21st Annual

CENTRALIA SWINE RESEARCH UPDATE

January 30, 2002

CENTRALIA SWINE RESEARCH UPDATE
Kirkton-Woodham Community Centre
January 30, 2002

WRITTEN-ONLY TOPICS

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Evaluation of a Two-Storey Swine Finishing Barn

Ron Fleming, P. Eng. and Malcolm MacAlpine
Ridgetown College - University of Guelph
Prepared for: Centralia Swine Research Update, Jan. 30, 2002

Introduction

In the past few years, several High-Rise™ swine barns have been built in Ohio, USA. The High-Rise™ barn is a two-storey hog barn where the pigs are raised on a slatted floor in the top storey. Manure falls through the slats to land on a bed of wood fibre (or other material with high carbon content). Air is used to dry the manure so that it can be removed as "solid" manure after a period of up to a full year. All room ventilation air is drawn down through the slats to exhaust through wall fans in the lower floor. In addition, aeration air is forced up through the carbon material/manure. This air is blown through pipes buried in the floor and upwards into the material via holes drilled through the concrete into the aeration pipes.

In 2000, Frank Hogervorst, Avonbank Farm Equipment Ltd., organized a tour to visit one of these barns to assess the potential for application to Ontario building design. The visit showed that the technology could be adapted for southwestern Ontario farms.

Based on the observations in the US, and on comments and ideas from a number of people, a variation of the Ohio designs was built on an Ontario farm. Frank Hogervorst, coordinator of this effort named the new version the **Environmentally Friendly Facility** (EFF). This concept was incorporated into a new hog barn constructed during the summer of 2000, near Exeter, Ontario.

Perceived advantages:

- lower odour levels from the storage and during spreading
- less total amount of manure to handle
- less environmental risk during spreading since the manure is in a solid form

Objectives

1) to assess the viability of this type of barn as a way to handle liquid hog manure - including: volumes of manure produced, nutrient concentrations, and economic considerations;
2) to determine the impact of this type of housing and manure system on the odours and ammonia exhausted from the barn as well as the environment inside the barn;
3) to determine the impact of this housing system on the production of hogs.

The Barn

The barn was constructed in the summer of 2000 on a farm near Exeter, Ontario. The figure shows the lower floor of the barn during construction. The barn is a fully slatted, fan-ventilated, hog finishing barn. It is 51.2 m by 16.76 m (168 ft by 55 ft) with ceiling heights of 2.4 m (8 ft) upstairs and 2.7 m (9 ft) downstairs. This depth of manure storage, if used for liquid manure, would be enough to handle the production for just over one full year (about 2,093,000 L), based

on 1000 feeder pigs.

Upstairs, there is a center alley with 34 pens in one open room. The barn is run as a continuous system - pigs are moved into the barn at regular intervals and they are shipped out when ready.

The feeding system consists of BSM wet/dry feeders with three water nipples per feeder. No additional water nipples were installed in the pens.

The barn ventilation was set up in three stages, controlled by thermostats. The first level was set to operate constantly, the second level was set to operate intermittently in colder months and the highest level would start in the warmer months. Fresh air entered the barn through the eave vents, then entered the room through ceiling-mounted actuator-controlled inlets. After circulating in the room and slowing down, the air dropped through the floor and exhausted through the exhaust fans in the walls of the lower floor. The barn was oriented in more-or less a north-south direction. The exhaust fans were set up to blow air from both sidewalls and each quarter of the barn was set up identically.

The aeration system in the lower floor consisted of a series of pipes running from the center to the ends of the barn. In the center was a plenum that was 810 mm wide by 910 mm deep. It was covered with concrete slabs, at floor level. The pipes running out from this plenum were 100 mm diameter and were spaced at 600 mm apart. These were buried in the concrete floor, 25 mm below the floor level. A 9.5 mm (3/8 inch) hole was drilled downward into the pipe after the concrete floor had hardened. These holes were spaced at 300 mm along the entire length of the pipes. At the side of the building, in the center, was the fan location for the aeration system. A small chamber was built on the outside of the barn. In it were mounted two inline centrifugal fans of 460 mm and 2.2 kW (18 inch, 3 hp). These blew air into the plenum. They were set up so that air from inside the bottom floor area could be circulated through the system, or fresh outside air, or a combination. These fans ran constantly.

A submersible pump was installed in the aeration plenum, just below the aeration fans. This was to handle any liquid manure that might find its way into the aeration system (after soaking through the bed of straw). Initially this was set up to pump any liquid that might accumulate into a nearby liquid manure storage (serving another barn).

Startup

The manure floor was loaded with 251 big round straw bales weighing about 200 kg each, giving a total mass of 50,200 kg of straw. The straw was placed in the Figure 1 Downstairs, partway through the study manure storage using a skid steer loader. The wrap was cut off the bales, then the bales were either rolled out by hand or shaken out using the loader. The final depth of straw throughout the bottom floor was about 1.8 metres (6 ft). The first pigs entered the barn in early September. The barn was gradually filled with pigs as weaner production allowed, and was full by November 7, 2000.

Pigs are brought into the barn weighing 32 kg (70 lb) and shipped at 109 kg (240 lb). Pigs are in the barn for approximately 90 to 100 days. Pens are washed down using a pressure washer between lots. A water meter was installed on the main water line to monitor total water use for the barn.

What We Learned

1. This system of handling hog manure has shown to be a viable alternative to liquid manure. The use of straw and forced aeration to transform the liquid hog manure into a dry manure was quite successful. This system greatly reduced the volume of manure produced, thus concentrating the nutrients and making it more easily transported. Even after the addition of the straw, there was a 58% reduction in manure volume compared to liquid hog manure. The manure did not appear to compost, but simply dried down to a final moisture content of 61%.

2. The economics of this system has yet to be evaluated. The added costs are:

    a) construction with the installation of the aeration system and the manure storage door.
    b) the installation and operation of the aeration fans.
    c) the installation and operation of a sump pump to drain the aeration plenum
    d) the cost of the straw and labour to spread it out in the manure storage
    e) the cost of equipment to handle dry manure if not already in use on the farm and the labour to operate it

    The cost savings:

    a) liquid manure handling equipment, spreaders and pumps and the labour to operate them
    b) possible improved herd health and improved pig performance due to a better environment in the barn
    c) the reduction of manure volume, thus reducing transportation costs.
    d) the ability to process the manure further through composting to eliminate odours, pathogens, destroy weed seeds, to greatly reduce volumes of manure, and increase it's market value.
    e) the improved environment in the barn should reduce veterinarian costs as well as an improved working environment for the herd workers in the barn.

3. This system has caused a significant reduction in odours exhausted from the barn, as well as those inside the barn. Ammonia levels, once a problem with the ventilation system was repaired, were very low. Odours measured outside the barn were very low and less offensive than liquid hog manure. Odours during manure application to the field were less offensive than liquid hog manure.

4. Less than 4% of the total initial liquid manure drained through the system and had to be handled. A system was eventually set up to pump this onto dry areas in the straw bed. This, therefore eliminates the need to spread any manure as liquid, which eliminates the risk of macropore flow of liquid manure to tile drains - a potential impact that farmers with liquid systems must take extra steps to guard against.

5. The owners feel there was an improvement in hog production using this system with days to market at around 90 to 100 days. Feed conversion and average daily gain were similar to conventional barns. Water use was significantly lower than conventional barns.

6. The system creates much more flexibility in determining manure spreading times than typical liquid systems.

Acknowledgements

The authors would like to acknowledge the funding support of Ontario Pork. Funding was also provided by the Ontario Ministry of Agriculture, Food and Rural Affairs. The project was coordinated by Frank Hogervorst of Avonbank Farm Equipment. Of course, the project could not have proceeded without the support of the farmers, who gave freely of their time and went out of their way to help with data collection.

Further Reading:

The full report (ready for download) is available at www.ridgetownc.on.ca in the research section. Title: Evaluation of a 1000-head “Environmentally Friendly Facility” Swine Finishing Barn - by: Ron Fleming and Malcolm MacAlpine

The Rural Community and an Evolving Agricultural Sector

Wayne Caldwell[1], PhD, RPP

Within many rural and agricultural communities there is the belief that the continued intensification of agriculture has degraded and will continue to degrade the rural environment. This concern over the impact of agriculture on the environment is occurring at a time when there are continuing shifts in the composition and aspirations of the rural community. For issues such as the siting of intensive livestock facilities there is increasingly a view that the broader community has an interest in where and how these facilities are established. At the same time there is a need to ensure that regulations are fair, and adequately protect the interest of the farm community and individual farmers. If there is not an appropriate balance between agriculture, the environment and community interests, there is the risk of two resulting extremes. At one extreme, if there is a failure to recognize legitimate community interests, intensive livestock operations will be established with a minimum of community involvement and regulation so that over time farmers are likely to face increasing harassment and corresponding legal action over issues related to air and water quality. At the other extreme, if society is over zealous in regulating the livestock sector there is a risk of a stifled and non-competitive agricultural industry resulting in shifts in production from one geographic area to another (with a corresponding shift in employment and economic activity).

Part of the challenge for policy makers in responding to the environmental impacts of livestock production on the rural community, therefore, is to develop an approach to the siting of intensive livestock facilities that strikes a fair and effective balance between agriculture, the environment and community. This response will need to be developed in recognition of the broader political and economic context of the rural community of the 21st century.

Many municipalities, the province and producer groups have been trying to come to grips with how best to approach this issue. The result is a smorgasbord of approaches across the province. While a provincial approach to legislation and regulations is on the horizon there remain many unanswered questions both related to the proposed Bill 81 and to the appropriateness of municipal actions. This presentation will attempt to identify key issues for agriculture in this evolving environment and will offer some strategies that may be helpful to agriculture in responding to the changes that continue to happen in rural Ontario. Key elements of the presentation follow:

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[1] Wayne Caldwell is a Senior Planner, County of Huron and an Associate Professor University of Guelph, School of Rural Planning and Development. He may be reached at the County of Huron (519-524-2188) or at the University of Guelph (519-824-4120 ext. 6420)

The Context

Issues For Agriculture in the New Rural Community: Potential Conflict & Potential Risk

- perceptual issues
- competition for land & inflated land values
- non-farm development and evolving rural landscape
- paying for services not required by the farm community
- complaints re. "normal" farming practices
- heightened environmental concern (ex. water contamination)
- policy reflective of urban community (vision of rural)
- requirements to adopt specialized production practices
- loss of local political clout
- local planning policy that is not supportive of agriculture
- **difficulty expanding "industrial" agricultural facilities**
- traffic and safety concerns
- loss of flexibility

Coping in the New Rural Community: Strategies for Agriculture

"strategies to avoid problems and strategies to manage issues"

- importance of education, communication and research
- work to ensure that local government (and the community) is aware of agriculture's contribution to the local community
- be vigilant - participate in the planning system (local & provincial)
- work for an agriculture first land use policy
- acknowledge legitimate interests of non-farm community
- don't shirk responsibility
- anticipate loss of protection from terms such as "normal farm practices"
- be vigilant - monitor and identify environmental issues
- be aggressive in developing & implementing approaches to environmental issues (i.e. Best Management Practices, Nutrient Management Plans, Good Neighbour Policy etc.)
- Promote a community based approach to environmental issues
- encourage participation of all of society in these initiatives
- coordinate and co-operate with other commodity groups
- take advantage of opportunities that the rural/urban interface offers
- conflict resolution tools

Maximum versus Standard Care for Piglets – Does it Make a Difference?

Cate Dewey, Karen Richardson
Population Medicine, OVC, University of Guelph

Introduction

We have spent the past few years looking at individual management factors that improve weaning weights of pigs such as the use of electrolytes, timing of processing and cross fostering. The purpose of this project was to put all of those ideas together into one management system. We wanted to know if we could improve weaning weights and reduce mortality if we provided the pigs with all of the right attention that we believed was also reasonable in a commercial setting.

Materials and Methods

The project was conducted on a 600-sow farrow-to feeder pig farm with 4 farrowing rooms. Each room has 4 rows of 6 farrowing crates. Within each room, two rows were assigned to be maximum care litters and the other two rows were assigned to be standard care litters. Each room was used twice so the rows of crates were rotated between treatments. A total of 1381 piglets were included in the study. The pigs were provided with a water nipple but were not given creep feed. The pigs were weighed at birth and again at 16 days of age (because 16 days was the youngest weaning age on this farm).

All pigs were processed within 24 hours of birth, typically 6-8 hours after the last pig was born. The number of pigs born alive and born dead and the parity of the sow were recorded. The pigs' teeth and tails were clipped and the pigs received 1 ml of iron. Pairs of sows within treatment group, whose pigs were processed at the same time, were used for cross fostering to establish evenly sized litters. Pigs were given a second 1 ml injection of iron at 10 days of age and male pigs were castrated.

Maximal care litters were processed as above but also received the following additional attention:

Processing: the teeth and tail clippers and castration scalpel were dipped in dettol between pigs, the tail and castration wounds and umbilical area were sprayed with dilute iodine, wounds. Small or weak pigs were not processed until day 3. Electrolyte solution was provided to all maximal care litters from one day of age until weaning. Baby pig water jugs / milk replacer bottles were used for the solution.

For newborns a rubber mat was put under the heat lamp for 3 days Some piglets were dried off by towel, chilled pigs were dried, given a hot water bottle, were given a warm bath, were put in a box with shavings underneath the heat lamp, given a solution of glucose orally and/or colostrum stripped from a farrowing sow. Splay-legged piglets were taped, massaged and helped to get colostrum.

Sow manure was removed from the crates twice daily. The sows on maximal care were to be given a third meal each day. The farmer was responsible for morning and evening feeding of the nursing sows.

Results

Mortality

The small birth-weight pigs (less than 1 kg) were only half as likely to die if they were in maximum care litters than if they were in standard care litters. The overall pre-weaning mortality in the study was 9.9%. All pigs that were 400 – 600 grams at birth died before 16 days. Of the pigs that were 700 – 900 grams at birth, 47% died if they were in standard care litters (33/71), whereas 30% of them died if they were n maximum care litters (24/79). On average, there were 9.8 pigs born alive per litter, 0.8 pigs stillborn per litter and 0.3 mummified pigs per litter. These numbers did not differ by treatment group.

Weight Gain

The pigs from the maximum care litters grew more than the pigs from the standard care litters. On average, the pigs from the maximum care litters weighed 4.91 kg at 16 days and had gained 3.5 kg from birth. The pigs from the standard care litters weighed 4.75 kg and gained 3.35 kg. This weight gain benefit was seen for all birth weight groups (small, medium and large). It appears that all sizes of pigs can take advantage of the growth benefits of being in a maximum care litter.

Problems with the study

With both study groups in the same room it was difficult for the technician to limit the care of the standard care pigs. Because she was in the room for a longer than standard time period meant that she noticed problems that would have otherwise gone unseen. Also, because the maximum care sows were fed at lunch time, to quieten the standard care sows, the food that fell out of the standard care sows' feeders was given to these sows. This encouraged the sows to stand up, eat and drink one more time of the day.

Discussion

Maximal care to a large extent in about paying attention to detail, having a plan of action to respond to what is observed and seeing it in the large picture. Attitude and perception can have a lot to do with whether maximal care is given or not. Is there a realistic sense of what caused the greatest numbers of pre-weaning deaths? Is there anything that might have been able to be done about it? If you assume your sows are full-fed is that really true for all of them, would some benefit from more feed? What is the treatment regime for sows and piglets? Having goals and a way of feeling pride in achieving those goals can be a great motivator whether it is financial and/or acknowledged in other ways. Paying attention to detail is time consuming. Determine how much time is being spent on each job and determine whether or not the time reflects the importance of that task? Is it possible to hire part-time workers to do specific jobs releasing other staff to pay attention to more detail? Is training or upgrading needed to change some aspects of the farm's management?

Take Home Message

Maximal care will result in reduced mortality in light-weight pigs (those less than 1.1 kg). Maximum care will also increase weight gain from birth to 16 days of age in all sizes of pigs (regardless of the birth weight).

CIPHER – A New Way to Compare Swine Farm Performance

Prepared for Centralia Swine Research Update
By Ken McEwan, Ridgetown College

1. Introduction

The acronym (i.e. CIPHER) stands for Comparative Information Process for Hog Enterprise Reporting and the project represents a collaboration of Ontario hog producers who wanted to use a reliable and tested means for comparing swine enterprise performance. The results are used to improve on-farm decision making and to provide a basis from which to discuss best management practices. Financial and production information is tabulated for six month intervals with particular care to ensure that comparisons are equivalent between enterprises so far as can be assured, and noting any differences in definition where strict comparability is not possible. On an aggregate basis, without divulging proprietary information of any business, producers have the opportunity to see how their operation compares to others on specific measures. The variables measured have been determined by the participating producers themselves to be the most relevant and determinable by a swine enterprise. Variables measured include revenues, feed conversions (i.e. adjusted for carcass weight), mortality rates, sow productivity, and other efficiency measures.

The swine operations in the project represent a wide range of scale of operations including family farms and larger loops. Further, participating enterprises also represent a mix of production types with the predominant systems being either sow or finishing operations. A producer steering committee oversees the project and the control and ownership of the information remains with the producers themselves. It should be noted that the project sponsors for this study are: Ontario Pork Congress; Agricultural Adaptation Council; Ontario Pork; Farm Credit Corporation; and the producers themselves.

2. Project Objectives

One of the key objectives of this project is to establish a culture or an approach among producers in which they are willing to share their data with one another as a step towards mutual improvement. Rather than viewing the swine farm down the road as the competitor, the farm down the road is viewed as a collaborator, with the real competition coming from swine farms in other regions of North America.

Other objectives include:

(i) use the gathering and reporting of information as an opportunity to bring participating producers together into management quality circles. Workshops are organized and serve as a "management clinic" in which producers discuss and assess the implications of the results for their businesses. The meetings are constructive, thought provoking, and participative.

(ii) to continuously improve the method of gathering data (i.e. use of electronic templates rather than paper) to enhance the accuracy and reliability of the information presented.

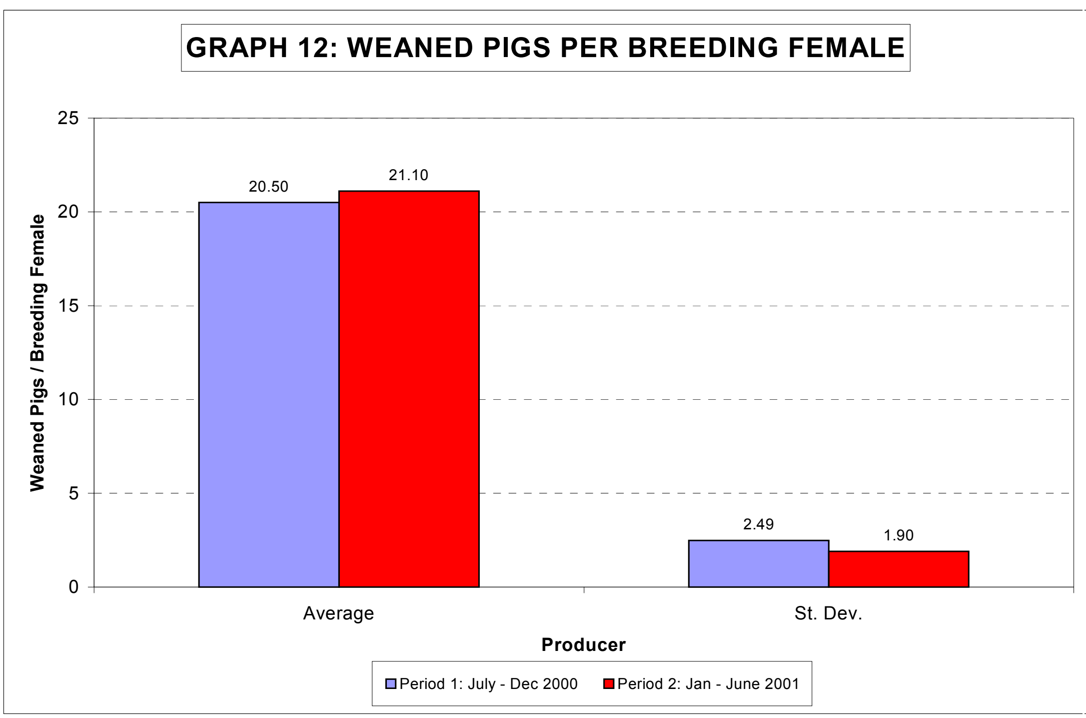
(iii) provide the information back to the producers in an easily interpreted format that identifies individual producer results. When possible variable trend lines are used to provide a long run perspective.

