Proceedings
of the

LSC
London Swine Conference

17th LONDON SWINE CONFERENCE

Where Research Meets Production

March 28-29, 2017
London, Ontario

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Proceedings

of the

London Swine Conference

Where Research Meets Production

Edited by

J.H. Smith and L. Eastwood

March 28th and 29th, 2017

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Where Research Meets Production

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Where Research Meets Production

Tuesday March 28 • SOWS & Wednesday March 29 • Wean To Finish

Chair's Message

Agricultural research takes many forms. From white-coated lab analysis to get-your-boots-on field studies, research is critical to our industry's growth and competitiveness. This year's London Swine Conference focuses on "Where Research Meets Production," where all of these varieties of research meet the realities of your farm, of your own swine production.

Beginning with Futurist Nikolas Badminton's Future Vision of Swine Production, there is a great deal in store for you at this year's conference. We will ask what tomorrow looks like for Ontario pork producers. How about a decade down the road? And are we ready?

We will hear what opportunities new technology has brought to sow operations (Mastering breeding in an era of new technology) and to swine nutrition over the past two decades (Swine nutrition and technology). We will discuss our role in building trust in the agriculture industry (Answering tough questions: Building public trust in agriculture) and learn what the markets might look like this year (Economics, grain and hog outlook). The combination of both main sessions and workshops gives you an opportunity to ask our speakers the questions that matter to you, questions that impact your farm.

Together let's explore where research meets swine production as we learn from each other, share ideas during networking sessions, and hear from some of the leading experts in their field. It is at events such as this that the future of the swine industry is shaped.

A huge thank you to this year's conference organizers—there is a ton of behind-the-scenes effort that goes into making an event like this run smoothly, and we all appreciate their work.

Teresa Van Raay
Steering Committee • 2017 London Swine Conference

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Thank you to all our sponsors and participants for investing in the future of our industry by supporting the London Swine Conference. We look forward to seeing you again in 2018.

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Day 1: Sows – Main Sessions

The Future of Agriculture

Nikolas Badminton
Futurist
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Now, more than ever, we are seeing more innovation delivered across many industries. In the next few years, there will be huge opportunities to look at, and implement, technology innovations that advance the business of agriculture.

Nikolas will look at key trends including the Internet of Agricultural Things (IofAT), big data, mixed reality, vertical farming, automation in the field, and quantified cattle. He will also deep dive into the pork production industry and you'll be surprised where we are heading in the next 5 to 10 years.

NIKOLAS BADMINTON, FUTURIST

Nikolas Badminton is a world-respected researcher, futurist, author, and teacher with over 20 years of research, writing, speaking, and technology implementation experience. Nikolas thinks about how society adopts exponential technologies and changes how we operate in the world and writes insightful and challenging articles that aim to open people's minds to the opportunities that lay in front of us.

MASTERING BREEDING IN AN ERA OF NEW TECHNOLOGY

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ABSTRACT

A number of new artificial insemination (AI) technologies have recently become available to swine producers, such as post-cervical AI (PCAI) and fixed-time AI (FTAI). With PCAI, semen is deposited just inside the uterus, requiring fewer sperm cells, and less time for breeding, than traditional intracervical AI. A new product released for commercial use in weaned sows (OvuGel; JBS United Animal Health, Sheridan, IN, USA) induces ovulation. The compound is administered 96 hours post-weaning, and a single, FTAI is performed approximately 22 hours later. Thus, the number of semen doses used for AI is decreased and labour associated with detection of estrus can be eliminated. Acceptable fertility outcomes from PCAI and FTAI have been demonstrated in large scale studies under commercial conditions. Meanwhile, advances have been made in the cryopreservation of boar sperm cells and use of frozen semen, perhaps in conjunction with PCAI and/or FTAI, is likely to increase in the future. It is important to emphasize, however, that potential benefits of new AI technologies can only be realized if highly fertile and productive gilts and sows are available for breeding. Although management of gilts around the time of sexual maturity greatly influences lifetime reproductive performance, it is now widely accepted that maternal conditions to which gilts are exposed *in utero* as well as management early in life, such as during the neonatal period and the nursery and grow-finish phases of production, have profound effects as well. Effective gilt selection and development strategies and subsequent management in the sow herd are paramount to the overall goal of optimizing reproductive efficiency in the breeding herd. This paper describes recent work that has been conducted to manage gilts with the goal of enhancing lifetime reproductive performance.

INTRODUCTION TO NEW ARTIFICIAL INSEMINATION TECHNOLOGIES

Because artificial insemination (**AI**) offers swine producers numerous advantages over natural mating systems, it has evolved into the most common method of mating sows and gilts on commercial farms in North America. Use of AI saves time and labour in the breeding barn, and allows new genetics to be incorporated into a herd with a lessened risk of disease introduction. Once collected, a boar ejaculate can be diluted in a semen extender, creating multiple insemination doses that can be used to breed many sows and gilts. Thus, fewer boars are necessary in production systems employing AI, and as a consequence, feed, veterinary, and housing costs are reduced. The use of AI also allows more extensive use of genetically superior sires.

Until recently, a fairly typical practice was to store extended semen at 17 to 18° C for no longer than 7 days and to perform 2 to 3 intracervical inseminations/estrus period with each AI requiring 3 to 5 minutes. Individual AI doses contained 1.5 to 3 billion sperm cells in a volume of 70 to 85 mL. New technologies are emerging, however, that are changing what is considered "typical" AI. For example, a significant proportion of sows in estrus on commercial farms are now bred 2 to 3 times using post-cervical AI (**PCAI**) with each AI dose containing approximately 50% of the sperm cells and volume that doses contained previously. With PCAI, semen is deposited just inside the uterus, requiring 10 to 15 seconds. Sbardella et al. (2013) conducted an experiment during which weaned, Parity 1 sows were mated 2 to 3 times during estrus using intracervical AI (3 billion sperm cells per 90 mL dose) or PCAI (1.5 billion sperm cells per 45 mL dose) (n = 165 sows per treatment group). Similar farrowing rates (89.1 and 91.5%) and litter size (11.9 and 12.5 pigs) were observed for the intracervical AI and PCAI treatments, respectively. Another technology called deep intra-uterine insemination (**DUI**), which involves deposition of semen high within the reproductive tract near the junction between a uterine horn and oviduct, has the potential to decrease the number of sperm cells used for each service even more.

A new product called OvuGel (JBS United Animal Health, Sheridan, IN, USA) is labelled for inducing ovulation in weaned sows by stimulating the release of luteinizing hormone from the anterior pituitary gland. Sows receive intravaginal treatment with OvuGel (200 µg triptorelin acetate) 96 hours post-weaning, and ovulation occurs 40 to 48 hours after treatment (Knox et al., 2014). Optimum reproductive performance occurs in sows when semen is deposited 0 to 24 hours before ovulation (Soede et al., 1995). Thus, when using OvuGel, a single fixed time AI (**FTAI**) can be performed approximately 24 hours after treatment. Flowers et al. (2013) conducted an experiment during which 398 sows (Parities 1 to 6) were weaned and assigned to one of three treatments: 1) Control sows bred once daily during estrus, and 2) Sows received OvuGel, or 3) OvuGel carrier (placebo- no active product) 96 hours post-weaning and bred 20 hours later without regard to estrus. Control and OvuGel sows had similar numbers of pigs born alive (11.0 and 10.8, respectively) and both were greater than the OvuGel carrier sows (9.3). Farrowing rate was greatest for control sows (90.0%), intermediate for OvuGel (78.5%) and least for OvuGel carrier sows (54.1%). However, when based on number of sows weaned or when only sows in estrus were considered, farrowing rates were similar between Control and OvuGel sows and both were greater than OvuGel carrier sows.

Because farrowing rates and litter sizes have historically been decreased when cryopreserved boar semen, rather than fresh liquid semen, is employed for AI (Knox, 2015), its use in commercial swine production systems remains very limited. Recently, however, acceptable farrowing rates and litter sizes achieved with frozen semen have been reported. For example, Didion et al. (2013) retrospectively analyzed data collected over a four year period on a 1,800-sow farm that performed 2,696 AI services using frozen semen. For each service, gilts and sows received three intracervical inseminations. Farrowing rate was 78.7% and total born/litter was 12.5 ± 3.9. Over time, fertility increased, suggesting farm personnel became more accustomed to the introduced technology.

In swine and other mammals, fertilization of an ovulated egg by an X chromosome-bearing sperm cell results in a female embryo, whereas fertilization by a Y chromosome-bearing sperm cell results in a male embryo. Scientists at the United States Department of Agriculture (**USDA**) developed a technology for isolating relatively pure populations of X and Y chromosome bearing sperm cells from rabbits that relied on differences between the chromosomes quantity of DNA (Johnson et al., 1989). The larger X chromosome contains about 3% more DNA than the Y chromosome. Prior to sorting, sperm cells were labeled with a fluorescent dye which binds to the DNA. Because of its greater DNA content, X-chromosome bearing sperm cell absorbed a greater amount of dye than did the Y-chromosome bearing counterpart. As a consequence, when exposed to UV light during flow cytometry, X sperm cells fluoresced brighter than did Y sperm cells. As the sperm cells were passed through the flow cytometer in single file, each cell was encased by a single droplet of fluid and assigned an electrical charge corresponding to its chromosome status (e.g., X-positive charge, Y-negative charge). The stream of X- and Y-droplets were then separated by means of electrostatic deflection and collected into separate collection tubes for subsequent processing. After AI, the sex-sorted sperm cells resulted in live births of offspring.

Later, Johnson (1991) reported the first live born piglets resulting from insemination with flow cytometrically sexed sperm cells. Although numerous advances in the technology have been reported since these initial reports, two major limitations to widespread commercial use by commercial swine producers remain: 1) the efficiency of sorting is low and an hour is required to sort approximately 20,000 sperm cells, and 2) the procedure damages boar sperm making them less resilient to storage and very large numbers of cells are needed to achieve acceptable fertility. Use of sex-sorted sperm cells in combination with PCAI could make the technology more practical in some situations.

Thus, a host of new AI technologies are available, or will be available, to commercial swine producers. **It is important to emphasize, however, that potential benefits of new AI technologies can only be realized if highly fertile and productive gilts and sows are available for breeding.** Effective gilt selection and development strategies and subsequent management in the sow herd are paramount to the overall goal of optimizing reproductive efficiency in the breeding herd. The remainder of this paper describes some recent work that has been conducted to manage gilts so as to enhance lifetime reproductive performance.

MANAGEMENT OF DEVELOPING GILTS TO ENHANCE LIFETIME REPRODUCTIVE CAPACITY

Management of gilts around the time of sexual maturity (5 to 6 months of age) greatly influences lifetime reproductive performance. Moreover, it is now widely accepted that maternal conditions to which gilts are exposed *in utero* as well as management early in life, such as during the neonatal period and the nursery and grow-finish phases of production, have profound effects as well.

Impact of In Utero Conditions on Future Gilt Reproduction

Management advances and selection for prolificacy have greatly increased litter size in commercial swine. For example, Knauer and Hostetler (2013) summarized production data from 1.8 million sows in the U.S. and reported a 10.2% increase in total pigs born, a

9.8% increase in pigs born alive, and a 7.3% increase in pigs weaned for the five year period from 2005 to 2010. An unintended consequence of an increase in litter size, however, is an increase in the proportion of low birth weight pigs. This relationship is illustrated by data collected at Virginia Tech (Figure 1; Estienne unpublished). Over a 15-month period, a total of 111 sows farrowed with total litter size ranging from 3 to 18. As litter size increased so did the percentage of pigs weighing less than or equal to 1.0 kg. A number of factors, such as inadequate maternal nutrition or disease, can contribute to intrauterine growth retardation (**IUGR**) in domestic livestock (Wu et al., 2006), defined as impaired growth and development of the mammalian embryo or fetus or its organs during pregnancy. From a practical sense, the most important cause of IUGR in swine, however, is probably insufficient uterine capacity, which limits the amount of placental attachment and as a consequence, nutrient exchange between the dam and fetuses (Foxcroft, 2010).

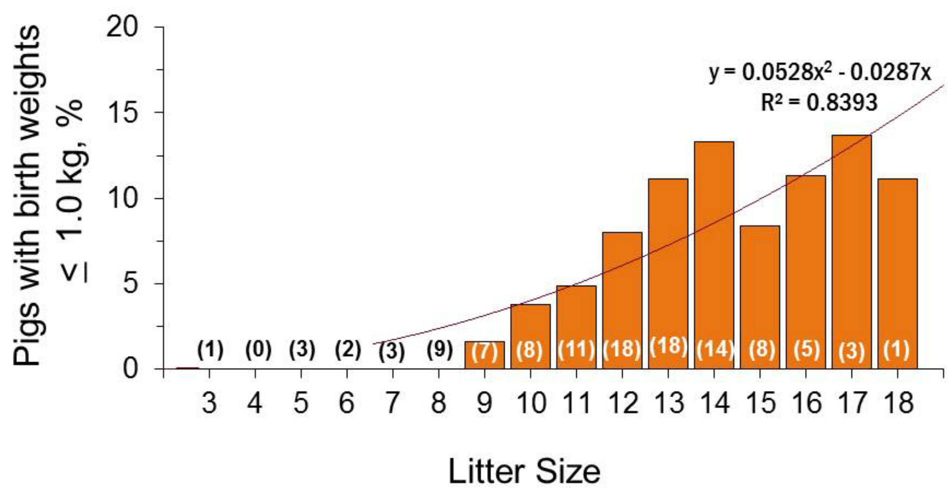

Figure 1. Relationship of total litter size and the proportion of pigs weighing ≤ 1.0 kg. Data is for 111 litters recently farrowed at the Virginia Tech- Tidewater Agricultural Research and Extension Center (Suffolk, VA). Number of litters for each litter size category appears in parentheses (Estienne, unpublished data).

Consequences of IUGR on postnatal growth performance in swine are well-documented and the detrimental effects of low birth weight are not only restricted to small pigs within a litter but also entire litters that are prenatally programmed to have a lower than average birth weight (i.e., low litter birth weight phenotype) (Patterson and Foxcroft, 2016). Compared with high birth weight offspring, IUGR newborn pigs have greater rates of pre-weaning mortality and lower postnatal growth rates; at slaughter, low birth weight pigs have less muscle, are fatter, and have poorer meat quality (for review, see Rehfeldt and Kuhn, 2006). The reproductive effects of IUGR have been less studied. However, Da Silva-Buttkus et al. (2003) reported that at birth, runt female pigs (mean weight = 0.7 kg) had more primordial follicles, but fewer primary and secondary follicles than normal weight littermates (mean weight = 1.5 kg), indicating the IUGR delayed follicular development. In a pilot study conducted in our laboratory (Estienne, 2012), age at puberty was defined as the first standing estrus in the presence of a mature boar and was determined for gilts that had been farrowed within litters with various average birth weights. A total of 33 litters each containing two to seven Landrace x Yorkshire gilts had a range of average pig birth weights of 1.13 to 1.98 kg. Boar exposure commenced at 150 days of age, and age at puberty tended to decrease as average pig birth weight increased (Figure 2). For all litters, average pig birth weight was 1.5 kg and Figure 2 also displays the age at puberty for gilts from litters with average pig birth weights greater than and less than or equal to this value. The proportion of gilts from litters with average birth weights of greater than 1.5 kg that had reached puberty by 190, 210, and 220 days of age was greater than for gilts from litters with average birth weights of less than or equal to 1.5 kg (Figure 3).

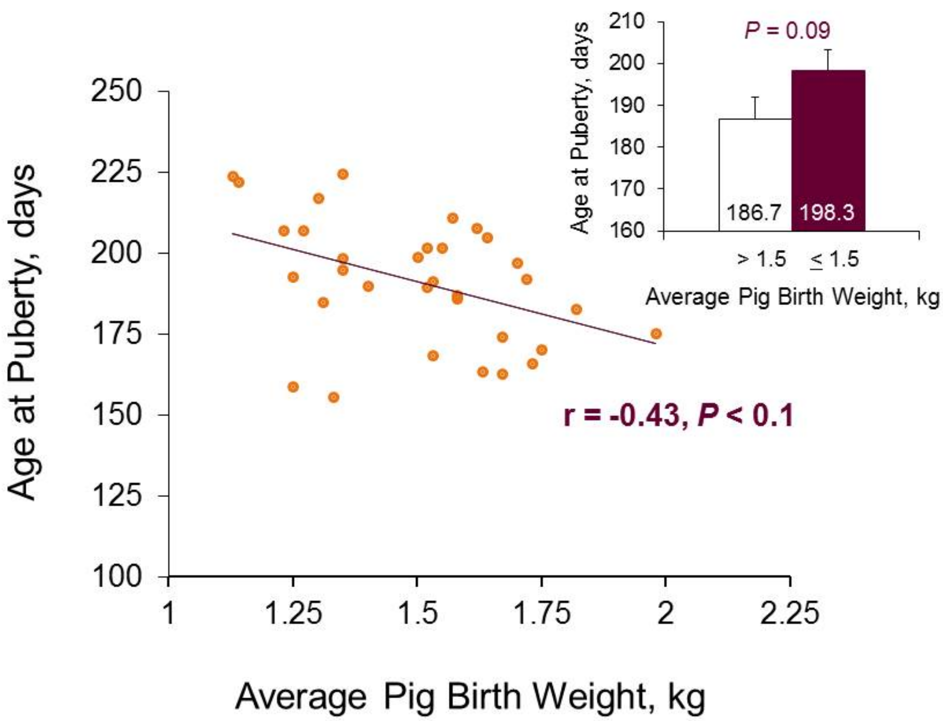

Figure 2. Age at puberty in gilts from litters (n = 33) with different average pig birth weights. Each data point represents the mean for two to seven gilts. Overall, pig birth weight averaged 1.5 kg and the inset depicts age at puberty for gilts that weighed greater than or less than or equal to this value (Estienne, 2012).

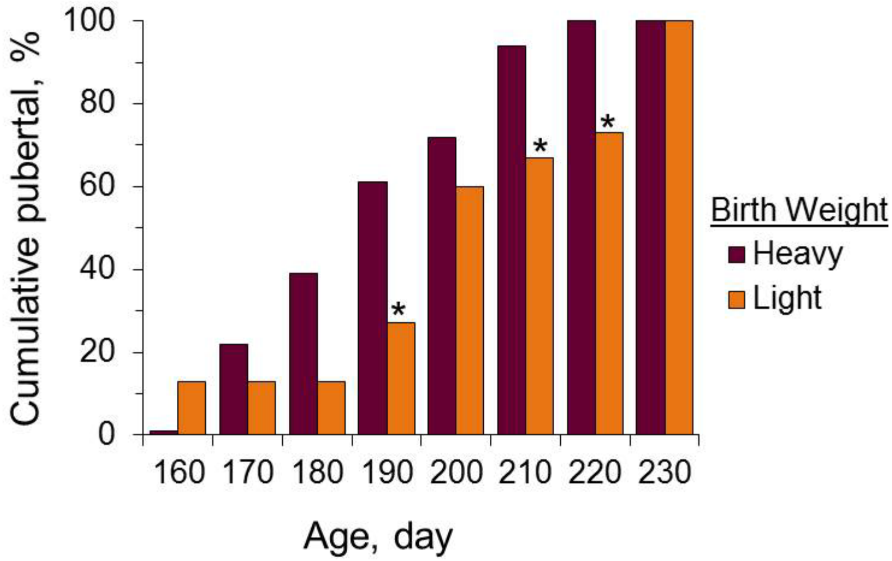

Figure 3. Proportion of gilts born within litters with heavy (> 1.5 kg) or light (≤ 1.5 kg) average birth weights that reached puberty by various days of age. Within ages, bars marked with "*" are different (*P* < 0.05) (Estienne, 2012).

In contrast to these results, Magnabosco et al. (2016) conducted a study during which 835 Landrace x Large White gilts were retrospectively classified into eight classes based on body weights at birth (0.41 – 0.99, 1.00 – 1.16, 1.17 – 1.28, 1.29 – 1.39. 1.40 – 1.50, 1.51 – 1.61, 1.62 – 1.77, 1.78 – 2.40 kg). Boar exposure commenced when gilts were 170 days of age. Overall, 23.8%, 44.4% and 64.6% of gilts reached puberty within 10, 20 and 30 days of boar exposure, respectively, and there were no significant differences among birth weight classes. Gilts not exhibiting estrus within 30 days of boar exposure were treated with P.G. 600 resulting in an overall average age at puberty of approximately 197 days. Differences in results between Estienne (2012) and Magnabosco et al. (2016) could be related to differences in age at which boar exposure commenced (150 versus 170 days of age, respectively). Moreover, in Magnabosco et al. (2016), but not Estienne (2012), exogenous gonadotropin therapy was employed in anestrus gilts, which would obscure effects of birth weight on the age at natural attainment of puberty in treated individuals.

Effects of birth weight on other indicators of sow reproduction have been reported. Magnabosco et al. (2016) reported that total litter size and the number of pigs born alive were less for Parity 1 sows that weighed less than 1 kg at birth compared to Parity 1 sows that were heavier at birth. Overall, females born weighing less than 1 kg produced approximately 4.5 fewer pigs across three parities than did females from heavier birth weight classes. Flowers et al. (2015) reported a significant effect of birth weight on longevity. The proportion of females that farrowed a sixth litter was greater for sows that weighed ≥ 1.6 kg at birth than for sows that had birth weights of ≤ 1.1 kg with sows that weighed between 1.2 and 1.5 kg at birth having an intermediate value.

The concept of fetal programming was first put forth by Barker (1997) with the central premise of the "Barker Hypothesis" being that the exposure of a fetus *in utero* to various acute or chronic stimuli may elicit a permanent response that impacts physiologic function later in life. In addition to the consequences of IUGR described above, management conditions to which pregnant females are exposed can also program the fetus such that adult reproductive performance is affected. For example, pre-weaning survival of pigs farrowed by gilts whose dams gestated under heat stress conditions tended to be less than survival of pigs farrowed by gilts whose dams gestated under control, thermo-neutral conditions (88.9 versus 93.9%, respectively) (Rhoads and Safranski, 2016). Researchers that have subjected pregnant sows to experimental "stress" conditions have postulated that at least some fetal programming occurs as a consequence of enhanced secretion of maternal cortisol. O'Gorman et al. (2007) conducted a study during which sows were subjected to daily restraint for five minutes during weeks 12 to 16 of gestation. Age at first estrus was significantly delayed in gilts farrowed by stressed sows (~ 172 days) compared to gilts farrowed by control females (~ 158 days). In an experiment conducted in our laboratory, reproductive characteristics of gilts farrowed by sows that were kept in individual crates throughout gestation, group pens throughout gestation, or individual crates for the first thirty days post-mating and then group pens for the remainder of pregnancy were assessed (Estienne and Harper, 2010). Fewer gilts farrowed by females kept in crates throughout gestation reached puberty by 165 days of age compared with the other two groups. Although the mechanisms responsible for these effects were not addressed, maternal cortisol secretion could be involved; Circulating cortisol levels were greater for gilts kept in individual crates compared with group-penned individuals (Estienne et al., 2006).

Impact of Neonatal Management on Future Gilt Reproduction

Conditions to which newborn pigs are exposed have been demonstrated to influence reproduction later in life. For example, colostrum is the first milk secreted by a sow during lactation and is produced for just 24 hours following the onset of farrowing. The substance is rich in energy, and contains antibodies and immunoglobulins required by the piglet to fight disease and infection. Recent research has demonstrated that colostrum also affects the development of various piglet tissues including the lining of the digestive tract (Hammon *et al.*, 2012) and the reproductive organs (Bartol *et al.*, 2013).

Vallet *et al.* (2013) developed a method for measuring immunoglobulin in piglet blood serum called the "*immunoglobulin immunocrit*" that allows determination of whether sufficient colostrum has been ingested. Using this technique, an experiment was conducted to assess relationships between Day 1 piglet immunocrit measures and subsequent growth, age at puberty, puberty failure, litter size, and lactation performance (Vallet et al., 2015). A low immunocrit on Day 1 of life was associated with a significantly reduced growth rate through 200 days of age. Reproductive traits in gilts such as age at puberty, and litter size and average daily gain averaged across 4 parities, were positively associated ($P < 0.05$) with immunocrit on Day 1 of life. In other words, the greater the immunocrit on Day 1 of life, the greater was the reproductive performance as an adult.

Strategic cross-fostering in order to decrease the litter size in which gilts are reared has been shown to positively impact reproduction as adults. Nelson and Robison (1976), reported that at day 25 post-mating, gilts that were raised in litters of six pigs prior to weaning, had more corpora lutea (an indication of ovulation rate) and embryos, than did gilts raised in litters of 12 pigs. Moreover, through three parities, sows raised in litters of seven pigs or less were less likely to be culled and had greater farrowing rates and larger litters than sows raised in litters of 10 or more pigs (Flowers, 2008).

Positive effects of decreasing litter size during lactation through cross-fostering on reproductive performance exhibited by gilts later in life are likely a consequence of increased weaning weights. In a study conducted by Callahan et al. (2017) on commercial farms in North Carolina, gilts were weaned at approximately 22 days of age, divided into three size categories: large (6.92 ± 0.06 kg), medium (5.60 ± 0.06 kg), and small (4.42 ± 0.06 kg) and placed in nursery pens to allow either 0.15, 0.19, or 0.27 m^2 floor space/gilt (achieved by placing either 14, 11, or 8 pigs/pen, respectively). After the seven week nursery phase of production, gilts were moved to grow-finish farms and ultimately one of 11 sow farms, where reproductive performance was tracked through three parities (Callahan, unpublished data). The largest pigs at weaning performed the best during the nursery phase of production, and as shown in Table 1, the proportion of pigs that were retained for breeding and that remained in the herd after the first parity were least for the smallest pigs at weaning. These results are consistent with the notion that there is a positive relationship between weaning weight of future replacement gilts and their future longevity in the breeding herd.

Table 1. Effect of pig size at weaning on growth during the nursery phase of production and retention in the sow herd (Callahan et al., 2017 and Callahan, unpublished data).

	Size of Pig at Weaning					
	Small		Medium		Large	
Body weight at weaning, kg	4.42 ± 0.06[a]		5.60 ± 0.06[b]		6.92 ± 0.06[c]	
Nursery growth, kg/day	0.40 ± 0.004[a]		0.45 ± 0.004[b]		0.49 ± 0.004[c]	
Nursery death loss, %	2.4 ± 0.5[a]		2.0 ± 0.5[a]		1.8 ± 0.5[a]	
Retention	*number*	*%*	*number*	*%*	*number*	*%*
Entered Nursery	851	---	861	---	824	---
Entered Sow Herd	414	48.6[a]	497	57.7[b]	483	58.6[b]
Completed Parity 1[1]	389	94.0[a]	477	96.0[a,b]	471	97.5[b]
Completed Parity 2[1]	313	75.6[a]	371	74.6[a]	364	75.4[a]
Completed Parity 3[1]	267	64.5[a]	316	63.6[a]	315	65.2[a]

[1]Of individuals entering sow herd.

[a,b]Within rows, values with different superscripts differ ($P < 0.05$).

Impact of Nursery and Grow-Finish Management on Future Gilt Reproduction

The post-weaning environment in which swine are raised can ultimately influence reproduction as well. In the study by Callahan et al. (2017) described above, restricting floor space allowance by altering the number of pigs/pen decreased pig performance during the nursery phase of production as expected. Reproductive performance during Parity 2, however, was also affected by group size-floor space allowance in the nursery (Table 2). Sows that had been allowed the *intermediate* amount of floor space during the nursery phase of production had the largest litter sizes. The proportion of females that entered the breeding herd was least for gilts allowed the *least* floor space, however, the proportion of gilts that entered the breeding herd and that completed Parity 1 was least for females allowed the *most* nursery floor space. These results suggest that stocking density in the nursery can affect the sexual maturation process by mechanisms that appear to be independent of direct effects on growth rate.

Table 2. Effect of group size-floor space allowance on growth during the nursery phase of production and reproductive performance and retention in the sow herd (Callahan et al., 2017 and Callahan, unpublished data).

	Floor Space Allowance[1]					
	0.15		0.19		0.27	
Body weight exiting nursery, kg	25.53 ± 0.2[a]		26.10 ± 0.2[a]		26.88 ± 0.2[b]	
Nursery growth, kg/day	0.43 ± 0.004[a]		0.45 ± 0.004[b]		0.46 ± 0.004[c]	
Nursery death loss, %	2.0 ± 0.5[a]		2.2 ± 0.5[a]		2.0 ± 0.5[a]	
Reproductive Performance						
Parity 1						
Total Litter Size	12.94 ± 0.21[a]		12.93 ± 0.21[a]		12.92 ± 0.21[a]	
Pigs Born Alive	12.24 ± 0.21[a]		12.17 ± 0.21[a]		12.20 ± 0.21[a]	
Parity 2						
Total Litter Size	13.08 ± 0.21[a]		13.62 ± 0.21[b]		13.05 ± 0.21[a,b]	
Pigs Born Alive	12.47 ± 0.21[a]		13.00 ± 0.21[b]		12.49 ± 0.21[a,b]	
Parity 3						
Total Litter Size	14.11 ± 0.30[a]		14.14 ± 0.30[a]		13.84 ± 0.30[a]	
Pigs Born Alive	13.34 ± 0.28[a]		13.36 ± 0.28[a]		13.11 ± 0.28[a]	
Total for Parities 1-3[2]						
Total Litter Size	33.05 ± 0.82[a]		32.85 ± 0.82[a]		32.56 ± 0.82[a]	
Pigs Born Alive	31.35 ± 0.82[a]		31.10 ± 0.82[a]		30.94 ± 0.82[a]	
Retention	*number*	*%*	*number*	*%*	*number*	*%*
Entered Nursery	1088	---	823	---	625	---
Entered Sow Herd	585	53.8[a]	448	54.4[b]	361	57.8[b]
Completed Parity 1[1]	568	97.1[a]	431	96.2[a,b]	338	93.6[b]
Completed Parity 2[1]	453	77.4[a]	328	73.2[a]	267	74.0[a]
Completed Parity 3[1]	387	66.2[a]	286	63.8[a]	225	62.3[a]

[1]Gilts were placed in pens of 8, 11, or 14 animals each resulting in floor space allowances of 0.27, 0.19, or 0.15 m^2/pig, respectively.
[2]Sows not completing parities 1 and/or 2 were assigned values of 0 for total litter size and pigs born alive as appropriate.
[3]Of individuals entering sow herd.
[a,b]Within rows, values with different superscripts differ ($P < 0.05$).

