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of the

2014 LONDON SWINE CONFERENCE

14th LONDON SWINE CONFERENCE

Positioning for Success

Wednesday, March 26, 2014
Thursday, March 27, 2014

London, Ontario

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ONTARIO PORK

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PROCEEDINGS

of the

LONDON SWINE CONFERENCE

POSITIONING FOR SUCCESS

Edited by

J.H. Smith

March 26th and 27th, 2014

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Positioning For Success

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CHAIR'S MESSAGE

This year I am proud to chair such a great conference under our theme of "Positioning for Success". Each year we aim to offer practical advice and expertise as it relates to what is happening in our industry.

Speakers will cover topics ranging from practical on-farm decision making and management to the impacts of international trade on pork production. The program is once again targeted for sow herds on Wednesday, and wean-to-finish herds on Thursday.

Wednesday's sow-focused agenda will include 'Lessons Learned from PEDv', along with experts in the areas of group sow housing, nutrition and lactation, and Ontario's position in the global marketplace. At the farm level, workshops will consider piglet and milk management, reproductive troubleshooting, feeding the sow, and practical aspects of group sow housing.

On Thursday, the focus is on wean-to-finish. Topics such as real factors that affect profitability, the importance of international trade to Ontario production, and national health status monitoring will be covered. Farm level workshops will include managing pile-ups, benchmarking and measuring profitability on-farm, spotting problems early, higher fiber diets, and improving feed efficiency.

This conference is possible because of a dedicated group of individuals, who, with the wonderful assistance of our industry sponsors, plan, coordinate and arrange all aspects of this outstanding event. I wish to thank everyone for their contribution and dedication. And most importantly, thank you for participating. It is your attendance and commitment to our industry that makes this conference a success!

Enjoy!

Teresa Van Raay

Chair, Steering Committee

2014 London Swine Conference

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Day 1: Sows – Main Sessions

POSITIONED FOR SUCCESS

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ABSTRACT

Over the past several years, outside observers of the Canadian hog industry would likely have the impression that there was little reason for optimism or expansion in the industry. The evidence would have been the reports of serious financial losses resulting from grim market developments such as skyrocketing grain prices and the appreciating dollar. These negative developments have resulted in a smaller industry as both producers and livestock have left the industry. In the latter half of 2013 and early 2014, however, the fortunes of the industry have turned for the better. Grain and hog prices have combined to generate profits for hog producers.

The bottom line for the Canadian pork industry is that while there are sound reasons for short term optimism, there are also reasons to look forward positively to the future. Whether from a global demand perspective or from a competitive supplier perspective Canadian hog producers can look to the future with a sense of promise.

INTRODUCTION

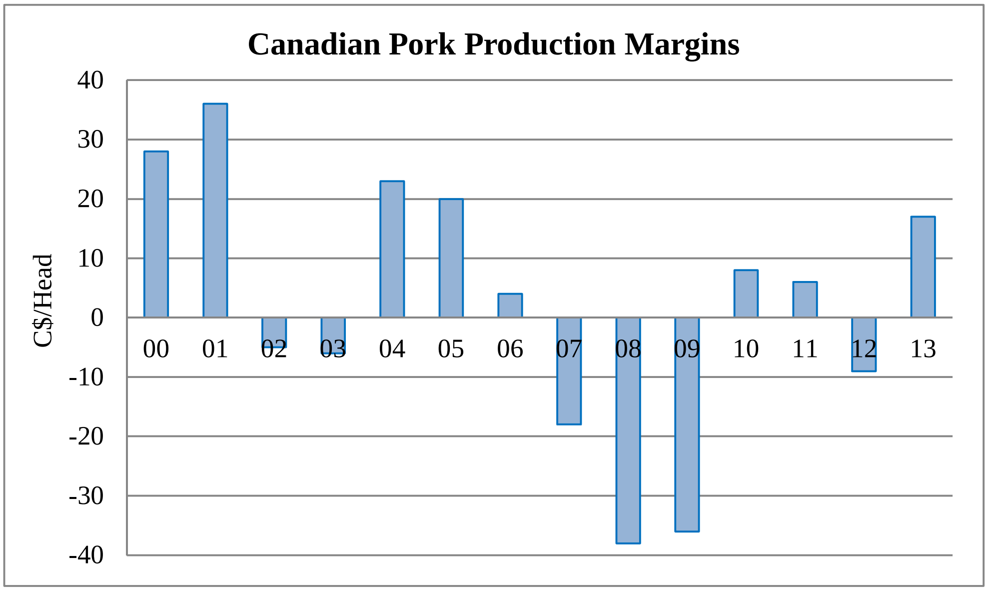
During the past several years the Canadian hog industry has undergone an unprecedented period of financial hardships. The financial stress was caused by market developments, weather, animal health problems and political factors. Within that context, Canadian hog producers entered 2014 with a sense of cautious optimism. This optimism was based on relatively strong financial returns in the second half of 2013 as well as the prospects for profits through most of 2014.

The purpose of this paper is to argue that while there are sound explanations for short term optimism, there are even more robust reasons for Canadian producers to look favourably on the industry's long term prospects in global markets.

THE LITANY OF PROBLEMS

From approximately the second half of 2006 through the first half of 2013, the Canadian pork industry experienced a nearly uninterrupted string of quarterly financial losses from hog production. While there may have been net profits overall in 2010 and 2011 they were modest and not nearly enough to recover lost equity from 2006 through 2009. Furthermore while 2012 began with promise, financial prospects quickly eroded during the summer when it became apparent that the US was undergoing a severe drought. That drought once again drove feed prices to new records and hog production returns to new lows. Those dismal returns continued through the first half of 2013. By the summer of 2013, however, tighter pork supplies and ample grain production worked to drive hog prices higher and feed costs lower. As such, while the spectre of Porcine Epidemic Diarrhea virus hangs over the industry, generally speaking producers enter

2014 on an optimistic note. The optimism, however is accompanied by caution given the past performance of challenge after challenge.



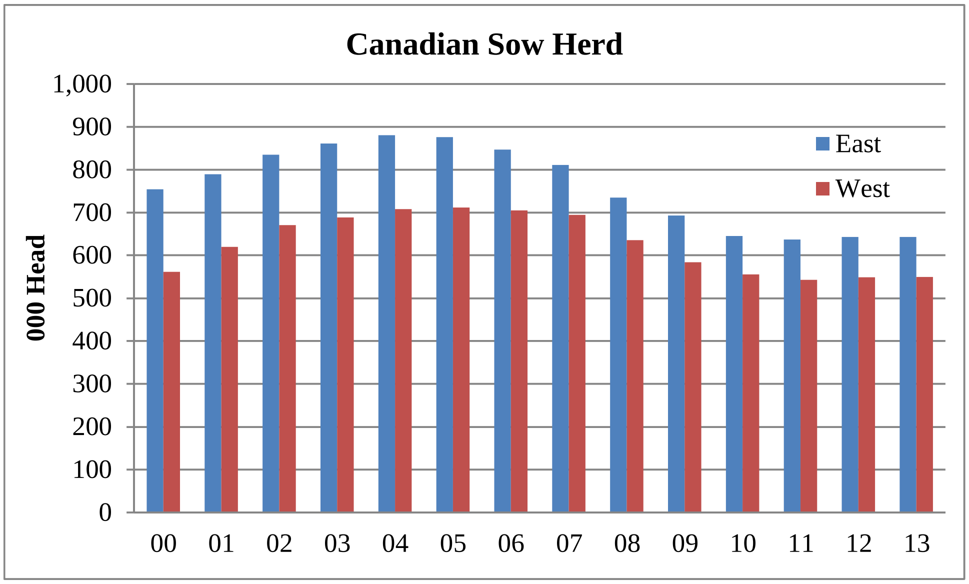
Source: George Morris Centre Estimates

With regard to those challenges, details are not necessary but it is instructive to look back at the litany of obstacles and burdens that the industry endured over the past several years.

1. The appreciation of the Canadian dollar resulted in an ongoing, continual erosion of the Canadian hog price relative to the United States.
2. The explosion of grain prices due to the advance of the ethanol subsidies and artificial usage mandates in both Canada and the United States.
3. The Country of Origin Labelling law in the United States discriminated against Canadian livestock and resulted in reduced demand, markets and pricing for Canadian hogs.
4. Animal health problems such as Porcine Reproductive & Respiratory Syndrome (PRRS) and H1N1 took out what little opportunity for profit existed.
5. Pork packer rationalization and inefficiencies resulted in lower price levels in Canada compared to the United States.
6. Global economic weakness during and after the recession made demand prospects weaker than would other-wise have been the case.

Of these problems the first two were the most relentless and lasting. While the dollar appreciation resulted in lower prices the ethanol mandates resulted in higher costs. It is little wonder based on those two factors alone that the industry endured such financial stress.

Needless to say these challenges resulted in a significant rationalization and consolidation of the Canadian pork industry. The sow numbers in Canada as of 2013 were 25% down from their peak in 2004.



Source: Statistics Canada

SHORT TERM REASONS FOR OPTIMISM

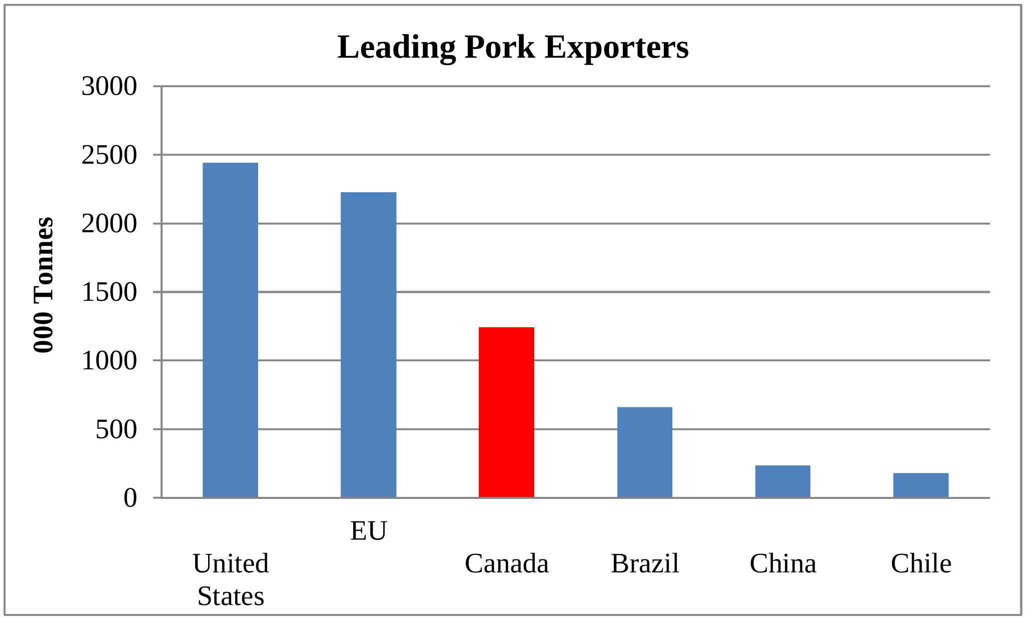
In the short term, meaning approximately one year, hog producers in Canada have seen feed costs decline by 35-40% while hog prices have risen by approximately 20%. This has translated into robust profits during the past three quarters. In addition as producers look to the grain and hog market futures contracts, they can see the ability to lock in profits through most of 2014. The overall picture in turn has been significantly aided by a weaker Canadian dollar during the past six months. Essentially producers see that while for most of the past several years factors have worked against them, currently those same factors are working in their favour.

LONG TERM REASONS FOR OPTIMISM

Canada is the seventh largest pork producer in the world and the third largest pork exporter in the world behind the United States and the European Union. Canada exports about 60% of its pork production. Exports began to exceed domestic consumption in Canada about 10 years ago. The main point is that Canada is a major player in global pork markets. Canada has pork trading expertise, is well respected as a supplier and is well positioned as a global pork trading power.

This positioning and logistical infrastructure is important because global demand for pork is going to continue to grow, likely rapidly in the coming years. The global population is growing by about 75 million people each year. That is two Canada(s) or 75 Saskatchewan(s) of population growth each year. Fundamentally that means more demand for food by that amount.

What is more interesting however is that we know that as incomes rise the demand for food changes. The change in demand is a change towards proteins and meat. UN FAO estimates show that since 1980, while the population of the world has grown by over 40%, meat consumption has grown by nearly double that rate. Furthermore, most of the demand has come from developing countries. That is, those countries that are emerging as markets are seeing the biggest growth in meat consumption. Simply put this means obviously that the demand for pork is going to be an ongoing source of growth and demand for the Canadian hog and pork industry.



Source: USDA Foreign Agricultural Service

As noted above, Canada is well positioned to take advantage of growing demand given its robust production and export infrastructure. Beyond that, however, there are underlying reasons why Canada is positioned for success for the long term in the pork industry. One main underlying reason that Canada is positioned for success is the fact that with Canada, Brazil and the U.S., Canada is one of the top competitive, efficient hog producing regions in the world. While producers often bemoan the fact that Canadian prices are among the lowest in the world, that is because Canada is among the most competitive regions in the world with production far in excess of consumption. Other reasons for Canadian optimism include the following advantages relative to competing regions:

1. Fresh water supply
2. Arable land
3. Absence of common major animal health problems
4. Livestock and human contact density
5. Ample feed grain supply
6. Technological adoption

CONCLUSION

The bottom line for the Canadian pork industry is that while there are sound reasons for short term optimism, there are also reasons to look forward positively to the future. Whether from a global demand perspective or from a competitive supplier perspective Canadian hog producers can look to the future with a sense of promise.

GROUP SOW HOUSING – THE FACTS

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ABSTRACT

Accumulated knowledge from research and experience in other countries as well as our own has provided tools to successfully house pregnant sows in groups, while providing individualized animal attention, an environment supportive of sow well-being and equal or better sow productivity. However, there is no template for the ideal system. The "best" housing system for any producer is one that is designed and operated based on attention to a number of key principles or concepts: ability for individualized sow attention and feeding; appropriate quantity and quality of space accessible to each sow in the group; mixing strategies to minimize aggression, injuries and distress i.e. facilitate establishment and maintenance of stable social hierarchy in the group; and stockpeople that are knowledgeable, attentive and like working with sows. Guidelines provide us with good recommendations for space allowance, pen design and layout, and group mixing strategies as well as sow behaviour indicators of well-being and distress. However, more information and research focus is needed on clearer definition of space requirements to accommodate dynamic behaviours and to provide better understanding of genotype, temperament and group environment interactions. Lameness associated issues, a particular concern for grouped sows and their ability to access resources, are an important area of ongoing research along with investigations into improving flooring characteristics for ease of sow movement and comfort.

INTRODUCTION

Housing pregnant sows in groups is far from a new concept. But, it is one that many North American pork producers do not favour to replace gestation stalls. However, many producers do recognize that this is the way of the future; for some that future is now. Our goals in converting from full-pregnancy confinement in stalls to sow group housing are: 1) to retain the benefits of stalls and of group systems while eliminating the negative housing features of both; 2) to provide an environment conducive to good animal welfare; 3) to retain or improve sow productivity/performance and 4) be economically successful.

The focus of this paper will be identifying things that we have learned and do know about group housing with emphasis on features important for sow well-being and success, and will conclude with some factors for success that we still need to work on.

WHAT DO WE KNOW ABOUT SOW GROUP HOUSING?

Markets do and will demand group sow housing

The European Union (EU) ban on the pregnancy-long housing of sows in gestation stalls has been in full effect since January, 2013. Although countries in North America have resisted national legislation banning these stalls, they are banned in four states and committed to being phased-out in another five. Major pork integrators, Smithfield's and Tyson Foods in the United States and Maple Leaf Foods in Canada, as well as several fast-food chains (e.g. Wendy's, McDonald's, Burger King, Tim Horton's) have documented and publically announced their requirement for "stall-free" pork, either immediately or within a defined time period. Producers not housing sows as required by the buyers within the stipulated timeframe will not likely be marketing pigs.

Sow reproductive performance can be the same or better than in stall systems

Understandably, an important criterion is that sow productivity cannot be compromised by converting to group housing. Certainly, both favourable and unfavourable comparisons can be found in the literature. However, a detailed review of the literature published ten years ago (McGlone et al 2004a) already concluded that well-managed group sow systems did not compromise sow welfare or productivity. Currently, we are all aware that farmers in Denmark, using sow group housing, set the bar at 30 pigs/sow/year a few years ago. Similarly, good reproductive performance is considered standard in the Netherlands (Table 1) and is certainly achievable in Canada (Connor, 2012).

During a farm's transition period from stalls to group housing there may be an initial dip in production performance especially if current sow inventory is moved into a group environment. Sows that have not been in groups may have to learn social 'etiquette' and may show more aggression initially. They will also likely be less fit and therefore more prone to locomotion problems and injuries associated with physical activity and fighting on concrete and slatted floors.

Table 1. Performance of sows on 'average' and 'top 10%' of 700 Dutch farms. Sows were grouped by 4 days after service. (adapted from Boyle et al. 2012)

	Average of farms	**10 % Best**
Ave. no. of sows per unit	449	562
No. litters per sow per year	2.4	2.5
No. weaned piglets per sow per year	28.1	30.9
No. liveborn piglets per litter	13.4	14.1
Pre-weaning mortality %	11.9	10.4
No. weaned piglets per litter	11.8	12.6
Interval, weaning – service (days)	5.5	5.3
Farrowing rate (%)	88	91

No one system suits all

One of the daunting aspects of converting to group housing is that, unlike standard stall systems, there are many choices that can impact the functionality of the system, animal welfare and productivity of the herd. Most often the system is designed around the choice of feeding method and even then there are several options within the general categories of competitive and non-competitive feeding (e.g. see Levis and Connor, 2013; Connor et al, 2014). Apart from the actual system there are some key features and concepts to consider:

- Ability to attend to and feed individual sows in order to maintain health and appropriate body condition.
- Group size and dynamics to accommodate ease of management and optimize stable sow group formation whether in static or dynamic groups.
- Space allocation and pen shape or layout.
- Timing of sow grouping/mixing – at weaning, just after breeding or post-implantation.
- Methods of sow introduction or mixing to minimize fighting and distress.
- Flooring – particularly slat and gap widths; abrasiveness and surface characteristics
- Space divisions/mixing pens to facilitate social hierarchy formation and stability.
- Space to segregate individual sows if necessary.
- Stockpeople **–** that are knowledgeable, attentive and maintain a positive attitude

In essence these have been distilled into four critical points gathered from the literature and interviews with experts (Johnson and Li, 2013): floor space allowance, feeding strategies to control variation in sow body condition, knowing how to mix sow groups including plans for mixing sows into dynamic groups, and stockperson skills.

Some of these concepts will be explored further in this paper, but practical information on options and considerations can also be found in a series of factsheets produced by the National Pork Board available at http://www.pork.org/Resources/3703/SowHousingOptions.aspx.

Fighting between sows is not essential to establish and maintain a dominance/social hierarchy

A major concern with group housing is the potential fighting at initial introduction of sows into their groups which can result in serious injuries. While overt aggressive behaviour towards stranger sows is one method of establishing position in the group's social order it is not the only method. When given enough space and opportunity many sows prefer to retreat and avoid perceived threats by group mates. Newly grouped sows may spend fewer than 10 minutes actually fighting and in a well-designed pen very little, if any, fighting should occur after the first day (Gonyou and Lang, 2013). But, it may still take several days for the social hierarchy to become stable.

Our understanding of the importance of appropriate management strategies for regrouping sows has grown considerably and practical resources are readily available (e.g. Gonyou and Lang, 2013). Incorporating mixing strategies that minimize sow injury and distress are well worth the effort. One approach worthy of consideration is the use of a mixing pen prior to placement of a group or subgroup into the actual gestation pen. The mixing pen provides more space per sow and is outfitted with good footing and space dividers/barriers so sows can more readily escape aggressors. After a few days, once that group has established its hierarchy, they can be relocated into the gestation pen without experiencing the injuries and distress that are likely to occur in the more restricted confines. Adding a familiar or established group of sows into a larger group also helps to lower the overall level of aggression in the larger group and can be effective for dynamic sow groups where sow cohorts are added and removed at regular intervals relative to breeding and farrowing. It is recommended that the subgroup size introduced into the larger group should number no less than 10% of the total number of sows in the pen (Gonyou and Lang, 2013). This is the case whether or not a mixing pen is utilized prior to introduction of new sows into the group. Aggression towards newcomers should, then, be spread amongst more animals rather than an unfortunate few.

Other considerations at sow mixing include grouping based upon sow size, parity and body condition/feeding requirement and gestational stage at mixing; the latter of which may influence the sows' propensity to fight (Gonyou et al., 2013). The relative importance of each of these to ready establishment of a stable social order is also a function of feeding system, with competitive feeding systems requiring more attention to these considerations than a non-competitive system which allows individualized feeding. Mixing strategies will be discussed more in the workshop section of this conference.

With each introduction or removal of a group of animals the hierarchy is disrupted and must be re-established with the inclusion of the newer group. Research is limited in this area, but some anecdotal evidence indicates that in large groups aggression at the time of new sow-group introduction may be more between newcomers to the group than with resident sows (Connor, 2012). While dynamic groups can be managed quite successfully, the preference from a sow welfare standpoint is to minimize aggressive and agonistic encounters between sows, meaning that static group management may often be the preference.

Since the dominance hierarchy determines access to resources agonistic interactions can be problematic for sow well-being even within an established hierarchy. Any situation of limited access to resources be they feed, comfortable resting space, or water can result in competition and compromised welfare, and potentially performance, for at least some of the animals.

For the social environment of group housing the 'personality' of the sows comprising a group becomes increasingly important. Research investigating the confident-fearful and active-passive dimensions of sows relative to their performance in group housing is relatively new. There are demonstrable links between temperament traits, aggressive behaviour and body injury score in sows (Seddon et al, 2013). Practical on-farm temperament assessment protocols may become an important tool in genetic selection and replacement strategies in the future.

Size matters

Certainly, pen size for the group of sows occupying it needs to allow all animals ready access to key resources. Crowding threatens social stability and increases the likelihood of fighting and compromised performance for at least some of the animals.

However, balancing the sow's need for space with the realities of the farmer's need to provide that space economically can be challenging. Further, the 'ideal' space allowance per animal encompasses several factors and has not been adequately quantified in the scientific literature. Currently, the North American experience and recommendations cover ranges of 15-18 ft^2 (1.4-1.7 m^2) for gilts, 19-24 ft^2 (1.8-2.2 m^2) for sows and 18-23 ft^2 (1.7-2.1 m^2) for mixed parity groups including gilts (Gonyou et al., 2013). However, actual space allowance needed should be determined by the particular situation and observation of animals' behaviour with recommendations used as guidelines. Other factors such as pen layout, feeding system used, group size, flooring and ambient temperature, to name a few, influence the amount of space required by each animal. Aggression, injuries and lower-ranking animals lying in less-than-desirable areas of the pen, such as alleyways and dunging areas, are outcomes of inadequate space allowances (Weng et al., 1998). With increased or adequate space more exploratory behaviour and few agonistic encounters are observed – both indicators of well-being (Bench et al 2013)

Group size also influences space required per individual animal. For sow group sizes greater than 40 animals, space allowance can be reduced by 10% (Gonyou and Lang 2013; Remience et al., 2008), which corresponds to the lower value of the ranges above; presumably because the total area is sufficient to allow effective escape and avoidance behaviours. Sows in larger groups may be more tolerant of unfamiliar sows and engage in more avoidance and 'ignore' behaviours rather than fighting.

Quality of space is important

Not only is the quantity of space critical, but the layout of the pen and the arrangement of its components are equally important. Access to resources and the ability of sows to move freely about the pen are functions of how the pen components are configured. Clearly defined, appropriately spaced areas for feeding, drinking, dunging and loafing contribute to minimal competition and social stability in the group. Where electronic feeding stations are used they need to be located so that every sow can have ready access, will not be hindered from exiting and cannot easily return to the entrance after exiting the station. Sows may congregate around the feeder entrance at the start of the feeding cycle, so the feeder entrance should not be placed near tight corners where sows can get caught by an aggressor and be seriously injured. Figure 1 depicts some important space quality concepts.

In general, pen layouts should accommodate natural activities while avoiding bottlenecks or cul-de-sacs (Thibault 2004). For example, walkways or places where sows may need to pass each other should be sufficiently wide so that passage cannot be easily blocked by a more dominant sow. Considering that the average sow is about 6 ft (1.8 m) long (McGlone et al., 2004b) the EU minimum of 10 ft (3m) could allow a sow to lie recumbent across a passage without totally blocking it. However, the 7 ft (2.1 m) minimum distance recommended in North America (Gonyou et al., 2013) could be problematic for subordinate sows, depending on the situation.

Brooks (2003), who studied and documented the pros and cons of various ESF systems in use, noted that creating a circuitous route in pens which a sow will follow, such as to access the feed area, reduces aggression and competition for resources.

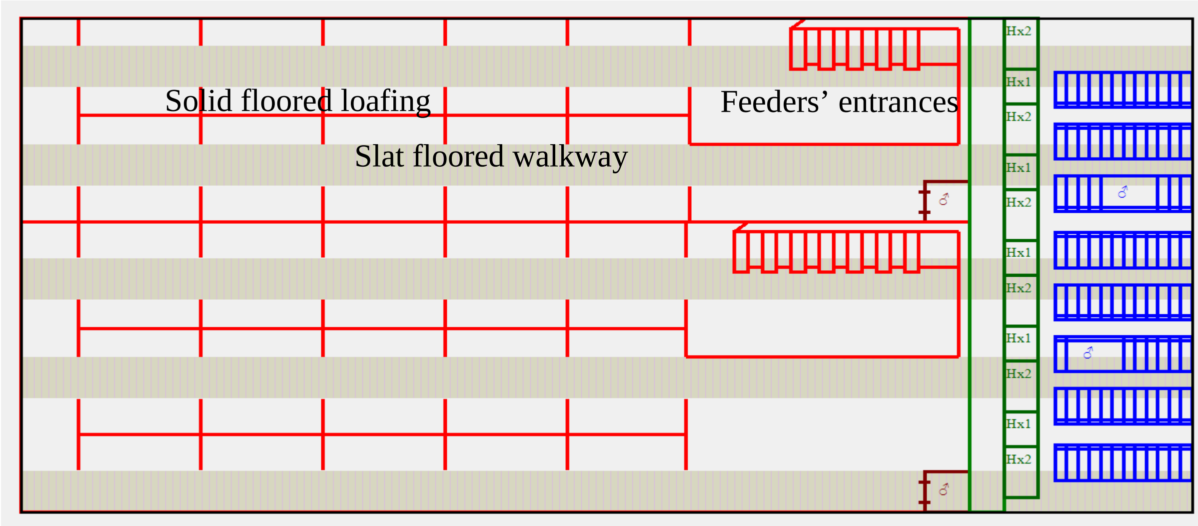

Figure 1. Example of group pen layout for ESF system demonstrating principles of circuitous walkway to feeding area, dividers on solid floor for loafing areas and feeder exit directing sows away from the entrance.

Improving quality of the group pen environment with strategic placement of space dividers or stub walls can create more desirable resting areas for small groups of familiar sows, provide escape or hiding places for lower-ranking sows to avoid aggressors, particularly at time of grouping, and can create discrete feeding areas when floor feeding. Such dividers also assist sows to lie down more readily (Marchant and Broom, 1996).

The quality of space is greatly impacted by the pen floor surface, the ratio of solid to void for slatted floors and the presence or absence of compressible material. These influence sow walking and lying comfort, incidence of claw and hoof injuries and lameness as well as sows' ease of accessing resources. The hardness, abrasiveness and slipperiness of concrete floors along with slat and gap widths can negatively impact leg soundness (Kilbride et al., 2009) and sow well-being. Slatted floors are associated with increased incidence of lameness in sows, particularly after regrouping-induced fighting (Anil et al, 2005). Sows kept on partially slatted flooring reportedly have lower lameness scores than those on total slats (Vermeij et al, 2009). Research conducted at the University of Manitoba comparing lameness (Seddon et al, 2013; Connor, 2013) culling and longevity (Fynn, 2010) of sows housed on partially slatted concrete floor to those on concrete overlaid with straw, noted that the lameness (Table 2) and involuntary culling rates were higher in the concrete partially slatted floor system. As well, a positive correlation was noted between body injury score and lameness on the partially slatted floor system, but not in the straw system (Seddon et al., 2013)

These results indicate that more solid floor, especially with a compressible surface, would benefit sow soundness and well-being. Where bedding is not available, sow comfort and longevity can be improved with provision of rubber mats (Rioja-Lang et al., 2013). Combined with research results of others it becomes clear that research efforts to improve the walking and lying surfaces in concrete slat-floored systems is critical since the majority of North American pig farms transitioning to sow group housing will need to retain liquid manure systems.