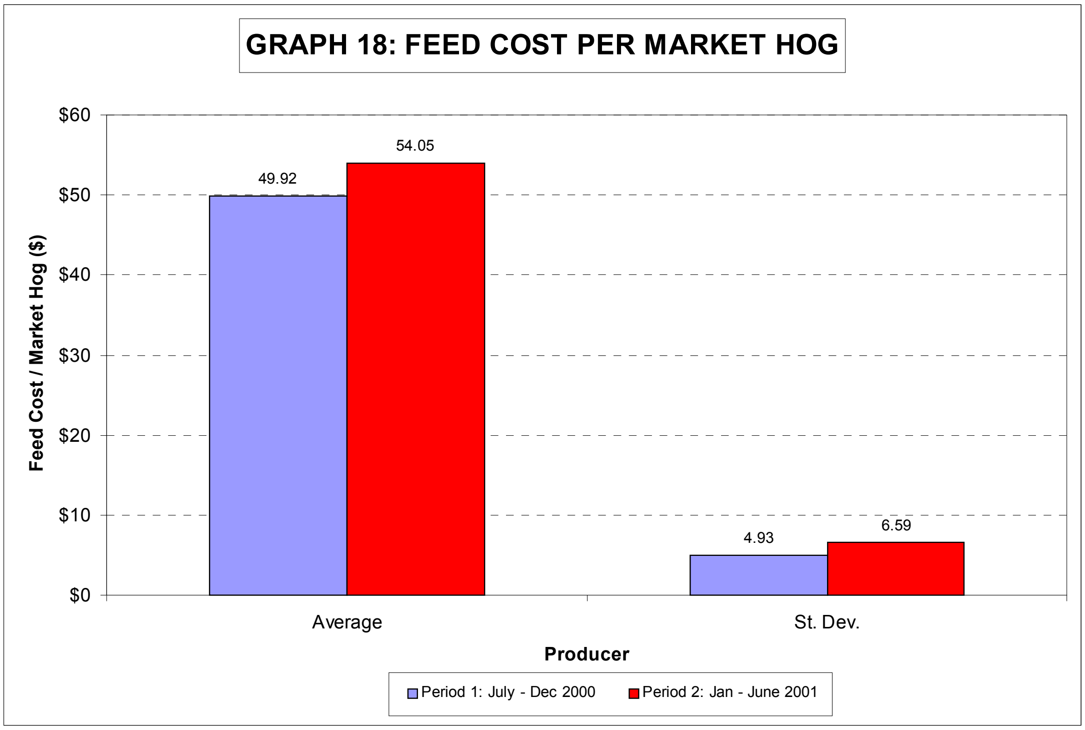
3. Challenges

One of the obstacles the group had to wrestle with was "How far can the performance of the swine enterprise be probed?" This is an important question since swine production performance links directly to financial performance. With this producer group, it was decided that balance sheet information was not to be discussed nor should any references to other farm enterprises such as cropping.

4. Results

The graphs shown below are for the July1, 2000 to June 30, 2001 time period.




GRAPH 18: FEED COST PER MARKET HOG
Feed Cost / Market Hog ($)
$60
$50
$40
$30
$20
$10
$0
49.92
54.05
4.93
6.59
Average
St. Dev.
Producer
Period 1: July - Dec 2000
Period 2: Jan - June 2001

Artificial Insemination: Know the Theory – Improve the Results

Roy Kirkwood
Department of Large Animal Clinical Sciences, Michigan State University
Email: kirkwood@cvm.msu.edu

Background
The basic principle of artificial insemination is simple; place enough viable sperm in the right place at the right time, and keep it clean. This presentation will not deal with the assessment of sperm quality. Similarly, the question of semen additives (e.g. hormones) will not be addressed.

How many are enough viable sperm? This depends on where you put them and how long they have to last before fertilising the eggs.

What is the right place? This depends on the number of sperm and the volume to be inseminated.

What is the right time? This depends on the number of sperm, their viability, and how long they are expected to last before fertilising the eggs.

The reproductive performance of females bred by artificial insemination is often poorer than that achievable with natural breeding (Claus 1990). The reason that some females perform relatively poorly following artificial insemination is not fully understood. However, at the farm level, estrus detection frequently does not involve direct/physical boar contact and so is more difficult to perform accurately. Accurate estrus detection requires good boar contact (Table 1). If the breeding staff is not expert in estrus detection, this may have a negative impact on the timing of insemination.

Table 1. Effect of boar presence on accuracy of estrus detection.

	Boar Present	Boar Absent
Estrus detection rate, %	90	52
Duration of estrus, d	1.4	0.7

Using current insemination technology, 3×10^9 sperm are deposited in the cervix. This large number is necessary because most of the sperm will be lost due to back-flow of semen, as well as entrapment and death in the cervix and uterus (Table 2). The development of new catheter designs that allow uterine deposition of sperm will allow for fewer sperm to be deposited without detriment to sow fertility (e.g. 1×10^9). However, it is not the number of sperm deposited in the cervix or uterus that ultimately controls fertility, it is the number of sperm that enter the oviduct that is important. The proportion of inseminated sperm that actually get to the oviduct is variable, but 2% is a reasonable figure. In order to reach the oviduct, the sperm must traverse about 1 meter of uterus and get through the junction of the uterus and oviduct (uterotubal junction or UTJ). This sperm transport is performed by uterine contractions. If uterine contractions are poor (e.g. if the boar is not present), sperm transport will be poor and fertility reduced.

Table 2. Sperm loss due to backflow.

	Percent sows	Percent volume	Percent sperm
During insemination	63	7 (1-56)	8 (1-50)
After insemination			
0 to 0.5 h	98	31 (3-76)	14 (1-79)
0.5 to 2.5 h	98	36 (1-94)	9 (1-30)

Steverink et al. 1998

After deposition inside the female sperm have to undergo the process of capacitation before they can fertilise an egg. Once started, this process takes about 6 hours to complete. Inside the female, capacitation is a one-way street at the end of which the sperm must either fertilise an egg or die. However, the non-capacitated sperm that enter the oviduct attach to the epithelium near the UTJ and enter an “arrested” state that slows (but does not stop) their attrition. Signals arriving near the time of ovulation cause the release of these sperm from their arrested state and allow capacitation and their redistribution along the oviduct towards the site of fertilisation (isthmus-ampulla junction). The number of functional sperm available for fertilisation (which will impact sow fertility) will be dependent on the number originally entering the sperm reservoir (which is influenced by sperm transport) and the interval between sperm entry to the reservoir and their redistribution at the time ovulation (which is influenced by timing of insemination relative to ovulation).

Timing of insemination relative to ovulation

Sow fertility following artificial insemination (i.e. fertilisation rate, farrowing rate, litter size) depends on the time of insemination relative to ovulation (Kemp and Soede 1996). If insemination occurs at or soon after the time of ovulation, by the time capacitation has occurred the eggs may be too old. If inseminated too far in advance of ovulation, too many sperm capacitate and die before ovulation occurs. The result is the same as inseminating too few sperm to begin with. To maximise fertility, deposition of fresh-extended semen into the sow should occur during the 24 hours before ovulation (Table 3), with peak fertility obtained by insemination at about 8-12 hours before ovulation (Waberski et al. 1994; Kemp and Soede 1996). Therefore, inseminations need only be performed every 24 hours. When frozen-thawed semen is employed, fertility similar to that seen with fresh-extended semen results if insemination occurs in the 4 hours before ovulation (Waberski et al. 1994). The reason for this is that cooling of sperm initiates a capacitation-like change in sperm. Once thawed, many of these sperm can not attach to the oviductal epithelium and so have a short window of time in which to meet and fertilise the ova prior to their death. Currently, the only practical protocol for using frozen-thawed semen is to perform very precise estrus detection and multiple inseminations (Martin et al. 2000). However, this protocol is labour-intensive and cost-prohibitive for normal commercial practice.

Table 3. Effect of insemination to ovulation interval on sow fertility.

	Farrowing rate, %	Litter size
Before ovulation		
24-36 h	68	11.8
0-24 h	92	13.2
After ovulation		
0-12 h	76	12.3

Nissen et al. 1997

The time of ovulation can only be determined retrospectively. The time from detection of estrus to ovulation is variable (Figure 1). In this data set 7-19% of sows ovulated by 24 hours after detection of estrus. Unless still showing a good standing estrus, females ovulating by 24 hours after estrus detection should not be bred on day 2. Although the exact figure is going to depend on the assessment of each farms estrus detection management and expertise, it is reasonable to suggest that about 10% of females will be early ovulators. Single mating of these animals is not a problem since it almost guarantees that they will be bred during the 24-hour window before. The corollary of this is that if too many females receive a single breeding (e.g. more than 15%), detection of estrus onset is probably inadequate. Further, if too few females receive a single breeding (e.g. less than 5%) it is probable that some early ovulators are being bred in late estrus (or possibly diestrus). Using the same data sets, 22-24% of females will ovulate more than 48 hours after the detection of estrus onset. Breeding of these females on day 3 is not a problem, except that the cost (time and money) of the first breeding is likely wasted. So, if the breeding records show much less than 20% of third-day breeding, it is possible that some females are being bred too early. Alternatively, greater than 25% third-day breeding indicates that some females are being bred too late. Effect of estrus duration and breeding frequency are illustrated in Figure 2.

Figure 1. Interval from estrus onset to ovulation in sows

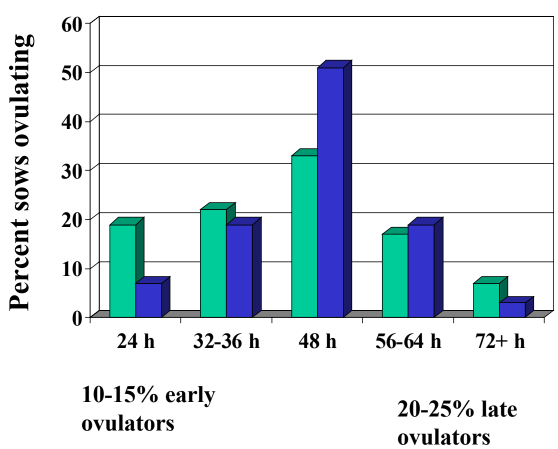
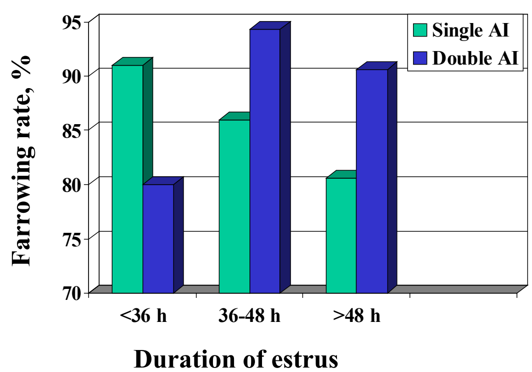


Figure 2. Effect of estrus duration and AI frequency on farrowing rate of sows



Tarocco and Kirkwood

Effect of wean-to-estrus interval on time of ovulation

It is accepted that sows having a short wean-to-estrus interval will tend to exhibit a longer duration of estrus and, conversely, sows having a long wean-to-estrus interval will tend to have a short duration of estrus. Further, ovulation is believed to occur at about 70% through estrus, independent of the duration of estrus. The effect of this is that sows having a short wean-to-estrus interval (e.g. 4 days) will tend to be late ovulators while sows having a long (e.g. >5 days) wean-to-estrus interval will tend to be early ovulators (Table 4).

Table 4. Effect of wean-to-estrus interval (WEI) on estrus-to-ovulation interval.

	4-d WEI	5-d WEI	6-d WEI
0-24 h	5%	16%	45%
24-32 h	19%	36%	17%
32-40 h	34%	25%	18%
>40 h	42%	23%	9%

Kemp and Soede 1996

In commercial practice, it is often observed that the fertility of sows inseminated following a wean-to-estrus interval of 6 or more days is less than for sows inseminated following shorter wean-to-estrus intervals (Vesseur et al. 1994; Steverink et al. 1999). The etiology of this effect is unknown but, given that these sows will likely be early ovulators, it may involve the timing of insemination relative to ovulation in these sows. Indeed, some sows may already have ovulated when estrus is first detected. A component of the interval between insemination and fertilisation is the approximately 6 hours required for capacitation of the sperm. The effect of this is that when a short interval between sperm deposition and fertilisation capability is required, such as following insemination at about the same time as ovulation, the time required for capacitation may be a major factor in the resultant poor fertility. If we accept that the association between long wean-to-estrus intervals and reduced fertility is due to poor timing of insemination relative to ovulation then, if we could reduce the time required for sperm to achieve fertilising capability, the fertility reduction associated with long wean-to-estrus intervals would be reversed.

Sow fertility to insemination with frozen-thawed (FT) semen

The introduction of new genetics into the herd, be it livestock or semen, is a risk for disease introduction. Livestock deliveries are relatively infrequent and the stock can be quarantined. However, fresh semen from off-site AI studs may be delivered once or twice every week and is not subject to quarantine. From the biosecurity standpoint, the use of FT semen would allow the sire line to be "quarantined" before insemination. Also, the use of FT semen removes the requirement to use semen within 72 hours of collection. However, the freezing and thawing of boar sperm results is some degree of cryoinjury (for review, see Watson 1995). The implication for production is that, unless the insemination of FT semen is timed precisely, both farrowing rate and litter size will be significantly reduced. In simple terms, the major problems with FT semen are sperm death (overcome by increasing the number of sperm deposited or using uterine deposition) and the cryoinjury-induced capacitation-like changes caused by the freeze-thaw process. If the negative effects of cost and the reduced fertility were overcome, then the biosecurity and convenience benefits of frozen-thawed semen will make its use the future industry standard. Correcting the adverse fertility associated with frozen-thawed semen is currently being investigated.

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THE ONTARIO SWINE SENTINEL HERD PROJECT

Robert Friendship[1], Catherine Dewey[1], and Timothy Blackwell[2]

[1] Department of Population Medicine, University of Guelph, Guelph, Ontario, N1G 2W1
[2] OMAFRA, Wellington Place, Fergus, Ontario, N1M 2W3

The objective of this project is to create a network of producers, veterinarians, diagnostic laboratory professionals and researchers, and to establish a resource of stored sera, feces, and other samples. With the creation of this frame work, it should be relatively quick and easy to respond to a public relations emergency. In addition, the Ontario pork industry will be able to demonstrate to both domestic and foreign customers that a thorough disease surveillance program is in place.

Approximately 100 herds are included in this project, representing a wide spectrum of production styles from small traditional farrow-to-finish to large operations utilizing multi-site production. Some of the farms have very little biosecurity and a wide variety of endemic diseases and other farms are closed, high-health units. Geographically, the farms are located from as far west as Windsor to as far east as the Quebec border, with a concentration of the farms located in the Perth-Huron region. We are confident that these 100 farms are reasonably representative of the Ontario pork industry.

During the summer of 2001, participating herds were visited. Thirty blood samples were taken from sows and thirty blood samples were taken from finisher pigs and in addition, manure samples were taken from finisher pigs. All samples were carefully labelled, processed, and stored in -70^{o}C freezers for further work. Most diagnostic tests require only a drop of serum or feces and therefore many tests can be performed on these samples.

The main emphasis of the work so far is in the area of food safety. With respect to this issue, we are interested in determining the prevalence of microorganisms that are potentially dangerous to humans such as *E. coli* 0157:H7, Salmonella, Yersinia, Toxoplasma, etc. We hope that by finding how widespread these organisms are and possibly discovering risk factors to explain why some farms have them and other don't, we might be able to reduce the chance of human illness and make the pork industry safer, and our markets more secure.

There is a great deal of other research that can be done once this resource is in place. There are many economically significant diseases that we really don't know very much about with respect to how prevalent they are and what types of farms are more likely to have them. For example, we have started to analyze sera for the presence of antibodies to *Lawsonia intracellularis*, the organism that causes "campylobacter" or "ileitis". We have found most farms positive but about 10% of the herds negative. A farm that is negative for *Lawsonia* needs to be careful if they sell breeding stock to positive farms. Commonly, a newly introduced gilt or boar after a 2-3 week period of exposure on the new farm will suddenly develop severe hemorrhagic diarrhea and quickly die. On the positive side, herds that are negative for *Lawsonia* may not see a great deal of benefit in using antibiotics as growth promoters. Drug use may be reduced if we are able to create and maintain herds that do not have this pathogen.

One important advantage to having a bank of samples like this is to be able to determine whether or not “new” diseases are present in Ontario. Each year there tends to be another potential disease problem, another PRRS or circovirus. In the past as new problems are identified and studies started, it has always taken months just to collect the samples, but if we can simply retrieve samples from a freezer in order to begin the investigation we greatly reduce the time and cost of determining whether or not a disease is already in the province and whether or not it is causing a problem.

The general philosophy behind this undertaking is that the more we know about our own industry the better off we will be. This study demonstrates to our customers and competitors that we have nothing to hide and that we are serious about finding problems early and hopefully rectifying these problems if possible. We believe this project will tie-in with CQA and other such initiatives to build confidence in the Ontario pork industry.

Acknowledgments

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Prevalence of Strains of *E. coli* O157 in Ontario Pigs

C. L. Gyles[1], R. Friendship[2], K. Ziebell[3], R. Amezcua[2]

[1]Department of Pathobiology, [2]Department of Population Medicine, University of Guelph;
[3]Health Canada Laboratory for Foodborne Zoonoses, Guelph, Ontario, Canada

Introduction

Some strains of *Escherichia coli* serogroup O157 are enterotoxigenic *E. coli* associated with with diarrhea in pigs and others carry the genes for the Shiga toxin (Stx2e) responsible for edema disease (2). Several recent studies have assessed whether strains of O157:H7, which can cause severe disease in humans, are carried by pigs. Studies in the US (3), the UK (8), France (1) and Hong Kong (5) failed to detect this type of O157 *E. coli* in the feces or on carcass samples of pigs. However, investigations in Japan, the Netherlands, and Norway found *E. coli* O157:H7 in from 0.1% to 1.4% of the pig fecal samples that were examined (4,6,7). In Chile, researchers found *E. coli* O157:H7 in a high percentage of samples of pig feces and suggested that pigs are an important source of human infections in that country (9). The present study was undertaken to determine whether *E. coli* O157:H7 was present in the feces of healthy pigs in Ontario and to identify the various types of *E. coli* O157 that were present in these pigs.

Materials and Methods

A total of 660 fecal samples were obtained from healthy grower pigs during the period June to September, 2001. On each of 44 farms, 15 pigs were sampled. The feces were transported in a cooler to the laboratory and processed within 24 hours. Five grams of feces were added to 45 ml of Trypticase Soy broth (Difco), to which cefsulodin (0.001%) and vancomycin (0.0008%) had been added. After incubation at 42 C for 6 h, two 1 ml samples of the culture were removed.

