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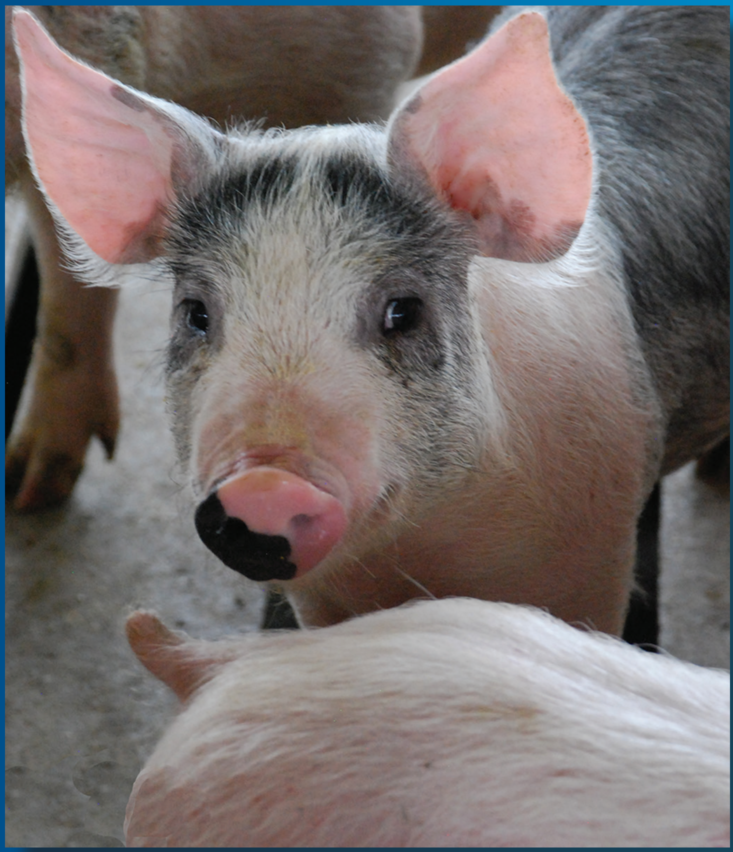

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Journal of Swine Health and Production

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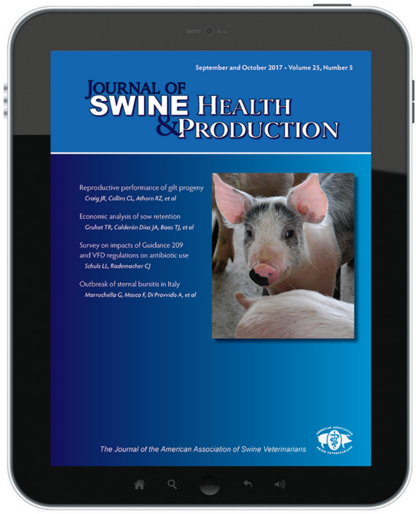

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nursery pig

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"Measuring [antimicrobial] use is a daunting task, but even more daunting is researching and developing the tools to interpret the data and make it more meaningful. There are also important questions about where to measure, who gets access to the data, and who pays for the measurement."

quoted from the Executive Director's message, page 227

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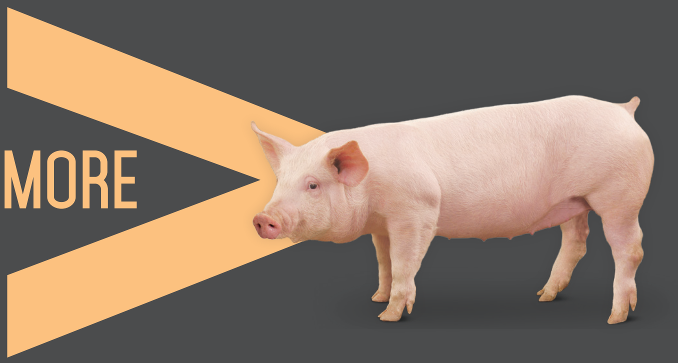

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What and when will the next game-changing technology be for pork production?

Technology changes are a fact of life. Ever since man has been around, new technology has been developed to facilitate and improve our daily activities. The swine industry has seen quite a few game-changing technologies over the years, including production of specific-pathogen-free (SPF) pigs, indoor housing for all stages of production, three-site systems, all-in, all-out, early weaning, and use of oral fluids just to name a few. All of these new technologies were game changers in helping improve the overall health and welfare of pigs. What technology will be the next game changer for our industry?

Some may say today's consumer does not like technology and expects us to go backward in the way we raise pigs. I will challenge everyone that that is not the case. Today's adults and youth love technology. One just has to see how smart phones play a major role in the daily lives of everyone, including us as veterinarians. One could argue whether this is good or bad, but that does not really matter. That is what today's consumer wants and likes. Remember the discussions occurring when the first large farrow-to-wean sow farms were being built? Several, including some veterinarians, wanted to keep the old traditional way of raising pigs, maybe because it required change and we all know that change is not something we look forward to. Change makes us uneasy, as many times the outcome is unknown. Change is what keeps us moving forward. Change is inevitable. Change can make you take a few steps back, but as long as we are focused on making change for the right reasons, change will be good. In basketball, one cannot make a basket without shooting at the hoop. Yes, it is true that sometimes we will miss the target. For some of us this happens quite often. But more importantly, one cannot win a basketball game simply by playing defense.

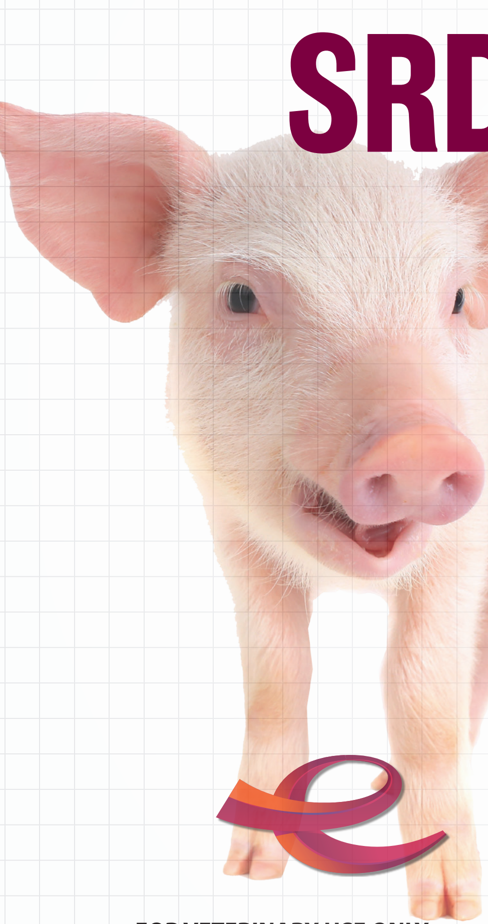
"I am just concerned that we have stopped innovating and are simply satisfied with the status quo."

What new technology can revolutionize our indoor housing? I truly believe we have dramatically helped pigs by moving them indoors, yet there still is room for improvement. I am not talking about gestation stalls versus pen housing. I am looking at our modern indoor facilities overall. Besides the addition of air filtration, what technology has been a game changer in pig housing? We basically continue to use the same ventilation system and controls. Yes, there have been some slight changes, but in my opinion, absolutely no game changers. I don't believe our housing is bad or creating a welfare concern. I am just concerned that we have stopped innovating and are simply satisfied with the status quo. Ask any teenager about technology and status quo. Technologies that maintain status quo and quit innovating become extinct.

I love technology. I believe swine veterinarians are some of the best at adapting technology. What new technology can continue to improve the health and wellbeing of the pigs we love to care for? Even more challenging, what new technology can help us better connect with today's consumer? I look forward to what the future can bring to pork production.

Alex Ramirez, DVM
AASV president

SRD Rapid Relief



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Cattle - Multiple-Day Therapy: Enroflox 100 is indicated for the treatment of bovine respiratory disease (BRD) associated with *Mannheimia haemolytica, Pasteurella multocida* and *Histophilus somni* in beef and non-lactating dairy cattle.

Swine: Enroflox 100 is indicated for the treatment and control of swine respiratory disease (SRD) associated with *Actinobacillus pleuropneumoniae, Pasteurella multocida, Haemophilus parasuis* and *Streptococcus suis.*

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Swine: Animals intended for human consumption must not be slaughtered within 5 days of receiving a single-injection dose.