Reproductive consequences of group size-floor space allowance during grow-finish have also been studied. Young et al. (2008) conducted a study during which 1,257 gilts were placed in grow-finish pens that allowed either 1.13 (15 gilts/pen) or 0.77 (22 gilts/pen) m^2

floor space/gilt. After grow-finish, gilts were managed similarly on 1 of 9 sow farms. A greater percentage of gilts attained puberty and attained puberty at a younger age when given the greatest space allowance in grow-finish. In contrast, reproductive performance and retention in the breeding herd through three parities was not affected by treatment. In contrast, Kuhlers et al. (1985) placed grower gilts in pens of 8 or 16 animals each and females reared in the smaller groups ultimately farrowed one more pig per litter than did gilts reared in the larger groups.

Impact of Nutrition on Future Gilt Reproduction

Recent research has focused on feeding strategies for gilt development that maximize lifetime reproductive performance and longevity within the breeding herd. Calderon Diaz et al. (2015a and b) conducted a study employing 1,221 gilts fed six fortified corn and soybean meal diets in a 2 x 3 factorial arrangement of treatments. Gilts received grower diets formulated to provide 0.86 or 1.02% lysine, and 2.94, 3.25, or 3.57 Mcal of metabolizable energy/kg from 100 days of age until approximately 90 kg body weight. Then, gilts were fed finisher diets that contained 0.73 or 0.85% lysine and 2.94, 3.26, or 3.59 Mcal of metabolizable energy/kg until 260 days of age. The lysine and energy levels used in the experimental diets were based on the results of a survey of commercial pork producers in the U.S. conducted by the National Pork Board to obtained levels being fed to developing gilts. Across dietary treatments, no differences were detected in growth or body composition, except for backfat thicknesses and carcass weights which were greater for gilts fed the highest energy diet (Calderon Diaz et al., 2015a). Moreover, there were no differences among dietary treatments on age at puberty, ovulation rate, or uterine length (Calderon Diaz et al., 2015b).

In a study reported by Petrone et al. (2016), the effects of menhaden oil, a rich source of omega-3 fatty acids, on growth and puberty onset in gilts farrowed by sows fed diets also containing menhaden oil were examined. Yorkshire x Landrace sows (n = 44) received: 1) control gestation and lactation diets, or 2) diets that included 4% menhaden oil; Control and menhaden oil diets were isocaloric and isolysinic. At weaning, 84 gilts farrowed by control or menhaden oil sows were placed in pens of three gilts each and provided ad libitum nursery and then grow-finish control or 4% menhaden oil diets. Nursery, grow-finish and overall growth were similar for gilts farrowed by control or menhaden oil sows, and for gilts fed control or menhaden oil diets. Compared to controls, however, gilts fed menhaden oil diets tended to consume 16.9% less feed in the nursery and 6.0% less feed overall. This resulted in feed-to-gain ratios that were 15% greater in the nursery and 7.5% greater overall for control compared with menhaden oil gilts. Age at puberty was greater for gilts farrowed by menhaden oil sows (205.1 ± 3.2 d) compared to gilts farrowed by controls (193.9 ± 3.2 d), and tended to be greater for control gilts (203.5 ± 3.2 d) compared to gilts fed menhaden oil (195.5 ± 3.2 d). Ovulation rate was greater for gilts farrowed by controls (14.9 ± 0.7) compared to gilts farrowed by menhaden oil sows (12.6 ± 0.7). Thus, feeding gilts menhaden oil diets enhanced feed conversion efficiency and hastened puberty onset. In contrast, puberty was delayed and ovulation rate decreased in gilts farrowed by sows that consumed menhaden oil during gestation and lactation.

CONCLUSIONS

A number of new and exciting reproductive technologies that have become, or are becoming, available to commercial pork producers that offer great potential for dramatically increasing reproductive efficiency. For this potential to be realized, however, breeding females must be selected and managed to exhibit a high level of lifetime productivity. New production systems and management protocols that are based on sound science are a wise investment and the improved breeding herd performance that results is illustrated by work reported by Patterson et al. (2016) and Foxcroft and Patterson (2016). Various benchmarks of excellent gilt performance exist, such as first service farrowing rates of > 80% and litter sizes of > 12.5 total born pigs. Using the system depicted in Figure 4, Patterson et al. (2016) reported that these and other reproductive expectations were met or exceeded.

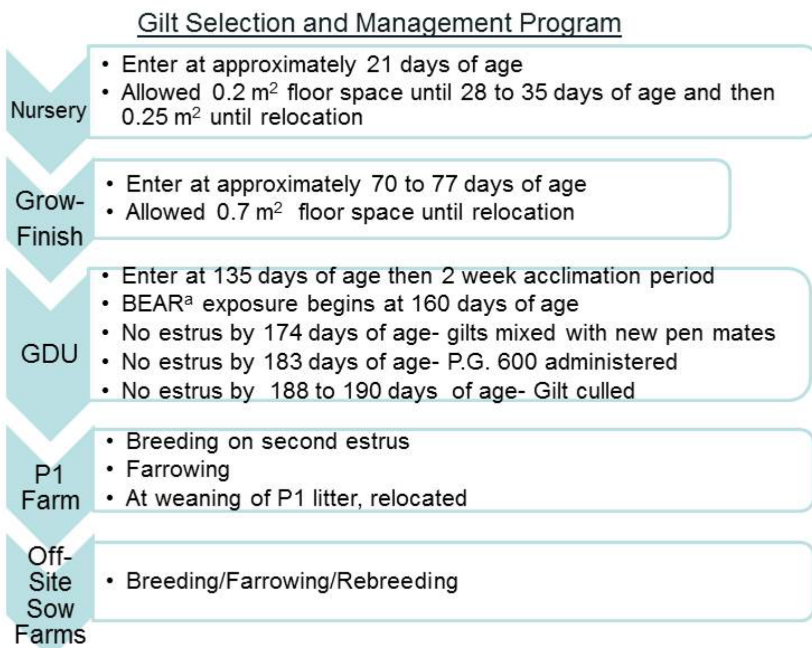

Figure 4. Components of a gilt selection and management system that resulted in a high level of reproductive performance and longevity. [a]BEAR = boar exposure area. Adapted from Patterson et al. (2016) and Foxcroft and Patterson (2016).

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THE ISSUE OF PRE-WEANING MORTALITY

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ABSTRACT

Pre-weaning mortality is a complex subject, as there are many factors that often lead to the final demise of the piglet. For example, "crushing" is often recorded to be the cause of death, but the piglet could have been chilled, causing it to lay beside the dam for warmth, which led to the piglet being laid on. Farms that have good management practices, to reduce the influence of environment and health on the sow and piglet, are usually able to accomplish what would be considered very low levels of pre-weaning mortality. In other complicated cases, getting mortality down to targets of less than 10% can be quite challenging and frustrating.

INTRODUCTION

Pre-weaning mortality (PWM), is the number of piglets, of those born alive, that did not survive the suckling period. We can break this down into infectious and non-infectious causes, but usually it is not those final causes of death that will give us solutions. So I prefer to break this subject down into the following categories:

1. Animal Factors
2. Environmental factors
3. Management/human factors

When working with a farm that has a goal to reduce the level of neonatal mortality, it is clear that there are many areas that need to be addressed, such as genetics; sow nutrition, including the gestation phase; herd immunity; management practices within the farrowing rooms (this is a huge topic) and sanitation/hygiene. Are we setting these piglets up with the best chance to survive?

ANIMAL FACTORS

The Piglet

The most critical influence on piglet survivability is birth weight of the individual piglet and overall robustness. This is influenced by genetics as well as sow nutrition and immune status. Genetics is very important to survival. Researchers have studied piglets and sows that were sired from boars with high survival rates. These studies have shown that survival can be significantly improved when breeding from "high survival" boars. Improving survival with genetic selection, is beneficial to both piglet and sow welfare.

Adequate colostrum intake is essential, as piglets are born with absolutely no circulating antibodies. If there is a failure to consume colostrum within the first 6-8 hours of life, that piglet will be compromised in terms of immunity. There is no doubt that these piglets are typically the smallest pigs, or the last pigs to be born, and are not able to attain adequate antibody levels. Passive immunity is a short-lived form of protection for the piglet, with usually half of those antibodies gone by 14 days of age and totally disappearing by the time the pigs are 30-60 days of age. Protection varies greatly from litter to litter and piglet to piglet.

Fostering of piglets has been shown to reduce PWM. Fostering of litters is usually done within the first 24 hours after birth and is done to even out litter numbers, as well as piglet size. The smallest piglets are usually placed onto one or two sows, to avoid competition with the larger piglets in the litter. P1 and P2 animals are often used for these litters due to teat size and the fact that they are usually more tolerant to accepting fostered piglets. Piglets that are moved to another sow should be marked in order to avoid re-fostering, and records should be kept on the sow cards when fostering has occurred, as a reference point.

The Sow

The sow has to be in the right place, at the right time when farrowing in order to give the piglets a chance of surviving. Sows that farrow in the gestation barn are a huge cause of profit loss and reinforce the need for good record keeping and stockmanship.

Sow nutrition prior to and during lactation, will not only influence this litter, but also the next litter and possibly even the next one after that. In other words, are you setting your sow herd up for success by paying adequate attention to proper feeding in terms of diet quality and feeding practices. The immune system requires energy, protein, vitamins and trace minerals for proper development of an immune response. If animals are lacking nutritionally, sows will be unable to produce adequate colostrum, as well as the colostrum that is produced, will be of poorer quality.

Gestation feeding should be focused on attaining suitable sow condition, without becoming over conditioned, as well as increasing piglet birth weights. Feeding during the lactation phase, should be aiming to provide maximum feed intake. The biggest management factor that can influence total feed intake is feeding frequency. Feeding rations that are more energy dense is often not a great solution when trying to make up for low frequency feeding programs.

Keeping good individual sow records are undervalued in their usefulness at getting to the root of the cause with sows off-feed or poor udder development. These records will also help in terms of figuring why something might be happening today, because of what happened during the last lactation.

Sow care management practices in the farrowing rooms are often overlooked, in terms of importance on piglet survival. How many farms own a digital thermometer? One that actually works and is being used on a regular basis. In the farrowing area, this is the first part of the sow examination that should be completed. A sow's rectal temperature will naturally be increased immediately prior to and after parturition, but if it continues to be elevated for more than 24 hours, this would be considered abnormal and further intervention may be warranted. I am not overly concerned if a sow does not eat for the first 24 hours after farrowing, as some sows in outdoor production won't even leave the farrowing arc for the first 1-2 days. Continuous water supply should be available and sows' rectal temperature should be checked daily and recorded, especially if there are any concerns with abnormal behaviour, or feed refusal.

ENVIRONMENTAL FACTORS

Due to the poorly developed thermoregulation system pigs are born with, they are highly susceptible to chilling, meaning they need to stay close to the dam's udder, or a suitable heat source, to avoid hypothermia. Are you providing the appropriate micro-environment for the piglet to keep warm and for sow comfort to maximise feed intake? Accessory heat sources are a critical management tool. If you aren't using anything, your mortality will be significantly higher than a farm that does. Heat lamps have been shown to be superior to heat pads, however any source, is preferable to no heat source.

Farrowing room flow, particularly all-in-all-out by room, is a significant factor in increasing piglet survivability, compared to continuous flow farrowing operations. Pathogen load will be significantly increased in farrowing quarters that are continuous flow for two reasons. Firstly, there are multiple age groups in one air space, all with differing levels of immunity. Secondly, it is more difficult to effectively clean the crates well between batches, due to concerns with affecting the remaining litters.

Sanitation of farrowing rooms should be performed between every batch. Removal of organic material, using a suitable detergent, is required to allow activity of the disinfectant. Rooms should be dried for as long as possible before re-loading sows to the farrowing crates.

Washing of sows prior to farrowing has been shown to have a significant impact on PWM, especially when you consider pathogens that can be shed by the sow, including Coccidia and Clostridium species. Sows should be washed with a mild soap and warm water, concentrating on the udder.

Vaccination programs should be reviewed on a regular basis. Herd dynamics change; therefore, if there is a change in clinical signs such as an increase in scouring litters, diagnostics should be performed to assess whether there has been a new disease introduction, or a change in pathogen presentation. Feed-back for scour management can be essential in some farms, particularly for strains of Rotavirus that are not included in a commercial vaccine.

Processing of litters is something that has had a lot of discussion in the last few years, mainly because of the need to administer analgesia when performing surgery. Any time a pig is handled we are creating stress, even if we just pick the piglet up and put it down with no other actions. Think about this if you have a farm with a higher percentage of scouring litters and higher PWM. I would suggest in those cases that a full review of handling technique, timing and procedures completed at each handling point be done.

HUMAN FACTORS

Clearly most sows are able to farrow on their own, but there will be a significant decrease in PWM if sows are farrowing while there are competent staff present. This can allow for farrowing assistance that could prevent a piglet being compromised by afterbirth, leading to weakness from oxygen deprivation. Use of drying agents has been shown to be beneficial in aiding pigs to maintain body temperature. These can be applied quickly after birth, if staff are attending.

Being present to monitor the motherability of sows can save piglets from being savaged. Providing oxytocin in a timely manner if required will assist with milk let-down. Assisting small piglets to access the udder, or split suckling large litters, can enable adequate colostrum intake and increase piglet survival significantly. Times that sows are farrowing without the possibility of human assistance, is an opportunity missed.

CONCLUSION

As you can see, there are still areas that I just do not have time to cover on this topic, due to the complexity of the subject (e.g piggy decks, in line milk systems, sow behaviour, etc.). However, I hope this is a driver to get you all to go back and review each of the areas above in your own operations, and have some discussions about where improvements could be made. Written SOPs are an excellent tool for staff training; however, as with anything, they can get outdated and should be updated regularly. I hope that you all see a positive impact on your farms in terms of improving piglet survival.

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Day 1: Sows – Workshop Sessions

REVISITING THE BASICS OF BREEDING

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ABSTRACT

With post-cervical artificial insemination (PCAI), semen is deposited just inside the uterus, requiring fewer sperm cells, and less time for breeding, than traditional intracervical AI. Regardless of whether PCAI or intracervical AI is employed, the ability to accurately detect estrus and timing of inseminations is critical for maximizing reproductive performance. Careful observation by an experienced breeding technician of gilts during an intense period of direct physical contact with a mature boar is the most ideal method for detecting estrus. Detection of estrus is facilitated by keeping gilts in groups of 8 to 12 gilts each, a group size that allows efficient movement to estrus detection pens. With larger groups it becomes more difficult both to assure every female within a pen receives adequate boar contact, and to carefully observe all gilts for the lordosis response. Boars used for estrus detection should be at least 11 months of age and the effectiveness of detection is enhanced by exposing gilts to several different boars in a boar exposure area (BEAR). A new product released for commercial use in weaned sows (OvuGel; JBS United Animal Health, Sheridan, IN, USA) induces ovulation. The compound is administered 96 hours post-weaning, and a single, FTAI is performed approximately 22 hours later. Thus, the number of semen doses used for AI is decreased and *labor associated with detection of estrus can be eliminated.* Acceptable fertility outcomes with FTAI have been demonstrated in large scale studies under commercial conditions. Effectiveness of OvuGel is dependent on sows having an available crop of mature ovarian follicles. Follicular development and hence estrus onset can be delayed in some situations such as in Parity 1 sows with less than optimum body condition or those lactating during high ambient temperatures. P.G. 600, a commercially available gonadotropin product (Merck Animal Health, De Sota, KS) has been demonstrated to accelerate the onset of follicular growth, estrus and ovulation in sows weaned during the summer and could perhaps be used in combination with OvuGel.

POST-CERVICAL VERSUS INTRACERVICAL ARTIFICIAL INSEMINATION

With traditional, intracervical artificial insemination (**AI**), 2 to 3 inseminations/estrus period are performed with each AI requiring 3 to 5 minutes. Individual AI doses contain 1.5 to 3 billion sperm cells in a volume of 70 to 85 mL. However, a significant proportion of sows in estrus on commercial farms are now bred 2 to 3 times using post-cervical AI (**PCAI**) with each AI dose containing approximately 50% of the sperm cells and volume that doses contained previously. With PCAI, semen is deposited just inside the uterus, requiring 10 to 15 seconds. Sbardella et al. (2013) conducted an experiment during which weaned, Parity 1 sows were mated 2 to 3 times during estrus using intracervical AI (3 billion sperm cells per 90 mL dose) or PCAI (1.5 billion sperm cells per 45 mL dose) (n =

165 sows per treatment group). Similar farrowing rates (89.1 and 91.5%) and litter size (11.9 and 12.5 pigs) were observed for the intracervical AI and PCAI treatments, respectively.

Regardless of whether intracervical AI or PCAI is employed, proper timing of inseminations is a prerequisite for high farrowing rates and large litter sizes. Reproductive performance in sows is greatest when semen is deposited 0 to 24 hours before ovulation (Soede et al., 1995), and females are generally mated 2 to 3 times during estrus to increase the likelihood that at least one mating occurs during that period of peak fertility. Because timing of AI is based on the onset of estrus, excellent estrus detection skills are paramount to a high level of reproductive performance.

PROPER DETECTION OF ESTRUS IS KEY FOR REPRODUCTIVE SUCCESS

The ability to accurately detect estrus, particularly in gilts, is perhaps the most important factor impacting reproductive performance and longevity on sow farms. In a recently reported study (Flowers, 2016), gilts from the same multiplication flow were sent to commercial farms with historically high and low longevity; The proportion of sows culled before Parity 6 was 68% and 92%, respectively. Management and performance characteristics of the farms were examined. Notable differences between sites were: 1) Twenty-eight % of the gilts delivered to the farm with low longevity were never bred, compared with only 7% of the gilts delivered to the farm with high longevity; 2) The proportion of culled gilts displaying normal ovaries at slaughter (in other words, gilts were actually cycling but estrus was not detected) was 38% and 4% for the low and high longevity farms, respectively; and 3) The high longevity farm had a designated person for detecting estrus and breeding gilts, whereas the farm with low longevity did not.

Just prior to and during estrus, gilts may display a variety of anatomical (e.g., red, swollen vulva and enlarged clitoris) and behavioural (e.g., moving back and forth along pen partitions, increased vocalization, etc.) changes. Estrus can only be confirmed, however, by display of the lordosis or immobilization response, during which the ears are pinned, the knees are locked and the back is elevated. The lordosis response is a natural reaction to a combination of visual, auditory, olfactory and tactile stimuli originating from the boar (Hughes et al., 1990). Thus, an intense period of direct physical contact with a mature boar is the most ideal form of boar exposure for detecting estrus in gilts. When daily boar exposure (10 to 15 minutes) commenced at 160 days of age, gilts given direct contact with a boar after movement to an estrus detection pen were significantly younger at first estrus (180.9 days of age) compared with gilts given fence-line contact only (191.9 days of age), with gilts given direct contact in their home pen having an intermediate value (183.8 days of age) not significantly different from the other two groups (Patterson et al., 2002). Although it is generally recommended that gilts be given direct physical contact with a mature boar for 10 to 15 minutes each day, this amount of time may not be practical due to the constraints of labour availability and design of facilities (Belstra et al., 2008).

In an experiment during which gilts were reared in pens of 15 (1.13 m^2 floor space/gilt) or 22 (0.77 m^2) females each, daily boar exposure (eight to 12 minutes/exposure) commenced when females were 140 days of age (Young et al., 2008). Compared to gilts given the reduced floor space allowance, a greater percentage of gilts attained puberty prior to leaving the rearing site at 200 days of age, and attained puberty at a younger age, when given the greater space allowance (37.2 versus 30.3%, and 182 versus 184 days of age, respectively). Once in the breeding barn, detection of estrus is facilitated by keeping gilts in groups of 8 to 12 gilts each. This size allows efficient movement to estrus detection pens. Additionally, with larger groups it becomes more difficult both to assure every female within a pen receives adequate boar contact, and to carefully observe all gilts for the lordosis response. Maintaining the immobilization response requires considerable energy expenditure and if a female in estrus becomes fatigued, she may become refractory (unresponsive) and not resume an immobilization response for several hours.

Age of boars used to detect estrus is important. The olfactory cue for stimulating the lordosis response is a pheromone that is produced and sequestered in the sub maxillary salivary glands of the boar, beginning at approximately 10 months of age. When daily boar contact (30 minutes/exposure) commenced when gilts were 165 days of age, age at first estrus was similar for females exposed to two year old (182 days) or 11 month old (181.6 days) boars but was significantly less than age at first estrus in gilts exposed to 6.5 month old boars (206 days) or those that received no boar contact (203 days) (Kirkwood and Hughes, 1981). Among mature boars there are there may be differences in quantity or type of pheromones emitted, level and frequency of their vocalizations, willingness to sustain physical interactions with gilts, and/or libido (Zimmerman et al., 1997). Thus, it is recommended that gilts be exposed to several different mature boars when detecting estrus in gilts. Modern systems such as the *boar exposure area* (**BEAR**) make use of multiple “teaser” boars housed in stalls separating two pens used for stimulating gilts and detecting estrus (Levis, 2008). Boars that become overly aggressive or violent should be culled.

SINGLE, FIXED TIME ARTIFICIAL INSEMINATION

A new product called OvuGel (JBS United Animal Health, Sheridan, IN, USA) is labelled for inducing ovulation in weaned sows by stimulating the release of luteinizing hormone from the anterior pituitary gland. Sows receive intravaginal treatment with OvuGel (200 µg triptorelin acetate) 96 hours post-weaning, and ovulation occurs 40 to 48 hours after treatment (Knox et al., 2014). Thus, when using OvuGel, a single fixed time AI (**FTAI**) can be performed approximately 24 hours after treatment. **And in theory, sows can be bred without regard to estrus (in other words estrus detection is not necessary)**. Flowers et al. (2013) conducted an experiment during which 398 sows (Parities 1 to 6) were weaned and assigned to one of three treatments: 1) Control sows bred once daily during estrus, and 2) Sows received OvuGel, or 3) OvuGel carrier (placebo- no active product) 96 hours post-weaning and bred 20 hours later without regard to estrus. Control and OvuGel sows had similar numbers of pigs born alive (11.0 and 10.8, respectively) and both were greater than the OvuGel carrier sows (9.3). Farrowing rate was greatest for control sows (90.0%), intermediate for OvuGel (78.5%) and least for OvuGel carrier sows (54.1%). However, when based on number of sows weaned or when only sows in estrus were considered, farrowing rates were similar between Control and OvuGel sows and both were greater than OvuGel carrier sows.

In order for OvuGel to be effective at inducing ovulation and facilitating a single FTAI, treated animals must have an available crop of mature ovarian follicles. Although most sows return to estrus within 7 days after weaning, follicular development and hence estrus onset can be delayed in some situations such as in Parity 1 sows with less than optimum body condition or those lactating during high ambient temperatures. P.G. 600, a commercially available gonadotropin product (Merck Animal Health, De Sota, KS) has been demonstrated to accelerate the onset of follicular growth, estrus and ovulation in sows weaned during the summer (Bates et al.,). Allen et al. (2014) conducted an experiment to determine reproductive performance after OvuGel in sows treated with P.G. 600 at weaning. Parity 1 sows (n = 544) were treated with P.G. 600 or received no treatment at weaning. All sows received OvuGel 96 hours post-weaning and were mated using PCAI with 3 billion sperm cells 22 to 24 hours later. After first mating, a greater proportion of control sows (24.8%), compared to P.G. 600-treated sows (12.0%) returned to estrus.

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RETROFIT FOR LOOSE HOUSING – WHAT YOU REALLY NEED TO KNOW

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INTRODUCTION

The die is cast. Right or wrong, the adoption of the 2014 Canadian Code of Practice mandates producers transition from individual gestation stalls to group housing by 2024. Aside from distinguishing that sows may remain in individual stalls for 28 to 35 days post-breeding, this mandate leaves other group housing specifics open to each individual farm. For many producers, this open-ended requirement may leave more questions than answers. As noted in a review by Bench et al. (2013), there are more than 72 possible combinations of feeding, grouping, and timing methods for group-housed sows. While breaking down each combination is beyond the scope of this discussion, it is important to acknowledge that each feeding system has its advantages and limitations. Properly implemented, many group-housing strategies can yield productivity similar to stall-housed sows.

Nonetheless, there are numerous variables that, if overlooked, can negatively impact group-housing success. Since joining GESTAL in 2015, I have helped 35 different sow farms encompassing over 90,000 sows implement group-housing in retrofit and new construction facilities. Leveraging this experience, I endeavour in the below discussion to present the major considerations and common pitfalls I've experienced in group-housing, with a focus on retrofitting existing facilities.

COMMON GROUP HOUSING QUESTIONS

Is retrofitting the most cost-effective investment long-term?

While retrofits are often the cheapest option based on short-term capital investment, it is not uncommon to find that by retaining the existing flooring substrate, feed system and pig flow, suboptimal sow productivity and feed utilization will result. Producers need to consider these long-term vs. upfront costs to determine whether expansion of existing facilities, or building new will ultimately yield better results for sow productivity and welfare.

When is the best time to mix sows into groups?

Regardless of timing, mixing unfamiliar sows elicits aggression during hierarchy formation and places increased stress on the sow. Important physiological reference points occurring in early pregnancy include maternal recognition of pregnancy (~d 11 to 12) and placental attachment or "implantation" to the uterine wall (~d 14 to 18; Van der Lende & Schoenmaker, 1990). To minimize the effect of mixing stress on pregnancy establishment, formation of sow groups is typically recommended to occur pre- or post-implantation. At this time, the scientific literature currently fails to definitively demonstrate differences between these mixing times. However, of note is a large-scale commercial study conducted by Knox et al. (2014), which showed poorer conception and farrowing rates for sows mixed between d 3 to 7 post-breeding versus sows housed in stalls or mixed at d 35 (Table 1).

Table 1. Comparison among sows bred and maintained in individual gestation stalls (STL) or mixed into group housing (58 sows/group) at 3 to 7 d (D3), 13 to 17 d (D14), and 35 d (D35) after breeding on reproductive performance (adapted from Knox et al., 2014).

	STL	D3	D14	D35	*P*-Value
Replicates	6	6	6	6	
Sows	158	463	347	464	0.48
Parity	4.4 ± 0.1	4.6 ± 0.1	4.3 ± 0.1	4.2 ± 0.1	0.001
Conception rate, %	96.2 ± 4.2^{a}	87.1 ± 1.4^{b}	89.2 ± 1.7^{a}	92.2 ± 1.8^{a}	<0.005
Farrowing rate, %	92.8 ± 3.1^{a}	82.8 ± 1.3^{b}	87.8 ± 1.6^{ab}	90.5 ± 1.6^{a}	0.001
Total born/litter	12.4 ± 0.3	11.9 ± 0.2	12.4 ± 0.2	12.2 ± 0.2	0.24

^{a,b} Within a row, least square means (± SE) without a common superscript letters differ ($P < 0.05$).

Based on these results, producers who opt to implement pre-implantation group formation must minimize mixing stress and carefully adhere to forming groups as early as possible to avoid loss of pregnancy. Furthermore, sows mixed into groups pre-implantation must undergo pregnancy check within the pen, be temporarily removed to stalls, or utilize within-pen boar RFID heat detection stations to identify open females.

What is the ideal stocking density? The Canadian Code of Practice set minimum space requirements for sows at 19 ft^2 (1.77 m^2) and gilts at 15 ft^2 (1.39 m^2). While feeding system and other pen design factors also effect optimal stocking density, there is general consensus that additional space should be allocated for small groups (< 10 head) vs. large groups (< 30 head) as the shared communal space is more effectively utilized in large groups. Personal observations within group-housed US herds indicate aggression, injuries and productivity are negatively affected at <20 ft^2 for sows and <18 ft^2 for gilts; whereas provision of additional space seems to be of little added benefit. A review by Bench et al. (2014) similarly concluded that space allocation above 20.5 ft^2 (1.9 m^2) did not affect sow productivity.

For retrofit facilities, the key to maintaining the previous stall-housed herd inventory in pens is to eliminate as many alleyways as possible, alleyways necessary in gestation stalls but no longer needed in group-housing. As seen in Figure 1 below, in some cases the total sow inventory can be maintained and even increased when converted to pens.

Figure 1. Example layout conversion from gestation stalls to group-housing pens.

The cost per added square foot in expansion and new construction is an important factor in the stocking density equation. In a 2016-2017 new construction barn with a 2100 sow inventory the cost was approximately CAD $52 per square foot to achieve the 22.5 ft^2 per total sow space in breeding and gestation (includes breeding stalls, pens at 20 ft[1], and alleys). Depending on pull plug or deep pit systems, each additional 1 ft^2 in gestation pens added between CAD $26-33 (US construction company, personal communication).

Static or dynamic grouping?

Properly managed, both static and dynamic grouping have been shown to be very effective with regard to sow welfare and productivity. Though both Anil et al. (2008) and Li and Gonyou (2013) observed significantly higher levels of aggression and injuries in sows housed in dynamic groups, there was no effect on farrowing rate, sow weight gain or litter size. Since there is no convincing evidence that sow welfare is compromised in dynamic versus static groups, the data suggests it may be more important to focus on getting other features right, such as pen design, space allowance, and selection of feeding system (Verdon et al., 2015).

How many sows per pen?