One of the 1 ml samples was used in an immunomagnetic separation procedure designed to concentrate low numbers of *E. coli* O157 that may be present in the enriched broth culture. This process consisted of adding to the broth culture 20 ul of magnetized beads coated with antibodies against O157, shaking the mixture at room temperature for 30 minutes, washing the beads 3 times with phosphate-buffered saline containing Tween-20 (0.05%) (PBS-T), and finally resuspending the beads in 100 ul of PBS-T. A 50 ul volume of the bead suspension was then spread on CT-SMAC plates, which consisted of MacConkey agar with sorbitol instead of lactose and with added cefixime (0.05 ug/ml) and potassium tellurite (2.5 ug/ml). The plates were incubated for 24 h at 37 C then examined for sorbitol-negative colonies, which were tested by slide agglutination to determine whether they were O157.

The second 1 ml sample was used for extraction of DNA, which was tested by PCR to determine whether O157 organisms were present. If the PCR test was positive, a 10 ul sample of the magnetized beads (above) was plated on SMAC (sorbitol-MacConkey agar). Both sorbitol-negative and sorbitol-positive colonies were tested by slide agglutination to determine if they were O157.

Typically, two presumptive O157 colonies, selected from samples by both procedures were subjected to further testing. PCR was used to detect genes for O157, Shiga toxin 1 (Stx1), Stx2, intimin (Eae) and enterohemorrhagic *E. coli* hemolysin (Ehly). Broth culture supernatants were tested for Shiga toxin, and production of Ehly was determined on washed sheep red blood cell agar. The isolates were serotyped at the Health Canada *E. coli* reference laboratory.

Results and Discussion

There were 21 herds in which *E. coli* O157 were detected (Table 1). In 17 of these herds, the O157 *E. coli* were non-motile, or had H antigen 11, 12, 16, 38 or 45; were negative for *stx*, *eae*, and *ehly* genes; and were recovered on SMAC. In 1 herd, the O157:H7 *E. coli* had the *eae* and *ehly* genes but was nontoxigenic. In 3 herds, toxigenic O157:H7 *E. coli* were isolated on CT-SMAC. These herds had 1, 7, and 12 pigs that were positive. The toxigenic O157:H7 isolates produced Stx2 and most produced Stx1 as well.

Table 1. Prevalence of O157*E. coli* in Ontario swine herds

No. of herds	O157	H7	*stx* genes	**Shiga toxin**	*eae* gene	*ehly* gene
17	+	-	-	-	-	-
1	+	+	?	-	+	+
3	+	+	+	+	+	+

The results indicate that in Ontario, as has been the case in a number of other jurisdictions (4, 6,7,9) *E. coli* O157:H7 may be present in the feces of healthy pigs. In this study, 3% of the pigs and 6.8% of the herds were positive for toxigenic O157:H7. The methods that were used were not designed to determine the concentration of *E. coli* O157:H7 in the feces, but it is evident that the concentration was usually low, as enrichment plus immunomagnetic separation usually failed to permit detection unless the sample was plated on CT-SMAC. The number of sorbitol-negative colonies on CT-SMAC plates from positive pigs usually ranged from 1 to 75, but in one pig the number was greater than 200, and this was the only pig from which toxigenic O157:H7 *E. coli* were also recovered on a SMAC plate. The samples were collected in the summer, a time in which this serotype is found in much higher prevalence in cattle compared with the winter.

The O157 *E. coli* that were not H7 were nontoxigenic and readily differentiated from the toxigenic O157:H7. The isolates from the herd in which the O157:H7 *E. coli* were nontoxigenic are interesting. A sorbitol-negative strain isolated on SMAC from this farm had a similar genotype and nontoxigenic phenotype.

Pork has not been identified as a source of foodborne *E. coli* O157:H7 illnesses in humans in North America, and the findings do not indicate that pork is likely to be a source. There are no new implications for environmental contamination, as pigs have long been known to harbour other human pathogens such as Salmonella and Campylobacter.

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Swine Influenza

Tamara Richards[1], Robert Friendship[1], and Suzy Carman[2]
Department of Population Medicine and Department of Pathobiology
University of Guelph, Guelph, Ontario, N1G 2W1

Background

Swine influenza is a respiratory disease caused by a virus. The clinical signs observed in pigs can be very similar to the common "flu" of humans. In a classic outbreak of swine influenza, all ages of pigs may be sick with fever, depression, reluctance to move, inappetence, and difficulty breathing. The level of coughing in the barn can be remarkable. The disease has a short incubation period and is highly contagious so the spread through the barn is dramatic so that it may appear that all the pigs became sick almost overnight.

Occasionally, the high fever associated with swine influenza can cause reproductive consequences such as abortion in sows and possibly reduced fertility in boars. Even in herds where clinical signs are severe, death loss tends to be very low and full recovery is rapid. Often antibiotics are used with the idea that they may be helpful in controlling secondary bacterial infection but, of course, antibiotics have no effect against the virus infection itself.

Various countries have reported severe influenza outbreaks over the past few years, but in Ontario, there have not been many cases of clinical disease. Serological studies in the 1970s revealed that some Ontario pigs had antibodies to swine influenza virus but clinical disease was not reported until 1981 (1). There have been small, sporadic outbreaks over the past 20 years, usually in the late fall and winter months and generally in the pig dense regions of the province (centered around Stratford). In general, despite evidence that swine influenza virus is present in Ontario, there has been little clinical evidence that it is causing a problem.

There is a public health concern associated with swine influenza. Humans can pick up the disease from swine and in turn, pigs are capable of becoming infected with human influenza strains. The pig is also capable of being infected with avian strains of influenza virus. The pig has receptors for both avian and mammalian influenza viruses and therefore, there is a strong likelihood that the pig can become a "mixing vessel" where two viruses might exchange genetic material and create a new virus, possibly one that is lethal for humans.

Several different strains of influenza viruses have been detected in the Ontario pig population (2). The predominant strain that has existed in Ontario for the past 30 or 40 years is swine influenza virus H_1N_1. At present, the diagnostic serological tests and vaccines that are available are directed toward this strain.

Research Project

The objective of the project was to determine the prevalence of swine influenza H_1N_1 antibodies in the Ontario swine population. A random sample of 70 farms were visited and blood samples were taken from 20 sows and 10 finisher pigs. Sera was analyzed for the presence or absence of antibodies to swine influenza virus H_1N_1 using an ELISA test (Herd Check® SIV H_1N_1 Antibody ELISA, IDEXX Laboratories) and performed at the Animal Health Laboratory in Guelph, Ontario. This is a new test which allows large numbers of samples to be tested at once and requires less labour than the old hemaglutination inhibition (HI) test. Before the new test was used in this trial, it was evaluated using blood from pigs with a known immune status. Pigs known to be negative for influenza were divided into two groups, vaccinated and not vaccinated. Sera from the same pigs were tested using both tests. The results are presented in the table below. The ELISA test was better at detecting both true positives (vaccinated) and true negatives (not vaccinated) compared to the HI test.

Table 1: Comparison of ELISA vs HI Test

	Vaccinated	Not Vaccinated
HI positive	336	89
HI negative	9	256
ELISA positive	341	29
ELISA negative	4	316

When the sera from the 70 Ontario farms were tested for the presence of antibodies to SIV H_1N_1 using the ELISA test, we found that 51% of all sows and 27% of finishers pigs tested positive. On a herd basis, 80% of the herds were classified as positive. Interestingly, of the 14 negative herds, 10 of these farms were located in the eastern part of the province. Some of the farms that tested positive were herds that could be classified as “minimal disease”. These high health herds had antibodies indicating exposure to swine influenza virus but no history of respiratory disease and no clinical evidence of coughing during the visit to collect samples. Only one farmer on the trial indicated a concern about swine influenza at the time of the visit and has subsequently started a vaccination program. There were no herds using influenza vaccine at the time of the sample collection.

Antibody titres can last a long time for influenza and so it is not surprising that more sows were positive than younger pigs. This reflects the longer exposure period and suggests that influenza may have occurred in the herd prior to the birth of the finisher pigs. Of the 56 positive herds, there were 20 farms where sows were positive but all the finisher samples tested negative. The results do suggest that the influenza virus does circulate most herds with young pigs becoming infected during the grower-finisher stage. It is possible that swine influenza contributes to respiratory disease on some farms, but is not recognized because of the other pathogens that are also present such as PRRS virus and mycoplasma. However, generally it would appear that influenza H_1N_1 is present on most farms and is not considered an important part of pig respiratory disease.

The ELISA test that was used does not react with other strains of influenza so samples will have to be retested with another test to determine the prevalence of some of the newer strains such as H_3N_2 which has recently been associated with severe clinical signs in the United States and which is known to be present in Ontario.

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Salmonella spp. Infection in Finishing Pigs in Ontario

Thomas Rosendal[1], Robert Friendship[1], Heba Atalla[1],
Andrijana Rajic[2], Eva Chow[2], John Wu[2]

[1] Department of Population Medicine, University of Guelph, Guelph, Ontario, N1G 2W1
[2] Agri-Food Laboratories Branch, Alberta Agriculture,
Food and Rural Development, Edmonton, Alberta

Background

Salmonella spp. can cause clinical disease in pigs. Traditionally, there have been two different expressions of Salmonella infection: systemic disease and enteric disease. Over the past few years, the incidence of systemic disease caused by *Salmonella cholerasius* has greatly decreased. However, there is a suspicion that enteric disease, particularly infection with *Salmonella typhimurium,* has increased. This disease is characterized by a watery yellow diarrhea and reduced growth rate of grower-finisher hogs. Rectal stricture causing the pig to develop a bloated abdomen is also associated with this disease.

Salmonella infection, in addition to the negative impact it has on pig performance, is also important because it can cause disease in humans. It is considered among the most important causes of food borne infections in humans. At present, it is estimated that about 10-30% of all Salmonella infections in humans are associated with pork and pork-based products (1). It is the objective of this project to investigate the prevalence of Salmonella in finishing pigs in order to eventually develop a strategy to reduce or hopefully eliminate the disease from Ontario farms.

Traditionally, Salmonella has been measured by culturing manure samples. Serology (measuring the presence of antibodies in the blood) using an Enzyme-Linked Immunosorbent Assay (ELISA) has been recently developed as a screening tool on a herd basis, particularly for detecting herds with high culture prevalence.

The Research Project

Eighty finishing units were visited and sera and feces were collected from 15 pigs on each farm. The sera were analyzed for the presence of Salmonella antibodies using the Vet ScreenJ Salmonella covalent Mix-ELISA adopted for serological screening of finishing units.

.Fecal samples from the majority of the herds were specially treated and frozen at -70^{o}C until culturing could be performed at a later date. Comparison of culture results between fresh and frozen samples to determine if freezing detrimentally affected the success of growing Salmonella was conducted. Almost exclusively, pigs with normal stool were collected. In a few instances, a comparison was made between culturing feces of normal pigs and pen mates with diarrhea. The likelihood of finding Salmonella was much higher when scouring pigs were tested. It is suspected that many of the pigs with normal stool and no clinical signs of illness will have antibodies to Salmonella particularly if they have clinically affected pen mates.

Results from the Ontario project are just being finished and hopefully preliminary data will be available at the meeting. We anticipate very similar findings to a project conducted in Alberta in 2001 (2). In Alberta, *Salmonella spp.* antibodies were detected in 12.05% of tested sera. There was a high correlation between the culturing of Salmonella from pigs on the farm and a herd with high antibody titres, but sometimes it required several visits to a farm before Salmonella was cultured. This indicates the very dynamic nature of Salmonella infection, in that pigs can shed the organism for a period of time, then stop shedding, but begin again after a brief period of stress. The serological test looks like a promising tool in pinpointing herds that are likely harbouring Salmonella and this can be followed-up with the more costly and time consuming job of culturing manure samples.

The next step in this project, once each of the positive herds are identified, is to evaluate whether or not risk factors for infection can be identified. Possibly methods for reducing or eliminating infection can be implemented. Recently, some exciting and novel approaches to controlling Salmonella have been developed. For example, bacteriophages (3) (viruses that infect and kill Salmonella) and live vaccines have been used experimentally with promising results.

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COMPOSTING MORTALITIES – AN UPDATE

J. R. Morris, Ridgetown College,

INTRODUCTION

Mortalities are a fact of life for commercial livestock producers. Under the Ontario Dead Animal Disposal Act, farmers with dairy or beef cattle, swine, sheep, horses or goats are obligated to dispose of dead animals within 48 hours, after knowledge of their death, in one of three ways, by:

- Licensed Dead Animal Collectors
- Burial under 0,6 m (2') of soil
- Composting

GUIDELINES

1. Site - The compost facility should be located in an area that is well- drained and has all-weather access to roads and work areas. Avoid areas that could cause leaching of contaminants into the ground water. Consider traffic patterns for the handling of mortalities and sawdust or other carbon sources. Offensive odours and flies are minimal if the compost piles are properly managed. However suitable distances should be maintained from farm and neighbouring residences and compost facilities should be out of sight as much as possible. The working side of the compost facility should face south where possible. Also, at certain times of the year, flies will be attracted to the area (first frost days in fall). A preferred site would be in a remote location on the farm.

2. Base - There is some run-off from the unit (surface and within), however the nutrient levels are relatively low. The compost unit should be located on the soil surface with drainage away from the site. No concrete floor is needed.

3. Carbon Medium - Sawdust is the best medium to mix with mortalities. Other high carbon materials including chopped straw, corn cobs, corn silage, mixture of manure and straw/sawdust. etc., may be possible but sawdust has been proven to work well in research trials at the Ridgetown College.

For every kg of mortality to be composted, 1 kg of sawdust is needed. If the mixture gets too dark during the compost period, more sawdust should be added. The mortalities can be buried into the medium as they occur.

4. Structure - The structure can be relatively simple. In Missouri, plastic-wrapped, large round bales were used to form walls around the compost unit. However, because of the risk of wild life entering the area, some walled structure (at least 1.5m or 5 feet high) is recommended. A minimum of 3 bins are recommended for a composting unit.

5. Management - One tonne of sawdust in a pile should handle the composting of one tonne of mortalities. Place the mortalities in the sawdust. Mortalities must be placed in the bins and covered with sawdust as soon as they occur. Mortalities must be place at least 300mm (1 ft) from the edge of the bins and covered with a minimum of 600mm (2 ft) of sawdust. A daily check must be made to ensure that the mortalities are adequately covered. Settling of the pile, and wind can move the sawdust.

A compost cycle would be 3 months to fill, 3 months sitting, then turning the material from one bin to a second, and allowing it to sit for a further 3 months.

For wintertime use, a pile should be initiated in September - October and filled over the winter, turned in May, and emptied in September. Avoid initiating a degradation pile in December - February.

After turning if there are any mortalities showing, cover with at least 300mm (1 ft) of sawdust.

For wintertime use, a compost pile should be initiated in November, filled over the winter, turned in May, and emptied in September. Avoid initiating a degradation pile in December to February.

6. Sizing a disposal unit -

Worksheet Example

A: Weight of carcasses to be disposed	**Example**	**Your Farm**
(1) Enter the number of dead animals per year	60	________
(2) Enter the average weight of a dead animal	65	________
(3) Calculate the weight of mortalities for disposal [(1) x (2)]	3900	________
B: Size of the Compost Facility		
(4) Calculate the volume of primary disposal needed (M^3) [(3) / 600]	6.5	________
(5) Calculate the volume of secondary disposal needed (M^3) [(3) / 900]	4.33	________
(6) Calculate area of primary storage needed (M^2) [(4) / 1.5]	4.33	________
(7) Calculate area of secondary storage needed (M^2) [(5) / 1.5]	2.89	________

GENERAL COMMENTS

- There are sufficient catalytic bacteria, enzymes, etc., within the mortalities to degrade them over time.
- Make sure that the mortalities are buried at least 300mm (1 ft) from the edges of the pile. If a large bone fragment remains at the end of the cycle, simply place it in the next cycle for further degradation.
- Make sure that the mortalities are covered by at least 600mm of sawdust immediately upon placing it in the pile. Warm mortalities degrade much more rapidly than cold ones. Immediate burial in the compost piles eliminates the risk of wild animals or dogs removing them. It also reduces the odour.
- At the end of the compost cycle, the product is still not completely stable. The mortalities are simply degraded to small segments and bones, demineralized so that further degradation can be completed once spread on the land, much similar to the spreading of manure. This material could be placed in a solid manure storage facility until the appropriate time for spreading.

COMPOSTING MORTALITIES ON FARM

Matt and Chris Cockle
Heronbrook farm Ltd Embro Ontario

In 1994 we started composting small pigs and afterbirth, after my wife Nancy complained about having to empty bags of dead pigs from the freezer, and the boys pumping manure were tired of having afterbirth wrap around the impellers of the manure pump.

We reviewed our options, grinding materials and dumping in the manure tank, grinding and feeding back to the sows, digging a deep pit 4'0" diameter and 30'0" deep, or composting.

We thought composting had some merit, so we constructed 3 bins out of woven wire weaner flooring that was 5'0" by 11'0". The bins were 6' 0" wide 5' 0" high and 11' 0" deep. We put a shallow layer of straw on the bottom and then started adding material daily. Each time we added, we covered with straw.

We were amazed with the results. Very quickly the temperatures generated were cooking the contents, and it smelt like we were continuously barbecuing. However we discovered a number of negative aspects of this process. We had too much leachate (juicy leakage), the neighbours dogs, skunks, coyotes and cats helped themselves, and we found carcasses all over. The weather played havoc, rain made it too wet and snow and freezing conditions slowed down composting or stopped it altogether. The open sides allowed too much air to get in, and so material decayed rather than composted. However we knew it would work. At this time we filled a bin until it was full and then started filling the next. When they were all full, then we emptied the first so that we could start the cycle all over again.

In 1996 when we expanded the sow herd to 950 sows we built our present system. There are 8 bays to make full use of the width of the barn, and sized to fit our small loader tractor that has a 54" bucket. We continued the same process filling one bin, and then moving on to the next. We also changed from straw as the composting median to shavings/sawdust, and were delighted with the results. At this time our deadstock operator started to charge for pickup of sows, so we started to compost everything.

Over the years we have refined our programme, so that we now have a four stage process, whereby the material is turned or aerated three times. Using 8 bays we use 2 and 3 for initial fill, empty these into 1and 4, and then empty 1 into 7, and 4 into 8. We then empty the composter onto a compost pile that we turn each month, to continue the composting process.

Our composting median is the shavings we use for trucking our early weans, feeder pigs, market pigs and cull sows and boars. We also purchase some bulk shavings so that we always have sufficient material on hand, storing this in bay 5, and the truck cleanings in bay 6.

When starting a new bay, it is important to lay a bed of approximately 18" of shavings, and it is important that no deadstock are closer than 18" to the front of the composter. When covering deadstock on a daily basis they should be covered by approximately 4-6" of shavings.

IF THE UNIT SMELLS, LEAKS, HAS FLIES, OR ANIMALS ARE NOT COMPOSTED......THEN IT IS NOT BEING MANAGED CORRECTLY.

Inducing Sows to Farrow

Roy Kirkwood
Department of Large Animal Clinical Sciences, Michigan State University
Email: kirkwood@cvm.msu.edu

Why?

Before considering any intervention, particularly the use of hormones, you should have a clear reason for doing so. Reasons to consider inducing farrowing include:

- Potentially, more efficient use of labor and facilities. However, ask yourself whether this is really needed, e.g. is the turn-around time on farrowing crates such that long gestations must be avoided?

- There is a consistent need to cross-foster piglets and this is best achieved by having sows farrow in batches. However, cross-fostering is also an intervention and should be avoided unless necessary. If it is performed, have a written protocol in place.

- Records indicate an increased level of stillbirths and/or early preweaning mortality. Problems during farrowing can kill piglets or cause a lack of oxygen resulting in poorer viability that predisposes to early mortality. In either case, improved supervision of farrowing is desirable.

