be noted the procedure used differs from current recommendations as the boar was nose to nose with the sows during the insemination process, which wouldn't be recommended today.

**Table 2. Traditional AI catheter depositing semen in cervix compared to a PCAI catheter depositing semen into the uterine body (Watson and Behan, 2002).**

Site of semen deposit	Sperm/ Dose (x 10 <sup>9</sup> )	Volume/ Dose (mL)	Doses/ sow	Sows	Farrow Rate (%)	Total born	Born alive
AI	3.0	80	2	540	91.1	12.5	10.9
PCAI	3.0	80	2	540	90.5	12.3	11.0
AI	2.0	80	2	540	91.8	12.6	10.9
PCAI	2.0	80	2	540	92.5	12.3	10.8
AI	1.0	80	2	540	65.8*	10.3*	9.0*
PCAI	1.0	80	2	540	86.9	12.1	10.9

\*within a column differed significantly P<0.01

**Table 3. Pigs born per 100 matings with 0.5, 1 or 4 billion sperm cells using PCAI or 4 billion sperm cells traditional AI. (Rozeboom et al., 2004)**

Treatment	Number of matings	Total pigs	± control
Trad. AI, 4 billion	100	947	
PCAI, 4 billion	100	1086	+ 139
PCAI 1 billion	100	892	-55
PCAI 0.5 billion	100	712	-235

Another experiment (Table 4) showed similar concerns with the volume relationship as the sperm numbers decline in a dose of extended semen when used with modified traditional catheter which can be inserted much deeper into the cervix (Behan and Watson, 2006). This was a catheter designed to help with low dose sperm number inseminations in gilts since they are quite problematic with the PCAI catheters and technique.

Data in Table 5 shows that as volume is reduced to match the declining sperm numbers the PCAI was more successful at matching performance of the traditional AI. Table 6 shows an example of taking a conservative approach to graduate into using lower sperm numbers with the PCAI technique until breeding managers were comfortable with the new technology. Again, little difference is seen between traditional AI and PCAI for reproductive results.

**Table 4. Conception rate and number of embryos in gilts after two intra cervical inseminations with a smaller size foam tip for gilts at reduced sperm numbers. (Behan and Watson, 2006).**

Gilts (n)	treatment	x 10 <sup>9</sup> sperm	Volume (mL)	Conception (n)	Concept. (%)	Total embryos	Mean embryos
17	control	1	80	15	88.2	166	11.06
17	T2	0.5	80	13	76.5	112	8.61 <sup>x</sup>
16	T3	0.25	80	2	11*	11*	5.50*
16	T4	0.25	40	4	29*	29*	7.25 <sup>x</sup>

\*within a column differed from the other means, P<0.001

<sup>x</sup>within a column differed from the \*, P<0.01

**Table 5. Comparison of traditional AI at 90 cc with 3 billion cells compared to PCAI with lower sperm cell numbers and amount of diluent. (Izco, 2006).**

Results	Trad. AI 90 cc – 3 billion sperm	PCAI 30 cc – 1 billion sperm	PCAI 15 cc- 0.5 billion sperm
N, inseminations	235	236	201
N, positive preg check	203	202	173
Farrowing, N	195	194	169
Born alive	2,239	2,148	1,995

**Table 6. Comparison of 1.5 billion sperm in 50 ml dose versus 2 billion sperm both bred by PCAI (Menard, 2011).**

	1.5 billion/50 mL	2.0 billion/80 mL
No. sows bred	267	264
No. farrowing	157	153
Farrowing rate (%)	89.5	92.8
Total born/litter	14.14	14.2

## PROS AND CONS OF PCIA

### Advantages

- Need fewer boars to service the same number of sows
- Select the highest estimated breeding value (EBV) boars – Estimates of this advantage range from \$0.80 – > \$2.00 per finishing pig marketed
- Improved production means of finishing pigs
- Quicker insemination times ( $\pm$  10 seconds) – reduce labor requirements in breeding
- Reduced extender/dose

### Disadvantages:

- Sanitation is more important
- Generally does not deliver greater reproductive results
- Does not reduce variation in offspring performance
- Generally it is not recommended to use PCAI on gilts unless they are older and past third estrus
- PVAI catheters are more expensive than traditional AI catheters (more than double the cost) (Fitzgerald et al., 2008).
- Temperature sensitivity of smaller volume doses.

It is reasonable to expect that PCAI should be able to be as good as traditional AI and natural service with doses as low as ½ billion sperm cells. As the numbers of sperm cells in a dose are decreased all the details with breeding become more critical to optimize success. Timing of insemination is very important and thus the need to continue to heat check with a boar. You do not want the boar in front of the sow when using the PCAI technique of insemination.

## CONCLUSIONS

The technique of insemination is not physiologically all that different in the sow except that you are using lower sperm numbers which demands paying attention to volume of dilution that should be used to maintain a high sperm concentration per ml. With less volume of extender the need to be more cautious with temperature variation can be an issue on the farm, but can be avoided by keeping the doses in a cooler until being used. Evaluation of the data suggests that to maintain reproductive performance be sure to decrease the amount of extender as one lowers sperm numbers to ½ billion sperm cell or less.

Don't start post cervical AI without proper training and understanding the physiological differences from a traditional AI mating or natural service. Please use a boar to do heat checking and don't have a boar present when mating the sow when using PCAI. It is not recommended to do the post cervical technique with gilts until you gain a great deal of experience. One should expect to achieve similar results to tradition AI or natural service. Track economics to be sure the adoption of the technology is giving a return on investment.

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# **IMPLEMENTING SIMPLE AND USEFUL PRODUCTION BENCHMARKING**

**Greg Bilbrey**  
**Agri Stats, Inc., Fort Wayne, Indiana, USA**

Much has been published regarding the importance of thorough record keeping and utilization of production records in swine finishing enterprises. In fact, Gary Dial, Brad Freking and Mark Weaver provided an excellent summary and guide for using finishing production records in a paper from a previous Manitoba Swine Seminar (“Diagnosing Problems in the Grow-Finish Phase of Production”, Dial, Freking and Weaver, Manitoba Swine Seminar, available on MAFRI website). One additional way to use records to improve overall performance and profitability is to benchmark or compare company or farm cost/performance data to data from individuals or groups of fellow producers.

## **BENCHMARKING**

Benchmarking is simply the act of comparing data to a contemporary group with the goal of improving performance or results. Modern formalized benchmarking is credited to the Rank Xerox Corporation though the practice dates back to ancient times. Japan sent teams to China in 607 AD to learn best practices for business, government and education (Zimmerman, 2003). Zimmerman also mentions that “economic Darwinism” (meaning business evolution) will lead to more companies participating in and utilizing benchmarking to improve production and profitability. Since modern agriculture and swine production should certainly be considered business enterprises, benchmarking should be a tool used by swine producers to improve their bottom line profitability and performance.

A key benefit of benchmarking is that it contributes to the ability to see outside personal or professional practices. The term “paradigm blindness” refers to the situation when individuals or businesses become so focused on or entrenched in the operation of their respective activities they fail to see what is going on outside their world. This blindness may be a source of stagnation and an impediment to progress. Benchmarking allows visualization of what individuals, companies and/or competitors are doing and how one compares to them. Effective benchmarking breaks this paradigm blindness and leads to creation of practices or processes that improve performance.

### **Production and financial benchmarking**

Most swine producers use some type of record keeping to measure performance. Common measurements related to finishing include Percent Mortality, Average Daily Gain (ADG) and Feed Conversion Ratio (FC). Some others utilized are Average Daily Feed Intake, Facility Turnover, Days in Finishing and Days to Market. Each of these measurements has its place and can be used to effectively measure specific aspects of performance in a program. These measurements can also be used in an effective benchmarking program to obtain a better gauge or evaluation of herd performance. For example, an ADG of 1.8, a Feed Conversion of 2.8 or Percent Mortality of 3.0 may all seem good and indicate acceptable performance. However, if these records are compared to a contemporary group of producers with better ADG, FC and

Mortality the first measurements do not seem that impressive. This is the benefit of benchmarking. Without comparing to other producer or contemporary group data one would not know if real opportunities exist or not.

Obviously if data will be compared between producers there needs to be some standardization of the way performance measurements are calculated. A common criticism of benchmarking efforts is that each producer may calculate their numbers a different way and therefore the numbers are not comparable. This is discussed to some degree in the Dial, Freking and Weaver article referenced earlier. The same article provides suggested calculations for key performance measurements. These are relatively simple calculations that can be used to establish the basis of an effective benchmarking program. Really, all a group needs to do is agree on how the measurements will be calculated and then proceed with the calculations.

The addition of financial data greatly increases the value of a benchmarking effort. While most producers can come up with and are more willing to compare performance measurements, the real strength of benchmarking comes from comparing profit, sales and cost data. Correctly recording actual cost data and ensuring the numbers are comparable between producers certainly requires more work but the effort is worth it. Best in performance (best ADG, best FC, etc.) does not necessarily mean best in cost or profit. Annual Agri Stats data on approximately 2,000,000 sows and 40,000,000 pigs has repeatedly shown operations with great advantages in performance but much higher production cost. Conversely, operations showing lower cost may or may not have superior performance.

## **AGRI STATS**

Agri Stats is a privately held company providing professional benchmarking services to the commercial livestock industries. Services are currently provided for broiler, egg, turkey, and swine production companies as well as their harvest and processing plants. Since 1985, Agri Stats has been working with production companies in North and South America to help improve their profitability by identifying opportunities to lower cost and improve production efficiencies through comparative analysis or benchmarking.

Agri Stats collects participant financial and production data electronically each month. Internal auditors convert the data, prepare it for comparison and perform the monthly audits. Each company's financial data is reconciled to their general ledger to help ensure actual costs are reported. Raw numbers are used in Agri Stats' standardized calculations so all company numbers are calculated the same way.

Data from the Agri Stats swine benchmarking program will be used to show the importance of benchmarking herd performance and cost.

In Example 1, DEMO clearly has attractive performance numbers and rankings. A producer with these numbers but no contemporary group comparison may conclude everything is fine with production. These numbers could easily be measured and calculated by swine producers and included in a benchmarking comparison. By comparing against other swine finishing flows or locations, DEMO can now find some opportunities in performance. Let us look further into DEMO to see if a benchmarking comparison yields additional information.

## Finishing benchmarking importance and examples

### Example 1. Finishing Performance Data.

Company: **DEMO**

	<b>Performance</b>	<b>Rank (n=47)</b>
ADG:	1.95	#5
Feed Conversion Ratio:	2.50	#3
Mortality:	2.73%	#7
Calories /Lb Gain:	3929	#10

### Example 2. Finishing Cost Data.

Company: **DEMO**

	<b>Cost</b>	<b>Rank (n=47)</b>
Total \$/cwt:	\$52.25	26
Pig Placement \$/cwt:	\$17.50	16
Facility \$/cwt:	\$4.70	20
Feed \$/cwt:	\$27.58	35

DEMO cost data in Example 2 shows us great performance may not result in competitive production cost. DEMO had a total cost /cwt that was \$5.57/cwt or \$15.21/head higher than the Top 25% in cost. Obviously in a real life situation further analysis and investigation would be used to identify reasons for DEMO's disadvantages in the costs listed above and actions to take. For our purpose here, we can clearly see the value of benchmarking and comparing both cost and production. Furthermore, when we consider the average performance of the Top 25% in cost – 1.87 ADG, 2.85 FC, 4.62% Mortality and 4098 Caloric Feed Conversion – we see that comparing only production information may produce some unsatisfactory outcomes.

### Example 3. Profit Data.

Company: **DEMO**

	<b>Profit</b>	<b>Rank (n=62)</b>
Farm Profit \$/cwt:	-\$0.44	42

Now we see a company that ranked #3 in FC, #5 in ADG and #7 in Mortality ranked #26 in cost and #42 in overall farm profit /cwt (Example 3). Without benchmarking DEMO company may have been satisfied with good finishing performance. Clearly there are opportunities in cost and profit.

## CONCLUSION

Most swine producers today are measuring finishing performance with or without elaborate accounting or technical systems. Using this information to participate in an effective structured benchmarking program can produce results and help improve profitability. By comparing to a peer group swine producers can get a more open, thorough and detailed evaluation of their finishing business. It is imperative that if benchmarking outside of a structured program, i.e. sharing results among a peer group that all agree on the metric calculations to ensure a fair and accurate comparison. At a minimum, sharing of production or performance metrics is of value, however, if cost, sales and profit information can be shared as well the value of the benchmark increases. Without a benchmarking comparison swine producers may not be aware of opportunities that exist for their operations.

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# **WHY BENCHMARKING IS IMPORTANT**

Rob McDougall  
Paragon Farms, Thamesford, Ontario

## **INTRODUCTION**

As the pork industry continues to evolve we must be prepared to compete in a Global marketplace. It is becoming increasingly important to ensure that you remain competitive in both economic and production efficiencies.

Benchmarking is simply measuring a company's data to improve performance. Benchmarking is done and used successfully in numerous industries, sports teams, countries and even in our personal lives.

## **PURPOSE OF BENCHMARKING**

The purpose and goals for benchmarking will be varied and unique amongst different companies.

1. To determine your current level of biological or financial level of efficiencies vs. your industry peers.
2. There is little point in benchmarking minor activities within your business, focus on the key areas of your business.
3. From this information and comparative data you will be able to accurately determine your company's strengths and opportunities for improvement.
4. To compare genetic performance levels for your maternal or terminal breeding program.
5. To be used for employee and grower performance evaluations.
6. To provide information and a better level of understanding to your lender in regards to your performance vs. others within the industry.
7. Internal vs. External Benchmarks.
  - a. Internal
    - i. System Analysis.
    - ii. Identified Key Drivers
  - b. External
    - i. Your performance vs. peer group
    - ii. Canadian vs. United States
    - iii. North American vs. Global

## **PRACITCAL USES OF BENCHMARKING**

To gain a better understanding and awareness of your own operations strengths and opportunities for improvement. With this better understanding it enables owners and employees to focus on identified areas of opportunities linked to your companies objectives:

1. Focus on identified opportunities with employees and enables the entire group to ensure resources are in place for improvement.

2. A clear measurement on the key drivers that are important to your operations overall performance. These could include kgs of pork sold per sow, pigs per sow, cost per kilo of gain, mortality rates, A.D.G., labour, dollar per pig weaned, etc.
3. A better understanding of your systems biological and financial performance to evaluate your operations' long term sustainability and growth potential.
4. There can be valuable relationships built within your benchmarking group. Through these relationships you have the potential to share knowledge, experience, understanding and awareness of key industry issues which can prove to be very beneficial.

## **LIMITATIONS WITH BENCHMARKING**

There are concerns and limitations with benchmarking that need to be factored into your decision to effectively use a benchmarking exercise to improve your overall performance.

1. Benchmarking is a process that needs a commitment to the program to succeed.
2. There must be clear and defined parameters that are used in the benchmarking process. It is imperative that key parameters are measured in the same manner and you must ensure that “apples to apples” comparisons are used.
3. There must be a commitment internally to the benchmarking process that will include both your time and funds to the exercise.
4. Benchmarking must be treated as an ongoing continual improvement process and not as a one off project.

## **CONCLUSIONS**

Benchmarking is a very useful tool to identify the strengths and opportunities within your operation as well as measuring progress and trends on a regular basis. This exercise should include production, cost and financial performance to provide the most benefit to the participant.

1. Benchmarking is not an exercise in imitation. It yields data, not solutions.
2. Keep things simple.
3. The importance of having standard definitions and measurements.
4. Link the benchmark activity to your company's objectives.
5. The relationships and knowledge that you are able to gain from your peer group.

Benchmarking is not a one-off activity. Even if you have achieved best practice today, regular benchmarking is essential to keep you up to date and ahead of the competition.



# **MAXIMIZING THE IMPACT OF HIGH VALUE AND HIGH FERTILITY BOARS**

**Michael Dyck\*, George Foxcroft, Jennifer Patterson**  
**Dept. of Agricultural, Food and Nutritional Sciences, University of Alberta, Alberta**  
**\*E-mail: [michael.dyck@ualberta.ca](mailto:michael.dyck@ualberta.ca)**  
**and**  
**Kilby Willenburg**  
**Reproquest Inc., 6064 McKee Road, Fitchburg, WI 53719 USA**  
**E-mail: [willenburg@reproquest.com](mailto:willenburg@reproquest.com)**

## **ABSTRACT**

The use of artificial insemination (AI) in the pig has had a major impact on genetic improvement in the swine industry over the last 40 years. However, the overall production efficiency of the breeding herd is highly dependent on the reproductive capacity of the boars used for breeding and the genetic merit of the boars for the performance of terminal line offspring. Given the widespread use of AI in swine production, poor quality boars will affect the reproductive outcome of numerous females. We instinctively know that not all boars are of equal quality, and all ejaculates collected for use in AI are subjected to standard semen analysis in commercial boar studs. However, the effectiveness of these evaluations is low compared to other food-animal species. This paper addresses the following points related to optimal use of superior boars:

- 1) Employing the use of sub-fertile boars and low quality ejaculates reduces production efficiency.
- 2) The use of pooled semen from poorly defined males breaks the link between known genetic value of individual boars and the paternity of progeny produced.
- 3) The excessive number of sperm used per litter born (probably over 9 billion sperm using current practices), and hence the high numbers of boars needed for semen production, reduces the genetic impact of our best boars compared to the limited number of superior sires used for meat and milk production in other food-animal species.

Collectively, these inefficiencies in AI use in the pork industry represent a major disadvantage to pork producers in a global food-animal marketplace and can be addressed with innovative breeding programs to increase the genetic impact of AI boars.

## **INTRODUCTION**

The ultimate measures of boar performance in production are pregnancy rate and litter size born. However, these are retrospective measures of boar fertility and can be highly influenced by breeding management and the quality of the gilts and sows bred (Colenbrander et al., 2003). Boar stud managers have come to accept that a combination of thorough physical examinations of the boar and conventional semen evaluation (concentration, morphology, motility) can provide an alternative to actual fertility data (Gibson, 1989). While these evaluations can establish that an animal is either sub-fertile or infertile, they cannot identify the relative fertility of boars that meet accepted industry standards for sperm and ejaculate quality (Ruiz-Sanchez, 2006). In general, the predictors of fertility currently applied in most commercial AI centres

provide a very conservative estimate of the relative fertility of individual boars. Furthermore, the relatively high sperm numbers used in commercial AI practice (usually more than 3 billion total sperm per dose of extended semen), and the pooling of semen from boars, masks the limited fertility of some of these boars. However, these differences in fertility become evident when lower numbers of sperm are used for AI and boars are evaluated on an individual basis.

Effective prediction of relative boar fertility is essential and will allow for the removal of less reproductively efficient boars from commercial studs. This in turn will optimize the use of proven, high fertility, and genetically high indexed boars at lower sperm numbers per AI dose. At the nucleus level this will allow for increased selection pressure by increasing the number of offspring bred per collection from high ranking boars. At the level of terminal line production, this would allow for considerable improvements in production efficiency to be realized, by capitalizing on boars with a high index for traits such as growth rate, feed conversion efficiency and the carcass characteristics of their progeny. If these changes in production strategy are to be realized, it is critical to identify boars of relatively low fertility that will not perform well when used in the more challenging situations of reduced sperm numbers per AI dose.

### **Approaches to assessing boar fertility**

There is a long history behind the search to find a single test or combination of tests that can accurately predict male fertility from a semen sample (Amann, 1989). Unfortunately, there appears to be no simple answer to this very complex question (Rodriguez-Martinez, 2003). Laboratory assays often examine all of the sperm present in a sample for fertility, yet only 1 to 30 or so sperm are necessary to fertilize all available oocytes. Braundmeier and Miller (2001) suggested that the sperm that fertilize the oocytes *in vivo* may be a small, highly selected, sub-population that is not representative of the average sperm evaluated in the sample. They also suggest that, because sperm must meet many requirements for successful fertilization, testing a single attribute is unlikely to be a true measure of ultimate fertility. Using similar reasoning, Rodriguez-Martinez (2003) suggested that to accurately predict semen quality it is necessary to test all key sperm attributes within large and heterogeneous sperm populations that potentially affect fertilization and embryonic development. Nevertheless, the markers of relative fertility finally selected must ultimately predict the relative fertility of boars when using low sperm doses of extended semen for AI (Rodriguez-Martinez et al., 2009). Braundmeier and Miller (2001) reviewed a number of functional and molecular tests used to assess male fertility. In this review they described two different sperm traits that affect fertility:

- *Compensable* traits are those that can be overcome by introducing large numbers of sperm during insemination. Problems with motility and morphology will reduce the number of sperm that are able to reach the oocyte, but by introducing large numbers of sperm the reduction in fertility can be minimized.
- *Uncompensable* traits are those that cannot be overcome by introducing larger numbers of sperm. These defects affect fertilization and embryo development and include nuclear vacuoles, sperm chromatin structure issues and morphological problems that do not inhibit fertilization.

Therefore, to effectively predict fertility, it is essential to discriminate between compensable and uncompensable traits in an ejaculate. Conversely, evaluation of relative boar fertility *in vivo* using high sperm numbers per dose (e.g. 3 billion sperm) will mask differences in compensable

traits and will not allow the industry to identify boars that will perform well in more demanding applications of AI.

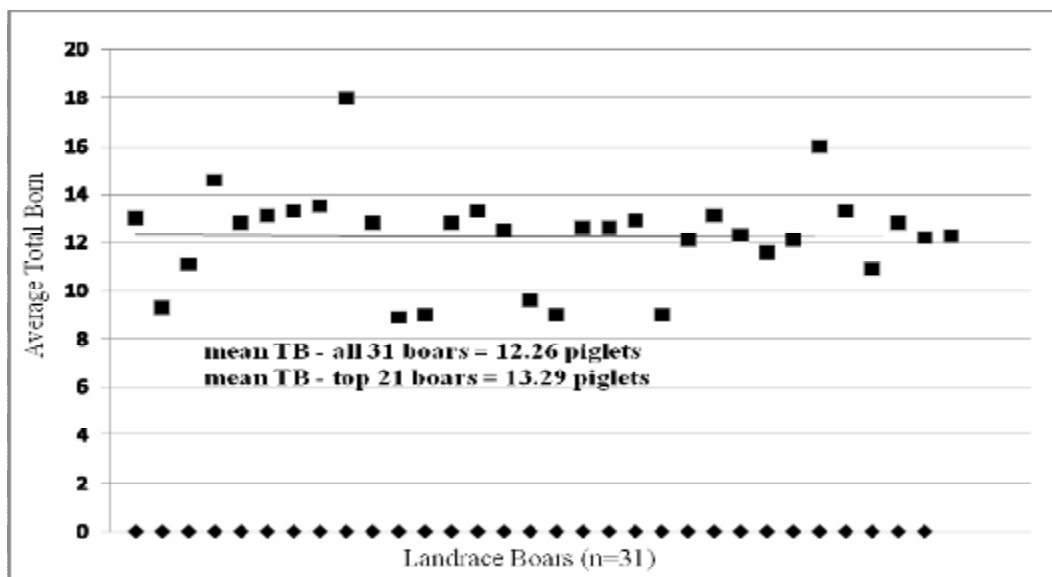
Conventional semen evaluation generally includes a measure of seminal volume, sperm concentration, and the percentage of progressively motile and morphologically normal sperm (Amann et al., 1995). Although some of these parameters are correlated with fertility in the boar (Flowers, 1997; Xu et al., 1998), several authors suggest that this information, while important, does not accurately predict whether a male is truly fertile (Brahmkshtri et al., 1999; Correa et al., 1997; Rawls et al., 1998). Existing analyses are also usually inadequate for predicting relative fertility in healthy boars with ejaculate quality that meets normal industry standards ( $>70\%$  motility and  $<30\%$  abnormal sperm) (Flowers, 1997; Alm et al., 2006), even though the reproductive efficiency of these boars may still be substantially different (Flowers, 1997; Tardif et al., 1999; Popwell and Flowers, 2004; Ruiz-Sanchez, 2006). Differences in relative fertility become increasingly evident when low sperm doses ( $<2.0$  billion sperm) are used for AI (Tardif et al., 1999; Watson and Behan, 2002; Ardon et al., 2003; Ruiz-Sanchez, 2006). This approach likely averts the compensatory effect of using excessive sperm numbers per AI dose (Saacke et al., 2000; Alm et al., 2006), thereby revealing important fertility differences among boars.

### **Evidence for differences in relative boar fertility in commercial studs**

The almost universal use of pooled semen doses in commercial boar studs severely limits the collection of data on relative boar fertility at production level. However, the limited data available continues to suggest a substantial range of fertility exists in contemporary populations of boars. Indeed, in the absence of routine procedures for identifying relative boar fertility, and hence an ability to effectively select stud boars for relative fertility at genetic nucleus level, a normal distribution of fertility traits should be expected. In recent discussions of overall breeding herd performance (Billy Flowers, personal communication) the point has also been made that limitations in AI technology may lead the industry to continually underestimate the existing productivity of contemporary commercial dam-lines. All these points are evident in recent data obtained from single-sire matings at the multiplication level (Figure 1).

These results indicate that the productivity of the top two thirds of these boars is very high, and at an average of over 13 pigs total born, would allow ambitious targets for breeding herd performance to be achieved. However, when the productivity of the lower one third of these boars is included, overall productivity falls by over one pig born. This relatively inferior performance of 20 to 30% of boars evaluated is consistent with the more extensive data available in the literature.

Moreover, if the genetic merit of the three boars in Figure 1 that averaged over 14 total born was high, the application of more efficient AI technologies would allow the merits of these “elite” boars to spread across a larger proportion of sows bred. However, with current AI practices, these substantial differences in boar productivity and the link to known progeny produced by individual boars are confounded by 1) the use of pooled semen and 2) high sperm numbers per AI dose. Furthermore, as reviewed in these proceedings (Willenburg and Dyck, 2012) the application of advanced AI techniques, such as post cervical AI (PCAI), single fixed time AI (sFT-AI), or the 2 techniques in combination can dramatically increase utilization of the most desirable sires.



**Figure 1. Data on litter size born in sows bred to commercial Landrace boars using single-sire matings with 3 billion sperm per AI dose. A minimum of 50 breedings per boar for each data point (Tony Chandaruk, personal comm.).**

### Breeding programs to increase the genetic impact of AI boars

Putting the above information together, future developments in AI technology would involve:

- A move to single-sire inseminations with the lowest possible doses of semen.
- Use of ejaculates from boars with high genetic value and proven fertility in a “low semen dose” environment.

The suggested economic model for implementing a program of AI use with lower numbers of sperm per dose and single-sire breedings, modelled on a 10,000 sow system using an internal 100-boar stud, is as follows:

Before any intervention occurs, the following assumptions would apply to the production system:

- All sows are bred by AI using standard catheters, multiple inseminations (average 2.2) dependent on the duration of estrus and existing breeding protocols.
- Semen is pooled from multiple boars, with 3 billion sperm per AI dose.
- Average Index (Estimated Breeding Values indexed on a relative 100 system) is 115.8 (range from 90-150).
- Pigs per sow per year (PSY) after grade-outs averages 24.5.
- Wean to farrow loss of 7%.
- Total pigs sold/year = 227,850.
- Pigs produced per boar = 2,279.

There are several stages in the proposed approach to improving the impact of superior boars within the system. At each stage typically only one item is altered.

### **Stage 1**

- All sows are bred by AI, using standard catheters, multiple times (average 2.2 times) dependent on the duration of estrus and standard farm protocol.
- For all ***new boars entering the stud***, semen is processed as ***single-sire doses of 2 billion sperm cells per dose***.
- Minimum of 50 single-sire matings per boar is used to identify the top 66% of boars in the stud (33% reduction in needs due to the change from 3 to 2 billion sperm per dose and hence 33% more doses created from the 66% best boars retained).
- The lowest performing boars are removed from service, increasing average index to 122.5 (range 110-150).
- An indirect result would likely be an increase in PSY to 26.5.
- Wean to farrow loss of 7%.
- Total pigs sold/year = 246,450.
- Pigs produced per boar = 3,734.

### **Stage 2**

- All sows are bred by ***post-cervical AI (PC-AI) technique***, multiple times (average 2.2 times), dependent on the duration of estrus and existing farm protocols.
- Semen used as ***single-sire doses at either 1 or 1.5 billion sperm cells per dose (from boars with proven fertility at 2 billion sperm/dose using conventional in AI Stage 1)***.
- 50 matings per boar used to identify top 33% of boar in stud.
- The lower performing boars again removed, increasing average Index to 129 (range 122-150).
- Pigs per sow per year (PSY) after grade-outs still averages 26.5.
- Wean to farrow loss of 7%.
- Total pigs sold/year = 246,450.
- Pigs produced per boar = 7,468.

### **Stage 3**

- All sows are bred ***using a single, fixed-time, AI protocol (sFT-AI) and the PC-AI technique***.
- Semen: ***One single-sire dose of 1 or 1.5 billion sperm cells***.
- 50 matings per boar used to identify top 15% of boar in stud.
- Again, remove the lower performing boars and average Index moves to 134 (range 127-150).
- Pigs per sow per year (PSY) after grade-outs still averages 26.5.
- Wean to farrow loss of 7%.
- Total pigs sold/year = 246,450.
- Pigs produced per boar = 16,430.

The potential economic gains achieved by adopting these advanced AI strategies are summarized in Table 1.

**Table 1. Cost:benefit analysis of improved swine AI procedures, based on a 10,000 sow system and an integrated 100-boar commercial AI stud. The steps 1, 2 and 3 are those outlines above.**

		<b>Start</b>		<b>Step 1</b>		<b>Step 2</b>		<b>Step 3</b>
	A.I. method	Standard		Standard		Post-Cervical		Post-Cervical
	A.I. dose (billion)	3	-	2	-	1	=	1
	# Inseminations	2.2	=	2.2	=	2.2	-	1
	# boars in stud	100	-	66	-	33	-	15
	Average Index	115.8	-	122.5	-	129	-	134
	Commercial Sows In Production	10,000	=	10,000	=	10,000	=	10,000
	PSY (after gradeouts)	24.50	-	26.50	=	26.5	=	26.5
	W2F Losses	7%		7%		7%		7%
	Total Pigs Sold/Year	227,850	=	246,450	=	246,450	=	246,450
	Value for 1 Index Point per Pig	\$0.07	=	\$0.07	=	\$0.07	=	\$0.07
	<b>Annual Opportunities:</b>	\$ -	-	\$ 115,585	-	\$ 227,720	-	\$ 313,977
	<b>Other Opportunities:</b>							
	Fewer Boars (per year)	0%		33%		66%		85%
	Savings	\$ -		\$ 90,750		\$ 181,500		\$ 233,750

## CONCLUSIONS

The evaluation of relative fertility amongst commercial AI boars, and a move to single-sire AI programs in combination with advanced AI techniques holds significant potential economic benefits to the swine industry. Data collected from initial boar evaluations would allow for elimination of the less fertile boars at an early stage. The characterization of AI boars that maintain high productivity at even lower numbers of sperm per AI dose then allows the industry to capitalize on established and emerging AI technologies like post-cervical, and single, fixed-time, insemination. These changes would be made without any loss in productivity, as measured in terms of pigs born per sow per year. The boars retained for commercial use would then have the highest genetic merit among boars available at any point in time, and would be used across a greater number of gilts and sows. Results to-date suggest that the relative value of commercial progeny could be increased by between \$0.80 and \$1.30 per pig born, and would largely reflect the genetic merit of elite boars in terms of growth performance and feed utilization efficiency of their offspring.

