



Proceedings of the London Swine Conference - *Tools of the Trade* 1-2 April 2009

Proceedings

of the



9th LONDON SWINE CONFERENCE

Tools of the Trade

April 1-2, 2009

London, Ontario

www.londonswineconference.ca



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of the
LONDON SWINE CONFERENCE

Tools of the Trade

Edited by
J.M. Murphy

April 1st and 2nd, 2009
London, Ontario
www.londonswineconference.ca

Proceedings of the London Swine Conference
Tools of the Trade

A limited number of additional copies of these Proceedings are available for \$25 each.

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ISBN 978-0-9688770-8-1

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CHAIR'S MESSAGE

Welcome to the 9th London Swine Conference!

The theme of the 2009 London Swine Conference is “Tools of the Trade”. This theme reflects the program’s focus on the fundamentals that must be done right in order to be competitive and profitable in a challenging industry in challenging times.

The presentations and workshops the Technical Committee has put together this year are intended to be relevant to decision makers, production managers and stockpersons. Consider bringing your employees along as part of their training and development program – a great investment in your personnel.

The program has an emphasis on practical pork production, from managing highly prolific sows and nursery management to grow-finisher efficiency to new market opportunities and health issues. Efficient production requires constant attention to details, and the workshops at the conference will provide insights on how to achieve this goal. The bigger picture is considered too, in a session titled “Looking Ahead”, with talks on a Vision for Canadian Pork Production and on Pork Production versus Consumer Demands. With our line-up of speakers and topics, the stage is well set for another successful conference in 2009.

The London Swine Conference was conceived nine years ago as an initiative of staff at the Ontario Ministry of Agriculture, Food and Rural Affairs, the University of Guelph, and Ontario Pork. This year we began a new partnership with the Ontario Pork Industry Council, broadening further our foundation in the pork industry. Since the beginning the objectives of the conference have been “to provide a platform to accelerate the implementation of new technologies in commercial pork production in Ontario, and to facilitate the exchange of ideas within the swine industry”. Through the efforts of our founding partners, our industry sponsors, and the enthusiasm of participants, this conference has become a principal event in the Canadian pork industry.

I look forward to seeing you there.

Enjoy the conference!

Jaydee Smith
Chair, Steering Committee
2009 London Swine Conference

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SOW AND WEANER PIG MANAGEMENT

MANAGING HIGHLY PROLIFIC SOWS

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ABSTRACT

Hyperprolific sows are the main characteristic of French swine breeding herds and has been/is always the object of research and reflection, as well as the object of criticism and controversy (these extreme and opposing positions are voiced even within one country such as France). That the debate is controversial forces us to question ourselves. One way to refrain from doing so would be to reject the question of hyperprolificacy, claiming that it is not part of one's culture and practices. In the face of such criticisms, the best we can do is to attempt to analyze them. In other words, we do not wish to take a stance in the controversy itself; we do not present ourselves as the defender of hyperprolificacy. Instead, in this presentation, we wish to look at the terms of the debate and question them. This is what we see: in France and in Denmark, hyperprolificacy is an issue that must be managed on a daily basis. And this issue will spread to all the pig producing countries. Management of hyperprolific sows is specific. To summarize, we can say that, for each individual management measure, there are always two opposite aspects, like in the "*Strange Case of Dr. Jekyll and Mr. Hyde*". We have the expected 'good' one (Dr. Jekyll) but also the 'bad' unexpected 'side effects' (Mr. Hyde). French producers had to learn 'hyperprolific sows' and ... they learned.

INTRODUCTION: HOW TO ANSWER THE QUESTIONS?

The Organizing Committee asked two questions:

- How should we manage the modern highly prolific sow?
- Have we put too much emphasis on maximizing litter size and compromised piglet viability?

The Country Effect and Hyperprolificacy

What is a 'country effect'? It is 'only' a particular feature pertaining to a given country rooted in a specific cultural environment and leading to numerous consequences. In pig production, it may have to do with herd management, with utilization of some diagnostic tools or even with the conviction that some choices are linked to health problems. All 'country effect' features lead to or should be of concern. Undoubtedly, these features certainly have positive components; however they are also a source of constraint or may sometimes generate negative consequences.

The 'country effect' should be of interest for producers and vets from abroad who only see the consequences and are not aware of the underlying causes (the 'roots').

At the 2008 Banff Seminar, our French colleague and good friend Sylviane Boulot gave a talk on the management of high prolificacy in French herds with this question: Can we alleviate side effects on piglet survival? Her first recommendation regarding specific strategies to be implemented at the farm level is 'farrowing induction' (Boulot et al., 2008). Induction of farrowing with prostaglandins is a typical aspect of what I call 'the country effect' (Martineau, 2008).

Nonetheless, whether you are for or against induction of farrowing (and you have valid reasons for either), you should know that in most Northern European countries, the use of prostaglandins is prohibited. The case of Denmark is particularly interesting given that its productivity is one of the best in the world. There is no doubt that Denmark is often cited as a model.

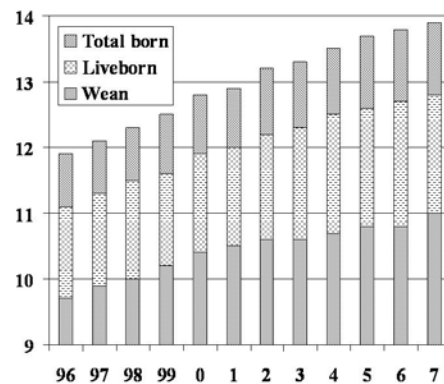
French producers are very large users of prostaglandins in sows, used for inducing farrowing as well as for the control of postpartum vulvar discharge, by injection of PGF₂ α 36-48 hrs after farrowing. The first rationale for using prostaglandins is to avoid farrowing during the weekend. In France, it is culturally difficult to work or to request employees to work during weekends. The second rationale is to be present during the farrowing process. By contrast, and with the same level of productivity, Danish producers do not use prostaglandins because it is forbidden by law. How do they manage to have such a high level of productivity? How difficult is it?

We are culturally accustomed to using prostaglandins and, more importantly, we do not have serious doubts regarding their relevance. However, some companies are now re-evaluating their recommendation to use prostaglandins after analyzing everything, on the economical point of view, on which it may have an impact. From the Danish perspective, farrowing performances are obtained without the use of prostaglandins or any other means linked with hormonal products. Shouldn't we ask ourselves the question: are prostaglandins a necessity? Once again, there are many advantages -- the objective of induced farrowing is to allow increased supervision of piglet delivery to improve neonatal survival, minimizing holiday and weekend work, and facilitating cross-fostering. Inducing parturition also allows batch farrowing to be used to reduce the variation in piglet age which has been widely documented in all textbooks. At the same time, the disadvantages - immature piglets and body-weight disadvantage at weaning - are also cited and are also very well-known. Some of the risks associated with early farrowing have been recently discussed by Gunvaldsen et al. (2007). Notwithstanding, there are ways to do a very good job even without these products.

Strategic and Tactical Management Measures

The word *strategy* is often confused with tactics. In modern usage, strategy and tactics might refer not only to warfare, but to a variety of business practices, including the pig business. There is no doubt that the 2000 (r)evolution of the sow herd is the strategy of hyperprolificacy which is characteristic of the majority of the genetic lines widely used in France (Figure 1).

Figure 1. Evolution of the prolificacy in France (GTTT: ~2,800 herds, ~1,000,000 litters). Since 1996, there has been an increase of 0.2 total born piglet /year, the same evolution between 1996-2003 and 2003-2007.



In 2006, mean live born of the top third French herds is above 13 live born piglets/litter (Table 1). As the standard deviation is around 3, that means that 2/3 of the litters have between 10 and 16 live born piglets but also that 15% of the litters have over 16 total born piglets.

Table 1. Evolution of the productivity in a 240 sow-herd in the South of France. (Charrier, personal communication, 2007)

	2004	2005	2006
Weaners/Productive Sow/Year	29.84	30.16	30.57
Total born /litter	14.90	15.26	15.32
Born alive / litter	13.60	13.92	14.05
Stillborn / litter	1.30	1.34	1.27
Weaners/litter	12.23	12.31	12.43
% Prewaning mortality on total born	17.91	19.33	18.86
% Prewaning mortality on born alive	10.07	11.56	11.53
Farrowing rate (%)	91.2	92.3	90.6
Interval Weaning-Conception (days)	5.8	5.5	6.2

Essentially, **strategy** is the thinking aspect of planning a change, organizing something, or planning a war. Strategy lays out the goals that need to be accomplished and the ideas for achieving those goals. Strategy can be complex multi-layered plans for accomplishing objectives and may give consideration to tactics.

Relative to our subject, an example of a relatively new global strategy for the sow herd is the batch farrowing management system mainly adopted for farrowing sows and piglet management, which is the topic of this presentation.

Tactics are the meat and bread of the strategy. They are the “doing” aspect that follows the planning. **Tactics** refer specifically to action. In the strategy phase of a plan, the thinkers decide how to achieve their goals. In other words they think about how people will act, i.e. tactics. They decide on what tactics will be employed to fulfill the strategy.

The tactics themselves are the things that get the job done. Strategies can comprise numerous tactics, with many people involved in attempting to reach an overall goal. While strategy tends to involve the higher-ups of an organization, tactics tend to involve all members of the organization, including pig workers.

Relative to our subject, there are many tactical management measures taking into account the new characteristics of the hyperprolific sow as well as for the supernumerary piglets (cross-fostering), each of them with advantages but also disadvantages and many constraints.

CHARACTERISTICS OF HIGHLY PROLIFIC HERDS

Besides general data, it is important to give an example of what is meant by the term “hyperprolific” with respect to commercial family farms in France (Table 1).

As reported in Table 2, French herd size is small compared to North America (and, in Europe, Denmark and Spain). The first consequence is that such herds are mainly part of a family farm with only one or two employees.

Table 2. Sow performance in France (from the French National Analysis of sow herd, Royer, 2008).

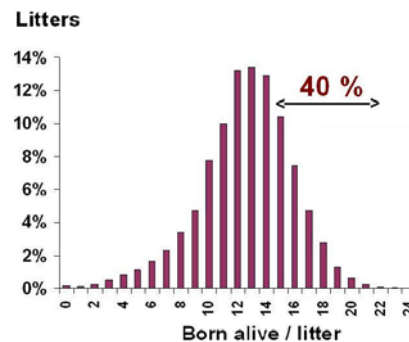
From 01/01/07 to 30/06/07	All herds Mean ($\pm SE$)	First 33% Mean ($\pm SE$)
Number of herds	1915	631
Number of sows/herd	180 (160)	250 (210)
Born alive/Litter	12.8 (0.9)	13.2 (0.6)
Stillborn/Litter	1.1 (0.4)	1.0 (0.3)
Weaned/Sow	11.0 (0.8)	11.6 (0.5)

CHARACTERISTICS OF HIGHLY PROLIFIC SOWS

Beside the positive aspects (increasing of the numeric productivity), we have to take into account the lactating capacities of the hyperprolific sow, the variability of the piglet’s weight at birth and also some deviations of the management regarding cross-fostering.

Concerning the number of mammary glands, 40% of litters are over 14 born alive and exceed “normal” teat number (Figure 2).

Figure 2. Distribution of 1,162,886 litters born in 2005 according to number of born alive (Boulot, 2008, IFIP-GTTT France, personal communication). 40% of the litters have live born piglets exceeding 14 teats.



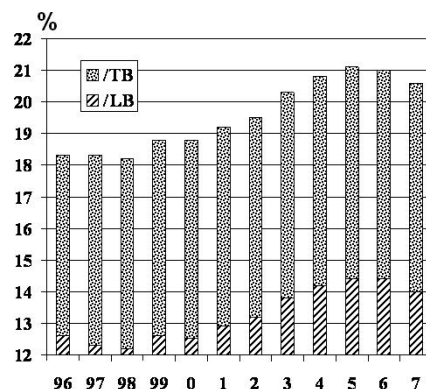
This observation explains why there is an active selection on number of teats (Table 3). Before this increasing capacity of sows (number of teats) will arrive at the production level, producers have to find solutions for these supernumerary piglets to survive.

Table 3. Evolution between 2002 and 2007 of the % of purebred French sows with 16 functional teats (Boulot, 2008, personal communication).

	Year 2002	Year 2007
Large White (LC 110)	9.6%	29.9%
French Landrace (LC 330)	11.8%	34.4%

Beside the evolution of the prolificacy in France (Figure 1), there is also an evolution of preweaning losses (on total born as well as on live born piglets) as reported in Figure 3 which is at the center of a polemic.

Figure 3. Evolution of preweaning losses French (GTTT: ~2,800 herds, ~1,000,000 litters). Producers had to learn “hyperprolific sows” and they learned according to the recent decrease of preweaning losses on live born piglets.



Furthermore, the higher number of weaned piglets results in overcrowding in nurseries and finishing rooms, due to the inadequacy between batch size and room capacity. This is because most facilities were designed a few years ago when litter sizes were smaller than currently. Consequently producers have to modify their tactical routine management measures in order to face these overcrowding issues. However, producers always wish to make their herds as profitable as possible and they are aware of the importance of having full batches on profitability and so a compromise needs to be worked out.

Strict observation of all-in, all-out means keeping batches of pigs together from weaning to slaughter. However due to the heterogeneous growth of pigs, it is difficult to stick fully to this principle and producers frequently move poor doing pigs between batches. There are many consequences of such a situation, mainly regarding the dynamics of infection such as PRRS.

For our topic, the major fact is the effect of litter size on the birth weight distribution (Figure 4A) and the importance of small piglets of less of 1 kg BW at birth (Figure 4B). In Figure 4A, we have to mention that there are always >1.8 kg BW piglets even if there are >15 piglets/litter. However, the percentage of piglets <1kg increases when litter size increases (Figure 4B).

For an increased number of total born piglets by 25%, there is an increase of 16% in the weight of the litter. Therefore, it is a mathematical certainty that there is an increased number of small piglets.

Figure 4A. Effect of litter size on the birth weight distribution.

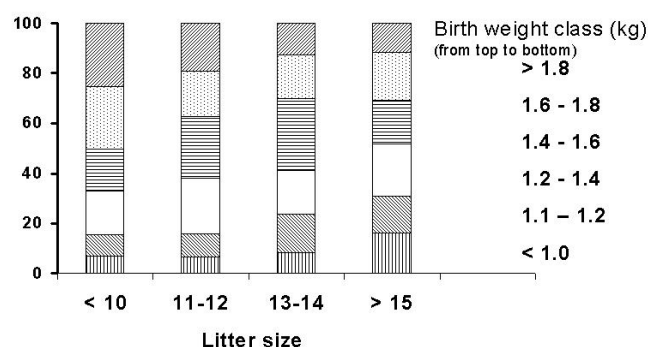
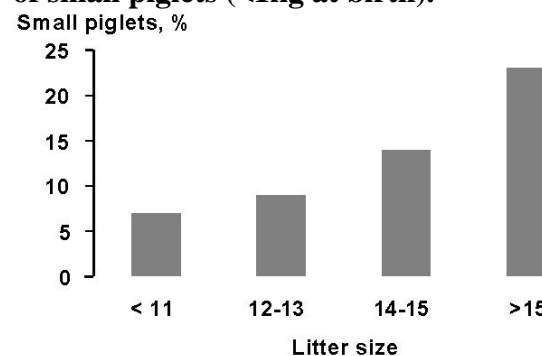


Figure 4B. Effect of litter size on the % of small piglets (<1kg at birth).



As illustrated in Figure 4B, around 20 to 25% of piglets are under 1 kg BW in large litters. There are a lot of questions regarding the evolution of lightweight piglets during growth until market weight but this is beyond the scope of our objective. There is a strong influence of weaning weight on age at slaughter: weaned piglets of 4-4.5 kg BW at 4 weeks reach market weight 28 days after piglets of 10-10.5 kg (Le Treut, personal communication, 2008). However, there are always light piglets in “conventional” (or standard) litters (Table 4).

Table 4. Distribution of piglets according to birthweight classes and litter size (observations from Experimental swine Station of Romillé from the French Swine Institute (Gourmelen and Le Moan, 2004) (data from 14,000 litters).

Distribution by classes of weight and litter size	Birth weight (kg)					
	<1.0	1.0-1.2	1.2-1.4	1.4-1.6	1.6-1.8	1.8-2
Total born						
Standard: 13	14.2	13.7	21.6	24.7	15.9	9.9
Hyper : 15	22.0	18.9	22.4	19.9	11.7	5.1
Live born						
Standard: 12	10.1	12.1	19.8	20.6	21.6	15.8
Hyper : 14	12.8	17.2	22.6	22.6	15.5	9.2

After farrowing, pre-weaning deaths (<10-12%) occur within the first 72h post-partum. Piglet birth weight is an important survival factor but we have to modulate it. Indeed, the weight alone is not enough to explain mortality even if it is well known that piglets under 0.8 kg BW are at greater risk of dying than heavier litter mates. Besides weight, we have to take into account maturity and vitality. There are a lot of field investigations regarding immaturity, defined by Foxcroft et al. (2006) as “Intrauterine Growth Retardation” (IUGR). Birthweight is not enough to describe immaturity. We have to add vitality, well described by Herpin et al. (1997), and evaluated by Baxter et al. (2008).

With respect to stillborn mortality, piglet shape and size (birth weight/(crown-rump length)³), body mass index (birth weight/(crown-rump length)²), and farrowing birth order are better indicators. For live-born mortality, postnatal survival factors identified as crucial are birth weight, vigour independent of birth weight, and the latency to first suckle (Baxter et al., 2008).

MANAGING HYPERPROLIFIC SOWS

Feeding Management for Hyperprolific Sows

There are a lot of feeding strategies for feeding gestating as well as lactating modern sows (Bussiere et al., 2008; Vignola, 2009) and I have no authority to give comments and/or criticisms.

For me, with regard to nutrition, two major observations characterize the hyperprolific sow, the lack of early embryonic death with overfeeding after ovulation and, the positive influence of overfeeding during the last weeks of pregnancy.

There is also another characteristic of the modern sow, the lean growth potential and its importance regarding reproduction. It has been well summarized by Foxcroft et al. (2005): *Accepting the risk of being considered somewhat heretical, most of our recent experiments with the lactating and weaned sow lead to the conclusion “that from a fertility and prolificacy perspective, fatness is simply not the key risk factor”*. It is why lean tissue mass is of major importance.

In the past, it was generally accepted that increasing dietary intake after ovulation may increase embryo mortality in gilts, related to a variation in the metabolic clearance rate of progesterone. However, analysis of the literature reported by Prunier et al. (1999) gives variable results. In favour: Dyck et al., 1980; Jindal et al., 1996, absence of effect: Dyck, 1991; Dyck et al., 1995; Pharazyn et al., 1991), and the most recent papers are in favour of the absence of effect (Prunier et al., 1999).

The influence of feed allowance during the last 14 days of gestation on farrowing progress and lactating performance has been studied in France in hyperprolific sows by Nathalie Quiniou (2005). In controlled experiments, the highest feed allowance seemed to make farrowing easier and improved neonatal vitality. However, this improved vitality was limited to the neonatal period.

Batch Farrowing

Batch farrowing is an old story in France (early '70s). It is a management system focused on sow production activities. All sows within the group are at the same stage of production: *theoretically* breeding within three days, *theoretically* farrowing within three days, and weaning on the same day. Some of the resulting benefits of adopting interval batch schemes are in two different fields: zootechnical performances (uniform age and weight at weaning, consistent sow nutrition and phase feeding management, more effective use of all-in, all-out systems) and health performance (disease control, herd stability). There is no doubt that the recent adoption of batch farrowing in North America is linked with disease control, mainly PRRS as well as PCVAD.

The selection of a batching interval is chosen according to the barn objective as well as herd management (such as in France, the employees' management mainly regarding vacations).

Currently, the most common system in France is the 3-week cycle but decreasing (Figure 5). This 3-week batch farrowing has been implemented in France for 30 years (late '70s) in very small herds to have enough sows at farrowing to give a revenue for the producer.

There is a clear effect of the herd size on the chosen batch system adopted by the producer (Table 5).

Do we have an impact of the batch farrowing system on performance? A recent study (2007) has been performed in >1,000 commercial herds in Brittany. Results on preweaning performances are reported in Table 6 (Pellois and Badouard, 2009).

The effect of batch farrowing on reproduction has been also evaluated by Larour, 2008 (Table 7). It can be concluded that performance is related to herd size and age at weaning but the impact of batch farrowing is weak.

Figure 5. Evolution of batch farrowing systems in Brittany from 2000 to 2007 (Pellois and Badouard, 2009). The 3-week batch farrowing system is still the most common but is decreasing in popularity while new batch farrowing systems (4 and 5 batches) are on the rise.

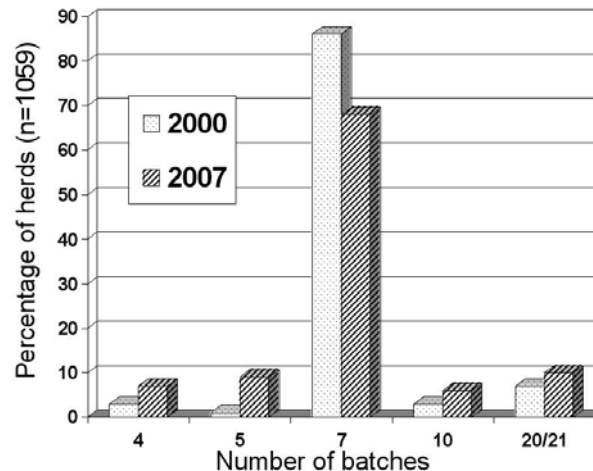


Table 5. Distribution of herds in Brittany (2007) according to the batch farrowing used (Pellois and Badouard, 2009)

# batches	4	5	7	10	20	21
Age at weaning (d)	21	28	21	28	21	28
# herds	60	16	99	90	632	49
% of herds	5.7	1.5	9.3	8.5	59.7	4.6
# sow (inventory)	155	141	222	220	176	344

Table 6. Prolificacy and preweaning performances according to the batch farrowing system used (Pellois and Badouard, 2009).

# batches	4	5	7	10	20
Age (planned) at weaning	21	21	21	28	21
# herds	60	99	90	632	49
# sow (inventory)	155	222	220	176	344
# weaned piglets/productive sow/year	27.8	27.7	27.6	26.4	29.0
# live born piglets	12.8	12.7	12.8	12.8	12.9
# weaned piglets/litter	11.1	11.1	11.0	11.0	11.4
Prewaning mortality (on live born)	13.4	13.1	13.7	14.5	11.6
Age (reality) at weaning	20.8	20.8	21.3	27.3	20.6

Table 7. Reproduction performance according to the batch farrowing system used (Pellois and Badouard, 2009)

# batches	4	5	7	10	20	
Age (planned) at weaning	21	21	21	28	21	21
Interval weaning-1 st mating	6.5	6.5	6.4	6.5	6.1	6.0
Farrowing rate on 1 st mating	90.7	88.2	88.3	87.8	91.5	90.6
Interval weaning and successful mating (d)	9.4	9.6	9.3	9.5	8.1	8.0
Average replacement rate	42.0	40.4	41.8	39.7	39.8	43.1
# litters / culled sows	5.3	5.3	5.3	5.2	5.6	5.4
Interval last weaning-culling (d)	48.2	42.8	41.6	44.1	36.9	34.3

In France, the implementation of this 3-week batch farrowing is in great part linked with the usage of Altrenogest (Regumate® in Europe, Matrix® in North America) to synchronise gilts for breeding. The only physiological parameter that is necessary for its use is that the gilts must be cycling. Although evident and not directly in relation of this presentation, we have to recognize that we have less and less boars in sow herds, a consequence of the general use of AI.

Average replacement rate seems lower in France compared to data presented by Peet (2008) for Canada, USA and UK.

In North America, the majority of batch farrowing systems have adopted the 4-week batch farrowing (in herds of medium size, from 400 to 800 sows) and the 2-week batch farrowing (in herds over 1,000 sows).

Although batch farrowing *theoretically* allows grouped farrowings, we have to take into account the natural variation of the distribution of farrowing in a given batch (Figure 6). Although in batch farrowing systems and with a same day of weaning, there is a “normal” variation according to the day of breeding and the duration of gestation.

Figure 6 demonstrates the difficulty of cross fostering on Day 1 of this week: only one sow farrowed, with 16 live born piglets. It is why producers have to use other management measures such as “split nursing” (Donovan and Dritz, 2000).

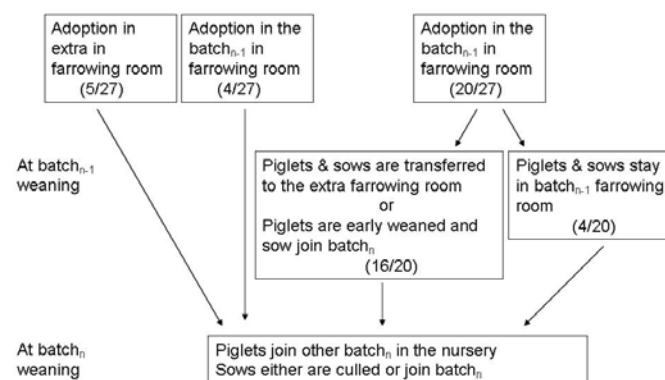
The major consequence of hyperprolificacy is cross-fostering. Although rules have existed for a long time (The “10 principles” developed by Peter English, 1993; Beymon, 1997) and application for piglets of low birth weight management are also well described (Deen and Bilkei, 2004), it is not so easy with hyperprolific sows. In other words, the strategy is well known but tactics vary from herd to herd. In herds with hyperprolificacy, the % of cross-fostered piglets is higher than commonly seen in “normal-prolific” sow herds (Straw et al., 1998).

In a recent survey in 47 herds in France, Hébert (2006) showed that piglets are fostered by a sow from the previous batch whose piglets were early weaned in 27 out of the 47 investigated herds. In this survey, there are different methods of cross fostering (Figure 7).

Figure 6. Distribution of farrowing in one batch of 17 sows in a 120 sow herd in a 3-week batch farrowing system with hyperprolific sows (born alive for each sow is indicated). In this herd, prostaglandin (PGF2 α) is used only on the Thursday to obtain last farrowings on the Friday (but not during the weekend). However, in this batch, 3 sows farrowed on the weekend). (Gin, 2008, data not published).

Sow	Mo	Tu	We	Th	Fr	Sa	Su
1	16						
2		20					
3		14					
4			18				
5				8			
6				14			
7				16			
8					19		
9					24		
10					16		
11					19		
12					16		
13					15		
14					14		
15						16	
16						15	
17							12

Figure 7. Example of different modalities of fostering in 27 herds resulted in a high number of tactical management decisions with variable consequences on within-herd animal movements. This Figure illustrates the different tactics concerning one strategy.



Another recent survey in 34 French herds has been reported (2008) comparing the coherence (between the theory and the practice) of a batch farrowing system and housing, true segregation between different ages and disinfection (Table 8).

A data base of 300 farms using computerized records has been used to examine the extent and timing of cross-fostering being practiced in commercial herds in the Midwestern US and Canada in the mid '90s (Straw et al., 1998). Authors concluded that farms under use cross-fostering as a

management technique. It was in agreement with English et al. (1977) that “few stockpersons exploit it [cross-fostering] as fully as they might usefully do”. However, in France, we are often in a situation of ‘over usage’ of cross-fostering. An example of ‘over-cross-fostering syndrome’ in a commercial French herd is shown in Figure 8. All piglets have been identified at birth. At 6 days of age, each litter has again been checked.

Table 8. Housing coherence according to the batch farrowing used (n=34 herds in Brittany) (Larour, 2008).

# batches	4	5	7	10	20	Total
Very coherent (100%)	3	3	6	4	6	22/34
Deficient (>95%)	0	3	3	0	0	6/34
Unsatisfactory (<95%)	2	1	1	1	1	6/34

Figure 8. Observational ‘over-cross-fostering syndrome’ (Too Well Done Job Syndrome) in a herd. At 6 days of age, sow #635 has only 2 of her 13 live born original piglets. On the opposite, sow #638 has all her native ones. Therefore, there are huge variations, mainly according to the day of farrowing (Gin, 2008, data not published).

	Liveborn	PIGLETS' ORIGIN												
		571	636	635	637	638	589	536	523	620	499	573	619	618
L A C T A T I N G	571	17	11	2	1									
	636	15	11								2			
	635	13	1	1	2	1	1	4			1	3		
	637	14		1	3	4					2			
	638	13				12								
	589	16			1		10				3			
	536	17			2	1		6				5		
	523	10						5	8					
	620	12	2							12				
	499	17				5	2		1		6			
S O W	573	22			2	2					1	7		
	619	9	3								2	6	2	
	618	12										3	10	

What may be the consequences? This ‘over- cross-fostering syndrome’ leads to too many manipulations. Even if all these stockmen are well informed of the importance of colostrum, there is some ‘drift’.

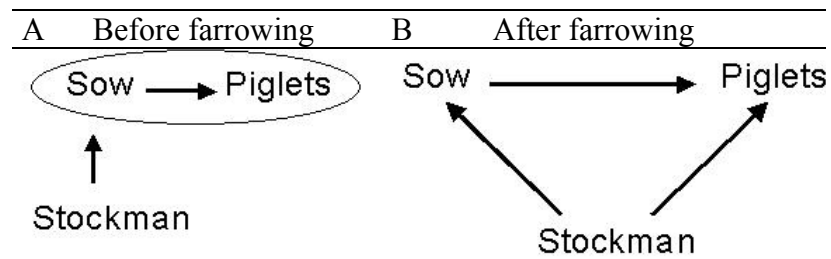
As a prelude, there is no true ‘big’ mistake in these sow herds: there are globally good sow and piglet management. However, some measures implemented for apparently good reasons lead to bad results by a counter-intuitive behaviour. These measures lead to more severe problems. To summarize, we can say that, for each individual measure, there are two opposite aspects, like in the “*Strange Case of Dr. Jekyll and Mr. Hyde*”. We have the expected ‘good’ one (Dr. Jekyll) one but also the ‘bad’ unexpected ‘side effects’ (Mr. Hyde).

Induction of Farrowing

There are two phases in the sow and piglets management around farrowing: before (Figure 9A), during and after (Figure 9B) farrowing. Indeed, some tactical management before farrowing (Figure 9A) may have consequences on the piglets’ performance. After farrowing (Figure 9B),

interaction is much more complex as management rules may be directed to the sow or to the piglets with direct consequences between the sow and their litter as well.

Figure 9. Management according to day of farrowing: before farrowing (left A), sow management has indirect consequences on piglets. After farrowing (right B), management is oriented primarily on the piglets.



Before farrowing, and just to illustrate this duality, the use of a classical management measure: induction of farrowing. Nobody contests the fact that there are many advantages to such a program. However, there are also ‘negative side effects’ as reported in a recent experiment (Gunvaldsen et al., 2007). In this study, average gestation length in non-induced and induced sows was 117.0 and 115.1 days, respectively. Beside the effect on growth (for every day of gestation, piglet growth rate increased 26 g per day; therefore, body weights of pigs from induced litters were 576 grams lighter at 16 days of age), there is a risk of higher mortality. The relative risk of morbidity was 2.0 times higher in piglets of induced sows. Therefore, there was a tendency towards higher mortality during lactation in piglets of induced sows and this is why they concluded that an understanding of the objectives of a farrowing induction program and the average gestation length of specific sow subpopulations in herds to avoid production loss associated with premature farrowings was extremely important.

Concerning the gestation length, there is conflicting observations. For many French swine specialists, there is a decrease of gestation length with increasing of litter size. However, results from Spain do not support it (Figure 10). Pedersen and Jensen (2008) reported that gestation length in primiparous sows is shorter than multiparous sows. However, we don’t know if it is a parity effect or a litter size effect because litter size of primiparous sows is lower.

In a recent observational study (Gin et al., 2008), we measured IgG content in colostrum samples from sows and blood samples from 6-day old piglets. There is a strong association between gestation length and IgG concentration in sows as well as in piglets (Figure 11).

Concerning induction of farrowing, one colleague from Quebec asked us the question: “If we cut one day in gestation, will this result in an added day in finishing?” We do not have the answer.

... What About After Weaning ...

Although out of the scope of this presentation, we mention the evolution of losses in post-weaning as well as in fattening period (Figure 12).

Figure 10. Gestation length according to litter size at farrowing (4,709 farrowings). D0 of calculation is the day of the first AI (Martinez, Cefusa, Spain, 2008, personal communication). In this sample, more than 56% of the sows have a gestation length of 116 or 117 days

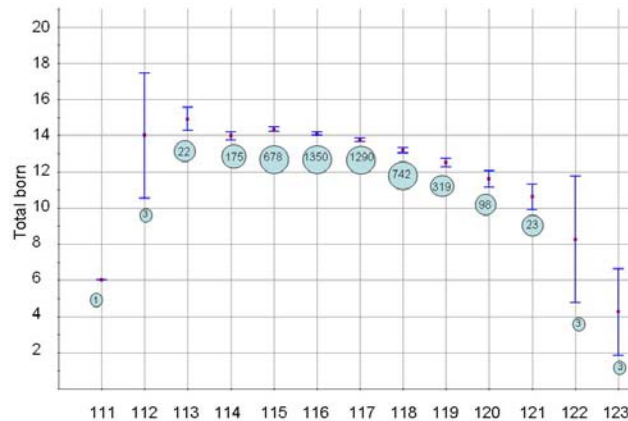
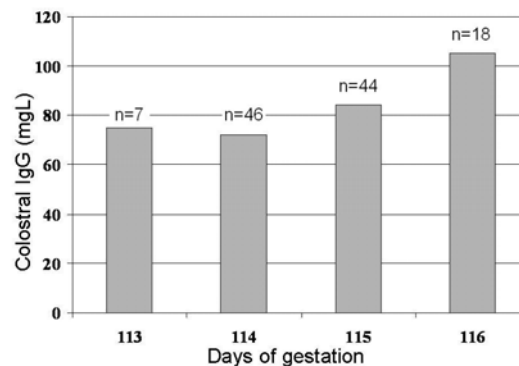


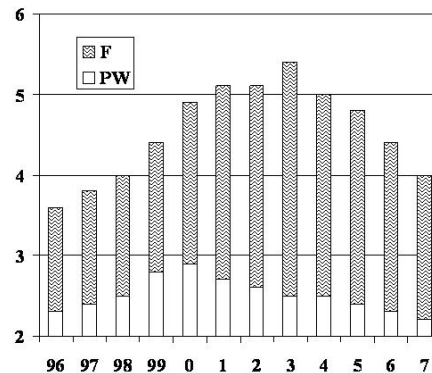
Figure 11. Relationship between gestation length and IgG concentration (mg/L) in colostrum from sows from parities in 10 herds (Gin et al., 2008, data not published).



... What About Economic Impact ...

Before we conclude, there is no doubt that there is an economic advantage with hyperprolificacy for pig producers. In 2007, the difference of gross margin on feed cost and replacement is 54 €/inventory sow/year. The economical impact of hyperprolificacy has been studied by Gourmelen and Le Moan (2004). Different scenarios of herd management were compared to an initial situation corresponding to standard (non-hyperprolific) sows. New accommodation investment costs concerning early weaning, post-weaning and fattening stages and labour costs were taken into account. According to the scenario, the difference of gross margin on feed cost and replacement vary from 34 to 126 €/inventory sow/year (Gourmelen and Le Moan, 2004).

Figure 12. Evolution of postweaning (3/4 weeks to 10 weeks of age) and fattening period (to 115kg, including) (GTTT: ~2,800 herds, ~1,000,000 litters). In France, PCAD appeared in 1998. Since 2003, we observe a decrease of the mortality in fattening pigs of about 25% (from 5.5% in 2003 to 4.0% in 2007).



CONCLUSIONS

How should we manage the modern highly prolific sow?

There is not one rule for farrowing sow and piglet management. We have to adapt it according to the country ('country effect') and to the time (some rules written 10 years ago may be now obsolete). Once the strategy is adopted, we have to develop some tactical measures to be able to manage hyperprolificacy. French producers had to learn 'hyperprolific sows' and, at least for the top pig producers, ... they learned.

Have we put too much emphasis on maximizing litter size and compromised on piglet viability?

Probably yes and it is probably why, at least in France, we are convinced that we have to stop the race to the number of total born piglets per litter. We have some tools and we have stockmanship. However, for each management implemented measure, we have positive effects (Dr. Jekyll) but also negative effects (Mr. Hyde) and these are less known. These negative aspects are at the origin of many other secondary interventions with many secondary bad consequences.

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FINE TUNING NURSERY MANAGEMENT TO OPTIMIZE PRODUCTION COSTS

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ABSTRACT

It is important that in pig production when buying high lean genetics and quality feed that we maximise the growth potential of the pig by fine tuning management. The benefit of improving the pig performance immediately post-weaning is as critical in determining the lifetime performance of the pig as weaning weight and is relatively easier to influence. Management is important in this post-weaning period to maximise feed intake and growth rate and this paper reviews some of the main areas of management that should be looked at in order to improve nursery performance and optimise lifetime production costs. Targeting a 5% improvement in 20 day post-weaning gain can produce an extra 1 kg gain at slaughter and, on a pig that is growing at 300 g/day, that is only a 17 g/day increase in average daily gain something that is achievable.

INTRODUCTION

With increased pressure on pig price and higher feed prices there is a greater need than ever to optimise lifetime pig production. The impact of improving post-weaning growth on lifetime performance is well known and the following paper reviews different areas of management that can be used to improve nursery performance and gain that extra 5% of gain, 20 days post-weaning.

LIFETIME GROWTH – NURSERY IMPACT

All pig producers around the world strive for the same objective of maximizing performance at the lowest cost/kg thereby providing the best return per pig. This is the everyday question posed to nutritionists and the initial focus of attention is often the sow and nursery production systems. Why the sow and nursery systems? Small adjustments in the lactating sow and nursery systems can have dramatic impacts on lifetime performance. It has been well documented that weaning age and weaning weight have large impacts on lifetime performance. Main et al (2004) showed in two trials the importance of weaning age on wean to finish performance (Table 1).

These results showed the benefit of increasing weaning age not only on pork throughput in the system but also on a greater income per pig. Based on Trial 1, the results indicate that for every 1-day increase in weaning age from day 12 to day 21 there is an approximate increase in income of \$1.00 to \$1.25 per pig.

Table 1. Weaning age versus lifetime performance.

Trial 1	Days Weaned		12	15	18	21
	Wean – Finish	ADG (g/day)	580	616	637	687
	Mortality	%	9.4	7.9	6.8	3.6
	Weight Sold Per Piglet Weaned	kg	94.1	110.5	104.4	113.1
Trial 2	Days Weaned		15.5	18.5	21.5	
	Wean – Finish	ADG (g/day)	676	697	722	
	Mortality	%	3.9	3.4	2.5	
	Weight Sold Per Piglet Weaned	kg	107.6	111.6	116.2	

Weaning weight is also important in improving post-weaning performance. A commercial evaluation in Canada (Wilcock; Unpublished) showed that increasing weaning weight from 3.8 kg to 6 kg improved the 42-day post-weaning performance by 4.2 kg or the equivalent of 45 g/day for a 1 kg improvement in weaning weight. This is supported by work conducted by the Prairie Swine Centre that showed for every 1 kg extra in weaning weight there was an improvement in ADG by 40 g/day through the nursery (Whittington et al, 2005).

Not only is the benefit seen through the nursery but also through the finishing units and Cooper et al (2001) reported that 1 kg extra at weaning resulted in 4.2 kg at 20 weeks of age (Table 2).

Table 2. Growth of pigs according to weaning weight.

	Weeks Marketed To 113 kg				
Weeks to 113 kg →	21	22	23	24	25
Number of Pigs that reached 113 kg	49	71	113	115	62
	← Weight at 21, 77 and 140 days (kg) →				
21 days	6.3	5.9	5.5	5.0	4.8
77 days	34.7	32.3	30.6	28.7	27.2
140 days	103.7	99.6	95.1	89.1	82.2
	32 pigs did not reach minimum of 113 kg market weight				

These results show that, as we know, improving weaning age and weaning weight improves subsequent performance and attention to the lactating sow is important in order to ensure that high weaning weights for age are achieved. This is too detailed to review here but had been covered in other reviews (Wilcock, 2008).

Although weaning weight and age are important, two studies out of Leeds University showed the importance of early post-weaning growth on subsequent pig performance. In the first study Miller et al (1999) showed that there was a strong correlation between both weaning weight and growth rate in week one on subsequent performance post-weaning. Their influence is very similar and their impact is additive.

Day 20 Liveweight = 3.73 + 1.25 weaning LW + 8.92 ADG in week 1 (r^2 0.798, $P < 0.001$)

As both weaning weight and week one post-weaning average daily gain had equal effect on the Day 20 weight then management practises that promote high feed intake in that first week after weaning should be given as much focus as maximising weaning weight.

The second study at Leeds University (Isley et al, 2001) conducted a similar study but investigated birth weight, weaning weight and 20 days growth rate on lifetime performance and showed the best predictor of weight at slaughter was day 20 post-wean average daily gain > weaning weight > birth weight and that weaning weight with day 20 post-weaning ADG were the best predictor for weight at slaughter. This is supported by Pollman (1993) that showed the importance of one week post-weaning growth rate on days to market with pigs doing greater than 115 g/day in week 1 getting to market 10 days quicker than pigs doing less than 115 g/day.

In the Leeds study it was possible to determine what was required at birth weight, weaning weight or 20-day growth rate to improve weight at market by 1 kg (Table 3).

Table 3. Performance improvement to give 1 kg extra at market.

Performance Parameter	Order of Importance	Weight Chance	% Change	Comment
20 day ADG	1	17 d/day	5%	Achievable
Weaning Weight	2	0.33 kg	5%	Achievable
Birth Weight	3	0.11 kg	10%	Difficult

Looking at the parameters of change required to gain the extra 1 kg at slaughter, both the 20-day ADG and weaning weight are achievable through management and nutrition while increasing birthweight by 10% is more difficult to achieve. It must be remembered that it has been reported in numerous trials that extra gain out of the nursery results in extra gain at finish with 1 kg in the nursery translating to an extra 2 to 4 kg at slaughter. On average the industry would equate an extra 1 kg out of the nursery to 2.5 kg at slaughter or 2.5 to 3.5 days saving to get to the same slaughter weight.

Therefore with respect to the remainder of this paper we are looking at nursery management that can improve post-weaning performance which, if we can achieve just a 5% improvement in that first 3 weeks post-weaning, can deliver an extra 1 kg of live weight to the producer at market. Thus this shows that if we can increase feed intake in the 3 weeks post-weaning and thereby gain then pigs should get to slaughter quicker or produce more pork in the same period both providing returns to the pig producer.

FEED INTAKE

It is well-known that dry matter intake drops immediately post-weaning as the pig comes off the sow's milk onto a dry feed in a strange environment. This is one common stress that reduces feed intake that needs to be overcome but this can be complicated as feed intakes vary dramatically from unit to unit depending on other stresses in the system. This is due to appetite being sensitive to all type of stress, discomfort and disease. Nucleus units with few stresses, for example, have

higher feed intakes while units with many stresses (disease and poor management) have lower intakes. If we are in the situation of low feed intake and low nursery performance due to disease and management, can we change it for the better? By improving feed intake Pluske (1995) showed that there was a positive relationship between increasing feed intake, improving gut integrity (villous height) and improving post-weaning gain - all factors we want to achieve.

A practical example of management improving performance was when five commercial farms all suffering from *E. coli* scour and mortality had pigs weaned into either their existing production system or into an R&D facility with excellent management and an all in, all out policy. Feed was taken from the commercial farms and fed to the pigs in the R&D facility thereby removing any feed factor on the evaluation as all pigs were fed the same feed program. The results are dramatic (Table 4) with a 140 g/day benefit in ADG and large reductions in mortality and scour.