When?

If farrowing induction is to be employed, do not use a text book value for gestation length. Rather, determine the average length of at least the previous 100 pregnancies on the individual farm. Then:

- Do not induce more than 2-days before due date. You must have good records to ensure that this is done accurately and then there will rarely be a problem with low birth weight pigs. The fat content of the colostrum will be reduced but its antibody content is unaffected.

- Pregnancies more than 2-day longer than average are associated with a higher stillbirth rate. Consider inducing any sow that is 2-days past her due date.

- Gilts will have a lower quantity and quality of colostrum than sows. While the induction of gilts is unlikely to cause a problem, I would avoid doing so unless necessary.

How?

The injection of prostaglandin has long been known to be effective for the induction of farrowing in sows, but a considerable range in the interval between treatment and parturition can still be expected. Experience has shown that only 50% to 60% of induced sows are likely to farrow during the normal working hours and so be candidates for farrowing supervision. Those that do must carry the cost of injecting sows that do not farrow on time. Therefore, effectively, the cost of treatment is increased. Even where, for example, stillbirth rates or neonatal mortality are increased, the poor predictability and associated increased costs causes many producers to avoid this excellent technique.

- One way to reduce costs is to reduce the dose of prostaglandin injected. When injected into the vulva, farrowing can be induced using only 25% to 50% of the recommended intramuscular dose (Table 1). If you are not familiar with this route of injection, see your veterinarian.

Table 1. Effect of dose and site of prostaglandin injection on time of farrowing

	Full dose, IM	50% dose, IM	50% dose, vulva	25% dose, vulva
Farrow 8-24 h, %	19	12	18	15
Farrow 24-32 h, %	50	41	61	62
Farrow >32 h, %	31	47	21	23

Various additional treatments have been applied in attempts to improve the predictability of farrowing following prostaglandin injection. The injection of oxytocin approximately 24-hours after the injection of the prostaglandin has been shown to reduce the variation in the time to onset of piglet delivery. However, while oxytocin causes a more rapid onset of farrowing, it often leads to interrupted farrowings that require manual assistance. My advise is to not use oxytocin unless at least one pig has been born. So, how do you improve predictability?

- A recent study has shown that a second prostaglandin injection 6-hours following the first improved the predictability of parturition (Table 2). Lower-dose injection into the vulva is used to control costs.

Table 2. Effect of a single or repeated injection of prostaglandin on time of farrowing

	Single injection	Repeated injection
0-8 h, %	8	4
8-22 h, %	17	10
22-32 h, %	56	84
>32 h, %	19	2

Anything new?

Recently, the inclusion of corticosteroids in the induction protocol has been examined. One study indicated a faster farrowing and improved neonatal survival. Another study should a decrease in birthweights, but a much higher growth rate. The birthweight difference disappeared by 3-days of age. The use of corticosteroids shows a lot of promise but more work is needed.

Nutritional Value of Heat Stressed Corn from the 2001 Harvest

C.F.M. de Lange[1], S. Carson[2], D. Burnett[1] and E. Jeaurond[1]

[1] Department of Animal and Poultry Science, University of Guelph
[2] Master Feeds
e-mail: cdelange@uoguelph.ca

The extreme draught and heat during the 2001growing season resulted in variable corn yields. This likely influenced the nutritive value of some 2001 corn samples as well.

To assess the feeding value of heat-stressed corn for pigs, samples were obtained from corn exposed to varying degrees of heat stress and with varying yields (Table 1; accurate agronomic data only available for 2 samples). All samples have been chemically analyzed and five samples are currently evaluated in a study to determine digestible energy content (DE, the number one determinant of the nutritive value of swine feed ingredients) and fecal digestibility of energy yielding nutrients and protein. Moreover, complete amino acid profiles will be established for these samples.

Clearly the kernel size of the corn sample grown under extremely dry and hot conditions is reduced (Figure 1). Interestingly, this did not coincide with changes in bushel weight, or fiber contents (acid detergent fiber, ADF; neutral detergent fiber, NDF; Table 1). Fiber is primarily present in the seed coat. Moreover, in this specific sample of heat stressed corn, the protein content was higher (probably a reflection of the relatively high germ content) and the starch content (main energy source) was similar to that in 2000 corn or non-heat stresses 2001 corn.

Across corn samples, the most variable chemical constituent is NDF. Since fiber is poorly digested in pigs, fiber content is inversely related with the DE content. In previous studies involving wheat, it was established that the DE content decreases by 16 kcal/kg with every 1% increase in NDF content (dry matter basis). Based on this simple relationship, the estimated DE content appears to vary considerably between corn samples (Table 1). Differences in estimated DE content between extremes exceeds 10%. Since corn makes up about 75% of typical pig diets, this would results in differences in feed efficiency of 7.5%, when feeding the extreme corn samples. It is rather surprising that the estimated DE content is highest in the severely heat stresses corn sample and lowest in some of the moderately heat stresses corn samples. It should be emphasized that these DE values need to be confirmed in the digestibility study that is currently underway at the University of Guelph.

In summary, based on chemical analyses there appears to be considerable variation in the nutritive value of corn samples, in particular in estimated DE content. This will have substantial impact on feed efficiency and thus feed costs. Studies are underway to determine the digestible energy content, to establish the complete amino acid profile in these samples and to evaluate relatively simple predictors of nutritive value of corn samples.

Acknowledgements

This research is supported by the Ontario Ministry of Agriculture and Rural Affairs Animal Research Program at the University of Guelph and Master Feeds. Special thanks to the U of Guelph RSO people for sourcing some of the samples.

Figure 1: Corn from the 2000 growing season (left) and corn grown under extreme dry and hot conditions during the 2001 growing season (right).

Table 1: Chemical analyses of eight corn samples (%, dry matter basis).

	Sample							
	Control (2000 crop)		Reg. corn	Severe heat stress	Moderate heat stress			
	A	B			A	B	C	D
#	1 Uof G	6 Stratf.	4 Elora	2 Arkell	5 Cavan	3 UofG	7 Charl.	8 Timm
Yield (bu/acre)			124	38				
Density (lb/bu)			56	56				
Dry matter	88.39	87.12	88.47	89.14	87.56	88.38	86.28	86.84
C. Protein	8.87	8.89	9.85	11.43	8.42	9.35	9.33	9.60
ADF	4.10	3.10	3.90	3.80	4.20	3.30	3.20	3.50
NDF	13.3	17.10	13.00	9.90	23.50	16.50	11.70	32.00
Calcium	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Phosphorus	0.28	0.28	0.32	0.34	0.30	0.30	0.29	0.25
Fat	3.82	4.02	4.63	3.94	3.93	4.74	4.75	3.95
Starch	62.2	68.2	63.6	64.4	64.2	65.7	62.4	64.9
Microminerals (mg/kg)								
Zinc	20.1	24.2	28.8	32.9	19.8	25.8	21.9	20.4
Manganes	5.31	6.13	5.54	6.21	5.32	5.19	3.99	5.44
Copper	2.07	2.62	1.47	1.84	1.72	2.15	4.84	1.68
Estimated digestible energy content (DE; MCal/kg)*								
Dry matter	4008	3947	4013	4062	3845	3957	4033	3709
As fed	3543	3439	**3550**	3621	3366	3497	3480	3221

* DE predicted based on a DE content of 3550 in regular corn (NRC 1998; as fed) and a reduction in DE content by 16 kcal/kg with very 1% increase in NDF content (dry matter basis; Zijlstra et al. 1999; Can J. Anim. Sci. 79: 193).

Variation in Total Phosphorus and Phytate Content in Ontario Soybean Samples

S. Leech and C.F.M. de Lange
Department of Animal and Poultry Science, University of Guelph
e-mail: cdelange@uoguelph.ca

Characterization of phosphorus content and phosphorus availability in feed ingredients is critical for addressing feeding costs and impacts of pig production on the environment. In pigs, phosphorus availability is inversely related to the proportion of phosphorus present in the phytate form. A study was conducted to identify variation in total phosphorus and phytate phosphorus content among Ontario soybean samples.

A total of 108 Ontario samples of whole soybeans were evaluated. Samples were from the 1999 and 2000 harvest, representing 19 varieties and 13 growing locations across Ontario. Total phosphorus content, phytate content and fraction of total phosphorus present as phytate phosphorus (% phytate phosphorus) varied considerably; differences between extremes were 57%, 70% and 39% of mean values, respectively. Mean total phosphorus content was 0.58% (range 0.36 – 0.84%), mean phytate content was 1.16% (range 0.55 – 1.89%) and mean % phytate phosphorus was 56.2% (range 43.3 – 70.7%).

A major contributor to all three parameters is the year effect, as indicated by the substantial difference between samples harvested in 1999 and 2000 (Table 1).

Based on statistical analysis on sub-sets of samples that allowed an independent assessment of variety and location effects, location effects were always significant while variety effects were generally not significant. Mean values per location are presented in Table 2. This indicates, given the current data set, that growing conditions, including year of harvest, had a much larger impact on total phosphorus content, phytate content and % phytate phosphorus than soybean variety.

Across the 108 samples, a close positive linear relationship between total phosphorus and phytate content exists (Figure 1), allowing a reasonable prediction of phytate phosphorus content and thus phosphorus availability from measured total phosphorus content.

In conclusion, considering variability in total phosphorus and phytate phosphorus content in diet formulation represents a means to reduce feeding costs and to manipulate the efficiency of phosphorus utilization in pigs and thus reducing phosphorus excretion with manure. Total phosphorus content, phytate content and % phytate phosphorus varied considerably among Ontario soybean samples. This will be reflected in soybean meal samples as well. It illustrates the need for characterizing total phosphorus and phytate content in other feed ingredients and further developing rapid, inexpensive and repeatable methods for analysis of phytate. Soybean samples should at least be analyzed for total phosphorus content.

Acknowledgements

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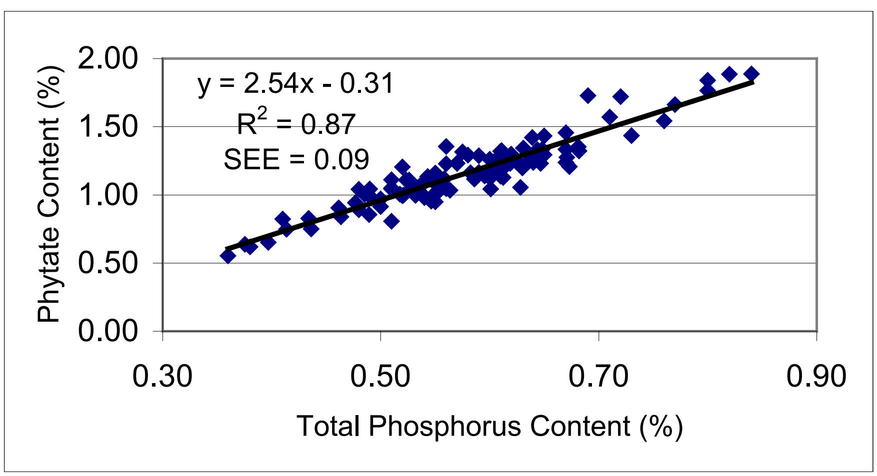
Table 1. Year means (standard deviation) for total phosphorus content (Total P, %), phytate content (Phytate, %) and % phytate phosphorus (% Phytate P, %) in Ontario soybean samples harvested in 1999 and 2000.

Year	no. of samples	Total P, %	Phytate, %	% Phytate P
1999	58	.55 (.08)	1.07 (.20)	54.7 (4.6)
2000	50	.61 (.09)	1.27 (.26)	57.9 (5.1)

Table 2. Location means (standard deviation) for total phosphorus content (Total P, %), phytate content (Phytate, %) and % phytate phosphorus (% Phytate P, %) across locations in Ontario soybean samples harvested in 1999 and 2000.

Location	No. of samples	Total P	Phytate	% Phytate P
Elora	13	.64 (.07)	1.27 (.20)	56.3 (3.8)
Emo	7	.61 (.11)	1.29 (.34)	59.3 (6.5)
Chatham	9	.61 (.03)	1.30 (.04)	59.9 (3.0)
Inwood	10	.51 (.06)	.97 (.10)	53.6 (2.0)
New Liskeard	7	.66 (.09)	1.36 (.26)	57.7 (5.2)
Ottawa	5	.60 (.06)	.98 (.15)	54.9 (4.5)
Ridgetown	10	.57 (.04)	1.19 (.14)	58.7 (4.6)
St. Paul's	8	.55 (.22)	1.10 (.61)	53.6 (8.9)
Talbotville	8	.55 (.04)	1.08 (.12)	54.7 (3.3)
Tilbury	9	.50 (.06)	.98 (.15)	54.9 (4.5)
Verner	7	.62 (.03)	1.25 (.13)	56.7 (6.8)
Winchester	7	.60 (.05)	1.18 (.10)	55.8 (4.5)
Woodstock	8	.53 (.05)	1.00 (.12)	53.7 (4.6)

Figure 1. The relationship between total phosphorus content (%) and phytate content (%) in 108 Ontario soybean samples.



The Influence of Colostral Immunity on Piglet Vaccination

Gaylan Josephson, Swine Health Advisor
Animal Health Laboratory, University of Guelph

The value of colostrum as it relates to quality, quantity, timeliness of delivery and function, cannot be overemphasized. No-one can argue with the beneficial effects of colostrum, but these benefits may be counteracted when piglet vaccination is used in an attempt to reduce the negative effects of disease, later in life.

To demonstrate this, I would like to comment on the effect of the presence of passive immunity at time of piglet vaccination on several diseases

- parvovirus
- *Mycoplasma hyopneumoniae*
- swine influenza
- PRRS

Parvovirus

It has been known for 15-20 years that maternally derived antibody titres up to 1:160 persist in pigs up to 6 months of age, with traces still evident in some pigs at 9 months. High antibody titres at time of vaccination depress the response to vaccination so a recommendation often made is to vaccinate gilts twice prior to breeding. In the last 3 years, parvovirus has been the most common agent identified in reproductive failure in sows, in submissions made to the Animal Health Laboratories, University of Guelph. The history in many of these cases describes a problem limited to gilt litters, suggesting a vaccination concern.

Mycoplasma hyopneumoniae

Mycoplasma hyopneumoniae vaccination failure is occurring with greater frequency. Several studies have indicated that the presence of maternal antibody may interfere with vaccine effectiveness. Biological companies initially recommended vaccination at 1 and 3 weeks of age, when colostral antibody levels are still detectable. Vaccination of sows/gilts results in a corresponding increase the piglet antibody levels to the point where they still have high readings at 6-8 weeks of age. Vaccination of this population of pigs needs to be delayed until piglets are at least 8 weeks of age. Recent research indicates that the antibody level is more important than the age of pig when evaluating whether or not maternal antibody titres have declined to a level where they will not interfere with production of active immunity.

Table 1. Vaccine status, antibody titre and age of pig.

	Age/ Group mean antibody titre/(% of positive pigs)								
Vaccine status	1 wk	3 wk	6 wk	8 wk	11 wk	15 wk*	21 wk**	% of lung consol.	Interference with vaccine
1 and 3 weeks	6.5% (100)	_	_	36.7% (68)	54.7% (47)	71.5% (26)	14.6% (100)	3.2%	YES
3 and 5 weeks	_	5.6% (100)	_	31.8% (74)	44.7% (68)	70.6% (37)	11.5% (95)	2.8%	YES
6 and 8 weeks	_	_	26.8% (84)	39.5% (63)	39.8% (100)	56.5% (73)	5.4% (100)	0.9%	NO
Nonvac.	_	9.0% (94)	_	32.1% (78)	36.5% (72)	86.7% (22)	23.0% (94)	5.0%	

-Jayappa et al. 2001. AASV Proceedings; 237-241

* - 1 week prechallenge
** - necropsy

Swine influenza

The clinical presentation of swine influenza has changed over the past few years. We still see the explosive outbreaks, but we now see cases of chronic or endemic pneumonias in all ages of pigs. Results of the Ontario Sentinel Herd Project have identified antibodies in 80% of sow herds tested (NOTE: very few negative herds in SW Ontario).

Table 2. Decline in passive antibody in pigs from vaccinated and non-vaccinated sows.

Sow vacc.	Age	No. of	Number of pigs with titre							
Status	(wks)	pigs	<10	10	20	40	80	160	320	>640
YES	0	23	0	0	0	0	0	0	0	23
NO	0	15	0	0	2	1	1	4	0	7
YES	2	23	0	0	0	0	0	1	5	17
NO	2	15	1	1	2	3	4	3	1	0
YES	4	23	0	0	0	0	1	7	4	11
NO	4	15	3	2	2	5	3	0	0	0
YES	6	23	0	0	1	5	3	9	5	0
NO	6	15	5	5	4	1	0	0	0	0
YES	8	23	1	0	6	6	3	7	0	0
NO*	**8**	**15**	**14**	**1**	0	0	0	0	0	0
YES	12	23	5	6	2	6	4	0	0	0
NO	12	15	15	0	0	0	0	0	0	0
YES	**16**	23	**17**	**4**	**2**	0	0	0	0	0
NO	16	15	15	0	0	0	0	0	0	0
YES	20	18	18	0	0	0	0	0	0	0
NO	20	15	14	0	0	0	1	0	0	0

*A level of ≥40 is required for protection, while a level of ≥10 inhibits vaccination

Thacker B. 2000. Keeping Pace with SIV: Proceedings, Allen D. Leman Swine Conference

PRRS

It must be remembered that piglet vaccination is an off-label use.

Research has shown that there is a protective effect of maternally derived antibody against virulent PRRS virus challenge. Therefore, if suckling piglets suffer from clinical PRRS, it is apparent that the sows are not passing on protective antibody in the colostrum, and it is possible that they are experiencing a clinical disease outbreak, or that there is a new strain of PRRSV in the facility. However, there is some evidence that maternally derived antibody might cause interference with vaccine induced antibody, and that if piglets are vaccinated during a clinical outbreak of PRRS, they should be revaccinated several weeks later.

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PRRS – What Have We Learned?

S. Ernest Sanford, DVM, Dip Path, Diplomate ACVP
Boehringer Ingelheim Vetmedica (Canada)
252 Concord Rd., London, Ontario N6G 3H8
Tel: 519-641-1785; Fax: 519-641-2334
Email: esanford@bur.boehringer-ingelheim.com

The first clinical outbreaks of PRRS were reported 15 years in the spring of 1987. Today, I have been asked to reflect back and ponder the query "What has PRRS Taught us?" "What have we learned from PRRS?" Seems quite straight forward, but sort of a loaded question when you get right down to it. However, I've come up with a Dave Letterman's Top 10 List of things we've learned because of PRRS.

Top 10 Lessons Learnt from PRRS

1. **Biosecurity & Barn Location**
2. **Quarantine / Gilt Management – Gilt Isolation and Acclimatization**
3. **Stable Sow Herds**
4. **Subpopulations**
5. **Nursery Depopulation**
6. **Pigflow Patterns – All-In/ All-Out Procedures**
7. **McRebel Techniques**
8. **Handling MLV vaccines**
9. **Diagnostic Tests – Serological Profiles, PCRs, RFLPs**
10. **Patience / A Tincture of Time**

1. Biosecurity & Barn Location

I am not entirely sure that the word "biosecurity" was even part of my working vocabulary back in the 1980s prior to PRRS. I am sure it had only limited application in my every day consciousness. Today, it is paramount on the lips and minds of producers and most people connected with the swine industry. We are now, industry-wide, much more careful about pigs and people accessing barns. Not everyone adheres to all the rules all the time but everyone is very conscious about them today. Location of a new barn comes along with the biosecurity issue. For most of the last century our barns were built right where we farmed. Pigs were part of a larger mixed farm operation. Herd sizes increased as hog farming became more specialized in the last quarter of the century. The benefits of locating new barns outside hog dense areas were certainly recognized early on. However, implementation of this prime biosecurity strategy was definitely accelerated by one factor … PRRS. We have also had a downside price to pay in our move to increased biosecurity. Neighbours and others who, suspicious over this ever increasing lack of access, perceive a cloak of secrecy surrounding our barns and this engenders a sense of mistrust and raises questions and concerns about "What are they trying to hide?"