Table 2. The incidence of lame and non-lame sows in straw-bedded and concrete part-slatted ESF housing systems over one gestation.

Straw-bedded ESF	Not lame	Lame	Total
Frequency	99	41	140
Percent (%)	35.7	14.8	50.5
Part-slatted ESF	**Not lame**	**Lame**	**Total**
Frequency	78	59	137
Percent (%)	28.2	21.3	49.5
Total (frequency)	177	100	277
Total (%)	63.9	36.1	100

Unfortunately, well-defined floor slat and gap widths most appropriate for sows are not readily available in the scientific literature. The European Union (EU) regulations for sow flooring include slat width of ≥ 80 mm (3.1 in.) and gap width no greater than 20 mm (0.79 in) (Council Directive 2001/88/EC). Most experiential information in Canada favours a slat width of 127 cm (5 in) and gap width of 1.9 cm (0.75 in) (Peet, 2011) for sow flooring. The functional challenge is to have slat widths of sufficient width and surface characteristics for sows to walk comfortably and gap widths that will not catch toes or claws but will allow manure passage.

Given the choice, sows prefer environments enriched with materials of 'biological value' that they can manipulate (Elmore Pittman et al, 2011) by chewing, rooting or both. Floor substrates such as straw or other compressible materials may also provide added advantages of lying and/or walking comfort (Bench et al, 2013b). Such amenities, required in the EU, are considered to impact favourably on sow comfort and well-being, particularly for the restricted-fed pregnant sow. However, like other resources, if enrichment material in a pen is limited, there is potential for agonistic interactions. Lower ranking animals may get displaced (Ellmore Pittman et al., 2011) thereby reducing the intended effectiveness. As pointed out by Bench et al. (2013b), investigations are needed to better understand the interactions between sow rank and effective enrichment so that these can be incorporated into group sow housing management systems.

Good Stockpeople are the key for success

Good stockmanship is considered critical for success in any livestock operation. With the transition from housing sows in stalls to housing in groups a different skill-set may be needed. With group housed sows, daily observation of individuals is critical, but can be difficult in the group environment. An 'animal-directed' approach is imperative. Stockpeople need to be equipped with good observation skills, a solid understanding of normal and abnormal gilt and sow behaviours and how these relate to animal health, comfort, well-being and distress. Moreover, clear strategies for dealing with signs of sow distress are essential for stockpeople to be effective. Positive human-animal interactions can be gratifying for workers and have a beneficial impact on sow performance (Hemsworth et al., 1986). One of the industry challenges is attracting people with the required level of training, either by recruitment or through retraining. However, the potential for improved job satisfaction from working with sows able to express more of their natural behaviours and the level of technology incorporated into many modern sow barns may be increasingly attractive to stockpeople of the future. As much as investment in getting the housing system right is well advised, investment in training of skilled stockpeople will pay dividends.

Economic viability need not be compromised

Although economic viability is essential for success with any sow housing system, this aspect will not be discussed herein. Whether converting a barn from stalls to group housing or building a new group housing barn, the capital expenditure is significant. The operating costs will vary depending on the type of group system and production achieved. Without individualized feed delivery, feed costs may be greater with efforts to ensure all sows receive their allocation. Providing a pen environment with sufficient space configured for sow comfort and stability of the social hierarchy can translate into higher productivity and sow longevity and therefore lower operating costs. This is an area which needs more investigation and information transfer, considering the variables within a sow group housing system which can impact profitability.

MORE KNOWLEDGE NEEDED

Although there are several areas worthy of further research and improved understanding, a few key areas discussed herein and that impact sow well-being will be mentioned.

In spite of regulations in the EU and recommendation in North America, flooring recommendations are not clear cut and scientific support for these values is lacking. This is particularly the case for the slat and gap widths in slatted flooring. These floors need to accommodate lying and walking support for the sow, without catching claws, hooves or other body parts, yet allow dung and urine to pass through. We recognize that sow leg and hoof injuries and lameness, particularly associated with agonistic encounters at mixing, are associated with concrete slatted floors. Can we do better for the sows with different slat and gap widths? Similarly, does the direction of the slats affect the incidence of injuries? As indicated previously (Rioja-Lang et al., 2013) we recognize that rubber mats on slatted floors can increase sows' movement and choice of lying area in pens. The next part of the question is whether placing mats, or other compressible materials, only on solid pen areas improves sow comfort and decrease the incidence of lameness. Answers to these questions become increasingly important since the majority of North American producers will choose to retain liquid manure systems with group housing.

The optimum space allowance, i.e. that needed for different sow activities, has not received as much attention as the minimum physical space for lying, standing, feeding etc. Comparisons, within systems, and across parities would help define specific requirements for the modern genotype for other shared-space activities such as avoidance of aggression, escape, exploration and separation of specific activity areas. We recognize the negative impact of too little space, but are somewhat at a loss as to what the optimal space allowance may be for the various systems. Space requirement may also be affected by the availability of enrichment materials and ways to economically provide appropriate enrichment, especially in slatted floored systems, is an important area for sow well-being.

Improved clarity of genotype and housing interactions as well as the importance of sow temperament in establishment and maintenance of a stable group dynamic are developing areas of research. Identification and management of low- and mid-ranking sows to maintain sow well-being and productivity in different housing systems will have overall economic benefits, as well.

The incidence of hoof and claw lesions and lameness is problematic in any housing system, but in group housing systems the impact may be greater. Sows need to walk to access feed, water and appropriate dunging area. A lame sow has a greater likelihood of being seriously compromised in a group housing situation than in stalls. Therefore, research needs to continue on lameness associated factors and mitigation strategies for sows in group housing.

The final area that will be mentioned is that of mixing strategies, particularly the time of mixing after weaning. While most recommendations encourage mixing after breeding – either immediately or after pregnancy has been confirmed – these methods require extra space/stalls for breeding and early pregnancy. If mixing at weaning can be effectively managed without compromising sow performance, significant economic benefits in terms of space utilization can be realized. Further, should a market demand for stall-free pork trend towards a complete phasing out of stall use, strategies to effectively manage weaned sows without stalls will be needed.

CONCLUSIONS

Housing sows in groups is the way of the future in North America, whether one considers it to be market driven or directed by a desire to accommodate more of sows' natural behaviours. Fortunately, we now have a good knowledge-base upon which to build and operate successful group housed sow barns. Research and experiences from the EU as well as successful systems operating in Canada and the U.S.A. demonstrate that sow productivity, longevity and welfare can be as good as or better than in total stall confinement. One of the big challenges is that, unlike conventional stall systems, there is no blueprint for one ideal sow group housing system. Rather, there are important principles that, if followed, promote sow well-being and success. These principles include such factors as being able to attend to and feed individual sows, adequate floor space allowance and pen configuration to afford physical comfort and social stability in the group, effective mixing strategies to minimize aggression, injuries and distress, and attentive, knowledgeable stockpeople who like working with sows. With the transition to group sow housing there are opportunities for pig producers to adopt a housing system that not only meets the needs of the sows, but also aligns with the management style of themselves and their stockpeople. Whether converting to a higher technology system such as with the ESFs or maintaining a lower tech system, success is very much a function of appropriate facility design and the people operating the system on a daily basis.

ACKNOWLEDGEMENTS

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LESSONS LEARNED FROM PEDV

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WHAT DO WE NOW KNOW ABOUT PED IN ONTARIO?

Clinical Cases

- As of February 26th, 23 pig sites have been diagnosed as PEDV positive. 19 of these sites are sow sites and represent approximately 16,000 sows or 5% of the Ontario sow herd. Of these 23 sites, 17 have PEDV contaminated feed as the common risk factor, linked to one US origin porcine plasma shipment to Ontario. CFIA bioassay has confirmed that this porcine plasma product was PCR positive for PEDV and on February 18th, CFIA issued a statement indicating "Testing with a swine bioassay has determined that the plasma ingredient contains PED virus capable of causing disease in pigs." The information from the balance of cases points to biosecurity gaps involving farm, transport and other. Pig movement from these sites will result in a significant increase in contaminated sites in the short-term.

- PED is an emerging disease that veterinarians must report to OMAF under the Animal Health Act. To date the rate of new cases remains very low. This is different from what was observed in the USA. OMAF and private veterinarians, Ontario Pork and many individuals in the swine sector are working hard to keep it that way.

- Working with their veterinarians, the original case farms continue to successfully manage this serious disease. Some farms are again farrowing healthy piglets and elimination plans are already being put into place on some farms.

- **Now that PED has infected a number of sites in Ontario, continued efforts around biosecurity and extra vigilance is required by all sectors of our industry to control and contain the virus and work to protect our sow herd base.**

- Reports on new clinical cases can be seen at www.ontario.ca/swine

Surveillance

Processors

- The best surveillance data to date comes from the major processors. Their help is greatly appreciated. This system is the result of work by OMAF, private veterinarians and our packers that market about 85% of Ontario hogs each week. To date only 5% of the 721 trailers tested have been positive for PED virus, although positives continue to be detected on a regular basis. All Ontario trailers monitored that delivered market hogs to Quebec have been negative. Positive trailer results could occur as a result of cross-contamination, hogs from already known positive farms, and other unconfirmed farms with mild PED infections. So far, tracebacks on these positive trailers have not uncovered any new serious PED virus infections on farms.

Transport

- Over the course of the past few months, 18 transport companies and associated wash bays have been audited by swine veterinarians, focusing on high risk and/or high volume companies. To date 274 environmental samples have been taken from trailers and facilities with 18 positive tests or just under 7% testing positive for PEDV. A number of these positive tests were taken from trailers that had transported PEDV positive pigs and so these results were expected. In these cases, wash and retest confirmed negative status of the trailers. The transport industry has been highly cooperative and is making excellent efforts to reduce the risks of PEDV transmission.
- The Lucan truck was has been identified as resource to assist in the management of trailers with high risk of contamination with PEDV. Primary targeted trucks for this wash:

1. Cull transport trucks returning from the U.S.
2. Dedicated trailers that will transport cull animals from Talbotville to Wyoming.
3. Trailers bringing cull animals from Quebec to Wyoming.
4. Any positive or presumed positive truck that does not have a satisfactory wash solution.

Assembly

- The three major assembly yards in Ontario have been working in close cooperation with the industry to reduce PEDV transmission risks and in fact had begun this work well before PED was diagnosed in Ontario. Environmental surveillance has confirmed that the Zantingh Direct Wyoming site is PEDV positive.
- Zantingh Direct has made significant effort in the development of biosecurity enhancements to reduce the risk of PEDV transmission. These efforts have included the development of a new assembly facility with controls for incoming and outgoing truck traffic as well as staff and visitor foot traffic. As well, a

transfer station format has been developed to reduce risks associated with the Wyoming site.
- The remaining two assembly sites have also implemented risk reduction strategies where required.

All of these industry partners are continuing to work with swine veterinarians to assess and reduce risks.

SUMMARY AND LESSONS LEARNED

- There is every hope we can keep the impact from PED at a low level in Ontario with **continued vigilance and strict biosecurity**, particularly at the farm gate.

- We must focus on containment in the remaining cold months so that we can get into the spring or early summer where this virus will not be nearly as easily transmitted.

- OSHAB/Ontario Pork investigation of high risk trucking events and reduction of risk from Oct to Jan was invaluable in being better prepared to respond to PED in Ontario.

- Advance preparation of who the response team would be and what they would do was also invaluable. The public/private partnership of the response team made up of OMAF, Ontario Pork, OSHAB, OASV, AHL and practicing veterinarians was quite effective.

- Producers and service companies were transparent with information, supportive of containment and control measures and invaluable in assisting with investigation. Without the openness of industry and producers we would not have been successful.

- Communication to industry was not timely, accurate or open. The broader industry was operating in a vacuum of rumours and misinformation. In future there needs to be a clear communication plan to keep industry in the loop as to what we know, what are we investigating, timing of results, update on what we know and what we are planning.

For further information please contact the Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs at 1-877-424-1300, or Ontario Pork at 1-877-ONT-PORK.

Resources on PED prevention and management are available from:

OMAF at www.ontario.ca/swine

OSHAB at http://www.opic.on.ca/biosecurity-resources/porcine-epidemic-diarreah-ped

Ontario Pork at http://www.ontariopork.on.ca/ped

LACTATION SUCCESS

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ABSTRACT

Lactation success is key to the profitability of a farrowing unit and producers are now faced with an increased challenge because of the current use of hyperprolific sow lines. Numerous factors come into play to affect lactation success and one major aspect which has been overlooked in the past is mammary development. The current overview will succinctly cover various factors that can affect sow milk yield and will then focus on mammary development, namely, when it happens, how it happens and what can be done to stimulate it. Lastly, results from a project looking at the importance of teat use in first lactation for its milk yield in second lactation will be presented.

SOW MILK YIELD

Sow milk yield is the main determinant of piglet growth rate as it is the only source of energy for suckling piglets. Sows do not produce enough milk to sustain optimal growth of their litter and this problem was made worst with the current use of hyperprolific sow lines. Milk yield is influenced by numerous factors such as litter size, parity, nutrition, genetics, management, environment and endocrine status. Yet, one important factor that is often overlooked is mammary development. Indeed, sow milk yield is dependent on the number of milk-producing cells that are present in mammary glands at the onset of lactation. There is a positive correlation between the number of mammary cells and piglet growth rate. Periods with relatively high mammary growth are of particular interest since it is during those periods that mammary growth may be susceptible to being stimulated by nutritional or hormonal manipulations.

MAMMARY DEVELOPMENT IN SWINE: HORMONAL CONTROL

Mammary development in swine occurs at 3 developmental stages: from 3-months of age until puberty, during the last third of pregnancy, and during lactation. It is controlled by a complex interaction of various hormones. During gestation, estrogens and prolactin are essential for mammary development and relaxin is also needed to stimulate total mammary gland growth. Few studies have looked at the effect of providing hormones on mammary development. Gilts receiving injections of porcine prolactin for a period of 28 days, as of 75 kg BW, increased their mammary development (based on visual appraisal) and also had lacteal secretions already present (McLaughlin et al., 1997). Interestingly, the degree of mammary gland development did not appear to be related to the dose of prolactin injected. A further study where gilts were slaughtered and mammary development actually measured, confirmed that injections of porcine prolactin to gilts for a period of 29 days, starting at 75 kg BW, stimulate mammary development at puberty (Farmer et al., 2005). Yet, the impact of such a treatment on subsequent milk yield is not known. Furthermore, porcine prolactin is not currently available commercially.

CAN PREPUBERTAL NUTRITION AFFECT MAMMARY DEVELOPMENT?

Nutrition does influence mammary development in growing gilts, yet, data on the subject is sparse (see review by Farmer, 2013). Either a 20% or a 26% feed restriction from 90 days of age until puberty drastically reduces mammary tissue mass (Table 1).

Table 1. Effects of feed-restriction and reduced protein intake during prepuberty on mammary parenchymal mass at puberty.

Treatment	Parenchymal mass		Statistical significance	Reference
	Control gilts	Treated gilts		
34% feed restriction from days 28 to 90	69.9 g/gland	65.4 g/gland	Not significant	Sorensen et al. (2006)
26% feed restriction from days 90 to 170	81.6 g/gland	53.7 g/gland	Significant	Sorensen et al. (2006)
20% feed restriction from days 90 to 202	344.9 g/udder	254.3 g/udder	Significant	Farmer et al. (2004)
Reduced dietary crude protein (14.4 vs. 18.7%) from days 90 to 202	344.9 g/udder	377.3 g/udder	Not significant	Farmer et al. (2004)

On the other hand, earlier feed restriction, from 28 to 90 days of age, did not affect mammary development at puberty (Table 1). Furthermore, lowering protein intake (14.4 vs. 18.7% CP) during the period from 90 days of age until puberty does not hinder mammary development of gilts (Table 1). Composition of diets fed to prepubertal gilts influences their mammary development. Phytoestrogens are naturally-occurring plant compounds that can have estrogenic properties. They are present in large amounts in soya and one class of these phytoestrogens comprises the molecule genistein. Gilts fed 2.3 g/day of genistein from 3 months of age until puberty had a 44% increase in the number of mammary cells at 183 days. On the other hand, dietary supplementation with flax as seed, meal, or oil during prepuberty brought about the expected changes in circulating fatty acids without any alteration in mammary development. Yet, when 10% flaxseed was supplemented from day 63 of gestation until weaning, beneficial effects (30.9% increase in parenchymal mass and 11.6% increase in number of parenchymal cells) were noted in the mammary tissue of the female offspring of these sows at puberty. This was the first demonstration of such an in utero effect and it opens new avenues in terms of potential management schemes to stimulate mammary development of gilts.

NUTRITION IN LATE GESTATION AND LACTATION: EFFECTS ON MAMMARY DEVELOPMENT

Effects of late gestation and lactation feeding on mammary development in swine were recently reviewed by Farmer (2013). During gestation, feeding very high energy levels (44 vs. 24 MJ ME/day) may have detrimental effects on mammary development and subsequent milk production whereas increasing the amount of dietary protein (16 vs. 4 g lysine/day) did not affect mammary development but may increase subsequent milk production. When manipulating body composition of gilts by changing their protein and energy intakes during pregnancy, overly fat gilts (36 mm backfat at the end of gestation) on a high energy-low protein diet had reduced mammary development (Head et al., 1991) and produced less milk than leaner gilts (25 mm backfat) at the same body weight (Head and Williams, 1991). However, backfat of gilts in that study was much thicker than what is normally seen and the ideal body condition required to ensure maximal mammary development in late gestation should be investigated further. Feeding in lactation also affects mammary development; an increase in weight of functional mammary glands is seen when sows are fed either more protein (65 vs. 32 g of lysine/d) or more energy (17.5 vs. 12 Mcal ME/d; Kim et al., 1999). It is therefore imperative to maximise sow feed intake during lactation.

INVOLUTION OF MAMMARY GLANDS

Mammary involution at weaning is an essential process of the mammary gland and much remains to be learned about it in swine. It is associated with dramatic changes occurring rapidly in the 7 to 10 days following weaning, with a loss of more than two thirds of the weight of mammary glands (Ford et al., 2003). Mammary gland involution also takes place in early lactation when a gland is not being suckled. It occurs rapidly during the first 7 to 10 days after farrowing and was irreversible after 3 days of non-suckling. On the other hand, involution is reversible after 24 h of non-suckling, but the "rescued" gland will never produce as much milk as if used right from the onset of lactation (see review by Farmer 2013).

DOES TEAT USE IN FIRST LACTATION AFFECT ITS MILK YIELD IN SECOND LACTATION?

With today's hyperprolific sow lines, swine producers are faced with a problem in their farrowing rooms: should they "load" the primiparous sows with as many piglets as possible or should they leave some teats unused to give these sows a "respite". This is particularly important in first parity sows with poor body condition, to avoid the “lean sow syndrome” that potentially leads to reproductive problems. New findings demonstrate for the first time that teats that are used in first lactation will produce more milk in the second lactation (Farmer et al., 2012). Indeed, piglets suckling teats which were previously used weighed 1.12 kg more on day 56 than piglets suckling a previously unused teat. Furthermore, development of a teat that was previously used is improved in the second lactation and piglets suckling teats which were not used previously show a greater level of hunger in second lactation. Interestingly, piglets seem to be able to differentiate between previously-used and -unused teats.

CONCLUSIONS

A combination of factors are involved in the control of sow milk yield and with the current use of hyperprolific sow lines it has become imperative to provide the best-adapted management and feeding strategies to improve upon it. Nutrition of replacement gilts and of late-pregnant sows requires special attention to ensure maximal mammary development and future milk yield potential. Management of first-litter sows can also impact subsequent lactation performances. We now know that teats which were suckled in first lactation produce more milk and have a greater development in second lactation than teats which were not suckled in first lactation. Such knowledge is critical for producers to make the best decision in terms of management strategies for their first-parity sows.

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Day 1: Sows – Workshop Sessions

SUCCESS WITH GROUP HOUSING

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INTRODUCTION

Managing sows in group housing requires different skills and activities compared to stall housing. This can pose new challenges to barn staff, but it can also provide rewards such as improved handling in sows, a better understanding of the animals and their individual differences and a more rewarding work environment. Producers who implement group housing are generally positive about the switch. Both the University of Manitoba and Prairie Swine Centre research herds have made this transition, and have found that barn staff prefer working with sows in groups. This workshop focuses on differences in management between group and stall housing, and how to prepare for and make the most out of managing sows in groups.

FAQ'S

For those who have always worked with sows in stalls, it is hard to imagine working with sows in loose housing. Questions frequently raised by barn staff include: Will the workload change (and will I still have a job)? How much will my daily routine change? Is it safe working in group pens? What can be done to reduce aggression at mixing? Do sows really need this extra space? How will I find sows and treat them when needed?

It is important to know that although some new skills may be required to manage groups of sows, the overall workload with groups is very similar. If the barn undergoes renovation, production will be disrupted during the transition phase as sows are moved or herd size is temporarily reduced, but once construction is finished and staff have the opportunity to adjust and retrain, staffing requirements will be very similar.

Comparing feeding systems

Unlike stall housing, group housing comes in many different shapes and sizes. It is important to understand the long term consequences of each system in order to make good choices based on staff capabilities, barn layout and herd size.

Feed competition between sows is an important consideration. Electronic sow feeder (ESF) and free access stall systems are known as 'non-competitive' feeding systems. They are designed to provide individual feeding to sows and limit competition for feed by isolating the sows at feeding time, so that all sows have access to feed and cannot be displaced by other sows. Short stalls, open stalls and floor feeding are known as 'competitive' feeding systems. Feed is provided in open troughs or directly onto the floor, and all sows will compete for access to this resource. Dominant sows in these systems can often get more than their share of feed: subordinates may be driven off and not receive their due share.

Different approaches are used to manage competitive and non-competitive systems in terms of group size and daily checks. In competitive systems, sows are typically managed in smaller groups, typically from less than 10 up to 30 animals. In free access stall pens, group size generally ranges from 30 to 60 animals, and ESF pens can be managed with large groups, ranging from 60 sows to over 300 sows in dynamic ESF systems.

In competitive systems, sows of similar size and body condition should be selected when gestation groups are formed. Having sows of similar size in the group helps to ensure that all sows will be successful when competing for access to feed. Also, feed can be provided in ways that reduce competition, making it more difficult for one sow to dominate a large share of feed. Despite this, some ‘dropout’ sows will occur, animals should be observed regularly at feeding time, and any sows not actively feeding or losing condition must be identified and removed promptly to another pen to ensure the health of the sow and subsequent litter.

In non-competitive systems, a wide mix of sow parities can be accommodated, however even in these systems the smaller and subordinate sows can be at a disadvantage. In ESF systems, this can result in younger sows accessing the feeding stall later in the daily feeding cycle, and lying in less preferred areas of the pen (Strawford et al., 2008); in free access stalls, younger animals have been found to spend more time in feeding stalls and less time in the open loafing area (Riocha-Lang et al., 2013), but this generally does not affect body condition or productivity.

Managing the transition to group housing can be the most challenging time. Sows that have spent their previous gestations in stalls may be more aggressive when first mixed. Once sows or gilts become accustomed to being in groups, they learn to become more tolerant and show less aggression, especially after repeated mixings. Thus the first mixing can be the most stressful, and some animals may not adapt well and should be housed separately or culled.

The transition to ESF systems also requires training sows on how to access the feeding system. Once established, only the incoming gilts need to be trained. Training of gilts should be done before breeding in order to minimize impact on production, and is sometimes done at the gilt development site. However, as noted when making the transition all sows must be trained, and this will require extra care and attention. A separate ESF training pen is helpful in teaching sows how to access the feeder. More cautious sows can be fearful around the entry gate and may need some encouragement from a handler, for example by tying the entry gate partially open or placing feed at the entry, in order to learn how to access the feeder. Other group systems generally do not require sow training.

Aggression between sows

When sows are mixed together, there is usually some fighting among sows. Sows typically fight in pairs, with two sows lining up sideways with head to head or head to hindquarters, thrusting and biting vigorously. Fighting does not occur because sows are ‘inherently aggressive’, but can be better understood by examining the social structure of sows in the wild. In the wild, pig groups are made up of several closely related females, with each group having a home territory that it will drive other groups of pigs away from. When we mix two groups of pigs they respond in the same way, trying to drive off the strangers. This understanding is helpful when implementing changes to reduce and minimize sow aggression.

Many things can be done to reduce aggression and injury at mixing. These can include changes to the pen environment, changes to development of gilts (experience), and genetic selection for reduced aggression. Some 'tricks' to reduce aggression and injury at mixing include: extra pen space, adding partitions/hiding areas, improved flooring to reduce leg and foot injuries, providing extra feed at mixing, use enrichment (e.g. straw) as a distraction. Changes to gilt development to reduce aggression include management in large groups (Samarakone and Gonyou, 2009), and multiple mixings.

Multi-parous stall housed sows put into group pens will typically show more aggression at mixing, as they have had little experience with 'fitting into the group'. For this reason, older sows often have more difficulty adjusting to group housing. Aggression can also occur at feeding time, especially in competitive feeding systems. In general, by 48 hours after mixing overt aggression (fighting) drops off significantly, and sows show more subtle behaviours when interacting, with subordinate animals avoiding dominant individuals by turning or moving away. This is one reason why adequate space is needed in group housing; it allows subordinate sows to move through the pen without confronting/ getting in the way of dominant individuals.

Even in established groups, however, aggression can still occur at feeding time, especially in competitive feeding systems. When mixing different groups of sows, it is advisable to add at least 20% new sows to the group. This rule of thumb ensures that new sows added enter with a familiar sub group, and the aggression of resident sows is directed at multiple sows.

Dominant sows are typically the larger, more mature individuals. For gilts and small sows, it can therefore be more stressful to be grouped with larger sows. Studies have shown that sub-grouping sows, based on their age and size can help to reduce problems due to aggression, and is especially helpful for younger sows (Brown, unpublished data). It is common to group first parity sows separately so they experience less stress and can be monitored more closely during gestation. Recent studies in Denmark (Ulrich Hansen, personal communication) have focused on the subject of gilt social development. The Danish studies found that gilts which experienced multiple mixings over time had better social skills; interacting better with other sows and showing reduced aggression.

Worker safely is another important consideration when mixing sows. Fighting sows can be extremely dangerous- the animals remain focused on fighting but they can easily injure a human handler. If sows are fighting, handlers should never intervene. It is better to wait a few minutes and see if it has resolved. Fights will normally finish within minutes, and by 48 hours after mixing there should be minimal fighting. However, in some cases sows may be persistently aggressive. These 'bully sows' can stress and injure other sows, so if fighting persists these sows should be found and removed from the group, and housed separately. Be sure that fighting has subsided before approaching the sow and removing her to a separate area using a panel or handling board.

Sow handling

Whether managing sows in stalls or groups, having good handling skills is an important asset. However, working with sows in groups will involve more daily interaction, so having attentive, calm and skilled handlers becomes more important, as it will encourage sows to respond calmly and to be more responsive during handling. It is common to find that handling becomes easier when sows are group housed. This can be the result of more daily handling and also improved fitness in sows.

These benefits are seen especially when moving sows to farrowing. Whether using stalls or groups it is helpful when moving sows into farrowing crates that feed be distributed beforehand, so that sows are rewarded immediately on entering the crate. If this practice is repeated, sows will learn to anticipate it, and will return more willingly in subsequent cycles.

Stockmanship and daily observation of the sows is also essential to identify sows which are 'off' and may require attention. Because sows in groups can move freely within the pen, it is important to be aware of their normal daily activities and recognize changes in behaviour or location in the pen that indicate a problem.

Routine management practices such as giving injections and pregnancy checking can be done while sows remain in the group. With good handling, sows do not move away from people fearfully and when people are not associated with feeding, such as with ESFs, a stockperson can often enter the pen without arousing resting sows. However, if sows are skittish and/or handlers are not confident around them, sows should be moved to a confined area for treatment. In free access stall pens, this can be easily accomplished using the feeding stalls. For other systems, sows can be moved to nearby stalls, if necessary, for health treatments.