Table 4. Management x health effect.

	ADG g/day	% Scour	% Mortality
Commercial Unit	325.4	37.14	3.28
R&D	465.8	4.40	0.00
Difference	+ 140.4	- 32.77	- 3.28

Source: Madec and Leon, 1999

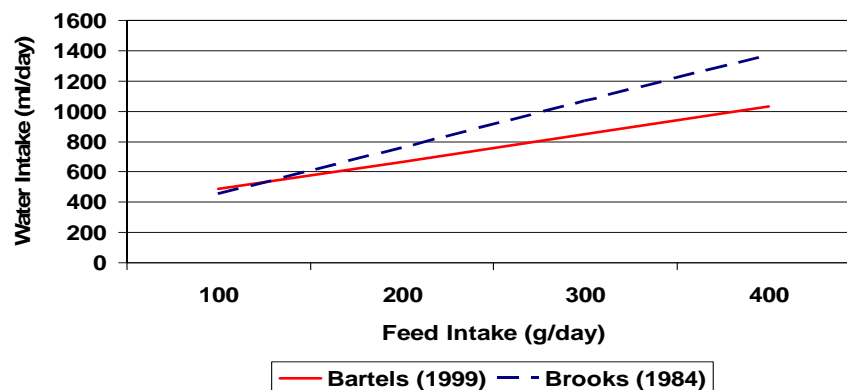
Remember this was achieved by reducing the multiple stresses on the pig and the following looks at some of these stresses and their effects.

WATER INTAKE

Water is often described as the forgotten nutrient as, although it is essential to the pig, it is often neglected with the assumption that as long as water is flowing from the drinker then the need for water is met and checked off. Recently, there has been a greater interest in water usage by piglets and a focus on water requirements.

On entry into a nursery system the pig has gone from the sow's milk which supplies both the food and water requirement of the pig to dry feed and water from a drinker. Lacking familiarity with both feed and water, it takes time for the pig to find the water and food supply and research has shown that it may take up to 35 hours for 85% of pigs (Varley and Stockill, 2001) to find the water supply and 30 hours for 90% of pigs to find the feed supply (Bruininx et al, 2002). Although these studies are not related there may be an indication that one event may be associated with the other and this was shown by Bartels et al in 1999 and Brooks et al (1984) (Figure 1) who both showed a positive relationship between feed intake and water intake. If we, therefore, can get the pig onto water and/or feed soon after weaning the better the post-weaning performance.

Figure 1. Estimation of water intake in young pigs as a function of feed intake for a 21 day weaned pig.



STRATEGIES TO INCREASE WATER INTAKE AND REDUCE WASTAGE

Drinkers

The most common drinkers used in commercial facilities include nipples, bite-type drinkers and bowls/cups. Nipple drinkers are often used in UK nursery facilities due to the perceived ease with which piglets can access the water. Often the problem with drinkers is not the access of the pigs to the water but the wastage that can occur. Wastage not only results in a cost through increased quantities of slurry but also through wasted medication in the event that water medication to the unit is being applied.

Water wastage can come from drinker height, the angle of the drinker, flow rate and type of drinker and so all should be checked to ensure wastage is minimised. For example McKerracher (2007) compared two drinker types in a commercial unit where the standard nipple drinkers were compared to ball-bite drinkers. The results showed that there was a 35% reduction in water wastage by using the ball-bite drinkers and a greater return per pig of approximately \$0.50 per pig compared to the nipple drinkers. This assessment needs to be reviewed unit by unit as all production systems differ.

Drinker type can have an impact on water intake and wastage. Comparing three types of drinker, Torrey et al (2008) showed that drinker type did affect water consumption by the pig and the amount of water wastage (Table 5). The float drinker performed poorly which can be partly attributed to the water even with daily cleaning becoming soiled by urine, feces and feed and it has been shown pigs will not drink from an unclean water source (Philips and Philips, 1999). Both the nipple and push drinkers showed similar water intakes which were reflected in improved average daily gains compared to the float drinker. However it was noted that the nipple drinker resulted in 56.1% water wastage compared to the push drinker which had water wastage of 19.3%.

Table 5. Mean water consumed, wasted and used at the three drinker devices averaged across 14 days post-weaning.

	Drinker Type		
	Float	Nipple	Push/Bowl
Water, ml/pig daily			
Consumed	475a	870b	774b
Wasted	295a	1114b	186a
Used	770a	1984b	960c
% Wasted	38	56.1	19.3
ADG (Relative % to Float)	-	+ 6%	+9%

This data shows the need to invest in the correct drinkers that not only stimulate water consumption and thereby pig performance but also limit wastage. Both improving pig performance and reducing water wastage will increase the return on the pig unit.

It is also important with drinkers that they are adjusted regularly during the nursery so that all pigs within the pen have no issues with obtaining access to water. The general rule is to adjust the height of the drinker to the shoulder height of the smallest pig in the pen. This ensures water intake; thereby feed intake is maintained and water wastage is reduced.

Water Flow

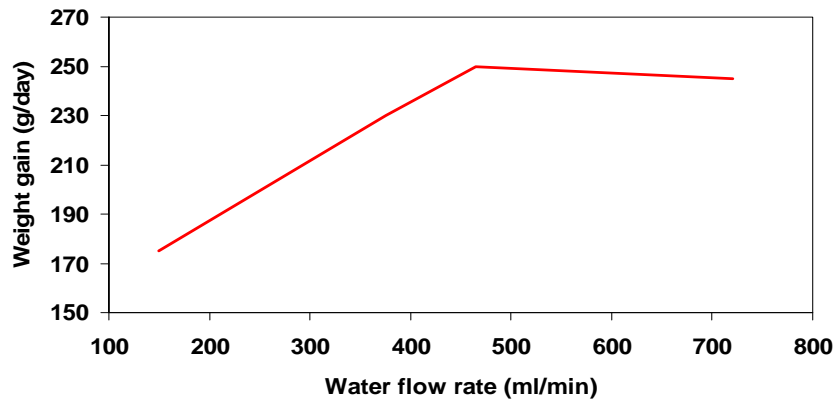
As part of the normal checking procedure drinkers are often checked to ensure no blockage and that water is flowing. However, how often do producers measure the flow rate? Flow rate is critical for the young pig as if it is too low the pig will move away from the drinker before satisfying their daily needs. Hence weight gain (feed intake) is reduced as the flow rate is reduced and water intake becomes insufficient (Barber et al, 1989; Figure 2).

It is generally recommended that a minimum of 500 ml per minute flow rate should be used in the nursery and 1000 ml should not be exceeded. It must be remembered that higher flow rates are correlated to an increase in water wastage. When checking flow rates within a nursery system, it is important to check pens at different parts of the nursery as the flow rate can be reduced due to pressure loss from the first pen to the last pen running the length of the nursery.

Water Enhancers

Although there is a need to stimulate water intake in the piglets post-weaning, it must be cautioned that over stimulation can cause excessive water intake which can result in gut fill and reduced feed intake.

Figure 2. Effect of water flow rate on weight gain.



Flavours

Recently there has been a new interest in using flavours in water to stimulate water intake in piglets post-weaning, although care needs to be considered when using flavours in water and feed as benefits are not always seen. Further work needs to be done in this area. Results (Bertram et al, 2002) have shown that the use of flavours have improved the critical 24-hour period post-weaning water intake by 34% while improving water intake over 14 days by +4%. Extra growth of 1.5 kg was recorded at the end of the nursery period on those pigs fed a flavour in the water post-weaning. This is supported by Roura et al (2005) with a flavour giving an improvement in both water intake and average daily gain 14 days post-weaning.

Globulin proteins

Work has looked at the benefit of using globulin proteins supplied through plasma and serum in the water on stimulating water intake and feed intake on post-weaning performance. Globulin proteins help support the gut integrity of the newly weaned piglet and should thereby stimulate increased feed intake. Data has shown that the use of globulin proteins improves water intake, feed intake and growth immediately post-weaning. (Steidinger et al, 2002; Miller and Toplis, 2001).

Water Quality

Water comes from many different sources such as main supplies, lakes and bore holes. Its quality can vary and the impact on pig performance is still not well-known but can lead to refusal and scour if quality is poor. Chemical characteristics are the biggest concern as these are natural properties of the water and high salts can cause water refusal, scouring and loss of appetite. This topic is too extensive to cover here but one of the most important tests to do is to test for Total Dissolved Solids (TDS). This will provide an indication of the level of salts (may include carbonates, sulphates, nitrates, chlorides, phosphates and fluorides) dissolved in the water and a guideline (Table 6) is set out as outlined by the NRC, 1998. It is advisable to do further chemical testing if TDS's are found to be > 1000 ppm.

Table 6. NRC water quality guidelines.

Total Dissolved Solids	Rating	Comment
< 1000 ppm	Safe	No Risk
1000 to 2999 ppm	Satisfactory	Mild diarrhoea in pigs not adapted to the water
3000 to 4999 ppm	Satisfactory	May cause temporary refusal of water
5000 to 6999 ppm	Reasonable	Higher levels for breeding stock should be avoided
> 7000 ppm	Unfit	Risky for breeding stock and pigs exposed to heat stress.

Of the potential chemicals dissolved in water, the main problem normally comes through high sulphate levels. Levels higher than 1000 ppm may cause diarrhoea but work by Patience et al (1997) showed that in commercial situations pigs receiving water with 1634 ppm sulphates performed as well as pigs with low water sulphate levels. High levels of sulphates may result in water refusal.

Improving water quality will ensure that the pigs drink adequate water to sustain high growth.

TEMPERATURE

Temperature control is still poor on many pig units and production and health are affected. Air temperature can affect growth performance mainly through its effect on feed intake if the pig is outside its thermal comfort zone.

The critical time for temperature control is the post-weaning period when the pig's feed intake is low as it adjusts to the new environment. In colder conditions the older pig can adjust somewhat by increasing feed intake to increase energy input, however post-weaning the pig cannot compensate with higher feed intakes and this results in reduced body insulation, and poorer pig performance.

An example of how performance of the piglet is affected by the post-weaning ambient temperature is shown in Table 7. Piglets were weaned at 28 days with a weaning weight of 6.64 kg and weaned into either a pen with a heat lamp or pen without a heat lamp. Room temperature was maintained at 21°C while those pigs with a heat lamp were maintained at 29°C. The outcome was that after 10 days the pigs at 21°C grew 33% less and consumed 53% more feed than those pigs maintained at 29°C.

This shows the importance of ensuring that the pig remains in the comfort zone thereby optimising pig performance. Often as producers we do not know what the temperature is at the pig level and not only is the average temperature important but the daily temperature variation. Studies (Kurihara et al, 1996; Le Dividich, 1981) have shown that large daily temperature variation (minimum and maximum) has a negative impact on performance. Kurihara et al (1996) compared pigs at an average of 58 days in a constant environment of 21°C with pigs that had a variation of 3°C around 21°C and pigs that a 6°C variation around 21°C (Table 8).

Table 7. Temperature impact on post-weaning performance.

	1 to 3 days	4 to 6 days	7 to 10 days	1 to 10 days
29°C – Wt Gain (g)	148	262	1165	1574
21°C – Wt Gain (g)	-68	123	1001	1057

Reference: Maenz et al, 1994

Table 8. Effect of varying pig temperature on piglet performance.

Temperature °C	21	21+/-3	21+/-6
Conditions	Std	Low	High
ADG (g/day)	682	660	602
ADFI (g/day)	1330	1300	1150
FCR	1.95	1.97	1.95
ADG (Relative % to 21°C)	-	- 4%	-12%

The feed intake of the piglets was reduced by 14% under the high fluctuating conditions while there was a 3% reduction in the low fluctuating conditions resulting in poorer performance in both treatments. It is therefore important to not only provide the correct temperature but with a minimum variation throughout the period and although limited data the minimum variation would be < 3°C.

LIGHTING

Lighting application in nursery has had little attention paid to it although in the last few years research has provided some interesting results which need further investigation. Initial research (Bruininx et al, 2002) showed that increasing the continuous light duration from 8 hours to 21 hours daily in the initial two weeks post-weaning resulted in an increased feed intake (+71 g/day) and average daily gain (+85 g/day). Other work by the University of Illinois (Niekamp et al, 2007) has shown similar response whereby ADG has improved when the lighting regime was increased from 8 hours of light to 16 hours of light. The interesting part of this trial is that, in addition to performance, the researchers looked at the immune function and found an interaction between light duration and weaning age on immune status. Interestingly, the study showed that for a 14-day weaned piglet, if the light period was increased from 8 hours to 16 hours then the liveweight at 10 weeks of age was increased. This may be linked to the immune system as those pigs on a 16-hour light regime had a lower level of B lymphocytes. Thereby, more nutrients supplied may be utilised by the pig for growth, resulting in the better gain response seen. Unlike poultry, little work has been conducted on pigs with different lighting regimes and this work throws up interesting areas of management research to improve pig performance.

FEEDERS – DESIGN AND MANAGEMENT

Design

As feed intake is a key determinant of post-weaning performance, the way the feed is presented by the feeder may be significant. The object of the feeder is to give good access to feed, some protection to the pig and sufficient comfort for the largest pig in the pen. On entry into the unit it is important to stimulate early feed intake and so it is important to have a high feeder space so that pigs can feed together as the piglets are used to group feeding from the time on the sow. It is important that, in this early period, pigs are not competing for feed as larger piglets have an advantage over the smaller pigs and, over time, these differences increase.

A comprehensive trial (O'Connell et al, 2001) investigated five different feeder types and their impact on pig performance from 5 weeks through to 11 weeks of age (Table 9). There were two feeding phases: 5 to 7 weeks and 8 to 11 weeks.

Table 9. Performance from 5 to 11 weeks of age.

	ADFI (g/day)	ADG (g/day)	FCR	Variation (kg) at 11 wks ¹
Dry Multi-Space	897	598	1.50	4.9
Wet & Dry Multi Space	951	605	1.58	6.5
Maximat	863	577	1.49	6.4
Lean Machine	839	572	1.47	7.5
Verba	824	575	1.42	7.4

1. Variation is the kg difference between the lightest and heaviest pigs in the group.

The researchers then tried to quantify the effectiveness of the feeders and this is shown in Table 10.

Table 10. Summary of pig performance, behaviour and management of different feeders.

	Stage 1 Growth Rate	Stage 2 Growth Rate	Variability	Feeding Pattern	FCR	Management
Dry Multi-Space	Good	Good	Low	Normal	Good	Easy
Wet & Dry Multi Space	Average	Good	Moderate	Normal	Poor	Prone To block
Maximat	Average	Average	Moderate	Normal	Good	Difficult to adjust
Lean Machine	Average	Average	High	Extended	Good	Very Easy
Verba	Good	Average	High	Extended	Good	Easy

From these observations it would seem that the traditional dry multi-space feeder provides the optimal solution for feeding the nursery pig. It is therefore important when refitting a nursery unit to determine the best feeder that gives maximum growth opportunity with ease of

management and low feed wastage. In this particular trial the difference between the best and worst feeders was a 5% difference in performance.

Management

As producers, it is important to manage feeders on a daily basis in the nursery. This means checking the feeder to ensure that there is not excess feed in the pan thereby resulting in feed wastage and that there is sufficient feed so the pig's feed intake is not compromised. This is difficult to determine but an experiment by Smith et al (2004) investigated the width of feeder gaps on pig performance. The interesting commercial application of this trial was that they related gap width to pan coverage and it was shown that the optimal pan coverage for performance was 38%. Looking at this in a practical sense it is suggested that 40-50% of the pan should be covered by feed in the first few days post-weaning but when the pigs intake starts to increase this can be reduced down to 25-35% pan cover. Ensure that on the walk through there is not a high level of feed wastage; if there is, then look at adjusting the feeder to compensate. Aggressive feeder management was shown by Dritz (2004) to improve growth performance 7 days post-weaning by +36% while FCR was reduced by 0.88 which is due to less feed wastage and continual access to fresh feed.

Mat Feeding

Mat feeding is a cost-effective way of feeding as long as feed wastage can be controlled. Controlled mat feeding over 3 days immediately post-weaning has been shown to double daily live-weight gain as mat feeding encourages the pig's rooting behaviour (Mavromichalis and Baker, 2000). Mat feeding should be done 3 times daily and it is better to use mats with rims to avoid feed wastage especially if feeding pellets. It is advised that if mats without rims are used then a crumb or meal is often better to use so as to avoid pigs rolling the pellets off the mat and increasing feed wastage of a high cost product. Floor mats should be situated away from corners and drinkers to avoid soiling and floor mats situated in front of feeders often help stimulate feeding activity. Mats are commonly used for 3 days post-weaning. Longer periods should be avoided so as to ensure that the pigs transfer feeding to the feeder.

GROUP SIZE

How many pigs to a pen? Interestingly it was always thought that increasing the number of pigs in a pen while maintaining the same stocking density would have a disadvantage on performance. Well, a review by Payne et al (2006) reviewed the literature and it showed that increasing group sizes from 5 to 100 pigs appeared to have a small impact on performance as long as the floor space, number of drinkers and feeders were the same. Gain was slightly reduced while feed conversion was not affected.

This supports the data of O'Connell et al (2001) that looked at 1280 piglets between 4 and 10 weeks of age. Pigs were grouped in pens of 10, 20, 30, 40 and 60 with each pig having the same space allowance, feeders per pig and drinkers per pig. Behaviour was monitored for changes in

aggression between the different group sizes. Variation was determined by the weight difference of the top 20% of the group and the bottom 20% of the group (Table 11).

Table 11. Performance of pigs from 4 to 10 weeks of age at different group sizes.

	Group Size				
	10	20	30	40	60
ADFI (g/day)	770	746	788	774	808
FCR	1.42	1.43	1.50	1.51	1.52
ADG (g/day)					
Small	449	510	517	515	513
Medium	577	540	519	546	536
Large	598	566	537	564	571
All	543	540	524	544	540
Wt Variation at 10 weeks of age (kg)	14.9	12.6	11.9	12.7	11.5

The researchers showed that there was no significant drop in performance with increasing group size and, surprisingly, the variation in weight was reduced. This can, in part, be explained by looking at the small pigs on trial. With 10 pigs per pen the small pigs were at a disadvantage due to greater competition at the feeder with large pigs. In larger pens due to the greater number of feeders available the smaller piglet gets easier access to feed and so growth is improved compared to 10 pigs per pen.

Equations have been determined (Turner et al, 2003) to calculate the small performance reduction seen for pigs when group size is increased (3 and 120 pigs per pen).

$$\text{ADG (g)} = 416 - 0.36 \times \text{No of Pigs per Pen}$$

$$\text{ADFI (g)} = 681 - 0.51 \times \text{No of Pigs per Pen}$$

This shows that performance reduction is low with an extra pig in a pen accounting for a reduction in ADG of 0.36 g and ADFI of 0.51 g.

It, therefore, seems that group size does not have a large effect on performance and so, in construction of new nursery units, the producer can review the benefits of a large pen system against a small pen system with respect to construction costs and labour costs.

STOCKING DENSITY

It is well-known that overstocking pigs in pen reduces feed intake and growth rate and results in more aggression between pigs and for vices to occur such as tail-biting, etc. The increased potential for vices to occur is bad for the producer as that means more downgrades and culling while increasing workload for stock people — all areas removing potential income from the production unit.

The optimum stocking density for performance may be different from the stocking density required to produce the maximum pork output. Smith et al (2004) showed (Table 12) that reducing stocking density from 0.35 m² to 28 m² to 0.23 m² resulted in a decreased performance. However based on pork output per pen from the nursery (pig number x weight gain) the greatest pork output was with the lowest stocking density (0.23 m²). It is therefore important to determine the optimal stocking density for the unit that brings the greatest return, balancing pork output per pen against improved performance for the unit while also ensuring that the national welfare standards are met.

Table 12. Impact of stocking density on nursery performance and pork output.

	Stocking Density		
Pig Per Pen	24	20	16
Stocking Density (m ²)	0.23	0.28	0.35
Start Weight (kg)	7.05	7.12	7.07
End Weight (kg)	28.03	29.39	29.69
ADG (g/day)	499	530	635
Gain (kg)	20.98	22.27	22.62
Pork Output (kg)	503	445	361

GENETICS

Different genetic crosses perform differently and a recent trial (Wilcock 2009, personal communication) shows the difference that genetic crosses can have within the same production system (Table 13) when measured over 18 days. Again, ensuring that you have the correct genetic cross to meet your needs is important.

Table 13. Differences in genetic crosses within same production system.

	Cross A	Cross B
ADG (g/day)	100%	118%
ADFI (g/day)	100%	120%
FCR	100%	103% (worse)

AIR QUALITY – AMMONIA

Excreta produces numerous gases including ammonia, carbon dioxide, hydrogen sulphide and methane. Ammonia is the most prominent gas in the pig house and it is recommended that levels below 20 ppm are targeted. Again in production systems ammonia levels are not often tested and if they are tested it should be at the same height as the pigs in the pens. If levels reach 50 ppm in the nursery the ADG can be reduced by 10-15% and pigs struggle to clear harmful bacteria from the lungs. If levels reach 100 ppm the ADG is reduced by 25-35% and there is an increase in vices such as tail-biting as well as irritation of mucosal linings. Ammonia can be reduced by

adequate ventilation or through nutritional manipulation such as the use of feed ingredients such as yucca or calcium chloride.

MIXING LITTERS

When unfamiliar pigs are mixed, pigs become aggressive and fighting can occur in order to sort out dominance within the pen (McGlone et al, 1987). This can lead to a reduced feed intake which in part may be explained by the increased aggression of mixing pigs at the feeder (Tan et al, 1991) or by stress-induced metabolic changes (Gonyou, 2001). Although the indications are that mixing litters is not advantageous in terms of production, many systems are set up to do this at weaning due to numbers of pigs per pen to fill to ensure that pork per area is maximised within welfare and production standards.

So, what is the impact of increasing numbers of litters per group? Research conducted by O'Connell (2008) compared the effect of increasing the number of litters per group on 6 week post-weaning performance with pigs weaned at 28 days (Table 14).

Table 14. Effect of numbers of litters per group on nursery performance.

	From 28 (weaning) to 70 days of age			
Numbers of litters per group	1	2	3	4
ADFI (g/day)	847b	765a	792ab	744a
ADG (g/day)	555b	516ab	545b	482a
FCR	1.53bc	1.48ab	1.45a	1.54c
COV Growth Rate	0.11a	0.16ab	0.13a	0.20b
Injury Scores 1 week post-weaning	2.8a	6.6b	8.8c	9.8c

As expected, if just one litter group was used then that gave the better performance and was associated with the lowest injury score in week 1. However if number of litters per group were increased there was a significant linear reduction in performance ($P < 0.05$) in respect of feed intake and growth while there was also a significant increase in injury scores. This reduced performance and could be explained in part by the increased aggression associated with the increase in litters per group. This increased aggression may also explain the increased variation seen with higher number of litters per group.

Mixing litters is important from a production standpoint and these results show that minimizing the mixing of pigs at weaning can give a benefit in production through the nursery. Reducing a group of pigs from 4 to 3 litters increases feed intake by +6% while increasing gain by +13%, production benefits that as a producer we want to gain.

FEED

The final area to cover with respect to management and achieving that early post-weaning growth is feed. Feed can assist in many units with overcoming some of the management issues we face but a combination of the correct feed, feed program and good management is the best chance of successful pig production.

Creep Feeding

Should we creep feed? In general there is a split view on creep feeding as in later weaning (> 21 days) most producers creep feed due to the increased intake of feed consumption from 21 days on. Researchers have shown that in late weaned pigs, creep feeding improves post-weaning feed intake and gain. Producers that wean less than 21 days are less likely to creep feed as feed intake is often low and the belief is that there is no potential benefit to performance. However, the use of creep feeding is important in large litter sizes where creep can be used to supplement the sow's milk but also creep feeding is important in the subsequent post-weaning performance. Dutch work (Bruininx et al, 2002) showed that offering creep feeding and getting pigs to consume creep improved the post-weaning gain performance by +17% post-weaning. This was recently supported (Sulabo et al, 2008) when in 21-day weaned pigs creep feeding was monitored by using green dye in the feed which allowed the researchers to determine which pigs had consumed feed or not. The outcome of these results was that pigs that were offered and consumed creep had a 5.5% benefit in post-weaning gain when compared to pigs that did not consume creep or were not offered creep at all. This shows the importance of offering creep but also in ensuring that pigs consume the creep. The US researchers did a further study that showed that one management technique that may work in 21-day-old weaned pigs is to introduce creep feed earlier in the life of the pig. Introducing creep from 7 days of life rather than 14 days was shown to increase the percentage (10% or an extra pig per litter) of pigs consuming creep by the time of weaning.

Another way of increasing creep feed consumption is to increase the complexity of the creep feed. Fraser et al (1994) showed that increased complexity of the diet increased the creep feed consumption of the piglet which improved post-weaning growth.

In addition creep feeder type can impact feed intake and percentage of piglets consuming food. Sulabo et al (2008) looked at three types of creep feeders and showed that one particular feeder type increased the percentage of pigs consuming creep by approximately 30% when compared to the other feeders.

These studies show that creep feed intake by suckling pigs in both early and late weaned pigs stimulates early post-weaning feed intake as improved post-weaning performance. The two studies showed that creep fed piglets improved gain by an average 11.25% at approximately 30 days post-weaning. This advantage in performance can be achieved through focusing on creep feeding and using management to stimulate creep feed intake.

Quality Starter Feeds

High quality starter feeds with improved digestibility (milk, cooked cereals, etc.) have been shown to improve post-weaning performance and result in improved growth performance right through to slaughter. In addition, the use of higher quality diets with lighter pigs at weaning does not promote equal growth performance to the level of the heavier pigs but does appear to help light piglets cope better with weaning and avoid being further disadvantaged. The benefit of quality starter feeds has been reviewed previously by Willis et al (2003) and in that paper the results of a quality starter feed on early nursery performance and subsequent nursery performance was shown (Table 15).

Table 15. Effect of feeding a complex high digestible feed 11 days post-weaning on subsequent nursery performance.

		Stocking Density		
		Standard	Complex	Difference
Test Feed (11 days)	ADG (g/day)	209	259	+23%
Standard or Complex	FCR	1.17	0.95	+19%
Common Feed (10 days)	ADG (g/day)	377	413	+10%
All pigs fed common feed	FCR	1.29	1.24	+4%
Common Feed (20 days)	ADG (g/day)	586	650	+11%
All pigs fed common feed	FCR	1.61	1.60	+1%
Total Weight Gain	kg	18.0	20.2	+2.2 kg

First there was, as expected, an immediate benefit with the complex diet in the first 11 days post-weaning. This is the result of the trial diets containing higher levels of milk protein and cooked cereals resulting in greater feed digestibility and thereby performance. In addition the lack of soybean meal in these early feeds ensured that the pigs fed complex feeds did not become immune activated, thereby diverting important nutrients such as energy and amino acids from growth into maintenance of the gut structure and immune functions. Earlier work has also shown that higher energy intake immediately post-weaning maintains villous height while lower energy intakes have an adverse effect (Pluske et al, 1996a, 1996b).

Using a complex diet for just 11 days post-weaning gave not only a benefit in that period but also improved performance thereafter in the nursery even when all pigs were fed a common diet. At the end of the nursery the use of the complex diet for 11 days improved the gain out of the nursery by 2.2 kg. Again this shows that when the newly weaned pig's early nutritional needs are met without compromising his digestive or immune systems, then the performance benefits are carried forward.

Other work (Mahan et al, 2004) shows the improved benefits of diet complexity and US researchers showed that increasing feed digestibility improved performance through the nursery with an extra 2.65 kg at 28 days post-weaning through the use of an improved starter feed quality.

Other advantages of complex feeds other than performance benefits are the reduced variation in nursery out-weights and the reduction of poor pigs (hospital pen) in the nursery (Wilcock, unpublished).

To achieve the targeted early post-weaning growth and nursery performance, complex high digestible feeds using quality raw materials can be used for 2 to 3 weeks post-weaning prior to moving on to common soy/cereal based diet with benefits not just in the initial 3 weeks but on the subsequent common program.

Gruel Feeding

Gruel feeding is often a method used with piglets up to 5 days post-weaning to be fed alongside traditional dry feed. It should not be fed for longer as it will lead to pigs having difficulty in learning to use the dry feeders. The exception to this is hospital pigs may be fed for longer. Gruel should be fed multiple times (2 or 3 is common) a day and it must be remembered that gruel is an area of potential bacterial growth so gruel pans/feeders should be cleaned out and any stale gruel removed. Additionally, gruel is also used to help pigs that do not move onto self-feeding quickly and would become starve outs. In this process gruel can be placed in a syringe with the end cut off and the pigs hand fed. When placing the pig down it is advantageous to place near the feeders as the pig will associate the gruel/feed with the feeder and improve the opportunity of self-feeding.

FEED PROGRAM

It is important to feed the correct program set out by the nutritionist and not to underfeed the pig so losing performance or overfeed the pig higher cost diets than needed. An example of this was shown by the Prairie Swine Centre (Whittington et al, 2005) in a pig unit where they measured feed used against budget. This showed that the unit was underfeeding phase 1 and phase 2 feeds by approximately 5 kg and this was reflected in a pigs being 4.5 kg behind the nursery target exit weight. On correcting the program nursery exit weights were now much closer at just 0.8 kg behind target. On this unit, it was calculated that although there was an extra cost associated with feeding more of phase 1 and 2 the corrected program increased profit by \$1.85 per pig or \$25,000 per annum on a 600-sow unit.

One area that seems to differ depending on the country that you are in is whether producers want to feed to kg or to days. It is important, if possible, to ensure that the feed budget in kg is consumed by the piglet rather than switch the feed due to days as getting the correct feed per pig in that immediate period post-weaning is critical in ensuring that piglets do not fall behind target weights. This often means that feed changes will need to be monitored by pen or minimum room, but the advantage is cost-effective growth.

There is still a debate over if there are any benefits of batching pigs by size at weaning and then feeding to start weight. Work by Schinkel et al (2003) showed that the top 80% of pigs through the nursery have a similar ADG while the bottom 20% of pigs have a fall off in gain. It is therefore important, where possible, to treat the bottom 20% of the pigs as a separate population

and take a proactive approach in minimising the negative impact these pigs can have on the production system. It is therefore suggested in typical commercial units that due to practicality the bottom 10% of pigs should be grouped together and fed a separate program whereby they get more of the initial phase 1 program compared to their heavier litter mates. This management practice promotes growth of the lighter pig and reduces the variation out of the nursery.

FEED WASTAGE

With high feed prices in the last 18 to 24 months, it is essential that feed wastage on the unit is minimised. This subject is too large to cover in this paper and is already well reviewed by Carr (2008). In this paper it is estimated on an average farm that 10% of all feed delivered to a farm is wasted. Based on a 500-sow unit, that is 300 tonnes of feed per year (based on 6 tonnes per sow and progeny per year). Based on an average feed cost of \$300 to \$400 per tonne and 21 pigs marketed per year, that would equate to a cost of \$8.57 to \$11.42 per pig marketed. This equates to approximately \$0.11 to \$0.14 per kg of deadweight. Even 2% wastage equates to \$1.71 or \$2.28 per pig cost. These calculations, although estimates, give a strong indication of what feed wastage can cost a unit in terms of additional cost of production and how a strategy on farm to reduce feed wastage can improve cost of production on the unit.

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LOOKING AHEAD

PORK PRODUCTION VERSUS CONSUMER DEMANDS

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INTRODUCTION

The Canadian pork industry has been challenged for the last three years. Producer margins have been negative during the last three years. This crisis is not limited to pork producers; processor margins have been largely negative for the past three years.

The crisis is due to the convergence of different factors:

- The rapid rise of the Canadian dollar.
- Rapid rise of input costs – notably feed grains.
- Production increase all around the world.
- The lack of processor competitiveness in Canada.

In global terms, Canada is a relatively small player ranking sixth in terms of pork production behind China, EU-27, US, Brazil and Russia. But Canada's industry is considerably more dependent on the export market with our reliance growing from 35.4% of production exported in 1999 to 55.8% in 2007.

Furthermore, USDA estimates the 2007 Canadian pig crop at 31,832 million head with 10,032 million (31.53%) exported to US as early wean, feeder and slaughter hogs (Ron Plain, Global Price and Production Forecast, Banff Pork Seminar 2009). Of total production, the needs for Canadian customers are not more than 9.6356 million, which means around 70% of pigs born in Canada are produced for export markets.

Our industry is very dependent on Canadian exchange rate and export market.

With the production cost we have in Canada, what can we do to build a long term competitive industry?

Do you know what the customer wants and can we produce it at the best price?

DIFFERENT MARKET TRENDS: NICHE TERMS AND ATTRIBUTES

Niche Terms and Attributes – What Do They Really Mean?

Some of the niche terminology used to describe alternative or specialty meat product attributes

today are better understood than others. Some terms have consistent meaning from person to person. Others may mean different things to different people.

Labelling requirements can be broad. So if you're looking for specific niche attributes, check the label to see if they're listed. That, along with a basic understanding of USDA production/labelling requirements, will help you get what you're looking for.

Some of the popular attributes in the market today include:

Locally Grown – One of the more easily understood terms and without USDA guidelines attached, although what defines “local” may vary from one person to another. For some it may represent a drive to a farmer’s market, for others it may be a broader geographic region. The reasons why people support locally grown products (i.e. keep money in the community, know where food comes from, support agriculture) may influence their definition.

Free Range – Also referred to as “pasture raised, free roaming, and raised outdoors.” The USDA standard to make this claim for pork is that hogs have had continuous access to pasture for at least 80% of their production cycle.

No Antibiotics Used, Raised without Antibiotics – “No antibiotics added” on the label means that the animals were raised without using antibiotics and that documentation has been provided to USDA demonstrating this.

Natural – Pork products that meet compliance with USDA Natural Standards which means the product contains no artificial ingredients or added color and is only minimally processed. The label must explain the use of the term natural (such as no added colorings or artificial ingredients; minimally processed).

Naturally Raised – There is currently no USDA standard for making a “naturally raised” claim on pork products, and definitions may vary from one naturally raised pork product to another. Attributes that may contribute to a hog being “naturally raised” might include raised without antibiotics, growth promotants or animal by-products in the feed, use of deep straw bedding, raised outdoors, etc. These attributes will likely be stated on packaging or in marketing materials.

Organic – Pork products that meet compliance with USDA Organic Standards. This involves an entire process in which synthetic inputs into all phases of animal production, meat processing and handling are prohibited. Labelling rules have been established by the USDA for products claiming to be organic and include four categories.



100% organic – Products produced exclusively using organic methods as defined by the USDA. Can carry the USDA organic certification seal.



Organic – 95% or greater of the ingredients (by weight, excluding water and salt) are organically produced with the remaining five percent of ingredients on the National List of Allowed Synthetic and Prohibited Non-Synthetic Substances. Can carry the USDA organic certification seal.

Made with organic – 70-95% of the ingredients are organically produced and would be displayed on the principle display panel as “Made with organic [specific ingredient(s)].”

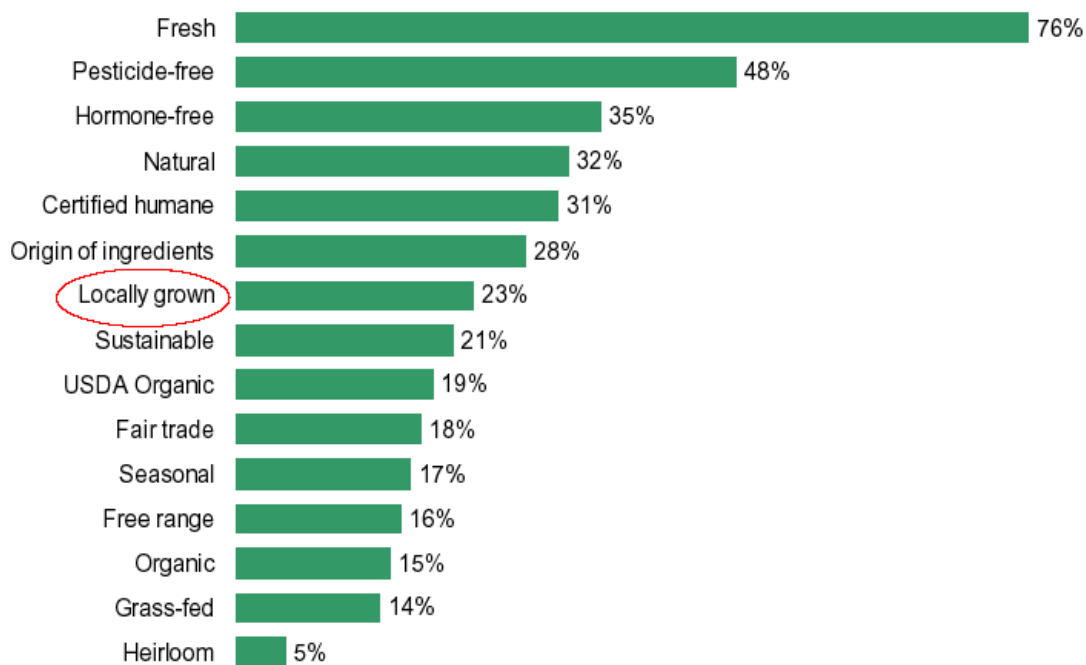
Less than 70% organic – These products have the option to include “X% organic” on the information panel and only need to list organic ingredients on the ingredient statement.

For more information on the National Organic Program:
www.ams.usda.gov/nop/indexNet.htm

Breed Specific – Just as there are breed-specific beef products like Certified Angus Beef, there are breed-specific pork products. Sometimes referred to as heirloom or heritage breeds, examples in the marketplace today include Berkshire (also known as Kurobuta meaning “black pig”), Duroc, and Tamworth.

Figure 1. How important are the following labels/phrases when selecting foods and beverages? (The Hartman Group Inc. study)

Natural and Certified humane overtakes in terms of importance when making a product purchase.



WHAT CAN WE DO AS AN INDUSTRY TO SUPPLY THOSE MARKET TRENDS?

There are 2 ways we can do to get out of the actual crisis is to reduce our cost of production and add value to our products.

DUBRETON MODEL OF PRODUCTION

Breton Foods Canada has developed during the last 20 years an integrated approach. Breton Foods Canada is first a pork producer who invests in R & D to build a sustainable model where we reduce cost of production and develop value-added products.

A presentation slide titled "duBreton at a glance" with a background image of green corn stalks. The slide lists the corporate profile of duBreton, a division of Aliments Breton Foods Canada. The text is white on a dark green background, with one bullet point highlighted in orange.

duBreton at a glance

Corporate Profile

- duBreton, a division of Aliments Breton Foods Canada
- A family company founded in 1944
- A fully integrated company
- Head office in St-Bernard, Quebec, Canada
- Over 1,000 employees
- **The largest organic and natural pork producer and processor in North America**
- A producer, not just a marketer
- One of the most technologically advanced pork processing systems in North America
- Food division: 3 plants
- Main product categories: niche pork, prepared meals and deli meats
- More than 2.8 million pounds / week - fresh pork

duBreton

4

Our products

A cut above for consistent pork quality

- Wide variety of niche pork products tailored to customer specifications
- Strict quality controls are adhered to achieve consistent quality products:
 - Control over hog feed
 - Breeds chosen for flavor and longevity
 - Precision meat trimming in ultramodern facilities
- The result?
Pork renowned for its flavor, juiciness and tenderness



duBreton

9

What We are Doing to Reduce the Cost of Production?

Through our genetic division, Genetiporc, we have developed genetics lines that are more prolific, faster growing and more efficient for feed conversion. But also because of our close relationship with the processing plant all our lines have to meet the standards for meat quality.

Genetiporc has the biggest portfolio of pure breed line and can adapt their products depending on the market place. Genetiporc has developed over the years the largest pureline portfolio in the industry. Each breed has its own strengths and we believe that we must understand them to best utilize them. First, quality basic ingredients are always important in the success of any recipe, and our genetic team has understood that perfectly. Among other things, Genetiporc's pureline portfolio is the ingredient of our successful genetic program.



Industry health leader

In the early 80's, health was not a concern for genetic suppliers. Mass vaccinations were common and there was almost no information available on the costs incurred by diseases. It was only after Genetiporc was founded in 1984 and provided the first assessments on the economic impact of major diseases on swine production that the industry began to seriously examine the problem.

Genetiporc's health program has been designed to minimize production cost for commercial farms. Creating and maintaining a production network free of primary diseases and their associated economic impact has guided Genetiporc's efforts since its very foundation. The rigorous application of strict biosecurity measures constitutes a fundamental priority. Genetiporc's team has developed a biosecurity "reflex" that has become second nature.

Hands-on approach

Buying breeding stock with exceptional health status:

- Facilitates the animal quarantine process
- Prevents the introduction of new pathogens
- Prevents the introduction of new strains of an existing pathogen into the herd

Maintaining a herd's exceptional health status:

- Enhances feed conversion ability and growth rates
- Reduces expenses for medication and care
- Streamlines work processes and decreases task time
- Increases percentage of marketed pigs

Unparalleled health status

- Rigorous biosecurity protocols
- PRRS & Mycoplasma naïve network for over 20 years

Integrated R&D

As an integrated group, "we do what we sell".

The company's vertical integration ensures that development is aligned with the increasingly specific needs of consumers and producers. We use ties between nutrition, production, genetics and slaughtering at Genetiporc to capture value at each step of the production chain.

Be the more efficient pork producer.

Genetiporc will always keep exploring new ways to make improvements at every level of the production chain. By doing this, Genetiporc is representing the most efficient option for the producer.

Integrated company benefits

Partnership in genetics

Exchange germplasm and technology with large innovative breeding companies worldwide
Through strategic business partnerships Genetiporc is giving access to its customer to the best worldwide genetics available in the industry.

Develop common product adapted to customer needs

Leverage strengths from each company and build a more efficient unparalleled product for the customer.

Value added products

Our products
















Zero deviation from our quality standards

Guaranteed Meat Quality

pH	5.6 – 5.9
Color	3 - 4
Pale, Soft, Exudative	none
Dark, Firm, Dry	none
Marbling	2 - 3

The result?