HUMAN WARNINGS: For use in animals only. Keep out of the reach of children. Avoid contact with eyes. In case of contact, immediately flush eyes with copious amounts of water for 15 minutes. In case of dermal contact, wash skin with soap and water. Consult a physician if irritation persists following ocular or dermal exposures. Individuals with a history of hypersensitivity to quinolones should avoid this product. In humans, there is a risk of user photosensitization within a few hours after excessive exposure to quinolones. If excessive accidental exposure occurs, avoid direct sunlight. For customer service, to obtain a copy of the Safety Data Sheet (SDS) or to report adverse reactions, call Norbrook at 1-866-591-5777.

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ADVERSE REACTIONS: No adverse reactions were observed during clinical trials.

ANIMAL SAFETY:
In cattle safety studies, clinical signs of depression, incoordination and muscle fasciculation were observed in calves when doses of 15 or 25 mg/kg were administered for 10 to 15 days. Clinical signs of depression, inappetance and incoordination were observed when a dose of 50 mg/kg was administered for 3 days. An injection site study conducted in feeder calves demonstrated that the formulation may induce a transient reaction in the subcutaneous tissue and underlying muscle. In swine safety studies, incidental lameness of short duration was observed in all groups, including the saline-treated controls. Musculoskeletal stiffness was observed following the 15 and 25 mg/kg treatments with clinical signs appearing during the second week of treatment. Clinical signs of lameness improved after treatment ceased and most animals were clinically normal at necropsy. An injection site study conducted in pigs demonstrated that the formulation may induce a transient reaction in the subcutaneous tissue.

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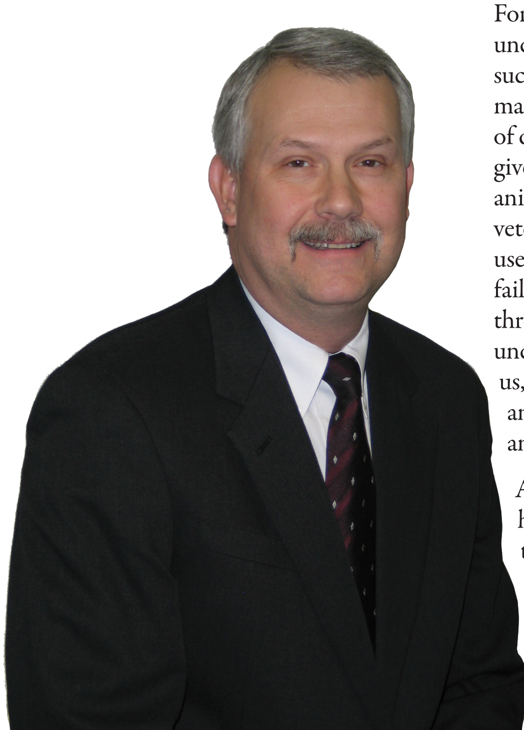
One-Health: condemnation or collaboration?

In my job over the years, I have had a few opportunities to interact with the medical profession concerning the use of antimicrobials and the role this use plays in the development of antimicrobial resistance. Recently I attended a meeting sponsored by the National Academies entitled *Combating Antimicrobial Resistance: A One-Health Approach to a Global Threat.* The "One-Health" descriptor meant that the meeting included topics on human and animal uses of antimicrobials.

Often these meetings can turn into finger-pointing events that end up villainizing animal agriculture. However, I found this particular meeting to lack much of the vitriol often piled on farmers and veterinarians. As usual, some of the anti-ag activist groups were represented, but there were limited opportunities for them to further their agendas. There was some finger pointing, but most of the meeting was guided towards describing the problems and working towards solutions.

During the meeting and in hallway discussions with infection-control physicians and researchers, I got the sense that these "front-line" clinicians are not very worried about antimicrobials used in animals. For the most part they are not very knowledgeable about such uses or how swine veterinarians strive to prevent pathogens from threatening pig health. One of their concerns was taken off the table due to the recent removal of the growth-promotion, feed-efficiency uses of medically important antimicrobials in animal feed by the US Food and Drug Administration. The role of the veterinarian in the decision-making process to use antimicrobials was also well received as we talked about the Veterinary Feed Directive.



Some issues that arose from meeting participants may someday affect veterinary medicine. One area of concern among meeting attendees was the fact that veterinarians make recommendations on the use of antimicrobials and also sell those drugs to the animal owner. There was a viewpoint that this should be avoided in order to prevent the veterinarian's recommendation from being influenced by the profit motive from sales. In the United States, human medicine relies heavily on pharmacists. It would be difficult to totally revamp the distribution system for veterinary drugs, but it is an issue that may confront us in the future, perhaps via legislation or marketing requirements.

Another area of concern expressed during the meeting was the routine use of antimicrobials, whether in human or veterinary medicine. For humans, the unneeded prescriptions for uncomplicated upper respiratory infections, such as bronchitis, were cited. For food animals, the ongoing routine uses for prevention of diseases were brought up. An example given was the treatment of every group of animals arriving on a farm. One food-animal veterinarian went as far as to say that routine uses for prevention purposes represent a failure to adequately manage the disease through means other than antimicrobials. As uncomfortable as that statement might make us, it is incumbent on us to continually assess and determine the need for routine uses of antimicrobials.

A theme common to discussions on both human and veterinary medicine was the desire to measure antimicrobial use. Measuring use is a daunting task, but even more daunting is researching and developing the tools needed to interpret the data and make it meaningful. There are also important questions about where to measure, who gets access to the data, and who pays for the measurement. My fear is that use data could be manipulated to further restrict use without any scientific justification. Another fear is that the burden of measurement will be solely placed on the veterinarian and the farmer, taking up resources that could be used in other ways that may in fact benefit animal health more than simply knowing the amounts used. It would be much more useful if the knowledge derived from use data could be applied to specific circumstances of bacteria-drug interaction on the farm rather than the simple solution of using the use data as a benchmark that must be reduced every year.

One theory brought forth at this meeting was concerning what a speaker referred to as the "organismal soup" of bacteria. It is hypothesized that this "soup" is where horizontal gene transfer occurs between bacteria, thus allowing genetic material imparting drug resistance to be passed. The theory postulates that any introduction of antimicrobials into the soup, whether in humans, animals, plants, or the environment, will lead to resistance and potential transfer of genetic material. This is the sort of nebulous theory that is difficult and expensive to prove or disprove. This then becomes a tool for anyone wishing to disrupt animal agriculture with a theory that is subjective enough that it can't be denied, but plausible enough to support further restrictions of antimicrobial use in animals.

I often dread attending these types of meetings due to the abuse often heaped upon animal agriculture. Fortunately, I found this meeting to be more practical and collaborative in its approach. I found it refreshing to openly discuss the resistance issues with physicians working in the area of infection control in human medicine. It seems to me that they want veterinarians to acknowledge that any health professional involved in the use of antimicrobials needs to recognize the potential consequences of such use, accept responsibility in the areas under their control, and work collaboratively across the One-Health spectrum.

Tom Burkgren, DVM
Executive Director

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Change

Change will soon be upon us at the *Journal of Swine Health and Production* (JSHAP), as we are getting ready to wish our associate editor, Dr Judi Bell, a happy retirement. Judi will be retiring at the end of the year. It makes me quite sad that Judi will be finishing her tenure with the journal, as it is never easy when a team member moves on to different things. Judi has been a paramount teammate of the journal staff for a long time. She has contributed immensely to the high quality of the manuscripts published, paying attention to each small detail to ensure that each journal issue is completed with excellence! While I am sad for this change, I am also very happy for her, and I wish her all the very best as she moves on to new adventures.

With this news of Judi's pending retirement, the AASV is requesting applications for associate editor of JSHAP. I remember when I applied to be the executive editor of the journal. The job description and responsibilities list seemed very daunting. I interviewed with Drs Cate Dewey and Tom Burkgren at the 2012 AASV Annual Meeting in Denver, Colorado. I remember sitting in the interview with a really bad headache and thought there is no way Cate or Tom could possibly think I was smart as my head was throbbing and I don't recall any of my answers to their questions. I soon learned that I had altitude sickness and luckily it passed with a few good sleeps and some ibuprofen. Not sure why I shared that story except perhaps to say that the associate editor's job description and responsibilities seem daunting as well. However, the new associate editor will work alongside the JSHAP and AASV staff team and I can personally say from experience that the team is terrific at welcoming and supporting newcomers!

"She has contributed immensely to the high quality of the manuscripts published, paying attention to each small detail to ensure that each journal issue is completed with excellence!"