The human factor

Stockpeople often find more enjoyment and job satisfaction when working with sows in groups. They have opportunities for positive interaction with animals, and to observe individual differences. Watching sow behaviour in a group pen can provide more information to evaluate sow health and well-being. Lying, feeding, pen investigating and social behaviours can be readily observed and provide valuable knowledge.

Adopting new technology can be a challenge, but in most cases this is a bonus, creating greater diversity of work and added interest. Technologies such as ESF also provide tools to improve the housing system and animal monitoring and management. Although this requires staff with technical abilities, this is less of a drawback now that computer literacy is more common than in the past. Such requirements may also contribute to recruitment of new young staff.

CONCLUSIONS

Managing sows in groups will hold new challenges for many of our current barn staff. Group housing requires a different set of skills and involves different daily activities compared to stall housing. This can pose difficulty, especially during the transition, but it can also provide rewards such as improved ease of handling in sows and a better understanding of the animals and their individual differences. The use of computer equipment as in ESF systems can also be a positive addition, and can result in increased staff engagement and better employee retention. Producers who implement group housing are generally positive about the switch. As discussed, success in group housing relies in a significant way upon a good understanding of sows' social behaviour. Management of groups -including controlling sow feed intake, minimizing stress and reducing inter-sow aggression- can be optimized based on this understanding, giving equivalent or better production levels compared to stall-housed sows, and providing equivalent or better working conditions for barn staff.

RESOURCES

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SOW HEALTH: IMPACTS AND CHALLENGES

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Sow lameness is gaining increasing recognition for it's impact on overall sow health, productivity and longevity. This workshop will focus on the evaluation and treatment of sow lameness, sow foot care, and provide practical advice on hoof trimming.

MANAGING A DYNAMIC SOW GROUPING SYSTEM

Doug Ahrens
Ham Land Acres Ltd.
Mitchell, Ontario

Doug Ahrens and his wife Kim have operated a farming business in their local neighbourhood near Mitchell, Ontario, Canada, since 1982. The operation currently consists of a 650 sows, farrow to feeder operation. The Ahrens' farm 500 acres of corn, wheat and soybeans. They also provide custom operations from planting to combining on an additional 1500 acres.

In 2012, they began the process to replace an old two story barn with a new loose sow housing barn incorporating dynamic grouping for 650 sows using five electronic sow feeding stations. Doug will share his experience managing this dynamic group system, which involves continuously adding and removing both gilts and sows. All gilts require training prior to their first entry into this group of 200 sows.

Doug will take you for a walk though his barn and highlight the flow and management within this dynamic system.

FEEDING THE SOW: PERI-PARTUM

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ABSTRACT

A major nutritional goal for the breeding herd is to maximize productivity and longevity by minimizing wide fluctuations in body condition as sows' progress through reproductive cycles. Optimal increases in body tissue stores during gestation are achieved by using some pattern of limit feeding. The extent of body tissue catabolism during lactation is minimized by maximizing feed intake during lactation. Less is known about what goals should be set for the peripartum sow. A review of peripartum feeding practices for sows during the last few days of gestation and the first few days of lactation may be beneficial.

INTRODUCTION

The peripartum period is a very critical period in the reproduction cycle – most sow mortality occurs then. The sow's activity during this timeframe also influences her performance in the remainder of lactation, pig growth to market, and her subsequent reproductive efficiency. Mosnier and others (2010) wrote that metabolism occurring during the transition from late gestation to early lactation is not clearly understood and requires further investigation. Prior to this, Cromwell and others (1989) wrote that "levels of energy fed during different phases of the reproductive process have interactive effects on reproduction performance of sows." The same reproductive cycle feeding program may have different outcomes on different farms due to different farm environments and sow genotypes.

The London Swine Conference has a long and outstanding history of inviting presentations and discussion of sow management, including feeding and nutrition. In 2009, Michel Vignola comprehensively reviewed sow feeding management during lactation, and Guy-Pierre Martineau and Brigitte Badouard clarified the specificities of caring for hyperprolific sows. In 2013, the nutrient recommendations for feeding pregnant sows were explained by Soenke Moehn, and Ronald Ball.

Feeding the reproducing female around the time of farrowing is an important part of an overall husbandry plan. Ultimately, a quick and healthy recovery from the parturition experience, accompanied by a rapid and sustained increase in feed consumption, is desirable.

FEEDING DURING THE PERI-PARTUM PERIOD

Late gestation

In 1989, Cromwell and colleagues from The S-145 Committee on Nutritional Systems for Swine to Increase Reproductive Efficiency observed heavier pigs at birth and weaning, greater sow weight gain, and larger litters at weaning when sows were fed an additional 1.36 kg of feed per day from day 90 of gestation to farrowing. Other studies have failed to observe an increase in piglet weight. Vignola (2009) wrote in the proceedings of the London Swine Conference that 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; leading to compromised milk production in late lactation and postweaning reproductive activity. At the same conference, Martineau and Badouard (2009) wrote that there is a 'major' positive influence of increasing nutrients during the last weeks of pregnancy with regard to the lactation performance of the hyperprolific sow. At last year's London Swine Conference, Moehn and Ball (2013) suggested that in late-gestation, providing the female the required amounts of amino acids (considering parity and litter size) was more important than providing additional energy. Provision of energy and amino acid requirements would be done most accurately with parity segregated phase feeding. Goodband and others (2013) recently completed a review of the literature related to providing additional feed to sows and gilts in late gestation, and concluded that extra feed in late gestation increases sow weight gain, might influence pig survivability during lactation, and may increase pig birth weight in parity-one farrowings.

Which feeding strategy to use in the last few days of gestation (days 112 to parturition) has long been debated. Dritz and colleagues (1998) wrote that sows should be fed daily the same amount of feed as was fed daily during the two weeks previous to this time. They suggested that this is usually between 2.3 to 3.6 kg per day. They described field experiences where intakes of 1 kg or less during this period limits the ability of the sow to increase feed intake rapidly in lactation and may increase the likelihood of ulcers. Sows may overeat if provided free access to feed on first few days after parturition and then experience a significant dip in feed intake early to mid-lactation.

DURING PARTURITION

The 'common-sense' standard operating practice is not to feed during parturition. It is most likely that the sow will not eat at this time. They will also be less likely to eat during early labor, prior to the birth of the first pig.

In the 2 to 24 hours before farrowing, most females are fed. Producers feed the sow 'on the day' that farrowing eventually starts as they may not know for sure it is going to occur. On most farms, the female is given her full allowance in this feeding. That allowance may be a greater amount if the farm follows a strategy of 'increased or bumped-up' feeding pre-farrow. The importance of the time interval between the 'last feeding and farrowing' and of the amount of feed given is not known for sure. There may be differences in this response depending on the parity of the female, whether a laxative is fed, and the availability of water. Greater control of feed intake immediately prefarrow is possible when the induction of farrowing is planned.

EARLY LACTATION

Sow appetite in the first week after farrowing is less than that in subsequent weeks. Approaches to feeding sows in the first days of lactation can be categorized:

- Aggressive
  - Feeding to appetite
  - Providing ad libitum access to feed
- Controlled
  - Restrict for a couple of days
  - Stair-step up for one week or the entire lactation

Michel Vignola (2009), at the London Swine Conference suggested that feed intake the day 'after' farrowing be the same amount fed daily during the last 14 days of gestation, in situations where gestation feeding is strategic and sows are not over-conditioned. He also stated that feed consumption should increase quickly in lactation as "too restrictive feeding patterns in early lactation (to prevent udder congestion, hypogalactia, piglet scouring, sow constipation and off feed events) can reduce lactation feed intake."

In practice, knowing exactly what is 'the day after farrowing' is slightly challenging and may have an impact on the sow's ability to maximize intake quickly. It is important for all people working in farrowing to communicate 'when is farrowing technically over.' If the sow finishes farrowing in the AM, is she fed for the first time in the PM? Would she be fed at noon if the farm practiced 'three-time' per day feeding? Lastly, if the female completes farrowing overnight, is she fed in the AM?

RESEARCH BY NCERA-219 COMMITTEE ON SWINE MANAGEMENT

Background

Gradually decreasing sow feed intake late prefarrow has been mentioned historically by some producers, practitioners, and nutritional consultants as a means to enhance sow lactation feed consumption, decrease the incidence of hypogalactia, and increase litter weaning weight.

Decreasing feed allowance in late gestation has been shown to decrease the incidence of periparturient hypogalactia syndrome (Tubbs, 1988; Göransson, 1989a; Göransson, 1989b; and Martineau, 1992). One idea as to why this practice is effective is that the sow's appetite may be increased throughout lactation promoting mammary gland growth and milk production. The research of Weldon et al. (1994) lends credence to the practice of less feed intake prefarrow, having showed that high feeding levels before farrowing depressed feed intake during lactation. Yet not all support the practice of prefarrow feed restriction. Tokach (1998) stated that decreasing feed intake prefarrow may lead to a catabolic state at farrowing which contributes to gorging immediately post-farrowing, and sows "going off feed" during lactation.

Objective

To determine the effect of a gradual decrease in feed intake during late gestation on sow and litter performance during lactation.

Procedures

A total of 155 multiparous sows and three gestational feeding regimens were used in this study, which was conducted at Michigan State University, Kansas State University, and the University of Tennessee. The feeding regimens were:

1. Control – 2.0 kg per day from breeding to parturition
2. Step-up – 1.8 kg per day from breeding to day 85, then 2.7 kg per day until parturition
3. Step-down – 1.8 kg per day from breeding to day 75, then 2.7 kg per day through day 108, after which intakes were decreased to a minimum of 0.9 kg per day.

All treatments were planned to provide an equal total amount of feed (235 kg) during a 115-day gestation. Estimated composition of diets are provided in Table 1.

Table 1. Estimated composition of diets.

Item, %	Gestation	Lactation
Lysine	0.55	1.0
Calcium	0.75	0.9
Total phosphorus	0.6	0.8
Salt	0.5	0.6
Added fat	-	3.0

No laxatives were included. Soybean meal (44% or 47.5% CP) and trace mineral and vitamin premixes were considered station effects. Diets were formulated to meet or exceed NRC (1998) minimum requirements.

Sows were moved from gestation to farrowing rooms following feeding on day 107. Beginning on day 108, sows were fed the lactation diet. Sows were fed once per day while in gestation facility and fed twice daily after they are moved to farrowing rooms. Sows were not induced to farrow. They were fed twice per day post-farrowing and fed “to appetite” from day 0 (day farrowing completed) on through all of lactation. By 3 days after farrowing, litter size was adjusted to 10 pigs per litter by cross-fostering. There was no cross-fostering thereafter. No creep feed was provided.

The unbalanced randomized incomplete block design was analyzed using MIXED procedures of SAS. Random effects were station and replicate within station. Repeated measures were used to assess differences in gestation body weight. Fixed effects were treatment, parity, treatment x parity. Litter size and lactation duration were covariates for litter weight gain, sow weight change, sow backfat change, and sow lactation feed intake. The percent of sows returning to estrus within 28 days of weaning was assessed using a Chi-square test.

Results

Step-down sows were heavier at day 107 of gestation because they had received more feed than others two treatments to this point (Table 2). Sow weight loss from d 107 of gestation to day 0 of lactation (post-parturition) was greater ($P < 0.001$) with the Step-down treatment than with Control or Step-up treatments. Feed restriction after d 107 appears to have resulted in sows mobilizing body stores for litter development. Step-up sows gained less body weight in lactation than did Control or Step-down sows. Control sows tended to be heavier at weaning than Step-down or Step-up sows ($P = 0.09$; 226 ± 8.9, 215 ± 8.9, and 218 ± 8.7 kg body weight).

Table 2. Sow and litter performance weight change during gestation and lactation, and lactation feed intake[a].

	Treatment			
Item	**Control**	**Step-down**	**Step-up**	***P*-value[b]**
Number of sows	48	52	55	-
Average parity	3.2	3.1	3.1	-
Body weight, kg				
Gestation d 0	197 ± 12.3	189 ± 12.3	192 ± 12.2	0.29
Change d 0 to 107 gestation	28.8 ± 3.8[a]	34.7 ± 6.5[b]	27.9 ± 6.5[a]	0.04
Change d 107 gestation to farrow	-8.6 ± 2.8[a]	-16.9 ± 2.7[b]	-6.2 ± 2.7[a]	< 0.001
Change farrow to weaning	10.6 ± 3.8[a]	10.1 ± 3.8[a]	3.8 ± 3.8[b]	0.02
Lactation length, d	19.8	19.3	19.8	-
Sow lactation feed intake, kg				
ADFI farrow to 6	4.95 ± 0.44	4.72 ± 0.43	4.77 ± 0.43	0.47
Total farrow to weaning	131.6 ± 6.4	127.5 ± 6.3	126.1 ± 6.2	0.53
Litter size				
Born alive	11.06 ± 0.69	9.75 ± 0.67	11.04 ± 0.64	0.13
Stillbirths	1.06 ± 0.22	0.71 ± 0.21	0.65 ± 0.20	0.27
Litter weight, kg[c]				
Day 0	14.98 ± 0.78	15.49 ± 0.77	14.92 ± 0.74	0.64
Weaning	65.5 ± 2.28	63.9± 2.20	61.3 ± 2.07	0.37

[a]Values were least square means ± standard error.
[b]Least squares means in the same row lacking a common superscript differ ($P < 0.05$).
[c]Litter weight on d 0, 7, 14, 18 and weaning are corrected for number born alive, number nursed on d 3, 14, 18 and weaning, respectively.

There was no difference in feed consumption early in lactation when all sows were 'fed to appetite' (Table 2). Feed disappearance for a given period of lactation was corrected for the number of pigs nursed in that period. Total feed disappearance was also corrected for lactation length. Feed intake during lactation (6.65, 6.61, or 6.37 kg/d for Control, Step down, and Step up, respectively) did not differ among treatments.

Statistically, there were no differences among treatments in the number of piglets born alive, the number of stillbirths, and the percent surviving during lactation. Litter birth weight and preweaning gains did not differ with prefarrow treatment.

There was no incidence of hypogalactia noted for any sow. Sow postweaning rebreeding performance was similar and in the subsequent parity after treatment. Step-down sows tended (P = 0.10) to have fewer piglets born alive than Control or Step-up sows (P = 0.10; 10.15 ± 0.82, 11.24 ± 1.12, and 12.10 ± 0.78, respectively).

Implications

The pattern of feed provision in late gestation influences sow body weight change, but not sow appetite or the growth performance of her litter. Decreasing sow feed intake in late gestation, to less than that fed earlier in the last trimester, does not have a negative or positive impact on the immediate lactation, but may be detrimental in the subsequent reproductive cycles. Increasing feed intake prefarrow was not beneficial and the practice of using a constant feed allowance pattern prefarrow continues to be acceptable.

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FEEDING THE SOW: COMPARISON OF GESTATIONAL AND LACTATION PROGRAMS

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INTRODUCTION

There are a number of important reasons that sow nutritional performance during lactation is of great interest to producers. In a series of excellent extension articles, Flowers (2002a,b) indicated that, when troubleshooting reproductive problems in sows, a key event to investigate carefully is feed intake of the sow during her previous lactation. Besides the reproductive performance of the sow, piglet performance is also intrinsically associated with the nutritional status and, as a result, milk production, of its dam (Noblet and Etienne, 1989). Piglets that are weaned greater than 3.5 kg have a 3x more chance of surviving to market and an 8.5x chance of not being lightweight at 10 weeks of age (Larriestra et al. 2005).

An element of how a sow performs during lactation has to do with the gestational feeding program that is in place (Koketsu et al., 1996; Quinioiu, 2005). There has been some interesting work on feeding during gestation (Young et al. 2004). These data have resulted in extension materials being developed recommending feeding according to gestating sow weight and back fat thickness rather than simply body condition score (Aherne, 2008b). With this method, Young et al. (2004) found no improvement in subsequent lactation performance but did find the program did result in fewer over-conditioned sows and less feed cost per sow annually. As well, by increasing feed allotment during late gestation sows experienced easier farrowing but no improvement in sow or piglet performance (Quiniou, 2005).

Koketsu et al. (1996) analyzed a large PigChamp database and found many factors to be related to the average daily feed intake of a sow. Pattern of consumption, litter size, lactation length, parity, gestation feeding program and environment (i.e. temperature and humidity) all were shown to affect average daily feed intake by sows (Koketsu et al. 1996). Vignola (2009) summarized a number of other principles or factors that affect feed intake of nursing sows: 1) Too restrictive feed allowance, 2) Water intake (both in the feed (as gruel) and as a separate fresh drinking source), 3) Employee stockmanship skills and 4) Animal comfort/equipment management. Some of these factors, when controlled, have been shown to affect sow feed intake and lactation performance, for example, water intake and temperature (Leibbrandt et al., 2001).

A number of strategies have been developed in efforts to reduce the risk of a drop in feed intake for nursing sows. While there are extension publications readily available explaining the "best" system, there has been very little experimental data published to compare these methods. Aherne (2008a) explained a method of slowly increasing feed intake up to a target (4 lb + 1.25 lb/piglet) by day 8 and holding that intake level until day 12 (which coincides with the time of high risk to go off feed seen by Koketsu (2006)). On day 13, Aherne (2008a) recommended feeding ***ad libitum***. Another method that appears to be popular is feeding *ad libitum* for the entire lactation. Finally, a method being recommended by some (Loula, 2009) is a variation of the last method where the sow can "self-feed" by dispensing feed into her trough by turning a wheel.

To my knowledge, no work has been done to investigate the three methods of feeding lactating sows side-by-side. Nor has there been any published work to investigate the interaction of the methods of feeding gestating sows and lactating sows on a sow's nutritional, metabolic and reproductive performance and resulting litter performance to weaning. Understanding the strengths and weaknesses of various feeding regimes for gestating and nursing sows and being able to monitor their nutritional/metabolic health will be of benefit in reducing pre-weaned mortalities and increasing weaning weight in piglets as well as improving the sow's subsequent reproductive performance.

ANIMALS AND TREATMENTS

Three hundred sows were randomly assigned (after being balanced for parity) to six treatments set up in a 2x3 factorial design. There were two types of gestational feeding. The first ("Conv.") was a typical method where the producer does a visual appraisal of the sow's condition and sets a feed amount based upon that visual inspection. The second ("Kansas") was the system as promoted by the Kansas State Swine Extension group (Young et al. 2004) where sows are weighed and their back fat is measured using an ultrasound. Feed amounts are set based on a table that can be customized for the energy density of the diet and number of feedings per day (one in this case). There were three types of lactation sow feeding. The first ("Conv.") was feeding as much as the sow wishes (*ad libitum*) from day 3 onward. The goal was that there was always a little feed left in the feed trough when the next feeding occurred. The second ("Ramp") was such that the amount is slowly ramped up to ad libitum over 13 days. On day 1, sows received 2.0 kg of feed, on days 2 and 3 sows received 3.0 kg of feed. From days 4 to 8 sows were ramped up as quickly as possible to 1.8 kg + 0.6 kg/piglet of feed. When this target level was attained, it was maintained until day 12. From day 13 onwards, the sow was fed *ad libitum*. This method was recommended by Aherne (2008a). The third ("Ad libitum") feeding method was self-feeders where the sow could decide for herself how much she would like to consume from day 1 to weaning. The treatments were applied over 3 parities in order to determine what the longer term effects of the various feeding regimes would be. All sows were fed the same diets across treatments (gestating and lactating rations).

DATA COLLECTION AND ANALYSES

Feed intake and sow and piglet mortality events were recorded on a daily basis. Piglets were weighed at birth and again at weaning. Sows were ultrasounded for back fat when moved into the farrowing crate and again after weaning. Feed samples were collected on a monthly basis. Sow weights were recorded when moved into the farrowing crate, as soon after farrowing as possible (usually same day or the next day) and when moved out of the farrowing crate. Reproductive parameters (weaning-to-estrus interval, farrowing rate, litter size (alive, stillborn and mummified)) were recorded for each parity. All data were analyzed using the Mixed procedure of SAS. Repeated measures were conducted on all data that were measured repeatedly over time. Factors of interest are: sow feed intake, back fat changes, piglet performance and reproductive performance of sows.

RESULTS

At time of submission of this article all of the data have not been analyzed but Table 1 is a summary of some of the data.

Table 1. Sow feed intake, body weight and litter size and piglet weight data.

	Gestational Feeding System[1]		**Lactational Feeding System[2]**		
	Conv.[3]	**Kansas**	**Conv.**	**Ramp**	**Ad libitum**
Sow feed intake (kg/d)					
Day -7 to -1	3.14 (0.01)[a]	3.15 (0.01)[a]	3.14 (0.01)[x]	3.15 (0.01)[x]	3.14 (0.01)[x]
Day 0 to 21	6.50 (.03)[a]	6.38 (0.03)[b]	6.44 (0.03)[xy]	6.52 (0.03)[x]	6.35 (0.03)[y]
Sow body weight (kg) after 1st period					
In crate	248.2 (2.1)[a]	254.2 (2.2)[b]	252.6 (2.6)[x]	253.1 (2.6)[x]	247.9 (2.6)[x]
Farrowing	237.9 (2.2)[a]	243.9 (2.0)[b]	243.3 (2.5)[x]	241.7 (2.4)[x]	237.6 (2.5)[x]
Weaning	232.3 (1.7)[a]	236.5 (1.7)[b]	234.7 (2.1)[x]	236.8 (2.1)[x]	231.7 (2.1)[x]
Sow body weight change (kg) after 1st period					
In crate to weaning	-16.5 (1.3)[a]	-18.2 (1.3)[a]	-18.5 (1.6)[x]	-16.5 (1.6)[x]	-17.0 (1.6)[x]
In crate to farrowing	-11.2 (1.0)[a]	-11.2 (1.0)[a]	-9.9 (1.3)[x]	-12.2 (1.2)[x]	-11.4 (1.2)[x]
Farrowing to weaning	-6.0 (1.2)[a]	-7.7 (1.2)[a]	-9.5 (1.4)[x]	-4.8 (1.4)[y]	-6.3 (1.4)[xy]
Litter size (live) after 1st period					
At birth	12.9 (0.4)[a]	12.9 (0.4)[a]	12.2 (0.5)[x]	12.5 (0.5)[xy]	14.0 (0.5)[y]
At cross-fostering	12.3 (0.1)[a]	12.2 (0.1)[a]	12.3 (0.1)[x]	12.2 (0.1)[x]	12.3 (0.1)[x]
At weaning	11.3 (0.1)[a]	11.1 (0.1)[a]	11.2 (0.1)[x]	11.2 (0.1)[x]	11.1 (0.1)[x]
Piglet age and growth data					
Age (d) at 1st weighing	1.6 (0.1)[a]	1.6 (0.1)[a]	1.6 (0.1)[x]	1.6 (0.1)[x]	1.6 (0.1)[x]
Weight (kg) at 1st weighing	1.61 (0.02)[a]	1.62 (0.02)[a]	1.65 (0.02)[x]	1.61 (0.02)[x]	1.59 (0.02)[x]
Standard deviation (kg) of weights at 1st weighing	0.20[a]	0.20[a]	0.20[x]	0.20[x]	0.19[x]
Age (d) at 2nd weighing	19.9 (0.1)[a]	19.8 (0.1)[a]	19.9 (0.2)[x]	19.9 (0.2)[x]	19.9 (0.1)[x]
Weight (kg) at 2nd weighing	5.85 (0.04)[a]	5.81 (0.04)[a]	5.84 (0.05)[xy]	5.92 (0.05)[x]	5.72 (0.05)[y]
Standard deviation (kg) of weights at 2nd weighing	0.85[a]	0.84[a]	0.83[x]	0.85[x]	0.85[x]

[1]Differences in gestational system with different superscript (a,b) are different ($P < 0.10$).

[2]Differences in lactational system with different superscript (x,y) are different ($P < 0.10$).
[3]Treatments descriptions are in paragraph "Animals and Treatments".

DISCUSSION

None of the statistical differences seen were remarkable but until the economics of the differences are determined we must be careful to pass them off as not important. The difference in feed intake during lactation for the two gestational treatments is interesting. Until we get the gestation data all analyzed it is difficult to make any substantial conclusions. It appears the slow ramp up method recommended by Aherne (2008a) resulted in the largest feed intake for the lactating sows. This, coupled with the combination of lowest body weight loss during lactation and piglet weaning weight for that treatment, makes this system positive especially for farms where sows lose concerning amounts of body weight during lactation. The conventional system of lactational feeding resulted in the largest body weight loss during lactation but also resulted in comparable weaning weights in piglets. The ad libitum system of feeding during lactation resulted in the largest litter size at birth (past the first period/trial parity) but unfortunately, because the cross-fostering that was completed on the farm what impact it would have accumulated in over lactations may have been confounded.

The companion paper to this one, by Dale Rozeboom (2014), delves into nutritional requirements during the critical periparturient period.

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CHALLENGES ASSOCIATED WITH REPRODUCTIVE FAILURE IN SOWS

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ABSTRACT

Solving problems associated with reproductive failure in sow herds can be a challenge. It is critical to meet breeding targets on a routine basis, and to achieve the appropriate farrowing rates. Reproductive failure interferes with the consistent production of pigs, which ultimately results in the suboptimal number of pigs for market. This paper is intended to highlight some of the challenges facing producers. Weaning provides a natural synchronization of estrus; however, it is not uncommon for sows to fail to return to estrus after weaning, return to estrus after seven days or fail to conceive after mating. Three pharmacological approaches to improving post-weaning returns to estrus are discussed with an emphasis on the role of effective management to improve the success of any approach. In addition, feed intake during lactation also represents a critical factor in the reproductive performance of sows. Diminished conception rates and high pregnancy losses can be attributed to both infectious and non-infectious causes. Solving the underlying causes of these problems often represents a major task. A diagnosis of an infectious cause usually is straightforward unless suboptimal management is involved. Key examples of the interactions between infectious causes and deficient management are highlighted with cases of PCV-2 reproductive failure and post-breeding vaginal discharges. In summary, it is critical to evaluate both infectious and management related causes of reproductive failure.

INTRODUCTION

Over the last few decades, producers have made major improvements in the reproductive performance of their sow herds. Obviously, the improved performance must also increase economic returns, and one must consider the sow costs per pig. There are several methods to manipulate the estrous cycle: some are approved, others are not. Unfortunately, our attempts to improve reproductive performance appear to be hampered by infectious diseases and suboptimal management. At times, the clinical presentation of a disease is relatively straightforward, which allows the producer and veterinarian to develop a diagnostic plan, treatment protocol, and with any luck, a worthwhile vaccination program. One major challenge often is the need to delineate a subclinical disease situation from a problem with the people managing the pigs. The primary goals of this paper are to highlight the importance of management (of pigs and disease), and to demonstrate some of the challenges of dealing with disease situations.

SYNCHRONIZATION OF ESTRUS IN WEANED SOWS

Weaning of piglets actually provides a natural synchronization for the onset of estrus. However, several factors contribute to delayed and variable returns to estrus after weaning. Lactation length, feed intake during lactation, season, parity, genetics, and other factors influence the return to estrus. Despite awareness of these factors, and in some cases, corrective procedures, it is common to see considerable variation in the weaning-to-estrus (WEI) and weaning-to-service intervals (WSI). As shown in Figure 1, most sows do return to estrus in one week, but the remainder exhibit estrus at various times after weaning. These latter sows group represent the "problem animals" and interfere with the goal of having 90-95% of sows bred within 7 days after weaning.

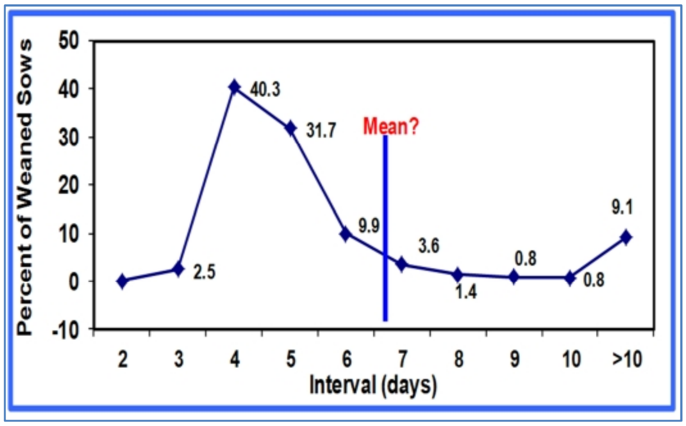

Figure 1. Percent of weaned sows exhibiting estrus after weaning. Data was obtained from a 4000-sow farm in North Carolina.