Pork renowned for its flavor, juiciness and tenderness

COLOR - Texture - Exudation					
					
PSE Pale pinkish gray, very Soft and Exudative. Undesirable appearance and excessive shrinkage.	R/F/N Reddish pink, Firm and Non-exudative. This ideal quality has desirable color, firmness and water-holding capacity.	DDF Dark purplish red, very Firm and Dry. Firm and sticky surface, high water-holding capacity.			
Color Standards - Minolta L* values use D65 daylight light source					
					
1.0 Pale pinkish gray 61*	2.0 Grayish pink 55*	3.0 Reddish pink 49*	4.0 Dark reddish pink 43*	5.0 Purplish red 37*	6.0 Dark purplish red 31*
Marbling Standards - Marbling scores correspond to intramuscular lipid content					
					
1.0	2.0	3.0	4.0		
					
5.0	6.0	7.0			

duBreton

4

Our programs

Exceeding expectations

FEATURES	ORGANIC duBreton	NATURAL duBreton (U.S.) CERTIFIED HUMANE	NATURAL duBreton (Canada) ABF-VF	NATURAL USDA	CONVENTIONAL
Organic feeds, GMO free	✓	-	-	-	-
Outdoor access for animals	✓	-	-	-	-
Loose sow housing	✓	✓	-	-	-
Controlled animal welfare (farms, transportation & processing plant)	✓	✓	✓	-	-
Rendered animal by-products in feed	Never ever	Never ever	Never ever	✓	✓
Subtherapeutic antibiotics	Never ever	Never ever	Never ever	✓	✓
Therapeutic antibiotics	Never ever	Never ever	Never ever	✓	✓
Monitoring for antibiotic residues	✓	✓	✓	-	-
Deep bedding	✓	✓	-	-	-
Third-party certification	✓	✓	✓	-	-
Minimal processing	✓	✓	✓	✓	Yes & No
No preservatives	✓	✓	✓	✓	Yes & No

duBreton

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Our programs (organics)

Because it's safe meat

- GMO-free feed
- Third party certification ensures the integrity of our organic system
- Small family farm
- Animals have outdoor access
- No growth promoter
- No antibiotic
- More space in gestation and loose housing
- More space in lactation
- Raising conditions that respect the animals natural behavior
- Environmental responsibility
(to minimize all forms of pollution that may result from agricultural practices)

Why eat organic pork?



duBreton

6

Our programs

NATURAL DUBRETON US CERTIFIED HUMANE

- Third party certification ensures the integrity of our organic system.
- Annual inspection and internal audit
- Small family farm
- No growth promoter
- No hormone
- No antibiotic
- More space in gestation and loose housing (32 sq.ft vs 14 sq. ft)
- More space in lactation (6 x 8 vs 5 x 7 in conventional)
- Weaning at minimum of 28 days of age
- 2/3 Solid floor on total space for each animal
- Animals are bedded at every stage of production
- Raising conditions that respect the animals natural behavior



duBreton

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Our programs

NATURAL DUBRETON CANADA ABF

- Third party certification ensures the integrity of our organic system.
- Annual inspection and internal audit
- No growth promoter
- No hormone
- No antibiotic
- No animal by-product



duBreton

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Modern facilities

State-of-the-art pork processing plant overview

Rivière-du-Loup, Quebec

Traceability Program

...at the farm: Hogs identified with tattooed numbers

...at the slaughterhouse: Classification, identification, and cutting of carcasses

- Receiving slip with tattooed numbers
- Classification of carcasses per program
- Individual identification of carcasses (reference to tattooed number and chip in the hook)
- Traceability based on time of processing (day, time, producer)
- Identification of cuts to be taken to market, with reference to carcasses



duBreton

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duBreton at a glance

Selected List of duBreton Customers, as of



duBreton

6

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- www.genetiporc.com

THE BOTTOM LINE

LOWERING FEED COSTS

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... UK practical nutritionist's perspective...

...often with costly penalties!!!

...possibly due to the neglect or misuse of the **“Tools of the Trade”**.

BASIC FACT

As recently described by Janice Murphy, almost irrespective of where you are working around the world, feed costs represent 65%-75% of the variable costs of swine production; this fraction is the biggest slice of the cost of production pie and hence is prone to attract the most interest when pressures on profitability or mitigation of loss are being felt. As a result, the level of feed costs always plays a major role in determining the profitability of a swine enterprise and must be foremost in the pig producer's mind. Whilst cereal and extracted soya bean meal are the comfortable industry standards for supplying energy and protein, there are many suitable alternatives that meet nutritional requirements while reducing the cost of the ration. But nothing is new! The principles are well known.

Sadly, the above comments could be applied just as well when I arrived at the start of my journey in commercial pig nutrition advisory work, 3 decades ago, and they have not altered much since but we have at least gained some useful experience along the way, albeit probably only capable of being mostly described as anecdotal. However, these anecdotal experiences have formed the basis for a rule book on how to proceed but the rule book is always going to be pig enterprise specific and hence the route along the associated road map will vary from unit to unit and country to country. This rule book always demonstrates the key role of the tools of the trade.

At this stage, it is most important that the title of this talk must be extended, first losing the plural “s”, leaving the word “cost”, and then rolling into the qualifier, “per unit of productive gain, saleable meat or, perhaps, better still, consumer acceptable (and routinely re-purchased) lean tissue”. This far better describes the target that the commercial pig nutritionist should be aiming at and hence my own approach to feed cost control is always a holistic one.

Whilst the circumstances surrounding my making this type of nutritional presentation have changed, both in the general audience make-up and the continent on which the lectern is located, the fundamental messages have altered little over those intervening 30 years. It is possible that, in reality, it is merely the volume of my personal plea for greater focussed research funding and testing activity that has changed, even if that research might only take the form of the ultimate in

extension studies using the farms in question where the desire to lower feed costs is being expressed.

In doing my homework for this talk, I sought the guidance of a Canadian researcher (formerly of the Prairie Swine Centre), not directly personally but from one of his most recent presentations in his newly adopted research base some 500 miles away from this city, and I found a strap-line which I intend to use on my travels for the next few years. This saying does highlight the key omission which goes some way towards explaining why there has been relatively little progress over these 3 decades, as follows:

“What gets measured gets managed” (attributed to John F. Patience and also being used by Greg in the next presentation) - is this perhaps a positive portent for the future improvements in cost control?

You will find that I reflect on this strap-line a lot as we proceed through the presentation and how the simple day-to-day activities of the humble nutritionist are hampered by a lack of meaningful measurement leading to reliance on anecdotal support rather than good, solid science or statistics.

In general, this talk will be a reflection of my own thought processes as I approach different growing/finishing cost of production challenges in my day-to-day activity in the UK.

Before we can attempt to lower something, such as feed cost per kg gain, we need to know where we are starting from!

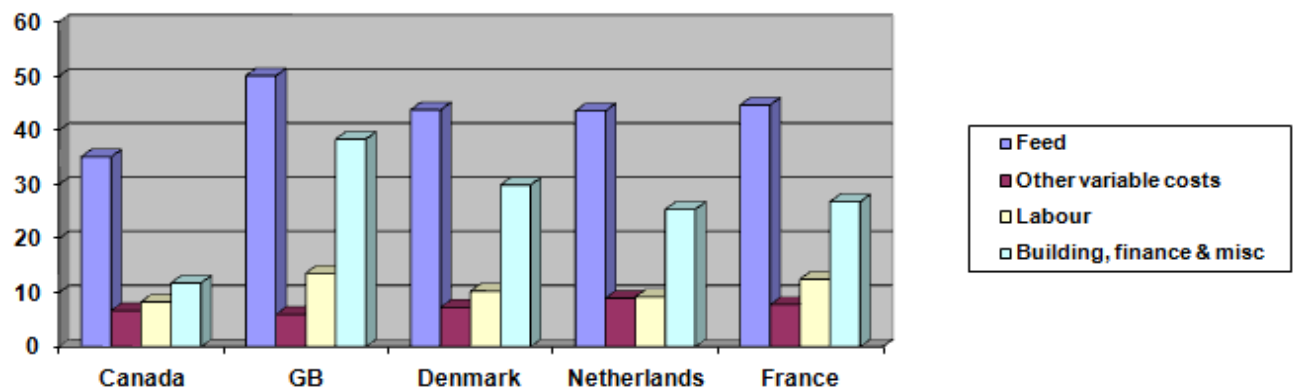
At this stage it is important to appreciate that my stand-point is as an adviser to home mixing producers with a predominant bias towards liquid co-product feeding. This role is genuinely hugely advantageous in potentially delivering influential downward pressure on feed cost per kg gain, as will become evident during the course of the presentation.

As an adviser, you do always try to seek out the start point from which to base any potential cost reduction recommendations and the only unbiased measurement information available to me is often limited to that thrown up by BPEX Ltd. the British Pig Executive, whose mandate is:

.....to represent pig levy payers in England, (being) focussed on enhancing the competitiveness, efficiency and profitability.....co-ordinating industry activity that yields a better return for levy payers than they can otherwise achieve individually.

From a global perspective, the problems that the UK pig industry and its nutritional servants face are self evident from the following figures and tables.

Figure 1. Cost of producing 1 kg of pigmeat in pence/kg (2006).



It is easy to see why feed cost reduction might be a primary driver in the UK!!!

Table 1. Performance trends in Great Britain from Agrosoft consolidation.

	2003	2004	2005	2006	2007
Rearing herd					
Weight at start kg	7.3	7.4	7.3	7.3	7.4
Weight of pigs out kg	34.7	36.4	36.3	35.1	35.3
Mortality %	4.3	5.0	3.4	2.5	2.7
FCR	1.77	1.84	1.70	1.71	1.82
DLWG g	462	449	509	493	453
Feeding herd					
Weight at start kg	26.9	27.7	25.9	27.2	26.6
Weight of pigs out kg	96.1	97.9	96.9	98.2	98.8
Mortality %	6.5	6.7	6.5	5.6	4.8
FCR	2.74	2.77	2.74	2.75	2.73
DLWG g	627	630	639	655	673

The data in Tables 1 and 2 are consolidated values from various recording systems and hence you can always say that you can pick and choose which you select to include in the table and there are always difficulties with meaningful comparisons when the carcass weights differ so much. However, if the pig production enterprise goal is expressed as meat sold per sow per annum, with the sow being deemed to be the expensive base unit, the numbers speak for themselves. When 2 tonnes per year is the target, <1500 kg does not cut it, as they say.

In our defence, the top third of UK/GB producers (as assessed by growth rate) will achieve upwards of around 55-75 g/d extra overall in the finishing period, ie. 710 g/d in 2006 vs. 654 g/d for the average on 2006 and 733 g/d vs. 660 g/d in 2007. I always feel that we, in the UK, have a much greater range of performance from best to worst than other European countries and I

believe that this is probably directly related to lack of re-investment and hence the age of the industry, often expressed in terms of both its buildings and its ownership!!!! This is a broad generalisation and is unfair on those that are investing.

Table 2. Summary of physical performance 2006.

	Canada	GB	Denmark	Netherlands	France
Rearing mortality %	2.0	2.5	3.2	2.0	2.3
Finishing mortality %	3.0	5.6	4.0	2.7	4.4
Finishing DLWG g	826	655	861	772	773
Finishing FCR	2.98	2.75	2.65	2.71	2.90
Live wt at slaughter kg	113.0	99.1	106.8	114.2	115.5
Cold carcass weight kg	90.0	74.3	80.5	88.4	88.4
Carcass meat produced per sow per year kg	1971	1461	1935	2118	2024
Lean meat percentage %	60.0	61.3	60.3	56.4	61.5
Lean meat produced per sow per year kg	1183	895	1167	1194	1245

A huge sum of levy payer money has been thrown at trying to enhance this baseline of production knowledge in the form of bench-marking but the UK has almost singularly failed at this. However, the details from one successful group appear in table 3.

It is purely by accident that the three most interesting farm subjects for grower-finisher performance appear side by side!!!! You should all be aware that data for DFI from weaning does not result from farm generated information. It is merely the result of factoring the data in the previous two rows but as such is still meaningful information. However, it is often the biggest factor in reducing the growth potential of the UK pig production enterprise.

The individual producers are number coded to hide their identity and you will see that there is an average for the group as well as the best (maximum value) and worse (minimum value) performance. On the far right hand side I reproduced the relevant BPEX values from Table 1. Note that the comparison is for weaning weight for the bench-marking group with the weight at the start of the finishing period for the BPEX data. Uniformity of data collecting or lack of it can lessen the value of a tool.

To my way of thinking this table shows the enormous strength of mensuration – always a good word to throw into a practical discussion like this! This also opens up the discussion of lessening feed cost per unit gain into its two component parts, i.e. absolute cost per tonne of feed and the efficiency with which that feed is utilised through the target animal in its particular environment.

Table 3. Bench-marketing group herd performance data – year to end Nov 2007.

Parameter/Producer No	1	2	3	4	5	6	7	8	9	10	11	Average	Max	Min	BPEX data
No Sows	340	400	390	304	606	315	398	506	242	570	358	393.3			
Nos Born alive	12.17	12.6	10.4	11.04	12.42	12.45	13.1	12.58	12.1	11.0	11.98	12.0	13.1	10.4	N/A
Pre Wean Mortality %	10.91	12.9	11.5	8.9	6.42	17.45	11.2	13.3	12.37	10.1	11.9	11.3	17.45	6.42	N/A
Nos Weaned	10.89	11.0	9.2	10.06	11.27	10.28	11.6	10.5	10.7	9.8	10.63	10.6	11.63	9.2	N/A
Litters/ Sow/Yr	2.35	2.35	2.29	2.25	2.32	2.37	2.39	2.34	2.36	2.26	2.38	2.3	2.39	2.25	N/A
Weaned/Sow/Yr	25.63	25.82	22	22.64	26.14	24.32	27.8	24.7	25.25	22.8	25.33	24.9	27.8	22.0	N/A
Wean/Service Interval	5.24	5.7	8.0	5.6	6.42	5.0	N/A	N/A	5.4	6.0	5.4	6.0	8.0	5.0	N/A
Farrowing Rate %	85.9	87.5	88.7	82.9	89.9	76.28	93.0	89.0	89.0	79.0	87.56	86.3	93.0	76.28	N/A
Sow Feed tonnes/yr	1.08	1.15	N/A	1.04	0.96	1.32	1.26	1.27	N/A	1.25	N/A	1.1	1.32	0.96	N/A
Weaning Age d	26.74	28.0	28.0	24.75	26.35	27.82	27.0	26.0	28.0	25.9	28.1	27.0	28.0	24.75	N/A
Av Wean Wt kg	7.8	8.6	6.5	7.5	7.51	8.0	7.3	7.0	7.5	7.5	N/A	7.6	8.6	6.5	26.6
Slaughter LWt kg	110.2	103.7	102.7	115.0	104.5	111.5	101	104.0	100.0	108.3	102.0	107.0	115.0	100.0	98.8
FCE from Weaning	2.72	2.38	N/A	2.78	2.46	2.5	2.6	2.52	N/A	2.6	N/A	2.6	2.78	2.38	2.73
DLWG from Weaning g	617	674	N/A	672	591	737.5	612	655	714	655	N/A	650.6	737.5	591	673
DFI from Weaning kg	1.68	1.60	N/A	1.87	1.45	1.84	1.59	1.65	N/A	1.70	N/A	1.69	2.05	1.41	1.84
Post Wean Mortality %	6.8	3.74	9.0	7.6	6.3	5.15	7.5	5.0	6.0	8.5	N/A	6.6	9.0	3.74	4.8

Short term economics – is this a British disease? I do not travel the globe, it is difficult enough working for a British company and having your headquarters and boss in another country whilst you live in the same nation, but I reckon that short term economics is at least a human condition.

What do I mean by short term economics? Common sense or human nature tends to suggest that it is easier to reduce your feed costs by paying less per tonne today than expecting an improvement in efficiency. The latter, by virtue of its dynamics, means that you need to measure performance over time into some point in the future, i.e. tomorrow, to determine improvement in response to a change. More to the point, today is here now whereas tomorrow, hell, don't they say that that never comes!!!!? This scenario often can determine the producer motivation to drive the desire to reduce the feed cost component of the overall production costs by only one means, much to the chagrin of the commercial nutritionist who then must become a mix of politician, psychologist and wily strategist to direct progress to actually reduce cost per unit of production. I am five pages into the paper and my natural cynicism has only just reared its head!!!

For years we have been directed by the geneticists and the nutritional scientists that there are clear nutrient requirements for pig growth but in the light of this knowledge, why are such vast differences in performance still being seen? The answer, of course, is very simple, namely that commercially it is nutrient ALLOWANCE that determines growth outcomes and not REQUIREMENT. Furthermore, the genetic predictability of growth flies out of the window just as soon as mixed gene lines are used on farm and, in this regard, it is important to note that purchased pooled semen is commonly used on UK pig units. In this regard, one also presumes that growth rate ranks highly on the list of reasons for genetic change whereas most recently in the UK it has been reducing feeding herd mortality, in the face of the combination of PCV and PRRS, that has been the driver of that genetic change, interestingly enough often with little thought being given to production outcomes, until they have come out, if indeed they ever do very clearly.

The ALLOWANCE is an expression of the REQUIREMENT in the singular environment that the growing/finishing pig experiences. From research, the REQUIREMENT has normally been expressed when the variables acting upon the pig have been either controlled or rendered highly predictable. Commercial reality is where the ALLOWANCE rears its head with its myriad of variables often in an uncontrolled fashion.

Hence predictability of outcome can only be achieved by the application of control over the variables or those that are within the realms of control in the circumstances that apply on the farm in question. So, which variables are routinely out of our control as we approach feed cost reduction challenges? A few that come quickly to mind are:

1. The semi-intensive housing that is widely used in the UK ensures that temperature flux and air change are a lottery. We know that oscillation in environmental temperature, even within the “comfort zone” of the pig, produces unpredictable growth and feed efficiency outcomes.
2. The pre-occupation in the UK with the use of an ingredient that, were it proffered to the Health & Safety Executive today, would fail to gain a certificate of approval, but is heavily

promoted for its contribution to animal welfare, namely straw, has an unpredictably negative effect on feed digestibility, respiratory health and the appearance of chemical toxins.

3. The UK has either retained very old pig-sick grower/finishing housing or has gone into large group size systems both of which bring their own variable-ridden issues.

4. Finally, there is disease and how we quantify its degree of debility on pig growth or overall carcass performance, including overt payment for sold weight and penalties via tissue condemnation.

Personally, I do not believe that any of these variables are measured or controlled particularly well in the majority of UK units, if any form of meaningful control has actually been possible.

It is, in part, for the reason of attempting to compartmentalise all of the parameters affecting growing pig performance that I revisit one particular nutritional management tool on a regular basis. However, I have nevertheless struggled to find a place in this commercial nutritionist's armoury for computerised growth simulation when quality farm data are hard to find and time to skilfully pilot the simulator less easy to locate. Not to be beaten, I am just embarking on a project to assist with the refinement of the most recent product of this type to appear in the EU market, namely INRA Porc. This product is as good as they get and I cannot deny that there will be a place for such systems when the predictability of the outcomes can have greater guarantees. Currently adequate expression of disease and group size effects on growth outcomes leaves something to be desired in simulation and we are hopeful that the emergence of an exciting new tool will enhance the accuracy of the simulator.

Until this time, I rely on the best that practical experience and close cooperation with producers brings. So, what happens in practice?

Table 4. Bench-marketing group herd performance data – selected extract.

	1	2	3	4	5	6
Av Wean Wt kg	7.8	8.6	6.5	7.5	7.5	8.0
Slaughter LWt kg	110.2	103.7	102.7	115.0	104.5	111.5
FCE from weaning	2.72	2.38	-	2.78	2.46	2.50
DLWG from wean g	617	674	-	672	591	738
DFI from wean kg	1.68	1.60	-	1.87	1.45	1.84
Mortality %	6.8	3.7	9.0	7.6	6.3	5.2

Back to the bench-marking group and the table above is a snap-shot from the larger database study merely focussing on the feeding herd. It is obvious, without even imposing the actual feed costs onto the chart, that there are widely varying likely outcomes for this parameter. It is awareness of this sort of data set that enables the commercial nutritionist to push for improvement with, in this case, producer 6 setting the pace. So, to demonstrate the approach can we ask why do the other two producers fall short of the mark, where do we look for the costly problem areas and how do push for improvement in what clearly impacts on feed cost? There

obviously are interactions and overlaps but, even so, this is a crucial exercise to be conducted if feed cost reduction is to be positively addressed.

FCE FROM WEANING – THE CHECK-LIST

What's to blame for Producer 4 not hitting the target? Is it poor feed utilisation, excessive competition for nutrients or feed (or nutrient) wastage?

Wastage

Clearly poor feeder design, poor feed presentation or simply running with leaky feeders is a basic mistake that is always costly but often is not remedied until the feeders are totally worn out. Short term economics perhaps? Certain ingredients of coarse particle size for which the pig has a craving will lead to the feeder being emptied as the search for the tasty morsels goes on unabated. Good examples here are dietary inclusion of lumpy chocolate and nuts. A failure to mill rape seed "meal" leads, in this case, to negative selective feeding as the pigs shuffle coarse, hard particles of high protein material to either end of the feed hopper.

Excessive Competition for Nutrients – A Selection of Candidates

1. Bugs and health. To what degree does disease elevate maintenance needs and thereby worsen feed efficiency? The fundamental information on the nutrient costs of the repeatedly activated immune system has been generated but do we really know what the £/\$ cost of a commercial disease challenge is out in the field? Do we know the cost of inadequate cleaning and disinfection of finishing buildings? The hope is that we work closely with the farm specialist veterinarian on such matters and use post mortem investigation and slaughter line data collection to create a background picture and an impression of trends.
2. Fungi and feed. To what degree does the feed threaten the intended (four-legged) consumer or deteriorate before it reaches the pig? The UK appreciates its temperate climate in that we cannot grow grain maize, which seems to attract more than its fair share of fungal interest around the globe, but we can still suffer the consequences of following crop contamination after whole crop maize. Equally, we have recently benefitted from Chinese genetics in our staple monogastric cereal crop, namely wheat, and with that has come increased fusarium head blight susceptibility with an increase in tricothecene presence, particularly in the form of DON, especially as June seems to involve rain and spore splashing. The geneticists are working to reverse this trend but I am told that we are at least 5 years away from commercial plantings. Hence we must think hard about which arable fungicide programmes to implement and lean on the specialist agronomist. Whilst last years higher fuel oil prices impacted on all downstream cracking by-product lines, propionic acid was still a very cheap insurance policy against fungal growth in the >15% moisture wheat that came out of the ground during the 2008 wheat harvest. However, what should we make of non-acid treated 17% moisture

grain showing up in store in March 2009? Bulk storage house-keeping should be an essential activity and not an occasional half-hearted consideration.

3. Bugs and feed. My involvement in the UK co-product feeding market tells me that bursting feed pipes and “redecorated” feed kitchens are stock-in-trade. These accidents happen due to the presence of wild (or deliberately included) yeasts and, to a lesser extent, bacterial action. You provide such organisms with resources for growth, i.e. moisture, carbohydrate and nitrogen feed-stock and warmth and they will respond by generating a string of waste products, including carbon dioxide. This gas subsequently increases the pressure in the feeding system until a weak point is found. Arguably the CO₂ is the least of your worries in that feeding system! Keeping to the CO₂ story, where do these yeasts get that gas from? Well, the relevant nutrient supply is in the feed mix, of course! Starch and sugars are rapidly broken down to varying degrees to alcohol and organic acid molecules with loss of dry matter. Worse still is the unbalancing effect that this has on the dietary ideal protein:energy ratio. Hence, upon lab analysis, the uncontrolled liquid feeding system almost always has more protein, oil and ash per unit of dry matter than formulation expectations would predict. Fortunately, there is some rebalancing of the protein:energy account as all microbial matter is predominantly comprised of protein and hence yeast and bacterial replication is demanding of proteinaceous matter. ‘Tis a pity that there are toxic nitrogenous metabolites produced as a consequence! Much research activity has been directed at this area and there should be no reason for uncontrolled fermentation in feeding systems but it still occurs all too regularly. Short term economics perhaps?

Poor Feed Utilisation

1. Poorly formulated diets with imbalances in either protein:energy ratio or ideal protein balance still occur due to simple misconceptions, such as weighing by volume, mis-reading conventional for 6-row barley, using soya bean oil as the substitution for soya bean meal in computerised feeding systems, etc. or the sudden appearance of farmer-driven diet formulation or failures to perform simple and routine feed (ingredient) analysis. Computerised feed formulation is the standard tool of the nutritionist’s trade and this facility has been around for years and has been perfectly functional since the early 1970’s, the days of the QELEQ, but even in its present form, it still does not always guarantee optimum feed utilisation but it will reach a solution quickly!
2. Matrix values – feed formulation activity and accuracy is only as good as the data tables held therein and these must be regularly replenished. To what degree of detail should one go? The following table illustrates the degree to which four decimal place diet formulation should, in theory, be supported by comparably detailed analysis work where even the most stable and trusted commodity should not be regarded as possessing of a single set of nutrient values.

Table 5. Average contents of essential amino acids of soyabeans collected in different Brazilian states (contents as % on an as-received basis). Data courtesy of ADM Specialty Ingredients - 2004.

Nutrient/State	Arg	Phe	His	Ile	Leu	Lys	Met	Thr	Val
GO	2.786	1.880	0.972	1.574	2.798	2.275^a	0.410 ^c	1.323 ^{bc}	1.661
MG	2.661	1.950	0.975	1.625	2.868	2.305 ^{abc}	0.402 ^{bc}	1.339 ^{bc}	1.695
MS	2.867	1.904	0.971	1.561	2.820	2.321 ^{bc}	0.375^a	1.274 ^a	1.670
MT	2.669	1.925	0.966	1.605	2.831	2.299 ^a	0.412 ^c	1.328 ^{bc}	1.650
PR	2.670	1.896	0.953	1.575	2.806	2.281 ^a	0.386 ^{ab}	1.256^a	1.628
RS	2.735	1.953	0.977	1.635	2.869	2.330 ^{bc}	0.420 ^c	1.355^{bc}	1.680
SC	2.499	1.952	0.955	1.647	2.848	2.339^c	0.421^c	1.303 ^a	1.628
Average	2.706	1.926	0.968	1.606	2.838	2.310	0.405	1.315	1.662
SD	0.144	0.050	0.020	0.047	0.053	0.046	0.030	0.063	0.042
CV %	5.323	2.576	2.088	2.916	1.887	1.991	7.326	4.762	2.538

Values in the same column followed by different letters are significantly different (p<0.01)

The data in this table have again been selected judiciously with only the three most relevant amino acids, in normal formulation work for growing pigs, being highlighted for their statistical variation via ascribed super-scripts and demonstrating the potential analytical variation by site of harvest. Best and worst values are highlighted. Fortunately for us all there may be less variation between varieties for certain commodities as the following table demonstrates, albeit devoid of statistics as this information is rather hot off the press.

Table 6. Average contents of protein and essential amino acids of different varieties of field beans (*Vicia faba*) [contents as % on an as-received basis] plus relativity to lysine of second and third limiting amino acids. Data courtesy of the GreenPig LINK Project – 2009.

	Protein	Lys	Meth %L	Meth	M+C %L	M+C	Thr %L	Thr
Spring								
Ben	23.78	1.531	11.34	0.173	30.2	0.462	54.0	0.826
Betty	25.27	1.648	11.20	0.185	30.2	0.498	55.1	0.908
Fuego	25.29	1.591	11.29	0.180	29.8	0.474	55.1	0.876
Memphis	24.85	1.595	11.53	0.184	29.6	0.472	54.9	0.876
Nemo	24.92	1.560	11.18	0.174	30.0	0.468	54.7	0.854
Synchro	24.90	1.569	11.43	0.179	30.6	0.480	55.5	0.870
Tattoo	25.34	1.599	11.09	0.177	30.1	0.482	53.9	0.861
Winter								
Arthur	25.25	1.591	11.75	0.187	31.0	0.493	54.9	0.874
Clipper	24.21	1.564	11.46	0.179	29.2	0.456	53.8	0.842
Griffin	25.23	1.615	11.72	0.189	30.7	0.496	53.8	0.868
Husky	25.90	1.614	11.08	0.179	29.7	0.479	53.5	0.864
Sultan	24.42	1.578	11.92	0.188	30.6	0.482	54.1	0.854
Wizard	25.52	1.621	11.18	0.181	30.9	0.501	53.8	0.872

Whilst the relationship of the second and third limiting essential amino acids to total lysine value is generally relatively consistent across the varieties and their sowing season, you can see that overall amino acid supply is such that I might just be more of a fan of Betty than I would Ben!!! The best and worst values again being highlighted. However, this variety choice does always presume that protein yield has predictability by growing site and by season and I dare say that tracking down the Internet link that will emerge as this 4 year GreenPig project matures will reveal this piece of the jigsaw. For the pulse genetics aficionados amongst you, you will know that there is every reason why field beans are potentially rather a poor choice to highlight inter-varietal differences on protein make-up or to hope to expect or find the basis for improvement, with that crop being a natural out-crosser. The pea variety data coming from this same piece of research may prove to be more illuminating provided that beneficial differences are not found in varieties that are destined for more lucrative human markets!

It is easy to become depressed by these complexities that lie within the matrices behind feed formulation, especially if I were vindictive enough to open up the debate of apparent ileal vs standardised ileal digestibility values or digestible vs metabolisable vs net energy systems, which you will be relieved to hear that I am not going to do. However, the next essential tool of the trade of the commercial nutritionist comes to the rescue, namely near infra-red spectroscopy. Whether it is used to characterise the essential amino acid profile of protein raw materials or simply to generate proximate analysis information for any raw material, this modern day all-in-one laboratory is totally essential to getting closer to enhancing the precision of raw material utilisation. This precision becomes all the greater as we break through into supply of regression equations even for digestible nutrients.

3. There has been plenty of research debate over the desired particle size selection for ingredients and particularly for cereals. The precise answer to this question is that it depends on your perspective. The digestibility and hence degree of utilisation of a feed particle must be a function of its surface area: weight ratio with light, small particles having the highest ratio. So let's mill the cereals as finely as possible, shall we? But what about processing cost? What about feed dust levels? What about breadth of modulus of fineness quotient and propensity for feed separation to occur on conveying meal/mash feeds from mixer to silo and silo to pig? However, with potentially in excess of 60% of slaughter pigs in the UK showing some signs of oesophageal ulceration or hyperkeratinisation, which we know to be at least for the most-part caused by abrasive particulate material of a carbohydrate origin roughing-up the stomach lining in concert with acidic reflux, can we get too fine? How can we characterise diets in terms of their functional fibre content where the balance of gut health and efficiency of feed utilisation needs to be made? This is still a point of some debate but at least when armed with a Bygholm Sieve there is a tool of the trade that will provide quantitative guidance.

DAILY FEED INTAKE FROM WEANING – THE CHECK LIST

It is basic stuff but if the pig does not eat enough, it will not grow fast enough. It's trite but it's true and the whole pack of cards stands or falls at that point! If feed intake in one situation is less

than 80% of that in another, e.g. producer 5 versus producer 4 and 6 in Table 4, what can we expect to see in terms of relative growth? The outcome is there for all to see.

There are very fundamental systems that drive voluntary feed intake and the principle of appetite determination and I am very, very ill-equipped to take this matter forward in this forum and hence I will leave this to the international gathering of experts that takes place at the pre-symposium workshop in Spain on May 19th ahead of the International Symposium on Digestive Physiology of Pigs (DPP).

I “stole” the following remark from an intra-company publication from an ex-colleague of mind, Dr. Mike Varley, who penned a rather valuable review entitled “Factors affecting the voluntary feed intake of the pig” and this is the opening sentiment from that review:

“The appetite of any living thing is the result of many years and generations of biological selection. Those animals with optimal foraging techniques were well nourished and more likely to survive, thus achieving prime reproductive fitness. Their successful diet selection skills were then passed on to offspring either by inheritance or through training. An ability of animals to select their diet has therefore evolved through a long line of naturally selected progenitors in an **unconstrained** environment”.

This review is referred to in the bibliography at the end of this paper and can be supplied upon request. Its strength is probably the fact that its 88 pages are comprised of 68 pages of references! However, I should point out that I recently read a summary note from researchers at Kansas State University that were reviewing some of their pig nutrition studies and comparing VFI values for these trials with comparative extension studies and found that the latter were of the order of 30% lower out in practical conditions. So just how applicable is the pure science?

You will note that I have emboldened the word **unconstrained** within my friend’s text as I believe that qualifier is the element that provides us with our biggest challenge to enhancing poor feed intake. Just what is it that is acting as the constraint in any practical systems?

To attack this question, the practical issues that I focus on in the field are to be found in the following list and they tend to concentrate on minimising the negative rather than accentuating the positive:

1. Is there feed in the feeding system and is it always present when the pigs require it? The term “feed outage” was a foreign concept to me until I opened up my investigation into the Barn Reporting system. This is another very valuable tool of the trade for the commercial nutritionist as it is capable of measuring the very basic requirement for growth, i.e. the merging of the animal with its feed, or not!
2. Is the pig able to access feed in the feed dispenser? Time after time I might be commended on how good a formulation might be, especially for the younger pig, only to be hit by the rejoinder.....it’s a pity that the pigs cannot get to it as it hangs up in the feeder! That is the penalty for not doing your homework and failing to appreciate that a lot of “*ad libitum*” feeders are designed, if ever they were, to restrict the flow of 3 mm

pellets and hence are not too sympathetic to an oily meal/mash feed! Careful consideration of particle grist size and efficiency of added oil dispersion are essential to provide adequate flow characteristics. In my travels, I have only been able to find one feeder in the UK market that had truly been ergonomically designed around the feeding behaviour of the pig with optimum intake and minimum wastage of meal/mash feed in mind. What does this say to you?

3. Is the pig able to adequately access feed in the feed dispenser? Determining what the provision of adequate feeding space is, is a major problem, especially when one needs to assess the impact of aggressive interactions between pigs, of which in excess of 85% happen around the feeding or drinking point. The other factor to consider here is the eating speed per meal and number of meals that any pig will make in a single day, something that is affected by both feeder design, e.g. dry vs. wet/dry vs. liquid, and diet ingredient make-up but to what degree does it impact? However the fall-back position, in ignorance, is that more feeding space is always better than less, if you can afford extra feeders!!!
4. Is the pig able to access clean feed in the feed dispenser? Floor feeding of finishing pigs still takes place in the UK! Misplacing of feeders still occurs so that fouling of feeders both restricts quality feeding space and also spoils the feed within the face of the feeder. Accumulation of moulds in feeding systems will lead to intake depression, either directly or via their metabolites.
5. Does the feed stay uniformly blended throughout the feeding system? We know that meal/mash feed can become unmixed as it is jogged around a conveying system with heavy, dense (mineral) particles sinking and light, bulky (fibrous) particles floating to the top of a meal/mash mixture in transit. We can also see evidence of particle separation in liquid feeding systems leading to the promotion of the agitator pipe by WEDA with its internal spiral. In this latter regard is the benefit of inclusion of suspending agents into the feed mix, either in artificial form e.g. M-Soup or utilising a property that is inherent within the co-product feed ingredient listing eg potato puree or soya pulp (Okara).
6. Does the diet formulation change on a regular basis, beyond that referred to in point 5 above? The presence of certain anti-nutritional factors (ANF) in various feed ingredients, e.g. glucosinates in rape seed are known to affect rate of eating but how does this vary from animal to animal given the presumed existence of greater ANF tolerances within certain breed lines or litters? Some diet changes are inadvertent but still should be better controlled and these are most often encountered in liquid co-product systems where basic chemical composition can vary from load to load and within the same load of product. The degree of fermentation of some of these materials gives rise to overtly unpalatable components, e.g. acetic acid or the range of toxic amines that will be off-putting to the acute sense of smell that the pig possesses.
7. Given marked effects of ambient temperature on voluntary feed intake what feed formulation strategies are in place to react to negative effects of hot weather?

8. What variation in inherent feed intake exists between breed lines? We should not simply assume that there is one basic feed intake curve for all breeds and the pure-bred Pietrain is a good example of an exception to the rule.
9. In the absence of accurate, short-term, pen-based dry feed usage monitoring equipment, all production systems should run (pre-weighed bagged) feed intake trials throughout the grower/finisher phase. Here there is a crucial demand for a tool of the trade as any nutritionist must own up to only being able to hope to control diet nutrient concentration. It is the knowledge of daily feed intake patterns that should be factored by requirement derived from research data, with some allowance built in, that will determine the correct nutrient density. How do nutritionists formulate correct diets currently then?
10. For liquid feeding systems, there normally is an intake recording facility built into the computation and it will be gathering data every day for every feed valve but remember that these data are structured on a volume passing through the valve per unit time basis. This is not always directly related to a fixed value of dry matter, especially in co-product feeding systems. It is very interesting to garner the feed intake data thus produced and compare its lack of day-on-day uniformity to expectations and seek out the impact of load-to-load ingredient changes.

So, if we simply assume, for now, that we have done our investigative on-farm homework to guarantee optimisation of feed intake and efficiency of utilisation of feed nutrients, what else can the nutritionist do to impact on feed cost? Finally, we can opt for the simple approach of reducing the cost of each tonne of feed. However, the null hypothesis must be retained such that we do not adversely affect intake or feed utilisation.

RATION COST REDUCTION

The generalised European approach to this challenge can be seen to some extent in Table 7 that I have again picked up from the John Patience presentation, this time originally from a recent compilation from Ruurd Zijlstra.

This table, in part, demonstrates the necessity to drive down the usage of the costly (in Europe) staple ingredient, i.e. the starch supplier, with The Netherlands' lack of available fertile arable land per unit of pig production showing that necessity certainly is the mother of invention. There is also evidence of the greater protein content of the diet in EU usage as seen from the higher use of oilseed co-products, something which is being more and more impacted upon by both nitrogen pollution pressure and the sheer cost of crude protein, which will start to affect a reduction in such figures.

If I am honest and can use what seems like a totally unsuitable description, the field of co-product usage is the sexy side of the commercial nutritionist's life! It features a rich array of products and origins, with varying or little legal constraint over their use as feedstuffs, save the obvious one regarding the compulsory avoidance of mammalian protein products. You generally do not know what a customer or supplier will challenge you with next nor, immediately have

anything approaching an appreciation of the correct application of the product to pig production nor often never do! It is the area where the upside potential for feed cost control appears to be so undeniably attractive but usually is totally out-weighted by a whole raft of hidden and potentially costly pitfalls.

Table 7. Approximate diet composition (%) by ingredient category and by geographical region.

	USA	Europe	Netherlands
Cereal grains	75	48	19
Oilseed co-products	15	25	32
Food co-products	2	14	32
Fats and oils	3	2	4
Others	5	11	13

The feed industry in the UK specifically has always had a strong tie with both the food and drinks industries with this being most admirably highlighted by the following text drawn from a most learned text on “The History of the British Pig”:

“The pig’s ability to consume and thrive on almost anything was considered a positive virtue, and the pig of the 17th century has been described by Gervaise Markham, writing in 1683, as:

...the husbandman’s best scavenger and the housewife’s most wholesome sink...for his food and his living is by that which would else rot in the yard and make it beastly.

Coates reported that some pigs during the 16th century were fattened on peas and beans, dairy and brewery wastes.

The pig’s ability to fatten on waste products was increasingly being put to use on a localised but large-scale basis from the mid-18th century onwards. Distillery waste was particularly popular, e.g. brewer’s grains, spent wash and dust from the barley stores, and the large breweries in Vauxhall, Battersea, and Wandsworth, for example, fattened some 9000 pigs annually. James and Malcolm, in 1784, quoted: Formerly that refuse was let off into the Thames.....

Waste from starch manufacturers was also considered nutritious, though not as highly as brewery by-products, as it had to be supplemented with peas and beans for adequate fattening.

In 1807, Young described how a Sir Richard Neave had successfully fattened his hogs on a diet including biscuit-makers sweepings.

Dairy waste was also used extensively as a fattening diet and pigs were regarded as an important source of profit for the well-managed dairy well into the 19th century. Thus 20 cows could supply sufficient waste for 12 hogs to be fattened to 20 score each in 1813, ten bacon and 15 pork pigs per annum in 1855. In fact, it was considered that such feeds were essential as the large quantities of grain that would otherwise be required would have been likely to render pig-fattening unprofitable”.

So, none of our current enthusiasm for exotic ingredient use is new! The detailed skill in exploiting such materials is normally the subject of a complete day's presentation for me and one that the Swine Liquid Feeding Association meeting in Stratford back in late February would have dealt with admirably so will not be addressed in detail by me now. However, the art of co-product raw material assessment is far and away best commented on in book form by Robin Crawshaw and I commend his text to you.

However, I cannot let this occasion go by without sharing at least some of my experiences of this sector of the industry with you in the form of the list of rules as follows:

1. Nutrient profile – is it consistent upon arrival? Usually no, both in terms of dry matter content and dry matter composition. Hence the essential tool of the trade is at least a basic dry matter testing kit, i.e. accurate set of scales and an oven that is capable of maintaining 100°C at an outlay of no more than £200. This process need not take longer than 3-4 hours to produce an acceptable result but faster outcomes can be generated via a £1000 outlay on a Sartorius or Mettler Toledo automated analyser. You can embellish upon the basic oven approach by using a refractometer for use in determining the dry matter of co-products with a known content of sugar in the dry matter but cuts out the electricity use! For co-products with a sizeable volatile component this must be accounted for in the final dry matter calculation. Where that volatile is alcohol, e.g. beer or brewers yeast that is slurried with beer, use a Vin-o-meter to assess the content of alcohol from a settled co-product sample. For co-product dry matter composition, always build up a dossier of analytical data by product and origin and find out as much as possible about the process from whence the co-product originates. Chemical testing of the dried residue of the co-product sample does not lend itself to NIR prediction and must use wet chemistry. This often merely generates historical data on material long since fed and hence the need for dossier generation and production plant auditing.
2. Nutrient profile – does it change over time? Usually yes, again in both dry matter content and composition. The nature and degree of this chemical alteration is product specific. Rapid use of each consignment reduces the impact of this deterioration. Deterioration is almost always problematic and is seen as a simple but costly loss of dry matter or the more insidious production of either unknown or damaging (toxic or appetite-depressing) components. The storage tank contents should be tested over the course of its life on farm for dry matter as well as meaningful but low cost chemical analysis. One positive outcome of co-product deterioration is the conversion of lactose to lactic acid with its consequent anti-bacterial functionality and minimal loss of energy per unit of dry matter.
3. Storage tank uniformity – assuming that sample testing has been derived from the assessment of a representative sample of that delivery then the resultant analysis should be consistently used in complete feed mixes. This can only be achieved in non-deteriorating product that is maintained in a homogeneous state in store. Very few co-products are natural solutions and hence will form sediments or supernatants if not adequately agitated. Any such partitioning will alter the chemical composition of the product in question in its use. Advisable tank agitation is co-product specific. Brewers yeast settles out very quickly but is easily re-suspended with the most rudimentary agitation. Potato products are usually in gel form and almost without exception will not

respond to conventional agitation but are liable to layering storage. Such products can be enhanced through carbohydrase application. Almost invariably, vertical tanks outstrip horizontal tanks for ease of maintenance of co-product uniformity.

4. Detailed nutrient profiling – unless the product in question is guaranteed of on-going supply, in meaningful quantities with significant diet saving, and without overt nutrient negatives, e.g. high salt, high potassium, unduly high laxative properties, e.g. sodium or magnesium sulphate presence or suspected ANFs, in the conventional sense, then proximate analysis would be all that would be justifiable. Even then, analysis is best to be targeted, i.e. don't always test for something that is not expected to be present, concentrate on potential for variation in the nutrients for which the formulation package is selecting its inclusion.. However, do set up a QC regime that expects the unexpected, starting by looking at, smelling and, dependant on your enthusiasm, tasting the product!
5. Palatability – the pig is an omnivore and hence will cope well with food/feed materials that we can deal with ourselves but not if unknown toxins are allowed to be present. It is folly to assume that liquid feeding will enhance dry matter intake. Avoidance of uncontrolled fermentation in the finished feeds is a must and the preferred tool of the trade is to dose the feeding system with organic acid mixtures that are specifically targeted at both yeasts and bacteria. Flushing of feed lines with water or aged low dry matter whey is beneficial to impose additional control. The only clearly beneficial liquid co-products from my limited experience are fruit jams, fruit yoghurts, chocolate and peanut butter! However, remember that sugary co-products can have a sting in the tail!!! Wasps are prone to accumulate.
6. Contamination – co-products are almost always not products of primary production interest and can indeed be wastes and, as such, can bring unwanted elements with them. HACCP planning goes without saying as safety to man and beast and consumer of that beast is of paramount importance. When such materials are not chemical or biological hazards, they can be physical in nature, e.g. broken glass (from bottling plants), stones (inorganic, from skin cleaning processes e.g. potato peelings), stones (organic, from fruit processing), plastic (from toy inclusions in packeted products), etc. all of which can damage conveying equipment and valves even before they reach the consumer! Regularly serviced filters and stone traps are essential.
7. General ease of handling – the easiest product to handle comes in a bulk tanker and flows easily through a 2 inch diameter gate valve, but such materials are not usually the order of the day. Boiled sweets in barrels are cheap as an energy source but not as cheap as margarine in tubs, mayonnaise in glass jars or cream in foil-topped plastic cartons!!! However, again necessity can be the mother of invention, with users of the latter product building crushing plants with hot water sprinkler systems and plastic recovery capability.