2. Quarantine / Gilt Management

Quarantine was a concept that veterinarians preached about for decades with little or no positive response by the industry. PRRS has changed all of that. Quarantine barns are now mandatory for entry of stock downstream in most genetic/ breeding company operations. Large commercial herds, integrated production units and most coordinated loops have isolation and acclimatization facilities or feel vulnerable if they do not have such facilities. Introduction of the replacement gilt into a herd is now recognized as one of the most disruptive forces to herd heath stability with dire consequences if not handled properly. As a result management of the replacement gilt has become more and more a specialized field with careful attention paid to proper integration of gilts into new herds.

3. Stable Sow Herds
Stabilizing the sow herd is the #1 prerequisite for controlling PRRS in a unit. Everything else about PRRS control follows after the sow herd is stabilized. A solidly vaccinated sow herd is still the best method of attaining and maintaining sow herd stability in commercial operations. Other methods include closing the herd for a period of 4, 6, 8 or more months with no new introductions. This allows the virus time to "die out". Alternatively, one can make sure that the entire sow herd is uniformly exposed over a short time frame and then allow a cool down period of 3-4 months before reintroducing replacements. These latter methods can be successful but the drawback in pig dense areas is that, over time, the herds become susceptible to new outbreaks of PRRS.

4. Subpopulations
Dr. Scott Dee introduced us to the reality of subpopulations within sow herds. This was a remarkable conceptual breakthrough that has propelled us positively since its revelation. It taught us that within large sow herds (>1000 sows, possibly ≥500 sows) there was a mixture of PRRS exposed and PRRS nonexposed animals. Over time, the PRRS nonexposed animals are susceptible and subject to infection by PRRS virus shed by the PRRS exposed animals in the population. This can then trigger new clinical outbreaks of PRRS in the herd.

5. Nursery Depopulation
Very early on in the fight against PRRS, Scott Dee, once again, was the luminary who led us to this early technique of gaining some measure of control over PRRS. Scott was not the first to introduce the concept of nursery depops, but he was the first to popularize it widely as a specific measure for control of PRRS in continuous-flow operations - the conventional herd at the time when he first introduced the concept in the early 1990s. Nursery depop is based on the knowledge that in farrow-to-finish and farrow-to-grower (weaner) herds the PRRS virus continuously re-circulates in the nursery, with older pigs infecting recently introduced uninfected young pigs after they have been weaned into the nursery. Nursery depopulation breaks this cycle and prevents the infection from occurring.

6. Pigflow and All-In/ All-Out Procedures
Pigflow patterns are key to the survival of the PRRS virus. Changing the pigflow pattern is the mirror image of nursery depop. All-in/ all-out (AIAO) pigflows, preferably by barn, perpetually break the cycle of infection since the barn is emptied before introduction of the next group of pigs. AIAO pigflow is in effect an ongoing, nonstop, nursery depop production system at work.

7. McRebel Techniques
Dr. Monte McCaw from North Carolina State University introduced us to McRebel techniques. Though not all of the McRebel steps are routinely practiced the concept is sound and is successful in reducing the impact of the PRRS virus in the farrowing house and thence the pigflow.

8. The Do's & Don'ts of Handling MLV vaccines
PRRS introduced pork producers to the challenge of handling modified live virus (MLV) vaccines. The list of do's and don'ts on handling MLVs was new to most producers and necessitated a steep learning curve for one and all. Separate syringes; no disinfectants, detergents or sterilizers between injections; using up the entire contents of a bottle once opened, were all revolutionary new steps that had to become ingrained in us.

9. Adoption of serology and other diagnostic tests on a large scale
Serological tests came into their own with the advent of PRRS. Serological profiles were established as the standard for tracking the circulation pattern of the PRRS virus within a herd. The application of PCR, RFLP and other molecular diagnostic techniques in veterinary diagnostic labs was spurred on primarily by the need for more accurate and specific diagnostics for PRRS.

10. Patience / A Tincture of Time
Finally, to round out my Top 10, we had to relearn the lesson of simple patience - a tincture of time. We learned that if we were patient and rigorous in what we were doing we were likely to surmount and overcome most of the ravages of PRRS. We might not be able to keep PRRS out of all barns at all times, but with patience we have learned that we can control PRRS and that it is not a forever nuisance.

Conclusions
Overall, PRRS has taught us to be better and more careful managers. We learned to pay more attention to details. We had to learn new skill to handle a complex and ever changing disease. We also learned that with time, we could be equal to the challenge.

WRITTEN-ONLY TOPICS

ONTARIO PORK

2001 Funded Research

Research serves as the fundamental building blocks for the advancement of our industry and the cornerstone of the industry's success. The continuation of a strong swine and pork research program in Ontario is vital if our industry is to maintain its competitive position.
On a yearly basis, research needs for the swine sector are reviewed and updated by hog producers to reflect the changing environment in which the hog industry operates. The projects funded through Ontario Pork in 2001, reflect this commitment.

Project Title Use of a Low Cost Synthetic BioFilter for Odour Control from Swine Housing.

Reseacher Jake DeBruyn Ontario Ministry of Agriculture, Food and Rural Affairs

Synopsis The objectives of the project are:
1.To determine the viability of using a low-cost synthetic biofilter medium to eliminate odorous compounds from livestock housing exhaust air.
2.To demonstrate the successful operation of a full-scale synthetic biofilter treating all of the exhaust air from the pits of a large swine barn.

Project Title Determining management strategies to minimize environmental impacts and optimize profits

Reseacher C.F.M. de Lange University of Guelph

Synopsis A series of studies will be conducted, using the Feed Intake Recording Equipment (FIRE) at Ridgetown College, to determine the effects of various aspects of the animal environment (pig density, feed delivery system, diet lysine, and phosphorus levels) on performance and nutrient utilization in three genotypes of growing finishing pigs. For each environmental aspect and pig genotype, observations will be made on at least 40 pigs. Data analyses will include generation of lean growth curves, carcass quality as well as an assessment of environmental and economic impacts.

Project Title The use of the new BI PRRSV vaccine in boars

Reseacher Cate Dewey University of Guelph

Synopsis Three mature PRRSV negative boars and 20 PRRSV positive exposed boars will be used in this study. Semen will be collected weekly from the boars for 45 days, then the boars will be vaccinated and then semen will be colledted for a further 45 days. Production before and after vaccination will be evaluated. Clinical illness due to vaccine will be recorded. Semen will be tested with PCR to determine whether the vaccine is shed in the semen and therefore could cause transmission of the virus.

Project Title The effect of litter-mate weight and exta farrowing labour on the survival and weight gain of low birth-weight piglets

Reseacher Cate Dewey University of Guelph

Synopsis An on-farm field trial will be conducted. Every four sows that farrow together will form an experimental unit. The smallest 5 pigs from the first two litters will be put on a sow with 5 other small piglets. The smallest 5 piglets from the second two litters will be put on another sow with 5 large piglets. The weight gain and survivability of the small pigs will be compared between small/small and small/large litters. The other two sows will nurse the remaining pigs. One of these litters will receive minimal care and the other maximal care. The weight gain and survivability will be compared between the two treatments.

Project Title Protozoal Parasites in the Uterus of the Pregnant Pig: Effects on Reproductive Preformance

Reseacher Heidi Engelhardt University of Guelph

Synopsis In samples of pregnant uterus, we have found a microbe closely resembling pathogens associated with infertility and abortion in humans and cattle. Gilts will be infected at breeding to determine whether this parasite is directly responsible for reproductive failure.

Project Title Manure Storage Sealing

Reseacher Ron Fleming University of Guelph

Synopsis A new barn will be monitored over a 3 year period to detect any leaking through concrete floor of manure tank. A lab study will be set up on the potential for manure under pressure to leak through various size slots.

Project Title Immunostimulatory potential of 1,6 beta-glucans from Antinobacillus suis, a pilot project.

Reseacher Janet MacInnes University of Guelph

Synopsis Lymphocytes will be purified from swine blood and their abilities to kill bacterial pathogens will be monitored in the presence of different concentrations of various glucan preparations.

Project Title Development of the Phytase Transgenic Pig: Phase III

Reseacher Cecil Forsberg University of Guelph

Synopsis Objectives:
A: To characterize the molecular and genetic properties of the phytase transgene integrand in selected founder lines;
B: To characterize expression of the phytase transgene in selected founder lines;
C: To characterize the physical, biochemical and catalytic properties of the secreted transgenic salivary phytase enzyme;
D: To characterize whole animal performance of selected phytase transgenic founder lines;
E: To develop a diagnostic methodology for in-the field identification of phytase transgenic pigs;
F: To develop and improve methodology for generation of transgenic pigs, for propagation of transgenic lines, and for transferring proven transgenes into commercial breeding stock.

Project Title Monitoring the prevalence of diseases of economic significance and public health interests.

Reseacher Robert Friendship University of Guelph

Synopsis A representative cross section of Ontario pig farms (100) will be enrolled on a surveillance program. Blood and fecal samples will be collected on a regular basis. Diagnostic tests will be preformed to determine prevalence of important pathogens.

Project Title The effect of nutrient availability on biogeochemical processes affecting the transport of Esherichia coli in soils.

Reseacher Chris Daughney University of Ottawa

Synopsis In this investigation, batch experiments will be conducted to determine the degree of E.Coli adhesion to soil minerals as nutrient availability, solution pH and soil mineralogy are independently varied. The major deliverable in this project will be a predictive model that can be applied to determine the degree of bacteria-mineral adhesion in a variety of different biogeochemical regimes, and thus be used to evaluate the environmnental risks associated with manure leaching.

Project Title Genetic Divergence of PRRSV circulating in Ontario Farms

Reseacher Dongwan Yoo University of Guelph

Synopsis PRRS virus from a total of 516 tissue samples collected from Ontario pigs will be cloned and sequenced to determine their genetic divergence.

Project Title Fusarium Resistance and Genetic Improvements in Ontario Corn through Biotechnology - Phase III

Reseacher Ken Hough Ontario Corn Producer's Association

Synopsis Research Objectives and Anticipated Deliverables:
I - Genetic Modification of Corn for Improved Fusarium Resistance.
II - Development and Application of Molecular Markers for marker-assisted selection of fusarium-resistant corn.

Project Title Production of transgenic pigs that are more resistant to diseases

Reseacher Julang Li University of Guelph

Synopsis An antimicrobial (protegrin 1) will be expressed in the epithelia of the digestive tract and airways of pigs. The transgenic pigs will be generated by "gene targeting" in combination with nuclear transfer (animal cloning). The controlled expression of protegrin 1 in the epithelia of the respiratory and digestive tracts will potentiate the local microbicidal defenses and thus block infection in its earliest phases.

Project Title Vitamins B9 (folic acid), B12 and methionine in growing-finishing pigs

Reseacher Jacques Matte Agriculture and Agri-food Canada

Synopsis Supplements of vitamins B9 and B12 will be incorporated in diets low and high in methionine in order to modulate homocysteine and monitor its impact on growth performance and meat quality.

Project Title Canadian Research Network on Bacterial Pathogens of Swine

Reseacher Mario Jacques University of Montreal

Synopsis The Network will focus on virulence factors of major pathogens of swine: Escherichia coli, Actinobacillus app., and Streptococcus suis. Collaboration with researchers across Canada in the development of diagnostic tools and vaccines.

Project Title Use of a Polymer Chain Reaction Based Method to Characterize Intestinal Microflora in Pigs

Reseacher Joshua Gong Agriculture and Agri-food Canada

Synopsis Studies will be conducted to develop a novel PCR based method of characterization of intestinal microflora. A model system, composed of predominant gut bacterial species and common pathogenic bacteria, will be used to develop the method, including the test of PCR primer specificity and optimization of PCR conditions. The method will be further tested with pig gut samples and verified by DNA sequence analysis. The PCR based method will then be used to examine the effect of feed additives (2000 Ontario Pork Research Proposals) on gut health and microbiology.

Project Title Investigating the effect of air movement (draft) on the development of behaviour problems in early-weaned and growing pigs

Reseacher Tina Widowski University of Guelph

Synopsis Early-weaned piglets and growing pigs will be subjected to different degrees of air movement in an environmental chamber. Behavioural data will be collected from video-records to determine whether drafty conditions are associated with the nosing and chewing behaviour that may contribute to the development of behaviour problems in commercial practice.

Project Title Evaluation of electrolysis for oxidation of odour components of hog manure

Reseacher Nigel Bunce University of Guelph

Synopsis Electroanalytical methods have been used to determine the electrical potential at which the desired reactions occur. Electrolysis in small scale is being used to demonstrate degradation of the odourous substances.

Project Title Development of PCR tests to identify and type swine pathogens

Reseacher Hugh Cai University of Guelph

Synopsis PCR identification and typing assays will be developed for the rapid diagnosis of M. hyopnemoniae and swine influenza virus in the lungs of infected pigs in Ontario Swine Herds.

Project Title Advanced Manure Management Technologies for Ontario Initiative

Reseacher John Alderman Cold Springs Farms Ltd.

Synopsis This project has four objectives:

1. To develop specific measurable criteria for evaluating manure treatment technologies that allow for alternatives to direct land application.
2. To evaluate technologies according to the specific, measurable criteria developed from Objective 1.
3. To develop a report outlining the required "Steps to Implement" for different technologies which rate highly in the evaluation process.
4. To initiate a pilot project to demonstrate and assess one or more of the viable technologies in Ontario.

Project Title Rhythms in feed intake behaviour during different growth periods in growing/finishing pigs

Reseacher Jim Morris University of Guelph

Synopsis The data in this study involves the daily feed intake of pigs used on other trials. Feed intake, time of feeding and number of entries into the station by individual pigs were recorded. The data will be summarized and analyzed within weight periods and at hourly intervals throughout the day (3*24 factorial).

Project Title Assessment of and Innovative Group Housing System for Gestating Sows

Reseacher Tina Widowski University of Guelph

Synopsis Recently, one of the two gestation rooms at Arkel Swine Research Centre was renovated to accommodate group housing of sows. While this design appears to offer a viable option for alternative gestation housing for pork producers, detailed information about sow productivity and behaviour in the system have not yet been generated. A long-term analysis of production statistics and management in this system will be conducted to provide information to producers interested in adopting a similar housing design.

Project Title Development of a PCR test to detect Lawsonia intercellularis, the cause of proliferative enteropathy

Reseacher Gaylan Josephson University of Guelph

Synopsis Diagnostic and laboratory samples will be used in the development of a PCR based test for the detection of Lawsonia intercellularis. The test will be validated through internal and external methods and offered as a diagnostic test to the industry.

Project Title Development and validation of a screening protocol for identifying sulfamethazine-violative swine carcasses at Ontario abattoirs using the charm SL test for sulfamethazine.

Reseacher Mark Mitchell University of Guelph

Synopsis Determination of test performance parameters such as detection level in urine, matrix effects, ruggedness and ease of use. Comparison of charm SL test to SOS test and a TLC confirmatory test which are currently used for regulatory testing.

University of Guelph/OMAFRA Pork Research

Bob Friendship, Pork Research Co-ordinator, University of Guelph

The University of Guelph/OMAFRA Pork Research program is organized under the following four major areas of activity: Environment, Meat Quality and Safety, Production, and Animal Behaviour/Welfare. In general, there is a shift in activity away from the traditional research focus of increasing production and performance with more emphasis now being placed in dealing with threats to the industry from public concerns such as pollution, disease spread from animals to humans, and the suitability of animal housing and care. The following is a list of currently active projects and the lead researchers involved with the project.

Objective 1 - Environmental Concerns

Goal 1.1 - Manure Handling

Project 1.1.1:
Neural networks for predicting nitrate-nitrogen in drainage water
- S.C. Negi, School of Engineering.

Project 1.1.2:
Chemical agents for the selective capture of heavy metals from swine manure
- A.L. Schwan, Department of Chemistry and Biochemistry.

Project 1.1.3:
Development of anaerobic digestion processes for treating swine manure and processed effluents
- H. Zhou, School of Engineering.

Goal 1.2 - Reduction of Nitrogen and Phosphorus

Project 1.2.1:
Application of transgenic methodology in swine for reduced environmental impact and enhanced carcass quality
- J. Phillips, Department of Molecular Biology and Genetics.

Project 1.2.2:
Nutritional value of new varieties of corn, sorghum, and pearl millet grains fed to growing pigs
- C.F.M. de Lange, Department of Animal and Poultry Science.

Project 1.2.3:
Comparative determination of efficacy of the transgenic phytase enviropig in digestive utilization of nutrients in plant feed ingredients
- M.Z. Fan, Department of Animal and Poultry Science.

Project 1.2.4:
Management strategies to minimize environmental impacts and optimize profits in Ontario pork production considering pig genotype by animal environment interactions
- C.F.M. deLange, Department of Animal and Poultry Science.

Project 1.2.5:
Determination of true digestive efficacy of phosphorus utilization in major plant feed ingredients for weaning and growing-finishing pigs
- M.Z. Fan, Department of Animal and Poultry Science.

Project 1.2.6:
Impact of management strategies to lower phosphorus excreted in manure on the bio-availability of phosphorus in manure and manure-amended soils
- I. O'Halloran, Ridgetown College

Goal 1.3 - Reducing Odour

Project 1.3.1:
Electrochemical oxidation of odour components of hog manure.
- N. Bunce, Department of Chemistry and Biochemistry

Objective 2 - Pork Quality and Safety

Goal 2.1 - Food Safety

Project 2.1.1:
Monitoring the prevalence of diseases of economic significance and public health interest –
- R.M. Friendship, Department of Population Medicine.

Project 2.1.2:
Confirmation of the absence of *E. coli* 0157:H7 from pigs in Ontario and Quebec
- C.L. Gyles, Department of Pathobiology.

Goal 2.2 - Reducing Antibiotic Use

Project 2.2.1:
Alternative methods for raising pigs without antibiotics
- C.E. Dewey, Department of Population Medicine.

Project 2.2.2:
Porcine ficolins and related lectins as indicators of resistance to bacterial disease
- M.A. Hayes, Department of Pathobiology.

Project 2.2.3:
Enhancing the microbial food safety of pork
- S.A. McEwen, Department of Population Medicine.

<u>Goal 2.3</u> - Improving Pork Quality

Project 2.3.1:
Development of a resource population of pigs for detection of quantitative trait loci controlling growth, carcass composition, and meat quality
- A. Robinson, Department of Animal and Poultry Science.

Project 2.3.2:
Quantitative and molecular genetic improvement of swine
- A. Robinson, Department of Animal and Poultry Science.

Project 2.3.3:
Fatty acid esters of estrogens in tissues and blood of the pig
- J.I. Raeside, Department of Biomedical Science.

Project 2.3.4:
Genetic selection for boar taint free pigs
- E.J. Squires, Department of Animal and Poultry Science.

<u>Goal 2.4</u> - Uniformity of Carcass

Project 2.4.1:
Variation in pig weight gain - determining the distribution and associated factors
- C.E. Dewey, Department of Population Medicine.

Project 2.4.2:
An economic analysis of hog carcass grading alternatives for Ontario
- G. Fox, Department of Agricultural Economics and Business.

Objective 3 - Improving Production and Performance

<u>Goal 3.1</u> - Feeds, feeding, and mycotoxins

Project 3.1.1:
Effect of nutritional supplements of Fusarium mycotoxicosis in swine
- T.K. Smith, Department of Animal and Poultry Science.