To circumvent problem sows and to improve timing of matings after weaning, there are three primary methods of pharmacological manipulation of the sows at or shortly after weaning. One method is the use of PG600® on the day of weaning (Estienne and Hartsock, 1998). This method appears to be useful for first parity sows, particularly in the summer months. The benefits of treating multiparous sows with PG600® at weaning are not as apparent as treating first parity (primiparous) sows. Another method of estrus control is the oral administration of Matrix® for 7 days (or other time periods) after weaning. We recently completed a large study with primiparous sows (approximately 3000) in a commercial farm. The use of Matrix® increased subsequent litter size (Control – 10.7 TB, 10.1 PBA, Treatment - 11.4 TB, 10.7 PBA), without affecting farrowing rates. Note: this is not an approved use of Matrix®. A veterinary prescription was required in the USA.

The breeding barn personnel indicated that the synchrony of estrus following the cessation of Matrix® administration was greater than the natural return to estrus. This synchrony of estrus facilitated estrus detection. Finally, the recent approval of Ovugel® for timed insemination appears to be promising. The administration of 2 mL (200 µg triptorelin) into the vagina of sows at 96 hr after weaning allows the producer to inseminate sows at approximately 24 hours after the treatment. From a personal perspective, all three approaches are useful for the control of estrus after weaning; however, they are not effective at improving sloppy technique and lazy personnel. In other words, an excellent producer can use most new techniques and make them work, but the methods will have marginal benefit if the breeding barn personnel are "suboptimal".

Sow feed intake during lactation

So, now that we have pharmacological means of manipulating the onset of estrus after weaning, we should be removing some of the pressure on farrowing house personnel and sow feed intake. Unfortunately, this is not a valid assumption. Feed intake during lactation has been recognized as one of the most important factors affecting the post-weaning reproductive performance of sows, particularly primiparous sows. One of the most informative studies on lactational feed intake was conducted by Koketsu and coworkers (1996). In brief, there are four primary feed intake patterns for lactating sows: 1) a steady increase in feed intake, 2) marginal feed intake throughout lactation, 3) marginal feed intake for the first 7 or more days and then a gradual increase, 4) a steady increase followed by markedly diminished feed intake at approximately 11-14 days after farrowing (Figure 2).

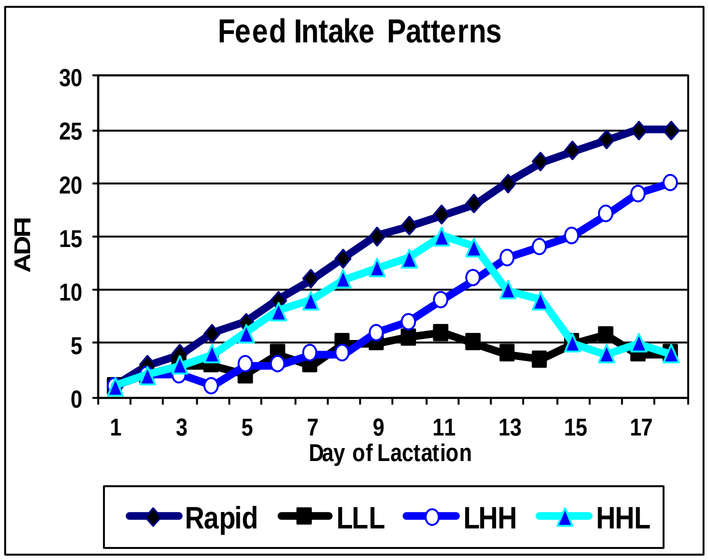

Figure 2. Feed intake patterns during lactation. The four patterns included a rapid increase (Rapid), a low feed intake during lactation (LLL), an initial low intake followed by higher feed intake in the last 10 or more days of lactation (LHH), and high intake for 11 days followed by a marked decrease (HHL). ***(Adapted from Koketsu et al. 1996).***

It should be no surprise that the post-weaning reproductive performance would be superior in the first group of sows. The other three groups would have subsequent reproductive problems. Why were groups 2, 3 and 4 having so many problems with feed intake?? Post-partum health issues offer partial explanations. From personal experience, it is evident that the primiparous sows often fall into the fourth group of sows. It may be related to gut fill: these animals go off feed because they simply cannot consume the quantity of feed expected by the farrowing house personnel. In our warm climates in North Carolina, part of the seasonal infertility problem is attributed to diminished feed intake (not allowance) during the summer months. Despite innovative methods to increase feed intake (balanced with the economics of feed cost), our producers continue to observe seasonal infertility.

INFECTIOUS VERSUS NON-INFECTIOUS CONCEPTION AND PREGNANCY LOSSES (DISEASE OR MANAGEMENT OR BOTH??)

Historically, veterinarians and producers recognized the onset of an infectious disease outbreak. For example, a dramatic increase in mummies and stillborn pigs would have been attributed to porcine parvovirus (PPV). Another example would be the near catastrophic outbreak of abortions, stillborns, and mummies associated with PRRSv infections in naïve herds. Things have changed. Now, we have issues with reproductive losses associated with porcine circovirus (PCV-2), swine influenza, and consequences of PEDv outbreaks. Most of us can easily list 5, 6 or more infectious agents that cause reproductive failure in sow herds. For some agents, vaccines are effective, while for other diseases, we continue to second guess ourselves on their efficacy. Often, we are simply too nervous to quit vaccinations for fear of an outbreak.

Some of the clinical signs associated with an infectious agent can be subtle or are present only in a particular age group or stage of pregnancy. An interesting case of PCV-2 associated reproductive failure (Pittman, 2008) illustrates the complexity of some of the disease problems. In this particular case, the average number of mummies per litter increased from 0.1 to 0.4. This increase reached a peak of 0.7 mummies per litter in one week. After 10 weeks, the frequency of mummies returned to <0.1/litter. The problem was restricted to gilt litters and only to gilts that entered the herd from an internal source. Concomitantly, the percentage of stillborn and mummified fetuses, and number of abortions were higher in these internally sourced gilts. Gilts entering the herd from an external source were not affected. Confused??? The diagnostic work-up confirmed the presence of PCV-2b in the aborted and mummified fetuses. Why the difference between the external and internal sources of gilts? The external source had been vaccinated for PCV-2. Upon the implementation of a vaccination program (and feedback) of gilts, the clinical problem abated. Similar cases of PCV-2 associated reproductive losses were reported in Canada and the USA. The particular case emphasizes the need for detailed farm records, including reproduction, vaccination and treatments, and a reliable diagnostic laboratory.

Unfortunately, many problems associated with reproductive failure can be attributed to management or mismanagement at one or more levels of personnel. Over the last 30 years, I have been involved in numerous cases of reproductive failure, which were not specifically associated with infectious agents. One of the best examples of a management problem, which often is considered an infectious disease, is the discharging sow. Affected animals produce a purulent discharge at 13-18 days after mating. Invariably, these animals return to estrus at a regular interval after mating. Cultures of the discharge material and the reproductive tracts yield a multitude of different bacteria. A specific infectious agent has yet to be identified (probably because it does not exist). The diagnostic evaluation often, but not always, described metritis or endometritis. Often, there were no pathological findings. The underlying cause of the discharging sow was a dilemma and many veterinarians and producers tried every kind of treatment with marginal success. This mystery was elucidated by De Winter and coworkers (1996), who demonstrated that the likelihood of a uterine infection increased dramatically when sows were mated after ovulation, i.e. late estrus. Our multiple mating schemes with AI and natural matings inadvertently “forced” producers to use a third or fourth mating in late estrus. These late matings took place after ovulation, which is a time when the uterus is highly susceptible to infection. Furthermore, discharging sows were more common when the onset of estrus was missed with poor estrus detection programs. In summary, the discharging sow represents an excellent example of a management problem erroneously considered an infectious disease outbreak.

CONCLUSIONS

This presentation was intended to reinforce the concept that at times, faulty management contributes to suboptimal sow reproductive performance. There is no easy fix for poor management and it often is easier and more convenient to place the blame on infectious diseases or the failure of an exogenous hormone preparation than to re-examine management protocols. Few producers or veterinarians will debate the fact that management of the sow herd is one of the critical keystones to farm productivity.

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REPRODUCTIVE PROBLEM SOLVING IN GILTS

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Gilts are the lifeblood or future of the sow herd and proper gilt management and selection starts at birth and does not end until the gilt is bred, farrowed and has weaned her first litter of piglets. All the steps in this process, no matter how small they may seem, are vital to ensure you are retaining the best gilts in your breeding program. When selecting and breeding the very best gilts, you reduce the incidence of reproductive problems with the replacement females coming into your sow farm.

- **Gilt selection**
  - At birth, end of nursery, at 160 to 180 days of age. Select only the best because only the best should make it to the breeding herd.
- **Feeding, care and acclimation of growing gilts**
  - Gilt developer diets, proper space per gilt, introduction to sow herd. All 3 very important but what do they mean.
- **Boar exposure, breeding age / breeding weight**
  - Determining the proper time for all 3 based on recommendations from your genetic company and based on past experience.
- **Breeding gilts**
  - Breed in crates, breed in pens, crate breaking. What is the best? What makes the most sense for my farm?
- **Maintenance through first gestating period**
  - Not too much feed that we end up with fat gilts at their first farrowing but enough to get them to grow through their first gestation period.
- **Rearing the first litter**
  - How many piglets to put on gilts and also pushing them on feed intake. Setting the stage for future performance.

We all know gilts are vital to the success of your sow operation. Success with getting gilts into the breeding herd comes from managing the gilt from birth through her first litter. When possible, do not skip any of the steps along the way. Make sure they are bred at recommended age and weight as set forth by your genetic supplier. Ensure the gilts have been given every chance to show off their genetic potential. Make sure they have been properly acclimatized to the sow herd. When we follow all the procedures involved in rearing and breeding replacement gilts, we ensure our future success with the supply of the very best females available.

RESOURCES

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CONVERTING TO GROUP SOW HOUSING – DECISIONS TO CONSIDER

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ABSTRACT

Dependent on legislative mandates or market forces many pork producers across North America must transition from housing gestating sows in stalls to group sow housing, often within the next 5-10 years. Pork producers are faced with many decisions in making this transition and these decisions are interconnected. Unfortunately the cost incurred will not be offset by an increase in market price, but the cost of this transition may be the price to be paid to remain in business. Pork producers evaluating the transition to group sow housing should consider the following decision points; 1. Status of the sow inventory, 2. Financial resources available, 3. Type of feeding system to adopt, 4. Floor space allocation per sow, 5. Number of sows per pen, 6. Changes to management practices and employee training and 7. Potential changes to production expectations.

INTRODUCTION

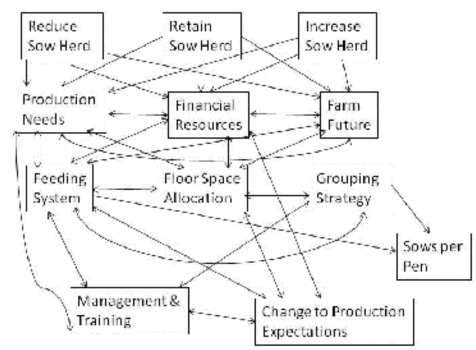
Throughout North America the pig industry is currently undergoing the most significant shift in production practices since the middle of the 20th century as it transitions from individual housing to group housing of gestating sows. A combination of legislative actions and customer purchasing decisions is driving this change. More recently, numerous retailers and food service chains that purchase or distribute pork products including McDonald's, Oscar Mayer, Kroger, Sysco and Tyson have announced that they are encouraging their suppliers to transition from individual stalls to group housing for gestating sows. Depending on the legislation or retailer, many pork producers must implement changes to sow housing between 2017 and 2022.

This change is not simply a matter of changing physical housing systems by replacing individual sow stalls with group pens. Genetic selection decisions in the pork industry over the past several decades have focused on production traits assessed on an individual animal basis and there is growing evidence that sows selected on this basis do not function or perform well in a group-housing environment. To make this change, pork producers will have to re-think how they manage sows. Evidence exists that overall sow productivity can remain similar to that experienced when housing sows individually. However, successful management of sows in groups will be different than when managing sows individually in stalls. Pork producers will have to improve their understanding of sow behavior and work toward managing sows individually, though housed in groups.

Decisions to consider

As farms change from individual stalls to group housing for gestating sows there are many, many decisions that farms have to consider. For the most part they can be categorized by the following; 1. What will be the status of the sow herd and will the present building shell be used or will additional space be added or a new barn built? 2. What are the financial resources for the project? 3. What type of feeding/housing system will be used? 4. What is the design specification for floor space allocation per sow? 5. What is the design specification for the number of sows per pen? 6. How will animal management and employee training change? 7. Will productivity change and if so, how will this affect subsequent cost of production and long-term profitability and viability? Under each of these categories are many subcategories that will also have to be addressed. However, these points can provide the framework of putting together a transition plan from individual stalls to group sow housing. It should be noted that decision making will not be linear and many of these topics are interconnected (Figure 1). Though the following discussion will be linear in nature, many of these topics must interact with each other to come to a decision regarding the transition to group sow housing.

Figure 1. Decision considerations and their interactions when transitioning to group sow housing



Financial resources

Farms that consider this transition must be realistic in what the initial capital costs will be and productivity changes that may occur which could alter cash flow. As with any project of this type it is realistic to assume that there will be a period of time where cash expenditures will increase and earnings may be reduced. Farms that are in good equity positions should be able to work with their lender and develop a reasonable transition plan that would include cash flow assistance over the time period of remodelling/construction when expenditures could increase as well as some type of sensitivity analysis that would show how earnings could fall. This will help the lender understand how operating loans may need to change while the farm works through this transition. Farms that are highly leveraged should evaluate their present financial position and determine what type of transition plan they can afford without worsening their position to a point of insolvency. This will be more challenging. There are tools available from the National Pork Board and Michigan State University that can assist in comparing the cost of transition when evaluating different housing systems. However, farms will need to have accurate and reliable quotes from companies that will provide the new equipment and complete the installation, a good understanding of their own production costs and realistic expectations of what transition short falls in productivity could occur.

Feeding/housing systems

As pork producers consider what type of feeding and housing system to implement many of the subsequent choices they have to consider will fall into place. This is a critical decision since once the type of system is chosen and installed; it can be difficult to change quickly. Several important topics should be reviewed when considering the available options; 1. Does the farm want sows to consume feed in a competitive or non-competitive system? 2. How much control does the farm want over the amount of feed offered to sows during gestation? 3. Can the system maintain a high level of sow care and welfare? 4. Will the system require more or specialized labour? 5. What is the management capacity of the farm staff to learn and manage the different systems of choice?

Non-competitive feeding systems are systems that allow the sow to consume feed without interference from other sows. The major types of non-competitive feeding systems are Electronic Sow Feeding and Free Access Stalls. Competitive feeding systems are systems where sows will consume feed with the potential of interference from other sows while eating. The major competitive feeding systems are floor feeding, non-gated feeding stalls and trickle feeding. However, for trickle feeding, some would contend that sows have little interference from others while feeding. Though, since sows are not protected, there will be cases where sows will interfere with others during feeding in a trickle feeding system. A more complete description of the different group housing systems was provided by Levis and Conner (2013).

The five major feeding systems mentioned in the previous paragraph, are classified regarding the level of feed control, level of care and welfare, need for specialized labour and the capacity of the farm staff to manage the system in Table 1. These classifications are somewhat arbitrary and the opinion of the author, and meant more for purposes of discussion.

Table 1. Classification of sow feeding systems.

	Non-Competitive		**Competitive**		
Item	**ESF**	**FAS**	**Floor-feeding**	**Non-gated stalls**	**Trickle**
Control-Feeding amount	HIGH[b]	LOW	LOW	LOW	LOW
Care and Welfare (?)[a]	MODERATE	HIGH	LOW	LOW	LOW
Specialized Training	HIGH[d]	MODERATE	MODERATE	MODERATE	MODERATE
Management capacity of staff	Farm Specific	Farm Specific	Farm Specific	Farm Specific	Farm Specific

[a]Dependent on the definition of care and welfare.
[b]High is considered either the most desirable.
[c]High is considered either the most desirable.
[d]High would indicate the most training required.

It is should be recognized that ESF does offer the greatest control of feed provided to the sow amongst all group housing feeding systems and was rated “HIGH”. This can be used to more effectively control body condition and manage feed resources of the farm. ESF systems offer other management options not discussed here. The other feeding systems were classified as "LOW" since all the sows within a pen will be offered the same amount of feed and therefore making it more difficult to manage body condition of individual sows. However, dependent on the design specifications for the sows per pen, and the farm's ability to group sows of similar size and body condition; the argument can be made that improvements in the allocation of feed resources to sows of differing body condition can be accomplished to some degree. For example within a breeding group of sows, if sows of similar size/body condition can be grouped together, then different amounts of feed will be offered to sows within a pen dependent on size/body condition and potentially achieving some of the benefit of ESF.

The classification of "Sow Care/Welfare" can be defined in many ways. For this exercise, concerns regarding feed management, sow aggression and the potential for injury were used to determine this arbitrary classification. The FAS system was classified as "HIGH" since sows can remain in the stall and be protected and only interact with other sows in the group as they choose to, unless water is not provided in the stall. The ESF was classified as "MODERATE" because of the reported concerns of regular aggression due to "cueing" or sows waiting their turn to enter the station. However, little data exists that have directly compared FAS and ESF for care and welfare characteristics. These classifications are meant more to bring to the attention of the producer, that better management may be needed to manage systems that have "LOW" or "MODERATE" classification. Farms have successfully implemented both competitive and non-competitive feeding systems. However, with competitive feeding systems, greater attention will be needed to grouping strategies, feeding strategies and daily care and observation of sows in pens. However, it is important to note that for sows housed with ESF or FAS, sows must be evaluated and their well-being status determined daily, as well.

The competitive feeding systems and FAS were classified as needing similar levels of training. This is not to say that specialized training is not needed. However, with these systems most of the training will focus on daily animal management, while some training will be required to manage the feeding and penning equipment. For ESF, the staff will be required to learn how to manage and monitor the equipment as well as train the animals to use the feeders. Staff will also have to monitor the feeders and evaluate the sows daily. This will include reviewing the daily reports generated by the feeders to determine if sows consumed their daily feed allotment.

Each farm will have to determine the capacity of its farm staff to manage whatever system is chosen. Employees will have to be trained to manage sows individually in groups, which will require a different level of stockmanship than when housing sows in stalls. Furthermore farms will have to determine how well farm staff can manage the equipment and the new management plan once group sow housing is implemented. Dependent on this assessment, this can weigh heavily into the decision process.

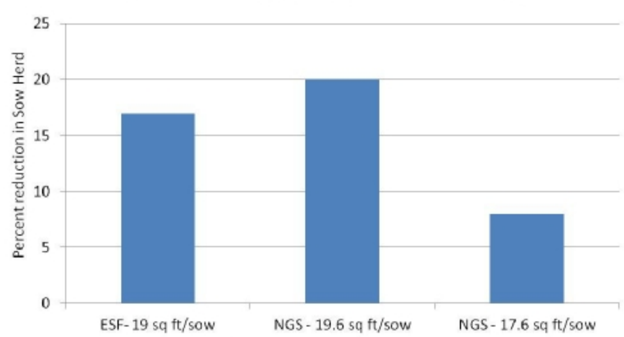
Remodel/add apace

Initially pork producers will have to determine if they will work within their present gestation space or add space. For the most part, gestation barns have 19-20 sq ft per sow, including walkways. Sows in stalls only require 14 sq. ft., so space is used very efficiently. However, with group sow housing, gestating females will have a minimum requirement of 16-20 sq ft, dependent on their age, mixing strategy and body condition

(Gonyou and Rioja-Lang, 2013). Therefore if the existing structure only has 19-20 sq. ft. to start with, converting to group sow housing suggests that either the sow inventory will be reduced or an addition is needed to maintain the sow inventory.

Dependent on the needs of the farm, a case can be made to reduce the inventory and therefore the number of pigs produced. Dependent on the age of the farm and grow-finish capacity, it may be beneficial to allow for an increase in sow lactation length and an increase market weight. With fewer sows, sows will be able to lactate longer and with fewer pigs marketed pigs can remain in finishing longer and be heavier at market. This could allow the farm more flexibility to access different markets. In Figure 2 is an example of the change in inventory, dependent of the type of sow feeding system and layout chosen for an example farm converted to group sow housing using only the current gestation space in the facility. For this example the percentage reductions in sow numbers, ranged from 8-20%. Dependent on the existing restrictions in the barn, the pen layout, the floor space allocation per sow and the number of relief pens provided, the percentage change in inventory could differ.

Figure 2. Sow herd reduction when implementing group sow housing



ESF – Electronic Sow Feeding; NGS – Non-gated feeding stalls

Adapted from Levis et al., 2013

A major challenge when remodeling an existing gestation barn is what to do with the sows during renovation. Some systems have developed a process than allows them to modify small sections of the barn that take 2-5 days at a time, dependent of sow flow. This process would continue each week, until the barn is renovated. Another option to this solution would be to reduce the sow herd by a few breeding groups in a weekly breeding system. This would allow for renovations to occur for 2-3 weeks in different sections of the gestation barn as the gestation "snake" moves through the barn. Modifications will still occur throughout a full gestation cycle.

This challenge of what to do with the sow herd during renovation often causes the farm to add to the existing facilities. The addition to the existing facility allows the farm to build the additional space without disrupting the existing production flow. Once completed the existing inventory can be moved into the new space and subsequent renovations can occur within the existing gestation space as needed.

DESIGN AND MANAGEMENT SPECIFICATIONS

Design specifications

Once the feeding system has been chosen and the fate of the sow inventory has been decided (i.e. reduce, retain or expand sow numbers), the design specifications have to be determined. Primarily this would include the floor space allocation per sow, number of females allocated per pen and number of pens for the facility, and the number of relief pens to be used.

The floor space allocation per sow will be used to determine the fate of the sow inventory or if additional gestation space will be added to the farm. A general rule of thumb can be found in Table 2. These estimates should be considered a starting point to determine what floor space allocation should be. For example, the authors of these guidelines (Gonyou and Rioja-Lang, 2013) recommend that when sows are housed in small pen groups (e.g. less than 10) floor space allocation should be greater than when sows are housed in larger groups (e.g. greater than 40).

Table 2. Floor space allocation guidelines[a,b].

Item	Floor space allocation
Gilts	15-18 sq ft
Mixed groups of gilts and sows	18-23 sq ft
Mature sows	19-24 sq ft

[a]Adapted from Gonyou, H. and F. Rioja-Lang. 2013.
[b]More space per sow is recommended for smaller pen groups.

The number of pens in the barn will be driven by the floor space allocation provided per sow and the number of animals per pen. It should be noted that breeding groups may not always have the correct number of animals to be placed within the gestation pens available. This is of bigger concern for static versus dynamic grouping strategies. Static grouping is forming a pen group at one time without adding any more females once the group is established. Dynamic grouping is the regular mixing of sows throughout the gestation period.

For static grouping strategies, pens should be filled once and sows should not be mixed multiple times. Also the number of relief pens within the barn will influence the space available for group pens. Relief pens are pens provided so that sows that may become injured or moribund can be removed from the group pen and individually cared for. In a summary of several European recommendations, it has been suggested that relief pens comprise up to 5% of the total gestation space (Bates and Ferry, 2013). It should be noted however, that for the most part sows are provided straw bedding in many of the European countries that have these guidelines. If sows are housed on solid cement or slatted floors the amount of relief space needed could be higher.

In a review of the literature, it has been suggested that when competitive feeding systems are used for group sow housing (e.g. floor feeding, non-gated stalls, trickle feeding etc) small pen groups should be used and those pen groups should be static (Bates and Ferry, 2013). Of the two (small pen groups vs static groups) it may be more important that static groups be used for competitive feeding systems. Yet, it has been suggested that for competitive feeding systems, sows housed in small groups (10 sows) may experience less wounding compared to sows housed in moderate sized groups (20 sows) (Guthrie et al., 2012). As floor space allocation is evaluated the type of feeding system and the number of sows per pen should be considered. In addition, having a relatively small number of sows per pen for static groups allows for sows to be sorted by size and body condition more effectively. This will allow for better allocation of feed resources to meet the needs of the animals in the pen. Simply grouping gilts with gilts, small sows with small sows, thin sows with thin sows and heavily conditioned sows with heavily conditioned sows allows for improved feed resource allocation based on the body condition and size of the sows in the pen. Also there is indication that for competitive feeding systems, grouping sows based on their ability to compete for feed resources is more advantageous for their overall well-being (Gonyou and Rioja-Lang,2013).

Changes in management and training

Changes in management and training of existing and new staff will occur when transitioning to group sow housing. For the most part this can be summarized by the following items; 1. Understanding the feeding system, 2. Time management/multi-tasking, 3. Sow observation skills and 4. Treatment of compromised females. Farm staff will have to learn how to manage the feeding system. The level of complexity could range from moderate (e.g floor feeding, etc) to high (e.g. ESF, FAS, etc). Regardless of the feeding system chosen, farm staff will have to quickly learn the nuances of the system and how it should be managed. If the staff does not understand how to manage the system, animal care and well-being can quickly erode. In addition, staff will have to improve their time management skills and be able to multi-task. Farm staff will also have to improve their sow observation skills and be observing sows constantly throughout the day. This will be necessary to quickly identify sows that may become compromised (e.g. lame, injured, etc.) and initiate a treatment regimen as soon as possible. A more thorough discussion can found in Bates and Ferry (2013) on this topic.

Expectations for changes in productivity

As the industry changes from housing sows in stalls to group sow housing, the question will arise regarding what changes in productivity may occur. It has been reported that sows housed in groups have similar performance to sows housed in stalls (Bates et al., 2003). However this is not the expectation across the industry. Unfortunately there has not been a definitive survey to estimate possible differences to productivity due to group sow housing. However, if nothing else most producers do expect that retention rate will be somewhat worse due to expected increases in culling rate. This is somewhat substantiated by work from Europe that suggests that sows housed in groups during gestation have a greater chance to become lame and/or injured compared to sows housed in stalls (Jensen et al., 2010).

An important point to consider for producers who transition to group sow housing will be maintaining total pigs produced during the transition from individual stalls to group sow housing. There are several things to consider during the initial transition to group sow housing. If the inventory is maintained during the construction of pens, sows will be moved from stalls to pens at various stages of gestation. Dependent on their present stage of gestation, body condition, general health and well-being, mixing sows at various stages of gestation could cause an increase in sow culling. This will result in fewer pigs born in the short term due to culling of gestating sows. Another critical issue is that employee training for the new system will occur while the sow herd is moved into pens. At the same time employees are being trained to operate the system the management and environment for sows is changing. This can cause distress and anxiety for both the sows and employees. This can cause increases in culling as both the sows and employees adapt. This can be especially critical for more complex systems such as trickle feeding, Free Access Stalls and Electronic Sow Feeding. Before the transition occurs, a plan should be formulated on how this transition will occur and how employees will be trained to manage the new system.

CONCLUSION

Pork producers should be able to adapt to group sow housing with minimal changes in productivity in the long term. However, to be successful, planning must be done carefully to provide the necessary system configuration and training for the farm to maintain its overall productivity. Pork producers must first determine if they plan to reduce, retain or increase their sow inventory and from that decision, determine what will be best for the farm business to be viable in the future. Persons wanting more information regarding different aspects of group sow housing are encouraged to go the National Pork Board site on sow housing, www.pork.org/sowhousing.

ACKNOWLEDGEMENTS

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RETROFITTING FOR GROUP HOUSING

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ABSTRACT

The new code of practice will be a challenge for most of the independent producers and smaller organisations of the province of Quebec who represent a large part of the pig production. Retrofitting for the new demands for group housing means new costs, new ways of raising animals and for now, no more expected revenues.

What is new can seem frightening at first. By having more information from other producers and visiting, when possible, other farms converted to large groups, the experience is actually quite rewarding. This presentation will share the conversion of two farrow to finish units in 2013, owned by Agri-Marché. We'll present the reasons why different choices of technologies have been made for those projects; the challenges people have faced and costs. The CDPQ (Centre de Développement du Porc du Québec) has produced an evaluation of the economic impacts of the new Code on costs of construction and retrofits of the Quebec pig barns; some details of this report will be presented.