Always use the unorthodox missing formulation selection nutrients of “risk” and “hassle factor” in any appraisal of such materials and then strive to do all that you can to mitigate the impact of those elements.

FUTURE DIRECTION - NOW

The final assessment of the suitability of any feed cost reduction strategies must be to evaluate their impact on the physical performance of the pig throughout its growth curve and thence on to the carcass and its overall yield. To my mind, these are areas where tools of the trade are most under-utilised but with *qscan* and *qbox* I believe that we have some distinct benefits to offer to all producers of growing-finishing pigs. The breakout session will reveal all!

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BENCHMARKING AND TOOLS TO MAXIMIZE PROFIT

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ABSTRACT

An effective benchmarking effort can help improve profitability by identifying opportunities for lowering cost and improving efficiencies. Benchmarking practices are commonly used by modern production companies and businesses worldwide and should, therefore, be considered for use by swine production companies or producers. For best results, a benchmarking effort should allow comparison of both production cost and performance. By comparing financial and production data against peers and industry leaders, swine producers are more likely to find areas for improvement that otherwise might remain hidden or concealed by routine business and pressing daily activities. Methods and procedures should be put in place to ensure a benchmarking program provides an equitable and fair comparison. It is also important for a benchmarking effort to provide enough detailed information and analyses to allow investigation of why a disadvantage may exist instead of simply reporting a disadvantage or opportunity. This presentation will use a DEMO Agri Stats swine benchmarking report to show how opportunities may be identified and pursued using a structured benchmarking program.

BACKGROUND

Agri Stats, Inc.

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

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

Participants receive monthly detailed reports and graphs that allow them to compare their performance and costs to other participants, the average of all companies, the top 25% and the top five companies. Current month, previous quarter and previous twelve month periods are reported. Each monthly report contains nine sections for analysis and comparison:

- Performance Summary
- Feed Mill
- Ingredient Purchasing
- Weaned Pig Production
- Nursery
- Finishing
- Wean-To-Finish
- Market Haul
- Profit and Sales

Agri Stats account managers conduct on-site live reviews to assist with report utilization and analysis.

In swine, there currently are over seventy finishing and forty-three sow locations included in the monthly comparison. Their associated nursery, ingredient purchasing and feed mill locations are also included. The monthly report is populated by more than 1.9 million sows and over 3.1 million weaned pigs. Over a twelve month period, the number of weaned pigs included in the analysis is approximately 40 million. The finishing comparison includes nearly 36 million pigs over a twelve month period.

Benchmarking

Benchmarking is simply the act of comparing data to a contemporary group with the goal of improving performance. Although the creation of formalized benchmarking is credited to the Rank Xerox Corporation, the practice dates back to ancient times. Japan sent teams to China in 607 AD to learn best practices for business, government and education (Zimmerman, 2003). Zimmerman also mentions that “economic Darwinism” (meaning business evolution) will lead to more companies participating in and utilizing benchmarking to increase production and profitability.

Zimmerman further states that “benchmarking is a process of continuously comparing and measuring an organization’s business processing against business leaders anywhere in the world to gain information which will help the organization take action to improve performance.” Note the mention of “*continuously comparing and measuring*” and “*against business leaders*”. Obviously for benchmarking to be effective it must receive a committed and ongoing effort. Comparison should, of course, be against those companies or entities leading in the specific industry or a compilation of data from industry participants.

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

Now that we realize the purpose and benefits of benchmarking, we should be able to agree with its use in the swine industry. In fact, it is used in various forms. These range from simple production comparisons to elaborate and sophisticated total production and financial comparisons. Each and every commercial swine operation is encouraged to participate in some benchmarking effort.

BENCHMARKING TOOLS TO MAXIMIZE PROFIT

In the current swine industry, much discussion is given to the maximization of performance in specific production variables. These may include Pigs per Mated Sow per Year, Average Daily Gain, etc. Efforts to improve performance in each area of production are important and necessary for growth and survival of swine production companies and the swine industry. Benchmarking production can help improve performance and efficiency. Yet, including only production measurements in a benchmark comparison can lead to ineffective efforts and may create a level of “paradigm blindness”. Some measurements of cost and/or financial performance should also be included. We must remember the ultimate goal is increasing profitability – not simply increasing level of production. Most pages in the Agri Stats report are ranked on cost of production. A common saying in the Agri Stats circle is “you cannot produce your way to the top of the page”.

Agri Stats Finishing Example

For an example of how benchmarking would identify opportunities to improve profit, DEMO data from a constructed Agri Stats report will be used.

Table 1. DEMO Big Picture Analysis, Twelve Month Period, vs. AVG and Top 25%.

	%Tile	Rank	varT25%	DEMO	AVG	Top25%	\$vs.T25%
Profit, \$/cwt	49%	39-74	-4.22	-5.20	-5.53	-0.98	-13.3m
Sales, \$/cwt	45%	42-74	-1.65	47.19	47.09	48.84	-5.21m
Cost, \$/cwt	20%	20-52	3.22	52.39	52.72	49.17	10.2m

NOTE: THESE ARE NOT REAL NUMBERS AND ARE CREATED FOR DEMONSTRATION PURPOSES ONLY.

These numbers show us that DEMO has opportunities compared to both the average company (AVG) and the top 25% (T25%). By ranking in the 49th percentile in profit, we know immediately that opportunities exist. We can see DEMO actually has a better profit and cost position than the AVG. Therefore, the comparison should shift to the T25%. DEMO has a \$4.22/cwt disadvantage in profit compared to the T25%. This is due to a \$1.65 disadvantage in sales price received and a cost disadvantage of \$3.22/cwt. The \$4.22/cwt profit disadvantage equates to an economic impact of -\$13.3million versus the T25%. (Profit should equal sales minus cost. In this case the profit and sales comparison comes from the profit section that contains both 3-phase or feeder pig to finish and wean-to-finish farms. The cost comparison comes from the 3-phase section only since this provides a more accurate cost comparison.)

Obviously there is a cost disadvantage that needs to be investigated. The next table provides a detailed cost comparison of DEMO vs. 3-phase or feeder to finish locations.

Table 2. DEMO Detailed Finishing Cost, \$/cwt, vs. AVG and Top 25%.

	%Tile	Rank	varT25%	DEMO	AVG	Top25%	\$vs.T25%
Pig Plcmt	67%	18-52	1.46	19.78	19.95	18.32	4.61m
Facility	77%	13-52	0.03	4.79	5.11	4.76	99.1k
Feed	56%	24-52	1.58	24.74	25.01	23.16	4.99m
Mill&Del	52%	26-52	-0.07	1.52	1.54	1.59	-240k
Med&Vac	35%	34-51	0.05	0.41	0.30	0.36	165k
Haul	35%	34-51	0.08	0.53	0.42	0.45	260k
Overhead	28%	37-50	0.09	0.62	0.48	0.53	266k
Total	63%	20-52	3.22	52.39	52.72	49.17	10.2m

NOTE: THESE ARE NOT REAL NUMBERS AND ARE CREATED FOR DEMONSTRATION PURPOSES ONLY.

This detailed analysis allows us to gain multiple pieces of valuable information:

- DEMO has opportunities in each cost category and overall (see %Tile and Rank).
- We can see where DEMO has opportunities compared to the T25% and we can see where the biggest opportunities are (see varT25%).
- The \$vs.T25% column gives us the economic impact of the disadvantage vs. T25% and allows us to prioritize or target efforts toward opportunities with the greatest economic gain.
- We no longer have to guess what the areas of largest opportunity are and we would not be spending lots of time on those areas with little opportunity.

It is obvious the largest opportunity for DEMO is in feed cost - \$1.58/cwt or \$4.99 million. The Agri Stats finishing report contains sixteen pages of detailed information to help drill down and analyze factors affecting feed cost. Key factors are summarized here:

- Feed cost disadvantage vs. T25% = +\$1.58/cwt
- Ingredient owning cost vs. T25% = +\$1.63/cwt
- DEMO Mortality = 5.26%; T25% Mortality = 5.78%
- DEMO Feed Conversion = 2.67; T25% Feed Conversion = 2.80
- DEMO Caloric Feed Conversion = 4115 kcals/lb gain; T25% = 4138 kcals/lb of gain
- DEMO Adjusted Feed Cost/Ton = \$224.41; T25% = \$214.31/ton (adjusted for ingredient owning and to 1500 kcals/lb)

From these numbers we can see that DEMO has production advantages – lower mortality and better feed conversion - yet has higher feed cost/cwt. The ingredient owning cost is an Agri Stats calculation that determines an ingredient purchasing advantage or disadvantage based on geography and ingredient availability. It tells us in theory DEMO should have had a feed cost disadvantage of \$1.63/cwt based on their disadvantage in ingredient cost. After including this owning adjustment and adjusting all companies to 1500 kcal ME/lb feed, we can see DEMO has an adjusted feed cost per ton disadvantage of \$10.10/ton. Since we have removed the ingredient

purchasing disadvantage and standardized calorie content, we can conclude the only thing left to create this higher cost would be a difference in formulation. Referring to the nutrient profile pages, DEMO does show higher protein, lysine and other amino acid levels. So, we can conclude DEMO has higher feed cost/cwt due to disadvantages in ingredient purchasing and differences in feed formulation. We would then go through many ingredient purchasing pages to compare DEMO's ingredient purchasing to the average and their region. This would show opportunities in ingredient purchasing. The nutrition and production teams would likely together determine if formulation changes would be appropriate.

The second largest economic opportunity for DEMO was pig placement cost. Two pages in the Agri Stats report would provide detailed analysis of pig placement cost. The effects of placed cost per pig, mortality, placement weight and finished weight would be reported and examined to determine what would be creating a disadvantage in pig placement cost. In this example, DEMO's pig placement cost was higher because of a higher incoming cost per head and heavier placement weight. DEMO's mortality advantage helped lower their placement cost as did a slightly heavier finished pig weight. We would challenge DEMO to show an advantage in finishing age and weight since they started with a heavier pig. In this case the heavier placement weight (52 lbs vs. 48 lbs) did give DEMO an advantage in finishing weight and days (263 lbs in 184 days vs. 265 lbs in 191 days). We would then conclude that DEMO's disadvantage in pig placement cost was due to a heavier incoming pig and should not be considered an opportunity to target.

Agri Stats Weaned Pig Production Example

For a shorter example, we will look at total cost and production effects on weaned pig cost.

Table 3. DEMO Cost and Production Comparison – Effects on \$/Weaned Pig (EOC).

	Farm \$/Sow/Week	#Weaned/100 Sows/Week	Production Measurements			
			LMSY	%Pool	NBL	PWM
DEMO	13.20	39.61	2.21	7.26	11.56	12.72
AVG	12.94	41.80	2.34	5.38	11.39	13.86
T25%	11.72	45.68	2.46	3.06	11.29	11.77
EOC	0.71	1.68	1.92	0.67	-0.47	-0.41

NOTE: THESE ARE NOT REAL NUMBERS AND ARE CREATED FOR DEMONSTRATION PURPOSES ONLY.

In this case we can see DEMO has both a cost and production disadvantage in the production of weaned pigs. The Farm \$/Sow/Week number represents total sow farm cost. This data shows DEMO has higher sow farm cost which adds \$0.71 to the cost of their weaned pig. The production measurement of # Pigs Weaned /100 Sows/Week shows a disadvantage which adds \$1.68 to the cost of a weaned pig for DEMO. DEMO's disadvantage in Litters/Mated Sow/Year adds \$1.92 to the cost of their weaned pig and a larger % Gilt Pool adds \$0.67. Advantages in Number Born Live and Pre-Wean Mortality lowered DEMO's weaned pig cost \$0.88.

Therefore, we would focus on ways to analyze and improve LMSY and % Gilt Pool. There are two additional pages in the Agri Stats report that would allow us to investigate open sow days for unbred gilts and active sows. We would follow this analysis with a detailed cost per weaned pig analysis similar to the one done for finishing.

CONCLUSIONS

These examples have used constructed numbers to demonstrate how information from a swine benchmarking program can be used to identify opportunities and help improve profit. It should be clear that benchmarking can help identify opportunities and focus efforts on the opportunities with the greatest economic gain. Though all producers may not be part of or fit into an Agri Stats type benchmarking program, all producers could participate in benchmarking in some way. Commercial benchmarking opportunities are available. Producer groups could design and operate their own benchmarking effort. In these challenging economic times each producer or company must capitalize on opportunities to increase efficiency, lower cost and improve profit. Modern businesses do it as part of doing business. Swine producers or production companies should also.

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HEALTH MANAGEMENT AND PATHOGENS

THE USDA'S NATIONAL ANIMAL HEALTH MONITORING SYSTEM

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ABSTRACT

The USDA's National Animal Health Monitoring System was established in 1983 and began as a state level pilot program. Roughly every five years NAHMS in cooperation with the National Agricultural Statistics Service (NASS), the National Veterinary Services Laboratories (NVSL) and the Agricultural Research Service (ARS), conducts a study of the national swine herd and collects information on production measures, management techniques, and swine health data. A NAHMS commodity survey consists of 5 phases that take approximately three to four years to complete. These steps are: Needs Assessment, Study Design, Study Implementation, Study Analysis and Information Dissemination. In general, descriptive and inferential statistical estimates are generated after validation, editing and weighting of individual observations in datasets that are created from all questionnaires and biological sampling results. We are currently in the Study Analysis Phase and the Information Dissemination Phase for the latest swine study, Swine 2006. Selected results from Swine 2006 are presented in these proceedings to provide data in four information areas: frequency of diseases and disease agents, management practices, disease modeling and support of surveillance systems.

NAHMS HISTORY

The United States Department of Agriculture's (USDA) National Animal Health Monitoring System (NAHMS) is one of three centers within the Centers for Epidemiology and Animal Health (CEAH) in Fort Collins, Colorado. In 1862 President Lincoln signed into law the Agricultural Act that established the USDA. About 20 years later, in 1883 the USDA's Commissioner established the Veterinary Division which changed its name a year later to the Bureau of Animal Industry (BAI). In that same year (1884) the Animal Industry Act charged the BAI "to investigate and report the condition of the domestic animals and live poultry in the United States and to collect such information on these subjects as shall be valuable to the agricultural and commercial interests of the country." From 1884 to 1953 the BAI grew into roles such as animal disease research, enforcement of animal import regulations and regulation of interstate animal movement.

In 1953 the BAI and several other existing bureaus (Bureau of Plant Industry, Soils and Agricultural Engineering and the Bureau of Entomology and Plant Quarantine) became part of the USDA's Agricultural Research Service (ARS) as part of the Reorganization Plan Number Two. In another USDA reorganization in 1961, two separate divisions of the USDA, the Division of Statistics and the Crop Reporting Board were merged into the National Agricultural

Statistics Service (NASS). This sister division of the USDA provides the list or area frame from which samples are selected for NAHMS studies. In 1971 the ARS plant and animal regulatory functions separated from ARS, and briefly became the animal and plant health services (APHS). A year later the Consumer and Marketing Service (now known as the Agricultural Marketing Service - which oversees the operations of the National Pork Board) became part of APHS making it APHIS.

NAHMS traces its roots to two reports from the National Academy of Sciences (NAS). In 1966 NAS released "A Historical Survey of Animal Disease Morbidity and Mortality Reporting" that summarized past efforts to build systems of animal disease reporting (morbidity and mortality) and animal disease nomenclature. This report called for the development of a new framework in which to report animal morbidity and mortality and this framework was proposed in the 1974 report by the NAS "A Nationwide System for Animal Health Surveillance."

In 1985, the National Center for Animal Health Information Systems (NCAHIS) was created in Fort Collins, Colorado to assist in management of animal health events using computer technology and NAHMS staff followed in 1987. In 1988, the management team in Fort Collins began a conceptual plan that eventually created CEAH. Different methodologies were piloted as State-level programs in 1983 to test the paradigm of federal veterinarians collecting data on national animal health. This collection began at the state level under a pilot program administered by the states. The results were successful enough so that in 1989 there was a transition from a state to a federal level program. Originally NAHMS was created to monitor changes and trends in animal health and management in selected commodities through periodic snapshots (roughly every five years) of U.S. food animal industries. NAHMS has since grown in scope to include other types of studies in response to stakeholder needs.

There have been four swine commodity studies: 1990, 1995, 2000 and 2006. For a synopsis of the development, scope and products available from each of these studies please see page 1 of our latest report " Swine 2006, Part IV: Changes in the U.S. Pork Industry, 1990-2006 (http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/swine/swine2006/Swine2006_PartIV.pdf)

NAHMS COMMODITY STUDY PROCESS (USING SWINE 2006 AS A TEMPLATE)

A NAHMS commodity study consists of 5 phases that take approximately three to four years to complete and are roughly sequential in time. These steps are: Needs Assessment, Study Design, Study Implementation, Study Analysis and Information Dissemination.

Needs Assessment Phase

The Needs Assessment Phase reaches out to various stakeholders in the commodity industry through a series of focus groups and usually a survey soliciting opinion as to which areas of interest to investigate (e.g., management practices, specific health issues, etc.). In the case of Swine 2006 a questionnaire was given through trade magazines and was also available online. Results from input sources generate objectives for the studies. An example of an objective from

Swine 2006 was, "Establish national prevalence of select grower/finisher respiratory diseases." More specific results of this stage are available upon request.

Study Design Phase

In the Study Design Phase participating States are selected and a sampling plan and data collection instruments are constructed. The sample size in Swine 2006 was influenced by an assumed prevalence, desired precision, expected response rate and budget. A goal for NAHMS national studies is to represent at least 70 percent of the animal and producer populations in the United States. Our original sample size in Swine 2006 was 5,000 sites with an inventory of 100 or more hogs which was then allocated to each of 17 participating states. This sample represented approximately 94% of U.S. hogs and sites with over 100 hogs. Biological specimens collected in Swine 2006 included blood from grower/finisher pigs 20 weeks and older and fecal samples from their pens. Blood was tested for PRRS, Swine Influenza, Porcine Circovirus, Toxoplasma and Trichinae. Fecal samples were cultured for Salmonella, Campylobacter, E. coli and Enterococcus and antimicrobial susceptibility was determined for isolates obtained.

Study Implementation Phase

The Study Implementation Phase involves mapping out the logistics of the study and executing them. Foremost is the designing of the content and timing of each stage of the study such as personnel training, printing the data collection instruments and promoting the study. In Swine 2006 there were two stages: the NASS component and the Veterinary Medical Officer (VMO) component. The former involved a single face-to-face interview while the latter involved two interviews and the collection of biological specimens.

In the NASS component, the General Swine Farm Report (GSFR) was completed during NASS interviews between July 17 and Sept. 15, 2006. At the end of the interview NASS enumerators asked producers if they would consent to have their names turned over to VS to participate in the VMO component of Swine 2006 study. Consenting producer names turned over to VS were then contacted by coordinators in each participating state to schedule subsequent site visits by VMOs. Responses from completed GSFR's was entered into a dataset by NASS state offices which then conducted preliminary validation and editing before sending the GSFR dataset to NAHMS for additional validation and editing.

For the VMO component of Swine 2006, NAHMS staff trained NAHMS coordinators from each state on how to administer the two questionnaires and collect biologic specimens during up to two VS farm visits. Subsequently, NAHMS coordinators trained the VMOs in their state and assigned names of producers turned over from the NASS component to VMOS for scheduling of farm visits. The Initial VS Visit and Second VS Visit interviews occurred between September 5, 2006 and March 15, 2007. Biological specimens were collected during either of the two visits. Data entry was conducted by NAHMS staff along with validation and editing. Blood and fecal samples were sent to the National Veterinary Services Laboratories (NVSL) and to the Agricultural Research Service (ARS), respectively. PRRS and Swine Influenza ELISAs were performed at NVSL while aliquots were sent to the University of Minnesota and the Beltsville Agricultural Research Center (BARC) for Porcine Circovirus and Toxoplasma/Trichinae testing,

respectively. All fecal culturing and antibiotic resistance testing was done at ARS while Salmonella serotyping was done at NVSL. All results were sent back to NAHMS and linked with questionnaire data on management practices.

For each validated and edited dataset, expansion weights are calculated based on the farms selection probability and response rates among similar farms. This value tells how many farms in the original national sampling frame this participating farm represents. These weights are used to generate summary estimates that allow inference back to the original population in a statistically valid manner that reduces non response bias.

Study Analysis Phase

The Study Analysis Phase involves generating descriptive estimates (e.g., means, proportions, rates) and inferential estimates (e.g., association and strength of association measures between a farm level factor and incidence of disease). Descriptive estimates are generated first as part of standard descriptive reports, usually one report for each survey done. For example, the GSFR questionnaire's dataset became the basis for Descriptive Report Part I: Reference of Swine Health and Management Practices in the United States, 2006 in Swine 2006. We recently released Descriptive Report Part IV: Changes in the U.S. Pork Industry, 1990-2006 (January 2009) which is a compilation of select estimates from all four national swine studies. Inferential estimates involve more complex analysis, are often done in collaboration with outside researchers, and are usually published as proceedings papers or peer-reviewed scientific articles.

Information Dissemination Phase

The London Swine Conference is a part of the Information Dissemination Phase for Swine 2006. This phase includes the distribution of the aforementioned reports as well as shorter information sheets and presentations like this one. It also includes fielding inquiries and receiving input about our products. All our swine reports and information sheets are available at our website (<http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/swine/index.htm>).

NAHMS SWINE 2006 SELECTED RESULTS

In Swine 2006 our original sample size selected by NASS was 5,157 sites. In the NASS component: 2,230 completed the GSFR and 1,005 consented to be contacted by VS. For the VMO component: 514 sites were surveyed for the Initial VS Visit Questionnaire and 435 sites were surveyed for the Second VS Visit Questionnaire. For biological sampling, 185 sites allowed blood sampling from their grower/finishers and 135 sites allowed fecal sampling from their grower/finisher pens.

The following selected results provide data in four information areas commonly addressed by NAHMS commodity studies: Baselines for diseases and disease agents, Management practices, Disease modeling and Support of surveillance systems (e.g., simulation modeling). Two other information areas that our commodity studies attempt to address are not presented here: design support of observational or experimental studies and hypothesis generation.

Baselines for Diseases and Disease Agents

A major concern of the pork industry in both of our countries has been in characterizing Porcine Circovirus Associated Disease (PCVAD) in terms of pathogenesis and more basic measures such as national incidence. In the Swine 2006 and Swine 2000 national studies producers reported whether or not PCVAD had occurred in nursery-age pigs and/or grower/finisher pigs during the previous 12 months. Table 1 shows that nationally, nearly 60% of large sites and over 30% of all sites with grower/finisher pigs experienced difficulties with PCVAD in 2006. The percentage of sites reporting PCVAD in either type of pig has increased by as much as ten fold between the two study years.

Table 1. Percentage of sites with PCVAD by production phase and by size of site and by year.

PCVAD in last 12 months.	Percent Sites by Size of Site ¹ (Total Inventory)							
	Small		Medium		Large		All Sites	
	2000	2006	2000	2006	2000	2006	2000	2006
Nursery	4.4	21.5	9.1	12.5	16.6	39.6	5.7	22.3
Grower/finisher	2.3	25.0	7.9	35.4	12.2	59.9	3.6	31.3

¹Small (Fewer than 2,000), Medium (2,000-4,999), Large (5,000 or More) total inventory

Additionally in 2000, 29.6% of those who reported PCVAD in nursery pigs indicated it was diagnosed by a veterinarian or laboratory compared to 58.1% in 2006. In 2000, 53.9% of those who reported PCVAD in grower/finisher pigs indicated it was diagnosed by a veterinarian or laboratory compared to 69.7% in 2006.

In response to the Needs Assessment survey we asked more in-depth questions on PCVAD in Swine 2006. Table 2 shows that for sites that had one or more weaned market pigs with PCVAD during the previous 12 months, 19.8% of weaned pigs on large sites were affected. The earliest and latest average age of onset in these pigs was 8.9 weeks (SE 0.6) and 16.3 weeks (SE 0.6), respectively.

Table 2. Percentage of pigs with PCVAD on sites with PCVAD by size of site.

PCVAD in last 12 months.	Percent Weaned Pigs by Size of Site ¹ (Total Inventory)							
	Small		Medium		Large		All Sites	
	Pct.	SE	Pct.	SE	Pct.	SE	Pct.	SE
Percent Pigs ²	7.7	(1.5)	13.7	(5.2)	19.8	(6.0)	15.4	(3.4)

¹Small (Fewer than 2,000), Medium (2,000-4,999), Large (5,000 or More) total inventory

²As a percentage of weaned pig inventory on day of interview.

The preceding summary data was weighted to extrapolate back to the original population (e.g., 94% of operations with 100 or more pigs on site) however the following biological results are not weighted.

The serology results from NVSL are presented in Table 3 for the prevalence of antibodies to the PRRS virus, two types of Swine Influenza Virus (SIV) and either type of SIV at the sample and farm level with the latter also broken out by geographic region. For each virus, the results were summarized from farms that did not vaccinate the sampled pigs for that virus (e.g., for PRRS, did not vaccinate for PRRS, for either type of SIV did not vaccinate for either type of SIV). Nearly 50% of samples were positive for PRRS antibodies. Over 71% of sites had one or more positive samples for PRRS antibodies or either type of Swine Influenza Virus (SIV). Numerically, the East Central region had the highest percentage of sites with one or more positive samples for any of the three viruses.

Table 3. Percentage of samples and percentage of sites with one or more samples positive for PRRS, two types of Swine Influenza and either type of Swine Influenza and by region.

Antibody ¹	Prevalence (Percent of samples or sites)					
	Region ²					
	Sample	Site	North	West Central	East Central	South
PRRS virus ³	49.8	71.1	56.8	70.5	77.1	69.6
SIV H1N1 ⁴	25.5	58.2	48.7	54.6	66.7	57.1
SIV H3N2 ⁴	26.1	57.6	48.7	50.0	71.4	42.9
Either type of SIV ⁴	38.6	71.5	62.2	65.9	81.0	71.4

¹Unvaccinated Animals

²North: Michigan, Minnesota, Pennsylvania, and Wisconsin

West Central: Colorado, Kansas, Missouri, Nebraska and South Dakota

East Central: Illinois, Indiana, Iowa, and Ohio

South: Arkansas, North Carolina, Oklahoma, and Texas

³For PRRS: Of the 6,234 samples on 185 sites tested for PRRS antibodies, 5,793 (92.9 percent) were from 173 sites that did not vaccinate grower/finisher pigs for PRRS virus. These 173 sites were used in all subsequent calculations.

⁴For SI: Of the 6,235 samples on 185 sites tested for swine influenza antibodies, 5,307 were from 158 sites that did not vaccinate grower/finisher pigs for H1N1 or H3N2 virus. These 158 sites were used in all subsequent calculations.

The Salmonella serotype results from NVSL (originally cultured by ARS) presented in Table 4 show the ten most frequent Salmonella serotypes identified in the past three swine studies. The top three serotypes were the same in all three studies.

For Swine 2006, up to 60 fecal samples were collected from up to ten pens containing grower/finisher pigs on 135 sites from September 5, 2006, through March 15, 2007. A total of 7,788 samples were cultured for Salmonella. Overall, at least one sample was found culture-positive for Salmonella on 52.6% of sites, 43.5 percent of barns, and 18.4 percent of pens. Of the fecal samples cultured, 564 (7.2 percent) were positive for Salmonella. From these samples, 584 isolates were recovered (20 samples had 2 isolates). Twenty-seven different serotypes were identified; however, the top four serotypes in Table 4 accounted for 70.5 percent of isolates.

Table 4. Rank of Salmonella serotypes over the last three studies.

Rank	1995	2000	2006
1	Derby	Derby	Derby
2	Agona	Agona	Typhi. Copenhagen
3	Typhi. Copenhagen	Typhi. Copenhagen	Agona
4	Brandenberg	Heidelberg/	Anatum
5	Mbandaka/	Brandenberg (tie)	Mbandaka/
6	Typhimurium (tie)	Anatum	Typhimurium (tie)
7	Heidelberg/	Typhimurium/	Worthington
8	Anatum (tie)	Worthington (tie)	Barranquilla/
9	Enteriditis	Infantis	Johannesburg (tie)
10	Worthington	Uganda	Muenchen

Management Practices

Regarding basic management practices, Table 5 shows the percentage of sites that have a gestation or farrowing phase on site, broken out by inventory size. Nearly 40 percent of all sites had gestation and farrowing production phases. The estimates for gestation and farrowing in each inventory size are not statistically different. Also, a smaller percentage of medium sites had these production phases than their small and large counterparts nationally. Note: Tables 5 and 6 do not imply that each production phase excludes the presence of others (e.g., 39.8% of all sites have a gestation phase but they might also have a farrowing or nursery or grower/finisher phase).

Table 5. Percentage of sites by production phase and by size of site.

Production Phase	Percent Sites by Size of Site ¹ (Total Inventory)							
	Small		Medium		Large		All Sites	
	Pct.	SE	Pct.	SE	Pct.	SE	Pct.	SE
Gestation	47.3	(1.7)	19.0	(1.8)	32.4	(2.9)	39.8	(1.2)
Farrowing	46.1	(1.7)	18.9	(1.8)	32.2	(2.9)	39.0	(1.2)

¹Small (Fewer than 2,000), Medium (2,000-4,999), Large (5,000 or More) total inventory

Table 6 compares the percentage of sites that had a gestation or farrowing phase on site in the Swine 2000 and 2006 studies, broken out by region. Note the numeric decline across all regions in 2006 in the percentage of sites that contained a gestation or farrowing facility compared to 2000, with the largest drop in the West Central states. To validate this unusual finding we asked NASS to confirm this using population data in a special run and it was confirmed. This decrease may reflect the continued increase in sow productivity and the increase in size of sow farms. Therefore, much fewer sites with breeding sows are needed than before.

Table 7 compares 2000 and 2006 estimates on how pigs were housed, specifically the percentage of pigs on sites with the specified production phases that were housed (Facility Type) in each of five ways. Fewer gestating sows and gilts were housed in an open building with outside access in 2006 (5.6 percent) compared to 2000 (14.7 percent).

Table 6. Percentage of sites by production phase and by region.

Production Phase	Percent Sites by Region ¹							
	North		West Central		East Central		South	
	2000	2006	2000	2006	2000	2006	2000	2006
Gestation	50.2	39.3	65.9	48.8	50.5	38.0	42.6	33.9
Farrowing	50.1	37.7	66.2	47.4	50.6	37.6	43.5	33.7

¹North: Michigan, Minnesota, Pennsylvania, and Wisconsin

West Central: Colorado, Kansas, Missouri, Nebraska and South Dakota

East Central: Illinois, Indiana, Iowa, and Ohio

South: Arkansas, North Carolina, Oklahoma, and Texas

Table 7. For sites with the specified production phases, percentage of pigs on these sites by facility type used most in Swine 2000 and 2006.

Facility Type	Percent Pigs by Production Phase							
	Gestation ¹		Farrowing ¹		Nursery ²		Grow/finish ³	
	2000	2006	2000	2006	2000	2006	2000	2006
Total Confinement	64.2	79.7	83.4	87.8	81.8	90.4	69.9	81.0
Open building no outside access	16.4	12.8	12.4	10.1	15.9	8.0	19.7	13.5
Open building with outside access	14.7	5.6	2.9	1.4	1.7	1.0	9.2	5.1
Lot with hut or no building	2.8	1.1	0.6	0.3	0.3	0.1	0.8	0.2
Pasture (w/hut or no building)	1.9	0.8	0.7	0.4	0.3	0.5	0.4	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

¹As a percentage of sows and gilts that farrowed.

²As a percentage of pigs entering the nursery phase.

³As a percentage of pigs entering the grower/finisher phase.

As a final example, Table 8 shows the average per litter productivity in 2000 and 2006 for a six month period (December to May). Total born per litter has increased by over half a piglet (10.9 in 2000 to 11.5 in 2006) on average and the number weaned per litter has increased on average by half a pig (8.9 in 2000 to 9.4 in 2006).

Table 8. Average per litter productivity in 2000 and 2006 (6 month period-December to May).

Measure	2000	2006
Stillbirths and mummies per litter	0.9	1.0
Born alive per litter	10.0	10.5
Total born per litter	10.9	11.5
Prewaning deaths per litter	1.1	1.1
Weaned per litter	8.9	9.4

Disease Modeling

Another application of data collected in the NAHMS Swine 2006 is to construct statistical models to identify factors associated with some outcome of interest. Because of the current interest in PCVAD a weighted, clustered logistic regression model was developed to shed light on the relationship between PCVAD and other concurrent respiratory disease in pigs or their vaccination status. Table 9 shows the final results of the model with the event of interest being whether or not weaned pigs on a site experienced PCVAD in the last 12 months and the factors of interest being the number of respiratory diseases the grower/finisher pigs on that site experienced in the same time period.

Table 9. Variable significant at $P \leq 0.05$ using the binomial distributions with weighted logistic regression and 2 levels of clustering.

Variable	Value	Odds Ratio	Lower 95% CI	Upper 95% CI	Overall P value	Individual value P value
Intercept	N/A	0.058	0.013	0.251	<0.001	N/A
Number of	0 ¹	1.00	1.00	1.00	<0.001	N/A
Respiratory	1	4.39	1.66	11.63		0.003
diseases	2	18.35	7.50	44.90		<0.001

¹Referent level

The most important factor associated with PCVAD in weaned pigs from this model is the history of respiratory disease in the grower/finisher pigs. If the site reported one respiratory disease problem (e.g., *Actinobacillus pleuropneumoniae* (APP), *Mycoplasma*, Influenza or PRRS) in grower/finisher pigs during the previous 12 months then the odds of PCVAD being reported on the site is over four times greater than sites not having any of these respiratory diseases in grower/finisher pigs during the previous 12 months. If more than one of these respiratory diseases is reported the odds of seeing PCVAD on the site went up over eighteen times (18.4) compared to not having any of these respiratory diseases. Is PCVAD the chicken or the egg when comparing it to a history of respiratory disease?

Over 92 percent of farms that had grower/finisher pigs and experienced one or more of the following respiratory diseases: APP, Glasser's disease, *Mycoplasma pneumonia*, Influenza or PRRS over the last 12 months also had an episode of PCVAD in the last 12 months in their weaned pigs.

Dr. Mike Murtaugh at the University of Minnesota developed a capsid protein ELISA to test for the presence of PCV2. There is no accepted gold standard test for measuring PCV2 exposure so to determine the accuracy of this test and that of a TaqMan real time PCR a Bayesian analysis was conducted. A Bayesian analysis can determine the sensitivity (Se) and specificity (Sp) of the ELISA and the PCR despite the absence of a gold standard. This type of analysis evaluated not only the Se and Sp as a measure of accuracy of the two tests, but the ranges of prevalence for exposure to this virus in potentially exposed and unexposed populations of pigs. This last is absent from previous literature. Of the 6,238 blood samples collected in the Swine 2006 survey 6,046 were tested by his lab for the presence of PCV2 antibodies while 4,147 of these samples were tested for the presence of PCV2 DNA using a TaqMan real time PCR. At an ELISA cutoff

of > 0.4 optical density the new ELISA test had a mean Se of 81% and a mean Sp of 74%. The PCR test had a mean Se of 85% and a mean Sp of 94%. The population prevalence for PCV2 was estimated to be 96-99%.

Survival analysis is a common technique used to estimate the factors that influence time until an event occurs, such as death. Dr. Francisco Olea-Popelka of Colorado State University is applying this analysis method to Swine 2006 data to determine how farm level factors influence the concentration of antimicrobials necessary to inhibit Salmonella.

Support of Surveillance Systems (e.g., simulation modeling)

Within CEAH there are a variety of researchers that collaborate with academia in devising models to predict the spread of a foreign animal disease in national commodity herds. These researchers are hampered (some say blessed) by the fact that such an event rarely occurs in the U.S. so there is little real data that is useful in assisting their efforts and they must often rely on "best guess" parameter estimates. Among parameter estimates that would be useful in modeling spread of disease are the shipping practices of farms in the U.S. In Swine 2006 a series of questions on the GSFR enabled summary statistics as to the nature of pig shipments in this country. Table 10 shows an example of this with national percentages of shipments by destination for sites that sold or shipped at least one pig off-site from December 2005 through May 2006. Nearly two-thirds of shipments (62.7 percent) went directly to slaughter.

Table 10. Percentage of shipments by destination.

Destination	Percent Shipments
Directly to slaughter	62.7
Sale/auction	5.3
Dealer	3.0
Show/fair	2.2
Feedlot/feed yard	1.3
Another operation	15.7
Another site-part of op.	9.8
Total	100.0

SWINE 2007 – SMALL ENTERPRISE STUDY

The 2007 Small Enterprise Swine study was conducted in cooperation with the National Surveillance Unit at CEAH to provide production and management population estimates for a previously unsurveyed segment of the swine industry, operations with fewer than 100 pigs. It was also done to describe risks related to feral swine, including the reintroduction of pseudorabies and classical swine fever (CSF) into the overall national herd. Pseudorabies and CSF have many common risk factors, and exposure of small enterprise herds to feral swine is an undocumented risk for reintroduction and transmission of these two diseases and possibly other foreign animal diseases.

Thirty-one States representing 84.4 percent of the total number of operations with 99 or fewer hogs nationally and 88.3 percent of the U.S. pig inventory on operations with fewer than 100 pigs at the time of the 2002 Census were selected. These States were included primarily because of their geographic location, as well as potential risk for pseudorabies and CSF.

Selected operations were mailed a prescreening questionnaire in 2007 (May 14, first mailing; May 29, second mailing) to determine if they had any pigs from June 1, 2006, through May 31, 2007. Those who did not respond to this prescreening questionnaire received a computer-assisted telephone interview (CATI) followup call (June 11 to 29, 2007) to obtain the relevant inventory information.

Operations from the prescreening questionnaire with fewer than 100 pigs from June 1, 2006, through May 31, 2007, were eligible to be mailed a GSFR questionnaire. Respondents filled out the GSFR and mailed it back to NASS State offices, or NASS enumerators administered the GSFR questionnaire via CATI with each selected producer. The first mailing was sent on August 2 and the second on August 16, 2007. Phone followup was conducted August 30 through September 18, 2007.

NASS performed initial data entry and validation. Data from mail-ins and CATI administration were entered into a dataset, and the edit and validation programs were executed. NAHMS staff performed additional data validation on the entire data set after data from all States were combined. Results for this study are available at the NAHMS website

CONSIDERATIONS IN A VOLUNTARY FIELD BASED APPROACH

Problems associated with voluntary commodity studies fall into roughly two categories: Commodity Structure and Logistics. In the case of the pork industry in the U.S. the commodity business structure increasingly consists of contractors and contractees rather than sole owners of the pigs and facilities. Assisting the enumerators and VMOs in finding the people who can answer the questions on the surveys most accurately is a challenge. Often in this type of relationship the person at the facility cannot answer health questions because the company that owns the pigs has their own veterinary staff. Also, the owners of the pigs may forbid the site person from answering any questions about their pigs.

In addition to newly predominating business structures such as the contractors/contractees relationship, the agencies of the federal government such as the Office of Management and Budget (OMB) increasingly mandate that we burden the public as little as possible in our studies. Many producers have "survey fatigue" in which they are constantly pressured to answer questions about their business through mail and phone. In the spirit of this and for statistical reasons as well NAHMS may also have to develop alternate sampling strategies to reflect that most of the pigs are in the hands of a few companies nationally.

In studies of this type the logistics of a successful completion of the study are huge. In Swine 2006 there needed to be communication ongoing between NASS, NVSL, ARS, VMO field

offices, pork industry representatives and state agencies to name a few. Diminishing budgets mean a crimp on resources at all levels involved in a national commodity survey in terms of funding, lab capacity and field personnel. These considerations are by no means an exhaustive list.

OTHER SURVEILLANCE CENTERS AT CEAH

CEAH is currently comprised of three Centers: the Center for Emerging Issues, the National Animal Health Monitoring System and the National Surveillance Unit. One of these, the National Surveillance Unit (NSU) was established by Veterinary Services in 2003 and is the first unit within VS devoted solely to surveillance and surveillance enhancement. Specific responsibilities of NSU include: coordinating and integrating surveillance activities, leading the planning and design of surveillance strategies and make recommendations to implement these strategies, working with the National Center for Animal Health Programs (NCAHP) and CEAH to enhance surveillance of program diseases (Brucellosis and pseudorabies virus (PRV)), foreign animal diseases, and emerging animal diseases.

The other center, The Center for Emerging Issues (CEI) was formed in the early 1990s to address emerging animal health issues. CEI is composed of three units: The Business Intelligence Team The Spatial Epidemiology Team (SET) and the Emerging Disease Tracking Analysis and Forecasting Team (TAF). The Business Intelligence Team (BEI) promotes innovative, systematic thinking processes that identify broad change drivers that have the potential to shape Veterinary Service's future operating environment. The Spatial Epidemiology Team (SET) supports Veterinary Services' spatial analysis and modeling needs in animal health surveillance, incident management, and epidemiological analysis. The Emerging Disease Tracking, Analysis, and Forecasting team (TAF) works to identify potential emerging animal health issues, assess and analyze emerging animal health issues, and forecast disease emergence.

ZOONOTIC DISEASES FROM PIGS

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INTRODUCTION

General Overview of Zoonoses

Zoonotic disease (zoonosis) is most commonly defined as any disease and/or infection which is naturally transmissible from vertebrate animals to man (WHO). The number of zoonosis is estimated to be at least 200, although this number could be much higher, depending how we classify agents. Although already high, this number is expected to increase further, in part due to changes in agricultural practices, human population growth, pathogen evolution, and international trade (Woolhouse and Gowtage-Sequeria, 2005).

The first key point in the above definition is that animals could show clinical signs (disease), or just transmit the agent (infection) to humans. In swine populations, a typical example of the former zoonosis would be a clinical disease in pigs caused by *Streptococcus suis*, whereas a typical example of the latter one would be infection with *Yersinia enterocolitica* which could have high prevalence on swine farms; but without any apparent clinical problems in pigs.

The second key point of the definition is “naturally transmissible”. For infection to transmit between an animal and a person, contact between the two is needed and some probability of transmission during this contact. Along the swine and pork production chain, people have variety of contacts with pigs, their products and byproducts. During each stage, opportunities for contacts occur, but frequency and type of contacts differ along that chain. With this variability, high exposure and high risk demographic groups will vary.

As a food animal species, pigs are raised globally but under a variety of production systems. Distribution and occurrence of specific zoonosis in swine is directly linked with this environment. Perhaps the best illustration of this is occurrence of *Taenia solium*, parasite of high public health importance in many undeveloped countries, but not existent in modern swine production.

The objective of this article is to give an overview of selected endemic and emerging zoonotic agents in the modern swine production systems, and to show data about several zoonotic pathogens pertaining to Ontario. For the purpose of this overview, infections will be classified into the following, mutually non-exclusive, categories: foodborne zoonoses, and occupational zoonoses.

FOODBORNE ZONOSSES

Salmonella

Infection with *Salmonella* is one of the most frequent reported causes of enteric illnesses in humans in industrialized countries. Between 1996 and 2001 in Ontario, the incidence of sporadic cases of enteric disease due to *Salmonella* was 22.6 per 100,000 people, which was the second highest incidence among the eight reportable pathogens (Lee and Middleton, 2003).

Between 4.5% and 23% of human salmonellosis worldwide have been attributed to pork (Lee and Middleton, 2003; Hald et al, 2004; Hald and Wegener, 1999). Although proportionally not as significant as poultry and eggs, these statistics place pork as an important animal food-source contributor to salmonellosis, and *Salmonella* as the most important foodborne pathogen of the swine industry in industrialized countries.