The short answer…it depends. On farm pig flow and feeding system are typically the greatest determining factors in the proper number of sows per pen. It is important to minimize the labour required to move and sort animals from gestation into farrowing rooms. Therefore, whenever compatible with the gestation feeding system the producer should design group pens which reflect the size of farrowing rooms and number of sows farrowing per week or per batch. For example, a 2400 sow farm farrowing 120 sows per week with three 40-crate farrowing rooms could target group pens of approximately 40 pregnancy-confirmed sows in order to easily flow these groups into farrowing.

The feeding system chosen also plays an important role. For example, sows floor fed or fed in shoulder stalls must be managed in groups or sows similar in parity and BCS or else aggression and BCS variation can impair performance. However, sows fed in traditional ESF stations are often managed in large pens of at least 40-60 animals and as many as 300 animals in order to disperse the higher cost of each ESF station. Free-access self-locking ESF systems offer flexibility in group size, as their intermediate cost allows for producers to adjust pen size by adding or removing a station. Free-access ESF manufacturers typically recommend between 10 and 20 sows per free-access ESF station.

Regardless, when determining pen size, producers must consider the daily chores of the stockperson in gestation, as one of their primary roles is in identifying "non-eaters". Reasons for not eating include: lameness, sick, lost RFID tag (activates the feed system), fear of dominant animals, or the animal is untrained/slow learner. In competitive feeding systems such as floor feeding, shoulder stalls or traditional free-access stalls, workers must observe sows at the time of dropping a meal to identify non-eaters. Conversely, most traditional and free-access ESF systems will produce reports which help workers identify sows who did not eat on a given day. Depending on the ESF system and farm management, determining where these sows are located and giving them access to feed can take a considerable amount of time per day. Based on testimonials from free-access ESF customers who have chosen pen sizes between 15 and 100 animals per pen, most producers in this system prefer pens between 30 to 50 animals to combine efficiencies of scale with ease of identifying non-eaters.

PEN STRUCTURE AND DESIGN

For retrofit buildings, rule number one is to accurately determine the current flooring and existing space available in the building. Whenever possible, producers should accommodate builders and consultants' requests to see the barn and take pictures and measurements to ensure proper recommendations. Too often, miscommunication or rushed decisions in this step can lead to suboptimal pen conditions in retrofit facilities.

Flooring type

Various combinations of solid, partially-slatted, or fully slatted buildings can be properly utilized in group housing. In fully solid and partially-slatted barns, the flooring texture and establishment of dunging areas becomes extremely important in order to ensure success, whereas in fully slatted barns there is more forgiveness in these respects. When given the option, sows prefer laying in solid concrete areas versus slatted areas. Therefore, in partially-slatted retrofit building design, pens need to be oriented in a way to place the solid areas in the lying areas of the pen and away from the dunging and high traffic areas. In Figure 2, layout A leaves a significant solid area in the traffic zone where sows will travel to access the feed stations. Layout B is preferred as the walkway is re-positioned to successfully isolate the existing solid concrete sections to the lying areas of the pen.

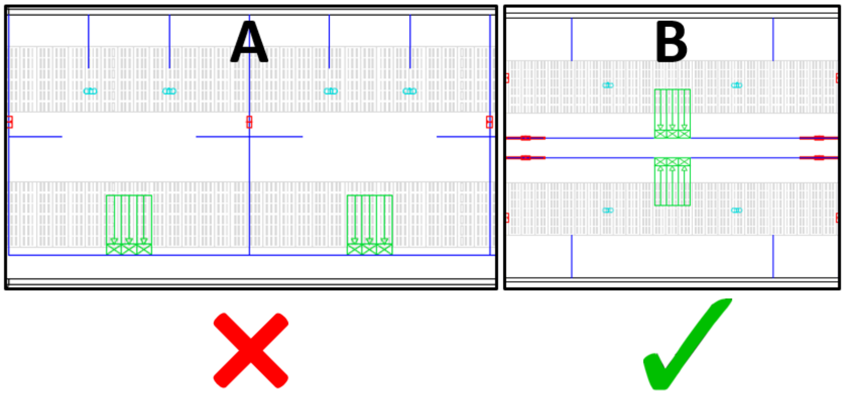

Figure 2. Layout examples of problematic and ideal partially-slatted pen designs.

Waterers

Number, location and type of waterers can seriously impact the success of a group-housing pen design. The recommended ratio is 10 sows per cup/bowl drinker and 5 sows per nipple drinker (Turcotte et al., 2015). I personally recommend a minimum of two waterers per pen to ensure water access if one becomes blocked. In partially-slatted pens, waterers must be oriented over the slatted areas in order to allow proper drainage and to encourage sows to use this location as a dunging area. In fully-slatted pens, there is more flexibility on waterer location, but positioning the waterers over the middle of the pen helps create “active” and “resting” zones within a pen. Figure 3 indicates examples of recommended waterer placement for cup waterers (Layout A) and hanging nipple waterers (Layout B). If waterers are anchored on the outside wall of the pen, such as in Layout C, aggressive interactions increase as sows will lay against the wall and block waterer access from other sows.

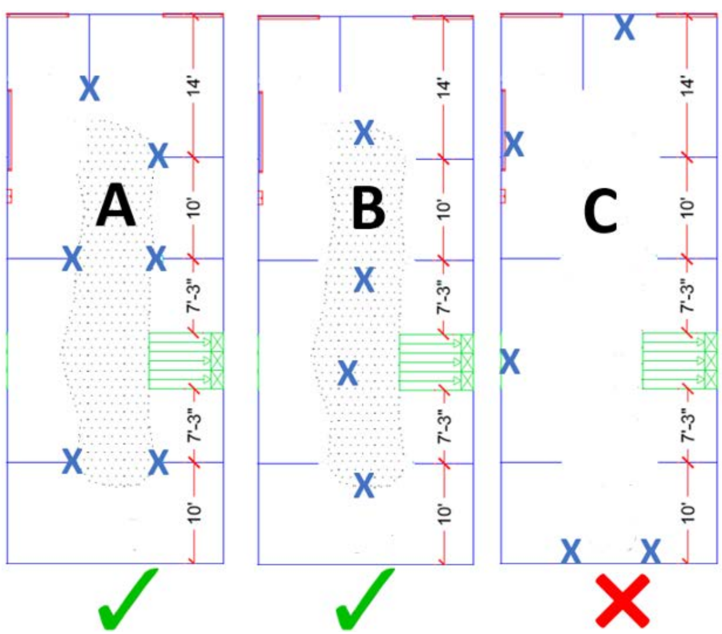

Figure 3. Correct waterer placement for cup waterers (A), hanging nipple waterers (B), and an example of poor waterer placement (C) in a 60 sow example pen.

Nesting walls and gating material

Including walls within group pens reduces aggressive interactions between sows at group formation (Verdon et al., 2015) and encourages formation of nesting areas for small groups of sows within a pen (Figure 4). These walls need to be approximately 2.0 m long and at least 2.5 m wide in order to sufficiently stimulate this nesting behavior. Furthermore, sows prefer to lay against solid walls whenever possible, but it is important that wall and gating material type does not interfere with barn ventilation. A popular option is to provide a solid surface for 24 in (60 cm), then vented above as seen in Figure 4. Moreover, placing too many nesting walls inside a pen can sometimes do more harm than good, as narrow alleys can be guarded by dominant sows who can restrict other sows access to feed. Recommendations to optimize pig flow include maintaining alleyways at least 3 m wide at the narrowest point and providing a minimum of 3 m clearance around the feeding area.

Figure 4. Examples of sow lying behavior in identical 60-head pens with (A) or without (B) nesting walls.

Lighting

In retrofits of existing facilities, one easy factor to overlook is lighting. Especially in non-competitive feeding systems (traditional and free-access ESF), it is important that the feeding station area is well lit. Dark areas and shadows cause animals to balk and slow their adaptation from stalls to feeding stations. Therefore, it is recommended that lights be positioned above each station or group of stations. However, the Code of Practice (2014) mandates that pigs also have access to darkened areas for a minimum of 6 hours per day, so providing variation in pen light intensity may be important if sows have access to feed stations 24 hr per day.

Hospital Pens

Regardless of feed system and pen configuration, there will always be a need to isolate animals that become injured or sick in group pen environments. Most guidelines in the European Union and North America recommend available hospital pens for 2-5% of the group pen inventory. However, as noted by Carroll (2017), hospital pens must be strategically designed as modern barns require maximizing productive space within a barn.

One option within group pens is to have "optional" hospital areas which can be implemented in times of need by swinging a gate into place and creating an isolation area within the larger pen, providing individual feed and water access for 1 to 3 hospital animals. If the hospitalized animal recovers quickly (<48hr) and retains nose-to-nose access to its former pen mates, it may be able to rejoin the group with minimal fighting. However, these hospital areas typically require around 150-200% of square footage of healthy sows, and by including the hospital areas "within pen", producers run the risk of overstocking the remainder of the pen if the hospital pens are normally in use vs. empty.

On-farm observations indicate these optional hospital areas cannot completely replace the need for dedicated hospital pens, yet they do serve as a useful area to isolate animals for further observation before permanent pen removal. For dedicated hospital pens, location within barn is important so that lame animals do not have to be moved far to reach the isolation area. These pens should also be positioned close to the office or vet area to allow caregivers to monitor these animals more closely.

Cost of retrofitting existing facilities

Since various feed systems and grouping strategies can be successful if properly managed, a major determining factor in the equation is the initial cost and capital investment to convert the facility to group housing. A cost-analysis by Turcotte et. al. (2015) evaluating 5 categories of feeding system can be seen Table 2.

Table 2. Cost comparison, per productive sow, for equipment and major renovations to the section used for the group housing of sows according to size of the herd and housing system used (adapted from Turcotte et al., 2015).

	ESF		**Shoulder stalls**[1]		**Free-access stalls**[1]		**Self-locking ESFs**[2]		**Self-locking ESFs**[2] **(minor renovations)**[3]	
Number of productive sows	250	600	250	600	250	600	250	600	250	600
Surface area used (ft^2/sow)	22	22	24.7	22	n/a	28.3	19	19	19	19
Cost of equipment alone[3] ($/productive sow)	$150 - 250		$90 - 105		$180 - 200		$125 - 166		$150 - 250	
Cost of renovations ($/productive sow)	$843	$579	$895	$560	n/a	$857	$541	$459	$377	$322

[1]European standard

[2] Canada Code of Practice

[3] Data obtained in 2012 from equipment suppliers.

[4] Retention of existing floor without breaking concrete.

MANAGING PEOPLE AND PIGS IN THE TRANSITION

Planning the process

Once producers have opted to convert existing facilities instead of expansion or new construction, planning the transition can be a complex process. First, a decision must be made on how to make room for the renovations. Can the herd inventory be temporarily decreased to make room for phase-by-phase renovations? Is there a location (ex. off-site finisher) which could temporarily house gestating sows during the transition? If a major disease issue arises, could retrofitting facilities coincide with a depopulation/repopulation event? Otten (2016) suggests producers apply the following factors: 1) calculate the barn capacity and outcomes from the housing conversion, 2) plan the timelines, 3) plan the details so that renovators and farm staff know the details and outcomes, and 4) allow lots of time to assist existing sows in adapting to the new feeding and housing system.

Stockmanship

Without adjustments in stockperson attitudes on farms, the transition from gestation stalls to group pens cannot be successful. As noted in Verdon et al. (2015), "No matter how acceptable a system may be in principle, without competent, diligent stockmanship, the welfare of animals cannot be adequately cared for". It is important to remember that to many farm workers, the transition to group housing is not a choice but a mandate, and they may not be willing/able to adapt themselves to the new system. Barn managers and must work hard to identify and train gestation managers who have the patience and stockmanship attitudes needed for group housing success.

Old sows

When existing herds are rolled over to group housing, inevitably sows that have been stall-housed for the majority of their lifetime will be placed into group pen environments. Frankly, some sows that were adequate in stalls may not be suited for group housing, and thus need to be culled. Sows with feet and leg issues such as overgrown toes and dewclaws must be identified before or during pen formation and quickly removed to a hospital pen or stall. Moreover, old sows typically exhibit greater levels of aggression at group formation and require additional attention to train to eat in traditional and free-access ESF systems. The best way to minimize these challenges is to provide a "mixing pen" during initial group formation which allows for extra floor space, visual barriers, and feed supplied ad libitum as a way to reduce aggressive behaviours and speed up transition to the new feed system (reviewed by Verdon et al., 2015). A practical way to apply this "mixing pen" strategy in retrofit facilities is to use two group pens (ex. space for 60 sows each), and initially form two groups of sows (ex. 30 & 30). After a 1 to 3 mixing period, combine the two groups to form the final pen (60 sows). Even if implemented properly, the first cycle through pens for these old sows will require additional labour and patience from the farm staff because all of the sows are learning at once, whereas after stabilization, the only naïve animals should be incoming gilts (<20-25% per cycle), which will require less labour.

FEEDING STRATEGIES FOR GROUP HOUSING SUCCESS

Optimization of sow body condition

If group-housed sows are competitively fed, such as floor feeding or shoulder stalls, extra effort must be placed on assigning sows to pens based on parity and similar body condition, as there is no way to individually apply different amounts/rations to individual sows within these pens. Typically, these feeding systems result in slightly higher feed usage (~0.25kg/d) than non-competitive systems such as traditional or free-access ESFs. Managers must take care to remove animals that are getting too thin or too fat, which is why managing these in small groups allows for better utilization of floor space.

For non-competitive feeding systems, sows can be placed on a "feeding curve" which can adjust the daily feed allowance to match her nutrient requirements based factors such as parity and BCS. The key for these types of systems is developing the proper feed curves and in training workers to recognize how to select the proper allocation of feed for individual sows. An important part of this feed curve allocation is training workers to assess body condition in mid-gestation to determine if previously "thin" or "fat" sows have been brought back onto average curves maintain consistent herd BCS.

Gestation diet

As gestating sows are typically limit-fed to maintain body weight, aggression around limited resources (especially food) is common in group housing. In a survey of 104 French sow farms, Cador et al. (2014) reported significantly higher incidence of major leg disorders for farms that fed less than 3.1 kg/d. One way to increase the bulk density of the diet and hypothetically increase satiety is by adding dietary fiber (such as soybean hulls or resistant starch), which has been shown to reduce stereotypies, aggression, and improve sow welfare without affecting sow productivity (Sapkota et al. 2016). In addition, sows in group pens may have increased maintenance requirements as they have a higher level of exercise and activity than stall-housed sows. One area of opportunity for gestation nutrition is the capability to access multiple feed lines and blend varying ratios of two or more diets in gestation. Currently, research on phase feeding in gestation has been inconclusive, but opportunities to feed gilts separately from sows offers economic savings since current gestation diets are typically targeted to meet higher gilt nutrient requirements.

Common mistakes

One of the most common problems seen on farms is over-conditioned females in gestation, and this is most common in gilts. Too often, gilts are bred late and are bigger than ideal when removed from ad libitum feeders, and then are not brought back into ideal condition before farrowing. In floor-feeding or shoulder stalls the cause is usually overfeeding the whole pen to maintain condition in thin sows; whereas, in traditional and free-access ESFs the issue is a failure to frequently calibrate the system or misapplication of feed curves. These are costly mistakes, not only in regard to wasted gestation feed. Young et al. (2004) showed that sows that were too fat at farrowing have reduced lactation feed intake, greater backfat loss in lactation, and reduced litter size in the subsequent lactation (Figure 5).

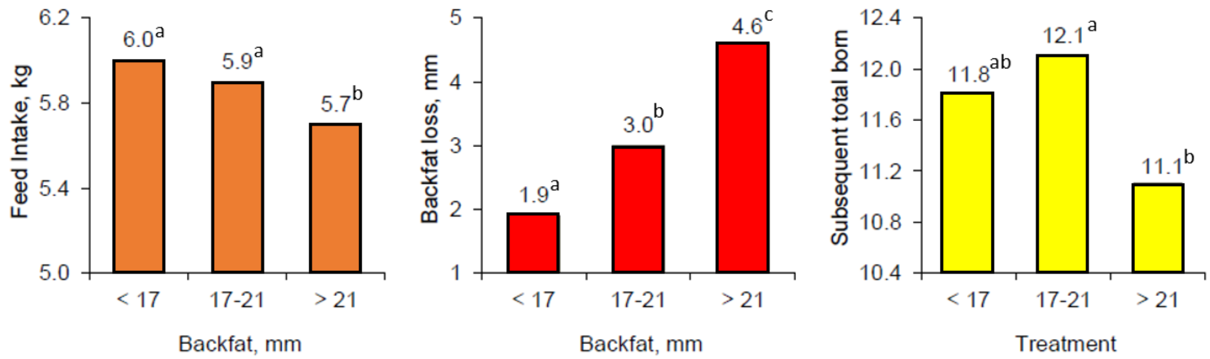

Figure 5. Effect of increased back fat at farrowing (Adapted from Young et al., 2004). Means without a common superscript differ $P < 0.05$.

CONCLUSIONS

There are many factors that affect the success or failure of retrofitting farms to group housing. Properly managed with the right care and attitude, many different forms of group housing can result in performance similar to gestation stalls. However, the challenge lies in the transition period, and making the choices which fit the resources, cost, and staff available on your farm. Due to the inherent unique features that differ between farms, peer-reviewed research alone can never answer all of the questions. Nonetheless, the transition to group-housing offers an opportunity to apply a focus on stockmanship in your herd. Future opportunities exist to reduce feed costs, minimize aggression and increase performance of group-housed sows through utilization of new technologies and pig production strategies.

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FARMING AS AN IMAGE AND ROLES BETWEEN EMPLOYER AND EMPLOYEE

John Otten
South West Ontario Veterinary Services

A good employee is a huge business asset. And like all business employees, farm workers perform only as well as they are managed, maintained, and motivated

The Canadian Agricultural Human Resource Council (CAHRC), based in Ottawa, has examined the farm labour recruitment situation and reports that demand for workers is expected to increase faster than supply, partly due to the poor image of farm labour.

“Agriculture is not very well defined,” says Danielle Vinette, executive director for CAHRC. “There is still very much a stereotypical view of farming — that it’s low-wage and back-breaking work. One of our objectives is to define occupations, so at least there is a more accurate picture of agriculture. That’s what we need to make it more attractive,” she explains.

Part of the trouble is that most farmers have always been their own boss; “They think that being a business owner and never being an employee sometimes means they might not be able to understand the worker’s viewpoint. It’s not just farming that is like that; it’s just that farming can be more urgent.”

Security is another issue for many farm workers. People seek permanent positions that help provide for their family and their future.

Some producers are stars at keeping staff. It takes energy, inventiveness and money, but the payoff comes in the shape of employees who stick with you, improve their skills and become increasingly valuable team members as the years go by.

EMPLOYER ROLE IN MOTIVATION

People who are appreciated are motivated.

People who are valued are motivated

People having fun are motivated.

People who know they matter to the organization or family are motivated.

And motivated people do **great things**.

Here are five tips for employers to help motivate employees in the work place:

Recognize good work and do so frequently.

Conduct exit interviews that ask questions to help understand why the person is leaving Use this information to help modify current practices and behaviours within the workplace when possible.

Use employee surveys that not only ask for feedback on the challenges but also why they stay with the operation. Do more of these things.

Review current organizational policies and practices frequently and remove any that aren't effective or are unnecessary.

Invest in the people and give them opportunities to learn both inside and outside of the operation.

Regularly review your mission statement with your workers:

- Tell them how important your business is to you and your family.
- Let them know how important they are to the success of your business.
- Let them know that they are important to you as individuals.
- Tell them you need their skills and experience.
- Tell them the business can only succeed with their help
- Tell them you want to see them grow in their job and achieve whatever they want and are capable of doing in your business.
- Show them that your business is a fun place to work.

Tell them the "little things" are the most important things.

HOW TO BE THE RIGHT EMPLOYEE

When hiring for any size business, it's not what the candidates know today. Information can always be taught. The most intelligent companies hire on future success and heavily weigh personality when determining the most apt employees.

Regardless of industry, pay, age or sex, all ideal employees share some common traits. These include, but are not limited to individuals who can be described as or possess the following:

1. **Action-Oriented** - Hire employees who take action and take chances. While chances may lead to failure, they will more often lead to success and mold confidence while generating new ideas. Stagnant employees won't make your company money; action-oriented employees will.

2. **Intelligent** - Intelligence is not the only thing, but it's a strong foundation for success. While there are many variables you can be flexible on when hiring, intelligence is a must or you're going to be spending an abundance of time proofing work, micromanaging and dealing with heightened stress levels.

3. **Ambitious** - Employees can only help your company if they want to help themselves have a better career. Ambition is what makes a company innovative, it's what spawns creative ideas and what generates candor and openness amongst employees.

4. **Autonomous** - You are hiring an employee who can get the job done without extensive hand-holding. As the owner of the company, you have your own tasks to take care of and, when you delegate activities to the individual whom you're hiring, you don't want 20 questions, rather you want execution.

5. **Display Leadership** - Do you see this individual being a significant part of your company and leading future employees of the firm? Leadership begins with self-confidence, is molded by positive reinforcement and repetitive success.

6. **Cultural Fit** - Are you going to enjoy working with this individual on a daily basis? Are your employees going to enjoy working with this individual?

7. **Upbeat** - Employees who come into work fresh and energetic everyday are going to out produce workers who think negatively and easily burn-out when they encounter defeat. Upbeat and optimistic employees create a working environment that is unique, spawns new ideas and, just as important is enjoyable for the other people involved.

8. **Confident** - Confidence produces results and encourages employees to take on challenges that others shy away from. The best companies are highly confident in their abilities to provide a superior product or service and this belief spawns a culture of improvement and client confidence.

9. **Successful** - One of the most effective ways to predict future success in a candidate is their past success at other firms. Have they remained at companies for a prolonged period? Have they met company goals? What achievements have these individuals accomplished? If one looks closely, a lot can be deciphered from a resume.

10. **Honest** - An employee can have all the talent in the world, but without integrity and authenticity, nothing great will be accomplished. If nothing else, you want honest, forthright employees at your organization; otherwise your company ultimately won't survive.

11. **Detail Oriented** - Attention to detail is crucial or mistakes will be made within your company. Detail-oriented employees take pride in their work. They dot the "i's", cross the "t's" and get the job done.

12. **Modest** - The most sought after employees shout their value not through their words, but rather through their work. They are humble, don't need to pump themselves up in front of others and quietly out produce those who do.

13. **Hard Working** - Nothing great is accomplished easily. Nothing great is accomplished via hiring 9 - 5 employees. Rather, the foundation of an effective organization lies in its ability to recruit results oriented, hardworking employees who execute.

14. **Passionate** - Employees who are passionate about their job never work a day in their life. While money should be a motivator in all individuals whom you hire, make sure that they enjoy the journey when pursuing that end-goal.

IN THE END

You can train an employee on your product or service, but you can't train someone to have integrity, resiliency, self-confidence and work ethic. The smaller the business, the more crucial any hire is. Be flexible on background requirements, but continue to be stringent on personality traits

SOURCES

- Forbes Traits of the Ideal Employee
- Farm Futures Employee Motivation
- Corn & Soybean Digest Successful Manager motivate workers
- Farm Forum Employee Investment pays Dividends

Team Building and Motivation

Marsha Chambers
South West Ontario Veterinary Services

So many seminars and meetings and activities are deemed as failures. Leaders fail to define the team they want to build. Developing an overall team is difficult from building an effective and focused team.

Culture change

Does the organization or ownership recognize team work and collaboration? Are you planning on changing how you reward, recognize, hire, develop, motivate and manage your people? Do we use failures for learning and support reasonable risk? Do we recognize change and support our teams, to know you will receive payback from the work of your team?

Clear expectations do our team members understand why they are on the team and how they fit into the team? The generation gap is real in our industry. Baby boomers represent a generation that consist of fully contributing individual performers. They had little experience in team work, other than playing soccer or hockey. It was difficult for them to work in a team environment, look at how these 2 generations were raised. The boomers didn't work on team projects, or do group work in school. It was all individual work alone, everything the boomers did was from the hard work they put in themselves.

The boomers worked hard and grew the businesses and or family farm to only start to hire employees, which was a new to most and didn't know what or how to manage or work in a team base setting.

Gen x or millennium's, they have worked in teams and groups growing up. Many of them struggle to work or think individually. They were also raised of being equal to one another and struggle to work alone. They want to be included in all aspects.

You have history and past practises to learn and overcome faults, most employees need consulting, coaching, training and hand holding.

Employee Empowerment enables employees to make decisions about their jobs. This helps employees own their work and take responsibilities for their results.

Employee involvement is creating an environment in which they have impact on decisions and actions that affect their job. This steams from management and leadership.

THE C'S WE NEED TO LOOK AT WHEN STRIVING TO BUILD A SUCCESSFUL TEAM

Clear expectations

Has leadership clearly been communicated of expectations and outcomes?

Context

Do our team members understand why they are on the team? Do they understand the goals of the farm, do they understand the work that is expected of the farm?

Commitment

Do our staff members want to be part of the team? Do they feel they are important to the farm? Are the team members excited and challenged are they engaged?

Creative Innovation

Are you really wanting to make changes? Are the employees able to be creative and come to you with ideas? Are they rewarded? Is training provided, continued educations?

Consequences

Does the team feel responsible and accountable for the team's achievements? Are they rewarded or recognized when they are successful? Do your employees point fingers rather than solve the problem and take ownership for actions?

Coordination

Is the team coordinated by a central leadership that help them obtain success? Does the team understand the concept of the next process? Are they working together effectively?

Culture Change is probably the big one for me.

Does the farm or ownership recognize team work, collaboration as important? Are you planning on changing how you reward, recognize, appraise, hire develop and motivate and manage your staff? Do we see the impact of having a good strong well trained staff is? What is the impact for your production and how do you value this on your farm?

Human Resources: Training and Evaluation

Trish Hyshka
Sunterra Farms

Training employees is a very difficult task to ask just anybody to do. People really know their job but are not always good at teaching others to do the same job. They are not natural born teachers and we have to realize that we need to take time to "Train the Trainer".

Obstacles That are Encountered in the Training Process:

- Every person has a different learning style and the trainer must be able to tune into how each person learns and be able to teach using that style.
- Some employees have no interest in learning new things.
- Training takes time out of an already hectic schedule.
- Some people take several sessions in order to comprehend what needs to be done and how to do it – need a lot of patience.
- Some people have poor listening skills – they hear but do not listen.

It is critical to have people trained and waiting in the wings for when their superiors leave – they are ready to step up. There are many obstacles, many the same as what are listed above as to why this often does not happen. Every person needs a contingency plan – especially in the supervisory roles. Supervisors and Managers need to understand that not passing on their knowledge is not creating job security. What it does in fact do, is hold them back if opportunities arise.

The most important skill for a leader to have when training employees is "COMMUNICATION". If you cannot communicate in many different styles, you will not have success in training employees.

What is Communication? Communication conveys a message and is measured as successful when both the sender and the receiver understand the same information as a result of the communication.

Considerations When Communicating:

- Understand the message that you are trying to send.
- Understand who your audience is and what their reaction will be. Understand their learning style and the process in which they need to be trained in order to understand.
- How will they perceive your message? Will they be bought in? Will they understand? Will they have confidence in what you are telling them?
- Watch for feedback ….
  - Have they understood? How can you tell?
  - Are they upset or discontent or do they have confidence in what they just learned?

- Are they motivated to go out there and do the job exactly as you have trained them to do?
- Did you achieve your desired outcome?

Listening:

One side of communication is talking or sending a message, the other is listening or receiving the message. Both are equally important for both the sender and the receiver to understand the same message that is being sent/received.

The Skill of Listening:

- Pay attention – make sure you are hearing and absorbing everything the other person is telling you. Make sure you hear their message loud and clear.
- Show the speaker you are listening – give them verbal cues that you are hearing and understanding what they are saying. Ask for clarification if you need to. Agree or disagree – engage in conversation.
- Provide Feedback – once the sender has sent the message, give feedback on what they are saying – agree or disagree. Why? Give an opinion if one is warranted.
- Defer Judgement – do not judge the other persons opinion or ideas. They are entitled to them. Once you start judging, you stop listening.
- Respond appropriately so that it verifies that you were listening to what they had to say and got the intended message.

Good Listening Results In:

- Improved productivity.
- Increases the ability you have in influencing others.
- Increases the ability to negotiate a situation and persuade someone to come to your side of the equation.
- Decreases the occurrences of conflict and misunderstandings.

Why Listening is Important:

- Listen to obtain information.
- Listen to understand.
- Listen for enjoyment.
- Listen to learn.

It is dangerous to just assume that someone is listening and was able to understand the whole message. Humans remember 25% to 50% of what they hear. For every 10 minutes that you talk, the other person is hearing 2.5 to 5 minutes of what you are saying. Do you know what part of the conversation that they heard? Is it what you needed them to hear?

Barriers of Communication:

- A lengthy, unorganized or inaccurate message will be misunderstood and misinterpreted.
- Poor verbal and body language will easily confuse the message.
- Giving too much information in too short of a time frame will put up a barrier to understanding.

TRAINING

First thing that you need to understand is what is your end goal when you are training an individual? Goals need to SMART. Specific, Measurable, Attainable, Relevant and Time Bound. If there is not a measure to know when you get to the finish line, you will continue to run aimlessly in an open field. Goals need to be reachable or our trainees will give up and feel that there is no point. They need to be relevant to what they are learning and the end goal that they are trying to achieve. And they need to be achieved in a reasonable amount of time, if things get too drawn out, the importance of the goal and what they first learned is lost.

Managers and supervisors need to develop a training plan for each employee. This needs to be a moving target that recognizes accomplishments and keeps things moving forward. Every employee is an individual and will be at different stages of their training than their coworkers. It is critical to plan how their training will go and ensure that it is going in a sequence that makes sense. Learning how to manage the farrowing rooms before you have mastered all the tasks in farrowing makes no sense.

At Sunterra we structure our training plan in different levels, starting at 1 going to 4 and then starting again in a supervisory capacity. Everyone has access to what the next level looks like and what they have to accomplish to get there. At each performance review, we cover what the employees have accomplished and document what the next goals and steps will be.