## ACKNOWLEDGEMENTS

Funding support for the research related to this work was obtained from Ontario Pork, Canadian Agricultural Adaptation Program (Alberta Agriculture and Food Council), NSERC,

and swine breeding companies (Hypor and PIC). We would also like to thanks Amanda Minton (PIC Technical Service) for her assistance in the cost benefit analysis.

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## **DAY 2: MAXIMIZING RETURN**



# MARKETING OPTIONS IN A NEW ENVIRONMENT

**Patrick O'Neil**  
**Division Manager – Marketing**  
**Ontario Pork, 655 Southgate Dr, Guelph, Ontario, N1G 5G6**  
**E-mail: [patrick.oneil@ontariopork.on.ca](mailto:patrick.oneil@ontariopork.on.ca)**

## ABSTRACT

The Marketing environment has changed dramatically in recent years. Regulatory change has added more actors and more options to the marketplace, it has also added more risk and different sources of information. Aside from the new regulatory environment, the marketing environment has also changed with reduced hog supplies and investments in processing capacity.

Ontario Pork's voluntary and self funded marketing services still exist to mitigate the risk, help sort through information, and capture maximum value.

## OLD VS NEW ENVIRONMENTS

The environment for marketing hogs has changed dramatically in the past 3 years due to both regulatory changes and changes in the competitive environment.

### Regulatory environment

There are many changes in the regulatory environment, the most significant being that Ontario Pork's marketing services are now voluntary as opposed to mandatory. Table 1 highlights some of the changes that have happened since 2010 based on the regulatory changes instituted by the provincial government.

**Table 1. New vs old regulatory environment.**

	<b>"Old" Environment</b>	<b>New Environment</b>
Ontario Pork Marketing Services	Mandatory	Voluntary
Price Reporting	Individual Contract details posted	Mandatory Price Reporting covers aggregate information
Price Reporting Timelines	Contract Prices Reported as soon as available	Previous week data published after all data is collected
Payment	Only Available Through Ontario Pork	Direct Payment and Payment through marketers available
Credit Protection	All hogs covered by credit policy	Only hogs shipped through Ontario Pork covered by credit policy; No financial protection program offered

Another significant change is that Ontario Pork's credit policy, which includes letters of credit as well as strict credit monitoring, is only available for hogs sold through Ontario Pork Marketing. This fact creates significant risks as evidenced by reports that a number of farmers did not receive payments for animals shipped to Quebec in the Spring of 2011.

### **Market environment**

The market environment has changed as much as the regulatory environment as the hog supply has contracted due to years of poor returns and uncertain prospects. At the same time investment in the processing industry in Ontario has led to stronger processing capacity. A similar trend has happened in Quebec; the result is greater bargaining power for farmers and an increase in marketing options. Table 2 summarizes the changes in the market environment.

**Table 2. New vs old market environment.**

	<b>“Old” Environment</b>	<b>New Environment</b>
Hog Supply	Surplus Hogs	Surplus Capacity
Hog Weights	Standard Grids	Variety of Grading Grids
Segregating Hogs	Segregation an Exception	Segregation for different markets; sub standard hogs
Inter Provincial Movement	Quebec hogs sold into Ontario	Ontario hogs sold into Quebec

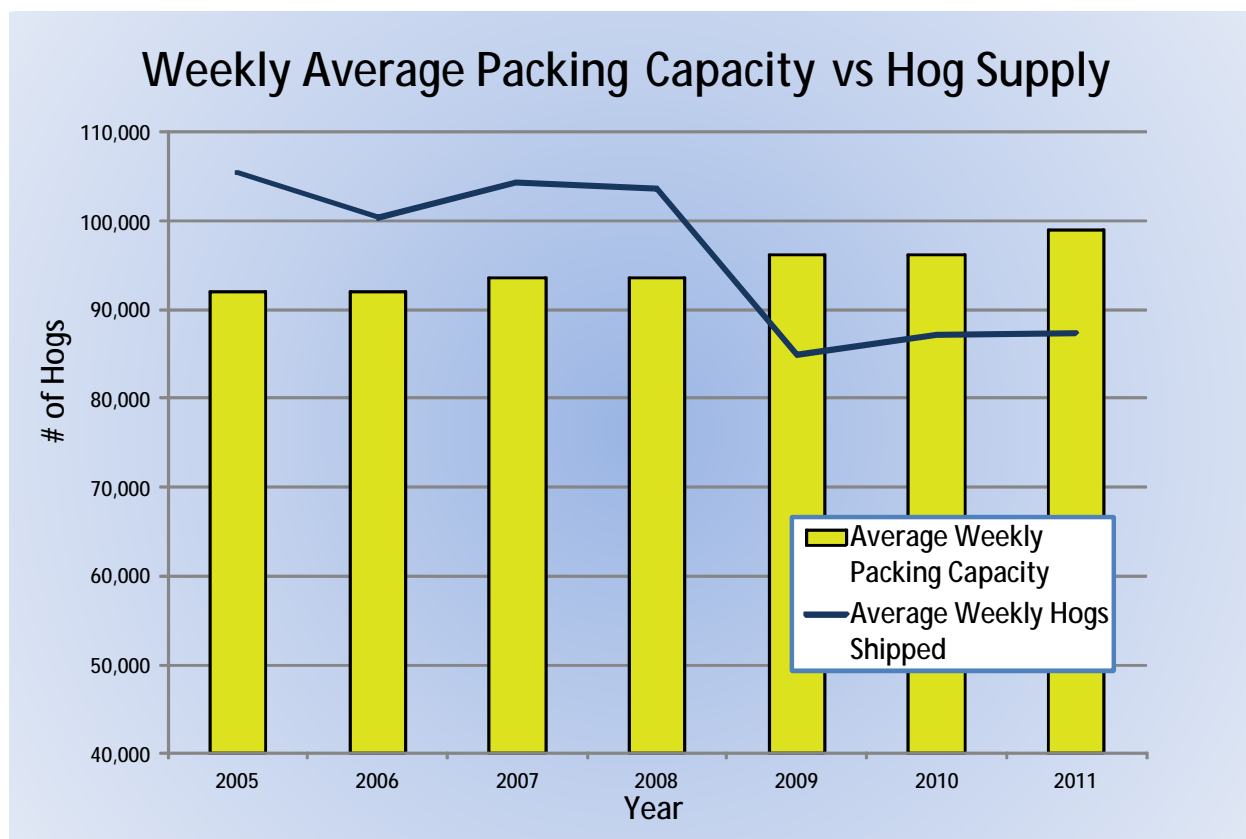
The marketplace is also evolving as various plants have experimented with segregating product to certify the product attributes of specific types of animals. New Products for specialty markets that use hogs with specific weight ranges, feed requirements or production practices require segregation on the truck and in the plant. This trend is expected to continue.

### **RISK IN THE NEW ENVIRONMET**

There is no Financial Protection Plan for hogs – if your customer does not pay for hogs your only recourse is to the courts.

### **MARKET CONDITIONS IN THE NEW ENVIRONMENT**

Local Hog Supply in Ontario has stabilized after falling dramatically after 2008. At the same time increased investment in processing capacity has created a hog deficit that has given Ontario hog farmers greater bargaining power. Figure 1 illustrates how we have moved from a hog surplus of approximately 10,000 hogs per week in 2007 and 2008 to a deficit of about the same amount today.



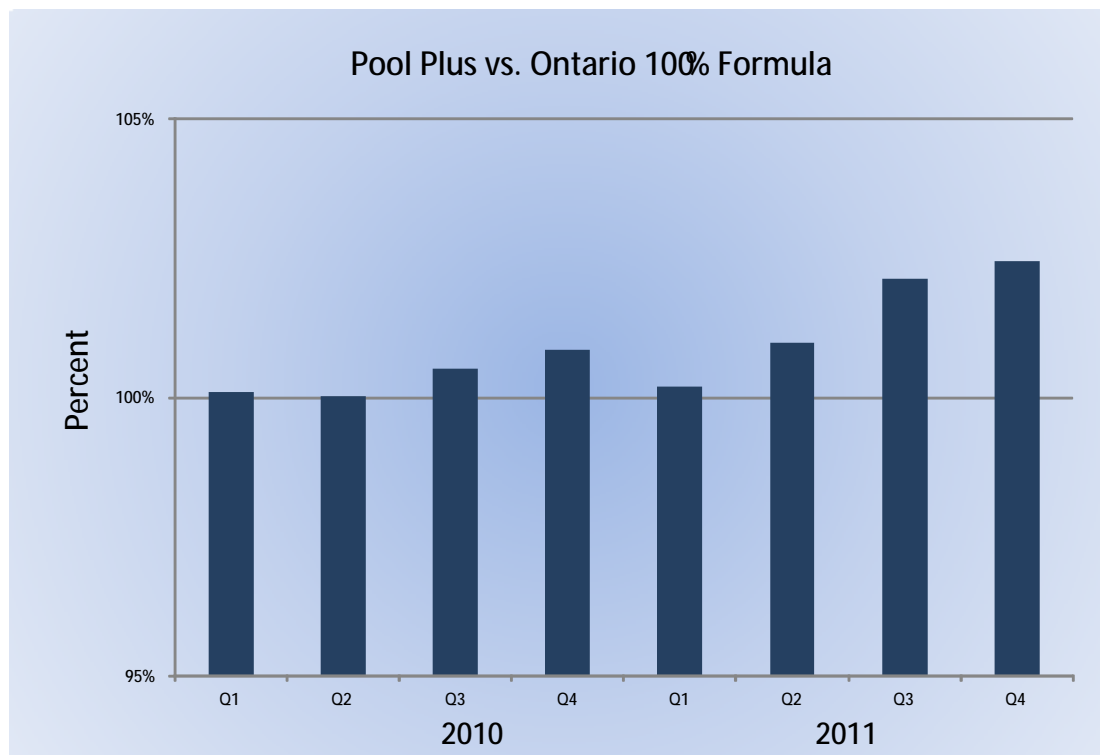
**Figure 1. Weekly average packing capacity vs hog supply.**

Not captured in Figure 1 is the fact that hog supplies in Quebec have also decreased over the same time period and a hog deficit also exists in that province. Despite the high cost of freight hogs are now moving from Ontario to Quebec, whereas there were times in 2007 and 2008 that hogs were sold from Quebec into Ontario. It should be noted that the capacity estimates assume a 5 day operating week at each plant.

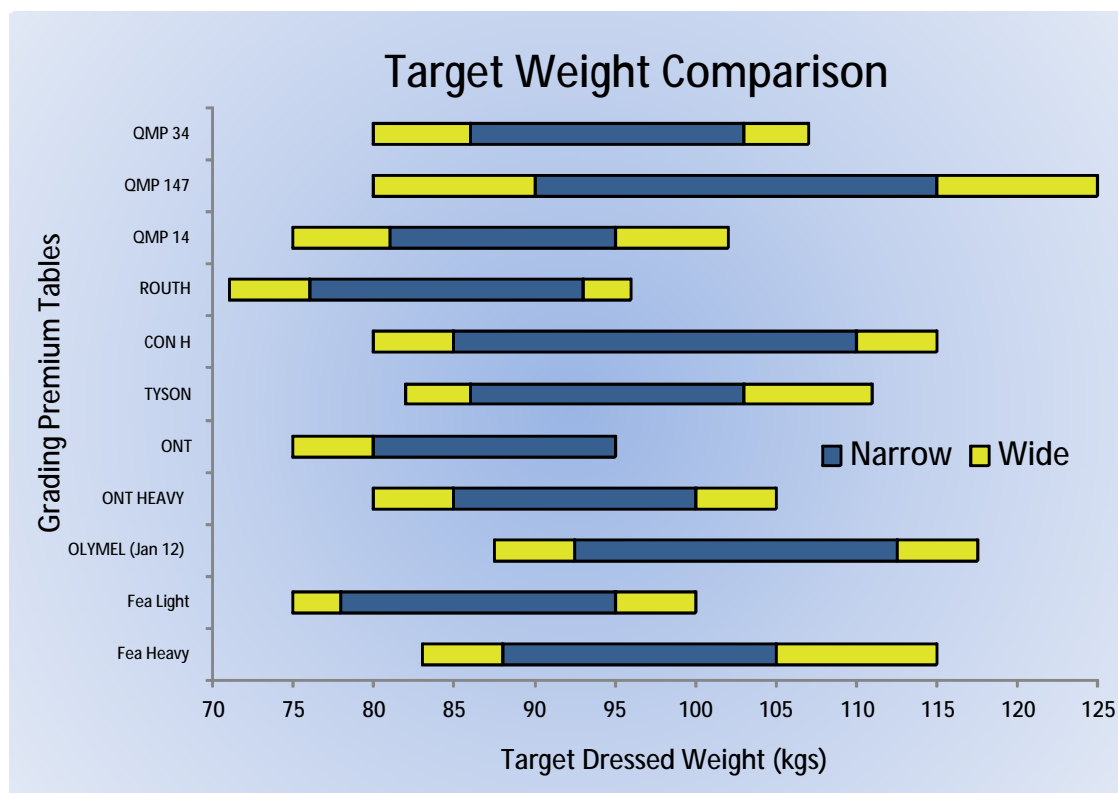
Figure 2 illustrates the impact on price. Prices such as Ontario Pork's Pool Plus program increased steadily through 2011 as contracts have been renewed at higher prices reflective of the shortfall of hogs. It should be noted that while the excess capacity did exist in 2009 and 2010, uncertainty regarding the future of the Maple Leaf plant in Burlington did not allow the market to respond to the hog deficit. With Ontario's capacity secure for the medium term prices have responded in 2011.

## **MARKET OPPORTUNITIES IN THE NEW ENVIRONMENT**

Over the past several years buyers have increased the number of grading grids that they are offering to farmers. Figure 3 illustrates that a pig with a carcass weight of less than 80 kg all the way up to a weight of 115 kgs may fit a grading grid at one plant.



**Figure 2: Pool Plus price vs. Ontario 100% Formula.**



**Figure 3: Target weight comparison.**

## MARKET INFORMATION IN THE NEW ENVIRONMENT

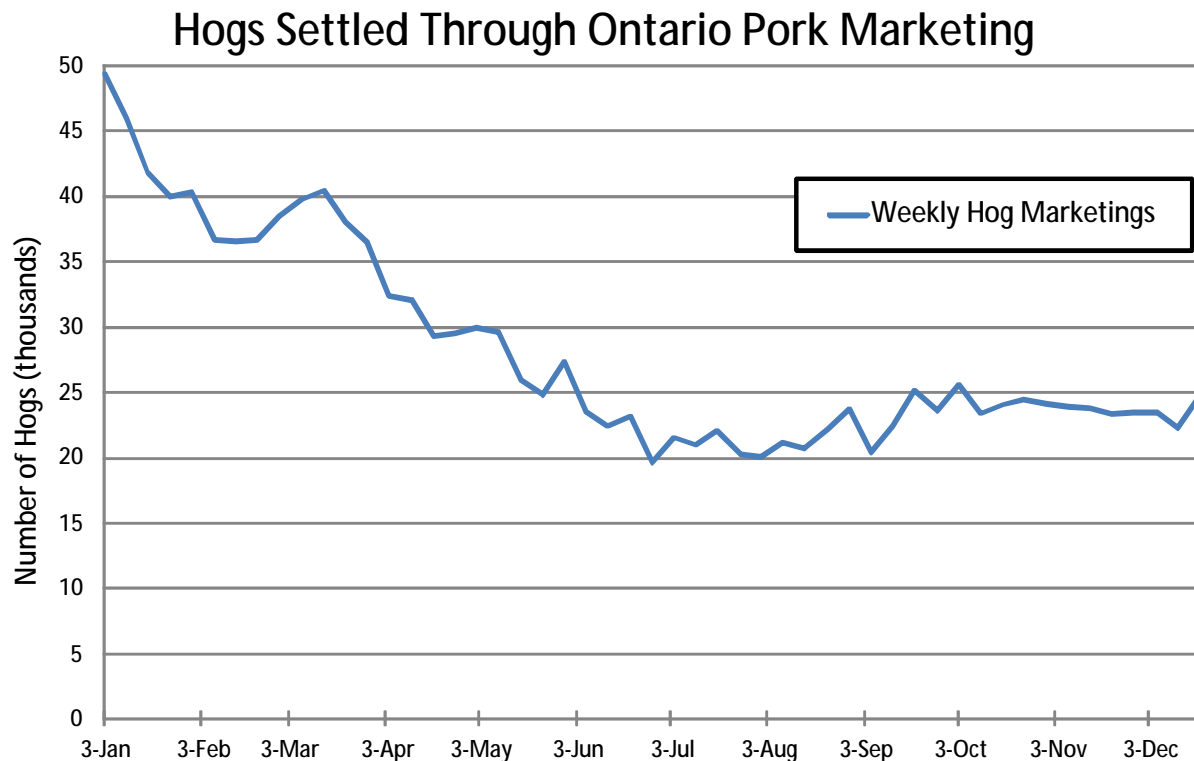
Ontario Pork Universal Services unveiled a new pricing methodology in March 2012, an update on the original mandatory price reporting launched in December 2010. Both methods report prices in \$/ckg total value. Essentially the total value of a hogs is divided by its weight to calculate this value. When it was first launched, the reporting caused some confusion because the units result in a dramatically higher price than the base prices that are still frequently quoted. Even adjusting for units the original mandatory price reporting included the top 5% of the hogs from each plant in their calculations. The result was high value specialty pigs were included in the average price and lower value conventional pigs were included in the high price. The new methodology groups all hogs together and then separates the averages. The result is that under the new methodology the High price is higher and the Average price is lower than it would be under the Dec 2010 methodology. Table 3 provides an example of the two methods.

**Table 3: Mandatory prices for the week of Jan.30, 2011.**

Description	Current Method Value	New Method Value
Average price /ckg DW total value	\$164.35 (90%)	<b>163.48 (70%)</b>
Low price /ckg DW total value	\$138.29 (5%)	<b>148.72 (15%)</b>
High price /ckg DW total value	\$176.00 (5%)	<b>187.39 (15%)</b>
<b>Implied premium (\$/ckg DW) NEW</b>	---	<b>19.42</b>
Total volume of Ontario hogs sold was	86,369	<b>86,369</b>
Weekly average weight of Ontario hogs was (/kg DW)	95.75	<b>95.75</b>
Weekly average fat measurement of Ontario hogs (mm)	18.39	<b>18.39</b>
Weekly average muscle measurement of Ontario hogs (mm)	63.07	<b>63.07</b>
<b>Weekly average yield (%) NEW</b>	---	<b>60.85</b>

## HOW ONTARIO PORK MARKETING CAN NAVIGATE IN THE NEW ENVIRONMENT

Ontario Pork still offers farmers the opportunity to sell their hogs through the Marketing Division on a voluntary basis. Marketing Services are funded by a voluntary \$0.65 per hog fee. Figure 4 illustrates that the volume of hogs sold through Ontario Pork has stabilized and remains at a level of 20-25% of all hogs sold in the province.



**Figure 4: Hogs settled through Ontario Pork Marketing.**

### Ontario Pork Marketing Services

Marketing Services include a variety of marketing options including numerous contract offers from various plants, the Pool and Pool Plus programs, and short term or single load contracts referred to as spot loads.

When evaluating various options marketing members are eligible to see a Net Return Analysis that compares selected marketing options with the grades of hogs that they have shipped over a given time period.

The Forward Pricing Program offers producers the ability to forward contract hogs 10 months into the future. Farmers can book any number of hogs and do not need to pay margin calls.

The strong internal controls and credit requirements that Ontario Pork maintains with its customers offers farmers peace of mind that they will receive payment for their hogs.

The OINK website allows farmers to download statements and run a variety of benchmarking data and health reports, as well as exclusive market analysis. The OINK website is well used by marketing members with significantly more reports run each month than there are marketing members.



# EVIDENCE BASED DECISIONS: COMBINING SCIENCE-BASED STUDIES WITH EXPERIENCE

Cate Dewey, DVM, MSc, PhD  
Department of Population Medicine  
Ontario Veterinary College, University of Guelph,  
50 Stone Road, Guelph, ON N1G2W1 [cdewey@uoguelph.ca](mailto:cdewey@uoguelph.ca)

**Key issues:** Defining the importance of using scientific studies to aid decision making and how we can balance experiential knowledge and science-based studies in the process.

## ABSTRACT

Information is not all created equally. Critically evaluating the source of the information is essential prior to applying the knowledge for clinical decisions. Randomized, controlled, blinded, side-by-side trials provide the best scientific evidence until the time when we catch up with our human medical counterparts who have systematic reviews available for their clinical decisions. Observational studies and case studies, in that order, provide the next best sources of information. The decisions we make affect the economics of the production unit, the health of the pigs, and the safety of the pork. The best evidence-based decisions are formed by combining the knowledge from a critical evaluation of the literature plus personal experience plus an understanding of the individual farm circumstances.

## INTRODUCTION

We in the swine industry are responsible for the health and welfare of pigs, the production of safe pork, and the economical viability of the pork value chain. Each day we make and implement decisions about how best to treat, manage and prevent disease in the herds with which we manage and consult. These decisions are made critically with a balance of scientific knowledge and experience. This paper will reflect on how best to evaluate scientific literature while acknowledging the intrinsic value of experience. Approaches to being a critical consumer in this information age and to scientifically determine the efficacy of a treatment or prevention on your own herd will be described.

## INFORMATION WITHOUT THE FILTER OF CRITICAL APPRAISAL

Evidence Based Decision making requires that we determine the relevance, quality, and applicability of source of data before we choose to apply the information to a decision made on our farms. Information – good and bad – is widely available on the internet. Clinical problems caused by *Strep. suis* are commonly seen in Ontario herds so I chose to use them to illustrate my point. I put ‘How do you treat and prevent *Strep. suis* in pigs?’ into an internet search engine. The key recommendations from the first five sites are summarized below.

*Treatment - Please do NOT follow the advice described below*

1. *Inject affected pig with an antibiotic for 3 -5 days. Penicillin is the drug of choice although amoxicillin, ampicillin, Cephalosporins, trimethoprim sulphonamide and other antimicrobials can be used. Not aminoglycosides or tetracyclines. Put antibiotics in feed or water for rest of the pen*
2. *Inject with appropriate antibiotic (amoxicillin and ampicillin 90% sensitive); resistant to tetracycline, clindamycin, erythromycin, kanamycin, neomycin, and streptomycin*
3. *Inject with penicillin and add penicillin to the water*
4. *Put tetracycline in the water*
5. *Aggressive injections of penicillin or ampicillin. For sudden death of finisher pigs, mass injection with penicillin.*

*Prevention - Please do NOT follow the advice described below.*

1. *Farrow sows in isolation, fumigate the room between animals, inject piglets at birth with long-acting penicillin, older pigs given Ampicillin or amoxicillin in water for 7 days prior to expected disease or put procaine penicillin in the feed. Medicated early weaning eradicates the disease from the herd but slaughter, disinfection and repopulation is most reliable.*
2. *Sanitary measures plus penicillin in the water (feed interferes with the absorption), amoxicillin gets higher serum concentrations. Response to vaccine is inconsistent. Cannot be eliminated by medicated early weaning*
5. *Decrease stocking density, minimize mixing, improve ventilation. Vaccinate piglets with autogenous vaccine may be of benefit. Strep suis bacteria infects a pig in the birth canal or by entering the umbilical cord or by pig to pig transmission through fighting. The bacteria can live in macrophages, a type of cell in the blood stream of the pig. The bacteria cannot be eliminated through mass vaccination. Therefore, medicated early weaning programs do not eliminate the bacteria from a herd. Vaccines made from a culture from the pig's brain MAY help in the prevention of the clinical problem.*

I did not use any criteria to classify the sources as reliable or not reliable. Using this approach, there are many conflicting recommendations; Do / do not: 1. Treat with penicillin, 2. Put penicillin the feed, 3. Treat with tetracycline, 4. Use medicated early weaning to eradicate, 5. Use depopulation to eradicate, 6. Use an autogenous vaccine. I am sure none of you would make decisions about treating and preventing *Strep. suis* by reading a few internet sources, but hopefully, this example illustrates the challenges in determining 'what to believe'.

## **RELATIVE 'VALUE' OF INFORMATION SOURCES**

Systematic reviews are considered the strongest evidence of our current scientific knowledge. They carefully gather and review all published reports to provide an overall conclusion based on the research that has been conducted. Unfortunately, these are rarely funded and completed in veterinary medicine. Randomised controlled side-by-side conducted in a blinded manner (the researchers, producers and statistician do not know which pigs are in which group) provide the next best evidence. Of next scientific value are the observational studies involving large numbers of pigs on many farms. These are the case-control, cross-sectional and cohort studies where we measure what is happening on commercial herds without imposing a treatment. These

farms will have ‘cases’ and ‘controls’ or ‘treatments’ and ‘controls’ based on what naturally occurs on the farms. Case series (referring to multiple herds) and case reports (referring to one herd) are often used by veterinarians to describe a new disease problem or a novel treatment option. A commentary or consensus report is a paper written by a group of experts discussing a treatment based on their experience and what they understand from the literature. Further down the list of evidence for us in swine production, in order of scientific rigor, we begin with research that involves other animals (rats), or parts of animals (cells in a lab), computer models, and finally expert opinion.

### **Systematic reviews**

Systematic Reviews are used frequently in human medicine to summarize all the known knowledge about how to clinically manage a specific disease. Funding agencies focused on human health are willing to support researchers to complete these reviews. Systematic reviews are used infrequently in veterinary medicine. There are a few that have evaluated the implications of animals, animal products and production systems for spread of zoonotic diseases to human populations. Hopefully in the future funding agencies will provide dollars to veterinary medical researchers to complete systematic reviews related to treatment of swine diseases. Systematic reviews differ from literature reviews. A systematic review requires a rigorous literature search to ensure that all peer reviewed literature, case reports, conference proceedings, white papers, and magazine articles are identified. Then using strict criteria for quality control, each piece of literature is evaluated to determine whether or not it will be included in the final analysis. Criteria for evaluation of the papers include such factors as equal likelihood of a pig being in the treatment and control groups, relative representation of pigs by age, clear description of the pigs and farms included in the study, very explicit definition of clinical or post mortem signs of disease, and severity of illness in the treatment and control groups, control for bias, clear definition of disease criteria, and complete follow up of case and controls. Papers that are retained for the next phase of the review are included in a table representing the results of the intervention. If this were an evaluation of a medication (such as an antibiotic) for the treatment of respiratory disease, the outcome measures would likely be mortality, morbidity (including signs of illness), days of treatment, average daily gain and feed to gain. Studies that are conducted on farm and with larger numbers of animals (assuming they were randomly assigned to treatment in a side-by-side trial) would be weighted more heavily in the final analysis than laboratory studies conducted on 6 pigs. A side-by-side trial implies that the pigs in the treatment and control groups were in the same barn at the same time. The researcher interprets the overall results from the selected papers and concludes that the treatment does work, does not work, only works under certain circumstances or that there is currently insufficient data available and therefore more studies are required before a treatment recommendation can be made.

### **Randomized blinded clinical trials**

Where does the veterinarian look for answers to the clinical questions that they face in their day-to-day practice? In a randomized clinical trial, the researcher randomly assigned pigs (or pens of pigs) to treatments so that each pig has an equal opportunity to be given each treatment. For the same batch of pigs, some are treated and some are untreated. If you do not want any untreated pigs, you might use the older (existing) treatment on half of the pigs and the new treatment on the other half of the pigs. Ideally, the study will be triple blinded. This means that the researcher, the producer, and the statistician do not know which pigs received each treatment.

To accomplish this, the researcher identifies all pigs with individual ear tags and weighs them before weaning. She then randomly assigns them to treatment A or treatment B according to weight and gender. Then, another person determines which drugs to assign to treatment A and B and injects the pigs. The information about which treatment was given to each group is kept in a sealed envelope until the project is complete. The person looking after the pigs does not know the treatment status and therefore the morbidity and mortality data cannot be biased by his expectations. Finally, the data is given to the statistician who analyses the data, comparing pigs in treatment A to pigs in treatment B, still not knowing which treatment was applied. Triple blinded studies are uncommon but not difficult to conduct. It is important that we think about how to use them more frequently in veterinary medicine.

### **Observational studies**

These research studies intentionally measure what happens on a large number of pigs on many farms. The value of these studies is that they measure what happens ‘naturally’ on swine farms without artificially imposing a treatment. The type of study depends on how the farms are selected. Cross-sectional studies are most common. Typically, farms in one region (e.g. south western Ontario) are selected and production, management, antibiotic use, vaccination, and disease are all measured on each farm. Then the research determines the associations between the factors of interest. An example may be to determine the association between reproductive performance and lactation length. In a case-control study, the researcher finds farms with the disease and other farms without the disease and then measures the outcome of interest (perhaps the production loss due to the disease). Cohort studies are rarely used in veterinary medicine. These would entail the researcher finding herds that do not have the disease of interest (PRRS negative) and then they would follow the herds over time to determine when they become PRRS positive and identify the management factors associated with becoming positive versus staying negative.

### **Case reports and case studies**

Case reports and case studies are also valuable starting points for either new clinical problems or new approaches to treat and manage clinical problems. They are the formal way in which experience from the field is recorded and scrutinized. I realise that veterinary practitioners are busy and publishing a report is very time consuming. However, these reports, once scrutinised through the peer review process form a valuable record of our profession. They are often the first record of a new disease. Without clinical trial data, case reports and studies are what the practitioner can rely on.

### **Peer reviewed manuscripts versus proceedings papers**

There is an important distinction between what is published in a proceedings paper (such as this) and a manuscript in a peer reviewed journal. The former has limited or no peer review and may represent the observations of one person. When that same paper is submitted to a scientific journal, it is critically evaluated by other researchers and practitioners. The author is challenged to reflect on what she has written, justify what she says and typically needs to either provide more detail of how the study was done or present the results and conclusions in a different manner. The peer review process usually ensures that the conclusions of a paper are limited to the scope of the study whereas often the author makes claims well beyond the work itself. When there is no information in the peer reviewed literature, conference proceedings are key resources. Once there are papers in the peer reviewed literature, it is recommended that we rely less on

proceedings papers. This is of particular importance if you are referring to a proceedings paper that is old. If that information is not eventually in the peer reviewed literature, perhaps the information did not stand up to the scrutiny of the reviewers.