While pigs can be infected with many different serovars, clinical disease is caused mainly by *S. Choleraesuis*, *S. Typhisuis*, and *S. Typhimurium* (Fedorka-Cray et al, 2000). Consequently, meat from pigs showing no clinical signs or lesions may be contaminated with *Salmonella*, and quality assurance throughout the production chain is required to lower the contamination level of the final product (Blaha, 1999). Due to public health implications, *Salmonella* surveillance programs may also have a potential to be used for commercial or trade purposes (Davies and Hueston, 2004). Interestingly, *S. Choleraesuis* has not been detected in Ontario recently, whereas *S. Typhimurium* is the most common *Salmonella* serotype in Ontario pigs.

On-farm management procedures have been evaluated as part of the overall effort to decrease *Salmonellae* in the preharvest portion of the production chain. Many of these studies evaluated farm-level management procedures (Beloeil et al, 2004; Lo Fo Wong et al, 2004; Nollet et al, 2004; van der Wolf et al, 2001). Although several management factors that could lower the risk of *Salmonella* shedding are identified, eradicating *Salmonella* from swine farms is unrealistic at this point. A realistic objective is disease control, which should be implemented using combination of measures along the pork production chain.

Yersinia enterocolitica

On the basis of biochemical properties, *Y. enterocolitica* is frequently classified into six biotypes, one of which (1A) is considered non-pathogenic for people, whereas others are considered to be human pathogens (1B, 2, 3, 4, and 5) (Nesbakken, 2005). Based on serological properties associated with another group of antigens, *Y. enterocolitica* is additionally classified into approximately 60 serotypes, 11 of which are reported to be associated with clinical illness in people (Bottone, 1999). Sources of *Y. enterocolitica* include the intestinal tract of mammalian, avian, and cold-blooded species (Bottone, 1997), and the environment, including water and soil (Bottone, 1997; Nesbakken, 2005). Environmental isolates are commonly classified as non-pathogenic, whereas animal isolates are typically classified as pathogenic (Bottone, 1997). In particular, porcine sources are frequently associated with pathogenic serotypes (O:3, O:9, and O:5,27) (Bottone, 1997; Nesbakken, 2005), and sometimes with the highly virulent serotype O:8 (Bottone, 1997).

Infection with *Y. enterocolitica* in humans may cause clinical disease affecting the gastrointestinal tract. Clinical signs may include watery, occasionally bloody, diarrhea; signs suggestive of appendicitis; necrotizing enterocolitis; and septicemia (Bottone, 1997). Infection with *Y. enterocolitica* in people may have a greater economic and public health burden than what is suggested by the incidence of reported cases (Nesbakken, 2005). Changes in farming, as well as the food processing industry might have contributed to the occurrence of this pathogen. A feature that likely has an impact on this emergence is the ability of *Y. enterocolitica* to multiply at temperatures near 0° C (Nesbakken, 2005).

The annual incidence of reported cases of *Y. enterocolitica* was 3 cases per 100,000 people in Ontario in the period between 1997 and 2001 (Lee and Middleton, 2003). Of the eight reportable and laboratory confirmed enteric pathogens, this was the fourth highest incidence, accounting for a 3.9% of total cases. Approximately 90% of clinical yersiniosis cases are considered to be of foodborne origin (Mead et al, 1999), and pork is an important source (Bottone, 1997; Jones, 2003; Nesbakken, 2005). In Ontario, 72.7% of people with yersiniosis were epidemiologically linked with pork (Lee and Middleton, 2003). In Denmark, the incidence of pork-related human yersiniosis and salmonellosis in 1996 was equal, at an estimated 9 cases per 100,000 people (Nielsen and Wegener, 1997).

Infection with *Y. enterocolitica* in pigs does not cause clinical disease. As such, it does not present a production problem, which disqualifies this pathogen as a subject of passive monitoring through clinical signs followed by diagnostic testing. Results collected during Ontario Swine Sentinel Project confirmed that finishing pigs shed *Y. enterocolitica* (Table 1). The most frequently identified *Y. enterocolitica* in all three years was phenotyped 4, O:3, a bioserotype frequently associated with clinical disease in people. Our data also demonstrated that herds tended to be repeatedly positive with the same bioserotype suggesting the presence of farm environmental contaminants, or alternatively, a cycle of repeated infections in pigs.

Interestingly, association between type of feed and *Yersinia* positivity was detected, but was opposite to common findings for *Salmonella*. For *Yersinia*, liquid feeding was found to be a factor that increases positivity, but this needs to be interpreted cautiously until we have more evidence to support or refute this finding.

Table 1. Pig and herd seroprevalence or prevalence of shedding of selected zoonotic pathogens.

Agent	Year	Pig prevalence (%)	Herd prevalence (%)
SIV H1N1	2001	61.1	87.7
SIV H1N1	2001	24.3	47.2
SIV H3N2 (TX	2003	0.7	9.2
SIV H3N2 (CO)	2003	0.6	7.9
<i>Toxoplasma gondii</i>	2001/03/04	1.4/0.06/0.25	13.7/1.3/3.8
<i>Salmonella enterica</i>	2004	11.4	46.3
<i>Yersinia enterocolitica</i>	2004	12.5	37.5

Toxoplasma gondii

Toxoplasma gondii (*T. gondii*) is a parasite with worldwide distribution. It is able to infect all warm-blooded animals and invade multiple cell types within these animals (Tenter et al, 2000). The life cycle of this parasite is divided into two parts. The sexual cycle occurs in the intestines of cats, which are the definitive hosts. This cycle results in the production of environmentally-resistant oocysts, each containing 4 sporozoites. The asexual cycle occurs in tissues of various mammalian and avian species which are the intermediate hosts. Tissue cysts may have lifelong persistence (Tenter et al, 2000). Tissue cysts stimulate the immune system, so that infected hosts become serologically positive and immune to new infections (Tenter et al, 2000). Seropositivity correlates with potential infectivity of the meat in food-producing animals (Dubey et al, 1995). *Toxoplasma gondii* may infect definitive and intermediate hosts through different routes. For example, orally through the ingestion of: meat containing tissue cysts and tachyzoites (foodborne; horizontal transmission); food and water contaminated with oocysts (foodborne; horizontal transmission); or transplacental with tachyzoites (congenital; vertical transmission).

Seroprevalence vary between countries and geographical regions, but overall seroprevalence in the global human population is high (Tenter et al, 2000). In a recent serological survey of the human population of the United States, 22.5% tested positive (Jones et al, 2001). Acute infection with *T. gondii* (toxoplasmosis) in healthy people most frequently is asymptomatic or manifests with non-specific symptoms, although outbreaks of clinical disease have been recorded (Ho-Yen, 1992). Similarly, chronic toxoplasmosis in healthy people is most frequently a dormant, asymptomatic, but persistent infection.

In contrast, during acute toxoplasmosis in pregnant women, tachyzoites may transplacentally infect the unborn fetus and cause conditions that range from asymptomatic infection to death or serious disability of children (Gagne, 2001). Moreover, toxoplasmosis in immunocompromised people may manifest as a serious clinical disease with lesions located in the central nervous system (Skiest, 2002) or other organs (Gagne, 2001). Foodborne toxoplasmosis has been reported as the third leading cause of mortality due to foodborne illness in the American population (Mead et al, 1999).

Toxoplasmosis in pigs is not a production problem (Lindsay et al, 1999). However, pork is considered as one of possible sources of foodborne toxoplasmosis in people (Evans, 1992). Changes in the pig farming systems over time have decreased the contact of swine with the outside environment, thus decreasing the *T. gondii* prevalence to a low level (Tenter et al, 2000). This low prevalence is also reflected in the way researchers currently look at swine toxoplasmosis. For example, Van Knapen et al (1995) recommended the use of within-herd seroprevalence of *T. gondii* infection as an indicator of pig contact with the outside environment, and Blaha (1999) considered the production of pork free of *T. gondii* as one of the objectives of quality assurance programs.

In early 1990s the apparent seroprevalence of 6.6 % in finisher pigs and 16.2% in sows was determined (Gajadhar et al, 1998; Smith, 1991) in these studies. In three Ontario studies, based on Ontario Swine Sentinel Project, in 2001, one herd had an apparent prevalence close to 50%, and 6% of herds had an apparent prevalence of $\geq 10\%$. In contrast, only one herd in 2004 had an

apparent prevalence of 10% (2 out of 20 tested), while other apparently positive herds in 2003 and 2004 each had only one positive pig (Table 1).

Campylobacter

Incidence of campylobacteriosis in the last several years regularly ranks highest among reported foodborne pathogens. It has been reported that it infects an estimated 1% of the population of Western Europe each year (Humphrey et al, 2007). *Campylobacter* species are particularly important for food safety, *C. jejuni* and *C. coli*, with the former causing the majority of human disease. Poultry is considered as a primary source of *Campylobacter jejuni*, whereas potential importance of swine, measured by prevalence of this type in swine, varies among regions. While in some regions *C. jejuni* is frequently found in swine, in others it is almost an accidental finding. In a study of 1200 samples from 80 Ontario swine farms, Varela et al (2007) found *Campylobacter* in all but 6 samples. However, most isolates were typed as *C. coli* (99.2%) whereas only 2 isolates were classified as *C. jejuni*.

OCCUPATIONAL ZOOSES

Influenza virus

In the late 1990's, after the emergence of a triple reassortant H3N2 strain of swine influenza virus, the epidemiology of swine influenza virus (SIV) in North America has changed (Olsen, 2002). The triple-reassortant H3N2 viruses (containing genes related to corresponding genes of human, swine and avian influenza viruses) were documented on swine premises from different regions of North America (Karasin et al, 2000c; Zhou et al, 1999). As expected, multiple reassortant SIV variants between the classical swine H1N1 and the triple-reassortant H3N2 virus (and other influenza viruses) emerged as a result of recombination. First, a reassortant H1N2 was detected in multiple herds and regions of North America (Karasin et al, 2000b; Karasin et al, 2002), followed by reassortant H3N1 (Lekcharoensuk et al, 2006; Ma et al, 2006). Although the antigenic drift in the classical swine H1N1 was documented in the early 2000's (Olsen et al, 2000); more recently, a reassortant swine H1N1 (containing PA and PB2 genes corresponding to genes of avian influenza viruses) has been found to be the predominant H1N1 strain isolated from the US swine population (Janke, 2004; Ma et al, 2006). Reassortant swine H1N1 (containing human influenza virus PB1 gene) have also been identified in Ontario swine (Karasin et al, 2000a). In addition, different influenza virus subtypes of wholly avian (H1N1, H3N3, H4N6) and human lineages (H3N2, H1N2) were identified from clinical cases in pigs in Canada (Karasin et al, 2000a; Karasin et al, 2004; Karasin et al, 2006).

Although the spatial distribution of all aforementioned subtypes and variants does not necessarily overlap, and different variants are not necessarily effectively transmitted; the intensive trade between regions in North America provides opportunity for mixing pigs from different sources. Consequently, the number of possible recombinations is high which could represent challenges from diagnostic and clinical perspectives, and concern for public health. Currently swine influenza virus is considered to be an occupational hazard. Although being of clinical importance in swine and in human population, direct transmission of swine influenza viruses to people is

reported at a surprisingly low level. Despite this apparently low occurrence, cases of human influenza due to exposure to swine influenza viruses are always concerning. This is because swine harbor receptors that could interact with human and avian influenza viruses. Thus, the concern is that a virulent virus, such as highly pathogenic H5N1 could emerge in avian population, infect swine and experience changes that could lead to more efficient transmission in people.

From surveys of Ontario herds prior to 2005 we concluded that the sow population was likely free from the selected H3N2 strains (Table 1). In early 2005, an outbreak of triple-reassortant H3N2 SIV in Ontario swine herds was documented (Carman and Ojkic, 2005).

Using sera collected in 2004, based on Ontario Swine Sentinel Project, 919 sera from 46 finisher herds were tested for H1N1 and 920 sera from 46 herds for H3N2. In 2005, 978 sera from 49 herds were tested for both SIV subtypes. At the pig-level, prevalence of antibodies against H1N1 SIV was 13.4% and 14.9% in 2004, respectively. Prevalence of antibodies against H3N2 SIV varied between 2.7% and 25.9% in 2004 and 2005, respectively.

Streptococcus suis

Streptococcus suis is a causative agent of septicemia, neurological signs, endocarditis and arthritis in swine. There are 35 serotypes reported so far, but clinical disease as well as illness in people is associated with serotype 2 (Gottschalk et al, 2007). This disease has been considered primarily as an occupational hazard in people who work in close contact with live pigs and during processing. Recently, two outbreaks were reported in China and atypical characteristics of this infection caused concerns in public health circles. Based on molecular typing, it seems that North American serotype is not molecularly similar to the variant that caused the disease in Asia.

ACKNOWLEDGEMENTS

Results reported here were made possible through financial support of Ontario Pork and Ontario Ministry of Agriculture, Food, and Rural Affairs and through cooperation of Ontario swine producers.

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BREAK-OUT SESSIONS

SOW FEEDING MANAGEMENT DURING LACTATION

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ABSTRACT

The challenge of feeding the lactating sow is not new and improvement to the genetic potential of lean and prolific dam lines make this issue of critical importance for any breeding herd. Precise feeding programs in gestation to avoid over-feeding will help. Management practices after farrowing can encourage early and quick increases of feed allowance and these include wet-feeding, giving time to sows to eat, monitoring of intake or simply feeding to appetite. The impacts of too warm ambient temperature on sow feeding behaviour and performance should also not be neglected. Finally, the effects of people, water availability, comfort of sows and control of automated systems are briefly reviewed.

INTRODUCTION

Anyone could consider sow feeding management during lactation as anything but a new topic. It is however still evident, from current field experience and observation, that there are numerous approaches to managing this part of the breeding herd. Eight years ago, the late Dr Frank Aherne (2001) stated the following: *'In an age of interplanetary travel, how can we still be arguing about how to feed the lactating sow? If we can crack the animal's genetic code, why can't we understand the interrelationship between feed intake and lactating sow performance? But perhaps we do understand these relationships but we are unable to translate the science into good farm practice. Perhaps we too often try to apply general rules or guidelines to fit very individualistic situations, be these genotype, farm or individual animal? Each individual lactating sow is different and applying general rules to individual animals will generally be less than satisfactory. But as farm size increases it may become more difficult to treat each sow as an individual. So what can we compromise and what aspect of sow management must stay sow specific?'* This paper will try to describe today's context and challenges for lactation, identify the main factors affecting lactation feed intake and management strategies contributing to improved performance. Finally, examples of the benefits of proper feed intake management of nursing sows will be presented in support of the suggested management practices.

CONTEXT AND CHALLENGES OF MODERN SOWS DURING LACTATION

One of the challenges of feeding the modern sow is how to support increased milk production associated with increased litter size. Today sows have to support litter growth rates of 2 to 3 kg/day or more (Etienne et al., 2000). This corresponds to milk production of 8-12 litres/day or

more (Noblet et al, 1998). Secondly, the weight of sows at maturity (260-290 kg) has increased with concomitant increases in maintenance requirements (Noblet et al., 1998; Dourmad et al., 2001). Also, at the start of their breeding career the replacement gilts are put in service with less fatty tissue reserves (Aherne, 2001) and therefore with less ‘buffer’ energy stores. The length of lactation has declined (75% at less than 21 days, Aherne (2001)) allowing for less time to attain higher feed intakes after farrowing. Genetic improvement for both weight gain and lean has resulted in either a reduction in the sow appetite (Aherne, 2001) or intakes have not increased in the same proportion as their energy requirements (Noblet et al., 1998). The end result of the above is best summarized in Table 1 which shows energy requirements and feed required/day for the entire lactation, irrespective of the duration. As the ME content of the diet referred to in this table is fairly typical of current practices (13.6 MJ ME/kg or 3250 kcal ME/kg), the amount of feed actually required could represent a real challenge in many farm situations. In reality, appetite is often not sufficient and sows have to draw from their body reserves.

Table 1. Energy and feed requirements of lactating sows according to bodyweight and litter weight gain. (Noblet, Étienne and Dourmad, 1998)

Litter weight gain (kg/day)	2.0		3.0	
Sow bodyweight (kg)	200	300	200	300
Maintenance requirement (MJ ME/day)	24.5	28.9	24.5	28.9
Milk production requirement (MJ ME/day)	52.0	52.0	79.6	79.6
Total energy requirement (MJ ME/day)	76.5	80.9	104.1	108.5
Feed required for the entire lactation (kg/day)	5.63	5.95	7.65	7.98

Using body reserves could lead to excessive weight loss accompanied by a reduced litter weight gain (lowered milk production) and subsequent reproductive problems for sows (Aherne, 2001). These conclusions are widely accepted and documented with the body of evidence showing why lactation is such a crucial cornerstone of sow production and reproductive efficiency. Therefore, for the modern lean and prolific sow *everything must be done to maximize lactation feed intake* (Goodband et al, 2006).

Factors Influencing Lactation Feed Intake

The following factors influencing lactation feed intake will be reviewed and discussed based on current scientific knowledge and the author’s experiences: gestation feeding, managing feeding during the nursing period, ambient temperature, water supply, people and equipment. This list has no pretention of being exhaustive.

1. Feeding during previous gestation. Any overfeeding during gestation will systematically compromise the feed intake of sows or gilts in the following lactation (Quiniou et al, 1998; Whittemore, 1998; Noblet et al., 1998). In addition the long term consequence of this overfeeding will lead to overweight and premature culling due to productivity or various locomotor problems. Very often, the problem with dry sow feeding is the feed allowance is set according to subjective assessment of the need of each sow or group of sows, often leading to incorrect assumptions concerning the sows condition and therefore systematic over-feeding (Goodband et al., 2002). Dry sows should be fed as precisely as possible using more objective

techniques to assess individual body weight, body condition (score determined following visual appraisal and palpation at hip bone level), and ideally, measurement of back-fat depth (Dourmad et al., 2001; Goodband et al., 2006). Research conducted at Kansas State University has demonstrated that fatter sows at farrowing have lower feed intakes during lactation, lose more of their reserve and are less prolific at the next parity (Young et al., 2004). These results are summarized in Table 2.

Table 2. Effect of backfat at farrowing on feed intake, performance of sows in lactation and subsequent performances. (Young et al., 2004)

Item	P2 Backfat at farrowing, mm			P<
	< 17	17 to 21	> 21	
No. of sows	123	258	162	
Lactation daily feed intake, kg	6.06	5.93	5.73	0.04
Estimated maternal weight loss, kg	1.9	5.6	6.3	0.08
Sow Backfat loss, mm	2.1	3.2	4.8	0.01
Subsequent performance: Nb of sows	93	200	131	
Subsequent performance: Total Born	11.8	12.1	11.1	0.02

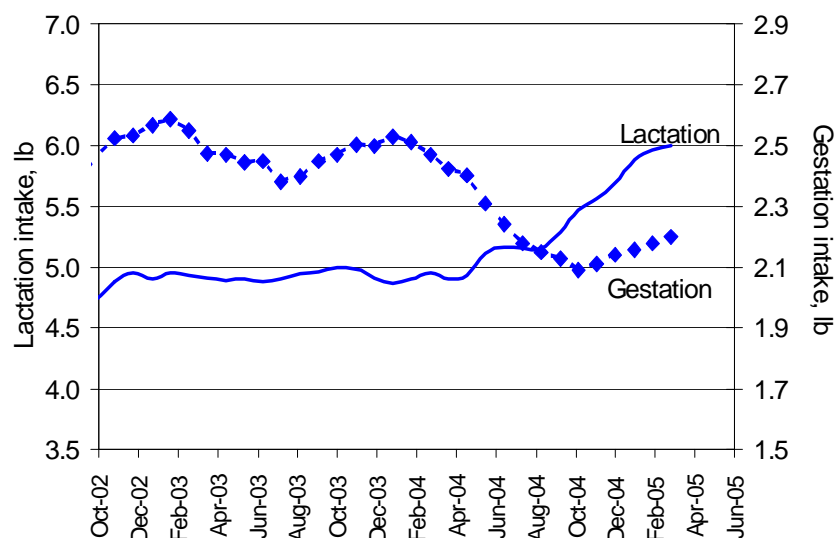
Most authors agree that feed intake problems during lactation will most likely occur in sows with back-fat depths of 23 mm or more at farrowing (Aherne, 2001; Dourmad et al, 2001, Goodband et al., 2006). The precision of the actual amount of dry sow feed delivered manually or by automatic feeding systems (drop boxes, canisters, etc.) needs to be checked on a regular basis because feed density (bushel weight of grains, diet composition) and therefore volumetric measurements will vary with each load of feed delivered (Goodband et al., 2006). Gestation feeding programs need to be validated by your nutritionist in order to more precisely adjust feed allowance settings to the specific diet density used on your farm and feeding targets (bodyweight and back-fat gains which could be genotype specific). Figure 1 illustrates the lactation intake results from a large US production system that lowered their gestation intakes after initially overfeeding during gestation.

Finally, feed allowance toward the end of gestation needs to be increased in order to avoid a negative energy balance in the sow prior to farrowing. This also paves the way to higher feed intake in early lactation (Whittemore, 1998; Aherne, 2001) and easier farrowing (Quiniou, 2005).

2. Management of feeding during lactation. A good principle is to ensure that the feed allowance the day after farrowing resumes to the same amount fed during the last 14 days of gestation: feed allowances should be at least 2.5 kg but I regularly see sows eating 3 to 4 kg the day after parturition in situations where dry sow feeding is well controlled and the sows are in good condition (not overweight). The amount of feed offered daily should rapidly increase in the following days by at least 0.5 kg/day and ideally by 1.0 to 1.5 kg/day. Research has repeatedly shown that too restrictive feeding patterns in early lactation (to prevent udder congestion, hypogalactia, piglet scouring, sow constipation and off feed events) can reduce total lactation feed intake for two reasons: 1) Feed intake in the last three weeks of lactation is not influenced by the intake in early lactation; and 2) The lost feed intake opportunities of early lactation cannot be recuperated in the later stages of lactation (Quiniou et al., 1998; Aherne, 2001; Quiniou et al.,

2000; Noblet et al., 1998). Finally, large surveys have demonstrated that 30-35% show a marked dip in feed intake for 2-3 days in the second week of lactation, while 30% of sows show no feed refusals at all (Aherne, 2001). Therefore, it is better to tailor our feeding management toward the 2/3 of sows which do not show a marked drop in intake and target appropriate management strategies for those sows that do refuse feed, rather than the other way round. Common targets should then be based on the following: over 50% of sows reach their maximum before 10 days post-partum; less than 25% of sows have a blockage for 2 or more days (it is normal to have some refusals between 5 and 10 days post-partum: the frequency is influenced by the control of gestation feeding and the sow's well-being/comfort during lactation). If a sow reduces or stops feeding 1 meal or 1 day, check vital signs (temperature, udder state, etc.), empty feeder when necessary and resume as soon as possible to the amount distributed the day preceding feed refusal.

Figure 1. Change in lactation feed intake after reducing dry sow feed allowance following stricter feeding program: six month rolling average. (Goodband et al., 2006)



The amount of feed fed daily should be captured using a feed budget card, clothes pins clipped on the crate or feeder or any other system to track daily feed intake (Goodband et al., 2006). This also improves communication and coordination between different workers. Alternatively, the KSU feeding method for lactating sows could work fine and calls for high feed allowance right after farrowing. See Table 3.

Sows should always be given enough time to eat, there is no hurry as they are hourly milking a litter of 10-12 piglets. It is preferable to distribute 2 to 3 meals daily at equal time intervals. Feeding as gruel by adding water stimulates intake by 3 to 12% (Quiniou et al., 1998; Genest and D'Allaire, 1995) but we should not add too much water as this could lead to feed wastage and too much dilution of the feed as well as possible fermentation and hygiene problems. There must be feed available in the feeder during most time of the day but feeders must be kept clean. These practices are referred to as "feed to appetite" which should be as close as possible to 'ad

libitum' feeding. According to KSU, as soon as 20% of feeders are empty at any given time during lactation, *the sows are restricted at the producer's will* (Tokach, 2002).

Table 3. KSU suggested feeding procedure during lactation. (Goodband et al., 2006)

Number of 1.8 kg (4 lb) scoops to feed at each feeding from day 0 to 2			Number of 1.8 kg (4 lb) scoops to feed at each feeding from day 2 to weaning			
Feed in Feeder	Feeding		Feed in Feeder	Feeding		
	AM	PM		AM	Noon	PM
Empty	1	1	Empty	2	2	2
< ½ scoop	0	0.5	< ½ scoop	1	1	2
> ½ scoop lb	0	0	> ½ scoop lb	0	0	1

3. Room temperature. The ambient temperature in the farrowing room is often overlooked as a source of intake problems. Sows are homeothermic animals producing a large amount of heat due to their high feed intake and rapid rate of milk synthesis. Due to these high metabolic demands there is a zone of thermal comfort between 12 and 20°C (Quiniou et al, 2000; Quiniou and Noblet, 1999; Makkink and Schrama, 1998). Research conducted on the impact of various ambient temperatures on behaviour and performance of lactating sows has demonstrated that sows start “feeling” hot between 18 and 22°C (Quiniou et al., 2000) (Figure 2). A consequence of which is a reduction in feed intake with the magnitude of the reduction more severe when temperatures exceed 22°C, as shown in Figure 3. These results highlight how the requirements of piglets at birth and during suckling are significantly warmer (26-30°C) compared to those of sows. Therefore, there is the need to compromise the choice for room temperature based on minimizing the negative effects for both the sow and the piglet. Practical recommendations would be to maintain the room temperature at 18-20°C (65-68°F, remembering for each °C above 20, the sow's appetite drops 0.15 kg/day) and provide additional heating (infra-red lamp, pad, covered creep area) for the piglets. Supplementary IR lamps should be switched off at the end of farrowing. However, during summer time the room temperature will inevitably be too warm leading to heat stress for the sows.

Research has also measured the impact of sows under heat stress in order to determine if the impact on production was exclusively a consequence of a depressed feed intake. Trial results are presented in Table 4 and they indicate that at levels of intake similar to sows exposed to heat stress, sows housed at 20°C produce much more milk as measured by weaning weight and litter gain. This milk production was supported by depletion of body reserves (bodyweight and backfat) which were much more intense than at 30°C. It was also observed that milking frequency was not reduced during heat stress so the reduced production observed is not piglet mediated. However, piglets suckling from sows that are under heat stress would benefit from extra milk (or possibly creep feed) to support their growth. The reduction in milk production from heat stressed sows is, therefore, linked directly to the metabolism of the sow and is probably caused by an alteration of the level of circulating hormones reducing its capacity to mobilize body reserves or by a redistribution of blood flow from mammary gland toward the

skin in order to increase heat loss, thus decreasing milk production (Quiniou et al., 2000; Williams, 1998).

Figure 2. Body temperature and respiratory rate of sows exposed to increasing ambient temperature. (Quiniou et al., 2000)

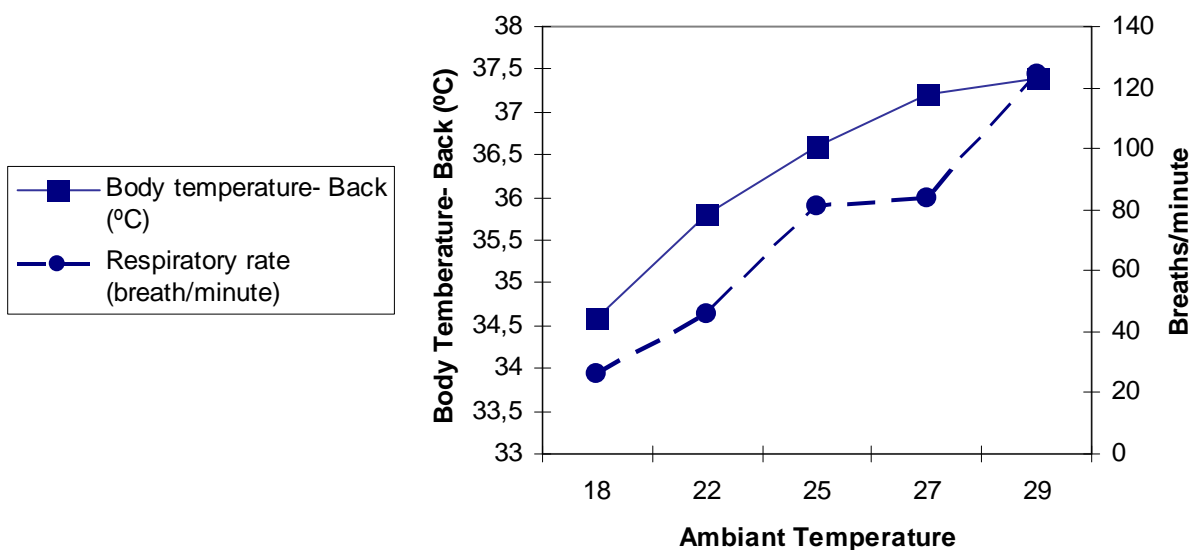


Figure 3. Average daily feed intake of lactating sows exposed to increasing ambient temperature for the farrowing to weaning or from day 9 to 19. (Quiniou et al., 2000)

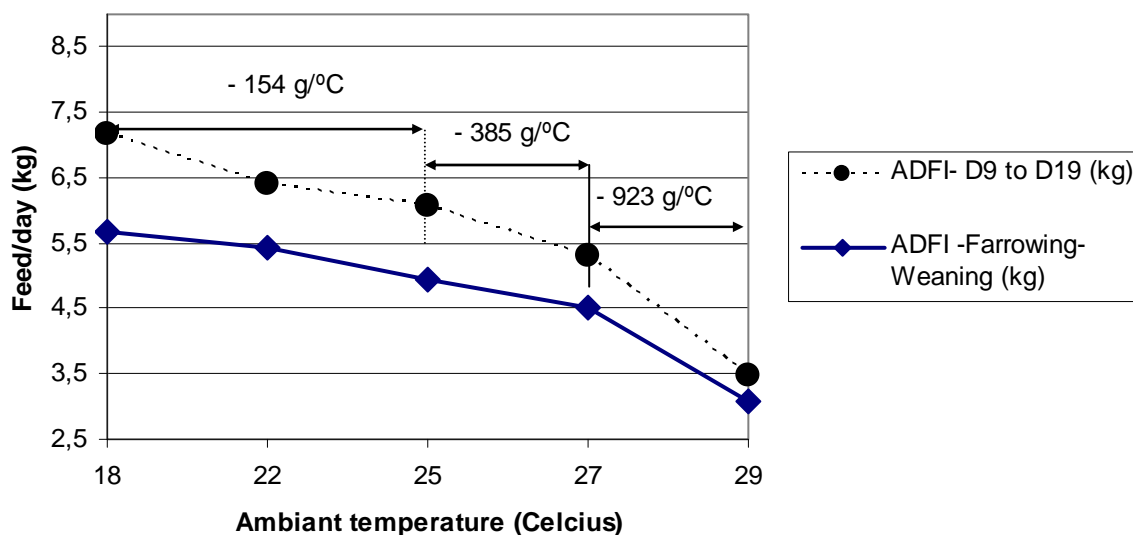


Table 4. Effect of ambient temperature and level of intake of performance of lactating sows (Messias de Gragança et al., 1997 in Étienne et al., 2000)

Room temperature (°C)	20	20	30
Level of feeding	Ad libitum	Restricted	Ad libitum
Feed intake (kg/d)	4.9	3.1	2.8
Weight loss (kg)	8.3	31.5	21.7
Backfat loss (mm)	0.9	3.5	2.8
Average pig weaning weight (kg)	6.44	6.29	5.80
Litter weight gain (kg/d)	2.05	1.97	1.62

Some strategies to reduce the effects of heat stress include: 1) use high energy feeds with lower fibre and crude protein content; 2) practice nocturnal feeding when outside temperature cools down; 3) multiply feeding times; 4) use of air cooling or water dripping equipment (Quiniou et al., 2000; Mavromichalis, 2008). Large addition of fat in the feed is not a cure-all. This additional source of energy is principally used by the mammary glands to produce very rich milk and it will not be an exceptionally efficient source of energy for the sow (Noblet and al., 1998; Goodband et al., 2006). High fat addition could improve piglet weaning weight but could also impair subsequent reproductive performance by reducing the number of LH peaks in the early lactation (Kemp et al, 1995).

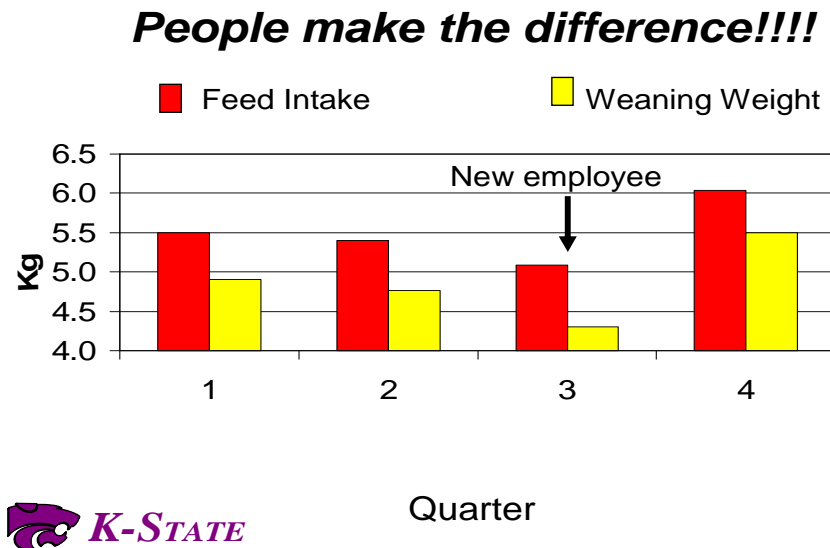
4. Water. It is essential to have good quality water but I will not discuss the details in this paper. Refer to specialised publications related to this topic and adhere to water quality guidelines especially related to chemical and microbiological specifications. Water quality should be properly checked annually. Water availability at time of feeding is important with a flow rate of 2 litres/minute being recommended as the requirement. Correct nipple position and ease of access to water are fundamental for optimum sow productivity and yet it is surprising how inaccessible some watering devices are (too high or too low). Also, beware that too high water pressure could reduce water intakes. As previously mentioned, wet or gruel feeding does help improve feed intake but be sure to correctly manage the amount of water provided and freshness of the feed.

5. People. Yes, human beings can make quite a difference as is well illustrated in the following figure. There are obvious differences among similar farms and quality of management is certainly a major contributor to this variation: caring, knowledgeable, experienced and skilled people who can take time to treat each sow properly can impact feed intake more than any other single factor (Aherne, 2001).

6. Comfort of the sows and equipments. This is more of a general comment that farrowing crate and floor designs should favour the maximum well being of lactating sows. Also, ergonomics of the feeders (size, volume, height and width) and the water nipple placement need to provide easy access to feed and water. There are a plethora of different troughs and feeders on the market with no particular type being preferable to others. Very often decisions regarding different ways or complexity of barn automation are based on cost but they should also consider the need to reduce manpower and training time. Each system has inherent pros and cons but the

investment made to save time dedicated to manual repetitive tasks allows more time to observe animals and measure performance parameters and thereby increasing management proficiency.

Figure 4. Quarterly lactation feed intake and weaning weight in a pig breeding operation. (Goodband et al., 2006)



CONCLUSIONS

Successful feeding management of sows during lactation could be summarized as ‘maximize feed intake’. Positive consequences of maximizing lactation intakes on lean and prolific genotype, including improved wean to service interval, farrowing rate and subsequent litter size, have been observed in numerous research and commercial production systems (Figure 5 and 6). It looks simple, but in reality it is a daily challenge. Sometimes it is necessary to overcome some inherent “belief” that limits change by applying sound science to practical problems. Attention to dry sow feeding, management during lactation, ambient temperature, water, equipment and people will lead to success.

ACKNOWLEDGEMENTS

Thanks to Dr. Neil S. Ferguson, Ph.D. (Nutra Canada Agresearch) for his help in preparing and reviewing this paper and Dr. Robert G. Goodband, Ph.D. (K.S.U.) for permission to use Figures 1, 4, 5 and 6.

Figure 5. Relationship between lactation feed intake and farrowing rate. (Goodband et al., 2006)

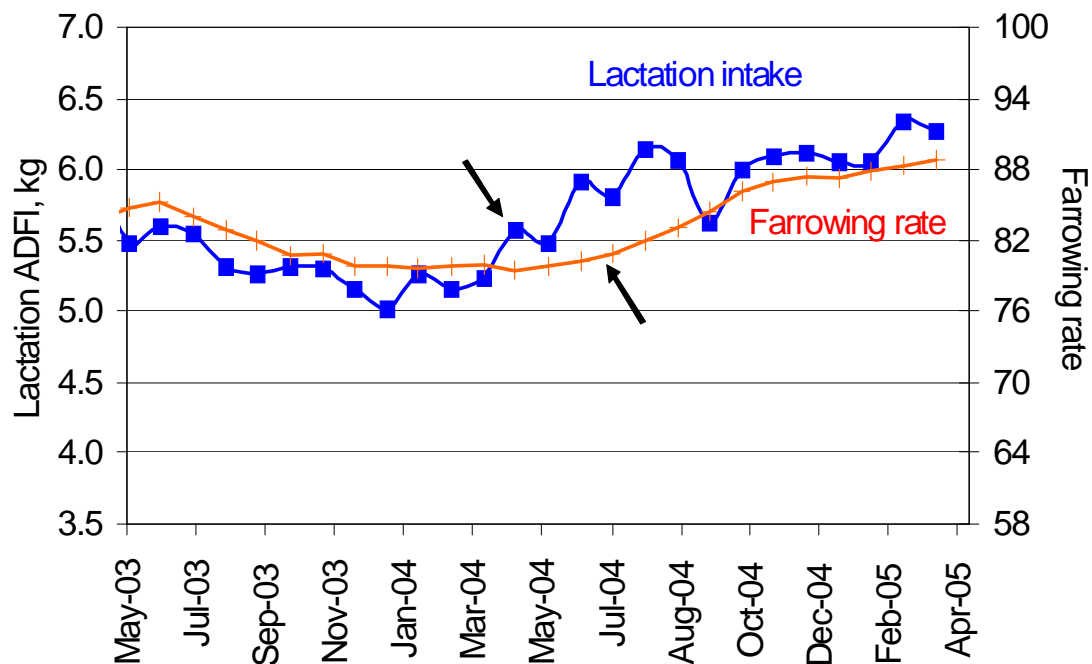
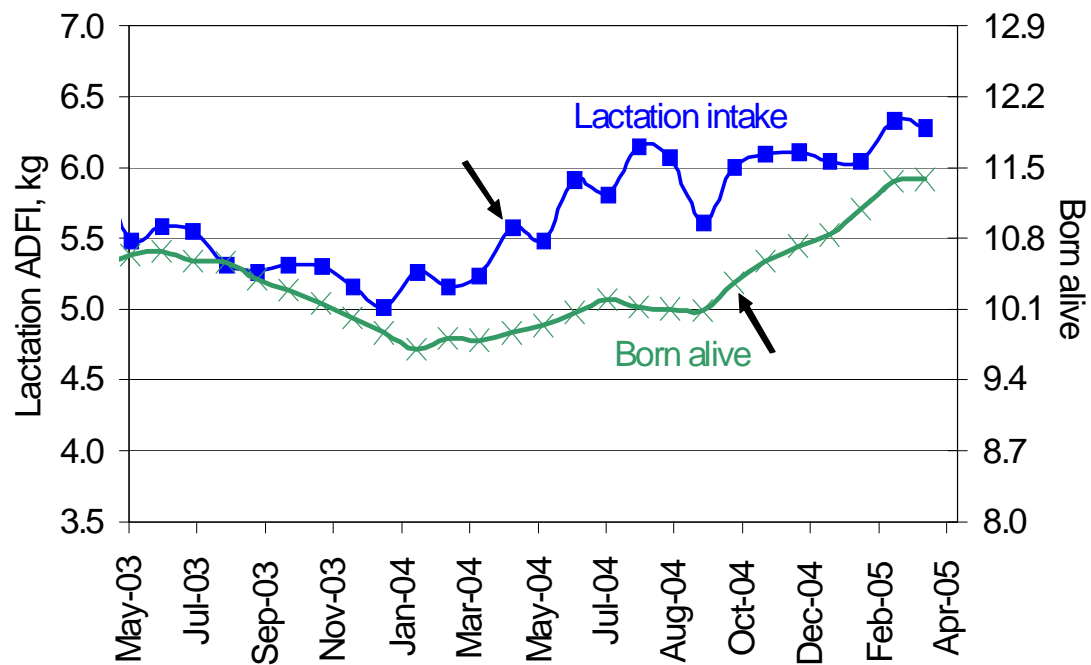


Figure 6. Relationship between lactation feed intake and subsequent born alive. (Goodband et al., 2006)



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NURSERY IMPROVEMENT – PRACTICAL TIPS

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INTRODUCTION

The general set-up of the nursery with respect to practical management has been reviewed previously in the London Swine Conference by Farrell and Templeton (2007). The following looks at one aspect of pre-nursery management in more detail that can improve nursery performance if focused upon – creep feeding – and also looks at the benefit of a walk through the nursery unit by the specialist.

CREEP FEEDING

Take Home Message

Focusing on creep management and getting as many pigs on the sow as possible to consume creep feed will give subsequent post-weaning benefit and improve nursery exit weights.

Creep feeding is used in later weaning (> 21 days), however it has often been neglected in young weaned piglets (<21 days). The following shows that introducing creep earlier in life than was conventionally thought for piglets weaned pre-21 days may be a management tool that can increase the number of piglets consuming creep feed and so improve post-weaning performance.

Investing in creep feeding on a litter at \$2.00 per litter can show a return of between 3:1 and 9:1 per litter dependent on pig price and also depending on the weaning weight improvement of using creep.

Background

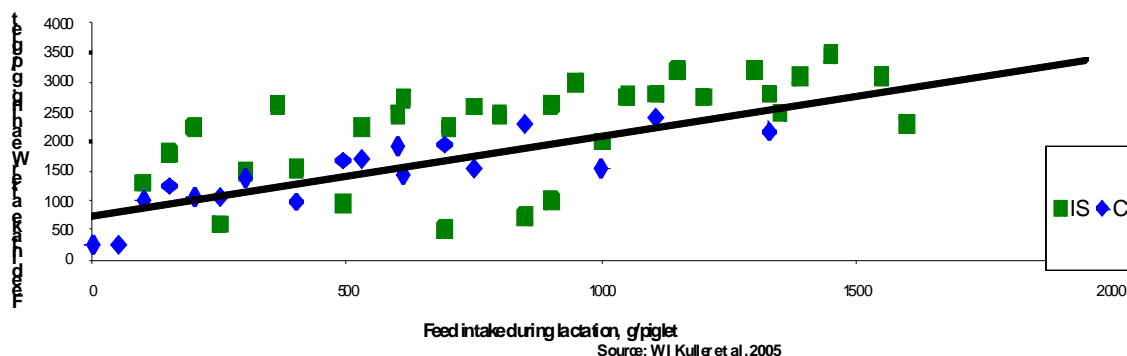
Creep feeding is increasingly important with:

- 1) Increased litter size
- 2) Later weaning

Although creep feeding is an important component in improving weaning weights, especially in later weaned piglets, it is more important in improving post-weaning performance. If pigs consume creep feed pre-weaning then there is less of a post-weaning feed intake lag and so post-weaning performance is enhanced.

This is shown in the following trial (Fig. 1) when pre-weaning creep consumption was compared to post-weaning feed consumption. These results confirm that the more a pig eats as creep feed the better the post-weaning feed intake, something that as a pig producer we want to achieve in order to avoid that post-weaning lag.

Figure 1. Creep feeding increases post-weaning feed intakes.