Project 3.1.2:
Preferential requirements of trophic nutrients for gut mucosal growth in weanling piglets
- M.Z. Fan, Department of Animal and Poultry Science.

Project 3.1.3:
Diet effects on microbial fermentation in the gut, gut health, and nutrient utilization in growing pigs
- C.FM. deLange, Department of Animal and Poultry Science.

Project 3.1.4:
Alternative feeds and management strategies to improve growth performance, manure composition and carcass characteristics, and to minimize environmental impact of pigs
- E.M. McNeilage-VanDeWiele/J. Morris, Ridgetown College, University of Guelph.

Goal 3.2 - Improving Pig Health

Project 3.2.1:
Improvement of health of weaned pig
- R.M. Friendship, Department of Population Medicine.

Project 3.2.2:
Gastric ulcers
- R.M. Friendship, Department of Population Medicine.

Project 3.2.3:
Variability of pulmonary defences against bacterial infection at specific stages of production in swine
- J. Caswell, Department of Pathobiology.

Project 3.2.4:
Pathogenic role of the capsid protein of porcine reproductive and respiratory syndrome virus (PRRSV) in swine
- D. Yoo, Department of Pathobiology.

Project 3.2.5:
Solving the piglet mortality problem
- R.R. Hacker, Department of Animal and Poultry Science.

Project 3.2.6:
Protozoal parasites in the pregnant uterus: a new porcine pathogen?
- H. Engelhardt, Department of Animal and Poultry Science.

Project 3.2.7:
Molecular analysis of important bacterial pathogens of swine
- J. MacInnes, Department of Pathobiology.

Goal 3.3 - Improving Reproductive Performance

Project 3.3.1:
Further definition and experimental manipulations of the relationships b3tween uterine Natural Killer lymphocytes and gestational success
- B.A. Croy, Department of Biomedical Science.

Project 3.3.2:
Manipulating sperm lipids to improve boar sperm storage
- M.M. Buhr, Department of Animal and Poultry Science.

Project 3.3.3:
Development and field testing of reproductive biotechnologies for the elimination of disease and germ plasm conse4rvation in swine
- C. Plante, Department of Population Medicine.

Project 3.3.4:
Understanding the transmission of PRRS virus
- C.E. Dewey, Department of Population Medicine.

Project 3.3.5:
The effect of reproductive status on the vasopressin/oxytocin-containing nucleus in the female pig hypothalamus
- G. Partlow, Department of Biomedical Science.

Project 3.3.6:
Oxidative stress and embryonic death in pigs
- G. Kirby, Department of Biomedical Science.

Goal 3.4 – Transgenics

Project 3.4.1:
Production of transgenic pigs that are more resistant to disease
- J. Li, Department of Animal and Poultry Science.

Project 3.4.2:
Establishment of a gene manipulation system in porcine somatic cells
- J. Li, Department of Animal and Poultry Science.

Objective 4 - Animal Welfare/Behaviour

Goal 4.1 - Behaviour and Housing

Project 4.1.1:
The use of high-fibre diets to reduce aggression and improve welfare in group-housed sows
- T. Widowski, Department of Animal and Poultry Science.

Goal 4.2 – Euthanasia

Project 4.2.1:
Evaluation of practical on-farm euthanasia techniques for young swine
- A. E. Deckert, Department of Population Medicine.

Goal 4.3 - Abnormal Behaviour and Vices

Project 4.3.1:
Causation and prevention of behaviour problems in pigs
- T. Widowski, Department of Animal and Poultry Science.

Pork Quality and Improvement through Genetics, Nutrition and Animal Handling

Wayne Du, Pork Quality Assurance Program Lead, OMAFRA
Wellington Place R.R.#1, Fergus, Ontario N1M 2W3

Introduction

Pork quality has become a very popular term and topic for discussion in recent years. There is no doubt that the pork industry's future and success will rely on the quality of the pork products produced because quality will have a big influence on how carcass and meat are valued and rewarded. To remain competitive and successful in both the domestic and global markets, the Ontario pork industry must continuously strive for high pork quality.

To discuss pork quality we have to define it first. So, what is pork quality? This is a question that is often asked and debated. Unfortunately, there is no single, worldwide definition and standard for it. Today's definition for pork quality is dependent not only on lean yield, back fat and meat characteristics but also many other factors such as the consumer preferences, public perceptions and the segments of the pork supply chain. For example, the Japanese consumers like dark red pork meat with a high level of marbling and subcutaneous fat. This type of product, however, is regarded as unacceptable in the European market. Hog producers may not regard meat color, drip and cook losses and shelf life as important as the lean yield but meat processors and retailers do. Therefore, depending on whom you ask, today's definition for pork quality could include some or all of the following components:

- **Technical pork quality**
  -Carcass characteristics and compositions: carcass uniformity and consistency, lean yield and fat;
  -Meat characteristics: color, marbling, meat pH and firmness, PSE (pale, soft and exudative), DFD (dark, firm and dry);
  -Eating quality: tenderness, juiciness, flavor, tastiness, boar taint;
  -Processing and retailing characteristics: drip and cook losses, shelf life, belly firmness;
  -Nutritional values: protein, vitamins, minerals and types of fat and cholesterol.

- **Pork safety**
  -Physical hazards: Broken needles, fragments of bones, other metals;
  -Chemical hazards: drug residuals and other toxin residuals;
  -Biological hazards: pathogens (salmonella, Toxoplasma drug resistant bacteria);
  -Product traceability;
  -Quality assured programs.

- **Animal wellbeing**
  -Space, dry sow stalls, farrowing crates, castration, tail docking, early weaning and animal handling.

- **Environmental acceptability**
  -Minimum or no pollution to ground water, land and air.

- **Production methods**
  -Natural, organic or free- range productions;
  -Hormones and antibiotic growth promoters.

- **Public perceptions**
  -Genetically modified (GM) animals and GM feed ingredients
  -Extensive swine production systems

It is becoming quite clear that the era of producing all-purpose hogs to fit all the markets is gone. The pork industry must be capable of tailoring the pork product to the needs and demands of different markets and consumer groups. High pork quality is a combined result of many factors such as genetics, nutrition, animal handling, production methods, carcass chilling and meat processing, etc. The article here is intended to give you a brief update on the effects of genetics, nutrition and animal handling on "technical meat quality".

Genetics

Genetics plays a major role in pork quality. There are three genetic factors contributing to the variation in pork quality: **genetic line difference**; **major gene effects**; and **heritabilities and genetic correlations** due to within breed variations.

- **Genetic line differences**

Meat quality varies considerably among different genetic lines or breeds. Results from the U.S National Barrow Show Sire Progeny Tests (with the data from 3,900 purebred pigs evaluated from 1991-1999) found:

-**Berkshires** have superior meat and eating quality to conventional breeds. They have the highest ultimate pH, color, and tenderness. Its loins have the lowest drip and cook losses;
-Durocs have the highest marbling or total lipid content. They have double the levels of intramuscular fat compared with Large White or Landrace.
-Hampshires have largest loin muscle area but with low loin ultimate pH, the highest drip and cook losses. Meat tenderness is acceptable.
-**Landrace and Yorkshire** pigs tend to have lower meat pH and intramuscular fat, and higher drip and cook losses than Durocs and Berkshires. Both Landrace and Yorkshire breeds have excellent maternal reproductive abilities.

- **Major gene effects**

The effects of several genes or gene candidates on pork quality have been well studied.

The Halothane (stress) gene

The Halothane gene causes increased incidences of PSE pork. This gene, however, has been removed from most breeding populations since the discovery of the halothane DNA test. Some producers still use this gene for the purpose of improving eye muscle area and lean yield. However, according to an U.S. study this is not a wise practice for the pork industry.

The RN (Rendement Napole) gene

The RN gene, also known as "acid meat gene" or "Hampshire gene" because it causes acid meat and is usually found only in purebred or crossbred Hampshire populations, has a significant negative influence on pork quality. Pigs carrying RN gene have high levels of glycogen in the muscle, which is converted to lactate after slaughter and results in the so-called acid meat, a condition which has lower ultimate meat pH, paler and yellowish muscle color and increased drip and cook losses.

Gene marker tied to boar taint

Entire male pigs or boars have better feed efficiency, higher average daily gain and leaner carcass than barrows and gilts. Producers can't take the advantages of using boars because of its off-flavor and smell known as boar taint. There are two primary causes of boar taint, high levels of the steriod androstenone and skatole. The later is a product of protein degradation found in the gut. Scientists are currently attempting to solve the problem through genetic means. Researchers in the U.S. discovered a gene marker tied to boar taint. A test for detecting this gene marker would reduce the likelihood and the intensity of boar taint and ultimately would lead to the development of taint-free genetics. Dr. James Squires' lab at the University of Guelph is working on the identification of genetic markers tied to boar taint as well. The ultimate goal is also to develop boar-taint-free genetic lines.

H-FABP gene

H-FABP (heart fatty acid binding protein) gene has been suggested as a potential candidate gene that has effects on intramuscular fat percentage. Results from some research shows that this gene can increase the intramuscular fat without increasing the back or overall body fat. But others show that the increased intramuscular fat is not independent from the increases of total carcass fat content in commercial lines. Therefore, further studies are needed on this gene.

- **Heritabilities and genetic correlations**

  Selection among animals within a breed or genetic line to improve pork quality depends on heritability, genetic correlations and method of measurement. All fresh pork quality traits have a medium to higher heritability and cooked pork traits have a low to medium heritability.

Nutrition

Nutrition plays an important role in further pork quality improvement in existing genetic lines. It is not hard to understand that meat quality can be affected by the feeds fed to animals. Studies have been continuing in search of nutrients, feeding regimes and feed additives that could be used to improve meat quality.

- **Conjugated Linoleic Acid (CLA)**

  The effects of dietary supplementation of CLA on pork quality have been intensively investigated in recent years. Linoleic acid is a polyunsaturated fatty acid containing 18 carbon atoms and two cis double bands at carbon atoms 9 and 11. Conjugated linoleic acid is similar except that the double bonds are in unexpected places. It is a series of positional and geometric isomers of linoleic acid. The specific isomer composition of CLA appears to be important.

Results from various studies show that dietary supplementation of CLA has the following effects on pork quality:

-Reducing back fat thickness;
-Increasing lean yield;
-Increasing intramuscular fat, therefore, improving marbling scores;
-Shifting the composition of body fat from unsaturated to saturated; Increasing the firmness of the belly; Soft belly is a problem for the processing industry and increased firmness will make processing more efficient;
-Lowering thiobarbituric acid-reactive substances (TBARS) values of pork after first 24 hours of storage;
-Improving water holding capacity (WHC) and, therefore, reducing water drip loss.

Research data suggests that addition of CLA to pig diet can improve pork quality without negative effects on other quality characteristics. It seems that supplementation of CLA has no or little effects on tenderness, ultimate pH, sensory scores and color. Overall, there are considerable interests in including CLA in pig diets to improve pork quality and production efficiency. The pork industry can adopt this technology easily if producers are adequately compensated accordingly.

- **Vitamin E**

Vitamin E is antioxidant and has positive effects on pork quality. Several tocopherols and tocotrienols have vitamin E activity, with alpha tocopherol being the most active and most commonly used as a dietary supplement. Many studies have been conducted to determine if high dietary vitamin E supplementation actually improves the oxidative stability of pork fat and the results have shown consistent reductions in TBARS in the pork.

Results form various studies that fed vitamin E at 100 IU to 400 IU/kg for 72 to 105 days before marketing show that vitamin E supplementation has the following effects:

-Increasing the oxidative stability of pork;
-Extending pork shelf life and slowing down the proliferation of spoilage bacteria;
-Increasing vitamin E level in pork (high levels of vitamin E in meat provide health benefits to consumers).

In addition, results from some studies found that vitamin E supplementation could also improve color and WHC of pork because it slowed down the oxidation of the bright pinkish-red oxymyoglobin to the brown metmyoglobin and reduced the oxidation of membrane lipids. The effect of vitamin E supplementation on pork pH has not been demonstrated.

- **Paylean**

Paylean, the trade name for ractopamine hydrochloride (manufactured by Elanco Animal Health), is a pharmaceutical product that causes the hog's metabolism to shift nutrients from fat to muscle growth. Ractopamine is also known as a beta-agonist (not a steroid, antibiotic, or biotechnology product). Studies on Paylean have been done under both laboratory and field conditions. The manufacturer reported that Paylean increases average daily gain by as much as 275 grams during the early weeks of feeding, but that amount decreases as the hog matures. Studies indicated that supplementation of Paylean at 5-10 ppm levels during the last 4 weeks of finishing period is ideal for improving hogs performance, meat quality and economic returns. Results from various studies show that supplementation of Paylean in finisher diet can improve:

-Growth performance (average daily gain) by 9-10%;
-Feed efficiency by 12%;
-Lean yields.

In addition to the above benefits, supplementation of Paylean in finisher diets also has a positive impact on environment (less N excretion and manure) due to improved feed efficiency. However, Paylean addition didn't show much effect on meat color, marbling, palatability and drip loss. Paylean has been approved for use in swine diets in the U.S but has not been approved for use in Canada yet.

- **Others Nutrients or feed additives**

The effects of other nutrients or feed additives such as magnesium, betaine, carnitine and chromium on pork quality have also been continuously investigated. Providing magnesium to pigs before slaughter appears to improve pork quality. Supplementation of betaine, carnitine or chromium in finisher diets could also make carcasses leaner. The results, however, are not always consistent due to different genetics and production and management systems.

Overall, there are means to improve pork quality through nutritional changes. However, the nutritional changes are usually associated with direct financial costs to producers. Therefore, the nutritional means would not be widely adopted unless there are financial rewards to adjust the costs.

Animal Handling

The effect of animal handling on pork quality is one of the areas causing attention in pork quality study in recent years. Studies indicate that proper animal handling is critical to pork quality and economic returns. In addition, proper animal handling is also an animal wellbeing issue. Improper animal handling, especially during their final hours before slaughter (from on farm loading to slaughter) can cause PSE and DFD pork, skin and meat damages and increased hog mortality.

- **Prior to Slaughter Feed withdrawal**

Pre-slaughter feed withdrawal can potentially reduce the levels of muscle glycogen at slaughter, which could theoretically increase the ultimate meat pH. Studies show that lack of feed withdrawal can result in increased incidences of PSE pork. On the other hand, if the feed withdrawal period is too long it could increase the incidences of the DFD condition. According to various studies withdrawal of feed for 12-18 hours before slaughter can help improve pork quality. Furthermore, 12-18 hours of feed withdrawal can also prevent or minimize fecal contamination of carcass at packing plants, reduce mortality rates during transportation, reduce producers' feed costs and abattoirs' waste disposal costs.

- **Prior to Slaughter Rest time**
  How long pigs should be allowed to rest after they reach the lairage and before slaughter can affect meat quality. Studies show that longer lairage times could improve meat color, reduce the incidences of PSE meat but increase the amount of skin damage and DFD meat. Shorter lairage times, on the other hand, appear to have the opposite responses, such as light meat color and higher incidences of PSE but with less skin damage and DFD incidences. Therefore, the optimum lairage times must be a balance between too long and too short rest times before stunning. The proper rest times are 2-3 hours for achieving high pork quality.

- **Quiet handling of pigs**
  Poor animal handling immediately prior to stunning has shown to cause a higher temperature in muscle and a faster meat pH fall early post mortem, which will result in a higher drip loss and PSE incidence. Animals should be handled quietly and gently right before the slaughter. The facilities must be designed for easy handling of hogs and tools such as electric prods should not be used.

Summary

In summary, the definition of pork quality varies among different consumer groups, markets and segments of pork supply chain. Technical meat quality is affected by many factors and all the segments of the pork industry. To remain competitive in both domestic and international pork markets the Ontario pork industry must work together, recognize the differences in quality preferences among consumer groups and tailor the products to meet their specific demands.

Two-Airspace Building Design For Reducing Odour and Gas Emissions From Grower – Finisher Barns

S.P. Lemay[1], H.W. Gonyou[1], J. Feddes[2], E.M. Barber[3] and R. Coleman[4]

[1]Prairie Swine Centre Inc., P.O. Box 21057, 2105-8th St. East, Saskatoon, SK, S7H 5N9;
[2]University of Alberta, Edmonton, AL; [3]University of Saskatchewan, Saskatoon, SK;
[4]Alberta Research Council, Vegreville, AL.

Air quality in the barn and in its vicinity

Odour and gas emissions from swine operations can be a nuisance to nearby residents. In Canada, most pig barns have outside manure storage resulting in two odour sources on the production sites: the building and the manure storage facility. By keeping the manure inside the building, the nuisance sources would be reduced to only one. A two-airspace building concept where pigs would dung in an enclosed dunging area (EDA) above the slats could result in an improvement of the barn air quality as odours and gases from dunging and the manure itself would be contained inside the EDA. By extracting part of the ventilation rate through the EDA and treating this air with a biofilter, the overall emissions from a swine operation could be reduced.

Objectives

The objectives of the project were:

- To construct an EDA that will:
  - be consistently used by the pigs.
  - minimise odour/gas transfer to the pig/worker airspace.
- To observe the pig behaviour in a pen equipped with an EDA.
- To design and test 4 types of opening for the EDA:
  - no door, solid door, strip curtain and air curtain.
- To construct and evaluate a two-airspace ventilation system.
- To investigate the use of biofiltration for odour removal from EDAs.
- To measure odour and gas emissions from a feeder barn provided with EDAs and biofilters.

This project was conducted at two locations: at Prairie Swine Centre (PSCI) for the engineering development of the EDA concept and pig behaviour analysis and at the University of Alberta for the development of the biofilter and its implementation with the EDA. This article summarizes the work completed at PSCI.

The development of the two-airspace concept

The EDA design was established through different steps to analyse the different components of the new concept and their impacts on the pigs.

- Air containment tests were performed in laboratory at the University of Saskatchewan to verify the potential of the EDAs for gas containment.

- Behavioural studies of the pigs using open EDAs were conducted at PSCI.

- Engineering modifications to the EDA design were implemented to help controlling pig dunging behaviour and to improve gas containment.

The most promising EDA was selected for thorough in-barn testing at PSCI and was equipped with:

- a full strip curtain on the whole width of the pen that reduced gas containment but greatly improved pig usage of the EDA and cleanliness of the pens;

- bars that were laid on the slats and intermittent water sprinkling used for a few days to discourage pigs from sleeping in the EDA.

Results

The following figures show the impact of the two-airspace concept on odour threshold and ammonia concentrations for both a conventional grower-finisher room (control room) and a similar room equipped with EDAs (treatment room). Air samples were taken in the middle of the rooms and also directly inside the EDA. Over the four sampling periods, odour threshold measurements showed a 20% reduction in the treatment room compared to the control room and no consistent differences were measured in the EDA. The ammonia concentration was reduced by 40% in the treatment room compared to the control room. However, the concentration in the EDA was more than double what was measured in the treatment room which demonstrated that a good gas containment could be provided by the two-airspace concept. No consistent differences were observed for the hedonic tone of the odour and the carbon dioxide concentrations.

Conclusions

Odour and ammonia concentrations were reduced using the full curtain EDA that was developed for the two air-space building design:

- Reductions of 20 and 40% were measured for odour threshold and ammonia, respectively;
- No difference were observed on the hedonic tone and the carbon dioxide concentrations.

Further steps have to be completed for this project:

- A full data analysis of the pig behaviour and odour and gas measurements based on the results obtained at PSCI;
- The experiment with a room equipped with EDAs and biofilters at the University of Alberta.