The role of the associate editor is quite comprehensive and I think in order to fully describe the duties of the associate editor would require a step by step explanation of the lifecycle of a manuscript. However, my word count is limited so I will summarize key qualifications and responsibilities here. Most importantly, the applicant should have experience in scientific writing and editing and possess excellent organizational, interpersonal, and communication skills. Ideally, a background in swine health and production and an advanced degree (MS, DVM, PhD or equivalent) would also be preferred. The job requires the individual to work with the authors and to copy edit the manuscripts in preparation for publication. To summarize, this involves converting the manuscripts to the JSHAP style (currently AMA style), editing for scientific grammar and style, preparing an expository summary for the authors, and proofreading the final manuscript and "all page final" of the entire journal. The journal staff meet by teleconference bimonthly after the publication of each issue and at other times when necessary. The individual will be required and expected to work unsupervised and be able to adhere to strict deadlines. If there are any questions please do not hesitate to contact myself or the AASV office.

I encourage anyone who has an interest in becoming the next associate editor of the *Journal of Swine Health and Production* to please forward a letter of interest and your curriculum vitae to Dr Tom Burkgren at the AASV office at **aasv@aasv.org**.

Terri O'Sullivan, DVM, PhD
Executive Editor

Investigating the reproductive performance of gilt progeny entering the breeding herd

J. R. Craig, BAnVetBioSc (Hons); C. L. Collins, PhD; R. Z. Athorn, PhD; F. R. Dunshea, PhD; J. R. Pluske, PhD

Summary

Objective: To quantify the performance of gilt progeny in the F1 breeding herd at a large swine farm in New South Wales, Australia (Rivalea Australia Pty Ltd).

Materials and methods: Performance data on all gilts selected for entrance to the commercial breeding herd from January 2014 until December 2015 were included in this study. Comparisons were made between gilt and sow progeny in terms of the proportion of animals to reach first breeding, performance to parity 4, and longevity to parity 3.

Results: Gilt progeny were lighter than sow progeny at each live weight measurement ($P < .001$), and had a higher P2 backfat level at selection than sow progeny ($P = .02$) at the same live weight. Gilt progeny selected into the breeding herd reached first breeding before 220 days of age less often than sow progeny ($P < .001$) and were 1 day older at first breeding ($P = .003$). Sow progeny had a lower farrowing rate from this breeding ($P < .001$). After the first breeding, there were few differences in performance indices between groups for the first four parities. There were no statistically significant differences between the groups in terms of longevity indices.

Implications: Fewer gilt progeny may be selected to enter the breeding herd; however, after farrowing their first litter, selected gilt progeny perform just as well as sow progeny. While it is recommended to continue to include gilt progeny in the replacement-gilt selection process, further research in this field is recommended.

Keywords: swine, gilt progeny, selection, breeding, reproductive performance.

Received: September 7, 2016
Accepted: March, 7, 2017

Resumen - Investigación del desempeño reproductivo de la descendencia de primerizas que entran el hato de cría

Objetivo: Cuantificar el desempeño de la descendencia de primerizas en el hato de cría F1 en una granja porcina grande en Nuevo Sur Gales, Australia (Rivalea Australia Pty Ltd).

Materiales y métodos: En este estudio, se incluyó la información del desempeño de todas las primerizas seleccionadas para entrar al hato de cría comercial entre enero del 2014 hasta diciembre del 2015. Se comparó, entre las descendencias de primerizas y hembras destetadas, la proporción de animales que llegaron a primera inseminación, desempeño hasta la paridad 4, y longevidad hasta la paridad 3.

Resultados: La descendencia de las primerizas fue más ligera que la descendencia de las hembras destetadas en cada medición de peso vivo ($P < .001$), y a la selección, tuvieron más grasa dorsal al nivel P2 ($P = .02$) al mismo peso vivo. La descendencia de las primerizas seleccionadas para entrar al hato de cría, llegaron a su primera inseminación, antes de los 220 días de edad, con menos frecuencia que la descendencia de las hembras destetadas ($P < .001$) y también tenían 1 día más de edad ($P = .003$). La descendencia de las hembras destetadas mostró una porcentaje de fertilidad más bajo en esta inseminación ($P < .001$). Después de la primera inseminación, se encontraron pocas diferencias en los índices de desempeño entre los grupos en las primeras cuatro paridades. No hubo diferencias estadísticamente significativas entre los grupos en términos de índices de longevidad.

Implicaciones: Se puede seleccionar menos progenie de primerizas para ser introducidas al hato; sin embargo, después de la primera camada, la progenie de las primerizas seleccionadas tiene el mismo comportamiento que las hijas de hembras. Aunque se recomienda continuar incluyendo la progenie de primerizas dentro del proceso de reemplazo de primerizas, se recomienda más investigación en este campo.

Résumé - Enquête sur les performances de reproduction de la progéniture de cochettes introduites dans le troupeau reproducteur

Objectif: Quantifier les performances de la progéniture de cochettes dans le troupeau reproducteur F1 d'une grosse ferme porcine dans la région de New South Wales, Australie (Rivalea Australia Pty Ltd).

Matériels et méthodes: Les données de performance de toutes les cochettes sélectionnées pour être introduite dans le troupeau reproducteur commercial entre janvier 2014 et décembre 2015 ont été incluses dans cette étude. Des comparaisons ont été faites entre la progéniture des cochettes et de truies en termes de proportion d'animaux atteignant le premier accouplement, de performances jusqu'à la parité 4, et la longévité jusqu'à parité 3.

Résultats: La progéniture des cochettes étaient moins lourdes que celle des truies à chaque point de mesure du poids ($P < 0{,}001$) et avait une épaisseur de gras dorsal P2 plus grande au moment de la sélection que la progéniture des truies ($P = 0{,}02$) au même poids vif. La progéniture des cochettes

JRC, CLC, RZA: Rivalea (Australia) Pty Ltd, Corowa, New South Wales, Australia.

FRD: Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Parkville, Victoria, Australia.

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This article is available online at http://www.aasv.org/shap.html.

Craig JR, Collins CL, Athorn RZ, et al. Investigating the reproductive performance of gilt progeny entering the breeding herd. *J Swine Health Prod.* 2017;25(5):230–237.

sélectionnée pour introduction dans le troupeau reproducteur a été accouplée avant l'âge de 220 jours moins souvent que la progéniture des truies ($P < 0{,}001$) et était 1 jour plus âgé au premier accouplement ($P = 0{,}003$). La progéniture des truies avait un taux inférieur de mise-bas relié à cet accouplement ($P < 0{,}001$). Après le premier accouplement, il y avait peu de différences dans les indices de performance entre les groupes pour les quatre premières parités. Il n'y avait aucune différence statistiquement significative entre les groupes en termes d'indices de longévité.

Implications: Un nombre moindre de la progéniture des cochettes pourrait être sélectionné pour introduction dans le troupeau reproducteur; toutefois, suite à la mise-bas de leur première portée, la progéniture sélectionnée des cochettes performe aussi bien que la progéniture des truies. Bien qu'il soit recommandé de continuer à introduire la progéniture des cochettes dans le processus de sélection de remplacement des cochettes, des études supplémentaires dans ce domaine sont recommandées.

Gilts represent a significant proportion of the Australian breeding herd, with recent sow turnover rates in Australia reported at 56.1%, and with 22.7% of sows bred being primiparous.[1] First litter progeny born to these sows ("gilt progeny") are eligible for selection as replacement gilts themselves in nucleus and F1 breeding herds.

Gilt progeny, however, are generally born[2,3] and weaned[4,5] lighter than progeny born to multiparous sows, are lighter at the conclusion of the finishing stage,[6] and exhibit higher rates of disease and mortality in the early stages of development before and immediately after weaning.[3,7] Differences in growth performance may be a consequence of breeding gilts at a young age, when they are still partitioning energy into their own growth rather than the growth of their fetuses,[8] and when uterine capacity may be limiting.[9,10] Higher morbidity and mortality rates in gilt progeny may be caused by differences in colostrum intake, quality, and absorption, as colostrum from gilts may be lower in yield[11] and may contain lower concentrations of immunoglobulins (Ig)[12-14] and growth factors[15,16] than colostrum from sows of higher parities. These characteristics may have negative implications for the selection of gilt progeny as replacements in the breeding herd and their reproductive performance and overall longevity.

Gilt progeny are more likely to be selected into nucleus herds that utilise estimated breeding values (EBVs) in their selection process as a result of increased genetic turnover. In F1 multiplier herds, which may not have EBVs calculated, having lighter body weights at selection as a result of slower growth rates early in life may cause a greater proportion of gilt progeny to fail to be selected for breeding. Little is known about the effect of dam parity on reproductive performance of the resulting progeny; however, there is evidence to suggest that being born to a gilt can result in lower re-breeding rates and prolonged wean-to-estrus intervals (WEIs).[17] Additionally, females that are compromised in terms of birth weight,[18] colostrum intake and immune status,[19,20] and growth rate and live weight around the time of selection and first breeding,[21-23] have been shown to exhibit a poorer reproductive capacity.