PIG PRODUCTION IN QUEBEC: A BRIEF OVERVIEW

In the report (Pouliot et al., 2012), the authors have tried to roughly estimate the number and age of pig farms in the province that will eventually have to comply with the new code requirements (Table 1).

Table 1. Estimate of average age of farrowing barns and finishing in the province of Quebec in 2012.

	16 years and less	17 to 21 years	22 to 26 years	27 to 31 years	More than 31 years	
Proportion of barns (%)	48.1	18.0	8.3	4.5	21.1	
Number of barns[1]	767	287	132	72	337	(1 595)
Number of finishing barns[2]	1472	551	254	138	646	

[1]BPR Groupe-conseil et Groupe Agéco (2001)
2FPPQ, 2011

The number of farms that are already compliant with the new rules of welfare would be about ± 35 currently in Quebec representing 25,000 sows (CDPQ 2013). The total sow herd in 2012 (Statistics Canada) was approximately 317,000 sows; the average farrowing herd was at that time around 200 sows per farm. According to an internal survey (not scientific), a good proportion of Quebec independent producers do not currently intend to invest in their farms to comply with the rules of 2024. The amount to invest, no expected compensation for now and no family takeover make them think they will sell or just close their farm. On the other hand, people so far are more or less well informed about the changes it will involve. Those who have made the changes are generally quite satisfied and say simply that it is a different way of raising sows that brings a part of good and bad sides. It is to think that after the shock of the adoption of the new code, producers will receive more information and options for changes to their farm and they might change opinion. There will certainly be some coming changes in the industry but with the structure of production in Quebec, it is expected that the inventory of sows will not change a lot, at least if we only consider the effect of the new code.

THE PROJECTS

Agri-Marché, a company that operates primarily in the manufacture of feed for the animals at the farm has a little over 15,000 sows divided into 19 sites in Quebec and one in Ontario. The age of these sites varies from 5 to 37 years. The business model brings the company to offer a multitude of services to independents dairy, poultry and pork producers. The swine division offers, beside feed, replacement gilts (pregnant or not), boars, semen and advice related to all aspects of production. With the arrival of the new Code, the management team received the mandate to acquire the necessary expertise in large group housing to better advise customers in their future choices. In early 2012, people were commissioned to investigate the available technologies, visit sites already in production both in America and Europe, develop a network of contacts and create a guide for conversion to large groups for our own barns and the customers. The ultimate goal is to convert all sow barns connected directly or indirectly to the network by 2022, the date targeted by our customer for commercial pigs.

The network of farms belonging to the company consists mainly of farrowing units, selling weaners except for six sites in 2012 that include nurseries and fattening. Most of these six sites are quite old and with improved sow prolificacy, the capacity of nursery and finishing is not sufficient any more. We have to transfer some piglets elsewhere and that doesn't suit with the philosophy of production. The opportunity is thus ideal to convert these units.

For the first three, the decision was made to transform them in grower farms only, for the other ones, it was decided to retrofit to farrowing units.

In 2013, the retrofit of the first two sites to large group housing started and, to meet the original mandate of the project, it was decided to use the two most opposite technologies available at this time: floor feeding for the first project and the ESF for the second.

FIRST PROJECT DESCRIPTION

The first farm is a multiplication unit of 250 sows that was raising only the gilts, barrows being sold to a small finishing barn located 30 kilometers from the farm. This farm built in the 70s is no longer functional for the reasons mentioned above and it is already decided to no longer use it for production of gilts despite its excellent location and its very good health status. It was decided to convert the unit into a farrowing unit of 625 sows weaning every 28 days for production of 1200 to 1300 pigs per band, which is slightly more than the minimum amount of piglets sought from each of our weaner suppliers.

The renovation of the fattening and selection was fairly simple because it was converted to floor feeding (Figures 1 and 2). Former grower pens are a total length of 18.5 feet, a width of 8 feet with a slatted part on the back of 4 feet. Pens in the selection room have the same dimensions. To create groups of 15 sows, the old feeder and the gate between two pens was removed. With 2 pens, we then create a single one with 19.8 sq.ft. per sow.

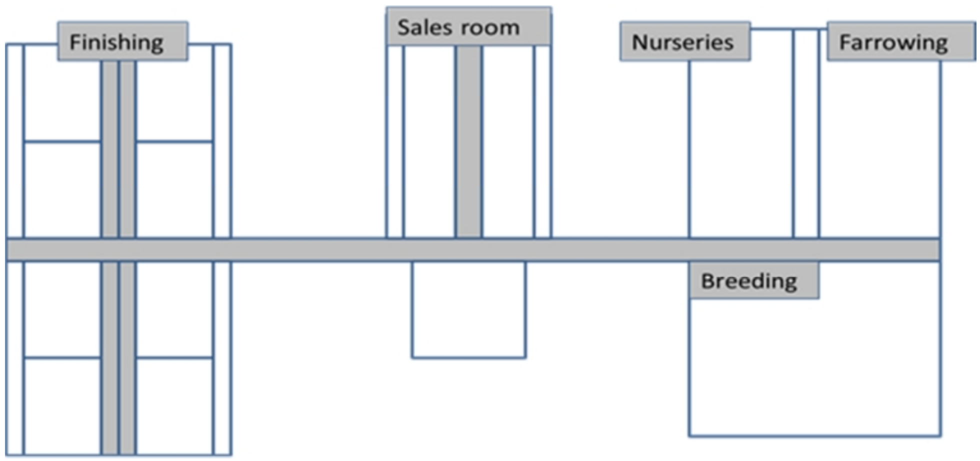

Figure 1. Initial plan for project #1.

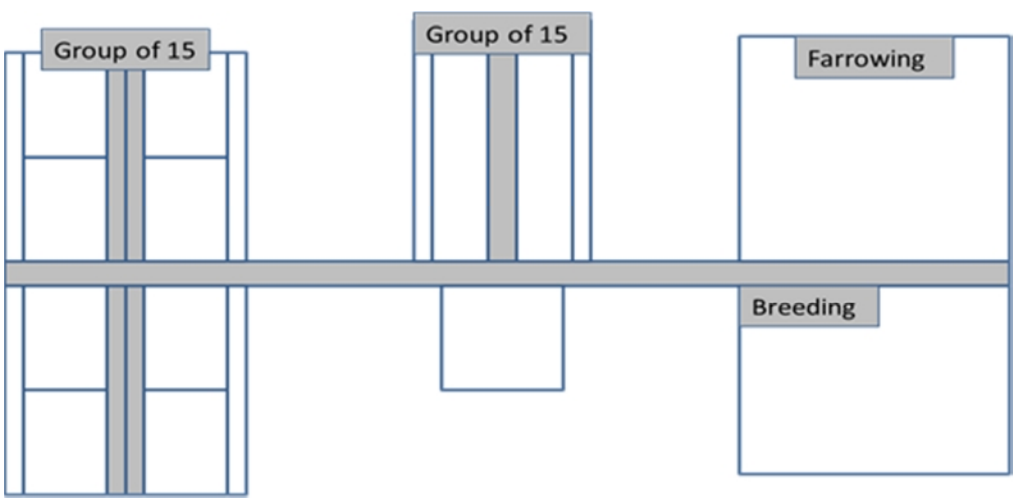

Figure 2. End plan for project #1

The breeding room did not have to be modifed, just a few repairs. Its capacity is 196 sows and gilts; we can keep them in that room up to the second preg test for most of the females (usually we keep our gilts in pens after breeding) before moving them in large groups.

The old nursery was more complicated to modify. Concrete had to be removed, building a new manure pit which represent a large part of the total expense. Used farrowing crates (washed and disinfected) were installed. Especially with the PED concern now, it’s not something we would do again without a lot of investigation. The total cost to raise the sow herd from 250 to 625 sows has been around $400000, so $640.00/head.

SECOND PROJECT DESCRIPTION

The second barn looks like the first one except for the year of construction (1999). An advantage of this site is that weaning takes place in farrowing crates. The total building footprint and the availability of at least 131 farrowing crates brings the ability to transform this farm into an 850 sows unit without having to invest heavily in the maternity section (Figures 3 and 4). Only the addition of 20 additional crates in the selection room had to be done. Using batch farrowing every 28 days, it will provide around 1500-1600 piglets per weaning.

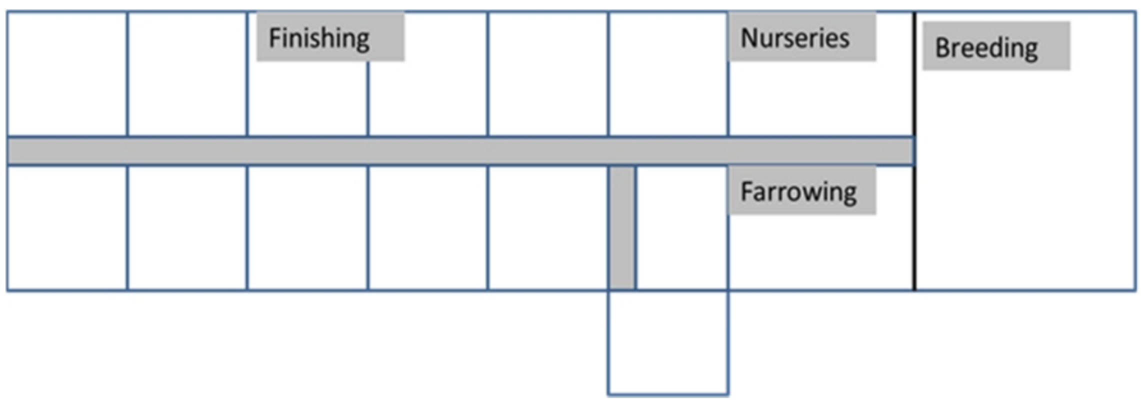

Figure 3. Initial plan of project #2

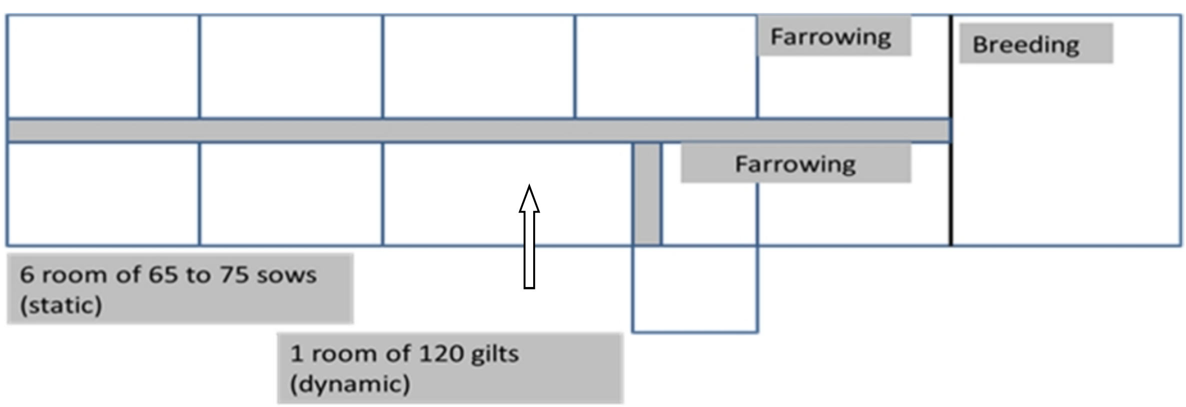

Figure 4. Final plan of project #2

The technology used for this project is ESF. To create large pens from 120 to 150 sows in the fattening rooms of the site, two walls (which separate 3 rooms) are removed for a larger room of 105 feet long by 31 feet wide (area about 24 sq. ft. per animal), this area is then separated in the middle by an open gate. An ESF is then installed in each half-room (6) created. As originally this barn had 11 rooms, 9 of them have served to form static groups for sows, the remaining two forming a large room of 70 feet long by 31 wide to operate a maximum of 110 gilts, a dynamic group for them (about 20 sq.ft. per animal).

It was decided from the beginning not to change floor design to reduce renovation costs (approximately $150,000 to $175,000 savings). The floor has ⅓ solid area in the center and ⅔ slatted. We knew that it would be a challenge so several designs have been used to create clean areas for each sow / gilt. The normal design with the ESF used is a pen of about 22-23 feet wide. As we had 31 feet, we had to adapt by using a few tricks to get the desired rest areas. After several tries, a plastic panel was installed on the solid areas (Figure 5), which allows us to keep our animals in a very satisfactory state of cleanliness despite only 45% of the floor is slatted.

Figure 5. Plastic panels used in Project #2.

Again, the breeding section of the farm has not had to undergo changes. With a capacity of 260 sows, it can keep the animals until the second pregnancy test for the majority of subjects but we still expect to have to test sows / gilts in large groups.

Maternity section that already has 131 crates has requested the purchase of 65 additional troughs and side sections. 20 additional used farrowing crates were added in the old selection room where we have had to remove slatted floors to install the crates after slight modifications. The total cost to go from 250 to 850 sows amounted to $323,000, or $380.00 / sow.

SOME INFORMATION PUBLISHED BY THE CDPQ

As we have seen with the two projects, the total cost of a modification of the building is greatly influenced by the characteristics of the farm of origin. The starting point in both cases was that we did not want to leave the existing walls because it is very difficult to do in Quebec with the current rules without counting the costs it generates. It is quite surprising that between these 2 projects presented, it is the barn with the most sophisticated equipment that has a lower cost of renovation.

CDPQ in its economic assessment (available on the Center's website: www.cdpq.ca) examined the potential costs of several assumptions processing in large groups. There are several scenarios for maternity; the first one is a 2400 sows unit (new construction), the second, a retrofit of a 600 sows farm to group housing and another scenario with a 250 sows farrow to finish. The scenarios are very different from each other but the study provides a good idea of the differences that may exist between different options and once again, the original features of the building vary the renovation costs. Table 2 presents one of the scenarios of the report.

Table 2. Comparison cost: Retrofitting of a 250 sows farrow to finish by using actual Footprint (31374 sq.ft.).

	ESF	Short stalls	Free stalls
Number of productive sows	750	700	650
$/Productive sow	932	910	1 277
$ per sq/ft	22.28	20.31	26.47

CDPQ 2012

CONCLUSION

The ideal system does not exist; people build new barns for many years and each time, improvements are made even if they are minor. In a case of renovation to house sows in large groups, it is often a matter of compromise if you want to adapt the building to the new rules. The first point to respect appears to be the area to be given to animals according to the standards of the Code. Then, depending on the technology chosen, we must decide whether the groups will be operated in static or dynamic management, the number of subjects per group, the need for rest areas etc.

Both systems presented above have their share of benefits, the first one for its simplicity of operation for example and the feeding accuracy of the ESF system on the other end. But, they also have some bad sides (training gilts to use ESF for example). Errors were made in the two projects, but we must learn to live with them. A solid floor in traffic areas with the ESF system would have been better but it was worth it to try not to touch the existing floors and modify the design of pens to find an acceptable solution because the amount saved was important.

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MAKING THE MOST OF THE SUCKLING PERIOD

Know why you do what you do and do it well!

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ABSTRACT

This paper and accompanying breakout session discussion was intended to help farm owners and managers refine the skills necessary to write and implement Standard Operating Procedures for the care of sucking pigs. Standard Operating Procedures should address specific practices and be effectively used animal caregivers. Standard Operating Procedures result in better care of pigs, enhanced productivity, and increased profitability.

INTRODUCTION

In the *Introductory Swine Management* course, taught each fall at Michigan State University, students study swine production practices and technologies. The desired outcome is that they would know how things are done and why they are done in a certain fashion. To facilitate this learning, students are required to complete two critical assignments, the writing of a Standard Operation Procedure Briefing and the writing of Standard Operating Procedures.

The Standard Operating Procedure Briefing (SOPB) is a 3 to 5 page review of current scientific literature which describes the justification for a specific production practice. The SOPB is written to answer the questions, "Should I do this on my farm? Why or why not?" The title of the SOPB should be written in form of a clearly understood question. The introduction should be sufficient, concise, and provide a clear scope of topic. The body of the paper briefly and thoroughly reviews original research papers focused on the specific swine management practice. Pertinent research methods are mentioned, but mostly undesirable or desirable outcomes are summarized. In the conclusion, the writer clearly states what to do or not to do. The conclusion must convey conviction and effectively convince others. References should be included; allowing another person to find the original research.

A Standard Operating Procedure (SOP) accurately explains in writing how to do something and when it should be done. It is a complete, logically ordered description of a process or technique or procedure. It should be very easy to read (large print, bold print, italics, indenting, and one aspect per page, correct spelling, spacing, and possibly with purposeful illustrations or photos). SOP's are best presented in outline or bullet format, using brief statements describing actions. Too much text or verbiage should be avoided. They should have an attractive professional appearance. References are generally not included in the SOP as they are included in the SOPB. Ultimately, an SOP should effectively train. The best test is how well it trains the novice person.

A farm's SOP manual is a comprehensive, typewritten set of production practices, specific to that farm. SOP's should be quickly and readily accessed by all who work on the farm. Existing SOP's should be reviewed and updated regularly to include new practices or changes in practices. The changes should be based on new research and summarized in a SOPB that justifies and describes the revisions.

EXAMPLE – BABY PIG CARE BIRTH TO WEANING

The Pork Information Gateway or Pork Industry Handbook factsheet entitled 'Baby Pig Management – Birth to Weaning' (Reese et al., 2007) is an excellent publication about practices meant for piglets from birth to weaning. The bulletin was written to discuss all practices. For some practices, an 'active' tense is used to describe how it is to be done. So the bulletin has portions that are SOP-like and could be used to train employee. The bulletin also includes portions that describe why various procedures are done. So in that manner, the bulletin is SOPB-like. However, references are not included and so the science justifying a practice cannot be studied to determine if the recommendation in the bulletin is true in all situations or if it is still relevant within modern intensive production systems.

To understand better how SOP's are written, an example of text from this factsheet about colostrum intake can be examined:

- Prevent chilling so piglets stay warm and active.
- Split suckle. This involves removing part of the litter for one to two hour periods the first 12 hours after farrowing. For best results, remove the largest, strongest piglets for a one to two hour period during the morning and again in the afternoon, leaving the small piglets on the sow to nurse. Give the sow 20-30 U.S.P. units of oxytocin (1 to 1.5 ml) each time the largest piglets are removed. Be sure to hold the large piglets in a box fitted with supplemental heat to prevent chilling. Use this technique to ensure high colostrum intake before crossfostering.
- Collect colostrum from the sow or obtain cow colostrum and give it to piglets via a stomach tube or a syringe. To milk a sow, remove all her piglets for one hour. Then give her 20-30 U.S.P. units or 1 to 1.5 ml of oxytocin, wait one or two minutes, then strip her teats (front teats are better because they produce more milk) to obtain colostrum. Cow colostrum also can be used and may be more easily obtained. Either type of colostrum can be frozen in ice cube trays for future use. However, do not thaw the cubes in a microwave oven, because rapid thawing reduces the immunological value of the colostrum. Stomach tubes can be made from model airplane fuel tubing or by using a urinary catheter (size 14 French) available from medical supply stores. Attach the tube to a syringe and lubricate the tube with vegetable oil or KY jelly before inserting it 6-7 inches into the piglet's stomach. Give the piglet 10-15 ml of colostrum once or twice during the first 24 hours of life.

Notice that the first bullet statement above is reasonable as it relates to good production. It does not, however, tell the reader specifically 'how' to prevent chilling. The second bullet has more action statements, "remove the largest, strongest piglets for a one to two hour period" and "give the sow 20-30 U.S.P. units of oxytocin (1 to 1.5 ml) each time the largest piglets are removed. But event these lack enough detail so that a person could be confident in accomplishing these tasks. An employee may ask “Is it one or two hours?” and “Where and how do I give the injection?” The content of the third bullet likewise has a few good action statements which could be developed into SOP statements, with just a bit more detail and exactness. But as is, there are questions which must be answered before a novice could accomplish provision of supplemental colostrum to disadvantaged piglets.

Another very informational document about the care of the piglet during lactation is Chapter 7 in the Swine Nutrition Guide (Patience et al., 1995). A portion of this chapter is also devoted to the importance of colostrum intake by the newborn piglet (below). Action statements have been underlined to draw attention to them here. However, a person reading these statements will likely have questions about “How do I observe litters? What do I look for? How do I know they are weak? How do I assist them? How long would I hold them up to suckle a teat? If I split the litter in half, where do I find a box with a heater? How much cow colostrum do I give each piglet?” The bulk of the text from this publication is reasoning for intervention and a discussion of the importance of colostrum intake. It is excellent background material to be included in an SOPB and would give a new employee an appreciation for why procedures should be followed. However, it would not be something a new employee could read and grasp what exactly should be done.

> The first requirement for successful piglet feeding is to ensure that each newborn receives an adequate supply of colostrum. Colostrum is the first milk produced by the sow after parturition; its function is to provide nutrients and other essential substances in a highly concentrated form. In addition, colostrum helps to increase disease resistance in piglets by providing immunization with immunoglobulins (also called antibodies). Immunoglobulins are proteins, absorbed by the newborn pig's gut, that provide protection against disease.
>
> The immunoglobulin concentration of sow's milk declines very rapidly after farrowing. In addition, as a result of a process known as gut closure, piglets rapidly lose their ability to absorb immunoglobulins. If piglets do not suckle during their first 24 hours; they have a greatly reduced chance of obtaining adequate immune protection and may not survive. A point to remember: immunoglobulins present in the colostrum are effective only against diseases to which the sow has been exposed. If pregnant sows are brought into a new bam and farrow within 21 days, they may not protect their offspring against bacteria present in the new bam. Scouring in newborn piglets is one symptom of inadequate sow exposure to disease causing organisms.
>
> To ensure all piglets acquire colostrum, producers should take the time to <u>observe litters</u> shortly after farrowing and <u>assist weak piglets</u> to suckle by giving them access to the sow's udder. One way to give access is called "split suckling". Shortly after birth, half the piglets are removed from the sow and are kept in a warm, dry box. The two halves of the litter are rotated on and off the sow to <u>give individual piglets’ maximum opportunity to suckle</u> and receive colostrum. Currently, commercial products that contain immunoglobulins and highly digestible energy sources are available. An oral dose of these products may reduce a newborn piglet's need for its mother's colostrum.
>
> Another way to ensure piglets receive some colostrum is to keep a supply of cow colostrum in the freezer and <u>give weak and unthrifty piglets an oral dose (using a small syringe)</u> if they have had inadequate suckling of their mother's colostrum.

In contrast to the two examples discussed above, the next and last page of this proceedings paper contains an example of text and formatting which is more typical of what may be included in an effective SOP about ensuring all piglets consume adequate colostrum. It is more reader-friendly, action oriented, and thorough in addressing all aspects of the split-suckle process.

CONCLUSION

Those who own and manage farms which have employees will be continuously challenged to train their employees how to best care for the animals on the farm. A Standard Operating Procedure Briefing (SOPB) is an evaluation of current scientific literature related to a specific production practice, in order to answer the question "Should I do this on my farm? Why or why not?" If the decision is to 'implement the practice on the farm' then the Standard Operating Procedure is written to help employees quickly develop the abilities to consistently complete the procedure effectively. Together, Standard Operating Procedure Briefings and Standard Operating Procedures result in better care of pigs, enhanced productivity, and increased profitability.

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Standard Operating Procedure

Split-**Suckling**

Making Sure All Pigs Consume Colostrum

The first necessity for keeping pigs healthy and growing is to ensure that each newborn receives as much colostrum as possible. Colostrum is the early milk produced by the sow soon after farrowing. Colostrum contains nutrients and other essential substances in a highly concentrated form. It increases the pig's ability to resist disease infection.

Materials

In the Med Room, locate:

- Grease marker (drawer 4)
- Paper towels (shelf above desk)
- Piglet split-suckle cart to contain piglets (against back wall)
    - With mounted heat lamp with 250W bulb
    - Make sure heat lamp works by plugging it into the wall outlet

In Feed Room, locate:

- Clean, dry shavings (along east wall, in white plastic bag)

Preparation

1) Split-suckle litters of 14 or more piglets.
2) Split-suckle within 6 hours of birth of last piglet.
3) Place 1 inch of shavings in bottom of cart.
4) Wheel cart next to the farrowing crate that contains the newborn litter.
5) Remove the largest, strongest piglets from farrowing stall and place them in the cart.
6) Do not remove more than half of the litter.
7) Allow other half of litter to nurse for 30 minutes.
8) Mark piglets that were in cart and place them back with sow.
9) Remove the unmarked piglet from the farrowing stall and place them in the cart.
10) Allow other half of litter to nurse for 30 minutes.

Clean-up

1) After split-suckling each litter, remove all shaving and place in lined waste container (located outside farrowing room).
2) Wipe out cart with paper towel. Discard in waste container.
3) Spray cart with bleach solution.
4) Dry cart completely with heat lamp "ON".

SPLIT-SUCKLING MAY BE DONE IN CONJUNCTION WITH OTHER PIGLET PROCESSING PROCEDURES. THERE ARE 5 SPLIT-SUCKLE CARTS TO BE USED AT THE SAME TIME, IF SEVERAL LARGE LITTERS WERE BORN WITHIN THE PAST 6 HOURS.

Day 2: Wean to Finish – Main Sessions

HIGH FIBER SWINE DIETS

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ABSTRACT

Fiber is one of the four macronutrients that yield energy (others are starch, fat, and protein). Effects of high fiber diets may depend on diets being balanced for energy value or not. To yield energy for pigs, fiber must be fermented in the gastro-intestinal tract and be metabolized into volatile fatty acids (VFA). High dietary inclusion of alternative feedstuffs such as co-products may cause high fiber diets for swine. In nursery diets, high fiber diets were thought to reduce feed intake, and thereby hinder energy intake during the energy-dependent phase of growth. However, such a relation is not proven to be solid across the spectrum of dietary fiber, and other factors may play a role. Fiber characteristics may play a role in gut health. In grower-finisher pigs, high fiber diets are known to increase viscera mass, and thereby reduce dressing percentage at slaughter. Overall, high fiber diets have a lower energy digestibility and a lower feed efficiency is thus expected. However, depending on prices of alternative feedstuffs, high fiber diets may be part of a range of solutions to reduce the feed cost per unit of gain, and may thereby support an economically-sustainable pork industry in Canada.

INTRODUCTION

Practically, feed of diets to swine that are greater in fiber content than a diet based on corn and soybean meal is usually is caused by increased dietary inclusion of alternative ingredients such as co-products (Zijlstra and Beltranena, 2013ab; Woyengo et al., 2014). Obviously in North America, co-products from the bio-fuel industry are an important component of alternative ingredients (Shurson et al., 2012). As omnivores, pigs are ideally suited to convert non human edible feedstuffs into high quality food animal protein. Dietary inclusion of co-products from food and bio-fuel production will considerably improve the human-edible protein balance (edible protein output/input) of swine production.

Compared with traditional diets based on a single grain as an energy source and soybean meal as a protein source, feeding high inclusion levels of co-products has a greater risk, including the greater content of dietary fiber. This risk can be managed using modern feed formulation such as net energy and standardized ileal digestible amino acids, feed evaluation such as near infra-red reflectance spectroscopy, feed enzymes to degrade fiber, and feed processing to reduce the impact of dietary fiber (Zijlstra and Beltranena, 2013b). Combined, these methods may then support pork producers to attain predictable swine growth performance, carcass characteristics, and pork quality.

UNDERLYING MECHANISMS

Previously, we reviewed fiber digestion, absorption of its metabolites, and the impact of digestive physiology in the pig (Zijlstra et al., 2012). Among labs, our lab also has used in vitro fermentation methods to mimic in vivo digestion of fiber (Jha and Leterme, 2012). Fiber can be important for energy metabolism of the pig. Fiber varies greatly in characteristics such as fermentability and viscosity that are important for its ability to affect physiological functions (Dikeman and Fahey, 2006.). In the gut, fiber via its metabolites may directly stimulate physiological functions via local endocrine responses (Hooda, 2010). Obviously, because fiber cannot be digested by the pig itself, it is fermented by the gut microbiota. A combination of digesta passage rate, fermentability, and viscosity that are all influenced by fiber contributes to nutrient availability and commensal bacteria colonization in the lower gastrointestinal tract (Metzler-Zebeli et al., 2010).