My Training Strategy:

- I show and explain to you.
- You show and explain to me.
- I correct any misunderstanding and show again if necessary.
- You show and explain to me.
- You show me.
- When both of us are confident, you show yourself!!

Feedback

It is critical to constantly evaluate employees and give feedback. All employees want the following questions answered:

- How am I doing?
- How can I do better?
- Am I ready for the next step?

Good Feedback Helps:

- Improve employee performance.
- Decrease turnover.
- Motivate self improvement and gain confidence.
- Build trust.

There are 2 ways to give feedback. Formal and Informal Reviews. Formal reviews occur on a regular schedule with written reports to employees – this is usually every 3, 6 or 12 months depending on the company and their specific policies and practices. Informal reviews are the most important and should occur several times a day. This is the constant coaching and feedback that supervisors and managers need to give their trainees to keep them always moving forward. A combination of formal and informal reviews is needed to fully develop employees to their full potential.

Ineffective Evaluations can Cause:

- Routine evaluations that are not linked to performance or advancement tend to cause management and employees to not take them seriously.
- If evaluations are rated on a 5 point scale, there can be a centralizing tendency whereby everyone gets a 3 or a 4 rating. Question is can the employee complete the task properly on a consistent basis?
- The evaluation tends to be a reflection of what the employee did last week as opposed to what they accomplished in the last quarter or year.
- It usually turns out that all employees are rated above average as to avoid confrontation or dealing exactly with the situation – dancing around the issue sometimes occurs.

Reward for Learning:

There needs to be incentives or rewards for learning and taking on more or new responsibilities or taking things to the next level. There needs to be something to strive for. You will be hard pressed to find employees that would like more responsibility without more pay. In most cases, they want to know what is in it for them. Make sure to structure you pay scales so there is always room to move in pay if an employee is advancing in skill and efficiency. Having a cap on salary will mean there is a cap on learning. This is not a situation that any company wants to get into.

Our Strength is in Our People – without them we are nothing!!

BATCH FARROWING: 10 YEARS LATER

Graham Learn
Producer

WHAT DOES BATCH FARROWING MEAN?

First we need to know what a batch farrowing system is - taking one week's production and compiling it into a multi-week system. It can range from a 2 week cycle (what we do) to a 4 or 5 week cycle. Instead of breeding and weaning every week, you do it once every 2 weeks or whatever length works for your operation, depending on labour availability, desired nursery group size, and target weaning age. The 2 week batch will give you 10 continuous groups in the sow barn or 26 groups per year.

FARM LAYOUT

In 2006, we built a 350 sow barn with 1500 weaner spaces. This was a big change from 90 sows we had before. The next issue was that we didn't have the finishing spaces we needed. With some help we went to a 2 week batch so we could get bigger weaner groups to sell. The barn layout fit best for a 2 week system. This layout has 3 groups in the breeding area, 5 in the dry sow barn and 2 groups in the farrowing rooms. We fill 8 weaner rooms, 2 at a time. When we ship weaners out, we can fill a 1000 head finishing barn in 3 groups.

WHY WE DECIDED TO BATCH

- After the sow barn was built we needed more finishing spaces and bigger groups to sell
- The barn layout works from dry sow barn to weaner rooms
- Better use of labour by weaning 32 sows in one morning
- Better management around cropping season
- Disease management by all in all out and less opening the door
- Disease elimination – we were hit with PRRS and PED and become negative again on both less than one year later
- Having to be more disciplined in our overall operation

BATCH FARROWING – OUR 2 WEEK CYCLE

Mon	Breeding approx. 10 sows, neuter nursing pigs
Tues	Breeding approx. 15 sows
Wed	Breeding approx. 10 sows, start farrowing
Thurs	Breeding if needed, some farrowing
Fri	Many farrowing, process approx. 8 litters
Sat	Many farrowing
Sun	Last sows farrowing
Mon	Process approx. 16 litters, ship cull sows, move dry sows & set canisters
Tues	Process approx. 8 litters, ship weaner group
Wed	Wash weaner rooms, process if needed
Thurs	Weaning, weigh & move weaned sows, wash farrowing room #1
Fri	Load farrowing room, weigh & move room #2, wash
Sat	Start breeding gilts & open sows, load room #2
Sun	Breed more gilts & open sows

ADVANTAGES TO A BATCH SYSTEM

- Larger and more uniform weaner group sizes
- Feeding the pigs more efficiently
- Defining the jobs amongst employees
- Planning your week out for busier days
- Using your labour more efficiently, when and where you need it
- Easier to plan for holidays and long weekends

THINGS TO CONSIDER IF YOU ARE THINKING OF SWITCHING FROM CONTINUOUS FLOW

- Do you and your staff adapt well to change
- Does the barn layout work for a batch system
- How long of a cycle will work best
- What are your expectations for going to a batch system
- Weighing the pros and cons to the new production flow
- Will you have enough labour for the busy days
- How will it work if you are a crop farmer or multi species
- There may be a loss of production while you initially establish the groups

CONCLUSION

Batch farrowing is a great tool to use. Many things need to be considered when looking at a batch system and if it will be a right fit for your farm. Batch farrowing is not for everyone or for every farm layout. If used in the right set up with producers that are willing to see it though, batch farrowing can be a very rewarding system on the modern sow farm.

WHAT DATA TO COLLECT AND HOW TO USE IT

Daniel Roelands
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WHY COLLECT AND COMPARE DATA?

- To improve your bottom line. "He who does it best gets to do it."
- To stop yourself from assuming and start being certain of your farm's performance.

HOW WE COLLECT AND COMPARE DATA ON OUR FARM

A few years ago we started benchmarking our farm's data against other farms. In doing so we realized that we were not equipped to collect accurate enough data to properly compare it. We were farrowing sows weekly. Our nursery and finisher barns were continuous flow making it difficult to do proper closeouts. The feed was made with a meter mill so it was hard to know exactly how much feed was being made. There was also no logical way of weighing pigs in the barn.

Last year we built a new farrow-to-feeder pig barn. We designed the barn to enable us to collect accurate data. The new barn is setup for a 4 week batch system. Due to the large group size, there are 2 all in all out nursery rooms and all in all out finisher barns. We installed a 12' x 6'8" hallway scale to weigh all pigs at weaning, as well as all feeder pigs being shipped out. The meter mill was replaced with a computerized batch mixer. We can now know exactly how much feed each nursery and finisher group gets, as well as their in and out weights. The all in all out farrowing barn allows us to keep track of creep feed, potato starch, milk replacer and drying agent usage for each batch. We also use PigWin to keep track of our sow production.

WHAT TO DO WITH THE DATA

We are involved with 3 different styles of benchmarking groups.

1- The first group keeps each producer's numbers confidential, but allows you to compare your farm to the high, low and average of the group. It gives you a good idea of how your farm is performing compared to similar farms in the area. It is open to any producers who which to participate.
2- In the second group, individual production numbers are shared. It is an informal, kitchen table, beer drinking kind of group. This meeting allows you to ask a specific producer what they are doing to achieve results from a specific aspect of their farm.
3- The third group shares individual production numbers as well as costs. It is a more formal meeting. By including the costs this meeting allows you to ask specific

producers about specific management strategies and see the financial implications of those strategies.

Any style of benchmarking will be beneficial to your farm as long as the data is reliable and the producers involved are trustworthy and willing to discuss the strengths as well as the weaknesses on their farms. The goal of the group should be to improve everyone's production/profitability, not to show off your own.

CONCLUSION

The best analogy I can come up with is to compare managing a pig farm to a water pipe. At one end, the pipe is full, representing maximum possible production and profitability. Along the pipe, there is a tap representing everything that can be managed on your farm (Feed Cost, mortality etc.). The taps are where profits leak out. What comes out the other end of the pipe is your actual profitability. Collecting reliable data, then comparing and discussing it is a great way to figure out which of your taps are leaking and what you need to do to close them.

WHAT DATA DO YOU COLLECT AND HOW DO YOU USE IT

Neil Harper
Ontario Pork

DATA

The dictionary defines data as a set of quantitative or qualitative values. There is a difference between Data, Information and Knowledge.

Data is only useful if it is accurate, maintained and collected in a form that can be analyzed. Only then can it become meaningful information which can then lead to knowledge.

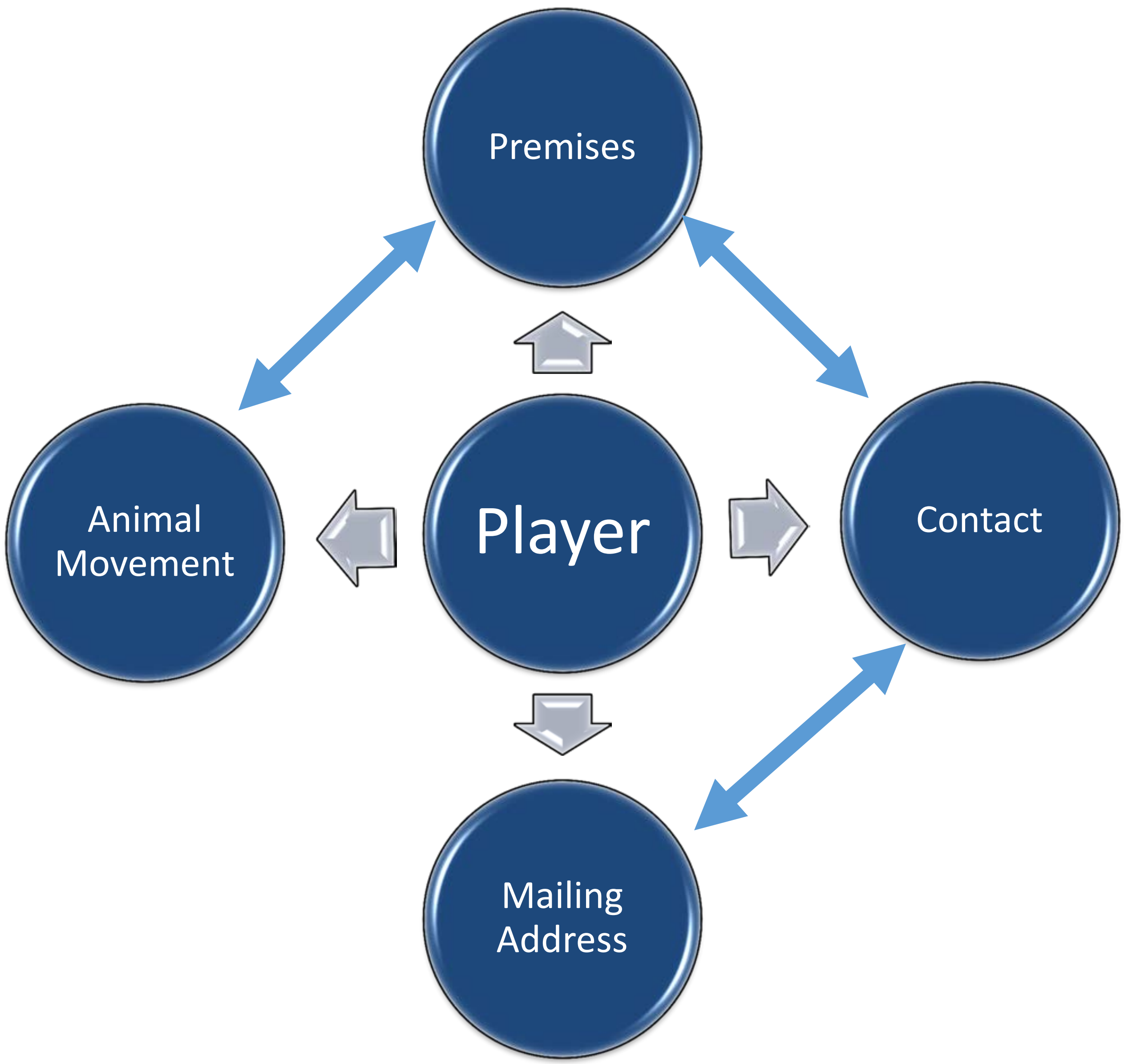
THINGS TO CONSIDER

- Data are generally organized into multiple tables containing rows and columns.
- Take some time to plan the structure – draw a diagram. Some column values are related to records in another table. Avoid redundancy. Identify any rules to be applied to certain column values. Avoid free form text or unstructured data. Anticipate future changes and requirements.
- How will the data be stored? Paper, Excel, Microsoft Access, Enterprise level databases
- How will the data be used and presented? Searching. Reports. Graphs.
- Leverage existing data. Try not to duplicate data that exists elsewhere. What connections can I make with external data sources
- Storage of data
  - How much space do I need
  - Where am I going to store these files
  - Backups. Data takes a long time to accumulate but can be destroyed in an instant
  - Recovery – How do I recover my lost data
  - Security – How do I protect my information

WHAT DATA DOES ONTARIO PORK HAVE?

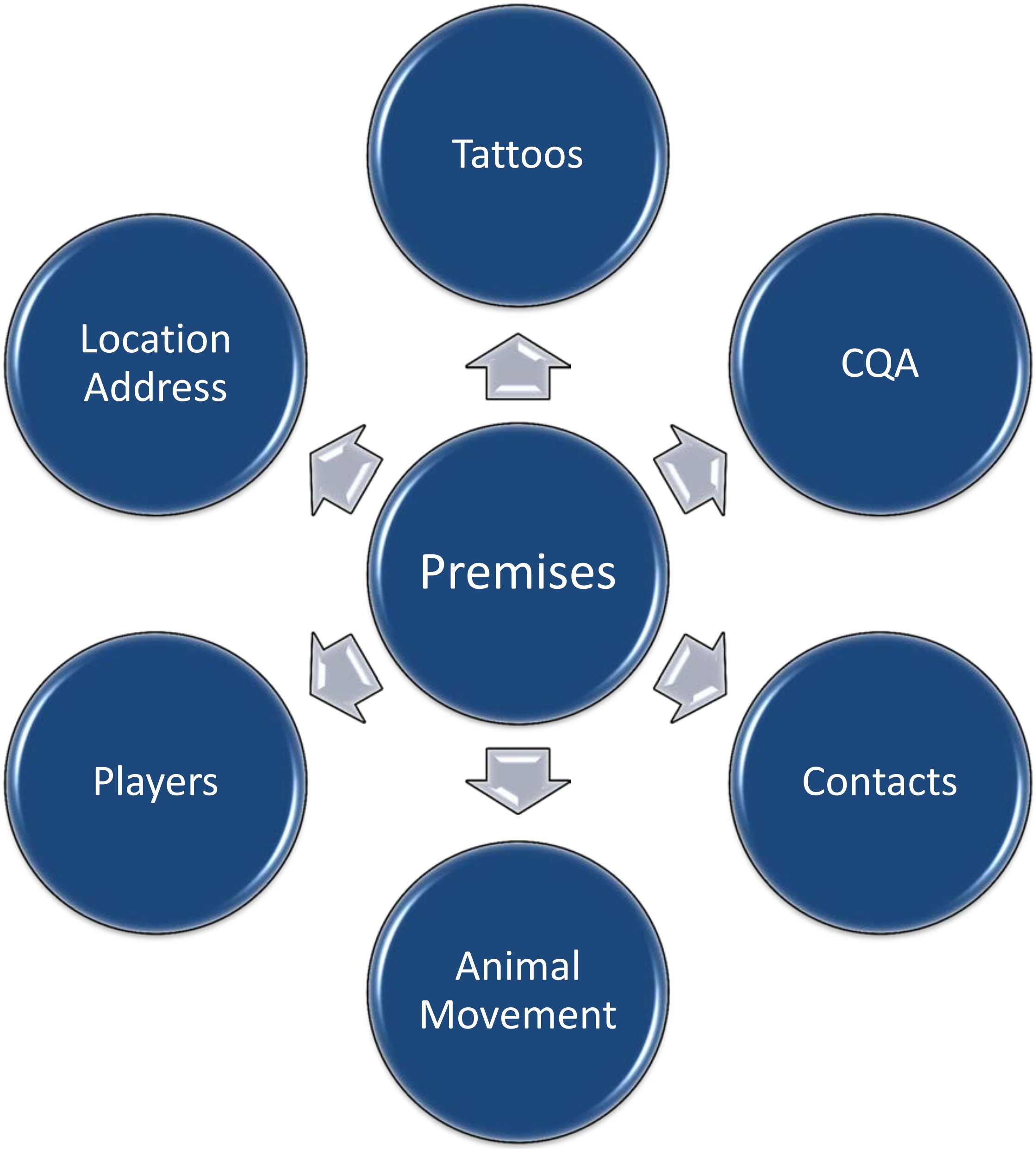
- Producer information (Producer registration #, Name, Address, …)
- Contact Information (Name, Phone #, Email Address, …)
- Premises Information (Premises Registration #, Address, GPS Coordinates, …)
- Tattoos (Tattoo #, Premises that the tattoo is assigned to, …)
- CQA Membership (CQA #, Vet, Renewal Date, …)
- Grading Data (Fat, Muscle, Weight, Yield, Price, …)
- Movement information (Movement Date, Origin, Destination, Number of animals, Tattoo, …)

Player Information (Producers, Transporters, Processors, …)



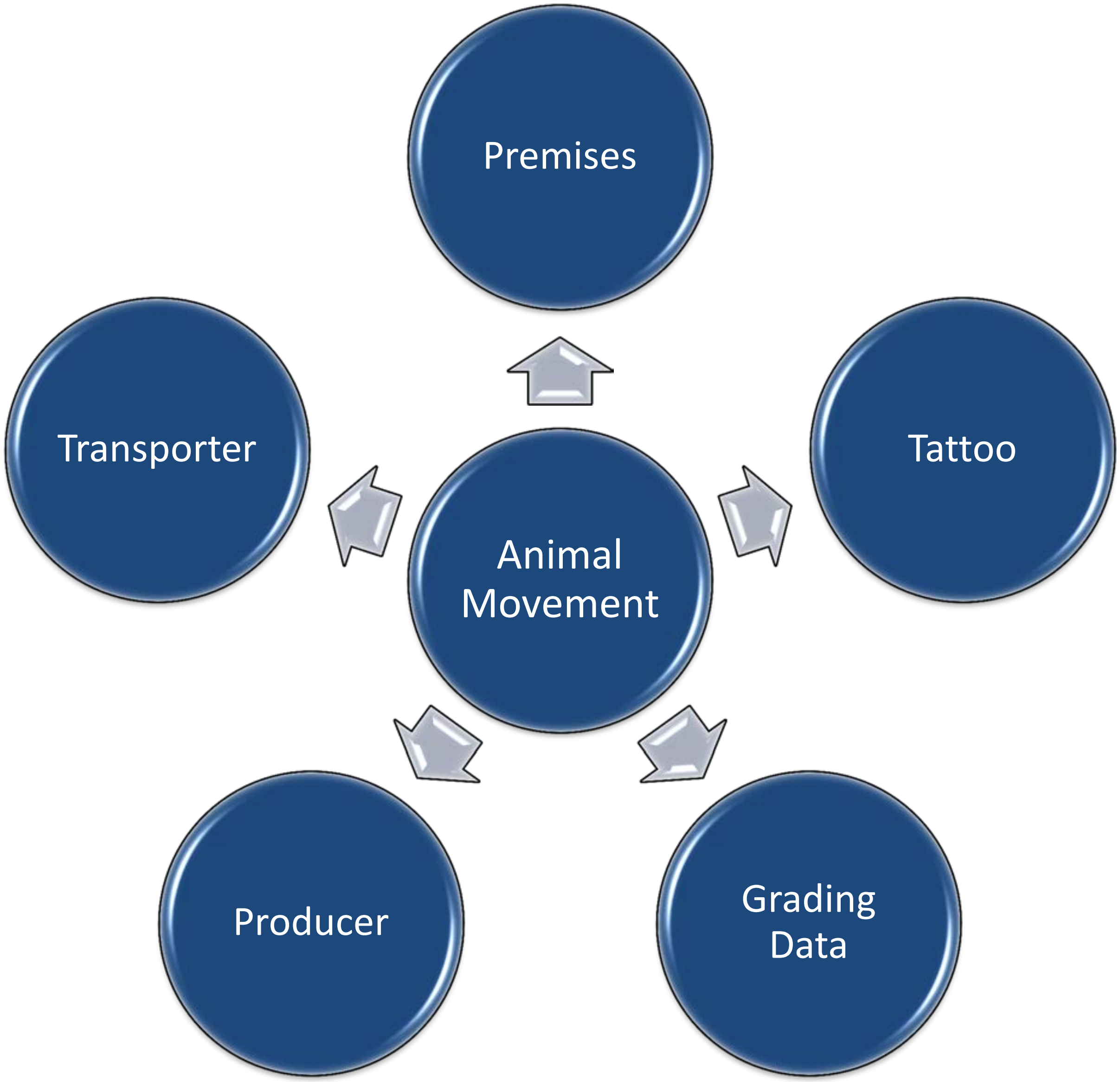
- A Player has one Mailing Address
- A Player is involved in multiple Animal Movements
- A Player is associated with one or many Premises
- A Player has one or many Contact persons
- Contacts have mailing addresses
- Premises are associated with one or more contacts
- Animal movements occur between premises

Premises Information



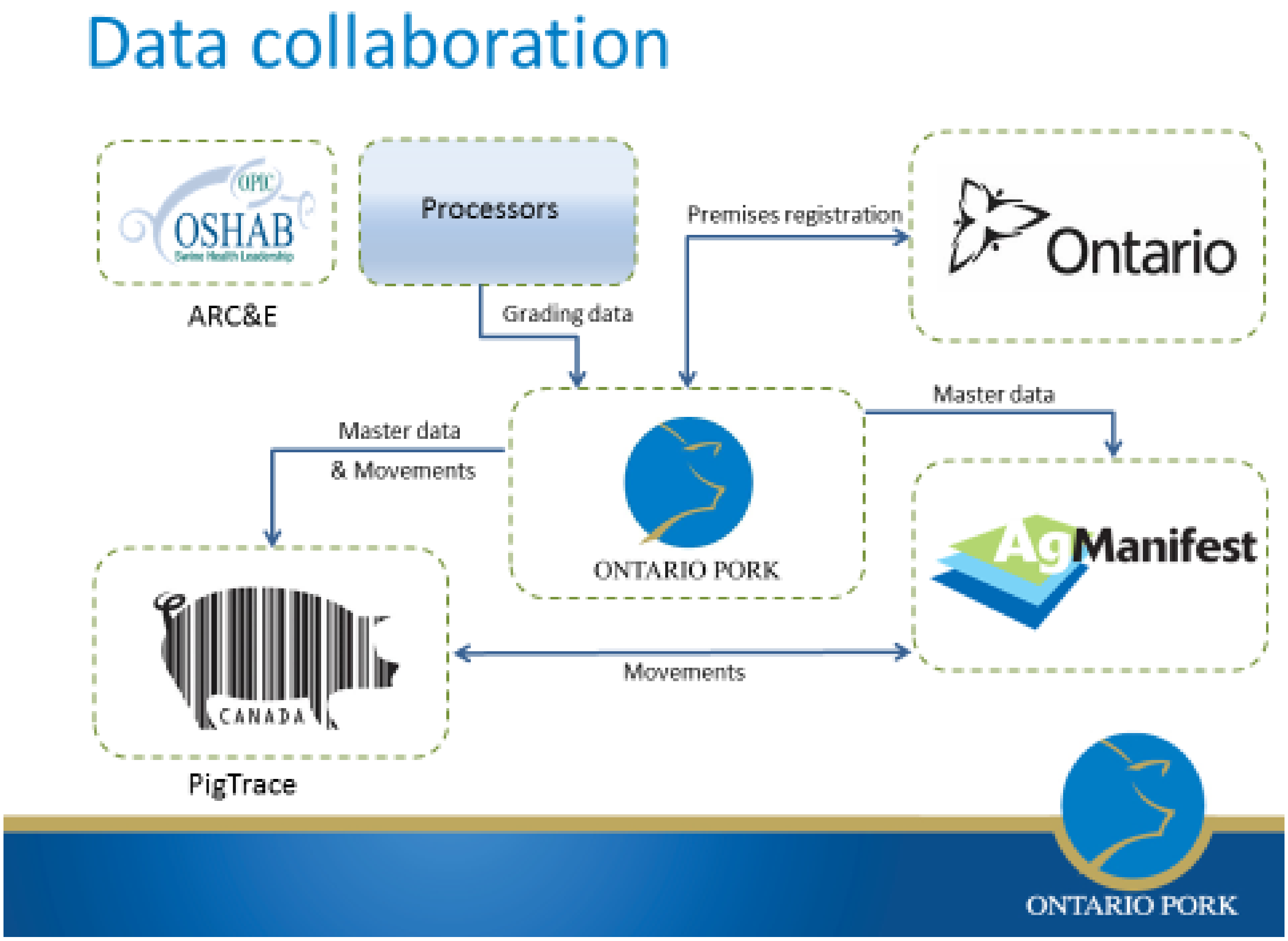
- A Premises has a Location Address
- A Premises is associated with one or many Players
- A Premises is involved in many Animal Movements
- A Premises has one or many Contacts
- A Premises is associated with one CQA record
- A premises is assigned one or many Tattoos

Animal Movement Information



- An Animal Movement involves a Producer
- An Animal Movement is associated with Grading Data
- An Animal Movement is associated with a Tattoo #
- An Animal Movement occurs between 2 Premises
- An Animal Movement is delivered by a Transporter

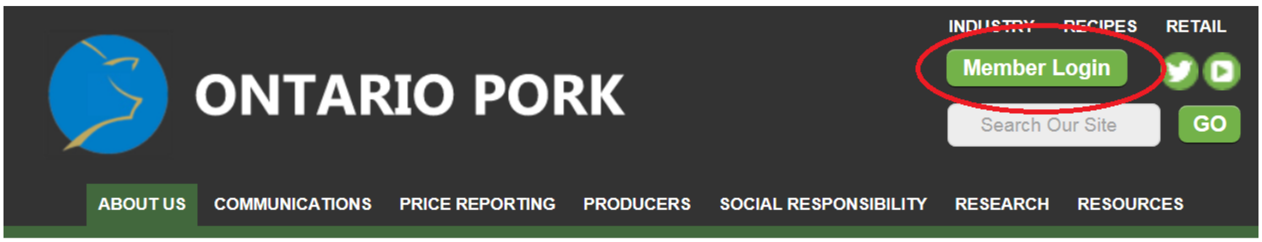
DATA EXCHANGE WITH EXTERNAL DATABASES



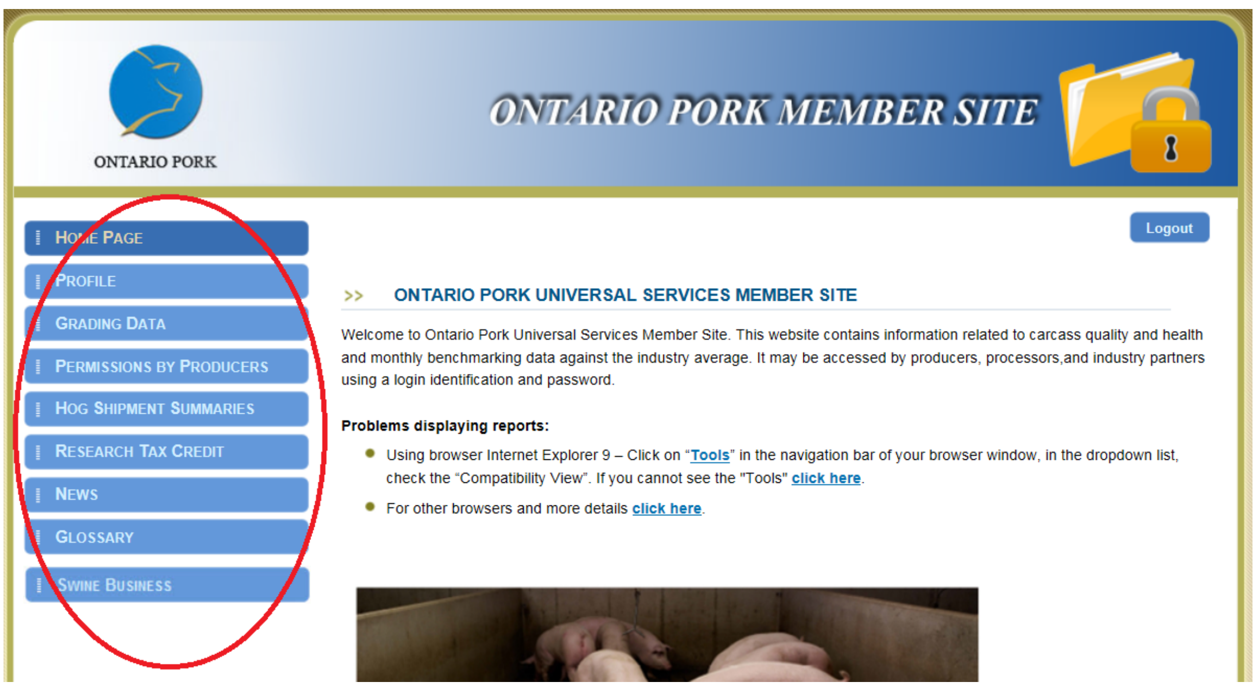
- Privacy and security is the number 1 priority!
- Ontario Pork submits Player, Premises, Tattoo and Movement information to PigTrace
- AgManifest receives Master Data from Ontario Pork and submits Movement Data to PigTrace
- ARC&E keeps track of disease status of Premises
- Ontario Pork receives Premises Registration #s from the Provincial Premises Registry
- Ontario Pork receives Grading Data from Processors

HOW CAN I ACCESS MY DATA?

- Some information is sent to Producers automatically such as Quarterly and Annual shipment summaries and annual Research Tax Credit Letters.
- Information can always be requested and we will do our best to fulfill your request.
- Information can be obtained from the Member Login of the Ontario Pork website. www.ontariopork.on.ca



There are numerous reports available in the member login area. All reports can be printed or downloaded into Excel or other formats.



PROFILE - This report displays the information that we have in our database including the Premises assigned to the Producer record. This is a good way to ensure that the information is accurate.