DIGESTIBILITY OF ENERGY AND AMINO ACIDS IN HIGH-OIL CORN

Ruurd T. Zijlstra[1], Tom E. Sauber[2]
and John F. Patience[1]
[1]Prairie Swine Centre Inc., Saskatoon, SK; [2] DuPont Specialty Grains, Johnston, IA

Summary

High-oil corn is used as a source of nutrients, especially energy, to meet requirement of pigs. In the present study, DE content and digestibility of energy and amino acids of high-oil corn was characterized and related to chemical characteristics.

The DE content of high-oil corn was 5% is higher than from regular corn. Corn DE content could be predicted using gross energy (GE) or oil content. High oil corn is clearly a source with a high DE content.

Introduction

Digestibility of energy and amino acids of high-oil corn has not been characterized thoroughly or related to chemical characteristics. Thus, the objective was to compare four near-isogenic sample-pairs of high-oil and regular corn and one standard corn sample for chemical and nutritional characteristics

Experimental Procedures

Corn sample were analyzed by proximate analyses. Diets consisting of one specific corn sample (96.3%), vitamins and minerals, and chromic oxide as an indigestible marker were fed to grower pigs cannulated at the distal ileum, for 6 pigs per diet.

Results and Discussion

In high-oil versus regular corn, oil content was 4.2% higher (9.1 vs 4.9%), resulting in a 6% higher GE content (4853 vs 4589 kcal/kg DM), and protein content was 9.5 versus 9.1%, acid-detergent lignin 0.51 versus 0.41%, and starch 68.2 versus 71.3%.

Total tract energy digestibility was 1.1% lower (87.4 versus 88.3% in high-oil versus regular corn; however, DE content was 5% higher in high-oil versus regular corn (4238 versus 4052 kcal/kg DM). The DE content could be predicted using single-regression by corn GE (R^2 = 0.93), oil (R^2 = 0.90; Figure 1), and protein (R^2 = 0.49). Ileal E digestibility was similar (75.4 vs 76.4%) between high-oil versus regular corn; however, ileal DE content was 4% higher in high-oil versus regular corn (3660 versus 3503 kcal/kg DM).

In Figure 1, equations to predict corn GE, DE, and ileal DE content using corn oil content are presented. The figure clearly illustrates the large range in corn oil content and the positive effects of increased oil content on corn DE content.

Apparent ileal digestibility of lysine was 2.4% higher in high-oil versus regular corn (64.0 versus 61.6%), although less difference was observed in standardized digestibility of lysine (76.3 versus 75.5%). The increase in oil content within each near-isogenic sample pair was related (R^2 = 0.47) to an increase in apparent ileal lysine digestibility.

Implications

In summary, feeding high-oil versus regular corn does result in more energy and amino acid that are available to the pig to support metabolic functions.

Acknowledgements

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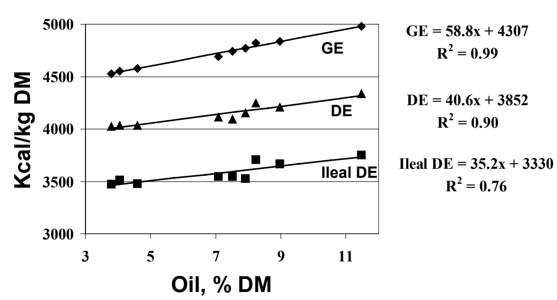


Figure 1. Effect of Corn Oil Content (% DM) on Energy Content (kcal/kg). To determine corn gross energy (GE), DE, or ileal DE, determine its oil content and use the provided equations.

SOW BODYWEIGHT CHANGES IN GESTATION

Dana R. Cooper[1], John F. Patience[1], Ruurd T. Zijlstra[1] and Meike Rademache[2]
[1]Prairie Swine Centre Inc., Saskatoon, SK; [2]Degussa Hüls AG

Summary

Defining nutrient requirements and feeding strategies for the modern high-producing sow is a step leading to greater efficiency in the breeding herd. Results demonstrated that setting target weight gains in gestation and feeding to meet these targets might not always provide predictable results.

Introduction

There are two steps in the design of a feeding strategy. The first is to set reproductive targets including the amount of maternal weight gain for sows of differing parities and the amount of reserves a sow can use for milk production in lactation. The second step is to set nutrient requirements to meet these specified targets. Models have been developed for sow nutrient requirements in gestation. These models attempt to patition nutrient requirements into three components (maintenance, growth of conceptus and reproductive tissues and maternal growth). By attempting to partition requirements, factors are added up, thus accounting for the factorial approach to determining nutrient requirements. The object of this experiment was to evaluate the factorial approach to defining energy requirements in pregnant sows.

Experimental Procedures

Daily feed allowance in gestation was determined using the maintenance requirement for energy of 110 kcal DE/kg $BW^{0.75}$ and total target sow BW gains, including maternal gain and growth of the conceptus, of 55, 50, 40, 30 and 20 kg for parities 1, 2, 3, 4 and 5 and higher, respectively. Feed allowances were calculated using BW at mating and the target BW gains set for each parity. Example calculations are demonstrated in Table 1.

Daily feed allowance of sows in gestation was closely monitored. Sows were fed their daily allowance as one meal in the morning. Sow BW was measured at mating, d 35, 75 and 110 gestation. The experiment was conducted over 3 replicates. After the first replicate, it was apparent that first and second parity sows gained an average of 9.6 and 13.3 kg more than targeted, respectively. In replicates 2 and 3, the daily energy allowances of these two parities was adjusted downward based on the energy required for protein and lipid gain to achieve the prescribed gestation BW gain. The calculation resulted in decreasing the average daily feed allowance by 100 g/d.

Results and Discussion

Sows gained an average of 10.6 kg above the target total gestation BW gain. It was clear that this model over-predicted DE allowance for sows in gestation, therefore, performance data for the sows was entered into the NRC (1998) model (Table 2). The actual number of piglets farrowed was put into the NRC (1998) model, a component not entered into the original model that was used. Comparisons between the predicted BW gain and the actual BW gain were then made. The deviation between the predicted and actual BW gains was then orgainized by parity, BW at breeding, totoal number of piglets born and the total weight of the litter born (Figures 1 and 2). The deviations between predicted and actual gains (NRC prediction – Actual BW gains) decreased with increased parity and initial BW at breeding until the 5th parity and a BW range of 210-240 kg, where it then increased. NRC (1998) obtained the closest estimate of BW gain in gestation for sows with litters larger than 11 piglets and litters weighing between 14-17 kg at birth.

Implications

Predicting daily DE allowances that will maximize sow and litter performance is possible with sows between parity 3 and 5. There is too much variation in younger parity sows and older parity sows to predict sow performance with any accuracy; therefore, there is a need for further research into this area. The size and weight of the litter at farrowing is important in determining the BW gain of the sow in gestation. Therefore, using the actual litter size and weight within a sow herd is desirable when using a factorial approach to determine daily feed allowance.

Acknowledgements

Strategic program funding provided by SaskPork, Alberta Pork, Manitoba Pork, and Saskatchewan Agriculture and Food Development Fund. Degussa Hüls AG provided direct funding for this project.

Table 1. Estimated daily DE requirements in gestation using original model estimates. Based on target weight gains in gestation.

Parity	No. sows	Ave. initial BW, kg	Target Wt. gain, kg[a]	$DE_{Maint.}$[b]	$DE_{Matgain}$[c]	Actual DE intake (kcal/d) $DE_{Conceptus}$[d]	DE_{Total}	Daily feed allowance, kg/d[e]
1	99	142	55	5161	1697	411	7269	2.3
2	102	168	50	5700	1662	411	7773	2.5
3	43	193	40	6129	1114	411	7654	2.5
4	54	208	30	6348	611	411	7370	2.4
5	44	220	20	6488	249	411	7148	2.3
6	23	230	20	6703	249	411	7363	2.4
7	23	233	20	6770	249	411	7430	2.4
8	12	236	20	6829	249	411	7489	2.4

[a] Including both maternal and conceptus gain.

[b] Maintenance requirement of 110 kcal DE/kg BW·). Body weight is average of initial BW and final BW based on target weight gain in gestation.

[c] Maternal BW gain requirement is sum of requirement for protein gain (12.78 kcal/g) and lipid gain (13.05 kcal/g). Assumes that maternal gain is 12.5% protein, resulting in a lipid:protein ratio in maternal gain of about 2:1.

[d] Assuming 20 kg conceptus and reproductive tissue gain over 115 days (174 g/d), assuming 18.5 % protein (32.2 g/d) and an energetic cost of 12.78 kcal/g.

[e] Assuming DE of diet was 3100 kcal/kg. Subsequent digestibility trial showed actual DE content of 3150 kcal/kg.

Table 2. NRC (1998) estimate of maternal body weight gain using actual daily DE intakes in gestation

Parity	No. sows	Net maternal BW gain, kg[a]	Litter size[b]	DE_{maint}[c]	$DE_{conceptus}$[d]	Actual daily DE intake, kcal/d[e]	DE for maternal gain, kcal/d[f]	NRC estimate of total BW gain, kg[g]	Actual total BW gain, kg
1	99	36	11.2	5607	419	7269	1234	57	61
2	102	33	11.9	5829	445	7773	1499	58	60
3	43	22	12.4	6261	463	7654	930	50	50
4	54	14	12.6	6501	471	7370	398	44	42
5	44	3	13.2	6650	494	7148	4	37	33
6	23	7	12.3	6884	457	7363	22	37	35
7	23	0	13.7	6905	511	7430	14	41	31
8	12	1	11.5	6924	427	7489	138	37	27

[a] Maternal weight gain (kg) = Gestation weight gain (kg) – (2.28 x No. of pigs).

[b] Total piglets born.

[c] Maintenance requirement of 110 kcal DE/kg $BW^{.75}$. Body weight is the average of the initial weight and final weight based on actual weight gains of the sows in the experiment.

[d] DE required for daily gain of the products of conception is 37.3 kcal/pig.

[e] Actual daily DE intake (kcal/d) based on original model.

[f] DE (kcal/d) remaining after estimates for maintenance and conceptus gain (based on NRC, 1998 model) are subtracted from the actual intake of the sow in gestation.

[g] Estimate of BW gain from NRC (1998) model using actual daily DE intakes obtained from original model.

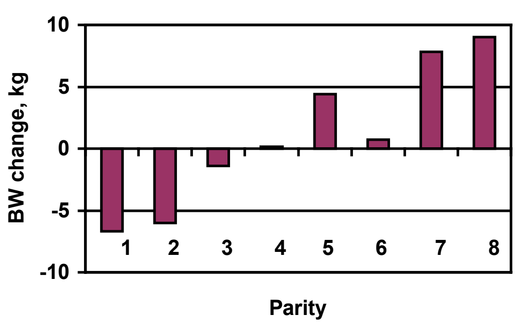


Figure 1: Deviation between predicted and actual BW gain by parity

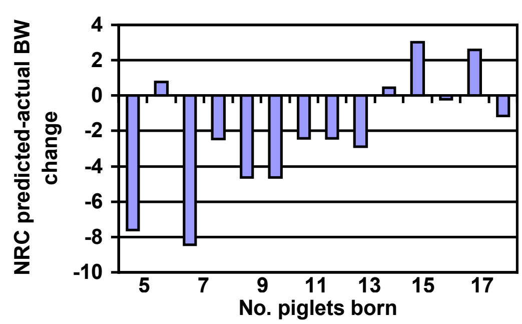


Figure 2: Deviation between predicted and actual BW gain by number of piglets born

Understanding Condemnations and Trim Demerits at Ontario Pork Packing Plants

Frank Wood
Field Service Representative
Ontario Pork
P (519) 338 2678
F (519) 338 3432
frank.wood@ontariopork.on.ca

There are many misconceptions and concerns within the hog industry regarding who or how condemnation, trim demerits are applied to a hog carcass. This article will explain the basic procedures of meat inspection in Ontario.

Meat Inspection
There are two levels of inspection in Ontario. Packer/Processors that market product only within Ontario are covered by OMAFRA (Ontario Ministry of Agriculture and Rural Affairs) under the provincial Meat Inspection Act (Ontario)* and packer/processors that export inter-provincially or internationally are covered by the CFIA (Canadian Food Inspection Agency) under the federal Meat Inspection Act**.

Ante Mortem (a visual inspection of live animals):
Government inspectors must be present during the receiving and processing of all market hogs. Plant employees, government inspectors and government veterinarians will perform an Ante Mortem. This is done to look for obvious health, stress and physical conditions that will result in the animals being approved for processing, held pending further consultation or condemned.

Evisceration (examining the glands, liver, lung and carcass):
On a typical evisceration floor government inspectors are strategically placed to examine the viscera and carcass. Questionable animals are then sent to the “Held rail” for further inspection by a government veterinarian.

Held Rail (carcass tagged and separated off main line for further inspection):
The Held rail allows closer inspection of the carcass by the government veterinarian. The severity of the problem will be determined, which may result in the trimming or skinning of the effected area if necessary before being re-introduced to the main line. In the case of carcass condemnation, the carcass is removed and marked for non-edible rendering. At smaller plants the tattoo number is recorded manually and at larger plants a transponder is used to record and ensure trims are deducted from the correct producer. The "transponder" is a small disk that hangs on the rollers holding the carcass. The transponder can be read by automated equipment on the line and links the carcass to the producer’s tattoo.

Who pays for the condemnation or trim?
Trims or condemnations of farm origin such as an abscess, arthritis etc are the liability of the producer. Trims or condemnation of packer origin such as over scalding, contamination etc are applied against the packer with the producer getting paid the full value for the carcass.

Verifying ownership of condemned hogs?
The government veterinarian records and issues a condemnation certificate against the carcass tattoo; a copy of this certificate is available by request from Producer Services at Ontario Pork by calling 1-877-668-7675. The cause of each trim and or condemnation is listed on the producers' statement. A list of codes is available on the Ontario Pork Web site*** or can be mailed on request from Producer Services.

In the event of continuous herd health related problems, most plants in Ontario will allow producers, their veterinarian or feed representatives access to the evisceration line while their hogs are being processed. These appointments must be arranged in advance by contacting Ontario Pork or the processor.

It is important to remember that all decisions to trim or condemn carcasses are determined by trained government inspectors employed by CFIA (federal plants) or OMAFRA (provincial plants) and not by the processor.

For more information regarding OMAFRA and CFIA programs you may want to check the following web sites:
* http://www.omafra.gov.on.ca/english/food/inspection/meat/programintro.htm
** http://www.inspection.gc.ca/english/toce.shtml

For a listing of trim and condemnation codes:
*** www.ontariopork.on.ca

Health Data Capture Program

Douglas Richards P.Ag.
Senior Field Representative Ontario Pork
519-293-1070
519-293-1071 fax
doug.richards@ontariopork.on.ca

OPGA

The Ontario Pork Grading Authority (OPGA) is a third party organization jointly funded by Ontario pork producers and processors. The OPGA is responsible for grading the pork carcasses and capturing the health data for hogs at Ontario slaughtering plants. The cost of providing the services is shared evenly between the two parties.

The OPGA's General Manager is Dan Bazinet. The General Manager is responsible for the day-to-day business of the OPGA. This includes the scheduling and training of the technicians along with conducting spot audits on the accuracy and uniformity of the technicians' carcass grading, health data capture skills and electronic grading equipment.

Health Data Capture Program

During the past year (2001), Ontario Pork and the OPGA looked at the Animal Productivity & Health Information Network (APHIN). The APHIN program took the carcass health information supplied by the OPGA technicians and processed it into a graphic format. The information was accessible on-line by those producers registered with the APHIN site and was also mailed to producers on a quarterly basis during the year.

The OPGA ended the agreement with the University of Prince Edward Island for delivery of APHIN on September 30th 2001. OPGA has been and will continue to collect the health data and it is available to producers in numerical form through the On Line Information Network Knowledgebase (OINK). The group is confident that the APHIN graphing services can be replaced with an enhancement to Ontario Pork's current system. The replacement would be more user-friendly and would be available to all producers through Ontario Pork's OINK site.

Health data: Is a service provided by the OPGA that scores the lungs, liver and adhesions. This service is currently available on hogs processed at Maple Leaf Pork, Quality Meat Packers and Conestoga Meat Packers on a regular basis. This information is retrievable for individuals at Ontario Pork's OINK site under **Grading Data - Enhanced Information** and can be a vital tool in determining treatment programs for individual farms.

Interpreting the data. If there is no data in the column, health data collection was not performed for that animal. The health data is not collected on all animals and is a secondary role that the OPGA staff performs. If there are numbers in the column, the codes definitions for these numbers are listed below and can also be found at the top left hand side of the producer **Grading Data** sheet under the heading **Glossary of Terms** at the OINK site.

Note: A producer should always check with their veterinarian or animal health specialist before making health management decisions on the health data information provided.

Health Codes

Code	Health Status
Health Codes for Lungs	
1	Normal
3	Mild Abnormal
6	Moderate Abnormal
9	Severe Abnormal
Health Codes for Adhesions	
2	Clean
4	Local
5	General
7	Abscess
8	Pericarditis
Health Codes for Liver	
1	Normal
3	Mild Abnormal
6	Moderate Abnormal
9	Severe Abnormal

CQA Update 2002

Christine Ritter
CQA® Coordinator   Ontario Pork
1-877-668-7675 x 260
Fax (416) 621-9787
christiner@ontariopork.on.ca

Ontario Pork is the provincial delivery agent for the CQA® program

- The number of validated producers as of January 2002 is 1911 with estimated hog sales of 2.9 million hogs.

Board Supports 100% CQA® Enrollment for Ontario Producers

- To secure present markets, open future markets and maintain confidence in our hogs, Ontario Pork's Board of Directors passed a motion supporting 100% enrollment in the CQA® program. This past summer all active producers not currently enrolled in the CQA® program received a letter notifying them that they will be enrolled in the program unless Ontario Pork receives notice from them declining the manual. The manuals were mailed out in late August.

Current list of processors requiring CQA® hogs in their supply agreements:

Federally Inspected Plants

- Maple Leaf Pork
- Quality Meat Packers
- Olymel (Quebec)

Provincially Inspected Plants

- Weston Meats   January 1st 2002
- Domingo Meat Packers   January 1st 02

Partial Validation Up & Running

- CQA® partial validation for producers has started. Ontario Pork will notify producers 60 days prior to their validation anniversary date. Validations follow a three-year cycle with year one of the cycle as a full validation and years 2 and 3 as partial validations. The partial validation **DOES NOT REQUIRE A FARM VISIT**. It is the producer's responsibility to maintain program standards following the validation process.
- Ontario Pork will be offering CQA® producer seminars in the upcoming months for producers wanting to enroll or needing some assistance in filling out the On Farm Assessment Manuals.
- This past summer an updated version of the On Farm Quality Assessment Manual was released. This version has "Summer 2001" in the bottom right hand corner. The changes in the revised manual make the questions easier to understand, answer and validate. The revised manual has not changed the program content or added new areas. All producers will receive this revised manual with their Validation / Partial Validation renewal notices.

New CQA® Coordinator

- Christine Ritter has joined Ontario Pork as the CQA® Coordinator. Her duties include communications with producers, validators and staff, program updates, data base tracking and other day-to-day functions of running the provincial program.

CQA® Validated Numbers Across The Country

B.C.	4
Alberta	172
Sask.	178
Manitoba	181
Ontario	1,911
Quebec	509
N.B.	10
N.S.	88
P.E.I.	18

Manure Processing Research Update

J.R. Morris,
Ridgetown College, University of Guelph, Ridgetown, Ontario, N0P 2C0 .

INTRODUCTION

Livestock production has been fingered as the culprit in causing pollution problems with water sources, producing offensive and unwanted odour problems and the over application of nutrients on the soil that could move into watercourses and supplies through the ground and off the surface. Water quality problems can also be implicated in reduced livestock production efficiency and mortalities. Farmers are under increasing pressure to develop sound nutrient management practices on the farm. A major component of this plan is having the land base for application. As nutrients such as phosphorus builds up in the soil farmers have to increase the land base to spread manure. The alternative is towards reductions in livestock production such as we have seen in the Netherlands (25%) would have serious consequences on Ontario's economy. A number of technologies are becoming more economically available to provide solutions for manure issues associated with livestock production.