Research in this field is warranted to give an understanding of the effects of selecting gilt progeny as breeding females in order to determine whether it is economically viable to involve these smaller, slower growing progeny in the selection process. If these progeny are compromised in terms of reproductive capacity and longevity in the breeding herd due to the shortcomings mentioned, producers could make decisions about their selection processes to improve herd efficiency. The purpose of this study was to benchmark the reproductive performance of F1 gilts born to primiparous sows (gilt progeny) compared to that of gilts born to multiparous sows (sow progeny) and investigate their reproductive outcomes in the breeding herd. It was hypothesized that gilt progeny would take longer, or indeed fail, to reach first breeding more often, and would have higher rates of gestation failure, lower litter sizes at birth and weaning, longer WEIs, and poorer overall reproductive longevity.

Materials and methods

Animals

This experiment involved collection of retrospective production data records under commercial field conditions. In this case, animals were not manipulated beyond what would be required for diagnostic purposes and were adequately housed and humanely cared for according to the Model Code of Practice for the Welfare of Animals: Pigs (Australia).

Retrospective production records for a total of 18,136 gilts (Primegro; bred on farm) selected to enter the multiplier (F1) breeding herd at Rivalea Australia's site in Corowa, New South Wales, from 1 January 2014 to 31 December 2015, were included in this study. This included 3164 gilt progeny (parity 1) and 14,972 sow progeny (parities 2 to 9; average 3.6). Records analyzed prior to selection were therefore included only for gilts that were selected to the breeding herd, as including data from animals not selected, but eligible for selection, was beyond the scope of this study.

Within this multiplier herd, gilts were selected on-site at approximately 23 to 24 weeks of age. Selection criteria included live weight (gilts had to be heavier than 70 kg at selection to be used for breeding); body, vulva, and udder conformation; teat number; and absence of physical defects such as hernias or lameness. Selection was carried out each week by a small group of trained staff, with personnel rotated each day. These selection criteria were different from those used for the nucleus herd, which included calculation of EBVs on the basis of reproductive and growth performance of relatives, live weight and backfat at selection, and numerous other records.

These animals were managed under commercial conditions at Rivalea Australia's Corowa site. The site consisted of five farms, all of which housed gestating sows in group pens throughout gestation in various group sizes depending on farm (space allowance approximately 2 m^2 per sow). Once selected, gilts were kept for approximately 5 weeks at the parent farm, after which they were transported to the breeding barn of one of the five individual farms for boar exposure and estrus detection from this period onwards (approximately 28 to 29 weeks of age, depending on farm). Gilts were then brought to the designated breeding area at least once daily and exposed to a number of "teaser" boars to stimulate puberty. Gilts were bred by artificial insemination at the second observed estrus; however, they might also have been bred at first or third (or later) estrus depending on the farm, time of year, and management recommendation indicated by the approximate weight at each observed estrus (measured by the Allometric Growth Tape for Gilts; Swine Reproduction and Development Program (SRDP), University of Alberta, Edmonton, Canada). The growth tape approximated the live weight of the animal at estrus according to the circumference of the girth at the level of the shoulder with recommendation of either breeding or measuring again at the next observed estrus (101 to 135 kg), breeding at the observed estrus (136 to 150 kg), or not breeding (< 100 kg or > 150 kg) on the basis of this approximation.

Gilts were given ad libitum access to a number of commercial weaner and grower diets from weaning until selection, and a specific gilt developer diet from selection until first breeding. In gestation, gilts and sows were fed approximately 2.3 to 2.5 kg per day of a commercial gestation diet up until farrowing. Access to feed was ad libitum during lactation, except in the first 4 days after farrowing where they were fed on a step-up program.

Data collection

Data was extracted from Rivalea Australia's record-keeping program (PigFM). All records for all females selected during the experimental period were used in the analysis. This meant that females were at different stages of their reproductive life cycle at the end of the recording period; however, this was accounted for in the statistical analysis. Records analyzed prior to selection included birth litter size (BLS; n = 18,136), birth weight (BWT, kg; n = 12,815), 21-day weight (21WT, kg; n = 9263), teat number at birth (Teat#; n = 14,156), post-weaning weight (approximately 2 weeks post weaning; PWWT, kg; n = 3224), selection weight (at approximately 23 to 24 weeks of age; SelWT, kg; n = 13,201), and selection backfat (P2, mm; n = 3929). Live weights at 21 days of age and PWWT of a subset of these gilts were obtained from an ongoing subsequent project (R. Z. Athorn, K. L. Bunter, J. R. Craig; unpublished data, 2017).

Gilts were categorized into quartile groups according to their birth and selection weights, with the groups being light (< 1.39 kg at birth and < 95 kg at selection), medium (1.39 to 1.59 kg; 95 to 102 kg), heavy (1.60 to 1.83 kg; 103 to 110 kg), and extra heavy (> 1.83 kg; > 110 kg).

Records analyzed after selection included age at first observed estrus (not recorded for every gilt; AgeE1; days; n = 2640), age at first breeding (whether successful or not; AgeB1; days; n = 14,077), days between first observed estrus and first breeding (B1-E1; days; n = 2390), approximate weight at first breeding (measured using the growth tape, SRDP; B1WT; kg; n = 10,448), and days between selection and first breeding (B1-Sel; days; n = 14,077). Age at breeding (Age; days), gestation length (GL; days), number born alive (BA), number of stillbirths (SB), number of mummified fetuses (Mumm), total born (TB), lactation length (LL), number of pigs weaned (#W), and subsequent WEI were recorded at each parity achieved in the recording period, regardless of the number of the breeding at which this parity was achieved. Records analyzed for lifetime performance within the recording period included traits relating to sow medications, such as total number of medication events (Med#; n = 18,136) and age first medicated (AgeMed; days; n = 2338). Average WEI (AveWEI; days; n = 8266), total breedings (TotB; n = 14,077), total litters produced (TotL; n = 14,077), and total number of reproductive failures (returns, abortions, negative tests, etc; #RF; n = 14,077) were also analyzed, along with age (AgeRem; days) and parity (ParRem) at death or removal from the herd (n = 3332).

Statistical analysis

Data were analyzed using SPSS software (IBM SPSS; Version 21.0). Continuous variables (eg, first breeding age, number weaned) were analyzed using the MIXED procedure, with dam treatment (gilt progeny versus sow progeny) as a fixed factor, and other blocking and (or) nuisance factors and covariates included in the final model as appropriate. Outliers (> 1.5 times the interquartile range from the mean) or obvious data input errors were excluded from the analysis. Nuisance factors and covariates found to have significant effects on some of the traits measured included birth month (BMth), birth litter size (BLS), age (Age), and weight (WT) of the animal at measurement, farrowing barn (Barn[Farm]), breeding month, total breedings (TotB), and age at the end of the experimental period (Ageatend), and these were included in the analysis as appropriate. There was no effect of farm on any trait measured, and this was therefore omitted from the overall model.

Five binomial traits were set up to evaluate first breeding achievement and (or) success and longevity to parity 3, based on appropriate ages at which to reach these milestones referenced in the literature,[24,25] and calculated from gilts that reached these milestones during the experimental period: bred prior to 220 days of age (first bred at or before 220 days of age; females at least 220 days of age by the end of the experimental period), bred prior to 270 days of age (first bred at or before 270 days of age, of females at least 270 days of age by the end of the experimental period), removed before first breeding (removed from herd before being bred at least once, of females that were not bred at or before 270 days of age), reached parity 3 (farrowed a third litter at or before 700 days of age, of females at least 700 days of age by the end of the experimental period), and removed before parity 3 (removed prior to farrowing a third litter, of females that had not farrowed a third litter at or before 700 days of age).

A limit was set on the age of the sows at the end of the experimental period to include only sows that had reached the age at which they would have the opportunity to achieve these milestones. The success of the first breeding was analyzed on the subset of sows that had achieved a first breeding, regardless of the age at which this was reached. For the females removed prior to first breeding or parity 3 within the appropriate age ranges, removals were grouped as reproductive, health, structural, or other reasons, and analyzed as binomial traits.