Within the European markets average weaning would be approximately 24 to 28 days and the benefits of creep feeding are well known and proven. However new research in a US University (Sulabo et al, 2008) shows the importance that offering creep feeding can have on 21 days weaned pigs' post-weaning performance. The trial was interesting as chromic oxide (green colour) was added to the feed so that pigs could be identified as eaters or non-eaters based on the colour of the faeces. Pigs that ate feed would have a green colour to the faeces as chromic oxide is not absorbed by the piglet. This allowed the researchers to categorize pigs as eaters, non-eaters (offered creep but did not consume any) and no creep (no creep offered). The results (Fig. 2) showed that pigs that ate creep had an extra 0.4 kg gain over pigs that were non eaters and no creep.

Figure 2. The effect of creep feeding on post-weaning gain.



These results show the importance of not only providing creep but also ensuring that the maximum number of piglets consume creep. The researchers showed in the trial that of the litters offered creep feed only a proportion of the piglets actually ate it:

60%	Ate creep	- Eaters
40%	Did not eat creep	- Non Eaters

So as pig producers it is important to manage creep feeding to maximise the number of piglets that consume creep. One management tool the researchers looked at was introducing creep feed earlier than their standard practice. They, therefore, did a trial comparing pigs introduced to creep at their standard 14 days of life with pigs offered creep feed at day 7. The results showed that an **extra 10%** of pigs consumed creep feed when it was introduced earlier at day 7.

Based on pigs consuming creep feed at an average 100 g per piglet in the trial up to 21 days, for a litter of 10 pigs the feed consumed per litter would be 1.0 kg or \$2.00 per litter. Pigs consuming creep showed an improvement of 0.4 kg per pig at 28 days post-weaning and based on lifetime performance could have an improvement of 1.2 kg per pig at slaughter. At a minimum 4 kg per litter (0.4 kg x 10 pigs per litter) and a maximum of 12 kg per litter (1.2 kg x 10 pigs per litter) then the return on consuming creep would be a benefit of between \$6.00 to \$18.00 per litter or a return of between 3:1 to 9:1 for a creep feed costing \$2000 per tonne.

This shows some idea of cost benefits of creep feeding. Other work has tried to relate pre-weaning growth rate on slaughter weight at 170 days and showed that a 10 g improvement in ADG pre-weaning can improve live weight at slaughter by 0.96 kg. One management tool that can be used to achieve this extra growth is by the use of a highly digestible complex (milk, cooked cereal, low soybean meal, etc.) as a creep feed. A highly digestible feed should be used as that stimulates feed intake in the piglet and Fraser et al (1993) showed that the use of a complex feed increased ADG pre-weaning by 20 g/day over a standard non-complex feed resulting in an increased weaning weight and subsequent benefit in post-weaning performance. Another practical tip to increase feed intake pre-weaning is gruel feeding (Miller et al, 1999) whereby feed and water are mixed together and offered to the piglet. Results have shown an increased dry matter intake and average daily gain.

These results show the importance that focusing on creep feeding can have from a performance and financial perspective and show that it is not the importance of getting creep feed in front of the litter but ensuring that the as many piglets in the litter consume creep as possible. Other management practices that can be used to stimulate creep feed intake will be discussed in the presentation.

Walk Through By Specialist

It is often good to get a second opinion on a production system and so walking through the farm with the nursery specialist can often highlight areas where improvement may help. As an example of this, a nursery unit where the producer had commented on how performance was not meeting expected targets requested a walk through for advice.

Some of the areas in that unit were changed:

- Point 1 Weaning weight had reduced by 1 kg due to pressure in the sow system but the nutritionist had not been informed and the same program that had been originally used for the heavier weaned piglet was still being used.
- Action A program was placed relating to weaning weight coming in and if pigs fell below 5 kg weaning weight a new higher digestible feed was introduced.
- Point 2 Pigs were being fed to days irrespective of feed intake during the period, meaning that pigs were moving to the next feed even if the first feed allocation had not been totally consumed. This meant that pigs were falling behind target performance as they were moving to the next feed lighter than expected.
- Action The feed program put in place for weaning weight was now based on kg per pig and the pig did not move to the next feed until the current feed allocation had been consumed.
- Point 3 Pigs were not going to feeders and so feed uptake post-weaning was slow and this was reducing initial feed intake.
- Action To stimulate early post-weaning feed intake, mat feeding was introduced for 3 days post-weaning with mats placed in front of the feeder to stimulate feed intake.
- Action In addition to mat feeding, gruel feeding was introduced in a trough to allow for pigs to feed together as on sow. Gruel was also spread a little onto the feeder to try and get pigs attracted to the feeder.
- Outcome The pigs were fed the correct program and correct amount of feed according to weaning weight and early feed intake was stimulated by feed mats and gruel. This led to performance targets being met.

In this case, another pair of eyes helped the situation and some small changes helped target performance goals to be met. Although there was extra management time required to implement the changes, the producer was happy to do it as he saw the performance benefits in the pig.

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BENCHMARKING AND FEED BUDGETING

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INTRODUCTION

Benchmarking to set up feed budgets is of great importance in the hog industry today. Exploring fresh concepts to make positive changes to your feed budgets within the nursery management program will hopefully let you move ahead.

BENCHMARKING

“You can’t manage what you don’t measure.” There are two main areas of comparison available; we use both for our benchmarking. The first, and most usable, is comparing against your own past history. “Am I better or worse than I was last year?” assuming you try to keep the test groups as closely matched as possible. The industry averages are good benchmarks to use as starting points as well. These numbers may be something you can directly compare to, or your numbers may have to be adjusted. Be sure to get “apples vs. apples” comparison. Make sure you use your numbers if you take the time to measure them. With all trials and benchmarking exercises you will have some variance in the pigs. They will either have a weight discrepancy coming into the barn, have a differing health status, or face different health challenges while in the nursery barn. Being able to sort through these complications to find usable numbers is the most challenging aspect.

FEED BUDGETING

On our farm we concluded that with increased feed costs we had to change budgets to try and save some money feeding nursery pigs. The plan of manipulating the feed budget may be a trial and error circumstance. You should use your feed supplier’s recommended feed budgets for a period of time to get a benchmark, and then you’ll be able to set your targets. In our trial we started taking away the amount fed on the most expensive feeds. We had a 4 phase budget:

Table 1. 4 phase budget; May 2004 - December 2006.

Phase	I	II	III	IV
Feed/pig	1.0 kg	2.5 kg	5.0 kg	25 kg
Approx. days	4	8	12	25

Table 2. 1st change of the budget was this; January 2007 - September 2007.

Phase	I	II	III	IV
Feed/pig	0.5 kg	3.0 kg	5.0 kg	25 kg
Approx. days	2	10	12	25

Table 3. 2nd change of the budget was this; October 2007 - November 2008.

Phase	I	II	III	IV
Feed/pig	0 kg	3.5 kg	5.0 kg	25 kg
Approx. days	0	11-12	12-13	25

We are moving further, but with each change we may soon find a threshold of how far we can move our targets. The good thing about working with pigs is their resiliency. They are tough, so don't be afraid to push them. The next step is moving more kilograms out of Phase II to Phase III, which is currently happening, however we have no finalized data on this initiative yet.

Table 4. Further changes; December 2008 - Present

Phase	I	II	III	IV
Feed/pig	0 kg	2.5 kg	6.0 kg	25 kg
Approx. days	0	8	12-14	27-29

At each change we looked at our closeout data to see if the pigs' average daily gain (ADG) was negatively affected. When it was not, we went further and took out Phase I totally and found no detrimental effects. Our numbers actually improved on our test groups, so it was an easy call. These trials were calculated using an in weight ranging from 4.0 kg to 6.5 kg with an average of 5.6 kg throughout the 2004-2008 time periods. It is important to remember that these diets are set to use Phase I feed to feed pigs starting at less than 6.0 kg. Be sure to know all the factors going into the trial to get best results in order to make the most informed decisions.

If possible, keep track of feed conversion, to ensure the increase in growth rate does not negatively affect the feed conversion rate enough to offset the re-budgeted feed cost savings. Again we were able to achieve a positive result on our trial but it's not guaranteed.

Table 5. Re-budgeting results.

May 04-April 07 (using Phase I)	466 g/day	1.4 feed conversion
Oct 07-Nov 08 (No Phase I used)	485 g/day	1.21 feed conversion

CONCLUSIONS

Measuring can be as easy as weighing pigs using a market hog scale, both at the start and the end of the nursery turn. Weighing of the feed can be more difficult but really needs to be done too. My trials were done using monitor pens with scaled feed hoppers. We measured just these pens for the trial. Using these results, we were able to compare our trial pens against the total barn closeout to extract more information. Being able to measure our pigs' growth potentials makes it possible to move forward. Whether it is cutting out one feed or scaling back another, it seems imperative for all hog farmers today to try to save some dollars by using lower cost diets sooner in all areas of the farm, especially the nursery barn.

EFFECTIVE VENTILATION

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ABSTRACT

Good air quality in swine rooms can only be achieved if sufficient air is exchanged to remove both the respired moisture from the pigs as well as the ammonia gas produced by the decomposition of the manure. Regardless of the size of the pigs in all rooms with slatted flooring and no bedding, this generally requires the use of some supplemental heat to both maintain the desired room temperature and still exchange sufficient air. Ideally, the ammonia gas level should be kept below 20 PPM and the relative humidity level under 70%. Some common mistakes regarding under-ventilating and heater management are discussed.

AIR QUALITY IN SWINE ROOMS

The majority of swine enterprises utilize liquid manure handling systems. One of the main manure gases produced as part of the decomposition process is ammonia. Ammonia gas is water soluble and will readily attach itself to every moisture molecule found in the room air. Given that pigs regardless of size expel significant moisture into the room air from respiration, there is an abundance of water vapour available to absorb the ammonia gas. This gas combination is quite odorous and reduces air quality.

Table 1 shows the typical quantity of moisture that various classes of pigs contribute to the room air. This moisture must be exhausted from the room on a continuous basis to prevent the room from becoming very humid and hence very odorous. This table shows that pigs produce more moisture as they grow and hence the minimum ventilation rate must also be increased to keep up with the moisture production rate. Unfortunately, this does not happen automatically in most rooms during cold weather and thus air quality often deteriorates as the pigs grow.

Ammonia gas is easy to measure and should be kept under 20 PPM (parts per million) and preferably under 15 PPM, but that can be hard to achieve during cold weather. Passive type gas diffusion tubes are available that can be broke open and hung in the room for a measured length of time. When the gas tube is retrieved and the colour change reaction value read and divided by the exposure time, the average concentration of ammonia gas is determined. Should the result be higher than 20 PPM, then the room is likely being under-ventilated.

All air exhausted from an animal room also expels significant heat energy along with the moisture and various manure gases. If sufficient air is exhausted to maintain a room relative humidity under 70%, the heat loss is sufficient to cause all swine rooms to be heat deficient during cold winter weather. Since all ventilation systems use temperature as the main control

basis for operating the exhaust fans, the minimum fans are going to slow down or shut off rather than allow the room temperature to drop very much. Of course this control strategy will simply increase problems with poor air quality.

Table 1. Typical moisture production from pigs.

Swine Category	Animal Mass kg	Moisture Production L / Day
Breeding & Gestation	150	2.8
	200	3.4
Farrowing Sow	160	4.9
	200	5.4
Weaned Pig	5	0.8
	10	1.1
	20	1.2
Grow – Finish Pig	25	1.3
	50	1.9
	75	2.1
	100	2.2
	120	2.4

Source: OMAFRA Fanvent Analysis Program

The proper solution is to add supplemental heat so that the exhaust fans can operate continuously and even increase their minimum speed as the pigs grow to both remove the moisture and still maintain the desired room temperature. Table 2 shows the typical quantity of supplementary heat required for each type of swine environment. Yes, even breeding and gestation rooms should be equipped with a heater for outside temperatures lower than about -10°C. All-in, all-out grow-finish rooms require some supplementary heat until the pigs reach about 45 kilograms.

Table 2. Supplementary heat requirements for swine rooms.

Pig Type & Size	Minimum Ventilation Rate	Outside Temperature -20°C	Outside Temperature -10°C	Outside Temperature 0°C
Breeding/Gestation	10 CFM / pig	500 BTU/h	250 BTU/h	0 BTU/h
Farrowing	17 CFM / crate	1000 BTU/h	600 BTU/h	200 BTU/h
5 Kg Pigs ^a	1.3 CFM / pig	225 BTU/h	180 BTU/h	130 BTU/h
20 Kg Pigs ^a	2.5 CFM / pig	50 BTU/h	25 BTU/h	0 BTU/h
25 Kg Pigs ^b	3.0 CFM / pig	200 BTU/h	100 BTU/h	0 BTU/h
40 Kg Pigs ^b	4.0 CFM / pig	110 BTU/h	0 BTU/h	0 BTU/h

Source: OMAFRA Fanvent Analysis Program

^a Weaned pigs housed in a typical all-in, all-out nursery room

^b Pigs moved from nursery room to an all-in, all-out grow-finish room

COMMON MISTAKES TO AVOID

1. Not Exhausting Sufficient Moisture

Under-ventilating a swine room during cold weather is the most common cause of poor air quality. This can occur due to several reasons.

- The minimum ventilation fan(s) may be allowed to shut off based on the room temperature dropping below the set point temperature and not re-start until the pigs have warmed the room back above the set point temperature. Ideally, the minimum exhaust fan should be sized such that it should never need to shut off. If it does shut off, then it should not be allowed to be off for any longer than 3 minutes or the humidity level climbs too high and the room becomes quite smelly.
- The minimum ventilation fan(s) may be operating on the timer function of the ventilation controller whenever the room temperature drops below the set point temperature. The timer settings may not be allowing the fan to run a sufficient portion of the total cycle time such that the off time is longer than 3 minutes. The only time that a longer off cycle is acceptable is when the room is empty between animal groups. During these time frames, it is only the manure gases that continue to deteriorate the room air quality and shorten the life of all metal components within the room. Running the minimum exhaust fan at its slowest speed for a couple of minutes out of every 10 minute time cycle is usually sufficient to maintain reasonable conditions in an empty room.
- The minimum speed setting on the first stage ventilation fan(s) may not be set high enough to exhaust all of the moisture being produced. This can be checked by measuring the relative humidity in the room with a temperature/humidity pen. If the humidity level is above 70%, the ventilation rate must be increased. One can also measure the ammonia gas concentration to ensure it is less than 20 PPM. If not, increase ventilation rate.
- Very often the minimum ventilation is not increased as the pigs grow. While quite a few of today's ventilation controllers provide a minimum fan speed curve feature that allows the operator to program an automatic minimum speed increase based on growth days in the room, many producers do not use this feature. If a room is heat deficient, then the pigs will never cause a temperature increase during cold weather to have the ventilation fan speed up on its own. The operator must ensure that the minimum speed is raised each week as the pigs grow to keep up with their moisture production rate.

2. Stingy with the Heat

All swine rooms should be equipped with some supplementary heat to ensure sufficient minimum ventilation can occur and the desired room temperature is also maintained. Yes, heat costs money, but so do poor air quality and animal discomfort (not to mention herdsmen working conditions). Even when heaters are installed in the various rooms, there can be air quality problems and also heat waste.

- Ensure all swine rooms are equipped with an appropriately sized heater and it is operated with the ventilation system controller to guarantee an interlock and minimize any unnecessary conflict between the two systems.
- If the relative start temperature for the heater is too far under the main set point temperature for the room, then often the heater will rarely turn on and coupled with too low of exhaust rate, air quality can remain poor. Normally, a relative heater set point of 1.0 or 1.5°C below the main set point temperature for the room is good.
- The heater differential temperature (degrees of temperature rise) needs to be properly set for good economical heater operation. If the heater differential is too small, the heater does not run long enough to help dry out the air volume of the entire room and thus the room will remain quite odorous. On the other hand, the heater off temperature is frequently set to match the main set point temperature for the room. This control strategy will almost always waste energy. With the heater sized for the coldest expected weather, it is over-sized for a good percentage of the year. Secondly, the typical temperature sensors that are used to control ventilation systems are relatively slow to react to a temperature change. Thus when a sensor signals a heater to shut off, the room temperature is actually still climbing, since the sensor has not fully responded to all of the heat energy available in the room. Any room temperature climb above the main set point temperature will automatically increase the speed of the first stage fan(s) and dump this extra heat. Therefore, the heater should always be shut off at least 0.3°C below the main set point temperature for the room.
- For many small rooms, a standard heater can be oversized such that it can alter the room temperature quite quickly. This can be stressful on the pigs and cause some heat waste. Many of today's box heaters have an adjustable gas orifice that can be partially closed to reduce the flow of gas to the burner and thus its heat output. Be sure to check whether or not your heater has this feature. It is very useful for all rooms housing younger pigs during the two swing seasons when less supplemental heat is required.

ALTERNATIVE HEAT SOURCES

Since heat is required, one is always interested in getting the most energy for the least cost. As fuel costs continue to rise, this aspect of production costs will demand more attention. Some producers have explored the use of corn as a fuel. However, it would currently appear that this commodity is better utilized as a food source than a source of fuel. It may be that corn stover and/or other crop refuse will become a more viable fuel source in the future. Methane gas or waste heat from on-farm digesters both look like they may have potential as a fuel source down the road.

Currently, the two technologies that are proven and commercially available for livestock farmers are heat exchangers and passive solar energy collectors. Heat exchangers can re-capture some of the heat energy leaving the barn through the minimum exhaust fan(s). Passive solar collectors can be installed on the air intake side of the building and warm the incoming air whenever the sun shines.

Both of these technologies will work well with existing ventilation and heating systems and can have a reasonable pay back period, particularly when some of the available energy grants are considered. Tom Sangster with Exacon Incorporated will discuss their experiences with these alternate heat sources on some swine farms.

EFFECTIVE VENTILATION

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This paper will describe our practical experiences with heat recovery systems and solar wall installations in all stages of swine barns.

NURSERY ROOMS

We have experienced dramatic differences in air quality and humidity levels in nursery rooms that have added heat exchangers. It has been a combination of heat recovery which is allowing the producer to raise the minimum ventilation rate higher than he had been doing, and the other benefit on minimum ventilation has been the powered air inlet on the heat exchanger which has been delivering the incoming fresh air at the proper air speed and at a continuous level. This proper air speed in a lot of cases was not being obtained before either because of improper minimum inlet settings on the ceiling inlets or just not being able to establish enough static pressure to bring the air in at the right speed. We did do some trials and found it necessary to power the fresh air into the rooms via a fresh air duct or poly air tube that complimented the pattern of the existing ceiling inlets. We did not obtain satisfactory results in nursery barns with just a diffuser on the heat exchanger and no duct system for the fresh incoming air. In most cases we were exhausting from the pit but it did not make a great difference if we pulled the exhaust air directly from the room. All the nursery rooms still required supplemental heat but the amount was reduced.

GROWER FINISHER ROOMS

History has shown that producers are always tempted to cut back on heating costs in these rooms. They will use the timer function on the ventilation controller, or just slow down the ventilation rate so the heaters do not come on. This always leads to higher humidity levels and higher amounts of ammonia gases, and the pigs are under stress.

We have found by installing a heat exchanger that is sized to provide the minimum ventilation requirement for both continuous and humidity we can provide excellent air quality and comfort level and not require any supplemental heat after the first two or three days of filling the room. Many producers are now getting along with just one portable heater that they move from room to room. This has saved them a lot of time on heater maintenance. We have experienced our best results if we have ducted the fresh air into the room complimenting the air pattern of the existing inlets. If the room was an auto-sorter layout and pigs were free to move around the room, then we were able to use only a diffuser as our fresh air inlet.

FARROWING ROOMS

The only farrowing rooms that we installed heat exchangers in were for organic producers that took the sow out of the farrowing pen at weaning and left the piglets in the pen. We had the same results here as we did in any nursery room. In conventional farrowing rooms heat exchangers can work well but I feel that solar walls may be all that is required to effectively raise the ventilation rate to where you will have excellent air quality.

GESTATION AND BREEDING ROOMS

These rooms do need supplemental heat when the outside temperature dips below -10°C if you wish to provide proper ventilation rates and good humidity levels. The addition of a heat recovery system in these rooms has eliminated the need for a supplemental heater, and has provided a warm dry environment for the sows. The producers that have installed these units in existing barns notice that they can obtain much higher ventilation rates which is giving them fresher air and increased comfort levels for the sows and the staff working in these rooms. If the gestation room was an individual stall layout we have always used a duct system or poly tube to distribute the fresh incoming air. If the room was loose housing then we were able to get by with a diffuser for fresh air delivery.

SOLAR WALL IN SWINE BARN

We are just getting started installing a solar wall in swine barns. In all phases of swine barns including farrowing rooms and gestation rooms it is going to help raise the minimum ventilation rate which improves air quality and promotes a drier room and it will do this without any additional costs. We see this product as a tool that will help any ventilation system work better, and it will give the producer a definite benefit. At the present time there is both a Federal and a Provincial grant in place that will help pay for this investment.

NEW PRODUCT COMING

Noveko Air Filters

I would like to mention a new product that we are handling to improve animal health. This product is being used by the A.I. units in some parts of Ontario - it is the Noveko Antimicrobial Air Filter. It is specifically designed for livestock operations. The Noveko filter cleans the outside air of bacteria, viruses, and dust that might affect the health of your animals. It is one more way of protecting your operation from disease outbreaks.

HORMONAL CONTROL OF PIG REPRODUCTION

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INTRODUCTION

In order to consistently reach breeding targets and maintain weaned pig production, sufficient service-ready gilts must be available in each breeding week. If enough gilts are not available in a predictable manner, subsequent pig production will suffer. To minimize the potential of gilt supply being a constraint to achieving the breeding target, large gilt pools are maintained to help ensure that an adequate number of gilts will be in estrus and available for breeding at specified times. Having replacement gilts exhibit estrus at a predicted time would allow more efficient scheduling and use of gestation and farrowing facilities and provide greater opportunity for introduction of females into sow groups at the time sows are bred following weaning. Reproductive efficiency could be enhanced with the use of effective methods for synchronizing estrus in replacement gilts and weaned sows that do not return to estrus when expected. The available methods of estrus synchronization in swine are varied, but they are all based either on controlling events leading to follicular maturation and ovulation or altering luteal lifespan. Before considering how available hormonal products can be used to manipulate reproduction in pigs, an understanding of how hormones naturally control the estrous cycle is necessary.

REPRODUCTIVE PHYSIOLOGY IN PIGS

Once gilts reach puberty at 6 to 8 months of age, they display estrus at 18- to 22-day intervals unless cycling is interrupted by pregnancy and lactation, poor nutrition, or disease. During estrus, gilts or sows stand to be bred. The physiological and behavioral changes associated with the estrous cycle are controlled by hormones produced by endocrine glands. Gonadotropin-releasing hormone (GnRH) is released from a specific area of the brain called the hypothalamus, travels through blood vessels to the pituitary gland, and there stimulates secretion of follicle-stimulating hormone (FSH) and luteinizing hormone (LH). These are called gonadotropins.

During the two to three day period just prior to estrus, increasing blood levels of FSH and LH cause follicles to rapidly grow on each of the two ovaries. These follicles secrete increased levels of the hormone estrogen into circulation, which in turn causes the behavioural and physiological changes associated with estrus (e.g., reddening and swelling of the vulva, lordosis or the "standing response" in the presence of a boar, etc.). Rising concentrations of estrogen eventually triggers increased secretion of GnRH, resulting in a massive release of LH during estrus. This "LH surge" stimulates the process of ovulation. Multiple ova, or eggs, are released from the follicles on the ovaries during the process of ovulation, which occurs, on average, 40 hours after the onset of estrus. Each ovulation site on the ovaries subsequently forms a structure called a corpus luteum which secretes another hormone, progesterone, into the circulation. During the

luteal phase of the estrous cycle, (or if pregnancy occurs), progesterone, in concert with low levels of estrogen, inhibits FSH and LH secretion from the pituitary gland, and thus inhibits follicular growth. Ova are fertilized in the oviducts, which are tubes connecting the ovaries and uterus. The embryos then progress to the uterus and develop into fetuses.

If fertilization and initiation of pregnancy did not occur during estrus, then the hormone prostaglandin-F2 α (PGF2 α) is secreted into circulation from the uterus around day 16 of the estrous cycle. PGF2 α causes the regression or death of the corpora lutea and as a result, progesterone levels decline. Decreasing levels of progesterone allow GnRH, and hence, FSH and LH to increase, follicles develop, and the gilt continues to cycle. In weaned sows, the wean-to-estrus interval is equivalent to the follicular growth phase of the estrous cycle.

HORMONAL PRODUCTS

PG 600 – is made up of 400 IU PMSG (or eCG equine chorionic gonadotrophin) and 200 IU hCG (human chorionic gonadotrophin). eCG has an FSH effect (follicles develop and mature, sows show estrus), while hCG has an LH effect (causes ovulation).

PG600 is used to induce cyclicity in prepubertal gilts or in non-cycling weaned sows.

When PG 600 is administered to prepubertal gilts, commonly up to 30% may not exhibit behavioural estrus.

Some eCG preparations are available and sometimes are used alone to induce estrus, since eCG has the effect of FSH. When using eCG alone, higher doses (900 vs. 600 IU) may improve the response of parity-one sows. GnRH (gonadotrophin releasing hormone) and porcine luteinizing hormone (pLH) have an LH effect and are sometimes used to stimulate or synchronize ovulation after induction of estrus or at the first sign of estrus. If ovulation can be synchronized, it may be only necessary to breed sows once to achieve pregnancy.

PGF2 α can be used for synchronization of sows or gilts by aborting early pregnancies (CL must be present). Following this induced abortion, sows or gilts may return to estrus 3-5 days later. This can be done to have these sows or gilts in estrus at a desired time. For induction of farrowing, PGF2 α should be given 2 days before expected farrowing. The manufacturer's recommendation is to give IM in the neck, but injecting in the vulva with half of the dose gives a similar response. There are some analogues of PGF2 α that may be used in a similar manner.

Altrenogest (Regumate or Matrix) is an orally active progestin and has progesterone-like activity. When Altrenogest is fed to a group of cyclic gilts or weaned sows, there is a suppression of gonadotropin secretion and, as a consequence, growth of follicles on the ovaries is inhibited. Ideally pigs should be individually fed so they can consume the required dose, which is usually fed for 14-18 days. Since estrus suppression is only needed from the time of luteal regression, if cycle dates are known, costs can be minimized by feeding Altrenogest from approximately 13 days after estrus detection until 5 days before scheduled breeding. When Altrenogest treatment is stopped, gonadotropin secretion increases and follicular growth ensues. Research has shown that up to 90-95% of gilts may show estrus on days 4-8 after the last feeding.

CONCLUSIONS

There are various hormonal and pharmaceutical products that may be used to manipulate swine reproduction. These tools are not meant to be a substitute for adequate management, and for best results compliance with protocols is required. A cost-benefit analysis should always be done to determine the real value of adopting any of these intervention strategies.

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PRACTICAL MANAGEMENT OF THE TRANSITION TO BATCH FARROWING

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ABSTRACT

Aarden Farms is a 250 sow farrow to finish operation. We farm 400 acres of grain crops and 35 acres of fresh market produce in Oxford County. In November 2007 we made the decision to slightly reduce the sow herd, which provided a good opportunity to transition to batch farrowing. We are now operating with 54 farrowing stalls in a four-week batch cycle with a goal of 46+ farrowings per batch. Realizing that all farms and managers are different, we will be discussing different options, the pros and cons of batch farrowing, and our transition to it.

POSITIVES OF BATCH FARROWING

- Grouping larger numbers of piglets together for sale or non continuous flow finishing barns. Many weaner buyers look for larger groups of pigs so that entire barns can be filled at once. Batching can open new markets for smaller producers who need larger numbers by multiplying their weekly production by the length of the batch.
- Time management efficiencies.
For example, by breeding sows once every four weeks in a larger group instead of smaller groups every week, you will actually spend much less time completing the work in total.
- Increase in monitored farrowings.
When four weeks of farrowings happens on one day as opposed to four days, it is easy to schedule help to ensure that the majority of the farrowings have someone there to assist, if required.
- Specialized labour sharing and scheduling.
Batch farrowers could get together and hire farrowing room technicians that could be shared amongst different farms. Smaller farms that require part time help can schedule help to come long in advance, for worthwhile amounts of time.

CHALLENGES WITH BATCH FARROWING

- Transitioning gilts into a batch.
Since there is no guarantee when a gilt will be bred, it is always a concern how to get gilts into one of the barns batches.

- Transitioning repeats and open sows that are not culls into the batch.
Since these sows don't always breed with the main batch it is always a concern as to how to get these sows into the barns batches.
- Added cost of hormones.
Using a hormone (Regumate) to hold sows to fit into a batch has a cost.
- Increased nonproductive sow days (NPD).
Whenever you have sows on Regumate that is a NPD.
- Barn limitations.
If your breeding area is designed to handle 10 to 15 sows at once, and you now have over 40 sows to breed at once, adjustments need to be made.

TRANSITIONING TO BATCHES

The length of batch will depend upon the goals of batching as well as the desired age of weaned pigs. Common batch lengths are 2, 3 and 4 week batches. Making the change to batch farrowing is greatly simplified when a farm is going through a herd depop, reduction in herd size or a new set up since you have excess farrowing stalls to work with. If there are extra farrowing stalls, you have the ability to leave sows with the piglets longer. You can then wean them as well as some sows slightly earlier than you normally would and create a batch of sows. This would be ideal for a shorter batch but for those who are running at near capacity or looking at a longer batch, the use of a hormone (Regumate) to delay estrus is required. The use of Regumate will allow you to wean sows but put off breeding them until the rest of the sows in the desired batch are weaned. Regumate is an effective tool in the transition to batching but also very useful for fitting gilts and sows into the desired batch. Keeping in mind that there will be a small percentage of sows that don't perfectly fit in the batch, it is recommended that once batching that there is a small excess of farrowing stalls over the targets to accommodate these overages.

CONCLUSIONS

Batch farrowing is an excellent way to manage a sow barn, however, a manager needs to adapt slightly from traditional methods. It is not complicated and opens new opportunities for many producers. The tools and practices are available to manage this system effectively; however the trick is to keep extra costs to a minimum and to make the most of the advantages.

IMPROVING ENERGY USE EFFICIENCY - REDUCING AND REFINING THE USE OF ENERGY INPUTS ON FARM

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INTRODUCTION

There are three main energy consumers on most swine farm: heating, ventilation and lighting. Another load that will be large is on-farm feed mills. This presentation will focus on the main areas and describe techniques for determining how energy efficient a farm is and methods to achieve optimum energy efficiency.

THE VALUE OF AN ENERGY AUDIT

Over the last several years, OMAFRA has worked with Agviro to develop an energy audit program. Over this time period, about 100 farms have received an audit. At the same time, other organizations including Natural Resources Canada, Enbridge Gas Distribution, Union Gas, as well as many local Electrical Utilities have all been providing partial funding for energy audits.

What is an Energy Audit?

An energy audit is defined as a “series of actions aimed at the identification and evaluation of energy management opportunities within a defined site.” The energy audit is a systematic approach for the farm operator to examine the current energy consumption and identify some alternatives for reducing energy costs. The first step in reducing the energy usage rate is to know how energy is used. The goals of an energy audit are as follows:

- To clearly identify the different types of energy use.
- To understand how this energy is being used.
- To identify alternatives that could reduce energy costs.
- To develop an implementation strategy, based upon an economic analysis of the alternatives, that is cost effective to the farm owner/manager.

The end result of an energy audit is to identify “energy management opportunities” (EMOs). EMO’s can be analyzed, implemented and then monitored as part of the farm’s energy reduction strategy.

What are the Benefits?

The immediate benefit to the farmer of conducting an energy audit is the knowledge that an organized audit brings to the farmer. Once this knowledge is imparted, the farmer can make cost

effective decisions that can be translated into a more efficient operation. The implementation of many EMOs is related to good maintenance practices that have the added benefits of decreasing other operating costs. The benefits to the farmer of improving farm energy efficiency are as follows:

- the opportunity for on-going substantial monetary savings
- a better understanding of the operating cost of production
- the possible reduction of nuisance breakdowns and emergency repairs
- an improved operating environment

Energy not used results in instantaneous cost savings now and into the future. Energy not used is cost savings shielded from future rate increases. Energy not used is stand-by and back-up energy capacity not required.

How to Conduct an Audit?

An energy audit need not be a complicated process. In general the audit process can be divided into nine general principles:

1. Define the study boundaries and prepare for the audit

Decide what part (or all) of the farm operation that is to be audited. Assemble the necessary equipment (checklists, tape measures, meters, etc.).

2. Gather site energy documentation

Put together a full year's worth of energy bills. This should include not just electricity bills but also propane, natural gas, tractor fuel and any other energy input to the farm operation.

3. Perform the "walk through" audit

This is the first audit of the farm operation. Carefully note all lighting, motors and heating arrangements and their energy use. Take note of energy use patterns.

4. Perform preliminary analysis

Review both the billing data and the walk-through audit information collected. Try to match the estimated energy used as observed with what is being billed. Take note of those areas that consume the most energy. Take advantage of any available energy audit checklists/templates and energy audit software available commercially or through your local OMAFRA office.

5. Identify "energy management opportunities" (EMOs)

Based upon the preliminary analysis, list those areas where the implementation of a change would result in an improvement of energy efficiency. These are your energy management opportunities (EMOs).

6. Perform "diagnostic audit"

Return to the EMOs for more detailed consideration. At this point, if the walk-through audit is showing some serious opportunity for savings, a closer look at energy use patterns and technology options may be advantageous. The use of metering and data logger to track "real" trends may be incorporated. The services of an energy professional may also prove beneficial.

7. Analyze EMOs and make recommendations

Analysis of the results of the diagnostic audit in addition to the information already collected from the walk-through audit should be performed to determine the true extent of each energy management opportunity. The end result of this step is a set of recommendations and a plan for implementation that has been based upon careful data analysis, cost/benefit analysis and review of alternate options.

8. Implement recommendations

Implementing the carefully considered recommendations developed is essential for taking advantage of any energy savings.

9. Perform “Monitoring and Targeting” (M&T) activities

An on-going energy auditing program is a prudent practice for understanding and taking advantage of developments to energy savings on farm operations. The initial audit can act as the “benchmark” against which continuous improvements can be monitored and tracked. The farmer may target new energy efficiency goals subsequent to each audit review.

Should I Do It Myself or Contract Out?

Whether or not the farm manager/operator conducts a self assessment or sub-contracts a more detailed audit to an energy expert is an individual choice dependent upon the farmer. An initial self assessment, such as the “walk through audit” discussed above, may reveal some obvious EMO’s that can be easily implemented. A more detailed or diagnostic audit performed by a third-party energy expert may provide access to more sophisticated approaches, equipment and improvement strategies that could significantly benefit the farm operation.

What are the Costs?

The energy audit, particularly the walk-through audit, is a data collection and analysis process. No special equipment or capital expenditure is required. The initial self assessment is the cost of labour and time to the operator with some possible expenses for instrumentation such as voltmeters, wattmeters, light meters, leak detectors and airflow measuring devices. Access to a computer and the cost of some basic energy auditing software may be a worthwhile investment. A more detailed audit replete with cost/benefit recommendations may cost \$200-\$500 if performed by a local energy specialist or Professional Engineer versant in energy auditing issues.

Is there Funding Assistance Available?

Currently there is no financial assistance available to the agricultural community for energy auditing activities. The return on investment of an energy audit is, however, extremely attractive. In addition to the many benefits discussed above, energy savings resulting from a thorough knowledge of farm operation make the implementation of at least a “walk through audit” an essential and prudent farm practice.

There are a number of incentives for both new and retrofit building projects. These include, but are not limited to:

- Your electricity company
 - New facilities through the High Performance New Construction Program (HPNC)
 - Existing facilities through Electricity Retrofit Incentive Program (ERIP) or similar type programs
- Enbridge and Union gas, if you have natural gas supplied from them
- Natural Resources Canada (NRCan)

After the Audit, What Next?

Completing an energy audit on even a part of your farm operation is the first step in developing a long term habit and vision of energy efficiency for the farm. Identifying significant EMOs, performing a diagnostic audit and following through with implementation recommendations will result in a more cost efficient farm operation. This energy knowledge will also assist the manager in making a wide assortment of critical decisions from current production adjustments to large expansion projects. Energy auditing should be an on-going practice. Careful documentation and analysis of energy use on a continuous basis will provide the farm manager with a “benchmark” against which to monitor and target continuous improvement activities. Finally, the knowledge gained from an energy audit can assist the farmer in making strategic decisions when considering renewable energy options.

ENERGY BENCHMARKING

Conducting an energy benchmarking analysis on the farm is a natural first step to understanding how you compare to other similar types of operations. Although there are many issues that make it difficult to ensure that each farm is being analyzed exactly the same way, it still provides some eye opening data. Some things that make it harder to directly compare include: house on the same meter as the barns; and an on-site feed mill, also on the same metering.

Agviro, with the Ag Energy Cooperative, has developed interactive, internet based energy benchmarking software at www.energybenchmark.com. This software allows users to input their own relevant energy and production data; and make exclusions of houses and feed mills to make the comparisons closer to other facilities.

Data so far has been quite dramatic (see Table 1). For example, the difference from the low to the high in the case of Farrow-Finish farms is from 11-44 kWh/sow/year, a difference of 4 times.

Average savings per farm have been in the \$2300/year. Note that this is for all farm sizes, and smaller farms have lower savings potential. The highest savings achieved was \$28,000 per year, with an average payback of less than one year.

Table 1. Energy benchmarking data from audited farms.

Swine	Farrow	Farrow-Finish	Farrow-Nursery	Finish	Nursery	Nursery-Finish
	kWh/sow	kWh/100 kg	kWh/100 kg	kWh/100 kg	kWh/100 kg	kWh/100 kg
kWh Max	338	44	136	17	19	16
kWh Av	296	31	91	12	14	16
kWh Min	254	11	46	9	12	16

Main Opportunities

There have been a number of identified technologies to save energy costs on swine farms. The main list is as follows:

1. Lighting

The main opportunities for lighting involve conversion to fluorescent systems. The temptation to install compact fluorescent has always been high, due to their low cost and easy retrofit. However, where lights are used for more than 6 hours/day, the longer lasting T8 4 ft tube fluorescent systems, in vapour tight housing, are a longer lasting, more economical and reliable system. These are best installed when doing major upgrades or building new.

2. Insulation, Air Sealing and Leaks

Insulation, properly installed and maintained, provides many benefits that simply cannot be over-emphasized: Reduce supplemental heat requirements, reduce radiation effects in summer, and extended building life.

Many barns as they age will develop leaks (and even new ones may not be properly sealed). Leaks mean the ventilation system will not direct air in where it should, disrupting air patterns and creating large variations in temperature and air quality. Smoking the barn for leaks and sealing with a good quality, long lasting silicone such as GE will be well worth the effort.

3. Ventilation: Dual; EE Fans

Where possible, dual ventilation (fans for colder weather and natural for summer) should be considered for grow, finish and breed/gestation barns. Electrical costs for fan systems will be reduced by up to 80% and reliance on the grip in hot weather is eliminated, also reducing generator size requirements.

Energy efficient fans should also be selected when renovating, replacing or building new. In many cases, a grant towards the cost is available. Check with the sales rep or your local utility for eligible products, or visit the web site: www.powerauthority.on.ca

4. Cooling: Water Based, Ceramics

Cooling has become more of an issue over the last 20 years. Water is the lowest cost method of providing relief from hot temperatures. There are a number of systems, with the lowest cost and simplest known a sprinkler system, to more complex high pressure mist and evaporative cooling

pads. Where major renovations are required on roof systems, the retrofitting of ceramic paint is a viable option to reduce attic heating. Ceramic paint reflects the sun's infrared rays away, and keeps attics at or close to ambient.

5. Heating

Heating is often the highest energy consumer on the farm but the use of natural gas, propane and oil keeps the costs significantly lower than if electricity were used. There are many different opportunities in the heat area:

- i) Creep heat systems can use higher efficiency 175 W Retrolite heat lamps with controls.
- ii) Creep heat systems can be converted to electric (or hot water) heat pads, also with a controller. Incentives are available for the electric models.
- iii) Conversion of forced air heaters to infrared tube (primarily nurseries).
- iv) Installation of high efficiency condensing boilers, for both space/creep heating and hot water for pressure washing.

6. Controls

Management of controls is a major reason why the benchmarking data ranges can be so widely different. Over ventilating minimum fans and improperly set stage settings waste large amounts of heat energy and also electricity to remove the wasted heat.

CONCLUSIONS

Many other things can be done around the swine farm to keep the systems as energy efficient as possible, such as cleaning all fans, soffit and air intakes regularly. And, the beautiful part is the reduced energy will not only save dollars but, without exception, performance of the animals will be maintained or even improved.

IMPROVING ENERGY USE EFFICIENCY

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INTRODUCTION

Producers need to know the basics of how their heating, ventilation and lighting systems function. While fuel and electricity are a small part of the overall cost of production, energy plays a significant role in feed conversion and overall animal output. It is possible through good design, management and maintenance to both reduce energy costs and improve pig performance. The three main energy users for swine facilities are heating, ventilation and lighting.

All ventilation systems operate on the principle of heat balance. That is, the heat produced by the animals must balance the heat lost through the building shell plus the ventilation system to maintain a good environment. Whenever there is a negative heat balance, supplementary heat is required to prevent the room temperature from dropping too much or allowing the ventilation system to shut off.

Supplementary heat must be added to many swine barns during the winter. Young pigs require heat year round. Heat is provided to ensure animals are kept above their lower critical temperature (LCT). This ensures they do not waste feed to keep warm. The temperature of the room alone does not necessarily mean the actual environment is above the LCT. Other factors affect it such as flooring type, insulation levels and ventilation system performance.

ENERGY AUDITS

An energy audit is aimed at identifying and evaluating energy management opportunities at the site. The goals of an energy audit are to:

- Identify the different sources of energy use
- Identify how much energy is used
- Identify alternatives to reduce energy costs
- Develop a plan, based upon an economic analysis of the alternatives that is cost effective to the farm owner/manager

The end result of an energy audit is to identify “energy management opportunities” (EMOs). EMO’s can be analyzed, implemented and then monitored as part of the farm’s energy reduction strategy.

Benefits of an Energy Audit

The immediate result is the identification of cost effective decisions that can be translated into a more efficient operation. The implementation of many EMOs is related to good maintenance practices that have the added benefits of decreasing other operating costs.

The benefits to the farmer of improving farm energy efficiency are as follows:

- On-going cost savings
- A better understanding of the operating cost of production
- Reduction of breakdowns and emergency repairs
- Improved barn environment

How to Conduct an Energy Audit

An energy audit is not a complicated process. The audit process can be divided into six steps:

- Preparing for the audit
- Performing the farm survey and inspection
- Analyzing the data
- Implementing the audit recommendations
- Documenting the audit activities
- Review the results

Energy Management Opportunities (EMOs)

Energy consumption related to ventilation on the farm is mostly concerned with heating and motors. Energy Management Opportunities (EMOs) result from a careful review of both use patterns and technology choices in the following areas:

Heating

- Insulate the building and other “hot” components (i.e. hot water storage tanks, hot water piping, etc.)
- Seal air leaks around doors and windows
- Use “set-back” or turn off equipment during non-use periods
- Creep heating
 - a. Install electric or hot water creep heat pads
 - b. Install creep heat controls
 - c. Install energy efficient heat lamps and controls
- Convert space heating in nurseries to infrared heating
- Maintain, calibrate and properly set ventilation controllers

Motors

- Install energy efficient exhaust fan and re-circulation fan systems
- Careful management of re-circulation fan systems
- Ensure ventilation controls are properly set and managed

ENERGY CONSERVATION

Energy conservation is the practice of reducing the amount of energy used. It is achieved by using more energy efficient technology, i.e. use less energy to achieve same result, or by changing management practices to reduce consumption of energy. Energy conservation may result in increased financial savings, environmental value, security, and increased comfort for the animals.