THE TECHNOLOGY AND THE PROCESS

Several manure processing technologies have been and are being tested for application on livestock farms. These include the use of compounds to reduce odours, separation of solids and liquids, composting, anaerobic digestion, aerobic digestion and artificial wetlands. There appears to be strengths and weakness to these individual technologies in single use strategies. It appears that a combination of technologies will be required to address the issues of farm generated manure. In addition to digesting/separation of manure components, a water purification unit is used to clean the water so that this water can be reused in the industry or release into the environment without harm. This complex combination of technologies is labeled as an environmentally friendly manure processing system benefitting not only farmers but also society at large by providing a sound defense against the risks associated with liquid and unprocessed manure.

Manure Processing Objective

To develop/construct economically viable livestock manure processing system that will be effective and economically viable on most farms with the following capabilities:

I. remove close to 100% of offensive odours

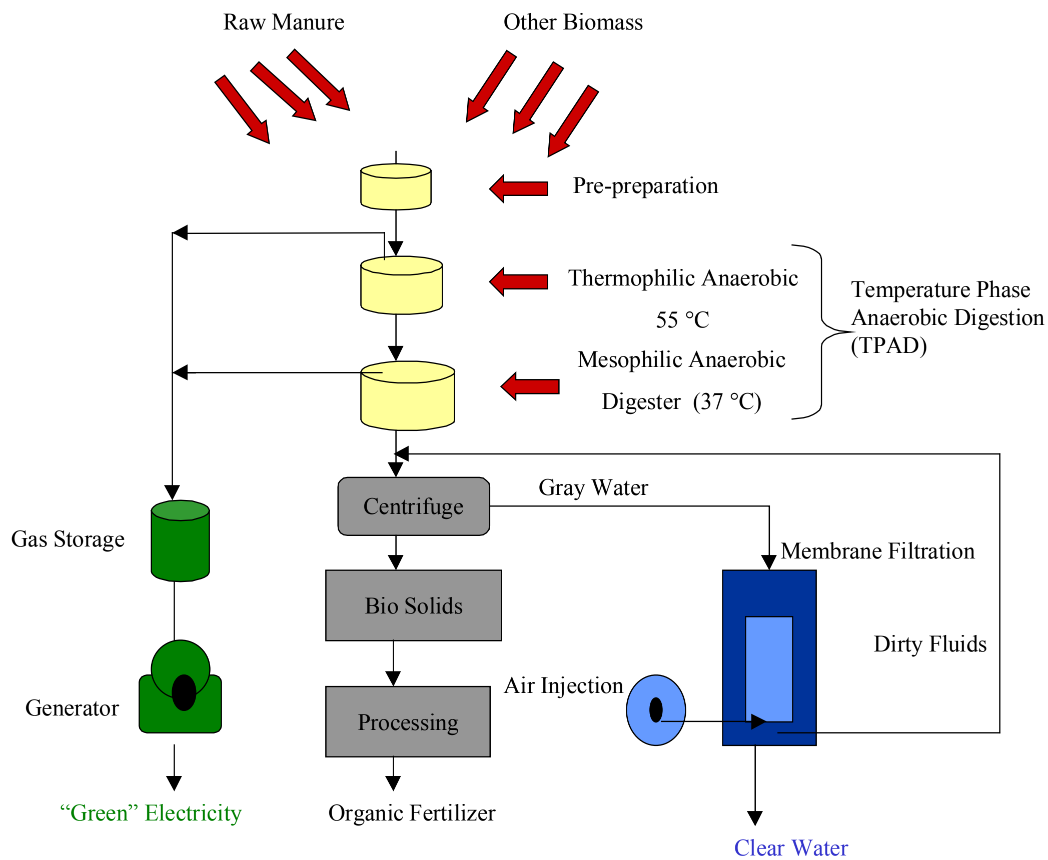
II. reduce emissions of total greenhouse gases

III. reduce water utilization on farms and improve water quality release from manure to comply with Canadian water quality standards

IV. to eliminate the presence of pathogenic bacteria in the organic gaseous and water outputs from the system

V. to produce an organic fertilizer that eliminates the need to spread liquid manure on the farm land

A Possible Schematic



Practical Benefits

A feasibility study conducted at Ridgetown College revealed that a manure processing facility can address the concerns associated with livestock manure. Such a process addresses the odour, nutrient instability, water quality and conservation and the greenhouse gas emissions of manure. Further work is underway to examine effective processes that are economically feasible.

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Advanced Manure Management Technologies for Ontario (AMMTO)

Franklin Kains, Ontario Pork Industry Council
(519) 742-4591 kains@golden.net

Background

For the past 10 years there has been an ever-increasing public concern for water and air quality in rural Ontario. The stories of pollution of the ground and surface waters by large swine farms in North Carolina, the intensification of our own livestock operations, and the Walkerton tragedy have all fuelled these concerns. There is a need to consider alternatives to the conventional practice of storing the raw manure for a period of time and later applying it untreated to the land.

However, the objective evaluation of such alternatives has proven to be something of a challenge. Cold Springs Farm started the search by inviting requests for proposals (RFP) to organizations that thought they could supply viable options to land spreading (e.g. methane digesters, composting, etc.). Their goal was to build a pilot project to test the most promising system but after receiving and reviewing over 20 proposals, it became evident that the criteria for making an objective selection was missing. In talking with others in the industry including OMAFRA, it was clear that others shared this frustration. Thus was born the Healthy Futures initiative known as the AMMTO project.

Objectives

The AMMTO project has 4 components:

1. ***To develop specific, measurable criteria*** for evaluating manure treatment technologies that allow for alternatives to direct land application based on these goals:
   - Improve or protect surface and ground water quality;
   - Eliminate or greatly reduce land base requirements for manure application directly adjacent to livestock production facilities;
   - Improve air quality by reducing offensive odours and green house gas emissions;
   - Capture the full marketable value of the manure in nutrient by-products and/or energy;
   - Ensure economic viability.
2. ***To invite technologies to be submitted for evaluation*** according to the specific, measurable criteria developed from Objective 1.
3. ***To develop a report outlining the required "Steps to Implement"*** (see below) for different technologies which rate highly in the evaluation process (Objective 2), and therefore show promise or have already been demonstrated to be viable elsewhere.
4. ***To initiate a pilot project(s)*** to demonstrate and assess one or more of the viable technologies in Ontario.
5. ***To monitor the pilot project(s) by an objective third party*** to verify whether a given technology and its implementation process can be used as a successful model for other projects in Ontario.

"Steps To Implement" Report

This report will compile the results of the evaluation and will clearly outline the necessary steps to implement a given technology in Ontario. This information base for decision-making will include assessment of:

- Volume and characteristics of manure required;
- Potential or requirement for co-mingling of by-products (e.g. food processing, municipal wastewater/ sewage treatment, rendering);
- Capital costs and operating costs;
- Impact on existing farm operations (landbase, building and manure storage requirements);
- Environmental concerns (effluent, emissions, contingency plans);
- Benefits or advantages (financial, societal, intangibles);
- Marketability of product or by-products;
- Legislative or regulatory stumbling blocks.

Any regulatory issues that need to be addressed that prevent a technology from being implemented will be clearly outlined. Technologies that are readily applicable today will be clearly identified. This report will be made available to the public via a web-based format, which will be accessible, searchable, updateable and highly useful.

There are several benefits to developing a "Steps to Implement" report instead of a typical database of technologies:

- The report would be useful to different groups who have varying manure management needs and scales of operation. For example, the steps to implement a simple static-pile composter or a complex methane digester could both be outlined so that an individual farmer, or a partnership of farmers with a municipality could all benefit from the report.
- The process and risks of moving forward with a technology or combination of technologies would be clearly outlined for stakeholders.
- The report would be structured so that as conditions change (energy costs, legislation, etc.), the viability of different technologies can be assessed on a continuing basis. The steps to follow to implement that technology would still be clearly outlined and useable (perhaps with limited modification).

Timelines

The funding was announced late in November. A project manager should be in place by late January. It is expected that the project will take 18 months to complete including the building and monitoring of a pilot project.

Stakeholders:

Healthy Futures for Ontario Agriculture (OMAFRA)
Ontario Pork Industry Council
Ontario Pork
Ontario Poultry Council
Cold Springs Farm
Selves Farms
Premium Pork

Funding

The projected budget is $317,150 with 70% coming from Healthy Futures and the balance from the other stakeholders. The funding does not include the construction of the pilot project (which is outside of the scope of Healthy Futures) and will be secured separately.

A Model of Returns to a Swine Finishing Operation

Jaydee Smith, OMAFRA, Ridgetown
Jim Morris, Ridgetown College, University of Guelph

Introduction and Objectives
The financial returns to a swine finishing operation are determined by the market price for hogs and replacement pigs (i.e. weaners), feed costs, carcass characteristics and grading grid, the growth rate and feed conversion of the growing pigs, among many other factors. Many of these variables have straightforward effects on returns and are easily calculated. Others have effects that are more difficult to calculate, and some may interact with other variables as well. While the value of a single carcass may be easily determined, calculating the potential annual returns to a finishing enterprise can be challenging. Cost of Production receives a lot of attention as a determinant of profitability; however, Returns are also a critical in determining profitability and, like Cost of Production, are influenced by management decisions.

Our objective was to develop a set of equations that would determine potential annual returns given values for the principal factors involved – these equations make up the OMAFRA/Ridgetown College Returns Model. A computer program was then developed in order to provide the means to easily adjust the model variables, automate the calculations, and provide a graphical display of the results. The aim of the software is to facilitate the use of the model as an educational tool and as an aid to decision making.

Development of the Model
The model was built up by starting with the target objective, potential annual Returns, and stating an equation for Returns. The factors that determined Returns were in turn defined by equations, which specified the factors that each of those factors depended upon. For example, Returns depends on returns per pig place, loss rate, and cycles per year (assuming all-in, all-out production). Next, cycles per year depends on how long it takes the pigs to grow to market weight, and the number of days the facility lies empty (open days). The growth period depends on the weight at which the pigs enter the building, the weight at which they leave, and their growth rate.

The process of determining the model variables, and their relationships, can be illustrated in a circular diagram where factors are successively broken down as one moves from the centre of the circle to the outside (Figure 1). The outermost variables in the diagram (e.g. grading grid values, market prices, and animal performance models) are the basic ones that the model requires as input. The effect of changes in these variables on potential returns can then be determined by calculating the equations that make up the model. Note that not all of the relationships in the equations are represented in Figure 1; for example, weaner cost will relate to entry weight, feed intake is related to growth rate, etc.

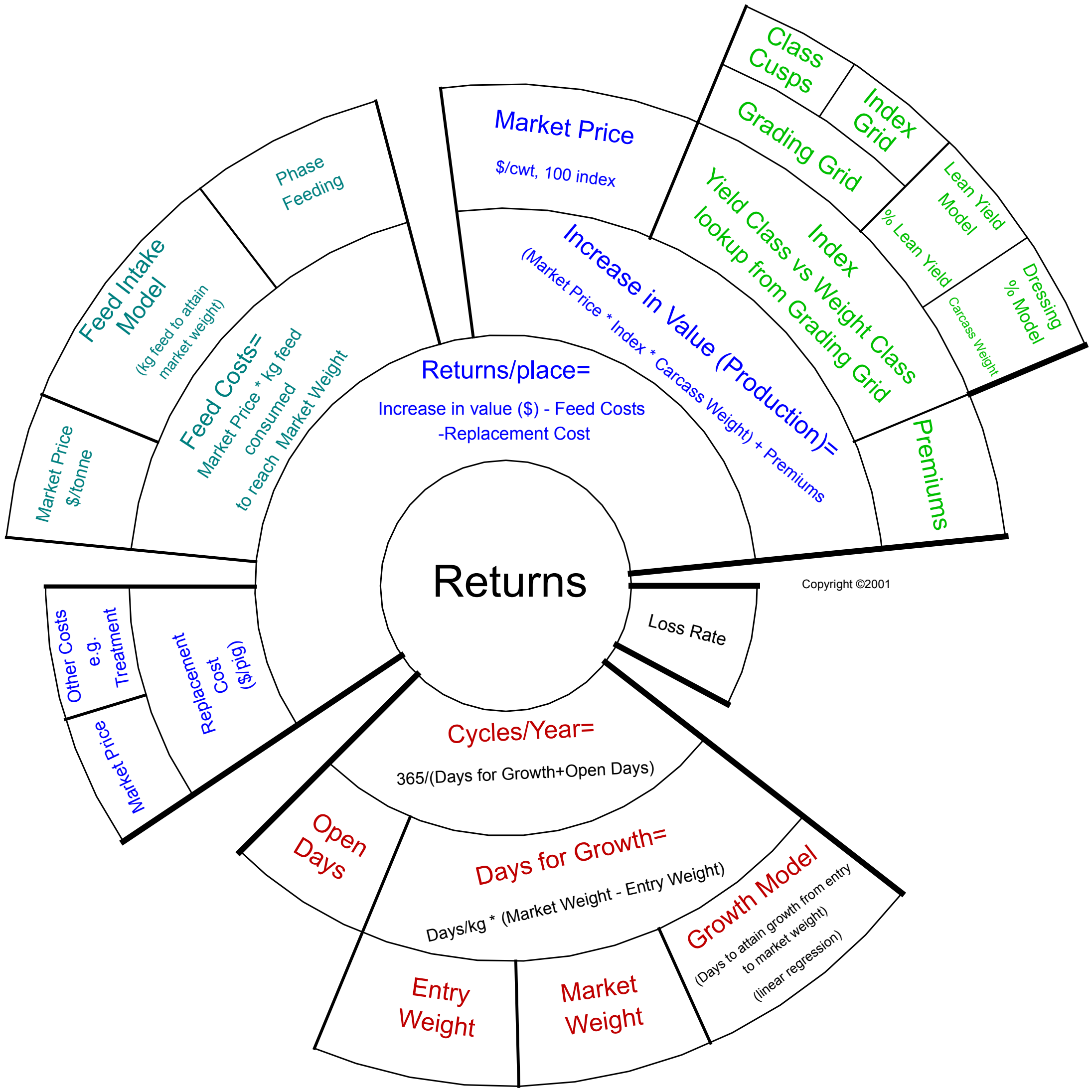

Figure 1. The principal factors in the OMAFRA/Ridgetown College Returns Model.

Application of the Model

A stand-alone computer application for the PC ("Finishing Sense") has been produced as a user interface to the model. In addition to basic variables (e.g. market prices), animal performance, carcass characteristics, and grading grids can be customised.

Changes made to the variables by a user initiates re-calculation of relevant parts of the model, producing a new value of potential returns per year over a range of possible market weights. The results are displayed graphically as changes are made. Most of the calculated factors in the model, such as feed costs, as well as other values such as kilograms of pork per tonne of feed, can also be plotted. This permits examination of the effects of changes as well as relationships between factors.

Inter-Row Application of Manure

By Chris Brown
Nutrient Management Field Crop Lead
OMAFRA, Woodstock

Rapid advancements in technology could well make inter row application of liquid hog manure into standing corn the best alternative from both an economic and environmental perspective.

Manure is a valuable resource especially when the nutrients are needed by the crop and are applied at a time when maximum utilization by the crop is possible. In theory, spring application of manure appears the ideal plan. However, time constraints and wet soils often mean planting delays sometimes combined with soil compaction. Manure applied at various opportunities during the year based on crop rotation, soil conditions, environmental precautions, work load and storage capacity is the better management practice, even though this can often mean compromising some of the nutrients – especially nitrogen.

Liquid hog manure is generally high in nitrogen, with about two-thirds of the nitrogen available quickly in the ammonium nitrogen form. Ammonium nitrogen converts to nitrate nitrogen – the same form applied to crops in commercial applications – in about two weeks during warm weather. Ammonium nitrogen in manure, if surface applied, volatilizes into the air easily. Dry, warm and bare soils are the worst scenario for volatilization. In these conditions over three-quarters of the ammonium nitrogen portion can be lost.

A corn crop has its greatest need for phosphorus during early corn growth and for nitrogen after the 6-leaf stage, usually mid June, until the end of tasseling. Applying manure at the same time that side-dressing of commercial nitrogen occurs would seem a good alternative from a utilization point of view, especially in soils where leaching of nitrogen below the root zone is a risk.

In recent years, there have been large advances in manure application technology. The biggest change has been a move toward low trajectory equipment and away from irrigation guns that distribute manure high into the air where manure drift and odour are issues. Application equipment that applies manure closer to the soil surface has resulted in less manure spills as well as reduced odour, dirty laundry, and runoff complaints.

Improvements have also been made in calibrating equipment so that application rate can be more easily determined. In some equipment the addition of flow metering devices and GPS (global positions technology) have helped this process. In addition to calibration, uniformity of manure spread pattern is also being improved. The goal is to have manure spread pattern more closely resemble spray application. From a surface application perspective, this may mean looking at the splash plate and determining if the application across the entire width of spread is uniform, or if the splash plate is set too close or too far causing uneven distribution of manure. Some application equipment has been set up with tool bars equipped with splash plates set at even intervals – in some cases to coincide with corn row spacing. With the tool bar systems as well as injection systems, more powerful distributor systems are being employed. These chop manure solids or other debris that may have found its way into the storage and have helped prevent plug-ups and improve uniformity.

With injection equipment the advantage has always been in reduced odour and immediate incorporation. However, the concern over manure movement to tiles where macropores have not been disturbed in front of the injection tooth, or where manure is applied in a concentrated band as opposed to uniform distribution across the entire soil profile, remain issues to be resolved. Advancement in equipment has made macropore movement less of an issue, however the style of tooth based on soil texture and condition will have a large impact on how well manure is distributed across the soil profile.

In a study done by Agriculture and Agri-Food Canada (AAFC - Delhi), application equipment was compared on sandy soils and heavier clay loam soils to examine the results in distribution from various "tooth" styles. The results were significant. A pink dye was added to water. Distribution patterns were observed after the equipment had applied the "manure". The best performance was measured where the pink dye was most evenly distributed across the soil profile. Worst performance was measured when there was a concentrated band of "pink" and/or where the pink dye followed an old root or earthworm channel. Equipment that performed best in sandy soil textures were not the best for heavier clay loam soils.

In a related AAFC study (partially funded by Ontario Pork), various application rates and methods of application using liquid hog manure were tested. The manure was applied to a clay loam soil using inter-row application techniques into standing corn at side-dress time (mid June). Equipment consisted of a six-row injection unit (supplied by Nuhn Industries) with in-tank mixing and electronic flow control (supplied by Green Lea Ag centre) and Kongskilde vibrashank teeth. Both surface applied and injected manure was compared to a control with no manure. Corn yields were measured as well as impact to surface water (via tile drains). Preliminary results indicate that broadcast side-dressing results in lower and more variable yields (especially in a dry summer), compared to injection, particularly when corn is small. As well, lower rates of more concentrated manure have less potential to move to tiles than higher rates of manure with higher water content.

Observations with inter-row application into standing crops suggest that driving straight is essential so that corn population is not negatively impacted. Inter-row application into narrow rows is virtually impossible. In addition, knowing the length of the field so that one tanker load will get from one end of the field to the other is important from a time efficiency, tracking and compaction standpoint. In some cases application rates may be reduced and commercial fertilizer could be applied at planting to compensate for adjustments to application rate.

There are still some details "to iron out" with inter-row manure application into standing corn. The benefits from a timing of manure to crop needs along with a reduced potential for environmental nitrogen loss viewpoint make this technology one that will continue to be explored and improved. The potential benefits are important for hog producers with liquid manure.