HIGH FIBER NURSERY DIETS

Interest in feeding an array of feedstuffs in diets of pigs was tweaked by an experiment where diets ranging from 2.37 to 2.19 Mcal of NE/kg were fed to young pigs (Beaulieu et al., 2006). Diets were formulating by replacing mostly oat groats with barley to reduce the dietary energy value. Consequently, the acid-detergent fiber (ADF) content increased from 2.5 to 4.0%, respectively. In contrast to expectations (Nyachoti et al., 2004), young pigs fed the diets containing less energy and more fiber had the greatest feed intake and gain, but a reduced feed efficiency (Beaulieu et al., 2006). These data indicated that young pigs may not always respond negatively to diets with a high fiber content.

To explore, we included alternative feedstuffs into diets for young pigs to replace soybean meal in a series of experiments (Table 1). These feedstuffs included wheat distillers dried grain with solubles (Avelar et al., 2010), solvent-extracted and expeller-pressed canola meal generated from *Brassica napus* (Landero et al., 2011, 2012a; Seneviratne et al., 2011), solvent-extracted canola meal generated from *Brassica juncea* (Landero et al., 2013). Occasionally, we also test alternative feedstuffs in the pulse seed family with a crude protein content ranging from 20 to 30% that replace soybean meal and some wheat. This group included lentil (Landero et al., 2012c). Interestingly, while increased dietary acid-detergent fiber consistently reduced energy digestibility, effects on reduced feed intake were not consistent (Table 1).

Finally, in our pilot-facility we can create our own feedstuff such as air-classified, solvent-extracted canola meal (Zhou et al., 2013). Interestingly, while pigs have strong preferences for certain feeds and feedstuffs (Landero et al., 2012b), fed diets including alternative protein feedstuffs can achieve a growth performance equivalent pigs fed a diet based on soybean meal (Landero et al., 2011, 2012a).

In each of the experiments above, diets were formulated to equal net energy value and standardized ileal digestible amino acids. Therefore, effects of the test ingredient cannot be attributed to a lower formulated energy value or amino acid content.

Table 1. Summary table of nursery pig trials with alternative feedstuffs. Dietary inclusion and acid-detergent fiber content (ADF, as-fed) are reported.[1]

Feedstuff	Inclusion	ADF, %	Performance
Oilseed meal			
Solvent-extracted canola meal	0-20%	3.7-5.9	= ADFI, = ADG, = G:F, ↓ ATTD GE
Expeller-pressed canola meal	0-20%	3.3-6.0	= ADFI, = ADG, = G:F, ↓ ATTD GE
Brassica juncea canola meal	0-24%	3.4-4.9	↓ ADFI, ↓ ADG, ↓ G:F, ↓ ATTD GE
Other co-product			
Wheat DDGS	0-20%	4.2-4.9	↓ ADFI, ↓ ADG, ↓ G:F, ↓ ATTD GE
Low fiber canola meal	20%	4.7-7.4	= ADFI, = ADG, ↑ G:F, ↑ ATTD GE
Pulse seed			
Lentil	0-30%	3.8-3.6	= ADFI, ↓ ADG, ↓ G:F, = ATTD GE

[1]ADFI = average daily feed intake; ADG = average daily gain; G:F = feed efficiency; ATTD GE = apparent total tract digestibility of gross energy; DDGS = distillers dried grains plus solubles. Data adapted from published papers.

HIGH FIBER GROW-FINISH DIETS

Using a similar approach for grower-finisher pigs, by including increasing co-products such as expeller-pressed canola meal or a combination of co-products, growth performance of pigs fed increasing dietary inclusion of co-products may not reduce growth performance (Figure 1).

Obviously, responses of pigs to increasing dietary inclusion of co-products are not consistent among experiments. Pigs in some experiments have reduced growth performance (Seneviratne et al., 2010; Exp. 1 of Jha et al., 2013), whereas growth performance remained consistent in others (Exp. 2 of Jha et al., 2013).

Consistently among experiments, carcass weight at increasing dietary inclusion of co-products was reduced at a similar slaughter body weight. This reduction indicates that increasing dietary co-products inclusion and, consequently, increasing dietary fiber reduced dressing percentage (Seneviratne et al., 2010; Jha et al., 2013). Pigs adapt to diets with increased fiber content by increasing gut volume and weight (Jørgensen et al., 1996). Increasing dietary co-products inclusion increased viscera weight, which in turn increased the energy and amino acid requirements of these organs in pigs (Yen, 1997; Nyachoti et al., 2000). Therefore, increased viscera size and weight at equal intake of net energy and standardized ileal digestible amino acids may reduce protein deposition in the carcass and thereby reduce loin depth (Jha et al., 2103). An increased dietary inclusion of dietary threonine that is linked to fiber content in the diet is important to alleviate some of this effect (NRC, 2012).

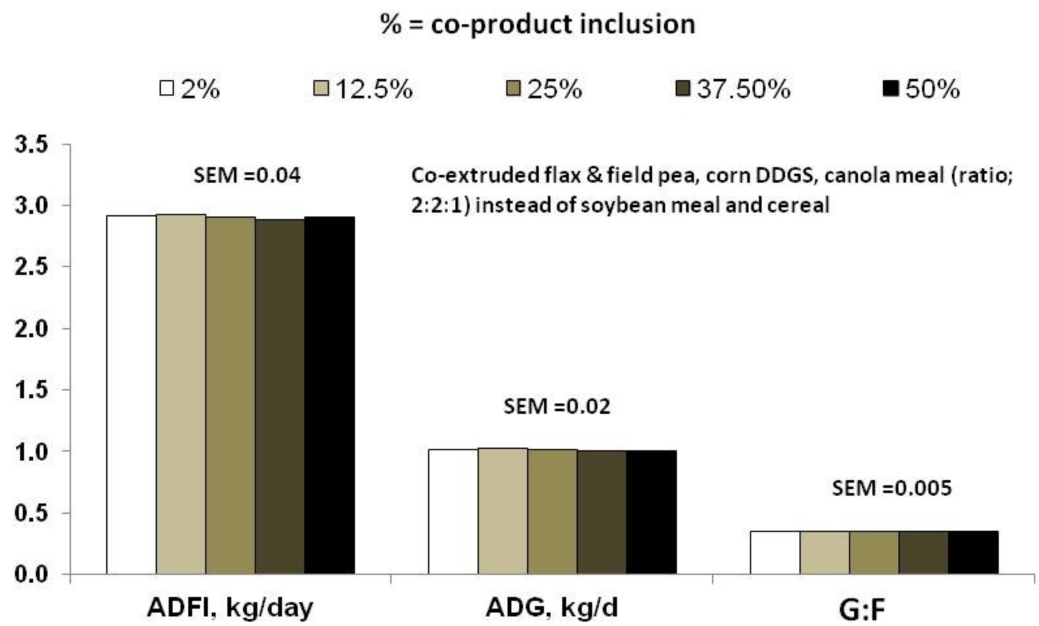

Figure 1. Growth performance of grower-finisher pigs fed increasing dietary inclusion of co-products (adapted from data of Exp. 2 of Jha et al., 2013).

One critique of research with increasing dietary inclusion of alternative feedstuffs has been that testing of single feedstuffs might not be relevant practically. Therefore, we conducted trials with grower-finisher pigs by adding increasing dietary co-products into diets that included DDGS co-fermented from wheat and corn (Smit et al., 2014). Increasing dietary canola meal inclusion decreased the apparent total tract digestibility coefficient of gross energy. For the entire trial, increasing dietary canola meal canola meal inclusion linearly reduced feed intake and weight gain. Increasing dietary CM inclusion quadratically reduced feed efficiency. Increasing dietary CM inclusion in diets including 15% DDGS did not affect carcass weight, dressing, backfat thickness, loin depth, and estimated lean yield. We concluded that grower-finisher barrows and gilts can be fed diets including up to 24% canola meal together with 15% wheat DDGS without having major effects on pig growth performance, carcass dressing or carcass characteristics.

SUMMARY AND CONCLUSION

For the long-term sustainability of swine production, economics, societal acceptance, and the environment are key components. Dietary inclusion of co-products and less reliance on cereal grains are important, but such diets will contain more fiber than traditional. As an omnivorous species, the pig is suited to efficiently convert co-products to pork products, but feeding co-products also provide challenges and opportunities. In conclusion, feeding alternative feedstuffs may reduce feed costs per unit of pork produced, but also provides challenges to achieve cost effective, predictable growth performance, animal health, environmental footprint, carcass characteristics, and pork quality.

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HEALTH MONITORING MATTERS: THE ROLE OF CSHIN

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ABSTRACT

The Canadian Swine Health Intelligence Network is a surveillance system developed by the swine industry through the Canadian Swine Health Board with funding from Agriculture and Agri-Food Canada. This data and communication network provides swine health information in near real time, to veterinarians and producers to reduce the cost of disease on to the swine industry.

HEALTH MONITORING

What do we mean by health monitoring? Is it the same as surveillance?

First I will provide two definitions to describe how I am using the terms health monitoring and surveillance. Health monitoring is one component of surveillance, that is, to detect changes in health. A functional surveillance system allows the early detection, characterization, and effective response (communication and decision making) to emerging diseases and other economically important hazards affecting swine in Canada.

To most people surveillance means blood tests conducted by some government agency but it can be many other things. Disease surveillance refers to activities that detect a change in the health of swine, information about how the distribution and characteristics of the disease, determining what the cause(s) are, communicating the information to those who need to know in order to improve response decisions made. The information or intelligence produced by surveillance "advances our ability to respond in a more predictable, measured and logical manner. Response can imply a multitude of things covering a range of activities from basic investigation and communication events through to establishing research priorities and major disease control programs."[i]

Whose responsibility is surveillance?

Most people consider animal health surveillance activities to be the responsibility of government for listed diseases that are covered by legislation. Animal health acts identify specific reportable diseases for which surveillance activities are conducted including Foreign Animal Diseases (FAD), diseases of concern to public health and others with trade significance. Our export markets expect the Canadian government to ensure that Canada meets the requirements of the World Organization for Animal Health (OIE). In the past that meant to be able to demonstrate that we are free of listed diseases. Today the requirements include being able to demonstrate and communicate that <u>we have a system in place to detect not only the listed diseases but also emerging ones</u>.

Both active (regular testing of a defined number of animals) and passive (reported by veterinarians and veterinary laboratories) detection methods are used for diseases falling under legislation. Historically, there has often been a significant delay in detecting outbreaks since detection requires the observation of symptoms or pathology that is recognized as being a reportable disease. Active surveillance is still intermittent and will usually miss the initial case of a new disease. Diseases that are endemic (common in production farms) are considered the responsibility of the industry and surveillance activities, where they exist, have fallen on researchers, farm veterinarians, producer organizations and occasionally provincial governments. Examples of diseases falling into the categories described can be seen in Table 1. This has been the primary focus of the new industry operated surveillance system called CSHIN (Canadian Swine Health Intelligence Network).

Table 1. Examples of diseases and the body responsible for surveillance.

	Responsibility for surveillance	
Federal Government	**Provincial Governments** (varies by province)	**Producers**
Trichinosis	Leptospirosis	PRRS
Brucellosis	Swine influenza	Coccidiosis
Pseudorabies	TGE (PED)	Streptococcus suis

There are seldom resources in place for a planned response to new emerging diseases or diseases that have not been observed for years but re-emerge. Detection is passive and requires informal social networks (vets talking to vets) to understand the significance of conditions being observed. The circovirus outbreak was an example. Changes in mortality patterns were slow to be observed as they came on gradually; laboratories did not recognize the new condition in the early stages because secondary common diseases were always present; responses occurred in several regions and were not coordinated.

GAPS IN SURVEILLANCE FOR EMERGING SWINE DISEASES IN CANADA

In 2011, the Canadian Swine Health Board commissioned an analysis of gaps in surveillance for emerging swine diseases in Canada. The study identified these gaps using diseases such as the recent circovirus debacle. Gaps in knowledge (understanding the purposes, methods and value of surveillance and the limits of current surveillance programs), the use of laboratories (fewer submissions), communication between stakeholders (veterinarians and clients, labs and veterinarians, researchers and practitioners, between regions) and a lack of commitment by decision makers (governments and industry for surveillance including appropriate responses) and lack of coordination in responses were identified. The Canadian veterinary diagnostic laboratory capability was good although not in all regions.[ii]

Addressing the surveillance gaps

Short of producers reporting all health changes in their herds, the next most likely person to observe a change was the farm veterinarian. The reporting of syndromes (coughing, diarrhea, lameness etc.) by practitioners, both human and veterinary, is becoming a growing source of surveillance information that is used to detect early changes in health. The recommendations of the study included three principal component networks making up CSHIN: the first was to develop a swine veterinarian communication network with regular meetings and reports about the current status of the health in the Canadian herd. Secondly, a data network would gather and analyze barn visit information but the farm identity is kept confidential (only the herd veterinarian knows the farm involved). An event detection system would monitor the information in order to recognize changes in health preceding the confirmation of a diagnosis. The response to a health change, where warranted, could occur through the communication network. The two components above are now operational and known as the Canadian Swine Health Intelligence Network (CSHIN). A third recommendation, now the subject of a number of projects, was to centralize laboratory data under the Canadian Animal Health Surveillance Network (currently part of the CFIA) and link to the veterinary data network. It should be emphasized that the practice syndromic and communication networks enhance our current understanding of swine health issues and are synergistic with current laboratory, government and university surveillance activities. Although active practitioner-based surveillance might identify a change in the status of swine health more rapidly, it requires laboratories and research to identify the cause and characterize the disease.[iii]

WHAT IS CSHIN?

Swine Veterinary Communication Network

Farm veterinarian and swine health specialists have access to information that identifies exactly what is happening right now regarding swine health issues in regions of Canada through CSHIN (Figure 1).

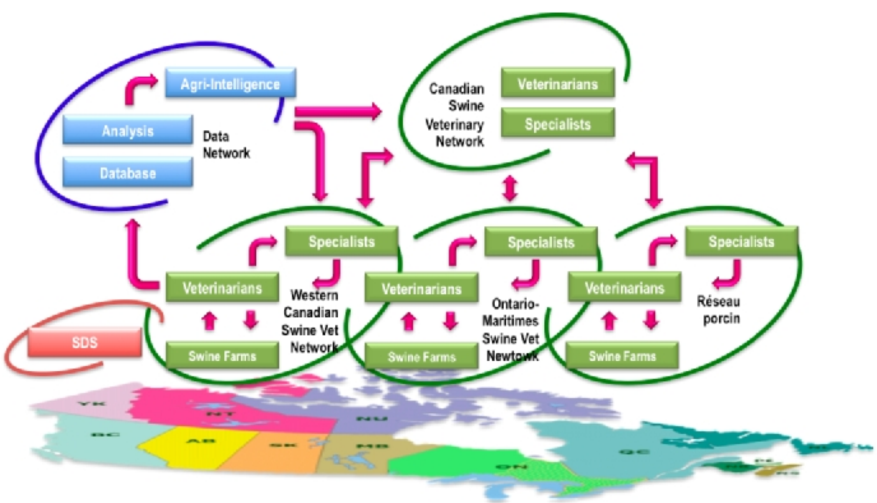

Figure 1. Regional networks combining to form a Canadian Swine Veterinary Network including the integration of the data network.

A small group of swine specialists (practicing swine veterinarians, researchers, pathologists and epidemiologists) poll all swine vets about conditions noted in the last quarter. They discuss what has changed such as finding a new strain of PRRS or a treatment that no longer works or that PED virus has not shown up. After a quarterly teleconference of the western Canadian swine specialists, a web-based meeting with a group from Quebec and one from Ontario/Maritimes occurs. The meeting's highlights are reported to all veterinarians working with pig farms so that they are up to speed regarding current swine health conditions in Canada. The goals are to react to changes in health more rapidly, in a more coordinated manner and to understand where health problems exist and how to keep them out of your region. Circovirus and PRRS have taught us valuable lessons in working together to manage the costs of these diseases.

The Syndromic Data Network

The Canadian Swine Health Intelligence Network (CSHIN) is more than just the communication network described above, however. Veterinarians can submit, within a week, a brief summary of what they saw at a farm visit or discussed with you on the phone or in an email. The information is completely blinded so that only your vet knows which farm is involved. This Data Network allows the industry to understand when health changes are occurring. When circovirus first occurred, unthrifty pigs were gradually but more frequently observed without understanding the severity of the problem for the industry as a whole. Subtle changes in a region or over time can be recognized as a new problem. If each veterinarian reports the one or two farms where they observed more coughing or lameness, for example, a health event is recognized. Although the practitioners are unaware of each other's problems and the cases don't seem to be linked a health change will be evident. We can also use it to show that no specific health issues are occurring in an area, such as with PED. On the graph below (Figure 2), the bars represent the highest % of piglets with diarrhea, reported on that day. The right hand side Y-axis has the scale. Note that twice in the past few months there were cases reported with high levels of diarrhea. In each case the farm veterinarian confirmed that it was not due to PED virus.

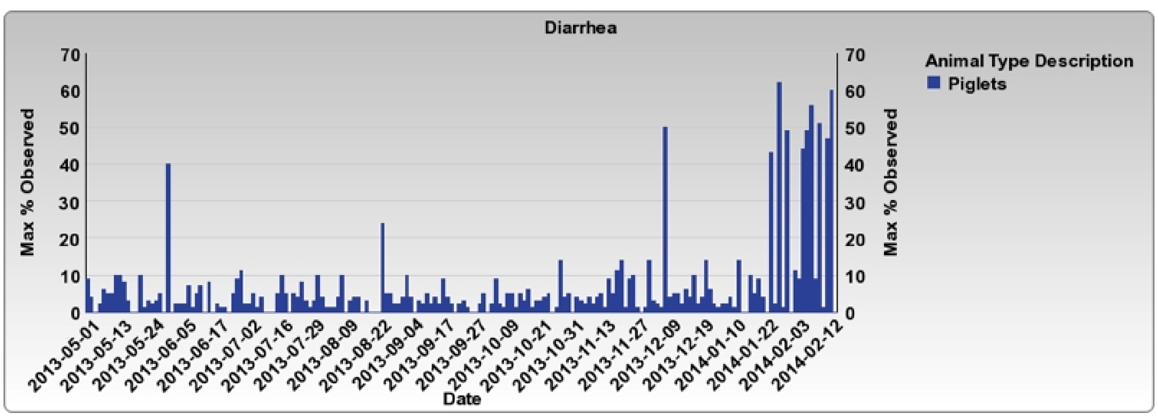

Figure 2. The maximum within-barn occurrence of diarrhea in piglets (% with diarrhea) on each day. The first case of PED (Ontario) was on January 22nd.

VALUE OF HEALTH MONITORING THROUGH CSHIN

Assist with prevention and control of disease

Early warning. The primary role of CSHIN is to help individual veterinarians reduce the burden of disease (the loss of animals and productivity and the cost of controlling disease) on their clients' (the producers) individual farms, by preventing and managing swine diseases. This will make the producers and the industry as a whole more profitable and sustainable in the long run. The network detects health changes earlier (in near real time) allowing intervention to restrict outbreaks. With circovirus diseases, the lack of a national surveillance program that would recognize a change in health and being stuck in the paradigm of not considering the changes as a new disease were recognized as bottlenecks to understanding and properly responding.[iv] In the case of PED, knowing where infected farms are as early as possible allows the at-risk herds to increase surveillance and institute enhanced biosecurity measures. The knowledge may allow farms to prevent the entrance of a disease that is new in their area.

Help with a more effective response to a health challenge. The network also has the infrastructure in place to create a more effective response, one that is guided by producers. A committee with producers and experts works with industry and government to develop or facilitate a response.

Information to understand the situation during an outbreak: CSHIN creates information from the data to provide the knowledge to understand the situation (where the disease is occurring, the geographical extent, the duration of the problem, what control measures are working) and prepare coordinated research into the problem to help develop a rapid response.

Communication within the industry. The swine health communication network means ensures that all health providers to swine farms and producers know what is going on. New information is rapidly shared with all veterinarians working with pig farms. The information is useful to the industry to develop a response for diseases that are not the responsibility of government, such as PRRS or PED. During PED, CSHIN provides a daily update of new information about the outbreak needed by the industry to respond. It also is helpful to support the provinces and the CFIA when they respond to reportable diseases.

Support pig and pork markets. As a major exporter of pigs and pork, buyers require an understanding of the health and quality of our pigs. CSHIN helps support our markets by improving swine health and providing an information system that can support our swine health claims. The OIE and our trading partners require scientifically accepted proof that Canadian pigs are healthy. We will be exploring the market value of knowing the health of our swine herd on a real time basis in both the national and international market then assist the industry to develop tools to capture that value.

Provides evidence of freedom from diseases. CSHIN will open markets faster by helping to detect trade limiting diseases earlier, helping to control outbreaks and proving disease freedom faster to open markets earlier. It can chart the veterinary visits where there are no specific health issues.

Protect from unnecessary trade sanctions. It will help protect Canada from unnecessary trade sanctions by being able to demonstrate where diseases are located or that there are no reported changes to health status.

THE STATUS OF CSHIN TODAY

Providing an integrated network is important for the swine health community. The Swine Veterinary Network is popular amongst swine veterinarians with several indicating that they would like to participate in the panels. The Clinical Impressions Survey has been well received with about one half of swine practitioners participating. Feedback from the Canadian swine health stakeholders is encouraged, as the report requires feedback. Given the multitude of sources of current swine health information, the reports must be relevant, brief and timely. A website with a discussion group will be operating later this fall.

Long-term development and sustainability. CSHIN has funding to remain operational through to the end of November 2014. In addition a project has been approved to consider integration with the Canadian Animal Health Surveillance Network, thereby developing long-term linkages. A project is being considered to develop alternate data entry methods, particularly for systems that already manage syndromic information. The project also aims to develop better reporting methods and 'knowledge creation' from the data.

The ability to test the efficacy of vaccines or control methods. During the PED outbreak, a number of herds have been immunizing pigs with a new vaccine. Efficacy data was not available but submissions of diarrhea, vomiting and mortality information can be sent to CSHIN allowing a comparison to herds not vaccinating. Similar research could be done with antibiotics or other control methods such as controlled exposure.

CSHIN requests a change to the way swine medicine is practiced. Participation by swine practitioners is still fairly low, particularly amongst integrated systems. The value of a national surveillance system has not always been apparent, until recently with the PED outbreaks, where CSHIN was able to provide data that showed the absence of the disease. Although there was no assurance that payments for practice data entering would continue. Participating requires extra veterinary and staff time. CSHIN partially remunerates practices for the time but providing reports that are meaningful and valued is the key. The projects mentioned continue development of effective communication of swine health information. Data capture systems will require some customization to minimize additional work.

The CSHIN can demonstrate both dramatic health anomalies and subtle changes through time or over geographical areas. Reports can demonstrate when dramatic health anomalies occur but perhaps more importantly when we know that the situation is stable. The network may assist with the early detection of acute events but will be more important in at least two other instances. The first is a condition with slow subtle changes that may occur with a temporal or spatial pattern but not be evident to the individual practitioners in the area. Circovirus would have demonstrated such a pattern. The second is the ability to demonstrate from the data that no abnormal health issues are occurring.

Canada as a leader in syndromic swine health monitoring. CSHIN provides an opportunity for our industry to be leaders in the ability to demonstrate exceptional swine health to the world. Several countries are trying to emulate the network. There has been a pilot project demonstrating a web-based tablet syndromic surveillance network in bovine medicine in Texas and New Mexico, now being expanded to 15 states. Some of the people that developed the expertise have been hired in other countries, including Switzerland and Australia, to develop similar systems. The next step is to integrate laboratory data with syndromic surveillance data. This will be part of a CAHSN project. The utilization of other electronic data sources such as demerit and slaughter data demands attention once the network financing is stable.

CONCLUSION

CSHIN is an industry operated surveillance network. The network has been set up with producers at all levels of decision-making – producers influence responses and communications. Confidentiality is critical. It responds to diseases that normally fall through the cracks, common endemic diseases that cost money but are not the responsibility of any level of government (Brachyspira, for instance). The information from the network is there to help producer and veterinarian manage diseases on the farm. The CSHIN is a world leader in the combination of hard data and a way to rapidly communicate it. This form of surveillance is rapidly becoming an effective way to identify changes to health so that we can rapidly use laboratories to identify the cause. The immediate goal is to provide veterinarians with tools to help the producers reduce the cost of disease. The long-term goal is for CSHIN to make Canadian pork more valuable. Speak to your veterinarian about CSHIN.

ACKNOWLEDGEMENTS

The CSHIN was developed as a Canadian Swine Health Board project funded by Agriculture and Agri-food Canada. Support continues from provincial pork boards and some provincial governments.

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REAL FACTORS AFFECTING PROFITABILITY

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INTRODUCTION

Murphy Brown LLC is the livestock production subsidiary of Smithfield Foods, a world leader in pork production, processing, and marketing of packaged pork. With 845,000 sows across 12 states, Murphy Brown produces about 17 million hogs annually. Another 205,000 sows are in production outside the US.

The Challenge

- Information overload
- Too many reports sometimes with conflicting info
- Tendency – treat all metrics similar
- Taking time to extract info

Objectives

- Acknowledge these challenges
- Share our methods
- Hope you will find a few beneficial nuggets

METHODS USED

- Vision and strategic plan
- Corporate metrics
  - Return on invested capital
  - External benchmarking
  - Crossover – used for controllable cost variances
- Production metrics and sensitivities
- Stretch Targets
- Lead indicators

1. The most important components affecting cost/cwt (excluding feed costs):

- Step-wise procedures used
- 28 variables evaluated
- Most important components (**R^2= 0.97):**
  - Weaned pig cost
  - Finishing cost
  - Wean-to-market mortality
  - Pigs weaned per female farrowed

2. Profit Factor Analysis Rankings (Bilbrey, Leman Conference, 2012):

Rankings of 12 components:

- 1st – Nursing-finishing mortality
- 2nd - % market culls
- 3rd – Preweaning mortality
- 4th – Finishing cost per cwt
- 5th – Weaned pig cost per head

Evaluated but not in top 5 factors:

- Market price, market weight, market age
- Finishing calorie conversion, finishing feed costs
- Born live, pigs per mated sow per year

3. "What If" Model

- Standardized decision-making financial model
- Evaluate multiple variables concurrently
- Logic based (stocking density, wean age)
- Helpful for capital investments
- Used to generate financial sensitivities (e.g. Table 1)

Table 1. Estimated financial sensitivities*.

Metric	Change	Cost/cwt, $	Cost/pig, $
Corn and soybean meal	$.25/bu; $20/ton	$1.597	$4.39
Nursery feed conversion	.01	$0.021	$0.06
Finishing feed conversion	.01	$0.102	$0.28
Nursery mortality	1.0%	$0.190	$0.52
Finishing mortality	1.0%	$0.721	$1.98
Additional sale weight	1.0 lb	$0.060	$0.17
Pigs weaned per sow farrowed	0.10	$0.150	$0.41

*Assumes single variable changes

Key cost relationships:

- Feed price increase (corn, $.25/bu; SBM, $20/ton) = **2.2%** finishing livability improvement
- Feed price increase (corn, $.25/bu; SBM, $20/ton) = **0.17** points improvement on finishing feed efficiency
- 0.5 increase number weaned = **~1%** improvement in finishing livability
- 1.0 increase number weaned = $.25/bu in corn price
- 10 lbs increase market weight = **.06** points improvement in finishing feed efficiency

Must focus on liveability, growth rate, and number weaned.

Feed Efficiency:

- Outcome metric not a lead indicator
- Marginal metric for effective benchmarking
- Requires extensive standardization adjustments
    - Mortality (1% = .04-.06 impact on F/G)
    - Dietary nutrient levels (ME and AA density)
    - Physical form
    - Market weight
    - Paylean (inclusion and duration)
    - Place weight

4. Stretch Targets

Set targets to stimulate and monitor constant improvement (e.g. Table 2).

Table 2. Examples of stretch targets.