An additional binomial trait (Medicated) was set up to assess the frequency of sows medicated at least once before reaching parity 3, and this was based on the subset of sows that had successfully reached parity 3 within the experimental period. Medications recorded after sows had reached parity 3 were not included in this analysis. Binomial variables and ratios of birth and selection weight categories were analyzed using chi square (χ^2). Values of $P < .05$ were considered significant and values of $P < .10$ were considered trends.

Results

Live weight

Sow progeny were heavier ($P < .001$) than gilt progeny at all periods where a live weight was obtained (Table 1). Birth weight of gilt progeny was even lighter when correcting for the smaller litter size (total born) of their birth litter (12.39 ± 0.07 pigs for gilt litters versus 13.71 ± 0.05 for sow litters). Gilt progeny had a higher ($P < .001$) number of animals in the light birth-weight group than sow progeny (39.2% and 23.0%, respectively), and this was also the case at selection (32.0% and 25.8%, respectively). Sow progeny grew faster ($P < .001$) than gilt progeny from birth until selection (601 ± 6 g per day versus 581 ± 6 g per day, respectively). Age at selection (AgeSel) tended to be higher ($P = .06$) for gilt progeny, and therefore

Table 1: Estimated marginal means and statistical models used for the mixed models analysis of growth traits up until selection and reproductive traits from selection to first breeding for gilt progeny (GP) and sow progeny (SP) selected to enter the Rivalea (Australia) F1 breeding herd between 1 January 2014 and 31 December 2015

Trait	Model	GP	SP	*P*
Live weight				
BWT (kg)	y = Tmt + BMth	1.44 ± 0.01	1.64 ± 0.01	< .001
21WT (kg)	y = Tmt + BMth + BLS + Age21WT	5.47 ± 0.08	6.58 ± 0.08	< .001
PWWT (kg)	y = Tmt + BMth + BLS + AgePW	11.0 ± 0.3	12.7 ± 0.3	< .001
SelWT (kg)	y = Tmt + BMth + BLS + AgeSel	99.1 ± 0.9	102.7 ± 0.9	< .001
B1WT (kg)*	y = Tmt + BMth + BLS + AgeB1	141.0 ± 0.5	142.7 ± 0.4	< .001
First breeding				
AgeSel (days)	y = Tmt + BMth	169.3 ± 0.6	169.2 ± 0.6	.06
AgeE1 (days)	y = Tmt + BMth + AgeSel	200.0 ± 0.7	199.9 ± 0.6	.79
AgeB1 (days)	y = Tmt + BMth + BLS + AgeSel	223.6 ± 1.2	222.4 ± 1.1	.003
Sel-B1 (days)	y = Tmt + BMth + BLS + AgeSel	54.5 ± 1.2	53.2 ± 1.1	.003

* Measured using the Allometric Growth Tape for Gilts (Swine Reproduction and Development Program, University of Alberta, Edmonton Canada). Data are expressed as mean ± standard error and *P* < .05 was considered significant (chi-square analysis).
BWT = birth weight; 21WT = 21-day weight; PWWT = post-weaning weight; SelWT = weight at selection (approximately 23-24 weeks of age); B1WT = weight at first breeding; AgeSel = age at selection; AgeE1 = age at first estrus; AgeB1 = age at first breeding; Sel-B1 = days from selection to breeding; Tmt = dam treatment (gilt versus sow); BMth = birth month; BLS = birth litter size; Age21WT = age at 21-day weight; AgePW = age at post-weaning weight.

models for selection parameters were adjusted accordingly, where the effect of AgeSel was significant (Table 1). At selection, there was no difference in backfat between groups (gilt versus sow progeny, 14.9 ± 0.4 mm versus 15.0 ± 0.4 mm, respectively; *P* = .66). However, when corrected for their lighter body weight at this time, gilt progeny (15.5 ± 0.3 mm) had greater backfat (*P* = .02) than sow progeny (15.2 ± 0.2 mm).

First breeding

There was no difference (*P* = .79) between gilt progeny and sow progeny in terms of age at which first estrus was observed. However, age at first breeding was higher in gilt progeny (*P* = .003; Table 1) and gilt progeny had a greater (*P* = .01) number of days between detection of first estrus and first breeding in the gilts that had their first estrus recorded. From selection, gilt progeny took approximately 1 more day (*P* = .003) to reach first breeding than sow progeny.

Fewer (*P* < .001) selected gilt progeny were bred by 220 days and 270 days of age than selected sow progeny (Table 2). As a proportion of gilts not bred prior to 270 days of age, more (*P* = .04) gilt progeny were removed from the herd than sow progeny, while more sow progeny remained active in the herd (Active in herd; Table 2). Of the females removed from the herd before first breeding, more (*P* < .001) gilt progeny were removed for reproductive reasons (ie, anestrus) than sow progeny, whereas more (*P* = .01) sow progeny were removed for health reasons (eg, sudden death, ill thrift), and tended to be removed more often (*P* = .09) for structural reasons (eg, lame, prolapse, udder defects; Figure 1).

Of the gilts that had been first bred in the experimental period, more (*P* < .001) sow progeny were bred unsuccessfully than gilt progeny, resulting in a lower farrowing rate (Table 2), with more pregnancies failing due to reproductive reasons (Figure 1) as signified by return to estrus, negative pregnancy test, abortion, etc.

Lifetime reproductive performance

There was no significant difference in total born between the two groups at parity 1 (*P* = .51; data not shown). Gilt progeny tended to have fewer (*P* = .09) born alive at their first parity than sow progeny when adjusted for total born (10.78 ± 0.02 versus 10.83 ± 0.03 piglets, respectively), and fewer (*P* = .02) piglets weaned than sow progeny (9.21 ± 0.07 versus 9.34 ± 0.08 piglets, respectively). There were no differences (*P* ≥ .05) between the groups in terms of number of stillbirths or number of mummified fetuses (data not shown). There were few differences between the treatment groups for any trait analyzed in the subsequent parities (2 to 4; data not shown). Between weaning the second litter and the subsequent breeding, gilt progeny tended (*P* = .05) to have a longer WEI than sow progeny (5.91 ± 0.21 versus 5.48 ± 0.08 days, respectively). At parity 3, gilt progeny tended (*P* = .09) to have a lower total born (TB) than sow progeny (13.25 ± 0.16 versus 13.53 ± 0.08 piglets, respectively); however, this difference was not reflected at other parities. There were no differences (*P* = .54) between numbers of females medicated in either progeny group (Table 2). Sow progeny were medicated more often (*P* = .02) in their reproductive lifetime than gilt progeny (0.28 ± 0.01 versus 0.24 ± 0.02 medication events per sow, respectively).

Longevity

There were no differences (*P* ≥ .10) between gilt and sow progeny in terms of longevity in the herd to parity 3 (Table 2). There was no difference (*P* ≥ .10) between groups in terms of average WEI, total breedings, litters and reproductive failures, and age and parity

Table 2: Results (means) from the chi-square (χ^2) analysis of binomial traits from first breeding until parity 3 compared between gilt progeny (GP) and sow progeny (SP)*

Trait	GP (%)	SP (%)	$\chi2$	*P*
Selection to first breeding				
Bred prior to 220 days of age†	40.5	44.4	14.61	< .001
Bred prior to 270 days of age‡	80.7	84.4	21.10	< .001
Not bred prior to 270 days of age‡	19.3	15.6	21.10	< .001
Removed	88.4	84.7	4.29	.04
Active in herd§	11.6	15.3	4.29	.04
First breeding FR	86.4	82.6	15.74	< .001
Longevity to P3¶				
Reached P3¶	47.5	49.7	0.89	.35
Did not reach P3¶	52.5	50.3	0.89	.35
Removed	93.9	94.2	0.03	.86
Active in herd**	6.1	5.8	0.03	.86
Medicated	26.3	27.9	0.38	.54

* Chi-square (χ^2) test analysis for binomial traits, described in Table 1; $P < .05$ was considered significant.
† Of females ≥ 220 days of age at the end of the experimental period.
‡ Of females ≥ 270 days of age at the end of the experimental period.
§ Gilts not bred most likely due to failing to reach puberty or management decisions (eg, not at optimal breeding weight), but remain in the herd and are eligible to be bred (have not died or been removed, such that Removed + Active in herd = 100%).
¶ Of females ≥ 700 days of age at the end of the experimental period.
** Sows that have not farrowed their third litter most likely due to prolonged non-productive days, but remain in the herd and are eligible to reach parity 3 (have not died or been removed, such that Removed + Active in herd = 100%).
FR = farrowing rate; P3 = parity 3.

at removal (data not shown). Reasons for removals prior to parity 3 did not differ between gilt and sow progeny (Figure 1).