## Experience

Experience is a key source of information for veterinary practitioners, pork producers and allied industry personnel. Through trial and error we learn what works ‘in our hands’ and what fails. But do we always? How often does something not work and we do not hear about it? How often was the problem going to either resolve or at least reach tolerable levels despite the use of an ineffective treatment or prevention program? This may be a function of herd immunity – at the beginning of a disease outbreak, morbidity and mortality are high, but once the disease has spread through a herd, there may be sufficient immunity to reduce the clinical problem. We have observed this with a new herd start-up that experiences Porcine Parvovirus one year but little to no loss due to Porcine Parvovirus the next year. For other disease outbreaks, there may be management circumstances that cause an outbreak that do not exist in the next batch. Examples of this may be overcrowding, insufficiently cleaned and disinfected rooms, or ventilation extremes that occur in spring and fall. This is likely what explains the variable responses to autogenous *Strep. suis* vaccines. When it does work, it may be that the vaccine is effective or it may be that the next batch of pigs was going to have a lower level of clinical disease anyway. When it does not work, it may be that the bacteria selected for the vaccine was not the one causing disease (not cultured from the brain) or that the vaccine is not effective. The best way to determine this on your herd is to conduct a randomized, blinded, clinical trial. If half of the pigs in one batch are vaccinated and the other half of the pigs are not vaccinated, then you can determine if the vaccine reduces losses due to *Strep. suis* on your farm. If the vaccine prevents losses in the vaccinated pigs but not in the unvaccinated pigs, you know it is worth your money to continue to use the vaccine. If both vaccinated and unvaccinated pigs die of *Strep. suis*, then the vaccine is not likely the answer on your farm. If none of the pigs get *Strep. suis*, you may not really know because it could be that you were not going to lose pigs in that batch.

The swine industry is ‘data rich’. Unlike those in human medicine or our counter parts working with dogs and cats, we have the advantage of numbers. We can more easily ‘test’ a treatment or prevention program to determine whether or not it works under the management structure of the farm we are advising or managing. My experience is that many producers are interested in doing a trial on their farm to test out new products or production ideas on their farm. An excellent resource for the design and conduct of field trials is the REFLECT<sup>1</sup> statement guidelines. Frankly I am frustrated by conclusions made from trials run as ‘one batch after the next’ rather than ‘side by side’ trials. It is not possible to interpret the results of these studies. Even without treatment, the clinical disease problem in one batch does not equal the clinical disease problem in the next batch. If we are dealing with an infectious disease outbreak, the problem is most likely to diminish on its own as the level of herd immunity increases. So, although I do put a high value on the experience of a practitioner, I also question conclusions that new treatments work when they have not been tested in a randomised, side by side trial. It reminds me of the days when producers were spending a lot of money using Egg Yolk Antibody in nursery feed to

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<sup>1</sup> Reporting guidelines For randomized controlled trials for livestock and food safety. See [www.reflect-statement.org](http://www.reflect-statement.org).

prevent post-weaning *E. coli* diarrhea. Randomized clinical trials showed that this was not efficacious.

### **Common problems – easy solutions**

Assume that the treatment, such as a vaccine, is given to pigs at weaning. Producers typically prefer to vaccinate one entire farrowing room and leave the next entire farrowing room unvaccinated and then compare the performance of the two groups. Again, we are comparing one batch to the next. Each batch has different levels of disease challenge and different nursery rooms (or barns). It is not possible to conclude whether differences in performance were due to the vaccine or the batch. Although the least biased way to do the study is to ear tag each pig and randomly assign each pig to either vaccine or control, a less onerous method would be to vaccinate all of the males and leave all of the females unvaccinated. We now have the vaccine individually applied to half of the pigs and each litter of pigs has some vaccinated and some unvaccinated. The nursery barn personnel keep track of the morbidity and mortality separately for male and female pigs. It is KEY that the people in the nursery do not know which gender was vaccinated so that there is not bias in identifying and treating pigs or in making culling decisions.

### **Veterinary training**

Veterinarians are charged with practicing evidence based medicine. By definition, this means to make a recommendation for an individual farm based on a complete evaluation of the herd, an intentional search for and evaluation of the current the best available clinical research and clinical experience. A veterinary degree provides the veterinarian with knowledge and skill in immunology, bacteriology, diagnostics, and physiology that enables him or her to evaluate and understand treatment successes and failures and differential herd responses. Let's return to the *Strep. suis* example for a few examples of what I mean by this. To be effective, antibiotics must be able to cross the blood brain barrier and remain in sufficiently high concentrations to meet or exceed the level that will actually kill the bacteria (MIC; minimum inhibitory concentration). This information is used along with the culture and sensitivity results from the diagnostic laboratory to choose the most appropriate antibiotic, dose, route and frequency of administration. Veterinarians, and other allied industry support people, have the experiential advantage of visiting many herds. What they learn at one farm becomes the relevant experience applied to the decision making at the next farm.

### **Producer experience**

The experience of the producer is invaluable. While each nursery pig producer has likely seen clinical *Strep. suis*, he or she is in the best position to know when the problem is changing, getting better or worse, responding to the treatment, or not. Producers are in the barn on a day to day basis and have knowledge about their own specific herd's successes and struggles from their observations of the clinical expression of disease and the herd's response to a new treatment or management change. A treatment that works in one herd may not work as well in another. We need to work together as a team to learn of the successes and failures to inform our 'expert' opinion for the next decision. The successes are easier to accept but the failures are key learning moments. Every farm has its own unique set of pigs, management, disease agents, and personnel. Experience gained on one farm is valuable data to be used to help the next.

## **Application of evidence based decisions**

All of us working together to improve the health and welfare of pigs, the quality of pork produced and the economic viability of our industry can apply the principals of evidence based decisions. The steps include determining the specific question to be answered (the more specific, the more likely you are to be able to evaluate the information gathered), search for the best evidence, critically evaluate the evidence by determining how the conclusions were made (randomized controlled trial, case report, expert opinion), apply the information from your critical appraisal with your clinical expertise and the specific circumstances of the farm, apply the treatment or prevention, evaluate the response to the treatment (prevention), and from the response alter the treatment by revisiting the previous steps.

## **RESOURCES**

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# COLLABORATION BETWEEN THE MINISTRY OF LABOUR, WSPS AND YOU

**Bob Van Wyk, Ontario Ministry of Labour**  
**Jay Remsik, Workplace Safety and Prevention Services**

## INTRODUCTION

The Ministry of Labour and Workplace Safety and Prevention Services (WSPS) provide information, services and enforcement related to workplace safety, including agriculture and the swine industry.

Producers will be aware that these roles can involve visits to their operation. Site visits can be characterized as proactive visits, for example, the Young and New Worker ‘blitz’; and reactive visits, for example, responding to a Work Refusal, a Critical Injury (see below) or a Fatality. All Inspectors are aware of biosecurity procedures and protocols in place when visiting hog operations.

## WSPS

Workplace Safety & Prevention Services (WSPS) provides industry-specific health and safety products, training and consulting services to 154,000 businesses and 3.8 million employees in Ontario’s agricultural, manufacturing and service sectors.

As one of four health and safety associations operating under the Health & Safety Ontario banner, WSPS is a trusted advisor to businesses, large and small, seeking to boost productivity and profitability by reaching zero work-related injuries, illnesses and fatalities.

Previously, you knew us as:

- Farm Safety Association (FSA)
- Industrial Accident Prevention Association (IAPA)
- Ontario Service Safety Alliance (OSSA)

The WSPS, as a designated Health and Safety Association, can provide In House Safety Awareness Sessions, onsite Safety Audits, and other valuable resource materials, templates, and general consultation.

## RESOURCES

### Online resources

Ministry of **Labour** – Agricultural webpage  
<http://www.labour.gov.on.ca/english/hs/topics/farming.php>

Ministry of **Labour** E-Newsletter  
<http://www.labour.gov.on.ca/english/resources/subscribe/index.php>

Workplace **Safety** & Prevention Services website  
<http://healthandsafetyontario.ca/WSPS/Home.aspx>

Farm Safety **Association** website  
<http://www.farmsafety.ca/public/index.html>

## **Definition of critical injury**

### **Critical Injury – Defined R.R.O. 1990, Regulation 834**

1. For the purpose of the Act and the Regulations, “critically injured” means an injury of a serious nature that,

- (a) places life in jeopardy;
- (b) produces unconsciousness;
- (c) results in substantial loss of blood
- (d) involves the fracture of a leg or arm but not a finger or toe;
- (e) involves the amputation of a leg, arm, hand or foot but not finger or toe;
- (f) consists of burns to a major portion of the body; or
- (g) causes the loss of sight in an eye.

Ministry of Labour: (877) 202-0008  
After Hours: (800) 268-6060

## **Contact information**

Ontario Ministry of Labour – OHS Call Centre  
Tel: (877) 202-0008

Workplace Safety & Prevention Services – Guelph Office  
Tel: (800) 361-8855

# PORK PRODUCTION IN A YOUTUBE™ ENVIRONMENT

**Trent Loos**

[www.loostales.com](http://www.loostales.com)

**About Trent Loos** (*from [www.loostales.com](http://www.loostales.com)*):

Loos records, produces and sends his radio programs from wherever his travels take him using his laptop computer and the internet. He presently has a radio listening audience of 4 million and can be heard on more than 100 stations across the country.

Trent's radio programming includes daily Loos Tales and Rural Route programming as well as Dakota Trails & Tales, Colorado Trails & Tales, Loos Trails & Tales and Illinois Truth be Told.

Loos also can be found addressing agricultural and non-agricultural groups alike. Among his favorite audiences are our nation's youth where he takes the opportunity to talk with them about the importance of food as a matter of national security and the value of their involvement in today's food production system.

Trent was raised on a diversified farm near Quincy, IL. He entered the hog business at a young age and has been involved in livestock production ever since. He and his wife Kelli operate a purebred Limousin and Angus herd. They enjoy working cattle, training horses and raising their three daughters on their ranch in central Nebraska.

**Note**

We plan to make a video of Trent Loos' presentation at London Swine Conference 2012 available on the conference website: [www.londonswineconference.ca](http://www.londonswineconference.ca).



## **DAY 2: WORKSHOP SESSIONS**



# **MAKING ON FARM RESEARCH TRIALS WORK**

**Marvin Wastell, Ph.D.**  
**Gro Master, Inc.**  
**3838 North 108th Street, Omaha, NE 68164**  
[mwastell@gromaster.com](mailto:mwastell@gromaster.com)

## **INTRODUCTION**

Today and in the future, swine producers will continue to be faced with high feed costs, facility and equipment costs. Swine producers of the future will need to have knowledge based upon sound performance data to be efficient and maintain low production costs. In the past, most swine producers relied upon research conducted by provincial and state institutions plus industry. Today government funding of research has decreased dramatically as a result of budget tightening and shifting priorities for tax dollars. As a result there is a greater need for producers to conduct and/or fund private research independently.

Most swine producers do not have large amounts of money to spend on research. As a result the producer must identify the area of production that is causing the greatest hurt (pain) and find solutions to reduce or eliminate the hurt (pain). Staying the course and doing the same thing over again is not a sound business decision. Conducting on farm research can be simple or complex depending upon the complexity of the need. The producer should realize there are professional people at research institutions, industry and consulting companies, who are available to provide assistance and guidance for conducting sound research studies on the farm.

## **ON-FARM RESEARCH**

Prior to conducting on the farm research, the producer should make an assessment of the equipment needed and estimate the cost of conducting the research trial. The availability of measuring devices, such as pig scales, feed scales, and water meters, RFID tags, environmental testing equipment and if needed other specialized equipment required for taking samples. Plus the availability of laboratories for analyzing specific samples, such as feed and tissue and recording forms need to be determined.

In addition to the equipment needs, the producer must analyze the need for additional manpower to conduct the research. The manpower requirements will be dependent upon the complexity of the research study to be conducted.

Research Protocol 1 is an example of a protocol used for on the farm testing of Crystal Spring Feeders versus X brand of feeders. A very similar protocol can be used for testing two types of feeds, nutritional or feed medication or other feed additives.

Ideally, any research study should have a minimum of 3 replications of each treatment – 4 to 5 replications would be better. A replicated treatment group will depend upon facility design, feed system and pig weighing equipment at each barn and/or farm site.

Very few barns are equipped with a feed delivery system that can deliver and record feed deliveries to each pen of pigs. Examples of these types of feed delivery systems are those made by Fancor, Roxel and Feed Logic.

Most barns will have two feed delivery lines. If the barn has a scale for either weighing individual pigs or weighing pens of pigs, the pens of pigs can be an experimental unit for gain but not for feed efficiency. Feed efficiency will be for the given number of pens delivered from the same feed lines (feed bins). If the barn has a scale, each treatment group should be balanced, for equal starting weight and sex. If a barn scale does not exist, then a random gate cut of the delivered pigs (truck weight) that is balanced for sex by treatment group can be used for the starting weight. At market time, the treatment groups must be sold as a group with each truck load weighed at a nearby truck scale or at slaughter plant scale providing each treatment group is delivered to the slaughtering plant at approximately the same time of the day with pigs weighing approximately the same weight or being on test for the same number of days. Treatment Design 1, 2, and 3 (Addendum A) show examples of different experimental treatment designs. Properly designed experiments are important for accurate treatment comparison.

Treatment Design 1 (Addendum A) is for one turn of pigs with 4 replications of treatment gain and feed conversion. To obtain feed conversion data, this treatment design requires a specialized feed delivery system or a feed cart and a barn scale.

Treatment Design 2 (Addendum A) is for barns or rooms that have 2 feed lines and a barn scale. This Treatment Design with 2 turns of pigs will provide 16 replications for gain and 4 replications for F/G.

Treatment Design 3 (Addendum A) is for barns with 2 feed lines per barn or room and no barn scale. This Treatment Design with 2 turns of pigs will provide four replications for gain and F/G.

If one is measuring the effect of different feeds for treatment designs 2 and 3, the treatments should be rotated from side to side for each turn of pigs. Or if there are two or more barns located side by side then the feed treatment line location should be alternated in the different barns or rooms.

All pigs on a given treatment from each barn (room) must be marketed as a group. Pigs from different treatments or barns should not be marketed together unless there is clear pig identification for each treatment and barn number.

Timely recording of the performance data gathered during the research trial and at close out time is important and should be done on an organized form. One of the more common and perhaps easiest forms for record keeping is provided by the use of Excel spreadsheets. Data can be summarized with the accurate entry of the data into these Excel spreadsheets. It is important to keep accurate notes for all incidents that occurred during the research trial, *i.e.* pigs being sick, pig treatments, out of feed incidence, pigs getting mixed up, etc. This information will be useful, when comparing the performance data to other previous and/future trials.



A producer conducting research trials should remember that there are limitations in comparing data with previous or future trials. Such factors as starting weight and ending weight will affect daily gain and feed conversion. Dr. Bob Goodband of Kansas State University in an article titled "Feeding and Feeder Management Influences on Feed Efficiency" presented at February 3, 2009 Swine Profitability Conference at Kansas State University, discussed adjusting close out data to make fair comparisons between different trials and comparisons of data with different growers. Kansas State's formula for adjusting Feed/Gain for different beginning and market weight pigs is as follows:

$$\text{Adjusted F/G} = \text{observed F/G} + (50 - \text{starting weight}) \times 0.005 + (250 - \text{market weight}) \times 0.005$$

Kansas State's equation to adjust nursery F/G to a common end weight of 55 lbs. (25 Kgs) is:

$$\text{Actual F/G} - 0.008 (\text{weight out} - 55 \text{ lbs.})$$

Goodband provides the following adjustment factors for fat level in the feed (grain Factor – (fat level X 2) where the grain factor is 1 for corn and the fat level is the percent fat in the diet. Goodband provides the adjustment for pelleting as (1 – pellet factor), where the pellet factor is the percentage improvement in feed efficiency due to pelleting (generally 4 to 6%).

Conducting lactation studies requires more replications than grow/finish studies. A lactation study needs 100 plus replications per treatment group (individual sows) to demonstrate a one pig treatment difference statistically due to the herd population differences. The research objective will have an influence on the type of treatment allocation based upon available equipment, feed system and available labor. In general, lactation studies require more labor and detailed record keeping analysis of the data than nursery and grow/finish studies. Research Protocol 2 gives an example of a sow feeder protocol and gives an example of a form for recording the data for a study.

Treatment Designs 4, 5, 6, and 7 (Addendum B) show examples of treatment assignments for a 20 sow farrowing room. It is important to remove as many non-treatment effects as possible from the research study. Therefore, the assignment of the treatments to the individual animals is important. The randomized Treatment (Design 4, Addendum B) assignment is for detailed scientific studies where it is important to remove as many variables as possible due to environmental effects. It is important that all farrowing crates, floors and feeders need to be the same. These types of studies will require extra labor and lots of attention to detail.

The Treatment by row (Design 5 Addendum B) is a much simpler type of research design for measuring two types of feeds or two different medications or two feeder types. Depending on the type of treatment study, it is recommended that the treatments be alternated by crate rows from replication to replication. If more than one room is available or sets of farrowing crate rows are available for the research study, use Design 6 (Addendum B). If two feed lines available per each row of lactation feeders or a feed cart is available the Treatment Design 7 (Addendum B) may be used.

In addition, to assigning treatments to a given set of farrowing crates/feeders it is important to have an even number of first litter sows, second litter sows and mature sows per treatment group. This emphasizes the need for large numbers of sows per treatment group.

## **SUMMARY**

In summary, before any research study is started it is very important:

1. to clearly define the objectives of the research study,
2. to determine the required equipment needed for conducting the study,
3. to determine the man power needed for conducting the research study
4. to accurately assess the attitude and commitment of those involved in conducting the research trial.

An old adage – If something is worth doing, it is worth doing right, if not, do not waste your time or money.

Research is the foundation for sound improvement and the reduction or elimination of producer pain.

### **Research Protocol Example 1:**

#### **Performance of Growing-Finishing Pigs Fed Through Wet/Dry Versus Dry Feeders**

**Objective:** Determine if differences in pig performance exists between grow-finish pigs fed through the Crystal Spring Wet/Dry Feeder vs. the \_\_\_\_\_ Feeder.

**Procedure:**

1. Allot pigs on the basis of initial weight (approximately \_\_\_\_ pounds) and sex into the various treatment groups. Record the starting weight of each pen. A total of \_\_\_\_ pens with \_\_\_\_ pigs will be assigned to each treatment.
2. Record dates at the beginning and completion of trial.
3. Record date and weight of any pigs that die during the trial.
4. Record number and weight of pigs not attaining market weights (culls).
5. Weigh pigs when they reach market weight.
6. Record all the feed offered each treatment of pigs.
7. Weigh back feed remaining in the feeders.
8. Record all observations related to adjustment of feeders and time involved with the different feeders.
9. Record water disappearance for each treatment group.
10. Rations and feeding program need to be identical for both groups of pigs.

## Addendum A

### Treatment Design 1

Growing-Finishing Barn

8 Pens/Room

Feed Delivery System to Individual Feeders/Pen

Barn Scale

4 Replications - 2 Treatments

Office	Scale
B	A
A	B
B	A
A	B

### Treatment Design 2

Growing-Finishing Barn

8 Pens/Room - Two Barns

2 Feed-lines/Barn

Barn Scale

8 Replications Gain - 2 Replications F/G

Office	Scale	Office	Scale
A	B	B	A
A	B	B	A
A	B	B	A
A	B	B	A

### Treatment Design 3

Growing-Finishing Barn

8 Pens/Room - Two Barns

2 Feed-lines/Barn

2 Replications Gain and F/G

A	B	B	A
A	B	B	A
A	B	B	A
A	B	B	A

## Research Protocol Example 2:

### Sow Feeder Study Protocol

Objective: Evaluation of Crystal Spring Sow Feeders on Performance of Sows During Lactation

The objective of the following study is to measure the traits associated with the lactation period which are important for the financial stability of the swine producer when sows are fed through the Crystal Spring Wet/Dry Sow Feeder. The study will continue for a minimum of twelve turns.

#### Procedure:

1. Record the I.D. and parity of each sow.
2. Weigh the sow entering leaving the farrowing crate.
3. Record the days when sows are in the farrowing crate.
4. Weigh the amount of feed offered to the sow and feed wasted per day.
5. Record the water usage of the farrowing room.
6. Weigh the newborn pigs at birth and at weaning.
7. Record date of piglet death and cause, if known.
8. Record days from weaning to rebreeding.

#### Data Collection:

1. Use the data sheets outline.

Example: Sow Lactation Data Record Sheet  
BARN NAME

					Sow Data		Pig Data		
Crate	Date	Date			In	Out	No.	Birth	Wean
No.	In	Out	I.D.	Parity	Weight	Weight	Born	Weight	Weight
					(lbs.)	(lbs.)	Alive	(lbs.)	(lbs.)

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**Addendum B**  
**Treatment Design 4**

Lactation Study  
 Randomize Design - 2 Treatments  
 Feed Cart

A	B
B	A
B	A
B	B
A	B
B	A
A	B
A	A
B	B
A	A

Allocate treatments by using a randomized number table

**Treatment Design 5**

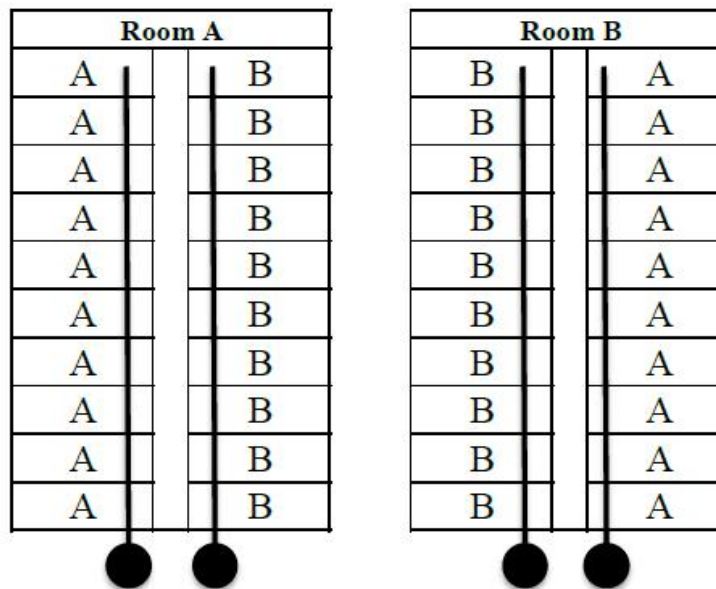
Lactation Study  
 Treatments by Sow - 2 Treatments

Treatment		Treatment
A		B
A		B
A		B
A		B
A		B
A		B
A		B
A		B
A		B
A		B
A		B

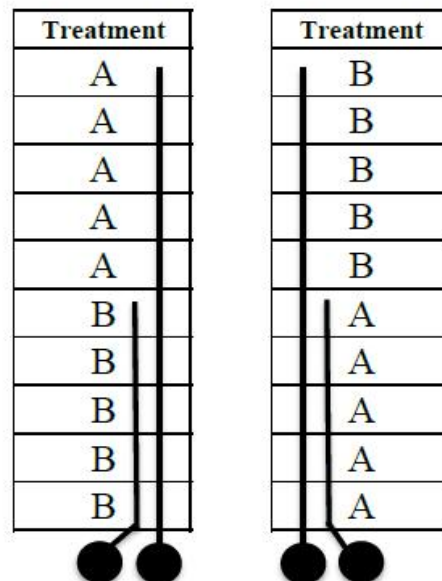


Treatments by row if there are only two feed-lines. Treatments alternate sides every other turn (trial) or when multiple rooms exist.

**Treatment Design 6**  
Lactation Study  
Treatment by Sow - Alternation Treatment Sides



**Treatment Design 7**  
Lactation Study  
2 Treatments/Row



Treatment by half row with two feed-lines per row or using a feed cart.

## **Appendix A:**

Quoted “Feeding and Feeder Management Influences on Feed Efficiency”

By Bob Goodband, Mike Tokach, Steve Dritz, Joel DeRouchey, and Jim Nelssen

KSU Applied Swine Nutrition Team

Presented at KSU at the February 3, 2009, Feed Efficiency Conference

### **Adjusting close-out information**

More and more producers are using nursery and or grow-finish records to evaluate production. Perhaps one of the easiest and most common forms of growing pig record keeping is done by the use of Excel spreadsheets. Data can then be quickly summarized in pivot tables for evaluation. However there are important limitations when comparing large data sets taken over time or comparing results of different producers or growers within a system. For example if one grower has a feed efficiency of 2.9:1 and a second has a 3.0:1 is the difference between the growers a true reflection of their management? One factor to include is the beginning and ending weight of the pigs. Grower #1 may have marketed his pigs at 270 lb, while grower #2 may market at 290 lb. The differences in final weight could be a greater factor affecting feed efficiency. Because of this variation we use a feed efficiency adjustment factor. Because factors other than purely management can affect feed efficiency, we need to adjust feed efficiency for differences in beginning and ending weight and dietary factors such as adding fat, pelleting, and in some cases grain source.

### **Nursery feed efficiency adjustments**

The data in Table 3 represents an example of adjusting nursery feed efficiency. Both nursery growers have identical feed efficiency; however when we take into account grower B having an 18 lb heavier pig, the adjusted feed efficiency indicates that this grower has the better feed efficiency when based on a common out weight of 55 lb.

The equation to adjust F/G to a common end point (55 lb) in this example is:

### **Finishing feed efficiency adjustments**

Several factors impact finisher feed efficiency. Expected feed efficiency will be influenced by the entry weight and market weight of the pigs, energy level of the diet, and whether or not the diets are pelleted. In order to compare feed efficiency among groups, adjustment factors for these major items must be used. Adjustment factors have been developed for entry weight and market weight of the pigs, energy level of the diet, and whether the diets are in pellet or meal form. Therefore, variation among close outs can be accounted for by these factors and may aid in detecting differences among groups for other factors, such as feed wastage.

An example of the importance of adjusting finisher feed efficiency is represented in Table 4. We have 5 different growers within a production system. Market weights range from 272 to 264 lb.



Average daily gain appears to be consistent among the growers with the exception of grower 4, who also had the greatest death loss. Feed efficiency appears to be relatively similar with growers 1 and 3 having the best F/G followed by growers 2 and 4, and lastly grower 5. But overall the differences among the 5 growers are relatively small. However when we adjust F/G for in- and out- weight, grower 1 has the best F/G by a wide margin.

The following equation can be used to compare different groups with different ending weights and market weights:

$$\text{Adjusted F/G} = \text{observed F/G} + (50 - \text{entry wt}) \times .005 + (250 - \text{market wt}) \times .005$$

This equation adjusts all groups to a common entry weight of 50 pounds and market weight of 250 pounds. Further adjustments can be made to compare groups with different grain sources, dietary energy levels, and pelleted or meal diets. The adjustment for energy level uses an adjustment for grain source and fat level in the diet (grain factor – (fat level × 2)), where the grain factor is 1 for corn and fat level is the percent fat in the diet. The adjustment for pelleting is (1 – pellet factor), where the pellet factor is the percentage improvement in feed efficiency due to pelleting (generally 4 to 6%).

The factors can be included in one formula to compare all of the factors at the same time:

$$\text{Adjusted F/G} = \square (\text{observed F/G} + (50 - \text{entry wt}) \times .005 + (250 - \text{market wt}) \times .005)$$

$$[\text{Grain factor}^1 - (\text{fat level} \times 2)) \times (1 - \text{pellet factor})]$$

<sup>1</sup> Grain factor = 1 for corn, 1.02 for milo, 1.18 for barley, and 1.07 for wheat

**Calculating Opportunity Costs.** Now that feed efficiency has been standardized to a common 50 to 250 lb basis, we can calculate opportunity values between the growers. An opportunity value is the dollars that could be saved if a grower could improve the feed efficiency (or mortality and average daily gain, and medication costs) to the best value for the group of growers. For example the growers in Table 4, we can calculate opportunity values for feed efficiency, average daily gain, mortality, and medication costs. The respective equations are:

### **Feed Efficiency**

$$\text{Observed F/G} - \text{the best F/G} \times (\text{weight out} - \text{weight in}) \times (\text{feed cost per lb of gain/F/G})$$

### **Mortality**

$$(\text{Observed mortality} - \text{the lowest mortality}) \times (\text{out weight} \times \text{market price})$$

### **Medication costs**

$$\text{Observed medication cost} - \text{lowest medication cost}$$

## Average Daily Gain

$$IF \text{ (final wt} > 275, 0, (275 - \text{final wt}) \times (\text{market value} - \text{feed cost/lb gain}))$$
□ The values in the chart represent a \$0.50 lb market value and an ideal market weight of 275 lb.

To interpret the data, the chart shows grower 1 having the best F/G (there is no F/G bar for grower 1). Growers, 2, 3, 4, and 5 could save approximately \$3.00, \$2.50, \$3.00 and \$2.75 per pig, respectively, if they improved their feed efficiency to that of the best grower, #1.

For mortality, growers 2 and 3 have the same mortality which happens to be the best among the group. Growers # 1, 4 and 5 could save approximately \$1.80, \$2.00 and 0.25 per pig, respectively, if they could lower their mortality to that of growers #2, and #3. For ADG, all growers are marketing pigs below the ideal weight range for this specific packer (275 lb). The equation yields the margin over feed cost (market value – feed cost per lb of gain) times the weight difference between the actual market weight and 275 lb. For growers #1, 2, 3, 4, and 5, these values are approximately \$0.25, \$1.00, \$1.50, \$1.00 and \$0.50, respectively. Lastly, with medication costs grower #2 has the lowest medication cost per pig. Growers #1, 3, 4, and 5 could save approximately \$0.50, \$1.10, \$1.00 and \$0.75, respectively. So not only can we compare among different growers with equalized feed efficiency, we can also determine the value a grower has to equal the best specific trait in that groups of growers.

In conclusion, there are several non-feed factors that play an important role in improving pig performance. It appears that feeder type can dramatically influence daily gain. Feeder adjustment also influences not only feed efficiency, but growth rate as well. Lastly, when comparing production values of different growers we can standardize feed efficiency to make fair comparisons among growers or production systems. We can then calculate economic differences of production traits to determine producer incentive to improve.

# MAKING AN ON-FARM TRIAL WORK

Mario Ramirez, Vicente Zamora and Malachy Young  
Gowans Feed Consulting  
1837 11<sup>th</sup> Avenue Wainwright, AB T9W 1N3  
[malachyv@telus.net](mailto:malachyv@telus.net)

## INTRODUCTION

The use of on-farm trials to evaluate a new product or additive can be an important way to determine the true economic value to your specific farm. Some companies marketing such products will provide controlled trial data which should be reviewed as part of the evaluation of the product or additive which have value but do need careful interpretation particularly how and where the trial(s) was conducted. Other companies will provide testimonials of before and after of when the product was fed by other farms and the difference in biological performance which has some value but a lot less than controlled side by side trials. Historically a lot of controlled product trials have been conducted at University farms or research stations with small numbers of animals per pen and very high health pigs that are not typical of commercial on-farm conditions in terms of stocking density, health status and number of pigs. Thus the validity and usefulness of these controlled trial results would be greatly enhanced if they were conducted again in commercial barns, thus high-lighting the importance of conducting trials on-farm under the actual conditions in which the products are to be used. Over the past 5 years or so we have observed more commercial on-farm research barns being set up to conduct trials in a controlled manner to test products under true conditions. Our company has become involved with a commercial grow-finish research barn in Alberta to run field trials to truly evaluate products under the actual conditions where the products are to be applied.