Criteria	AgristatsTop 25% (Based on Trait)	3-Yr Stretch Target
Pigs Weaned / Litter Farrowed	10.98	11.00
Pigs Weaned / Mated Sow / Year	26.32	26.00
Nursery Mortality %	2.24	1.25
3 Site Finishing Mortality %	2.97	2.25
Wean-to-Market Combined Mortality %	5.21	3.50
2 Site Finishing Mortality %	3.52	3.50
Nursery ADG	0.92	1.10
3 Site Finishing ADG	1.87	2.06
Wean-to-Market Combined ADG	1.59	1.75
2 Site Finishing ADG	1.62	1.75
Pounds / Mated Sow / Year	6,887	6,929

5. Monitor Lead Indicators

Traditional methods

- Nursery and finishing - weekly mortality, close-out results
- Sows – PSY, Farrowing rate, Breed targets

Standard Site Visit Concept – identify key lead indicators and verify completion will result in better outcomes (process verification)

Example lead indicators checked frequently

- Feeder and water adjustments
- Ventilation functionality
- Pig treatment

- Pen usage
- Process verification (Day One Pig Care)

SUMMARY

- Have a plan….determine how you are going to keep score
- Focus on wean-to-market liveability and growth and number weaned
- Create reasonable stretch targets for your system
- Use benchmarking
- Identify and use lead indicators

INTERNATIONAL TRADE – BARRIERS AND OPPORTUNITIES FOR CANADA'S PORK SECTOR

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ABSTACT

Canada is the single most important market for Canadian pork products. However Canadian domestic pork consumption has plateaued making Canada's hog industry increasingly reliant on export markets in order to grow production and increase carcass values. Facing stiff competition from other major pork exporters like the United States, the European Union, and Brazil, Canada must maintain an aggressive export strategy that preserves existing markets from competition, identifies new export opportunities, and fends off trade disrupting market access barriers.

INTRODUCTION – WHY TRADE MATTERS

Canada's economy is based on trade, and agriculture is one of Canada's most trade intensive sectors. In 2012 Canada exported almost C$44 billion in agriculture and food products, representing half of all the food grown or manufactured in the country and making Canada the fifth largest agri-food exporter in the world. Today, agriculture production and food processing account for 11% of Canada's goods GDP and agri-food exports represent almost 10% of Canada's total merchandise trade.[i]

Canada's pork industry is particularly reliant on trade. Since 1990, Canadian pork production has increased by almost 80% notwithstanding both a decline in domestic per capita pork consumption and significant growth in pork imports (Table 1). In short, the growth in Canada's hog industry is mainly the result of export opportunities. Today, two-thirds of Canada's pork is exported and Canada is the 3rd largest pork exporter in the world after the European Union (EU) and the United States (U.S.).

Table 1. Pork production table, domestic consumption Canada[ii].

	Production (000 MT)	Exports (000 MT)	Imports (000 MT)	Domestic Disappearance (000 MT)	Per Capita Consumption KG (Carcass)
1990	1123.8	297.1	14.3	723.9	26.0
1995	1275.8	357.0	40.2	814.8	27.8
2000	1640.0	636.7	74.1	880.5	28.7
2005	1918.5	1103.0	134.3	742.6	23.0
2010	1933.6	1179.6	185.4	746.7	21.9
2011	1969.6	1222.8	206.6	731.8	21.2
2012	1999.5	1262.3	241.8	769.8	22.1
Growth	**77.9%**	**324.9%**	**1590.9%**	**6.3%**	**-15.0%**

THE CHALLENGE – OPPORTUNITIES AND BARRIERS

In 2013, Canada exported $3.2 billion in pork products to 99 countries around the world with 90% of sales going to ten countries including the U.S., Japan, China, Russia and Mexico (Table 2). With domestic pork consumption plateaued, growth in Canadian pork sales will require additional sales into these or new markets.

New export opportunities do exist and the current Canadian policy environment bodes well for domestic pork exporters: pork is already the most consumed meat in the world[iii] and changing global consumption patterns are boosting demand for pork products particularly in the Asia Pacific region; the Canadian government's ambitious trade agenda is focused on opening markets for Canadian exporters, including Canada's agri-food sectors; and the Canadian hog industry has developed the influence, capacity and expertise to support growth in foreign markets.

Table 2. Canadian domestic exports of pork products to all countries[iv].

	2011	2012	2013	Share of Total Exports
United States	$998,215,510	$981,140,374	$1,144,380,991	36%
Japan	$893,750,980	$878,241,841	$813,224,303	25%
China	$211,033,465	$239,768,376	$263,083,522	8%
Russia	$358,686,975	$492,036,340	$260,236,515	8%
Mexico	$69,423,986	$82,432,962	$125,007,950	4%
Australia	$99,171,577	$99,338,277	$99,299,092	3%
South Korea	$233,409,582	$129,273,733	$76,145,689	2%
Philippines	$58,049,726	$54,592,337	$71,301,250	2%
Taiwan	$60,454,763	$36,327,632	$45,797,740	1%
Chile	$9,037,616	$9,897,127	$29,258,855	1%

The pork industry's rising influence was demonstrated most recently in negotiations for the Canada-EU Comprehensive and Economic Trade Agreement (CETA), where Canada secured new pork access into the EU estimated to be worth, when the deal is fully implemented, up to $400 million a year. Canada's pork sector was among the most successful beneficiaries of these negotiations.

But continued success in export markets is far from guaranteed. As Canadian exporters strive to secure new export opportunities through bi-lateral and regional trade deals they face stiff competition. Other pork producing countries like the EU, the U.S., Brazil, Chile and Mexico are themselves aggressively pursuing preferential access into key pork markets like Japan, Russia, China and South Korea (Table 3).

The need to secure key export markets ahead of our competitors is paramount. Since the EU and the U.S. concluded free trade deals with South Korea, placing Canada at a competitive disadvantage in that market, Canadian pork exports to Korea have fallen from a high of $233 million in 2011 to just $76 million in 2013. Even where we have the upper hand, there is still work to be done. Canada did well in the CETA, but other major pork exporters like the U.S. and Brazil are now negotiating their own trade deals with the EU. In this and other key markets, Canadian exporters must reinforce any trade advantage by quickly securing commercial relations and cementing their competitive position.

Table 3. Total pork exports by country, 1,000 tonnes[v].

Country	2012	2013	2014 Projected
European Union	2,171	2,200	2,200
United States	2,441	2,292	2,390
Canada	1,243	1,245	1,245
Brazil	661	600	620
China	235	250	265
Chile	180	185	190
Mexico	95	110	120
Belarus	104	75	95
Australia	36	35	36
Vietnam	25	25	25
All Others	63	41	57

Canadian pork exporters must also remain vigilant in responding to market access issues that plague them even in their most stable markets. Market access issues can include everything from Country of Origin Labelling (COOL) regulations in our largest trading partner, the U.S., to differences in processing standards in areas like the EU, to the management of Minimum Residue Levels for veterinary products like ractopamine in countries around the world. As agri-food trade expands, countries are increasingly relying on non-tariff barriers like these to manage import levels and to support their own domestic agriculture sectors. Canada's hog industry will need to invest increasing resources to continue overcoming the trade challenges these barriers present. Even more, industry will need to invest in both economic and political intelligence in key markets in order to identify, and possibly mitigate, potential problems early on.

TRADE PRIORITIES FOR THE CANADIAN PORK SECTOR

Export growth will require a multi-pronged strategy to preserve existing markets from competitors, identify new export opportunities, and fend off market access barriers. Canada's pork industry has identified five key trade priorities that will help the industry to achieve this goal.

The European Union

The Canada-EU CETA is an example of how Canada's hog industry can benefit from opening new markets. Europe is the only important pork-consuming region into which Canada has little effective market access. Europe remains closed to most countries – despite being the second largest pork consumer and largest exporter in the world the EU imports just 0.2% of its domestic consumption. With a population of 500 million, the EU is a key export interest for Canada's pork sector.

To date, high tariffs and onerous import administration rules have limited Canada's pork exports to the European Union. In 2013 Canadian pork exports to all 28 EU members states were just 4,000 tonnes, compared to total Canadian pork exports of over 1.1

million tonnes. But this is about to change. In October 2013, Canada and the EU announced that they had reached an agreement in principle on the CETA, a landmark trade deal that will increase Canada's agri-food exports to the EU by an estimated $1.5 billion a year. Significantly, the CETA will also make Canada the first major global pork exporter to secure access into the EU market.

Finalizing the CETA is a priority. When implemented, it will grant Canada duty-free access for 80,000 tonnes of Canadian pork, to be phased in over several years, and immediate duty-free access for processed pork products. The Canadian Pork Council estimates that the CETA will result in up to $400 million in new pork exports to the EU each year.

South Korea

A free trade agreement (FTA) with South Korea is also a top priority for the Canadian pork industry. This interest is driven by Canada's need to regain ground relative to its major competitors – the U.S., the EU and Chile – all of which now have trade deals with Korea.

Korea provides clear and painful evidence of what happens when Canada loses its competitive position in export markets. For many years, South Korea was a stable and high value market for Canadian pork. Although Korea imposed high tariffs on pork products – 25% on frozen and 22.5% on fresh/chilled products – these applied to all countries creating a level playing field. Now these tariffs are being phased out for countries like the U.S., the EU and Chile under their FTAs. For example, under the Korea-US FTA (KORUS), which came into effect in 2012, most tariffs will be eliminated on U.S. frozen pork and processed pork products by 2016 and fresh-chilled pork will be duty free by 2022.

Since these FTA's have come into effect, Canada's pork exports to South Korea have suffered (Table 4). Many factors impact trade – in 2012 total Korean imports fell as a result of domestic oversupply. However, a comparison of Korea's pork imports from 2011 and 2012 by country reveals that Canada suffered more. Those countries that had FTA's with Korea – the EU, the U.S. and Chile – were significantly less impacted.

Table 4. Korea pork imports[vi].

	Value $000			Volume Tonnes		
	2011	**2012**	**Change**	**2011**	**2012**	**Change**
European Union	$ 638,983.00	$ 487,649.00	-24%	195,228	149,524	-23%
United States	$ 472,812.00	$ 364,944.00	-23%	152,152	122,567	-19%
Canada	$ 208,867.00	$ 132,222.00	-37%	80,237	58,551	-27%
Chile	$ 116,363.00	$ 124,600.00	+7%	40,496	37,054	-8%
Mexico	$ 33,522.00	$ 27,661.00	-17%	10,180	8,992	-12%
Others	$ 30,729.00	$ 19,864.00	-35%	13,669	9,062	-34%
Total	$1,501,276.00	$1,156,940.00	-23%	491,962	385,750	-22%

The situation with Korea demonstrates how vulnerable Canada's position can be, even in its most secure markets. Having lost its competitive footing, the Canadian hog industry must press for Canada to finalize its own FTA with Korea and minimize any further damage.

Japan

Japan is the largest importer and 5th largest consumer of pork in the world. It is also Canada's most important and stable export market after the U.S., with shipments of 193,000 tonnes worth $813 million in 2013. In 2013, Canada was Japan's second largest pork supplier after the U.S. with a 17% share of total Japanese pork imports and a 10% share of domestic consumption. Chilled pork now represents more than 60% of the total Canadian pork exports to Japan.

Today, Japan applies tariff and non-tariff barriers on imports from all its major pork suppliers. This includes an import tariff of 4.3% on pork products. Japan also maintains a complex gate price system (minimum import prices) for pork products and an emergency "snapback" measure that returns the gate price to a bound level whenever total imports in a given quarter are 19% higher than the previous three-year average from the start of the Japanese fiscal year to the end of that quarter. This could raise the minimum import price by approximately 25%. While the snapback has not been activated since 2005, its existence creates uncertainty in the market place.

Until now, Japan's import barriers have resulted in a level playing field for its major pork importers. But the ground could be shifting. Japan is currently negotiating trade deals with all of its major pork suppliers including with the EU and Canada through separate bilateral trade negotiations and with the U.S., Canada, Mexico and Chile through the Trans Pacific Partnership (TPP).

The goal of any free trade deal is the elimination of all trade restrictions but, at a minimum, a trade deal must secure Canada an advantage over its competitors. This is critically important in Japan where domestic consumption is flat. But with so many countries in the fold, it will be challenging for Canada to negotiate a trade deal with Japan that gives it an advantage over its competitors – particularly the U.S. or the EU. Canada's best hope is to secure a trade deal with Japan, either through the bilateral negotiations or through the TPP, that keeps the Canadian pork industry on a level playing field with these other countries. If Canada fails it risks, similar to what has unfolded in South Korea, the loss of another major pork export market.

Country-of-Origin Labelling (COOL)

COOL is an example of how non-tariff-barriers, imposed unilaterally, can have a devastating impact on trade and on the domestic hog sector. In 2008 the U.S. introduced mandatory COOL for fresh beef and pork sold in U.S. retail outlets. Under COOL, meat can only be labelled as being a product of the U.S. (Label A) if the source animal is born, raised and slaughtered in the United States. Meat from animals born or raised in other countries but slaughtered in the U.S. must be segregated and assigned different labels (the new COOL rule having eliminated comingling) to show the country(ies) in which each of the three stages – birth, raising and slaughter – takes place.

Given the highly integrated nature of the North American livestock sector, COOL has had a significant disruptive effect on trade. Because COOL adds costs for feedlots, processors and packers who must segregate animals and/or meat most U.S. pork processors have stopped buying Canadian-born pigs. Those few that still do are buying them only on certain days or are even at discounted prices. The Canadian hog industry estimates that COOL has resulted in over $400 million a year in losses to Canada's hog industry through lost sales, added costs, and reduced hog prices.

Canada launched a WTO complaint against the U.S. and in 2012 the WTO determined that COOL does discriminate against foreign livestock and violates the U.S.'s trade obligations. To comply with the WTO decision, the U.S. amended COOL but the new provisions – requiring that labels specify the country of birth, raising and slaughter, and eliminating the flexibility of comingling – have made matters worse. Canada and Mexico have challenged the U.S.'s response at the WTO but this final step will take another 12 to 18 months to finally resolve.

Canada's ultimate goal is to resolve the issue with the U.S. This could be accomplished through amendments to COOL that provide for meat from all animals processed in the U.S. to be labelled the same way regardless of where the animal is born or raised. If the U.S. does not comply with a WTO ruling, Canada's only option will be to retaliate by applying tariffs on U.S. products. Canada has released a list of U.S. products that could be the targets of retaliation.

COOL demonstrates the significant impact trade barriers can have and the importance of industry vigilance in monitoring and responding to the political situation in our key export markets.

FEED BASED MARKET ACCESS REQUIREMENTS

Increasingly, Canada's pork industry is being shut out of export markets by production or processing requirements imposed unilaterally, and often in defiance of international standards, by foreign governments. These Technical Barriers to Trade (TBT) and Sanitary and Phytosanitary Issues (SPS) impede the smooth flow of agri-food trade. A particular problem for the pork industry is the inconsistent approaches to managing the use of veterinary health products (such as antibiotics) and additives (such as ractopamine) in feed.

An example of this is the disparate treatment of ractopamine, a feed additive used to promote leanness in animals, in various countries around the world. The international standard setting body, Codex, has approved safe residue limits for ractopamine in meats. As well many countries, including Canada, the U.S. Japan, Korea, and Mexico, have evaluated ractopamine and determined that meat from animals raised with it is safe for human consumption. Notwithstanding this, large pork importers like Russia and China have banned ractopamine – in the case of Russia, with limited notice. The impact was significant. In 2012 Canada exported $207 million in pork products to Russia. In 2013, after the ban was imposed, Canadian pork exports dropped to just $92 million. In addition to the lost sales, Canada must now implement a ractopamine-free protocol to demonstrate to Russia compliance with its ban and to regain lost ground.

The impact of these trade disruptions can be significant. Disparate regulatory standards, different approval and inspection systems, regulations that are not grounded in science and inconsistent adherence to policies developed by international bodies such as the OIE and Codex are a growing and costly issue for food exporters. For this reason, TBT and SPS provisions, such as specifying harmonization of standards and of standard-setting processes, have become of critical importance in virtually all trade agreements Canada now negotiates and Canada has invested considerable resources into monitoring and managing these issues in its major export markets.

CONCLUSION

Two thirds of Canada's pork products are exported making export markets vital to the health and continued growth of Canada's hog industry. The Canadian hog industry has significant opportunities abroad. The growing global demand for pork, Canada's national trade strategy that supports the agri-food sector, and the domestic hog industry's significant trade experience and strong reputation all weigh in Canada's favour. But as Canada strives to increase its pork exports, other major pork exporters, like the U.S., the EU, Brazil, Mexico and Chile, are focused on the same goal. To maintain and grow its exports, Canada's hog industry will have to protect existing markets from competition, identify and open new markets ahead of its competitors, and diligently fight market access barriers set up to impede trade. A multi-pronged dedicated trade strategy and a commitment of resources in all of Canada's major pork markets will be necessary to ensure continued success.

ACKNOWLEDGEMENTS

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Day 2: Wean to Finish – Workshop Sessions

MANAGING PILE UPS

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ABSTRACT

Since many years, genetic companies seek to improve the performance of their maternal lines especially for prolificacy. To keep pace with genetic improvement, new farming techniques have been developed (split-suckling, high suckling litter at first parity, etc. ...). In addition, improved nutrition to power these super-sows, new AI technologies, as well as advances in farrowing crates to reduce losses have made it so that today, annual productivity may exceed in many cases 30 piglets per sow per year (and much more in some European countries).

The race for high prolificacy will always be a major aspect of the selection criteria but now we can observe that companies also introduce the concept of quality of weaned piglets.

The challenge for farmers is to wean piglets of maximum quality for an easy and profitable finishing after weaning.

In 2008, as part of an annual meeting of a genetics company, we had to ask ourselves about hyper prolificacy and its impacts on a large-scale system (if we consider the market in Quebec) like ours. Choices that were then made will be discussed in this presentation and the direction we have given to our network.

DESCRIPTION OF NETWORK PRODUCTION

Agri-Marché owns a little over 15,000 sows and also buys piglets from independent producers who represent around 5,000 females. Among these 15,000 sows, 3,000 produce hybrid females (F1) for the whole network including customers.

To raise all these piglets, a network of approximately 150 farms (nurseries, finishing barns) was established (contract or owned by the company) with the basis that all-in all-out must be respected with a single source supplier.

A CHANGE OF PHILOSOPHY

If we go back twenty years ago, it was common for us to pick up 17 kilos piglets from different sources and mix them together in a finishing barn. With the emergence of PRRS and some other diseases, this practice gradually disappeared. The size of farms in Quebec not being what it is in western Canada and the USA, we had to raise pigs several years in rotation if we wanted to stay single source. Then early weaning appeared with two pickups per week, rotations in maternity were simply amazing and the perspective of mixed sources reappears. As this was not exactly what happened, we had to find other solutions.

Larger farms projects have emerged but the moratorium in 2002 has ended many of them; this moratorium had certainly not helped the pork producers of the province. How can we raise more piglets when you don't have the space to finish them and you can't build new facilities?

Our network was fine at that time on the maternity side but in finishing, we could do better. More piglets were produced by farrowing barns, but some were smaller and started poorly in the nursery after a transport. We could see more and more pigs hanging at the end of the lot and therefore an increasing percentage of non-full value pigs.

The philosophy of the company then changed: yes produce as many piglets as we can from the farrowing barns but not at the cost of losing money in finishing.

THINGS HAVE CHANGED

In 2000, 10 of our farms were either farrow-nursery or farrow to finish. No nurseries could raise a larger amount of piglets, they had been built for a productivity of 20 p/s/y. Today, only one site still remains farrow to finish and it is planned to turn it into 1200 sows in 2015 with large groups housing.

Of the 150 farms that raise pigs, 28 are nurseries whose capacity can vary from 1000 to 4000 places. Finishing sites vary from 250 to 3000 places.

With the desire to use only one source per farm, we had to change the way were working in farrowing barns; this is good for our own barns as well as those of customers. The goal is always to pick up from 1000 to 1500 wean piglets per unit. Larges farms (2500 sows, for example) wean 1350 piglets per week; farms from 1000 to 1200 sows will wean every 14 days (batch farrowing) in order to obtain our goal of piglets. For smaller farms, batch farrowing every 28 days achieves our needs.

Who says batch farrowing every 2 or 4 weeks also said unproductive days (we don't want to buy “out of band” piglets). To ensure a stable supply, a former nursery of 2000 places has been converted into a breeding unit. In this farm, operated as if it were a multiplication unit, we're breeding gilts every week (without having to use hormone ($ $ $)) for a network of 5 farms. Blood tests are performed once a month just before each delivery of gilts to customers; animals are sold after 75 days of gestation.

In order to ensure you never have farrowing cages empty, the customer of this breeding unit is encouraged to breed some old sows that would normally be culled (single dose). As soon as we confirm the number of pregnant gilts that will be delivered, the customer decides the number of those old sows he will send to reform. The choice whether or not to use this method belongs to the clients. A second breeding unit is currently in preparation to meet the needs for other farms. We’re currently out of pregnant gilts.

Farrowing barns therefore provide a fairly constant number of wean piglets but the number is increasing year after year with improved productivity. The problem of under-capacity nursery is sometimes present but many permits were given for 30 kilos piglets, so it's easy to get little more piglets in these farms and have enough space by selling them at 25-26 kilos.

The transport coordinator juggles every week with the future placement of piglets. Using the management software and the monitoring performed by our field technicians every month, we know several weeks in advance the approximate number of pigs we'll have to deal with. We manage approximately 7000 to 7500 pigs per week that we place in nurseries or finishing units, we have some flexibility. We may also speed up or delay entry (maximum 1-2 weeks) if there's a need.

Currently 40% of our network is in wean to finish. Finishing barns have been partially modified (half of the barn) to receive weaned piglets. The problem of lack of space is not as important in finishing compared to nurseries; this technique has allowed us to solve part of the problem generated by the hyper prolificacy.

CONCLUSION

Management of surplus is part of the daily management of each producer. We've decided to focus on fattening results without neglecting the farrowing performances but not at any cost. Those extra piglets must be viable and profitable for the whole system. Our customers and employees know our rules and they accept them. We choose this orientation 5 years ago and even if we're pushing to increase sow performances, we still believe that the money is made or lost in finishing.

MANAGING PILE UPS

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INTRODUCTION

With the advancements being made in genetics, fertility and farrowing management the trend of increasing pigs weaned per sow continues to increase yearly. While great effort has been put into maximizing the output of piglets from sow units, how we handle those increasing number of piglets will determine the overall success. "Pile ups" are the result of those extra weaned pigs and heavier market weights. Facility space becomes the limiting factor for many farms; the idea of building or contracting out that extra space is not always feasible. With the lack of space and limited time how do we capture every opportunity to maximize the growth of these extra pigs?

MANAGEMENT STRATEGIES

A "pile up" is the change or disruption to the normal flow within the operations. How these "pile ups" are managed can either be a gain or loss in opportunity. Strategies that have been used may or may not achieve positive results. The following are examples of pile up strategies that have been used.

- Reduced fill to fill intervals, therefore reducing the days on feed and the downtime between batches received at the facility. Challenges arise when the facility has limited time for maintenance and to be washed thoroughly prior to receiving the next batch of pigs and possibly comprising the health status. The potential for more light weight pigs is increased.
- Disruption of all in all out flow. New pigs are received prior to shipping the last batch in the facility leading to increased problems arising and possibly compromising the health status of the new pigs or both.
- Increased stocking density, filling barns at a higher rate than the barn was intentionally built for. Can be perceived as advantageous at the beginning of a batch of pigs when they are smaller but will quickly become problematic as the pigs become larger.

Setting up for success...Managing the pile up:

- Focus on the nursery! The early stages of a weaned pig's life have some of the greatest potentials to influence the lifetime performance of that pig. Take your time to get all the details right prior to new pigs entering the facility.
- Upon entry, Sort, Sort, Sort!!! As much as it seems to be a nuisance, nursery pigs should be sorted by size, within a single wean. When we can visibly see an extreme variation of as much as 4 kg between pigs…treating them as equals does not work.

- Once a barn is filled and the sort has been completed, we can then address feeding multiple budgets for different sizes of piglets. This allows for the smallest of the pigs to be given higher density diets increasing their gain within the first 10 days, therefore greatly increasing their potential weights or survival.
- Don't lose sight of where you are or where you've been. The use of trials for feed, medications, feed space, water space, stocking density, using scales for weighing feed etc. – the trials you can execute are endless; just opening your mind to what can be trialled is the key and gives immediate feedback on any changes that were made. Record this data so you keep track of what worked for that facility and the use of closeout software is an important piece to the puzzle to monitoring productivity.

CONCLUSIONS

In conclusion, managing pile ups is a developing challenge to overcome as production increases from our sows. In the ideal world we would all love to build a new barn to accommodate these extra piglets but in the real world we have to evaluate each facility case by case by trial and error. Try and break your daily cycle and take the time to evaluate your potentials for loses or gains to capture the opportunity.

SUDDEN DEATH DURING TRANSPORT: HOW HOG HEART HEALTH AFFECTS IN-TRANSIT LOSSES

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ABSTRACT

Hogs that die during transportation to the abattoir are sent immediately to rendering and are rarely examined for a specific cause of death. Post-mortem examinations of hogs that died in transit found that the majority of hogs appear to have died from heart failure due to pre-existing heart lesions. The lesions had developed weeks to months prior to shipping and appear similar to the lesions observed in a genetic heart disease of humans called hypertrophic cardiomyopathy (HCM). HCM can result in sudden death, often during exertion, in individuals with no previous signs of heart problems. Testing is ongoing to determine if the pig heart lesions also have a genetic association.

BACKGROUND

The specific cause of death for hogs that die in-transit to a packing plant has rarely been investigated. The increase in shipping mortalities during the summer months is often attributed to heat exhaustion or stress. In Ontario, approximately 0.07% of hogs shipped in a year die during transport to the plant. However it is rarely questioned why so many hogs are able to tolerate the shipping conditions and why only a small percentage cannot.

Research from the author and other published studies have suggested that heart failure from pre-existing heart lesions may be the specific cause of death of the majority of hog shipping losses. However why the hogs develop these heart lesions is not known. The goal of this project was to examine and characterize market hog heart lesions and investigate if there is a genetic association with hog heart lesions.

THE PROJECT: WHAT WE DID AND WHAT WE FOUND

From May 2012-September 2013, examinations of hogs that died while in transit to one slaughter plant were completed at the Animal Health Laboratory, University of Guelph. The hearts were removed from the carcass and preserved for further examination. For comparison, hearts were also collected from hogs that did not die in transit. Heart weights for hogs that died in transit were compared to the hearts of hogs that did not die in transit. Each heart was examined by one veterinary pathologist both visually and microscopically.

Tissue samples from a selection of the hearts were sent to Geneseek Labs Inc. for gene sequencing. These sequence data were analyzed to determine if a common gene or genes could be associated with pigs that die during transport. A second analysis was completed to determine if a common gene or genes could be associated with pigs which had visibly affected hearts regardless of whether or not they died during transit.

Post mortems were completed on 83 in-transit loss (ITL) hogs and 67 hearts were examined from hogs that did not die in transit. Post mortem findings on ITL hogs indicated cause of death was consistent with heart failure. The average total heart weight of hearts from hogs that died in transit was significantly heavier than the average total weight of hearts from the hogs that did not die in transit. ITL hearts 442.0 gm + 66.4gm vs Non-ITL hearts 368.8gm + 37.9gm ($P<0.05$)

Visible enlargement of the heart was more common in the hearts of hogs that died in transit. 77/83 (93%) of the ITL hearts had visible enlargement (hypertrophy) of the left or right ventricle. 5/67 (7%) of the non-ITL (hearts from hogs that did not die in transit) had visible enlargement of the left or right ventricle. Abnormal microscopic lesions were found in the hearts of hogs that died in transit and in those that did not die in transit. 63/83 (76%) of the ITL hearts and 51/67 (76%) of the non-ITL heart had microscopic lesions similar to those seen in Hypertrophic Cardiomyopathy (HCM). Heart lesions were chronic in nature, i.e. the lesions were developing in the pig's heart for weeks to months prior to the truck ride to the plant.

38 ITL hearts and 34 non-ITL hearts had samples sent for genetic sequencing and analyses. Analysis of the gene sequencing data showed over 40 genes possibly associated with a pig dying during transport. Two of these genes are known to cause HCM in humans. The second analysis of the gene sequencing data compared the genes of hogs with visible heart lesions to those that did not have visible heart lesions. This analysis found fewer genes possibly associated but the statistical associations were stronger with these genes compared to the first analysis.

HEART LESIONS TO HEART FAILURE

Heart lesions may cause a heart to not function properly. The heart then has to work harder to maintain normal function. The heart is a muscle. If it has to work harder to function, the heart becomes enlarged. The enlargement of defective hearts resulted in greater heart weights in this study. Compared to most other mammals, a pig's heart is small in relation to its body size (1). As a result, hearts with compromised function have little reserve capacity to respond to challenges. Therefore if the heart is abnormal, any event that increases a pig's heart rate (e.g. hot temperatures, fighting, being loaded on a truck) may result in heart failure.