Discussion

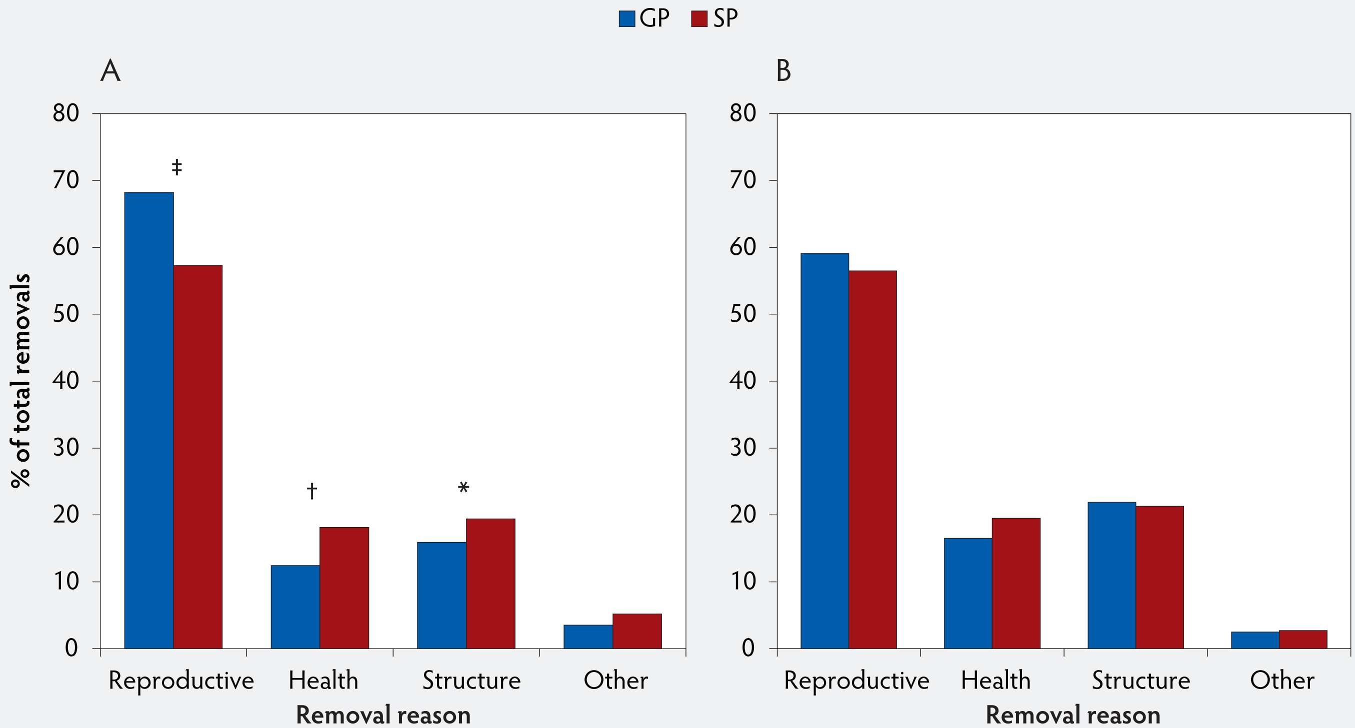
The overall objective of this study was to evaluate, in a retrospective manner, the reproductive performance and longevity in the breeding herd of progeny born to primiparous sows ("gilt progeny") selected as replacement females. It was found that, in accordance with previous studies,[5,6,26] (selected) gilt progeny were born lighter, grew more slowly, and were therefore lighter at later ages, such as at 21 days of age, 2 weeks after weaning, at selection, and at first breeding. As this study included only gilts selected to stay in the breeding herd, these figures may be even more disparate if the data for females that were not selected or eligible for selection due to lighter body weights, morbidity, or mortality were able to be included in the analysis.

Gilt progeny had more backfat than sow progeny at selection after adjusting for their lower body weight. This may be due to differences in birth weight, as some studies[27-29] report that low birth weight piglets (LBW; < 1.2 kg) have a higher fat-to-lean ratio at slaughter (or in this case, at selection). This may be due to increased adipocyte numbers in the carcass as the result of heightened activity of fatty acid synthase and malic enzyme in backfat tissue.[27] Low birth weight pigs also have fewer secondary muscle fibers at birth, which may translate into less lean muscle at older ages.[30]

Collectively, these results suggest that any differences in growth over the lifetime of a selected gilt born to a gilt are direct results of being born and weaned lighter than sow progeny. Strategies to increase birth weights and (or) growth rates in the pre-weaning period may improve the reproductive performance of these gilts. However, improving birth weights of gilt progeny may be difficult, as pressure to breed gilts earlier in life[24] means their parity 1 dams are still partitioning energy into their own growth and energy metabolism,[8,31-33] and may not have the uterine and (or) mammary capacity to support such large litters. Therefore, improving growth during the pre-weaning period using techniques such as cross-fostering[34,35] and feeding supplemental milk,[26] may be an opportunity to improve the subsequent growth of gilt progeny to improve their chances of being selected for the breeding herd and of being more reproductively successful.

The results of this study suggest that gilt progeny have higher rates of anestrus and take approximately a day longer to reach first breeding than their sow progeny counterparts. This is in accordance with other studies that found that low birth weight,[19,36] restricted access to colostrum,[20,37] and low growth rates[22,38] in gilts can result in prolonged days from entry to puberty and first breeding and (or) slower rates of sexual maturation. Lighter gilts at selection have been shown to have lower levels of estradiol, IGF-I, medium to heavy follicles, and lighter reproductive tracts than heavier gilts,[39] which may suggest that lighter gilt progeny may be less sexually developed than sow progeny at selection. However, age at first observed estrus in the two progeny groups in the present study did not differ significantly, which may suggest that age at first breeding was prolonged in gilt progeny due to these gilts not being at a desired weight (as estimated by allometric growth tape) by

Figure 1: Removal reasons (A) prior to first breeding (females ≥ 270 days of age by the end of the experimental period) and (B) prior to parity 3 (females ≥ 700 days of age by the end of the experimental period) for gilt progeny (GP) and sow progeny (SP; Table 1) analysed using chi-square (χ^2). No symbol indicates no significant difference between GP and SP ($P \geq .10$); * $P < .10$ indicates a trend; † indicates a significant difference at $P < .05$; ‡ indicates a significant difference at $P < .001$.



their first estrus rather than as a result of being more immature reproductively. However, it is important to note that in this commercial system, age at first observed estrus is not always recorded, which may be a confounding influence. The result that gilt and sow progeny reached first estrus at the same age should therefore be interpreted with some caution. With this in mind, the finding in the present study that sow progeny had a lower farrowing rate at first breeding than gilt progeny was unexpected. One study[17] found that younger gilts at first breeding were more likely to have been bred more than once before farrowing, which is consistent with the current results, as sow progeny were approximately 1 day younger at first breeding. It may be possible that gilt progeny that are underdeveloped reproductively are removed during the selection processes, as they are below the weight threshold at that period. Larger sow progeny may be selected into the breeding herd, but underlying reproductive issues may not be identified until the time of first breeding, where these higher rates of reproductive loss occur. The higher proportion of gilt progeny under this weight threshold would experience increased selection pressure, which may result in the better breeding females reaching the first breeding and therefore increasing farrowing rate in these animals.

The higher number of sow progeny being removed before their first breeding for structural reasons may be due to their higher growth rates, as heavier, faster growing gilts tend to have an increased incidence of lameness as the weight load on the hooves and legs increases.[40,41] The fact that more sow progeny were removed for health reasons and had more medications per sow than gilt progeny is surprising, as other authors have found that gilt progeny have higher morbidity and mortality rates than sow progeny.[5,7,26] However, much of this prior research focuses on disease rates earlier in life, and little evidence is available for differences in morbidity and mortality of gilt progeny compared to sow progeny in later life. This again may reflect smaller, unthrifty gilt progeny not being selected for breeding in this particular herd.

Contrary to the current hypothesis, after gilt progeny were bred at least once, they were generally equivalent to sow progeny in terms of reproductive performance and longevity characteristics. Gilt progeny tended to farrow fewer live piglets at their first parity than sow progeny, which is in agreement with Vallet et al,[19] who found that females born lighter had a shorter uterine length at puberty, which may represent lighter-born gilt progeny. However this difference was not seen at later parities, which may indicate that these females caught up in terms of reproductive capacity by these later ages. Unfortunately, observed estrus was not always recorded in this production system, and this may have a confounding influence on factors such as farrowing rate and litter size if, for example, more gilt progeny than sow progeny were bred on the second estrus.