## IMPORTANT CONSIDERATIONS FOR ON-FARM TRIALS

1. ***Question to be answered and economic value*** – It is important to clearly lay out at the outset what you are trying to achieve with the trial in terms of what question(s) you want to answer. Be careful not to try to answer too many questions with one trial as it may end up not answering any. A good example is evaluating two boar lines and two stocking densities, which are four treatments for a farm with 20 pens in the barn – this will only give five replications per treatment, which will likely not be enough to pick up real differences if they exist. For this trial one would be better to focus on evaluating the two boar lines given the amount of planning and resources gone into breeding and identifying the two lines for the trial, and ensure you have ample replication to pick up real differences if they exist between the two lines. The second most important part of on-farm trials is to determine what the likely financial benefit of a successful trial would be to your operation. It is very important to remember that an on-farm trial showing no response is equally important to one showing a significant biological and economic response as this will tell you that there is no value to your farm of using a particular feed additive or product and thus saving you the cost of using it, which you otherwise would not know without the trial data.
2. ***Trial design and allotment*** – Design is an important factor that should be considered when planning trials. The primary designs used for pig trials (production and nutrition) include

completely randomized design (CRD) and randomized complete block design (RCBD). One of the main purposes is to dictate the process of allotting treatments to experimental units (EU). Regardless of the trial design it is important to balance studies by having equal replications of each treatment factor to maximize the power available to detect real differences if they exist. The CRD is the simplest of all designs; treatments are allotted to EU independently of any factors. This design allows for the most degrees of freedom for the error term in the model to test for treatment differences. However, the CRD can be unreliable if the EU are not homogenous. Non-homogeneity of the EU can cause inflated error variance components and can increase the chance of type II error.

For RCBD, treatments are allotted to EU on the basis of some factor commonly referred to as a blocking factor, which should reduce the error variance if the blocking factor is important. The blocking factor groups EU based on a particular factor, for example gender or weight, with each treatment having a minimum of one EU in each block. The primary function of blocking is to obtain groups of homogenous EU. Common blocking factors to use in nursery and grow-finish trials are location in the barn, initial pig weight, and pig gender. These factors could affect performance and affect interpretation of the results if not equalized across treatments. The importance of the allotment of pigs to treatments for an on-farm trial examining the effects of two feed programs on nursery pig weights is shown in Table 1 (Dritz and Hancock, 2002). Due to improper sorting of pigs by weight at the beginning of the trial pigs placed on Feed 2 were 0.2 lb heavier than those on Feed 1. Pigs fed Feed 2 were significantly heavier than those on Feed 1. Pigs fed Feed 2 weighed significantly more on day 5, 10, 14 or 28. A second analysis using initial weight (d0) as a covariate resulted in no significant differences of weight on any of the weigh days. This example highlights the importance of correct allotment of EU to treatments. Using initial weight as a blocking factor and balancing across blocks would have avoided this error.

**Table 1. Impact of allocation on treatment differences.**

Weight, d	Feed 1	Feed 2	SEM	With Weight d0 Covariate		
				Feed 1	Feed 2	SEM
0	11.4	11.6	0.1	-	-	-
5	13.1 <sup>a</sup>	13.4 <sup>b</sup>	0.1	13.2	13.3	0.1
10	15.3 <sup>a</sup>	15.6 <sup>b</sup>	0.1	15.4	15.5	0.1
14	17.7 <sup>a</sup>	18.1 <sup>b</sup>	0.1	17.8	18.0	0.1
28	30.0 <sup>a</sup>	30.9 <sup>b</sup>	0.3	30.1	30.7	0.2
42	48.8	49.7	0.4	49.1	49.4	0.3

<sup>a,b</sup> Pairs of means with different superscripts differ ( $P < 0.05$ ).

The importance of sow parity should be taken into consideration when allotting pigs to treatments due to the impact gilt progeny can have on live animal and economic performance. Table 2 shows some of the differences in biological performance between the progeny of gilts and older parity sows (Moore et al., 2005). Ensuring gilt progeny are equally balanced across treatments is important to avoid gilt progeny impacting one treatment more than another. It is well known that litter size is typically lower in gilt litters than older parity sows thus for sow and boar line trials it is important to balance parity across treatments.

**Table 2. Impact of sow parity on progeny performance.**

Item	Gilt progeny	P2+ progeny
Wean weight, kg	5.30	5.74
Nursery mortality, %	3.17	2.55
Nursery ADG, g/d	412	435
Nursery drug cost, \$/pig	2.15	0.85
Finisher mortality, %	4.31	2.95
Finisher ADG, g/d	735	763
Finishing dry cost, \$/pig	1.82	1.01
Lungs with enzootic pneumonia lesions	31	11

Moore et al. (2005) (more than 5000 pigs per column).

3. **Replication** – The number of replicates needed to detect differences is dependent on the amount of variability in the response criteria (ADG, Feed:Gain, etc.) and the magnitude of the desired difference from the control group. Increasing variability increases the sample size needed to detect significant differences (Table 3). As the magnitude of the difference to be detected between treatments increases the sample size required decreases. Typically the coefficient of variation (CV) of growth rate and feed efficiency is 10 to 15% in nursery trials and 5 to 10% in finisher trials (a greater CV reflects greater variation). Therefore, a trial with 6 to 10 replications will be able to detect significant differences of 10 to 20%. For reproductive studies, typically CVs observed for total and live born per litter are 25 to 30% and need approximately 100 litters to detect 10% differences.

**Table 3. Replicates needed per treatment for experiments of 80% power and p-value <0.05.**

CV( %)	Difference from control to detected (%)				
	5	10	20	40	80
5	17	6	3	2	2
10	63	17	6	3	2
20	252	63	17	6	3
40	1005	252	63	17	6
80	4020	1005	252	63	17

CV = coefficient of variation = standard deviation/mean.

Adapted from Berndtson (1991).

4. **Trial protocol** – Once the question(s) to be answered is (are) clearly determined, and potential economic value to your farm, trial design, and number of replications required is determined, the next step is to write out how the trial is to be conducted step by step. A good trial protocol should contain:
- A brief introduction as to why the trial is being conducted with specific objectives.
  - Details of the materials and methods of the trial:
    - The number of pigs and experimental units (EU) to be used.
    - Number of treatments and what they are.

- iii. Explanation of how treatments will be assigned to EU.
  - iv. If a feeding trial full details of the diets should be included.
  - v. What measurements are being taken (ADG, feed intake, etc.) and how.
  - vi. Over what period pigs are going to be on trial.
  - c. Trial management:
    - i. How are pigs going to be assigned to pens?
    - ii. Feeding program for the trial.
    - iii. Are pigs going to be blocked, and blocked based on what (location in room, initial weight, gender, etc.)?
    - iv. How often are pigs going to be weighed?
    - v. Samples of treatment diets should be taken on each weigh day.
    - vi. Daily checking of pens – what is going to be done – provide details.
    - vii. Pigs removed off test – what is recorded.
    - viii. If pigs need to be treated individually or as a group this should be recorded along with the reason.
    - ix. Out of feed events should be recorded with the reason.
    - x. Checking of scales with test weight on each weigh day.
    - xi. If feed is to be weighed how is this going to be done – provide details.
    - xii. Feed budget (kg/pig or days) to be fed on each diet.
    - xiii. If it is a feeding trial involving dietary treatments, diets need to be sent to the feed mill, and printed and signed copies from the mill computer returned to verify they were entered correctly.
    - xiv. All hard copy records should be stored in a folder on site and a copy sent to the main contact person in the trial to store a copy off site.
  - d. Marketing:
    - i. Are pigs to be weighed live before leaving the barn to allow calculation of dressing percent or carcass yield?
    - ii. Carcass data to be obtained, e.g. back fat, loin depth, index, etc. should be detailed.
    - iii. How pigs are going to be tattooed for marketing on a per pen or treatment basis.
    - iv. Are pigs to be marketed on reaching a target market weight (for example 120 kg) or a fixed number per pen on each marketing day?
  - e. Personnel involved – A list of all the personnel involved with the trial, their contact information, and their responsibilities should be clearly laid out so everyone is clear on what is expected of them. This should be included in the protocol. This clearly lays out who is responsible for what and there is no confusion. One person needs to be listed as the main contact if there are questions with the protocol or during the trial.
5. ***Data analysis and expressing results*** – Once the trial is completed all the data should be summarized and double checked to verify no entry errors. The pivot tables function of Microsoft Excel could be used to summarize the data and to look at the raw data, however, caution must be used when interpreting the numbers since averages in pivot tables are rarely weighed (adjusted for group size). If group sizes are relatively similar, not accounting for weighting will have little impact. However, if group sizes are variable the raw means and the mean of the groups can differ significantly from the weighted average. The raw data can be imported into a statistical software program for analysis and tables generated with the key results of importance of the trial for the farm. Methods to express the results of production

and nutrition trials have evolved from biological to economic measures. In the past, simplistic measures such as growth rate, feed disappearance, feed:gain, death loss and diet cost were commonly evaluated, whereas today we look more at feed cost per kg of gain, and income over feed cost (IOFC). As we feed more co-products (DDGS, millrun, canola meal, etc.) and less grain we can potentially see lower biological performance (growth rate and feed intake) but depending on the diet cost savings the feed cost per kg of gain and IOFC can be higher with the higher co-product inclusion level (Table 4; Jha et al., 2011). However, co-products contain more fibre, which stimulates development of visceral organs, which can reduce dressing percentage. Therefore, using response criteria such as carcass growth rate and IOFC (which includes carcass dressing percentage) are a more accurate measure of the impact of treatments on net return to your farm as it is based on carcass weight, which you get paid for, not live weight.

**Table 4. Effect of diet co-product levels on biological and economic performance.**

Co-product level	Low	Medium	High
Growth, g/day	999 <sup>a</sup>	933 <sup>b</sup>	920 <sup>b</sup>
Feed disappearance, kg/d	2.87 <sup>a</sup>	2.71 <sup>b</sup>	2.66 <sup>b</sup>
Feed:gain	2.87	2.90	2.89
Feed cost/kg gain, \$	0.842 <sup>a</sup>	0.788 <sup>b</sup>	0.747 <sup>b</sup>
IOFC, \$/pig	39.5 <sup>a</sup>	39.9 <sup>a</sup>	42.4 <sup>b</sup>
Diet cost, \$/tonne	295	273	260
Carcass dressing % <sup>x</sup>	78.0 <sup>a</sup>	77.1 <sup>b</sup>	77.0 <sup>b</sup>

IOFC = Income over feed cost; <sup>x</sup> Carcass weight was used as a covariate.

## CONCLUDING REMARKS

Conducting on-farm trials can provide very valuable biological and economic information to determine the value of new products or technologies for your specific farm. Careful planning and management of the trial are required, however, to ensure that the trial is successfully conducted and to maximize the value of the results.

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# **PIG HANDLING AND TRANSPORTATION STRATEGIES UTILIZED UNDER U.S. COMMERCIAL CONDITIONS**

**Matt Ritter, Phil Rincker, and Scott Carr**  
**Elanco Animal Health**  
**2500 Innovation Way, Greenfield, IN, 46140**  
**E-mail: [ritterma@elanco.com](mailto:ritterma@elanco.com)**

## **ABSTRACT**

The percentage of dead and non-ambulatory pigs at the packing plant averaged across 23 U.S. commercial field trials were 0.25% for dead and 0.44% for non-ambulatory pigs, and these losses have been estimated to cost the U.S. swine industry approximately \$46 million annually. There are two types of non-ambulatory pigs observed under U.S. commercial conditions: fatigued (non-ambulatory, non-injured) and injured. The vast majority of non-ambulatory pigs are classified as fatigued. Fatigued pigs display signs of acute stress (open-mouth breathing, skin discoloration, and/or muscle tremors) and are in a metabolic state of acidosis characterized by low blood pH and high blood lactate values. Transport losses (dead and non-ambulatory pigs) at the packing plant are a multi-factorial problem consisting of people, pig, facility design, transportation, packing plant, and environmental factors. Although few studies have been conducted to determine the causes of dead and non-ambulatory pigs, it is well established that transport losses are increased by the HAL-1843 mutation, aggressive handling with electric prods, crowding pigs during transport, and extreme weather conditions. Management strategies to reduce transport losses under U.S. commercial conditions include better preparing pigs for transport, improving facility designs, minimizing stress during handling, and optimizing transport conditions.

## **INTRODUCTION**

Transport losses at the packing plant represent animal welfare, regulatory, and economic concerns to the U.S. swine industry. First of all, improving the well-being of pigs during transport and reducing the incidence of dead and non-ambulatory pigs are animal welfare priorities. Secondly, non-ambulatory livestock are the subject of increased rules and regulations. For example, U.S. Department of Agriculture (USDA) inspectors and plant welfare auditors evaluate how non-ambulatory pigs are handled at the packing plant. Improper handling of non-ambulatory pigs at the plant can result in a USDA non-compliance report and/or a failed plant welfare audit. Thirdly, transport losses represent direct financial losses to pork producers and packers, and these losses have been estimated to cost the U.S. swine industry approximately \$46 million annually (Ritter et al., 2009a). The objectives of this paper are to: 1) define transport losses in market weight pigs; 2) estimate the incidence of transport losses; 3) discuss seasonal variation in dead and non-ambulatory pigs; 4) describe the symptoms and metabolic characteristics of fatigued pigs; 5) review pre-disposing factors for transport losses; and 6) outline management strategies to reduce these losses under commercial conditions.

## TERMINOLOGY / DEFINITIONS

Dead and non-ambulatory pigs are most commonly observed during unloading at the packing plant, but these losses can occur at any stage of the marketing process from loading at the farm to stunning at the plant. Transport losses at U.S. packing plants include:

- Dead on arrival (DOA) – a pig that died during transportation
- Dead in yard (DIY) or dead in pen (DIP) – a pig that died after unloading at the plant
- Non-ambulatory pig – a pig unable to move or keep up with the rest of the group at the plant

There are two types of non-ambulatory pigs observed under U.S. commercial conditions:



Fatigued



Injured

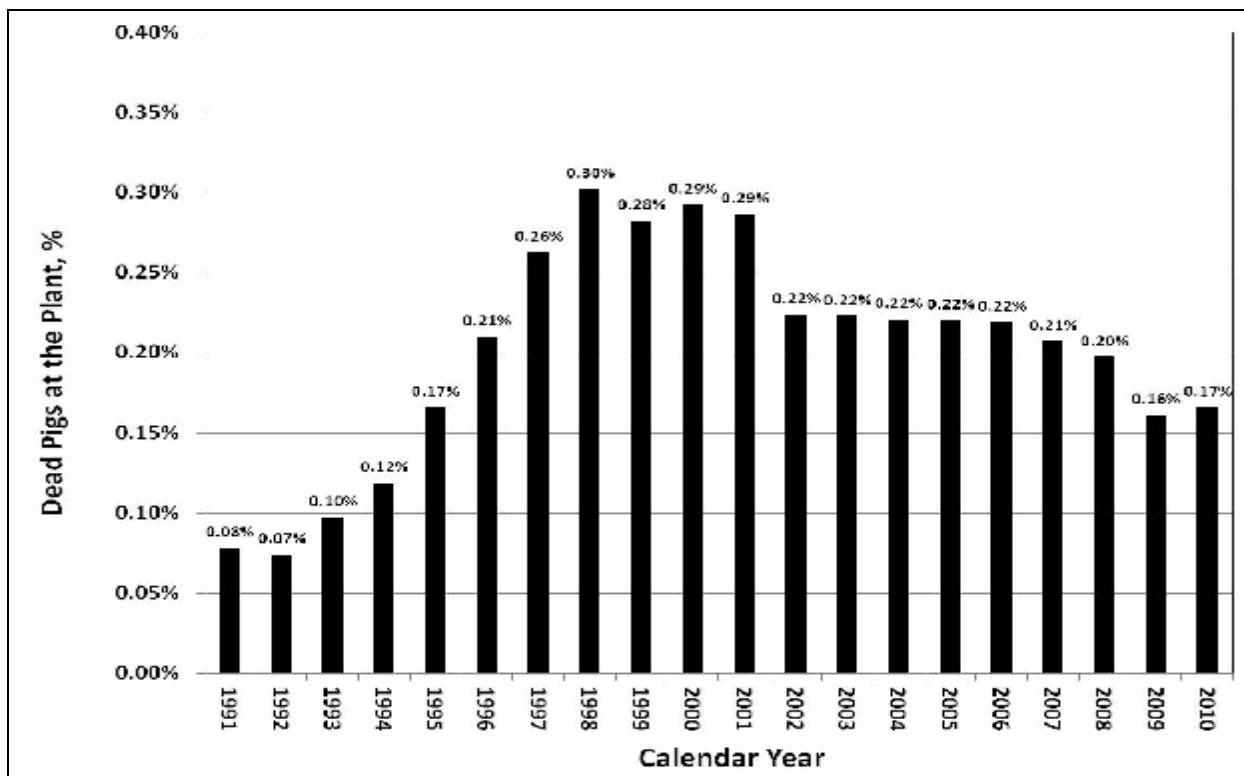
Fatigued pigs are pigs without obvious injury, trauma, or disease that refuse to walk at any stage of the marketing process from loading at the farm to stunning at the plant. Meanwhile, injured pigs have a compromised ability to move due to structural unsoundness or due to an injury sustained during the marketing process (Ritter et al., 2009a).

## INCIDENCE OF DEAD PIGS AT PACKING PLANTS

The percentage of dead pigs at USDA inspected plants is reported to the Food Safety Inspection Service (FSIS) as “swine condemned ante-mortem for dead”. These national statistics are available to the public via the Freedom of Information Act and take into account all dead pigs at the packing plant (i.e., dead on arrival, euthanized, dead in pen, and yard dead). The annual data on the percentage of dead pigs at USDA inspected packing plants for the calendar years of 1991 through 2010 are presented below in Figure 1 (FSIS, 2007; 2008; 2009; 2010; 2011).

### 1991 to 2001

The incidence of dead pigs at U.S. plants was very low in 1991 (0.08%) and 1992 (0.07%). However, the percentage of dead pigs at U.S. plants increased three-fold between 1993 and 1998 (Figure 1; 0.10% and 0.30%, respectively) (FSIS, 2007). It is unclear why this value increased over this period, but some potential explanations include changes in genetics, increased live weights, and increased size of production operations (Ellis et al., 2003). From 1998 to 2001, the percentage of dead pigs peaked and remained relatively constant (range: 0.28% to 0.30%; Figure 1) (FSIS, 2007).



**Figure 1. Percentage of dead pigs at USDA inspected plants by year from 1991 to 2010 (FSIS, 2007; 2008; 2009; 2010; 2011).**

## 2002 to 2010

From 2001 to 2002, the percentage of dead pigs at U.S. plants decreased from 0.29% to 0.22% (Figure 1) (FSIS, 2007). This decrease might be attributed to greater industry awareness of losses during the marketing process. In 2002, the National Pork Board's Transport Quality Assurance™ (TQA™) program was made available, and there was a strong focus on research that yielded important results (Anderson et al., 2002; Ellis et al., 2003; NPB, 2004).

The percentage of dead pigs at the plant then leveled off at 0.22% during the years of 2002 to 2006 (Figure 1) (FSIS, 2007). It is currently unknown why little change was made over this time period. However, it is important to note that during this same time period, several packers began to euthanize non-ambulatory pigs that had a low likelihood of recovering, and these pigs were reported as dead pigs to FSIS. Therefore, the definition of a dead pig at USDA inspected plants has recently changed and now includes pigs that are euthanized at the plant (Ritter et al., 2009a). Another important fact to consider is that porcine circovirus type 2 (PCV2) had a major impact on the health and mortality of finisher pigs marketed over this time period as the first commercial vaccine was not available in the U.S. until July of 2006 (Gillespie et al., 2009; Kristensen et al., 2011).

Meanwhile, dead pigs at the packing plant have decreased over the last four calendar years to 0.17% in 2010 (FSIS, 2007; 2008; 2009; 2010; 2011). This improvement may be attributed to pork producers and packers working together to implement proactive management strategies to prevent / minimize transport losses. For example, on-farm and in-plant training programs,

standard operating procedures for pig handling and transportation, loading assessments, handling audits, and databases for transport losses have evolved significantly over the past four years.

## **INCIDENCE OF NON-AMBULATORY PIGS AT PACKING PLANTS**

Unfortunately, national statistics are not available for the percentage of non-ambulatory pigs at the plant, and thus, commercial field trials are currently our best indicator of the incidence of non-ambulatory pigs in the U.S. A total of 23 commercial field trials have been conducted in the U.S. and the results from these studies have recently been summarized (Ritter et al., 2009a). The percentage of dead pigs, non-ambulatory pigs, and total losses (dead and non-ambulatory) at the plant averaged across the 23 field trials (n = 6,660,569 pigs) were 0.25% for deads, 0.44% for non-ambulatory pigs, and 0.69% for total losses. Non-ambulatory pigs were classified as fatigued or injured in 18 of these field trials, and the rates of fatigued and injured pigs averaged across these 18 field trials (n = 4,966,419 pigs) were 0.37% and 0.05%, respectively. Therefore, the majority of non-ambulatory pigs at the plant in U.S. field trials were classified as fatigued.

## **SEASONAL VARIATION IN TRANSPORT LOSSES**

Figure 2 illustrates the monthly incidence of dead market pigs at USDA-inspected plants for the calendar year of 2010. The months of July, August, and September had higher rates of dead pigs than the 2010 average of 0.17% (FSIS, 2011). This comes as no surprise as it is well documented that the percentage of dead pigs at the packing plant is highest during the summer months (Rademacher & Davies, 2005; Ellis & Ritter, 2006; Ritter, 2008).

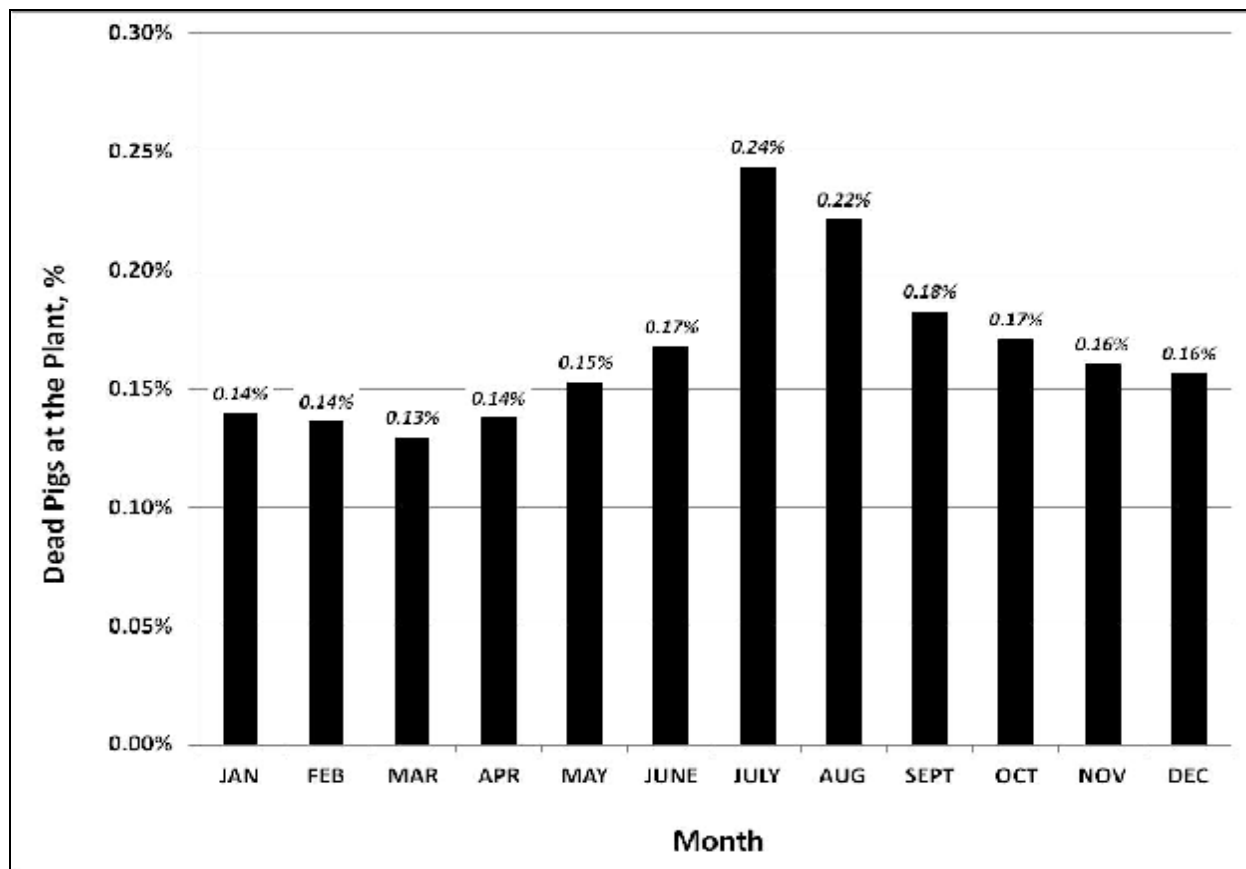
Meanwhile, several U.S. field studies have reported that the rates of non-ambulatory pigs are the highest during the late fall and early winter months (Rademacher & Davies, 2005; Ellis & Ritter, 2006; Ritter, 2008). It is currently unknown why the rate of non-ambulatory pigs increases during the late fall and early winter months. However, some potential explanations include: temperature stress, heavier market weights, increased numbers of pigs being harvested, and changes in health status (Ellis & Ritter, 2006).

## **SYMPTOMS AND METABOLIC CHANGES IN FATIGUED PIGS**

Fatigued pigs display signs of acute stress (open-mouth breathing, skin discoloration, and/or muscle tremors), are in a metabolic state of acidosis (characterized by low blood pH and high blood lactate values), and may have elevated body temperatures (Ritter et al., 2009a; Gonyou H.W., unpublished). However, controlled research has demonstrated that the vast majority of fatigued pigs will metabolically recover, if the stressors are removed, and pigs are allowed to rest for 2 to 3 hours (Anderson et al., 2002; Hamilton et al., 2004; Ritter et al., 2006).

It is interesting to note the striking similarities between the symptoms and metabolic characteristics of fatigued pigs to those of pigs with Porcine Stress Syndrome (Ritter et al., 2009a; Topel et al., 1968; Topel et al., 1981). A recent commercial field trial involving 2,109 pigs was conducted at four Midwestern U.S. packing plants to determine the impact of the HAL-1843 mutation on the incidence of dead and fatigued pigs at U.S. packing plants. This study demonstrated that 98% of the normal pigs, 95% of the dead pigs, and 98% of the fatigued pigs evaluated were negative for the HAL-1843 mutation (Ritter et al., 2008a). This suggests that the HAL-1843 mutation has basically been eliminated from the U.S. commercial pig population, and

thus, has only minor effects on the overall incidence of dead and non-ambulatory pigs at the packing plant.



**Figure 2. Percentage of dead pigs at USDA inspected plants by month in 2010 (FSIS, 2011).**

## **PRE-DISPOSING FACTORS FOR TRANSPORT LOSSES**

Transport losses are a multi-factorial problem consisting of people (handling tools and handling intensity), pig (genetics, diet, gut fill, live weight, gender, health status, and previous handling experiences), facility design (pen size, pre-sorting strategies, aisle width, distance moved, and loading ramp angle), transportation (trailer design, mixing of unfamiliar pigs, loading density, and length of journey), packing plant (waiting time at the plant, unloading procedures, distance moved, facility design, and lairage time), and environmental factors (season, temperature, relative humidity, and trailer settings for bedding, boarding, and misting) (Ritter, 2008).

Of these fore-mentioned factors, it is well established that transport losses are increased by:

1. The HAL-1843 mutation (McPhee et al., 1994; Murray & Johnson, 1998; Fàbrega et al., 2002)
2. Aggressive handling with electric prods (Benjamin et al., 2001; Gonyou, unpublished)
3. Crowding pigs during transport (Ritter et al., 2006; 2007; Ritter, 2007)
4. Extreme weather conditions (heat stress and cold stress) (Ellis & Ritter, 2006; Ritter, 2008)

## MANAGEMENT STRATEGIES TO REDUCE TRANSPORT LOSSES

Pre-slaughter stressors have additive effects on the stress responses (rectal temperature, blood lactate, and blood pH values) of market weight pigs (Ritter et al., 2009b). Therefore, removing just one stressor during the marketing process can improve the pig's well-being and can potentially reduce transport losses at the plant. Management strategies to reduce transport losses under U.S. commercial conditions include preparing pigs for transport, improving facility design, minimizing stress during handling, and optimizing transport conditions. Below is a summary of recent research and key findings on these topics.

### Prepare pigs for transport

**1. Previous handling.** Stewart et al. (2008) evaluated the effects of previous handling on loading time, physical signs of stress during loading and unloading, and transport losses at the packing plant. Previous handling treatments (control vs. previous handling) were implemented the day before loading. Pigs assigned to the previous handling treatment were moved out their barn pen to an outside load-out area, were turned around, and returned to their home pen by two handlers. Meanwhile, control pigs were not handled and remained in their original barn pens. These authors reported that previous handling reduced loading time, pigs exhibiting open-mouth breathing and skin discoloration during loading, and tended to reduce total transport losses (0.07% vs. 0.38%) compared to pigs that were not previously handled.

**2. Feed withdrawal.** Two U.S. commercial trials have evaluated the effects of feed withdrawal on transport losses at the packing plant. Ritter (2007) compared pigs fasted for 0 or 24 h prior to loading and reported that 24 h feed withdrawal reduced total transport losses by 50 % compared to the control treatment, but these results were not statistically significant (0.18% vs. 0.36%;  $P = 0.31$ ). In a follow-up trial involving 14 loads of pigs, Stewart et al. (2008) compared pigs fasted for 0 or 16 h prior to loading and reported that 16 h feed withdrawal significantly reduced total transport losses (0.0% vs. 0.39%). Collectively, these two commercial field studies suggest that feed withdrawal may reduce transport losses in market weight pigs, but additional research involving a larger number of animals are needed to confirm these findings.

### Improve facility design

**1. Loading distance.** Loading distance refers to the distance pigs are moved from the barn pen to the trailer during loading. Two commercial field trials have evaluated the effects of loading distance on transport losses at the packing plant (Ritter et al., 2007; 2008b). These studies compared pigs moved short (front 1/3 of the barn) vs. long distances (back 1/3 of the barn) during loading. Both studies reported that pigs moved long distances during loading tended to have higher rates of non-ambulatory pigs at the farm than pigs moved short distances. However, after a 3 to 4 h journey to the packing plant, there was no effect of loading distance on dead or non-ambulatory pigs at the packing plant.