IS THERE A GENETIC LINK TO HOG HEART LESIONS?

The visible and microscopic heart lesions found in the hogs in this study were similar to those observed in a genetic heart disease called Hypertrophy Cardiomyopathy (HCM). HCM has been recognized in people and some breeds of dogs and cats. HCM can result in sudden death in young, apparently healthy individuals. HCM-like lesions in pigs have been previously documented by a research group in Taiwan (2). Based on breeding experiments, the researchers suggested that the heart lesions were inherited (3), however no gene sequencing analyses were completed by the Taiwan research group.

The analyses of the gene sequencing data are very preliminary. A greater number of heart tissue samples will need to be tested to determine the specific gene(s) associated with heart lesions in hogs. If this can be established, it could be possible that the swine industry will be able to proactively address shipping mortalities through genetic selection to eliminate a HCM-like heart lesion gene or genes from the Canadian swine population.

CONCLUSIONS

In this study the majority of hogs that died in transit had a pre-existing cardiac abnormality resulting in hogs that were unable to survive standard transport practices. The hog heart lesions found in this study were similar to a genetic heart disease of humans, called Hypertrophic Cardiomyopathy (HCM). Preliminary analyses from this study appear to demonstrate that HCM-like hog heart lesions may have a genetic association, but further testing and analyses are needed to identify specific gene(s) involved. The project is continuing to collect samples for more testing.

ACKNOWLEDGEMENTS

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WATER SPRINKLING MARKET PIGS IN A STATIONARY TRAILER PRE- AND POST-TRANSPORT: EFFECTS ON PIG BEHAVIOUR, GASTROINTESTINAL TRACT TEMPERATURE AND TRAILER MICRO-CLIMATE

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Excerpts and data as published in Fox et al., 2014.

ABSTRACT

Pigs are often transported to slaughter under conditions of high temperature and humidity, which can lead to reduced welfare and increased in-transit losses. Water sprinkling in barns is used to control microclimate, resulting in pig body temperature reduction and improved welfare; however there is no clear evidence of these effects during transport. The aim of this study was to observe the effect of sprinkling pigs in trailers on behaviour and body temperature during transport and lairage, as well as to observe the effects on trailer microclimate. The results suggest that sprinkling pigs in a stationary vehicle when ambient temperature exceeds 23°C has the potential to prevent increases in body temperature during short duration transport without detrimental effects on ammonia levels within the trailer or on behaviour during unloading.

BACKGROUND

Transportation is one of the most stressful experiences in a pig's life, particularly when it occurs during environmental extremes (Ritter et al., 2009). As pigs do not sweat, they are limited in their capacity to control core body temperature in hot environments and are sensitive to heat stress (Bligh, 1985). In-transit mortality has been reported to increase beyond ambient temperatures of 16-17°C (Warriss and Brown, 1994; Haley et al., 2010) and increase with increasing temperature (Sutherland et al., 2009; Haley et al., 2010). Furthermore, the frequency of heat stress indicators (e.g. panting, skin discoloration) has been shown to increase in warmer months (Ritter et al., 2008). As temperature increases, pigs modify their behaviours in order to reduce heat production and increase heat dissipation by reducing activity (Hicks et al., 1998; Brown-Brandl et al., 2001) and increasing contact with cool or moist surfaces (Hillmann et al., 2004; Huynh et al., 2005). Water sprinkling systems in barns have been shown to increase the evaporative cooling capacity and decrease the temperature-humidity index (Haeussermann et al., 2007), but there are currently few methods available to cool pigs during transport besides natural ventilation. Both active ventilation and water misting in a stationary truck are credited with reducing deaths during transport (Nielsen, 1982; Colleu and Chevillon, 1999). Colleu and Chevillon (1999) found that sprinkling pigs at an ambient temperature above 10°C in one deck of a trailer helped to reduce skin temperature by 10% compared to the non-sprinkled pigs in another deck on the same trailer. However, considering known differences in micro-climate within a trailer

(Brown et al., 2011; Weschenfelder et al., 2012), the effect of sprinkling pigs within compartments in a trailer needed to be examined.

EXPERIMENTAL DESIGN

The aim of this study was to examine the effect of sprinkling water within full trailers of pigs at the farm before departure and before unloading at the plant on trailer conditions, behaviour and gastrointestinal tract temperature during transport, unloading and lairage. Effects on measures of stress physiology and meat quality are reported in Nannoni et al., 2014.

In each of 12 weeks from May to September 2011, 2 pot-belly trailers with 208 pigs each (n = 4,992) were transported from the same farm on the same day 2 h to slaughter. One trailer was equipped with a custom-built sprinkler system connected to a standard water hose, which ran for 5 min (~125 L) before departure and before unloading, and the other trailer served as the control. In each trailer, 4 compartments were outfitted with cameras, ammonia detectors and temperature/humidity data loggers (Figure 1). The gastrointestinal tract temperature (GTT; ^{o}C) of 4 randomly chosen pigs (n = 384) in each test compartment was recorded using orally administered data loggers. Trailer and deck loading order were randomized. Behaviour during transport, unloading and lairage (standing, sitting, lying; slips and falls) was recorded from video or live observations. Data were analyzed through ANOVA with ambient temperature external to the trailer (AmbT) as a covariate. AmbT averaged 19.5^{o}C ± 3.8^{o}C (range: 13.6 to 25.8^{o}C).

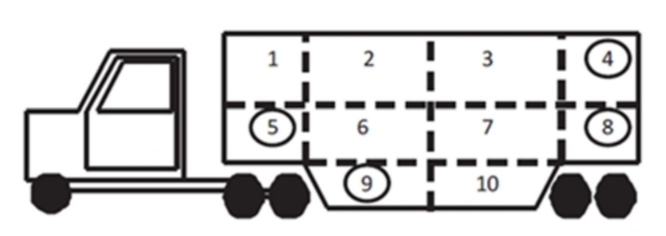

Figure 1. Pot-belly trailer compartment designations (1-10); circled numbers indicate test compartments selected for micro-climate data collection and behavioural observations during transport; 4 test pigs in each test compartment were monitored for gastrointestinal tract temperature.

RESULTS AND DISCUSSION

Sprinkled trailers showed lower (7.9 v 8.7^{o}C; $P = 0.002$) increases in internal compartment temperature from loading to unloading and smaller (-21.5% v -27.9%; $P < 0.001$) decreases in humidity. The sprinkling treatment did not affect ammonia levels, which is encouraging as the introduction of water may volatilize components of urine and feces which would be a concern for pigs and handlers. Consistent with Brown et al. (2011) and Weschenfelder et al. (2012), trailer microclimate characteristics were most impacted by compartment, with the back compartments (4 and 8) displaying smaller increases in air temperature than the front compartments (5 and 9). This may be due in part to differences in air flow, since during transport, air flows up and over the trailer and enters from the rear, moving towards the front, thereby allowing greater air flow in the rear compartments (Kettlewell et al., 2001).

At AmbT > 23^{o}C, there was no effect of sprinkling on behaviour on the trailer, but at AmbT < 23^{o}C, more pigs stood on sprinkled trailers (Figure 2; $P < 0.05$). It may be that in the sprinkled trailer, the novelty of the sprinkling stimulates activity at ambient temperatures below 23^{o}C, as indicated by pigs spending more time standing and less time lying throughout the duration of transport than in the non-sprinkled trailers.

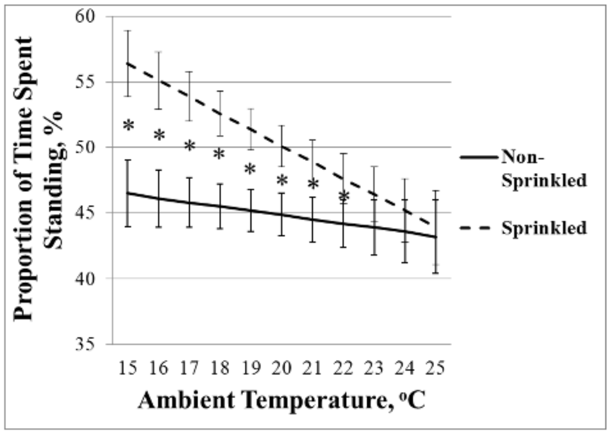

Figure 2. The interaction of ambient temperature and sprinkling treatment on proportion of time (LSMEANS; % ± SEM) pigs spent standing during transport (* $P < 0.05$).

The addition of the water to the trailer during sprinkling did not affect slips or falls during unloading. In lairage, latency to rest was reduced as AmbT increased for all compartments (Table 1; $P < 0.05$); sprinkled pigs spent more time lying (Table 1; $P < 0.05$) and had fewer drinking bouts than non-sprinkled pigs (Table 1; $P < 0.001$) regardless of AmbT. The greater time pigs from sprinkled trailers spent lying vs. sitting could be related to the fact that pigs from non-sprinkled trailers performed more drinking bouts, which resulted in pigs spending more time active near the drinkers. As well, pigs from compartment 4 showed the fewest drinking bouts per pig, regardless of treatment (Table 1; $P < 0.001$). The low numbers of drinking bouts by pigs in compartment 4 may be indicative of increased fatigue due to the movement up and down ramps during loading and unloading and this is also reflected in smaller proportions of time spent standing and reduced latency to rest.

GTT increased between loading and departure and decreased during transit for all pigs regardless of treatment (Figure 3; $P < 0.001$); and sprinkling tended to further reduce GTT at arrival at AmbT > 24^{o}C ($P = 0.08$). Due to the negligible impact of ambient temperature or sprinkling treatment at loading and departure, this rise in temperature is likely the primary result of the exercise (D'Allaire and DeRoth, 1986) experienced by the pigs during loading. This is particularly evident in pigs from compartment 4 (top deck, rear), which experienced greater increases by departure than compartment 8 (middle deck, rear). This could be due to the fact that pigs in compartment 4 are required to go up a 30^{o} ramp to the top deck, and then they must turn around to and go up a smaller 20^{o} ramp to enter that rear compartment. The response to multiple stressors (heat, distance moved, floor space, social mixing, handling) has been shown to be additive (Huyn et al., 2005; Ritter et al., 2009), and so the increased GTT at loading for pigs in compartment 4 could be the result of the exercise of loading, negotiating the ramps and increased handling (Tamminga et al., 2009; Torrey et al., 2013). Although there were no significant differences in GTT at loading or departure between sprinkled and non-sprinkled pigs, it is interesting to observe that at high temperatures (> 25^{o}C) when pigs are at a significantly greater risk of mortality during transport (Haley et al., 2008; Sutherland et al., 2009), the sprinkling treatment showed a trend towards greater reductions in GTT by arrival at the plant (***P*** = 0.08). This could indicate that the sprinkled pigs are likely experiencing greater evaporative heat loss capacity when the trailer is in motion and air flow is maintained, enabling greater control of core body temperature under hotter ambient conditions when temperature control becomes more critical and physiological heat dissipation means (panting and peripheral vasodilation) become less effective (Marple et al., 1974; Robertshaw, 1985).

Table 1. Least squares means (± SEM) of unloading time and behavior of pigs during lairage by sprinkling treatment and compartment.

	Treatment				**Compartment Group**					
Pig Behavior	**Sprinkled (n=12)**	**Non-Sprinkled (n=12)**	**SEM**	***P-Value***	**4**	**5**	**8**	**9**	**SEM**	***P-Value***
Unloading Time (s/pig)	2.4	2.4	0.16	0.72	2.4^{a}	2.8^{a}	1.6^{b}	2.9^{a}	0.20	<0.001
Standing (%)	23.1	24.8	1.50	0.26	18.7^{c}	22.0^{b,c}	29.3^{a}	25.7^{a,b}	1.80	<0.001
Sitting (%)	7.9	10.7	0.50	<0.001	9.7	8.1	9.8	9.7	0.70	0.16
Lying (%)	58.3	53.5	1.90	0.02	63.1^{a}	61.4^{a}	42.7^{b}	56.4^{a}	2.40	<0.001
Latency to rest (min)	31.6	35.3	2.75	0.20	26.3^{b}	29.3^{b}	42.3^{a}	36.0^{a,b}	3.50	0.001
Drinking bouts (total per pig)	4.3	6.1	0.70	<0.001	2.9^{b}	6.0^{a}	6.6^{a}	5.3^{a}	0.80	<0.001

[a,b] Within a row, least squares means lacking a common superscript differ at $P < 0.05$

CONCLUSIONS

The results suggest that sprinkling pigs in a stationary vehicle when AmbT exceeds 23^{o}C has the potential to prevent increases in body temperature during short duration transport without detrimental effects on ammonia levels within the trailer or on behaviour during unloading. Due to the practical limitations of installation and maintenance of sprinkler systems in trailers, further research should be done to determine the effects of water sprinkling at higher ambient temperatures. As well, examining the efficacy of sprinkling stationary trailers from the exterior, perhaps in combination with forced ventilation to improve air flow and evaporative cooling, is warranted.

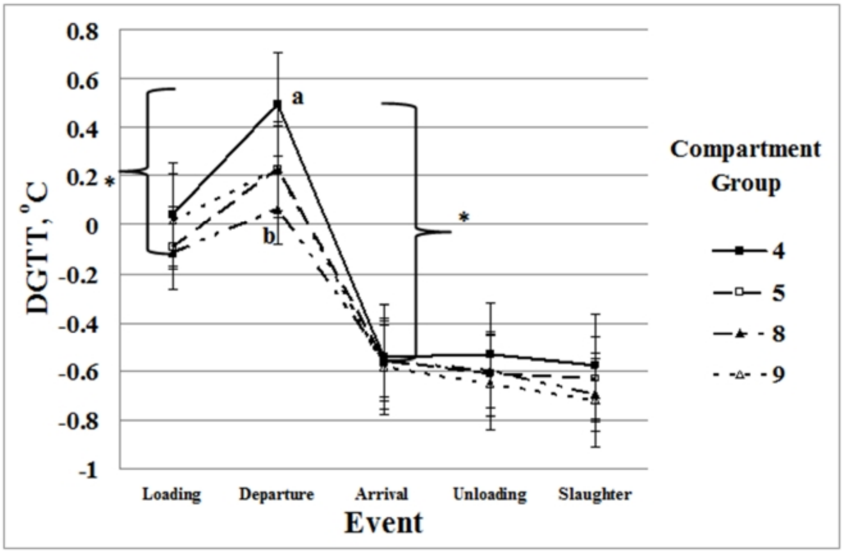

Figure 3. Changes in gastrointestinal temperature (LSMEANS DGTT; °C ± SEM) from baseline (500 h the day of transport) by event and compartment group location (* *P* < 0.001; a,b *P* < 0.001).

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SPOTTING PROBLEMS EARLY

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All in/all out (AIAO) pig flow has many benefits for health management of growing pigs. The age separation could be achieved with ease, and the system allows good cleaning and disinfection. Both of these management procedures greatly reduce the infectious pressure in swine barns, ultimately leading to higher health of populations and superior production performance. Such system also allows easy benchmarking of cumulative data for the entire batch, including mortality and culling rates, treatment costs, average daily gain and feed conversion ratio. Useful insights could be obtained when such cumulative records are compared between sequential batches, and among different production systems. Nonetheless, the nature of such investigation is always retrospective because all data for the batch need to be available before the summary statistics is produced. However, data recorded in such way could be utilized as a real-time monitoring tool using different approaches. This includes real-time monitoring of very basic information such as mortality and mortality due to certain syndromes, treatment records and reasons for treatment. Such information could then be used to assess the health of populations in batches of pigs at the barn level on a day-to-day basis using very simple visualization tools. Such data often are entered into online databases.

This is an approach that offers opportunities to evaluate data in a more comprehensive manner, and to potentially evaluate data from multiple barns at the same time. This concept is not new, human health data such as visits to emergency departments are used frequently with the purpose of early detection of outbreaks. In addition, other production parameters regularly available in many swine barns could also be used. One parameter that has frequently been discussed as particularly useful is monitoring water consumption. Water consumption could be entered into spreadsheets and visualized for interpretation purposes (1). But, water consumption could also be monitored automatically, which has obvious advantages with respect to data collection and analysis. The advantages of monitoring the water consumption is that a change in water consumption could be observed earlier than clinical signs are observed at a substantial level. This could have obvious implications for early implementation of corrective actions.

Barns could also be monitored using the noise level through methods that vary in their complexity. An example of a disease that is not always easy to identify using regular observations is influenza. Influenza typically develops as a sudden outbreak of coughing affecting large proportion of animals, but is not uncommon to have endemic circulation of influenza without obvious clinical signs. Apart from disease monitoring, electronic devices such as cameras and microphones could be used to monitor welfare of animals. In conclusion, we are in the early phases of development of precision agriculture in which ongoing data collection and analysis will become an essential part of livestock production. It will continue to be based on integration of electronic devices into continuing measurement of performance, monitoring of health trends, and development of early warning systems for outbreak detection. Structure of industry, development of devices to record data and store them, as well as algorithms for data analysis and visualization will be an important part of the entire process.

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PROFITABILITY INDICATORS

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INTRODUCTION

Profitability indicators can vary depending on each producer's individual business strategy and what they view as important variables for their farm. Variables that can be monitored include production, financial, and whole farm measures. Other monitoring possibilities include human resource, customer and supplier relationships.

ONTARIO DATA ANALYSIS PROJECT (ODAP)

This project has been conducted by University of Guelph, Ridgetown Campus since 1991. It is a benchmarking study based on financial and production data from land-based farrow to finish farms in Ontario. Information that is collected for each farm includes income statement, balance sheet, production and demographic data. Participants that provide information receive a personalized farm analysis that compares their farm data to the group average. It is thought that this is the only project of its' kind in Canada.

The farms that are involved have about 100 to 700 sows and it is believed that the results generated are fairly representative of a farm this size. The results for the swine enterprise are calculated on a "pigs produced" basis. This reflects the number of market hog equivalents produced on the farm and it takes into account all production and inventory changes. Results do not include program payments or family labour expense. The group of 15-20 participants varies from year to year. Although it is small in terms of farm numbers it is powerful in terms of detail and accuracy and provides a relatively complete financial picture of the farm operation.

SELECTED RESULTS

Table 1 shows some average production variables over the 10 year period from 2003 to 2012. The average for the period is compared to the top 50% of producers based on Return on Assets (ROA) for the whole farm. The top half of producers is not the same group from year to year. ROA is calculated as: (accrual net farm income plus interest expense) divided by total assets (average of beginning and ending). This gives a measure of the farm's operating performance without the influence of debt. However, family labour expense has not been factored into this value.

Generally, the results show that there are not large differences between the top 50% and the group average. One area where the top 50% have an advantage is in lower nursery and grow-finish mortality.

Table 2 shows some average financial variables over the 10 year period from 2003 to 2012. Numbers are presented on a $ per kg basis (dressed). These values show that within the swine enterprise portion of the farm the top 50% group has a bit of an advantage in revenue but most of their advantage comes in the cost categories.

Table 3 shows some average financial variables for the whole farm over the 10 year period from 2003 to 2012. These values give a picture of the performance of the entire operation including swine and crop enterprises. The top 50% of farms in the project averaged 9.1% ROA over the 10 year period. This was 3.8% higher than the group average. Accrual net farm income averaged $183,482 per farm for the top 50% which was $92,177 higher than the group average. Recall that family labour expense has not been accounted for in this value. Average total assets and total debt per farm for the two groups were similar.

Table 4 shows some management factor variables. These values are the percentage of producers within the two groups utilizing these tools over the 10 year period from 2003 to 2012. For example, 80% of the producers in the top 50% group weighed their market hogs prior to shipping whereas the average for the entire group was 73% of producers. The table shows that the top 50% group had higher utilization of these tools. The average full-time-equivalent persons in terms of family labour was 1.8 or 1.9 for the two groups.

Table 1. Production measures, 2003-2012.

Variable			**Difference**
	Avg	**Top 50%**	**Top 50% vs Avg**
Number of sows	224	238	+14
Total crop acres	403	435	+32
Litters/sow/year	2.27	2.26	-0.01
Born alive/litter	11.14	11.20	+0.06
Weaned/litter	9.73	9.79	+0.06
Preweaning mortality (%)	10.91	11.56	+0.65
Nursery mortality (%)	3.16	2.88	-0.28
Grow-Finish mortality (%)	3.30	2.59	-0.71
ADG – nursery (kg)	0.46	0.45	-0.01
ADG – finish (kg)	0.88	0.88	-
ADG – wean to finish (kg)	0.76	0.75	-0.01
Dress weight (kg)	92.7	92.4	-0.3
Pigs weaned/sow/year	22.07	22.12	+0.05
Pigs produced/sow/year	18.73	18.49	-0.24

Source: University of Guelph, Ridgetown Campus

Notes: Top 50% based on Return on Assets (ROA). Numbers have been rounded.

Table 2. Financial measures in the swine enterprise, 2003-2012.

Variable ($ / kg)	Avg	Top 50%	Difference Top 50% vs Avg
Total revenue	1.56	1.61	+0.05
Feed expense	1.08	1.03	-0.05
Health expense	0.06	0.05	-0.01
Utilities expense	0.06	0.06	-
Interest expense	0.09	0.08	-0.01
Depreciation expense	0.17	0.14	-0.03
Total expense	1.65	1.52	-0.13
Net farm income	-0.09	0.09	+0.18

Source: University of Guelph, Ridgetown Campus
Notes: Top 50% based on Return on Assets (ROA). Numbers have been rounded.

Table 3. Whole farm measures, 2003-2012.

Variable	Avg	Top 50%	Difference Top 50% vs Avg
Net farm income ($ / farm)	$91,305	$183,482	+$92,177
Total Assets ($ / farm)	$2,979,776	$3,000,330	+$20,554
Total Debt ($ / farm)	$1,048,061	$1,013,456	-$34,605
Debt : Assets	0.36	0.34	-0.02
Working Capital : Total Cash Revenue (%)	24.4	27.2	+2.8
Return on Assets (%)	5.3	9.1	+3.8

Source: University of Guelph, Ridgetown Campus
Notes: Top 50% based on Return on Assets (ROA). Numbers have been rounded.

QUESTIONS TO THINK ABOUT WITH BENCHMARKING

Think about your operation in terms of production, financial, human resources, customers, suppliers, and etc.

What variables do you like to track?

What additional or alternative variables would you like to monitor?

Which ones are more important in the success of your farm?

What variables are in your control vs. those outside of your control?

What is your cost to grow corn vs. purchasing?

What would it take to gain one additional pig per sow per year? What is the marginal revenue compared to the marginal cost to achieve this?

What does it cost (feed, feed conversion, facility cost, etc.) to market heavier hogs vs. marginal revenue?

What is the additional return if you could improve any of farrowing rate, weaned per litter, mortality, average daily gain or lean yield by 1%? by 5%?

Table 4. Management factors, 2003-2012.

Variable (% of producers)	Avg	Top 50%	Difference Top 50% vs Avg
Weigh market hogs	73	80	+7
Use hedging / options	20	23	+3
Use forward selling	40	45	+5
Prebook feed	77	84	+7
Split sex feeding	7	9	+2
Family labour (FTE)	1.8	1.9	+0.1

Source: University of Guelph, Ridgetown Campus
Notes: Top 50% based on Return on Assets (ROA). Numbers have been rounded.

CONCLUSIONS

Some key points about benchmarking and profitability indicators:

1. Keep things simple. Unless you like dealing with lots of data try to measure a few key variables for your operation.
2. Be consistent in how you measure something. This allows for comparisons within your own system and over time. The hardest part is getting started.
3. A good place to start is looking at the average. If you have access to detailed data, look at the low and high values. A standard deviation value allows you to calculate (i.e. average +/- 1 standard deviation) a range that represents where 67% of the data should fall within.
4. Find out the story behind the numbers. This is the real value in benchmarking groups. Members can ask each other how they achieved a certain number, things that worked well and things that didn’t work so well.
5. Productivity is important. Increased productivity allows for certain costs (e.g. interest, depreciation, utilities, etc.) to be allocated over more units.
6. Cost control trumps production. The farm’s bottom line is what you are most interested in.

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IMPROVING FEED EFFICIENCY

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INTRODUCTION

Improving feed efficiency is a good objective in itself (Patience, 2012). But, one of the most important things we need to clarify at the onset when discussing this topic is that improving feed efficiency is not synonymous with cost efficiency. Every producer has different goals to achieve depending on their particular situation of their operation. Reducing cost per kilogram gain often translates to feeding more of a less nutrient dense feed for less overall cost, which is of benefit to producers who are not bottlenecked by days in the barn. For producers who are tight on barn space and days, improving feed efficiency frees up physical and time constraints.

FEED EFFICIENCY

There are many ways in which we can improve feed efficiency nutritionally, most of which have a direct impact on the improvement of overall gut health of the animal that ultimately leads to improving feed conversion. Some of those include antibiotic growth promoters (AGPs), gut acidifiers, enzymes and probiotics. AGPs show the highest benefit in improving average daily gain and feed conversion, but organic acids are a close runner-up and mixed combinations of AGP alternatives can come close to the performance response seen with AGPs (Dansk Slagterier, 2001).

Feed form

Feed form can have a significant impact on feed conversion. Both the type (pelleted vs. mash) and the ingredient particle size (particularly for corn) can influence the growth rate of the pig. Pelleted feed improves feed conversion over mash diets (Medel et al., 2004), because the process of pelleting (temperature, heat and pressure) physically breaks down chemical bonds in the feeds, making them more digestible. Changes in ingredient particle size, looking at corn in particular, can have a significant improvement on feed efficiency (Healy et al., 1994). In a healthy herd, a finer particle size has a direct improvement in feed efficiency. We must be cognisant of herd health as a fine particle size may also contribute to incidence of gut ulceration.

Within a nursery barn, the piglet, especially early on in life, has a finite capacity for maximal daily feed intake. Since we can't significantly change feed intake to improve daily gain in the early nursery feeds, we need to improve feed conversion. We need to make sure that the feed efficiency is also in line with cost per kg of gain. This is arguably less important in the nursery. Additional gain can come at a higher cost in the nursery because the value of that additional gain multiplies in the grow-finish phase by higher average daily gain and less days to market (Primary Diets 2002).

Nutrient density

Another way we can improve feed efficiency is by increasing the nutrient density of the diets. This can either be achieved by feeding additional energy (tallow or vegetable oils) or adding enzymes such as phytase, xylanases and β-glucanases to break down indigestible fractions in the diet. This causes an increase in availability and digestibility of amino acids, energy and carbohydrates (9300.USA.09.38 Purdue University, West Lafayette, USA). The greatest benefit from these enzymes is when you are feeding a diet particularly high in fibre content (Shorts, DDGS, etc.).

Pig response

Today's lean genetics also respond well to high levels of amino acids. Now that many of the limiting amino acids are synthetically available in the marketplace, we can improve the digestive efficiency of the pig by having a more balanced ideal protein ratio, decreasing the plasma urea nitrogen (PUN) while sparing energy that would have been used to catabolize excess amino acids and use it to improve feed conversion.

Feed cost vs. feed efficiency

For a given dietary ingredient composition, increasing the efficiency of pigs to convert feed into growth is an excellent objective. For example, improved health management will reduce the dietary energy and amino acids spent on increased maintenance requirements and increase protein deposition, combined increasing feed efficiency and likely feed cost per unit of gain. However, feed formulation to increase feed efficiency does not automatically reduce feed cost per unit of gain (Woyengo et al., 2014).

Alternative feedstuffs may provide opportunities to reduce feed cost per unit of gain. Such feedstuffs contain in many cases more fiber, hence result in reduced diet nutrient digestibility. Then a reduced feed efficiency would be expected; however, results among experiments with the feeding of corn DDGS to grower-finisher pigs is not consistent (Stein and Shurson, 2009). Indeed, of the 25 studies listed with grower-finisher pigs, on only 5 studies with increasing corn DDGS coincide with reduced feed efficiency. In research with increasing co-product inclusion in diets formulation to equal net energy and standardized digestible amino acids, feed efficiency did not decrease (Jha et al., 2013). Such a lack of response for feed efficiency to increasing dietary co-products is not uncommon, as indicated in the high fiber diets paper at the 2014 London Swine Conference. Perhaps such should be the target of inclusion of alternative feedstuffs, instead of accepting a reduction of feed efficiency

CONCLUSION

In closing, there are many nutritional strategies that can be implemented to improve feed efficiency. The challenge is to identify the areas that can both provide an improvement in feed efficiency and return a lower cost per kg of gain.

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