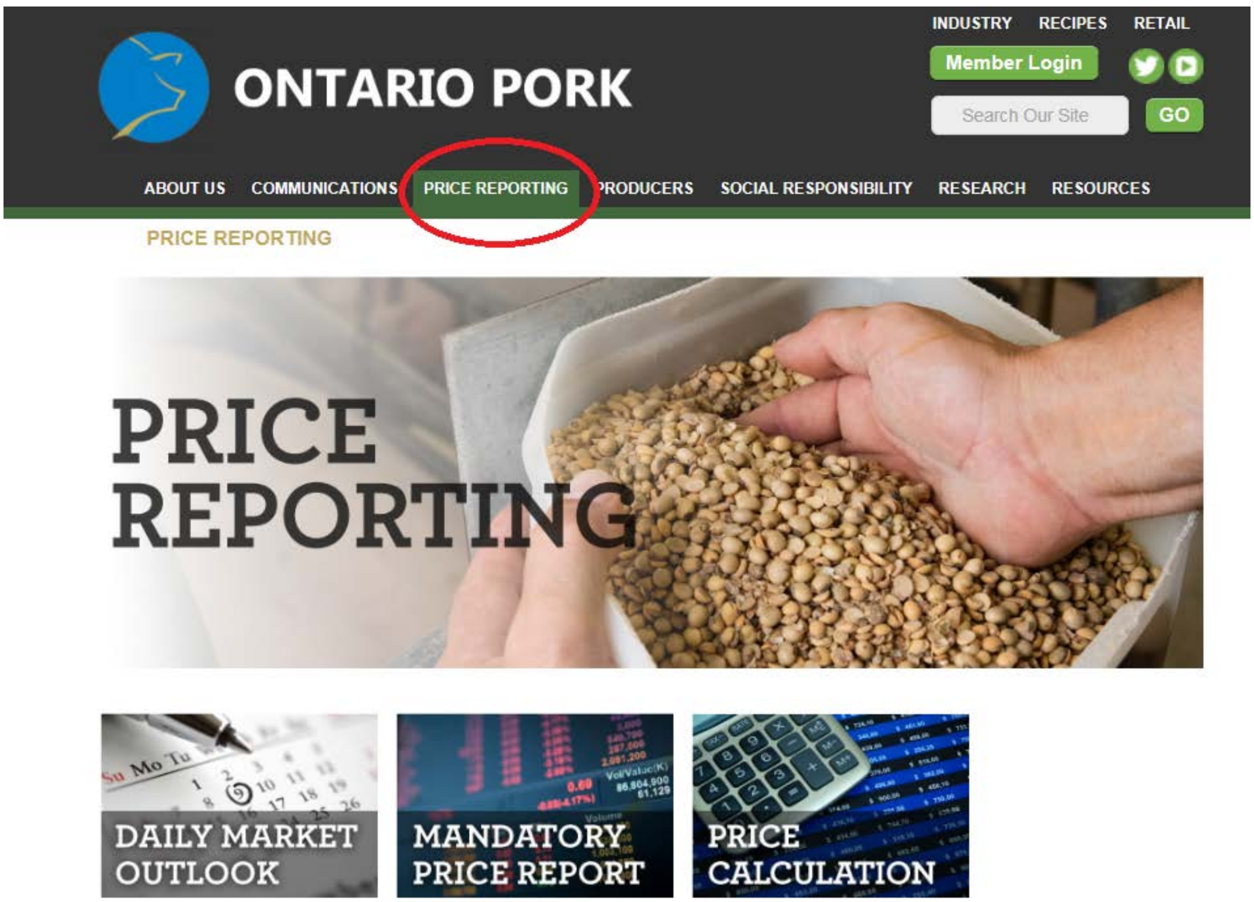
GRADING DATA - This report can be used to download the grading data that has been submitted to Ontario Pork by the processors.

PERMISSIONS BY PRODUCER - You can grant permission to others to view your grading data such as your Vet or Feed Company.

HOG SHIPMENT SUMMARIES - Summarized shipment reports are available either Weekly, Quarterly or Annually

RESEARCH TAX CREDIT - These letters for use in Income Tax returns are mailed to Producers each year but can be downloaded from the Member Login area as well.

The Public Industry area also contains useful information such as Price Reporting, Daily News Brief, Research information and other useful resources



SOLUTIONS TO PRODUCTIVITY CHALLENGES

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SUMMARY

Productivity challenges occur throughout all stages of hog production, but those that occur in the sow barn will impact the entire system. Every barn is likely to experience a different set of productivity challenges; however, some issues will rear their heads in many barns across the country. This workshop session is designed to address some of the common productivity challenges faced in the sow barn, exploring their causes and potential solutions. We will also work with the audience to problem solve around specific productivity challenges that may be occurring on your own farms. Breeding practices will not be addressed in this workshop as that topic has a session of its own.

INTRODUCTION

Issues that present in the sow barn may be related to health (such as scouring and lameness in the farrowing quarters), management, environment and/or genetics. In many cases, challenges are interconnected. For example, issues with sow feed consumption in gestation will impact the litter, affect milk production and impact feed intakes during lactation. Issues with sow feed consumption throughout lactation will impact the sows ability to rebreed as well as her litter performance through decreased milk production. Both situations can be caused by health related challenges, or management factors and both situations can lead to subsequent health challenges such as scouring piglets and potential lameness (poor milk production = poor immunity). The relationship of different challenges makes it difficult to address one thing at a time, but by breaking things down, perhaps overcoming the challenges will seem like a smaller mountain to climb.

CHALLENGES WITH SOWS

Feed Intake

As mentioned above, sow feed intake impacts many different aspects of the reproductive process (Table 1) and piglet performance. In many instances we see sows that go off feed or have sub-optimal feed intakes throughout lactation. Variation in intakes from one sow to another can be quite large, as well as from barn to barn. Some of these differences can be explained by differences in genetics, herd size, lactation length, litter size, parity distribution, diet quality and health status. However, feeding management is a large factor that accounts for a significant amount of the observed variation. Throughout this workshop we will discuss the reasons why sows may go off feed, how to get them back onto feed, how to prevent drops in feed intake, and strategies to maximize intake throughout lactation. Feeding during gestation, lactation and post-weaning, as well as different management practices associated with feeding gilts versus sows will be addressed.

Table 1. Effects of protein loss in lactation (21 days) on sow reproductive performance (Clowes et al., 1999).

	Dietary Protein Level		
	High	**Medium**	**Low**
Lactation Crude Protein Intake, g/d	878	647	491
Lactation Lysine Intake, g/d	50.2	34.6	24.2
Lactation Weight Loss, kg	12.9	16.9	28.4
Lactation Body Protein Loss, %	6.9	9.2	15.8
Milk Protein Composition, %	5.0	4.8	4.5
% of Follicles > 4 mm diameter*	55.4	55.4	23.6

*Follicles of 4-6 mm are the ones most likely to produce viable ova at the time of estrus.

Lameness

Sow lameness, is one of the most common reasons for culling, even in young parity animals. Due to sows being euthanized or culled as they approach the most productive part of their life, it can cause huge financial losses.

Lameness occurs in sows housed in both stall and group housing systems. Most commonly we see injuries (or other non-infectious causes) as a cause of lameness, much more frequently that infectious causes. More importantly, one of the most common causes of lameness in sows is inappropriate flooring, leading to foot and leg injuries. Understanding the potential causes of lameness, can help us to reduce the overall level within the herd and improve productivity and welfare.

CHALLENGES WITH LITTERS

Litter management encompasses a wide range of topics. This workshop will focus on reducing litter variability (both across and within litters), dealing with large litter sizes, pre-weaning mortality, and health related issues such as scours and piglet lameness.

Over the last 12 years we have seen significant increases to litter sizes across the pig industry. PigChamp benchmark summaries indicate a 14 % increase in the mean number of total pigs born per litter between 2005 and 2015 (Table 2). More and more herds are approaching 30 pigs per sow per year; however, these increases in litter size are not easy to manage. A significant amount of data shows that as total litter sizes increase, stillbirths increase, piglet birth weights decrease and the variability in piglet size increases (Table 3). Additionally, lower birth weight piglets have significantly higher mortality rates throughout the lactation and nursery phases (Ferrari et al., 2014), and also take longer to reach market weight (Figure 1).

Table 2. Total piglets born per litter between 2005 and 2015 (PigChamp Benchmark Summaries).

Year	Lower 10 %	Mean	Top 10 %
2005	11.00	11.93	12.87
2015	12.30	13.64	14.91
% Change	+ 11.8 %	+ 14.3 %	+ 15.9 %

Table 3. Effect of number of piglets born per litter on piglet birth weight (Quesnel et al., 2008).

	Litter Size Category				
	≤ 9	**10 to 11**	**12 to 13**	**14 to 15**	**≥ 16**
Number of Litters	195	154	276	394	579
Average Parity	2.6	2.3	2.5	2.6	3.5
Total Born	7.1	10.6	12.6	14.5	17.7
Born Alive	6.9	10.2	12.0	13.7	16.1
Stillborn	0.3	0.4	0.6	0.8	1.5
Avg. Birth Weight, kg	1.88	1.67	1.57	1.48	1.38
Coefficient of Variation, %*	15	18	21	22	24

*CV is a measure of the distribution of data points around the mean value.

There are many different management strategies that can be implemented to help manage large litters. The workshop session will discuss several of these topics, including addressing ways to increase piglet survivability and reduce piglet weight variation within a litter. Strategies such as cross fostering, using milk replacers and creep feeding can all increase survivability and improve piglet performance in the farrowing room.

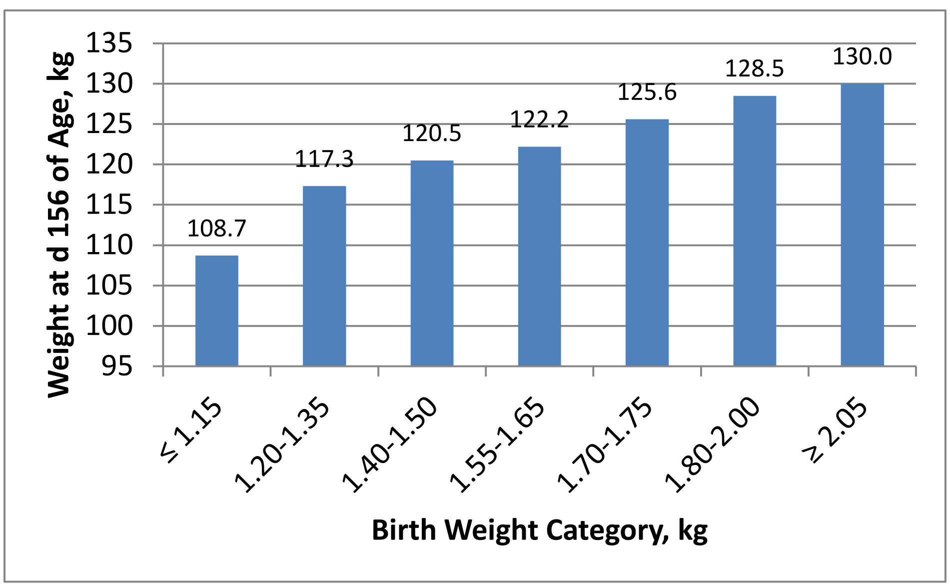

Figure 1. Influence of birth weight category on pig body weight at d 156 of age (Bergstrom et al., 2009).

In addition to the challenges associated with large litters, other factors also play a role in the farrowing room. Immunity is not equal between litter mates, as piglets are not all born at the same time, and do not reach the udder at the same time. There are 4 points that must be discussed to allow full understanding of how piglet immunity is impacted:

1. Piglets are not born with any antibodies from the sow, via the placenta, like human babies are. Therefore, without maternally derived antibodies from colostrum, the piglet is **highly** susceptible to infection.

2. There is a short window available for colostrum to be effective. Once the piglet has consumed its first drink, that window becomes even tighter. That makes fostering times and methods critical.

3. If a pig is overwhelmed with infection in the farrowing room, more than the circulating amount of antibody in its bloodstream can handle, then the pig will still get sick! Don't assume because you vaccinated the sow for Rotavirus A (for example), that the piglets should not get scours. There may be more pathogen than the antibody can mop up.

4. Passively acquired antibodies begin to wane at 10-14 days of age, dependent on the initial intake of colostrum.

These principles are important to understand, in terms of both neonatal scours and infectious arthritis.

Across North America, in terms of Neonatal diarrhea, we are seeing increased cases of Rotavirus type C, with other mixed infections of Clostridium Perfringens and Clostridium difficile. We will discuss potential control methods during the workshop.

Piglet lameness is typically an issue that waxes and wanes, and there are often management changes that go along with outbreaks. As noted above, when challenge exceeds immunity, we will see increased cases and then you need to ask "why?". The pathogen is always present in your herd, most typically Streptococcus suis (1, 2, 1/2 are most common), so what made it show up today?

General farrowing room management also plays a key role in obtaining maximal performance from your sows and your piglets. Labour availability often impacts the amount of time and effort we can dedicate to the farrowing barn, but certain tasks are essential to help you maximize performance, welfare and profitability. Topics such as assisting sows, drying piglets and suckling management will all be addressed. Additionally, we will discuss how you can determine when reproductive losses may be occurring in your herd prior to farrowing.

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Day 2: Wean to Finish – Main Sessions

How Have New Technologies and Knowledge Changed Our Views of Nutrition in the Last 20 Years

The CFM de Lange Lecture in Pig Nutrition

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It is an honour to be asked to present the first CFM de Lange Lecture at the London Swine Conference. Kees was a pillar in the swine nutrition community and loved and respected by all of the nutritionists and producers who had the opportunity to interact with him. His important research on modelling, feed ingredient evaluation, and liquid feeding truly made an impact moving our industry forward. He was one of those rare souls that could take the most difficult basic research and make it understandable for people at all background levels. He had a high regard for applied science and people that were in the barn. I certainly miss being able to ask Kees questions on so many topics, although he will live on in his highly regarded publications, students, and friends that he has touched over the years. As we highlight some of the breakthroughs in swine nutrition over the last 20 years, Dr. de Lange's fingerprints are on many of them.

ABSTRACT

Similar to other industries and disciplines, knowledge and technology continues to grow at a dizzying pace in the swine industry. Our core goals of providing cost effective programs that meet the nutritional needs of the pig on a daily basis remain the same; however, knowledge and technology allow us to meet these needs with increasing precision to reach new heights of efficiency. In this paper, we will highlight some of the main areas where changes in nutritional approaches have had the greatest impact over the last 20 years.

Transitioning from total to digestible amino acids and phosphorus and from DE and ME to NE systems have allowed us to understand key nutrient requirements. This has allowed for increased use of byproduct ingredients, thus improving economic efficiency. Robust growth and production models allow more accurate depiction of nutrient requirements while a growing number of on-farm research facilities allows for testing of those requirements, feed ingredients and additives under field conditions. Clearer understanding of the impact of protein levels on diarrhea during disease challenges, coupled with knowledge of the reality of compensatory gain has changed approaches to nursery diets.

The rapid adoption of automatic feeders for lactating sows has decreased problems with underfeeding that often had occurred during this phase. Improvements in nursery and finishing feeders has decreased feed wastage. In the last 20 years, use of the ethanol

byproduct, DDGS, has caused an improved understanding of the impact of nutrition on fat quality, optimal crystalline amino acid use, and fiber withdrawal strategies.

Although this is not meant to be a comprehensive list of the changes that have happened in swine nutrition over the last 20 years, we can be proud of the knowledge gained while being humbled by the amount still left to be learned.

NUTRIENT EXPRESSION AND DIET FORMULATION

One of the biggest changes that has occurred over the last 20 years is to more accurately express nutrient requirements allowing for more precise diet formulation (Figure 1). Although we knew about ileal digestibility of amino acids before 1990, most diets were formulated on a total amino acid basis. Kees de Lange was one of the pioneers in helping us understand why apparent digestible amino acids levels for individual ingredients were not always additive in predicting the level in final diets. First, by helping us understand true digestibility (de Lange et al., 1990) to account for endogenous losses specific to the ingredient and then the move to standardized ileal digestible amino acids (Stein et al., 2007). The use of standardized ileal digestibility (SID) has been adopted throughout the swine nutrition world and allows the use of high levels of feed-grade amino acids and use of byproduct ingredients while minimizing any negative impact on pig performance. Research has also proven that SID amino acid values for ingredients fed to gestating sows (Stein et al. 2001) and young pigs (Urbaityte et al., 2009) are different than values published for grow-finish pigs; however, diets are currently formulated using SID values from grow-finish pigs by most nutritionists. To allow formulation with SID values for the particular production stage, SID values for gestating sows and nursery pigs would need to be measured on more ingredients. Nutrient requirement estimates would also need to be conducted using SID values specific for that stage of production.

Similar to amino acids, diet formulation has moved from total phosphorus to an available or digestible phosphorus basis. In North America, available phosphorus was first adapted as a measure of the true bioavailability of phosphorus in an ingredient. Bioassays measuring bone ash or bone breaking strength were conducted with individual ingredients. This process is expensive and time consuming. Total tract digestibility of phosphorus is much more easily measured. For a period of time, apparent total tract digestibility of phosphorus was used, but values for ingredients were not additive. The development of a procedure to easily measure endogenous losses (Petersen and Stein, 2006) allowed determination of standardized digestible phosphorus values, which are used by many nutritionists today.

For energy, digestible (DE) or metabolizable energy (ME) were the standard for many years. Digestible energy is easily measured, but overestimates true energy utilization of high protein and high fiber ingredients and underestimates the value of high fat ingredients. By correcting for urinary energy loss, ME values can be determined from digestible energy. In most cases, urinary energy loss is simply calculated from the nitrogen content of the ingredient. Thus, ME has the same issues as digestible energy. Researchers from INRA (Noblet et al., 1994) provided much of the initial information and equations used to determine net energy (NE). Net energy accounts for energy loss due to differences in heat production during digestion. Thus, it gets closer to the true energy value of an ingredient or diet (Acosta et al., 2016). Although more accurate than DE or ME in terms of predicting feed efficiency responses, NE values also do not always agree with feed efficiency values for individual ingredients or diets when fed in research barns. Thus, some have adopted "modified" ME or "modified" NE values by doing slope ratio experiments where an ingredient is titrated against known standards (usually corn and soybean meal) with the difference in feed efficiency between diets used to calculate the energy content of the test ingredient in relation to the known ingredients (Boyd et al., 2010; Boyd et al., 2011; Graham et al., 2014). This process is expensive and time consuming, but more closely predicts feed efficiency and growth responses than DE, ME, or NE values. Some are starting to refer to this energy value as productive energy.

Amino acids	Phosphorus	Energy
Total	Total	Digestible
↓	↓	↓
Apparent digestible	Available	Metabolizable
↓	↓	↓
True digestible	Apparent digestible	Net
↓	↓	↓
Standardized digestible	Standardized digestible	Productive (modified NE or ME)

Figure 1. Increasing precision in determining nutrient values and requirements.

Because energy is the most expensive portion of the diet and the critical first step in formulation, the expense of determining modified or productive energy values for major ingredients is certainly warranted. How productive energy values change as composition of the particular ingredient changes requires additional research. Thus, we have learned a tremendous amount about energy in the last 20 years as we have evolved to using NE in diet formulation, but realize that there are unanswered questions as to why NE doesn't always accurately predict performance (Nitikanchana et al., 2015).

DETERMINING REQUIREMENTS

As genetic improvement continues to increase sow and growing pig productivity, there is a continual need to update the requirement estimates for the pig. Methods used to estimate and determine requirements have changed greatly over the last 20 years. At one time, requirements were determined using small number of pigs in university settings. Those requirements didn't always work under field conditions where the level of feed intake is much lower and disease pressure is much greater. The development of growth models and field research barns has greatly changed this process.

Growth and reproductive models greatly assist nutritionists in estimating the requirements for different levels of productivity. The models also can be quite helpful at answering other “what if” type scenarios. Kees de Lange was one of the leading pioneers in model development for the North American swine industry (de Lange and Schreurs, 1995; Schinckel and de Lange. 1996; de Lange et al., 2001). He was the key force behind the model used in the NRC (2012) and in the more sophisticated models used by many feed companies. Nutritionists from around the world have applied the concepts from his work in estimating nutrient requirements of pigs.

Models allow us to estimate the requirements of the pig, but there is always a need to verify those requirements or to test some new ingredient or concept that may not be explained well enough in the literature to model the response. The growth of field research barns within production systems has allowed testing of nutrient requirements in similar situations to where pigs are grown (Tokach et al., 2010). These research facilities also allow more robust testing of ingredients and additives in production systems. The availability and use of these research facilities has greatly changed the model and expectations of university and feed company research. Production systems want initial data from university or feed company facilities, but then test the concept within their internal research barns before widespread application.

REDUCED RELIANCE ON HIGH COST NURSERY DIETS

Another area that has changed greatly over the last 20 years is the prolonged use of high cost nursery diets. We still realize that quality nursery diets are important to get pigs started on feed promptly after weaning; however, the nutrient levels in the initial diet and length of feeding of the complex diets has decreased.

Historically, there has been a strong drive to maximize growth rate in the nursery in the belief that any growth gained in the nursery multiplied to give further benefits in the finisher. Research has revealed that this only occurs if the pig’s GI Tract was fundamentally changed. For example, many studies have observed increased nursery growth rate by increasing weaning age (Main et al, 2004) or pig weight at weaning (Wolter and Ellis, 2001; Schinckel et al., 2007; Collins et al., 2017). In these cases, the increased growth rate in the nursery continued into the finisher stage resulting in heavier market weight. In these trials, the pig was fundamentally changed, such that the increased nursery growth as a result of increased weaning age was accompanied by improved immune and digestive function (Moeser et al., 2006; Smith et al., 2010). Al Masri et al. (2015) reviewed the dynamic structural changes that occur in the gut mucosa as weaning age increases.

In many nutritional studies, feed additives or ingredients often lead to a change in performance while the diet is being fed; however, after pigs are switched to a common diet, the benefit that was gained is either diminished or remains the same through the finishing period. Examples of ingredients or nutrients that generate this type of response include nursery diet complexity (Whang et al, 2000; Wolter et al., 2003; Skinner et al., 2014), added fat (Tokach et al., 1995), amino acid concentrations (Fabian et al., 2002), antibiotics (Skinner et al., 2014), or liquid milk replacers (Wolter and Ellis, 2001). For most feed ingredients or diets, their impact on performance is only found when they are fed and not in subsequent performance. Thus, the value of an additive, ingredient, or diet should only be considered for the benefit gained during its feeding period and not any projected for additional benefit unless a carry-over effect has been observed and measured. This knowledge has greatly reduced nursery diet complexity and cost for many production systems.

One ingredient that was not used at all 20 years ago that is a staple in early nursery diets today is pharmacological concentrations of zinc, usually in the form of zinc oxide. Zinc is used to minimize diarrhea and increase growth rate in the early nursery stage. Added zinc has many proposed modes of action (Li et al., 2001; Liu et al., 2014), but maintaining gut integrity through tight junctions is likely the most important. Data also suggests that prolonged use of pharmacological concentrations of zinc, while beneficial for diarrhea control, eventually leads to toxicity and begins to decrease performance. Numerous trials demonstrate that pharmacological levels of zinc only improve growth rate during the first 3 to 4 weeks after weaning. The use of high levels of zinc after 11 or 12 kg body weight can have negative effects on growth and also increases zinc excretion in swine waste. Use of pharmacological concentrations of zinc in the nursery is coming under increasing pressure world-wide. This is because of implications for increasing methicillin-resistant staphylococcus aureus (MRSA; Slifierz et al., 2015). As an industry, we must be proactive in only using pharmacological concentrations of zinc in nursery diets up to 11 or 12 kg where the greatest benefits are observed.

A change in management that also is contributing to the reduced reliance on high cost nursery diets is the move to increased weaning age. Although this area is still evolving, research by Main et al. (2008) helped demonstrate that mortality rate was linearly reduced and growth rate to market linearly increased as weaning age was increased to at least 21 days. Subsequently, excellent work by Adam Moeser's group (Moeser et al., 2007; Smith et al., 2010; McLamb et al., 2013) demonstrated that mucosal barrier function improves as weaning age increases and that pigs weaned less than 23 days of age have increased gut permeability, that even extends into the finishing phase. These findings help explain why pigs weaned at young ages are more susceptible to disease pressure later in life and can have increased mortality rate in finishing. The move towards older weaning ages is still underway in the North American swine industry and average weaning age will likely continue to increase as antibiotic use decreases.

FEEDING METHODS

Research at the University of Illinois in the late 1980s highlighted the high level of feed wastage from growing pig and sow lactation feeders that were on the market at the time. Considerable research was conducted in the 1990s that taught us a great deal about critical design features for feeders for growing pigs (Gonyou, 1999). As a result, the quality of feeders used in pig barns have greatly improved over the last 20 years.

An even greater change occurred in the design of sow feeders and methods of feeding lactating sows. Sow feeders used to be very narrow and difficult to access with the thought that it would reduce feed wastage. After the research demonstrated that sows actually wasted less feed from a feeder where they could easily access feed, the large bowl feeders became standard in the industry. In recent years, some have forgotten these lessons and decreased feeder bowl size in order to reduce the cost of the feeder. However, ingenuity has prompted the widespread adoption of automatic feeding systems to allow lactating sows to have ad libitum access to feed in the farrowing house. This change has allowed labour reallocation to other high priority activities and at the same time increased sow feed intake productivity.

One area in feeding methodology where the research of Kees de Lange was particularly beneficial was around liquid feeding systems. He pioneered research looking at all practical applications of liquid feeding, such as feeding systems, ingredient selection, and additives. Nobody in North America dedicated as much time on liquid feeding as Kees. As a result, he was frequently asked to share his knowledge on liquid feeding with many pork producers in Ontario, throughout Canada, and around the world (de Lange and Zhu, 2012).

DRIED DISTILLERS GRAINS WITH SOLUBLES (DDGS)

We hesitate to discuss an individual ingredient, but the use of DDGS has changed feeding programs in many North American production systems more than any other ingredient over the last 20 years. The availability and use of DDGS has also led to improved understanding of many other areas of swine nutrition. For example, the high level of unsaturated fat in DDGS forced research into understanding the impact of fat source and feeding duration on fat quality (Benz et al., 2010; Paulk et al., 2015). Because corn protein is second limiting in tryptophan and contains high levels of other limiting and non-essential amino acids, use of DDGS greatly increased use of crystalline amino acids and led to improved understanding of the pig's tryptophan requirements (Goncalves et al., 2015). The high fiber content in DDGS decreased carcass dressing percentage and led to a more complete understanding of the influence of fiber withdrawal strategies on dressing percentage and carcass weight (Asmus et al., 2014).

OTHER MAJOR CHANGES

A few other areas where we have seen major changes over the last 20 years that are still evolving include antimicrobial use, mycotoxins, and ractopamine.

Beginning January 1, 2017, most antibiotics can no longer be used for growth promoting purposes in the United States. There are still a few antibiotics that are deemed as not critically important for human medicine that can still be fed to pigs for growth promotion, but the removal of numerous antibiotics from this list is a major change for the industry. Oversight and cost of compliance will continue to increase and apply further pressure on antibiotic use. Thus, the health benefit of any antibiotic must be justified before implementation.

Although mycotoxins have been an issue in livestock feed for decades, mycotoxin issues appear to be increasing. Whether they are due to new technologies in corn production (upright ears, wider growing area, etc.) or better mycotoxin testing and measuring methods is left to be determined; however, considerable contamination has been present in corn and wheat crops in several recent years. Depending on the region grown, fumonisin, deoxynivalenol, zearalenone, and aflatoxin have all been found in high concentrations in recent years. Use of products containing sodium metabisulfite have proven to provide some relief for deoxinivalenol (vomitoxin) contamination, with particular efficacy in pelleted diets. An enzyme for detoxifying fumonisin has been approved and used in Europe, but is not available in the U.S. Clay-based binders provide some help with aflatoxin. There appear to be some modified phyllosilicates with efficacy for fumonisin contamination although published literature for many of these compounds is sparse or non-existent in pigs.

Shortly after its approval, ractopamine became widely used as a means to increase protein deposition, market weight, and improve feed efficiency during late finishing. Typically fed for approximately the last 3 weeks before market, ractopamine allowed producers to increase pig carcass market weight by approximately 3 kg with the same days on feed. Although still being used successfully by many production systems, processors exporting pork to China halted use of ractopamine in their pork suppliers towards the end of 2015. Thus, use today is much lower than 2 or 3 years ago. This change provided another strong signal that customer preference will trump production, economic, or even environmental benefits of technology use in the swine industry.

SUMMARY

Over the last 20 years, there have been numerous changes in our understanding of swine nutrition and feeding programs. Dr. Kees De Lange played an instrumental role in advancement in much of this new knowledge. It is a privilege and honour to share some of the key findings in which Kees played such an important role. However, not only will he be remembered for his research, but most importantly the many friendships and relations he built among all of us. We will miss his advice, mentorship, and friendship greatly.

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GUT HEALTH AND THE MICROBIOME

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ABSTRACT

Animals (including humans!) are teeming with microbes. Bacteria, archaea, yeasts, viruses and protists colonize every surface of an animal's body exposed to the outside environment. The greatest concentration and species diversity of these microbes in mammals is found within the gut. In pigs, and humans, which have similar GI tract anatomy, by far the largest amount of diversity can be found in the colon. The colon is a specialist organ for microbial fermentation, and in a healthy gut, many of the microbial metabolites produced are beneficial to the host, regulating the immune system and protection from pathogens, increasing the efficiency of caloric extraction from food, and detoxifying otherwise harmful substances. Those who study the human microbiota have begun to understand how diet and the use of pharmaceutical agents such as antimicrobials can radically affect the balance of the gut microbial ecosystem with unintended, detrimental effects. The results of this work are also appropriate to swine management strategies, since effectively managing the gut microbiota of a herd will likely promote great benefits to both animals and farmers.