**2. Large pens with pre-sorting capabilities.** Raising grow-finish pigs in large pens with pre-sorting capabilities has important implications for minimizing stress during loading and reducing transport losses at the packing plant because: 1) large pens allow pigs to have more room to exercise during the grow-finish period; 2) pre-sorting allows market weight pigs the opportunity to rest and recover from the stress of being sorted from pen mates; 3) pre-sorting enables producers to withdrawal feed on all pigs marketed; 4) pre-sorting may reduce the distance pigs are moved during loading, if pre-sort pens are located by the barn exit; and 5) loading pigs from

large pens may reduce the number of unfamiliar pigs that are mixed during transportation. Barns with auto-sort systems house pigs in pens of approximately 500, require pigs to walk across a scale before entering a food court, and automatically pre-sort market weight pigs from pen mates prior to loading. Two U.S. commercial surveys have reported that pigs raised in barns with auto-sort systems have fewer dead pigs at the packing plant than pigs raised in traditional finishing barns with small pens that were not pre-sorted prior to loading (Brumsted, 2004; Rademacher & Davies, 2005). Furthermore, a few large production systems in the U.S. are raising pigs in large pens ( $\geq 200$  pigs/pen) with internal swinging gates that are used to manually pre-sort market weight pigs from pen mates prior to loading. This new facility design system was recently evaluated by Johnson et al. (2010), who compared pigs raised in small pens of 32, not pre-sorted prior to loading vs. pigs raised in pens of 192, pre-sorted 24 h prior to loading. This study demonstrated that raising pigs in large pens and pre-sorting prior to loading reduced dead and non-ambulatory pigs at the packing plant by 66% compared to the traditional grow-finish design (pens of 32, not pre-sorted). However, additional research is necessary to determine if this improvement is due to raising pigs in large pens and/or the management practice of pre-sorting market weight pigs prior to loading.

**3. Loading ramp design.** Berry (2007) compared the handling characteristics and transport losses of market weight pigs loaded at the farm by using a traditional metal covered chute or a prototype loading gantry. The prototype loading gantry was used to load both the bottom ( $7^\circ$  ramp angle) and top ( $18^\circ$  ramp angle) decks of the trailer. Meanwhile, the traditional chute was used to load only the bottom deck of the trailer ( $19^\circ$  ramp angle), while the internal trailer ramp was utilized to load the top deck ( $23^\circ$  ramp angle). The number of shocks administered from an electric prod, slips, falls, vocalizations, and pile ups observed during loading were reduced by using the prototype loading gantry compared to the traditional chute. Furthermore, the percentage of total transport losses at the packing plant was lower for pigs marketed on the first cut with the prototype loading gantry compared to the traditional chute, but there were no treatment differences between loading chutes for transport losses on the close-out loads. Additional research is necessary to evaluate the different components of loading chute design (ramp angle, chute width, flooring, lighting, covered vs. uncovered, etc.) and their impact on dead and non-ambulatory pigs at the packing plant.

## **Minimize stress during handling**

**1. Flight zone and point of balance.** The flight zone refers to the animal's personal space or comfort zone (NPB, 2004; Grandin, 2008). When a handler enters the flight zone, the animal will move away in the opposite direction from the handler. Meanwhile, the point of balance is located directly behind the shoulder. Where the handler stands or taps the pig in relation to the point of balance will dictate which direction the pig will move. McGlone et al. (2004) conducted a study to determine the optimal place to tap or shock pigs in order to move them forward. This study compared tapping or shocking pigs with plastic paddles or electric prods on the ham, neck, rear leg, back, left side or right side. These authors confirmed that the most effective area to tap or shock a pig to move it forward is on the back behind the point of balance.

**2. Handling tools.** Three common handling tools that are used at the farm during loading include: sorting boards, plastic livestock paddles, and if necessary, electric prods. In a recent study (McGlone et al., 2004), pigs were moved through a handling course with one of three different handling tools (sorting board vs. electric prod vs. plastic paddle) and the time to

complete the course for each group of pigs was recorded. Pigs moved with sorting boards required less time to complete the handling course than pigs moved with only plastic paddles or electric prods. The authors concluded that the sorting board is the single most effective tool for moving pigs. Therefore, all handlers and drivers need to use a sorting board when loading pigs.

**3. Handling intensity.** Handling intensity refers to the pace in which pigs are encouraged to move during handling. It is well documented that aggressive handling with electric prods increases rectal temperature, blood lactate values, and the percentage of fatigued pigs during handling (Benjamin et al., 2001; Anderson et al., 2002). Furthermore, a recent study by Gonyou (unpublished data) compared moving market weight pigs through a handling course with three different handling treatments: 1) gentle handling with plastic paddles; 2) aggressive handling with plastic paddles; and 3) aggressive handling with electric prods. When pigs were handled aggressively with electric prods, 34% of the pigs were classified as fatigued immediately after the handling procedure. If the electric prod was replaced with a plastic paddle and the pigs were still moved aggressively, a 19 percentage point reduction in fatigued pigs was observed. However, there was an additional 13 percentage point reduction in fatigued pigs, if pigs were moved at a slow and calm pace with a plastic paddle. These data demonstrate the negative effects of aggressively handling pigs with electric prods on transport losses and highlight the importance of moving pigs at a slow and calm pace with a plastic paddle.

**4. Electric prod use.** As mentioned above, it is well documented that aggressive handling with electric prods increases the rate of fatigued pigs (Benjamin et al., 2001; Gonyou, unpublished data). Therefore, electric prods should only be used as a last resort to move pigs. Unfortunately, the acceptable number of shocks that can be applied to market weight pigs during handling is currently unknown as there is a limited amount of published data on the effects of minimal electric prod use on stress responses during handling. Ritter et al. (2008c) compared the stress responses of 48 market weight pigs moved through a handling course with 0, 2, or 4 shocks from an electric prod. The pigs evaluated in this study were allowed to move at their own pace, the duration of the shocks was  $\leq 1$  second, and pigs assigned to the 0 shocks treatment were moved with a plastic paddle. These authors reported that pigs moved with 4 shocks had higher rectal temperatures and blood lactate values than pigs moved with 0 shocks, but pigs moved with 2 shocks had similar rectal temperatures and blood lactate concentrations as pigs moved with plastic paddles (0 shocks). This small study suggests that stress responses during handling can be minimized if market weight pigs are moved with  $\leq 2$  shocks/pig. However, additional research involving a larger number of pigs under commercial conditions is necessary to confirm these results and to define acceptable use of electric prods.

**5. Group size.** Berry et al. (2009) conducted a controlled commercial study to evaluate the effects of loading market weight pigs (119.9 kg) in two different group sizes (groups of 4 vs. 8) through a 76 cm wide aisle to determine the effects of group size on loading time, physical signs of stress (during loading and unloading), and transport losses at the plant. The key findings from this study were that pigs moved in groups of 4 required less time to load, had lower rates open-mouth breathing and skin discoloration during loading and unloading, and had 56% fewer dead and non-ambulatory pigs at the packing plant. These data confirm that group size during loading has a major impact on transport losses at the plant, but additional research is necessary to determine the optimal group size for moving pigs of all ages through various aisle widths.



## Optimize transport conditions

**1. Trailer design.** Ritter et al. (2008b) utilized 109 trailer loads of pigs to investigate the effects of trailer design (pot-belly vs. straight-deck trailers) on handling characteristics, stress responses (during loading and unloading), transport losses, and carcass trim loss. Although pigs unloaded from pot-belly trailers took 16 min longer to unload, required more electric prod usage to exit the trailer, and exhibited a higher percentage of open-mouth breathing and skin discoloration at the plant compared to pigs unloaded from straight deck trailers, there was no effect of trailer design on the percentage of dead pigs, non-ambulatory pigs, total transport losses, or carcass trim loss.

**2. Transport floor space.** Transport floor space refers to the amount of space that pigs are provided on the trailer during transportation. A series of three controlled studies were conducted under U.S. commercial conditions to determine the effects of transport floor space on dead and non-ambulatory pigs at the packing plant. These studies utilized market weight pigs (129 kg) with journey times of 2-3 h and demonstrated that transport floor space has a major impact on dead and non-ambulatory pigs at the packing plant (Ritter et al., 2006; Ritter et al., 2007; Ritter, 2007). In general, transport losses were minimized in these studies when market weight pigs (129 kg) were provided with transport floor spaces of  $\geq 0.46 \text{ m}^2/\text{pig}$ , and this translates to loading densities of  $281 \text{ kg/m}^2$  or  $0.355 \text{ m}^2/100 \text{ kg}$ . However, it is worth mentioning that in one of the studies (Ritter, 2007), the effects of transport floor space on losses at the plant were dependent upon season, where transport floor space had a pronounced effect on transport losses in the summer the months, but no effect in the winter months. Therefore, additional research is necessary to determine the optimal transport floor spaces for market hogs transported on short and long hauls over all four seasons.

**3. Mixing unfamiliar pigs during transport.** Ritter (2007) utilized 37 trailer loads of market weight pigs to determine the effects of mixing unfamiliar pigs during transport on transport losses at the plant. This study compared two treatments: mixed vs. unmixed. Unmixed groups had ~50 % numerically lower total transport losses than mixed groups, but these differences were not statistically significant (0.19 % vs. 0.37 %;  $P = 0.34$ ). It is important to note the low percentage of dead and non-ambulatory pigs observed in this study. Therefore, additional research is necessary to evaluate the effects of mixing unfamiliar pigs during transport on farms experiencing higher rates of transport losses than those encountered in the work of Ritter (2007).

**4. Managing trailer settings for cold and hot weather.** Current U.S. recommendations for boarding / bedding trailers in cold weather and showering pigs in hot weather can be found in the National Pork Board's Trucker Quality Assurance Handbook (2010). However, these recommendations are based on best industry practices and not on scientific studies, and this represents a large gap in the literature. Therefore, a series of controlled studies are currently being conducted in the U.S. to scientifically define boarding / bedding and showering requirements for market hogs transported in cold and hot weather, respectively.

## CONCLUSIONS

Approximately 0.7% of all U.S. market weight pigs become non-ambulatory or die at or en route to the packing plant. In other words, over 99% of the market hogs transported in the U.S., walk off the trailer, walk through the plant, and are processed without delay. Despite the large percentage of pigs that are unaffected, these transport losses have been estimated to cost the U.S. swine industry approximately \$46 million annually. Transport losses are a multi-factorial

problem that can be influenced by growers, loading crews, transporters, and handlers at the packing plant. Management strategies to reduce transport losses under U.S. commercial conditions include better preparing pigs for transport, improving facility designs, minimizing stress during handling, and optimizing transport conditions.

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# **NEW HANDLING AND TRANSPORTATION STRATEGIES UNDER CANADIAN CONDITIONS**

**Luigi Faucitano**  
**Agriculture & Agri-Food Canada**  
**Dairy and Swine Research and Development Centre**  
**2000, College Street, Sherbrooke, QC, J1M 0C8**  
**E-mail: [luigi.faucitano@agr.gc.ca](mailto:luigi.faucitano@agr.gc.ca)**

## **ABSTRACT**

Death losses during transportation in Canada may be low (0.08%), but the total loss amounts to approximately 17,000 pigs per year. The rate of loss is higher during the summer months and differs with farm of origin and with transporters. The effect of the farm of origin can be attributed, among others, to the pre-transport handling of pigs and farm design. Canadian research and industry reports showed that withdrawing feed prior to transport, the elimination of electric prods and driving pigs in small groups through sufficiently wide alleys and ramps reduce the incidence of transport losses (DOA and non-ambulatory pigs) and carcass condemnations, while improving pork quality. Results arising from transportation studies run in Canada over the last few years showed that the design of the pot-belly trailer, characterized by multiple and steep ramps, and 180° turns, increases the use of electrical prodding, influences pig behaviour and welfare parameters (core body temperature, heart rate and blood indicators) and reduces meat quality. These effects are even more evident when this truck is used for the transport of stress-susceptible pigs for short distances, and for long distance transportation (18 h) in winter.

## **INTRODUCTION**

In Canada, up to 17,000 dead-on-arrival (DOA; 0.08%; CFIA, 2006-2010) has been reported each year. A pig death during transit is a major economic loss for producers and transporters. In Quebec, it has been reported at \$4 million lost due to death losses (13,000 deaths or 0.08 %) and carcass value loss (30 %) resulting from the percentage of pigs becoming non-ambulatory during transport (0.44 %; Martel, 2010).

An epidemiological study run in Ontario reporting 0.17% in-transit mortality rate and 0.27% non-ambulatory pigs on arrival at the plant identified the major source of variation in animal losses as being the farm (25%) followed by the transporter and the packer (16 % each) (Sunstrum et al., 2006; Dewey et al., 2009).

The objective of this paper is to provide an overview of current research findings and outputs of industry initiatives related to the effects of handling techniques, moving strategies, loading facilities and transport conditions on total losses, stress response to preslaughter handling and carcass and meat quality.

## **HANDLING AT THE FARM**

In the afore-mentioned Canadian epidemiological study a wide variation among producers was reported with 10% of the producers losing at least 0.4% of their pigs during transport (Dewey et

al., 2004). The effect of the farm of origin on animal losses and stress response, as well as on carcass and meat quality in pigs, can be partly attributed to differences in the preparation of pigs for transport (i.e. feed withdrawal), barn design and in the handling of pigs as they are moved out of the barn and loaded onto the truck (Correa et al., 2010; Correa, 2011a).

## **FEED WITHDRAWAL BEFORE TRANSPORT**

Feed withdrawal is one of the practices for on-farm preparation of pigs before harvest which in Canada is regulated by codes of practice (AAFC, 1993). The potential advantages of feed withdrawal include the higher well-being of animals during transport (Bradshaw et al., 1996; Guàrdia et al., 1996), higher ease of handling (Eikelenboom et al., 1991), reduced carcass contamination due to lower risk of gut contents spillage during carcass evisceration (Saucier et al., 2007), and improved pork quality (Guàrdia et al., 2004, 2005).

Under practical conditions, Correa (2011a) reported that the application of the appropriate fasting interval at the farm reduced by half the proportion of animal losses during transport, while its misapplication produced 77% condemned carcasses due to contamination.

Despite these potential advantages, however, feed withdrawal is sometimes not used or misapplied by producers, resulting in complaints and penalties from the slaughter sector. For instance, a survey conducted at swine farms in Quebec reported that only 15% of pigs had no access to the feeder until the time of transport (Viau and Champagne, 1998). Some reasons for not withholding feed prior to transport were: 1) lack of a shipping room to which pigs sorted by live weight (split-marketing) could be transferred from their home pen in order to withdraw feed and allow them to rest until the arrival of the truck and 2) concern about body weight losses reducing the economic value of the carcass.

Chevillon et al. (2006) reported significant carcass weight loss (360 g/pig) only after 24 h of feed withdrawal. This loss resulted in a 0.33-point difference in dressing yield, which is equivalent to 30 g/h of cold carcass weight loss for a pig weighing 110 kg at slaughter. Kephart and Mills (2005) reported that 24 h of feed withholding permitted a savings of 2 kg of feed/pig. Furthermore, feeding pigs until the time of transport may be very costly because feed consumed by pigs takes 4 to 8 h to be absorbed in the small intestine after ingestion and most nutrients enter the blood 9 h after intake; thus, feed provided to pigs in the last 10 h will not be converted to carcass gain and represents a waste that the processing plant needs to deal with (Warriss, 1985).

Based on current data, Faucitano et al. (2010) considered that a period of 24 h between the last meal and slaughter appears to be an acceptable compromise to obtain optimal carcass yield and pork quality and safety. However, the welfare of fasted pigs still needs to be elucidated as pigs arriving at slaughter with empty stomachs are likely to feel hungry, as suggested by the increased drinking rate (Saucier et al., 2007; Goumon et al., 2012).

## **LOADING FACILITIES AND HANDLING**

Loading pigs onto the truck is considered the most critical stage of the transport period as shown by the 110-130 increase in the heart rate and by the increase of stress indicators (lactate) levels in blood compared to the values observed for a pig at rest, with these effects lasting until slaughter and eventually affecting meat quality (Correa et al., 2010; Edwards et al., 2010). The stress associated with loading procedures results from a combination of different factors, such as the

design of the loading facility (either ramp or quay), group splitting in the finishing pen, group size, and handling system.

### **1. Alley and ramp design**

On farms, the alley width is generally limited to the width of two pigs (0.6 to 0.8 m; Lachance et al., 2005). According to Kavanagh et al. (2009), an alley width of 0.9 to 1.2 m is the most conducive to easy handling (less turn-backs and handling interventions) compared to 2.4 m, regardless of the group size. However, these recommendations may not be applicable to the pigs of today as they are heavier and larger than in the past, which may result in increased incidence of bruises and lacerations on the carcass caused by animals hitting the alley and ramp walls while being driven to the truck (Correa, 2011a). In view of the risk of injury and the changes in pig body weight (from 113 to 130 kg) and conformation (3-4 inches wider) that have occurred over the last 5 years, the barn ramp and exit width have been increased by almost 1 m at a number of swine farms in Quebec (Correa, 2011a).

### **2. Group size**

Moving pigs in a group size larger than the farm alley, loading quay or ramp is a common practice at loading. This practice is mistakenly considered effective for speeding up handling; instead, it increases aggression and reduces resting behaviour, even in unmixed pigs (Barton-Gade, 1997). Considering the heart rate increase and the time involved in loading a transport vehicle, moving groups of 2 to 6 pigs at a time, depending on the farm alley and loading quay or ramp design, is recommended to help both producers and transporters save costs and ensure good animal welfare (Grandin, 1999; Lewis and McGlone, 2006). Recently, research trials run at the Prairie Swine Centre in Saskatchewan (Kavanagh et al., 2009) reported that, compared to groups of 12 or 20 pigs, moving a group of 4 or 8 animals is preferable for minimizing stress, based on the number of turn-backs, subjective handling score, squeals and handling interventions, regardless of the alley width (2.4 or 0.9 m).

### **3. Moving tools**

Poor farm facilities combined with the presence of large groups of pigs may cause handling problems at loading leading to indiscriminate use of electrical prodding and slowing down the loading procedure.

In Canada, the electric prod is used by 90 to 95% of truck drivers (Correa, 2011b). Recently, Correa et al. (2010) compared the efficacy of the board combined with either the electric prod or the paddle for driving pigs out of the finishing pen and along the alley and loading ramp. The electric prod helped move pigs quickly, but it was an aversive method with more pigs slipping, falling and overlapping. These behaviours may cause injury and muscle fatigue as evidenced by the higher number of non-ambulatory pigs on arrival at the plant and bruised carcasses resulting in higher ultimate pH due to glycogen exhaustion and blood splashes in the ham at slaughter (Correa et al., 2010).

Aggressive handling from handlers is often related to fatigue caused by the physical effort (higher heart rate) to load pigs onto a truck, especially when facilities are inadequate (e.g. > 24° ramp slope; Goumon et al., 2011). The implementation of animal welfare programs including training of personnel, removal of electric prods and economic incentives proved to reduce the proportion of animal losses from 0.41 to 0.08% and of condemned carcasses from 0.13 to 0.03% (Correa, 2011a).

## **TRANSPORT CONDITIONS**

### **1. Trailer design**

In Canada, truck designs can vary widely, from small single deck trucks to large three-deck punch-hole trailers (often referred to as “pot-belly” trailers). Pot-belly (PB) trailers are quite common in Canada, as they are often dual-purpose (transporting either pigs or cattle) and allow the transport of large loads of pigs (more than 200) on three decks (10 compartments) in one journey and for long distances. However, these vehicles incorporate multiple (up to 5) and steep (up to 40° slope) internal ramps and 180° turns, which result in a lower easiness of handling during loading and unloading, increasing the use of electric prods and extending the load and unload time (Torrey et al., 2008). These observations have been associated with the higher proportion of DOA and fatigued pigs in the PB trailer when compared to other vehicle types equipped with hydraulic decks, such as a double-decked truck or a flat-deck trailer (Cormier and Doonan, 2008; Correa, 2011a). This difference in stress response (based on exsanguination blood variables) between the PB trailer and other vehicle types equipped with hydraulic decks (flat-deck trailer) is even more evident when they are used to haul stress-susceptible (Hal-carriers) genotypes for a short distance (40 km; Vanelli Weschenfelder et al., 2010).

The very few results on the effects of vehicle design on pork quality are inconclusive. Correa et al. (2008) reported no effect on pork quality when comparing a PB trailer with a double-decked truck during 2 h travel time, whereas Vanelli Weschenfelder et al. (2010) found higher pH<sub>u</sub> (ultimate pH) values in hams of pigs being transported a short distance (45 min) using a PB trailer compared with a flat-deck trailer. However, no effect on meat quality was reported when these two trailer models were used for longer distance transportation (7 h).

It has been evidenced that the animal location (deck and/or compartment position in the truck) during transportation has an impact on its welfare and meat quality (Bench et al., 2008). Within the PB trailer, a higher proportion (32%) of pale, firm and non-exudative (PFN) pork was reported in pigs transported in the upper and lower decks in summer by Correa et al. (2008). Within the deck, pigs located in the upper front and bottom rear compartments showed an increased body temperature after loading (Tamminga et al., 2008) and higher heart rate at unloading (Goumon et al., 2012), while higher pH<sub>u</sub> and lower drip loss values, indicative of DFD (dark, firm, dry) pork, were reported in the loin and hams of pigs located in the middle front compartment (“bottom-nose”; Correa et al. 2009). More recently, Brown et al. (2012) reported an overall increased risk of PSE (pale, soft, exudative) pork traits in pigs loaded in the top front compartment. These effects are very likely the result of the physical exertion required by pigs to negotiate the ramps to get to these compartments.

### **2. Microclimate control inside the truck**

Environmental temperature during transit is generally considered as one of the greatest contributors to in-transit losses (Clark, 1979; Haley et al., 2008a,b). The highest deaths recorded in the above-mentioned Canadian transport survey were during the month of August (0.40%) when the maximum ambient temperature was 33.6°C (Haley et al., 2008b). However, seasonal effects on total transport losses do not always correspond with increases in environmental temperature. For example Clark (1979), using data from Saskatchewan, reported greater mortality losses in winter.



Given that the thermoneutral zone for pigs is 26-31°C, the air temperature inside the vehicle should not exceed 30°C (Randall, 1993). Temperatures up to approximately 30.2°C have been reported inside the PB trailer, with the the lower front compartments being up to 6 and 20°C warmer than the external ambient temperature during Canadian commercial transports in winter and summer, respectively (Brown et al., 2011). Haley et al. (2008b) found that as internal trailer temperature increased, DOA also increased with the 90<sup>th</sup> percentile of temperature corresponding with an internal temperature of 26.3°C. As the 90<sup>th</sup> percentile of temperature increased by 1°C, DOA increased by 1.26 (Haley et al., 2008a). Within the PB trailer, higher temperatures have been recorded in the front compartments of the middle and bottom deck (or “belly”), while the upper compartments presented lower temperatures (Brown et al., 2011). The higher and lower temperatures have been explained by the reduced ventilation and poor insulation, respectively (Brown et al., 2011). As suggested by Brown et al. (2011), in the summer the bottom and front compartments of a stationary PB trailer can be cooled by increasing the ventilation rate using fans in combination or not with water sprinkling to increase evaporative cooling. Indeed, effective ventilation and/or water sprinkling in a stationary truck are credited with reducing deaths during transport (Nielsen, 1982; Chevillon, 2000). In the summer of 2011, a joint project was run by the pan-Canadian swine transportation group with the objective to evaluate the efficiency of water sprinkling in a stationary vehicle on the behavioural and physiological response, and carcass and meat quality, in pigs and to identify the most appropriate average temperature to obtain the maximum efficiency. According to the preliminary results, the increase in ambient temperature (from 15 to 25°C) and the application of water sprinkling after loading and before unloading reduced lactate levels in blood at exsanguination, resulting in higher pH at 1 h post-mortem in the loin muscle. However, the better post-mortem muscle acidification rate only resulted in higher water exudation in this muscle at higher ambient temperature, regardless of water sprinkling in the truck. The effects of water sprinkling were different according to the compartment location inside the trailer, with better pork quality in the loin and ham being especially recorded in sprinkled pigs located in the middle front compartment. Water sprinkling also reduced exsanguination lactate levels in pigs transported in the middle front and rear compartments. Overall, it can be concluded that the maximum efficiency of water sprinkling in the stationary truck, in terms of lower transport stress and improved pork quality, can be obtained in the warm season, starting from 20°C (Nannoni, unpublished results).

### **3. Transport duration and distance**

According to the most recent transport survey in Canada, most pigs spent less than 3 h in the truck and 4% spent more than 24 h in transit (Aalhus et al., 1992). However, due to increased regionalization of packing plants over the last 15 years, it is speculated that today a larger percentage of pigs are long-haul transported (Bench et al., 2008).

The relationship between journey length and transport stress does not appear to be linear. Haley et al. (2008b) found that for each 50 km increase in distance DOA can be expected to decrease 0.81 times, and finally reported a decreased risk of in-transit death losses with distances over 134 km. Similarly, it has been observed that pigs hauled very short distances for under 30 min are less easy-to-handle at the plant and may produce poorer pork quality (PSE) than pigs transported for longer distances (Grandin, 1994).

Based on the results of the pan-Canadian swine transportation project (2007-2011), it appears that transport times above 6 h may result in energy depletion and an increased incidence of meat

quality defects related to the production of DFD pork (Correa et al., 2009). The combined effects of winter transport and longer transport times may have caused increased levels of energy depletion and further increased the incidence of DFD meat. Therefore, a study was run to evaluate the effects of transport duration (6, 12 and 18 h) on animal welfare during transportation and pork quality in summer and winter in Manitoba. The first preliminary results showed that under Canadian climatic conditions, pigs transported for 18 h in winter showed greater evidence of stress, in terms of higher core body temperature and heart rate (Goumon et al., 2012). The effects of season and trip duration on pork quality were modulated by the compartment location in the truck, with the winter longer transport time (18 h) resulting in a higher incidence of DFD pork in pigs located in the rear bottom compartment (Brown et al., 2012).

## CONCLUSIONS

The quality of the design of the loading facilities and of the handling system plays a key role in determining the effects of the farm on pig response to preslaughter stress and on meat quality. To reduce the load time and the workload of loading crews, it is recommended that farms use shipping rooms, move pigs in batches suited to the alley and ramp size and minimize, if not eliminate, the use of electric prods. With regard to moving tools, more research is needed to develop a low-stress handling tool to assist loading crews in loading and moving pigs in challenging areas, such as the transition area between the barn and the loading area and loading ramps.

Research on swine transportation is very recent in Canada as showed by the fewer number of studies being run so far compared to the US and Europe. Considering the incidence of transport losses under Canadian transport conditions, more research on transport factors such as vehicle design, loading density, travel time and their interaction is needed. More specifically, considering the impact of thermal conditions during transport on pig welfare and mortality, transport conditions should be improved by the use of fan-assisted ventilation in combination or not with water sprinkling or misting in summer, or by a combination of insulation and ventilation in winter. The use of truck models featuring hydraulic ramps or decks ramps would reduce the workload of handlers and improve the welfare of pigs.

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## **EFFECTIVE GRADING**

**Frank Wood**  
**Conestoga Meat Packers Inc.**

Packers implement grids to try to ensure fair payment for the hogs they require to meet their customer needs. They are also used to discourage the delivery of hogs that do not meet the needs of their customers. An effective grid should encourage producers to provide the packers with hogs within a targeted weight range and, to some degree, a level of quality based on the muscle and fat and ensure consistent payment to the producer for the ideal hogs.

With the prospect of heavier hogs the ability of grids to reflect the increased weight need to be in place. Producers and plants are starting to shift from focusing on a per head return and more towards a per kg return. The challenges for the industry will be to ensure that efficiencies at both farm and packer level are improved to help offset against a strong Canadian currency, ensuring our industry can continue to compete on a global basis.

Collectively the Ontario Industry will start to evaluate different grading technologies that may be available to help further differentiate Ontario products. The commitment has been made to continue working towards a third party neutral system that utilizes the best technologies and accuracy available to help re-enforce Ontario's position as a leader in pork products.



# **EXPLORING THE ONTARIO PORK GRADING DATA ONLINE DATABASE**

**J. H. Smith**

**Ontario Ministry of Agriculture, Food and Rural Affairs  
University of Guelph, Ridgetown Campus, [jaydee.smith@ontario.ca](mailto:jaydee.smith@ontario.ca)**

## **INTRODUCTION**

Examining shipping information is an essential part of assessing production and identifying opportunities for increasing revenue. Unfortunately, poring over columns of data or programming spreadsheets to perform an analysis can be tedious – and so many people simply don't bother. This means that some producers may not realize the variation that exists in the hogs they ship, nor how well they are hitting their target weight range. This is the first step in identifying ways that variation and revenue can be improved.

Reducing shipping variation and hitting the grading grid correctly can dramatically affect returns and therefore profitability.

## **ACCESSING THE ONLINE DATABASE**

Ontario Pork's online database contains shipment and carcass data provided by marketers and processors in Ontario. Producers can access their data from a secure website by obtaining a password from Ontario Pork.

To further facilitate access to the data, OMAFRA, working together with Ontario Pork, has developed a computer program for PC (Ontario Grading Data Explorer) that will allow any producer easy online access to their shipping data for a given date range, and visually explore the range and distribution of the carcass characteristics weight, estimated lean yield, and fat and muscle depth (Figure 1). Data such as various codes, plugged tattoo numbers, etc. associated with the grading data are also available.

Descriptive statistics (minimum, maximum, average, S.D.) are calculated automatically. Target ranges can be entered for the four carcass measures, and the percentage of carcasses falling within the range is also calculated. The ranges are visually represented on the charts. A number of data charting options, as well as filtering options and sorting options, allow point-and-click exploration of the data.

A number of different charts are automatically created to help understand the spread and variation in the grading data, including relationships between factors, and trends over time. (Figures 2 and 3).

Access to the online database is made easy by the program, once the appropriate user ID and password is obtained from Ontario Pork. Once data has been downloaded, it can be saved for future access offline.