Progeny born to gilts[39] and low-growth-rate gilts[17] have been known to have longer WEIs than their heavier or faster growing counterparts. The WEI after parity 1 did not differ between gilt and sow progeny in the current study. This is in contrast to Tummaruk et al,[17] who found that gilt progeny had a significantly longer WEI after parity 1 than progeny born to parity 4 and 5 sows. There were a few differences between the groups in terms of performance indicators at later parities (ie, WEI after parity 2); however, in the current study, these were not replicated at other parities and therefore seem to be anomalies. It would be interesting to see if these results could be replicated in other herds, as there are no apparent reasons for these seemingly random differences to occur.

It was further hypothesized that gilt progeny would not persist in the herd to the same degree as sow progeny, as low birth weight,[18] slower growth rates,[17,23] and higher age at first breeding[24,42] have all been associated with impaired sow longevity. However this was not the case in this dataset, with both groups exhibiting the same percentage of sows reaching parity 3. Future studies should focus on investigating the longevity of both gilt and sow progeny beyond parity 3, to explore whether these differences become more apparent later in life.

It is possible that due to lower growth rates in gilt progeny, these females are under the weight limit at selection and are therefore culled before entry into the breeding herd. This would result in better quality gilt progeny being selected for the breeding herd, which may be a reason for the lack of differences in reproductive performance and longevity between gilt and sow progeny. Unfortunately, investigating the proportion of gilt progeny selected from the gilt pool available for selection was beyond the scope of this study, as records were not kept for gilts culled at selection. Further research into this area is recommended to confirm these assumptions that gilt progeny are selected less frequently due to weight restrictions, among other restrictions at selection.

As gilts born to primiparous sows are the result of increased genetic turnover, these progeny often have higher EBVs and may be selected preferentially into nucleus herds as a result (J. Harper, Rivalea Australia Pty Ltd, oral communication, 2017). Gilt progeny selected into nucleus herds may therefore have more reproductive problems than sow progeny, which should be a target of research in the future. Longevity per se is not the priority in these herds, as sows are culled or moved out of the nucleus earlier in their reproductive lifetime for genetic turnover gains. It would be of interest, however, to quantify the effects of dam parity on effectiveness of their progeny as breeding sires to further evaluate the usefulness of gilt progeny as breeding animals, with one study suggesting that the amount of colostrum and milk consumed during the preweaning period can affect the reproductive performance of boars.[43]

In conclusion, gilt progeny are more likely than sow progeny to exhibit anestrus before optimal time for first breeding, and are hence more likely to be culled from the breeding herd in that period. However, once bred, gilt progeny in this study performed just as well in the breeding herd as sow progeny. To the best of these authors' knowledge, this is the first study to quantify the differences between gilt progeny and sow progeny selected for breeding in a commercial herd in Australia. As this is a new area of research, further investigation of the impact of gilt progeny in the breeding herd is warranted. It is recommended that further research should focus on improving growth and health of gilt progeny, especially in the vital pre-weaning period. Selection practices may need to be reviewed in light of this new information, and future research should focus on suggesting selection benchmarks and improving management practices for gilt progeny in the breeding herd to improve their lifetime productivity.

Implications

- Under the conditions of this study, gilt progeny are born lighter and grow more slowly than sow progeny throughout their lifetime in the growing herd.
- Under the conditions of this study, while gilt progeny selected into the breeding herd are less likely to reach first breeding than sow progeny due to anestrus, gilt progeny have a higher farrowing rate at first breeding, which may be a result of increased selection pressure.
- After being bred for the first time, gilt progeny perform just as well reproductively as their sow progeny counterparts (born alive, number weaned, etc, at least up until parity 4), and their longevity in the herd does not differ (at least up until parity 3) under the conditions of the current study.
- Further research is warranted to determine what proportion of gilt progeny eligible for selection is selected to enter the breeding herd, in order to make decisions on the necessity and (or) appropriate timing for selection of these females.

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Conflict of interest

Jessica Craig, Dr Cherie Collins, and Dr Rebecca Athorn are employed by Rivalea (Australia) Pty Ltd in the Research and Innovation Department.

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An economic analysis of sow retention in a United States breed-to-wean system

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Summary

Objectives: To determine the number of parities sows should be retained in a breed-to-wean system to maximize returns over total cost per weaned pig and net return on investment, and to assess the sensitivity of returns over total cost per weaned pig to feed price and number born alive (NBA).

Materials and methods: Data used to estimate NBA and pre-weaning mortality by parity were collected between 2001 and 2014 at 17 Midwest US farms representing a total of 105,719 sows, accounting for 502,491 total records. Projected budgets were compared for various parity distribution scenarios using a "steady-state" farm model that included both variable and fixed costs associated with the farm and the proportion of sows by parity in the distribution.

Results: The cost of producing a weaned pig was minimized by culling after parities 5 through 9, and culling after late parities (ie, parity 7 through 9) showed greater returns over culling after parities 1 through 4. Culling after parities 5 to 9 showed approximately a 15% net return on investment. When NBA increased, culling after parities 5 through 9 had the highest returns. Culling after parities 6 through 9 showed the greatest returns with low feed prices. With high feed prices, all parity distributions costs exceed returns, though culling after parities 5 and 6 came closest to breaking even.

Implications: Retaining sows in the herd longer has economic benefits that could increase the financial returns of a breed-to-wean system.

Keywords: swine, economic analysis, optimal parity distribution, sensitivity analysis, sow longevity

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Resumen - Análisis económico de la retención de hembras en un sistema de cría a destete en los EUA

Objetivos: Determinar el número de partos que las hembras deben ser retenidas en un sistema de cría a destete para maximizar el retorno sobre el costo total, por cerdo destetado, y el retorno neto a la inversión, así como valorar la sensibilidad del retorno sobre el costo total por cerdo destetado en base al precio del alimento y el número de nacidos vivos (NBA por sus siglas en inglés).

Materiales y métodos: Se recolecto información utilizados para valorar el NBA y la mortalidad pre destete por parto entre 2001 y 2014 en 17 granjas del Medio Oeste de los EUA con un total de 105,719 hembras, contabilizando 502,491 registros totales. Se compararon los presupuestos proyectados en varios escenarios de distribución por paridad utilizando un modelo de granja en "estado constante" que incluyó los costos variables y fijos asociados con la granja y la proporción de hembras por paridad en la distribución.

Resultados: El costo de producción de un cerdo destetado fue minimizado cuando se desechó después del parto 5 al 9, desechar después de los últimos partos (vg, parto 7 al 9) mostró mayor retorno sobre desechar después de los partos 1 al 4. Desechar después de los partos 5 al 9 mostró aproximadamente un 15% sobre el retorno neto a la inversión. Cuando el NBA aumentó, desechar después de los partos 5 al 9 presentó los retornos más altos. Desechar después de los partos 6 a 9 mostró los mayores retornos con precios de alimento bajos. Con precios de alimento altos, todos los costos en las diferentes distribuciones de paridad excedieron el retorno, aunque desechar después de los partos 5 y 6 se acercó al punto de equilibrio.

Implicaciones: Retener a las hembras en el hato más tiempo tiene beneficios económicos que podrían incrementar los retornos financieros de un sistema de cría a destete.

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Résumé - Analyse économique de la rétention des truies dans un système de production de type accouplement-sevrage aux États-Unis

Objectifs: Déterminer le nombre de parités pour lesquels des truies devraient être maintenues dans un système de production de type accouplement-sevrage afin de maximiser les retours sur le coût total par porc sevré et le retour net sur l'investissement, et d'évaluer la sensibilité des retours sur le coût total par porc sevré au prix de l'aliment et du nombre d'animaux nés vivants (ANV).

Matériels et méthodes: Les données utilisées pour estimer l'ANV et la mortalité pré-sevrage par parité ont été accumulées entre 2001 et 2014 dans 17 fermes du Midwest Américain représentant un total de 105,719 truies et 502,491 dossiers. Les budgets prévus ont été comparés pour différents scénarios de distribution de parités en utilisant un modèle de ferme stable qui incluait autant des coûts variables que fixes associés à la ferme et à la proportion de truies par parité dans la distribution.