THE GUT MICROBIOTA: A VIRTUAL ORGAN

It has only been within the last 15 years or so that scientific techniques have evolved enough for us to be able to obtain a broad view of the complexities of the gut microbiota – the microbial ecosystem that lives within the GI tract. What has been uncovered so far has proven extraordinary, and the implications of some of the findings are rewriting text books and influencing medicine in a microbiology renaissance that is unprecedented. With particular reference to the microbes of the colon, we are learning that microbial metabolites produced by the direct action of the microbiota on food substrates have enormous impacts on the health of the host. Figure 1 presents a Venn diagram (after Clarke *et al.,* 2014), indicating the range of 'jobs' that the gut microbiota carries out in the context of host health. It is estimated that collectively, the gut microbiota does as much metabolic work for the host as the liver (Clarke *et al*. 2014). Since the liver is considered to be a vital organ, the gut microbiota should also be reconsidered in this light.

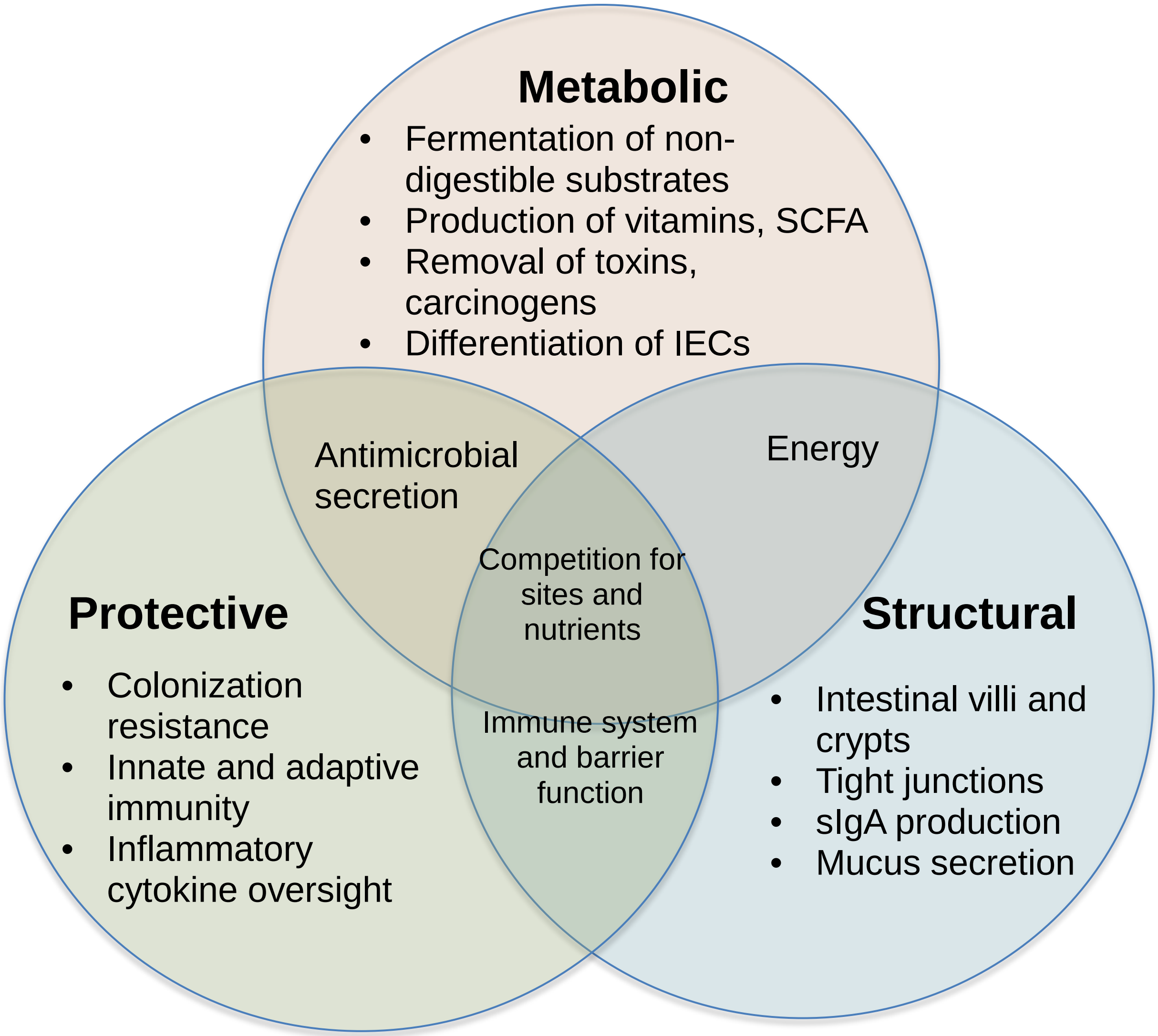

Figure 1: Venn diagram presenting an overview of the many roles which the gut microbiota is involved with which are vital for development and the maintenance of health. SCFA: Short Chain Fatty Acids; IEC: Intestinal Epithelial Cells; sIgA: secretory immunoglobulin A.

DEVELOPMENT OF THE GUT MICROBIOTA

A fetus residing in an unbroken amniotic sac within the womb is essentially floating within a sterile environment, although some small amount of maternally-directed colonization may occur in the later stages of pregnancy through placental transfer (Collado *et al*., 2016). The process of birth, however, exposes the newborn animal to a large number of microbes that rapidly start to colonize the GI tract. In humans, the process is becoming more clearly understood, and a series of microbial 'successions' during early childhood eventually result in the formation of a stable 'climax community' by the age of ~3yrs, which then (with no intervention) remains compositionally stable over an individual's lifetime, with a small amount of disturbance during adolescence and a gradual decline into old age (Munyaka *et al*. 2014). This gut microbiota is a reflection of a person's exposure to microbes from their early environment, their diet, exposure to pathogens and geography, and results in a complex tapestry that is unique to an individual, and somewhat analogous to a fingerprint.

THE IMPORTANCE OF MICROBIAL DIVERSITY WITHIN THE GUT MICROBIOTA

As for most microbial ecosystems, the gut microbiota thrives best when there is a large amount of species diversity within the ecosystem (Carlucci *et al*., 2016; Moya & Ferer, 2016). The reason for this is, however, less about species diversity and more about diversity in gene function. Healthy ecosystems retain robustness – an ability to adapt to changes in environmental conditions – because within the collective group of individual species there is functional redundancy. In other words, there are multiple species that may carry out metabolic work within the ecosystem, but as conditions within the ecosystem change, for example because of a change in diet, different microbial clades take on the metabolic workload to maintain the overall efficiency of the ecosystem. The human gut contains around 200-300 different bacterial species and each of these can carry out myriad metabolic functions under varying conditions (Carlucci *et al.,* 2016). Thus, the overall effect is that the ecosystem works efficiently even when faced with different nutritional inputs (Heiman & Greenway, 2016). This can also be illustrated by the finding that, despite large amounts of individual variation in the microbiota species make-up across a population, at the functional level (i.e. the presence of genes that confer various functions), this variability is much less (Carlucci *et al.* 2016).

DAMAGE TO THE GUT MICROBIOTA AND IMPLICATIONS TO HEALTH

It follows from the last section that erosion of species diversity within an ecosystem renders the ecosystem much less able to adapt to environmental changes. In recent years, it has been shown that, within the human population, many of the lifestyle changes that have been made can have profound effects on the diversity of the gut microbiota. Such lifestyle changes include dietary changes (for example, an increase in the consumption of processed and refined foods), living under increased sanitary conditions designed to remove most microbes, and consumption of drugs – including antimicrobials (Petrof *et al*. 2013). Of these factors, antimicrobial use has been the most comprehensively studied. All antibiotics promote drastic changes to the gut microbiota through collateral damage effects (despite an antibiotic being prescribed to treat a particular pathogen, no antibiotics are specific enough that their only activity is against pathogens, and vast swathes of species within the gut microbiota may be severely affected by the treatment) (Lange *et al*. 2016). Many studies have shown that therapeutic antimicrobials have a rapid and unpredictable effect on the gut microbiota (sometimes resulting in diarrhea as a direct symptom of ecosystem disturbance). While in many cases once the antibiotic is withdrawn the ecosystem gradually returns (over weeks or months) to its baseline composition, in some cases the baseline composition will not return and the ecosystem finds a 'new normal' state of equilibrium (Carlucci et al., 2016; Lange *et al.*, 2016). Usually this new state is less stable than the previous state and reflects extinction of particular taxa, and their engendered metabolisms, from the gut microbiota. This outcome is more likely when multiple antimicrobials or classes of antibiotics are used together or in quick succession of each other. Figure 2 provides a conceptual overview of the effects of ecosystem damage on gut microbiota stability and function.

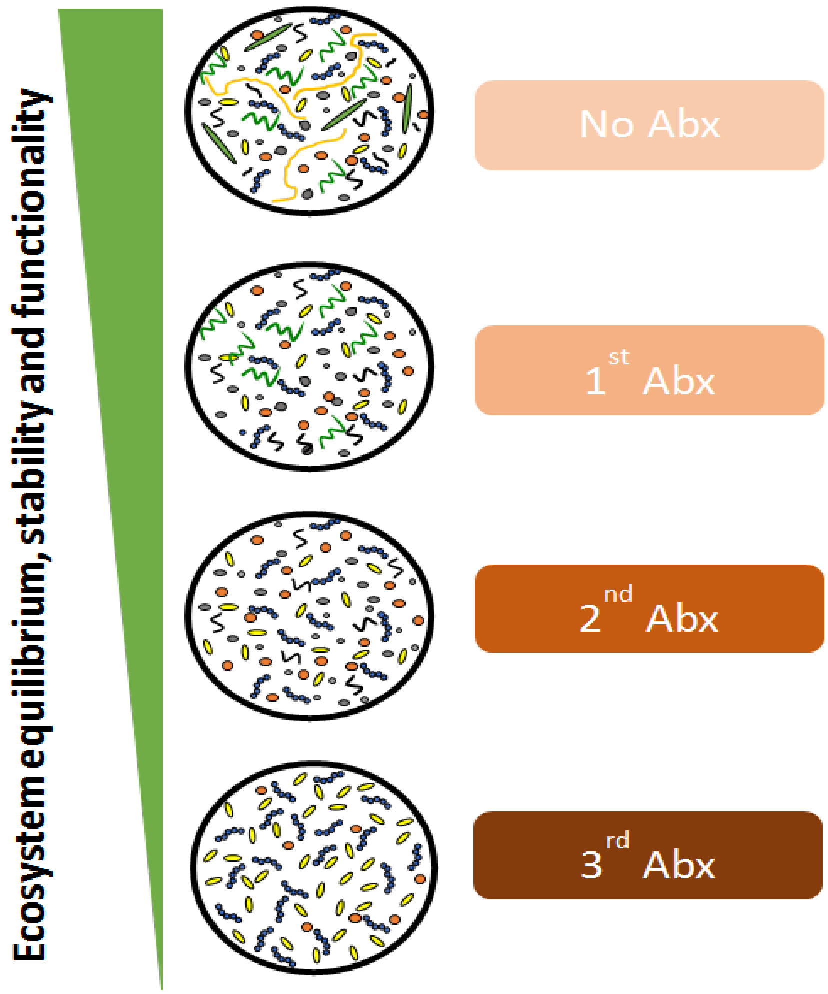

Figure 2. Conceptual overview of ecosystem damage to the gut microbiota following antibiotic exposure. The top circle represents a diverse ecosystem, not yet exposed to antibiotics. As 1, 2 and 3 antibiotic exposures are accreted, the ecosystem gradually becomes less compositionally diverse, although the total number of microbial cells stays relatively stable. With less diversity, antibiotic-perturbed ecosystems have a reduced collective metabolic activity, and as a result are less stable than the undamaged starting ecosystem. Abx: antibiotic.

MITIGATION STRATEGIES TO PROTECT THE GUT MICROBIOTA ORGAN AND PROMOTE HEALTH

There are a variety of strategies that have been explored to help augment gut health through modulation of the microbiota, which are briefly outlined below.

PROBIOTICS

Probiotics are live micro-organisms which, when administered in adequate amounts, confer a health benefit on the host (Gilliland et al., 2001). Most probiotics fall within the category of lactic acid bacteria – i.e. bacterial species that are able to produce lactic acid as a direct result of their metabolism – and probiotic strains commonly belong to species of the *Lactobacillus*, *Streptococcus* and *Bifidobacterium* genera. However, it's important to note that not **all** strains of these genera can be considered to be probiotic, and not **all** probiotics belong to these genera. There are, for example, *Lactobacillus* spp. that do not possess beneficial properties, and there are also strains of species such as *Escherichia coli*, and even non-bacterial species such as the yeast, *Saccharomyces boulardii*, that contain strains of probiotic value.

The beneficial mechanisms of probiotics are poorly understood, although it is thought that their presence in the gut may stimulate the immune system and exclude pathogens (Sánchez et al., 2017). The metabolic products of some probiotic strains may also stimulate the growth and beneficial activities of the resident gut microbiota (Sánchez et al., 2017). However, since there is widespread variability in gut microbiota composition across individuals, it is difficult to predict beneficial effects of probiotic administration, and, indeed, many studies of the benefits of consuming probiotics have shown either minimal benefit (if at all), or moderate effects on host health (Sánchez et al., 2017). There are a few probiotic strains that have risen above others in terms of their clinical benefit for specific indications, however the blanket approach that the probiotic industry currently takes to marketing of strains is likely invalid and can be wholly misleading. On the other hand, probiotics are generally regarded as safe and so the risk to consumers is considered minimal (Sánchez et al., 2017).

PREBIOTICS

Prebiotics are defined as a non-digestible food ingredients that promote the growth of beneficial microorganisms in the gut (Gibson & Roberfroid, 1995). These are generally fibers or complex sugars that cannot be digested by the upper gut (stomach and small intestine) and which therefore pass unchanged to the colon, the site where most microbial fermentation in the body takes place. In general, prebiotics tend to stimulate the growth of fermentative microbes in the colon that can use these complex sugars as a food substrate. In doing so, the fermentation products may be made available to other microbes as well, in turn stimulating their growth. However, again because of the complexity of the gut microbial ecosystem and the compositional differences across individuals, it is not (at this time) possible to easily predict the effects of prebiotic administration and the relevance of these substances to health. Similar to probiotics, prebiotic preparations should not be considered as a one-size-fits-all approach to supplementation. Of importance, it is not only the growth of beneficial organisms that prebiotics may support, but any microbes that are able to utilize the substrate, and these may include non-beneficial species, or even pathogens (Cockburn & Koropatkin, 2016). However, all healthy diets should contain a high fibre content and this fibre should be acquired from many different food substrates in order to support the diverse microbial species of the colon. In other words, prebiotic supplementation should be considered as an augmentation to an existing healthy diet, not as a substitute for one.

MICROBIAL AUGMENTATION

Recently, in human medicine, efforts have been made to use whole microbial ecosystems as therapeutic interventions for a range of conditions. At its most crude, in the context of the gut, transfer of fecal material from a healthy to a diseased host (so-called fecal microbial transfer, or FMT) has become a topic of great interest, both for its 'ick' factor, but perhaps more importantly for its efficacy in treating serious gut conditions such as colitis caused by *Clostridioides* (formerly *Clostridium*) *difficile* (Carlucci *et al*., 2016). *C. difficile* infection (CDI) is a disease of rising occurrence that is precipitated by antibiotic use (for unrelated conditions) that results in damage to the gut microbiota leaving a niche in which the pathogen can thrive. As *C. difficile* cells proliferate, they start to produce a number of toxins which damage the gut and induce diarrhea. The standard treatment for CDI is a course of further antibiotics to remove the pathogen, but *C. difficile* possesses various virulence strategies that can render this approach ineffective, and in this case, the infection can be very difficult to clear (Carlucci *et al*., 2016). As an alternative approach, FMT has been proven to rapidly resolve CDI, through replacing gut microbial species that exert control over pathogen numbers and prevent damage caused by the toxins (Carlucci *et al*., 2016).

The success of FMT for the treatment of CDI has led to an increasing interest in using the strategy to treat a number of other disease indications thought to originate from damage and imbalance to the gut microbiota. These include inflammatory bowel diseases, obesity, metabolic syndrome (including Type 2 diabetes) and others. However, the available studies of using this approach to treat non-CDI disease have shown mixed success, and it is likely that there is much more to learn about the role of the gut microbiota in these diseases before the gut microbiota can be used as an effective therapy (Carlucci *et al*., 2016).

One of the limitations of using stool as medicine, aside from the unpleasantness, is the problem of pathogen transfer. While stool destined for use in FMT is screened, along with the donor, for a comprehensive range of pathogens and disease markers, this limits - but does not eliminate -risk (Carlucci *et al*., 2016). As yet, it is not understood what the long-term effects of stool transfer may be to a recipient, for example through unintended immune system stimulation, transfer of as-yet unknown pathogens or aberrant integration of the transferred ecosystem with the resident microbiota causing further ecosystem damage. In addition, stool is an undefined product, and its availability depends on the health and accessibility of the donor. All of these problems can be mitigated to a certain extent by the use of a defined and purified mixture of microbes derived from stool to create a ‘probiotic ecosystem’. The long-term effects of such a defined medicinal mixture will be much more easily assessed in this way, and furthermore, with a modular design to the therapeutic ecosystem, the approach can be, to a certain extent, personalized to treat different indications in different individuals (Carlucci *et al*., 2017).

RELEVANCE TO SWINE HUSBANDRY

As noted above, the human and porcine gut anatomy and physiology are very similar. Although conclusive studies have yet to be done, it is reasonable to assume that gut microbial diversity in pigs may be negatively impacted by modern, intensive farming practices that include indoor housing, standardized feeds, early weaning practices and use of sub-clinical levels of antibiotics as growth-enhancers. Since a reduction in gut microbial diversity in humans is associated with a range of different disorders, what are the implications of similarly reduced gut microbial diversity to swine health?

The current drive to remove antimicrobial growth enhancers from agricultural practice serves a necessary role in the protection of human health and the reduction of antimicrobial resistance spread, but creates challenges for farmers faced with the need to produce more meat less expensively. Perhaps these challenges can be met through better understanding of the porcine gut microbiota and how it may be supported and modulated to improve animal health and feed conversion rates. For example, since it has now been clearly demonstrated that gut microbiota composition is a key player in human obesity, perhaps this knowledge can be used to shift microbial ecosystems in pigs into conformations that promote weight gain. And since there is now an increased understanding of how the gut microbiota in humans helps to protect against pathogens and to modulate immune responses, perhaps this new awareness can be harnessed to inoculate newborn pigs with microbes that confer optimal immune system performance, reducing the risk of disease and enhancing the protective effects of vaccination strategies.

CONCLUSIONS

The gut microbiota is a virtual, but forgotten organ. Studies in humans have clearly demonstrated the importance of gut microbiota to health and well-being, and how dysbiosis within the ecosystem may be associated with a surprising variety of diseases. Since pigs and humans share similar gastrointestinal tracts, perhaps the major findings from these human studies may have relevance to swine husbandry. If a smart approach is taken to modulation of the swine microbiota with live microbes or prebiotic feed enhancement strategies, this may help to improve animal health and product safety, and to reduce farming costs.

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ECONOMICS: GRAIN AND HOG OUTLOOK

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ABSTRACT

Rapid growth in U.S. ethanol production produced very high grain prices during 2006 to 2013. This caused a great deal of financial stress for livestock and poultry producers. Slow growth in ethanol production combined with record corn harvests in 2013, 2014 and 2016 have pushed down feed prices and aided livestock profits. The death of nearly 7 million baby pigs from the PED virus reduced hog slaughter and pushed 2014 hog prices to record highs. Since then hog numbers have increased and prices decreased. The outlook for 2017 is for record hog slaughter and prices slightly below the breakeven level.

HOG INVENTORY

USDA's December hogs and pigs report said the market hog inventory was up 4.0%, but swine kept for breeding was up only 1.5% compared to December 1, 2015. USDA's estimate of the total number of hogs and pigs on U.S. farms at the start of December was up 3.7% compared to 12 months earlier. (Table 1)

Table 1. Hog Inventories December 1, 2016, U.S.

	2016 as % of 2015
All hogs and pigs	103.7
Kept for breeding	101.5
Market hogs	104.0
Under 50 pounds	104.4
50 - 119 pounds	104.5
120 - 179 pounds	104.0
180 pounds and over	102.5
Pig Crop	
September-November	104.8
Pigs per Litter	
September-November	100.9

Source: USDA/NASS December 2016 Hogs and Pigs Report

USDA's survey indicated the number of market hogs weighing 180 pounds or more on December 1 was up 2.5% compared to 12 months earlier. The 120-179 pound market hog group was up 4.0%; the 50-179 pound inventory was up 4.5%; and the inventory of pigs weighing less than 50 pounds was up 4.4% compared to a year earlier. Slaughter of U.S. raised barrows and gilts during December-February was very close to the 3.3% increase implied by the December market hog inventory.

USDA said summer (June-August) farrowings were up 0.3% from a year ago (Table 2). They said fall farrowings (September-November) were up 3.9% compared with a year ago. USDA said winter (December-February) farrowing intentions were up 1.4% compared to 12 months earlier and spring farrowing intentions are for 1.0% more sows to farrow than in March-May 2016.

Table 2. Sows Farrowed and Farrowing Intentions, U.S.

	2016 as % of 2015
March-May	104.0
June-August	100.3
September-November	103.9
	2017 as % of 2016
December-February	101.4
March-May	101.0

Source: USDA/NASS December 2016 Hogs and Pigs Report

With the number of litters farrowed expected to be up 1.4% this winter and pigs per litter up by 1.0% (my guess), the winter pig crop should be 2.4% or so larger than a year earlier.

INTERNATIONAL TRADE

Over the last 20 years U.S. pork imports have typically been between 3.5% to 5.5% of U.S. pork production (Table 3). Imports of live hogs peaked at 10 million head in 2007 and have been around 5 million head the last few years. U.S. pork exports in 2016 were the second highest ever behind the 2012 record. During the last seven years, the U.S. has exported more than 20% of its pork production.

The U.S. is the world's second largest pork exporter after the European Union. Canada ranks third in pork exports.

Table 3. U.S. Imports and Exports of Pork and Hogs.

	---------------Imports---------------			--------------Exports--------------		
	-----------Pork------------		Hogs	----------Pork----------		Hogs
	Million Pounds	Percent of Production	Head	Million Pounds	Percent of Production	Head
1998	705.392	3.7	4,122,914	1230.124	6.6	229,454
1999	827.115	4.3	4,136,943	1277.105	6.6	177,204
2000	966.592	5.1	4,357,564	1286.664	6.8	69,228
2001	950.745	5.0	5,377,688	1559.458	8.1	64,049
2002	1070.726	5.4	5,740,675	1612.227	8.2	205,121
2003	1185.201	5.9	7,438,254	1716.697	8.6	169,881
2004	1099.465	5.4	8,505,518	2180.534	10.6	174,010
2005	1023.846	4.9	8,190,801	2666.115	12.9	153,650
2006	989.680	4.7	8,763,378	2995.096	14.2	164,621
2007	968.436	4.4	10,004,348	3141.183	14.3	136,816
2008	831.883	3.6	9,347,951	4651.465	19.9	97,340
2009	833.767	3.6	6,364,553	4094.111	17.8	21,245
2010	859.490	3.8	5,749,134	4224.044	18.8	14,958
2011	803.403	3.5	5,794,601	5193.327	22.8	30,459
2012	801.691	3.4	5,656,402	5383.429	23.2	56,428
2013	879.422	3.8	4,947,751	4992.308	21.5	34,004
2014	1007.492	4.4	4,947,243	4855.118	21.3	18,933
2015	1112.199	4.5	5,740,376	4946.571	20.2	40,601
2016	1091.915	4.4	5,668,734	5233.024	21.0	48,018

Source: USDA-ERS

Canadian pork exports set a record in 2016 for tons exported (Table 4). Canadian pork imports were the highest since 2012.

Table 4. Canada Imports and Exports of Pork

	Imports Tonnes	Exports Tonnes
1998	66,883	433,023
1999	69,811	519,587
2000	74,088	636,646
2001	92,598	718,703
2002	96,117	827,378
2003	109,224	924,345
2004	126,508	931,287
2005	137,096	1,030,546
2006	142,250	1,037,968
2007	156,800	997,042
2008	150,298	1,094,500
2009	169,346	1,075,314
2010	182,437	1,098,171
2011	191,524	1,152,718
2012	221,106	1,189,433
2013	201,188	1,184,159
2014	195,016	1,154,974
2015	203,272	1,177,772
2016	207,399	1,249,045

Source: Canada Pork International

Slaughter weights have increased at an average rate of 1.3 pounds per year over the last 60 years. Weights were record high in 2014 and down in 2015 and 2016. Slaughter weights re likely to be higher in 2017.

U.S. hog marketings were at the slaughter capacity limit for much of the fourth quarter of 2016. This produced both outstanding packer margins and extremely low hog prices. Two large new slaughter plants (Coldwater, Michigan and Sioux City, Iowa) are expected to open this summer. Another large slaughter plant is likely to open at Eagle Grove, Iowa in 2018. This expansion should eliminate concerns about slaughter capacity for several years. Consequently, look for both increased hog slaughter and higher hog prices in the fourth quarter of 2017 compared to a year earlier.

FORECASTS

If USDA's numbers are close to right, 2017 hog slaughter will be above 120 million head, up 3.3% from 2016, and a new record.

For 2017 look for hog slaughter to be up 3.8% on a daily basis with 51-52% lean hogs averaging in the upper $40s/cwt live and Iowa hogs averaging in the low $60s/cwt on a carcass basis (Table 5).

We anticipate only a modest slowdown in herd growth during the second half of 2017.

On average, hog slaughter drops below the year-earlier level 15 months after losses begin. Financial losses by hog producers were modest in 2016 and are expected to be small again this year. Given corn prices under $4 per bushel there is no clear signal that producers should cut back the sow herd.

USDA's long term year forecast has U.S. farm prices for corn averaging between $3.50 and $4.00 per bushel over the next ten years (Table 6). Pork production is expected to increase at an average rate of 1.3% per year. Hog prices are expected to bottom in 2017 then steadily increase through 2026.

RESOURCES

Canada Pork International

USDA/ERS Livestock and Meat International Trade Data

USDA/ERS Livestock and Meat Domestic Data

USDA/NASS Hogs and Pigs Report (various editions)

USDA/NASS Livestock Slaughter (various editions)

USDA/OCE Long Term Projections

U.S. Meat Export Federation

Table 5. Commercial Hog Slaughter and Barrow and Gilt Price by Quarter.

	--Comm. Hog Slaughter--			----Barrows & Gilts, U.S. price/cwt----		
		Percent change		51-52%	Iowa-Minn	Non-packer-sold
Year &	Million	from year ago		Lean	Base	Net
Quarter	Head	monthly	daily	Live	Carcass	Carcass
2013 1	27.864	- 0.9%	+0.6%	$59.03	$80.15	$82.75
2	26.765	+ 0.4	+0.3	65.46	89.62	90.83
3	27.657	- 1.1	-2.6	70.58	95.37	98.07
4	29.791	- 2.1	-2.1	61.11	82.36	85.26
Year	112.077	- 1.0	-1.0	64.11	86.87	89.22
2014 1	27.131	- 2.6%	-2.6%	$68.69	$94.98	$93.80
2	25.575	- 4.4	-4.4	85.40	115.42	116.83
3	25.558	- 7.6	-7.6	83.31	112.00	114.25
4	28.612	- 4.0	-3.9	66.75	88.90	91.41
Year	106.876	- 4.6	-4.6	76.04	102.82	104.07
2015 1	28.724	+ 5.9%	+5.9%	$48.47	$64.23	$66.03
2	27.850	+ 8.9	+8.9	53.20	73.26	73.22
3	28.477	+11.4	+11.4	54.59	73.59	74.92
4	30.375	+ 6.2	+6.2	44.66	57.93	59.80
Year	115.425	+ 8.0	+8.0	50.23	67.25	68.49
2016 1	29.259	+ 1.9%	+0.7%	$44.63	$60.52	$60.14
2	28.111	+ 0.9	+0.7	53.71	73.08	73.15
3	29.317	+ 2.9	+2.8	49.25	63.68	66.25
4	31.516	+ 3.8	+4.8	36.99	46.83	47.69
Year	118.203	+ 2.4	+2.3	46.15	61.07	61.81

2017	1*	30.224	+ 3.3%	+3.3%	$47.43	$62.84	$64.00
	2*	29.240	+ 4.0%	+4.4	49.84	65.00	66.50
	3*	30.108	+ 2.7%	+4.0	51.24	66.33	67.85
	4*	32.514	+ 3.2%	+3.5	44.32	57.67	59.50
	Year*	122.085	+ 3.3%	+3.8	48.21	62.96	64.80
2018	1*	30.759	+ 1.8%	+1.6%	$44.49	$58.00	$59.80

*forecasted

Source: USDA/NASS (actual values), and Ron Plain (forecast)

Table 6. USDA Long-term Forecasts, U.S. Pork and Corn.

Year	Commercial Pork Production Million Pounds	Percent Change Previous Year	Live Hog Price US$/cwt	Marketing Year	Corn US$/bu
2015	24,501	7.3%	$50.23	2015/16	3.61
2016	24,946	1.8	45.65	2016/17	3.30
2017	25,800	3.4	40.00	2017/18	3.30
2018	25,653	- 0.6	40.64	2018/19	3.35
2019	26,009	1.4	41.50	2019/20	3.35
2020	26,447	1.7	42.50	2020/21	3.45
2021	26,788	1.3	44.38	2021/22	3.50
2022	27,156	1.4	45.63	2022/23	3.55
2023	27,330	0.6	47.36	2023/24	3.60
2024	27,685	1.3	48.26	2024/25	3.65
2025	28,055	1.3	49.11	2025/26	3.65
2026	28,443	1.4	49.91	2026/27	3.70

Source: USDA/OCE

Day 2: Wean to Finish – Workshop Sessions

Mental Wellness Amongst Our Agricultural Producers: Where Are We, And Where Do We Go From Here?