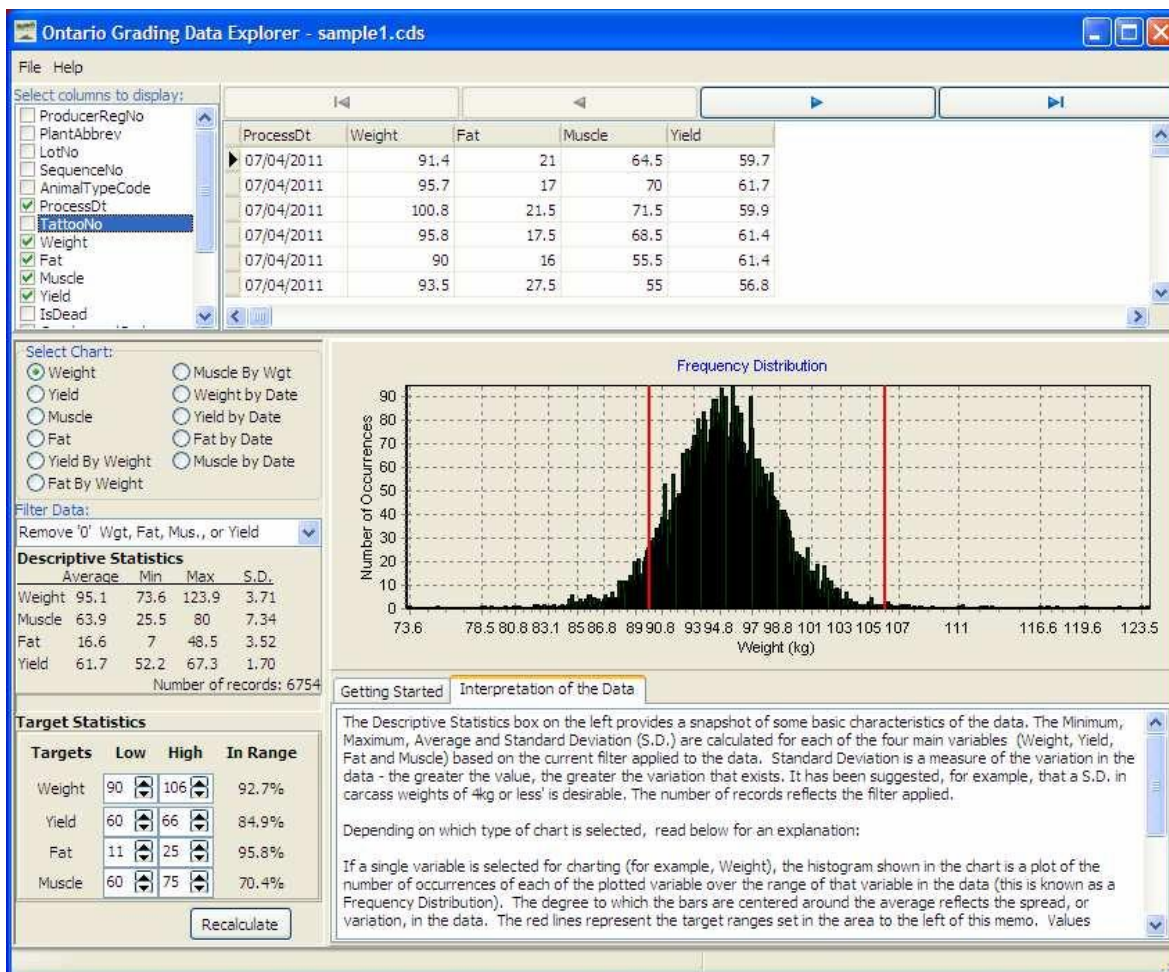


Figure 1. Screenshot of the Ontario Grading Data Explorer showing main features.

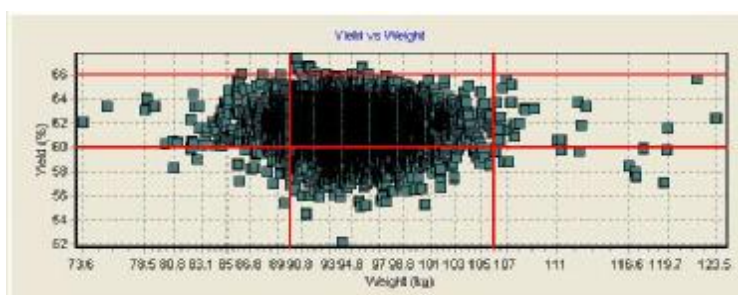


Figure 2. Scatterplot of yield and weight, with lines indicating the boundaries of target ranges for each.



Figure 3. Trend plot of weight over time.



## **TAKING THE “ALTERNATIVE” OUT OF ALTERNATIVE INGREDIENTS**

**Clarence Keen  
Keenview Farms Ltd**

Clarence Keen has been farming with his father, John, all his life in Dunnville, Ontario. When Clarence joined the farm full-time, it was a dairy farm. Sixteen years ago, they decided to sell the dairy and start raising broiler chickens. Seven years later, two contract finishing barns were added. After losing the finishing contracts, it was decided to purchase the herd of pigs ourselves. At that time, corn was much cheaper. Since we grow all of our own corn, it was decided to build a feed mill to feed the pigs and chickens.

Over the years, the feed mill has grown to include several ingredients to help with the rising cost of the corn. We work closely with Purina, who helps us to balance our rations, and makes it possible to use the different ingredients that are in the marketplace to keep the costs down.

We use chicken or hog premix, soy meal, pork meal, bakery meal, canola meal, wheat, wheat shorts corn, fat, roasted soybeans, and distillers. We also add all of our own medications to the ration, if needed. We manufacture and sell some feed, therefore we get audited every six months from CFIA to ensure the operating procedures are correct and all of the guidelines are followed. Of our own, we feed 12,000 hogs and 150,000 chickens each year.

The feed mill has become a vital asset in our operation.



# FEEDING ALTERNATIVE FEED INGREDIENTS

Mario Ramirez, Vicente Zamora, and Malachy Young

Gowans Feed Consulting

1837 11<sup>th</sup> Avenue, Wainwright, AB, T9W 1N3

[malachyy@telus.net](mailto:malachyy@telus.net)

## INTRODUCTION

Alternative ingredients are those ingredients that: a) may not have been commonly used in pig diets in the past due to availability, b) many have been used but at limited quantity due to previous anti-nutritional factors (ANF) or cost. New ingredients pose a bigger challenge and potentially greater risks in that a lot less is known about their nutrient content and the availability of those nutrients, the impact they may have if any on feed intake, and if they contain ANF. Examples of new alternative ingredients are dried distillers grains with solubles (DDGS) and expeller processed canola meal. Existing alternative ingredients that have been around for some time are canola meal, peas, lentils, wheat middlings, bakery by-product, liquid stillage from ethanol plants, and liquid whey from dairy industry. As we learn more about these ingredients we can more effectively formulate them into pigs' diets to control and/or reduce diet and feed costs while minimizing the impact on animal performance. Steps involved in evaluating a new or learning more about an existing alternative ingredient are: a) Chemical analysis to determine nutrient content, b) Digestibility study to determine availability of nutrients, c) Feeding trial (with diets formulated on digestible amino acid and Net Energy (NE) basis) to determine impacts on feed intake, growth rate (carcass basis), feed efficiency, carcass grading and characteristics, and meat quality characteristics.

## RISKS ASSOCIATED WITH USING ALTERNATIVE INGREDIENTS

When considering the use of new or modifying maximum inclusion levels of an existing ingredient in diets consider the following points:

- a) How much information is available on the nutrient composition of the ingredient and variation in its nutrient content within and between suppliers?
- b) What will happen with diet energy density and fibre content?
- c) Is nutrient digestibility information available, accurate (large data set), and is it representative of the source you will be using?
- d) Are there any concerns the ingredient may impact diet palatability and feed intake?
- e) Will animal performance and pork quality be impacted? How, and by how much?
- f) Will this ingredient increase feed mixing and handling costs (bulk density) or affect feed flow in feed bins and inside the barn?
- g) How much of the ingredient is available, and does it warrant its inclusion in diets?

The higher the risk with using alternative ingredients the greater the return has to be to justify their use and associated risk. To assess in more detail some of the risks involved:

### a) *Variation:*

- i. Understanding – It is extremely important that we understand or have some handle on the variability in nutrient content and availability of those nutrients to avoid losses in animal

performance and overvaluing opportunity ingredients. Not only the composition of the ingredient but any processing it undergoes can have a substantial impact on nutrient content and availability. A good example of this is with dried distiller's grains with soluble (DDGS) – how much syrup is added back to the wet cake before drying will impact the final ingredient nutrient content. Drying temperatures can vary greatly (120-600°C) during drying, and if not controlled effectively, over-heating can cause significant heat damage to the final DDGS (Payne, 2007) and its value.

- ii. Assessing – Working in conjunction with the ingredient suppliers a quality control testing protocol should be put in place to monitor the variation in nutrient content. Key nutrients such as moisture, protein, and fat should be analyzed on a regular basis, while amino acid analysis and fibre components should be periodically analyzed. It is important to be aware that considerable variation exists between analytical laboratories, thus working with one lab will allow comparisons between samples and remove lab to lab analytical variation. With feedstuffs that undergo heat treatment, such as DDGS, conventional amino acid analysis may grossly overestimate the actual amount of lysine bioavailable to build protein. New methods for determining dietary bioavailable lysine have been proposed and have considerable utility in practice (Moughan, 2008).

*b) Impact on diet energy density and fibre content:* Typically when we add or increase the inclusion level of alternative ingredients to pig diets they are replacing grain and soybean meal, thus diet Net Energy (NE) decreases and fibre content increases. We need to understand the impact of this.

- i. Growth rate can be reduced, however, the magnitude of the change will be impacted by genetics, pig health status, environment and diet NE change. Putting a cost on the loss in growth can be more difficult depending on whether a farm is long or short on finishing space and season; summer month's space is usually tighter with higher temperatures and low intake and growth rate, and market price is higher.
- ii. Feed efficiency will deteriorate as diet NE decreases. This is much easier to determine as feed cost per pig will need to be lower even with the higher feed usage for the alternative feed ingredient to be cost effective.
- iii. Dressing percent or carcass yield will be reduced as dietary fibre content increases as a result of the increase in large intestine content weight. The magnitude of the change will depend on the dietary fibre content increase and whether the diet fibre level is reduced and diet NE level increased for a period prior to marketing. Withdrawing pigs from the higher fibre diets containing corn DDGS and wheat midds 3 weeks before marketing can improve carcass yield and reduce large intestine weight (Asmus et al., 2011; Table 1).
- iv. Fat iodine value (IV), which is a measure of fat softness, can increase indicating that carcass fat is softer for pigs fed lower NE and higher fibre diets. The reasoning for this may be that fat becomes a higher percentage of dietary energy in higher fibre diets, and because pigs fed diets with higher fibre levels have less backfat, which can lead to higher iodine values. The negative effects on fat IV can be reduced by switching pigs to lower fibre and higher NE diets, however, a longer withdrawal was needed to make a greater change in IV compared with carcass yield (Table 1).

- v. Manure volume can be increased with feeding alternative ingredients with higher fibre content and can lead to more retained solids in storage facilities.
- c) *Mycotoxins*: Mycotoxins are defined as secondary metabolites of mould growth which are generally believed to be produced in response to stress factors acting on the fungus (Osweiler, 2006). Of particular interest in pigs: vomitoxin causes pigs to refuse feed, zearalone affects the reproductive organs, ochratoxin causes kidney damage, and aflatoxin increases susceptibility to disease through their action as immunosuppressants. It is really important that we have a good handle on their content in co-products such as DDGS in addition to other ingredients included in pig diets. DDGS are of particular concern as the mycotoxins are concentrated three fold over the level of the parent grain. Other alternative ingredients such as wheat shorts will contain higher levels of mycotoxins than source grains. Some steps that can be taken to reduce the potential risks:
- a. Have a complete understanding of the mycotoxin testing protocol of the source ingredients being used in the process. What mycotoxins are they testing for, what is the frequency of testing, what are their acceptable limits for ingredients, and other issues concerning avoiding or minimizing the use of contaminated feedstuffs with these compounds.
  - b. Is the final ingredient or co-product being tested for mycotoxins, which ones and how frequently?
  - c. If purchasing co-products such as DDGS with higher risk associated with them through a trader, request they test samples periodically (weekly, bi-weekly) and include frequency of testing in the contract.
- d) *Feed mixing and handling/bulk density*: Increasing inclusion levels of certain alternative ingredients that are higher in fibre will impact feed bulk density, mixing, and flow ability of the final diets. A good example of this is for each 10% corn DDGS that is included in the diet, the volume of the diet will increase approximately 3% compared with a corn-soybean meal diet (Stein, 2007). This has implications for feed mixing and haulage costs and on-farm feed storage. For a mixer with a capacity for 3 tonne of a grain soybean meal diet adding 30% co-products (DDGS and midds) to the diet will not allow mixing of a 3 tonnes batch but likely 2.5 tonnes; this will increase diet mixing costs. If a feed truck has capacity to haul 30 tonnes of a conventional corn-soybean meal diet and if we add 20% corn DDGS to the diet this reduces truck feed capacity by 6%, which has implications for total feed cost per tonne and feed cost per pig. If the on-farm bin has the capacity to store 16 tonnes of corn-soybean meal diet then it will only be able to hold 15 tonnes of a diet with 20% DDGS.
- Particle size of corn DDGS was lower than soybean meal (665 vs. 754 microns) and was more variable among sources ranging from a low of 127 to high of 1105 microns (Shurson, 2006). As a lot of feed mills do not grind corn DDGS at the lower end of the particle size spectrum this greatly increases the risk of feed hanging up in feed bins and feeders resulting in out of feed events with associated consequences of lower feed intake and growth rate. Inclusion of high levels of midds (20 to 25%) with DDGS in the diet, which have lower bulk density than ground grains, can pose greater risk for feed flow issues from bins and within the barn when dealing with mash diets.

**Table 1. Effect of Dietary Neutral Detergent Fibre (NDF) Level Prior to Marketing on Finishing Pig Performance and Carcass Characteristics.<sup>a,1</sup>**

	Treatment						SEM
	1	2	3	4	5	6	
d 0 to 43:	Low <sup>2</sup>	High <sup>3</sup>	High	High	High	High	
d 43 to 67:	Low	Low	Med <sup>4</sup>	High	High	High	
d 67 to 90:	Low	Low	Med	Low	Med	High	
<b>Day 0 to 90</b>							
ADG, g/d	885	898	903	894	894	894	9
ADFI, kg/d <sup>a</sup>	2.56	2.62	2.64	2.68	2.68	2.70	0.05
F:G <sup>a</sup>	2.90	2.92	2.92	3.00	3.00	3.02	0.03
<b>Carcass characteristics</b>							
Yield, % <sup>5,a,b</sup>	73.2	72.9	71.6	73.0	72.4	71.7	0.26
HCW, kg	88.13	88.81	87.86	88.68	87.77	86.82	1.15
Backfat, mm <sup>6,a</sup>	58.4	59.7	58.7	59.2	57.2	59.2	1.0
Lean, % <sup>6</sup>	53.0	53.4	53.6	53.3	52.7	53.9	0.31
Jowl iodine value <sup>a,b</sup>	68.4	70.6	75.8	74.8	76.6	78.5	0.94
Large Intestine, kg <sup>a,b</sup>	2.98	3.23	3.71	3.03	3.39	3.94	0.21

<sup>a</sup> Data from Asmus et al., 2011.

<sup>1</sup> Total of 264 pigs were used in this trial.

<sup>2</sup> Low = corn-soybean meal diet with 0% DDGS, 0% midds with NDF of 9.3%.

<sup>3</sup> High = corn-soybean meal diet with 30% DDGS and 19% midds with NDF of 19%.

<sup>4</sup> Medium = corn-soybean meal diet with 15% DDGS and 9.5% midds with NDF of 14.2%.

<sup>5</sup> Percentage yield was calculated by HCW by live weight at the farm before transport to the packing plant.

<sup>6</sup> Carcass characteristics other than yield and iodine value were adjusted by using HCW as a covariate.

<sup>a</sup> Linear effect of withdrawal time  $P < 0.01$ .

<sup>b</sup> Fibre level fed during withdrawal  $P < 0.05$ .

## FORMULATING WITH ALTERNATIVE INGREDIENTS

As a nutritionist working for a pig/commercial feed mill owner I learned in my early days of formulating diets one had to be a formulator in addition to being a nutritionist. Not only had you to formulate diets to meet specific nutrient requirements of pigs at different stages, consideration had to be given to ingredient inclusion levels and their effects on producing quality diets (feed flow and pellet durability) with a limited number of ingredient bins in the mill. Our objective in formulating diets is to achieve predictable performance while maximizing margin over feed and facility cost. When we formulate diets we **best** as opposed to least cost formulate diets. There are distinct differences in achieving our end result of predictable performance with optimal return. Several considerations are included when deciding inclusion level of alternative ingredients in diets.

a) *Nutrients*: Pigs have requirements for nutrients such as energy and amino acids and not for specific ingredients. Thus when we formulate diets for different stages of growth we

formulate to specific nutrient levels, such as net energy (NE), digestible amino acids, available phosphorous, and other nutrients.

- b) *Ingredient analysis*: With the availability today of a vast array of cost effective alternative ingredients it is very important we have a good handle on the nutrient content they offer so we can cost effectively optimize their use. A clearly defined quality control program for ingredient analysis should be in place to best estimate/predict the key nutrients in specific ingredients. Alternative ingredients that tend to have greater variability in nutrient content require more frequent analysis such as DDGS and wheat middlings. Most systems will have a fixed budget available to spend on ingredient analysis so the key will be to use this in a cost effective manner to get the most from it. With any co-product increased sampling and testing must occur to minimize variability in the ingredients delivered to minimize negative impacts that the variability will have on pig performance.
- c) *Palatability*: We need to understand the impact ingredients can have on diet palatability and feed intake as this will directly impact growth rate and barn throughput. In general there are few ingredients that pigs will not eat though feeding increasing levels of some ingredients can have a subtle and significant impact on feed intake. A simple feeding trial using graded levels of the ingredient will allow us determine the impact of feeding increasing levels on feed intake, growth and feed efficiency. It is very important that an accurate nutrient profile of the ingredient is available to ensure diets can be balanced correctly and a difference in feed intake is truly associated with palatability and not a diet nutrient imbalance. Alternative ingredients that negatively impact diet palatability can result in similar feed disappearance as opposed to feed intake but lower growth and poorer feed efficiency as a result of pigs foraging through feed and resulting in greater feed wastage. A recent feeding trial conducted by Senevirante et al. (2008; Table 2) with graded levels of expeller pressed canola meal found with increasing dietary inclusion levels feed intake and growth rate decreased, however, income over feed cost (IOFC) increased thus it was cost effective to feed higher inclusion levels than those that maximized biological performance. It is important to have continuity between diets in terms of ingredient inclusion levels and avoid large swings in diet composition between phases to avoid negatively impacting feed intake.
- d) *Pellet quality/feed flow ability*: When formulating diets we must consider the impact ingredients have on final diet quality such a feed flow and pellet quality. Out of feed events resulting from feed that is ground too finely or a high inclusion level of co-products with poor flow characteristics (high fat content, very fine particle size) can result in greater cost at barn level if growth rate is reduced and days to market are increased, which more than offsets the diet cost savings. Our objective in pelleting diets is to allow finer grinding of ingredients to smaller particle size to achieve higher nutrient digestibility, capture feed efficiency benefits and avoid feed flow concerns. However, if high inclusion levels of opportunity ingredients (high in fat) results in excessive fines, < 70% pellets at feeder, the benefits of pelleting rapidly disappear. Thus, in formulating diets one must bear in mind the impact each ingredient has on pellet quality and durability otherwise the benefit of pelleting can rapidly disappear and become only an added cost.
- e) *Formulate for maximum margin over feed facility cost (MOFFC)*: In the past diet formulation strategies have been to formulate for maximum growth as the highest margin over feed costs was associated with diets that maximized growth rate due to low diet cost and most barns being short on space. Because diet energy costs have increased dramatically

increases in diet energy level have become much more expensive. Formulating diets to lower energy levels that lower growth rate and result in poorer feed efficiency will become more economical now due to the high cost of energy. It is very important that we understand the impact of changing diet energy levels on growth rate, feed efficiency, and MOFFC for the genetic lines and barns we work with. Alternative ingredients can be used to reduce diet cost but may consequently reduce feed intake, growth rate and/or result in poorer feed efficiency, but it is very important we understand the net economic impact they have for the barn or system. For example, a large scale commercial grow-finish feeding trial looked at the impact of feeding increasing levels of co-products (Jha et al., 2011; Table 3). They found as the level of co-products in the diet increased growth rate and feed intake were reduced, while feed:gain was unchanged, however, feed cost per kg of gain decreased and income over feed cost increased as the level of co-products increased in the diet. We must remember that the producers we work with manage large agri-businesses, thus net economic return is what should dictate the use and optimum inclusion levels of ingredients rather than maximum biological performance.

## **INGREDIENT PROCUREMENT/PURCHASING**

Identifying opportunity ingredients that present feed cost savings to your barn or system is the first step in the process of attaining those cost savings. Evaluating the different sources in terms of available supply, nutrient content and variation, are key components in determining the true value of these ingredients. For example, there are 5-8 ethanol plants you can source corn DDGS from in the Northern US, however, there are vast differences in proximate analysis (moisture, protein, fiber, fat), and in total and available nutrient content between these sources. Many ethanol plants today are spinning off the fat producing a lower (6-8%) fat DDGS which has much reduced value than they produced in the past (9-11%). In addition there are some big differences in the drying methods that each plant use, which has a big impact specifically on total and available amino acid content of the DDGS. It is clearly important to realize that all sources of ingredients are not equal and this becomes more important when dealing with co-products that undergo heat treatment. Building a data base of ingredient nutrient content over time allows one to understand the variation associated with specific ingredients and sources over time.

Many suppliers of ingredients fail to understand the variation that exists between sources, especially heat treated co-products, and they value each source similarly; thus a cheaper source is simply taken as a better deal. This is simply not the case for pigs and we have been working with suppliers of DDGS to educate them with regard to the differences between sources in terms of nutrient content and value in pig diets. Once nutrient content and variation (or testing protocol to established variation) has been established the true nutrient value that an ingredient is offering to pig diets can be evaluated relative to other ingredients. Periodically, value analysis should be conducted to determine the on-going value new ingredients offer to diets. Typically we like to see a minimum return of \$0.3/pig with a new alternative ingredient to warrant its use. For ingredients that have greater variation in nutrient content, and thus pose greater risk to animal performance, the minimum net return required to justify their use will be greater.



**Table 2. Effect of Increasing Expeller Canola Meal Level on Biological and Economic Performance<sup>a</sup>.**

Item	Expeller canola meal, %					SEM	P <	
	0	7.5	15	22.5/18	Graded <sup>b</sup>		Lin	Quad
Day 0 to 90 <sup>c</sup>								
ADG, g/d	974	958	929	912	933	15.8	0.01	0.01
ADFI, kg/d	2.57	2.52	2.40	2.35	2.45	0.037	0.01	0.01
Feed:gain	2.64	2.63	2.59	2.57	2.62	0.032	0.14	0.03
Feed cost, \$/kg <sup>d</sup>	0.670	0.649	0.629	0.618	0.648	0.0077	0.01	0.01
IOFC, \$/pig <sup>e</sup>	40.2	41.3	42.3	42.2	41.4	1.01	0.05	0.02

<sup>a</sup> Data from Senevirante et al., 2008. A total of 1100 pigs housed 22 per pen with 10 replications per treatment.

<sup>b</sup> Stage 1 – 22.5/18%; Stage 2 – 15%; Stage 3 – 7.5%, Stage 4 – 0%.

<sup>c</sup> Initial weight was used as a covariate.

<sup>d</sup> Average ingredient costs: wheat \$205, barley \$195, corn \$210, soy \$420, expeller canola \$210, wheat:corn DDGS \$175, lysine \$1900, tallow \$700.

<sup>e</sup> Income over feed cost (IOFC) = ((ADG × 90 d × 78.5% × Index × \$1.3/kg) – (ADG × 90 d × Feed cost/kg gain)).

**Table 3. Effect of Diet Co-Product Levels on Biological and Economic Performance<sup>a</sup>.**

Co-product level	Low	Medium	High
Growth, g/day	999 <sup>a</sup>	933 <sup>b</sup>	920 <sup>b</sup>
Feed dissapp, kg/d	2.87 <sup>a</sup>	2.71 <sup>b</sup>	2.66 <sup>b</sup>
Feed:gain	2.87	2.90	2.89
Feed cost/kg gain, \$	0.842 <sup>a</sup>	0.788 <sup>b</sup>	0.747 <sup>b</sup>
IOFC, \$/pig	39.5 <sup>a</sup>	39.9 <sup>a</sup>	42.4 <sup>b</sup>
Diet cost, \$/tonne	260	295	273
Carcass dressing % <sup>x</sup>	78.0 <sup>a</sup>	77.1 <sup>b</sup>	77.0 <sup>b</sup>

<sup>a</sup> Data from Jha et al., 2011 (unpublished).

IOFC = Income over feed cost; <sup>x</sup> Carcass weight was used as a covariate.

## CONCLUSION

Alternative ingredients can offer significant diet and feed cost savings if formulated correctly into diets. However there are risks associated with using them. The risks can be mitigated by acquiring as much information on the ingredient as possible prior to using, such as the nutrients it brings to the diet, impact on diet palatability, and diet handling characteristics. Changes in system flow to add more space may be required to maintain the same market weight when using

alternative ingredients. As the demand for traditional feed ingredients increases we will be forced to use more alternative ingredients in diets if we are to control feed costs and remain competitive.

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# **LIQUID CO-PRODUCTS: A PRACTICAL OVERVIEW**

**Drew Woods**

**Swine Nutritionist, Shur-Gain/Nutreco Canada  
150 Research Lane Guelph, ON, N1G 4T2**

## **ABSTRACT**

With a growing world population and unprecedented competition for grains and protein sources, pork producers are looking for alternatives to traditional feed ingredients. Current liquid ingredients from the food and fuel industries already assist in reducing dependence on grain and protein crops while new liquid ingredients are constantly being evaluated. By making small changes to the way they handle, store, analyze and deliver liquid co-products, producers can take full nutritional and economic advantage of them.

## **INTRODUCTION**

Liquid co-products can come from a variety of industries. Food and fuel industries are the key drivers of current and potential co-products. The Ontario marketplace for liquid co-products is fragmented and usually made up of agreements between producers and the manufacturers of the food/fuel product that the co-product is derived from. This is the opposite of the mature co-product marketplace that exists in Northern Europe for both dry and wet co-products. Liquid co-products have potential to provide savings and performance on farm provided some simple and practical guidelines are adhered to. Everything from analysis, storage, and handling to dosing of the product can have an impact the value of a feed ingredient on farm.

## **CURRENT CO-PRODUCTS**

### **Corn distillers solubles (CDS)**

Corn distiller's solubles are the liquid fraction of dried distiller's grains with solubles (DDGS) that get added back on to DDGS after ethanol production. This product is currently one of the most commonly used liquid co-products in Ontario. CDS typically has a dry matter (DM) of 27-30% and contains approximately 20-22% crude protein (CP) on a DM basis. It also contains energy in the form of fat, 15-19% on DM basis (de Lange et al., 2006). This makes CDS a valuable feed ingredient provided we remember that it has an amino acid profile that is reflective of corn. The poorer amino acid profile can simply be balanced using other on farm ingredients or via your premix.

### **Corn steep water (CWS)**

Corn steep water is a co-product from the corn wet milling industry which produces corn sweeteners and other corn products. CSW typically has a DM of 35- 40% and a CP of 40% on a DM basis (de Lange et al., 2006). CSW also contains approximately 20% lactic acid on a DM basis (Niven et al., 2006), which not only acts as an energy source for the pig but also helps preserve the product and keep harmful bacteria out. As with CDS, CSW is just a condensed corn AA profile that needs to be balanced properly using various protein sources or synthetic AA's.

## Brewer's yeast

Brewer's yeast is the slurry of yeast-containing liquid from beer production. Brewer's yeast has a cyclical availability tied in to typical beer consumption patterns. The volume tends to reduce during colder months and increase during the warmer months during which people consume more beer. Brewer's yeast is starting to be dried down and sold to pet food manufacturers and even for human consumption. Brewer's yeast typically has a dry matter content of 10-15% and a protein content of 45-50% (on a DM basis) (Crawshaw, 2001).

## Whey

Liquid whey and whey permeate are actually two separate ingredients. Whey is a co-product of the cheese industry and used to be abundant in Ontario. With increased pressure from human food markets and biogas production whey has become more and more difficult to find and feed. Whole whey is the co-product available from cheese producers that has not undergone any further processing such as condensing or removal of proteins. Whole whey typically has a dry matter content of 4-7% and a protein content of 10-12% (on a DM basis) (Braun and de Lange, 2004, Crawshaw, 2001). Whey permeate is whey that has been taken and passed through filters to remove the proteins which are used in the human food industry for health food products.

**Table 1. Nutrient composition and recommended feeding rates of current Ontario co-products.**

	<b>DM(%)</b>	<b>CP(%)</b>	<b>ME (MJ/kg)<sup>1</sup></b>	<b>Max Inclusion(%)</b>
CDS	27-30	20-22	13.5-16.5	15
CSW	35-40	45-50	12.5-14	7
Brewer's Yeast	12-15	45-50	15.25-18.75	5
Whey	4-7	10-13	13.5-14.5	20
Whey Permeate	20-30	2-8	14-14.5	20

<sup>1</sup> Based on DE values from survey of Ontario samples (Braun and de Lange, 2004).

## POTENTIAL CO-PRODUCTS

### Potato products

Potato co-products such as liquid potato starch and steamed potato peels have been in use in countries such as the Netherlands and parts of Canada for many years. With their food processing industries the supply is abundant and it is a common product. Potato products are primarily an energy source in pig rations but can provide a reasonable amount of protein to the diet in certain forms. When added to a liquid ration, potato products will help hold particles that have poorer water holding capacities in solution and allow for a more homogeneous mix to be sent to the pens. Some producers even take dry potato products such as dehydrated mashed potatoes and French fries and re-constitute them with water to create thick potato slurry that is then stored to be used as an ingredient in their rations.

### Liquid wheat starch

Liquid wheat starch is a cornerstone ingredient used in swine liquid feeding in Europe. The use of wheat to produce glucose is very common in Europe and creates a large volume of liquid wheat starch. Liquid wheat starch has many different varieties and trade names, each one with

unique properties. Liquid wheat starch provides protein to rations and much like potato products helps to keep the mix in suspension when it is delivered to the pens. This product is also quite acidic and is palatable to pigs at proper feeding levels.

### **Sugar based liquids**

Sugar based liquids would include products such as juice and colas that are primarily an energy source and do not provide a significant amount of protein or minerals. Chocolate products, jams, and syrups such as high fructose corn syrup are other high sugar based liquid products that can be used in liquid feeding. These products are taken directly from the human food industry either as “expired” product or ‘off spec’ during manufacturing. Sugar based liquids are typically benchmarked against corn in swine diets and as a result must contain enough energy to replace corn and be priced accordingly. Sugar based products could effectively replace corn in swine diets and could be a valuable ingredient as energy sources increase in price.

### **Sauces**

Sauces such as ketchup, mayonnaise, pasta sauce and others could be a potential ingredient in swine diets. These products could provide energy and flavor to feeds but would need to be fed in very small amounts due to their high sodium contents. Mayonnaise and dip sauce components are usually quite high in fat and are devoid of any valuable proteins. They can also contain significant amounts of sugar which adds to the energy value. Ketchup and pasta sauce would be a less energy dense ingredient as they are lower in fat and sugar but could still provide nutrients to pigs if priced appropriately.