Fan Efficiency

All motors have a nameplate rating that shows its operating parameters. Most motors will have a horsepower (H.P.) rating. This refers to power at the shaft under steady state conditions. This number is not reliable for comparing the efficiency of various fans.

The motor nameplate also states the amperage and voltage that occur during steady state conditions. The combination of amperage and voltage can be used as part of the information needed to calculate fan efficiency. They should not be used separately for several reasons:

- Amperage is only one of many factors affecting motor performance. It is extremely unreliable for comparing fans.
- Wherever possible, wire motors to operate with 240 volts, rather than 120 volts, to increase energy use efficiency. Higher voltage will decrease losses that occur in the wire itself.
- All motor wiring should be a minimum of 12 gauge or larger to reduce line losses.

Lighting

Fluorescent lights are 5-6 times more efficient than incandescent, last longer and reduce the summer heat load. As the price of different technologies such as LED's becomes lower, these systems may become commonplace in future swine facilities.

There are programs available to assist with the conversion to more energy efficient lighting systems.

AVAILABLE RESOURCES

In the summer of 2009, OMAFRA is planning to release an updated ventilation guide. Topics covered are heating and ventilation basics, controllers, design information, different ventilation systems, energy efficiency, commissioning and calibration as well as troubleshooting. This manual is meant as a resource to educate producers on the importance of choosing a proper functioning system. While it will not replace the role of ventilation designers and commissioners, it will allow the producer to ask the proper questions to their ventilation suppliers and designers to obtain the best system for their needs.

OMAFRA has many factsheets available on the subject of energy efficiency at:
<http://www.omafra.gov.on.ca/english/engineer/energy.html> .

CONCLUSIONS

Producers and their employees should be aware of how the heating and ventilation system works and receive training on how to adjust it to obtain its maximum energy and pig performance. A properly designed and commissioned system will maximize pig performance while reducing energy input costs.

HOG PRICE REPORTING IN CANADA

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INTRODUCTION

Hog price reporting in Canada has historically been performed by the various mandated single desk selling agencies that were established in the early 1970's in most provinces. Many of these marketing systems were originally set-up because of serious concerns about the income distribution between producers and packers. The system was intended to give producers economic power and reduce total costs of marketing. These agencies were given exclusive authority to negotiate prices with packers on the basis of grading grids in each province, pool returns to producers, and provide a number of other services. However, today many of these agencies have lost their exclusive marketing powers and are in a state of flux as they try to add value through the services they provide to their memberships.

The Canadian hog-pork sector has experienced tremendous growth by moving from a situation where production and consumption were more or less in balance in the 1970's to now where exports represent approximately 60% of total pork production. Still, despite this growth in pork production, consolidation has occurred in all segments of the supply chain as retailers, meat processors, and producers respond to changing market forces and try to maintain a competitive edge by trimming costs. In Ontario, at the production level, the number of farms in the swine class of 1 to 77 animals decreased by 50.5% between 1996 and 2006. At the other extreme, in the largest swine farm class of 4,685 animals and over, the number of farms increased by 245% during this time period.

Given this back drop of industry change, Ontario faces the complicated questions of what is the most effective and efficient hog marketing system to embrace and what services should be provided to the sector, such as price reporting.

PURPOSE AND METHOD

The purpose of this document is to describe how market hog prices are reported across Canada. Specific components to this question include: (i) frequency of price reporting?; (ii) who does the price reporting?; (iii) what does the price mean with respect to transportation, premiums, discounts, grids, volume of animals, etc? and (iv) how is the price formulated that gets reported?

The information used to compile this report was obtained either electronically or by telephone interview with individuals responsible for price reporting in their respective province (e.g. general managers of marketing organizations and provincial marketing specialists). It should be noted that this report has some possible limitations including misinterpretation of information, collection methodology, and the limited number of individuals contacted.

FINDINGS

Below are the summaries of the conversations and electronic notes provided by the various provincial contacts.

Alberta

Since removal of single desk marketing in 1996, Alberta has had no official price reporting. This function has been left up to marketing organizations such as the Western Hog Exchange (WHE) and independent dealers to report as each sees fit to their clients. The provincial government does not make any reports available to the public from data collected by them. However, the province may quote prices as supplied by others such as the WHE and other independent dealers. Individual contract prices that have been struck between producers and processors are not reported to the public.

The WHE supplies a daily price report to its members that provides information on the hog futures, Canadian dollar, U.S. hog prices (i.e. Iowa/Minnesota), U.S. daily hog slaughter, a base hog price for WHE members, and some commentary on the grain markets.

Saskatchewan

The marketing organization, called SPI, reports both a daily price, which is the Maple Leaf Foods Signature 3 base 100 contract price, and a weekly price, which is the average of the Signature 3 daily prices for the week. The Signature 3 contract price is the U.S. Western Corn belt price times a factor of 1.833 times the daily exchange rate. All prices are quoted as FOB the plant. It was stated that the SPI daily price reported does vary slightly from the Manitoba Pork Marketing price (discussed below) because SPI's prices have marketing service charges deducted.

Manitoba

In the province of Manitoba, there are 3 different price reports available to the public. The first report is published weekly by the provincial government and is referred to as an all-in-slaughter price. This price represents the total dollars paid for hogs within a week by the two main federally inspected plants that are located in Manitoba. This price is FOB the plant and includes all premiums, discounts, grid adjustments, etc. The price is calculated by using the variables of total dollars paid out, weight per animal, and number of animals slaughtered during the week.

The second price series that is publicly available in Manitoba is the one supplied by Maple Leaf Foods and it is on a weekly basis. This price series is to reflect the Signature 3 contract prices which is the majority of the animals slaughtered at the Brandon plant. This price series is a base price before any premiums, discounts, and grid adjustments.

The third price series that is published In Manitoba is supplied by Manitoba Pork Marketing and is distributed daily. This report calculates the base price for the two largest federally inspected plants in the province at 100 index. As stated above in the Saskatchewan section, the base price used by Maple Leaf is the Western Corn Belt price times a factor of 1.833 times the daily exchange rate.

Quebec

All prices reported in Quebec are supplied by the FPPQ (Federation of Quebec Pork Producers) on their website. The first price series released by the FPPQ is an average price which is reported daily and is based on 3 different price series and they are: U.S. base price which uses the LH201 report - 50% of the hog volume; English type auction – 25% of the volume; and Dutch auction – 25% of the volume. The second price series reported is a pooled price that accounts for all collective marketing expenses.

All prices reported in Quebec are FOB the plant and exclude premiums, discounts, and grid adjustments. Further, the prices are formulated at 100 index.

Prince Edward Island

The PEI Hog Commodity Marketing Board puts a calculated weekly price on an information tape so that producers can dial-up to obtain a 100 index price for pigs delivered to the Larson slaughtering plant located in Nova Scotia. This plant uses the Ontario Pool and Pool Plus price plus 4.5 cents per kg to calculate a 100 index price.

SUMMARY

Price reporting varies by province depending on the marketing system in place. In Western Canada, where single desk selling has been removed, most of the price reporting has been picked up by the marketing organizations that have been established in each province (i.e. WHE, SPI, and Manitoba Pork Marketing). Typically, each one of these organizations reports a base contract price that has been formulated off a U.S. price series and adjusted for exchange rate and index. In Quebec, where single desk selling has been maintained, all price reporting is done by the FPPQ.

REDUCING FEED COSTS IN GROWER-FINISHER BARNs

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INTRODUCTION

By now it should be no surprise that feed is by far the biggest cost in raising a hog to market. The remarkable roller-coaster that commodity markets have been on over the last year and a half is a sobering reminder of the impact feed has on the economics of raising hogs. Fortunately there are a number of things that producers can do to reduce or control feed costs. However, on most farms we are probably ignoring \$2 to \$5/pig in potential feed savings.

THE BASICS

This is by no means a comprehensive list but represents opportunities producers have to reduce or control feed costs. You have heard about each and every one of these but how many have you implemented?

- High health status
 - Fighting infection and disease takes away nutrients from growth and feed conversion. Your health status is worth protecting! Implement a workable biosecurity protocol and strictly follow it.
- Phase feeding
 - Matching the diet nutrient density to stage of production and intake saves money. As you increase the number of phases the amount of savings is diminished but 3 to 4 phases is usually optimal.
- Split sex feeding
 - Barrows eat more than gilts. Due to this difference, implementing separate feed budgets for barrows and gilts reduces feed costs.
- Reducing feed wastage
 - Are you achieving 5% feed wastage?
 - Feeder settings
 - Are you setting the feeders regularly?
 - Are you checking feeder pan coverage daily?
 - Feed system repairs
 - Any leakage in your feed system is a lost opportunity.
 - Remember duct tape is supposed to be temporary!
- Using “alternative” ingredients

- This requires the help of a nutritionist and typically more focus on ingredient quality control.
- Using ingredients like distillers dried grains with solubles, wheat shorts, bakery meal, field peas, canola meal, etc. can be well worth the extra effort.
- Feed budget
 - How well do you know your pigs' feed intake and growth?
 - Are you setting targets for kilograms of feed delivered and growth for each phase?
 - Are you achieving those targets?

This final point is critical to return over feed cost as it is a reflection of the unique combination of the genetics, nutrition, health and management in your operation. This combination determines your feed cost. It is also a complicated question to answer as changes in one area can dramatically alter another.

A CASE STUDY

Let's examine a case study from a 2000 sow farrow to finish loop. This loop is comprised of 3 sow units all stocked with the same maternal line. The early weans from the sow units are co-mingled in nurseries and then flow into the finishers. The majority of feed used in the system is complete feed. The group finishes 40,000+ market hogs per year, collects close-out data on every batch through their nurseries and finishers and participates in a benchmarking group.

In February 2008, they came to me with a problem. They had recently changed terminal sire genetics and were not achieving the average daily gain (ADG) or feed conversion they had seen in their test groups. Average daily gain was in the low 800 g/day and feed:gain was hovering in the 3.1 to 3.3 range. To help find a solution we attempted to answer the following questions:

What should the performance be?

We needed to gather enough information to estimate the performance potential for these pigs. From the closeouts we could roughly estimate feed intake, Ontario Pork's OINK system provided valuable carcass information and their nutrition provider shared the nutrient specifications of the diets they were using. We then used the PorkMaster® growth model (Massey University & University of Guelph) to see if we could predict current performance. Based on the information we had, the model predicted significantly better growth and feed conversion than was being observed. It also told us that we were likely over-feeding these pigs, especially in the late finisher.

Is the feed budget correct?

While there was a feed budget in place (Table 1), it needed to be validated to see if it was appropriately matched to the growth rate of the pig.

Table 1. Original feed budget.

Feed/Phase	Start Weight (kg)	End Weight (kg)	Feed Budgeted (kg)	Feed Budgeted (%)
Grower 1	25	34	20.25	7.8%
Grower 2	34	55	52.5	20.3%
Grower 3	55	80	69.25	26.9%
Grower 4	80	115	115.5	44.9%

The production manager conducted a series of spot weight checks at various finisher barns at the end of each phase. In some cases the feed budget was correct but in most cases the pigs appeared to start falling behind the budget around Grower 2 or 3.

What is the feed intake and growth curve for these pigs?

In June 2008, we decided to do a feeding trial to monitor feed intake and growth over the entire finishing period. Prior to beginning the trial we re-designed the feed budget and added a fifth phase. Based on model predictions we anticipated these changes would reduce expected feed costs by approximately \$3.25/pig.

The trial was set up to monitor feed intake and growth in four adjacent pens. Each set of two pens shared a fence line wet-dry feeder. Sixty-five barrows were placed in the first set of pens and sixty-five gilts were placed in the second set of pens. All pigs were weighed on entry and re-weighed every 7 days using a digital scale. Weights were totalled and average daily gain calculated weekly. Any pigs that were removed from the trial (due to injury or mortality) were weighed and the weight data adjusted to reflect their removal in the following week. Once the first group of pigs reached shipping weight the trial was ended.

The feeding system delivered feed into large plastic hoppers suspended above each feeder. Both hoppers were suspended by spring scales so the feed could be weighed prior to being emptied into the feeder. Daily, the producer would record the weight of feed deposited into the feeder on a calendar posted beside the hoppers. Each week the feed would be totalled and feed intake and feed:gain calculated.

From the trial we were able to develop feed intake and growth curves (Figures 1 and 2).

Figure 1. Feed intake curve for mixed sex grower-finisher pigs.

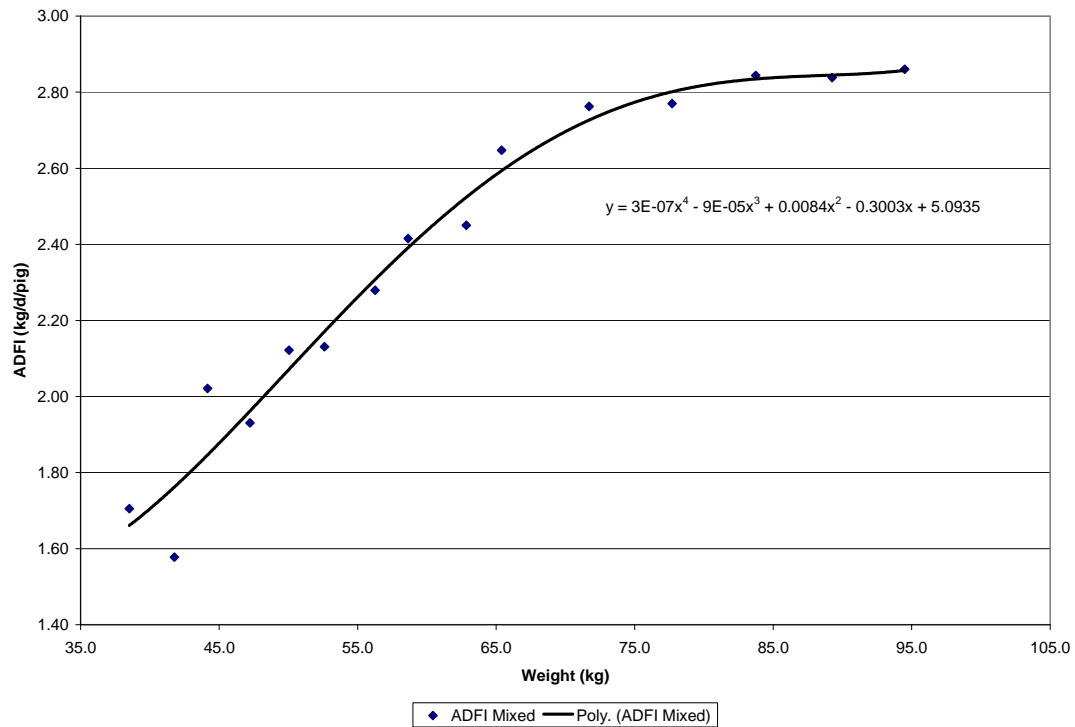
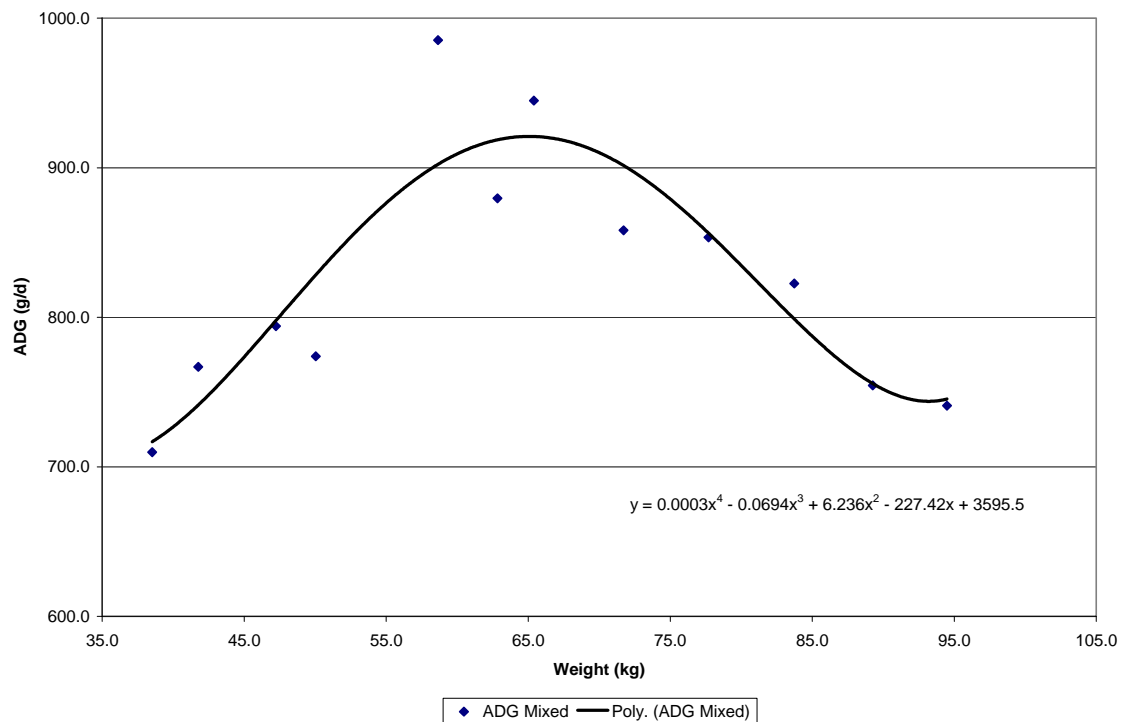


Figure 2. Average daily gain curve for mixed sex grower-finisher pigs.



Using PorkMaster® we compared the model predictions for the trial against the closeout (Table 2).

Table 2. PorkMaster® predictions versus trial results.

	Average Daily Gain (g/day)	Feed:Gain	Carcass Yield (%)
PorkMaster® Prediction	843	2.93	61.4
Trial Result	806	2.95	60.8

While we appeared to be closing in on characterising the feed intake and growth potential of these pigs we were not all the way there yet. This process also identified a few areas for improvement and further refining of the diets and feed budget (Table 3). Based on model predictions this new budget reduced expected feed cost by approximately \$2.00/pig.

Table 3. New feed budget.

Feed/Phase	Start Weight (kg)	End Weight (kg)	Feed Budgeted (kg)	Feed Budgeted (%)
Grower 1	28	36	16.2	6.3%
Grower 2	34	47	24.8	9.7%
Grower 3	56	68	38.5	15.1%
Grower 4	68	88	77.2	30.2%
Grower 5	86	118	98.6	38.6%

Continuous Improvement

Since then we have repeated the trial to gather more information and continue to refine the diets to improve carcass characteristics. Performance has improved throughout the system and closeouts are now showing ADG around 850 g/day and feed:gain near 2.9 without affecting carcass characteristics.

SUMMARY

Every swine producer should have a deep understanding of how their unique combination of genetics, nutrition, health and management impacts return. That knowledge is the key to reducing feed cost and is well worth the effort and time commitment to obtain.

ACKNOWLEDGEMENTS

I want to thank all of the companies and individuals involved in this process for their time and commitment to continuous improvement and allowing me to participate. Your enthusiasm is infectious!

REDUCING GROWER-FINISHER FEED COSTS

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To what degree, in practice, do we actually meaningfully analyse and then manipulate feeding programmes to meet the growth potential of finishing pigs? To my mind, the answer is seldom and usually ineffectually. To find out why, we need to ask how the cycle of intended successful progress, as it relates to the subject matter of this presentation, pans out.

Thus, faced with the feed-on-farm challenge, this practical nutritionist utilises the thought processes and strategies as I have laid them out in the earlier presentation at this conference. The result is The Diet Plan which is then agreed with the producer. If it is deemed to be practically capable of being enacted, it is agreed and then The Plan is put into practice for a set period of time. After that time period has elapsed, any relevant data are accumulated and The Evaluation takes place and from whence The Outcome is assessed. This forms The Review which leads to The Revised Plan. This is the simple rotational approach.

You will note that I have not included the word “monitor” or the couplet “statistically significant” in that process! Experience in the UK tells me that monitoring is not something that takes place with accuracy or regularity and is usually approached in the same way that laying concrete in a farm yard often is – “it won’t earn me any extra money so I’m not doing it!” More recently, quality, skilled labour has become a prized possession and hence a rarity on pig units, generally, let alone on the more simplified and less labour-intensive growing-finishing enterprises. Thus, weighing crates lay idle. However, an absence of accurate monitoring means that the rotational approach can never succeed other than by chance effect. To my mind, there is insufficient financial slack in the pig industry to allow decision making to be based on the chance effect.

If inadequate monitoring takes place then any observed apparent change in productivity is highly unlikely to reach a level of statistical significance!!! I’m no statistician, but this tends to mean to me that we are once again relying on chance!

The repeated absence of the valued numerical judgement upon which to base revised nutritional strategies or, more broadly, overt pig management strategies, has led to the little firm of Harbro Limited, from the North East of Scotland, investing in the search for “Tools of the Trade” to correct this irregularity. As a company with long-standing nutritional technical roots, the need for informed decision making was very much the key to Harbro’s motivation to push for change in this state of affairs.

The basic requirement was for “the most to be made out of the least”, to see if we could use what data might currently be being generated by the enterprise or could be produced with

minimal farm inputs to the greater good of the partnership between nutritionist and pig producer.

The outcome of this search, which began shortly after the start of this millennium, has been the production of two pieces of software that now regale under the titles of *qboxanalysis* and *qscan*. The key element is the first letter that they have in common, “q”, for quality, which should be the watchword of all pig production systems that are striving to reduce costs.

It is common practice in the UK for the accepted performance measure on growing/finishing enterprises to be the weekly grading returns sheet. This sheet contains a mass of figures for the batch or batches of pigs submitted to the abattoir(s) in question covering pig type, hot and cold weights, backfat thickness, lean meat percentage, condemnations, price per kg, price per carcass and the more detailed raft of information should the AutoFom or similar be in use. These sheets, whilst regularly being proffered at any visiting technician that asks to see them, are rarely studied in detail by the producer recipient and normally have a deep desk drawer or dusty box file to reside in. However, these are valuable, if under-utilised, pieces of data that potentially say much about that enterprise and can aid in monitoring the impact of management change.

The first element to come from within the stable of Innovent Technology, a Harbro sister company, was *qboxanalysis*. This piece of software utilises the on-line data capture facility in the abattoir to assess the grading of pig carcasses against the precise demands of various contract specifications and, with automatic upload, makes the information visible, real-time, over the internet in a form that is easy to assimilate and manipulate. The use of web browser technology retains secure, confidential data reporting.

qboxanalysis enables the user to:

1. Target production for maximum profit – the system quickly identifies the potential for improving profit by fine tuning your pig output
2. Graphical reporting of product quality – you can receive daily/weekly updates highlighting changes to grade, weight and proportion of pigs achieving quality returns
3. Instant output and efficiency monitor – constantly monitoring pig output and reporting on changes as they happen. The meat output can be combined with feed usage to give an accurate and progressive monitor of feed conversion efficiency
4. Benchmarking against similar producers – the system offers a unique opportunity to benchmark against production sites or against similar producers over a wide range of parameters including genetics, feed type and health status
5. Improved pig management and marketing – the system offers an unrivalled focus on carcass quality and targets production to maximise profit on the available slaughter contracts
6. Trend analysis – the program reports detailed trends in production output allowing rapid responses to any change

The program allows you to select your own data by date, site or slap (farm ID) mark.

The program allows full graphical analysis of pig output plus financial modelling. This enables identification of the proportion of pigs hitting premium grades and calculates the net margin impact of changing sale weight.

The program enables full bench-marking between your production sites or against a pool of similar data. This enables the identification of the impact of health, management, genetics and region.

The *qboxanalysis* process can also provide the processor/packer with advantage in the form of:

1. Improvement of product quality
2. Greater achievement of contract specifications
3. Manageability of producer supply chain
4. Accurate fault analysis and reporting
5. Benchmarking of supplier performance
6. “High visibility” contract management
7. A producer awareness programme = pro-activity

The facets of the program, some of which are featured below, will be demonstrated during the course of the break-out session but more information can be gained by accessing the web-site, www.qboxanalysis.com.

Figure 1. *qbox* chart of average batch and back fat probe over time.

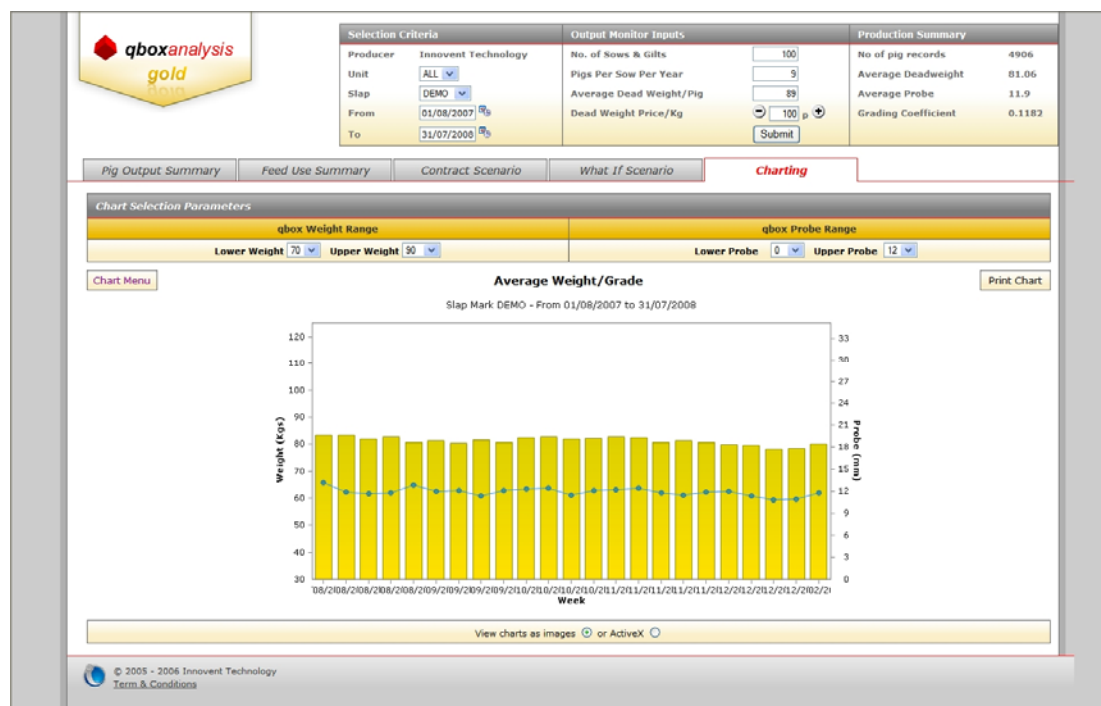


Figure 2. *qbox* histogram of back fat distribution per batch or time period.

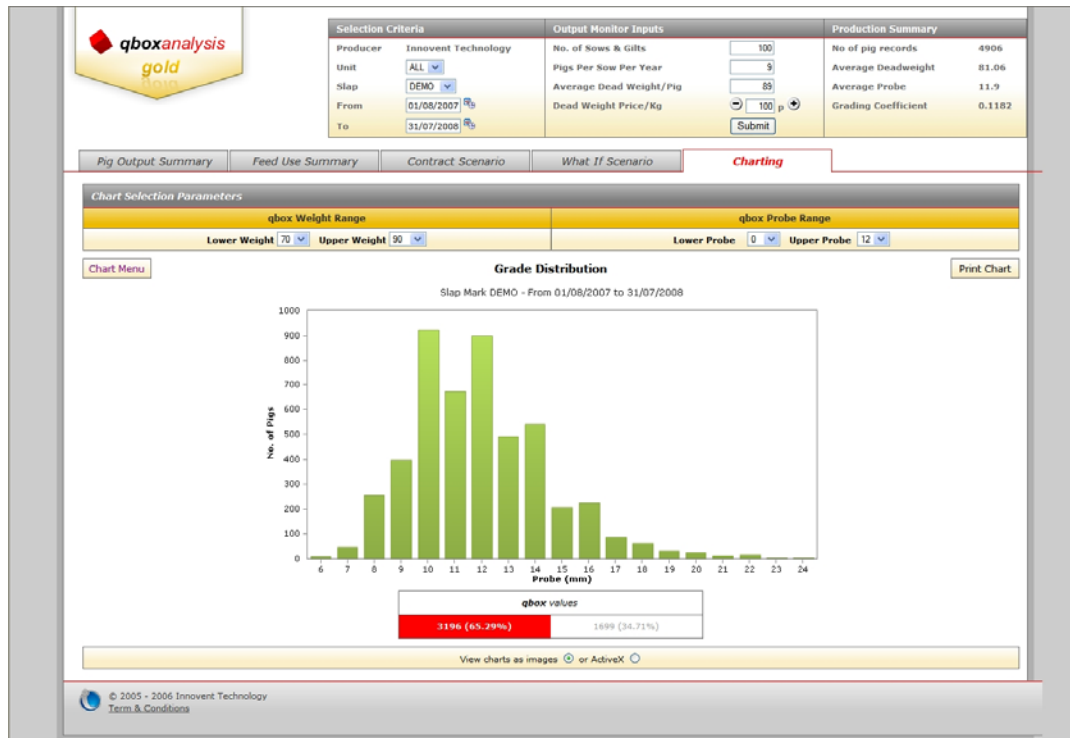


Figure 3. *qbox* basic chart showing degree of fit with contract specification per batch or time period.



Figure 4. *qbox* contract comparison outcome.

The screenshot displays the **qboxanalysis gold** software interface. At the top, there are three main sections: **Selection Criteria**, **Output Monitor Inputs**, and **Production Summary**.

Selection Criteria:

- Producer: Innovent Technology
- Unit: ALL
- Slap: DEMO
- From: 01/08/2007
- To: 31/07/2008

Output Monitor Inputs:

- No. of Sows & Gilts: 100
- Pigs Per Sow Per Year: 9
- Average Dead Weight/Pig: 89
- Dead Weight Price/Kg: 100 p

Production Summary:

- No of pig records: 4906
- Average Deadweight: 81.06
- Average Probe: 11.9
- Grading Coefficient: 0.1182

Below these sections are tabs for **Pig Output Summary**, **Feed Use Summary**, **Contract Scenario** (selected), **What If Scenario**, and **Charting**.

The **Contract Scenario** tab contains two main tables:

Contract Parameters:

	Contract	Price/Kg	Contract Value
Default	Dan Day 1	100	404442.49
Comparison	Normal	100	139193.71

Contract Comparison:

	Current	Comparison	Difference
Contract	Dan Day 1	Normal	-
Price/Kg	100	100	0
Av. Value/Pig	82.44	28.37	-54.07
Total Batch Value	404442.49	139193.71	-265248.78
Cost Deductions (£)	0	0	0
Net Value/Pig	82.44	28.37	-54.07
Total Value/Batch	404442.49	139193.71	-265248.78

Default Production Parameters:

DLWG	FCR	KO%	Feed Cost	ACCOM Cost	Grading Coefficient
0.85	3.0	75	80.00	0.10	0.12

Weight Change Scenarios:

Change (Kg)	-5	0	5	10	15
Change (£/pig)	-55.8	-54.07	-52.31	-50.56	-48.81
Feed Req.	-20	0	20	40	60
Feed Cost (£/Pig)	-1.6	0	1.6	3.2	4.8
Change (£/Pig)	-0.13	0	0.15	0.31	0.46
Accom. (days)	-7.84	0	7.84	15.69	23.53
Accom. cost (£)	-0.78	0	0.78	1.57	2.35
Net Change/Pig	0.65	0	-0.63	-1.26	-1.89
Net Change/Batch	3188.9	0	-3090.78	-6181.56	-9272.34
Net Change/Kg	0.01	0	-0.01	-0.03	-0.07

At the bottom left, there is a copyright notice: © 2005 Innovent Technology, Contact qboxanalysis, and a link to Term & Conditions.

The output of *qboxanalysis* and its technical interpretation should perhaps be viewed as a toe dipped into the water of the performance monitoring pool and was always intended to be the basis upon which more detailed enterprise assessment was to be founded. Yes, the programme will indeed open up the arena of greater degrees of confidence of cost reduction both in actual performance and also in the variation in those values but only in a macro sense.

This then leads us nicely on to the more recent innovation – *qscan*.

In this regard, the background to this initiative is, in part, the paucity of computerised herd recording that now takes place in the UK. Speaking as a past exponent of the Easicare herd recording bureau service through another technically-based commercial nutritional company, from a “former life” in the UK, it is notable that good recording, where it can be found, seems to exist numerically confined within the scope of the digits on the hands and toes on the feet of the party that is interested in such recording! Thus, we find that breeding herd productivity has a history of being very well recorded and yet the repository for up to 80% of the feed spend, the feeding herd, comes a very poor second.

I jokingly remark at this juncture that what we know about the performance of the finishing herd is often a growth curve that is made up of two points, a contradiction in terms, I hear the mathematicians amongst you say. These two points can also often be of interesting derivation when you dig more deeply. The first, the start point, is either a single digit whole number of kilogrammes or one with the figure 5 after the decimal point – it’s the weaning weight – often a guess at a roughly rounded value! The point at the other end of the growth “curve” is often taken from the grading sheet, ie the average cold slaughter weight, with a killing out percentage (KO%) factor being used, conveniently positioned at 75%! If any of you have

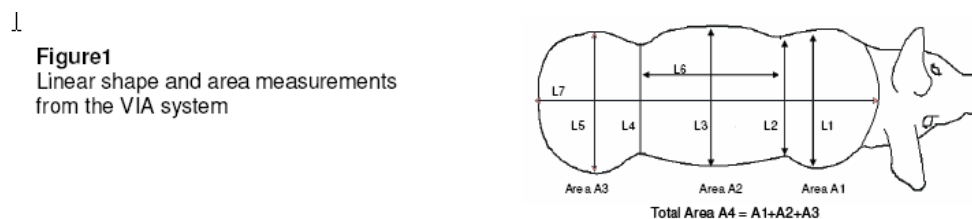
checked out the KO% of your finished pigs, and you certainly should do if you are paid on a dead weight basis, you will find that it is not static, rarely predictable and certainly is not absolutely 75%! The end point of the “curve” then is an estimate. As technical assistants, we are wont to rely on this information and rarely have the temerity to ask for it to be provided with accuracy, ie without the guesswork or estimation.

Not only is such information that we glean unreliable but it also usually merely reflects nothing more than an unreliable average and fails to tell us anything about the variation about that mean figure. The one thing that we know for sure is that the modest variation in birth weight that we know occurs in the farrowing house is many times greater 22 to 25 weeks later into that pig’s life and it is this that is the Achilles Heel of profitability in pig production systems around the world.

With *qscan*, the progressive user of data can start to accumulate valuable information about growth on a day-by-day basis for individual pigs in batches.

In the early 1990’s my research browsing led me to note that there were rumblings about the existence of a relationship between various two dimensional spatial measurements of the pig and its live weight.

Figure 5. 2-D spatial measurements used.



However, other distractions got the better of me and I thought nothing more of this concept until about 4 years ago when I had had time to think, an able computer-attuned colleague accompanying me and the chance to get sight of a failing visual imaging system in need of commercialisation. Cutting a very long story short, thus, *qscan* was borne.

What is *qscan*?

It is a complete solution to providing accurate growth recording within pig production units. It has been extensively tried and tested on pig production units across the UK and now is commercially available from Innovent Technology.

How does *qscan* work?

Cameras are located above a point of congregation (feeder or drinker) in each pen and they record the movements of pigs within that pen. Each camera can capture up to four framed images per second. Captured images are processed in seconds and appended to the

accumulating *qscan* database. Captured data is then displayed locally as easy to interpret reports and charting details.

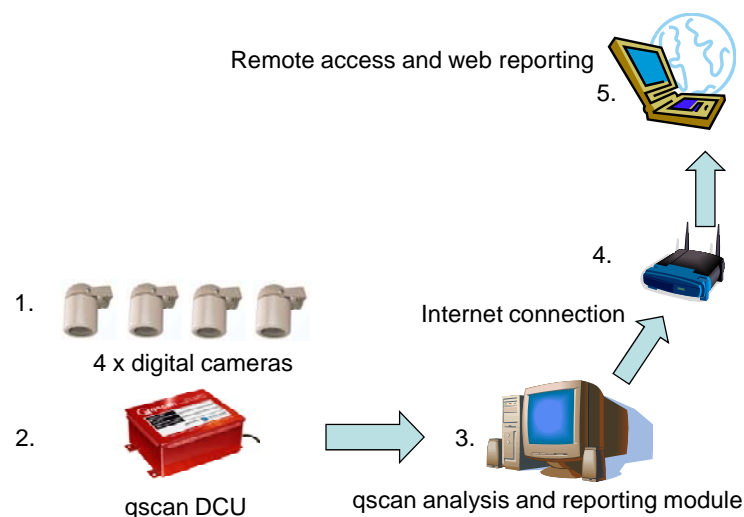
The information that is retained is daily growth performance per pen, actual weights of “captured” pigs, actual growth curves achieved over the monitored period and some behavioural analysis of each 24 hour period. This database can be used by anyone wishing to study performance across different batches of pigs exposed to differing medication/vaccination regimes or, of course, nutritional programmes.

Data is then uploaded on a routine basis, using industry standard file transfer protocol (FTP). This enables collaborative analysis of available data by multiple users located anywhere in the world. Nutritionist, veterinarian, geneticist and producer alike can evaluate performance from their own respective offices without having to routinely set foot on the actual unit – a huge plus for bio-security.

What makes up *qscan*?

The standard format is either a four or 8 camera arrangement displayed in a crude sequence as indicated below:

Figure 6. *qscan* – The set-up.



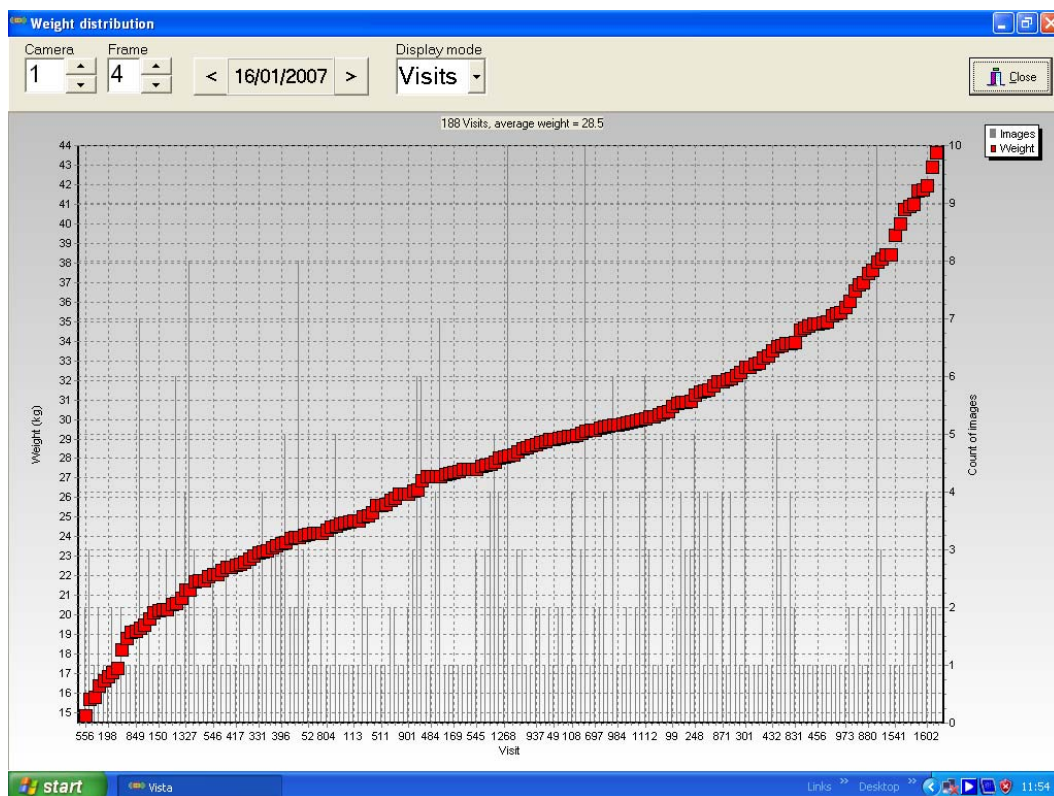
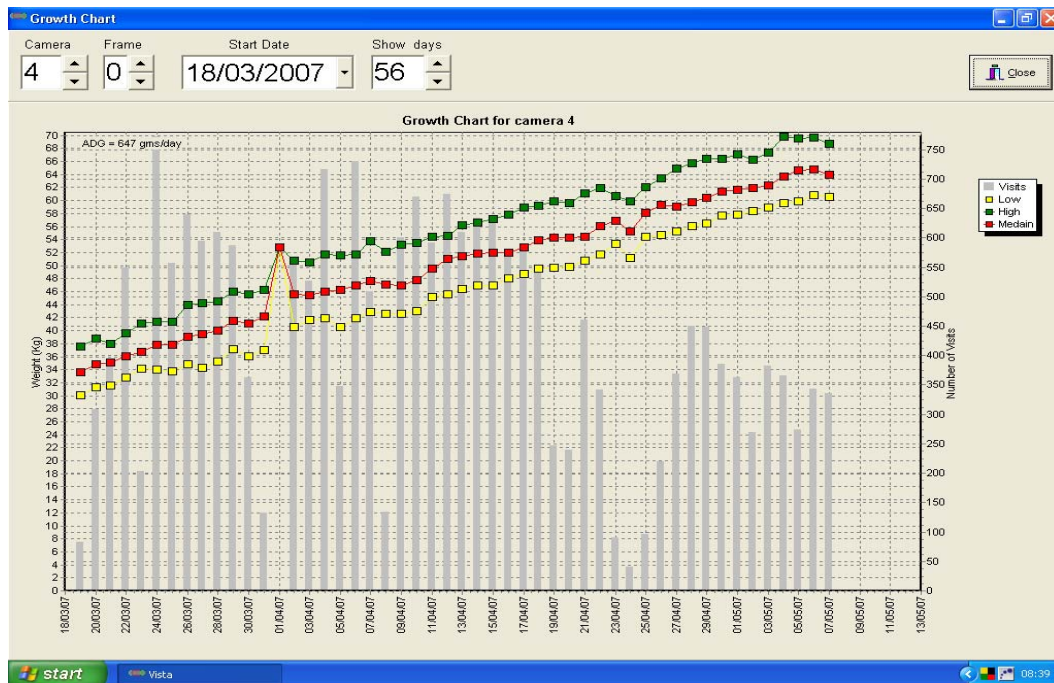
What does the *qscan* camera see as the live still image?

Figure 7. *qscan* – What the camera sees – slats or straw-based.



What sort of *qscan* data can be made available locally?

Figure 8. *qscan* – Locally available data – daily weight distribution and overall growth curve plus quartiles.



These features of the program will be demonstrated in much more detail as will other elements of the system during the course of the break-out session but more information can be gained by accessing the web-site, www.qscan.co.uk.

It takes but little imagination to see how powerful this tool of the trade is to either the supportive technician or the progressive producer. This really is a bottom line solution which is what you need when your stated and necessary aim is to reduce grower/finisher costs, whilst also reducing variation.

ALTERNATIVE VALUE CHAINS: JONES FEED MILLS CASE STUDY

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During the development of our supply of niche market hogs, we had the opportunity to get in touch with the Jones Feed Mills Group. The Jones Feed Mills were looking for a market that would provide income to small family farms. The Jones Group decided to tour the duBreton processing plant in Rivière-du-Loup in Québec to see if creating a partnership with the Breton Family would fit with the ideology of their Mennonite and Amish suppliers.

After the visit, meetings were held with the community to see if barns could meet the standards of the **Certified Humane®** certification. It was decided that 3 site productions would best fit into this program. Also, it was economically beneficial to do complete depop - repop, so the health of the animals could be maintained. In this program, no antibiotics are allowed during the lifetime of the market animals.