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ASTRACT

Mental health needs amongst agricultural producers are being increasingly recognized, particularly in the wake of large-scale animal disease outbreaks, mass animal depopulations, and extreme weather events. Worldwide, producers experience depression, anxiety, and suicide at levels higher than the general population and report significant occupational stresses. Reluctance in help seeking amongst producers further compounds the issues and makes it difficult to effectively reach this population. In addition to the important human health element, the impacts of mental distress on producers' animals, their welfare, and agricultural production must also be considered.

Very little Canadian knowledge exists on the mental health impacts of day-to-day farming stresses and those brought on by agricultural emergencies. It is essential that we address this gap given our unique agricultural setting. This will help limit the impact of the occupational stresses, and promote good human mental health, animal welfare, and agricultural production.

To address the lack of collective knowledge, we conducted a cross-sectional pilot study of Canadian agricultural producers between September 2015 and January 2016 to determine the prevalence of, and factors associated with, perceived stress, depression, anxiety, burnout, and resilience. Presented here are the prevalence results for perceived stress, anxiety, depression, burnout, and resilience.

BACKGROUND

The mental health needs of agricultural producers are being increasingly recognized worldwide. Even during relative times of calm, producers worldwide experience a wide range of occupational stresses, many of which are beyond their control. These include: changing climate, changing government, changing regulations, disease, weather, significant financial burdens, and succession planning. Several studies worldwide have shown that producers have higher levels of psychological distress than the general population, and have elevated rates of suicide compared to other occupations (Fraser et al., 2005; Hounsome et al., 2012). These issues are even more severe during times of agricultural emergency (Hall et al., 2004; Olff et al., 2005). Further complicating the issue is the relative lack and uptake of appropriate mental health resources by producers (Peck, 2005; Goffin, 2016). Even in the aftermath of the Foot and Mouth Disease outbreak in the UK, where producers experienced post-traumatic stress, only 1.5% of producers sought professional help (Peck, 2005). Until very recently, there was an unfortunate lack of published knowledge on the mental health and wellbeing of Canadian veterinarians and agricultural producers.

METHODS

It was the above realities that led to the national survey on Agricultural Producer Stress and Resilience, conducted by Andria Jones-Bitton and colleagues from the University of Guelph. The survey was administered online, from September 2015 to January 2016. The following validated mental health scales were used to assess a variety of outcomes: Perceived Stress Scale (stress), Hospital Anxiety and Depression Scale (anxiety and depression), Maslach Burnout Inventory (burnout), Connor Davidson Resilience Scale (resilience). In addition, data were collected on help-seeking, demographics, employment, farming, and lifestyle factors. Presented here are preliminary results from the survey; statistical analyses to identify risk factors and potential associations with demographic, lifestyle, employment characteristics, etc. are on-going.

RESULTS

Responses were obtained from 1132 producers, from all commodity groups, across Canada.

PERCEIVED STRESS

Approximately 45% of our surveyed producers were classified in the high stress category. Notably, chronic stress is closely associated with poor health practices and outcomes, poor attention, decreased life satisfaction, depression, anxiety, and higher death rates (e.g. Shapiro et al., 2005).

ANXIETY AND DEPRESSION

More than half of surveyed producers met the scale definition for "anxiety caseness"; specifically, 25% were classified as mild, 25% as moderate, and 8% as severe levels of anxiety. Over one-third of producers met the scale definition for "depression caseness", with 20% of cases as mild, 12% as moderate, and 3% as severe. Both the anxiety and depression scores, and prevalence of anxiety and depression, were higher than the general population norms for the scales and the results from previous producer studies in the UK and Norway that used the same scale (Booth & Lloyd, 1999; Crawford et al., 2001; Sanne et al., 2004).

BURNOUT

We measured burnout using the validated Maslach Burnout Inventory. This scale has 3 sub-scales: professional efficacy, emotional exhaustion, and cynicism. More than half of producers scored high on professional efficacy, meaning they had high expectations for continued effectiveness at work. Approximately 1 in 5 producers had low professional efficacy. Unfortunately, one-third of producers scored high in emotional exhaustion, and 2 in 5 producers scored high in cynicism. Hence, surveyed producers scored high in two of the three components of burnout. Burnout can impact wellbeing, productivity, job retention, and production (Huebner, 2003).

RESILIENCE

Resilience has been described as a "state of being that promotes wellness and decreases the impact of physical and psychological stress" (Adams et al., 2010), or the ability to "bounce back" from adversity or challenge (Bakker et al., 2017). Roughly two-thirds of producers had levels of resilience that were lower than that of the United States general population. Resilience can protect against depression, anxiety, burnout, stress, and suicide (Howe et al., 2012); fortunately, resilience is also something that can be practiced and learned (Leppin et al., 2014). Investigations of interventions that can help producers build resilience would be worthwhile.

PRODUCER HELP-SEEKING & SATISFACTION WITH INDUSTRY SUPPORT

Surveyed producers had favourable attitudes towards help for mental health. Over two-thirds of producers indicated that seeing a mental health professional can be helpful, that they would seek professional help if they were worried or upset for a long period of time, and that seeking professional help did not make them a weak person. Unfortunately, perceived stigma remains an issue for some: 40% of producers said that they would feel uneasy seeking professional help because "of what other people might think", and one-third said that seeking such help can "stigmatize a person's life".

Level of satisfaction with industry support for mental health was also sought; just 12% to 60% (dependent on commodity) of participating Canadian producers indicated being satisfied or very satisfied with current industry supports. Hence, there is considerable room for improvement in producer mental health support in Canada's agricultural industries.

CONCLUSIONS

Participating Canadian producers showed high levels of anxiety, depression, and emotional exhaustion, as well as low levels of resilience. Producers expressed positive attitudes towards help-seeking, and low levels of satisfaction with current industry support. Regrettably, producers also perceived others as having stigma around mental health. Current directions for producers include development of a mental health literacy program specific for Canadian agriculture, and development of an emergency response model to facilitate quick and efficient response to producer wellbeing during times of agricultural crisis.

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REDUCING ANTIMICROBIALS POST-WEANING

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ABSTRACT

Antibiotics need to be used judiciously. If antibiotics are used when they are not needed, or in a way that provides no benefit, it is a waste of money. Reducing antimicrobial use may help to reduce production costs. In addition, antimicrobial resistance is an emerging problem on pig farms and the over use of antimicrobials does create selective pressure which promotes the increased prevalence of resistant pathogens making treatment of sick animals more difficult. Treatment of animals without a good response due to resistance causes economic loss because of reduced pig performance but also the expense associated with medication. Judicious use does not mean that antibiotics should never be used. Failure to treat conditions that can be readily cured with appropriate antibiotic use results in economic loss and reduced animal welfare. The swine industry has made huge strides over the past few decades to improve pig heath through housing, management, nutrition, genetics, biosecurity and vaccination programs. This increase in health status should be reflected in less need to use antibiotics to control disease.

INTRODUCTION (WHY THIS IS AN IMPORTANT ISSUE)

It is very difficult to maximize animal welfare and production efficiency without the use of antibiotics. An example commonly used to describe good stockmanship is the ability of a herdsman to identify a sick pig at the early stages of illness and provide appropriate treatment, which may involve medication with a suitable antibiotic. However, there have been very successful marketing campaigns by certain retailers to suggest that pork produced from pigs raised on farms where antibiotics are never used, is in some mysterious way superior to other meat products. Although the attributes of this RWA product that make it so desirable are never explained, there is a strong implication that there is a human health benefit and this is a very successful and growing niche market.

In general, there are two public health concerns raised regarding the use of antibiotics in livestock production. Firstly, there is the concern that residues of antibiotics might be present in the meat. When antibiotics are approved for use this is carefully examined and a withdrawal time established to ensure residues don't occur if used according to the label directions. For a country that is so export focused as Canada when it comes to pork, residue avoidance is a very important issue. The Canadian Quality Assurance program is focused on the goal of minimizing the risk of residues and the Canadian Food Inspection Agency monitors meat closely at slaughter. It is in the interest of the entire swine industry to make sure antibiotic residues do not occur in pork and fortunately the detection of residues has become a very rare event. This is also an area where the swine industry has made huge strides in the past 20 years.

The other major public health concern associated with antibiotic use in livestock is that antimicrobial resistance will develop to antibiotics that are used on farms, and that this resistance might spread, from the pig farm to bacteria that are harmful to humans. The concern is primarily with the movement of these resistant bacteria through the food chain but there is also the potential for occupational exposure. It is undeniable that antimicrobial resistance is becoming a major concern in hospitals with the emergence of "superbugs". This is a frightening reality. There are situations in human medicine where antibiotics are becoming almost ineffective against bacterial infections that were once easily controlled. It is unclear how much agriculture contributes to this problem in human medicine; however, there is concern with the use of antimicrobials in livestock production. Pork production is often mentioned in this context because a huge quantity of antibiotics is used in pig farming. The vast majority of this use is in-feed medication for growth promotion or for prevention of disease and not to treat a sick animal. Upcoming changes in regulations will remove the use of medically important antibiotics for growth promotion. However, some antibiotics have little or no value in treatment of disease in humans or livestock and these will still be available for growth promotion.

Aside from these public health/public relations issues, there are a couple of important reasons why pig farmers should be interested in monitoring antibiotic use and ensuring that antibiotics are used appropriately. Firstly, antibiotics can be an expensive input cost and if their use is not warranted or their use is ineffective, then the discontinuation or reduction of antibiotic use can save money. Secondly, there are a very limited number of antibiotics that are approved for use in livestock and the more they are used the greater likelihood that bacteria will develop resistance and these antibiotics will no longer be effective for the treatment of pig diseases. It is likely that in the future the arrival of a new antibiotic for use in livestock will be a very rare event. The lack of an effective treatment for a common bacterial pig disease will result in economic losses from mortality and slow growth and reduced animal welfare. Therefore it is important that we do what we can to preserve the effectiveness of the antibiotics that we have.

Evidence of swine pathogens carrying multiple antimicrobial resistance (an example)

A few years ago we examined cases of greasy pig disease on 30 Ontario pig farms. This disease is caused by *Staphylococcus hyicus*, bacteria that are found on all farms, and can sporadically cause severe skin disease in piglets or newly weaned pigs. Textbooks suggest treating pigs with this condition by injecting them with penicillin, but in our study almost all of the hundreds of isolates we looked at were resistant to penicillin and most of the staphylococci isolates were resistant to multiple antibiotics. We found that many of these bacteria were carrying the gene that makes *Staphylococus aureus* resistant to methicillin. This resistance problem (MRSA) is commonly described in the media as a superbug and MRSA in hospitals is a major health concern. The presence of MRSA on pig farms has very little importance as far as pig health, but the fact that this same multi-drug resistance is common in *S. hyicus,* the cause of greasy pig disease, means that this pig disease has become much harder to treat. A simple injection of penicillin will be completely ineffective (Park et al. BMC Veterinary Research 2013, 9:211).

REDUCING ANTIMICROBIAL USE

Reducing the need to use antimicrobials

Many bacterial swine pathogens are present on almost all farms, for example *Streptococcus suis* meningitis or ileitis caused by *Lawsonia intracellularis,* which are two of the most common reasons given for using antibiotics in nursery pigs and grower-finisher pigs, respectively. These types of diseases are sometimes described as endemic. In general, these diseases can be controlled in two ways: firstly, by minimizing the bacterial challenge that the pig faces, and secondly by maximizing the pig's immunity or ability to fight off the bacterial challenge and not get sick.

Techniques to minimize the bacterial challenge that have become routine practice in pig farming include strategies like all-in/all-out pig flow that is generally associated with washing and disinfecting between batches.

In conjunction with minimizing challenge it's also important to take steps to maximize the pig's immunity. The use of vaccination programs is an example of one way to boost immunity, but management procedures that increase the pig's robustness such as good nutrition, minimal stress, and a crossbred breeding program that takes advantage of hybrid vigor are all methods of improving the pig's chances of fighting off a bacterial infection.

There are also important bacterial diseases that are not present on most farms, for example swine dysentery, and pleuropneumonia. In addition, the swine industry has used creative methods, such as the "Specific-Pathogen-Free" program that used Cesarian-derived piglets to establish high health herds. When herds are free of diseases there is a need to remain free of these pathogens by instituting effective biosecurity programs.

There have been viral diseases that have emerged and caused great economic losses to the North American industry but at the same time have greatly increased the awareness of biosecurity and increased our knowledge of how diseases spread. For the most part biosecurity systems designed to keep out viral diseases such as PRRS and PED will also stop bacterial diseases.

In summary, improved management and housing, the development of effective vaccines and the implementation of biosecurity programs has improved herd health and reduced the need for antibiotics.

Why do some herds still use high levels of antibiotics?

The obvious reason that some herds use more antibiotics than others is that they have a lot of bacterial disease problems. It is possible that the farm could reduce antibiotic use by being more diligent with management procedures or making renovations to correct environmental flaws but it has been easier to use antibiotics to keep disease under control. It has been said that antibiotics can serve as a crutch, that it is easier to use antibiotics than make the necessary changes to control or eliminate disease. In certain cases, antibiotics are used because of previous disease problems and have just been left in the feed even though everything is now okay. The need for high levels of routine antibiotics to control a constant threat of disease was probably more likely to be true a few decades ago, when there were a lot of old renovated barns, mostly continuous pig flow, and generally poor biosecurity.

Various studies have found that often the very high productive farms with little obvious disease issues are high antibiotic users. A veterinarian in France, Guy-Pierre Martineau, described this type of behaviour as the “overboard syndrome”. He suggested that some farmers are so driven to do a good job that they rush to treat every cough and are afraid not to use mass medication in case a disease outbreak might occur. These producers may try to save every pig and therefore elect to treat a very sick pig that on most farms would have been euthanized. These producers tend to go overboard with biosecurity, vaccination, cleaning and disinfection. If you are a veterinarian you are unlikely to advise such a client to relax their biosecurity, to try using fewer vaccines, or reduce their antibiotic use because you don’t want to be blamed if or when a disease outbreak occurs. It is easier to work with a client who has poor performance and who is using antibiotics as a crutch. In that case, as management improves antibiotic use can be pulled out, but when performance is really good and antibiotics are not needed, changing anything can coincide with a disease flare-up.

Can antibiotics be replaced by other types of antimicrobials?

If there were simple alternatives that are readily available and work as well as antibiotics, then we would be using them and no one would be very concerned about the loss of effectiveness of antibiotics due to resistance. There is nothing comparable to treat infectious disease, although there are many products that have been promoted as alternatives to antibiotics. There are a few products that may be useful in reducing diarrhea or improving growth rate. The increasing likelihood of restrictions on the use of antibiotics as feed additives has driven swine researchers, nutritionists and feed manufacturers to test for different antimicrobial alternatives. Pre and probiotics, organic acids, essential oils, phages, heavy metals, egg-yolk antibodies and antibacterial peptides are some alternatives to antibiotics that have been investigated in weaner pigs. Among these products only the use of high levels of heavy metals, specifically zinc oxide at levels of greater than 2500 ppm in nursery rations has proven to be consistently effective in disease control. The use of therapeutic levels of zinc oxide has become widespread in many countries as a way to control post-weaning *E. coli* diarrhea, but its use is controversial, particularly from an environmental standpoint.

MONITORING ANTIBIOTIC USE

We have been conducting a research trial looking at nursery performance and antimicrobial use. The nursery is the phase of production that is most reliant on antibiotics to keep diseases under control. In the nursery, pigs lose the passive immunity they original obtained from colostrum at birth and become reliant on producing their own immunity but their immune system is immature and this is a vulnerable period when their immune system can be easily overwhelmed. A review of nursery close-out records from our study shows that in well managed nurseries mortality is generally below 2% but once in a while one fill of weaners will experience >7% mortality. The most common causes of mortality in our study were *E. coli* diarrhea and Streptococcal meningitis.

The hardest problems with measuring antibiotic use are;

1. What unit do you use to describe antibiotic use? It becomes difficult to determine which farm is a high antibiotic user when you are comparing pigs fed low doses over long periods of time, with another farm where pigs are being injected with a high dose of antibiotic but possibly just once?

2. How do you compare the use of one antibiotic with the use of a different antibiotic because there is a huge difference in the relative importance between certain antibiotics? Some antibiotics have no therapeutic use in humans or even animals (some growth promotants), and others may be very important for human or veterinary therapeutics (such as a 3rd generation cephalosporin or a fluoroquinolone)?

3. How do you persuade anyone to keep accurate records of their antibiotic use? At present there is very little motivation to record antibiotic use in the nursery. In general, it is months before these pigs will be going to market and therefore the need to have records to ensure withdrawal periods are observed is not too important. There may be some merit in recording drug use to accurately monitor all costs of production but in most cases antibiotics are a very small input cost. However, monitoring of antibiotic use may become necessary in order to demonstrate to the public and trading partners that antibiotics are being used wisely in pork production.

The International and Canadian Perspective

The European pig industry has been under greater public and political pressure to reduce antibiotic use than in North America and banned the use of antimicrobials for growth promotion a number of years ago. There have been several different approaches taken to reduce antibiotic use that are worth examining from the Canadian perspective. Denmark has implemented a system where all antibiotic use is reported to a central database and a “yellow card” system was introduced. Farms that use a lot of antibiotics are given a warning (a yellow card, as in soccer). If antibiotic use continues to be high, there are penalties. In contrast, the Netherlands set a target of 50% reduction in the use of antibiotics over 5 years and then tasked industry with determining how that reduction should be achieved. Industry worked together and met that target. Similarly, France has set a target of 25% reduction over 5 years. The United States has not set targets for reduction but is making changes in the use of antibiotics in feed and for growth promotion. Within Canada, in addition to the regulatory changes underway with regards to growth promotion and over-the-counter medications, there have been some industry initiatives. The new Pork Excellence program, which replaces the CQA program, will have a stronger emphasis on monitoring antibiotic use. As well, in 2014 the Canadian broiler chicken and turkey industry eliminated the preventative use of antibiotics that are very important to human health. This decrease in use corresponded to a decrease in the resistance of *Salmonella* and *E.coli* to those antibiotics (https://www.canada.ca/en/public-health/services/publications/drugs-health-products/canadian-integrated-program-antimicrobial-resistances-surveillance-bulletin.html). Proactive industry initiatives may decrease the public pressure for increased regulation.

TAKE-HOME MESSAGE

In all likelihood, the Ontario swine industry will need to reduce antibiotic use because of public and political pressure. Producers can benefit from being more judicious regarding the use of antibiotics. Over-use or incorrect use of antibiotics needlessly adds to production costs. The emergence of antimicrobial resistance will make the treatment of pig diseases more difficult and so steps to minimize the development of resistance is necessary. Treatment record-keeping will need to become routine and we will need to begin to create a standardized method of comparing drug use between farms such as calculating animal daily doses so that antibiotic use can be discussed in the same way as pigs/sow/year. This issue is not going away.

EMERGING SWINE PRODUCTION DISEASES – AN INDUSTRY PERSPECTIVE AND ACTION

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ABSTRACT

The swine industry has experienced major emerging swine production diseases, including outbreaks from Influenza A Virus – swine, Porcine Circovirus and Porcine Epidemic Diarrhea Virus (PEDV), within the last 10 to 15 years. The challenges to herd health, animal welfare and food security are costly for both producer and consumer. Developing and implementing a plan to respond to emerging and re-emerging diseases of significance is top priority. The major swine organizations within the United States, the American Association of Swine Veterinarians (AASV), the National Pork Board (NPB), the National Pork Producers Council (NPPC) and Swine Health Information Center (SHIC), have worked together to develop a plan to address emerging disease. This presentation will focus on the specific plan and actions from this coordinated effort. Along with an industry focus, the United States Department of Agriculture (USDA) is also in the process of finalizing an Emerging Disease Response Plan. This has been a collaborative effort with industry to help develop a cooperative approach to identify, respond to and mitigate the next emerging threat.

INDSUTRY IDENTIFICATION AND RESPONSE TO EMERGING DISEASES

Identification of Disease Threats

In the aftermath of the Porcine Epidemic Diarrhea Virus outbreak, a formal mechanism to identify and investigate newly emerging diseases was needed. However, the three existing swine-centric organizations were not able to meet this need. In 2015, the National Pork Board allocated funding for the development of the Swine Health Information Center (SHIC) for this purpose. The mission of the Swine Health Information Center is to protect and enhance the health of the United States swine herd through coordinated global disease monitoring, targeted research investments that minimize the impact of future disease threats, and analysis of swine health data. The mission complements but does not replicate activities of the National Pork Board and exists as a stand-alone entity.

Disease identification includes the review and evaluation of the swine disease matrix, which is a listing of diseases that are, or could potentially be, a threat to United States pork production and are prioritized by impact. The matrix is populated with known information on current diagnostic test capabilities and management tools (i.e. vaccines or other treatment). If data is not available for a disease, then it becomes a research gap for further review. This is a collaborative process of review by both Swine Health Information Center and the American Association of Swine Veterinarians. Evaluation of diseases includes both domestic and foreign intelligence gathering and the collaboration with the USDA Center for Epidemiology and Animal Health, Risk Identification Unit.

For specific pathogen identification, a Rapid Response Team concept has been developed to investigate new or unusual presentations of a disease syndrome. This concept has been a collaborative effort within industry and government that initially started with the 2013 PEDV outbreak investigations. The Swine Health Information Center coordinates the current team. Experts in the field of biosecurity and epidemiologists from the USDA Center for Epidemiology and Animal Health have been tasked to develop a standardized format for outbreak investigation that can be applied on-farm.

The Swine Health Monitoring Project is an example of monitoring current diseases on a weekly basis. Initially funded through the National Pork Board, Swine Health Monitoring Project is currently funded by the Swine Health Information Center and accounts for at least 50 percent of sows in the United States. The goal is to track the incidence of disease over time. Diseases monitored include PRRS and PEDV. Additional pathogens, such as Influenza A Virus of swine, can be added to the monitoring list.

The National Pork Board has engaged veterinary practitioners from different regions and practices across the United States to supply information on a routine basis about new or potentially emerging syndromes seen on-farm. Major swine laboratories are included in the communication to add information that diagnostic labs are seeing for swine disease syndromes. Calls and reporting from the Sentinel Veterinary Clinic are designed to identify potential disease syndromes that are emerging and provide an early alert to investigate such threats. Added to the syndromic review is condemnation data provided by the USDA to augment on-farm data if "signals" in slaughter health are present. Combined, the Sentinel Veterinary Clinic calls can provide one more piece of information on potential threats to swine health.

Research

Research for emerging and endemic diseases has long been a priority for the National Pork Board. As part of the Strategic Plan developed in 2015, the goal for emerging disease is as follows: "By 2020, the National Pork Board will develop, with key stakeholders, the identification and diagnostic tools, surveillance and mitigation strategies for the potential elimination of the top domestic swine diseases". The tactic language for 2017 is "To reduce the economic impact for producers, a research-based approach will be utilized to focus on producer needs for investigation, development, detection and validation for emerging and endemic diseases of high impact to producers such as swine enteric coronaviruses and swine influenza virus". The research focus of the Pork Board has been on diseases that are or have become endemic within the United States but also focus on specific Foreign Animal Diseases. Individual research reports are posted at www.pork.org/Research once they are finalized.

Swine Health Information Center responsibilities for research include the newly emerging diseases that are not in the United States. Other research includes development of diagnostic tests for emerging disease as identified by the swine matrix. Research priorities are shared across organizations and members from all swine organizations are represented in the review and selection process through the various swine health committees.

Response

In 1998, USDA published a final report of the Swine Futures Project, which "represented a unique partnership between industry and government to develop a shared vision of future industry service needs and how to best address those needs collaboratively". The final report included recommendations to establish a system for the rapid detection of emerging animal issues, which encompasses emerging diseases, and the development of a collaborative process to identify and respond to issues of concern. Based on these recommendations the industry has been working collaboratively to develop an industry state and federal cooperative structure to identify and address emerging swine production diseases.

A standardized process that coordinates industry, state, and federal cooperative efforts to identify, characterize, prioritize and respond to emerging swine production diseases of concern to the United States pork industry will provide numerous benefits. Identification, characterization and prioritization of such diseases can currently be accomplished though collaboration between the Swine Health Information Center and USDA's Risk Assessment Unit within the Center for Epidemiology and Animal Health. According to the plan, once a disease of concern is identified, a Swine Disease Response Council will complete a collaborative response recommendation. The recommendations will be developed with input from regulators familiar with the industry but will not carry regulatory authority.

The National Pork Board, the American Association of Swine Veterinarians and National Pork Producers Council approved representation from each organization. The National Assembly of State Animal Health Officials has nominated several state veterinarians as their representatives. Industry will also be working with USDA to identify two representatives to serve as advisors to the Council.

The Council will convene to start the team building process this summer, which will include an in-depth review and discussion of the emerging swine production disease plan, mock scenarios designed to exercise the plan and the development of a communication strategy to keep the Council engaged and at the ready. In the event that a disease of concern is identified, the Council would provide a core function of developing response recommendations and identify the responsible party for implementation. This process would also include representation (state vet, state pork association) from the affected State and subject matter experts as needed. The recommendations would be provided to stakeholders for consideration and if accepted implemented by the responsible party.

The USDA is also finalizing an Emerging Disease Response Plan to address the many emerging diseases appearing in United States livestock production. USDA has formalized response plans for OIE listed foreign animal diseases and for other domestically regulated diseases (Pseudorabies and Swine Brucellosis) but no such plan has been available for emerging diseases. The draft plan is under development and should be available soon. The plan outlines roles and responsibilities for identification and response of an emerging disease for all stakeholders including diagnostic laboratories, state and local veterinarians, producers and allied industry. A second component that outlines reportable animal diseases, the National List of Reportable Animal Diseases, will complement the Emerging Disease Response Plan.

CONCLUSION

In conclusion, emerging and re-emerging diseases of swine pose a significant challenge to the health and wellbeing of United States swine herds. In order to effectively identify and address such challenges, a collaborative approach is being taken to cover different areas of disease management including disease identification, identification of gaps in knowledge, targeted research and development of response plans. The combined efforts for plans that will rapidly identify and managing new and emerging diseases will help to maintain the health and wellbeing of United States swine herds.

ACKNOWLEGEMENTS

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Swine Health Information Centre; http://www.swinehealth.org/

EMERGING DISEASES: CASES, DIAGNOSTIC TOOLS AND VIDEOS FROM THE MIDWEST

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ABSTRACT

The goal of this presentation is to cover several topics related to emerging diseases. First there will be a case study on a Seneca Virus A outbreak on a sow farm. This will be followed by description, pictures and videos of diagnostic tools currently in use and development at Iowa State University. These tools are meant to make sampling for current and "new"/emerging disease easier for caretakers and veterinarians alike. Lastly, the presentation will focus on online digital resources available to caretakers on clinical skills and diagnostic tools.

1. CASE STUDY

This presentation will contain a short overview of Seneca Virus A (SVA) outbreak in a farrow to finish farm in Iowa. Seneca Virus A is an emerging virus in the United States and has been found in county fairs, growing pig sites and sow operations. The virus causes vesicles (blisters) on the nose and feet that mimic those seen with Foot and Mouth disease. SVA can also cause a short-term increase in pre-weaning mortality. It is essential that producers and caretakers stay vigilant for these vesicles and report them immediately to their veterinarian for further diagnosis. This presentation will feature pictures of clinical signs associated with SVA (Guo, 2015 and Canning, 2016).

Figure 1. Photos from the Seneca Virus A outbreak on a farrow to finisher farm. From left, recently ruptured vesicle on sow nose, healing vesicle on sow nose, healing vesicles on sow hoof, hemorrhages on sow hooves.

2. NEW DIAGNOSTIC TOOLS AND APPROACHES

Urine Collection in Sows and Gilts

Catheterization of sows and gilts for urine collection has been previously reported but is technically demanding. We investigated additional methods to supplement cases where catheterization was unsuccessful or sample collection must be conducted by caretakers. Sows were selected for urine collection and analysis using three techniques: free catch, tampon and Whirl Pak. A free catch urine sample was collected from each sow using a 120 mL urine cup. The tampon collection technique included the use of a super-sized, unscented tampon with a plastic applicator and umbrella absorbency. The tampon was inserted into a female's vestibule and the exterior string was taped on the side of the vulva with elastic waterproof tape. Following urination, the tampon was transferred into a 120 mL urine cup. The Whirl Pak technique included the use of a 24-ounce Whirl Pak bag and elastic adhesive tape. The bag was positioned around the vulva and secured at the lateral, dorsal and ventral aspects. Following urination, the bag was removed from the rear of the sow and the urine sample was transferred into a 120 mL urine cup.

Time required for placement, reproducibility, reliability and cost of each collection method was evaluated in the field. Free catch was facilitated by boar exposure, even when sows were mid-gestation or later. Free catch collection of multiple sows becomes labour intensive and inefficient as sample size increases due to the need to stay in physical proximity of the target sows. Of the two remaining methods, tampon was placed in the shortest amount of time and produced urine samples with enough volume for processing more often than the Whirl Pak method. Further, the sample cost of tampons was approximately 19.3% of the Whirl Pak method. A variety of urine analysis parameters did not indicate significant or consistent differences between sample methods although microscopic evaluation of sediment from samples collected by the tampon method included fibers. Fibers did not obstruct the observer's ability to evaluate the sample.

The collected urine can be used for diagnostic testing including: urinalysis, calcium/phosphorus and creatinine levels, mycotoxins, drug residue testing, bacteria, viruses and parasite eggs.

New Information for PRRSV and SIV (Flu) Monitoring:

1. Nuts and tails or "processing fluids" for monitoring sow farm status
2. Oral fluid sampling recommendations for suckling pigs or "family sampling"
3. Oral fluid sampling recommendations for growing pigs

This section will discuss how to collect processing fluids and how they may be useful for PRRSv surveillance. It will also include recommendations for oral fluid sampling of barns, including how many ropes to hang and where to put them in the barn to maximize chance of detection.