**Table 2. Nutrient composition and recommended feeding rates of potential Ontario co-products.**

	<b>DM(%)</b>	<b>CP(%)</b>	<b>ME (MJ/kg)<sup>1</sup></b>	<b>Max Inclusion(%)</b>
Wheat Starch	20-30	17-20	15-16	15
Potato	13-20	8-15	14-22	10
High Sugar Products	10-60	0-8	14.75-19	5
Sauces	20-60	0-2	NA	2-3

<sup>1</sup> Based on DE values from Co-Product Feeds (Crawshaw, 2001).

## **STORAGE AND HANDLING**

One of the most overlooked elements of co-product usage is the storage and handling of that product. In Ontario the typical liquid fed farm has 2-4 underground concrete tanks capable of holding up to 40 MT of liquid each. The contents of these tanks are typically agitated using a manure pump and recirculation valve at the time of mixing. This system is quite economical but is far from optimal. In Northern Europe liquid storage is almost exclusively done in above ground concrete or polyester tanks that are no more than 3.5 x 3.5 m in width and can be up to 6 m deep depending on the need for storage. The tanks are open topped for easy viewing of the products being stored and have top mounted agitators in the centre of the tanks with multiple wheels or paddles spaced throughout the depth of the tank and ending as close to the bottom as possible. This is to ensure proper mixing of the co-product by allowing for no dead spots in the tank where product can avoid agitation. Concrete tanks are coated in epoxy to prevent acidic products from damaging them and are cleaned after each load of product is fed out to the

animals. Two tanks are dedicated to each co-product to allow for this to be done on a rotational basis. Products that are at risk for contamination, spoiling or dry matter losses due to yeast such as whey, brewer's yeast and potato products are acidified immediately using a blend of organic and inorganic acids to ensure pH is lowered and pathogens are killed. Brewer's yeast can be stored in the same style of storage vessels as the other liquid co-products but care must be taken that it does not come in contact with them until the time of mixing. Brewer's yeast is an active live culture that is typically killed using heat, mechanical means, or chemical treatment. Most farms would find it easiest to chemically treat the yeast with an acidic preservative. Again, this preservative must contain a combination of organic and inorganic acids in order to kill the yeast and halt their growth. If this is not achieved the yeast cultures will continue to ferment and produce CO<sub>2</sub> and alcohol. With ingredients such as colas, pH is approximately 3.5-4.0 and will require no additional preservative. Products like jams and liquid sugars use the high sugar content and its subsequent high osmotic pressure to keep bacteria away and preserve the product (Crawshaw, 2001). As always, freshness is key and all products used on farm should be fed out in approximately one week to minimize potential spoilage to maintain maximum nutrient availability and palatability.

Ingredients should be agitated for 5 minutes prior to each feeding to ensure a homogenous mix. Co-products such as CDS, brewer's yeast and whey are more prone to settling in tanks, the fat fraction rises to the top in CDS and solids drop to the bottom with brewer's yeast and whey. Sugar based liquids and potato products tend to stay in solution much better and require less agitation. In order to save on the number of pumps used and pipe needed in a feed kitchen the products can be pumped to a central line with a stone catcher and dividing station and sent via a single feed line to the mix tank. When taking this approach proper sequencing is essential in order to get the proper proportions of ingredients in the mix tank.

Proper testing of ingredients will help with storage and handling decisions as well as allowing for proper formulation to be done using co-products. Up to date proximate analysis on almost all co-products in the province do not exist and this leaves the onus on producers to ensure they are aware of the nutrient profiles of their ingredients. Routine lab testing done by certified labs will help monitor variability in key nutrients over time but there are simple on farm tests that can be done as well. Upon arrival each load of co-product should be tested for dry matter using either a dry matter oven or an infrared dry matter tester; these are easily found on the internet both new and used. If an ingredient is off by even a couple percentage points of dry matter it can have a profound impact on growth and the feed value of the product. Another simple on farm test is to measure the pH of the incoming product. Portable pH meters are inexpensive and very user friendly.

## **Determining Feed Value**

When deciding on the purchase and use of a new ingredient or simply monitoring the key characteristics of current ingredients many factors should be evaluated to help in the decision making process. What is the availability of the product, will it be a short term or long supply and how often can it be accessed? Does it require specialized handling and storage? What is the nutrient profile? These will all help determine if a product will be a valuable feed ingredient. When looking at the nutrient profile the first thing to know is the dry matter content. Even the highest quality ingredients when diluted with enough moisture will no longer be economically feasible. This is mostly due to the high cost of transporting liquids to farms. Simple on farm

methods of analysis are listed above. Another common problem is variability of the product. Monitoring variability of key nutrients in an ingredient can help determine if a supplier is doing a good job of ensuring a uniform product.

When lab analysis is done and nutrient contents confirmed there are multiple methods to determine the maximum value for the product. One method is to use a simple simultaneous equation which uses information such as energy, lysine and phosphorus to determine the value of a feedstuff relative to common ingredients such as corn, soy and dicalcium phosphate (OMAFRA, 2011). These equations are fast and easy but are not as detailed as the linear regression equations used in most formulation software. The more detail used in evaluation of ingredients will allow for a full of understanding of its usefulness on farm. Some ingredients are solely energy sources while others can contribute both protein and minerals. It is now also possible to take an ingredient and see its effect on growth performance and carcass characteristics by using it in a swine model. By doing this you can simulate the growth performance of the animal with the nutrients provided by the new feed ingredient and have a whole picture of its potential on farm. Ingredients are now more scrutinized than ever before and by taking full advantage of the knowledge and services available from your nutrition supplier you make the most informed and profitable decisions possible for your farm business.

## CONCLUSIONS

Based on currently available co-products and potential co-products Ontario swine producers find themselves in a very unique position. With proper management practices and minor investments in infrastructure they stand to benefit from an abundance of economically advantageous ingredients that are at their disposal. As grain and protein crops continue to rise in price it will be interesting to see just how new alternative ingredients are adopted into liquid fed swine diets.

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## THE FUTURE OF FINISHING BARNS

**Murray Elliott**  
**FGC Limited**

The theme of the London Swine Conference is A Time for Change. A theme like this encourages one to make bold leaps forward and attempt to reach down to the roots of the way Ontario approaches finishing, and totally redesign how we finish pigs. There are times in all industries when these types of bold fundamental changes are required to rejuvenate it from whatever decay has caused it to become stagnant and uncompetitive. This is not the case with the Ontario hog sector at this time. I would suggest that we are world competitive in the production sector of our industry. Ontario primary producers are now the most competitive sector of the overall industry. The change that should be made with finishing barns, or indeed all barns, is that the decisions made when building should be tied to the overall production parameters. Currently the focus at the time of building is to reduce the capital cost of the project as much as possible. Of course this is important, but we also need to factor in the downstream performance of the structure. Therefore the capital cost and the expected performance from that capital spent should be given equal weight when making such a major business decision. Certainly we can and should continue to drive cost from the system but by building on what we already do well.

Pork is a commodity. It is traded predominantly on price alone. Certainly food safety, traceability, and the reputation of the producing country are factors but only as prerequisites to get on the list of whose pork is fit to purchase. Getting on the list is mandatory but then it is largely about price. The niche markets for organic, local and 'without whatever' point of differentiation are exempt from the commodity pork and are important their own right, but the largest volume of pork is a commodity. Therefore a suggestion that not striving for the lowest capital cost of a structure is counter-intuitive. The following chart suggests that the higher prices Ontario pays for structures must have some production returns.

### **Cost Of Production By Country\***

Italy	\$ 2.50 kg.
Germany	\$ 2.13
Denmark	\$ 1.97
Canada	\$ 1.55
Brazil (SC)	\$ 1.54
Brazil (MT)	\$ 1.42

\*Data collected by InterPig, published by Bernie Peet, Western Hog Journal Winter 2012. Includes physical performance and costs of production.

A dramatic example of production-based returns on a simple capital investment is feed conversion. A reduction of a single point of feed conversion can pay for almost 80 % of the

capital cost of an entire structure. If feed conversion is improved from a 2.7:1 ratio to 2.6:1 the return is as follows:

Average weight gain for a market hog in a finishing barn is 90 kg. The reduction of one tenth of a point of feed conversion is 8.8 kg of feed per pig, or a \$3.16 saving per hog marketed with feed at \$330.00 per tonne. On a one thousand head barn with three turns per year for a 30 year life span of a barn the total feed savings is \$285,000.00. Assuming a cost of \$365,000.00 for a Canadian style barn, this savings would cover 78% of the original cost of the entire structure.

With a manufacturer's recommendation for certain feeders at 10 -12 pigs per feed hole, taking the rate of 12 pigs per hole as opposed to 10 would lower the cost of the structure by approximately \$3000.00 per thousand head barn or \$3.00 a pig space. Over the last 30 years the one constant demand that packers have had is for a larger carcass. If during the design the 12 pigs per hole recommendation was used, some damage to production could easily have occurred. Reducing capital costs is certainly important but must be tempered with perspective and the even more important consideration of ongoing production costs.

The need to correctly find the balance between capital costs and production costs in Ontario finishing barns is of paramount importance. Ontario currently has a need for 86,000 new spaces and an annual replacement rate of another 55,000 spaces. Ontario will need these 141,000 spaces soon.

**Market Hogs Required In Ontario\***

Fearmans	40,000 - 45,000
Quality	30,000 - 32,000
Conestoga	15,000
Mitchell	10,000
Others	5,000
Total weekly	100,000 – 107,000

\*Murray's best guess.

It is important to keep all of our packers near full production in order that they may also remain competitive. Obviously this is complex issue but from a flow point of view only packers are traditionally a low-margin high-volume type of operation. If the packers cannot maximize shackle space they cannot be profitable and hence they will not be here in the future. The combined need of Ontario packers is approximately 100,000-105,000 pigs per week. Ontario is currently shipping in the 96,000 per week range. To generate the extra 5000 pigs weekly or 260,000 annually we need 86,000 new spaces quickly. The space currently in production to produce the 96,000 pigs per week that we do generate now is 1.6 million finishing spaces. If this space has an average useful life span of 30 years then Ontario needs to replace approximately 55,000 spaces every year to stay current. This space replacement can be adjusted for current circumstances but sooner or later the piper must be paid. Both the primary producers and the packers are equally important in the long term health of the industry. A balance needs to be found.

**Corn Prices In North America 2010\***

	ON Corn	IA Corn	OH Corn	NC Corn
Qtr 1	153.65	138.02	136.11	163.65
Qtr 2	152.65	145.75	155.63	175.63
Qtr 3	151.83	155.37	163.57	183.50
Qtr 4	190.38	208.98	214.29	232.81
<b>Ave.</b>	<b>162.13</b>	<b>162.03</b>	<b>167.40</b>	<b>188.90</b>

**Corn Prices In North America 2011\***

	ON Corn	IA Corn	OH Corn	NC Corn
Qtr 1	231.14	245.76	253.94	274.73
Qtr 2	273.79	266.75	278.78	286.63
Qtr 3	291.14	262.82	276.11	283.74
Qtr 4	233.83	239.72	249.96	266.32
<b>Ave.</b>	<b>257.48</b>	<b>253.76</b>	<b>264.70</b>	<b>277.86</b>

\*Corn charts courtesy of Robert Hunsberger.  
We are competitive on a feed basis.

It can be seen from the above 2010 and 2011 corn charts that Ontario finishing can compete from a feed input angle. It is worth considering the production models of other countries. The Canadian production model can be characterized as well-built, mainly concrete structures with considerable manure storage under the barn and possibly outside in concrete tanks, one or two barns per site. The equipment is of good quality: concrete penning, wet-dry feeders, fan or dual ventilated. Building costs for this type of structure with sandwich wall, feed system, tractor generator, alarm, presoak, penning, washer, pipeline, electrical, engineering and geotechnical investigation would be approximately \$365.00 per pig space. This was both integrated and independent production systems.

The US style finishing model is multiple units on a single site. Manure is stored outside in earthen pits that are often plastic lined. The barns are concrete (not sandwich wall) and frame type construction, using dual type ventilation with fabrene type curtains and often tunnel ventilation. Equipment is largely steel type penning with dry feeders. This model was developed in the 1985 through until 2000. The Americans reinvented modern production with multiple sites and became a power house in world production. This was a very successful model but it should be noted that it was built during a period of cheap feed prices. This was largely integrated type production. The estimated price for this style of barn is \$265.00 a pig space. This number is an estimate only as it is difficult to actually get a current hard number.

The newest style worth noting is the Russian model. The Russian system began in the last 10 years and is still developing. The Russians have used pieces of both systems. They have chosen

to use largely sandwich wall type buildings, fan ventilation, and manure storage under barn with additional storage in exterior concrete tanks. They build multiple units per site. The equipment used is good quality of the high-end Canadian and European style. These are fully integrated production units. The Russian hog industry is lucrative at this point in time, so that capital is available. It is worth noting that they searched the world for a model to revitalize their industry and they decided on the large American integrated multiunit model with the more substantial Canadian construction and equipment.

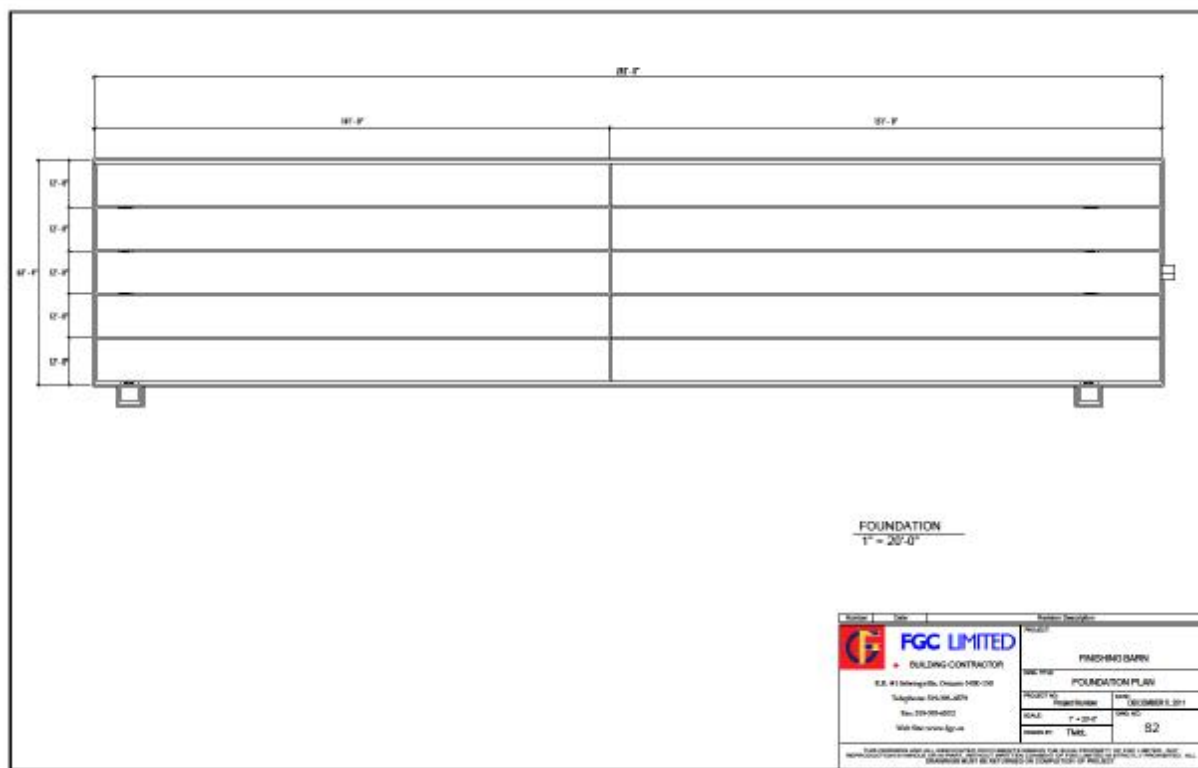
Equalizing the price of construction between the Canadian cost of \$365.00 per pig space and the American cost of \$265.00 per pig space is difficult without knowing everything that is included. Some of the more obvious savings can be quantified. If we could put six identical units on a site at one time the savings would be \$23.00 a pig space. This is a substantial savings, largely associated with reduced labour due to replicating the same features over and over, a reduced cost of moving in and out, and the savings in geotechnical investigation and engineering. These savings would be understated if this could be replicated multiple times. Galvanized roof cladding would save \$4.00 per space, no swing gates \$5.50 per space, tunnel ventilation with no inlets \$13.00 a space and dry feeders \$5.50 per space. Exterior plastic-lined earthen pits would save at least \$40 a pig space on these large units. These total savings would be \$91.00 per pig space to give a somewhat comparable cost. Obviously because of regulations not all of these savings are achievable in Ontario, but it is worth noting that barn prices come within a few dollars when these things are accounted for. It is also worth considering what we could do to achieve some of these substantially reduced costs.

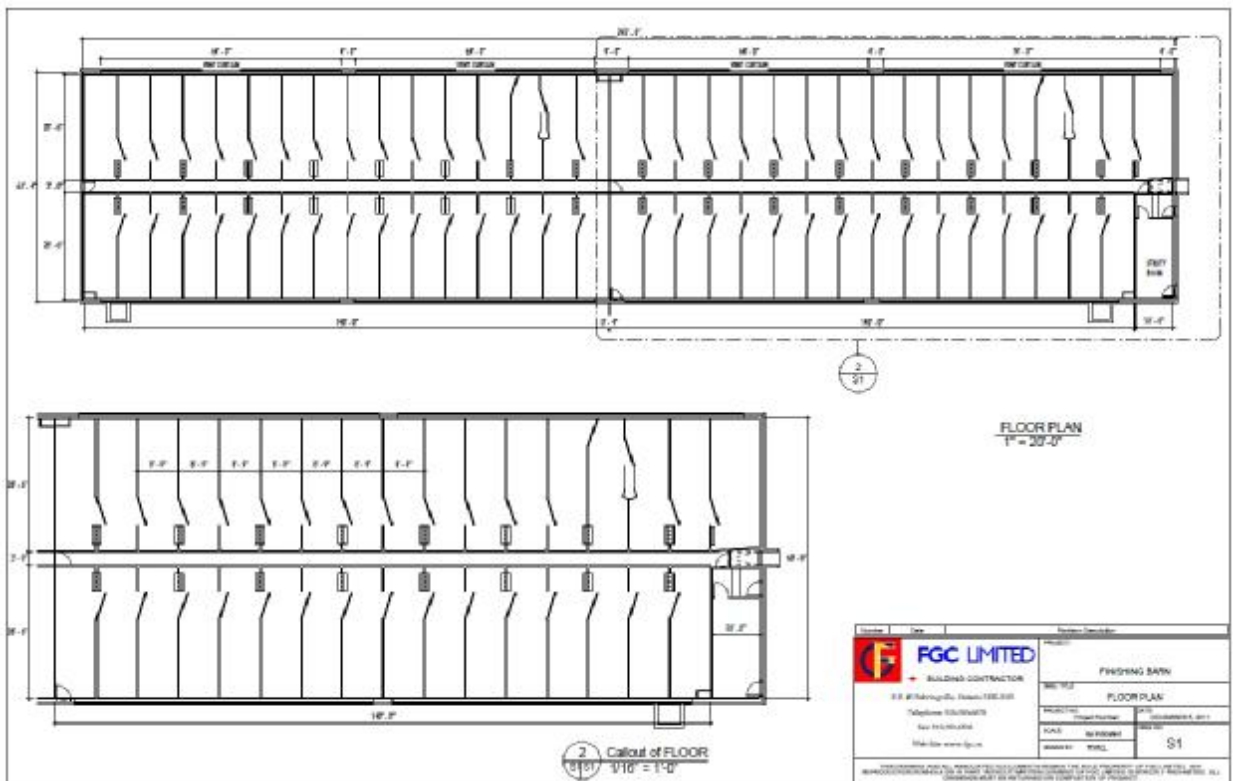
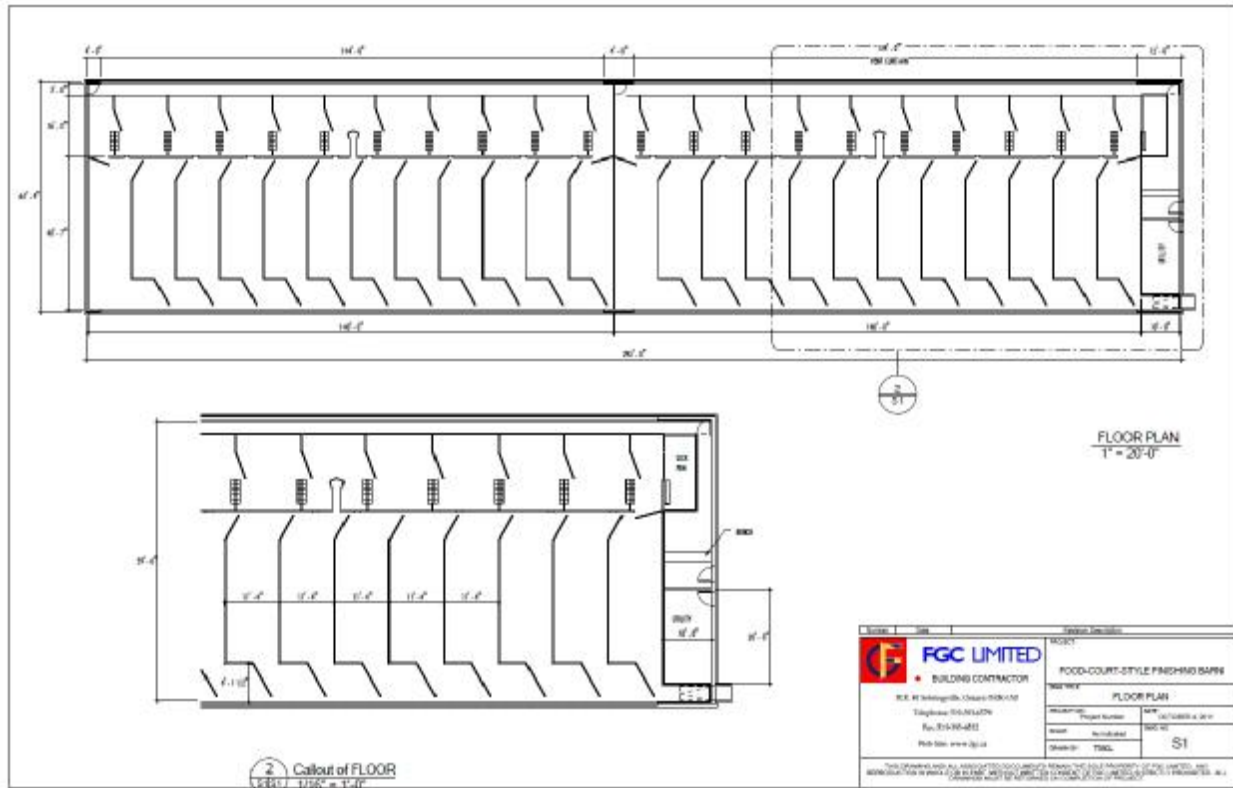
Every single barn built in Ontario at this time is a custom build. If we could decide on a barn plan and build exactly that barn, and I do mean exactly, over and over again then much of that \$23.00 savings could be realized in Ontario. Short of this, if we could at least decide on two pit plans that could be replicated, one for fan ventilated and one for dual ventilation, and then overlay an option of three floor plans that would fill the Ontario producers' need to have dry feed conventional, liquid feed and food court type barns, much of the \$23.00 could be saved. The following illustration shows a single pit layout with two optional floor plans, one being food court and one traditional swing gate design.

The other savings that could be looked at is galvanized roof steel. With the current use of R-5 insulation under roof steel, it is possible that this could now be an option for Ontario. This should be explored in the near future to ensure we do not raise attic temperatures, but it seems like a viable possibility. Increasing pen size throughout the structure or at least away from the sorters would save about \$1200.00 per double wall and gate. Every room that can be reduced will cut costs by approximately \$8000.00 per room. The other option that is available is to reduce pit depth. Going from an eight foot deep pit below the slats to a six foot pit would save approximately \$15,000.00 and still meet Ontario storage requirements. That would mean that producers would have to spread manure twice a year as opposed to once but in many circumstances that is achievable. The other American advantages of lined earthen pits and many thousands of pigs per site are just not available to Ontario producers due to legislation. The cost reductions above are not great but should be considered as they do not have any impact on production.

## CONCLUSION

Over many decades Ontario has developed its current style of finishing barns. These barns help producers achieve world class efficiency but a higher capital cost than our American neighbours. Other countries have seen the advantages and adopted our barn styles even though they are more capital intensive while capturing the advantage of scale to partially decrease the differences seen between the American and Canadian comparison. There are still a few avenues that Ontario can explore such as standardization of design spread over multiple sites, reduction of manure storage to still meet environmental regulations and some minor changes in pen design or building materials to reduce costs. Overall I believe that a major shift towards less capital intense designs would in the short term lower initial building costs but would be detrimental to day to day production costs and ultimately damage one of the productive edges that now make us competitive. The decision on building design needs to be intimately connected to operating costs before significant changes are implemented.





# LARGE GROUP AUTO SORT SYSTEMS FOR MANAGING GROWING – FINISHING PIGS - 2012

Marvin Wastell  
Gro Master, Inc.  
Omaha, Nebraska  
[mwastell@gromaster.com](mailto:mwastell@gromaster.com), 402-493-4550

## INTRODUCTION

Today, feed, facility, and equipment costs are very high. These high prices are causing every producer to scrutinize every aspect of production costs.

In addition, the consumer is demanding consistent sized, quality meat cuts – a cut that is of a consistent color, pH, marbling and taste. The consumer also cares that the product they buy comes from animals that have been raised in a friendly environment.

Today, producers are also facing a shortage of skilled knowledgeable labour, and the labourers require a better environment in which to work. Additionally, a world of new technology has entered the pork production industry, including electronic controllers, sensors, computer chips and computers to monitor and control ventilation, alert systems, power consumption, water consumption, growth performance, feed consumption, manure levels in pits, and marketing dates.

The producers that will remain in Pork Production will learn to understand and adapt the latest technology and use real-time data and reports to produce pork more efficiently.

In December 2005 a group of Swine Producers from 5 different countries and several scientists met in Northwest Iowa to evaluate and discuss raising pork in large pens utilizing Auto Sorters.

The producers learned that there is an economic improvement potential of 16 US dollars per pig marketed by raising pigs in large pens with Auto Sorters (Table 1).

Since December 2005, these producers and others have learned the following about raising pigs in large pens with auto sorters:

- Large pen auto sort is **NOT** for every producer
- Preplanning is a must
- The system must be designed for pig flow and people
- Training of pigs and **people** is a must – there is a learning period
- Change of management procedures is required
- Surge protection for the electronics and the communication system is must
- Direct communication with AutoSort System is highly advantageous
- Requires a commitment of the producer, employees managing the barns, distributor, and the manufacturer
- The sorter structure and one way gates must be durable and pig and people friendly
- After installation, service and support are a must
- The software must provide real-time, accurate, usable reports.

**Table 1. Economic improvement potential for large pen Auto Sort system.**

	<b>\$ Per Pig</b>
Sort Loss Improvement (Packer Grid)	5.50
Reduced DOA's and DIP's and Downers	0.40
Reduced Labor for Loading	0.25
Improved Meat Quality	
Stress Impact	0.25
Color	0.50
Additional Space Benefit	0.60
(Daily Gain, Feed Efficiency, Culls, Mortality)	
Targeted Feeding Program	1.30
Feed Withdrawal - 12 hours	0.20
Targeted Paylean Feeding Program	3.00
Use of Crystal Spring Wet/Dry Feeder	3.50
Minimization of Number Feed Events	0.44
Labour Savings for Cleaning	0.10
Human Safety and Injury	0.05
Reduced Environmental Pollution due to decreased phosphorus and protein excretion	?
<b>TOTAL BENEFIT/PIG</b>	<b>\$16.09</b>

In the last 8 years many US swine producers have removed their auto sorters for a variety of reasons – 10 to 15% decreased gains, pigs dying in food and water courts, poorly designed building and food court layouts, and failure to change management procedures and lack of after-sale support by the distributor and manufacturer.

The number one question being asked since the introduction of the Large Pen Auto Sort is will pigs gain and convert feed to pork as efficiently as pigs raised in small pens of 25 to 30 animals. Blue Marsh Hog Farm of Plum Coulee, Manitoba conducted a test comparing performance of pigs raised in small pens with pigs raised in large pens with auto sorters. Table 2 provides a summary of their findings.

Blue Marsh Farms found that pigs raised in large pens with auto sort do gain and convert feed to gain as well as pigs raised in small pens. In addition the labour cost for sorting was significantly reduced.

A South Dakota producer conducted a similar test. Their findings may be found in Table 3. The South Dakota producer had a 0.04 kg less daily gain but had 0.18 percent better feed conversion and \$5.44 per head better carcass premium. Production cost was \$1.31 less. The South Dakota producer realized \$8.91 advantage per pig marketed from the use of the large pen auto sort system.



**Table 2. Blue Marsh Hog Farm, Plum Coulee, Manitoba: Large Pen - Auto Sort (LPAS) vs. small pen (SP, 20 pigs/pen).**

	<b>LPAS</b>	<b>SP</b>
Number Pigs	552	574
Average Daily Gain, kg	1.06	0.98
Feed Conversion	2.59	2.64
Man Hours for Marketing	2.7	32
Labour Cost for Marketing, Per Pig	\$0.10	\$1.22

**Table 3. AutoSort System production numbers: South Dakota producer sorter barn comparison.**

	<b>Sort System</b>		
	<b>Sort System</b>	<b>Small Pens</b>	<b>Advantage</b>
Number pigs started	673	623	
Mortality, %	1.63	0.96	-0.67
Average daily gain, kg	0.87	0.91	-0.04
Feed per gain,	2.69	2.87	0.18
Feed cost/pig, \$	51.59	53.75	2.16
Production expense/head,\$	37.50	38.81	1.31
Carcass Premium/head, \$	8.87	3.43	5.44
<b>Total</b>			<b>\$8.91</b>

An Iowa producer compared iso-weaned pigs raised in large pens (150 plus pigs for 6 weeks and 600 plus pigs per pen thereafter) with pigs raised in large pens (660 pigs) with auto sort. The results of 4 replications (Table 4) showed that pigs raised in pens with the auto sort had slightly better gains with 0.18 improved feed conversion and US \$1.98 less feed cost. In addition, the producer received US \$5.50 more revenue per pig sold. The improved carcass revenue plus the decrease feed cost resulted in US \$7.98/pig improved revenue for pigs raised in the Large Pen Auto Sort System. The Pro Sort System return on investment was US \$10,534 per year or a ROI of 18 months.

Since December 2005 there have been several Manitoba swine producers that have installed auto sorters. The performance from a few of these producers and one South Dakota producer are shown in Table 5. The performance data represents a cross section of genetics, feeding programs, health, and management.