At this time, the Jones network consists of 37 different farms. Farrowing units range from 180 to 200 sows. The nursery barns and the finishing barns are on different sites. The biggest finishing barns are not more than 500 head. All nursery and finishing sites are working with all-in, all-out.

For biosecurity, sites use the Danish entry system.

These are some of the highlights of the **Certified Humane®** program:

A. Feed

FW 1: Wholesome, nutritious feed

- a. Pigs must be fed to meet or exceed nutrient requirements as determined by the National Research Council.
- b. Pigs must be fed a wholesome diet which is:
 1. Appropriate to their species, stage of production, and age.
 2. Fed to them in sufficient quantity to maintain them in good health; and
 3. Sufficient for their nutritional needs.

FW 4: Substances prohibited in feed

- a. No feedstuffs containing mammalian-derived protein are permitted, with the exception of milk and milk products.
- b. Pigs must not be fed or implanted with any growth promoter or fed antibiotics deliberately to boost growth or feed efficiency.

c. Antibiotics may only be given to individual pigs for therapeutic reasons (for disease treatment) and only under the direction of a veterinarian.

FW 9: Easy availability of feed

a. For ration feeding pigs in a trough, there must be enough feeding space (1.1 times shoulder width) for all pigs to feed simultaneously. A feeding place is described as space required by a single pig while eating.

b. For ad lib feeding there must be no more than:

1. 6 pigs per feeding place when using a dry feeder with no full head barriers between each feeding place;
2. 10 pigs per feeding place when there are full head barriers; or
3. 14 pigs per feeding place when there is the opportunity to mix water with the feed (wet and dry feeders).

c. If wet feeding of sows indoors is used, head and shoulder barriers must be erected between each feeding place.

FW 12: Weaning

Piglets must not be weaned from the sow before the fourth week after farrowing, unless a veterinarian confirms that the welfare or health of the sow or piglets would otherwise be adversely affected. When batch farrowing practices are used, the average age of the batch at weaning should be 28 days or more.

FW 13: Creep Feeding

Solid feed, of appropriate nutritional and palatable quality, must be provided to all piglets from 10 days of age but inaccessible to the sow.

B. Water

FW 15: Water supply

a. All pigs must have access to an adequate supply of clean, fresh drinking water each day, except when directed by the attending veterinarian.

b. Special care must be taken to ensure that drinkers are adjusted (height and flow rate) so that water is accessible for every pig.

FW 16: Extra drinker when using wet and dry feeders

When wet and dry feeders are used (i.e. both the feeder and drinker are within a single pig place), an additional drinker must be supplied in the pen.

A. Buildings

E 1: Records of features of facilities that promote animal welfare

a. For all accommodations, the key points relating to welfare must be recorded in the farm log book or on the farm site plan, and if practical, be displayed at or near to the entrance to each building and be amended accordingly.

b. These must include:

1. Total floor area;

2. Building area available to pigs; and
3. Current number of pigs in relation to age and weight, and consequent feeding, drinking, and bedding space per pig.

C. Lying Area/Floors

E 11: Lying area

a. Pigs kept indoors must be kept on, or have access at all times to, a lying area (see E 14) that is:

1. Of solid construction (i.e. not perforated);
2. Bedded to a sufficient extent to avoid discomfort; and
3. Either sloped to provide drainage or bedded to a sufficient extent to provide a dry surface.

b. Pigs kept in outdoor systems must have access to a comfortable, dry lying surface of sufficient size to allow all pigs to lie down at the same time. In inclement weather, (i.e., rain, snow, cold) the pigs must have access to a covered comfortable, dry

D. Space allowances

E 13: Total floor space

Pigs must always be provided with a total floor space no less than 1.5 times their minimum lying area.

E 14: Bedded space for growing pigs

The minimum bedded space and total space allowances for growing pigs are as follows:

Live weight		Lying area		Total area	
(kg)	(lbs)	(m ²)	(ft ²)	(m ²)	(ft ²)
10	22	0.10	1.1	0.15	1.7
20	44	0.15	1.6	0.22	2.4
30	66	0.20	2.2	0.30	3.3
40	88	0.26	2.8	0.40	4.2
50	110	0.31	3.3	0.47	5.0
60	132	0.36	3.9	0.55	5.9
70	154	0.41	4.4	0.61	6.6
80	176	0.45	4.8	0.67	7.2
90	198	0.47	5.0	0.71	7.5
100	220	0.50	5.4	0.75	8.1
110	242	0.53	5.7	0.79	8.5
120	264	0.57	6.1	0.85	9.1

E 15: Space allowance for sows and gilts

Sows must be given a minimum total floor space of 37.6 sq. ft (3.5m²)/sow for mature adults, and 28.9 sq. ft. (2.5m²) /sow for first and second parity animals, though this may

exceptionally be slightly altered (for different breeds, genetic lines) with the agreement of the Humane Farm Animal Care Inspector. Lying area must be at least equal to the square of the length of the pig, which roughly equates to a minimum of 16 sq. ft. (1.5m²) for each adult sow and 11sq.ft. (1m²) for first and second parity animals. (See E23 for farrowing space requirements)

E 18: Freedom of movement

The pig must be free to turn around without difficulty at all times. Individual stalls or crates that prevent pigs from turning around (except for hospital pens) and tethers for pigs are prohibited.

E 19: Confinement

Pigs must not be closely confined or restrained except in the following circumstances, and even then only for the shortest period of time necessary:

1. For the duration of any examination, routine test, blood sampling, treatment or operation carried out for veterinary purposes;
2. While they are being fed on any particular occasion;
3. For the purpose of marking, washing or weighing;
4. While accommodation is being cleaned;
5. During artificial insemination; or
6. While they are awaiting loading for transportation.

E. Farrowing Systems

E 23: Farrowing area

- a. A sow must be housed in a farrowing environment that is bedded (such as straw) and allows her to turn around.
- b. Approximately 48 hours prior to farrowing materials must be provided in sufficient quantities and be of a type which allows sows to carry out their natural nesting behaviors. Sawdust and sand are not acceptable as nesting material for the sow.
- c. Traditional straight, narrow farrowing crates are not permitted.
- d. Established farrowing systems such as the sloped farrowing pen and outdoor pastures with huts are all acceptable substitutes for the traditional farrowing crate.
- e. Farrowing Pens must be at least 6 x 8 ft (1.8 x 2.4m).
- f. Farrowing pens of 10 ft x 10 ft (3 x 3 m) are preferred because they provide more room for the sow to move around, but when using pens of this size or larger, a protected zone for piglets must be provided. The protected zone must be at least 8 sq.ft. (0.8 m²) in size and be zone heated.

E 25: After farrowing

- a. Sows must be kept in the farrowing area for at least 28 days after farrowing.
- b. Piglets must not be weaned from the sow before the fourth week after farrowing, with the average age of each farrowing batch being 28 days or more, unless a veterinarian confirms that the welfare or health of the sow or piglets would otherwise be adversely affected.

F. Environmental Enrichment

E 27: Stimulating environment

- a. Pigs are naturally inquisitive and show a high level of motivation to perform rooting behavior. They must, at all times, have access to straw or other suitable media such as wood chips, sawdust or peat for the expression of rooting, pawing, mouthing and chewing behaviors.
- b. Provision of other objects for manipulation, such as chains, balls and materials such as rope is also required.

E 28: Mitigating abnormal behaviors

- a. When pigs develop abnormal behaviors that injure other pigs (e.g., tail, flank, ear, or vulva biting), they must promptly be given additional stimuli to encourage foraging or other non-injurious behavior.
- b. When such incidents occur, the caretaker must implement ways of avoiding/eliminating the problem.
- c. Each incident must be recorded, together with action taken, in the farm records.

E 29: Isolation

- a. Pens must not be sited or constructed in such a way as to isolate any pig from the sight, sound or odor of other pigs, except for quarantine.
- b. Sick or injured pigs may be isolated temporarily for treatment after consultation with the veterinarian.

A. Health Care Practices

H 1: Animal Health Plan

- a. All pig units must have a written Animal Health Plan (AHP) that is regularly updated in consultation with a veterinarian.
- b. The AHP must include:
 1. Details of any vaccinations;
 2. Information on treatments and other aspects of herd health;
 3. Causes of morbidity and mortality, when known;
 4. Tolerance limits on overall herd performance;
 5. Bio-security provisions; and
 6. Cleaning and disinfection policy

H 6: Care of sick and injured animals

- a. Provisions must be made for segregation and care of sick and injured animals. Any injured, ailing or distressed pig must be:
 1. Segregated; and
 2. Treated without delay (including seeking veterinary care when needed); or
 3. If necessary, humanely killed according to the American Association of Swine Practitioners and the National Pork Producers Council's euthanasia guide.
- b. Urine and dung from hospital pens containing sick and injured animals must be disposed of separately to reduce the risk of spreading infection to other stock.

c. Pens must be constructed to facilitate effective cleaning and disinfection of surfaces and the possible removal of a carcass from the box.

H 9: Physical alterations

a. The only potentially injurious husbandry procedures that are allowed under the Animal Care Standards are as follows (except those done for therapeutic reasons by a veterinarian):

1. Needle teeth of newborn pigs may be trimmed as early as possible and not later than 48 hours after birth, or in the case of weak or sick piglets, within 3 days of birth.

a) Tooth trimming must only be carried out by a trained and competent person.

b) No more than the first third of the tooth may be removed.

c) The procedure must leave an intact smooth surface to the teeth.

d) Grinding of the sharp point of the teeth is preferable to clipping, as this is less likely to break the tooth or remove too much of the tooth.

2. Ear-notching is prohibited as a routine method of identification. Ear tagging, slapmarking and tattooing are permissible.

3. Tail docking must not be carried out routinely. If the risk of tail-biting exists, other measures should be taken to prevent tail biting such as environmental enrichment or reducing stocking densities. If by veterinary recommendation tail docking should be done, HFAC must be notified before tail-docking is permitted. The method and age of the animals, as well as the justification for the procedure will be reviewed. Following review the producer will be notified on the decision from HFAC.

4. Castration of pigs is permitted but must be done before pigs are 7 days of age. If older pigs are castrated for veterinary reasons, anesthetic and post-operative analgesic must be used. Castration must be done using sanitized equipment.

5. The trimming of tusks in boars may be undertaken only by the attending veterinarian, or other competent and trained person, and only to ensure the safety of other animals and protect caretakers from injury.

6. Nose rings are prohibited.

b. All of these practices must be performed in a way that minimizes suffering and by veterinarians or trained and competent caretakers.

REFERENCES

Humane Farm Animal Care (HFAC) web site: www.certifiedhumane.com

WILLOWGROVE HILL – AN ONTARIO SUCCESS STORY

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A success story? I'm not so sure!!

The first time that Greg Simpson asked me to speak at this swine conference I declined the offer. I was not ready to explain to other people how to market something when we really were not sure what we were doing ourselves. Greg assured me that was exactly the point that needed to be made - people need to hear both the ups and downs of what we are doing, basically the complications of marketing your own product.

Let me explain, “niche” marketing is not for everyone.

MY OBJECTIVES

1. The first objective for creating this value added product was to become a profitable Ontario hog farmer again, something that has been extremely hard to do in the last couple of years.
2. The second objective was to create a value added pork product that the world had never seen. This would give us a huge market advantage over regular pork products.
3. The last objective we had in mind is once Willowgrove Hill starts to command a market share with this value added product, we would take on third party barns enabling more Ontario producers to become profitable as well.

So before we continue I think you should know where I come from, my history. I have been hog farming since 1971. That is when my Dad bought our first 18 sows, as a “make work” project for my brother, sister and I. In 1973, I lost my father to a heart attack. I continued to work on the family farm until I completed high school. I then went off to attend university in Guelph, where I spent one year before deciding that I just really wanted to farm. So, I returned home and continued on with the 18 sows. In 1988, I expanded my herd to 50 sows, and had nursery space at home so I sold weaners to other local farmers. It was also around this time that I met my wife, Rosie.

In 1996, I expanded the herd again to a 350 sow to weaner operation. Rosie and I got married in 1997 and we worked in the barn together. In August of 1999 we were blessed with our first son Ryan. In the year 2000 we were approached to expand our herd again and to sell SEW pigs. So, we converted nursery spaces to house more sows and expanded to 500 sows and started to sell SEW pigs. In the summer of 2001, our son fell ill and was diagnosed with liver cancer. Ryan lost his short and courageous battle with this awful disease on Sept 12, 2001. Three months later we were once again blessed with the birth of our daughter, Maddie. And

in March of 2003 we welcomed our second son, Joey. As our family grew so did our operation. In 2004, we evolved from selling SEW pigs to becoming a farrow to finish operation with a base of 500 sows.

In the years of 2005-2006 we were plagued with the disease issues that faced most Ontario producers - PRRS, Circo, PMWS - you name it, we had it. Our death loss was 20% while most commercial herds should run around 3-5%. So in 2006 the decision was made to do a total repop. We changed our genetics to Topigs and mated them to a Tempo boar. Topigs are a fatter, heartier pig, which would definitely help fight against future disease challenges. It was also at this time we went to a closed 3 site production loop. We increased our biosecurity and started to think about a “niche” market.

COMING UP WITH THE CONCEPT/IDEA

I wanted to market our own pork. As the hog price started to crash again in the fall of 2006, Rosie, another person, and I started to brainstorm some different avenues. We thought about natural, organic, and humane. Then someone suggested Omega 3 pork. This made perfect sense to us, given our family history, my Dad, and our son Ryan. Not to mention that consumers were starting to become more and more aware of where their food was coming from.

SO THE RESEARCH BEGAN...

We learned that Omega 3's are very healthy for us. Some of the major health benefits are reduced risk of heart attack, and reduced risk of certain types of cancer, both areas that have touched us deeply. I understand that the risk of certain types of cancer is reduced, not cured. I am sure that everyone in this room has been touched by this terrible disease, in my case I lost my 2 year old son, Ryan. Maybe this new product we were creating could make a difference to just one person, and then this will all be worth it.

We also learned that it helps with the normal development of the brain, eyes and nerves. Studies show that certain types of Omega 3's can make children smarter, and increase birth weights in infants.

We learned that there are 3 major types of Omega 3's - DHA, EPA and ALA. ALA Omega 3's are found mostly in plant sources such as flax, nuts, etc. and our bodies must convert ALA Omega 3 to DHA and EPA Omega 3 but it is a very inefficient process. Males process ALA Omega 3 at about 1% and females do so at about 4%. We also learned that the only Omega 3's that give any benefit to human health are the DHA EPA Omega 3's and the human body does not produce these types of Omegas, they must come from the diet. The only source of DHA EPA Omega 3's is oily fish.

So here was the thought, not everyone likes the taste of fish. Why not give people another option, nutritionally enhanced pork?

So to get the most bang for your buck, DHA EPA is the way to go. And that is exactly what we did with the help of our feed company, Grand Valley Fortifiers. We were able to create the only DHA EPA Omega 3 Pork in the world. It is done nutritionally thru the feed not by injecting the pork.

I will not talk any more about the feeding process, for obvious reasons. The one thing I will tell you about the feeding program is that it is very expensive.

We then took this pork a couple of steps further. We added organic selenium, which is like the CEO of your immune system. Studies also show that selenium is linked to reduced cancer rates as well.

Then we decided to remove all antibiotics out of our system. So our pork is raised without antibiotics from birth to market, sow herd included. This almost cost me the nursery barn since the manager there was afraid to try raising nursery pigs without the use of antibiotics.

Our biosecurity is huge, and for that reason, the nursery barn, finishing barn, and sow unit are separate units. I do not go into the nursery, or finisher barns, just the sow unit. We have been through PRRS three times, and it usually costs about \$250,000 each time.

So we started the process of switching to enriching our pork, and we didn't tell anyone what we were doing, since I was told once that the second rat gets the cheese.

So the process is rolling in the barns. Now we are thinking, wow, we have some healthy, safe pork here, a first in North America; people are going to be beating our door down to get some of this stuff!! Wrong!

NOW THE MARKETING LESSON BEGINS

Where do I begin?? I can honestly say that so many people have been very helpful. Many listened to our idea and liked the fact that we were trying to do something different, outside of the box.

Lesson number one, don't think like a farmer. That was one of the first statements made to me. Boy, were they right. I do not consider myself a stupid person but this was completely overwhelming.

Our next lesson was "niche" marketing is not for everyone. If you don't have the passion, desire, resources and connections you may want to stop before you even start. Sometimes I wish we would have had someone tell us this before we started. I likely would not have listened anyhow.

I will now jump ahead a bit. After about a year from first coming up with the idea, we now have product but we have to get it to the marketplace. We are still thinking this will be the easiest part... Not.

SO HOW DID WE DO THIS??

First, surround yourself with great people, and realize that each of those people has a specialty, and you need to follow their advice.

We first approached my brother-in-law, who has had a very successful career in the investment banking world. He was intrigued by our idea, and had actually been after me to “niche” market for years. He is now our partner in Willowgrove Hill.

Rosie and I had started to design a web page ourselves, until our new partner saw it, and we were promptly told what he thought of it. He knew where we could get a website put together, so he put us in touch with Capital Communications, who had done work for his firm. So a few days later we find ourselves in downtown Toronto, in an office, in a business meeting (not around the kitchen table as business meetings are done at the farm) to create our website.

This was our first taste of how things would be done – properly. We have been to Toronto many, many times since for more design meetings and media training, and it is now less daunting.

So now we have a great website. Watch out, the product is going to be flying off the farm now... No, not exactly. The website gives you credibility that you exist and are serious. Credibility, that’s a costly word. We have spent 10’s of thousands of dollars on this. The Omega 3 pork products had to be tested numerous times to make sure we had the right omega levels in the meat. You must have proof that what you claim on the label is actually what is in the package. This comes at a huge cost.

We live in Mitchell, population 3500, not my target audience. So we need to travel to the intended market, Toronto. I remember finally getting a meeting at one of the independent grocery stores in Toronto, in a very affluent area. We went into the meeting with samples and really no idea what to do. The first question they asked me was “why is your pork different?”

So I am explaining about the Omega 3’s, and about the flavor, but am trying to be very cautious since I am not sure how they will receive the idea that our pork is fatter, so finally I just came out and said “I have fat pigs”. The all answered “finally”. For years as a producer I was paid more for raising lean pigs. We learned quickly that the trend of lean, lean, lean is changing. More and more are looking for marbling and flavor.

On to our next hurdle; for some reason we thought people would want to buy whole pigs for their freezers, just like we have always done on the farm. This is the craziest idea in the world to people not raised on the farm. So we were finding that people wanted pork chops and bacon for the most part. That leaves a whole lot of the pig left over, and the freezers were filling up with shoulders, hams, butts and sausage. What do we do with all of that??? So we started to supply sausage to baseball tournaments, which was a help. But there had to be a better way to move some of this product. Necessity is the mother of invention. So Rosie, who

holds a diploma in foodservice management, started to experiment in the kitchen. She tweaked an old family recipe for sauce, and developed the world's first Omega 3 pulled pork. We have also developed the world's first Omega 3 wieners which also help with the imbalance problem. We tried about a dozen different processors before we found someone who made a wiener that we liked. There were a lot of hot dog taste tests at the Hill house.

Many people have told us that we are a couple years ahead of our time. But we feel it is best to be early than late.

Another major challenge was pricing the product. It is a brand new product so you do not have any benchmarks to go by. So we started by hanging out in grocery stores and writing down prices of certain products. Our partner, Jan, was actually asked to leave a store once while doing this.

So finally we come up with pricing. So we have a product and a price but nowhere to sell it. Many stores were afraid to try it, or give us a try.

One positive thing we found was that people were so impressed that the farmer was coming to these meetings. Do you know that most people in these stores have never met or spoken to a farmer before?? I was not what they were expecting; no rubber boots, pitchfork or straw hat. Not to mention that I have a very forward thinking value added food that I want to introduce them to. Surprisingly enough, these people are really interested in what we as farmers do. People are interested in where their food comes from. That part of the marketing is really neat.

Another important part of marketing... contacts, contacts, contacts. The food industry is huge, but it seems that everyone knows someone who knows someone, if that makes sense.

One of our first retail customers was a little butcher shop in Port Carling, Ontario, called Morley Stephen's Butcher shop. It is a small shop in the resort area of Muskoka. At first Morley was hesitant to give us a try, since he does not use a huge volume of pork. What we did not really know at the time was the contacts that Morley has in that area. He has quite a diverse clientele. From this small butcher shop we have made contacts with many chefs in the Muskoka area, some of which have taken time to visit our farm this winter.

Another contact story is that I have a cousin who was very interested in what we are doing; she mentioned to me that she knows one of the chefs at the Deerhurst resort in Huntsville. So she passed our information and website on to her friend, who passed it on to the executive chef. My cousin in turn gave me contact information for the Executive Chef there, Rory Golden. So 28 phone calls later, I finally got Chef Rory on the phone and we set up a meeting for that Friday at 2 pm at the Deerhurst. So I contacted everyone I wanted to take to that meeting with me. Ian Ross, CEO, Grand Valley Fortifiers, my feed rep for GVF, Duane Firminger, and my business partner Jan. Then I started to prepare what to take for samples. We have given out a tonne of pork - people need to see and taste your products. In our case, to see if there is a flavor deviation. This is another expensive area of "niche" marketing.

So, on the morning of the meeting I packed my cooler with chops, bacon, sausage, and pulled pork samples and headed to Huntsville. On the way I picked up Duane, and he asked me “What do you expect to happen at this meeting today?” I told him “I expect him to cook and try all of the samples I have brought for him”. Duane told me not to be too disappointed if that did not happen, to which I replied “I’ll be pissed if I drive 4.5 hours and he doesn’t try it”.

So when we all arrived at the Deerhurst, Chef Rory was awesome. He gave us 2 hours of his time, and he cooked all of the products I took him. I was a little nervous as I had never met an executive chef before, and on TV they seem kind of scary, but Rory was a great guy. We now supply the Deerhurst with various cuts of pork and pulled pork as well. The one restaurant there called “Steamers” actually lists Willowgrove Hill Pork on their menu.

When we were going to the Grocery Innovations Trade show in Oct 2008, we were looking for someone to cook our samples to give out at the show. We really didn’t know who to ask, so we asked Rory, fully expecting an executive Chef to turn us down, especially to take time out of his busy schedule to cook pork samples at a trade show. Much to our surprise, he said he would. Talk about connections, he seemed to know everyone who came around to the corner at the trade show. Chef Rory Golden has been, and continues to be, a great asset to Willowgrove Hill.

Before arriving at the Grocer Innovations trade show, we thought we were doing pretty well, having overcome so many hurdles, solved so many problems. And then along came a whole new set of questions that we never even dreamed of. Such as, how is your product packaged, what size are the packages, what type of processing do you do?? And those were just a few of the questions. Now there is a whole new side of things we have to learn about, but one thing is obvious, the brown butcher paper is not going to cut it anymore. So where do you go to learn about this stuff?? Thank goodness for the Internet and a few kind people who are willing to help you out. Jan and I often kid each other that our learning curve is not a curve, but straight up. We have learned a lot, but I know there is so much more for us to learn.

Then finally we got our first break. An independent grocer called and gave us an order. So we promised him the delivery times and product he wanted, basically the world on a platter, only to find out that the processors could not meet the order in the time promised. It just was not going to happen. Those were not good calls to have to make, to have to call this guy back who was willing to give you a chance, and tell him that “oh by the way everything I promised you isn’t going to happen”. Basically the processor was going to do his own products first, so ours would have to wait until his was done.

Then, once we got product into stores we started getting questions about POS. I first had to find out what POS materials are. They are Point of Sale items, such as labels, pamphlets, posters, etc., another costly, but necessary evil of niche marketing. We had pamphlets and stickers printed, but then thought we should try to get the Homegrown Ontario endorsement, which we did, after one batch of stickers and pamphlets were already printed. So we needed to get another batch printed. This happened a number of times, with different things like omega levels, and going to “raised without antibiotics”. So it is easy to see how costs can skyrocket for beginners.

On to pricing... this is where you can't think like a farmer. So you have a premium product and you need to figure out a price. We finally thought we had a price figured out, but then everywhere you turn someone is taking a piece of the pie. A bit of advice is to start out high - you can always come down and you might need some extra buffer built in for those many fingers that get in the pie.

Also the hog price was a heck of a factor. COOL (Country of Origin Labeling) has not helped either by causing fewer Canadian hogs to be shipped to the USA, resulting in a surplus that has depressed the hog price. Everything is based off of the current market price of hogs, so even adding a premium to our product, being based off of the hog price, we are still losing money. We did not do all of this to lose money. So our products are definitely premium priced; some people may feel they are too expensive. We have decided to become price makers not price takers. The current state of the economy is not helping either, since our products are premium priced a lot of people are not spending the extra money that they may have in the past.

So, we are trying to figure out the puzzle of packaging and pricing. There is a new factor that keeps coming up in the meetings we have with potential customers. "Do you have federal kill and processing???" To which we would answer, we currently have provincial kill, is that a problem??

The answer was obvious - we needed to get to the next level, federal kill. Wow, this narrows the options, since there are only 5 federal kill plants in Ontario. Not to mention the fact that most of them are at capacity thanks to the surplus of pigs due to COOL, as I mentioned before. Not only that, we would need to have our hogs segregated on the line and tracked through the plant to ensure we were indeed getting our own pigs back, which causes logistical issues as well. We did manage to overcome this hurdle but it did make, once again, for more fingers in the pie and like I said before, everything comes with a cost.

One of my last tips, use your government agencies. OMAFRA has been a huge help to us. Even if you are not sure there is anything they can do for you, give them a call. You might be surprised how they can help or even point you in the right direction.

CONCLUSIONS

So, in summary, are we a success story? Not quite yet.

Niche marketing is not for everyone, if you do not have the passion about your product, you need to think twice about what you are doing. Quite often when we are in a meeting and I am telling people about our products, people remark about how passionate I am about our products. I have many reasons to be as passionate as I am.

Willowgrove Hill started out as a means to become a profitable farrow to finish operation (we are not there yet), but it has evolved so much since we first came up with the idea.

I am hopeful that we have met 2 of our 3 objectives, with the third being the most important, market share. One thing that I am confident about, I am sure there will be more hurdles and road blocks in the road ahead. That is just the nature of 'niche marketing'.

Like I said in the beginning, we haven't got it all figured out yet.

DESIGNING FIELD TRIALS TO COMPARE VACCINES OR ANTIBIOTICS

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ABSTRACT

Field trials conducted in your own barn will provide real results of the impact of a new product in your herd on your pigs. It is essential to have control pigs so that you can determine the difference in health and production between the treated pigs and the untreated pigs that are living in your barn at the same point in time. Treatment must be randomly assigned to pigs so that there is no difference between the treated and the control pigs. Ideally, the people in the barn will not know which pigs received which treatment so they will not care for the pigs differently. This is called blinding the trial. If you want to determine whether or not there is a significant difference between two groups, the number of pigs must be large enough to measure the expected difference. Sample size equations can be used to determine the number of pigs needed. If the treatment cannot be randomly assigned to an individual pig, then the calculations will be based on pens of pigs rather than individual pigs. This is true for in-feed treatments.

INTRODUCTION

Maintaining healthy pigs, improving productivity, and minimizing the effects of disease through the use of effective management procedures or biologicals (vaccines and antimicrobials) is important. Field trials are a very useful way to test the ability of a product to improve production or decrease illness and death. We obtain information about the efficacy, and/or safety, of a specific treatment from personal and collective experience, laboratory studies, observational field studies, and experimental field studies (called clinical, or field, trials). Although each source of information can provide some insight into the effectiveness of the treatment, a well designed clinical trial will provide the most valid information about how the product works under field conditions. Field trials conducted in your own barn will provide real results of the impact of a new product in your herd on your pigs.

For a field trial to be valid, the observed association between the treatment and the outcome must be due to the treatment and not the result of chance or of bias. If you give a growth promotant to only the smallest, sickest pigs and then compare their growth rate to the large, healthy pigs who did not get the medication, you will conclude that the growth promotant did not work. That is called bias. The results were ‘caused’ by how you assigned the treatment.

CONTROLS

Control pigs, those that do not receive the “new” treatment, are essential if we want to know the impact of the new treatment. For example, when egg yolk antibody became available to treat post weaning *E. coli* diarrhea in nursery pigs, many producers and veterinarians thought the product worked well. However, this clinical problem often caused severe losses in one batch of pigs and reduced losses in the next. It was not possible to distinguish between normal variation in clinical problems due to the disease and the impact of the very expensive egg yolk antibody. Extensive research work by Dr. Bob Friendship proved that the egg yolk antibody was not effective. These results were only possible because his work included CONTROLS. The pigs in the control groups, that did not receive the egg yolk antibody, performed as well as the pigs that received the egg yolk antibody. When we do not use controls, we can only compare performance to historical data. We all know that one group of pigs is not the same as the next. Only with side by side controls, pigs that are being raised in the same barn at the same time, can we honestly measure the impact of a new product.

EXPERIMENTAL UNIT

The experimental unit is the smallest independent group of pigs that can be assigned to a treatment group. Even if you want to know the average daily gain (ADG) of individual pigs, if the treatment can only be administered to pens, then pens become the experimental unit. For example, if you are testing a feed additive, then the pen is the smallest group that can be assigned to the treatment, so the statistical analysis is done by comparing productivity at the pen level. This treatment should be randomly assigned to pens of pigs and the growth rate should be compared on a per pen basis. To determine the number of pens to use in a trial you need to decide what your expected outcome will be for each of the treatment groups on a per pen basis, and the variance (variability) between pens in the trial size (there are equations shown below that can be used to calculate sample size). To reduce the total number of pigs on the trial, you can keep the number of pens as large as possible and reduce the number of pigs per pen.

When experimental unit is the pig and pigs of different treatments are housed together we must consider spill-over of treatment effects. For example, if the treatment is a vaccination or a dewormer, herd immunity could mask a true treatment effect. Herd immunity reduces the challenge to the control group and decreases the differences in outcome between the treated and control groups. Sometimes the treatment looks less effective compared to the non-vaccinated pigs because of herd immunity. Alternately, if treatment is assigned to individual pigs and then pigs of one treatment are housed in the same pen, the unit of analysis is pen and not pig because the treatment effect is confounded by the pen.

RANDOM ASSIGNMENT

The pigs should be allocated to treatment groups using a formal random process. This means that each pig in the trial has the same chance of being selected to receive the treatment or

control. There should be a clearly outlined treatment protocol prior to the beginning of the trial. This should include how the drugs will be prepared, stored, and delivered; where the injections will be given; how often the feed should be delivered; when and how to remove fines from the feeders. The control can either be no treatment or the standard treatment. For example you might compare a new vaccine to the vaccine your herd typically uses.

BLINDING

Blinding is what we do to make sure that people involved in the trial do not know which pig is in which treatment group. This reduces bias. Blinding ensures that pigs in the two treatment groups are treated in the same manner and prevents one treatment from falsely appearing better than the other treatment. For example, if a farm worker knows that the pigs with yellow ear tags were given the new vaccine, he might be less likely to treat that pig for sickness than the pig with the red ear tag that is part of the control group.

SAMPLE SIZE

We need to determine the appropriate sample size to use. A sample that is too small will result in finding no difference between the groups when a difference does exist. A sample that is too large is expensive. The sample size is determined by how variable the outcome (ADG or death rate) is expected to be, the expected difference between treatment and control groups, and how sure you want to be of the results (usually set at 95%).

Chi-square tests determine the difference between independent rates or proportions. The death rate for unvaccinated pigs is compared to the death rate of pigs that were vaccinated using a chi-square test. Sum the number of unvaccinated pigs that died and the number of vaccinated pigs that died and record the number of pigs in each group that lived. We had 500 pigs in the study and each pig was randomly assigned to receive the vaccine or not receive the vaccine.

	Died	Lived
Not vaccinated	22	228
Vaccinated	9	241

The p-value is 0.01 and the odds ratio is 2.5. We conclude that pigs were 2.5 times more likely to die if they were not vaccinated than if they were vaccinated. This difference would occur by chance alone 1% of the time.

ADJUSTING RATES OF GAIN FOR DEATH LOSS

A feeding trial was conducted on 24 pens of pigs (3 replicates of 8 pens). The pigs were grouped as 30 pigs per pen. Alternate pens were given either feed A or feed B. The unit of concern is the smallest level at which the factor of interest changes. Because we assign feed type by the pen, the unit of concern is the pen, not the pig. Hence the unit of concern was the pen, and the sample size was 24. The target population refers to the pigs about which the decision is to be made. In this example, the target population is the population of nursery pigs on the farm.

All statistical tests and sample size equations assume that the treatments were randomly assigned. In our nursery feed example, if 250 pigs were to be fed in 8 pens, the pigs should be randomly assigned to pens. The numbers from 1 - 8 are put in a hat. As each pig runs down the hall, a number is drawn from a hat and the pig is marked according to his pen number. Alternatively, each pig can be given an ear tag and a random number table can be used to determine which pigs go in each pen. If two feeds are to be used, flip a coin to determine which feed pen #1 is assigned, then alternate feeds for every other pen.

BIAS is a systematic error in measurement or a systematic difference between groups. Selection bias occurs when a group of pigs is assembled incorrectly. Random assignment of pigs to pens, and feed to pen should remove bias. It is assumed then that the weight of the pigs will be randomly distributed by pen and thus there will be no association between the weight of the pigs and any other factor. Even if the producer normally sorts pigs by weight at weaning, it was inappropriate for a feed trial. Controls, pigs fed the usual diet, are important as a comparison group. In a trial dealing with an injection, the controls should receive an injection of sterile water. The person(s) measuring the outcome should be blinded to the trial. The diets should be labelled A and B in similar bags. Often preconceived ideas of the results of the trial will bias the outcome. All pigs weaned on the farm during the trial should be included in the trial so that the results are representative for the herd. The trial should be repeated over time to ensure that the results are consistent.

For each pen we had the weight of pigs starting and finishing the trial. We plotted the distribution of average daily gain by pig per pen by feed and the mean, median, and standard deviation of growth rate. We used a Student's t-test to determine if there was a difference in growth rate by feed. Although, on average, these pigs were fed for 20 days, this varied by pen. Typically the crude daily gain per pig for feed A will be compared to the crude daily gain per pig for feed B. But, for a more accurate comparison between the feeds we should use weight gains adjusted for dead and culled pigs.

PIG-DAYS are calculated as the (number of pigs at the end of the trial * the number of days those pigs were on the trial) + (the number of pigs that were removed * the days they were in the trial).

For example, a pen that started with 30 pigs and finished with 26 pigs would be as follows:

26 pigs on a 20 day trial	=	520 pig-days
1 pig died on day 5	=	5 pig-days
1 pig died on day 10	=	10 pig-days
2 pigs died on day 15	=	30 pig-days
TOTAL	=	565 pig-days

Similarly, to calculate the **WEIGHT GAIN** of the **PEN** we weigh the pigs that die during the trial and include their weights in the total gain of the pen. We also need to determine if significantly more pigs die on feed A than on feed B (or vice-versa). After adjusting for the number of pig-days and the actual weight gain of the pen, we compare the adjusted daily gain on feed A to the adjusted daily gain on feed B. The Student's t-test is used for this statistical comparison.

If you do not know on which day the pig died or the weight of the dead pig then use the midpoint of the trial as the day of death and the average weight of the pigs at the midpoint of the trial as the weight of the dead pig. Alternatively, if we know that all of the pigs died within one week of the trial then the assumptions can be changed.

SAMPLE SIZE ESTIMATION

Sample Size Estimation for Two Means (Averages)

$$n = 2[Z_a - Z_b] S / (X_e - X_c)]^2$$

n = number of sows required in each group

Z_a = 1.96 (for a 95% confidence interval)

Z_b = - 0.84 (for a power of 80%)

X_c = the average litter size in naturally bred sows

X_e = the average litter size in artificially bred sows

S = the standard deviation of litter size

$$n = 2[Z_a - Z_b] S / (X_e - X_c)]^2$$

$$n = 2 * [(1.96 - (-0.84)) * 2.6 / (9.7 - 9.2)]^2$$

$$n = 2 * [(2.8 * 2.6) / (9.2 - 9.7)]^2$$

$$n = 424$$

To find a difference of 0.5 pigs born alive, there needs to be 424 sows randomly assigned to the treatment group and 424 sows randomly assigned to the control group.

Sample Size Estimation for Proportions

$$n = [Z_a (2PQ)^{1/2} - Z_b (P_e Q_e + P_c Q_c)^{1/2}]^2 / (P_e - P_c)^2$$

n = number of sows required in each group

$Z_a = 1.96$ (for a 95% confidence interval)

$Z_b = -0.84$ (for a power of 80%)

P_c = the average farrowing rate in vaccinated sows (0.85)

$Q_c = 1 - P_c$
 $= 1 - 0.85$
 $= 0.15$
 = the average (return + open) rate in vaccinated sows

P_e = the average farrowing rate in unvaccinated sows (0.80)

$Q_e = 1 - P_e$
 $= 1 - 0.80$
 $= 0.20$
 = the average (return + open) rate in unvaccinated sows

P = overall average farrowing rate $= [(0.85 + 0.80)/2] = 0.825$

Q = the average of $(1 - P)$

= the average (return + open) rate for both groups

$= [(0.15 + 0.20)/2] = 0.175$

$$n = [Z_a (2PQ)^{1/2} - Z_b (P_e Q_e + P_c Q_c)^{1/2}]^2 / (P_e - P_c)^2$$

$$n = 1.96 (2*0.825*0.175)^{1/2} + 0.84 (0.85*0.15 + 0.80*0.20)^{1/2}]^2$$

$$(0.85 - 0.80)^2$$

n = 45

To determine if farrowing rate differs in vaccinated and unvaccinated sows the vaccine needs to be randomly assigned to 45 sows and 45 sows need to be left unvaccinated.

EXERCISE

Assume you are working with a herd that has high mortality in the finisher barn due to *Actinobacillus pleuropneumonia* (APP, formerly called *Haemophilus pneumonia*). The herd is positive for Porcine Circovirus Type II and the herd is not currently vaccinating the nursing or nursery pigs. The death loss in the finisher barn is likely caused by both Circovirus and APP.

You wish to vaccinate weaned pigs against Porcine Circovirus Type II but you don't know which commercial product will work the best in your herd.

How are you going to randomly vaccinate pigs with vaccine A and vaccine B?

What do you want to consider as you decide how to randomly assign pigs to treatment?

What factors do you think might influence the response to the vaccine?

I expect the litter will have an effect. Pigs in one litter will have similar levels of maternal immunity and therefore will be more alike than pigs in different litters.

If we randomly assign the vaccine to one litter or another, then our unit of analysis is litter because that is the smallest group at which we randomly assigned the vaccine. If we randomly assign the vaccine to pen in the nursery, then nursery pen is the unit of analysis. If however, we randomly assign vaccine to piglet, then the piglet is our unit of analysis. This will result in the smallest required sample size.

How are you going to randomly vaccinate pigs with vaccine A and vaccine B?

How are you going to follow the pigs through the barn?

What measures will you take to decide which vaccine works best in your barn?

COST BENEFIT OF VACCINES AND MEDICATION - NICKELS AND DIMES?

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ABSTRACT

Recent low hog prices have driven successful Ontario producers to focus on cost control like never before. While not one of the major cost centres in swine production, veterinary inputs are a significant expense, and there are opportunities to review and reduce costs.

INTRODUCTION

Veterinary or health-related costs, per pig, for a farrow-to-finish farm in Ontario have been estimated at \$7.70 per pig, or 4.5% of the total cost of production (\$167.46 total cost per pig) (Richards, 2008). Of course, much of the variation in health cost amongst different farms is due to differences in productivity, health status, and business goals, but aside from this, costs may also vary because a critical review of health spending has not been undertaken. This paper will review the costs and benefits of some veterinary and health inputs, with the purpose of providing a framework for discussion between producers and their attending veterinarians.

VETERINARY INPUTS AS COMMODITIES

Vaccines

It is not, strictly speaking, appropriate to treat swine biologics as commodities; each manufacturer has obtained a unique drug identification number (DIN) from Health Canada, based on the fact that their products have real differences in: manufacturing method, antigen, adjuvant, presentation, and labelling. In spite of this, efficacy comparisons, when available, are not commonly based on randomized, controlled trials. Some such comparisons are equivocal regarding real economic differences between vaccines (Thacker, 1998; Cunningham, 2005). Thus, on some farms, for some pathogens, moving from a higher-cost biologic to a lower-cost biologic is a sensible option, especially if the disease challenge is low. This decision should be made carefully, in consultation with the herd veterinarian. Examples of diseases for which the producer might consider a low-cost biologic could include: enzootic (*Mycoplasma*) pneumonia, parvovirus/leptospirosis/erysipelas, suckling piglet diarrhea.

In addition to vaccines, producers and veterinarians can collaborate to consider lower cost antiparasitic programs, reproductive hormone protocols, and ancillary treatment protocols (e.g. piglet iron injections) to reduce cost in some situations.

Injectable Antibiotics

Swine producers and veterinarians are fortunate that in 2009, in PCV-2-controlled herds, the use of many of the available injectable antibiotics will result in a clinical response! This was not the case prior to the introduction of PCV-2 vaccines.

There are several considerations in choosing an appropriate injectable antibiotic for use in swine: label indications and withdrawal time are usually the primary concerns. But when creating a medication plan, cost per dose should be another deciding factor. Selecting a low cost injectable antibiotic as the primary treatment—in consultation with the herd veterinarian—can significantly reduce cost, especially in disease-challenged finishing herds.

COST BENEFIT ANALYSIS OF VETERINARY INPUTS

Circovirus Vaccines

PCV-2 vaccines have been the most significant advancement in swine health in the past decade. The stark improvements in clinical presentation, and subsequent improvements in performance, have been remarkable. The cost to benefit ratio for PCV-2 vaccine use is very strongly positive, even for farms with minimal evidence of clinical PCV-2 disease (Maitland, 2008).

There does not appear to be one standardized approach to PCV-2 vaccine protocol design; there are significant differences between commercial products which make the PCV-2 vaccine decision a critical point at which a producer needs to involve his/her veterinarian. Questions of dosage, timing, product, and use with other vaccines are all critical to successful PCV-2 control.

Feed Medications

Many feed budgets have been stripped of the high levels of feed-grade antibiotics that were used to control clinical signs during the worst years of PCV-2. However, we should not forget that growth promotion through use of feed medication is efficacious and cost effective (Walsh, 2007; Walter, 2000). Feed budgets should be reviewed to minimize cost without impacting productivity. Of course, the benefit of growth promoters is through sparing feed ingredients through improved feed efficiency. A simple spreadsheet can help guide feed medication decisions as feed prices change.

Metaphylaxis

The recent introduction of several long-acting, broad-spectrum injectable antibiotics has stimulated interest in metaphylaxis (treatment of an at-risk group within a population of pigs). For example, the use of Draxxin Injectable has been shown to be cost effective for metaphylaxis in several species, including lightweight weaned pigs (Allerson, 2007; Booker, 2007).

Health Program Review

Because many production systems are complicated, involving numerous participants, and because there is a tendency for health product use to be additive over time, we promote and facilitate a periodic review of veterinary costs to ensure that:

- 1) Product purchase over time is in line with pig inventory (e.g. doses of iron purchased versus number of pigs born).
- 2) Ineffective, costly products are purged from the animal health plan.
- 3) Opportunities to add value through new health products (e.g. metaphylaxis using long-acting injectable antibiotics) are explored.
- 4) Health care cost per pig is in line with other similar production units (i.e. benchmarking).

This review can be conveniently incorporated into the CQA validation process, when producers and veterinarian are already reviewing animal health products from the food safety perspective.

CONCLUSIONS

In our highly competitive, global, meat production system, the ability to analyze and reduce costs without sacrificing productivity is a core competency for all farms, small or large. Working in collaboration with one's herd veterinarian, a periodic, thorough review of all animal health-related spending can save thousands of dollars for an average Ontario farrow-to-finish farm.

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