Figure 2. Whirl Pak Bag and Tampon urine collection techniques.

3. MAKING USE OF DIGITAL RESOURCES

There are several online digital video platforms available to producers and veterinarians that feature useful training and informational videos. These platforms feature videos on how to collect samples critical to diagnosis of endemic and emerging disease. The two sites that will be discussed in this presentation will be the SMEC Digital Library and the Pork Avenue Training portal.

SMEC digital Library: https://library-smec.sws.iastate.edu/

- Technical resources on swine medicine
- Includes how-to collect samples such as blood, oral fluids and necropsy

Pork Avenue Training: http://www.porkavenuetraining.com/

- Focused on production training for employees

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RETROFITTING FOR LOOSE HOUSING

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INTRODUCTION

Planning for group housing is perhaps the most important step in the conversion process. Regardless of the system implemented, the transition to groups requires a significant investment of time and money. Understanding what the options are, and imagining how these options fit within the long term goals of the operation, are critical steps in making the right choice. Good planning is also important to help maintain herd flow and generally ease the transition for barn staff and animals.

This talk presents three main areas to be addressed when considering the transition to group gestation. First of all the type of construction project needs to be considered: will it be a renovation of current facilities; an addition to an existing building (e.g. providing space for loose housing or an increase in overall herd size); or is it a new build? The second question addressed is; what feeding system will be implemented? Unlike stall housing, where feeding and management options are limited, group housing includes a large number of options. Becoming knowledgeable about feeding options, including their strengths and weaknesses in terms of cost, barn layout, technical requirements and daily management inputs going forward, is crucial when selecting the right system for your operation. The third area to be considered is how the transition will take place. This will vary depending on the availability offsite barns, parity distribution and disease status, among other factors. Some options include keeping the existing herd intact; making a temporary reduction in the herd size; or doing a complete repopulation.

WHAT TYPE OF PROJECT?

Depending on the size, age and condition of the existing barn, the first decision to be made is the type of project being planned. Will it be a renovation of an existing site, and addition to an existing site, or a new build?

Renovation

Before deciding to renovate, the structural condition of the barn should be assessed by a qualified builder, with particular attention being paid to support walls, roofing trusses and areas where dry rot may be present due to poor ventilation and condensation build-up. If any structural weaknesses are found, these must be addressed and the increased cost or shortened life span may rule out a renovation. Also, the effectiveness of ventilation and drainage of manure pits should be evaluated to determine if these require changes to accommodate sows in groups.

There is no point in investing in an expensive renovation if it will not result in a suitable environment for pigs and ease of daily management. Pig comfort includes providing appropriate flooring, and ventilation and sufficient space for animals- including pens that promote separation of feeding dunging and lying areas and room for hospital or recovery pens. Ease of management is aided by reliable feeding systems, including a potential backup system, wide alleys, easy to access pens, and well-designed penning and gating.

Converting a room of gestation and breeding stalls to group housing is the most obvious transition, but many other options are available. Some producers are building new farrowing units, and either converting the existing sow barn to grow-finish production, or turning the existing farrowing units to a dry sow barn with loose sow housing. The renovation can be seen as a chance to properly size your production flow by providing more room for gestation or finishing.

Other options such as converting grow-finish pens to gestation. The farrowing units tend to be the most worn part of the barn, and with the increased litter size and older weaning age of modern sows, the facilities are no longer meeting production requirements. We can build the new farrowing barn to meet the new production parameters, move production and then start the renovation. This allows the unit to stay in production while the work is being done, while still maintaining biosecurity.

The new build

Building new has the obvious advantage that it avoids the potential headaches of a renovation, and the long term problems related to living with less-than-ideal ventilation or manure management systems. A new build can be specifically designed to fit your herd and the chosen housing system. Another consideration for new builds is the need for building permits, depending on the barn site and local regulations.

FEEDING SYSTEM OPTIONS

The choice of feeding system is a critical one. There are two main categories of feeding systems: competitive and non-competitive. The main distinction is whether sows can gain feed by directly competing with another animal (competitive), or they are fed individually (non-competitive). Each system can be made to work when properly managed, and each has different pros and cons (Table 1). For example, competitive feeding systems (such as floor feeding or shoulder stalls), are generally much cheaper to install, but in the long term they can require more floor space, more hands-on management and more feed per sow. In contrast, the non-competitive systems (such as Electronic Sow Feeders [ESF], free-access stalls, or free-access ESF) are more expensive to install, but provide control over individual sow feeding and should provide better ease-of-management.

Table 1 gives a general comparison of the cost and features of each feeding system.

Smaller herds will often opt for small group pens with floor feeding or shoulder stalls. Often the existing feed lines can be used, and the conversion can be done by the producer at a cost of $300 - $500 per sow place. However, these competitive feeding options do require more hands-on management in the long run, including careful formation of sow groups to match sows for size and parity so they can compete equally for feed, as well as daily monitoring during feeding to ensure that all sows are up and feeding, and to remove any ‘drop outs’ to a comfort pen. Overall, competitive systems require greater feed usage, as sows are overfed to give less competitive sows access to sufficient quantities of feed.

Table 1. Feeding System Options- at a glance.

Feeding System	Floor type	Floor space requirement	Cost	Management input
Floor fed	Some solid floor required	Low	Low	High
Shoulder stall	Solid floor/partial slats	Med	Low	High
ESF	Solid to fully slatted	Low	Med	Med
Free-access	Solid to fully slatted	High	High	Low
Free-access ESF	Solid to fully slatted	Low-Med	Low-Med	Med

Competitive feeding systems: Floor feeding and shoulder stalls are competitive feeding systems where sows receive their feed in a common area and actively compete for access to feed. Because of the competition, small group numbers are recommended (e.g. up to 25 sows), and sow groups must be selected carefully based on similar size, body condition and parity in order to ensure that subordinate sows are not bullied or displaced at feeding. Competitive systems require more hands-on management of sows, with daily checks during feeding to observe that all sows are up and actively feeding. Sows which are lame or fall behind in condition must be removed to relief (comfort or hospital) pens, with a recommendation for provisions for 5% of gestating sows in relief pens in these systems.

Barn conversions for competitive feeding systems are attractive from a cost perspective. Often an existing stall gestation or finisher room can be adapted, using an existing feed delivery system, and with minor changes to flooring. Competitive systems are more commonly seen on smaller farms and in older barns where the producer can provide much of the labour needed for installation, and the barn may not warrant a more expensive renovation. Space requirements for sows in these systems are greater due to the fact that smaller groups require more space per sow to minimize conflicts between sows. The costs of renovation should be carefully weighed against the potential for higher feed consumption, lost production and injury, and the extra time needed to manage these systems well.

Non-competitive feeding systems: ESF, free-access and free-access ESF are known as non-competitive feeding systems because sows are isolated during feeding. This allows for greater control of individual feed intake, with the potential for feed savings, especially in ESF and free-access ESF systems where animals can be placed on individual feed curves. Both types of ESF systems require the use of RFID tags which allow sensors to identify individual animals as they enter the feeder. Feed is delivered in small allotments, so that if the sow exits the feeder she can return later in the day to obtain the rest of her feed allowance. The feed deliveries are reset electronically each day, with the most common reset times between midnight and 10am, depending on management preference. Sows soon become aware of the reset time, and dominant sows will typically be first to access the feeder after reset (Strawford et al., 2008). ESF systems are designed to feed up to 60 sows per station, with some manufacturer's recommending as many as 80 sows per feeder. ESFs are designed for sows to move through the feeder, entering at the rear and exiting from the front, and offer more technological methods for sorting and marking sows, and are consequently more expensive than free-access ESF. Free-access ESF stations are typically run at a ratio of 20 sows per feeder, with sows entering and exiting from the rear and are less expensive to install. While a large amount of research has been done on ESF systems, free-access ESF is a new system developed in Canada that has yet to be studied in depth.

Free-access stalls are designed with self-closing gates that are operated by the sows. Each sow has a stall, and each pen includes a loafing area outside of the stalls where sows can co-mingle. Free-access stalls are very easy to manage: each sow has a feeding stall so animals obtain their full ration, however, since sows choose the stall they enter, all sows are fed the same amount and any requiring extra feed must be topped up by hand. Although they are very welfare-friendly and easy to manage, free-access systems do require a large amount of floor space and penning, with the result being that they are the most expensive system to install.

MANAGING THE TRANSITION

The management of the herd during the transition can be a tricky problem, especially during barn renovations. How do you manage biosecurity and keep producing pigs- while allowing construction to take place unhindered?

Repopulation: The easiest solution is a complete repopulation. If the project is a new build this is straightforward. For an existing site, there may be a disease issue which is depressing production, in which case the transition could be a good opportunity to clean out the barn and make a fresh start.

Offsite removal: Is there an offsite location where sows can be held? Depending on the barn site, sometimes sows can be temporarily moved to an alternative site. However, the biosecurity risk of moving animals in and out needs to be considered carefully. If there are risks to returning sows and gilts are readily available, the older sows can potentially be moved to the offsite for farrowing and culled rather than returning them to the main herd.

Herd reduction: Frequently a portion of the herd will be culled to make room for construction. For example, a percentage of sows can be culled to open space in breeding and gestation. The room(s) can be blocked off using temporary walls and kept separate from the construction area. As each section is completed the walls are moved in turn and animals are introduced to the finished pens. This requires good communication between production and construction crews and thorough biosecurity practices.

Startup

Following a renovation, sows will require some time to adjust to social housing, and must be trained to use the feeding system. Because feed is readily available in competitive systems, no training is needed. But for non-competitive systems, sows will take some time to learn the system. Pens and gates for training should be considered, especially for ESF feeding. In general, young gilts are easier to train, whereas high parity sows which have spent their lives in stall housing can be very set in their ways and difficult to train.

OTHER CONSIDERATIONS

Space

Regardless of the type of build, space allowance is one of the most important considerations. Sow space allowances in the European Union are legislated at approximately 24 sqft for sows and 18 sqft for gilts. While the Canadian Code of Practice for pigs does not have requirements for space allowances, it does include very sound recommendations for space allowance (Table 2).

Table 2. Recommended minimum floor space allowances for gilts and sows in group housing*.

Group Description	Partially slatted floors		Solid bedded floors	
	m^2	ft^2	m^2	ft^2
Gilts	1.4-1.7	15-18	1.5-1.9	16-20
Sows	1.8-2.2	19-24	2.0-2.4	21-26
Mixed (gilts & sows)	1.7-2.1	18-23	1.9-2.3	20-25

*Adapted from NFACC, 2014.

The Code also indicates that the amount of space needed varies with the feeding system used, group size, flooring type, etc. Within the ranges shown in Table 1, smaller space allowances should be used for larger group sizes (over 40 sows), and larger allowances will be used with smaller group sizes (under 20 sows) to give sows space to interact properly with their environment and reduce aggression.

Sow welfare

Several scientific reviews have compared production levels in stall systems and group housing, with all concluding that similar levels of production are found, and that management is more important in achieving high production levels than the system (McGlone et al 2005; Rhodes et al 2005).

Aggression between sows is an important consideration, and there are many ways to reduce and manage aggression, both at the time of mixing and daily when the sows are feeding. Understanding sow social behaviour can help in developing routines that can reduce conflict between sows. Group size, mixing practices, space allowance and pen design and the use of enrichment can all influence aggression (PSC, 2013).

When stall-housed animals are moved into groups, obvious weaknesses in feet and legs become more apparent, especially if the flooring is less than ideal. Initially the sows will be unfit, and during the first 48 hours there will be some initial mixing aggression. However, once sows have adapted to the system they will become fitter and more socially tolerant. The bone strength of loose sows is better than in stalls (Marchant and Broom 1996), and reductions in farrowing time and stillborn numbers have been found (Anil et al 2005). Genetic contributions to sow aggression and hoof and leg conformation become more important in loose housing, so gilt selection and breeding programs must place greater emphasis on these characteristics. Swine genetics companies have recognized this and are adapting animal selection to focus on sow robustness characteristics and temperaments more suitable for groups.

Good flooring is also important for sow's leg health and comfort. Gap widths of ¾" (20mm) are recommended, and areas of solid flooring can added which improve sow comfort and draw sows away from alleys. Some solid flooring also provides the possibility of floor feeding in the event of a feeding system breakdown.

Staff considerations

It is also important to think about barn staff and the ongoing management of sows. A transition can be a stressful time and brings uncertainty around duties and future work. Following the conversion, staff generally report that there is a similar workload, but the duties have changed. Also, following the conversion staff frequently report that the human-animal bond is improved, and the individual personalities of sows are easily seen. Sows are also generally fitter and easier to handle and this makes moving sows into farrowing pens easier.

CONCLUSIONS

Making decisions around barn renovations can be difficult but are extremely important. There are significant capital expenses and management changes- which will potentially impact farm production efficiency and economics for years to come. It is a good idea to consider this change as an opportunity to invest in the future, and to improve or properly size your business. The good news is that getting these changes right can lead to positive changes for the farm, including positive changes for staff, improvements in sow health and longevity, and greater sustainability and profitability of the business.

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SOW HOUSING RESOURCES

National Sow Housing Conversion Project: http://www.groupsowhousing.com

Prairie Swine Centre: http://www.prairieswine.com/the-science-of-ethology/

Manitoba Pork: http://manitobapork.com/manitobas-pork-industry/animal-care/tools-for-group-housing/

Ontario Pork:
http://www.ontariopork.on.ca/ProductionStandards/AnimalCareResources.aspx

Australian Pork: http://australianpork.com.au/latest-news/successful-group-housing-systems-for-dry-sows-workshop/

ADVANTAGES, DISADVANTAGES AND ECONOMICS IMPACTS OF BATCH FARROWING

Jean-Marc LAURENT
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Current paper aims at providing a brief overview of batch farrowing, a key production strategy for the pig industry, compares all-in-all-out (AlAO) production with continuous-flow(CF) production and discusses different options, the pros and cons of batch farrowing.

INTRODUCTION

Traditionally, pig producers have used a continuous flow production method, which usually involves weekly mating, farrowing and weaning. As a result, a farrowing room may house piglets ranging from newborn to weaning age, while grower sheds may house pigs with an age spread from 10 weeks to slaughter weight. In America, most growing/ finishing swine facilities have been operated on a continuous basis; barns always contain pigs of different ages and weight. Due to the fact that pigs are always present, it is impossible to thoroughly clean, disinfect, or fumigate the environment. It is generally assumed that the common air space shared by pigs of various age groups allows for both clinical and subclinical diseases to be more prevalent and be transmitted easily in these types of facilities. Indeed, this mixing of age groups maximize the spread of disease and increases the reliance of medication in order to control disease which further adds to the cost of production. As an example, studies have shown that as many as 70% of the hogs slaughtered have signs of enzootic pneumonia[1].

Several pig farms were faced to important health problems affecting their livestock in recent years, causing enormous losses. The post weaning syndrome (SDPS) caused by type II circovirus associated or not, with porcine reproductive and respiratory syndrome (PRRS) was the main cause of loss. The severe outbreak of the SDPS, which began in 2004 in Quebec, caused big losses even in production systems with three sites. Quebec producers were therefore forced to review their breeding techniques at several levels. Some have adopted rigorous breeding principles such as decreasing the mix of piglets in nursery and adopting a full all-empty strict All-in all-out systems (AIAO) .

ALL-IN ALL-OUT SYSTEMS (AIAO)

In the world, when we talk about batch management or AIAO, it often means small farms in Europe, where we wean every three weeks. Indeed, this type of management is most frequently encountered in France and is developing in other countries. Batch farrowing is an old story in France; has been implemented in the early'70s. But working with groups of animals means organizing the farm, placing all sows in batches no matter if we wean once or twice per week, or every two, three, four or even five weeks. Size is not a limiting factor either when thinking about group management: we can group 100 sows as well as 100,000 sows; but grouping is necessary. To be profitable in the swine production sector today we need to organize our farm in batches and there is no doubt that the recent adoption of batch farrowing in North America is linked with disease control, mainly PRRS as well as PCV.

Batch management means that sows are divided into several groups of sows in the same reproductive stage and of similarly aged pigs. Sows are formed into groups which allow mating and farrowing to occur at distinct intervals. In an AIAO system, sows are bred as groups to farrow during a 5- to 10-day period. By comparison, sows in a continuous flow system are bred continuously and farrow continuously. So, instead of farrowing at weekly intervals, sows will farrow in batches and the entire group can be weaned on the same day. This provides an age break between groups of pigs which disrupts the spread of infection from older to younger pigs. This allows the farrowing room to be thoroughly cleaned and disinfected between batches of sows.

Typically, this management allows for an age segregated rearing and so, pigs coming from different batches are housed in different rooms and have no direct contact. The group is moved into a phase of production together, such as into an empty nursery, and is moved out of that phase as a group according to a production schedule. This allow also the nursery and finishing room to be thoroughly cleaned and disinfected between batches of pigs in contrary with a continuous flow system, pigs move as individuals, not as closely matched age groups, and a facility is never totally emptied because pigs or sows are always moving through it.

BENEFITS OF ALL-IN ALL-OUT SYSTEMS

- ✓ Building management
  - o The rationalization of the barns leads to the division into several compartments. Each one is dedicated to a specific activity: farrowing house, breeding house, gestation house, post-weaning and fattening. Each compartment is divided into several rooms, the number of which is determined according to the number of sow batches present in the herd.
  - o The use of the barns is optimized. Each room must be designed specifically to accommodate a particular category of animal and meet its needs as much as possible. The batch allows an optimal use of each barn and rooms which are adjusted, build precisely to the size of each batches. This makes building investment more profitable. By choosing the dates of entry and exit of animals in each room, it is possible to integrate a period of withdraw which is essential for the control of the contamination of the animals with each other.

- ✓ Better health
  - o Health is improved because AIAO breaks the chain of infection and prevents disease buildup. Infection from other pigs is reduced or eliminated in an AIAO

system because once a group is established, no pigs are added to it. Pigs that have similar ages, immunities, and disease histories are kept together. This grouping reduces infection from older hogs which may be shedding organisms to which younger pigs have not been exposed. Infection from the environment is reduced or eliminated in an AIAO system because the facility can be totally emptied and sanitized between groups. The effect of a cleaning program is shown below on the table 1[2].

Table 1. Effect of cleaning program due to AIAO.

	Part cleaned	Totally cleaned	Improvement (%)
Number of batches	13%	13%	
Start weight (kg)	25,4	26,4	3,9
Daily gain (kg)	693	744	7%
Treatment for respiratory diseases	6,9	4,1	40,6
Mortality (%)	3,5	2,2	40,0

- ✓ All-in All-out
  - o Batch farrowing makes it easier to manage an all-in all-out system (AIAO). In this system, pigs move through the production sequence as a group. Each group of pigs remain together, never coming into contact with other pigs. This system reduces the risk of disease spread between groups of pigs.
- ✓ Improves pig performance
  - o Better animal health status leads to lower medication reducing herd health cost. In addition to that, batch management can improved daily life-weight gain, improved feed efficiency, lower mortality.
  - o With larger group sizes and with all pigs of a similar age grouped together, there is an opportunity to adopt phase feeding with a progressive adjustment of the diet through the entire growing/finishing phase. Phase feeding involves feeding a number of successive diets, each different in protein, energy or amino acid balance to match the nutritional excreted and a potential improvement in feed efficiency.
  - o Replacing the original grower and finisher diets with phase diets would have resulted in a reduction in nitrogen intake and a reduction in nitrogen output compared with the original diets.

- ✓ Economic criteria
  - o By conducting a farm with a batch management, the farmer can make regular inputs of pigs into the market, offer a larger group of pigs of the same age, which smooth out fluctuations in the price of pork.

- The batch management involves management of animals according to their age and ensures greater homogeneity of batches throughout the growing cycle and carcasses at the time of placing on the market.
- Economic gains from the implementation of AIAO, can be quantify as changes in production efficiencies were considered and are presented in table 3[3] below.

Table 3. Assumed changes in cost and production efficiencies due to AIAO.

	Original	With AIAO	Difference
Death Loss	7%	5%	-2 Percentage Points
Medicine Cost	9$ (litter)	4,95$ (litter)	45% Decrease
Feed Efficiency	3,5	3,3	5% Improvement
Days to Market	183	172	11 Days

- ✓ Higher efficiency of labor
  - The various tasks within the sow farm are planned with precision. The farmer is then more available for other activities in the farm and could easier anticipates future events.
  - Employees have specialized tasks over the weeks. A given week corresponds then to a particular activity: mating, farrowing, or weaning. It may even be indispensable in very large herds and in weekly system, where all activities are concentrated during the week.
  - In the context of working time arrangements, batch management is the ideal tool for managing the working time of employees in livestock. Indeed, there are regular periods of less work during which maintenance, holidays or field work can be scheduled

- ✓ Specialization of tasks and better monitoring
  - This specialization of the tasks made it possible to rapidly increase the technicality of breeders. Indeed, some major tasks, such as farrowing, insemination, weaning can be done for larger groups, are larger and less frequent and can thus be done more efficiently. The larger number of litters of a similar age means that management tasks can be concentrated in time.
  - The adaptation of barns facilitates the monitoring of animals, the distribution of care and feeding.

DISADVANTAGES OF ALL-IN ALL-OUT SYSTEMS

- ✓ More labor peaks

There is a lot of pressure during some week as the service week. Mismanagement of large numbers of sows in the service area can lead to overstimulation as well as under-stimulation, resulting in poor conception rates. With substantial numbers of sows to be inseminated on one day, it is important that the last sow is inseminated as carefully and diligently as the first.

✓ Production targets

Batch farrowing places a heavy reliance on meeting production targets. Mating targets must be achieved and gilt cycling is important. Both gilts and sows may fail to cycle within the required period, in which case extra females need to be mated to avoid empty crates. So more gilts are needed and the culling rate will go up.

✓ Hormones

To keep the sows on the chosen schedule and to introduce the gilts into a batch, hormones are sometimes used to keep the sows in batches. Indeed Strict batch management has integrated techniques as hormone using such as Altrenogest for synchronization and prostaglandins for farrowing induction of sows and resulted in a notable improvement in the technical, economic and sanitary performance of livestock.

✓ Investment

One of the main disadvantage is the barn limitations and require additional capital. If your breeding area is designed to handle 10 to 15 sows at once, and you now have over 40 ,sows to breed at once, adjustments need to be made.

CALCULATING BATCHES

The number of batches in a farm will depend on two factors: the cycle length and the interval between batches.

- ✓ Sow cycle length. The duration of the reproductive cycle is the sum of the interval from weaning to estrus + gestation length + lactation length, for example 114 days + 5 days + (21-28) days. Therefore, the cycle time ranges between 20 weeks (if weaning at 21 days) and 21 weeks (if weaning at 28 days).
- ✓ Interval between batches. The time interval between groups is the number of days that separate two repetitions of the same productive event (interval between two groups of farrowing, weaning or mating).

The number of batches is obtained by dividing the cycle time by the interval between groups, both expressed in weeks: Number of batches = cycle time/ interval between batches (in weeks).

The batch number must be an integer number (without decimals). Therefore, the cycle length, and consequently the duration of lactation, must be 'stretched out' in order to achieve this exact number.

Table 4 shows how the number of batches is calculated under different management systems. To correctly distribute the total sow population within the batches we need to divide the sow census by the number of batches. For example, if we have 2000 sows and we apply option 1, we need to place 100 sows per batch. Batch production is not one option among many, it is the only option to produce today.

Table 4. Calculating number of batches under different management systems.

	1 (3 weeks)	**2 (4 weeks)**	**3**	**4**	**5**	**6**
Cycle length (weeks)	**20**	**21**	**20**	**21**	**20**	**20**
Interval between groups (weeks)	**1**	**1**	**2**	**3**	**4**	**5**
Batch number	**20**	**21**	**10**	**7**	**5**	**4**

Until now, the three week batch management system, which was the first batch management system introduced in Europe (2), has been the most used system. Batch management systems have become particularly popular due to their advantages in labor planning, increased batch size of weaned piglets and strict all-in all-out practices (2). Besides the three week batch management system, four and five week batch management systems have been introduced during the last decade. The different characteristics of each batch management are described in annex 1.

FRENCH EXAMPLE

In 2015, the batch management conducts with 7 groups and weaning every 3 weeks continues to dominate, with 48% of the farms (data from the National data base – IFIP). However, it has decreased significantly in the last five years (-16 pts), but is stable over the past two years.

The batch management conducts with 4 and 5 groups are represented in 1/3 of the farms. In the 7 and 21 bands, the sows are weaned preferentially at 4 weeks, while the other piglets are weaned at 3 weeks.

Table 5. Evolution of the distribution of number of herd per batch type – Bretagne.

Type of batch	4	5	7	10	20	21
2010	8%	12%	64%	6%	8%	2%
2015	12%	21%	48%	10%	8%	1%
Evolution	4%	9%	-16%	4%	0%	-1%

The productivity of the sows is superior in the farms with a management conducts with 4,5,10 and 20 batches, associated with a weaning at 3 weeks. The number of piglets born alive is not very different between the groups except for the 21 bands (13.9). Loss rates are lower in farms conducts with 10, 20 and 21 batches.

The Weaning-service interval is higher in farms conducted in 4 and 5 batches and the longevity of the sows slightly higher in the farms conducted in 10 and 20 batches.

The productivity advantage noted on sows performance for weaning at 3 weeks is found in GTE, especially in the case of 10 or 20 bands. The upper margin for 20-batches is also explained by the slightly lower food price of this group.

It can be concluded that performance is related to herd size and age at weaning but the impact of batch farrowing is weak but good performance is possible, regardless of the band behavior chosen.

In France, the implementation of this 3-week batch farrowing is in great part linked with the usage of Altrenogest (Regumate® in Europe, Matrix® in North America) to synchronize gilts for breeding. The only physiological parameter that is necessary for its use is that the gilts must be cycling but this is also true of any batch system.

Table 6. .Sows performances - Bretagne 2015[4].

Type of batch	4	5	7	10	20	21
Number of herd	114	195	449	95	74	13
Number of present sows	184	256	208	466	696	720
Weaned per productive sows per year	29,7	29,7	28,9	30,3	30,4	30,3
Born alive per litter	13,6	13,6	13,7	13,6	13,7	13,9
Weaned per litter	11,7	11,8	11,8	11,9	11,9	12,3
Loss rate / born alive (%)	13,5	13,6	13,9	12,9	12,9	11,5
Weaning age (days)	21,2	20,8	26,4	20,9	21	25,4
Weaning service interval (days)	8,4	8,9	7,9	7,7	7,4	7,6
Litter weaned per culled sows	5,2	5,3	5,4	5,6	5,6	5,3

Table 7. Technical & economical performances - Bretagne 2015[4].

Type of batch	4	5	7	10	20	21
Number of herd	121	176	445	75	52	
Number of present sows	192	247	203	433	615	
Sold per productive sows per year	23,3	23,6	23,1	24,4	24,3	
Feed consumption per present sow per year	1177	1176	1240	1189	1168	
Global FCR	2,78	2,78	2,81	2,79	2,8	
Loss rate -weaning-sale- (%)	6,2	6,3	6,1	6,4	6,8	
FCR -8 to 115 kg-	2,45	2,46	2,47	2,47	2,49	
Age at 115 kg	179	179	179	181	183	
T.M.P	61	61,1	60,9	61	60,9	
Feed cost (€/ton)	241	241	241	240	239	
Meat price per pig sold (€/kg of carcass)	1,394	1,394	1,387	1,391	1,387	
Margin / feed cost and replacement cost (€/pres. Sow/year)	962	996	930	1030	1026	

CONCLUSION

- Main advantages of this technique allows to:
  - Great health benefits. Limit contamination between animals of different ages,
  - Create a good withdraw (cleaning, disinfection, room maintained without animals) on a regular basis before the arrival of the next strip,
  - Schedule technical actions at regular intervals, depending on the period between, two successive weaning.
  - With larger numbers and pigs of a similar age being housed together, there is the opportunity for introduction of phase feeding.
  - Larger numbers and more uniform groups of piglets and pigs with less variability of pig slaughter weights,
  - Regular and optimal gilt introduction.

- Conditions for Success :
  - Requires a considerable degree of planning
  - Ensure that sufficient staff is available to cover peak of work
  - It may be difficult to accommodate returning sows
  - Getting mating targets correct can be difficult

ANNEX

Annex 1. Characteristics of different batch management - Weaning at 21 and 26 days[5].

Number of batches	Interval between batches	Mating & gestation	Farrowing		Post-weaning		Growing		Finishing	
			Room	Age at exit	Room	Age at exit	Room	Age at exit	Room	Age at exit
3	49	4	1	33	1	77	0	0	2,5	180
4	42-35-35-35	4	1	21	1	51	0	0	4	186
	42-35-35-35	4	1	21	1	51	1	81	3	186
	42-42+42-42-21	2	50	0	0	0	0	0	4	190
5	28-28-28-28-35	5	1	21	2	71	0	0	4	178
	28-28-28-28-35	5	2	42	2	91	0	0	3	171
	42-21-42-21-21	5	2	26	2	63	0	0	4	182
7	21	7	2	26	1	42	2	77	6	198
	21	7	2	26	1	42	3	100	4	179
	21	7	2	26	2	63	2	98	5	198
	21	7	2	26	2	63	2	98	4	179
	21	7	2	26	3	84	0		5	184
10	14 & 21 days	10	3	26	2	49	3	86	7	179
	14 & 21 days	10	3	26	3	63	3	100	6	179
	14 & 21 days	10	3	26	4	77	0		8	184

20	7	19	5	21	5	51	7	95	13	181
	7	19	5	21	4	44	7	88	14	181
	7	19	5	21	6	58	6	95	13	181
	7	19	5	21	9	9	0		15	179
21	7	20	6	26	5	56	6	93	14	186
	7	20	6	26	5	56	6	93	13	179
	7	20	6	26	6	63	6	100	12	179
	7	20	6	26	8	77	0	0	16	189

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