Most producers if not all report improved carcass weight uniformity and desired packer carcass weight with the installation and use of auto sorters (Tables 6 and 7).

**Table 4. Conventional barn to Large Pen Pro Sort comparison: Iowa swine producer.**

	Large Pen	Pro Sort System	Advantage
Number Replications	4	4	
Number Pigs	5282	5937	
Average Start Weight, kg	11.4	11.8	0.04
Average Market, kg	126.7	129.4	2.7
Average Carcass Wt., kg	95.8	98.1	2.3
Total Carcass/Head, US\$	215.27	220.77	5.5
Feed kg/Pig Sold	341.8	328.7	13.1
Feed Conversion	2.98	2.8	0.18
Feed Cost/Head, US\$	90.06	88.08	1.98
Pig Revenue - Feed Costs	125.21	132.69	7.98

**Table 5. Summary of auto sort producer data.**

Producer	Turns	No. Groups	Av. No. Pigs per Group	Av. St. Wt., kg	Av. End Wt., kg	Av. Gain, kg	Av. # Days	ADG, kg
Blue Marsh	3	18	535	52.2	93.1	49.9	44	0.93
Bon Homme	1	4	397	43.6	102.6	59.0	62.5	0.94
Concord	1	4	324	48.1	101.2	53.1	55	0.97
Cool Spring	15	15	275	59.9	100.0	40.9	43	0.94
First Choice	1	4	572	69.9	100.8	30.9	29	1.06
Rock Lake	6	64	579	33.1	114.0	80.9	87	0.98
Overskei	3	10	543	5.9	120.3	114.4	147	0.78
Overskei	2	8	528	63.6	109.0	45.4	46	1.00
Starlite	4	20	401	69.9	96.7	26.8	27.0	0.96
Windy Bay	<u>2</u>	<u>8</u>	<u>400</u>	<u>64.0</u>	<u>103.1</u>	<u>39.1</u>	<u>45</u>	<u>0.87</u>
Totals	38	155	76,862	48.1	104	53.1	58.6	0.93*

\*Weighted Average 2/27/2009.

**Table 6. Manitoba Pork Marketing Coop Colony Members Top 10 List, September 2007.**

	<b>Before Auto Sort</b>	<b>Sept 07</b>	<b>Dec 07</b>
<b>Carcass Weight (Average 95)</b>			
Windy Bay Colony Farms	< 10	1	3
Rock Lake Colony	< 10	2	6
Blue Marsh 93 LTD		6	-
<b>% in Core Area of Grid</b>			
Windy Bay Colony Farms	< 10	5	2
Rock Lake Colony	< 10	4	8
Blue Marsh 93 LTD		1	-

**Table 7. Effect of auto sort on carcass market value. Manitoba Pork Marketing Co-op, Inc., Jan-08\*.**

<b>Producer</b>	<b>Auto Sort</b>	<b>Number Pigs</b>	<b>Average Weight, kg</b>	<b>Average Index</b>	<b>% in Core</b>	<b>Average Revenue Per Hog</b>
A	No	21,370	92.6	110.1	86.9	\$129.12
B	Yes	18,500	94.4	109.5	98.7	\$131.04
Difference					11.8	\$1.92

\*Two Manitoba producers of similar size. Marketing pigs in 2007 at \$1.24/kg.

Hormel, a US packer, reported at the December 2005 meeting in Le Mars, Iowa that pigs marketed by producers with auto sorters have a \$5.70 increased value as compared to producers who do not have auto sorters.

A second question that is frequently asked is how many pigs can be sorted by a given sorter. To answer this question, one must define the type of sorting system that is employed. There are auto sorter systems that are primarily used to sort market pigs. One manufacture advocates 1000 to 1400 pigs per sorter by alternating pens of pigs being sorted. To date, there are varied reports from producers regarding the success of this system.

Two Manitoba producers, Rock Lake and Starlite Colonies, have been monitoring the growth performance of pigs housed in different size pens and sorted into three different food courts several times daily. Their findings are shown in Table 8. To date these producers have not found a performance difference in pigs housed in pens of 300 to 600 pigs that are sorted daily. Food Court design can have an effect on pig gains. A Saskatchewan producer found that pigs increased their number of times passing through a sorter by 3 fold and had 0.16 kg increased average daily gain by changing the design of his food court (Table 9).

A South Dakota producer found 0.05 kg increased daily gains by revising the design of his food courts.

A Minnesota producer compared two different types of feeders in his auto sort food courts. He found that pigs fed from Crystal Spring Wet/Dry Feeders had a 0.07 kg per day better gain than pigs fed from tube feeders (Table 10).

**Table 8. Effect of number of pigs/sorter on daily gain.**

	Group		
	1	2	3
<b>Starlite Colony - 1 Rep</b>			
Number Pigs/sorter	300	425	536
Average Daily Gain, kg	1.08	1.00	1.07
<b>Rock Lake Colony - 3 Reps</b>			
Number Pigs/sorter	306	605	
Average Daily Gain, kg	0.94	0.95	

**Table 9. Effect of food court design.**

	Initial Design	Revised Design
<b>Saskatchewan Producer 2006</b>		
No. Hits/Day	1.8	6
ADG, kg	0.71	0.97
<b>South Dakota Producer Spring 2007</b>		
ADG, kg	0.84	0.89

**Table 10. Auto sort data, Minnesota producer<sup>1</sup> feeder comparison, 22-Feb-07.**

Feeder Type	No. Pigs	Start <sup>2</sup> Date	Finish <sup>3</sup> Date	Av. Start Weight, kg	Av. End Weight, kg	Av. Gain, kg	Number Days	ADG, kg
Tube	553	12/06/06	02/07/07	54.9	100	44.9	59	0.76
Crystal Spring	550	12/06/06	02/07/07	51.8	100.8	49.0	59	0.83
Advantage Crystal Spring W/D								0.07

<sup>1</sup>Curtain sided building. Average health pigs.<sup>2</sup>Start date for sorting.<sup>3</sup>Date before first pigs sold.

High ingredient prices today are stimulating swine producers to utilize a targeted weight feeding program with their auto sort system. Kansas State University reported a feed savings of US \$1.29 per pig marketed by specifically formulating and feeding diets for light and heavy pigs within a group. Using October 2007 ingredient prices the cost differential between diets formulated for light, medium, and heavy pigs with an average weight of 99 pounds was US \$33/ton (Table 11).

**Table 11. Auto sort three food court feeding program (October 2007 Prices).**

<b>Court</b>	<b>Pig Wt kg</b>	<b>Protein, %</b>	<b>Added Fat, %</b>	<b>Cost/Ton, \$</b>	<b>Difference</b>
Light	32	19	5	204	\$26
Medium	45	17	2	178	
Heavy	57	16	1	167	\$11

A Minnesota producer in 2011 desired to learn if increasing the number of pigs per given barn by 10% would affect his pig performance. His barn was designed with 4 auto sort pens of 625 pigs per pen and a pig density of 0.7 square meters per pig. In his study, he increased the number of pigs per pen to 686 pigs with a pig density of 0.62 square meters per pig. He compared the performance of the pigs raised in the auto sort pens with pigs raised in conventional small pens that were marketed at the same time. He reported that pigs in the Large Pen-Auto Sort pen had a 0.08 kg greater ADG than pigs raised in conventional pens. The results are shown in Table 12.

**Table 12. Pro Sort System performance results: conventional small pen comparison to Large Pen Auto Sort. Three way sort, three separate phase feeding program for the light, medium, and heavy pigs (April - September 2011).**

	<b>Conventional*</b>	<b>Pro Sort</b>	<b>Difference</b>
Number Groups	9	2	
Total No Pigs Start	11,453	2744	
Av No Pigs Start/Barn	1273	1372	99
Av Start Wt, kg	23.6	22.8	
Av No Pigs Sold/Barn	1239	1334	95
Av Market Wt Sold, kg	116	117	1
Av Daily Gain, kg	0.81	0.89	0.08
Av Total Wt Sold/Barn, kg	114,065	156,050	11,985
Av Sq M/Pig Start	0.65	0.62	-0.03
Feed/Gain	2.68	2.64	-0.04

\*Conventional 25 pigs/pen with dry feeders.

Two pork producers who attended the Northwest Iowa meeting were Don and Bert Huftalin from Illinois. Their company had 18 auto sorters located in Illinois and Iowa at the time of the Prairie Swine Centre Conference. At the 2006 Prairie Swine Producer Seminar in Saskatoon, Don shared their results with the attendees.

Don and Bert's company, Hufco, marketed 2,730 pigs from auto-sort. Per pig, they tallied the following saving benefits:

Reduction of labor	0.25
Reduced sort loss	0.98
Improved lean value	2.37
<u>Hormel Red Box Premium</u>	<u>1.00</u>
<b>TOTAL BENEFIT PER PIG</b>	<b>\$4.60</b>

Since January 1, 2006, Hufco has gained additional knowledge in managing the auto sorter and reaped further benefits. Specifically, they sold 2,050 pigs from one farm and gained an additional \$0.69 per pig due to improved grade and yield; also, they achieved an additional \$1.00 per pig bonus from improved carcass uniformity and packer desired carcass weight. Total bonus per pig sold in 2006 was \$6.29! The Huftalin's found their return on investment in the auto sorters was 1.4 years with the \$6.29 per pig bonus.

In summary, large pen auto sort is a fresh way of utilizing technology with significant benefits. It allows for targeted marketing; it enables producers to optimize facility use; it ensures animal welfare; it permits producers to monitor real time animal performance; and it provides the capability to administer targeted feeding programs and reduce feed costs.

The auto sorters not only help producers manage their pork production more efficiently, it allows them to directly meet the demands of today's consumers.

# TEN RULES TO OPTIMIZE NURSERY-GROW-FINISH PRODUCTIVITY

Greg Wideman<sup>1</sup>, Dallas Reimer<sup>2</sup>, John Otten<sup>1</sup>

<sup>1</sup>South West Ontario Veterinary Services

<sup>2</sup>Minor Brothers Farm Supply Ltd

## INTRODUCTION

Throughout the period from 1990 to 2004 Ontario pork producers enjoyed and endured, by turn, the usual economic ‘highs’ and ‘lows’ of the hog cycle. In general, though, the entire period was marked by three relative advantages that favoured Canadian producers: a North American free trade agreement; an advantageous currency exchange rate; and a relative health advantage over the two pork powerhouse regions in the USA – North Carolina and Iowa. Since 2004 the ‘tables have turned’: rapid currency exchange movement towards ‘parity’; new and severely debilitating strains of PRRS and PCV-2; and challenges to free trade (e.g. mCOOL).

So at the start of 2012 the Ontario producer finds himself in a new production environment of narrow margins and very little room for error. The authors hope that this paper will effectively review some of the important factors that can promote profitability in the nursery and grow-finish barns.

## 1. CONTROL PRRS VIRUS INFECTION IN THE NURSERY

Porcine Reproductive and Respiratory Syndrome virus (PRRSv) is an economically devastating disease in swine production. Recent epidemiological information from Quebec indicates that 75% of all herds are infected with PRRS virus (Lambert et al., 2012). In the nursery, PRRS virus infection is especially problematic because many weaned pigs become infected shortly after weaning (Cuatero et al., 2002). They are therefore sick at a critical time, when they are adapting to different feeds in a new environment, and are often required to respond effectively to vaccines for PCV-2 and *M. hyopneumoniae*. PRRSv infection causes typical clinical signs of failure-to-thrive, respiratory signs, and elevated mortality. PRRSv can ‘potentiate’ co-pathogen infections; for example, *Streptococcus suis* type-II mortality has been reported as five times higher in PRRSv-positive pigs relative to PRRSv-negative (Feng et al., 2001). The cost of PRRSv infection in the nursery was calculated to be \$6.01 per pig based on reduced feed efficiency, decreased gain, and increased mortality (Johnson et al., 2004).

The key to controlling nursery PRRSv infection is PRRSv control and eradication in the sow herd. Eradication has been repeatedly achieved through the process of herd closure in the sow herd, although other techniques also can be employed (Corzo, 2010). Once the flow of weaned pigs is verified to be 100% PRRSv-free, the infection can often be eradicated from the nursery through complete depopulation and thorough cleaning, washing, disinfecting and drying.

If PRRSv eradication is not possible in the nursery (e.g. a large continuous flow nursery) the goal should be to increase the age at which piglets become infected after weaning. Older pigs clear PRRSv infection more quickly than younger pigs (Klinge et al., 2009).

## **2. PROVIDE OPTIMAL RESOURCES TO THE WEANED PIG**

### **Floor space allowance**

Allowing adequate space means that if we keep pigs in a nursery up to 25kg body weight then 2.85-3.0 square feet is ideal. If raising pigs into the 30kg range then target at least 3.0 square feet, and maybe closer to 3.5 square feet. This will depend on the housing cost and the farm's measurement of improved performance of the pig. Leaving pigs in nurseries to a heavier weight can be hard on the hardware of the nursery (especially plastic flooring), but if exit weights can be managed to allow 'All-In, All-Out' pig flow, this is the best way to manage flow and segregation between groups of pigs.

### **Thermal environment**

It should be noted that the optimal temperature for different groups of weaned pigs ranges from a low of 22.9°C to a high of 29.8°C depending on age and size. Reduction of temperature can begin after 2-3 days after weaning, and after three weeks into the nursery period, begin to lower (slightly) on a daily basis until the pigs leave the nursery. If we lower the temperature but keep the pig comfortable we will be able to provide the conditions for optimum feed intake. Many current recommendations tend to keep our nurseries slightly warmer than necessary, resulting in lowered feed intakes and poorer growth. In studies, piglets preferred cooler temperatures at night. Between 10:00 pm and 6:00 am, piglets selected temperatures that were about 3°C to 4°C lower than during the daytime. A larger daily temperature variation is undesirable.

## **3. PROVIDE THE STOCKMANSHIP TO GIVE WEANED PIGS A GOOD START**

While environmental management and proper nutrition are critical to success in the nursery, piglet management is the most important of all. Following is an abbreviated list of key management practices to achieve success in weaned piglet management:

- The room, including all equipment, must be thoroughly cleaned and disinfected. This includes fans and blades, air inlets, feeders, penning and flooring. Any attention paid to proper cleaning is likely to pay significant dividends in piglet performance and health after placement.
- Prior to arrival, the room air and all equipment in the room should be warmed to receiving temperature. The recommended receiving temperature will depend on piglet size and initial feed intake, but an average of 28°C is a reasonable starting point. Piglet behaviour will reveal if the temperature is too high or too low.
- Adjust the feeder gate so that about 40% of the feed tray is covered with feed. Anything less than this will impair pig performance, and greater coverage provides no benefit but increases the risk of wastage.
- Check all drinkers to ensure they are functioning correctly. If nipple drinkers are used, they should be adjusted so they are at shoulder height of the smallest pig in the pen. Additional waterers are recommended for pens with smaller pigs, to ensure dehydration does not occur.
- Pigs should be placed in pens according to bodyweight; this is not to improve uniformity of growth (because it will not!), but because it facilitates more effective feeding and water management. In other words, the pens of smaller piglets will probably require more attention than the pens of larger pigs.



- By about 36 hours post-weaning, piglets not eating or drinking can generally be easily identified. The management of such pigs will depend on individual units, but hand feeding, offering ‘gruel’, or other personal attention will reduce mortality and “pulls.” If weaning has occurred on Thursday, unfortunately this critical time will fall on Friday night or Saturday morning, a time when labour could be in short supply. Nonetheless, this is the time when potential non-viable pigs can be turned into healthy productive animals.

#### **4. DEVELOP AN OPTIMIZED NURSERY FEED BUDGET**

It is critical to practice strict discipline when using a feed budget, to prevent overfeeding of the more expensive nursery diets past the desired weight range. Often this is the cause of high feed costs in the nursery. However, limiting piglets of complex diets in the first 2 weeks can also affect end financial numbers.

##### **Switch from complex to simple diets as quick as possible**

Diet formulation for feeding weaned pigs should be designed with certain key considerations in mind:

- Feed intake drives growth performance.
- Complex diets with specialty ingredients are beneficial during the first few weeks after weaning, because they increase feed intake.
- Diet complexity must be reduced rapidly as feed intake increases, and economic benefit declines rapidly.

##### **Feed budget**

The following 3 weight ranges are the most typical with a fourth diet being either added or splitting up the 11-25 kg range, depending on the days in nursery and desired pig weight:

1. **WEANING TO 7 KG:** An effective nursery feed program aims to transition pigs to a low cost, corn-soybean meal-based diet as quickly as possible after weaning, without sacrificing growth performance regardless of the number of diet phases used. This stage is where the most attention should be paid to pig weight and amount of phase to reach goals. With variance from pen to pen and week to week, both over and under feeding at this time are major contributors to poor financial outcome!
2. **7 TO 11 KG:** At this weight, the diet is typically a corn-soybean meal based diet with about 7% to 10% high-quality lactose, and a small amount of specialty protein source, such as plasma or high-quality fishmeal. Again, if a great job of assessing the first stage is done there is limited assessment needed here. However, if variance in pig weight is observed the budget should be observed to fit the end goal and weight range.
3. **11 TO 25 KG:** This diet will be a simple corn-soybean meal diet with limited specialty protein products or lactose sources, resembling a grow-finish diet. The digestive capacity of pigs at this weight means that specialty products are unnecessary, and including them will only increase the feed cost per pig with limited benefits. This is the lowest-cost diet in the nursery program, but since consumption is the greatest at this stage, it accounts for

more than half of the total feed cost from weaning to 25 kg. Typically, 20 to 25 kg of feed is budgeted for pigs during this last phase.

### **Factors that can reduce the effectiveness of the feed budget**

1. Weaning weight. There is a linear relationship between birth weights and wean weights, affecting nursery production. However, most farmers only have the wean weight so it is the most common predictor of nursery budget success. Make sure you are monitoring your wean weights regularly, to assure you are maximizing nursery performance and validating your program. If wean weights fluctuate so should your nursery budget, to maximize your program.
2. Water and Feed availability. Limiting water or feed will always affect your budget. Water will affect feed intake and is easy to measure if limiting. The best way to know if feed intake is being obstructed is to manage feeders and measure average daily feed intake. 650g per day is very attainable, if the conditions are right.
3. Environment. Air quality, flow and temperature play a major role in the effectiveness of your budget. If the room is cold, efficiency will go down, and if the room is hot, efficiency will go down. Environment must be assessed daily to assure the optimum is achievable.
4. Management. Pigs that need extra care and assessing disease are crucial to knowing if the budget is going to fail or succeed. The faster we can get on this the better chance we have of reaching our nursery budget goals.
5. Measuring. Once water, feed allowance, management and environment are assessed, measuring is going to be the key to objectively following a budget. In many cases early diets are very easy to manage due to low amounts needed. Wean weight is probably the largest teller of success or not in the nursery. This means that we should be always assessing our budget to wean weight. Ideally, each phase should be monitored to assure weight ranges are being achieved. If not, every crop or room can be measured, then make sure you get some quarterly numbers or verify your data every time a change is made to medications and ingredients.

If simple measurements such as weight in, weight out, avg. daily gain, feed conversion and cost per kg of gain are not regularly being assessed, there is no real way of knowing if your budget is working. Nursery programs can vary \$5 per pig and go unnoticed, unless you combine measurements with management, feed, water and environment, they all can be fairly limiting in what they tell you.

## **5. CONTROL OTHER COMMON NURSERY PATHOGENS**

Clinical signs for a great variety of diseases may be seen in the nursery because this period occurs at the intersection of two biological processes: 1) decrease in maternally-derived immunity in weaned pigs, and 2) increase in contact rate and pathogen transmission between pigs after weaning. Some common diseases are due to infections with *Streptococcus suis*, *Haemophilus parasuis*, influenza A, and enterotoxigenic *E. coli*. These diseases are not generally regarded as ‘major’ contributors to poor productivity (Holtkamp, 2008) and can often be limited to an increase in 1.0-1.5% per pathogen when present without co-pathogens (Holtkamp et al., 2007). However, occasional severe outbreaks of disease do occur, and

medication programs designed to control these pathogens add to cost. Several of the pathogens (e.g. influenza A) have zoonotic potential as well, causing concern for occupational health and safety for farm workers.

Control of the ‘minor’ pathogens can be attained by various means such as: 1) vaccination of sows for pathogens such as influenza A and *Haemophilus parasuis* (Baumann, 2002) 2) medication programs 3) nursery depopulation.

## **6. SET UP THE FINISHING BARN TO SUCCESSFULLY RECEIVE NEW FEEDER PIGS**

Make sure:

- The controller is reset to meet minimum ventilation requirements.
- Pig temperature requirements are determined based on size and health.
- All fans are clean and completely operational.
- All building curtains are functional, level and without holes.
- The curtain drops are fully operational.
- All air inlets are working, clean and open.
- The heaters are set correctly on the controller and prepared to operate.
- Backup thermometers are reset to meet new group needs.
- Soffit attic inlets are clean and open.
- Alarms are set and tested.

The critical component to early finishing barn management is that a ventilation plan is reviewed and the barn is set up correctly to meet the immediate needs of the incoming group. To test the equipment grab a temperature probe and hold it in your hand for one minute. The change in temperature should increase fan speeds and different stages coming on and inlets or curtains responding. Arrival time is a critical stress point in the life of a pig. Waiting to correct ventilation settings after the group has been placed in the finishing barn for several days can have serious consequences.

During the downtime between finishing groups, when the barn is being washed, cleaned and disinfected, make sure the water lines and nipples get cleaned with chlorine and rinsed out. Prior to pigs arriving, each individual water nipple should be checked for flow. Flow rate is critical as it affects the pigs' ability to consume the correct amount of water each day.

Any moist surface is a candidate for bacteria and viruses to persist and infect the next set of pigs: get the barn dry!

It sounds like such a simple statement that pigs need feed in order to grow, but it is common to see empty feeders when walking finishing barns. In today's production systems, since many finishing barns are not on the “home farm,” it is not as easy to hear the feed system running empty. ‘Out of Feed’ situations must be avoided at all times because of the negative impact on health and productivity.

## **7. CONTROL LATE FINISHING COMPLEX RESPIRATORY DISEASE**

Many groups of finisher pigs experience what we have called the “20-week wall”, a severe clinical outbreak of respiratory disease occurring shortly before pigs attain market weight. This

occurs at the peak time in pig density and as a result of multiple pathogens reaching high prevalence within the group. The most common primary pathogen is PRRSv. Contribution to complex respiratory disease is part of the estimated \$7.67 cost of PRRSv infection in the finisher (Johnson et al., 2004). A Quebec study found PRRSv in 95% of lungs with severe pneumonia at slaughter (Drolet et al., 2003)

Other major pathogens that contribute to complex respiratory disease include influenza A, *Mycoplasma* and PCV-2. Vaccination programs must be properly designed and diligently followed to prevent these infections. Properly calibrated ventilation systems and appropriate pig density are both critically important in controlling finisher respiratory disease as well.

## **8. OPTIMIZE FINISHING BARN FEED BUDGETS**

It is important to continuously monitor alternative ingredients and consider their possible use in diets. However, corn will likely be the major ingredient in swine diets. If we look at higher feed costs, as a whole, anything to improve feed efficiency can help maintain or improve profitability.

Feed conversion during the grower and finisher period is a key factor to monitor. This is the period of the animal's life when the majority of feed is consumed. The efficiency of feed utilization can be dramatically influenced by factors such as; feed wastage, nutrient levels in diets, feed budgets, diet form (pellet or mash) and other environmental factors.

### **Why budget for finishing hogs?**

Feed budgeting in the finishing barn allows you to accurately feed to the daily required energy level, which is needed to maximize gains economically. As the animal grows, the feed intake increases, and as the intake increases, a lesser concentration of energy is needed to maximize gains. Budgeting allows you to minimize over- and under-feeding pigs, therefore allowing you to feed the pig more economically.

Both your genetics supplier and nutrition team should be consulted when a budget is being set up, and should have input about what potential savings would be realized if phases were added, taken away, or weight ranges moved up or down.

Trials in finishing pigs show that the first 28 days have the greatest effect on different feed budgets. This coincides very similarly to feeding nursery pigs; the better start you get in the first 2 stages, the more efficient the pigs will be in later stages.

Feeder wastage and management are the most critical factors in feed:gain ratios, but other factors that must be taken into consideration are: environment, diet form (pellet vs. mash) and nutrient levels. Feed budgets are part of this equation to monitor. Like the nursery, all of the above must be observed to make any true assessment of your feed program. The correct diets may be fed, but if we are using feed budgets we need to be sure we are feeding the appropriate budget for the appropriate stage of production. There are many metrics to observe in the finishing pig (average daily gain, feed:gain ratio, feed cost per kg gain). Table 1 shows the economic effects of feed:gain ratio for different ration costs.

Grower-finisher feeds represent the largest share of feed cost in a farrow-to-finish operation. Therefore, decisions to change or modify finishing diets must be made based on economics. Modern production systems have resulted in large groups of similar age and weight pigs, which allow for more efficient feed deliveries, phase feeding, and split-sex feeding. Some simple tools

to allow farm specific diet formulation and feed budgeting are available, to more efficiently reduce feed cost and improve growth performance in the grower-finisher phase of production.

**Table 1. Feed cost/pig (50 to 260 lb.) at various feed prices and feed:gain ratios.<sup>1</sup>**

		Feed:Gain							
		2.50	2.60	2.70	2.80	2.90	3.00	3.10	3.20
Feed Cost, \$/ton	\$200.00	\$52.50	\$54.60	\$56.70	\$58.80	\$60.90	\$63.00	\$65.10	\$67.20
	\$225.00	\$59.06	\$61.43	\$63.79	\$66.15	\$68.51	\$70.88	\$73.24	\$75.60
	\$250.00	\$65.63	\$68.25	\$70.88	\$73.50	\$76.13	\$78.75	\$81.38	\$84.00
	\$275.00	\$72.19	\$75.08	\$77.96	\$80.85	\$83.74	\$86.63	\$89.51	\$92.40
	\$300.00	\$78.75	\$81.90	\$85.05	\$88.20	\$91.35	\$94.50	\$97.65	\$100.80
	\$325.00	\$85.31	\$88.73	\$92.14	\$95.55	\$98.96	\$102.38	\$105.79	\$109.20
	\$350.00	\$91.88	\$95.55	\$99.23	\$102.90	\$106.58	\$110.25	\$113.93	\$117.60
	\$375.00	\$98.44	\$102.38	\$106.31	\$110.25	\$114.19	\$118.13	\$122.06	\$126.00
	\$400.00	\$105.00	\$109.20	\$113.40	\$117.60	\$121.80	\$126.00	\$130.20	\$134.40

## 9. DO HIGH QUALITY DAILY CHORES

It is great to achieve good production closeout numbers for finishing: 2.6 feed conversion, 950 grams/day average daily gain and less than 2% mortality. But in order to brag about good production numbers, we must be able to continuously achieve them – and that requires excellent daily management. I often hear: “If you want me to get good finishing numbers, give me good pigs.” This is certainly a true statement. However, as this review will illustrate, there are many factors that can turn good pigs into average pigs by improper finishing management.

### Walking the barns

To do high-quality daily chores, the producer must meet the individual needs of each pig in the barn on a daily basis. This includes feed, water, air and health management. The first and most important point to remember is – it is impossible to perform quality daily chores without being in the barn. Being in the finishing barn and focused on chores for a morning and an afternoon walk-through is critical. The morning walk-through is usually the more thorough, during which each individual pig should be carefully observed. The afternoon walk-through can be a quick visual observation to check for major problems in feed, water or ventilation areas.

Chores can be broken down into: observations at the barn level, the pen level, and the pig level.

At the barn level, it is important to step into the barn and spend a few seconds understanding what the barn is telling you. Let your observational skills go to work. What is the temperature? What is the humidity? Is the ventilation system working? Are the curtains operational? Is the feed system working? Are there abnormal noises? Are there abnormal smells?

At the pen level, be sure to check for individual items within the pen that affect pig production. Is there feed in the feeder? Is the feeder adjusted correctly? Is the water flow adequate? How are the pigs lying within the pen? Are pen floors wet? Is diarrhea present?

At the pig level, instead of seeing a sea of pigs, teach yourself to see every individual pig. It does not matter if there are 200 pigs or 2,000 pigs in the barn. Each pig must be observed. This

<sup>1</sup> Source: <http://wengerfeeds.wordpress.com/2011/02/>

process does not take long. When looking at each pig, note posture, position in the pen, respiration rate, attitude and even facial expression. If a pig is hurting it will show by how quick it can move or if they have a full stomach.

Initially, you think this process is going to take an unreasonable amount of time. However, I am quite confident that most individuals can walk a 1,000-head finishing barn, under normal disease conditions, and accomplish all of these evaluations in approximately one hour.

### **Individual pig treatments**

Rate of success is much greater if sick animals are identified in the early stages of a disease. This is very intuitive, yet often not put into good barn practice. Early treatment of infectious disease can limit the spread of pathogens throughout the herd, and affect the disease level of the entire barn, not just the treated individuals. You can't find sick pigs early without looking at each pig every day.

A system of quality chores allows you to find the sick pig early, get a good individual treatment response, and have an impact on the overall disease experience in the barn by keeping pathogen levels below critical thresholds. I often hear: "It does no good to treat individual pigs because few recover." To me, this comment should be translated into, "By the time I get the pig treated, it is too sick to get better!"

When seeking assistance from outside the barn have a policy that if there are multiple deaths in one day, or three days consecutive days of mortality, or increasing amount of individual treatments, then call someone (e.g. Farm Manager, System Manager, or Veterinarian).

## **10. CONTROL GROWER DIARRHEA**

Thankfully, PCV-2 is no longer a common cause of grow-finish diarrhea. However, grower diarrhea continues to be a common syndrome observed in Ontario, and there are a few common culprits on the list of pathogens.

Ileitis caused by infection with *Lawsonia intracellularis* is very common and can be a significant profit-robber. Various recent papers from around the world have placed the cost of ileitis infection in the finisher in a remarkably similar window between \$6.73-\$8.92 per pig marketed (Morel Saives et al., 2008; Holyoake et al., 2010; Johnson and Lowe, 2008). Fortunately, control of *Lawsonia* can be reliably attained through use of feed medications or a commercially available modified-live vaccine.

Salmonella infection occurs with regularity in Ontario finishers and some risk factors, such as the use of pelleted feeds, are hard to avoid. Outbreaks of disease due to Salmonella are infrequent, but can contribute very significantly to mortality when they do occur. Sudden changes in grow-finish diarrhea prevalence or appearance should be promptly investigated with the herd veterinarian.

Finally, swine dysentery due to *Brachyspira hyodysenteriae* is making a comeback as a cause of grower diarrhea in western Canada and the Midwest. The clinical signs of this agent often include bloody diarrhea. Good biosecurity diligence is required by Ontario producers to keep this pathogen out of our farms, for it has a very negative impact on productivity. A recent US system reported that dysentery-affected batches were 20 times more likely to be in the poorest

quartile for mortality, gain, feed efficiency and culls when compared to dysentery-negative batches (Harms, 2011)

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