Résultats: Le coût de produire un porcelet sevré était minimisé en réformant les truies après les parités 5 à 9, et une réforme suite à des parités tardives (ie, parités 7 à 9) a permis un retour plus élevé qu'une réforme après les parités 1 à 4. Une réforme après les parités 5 à 9 avait un retour net sur l'investissement d'environ 15%. Lorsque l'ANV augmentait, la réforme après les parités 5 à 9 donnait les retours les plus élevés. La réforme après les parités 6 à 9 montrait le plus grand retour avec des prix faibles des aliments. Avec des prix élevés des aliments, les coûts associés avec toutes les distributions de parités excédaient les retours, bien que la réforme après les parités 5 et 6 soient venues bien proche de faire leurs frais.

Implications: La rétention plus longue des truies dans le troupeau avait des bénéfices économiques qui pourraient augmenter les retours monétaires dans un système de production de type accouplement-sevrage.

Higher parity sows wean heavier pigs and produce more pigs per year than females in lower parities.[1-3] For these reasons it has been recommended that producers keep culling levels low to reduce the number of dams in first or second parity within a breeding herd, as the ability to produce and wean more pigs per year directly influences the profit capability of a farm.[4]

Sow retention rate drives optimal parity distribution (OPD), and the more productive parities should compose a greater proportion of sows in the herd parity distribution.[5] It has been proposed that 52% of sows in a given herd should be in parities 3 through 6, as these are considered peak performance in the sow's lifetime.[6,7]

A sow should not be replaced until the productivity and profit generated by the later-parity sow are less than those of a potential replacement gilt.[4,8] Once a replacement gilt is introduced into the breeding herd to replace an older sow, the gain in genetic improvement will be recognized immediately, though allowing the sow to produce in the herd longer increases the profit level per animal.[8] Furthermore, it has been reported[8] that current replacement rates are not profitable if the reason for a system's high replacement rate is to solely introduce new gilts at a higher percentage to keep up with gains in genetic improvement that are being observed at the multiplier and nucleus levels of production.

Dhuyvetter[3] and Abell et al[8] reported that maximum pigs weaned per sow per year are observed by allowing sows to remain in the breeding herd until their 8th parity, and Stevermer[4] reported that sows as old as parities 8 through 10 out-perform sows in their first parity. A sow reaches a positive value for lifetime net income at parity 3.[9,10] However, in the United States, the average culling parity is between 3.1 and 3.7,[10] indicating that a sow barely covers her replacement cost at the time of removal. This represents a loss in profit potential by not retaining sows until later parities. If the cost of a replacement gilt can be spread over a greater number of pigs produced, such as the case when sows are retained longer, the cost to produce a market hog decreases.[8]

The objectives of this analysis were to assess a series of parity distributions to determine the number of parities for which a sow should be retained in a breed-to-wean system to maximize returns over total cost per weaned pig and net return on investment, and to assess the sensitivity of returns over total cost per weaned pig to feed price and number born alive (NBA).

Materials and methods

Animal care and use committee approval was not obtained for this study because the data used for this analysis were obtained from a single private company's existing database.

Production data and data exclusion criteria

Data editing and categorization was conducted in R.[11] Data were collected from 2001 to 2014 from 17 farms located in the Midwest region in the United States. Both purebred and crossbred sows were included in the dataset. Data editing was performed to ensure data were within normal physiological ranges and free from recording errors. Outlier records were removed, and any sow that did not have complete lifetime performance records was not included in the analysis. Individual records were considered outliers and removed from the data set if they were ± 3 standard deviations from the mean for the following traits at each parity: NBA, number of piglets weaned, total piglets born, number of stillborn piglets, wean-to-first-service interval, and weaning age. Records greater than parity 10 were removed due to the small number of records in those high parities. Approximately 4% of the total litter observations needed to be adjusted for piglets fostered due to recording errors in either NBA, fosters, or number weaned. These errors caused the recorded number of weaned pigs to be impractical on the basis of the given values for NBA and fostered. The values for NBA, fostered, and number weaned were needed in the calculation of pre-weaning mortality. The Shapiro test was used on the model residual information, as well as an examination of the normal plot to evaluate the dataset for normal distribution. The final data set included 502,491 records accounting for lifetime performance of 105,719 sows.

Estimation of number born alive and pre-weaning mortality from the production data

Statistical analyses were conducted using ASReml software. The first model was used to estimate pre-weaning mortality by parity. Fixed effects included parity, farm, year, breed, and piglet age at weaning. The random effect of sow was included to account for correlation among repeated dam records. Number born alive by parity was estimated using a second model. This model included fixed effects of parity, farm, year, breed, and wean-to-first-service interval. Random effects of sow and contemporary group (farm by year by season) were also included. The statistical method used to produce *P* values to evaluate statistical differences between estimates was a *t* test.

Value of animals

Price per weaned pig sold was calculated by using the composite weighted average price of a 4.5- to 5.5-kg weaned pig from the National Direct Delivered Feeder Pig Report.[12] The weaned pig price used in the model ($36.90 per pig) was based on an average of weekly prices reported during the 2001-2014 period.[12] The price paid for replacement gilts was calculated using the monthly negotiated Iowa/Minnesota Daily Direct Prior Day Hog Report (plant delivered) prices for 2001-2014.[13] An average weight of 125 kg was used with a dressing percentage of 72%,[14] which resulted in a value of $137.48 per head. An additional $85.00 per head was added for genetic premium,[10,15] which resulted in the value of a replacement gilt being $222.48 per head. If breeding is not successful then gilts are culled. The cull-gilt price used assumed a weight of 129 kg at a price of $142.48 per head from 2001-2014.[14] It was assumed that approximately 20% of purchased gilts do not conceive and are culled from the breeding herd under all scenarios.[16,17] The cull-sow price was based on the Weekly National Direct Swine Report[18] national weighted average price of negotiated sows weighing 136 to 227 kg from 2002-2014.[18] Table 1 provides a listing of additional animal and production values.

Model operation

The modeled enterprise was a 5000-sow breed-to-wean operation. This facility was assumed to individually house sows during gestation and lactation, as this represented the housing system used by the production company at the time the data were being recorded. The total number of sows (5000) and 2.32 litters per sow per year were held constant across all scenarios. Replacement rate was calculated as gilt purchases over the running inventory, per parity distribution. Death loss and culls due to failure to conceive were considered in the calculation of gilt purchases needed to maintain the breeding herd.

The budgets used in this analysis were developed by Dhuyvetter [3,16] and were used to demonstrate a breeding herd that culls sows after their first through 10th parities as a means to identify the optimal parity distribution on the basis of returns over total cost per weaned pig. Conception rates play a large role in OPD. For this analysis, gilt conception rate was slightly below 80%, while conception rate at all other parities was approximately 86%.[16] Examples of the parity distribution scenarios include a system that culls sows after their first parity, resulting in a breeding herd comprising only gilts, whereas a system that culls sows after their fourth parity would be composed of dams through their fourth parity. Under current economic situations it is not likely that producers would maintain a breeding herd composed of only gilts. However, in operations that utilize a parity segregation system, a gilt-only herd would be applicable and was included for comparison purposes. A "steady-state" model was used to demonstrate returns on the basis of an existing farm versus a system that is just entering production. Feed cost sensitivity analysis, as well as increased sow production, was conducted as a part of the economic analysis. The budget analysis is presented on a per weaned-pig value basis.

Variable costs

Variability in feed consumption by parity was accounted for with a linear range for gestation diets of 2.5 to 2.7 kg per sow per day for parities 1 through 10 and a non-linear range for lactation intake of 4.6 to 5.7 kg per day per sow for parities 1 through 10.[16] The assumption was made that no creep feed was provided prior to weaning. The corn and soybean meal prices used in the present study were an average of 48% higher than the prices used by Dhuyvetter.[3] The price of base mix was calculated using this average percentage price increase, applied to the price of base mix used in formulating sow diets as described by Dhuyvetter.[3] Semen cost per litter was assumed to be $4.00 per dose: this price was provided by the company supplying the production data. It was assumed that two semen doses per sow per litter are required, as well as an additional $4.00 charge per sow that farrowed, as a means to cover the expense of sows or gilts that were bred and did not conceive or farrow. The cost of insurance on the breeding herd was calculated as 1% of the total breeding herd investment divided by the number of weaned pigs sold per year.[3] A complete variable costs breakdown can be found in Table 1.

Fixed costs

Total building and equipment investment costs accounted for the cost of gestation and farrowing stalls, cost per square meter of building, and the equipment required in the building, such as feeders and panels. A useful life of 20 years was assumed and applied to the building, and a 12-year useful life for equipment was assumed and used in the depreciation calculation.[3,26] Insurance on buildings and equipment was an assumed value of 1%. A 10% salvage value was applied to buildings, while a 0% salvage value was applied to all equipment and stalls.[3] The fixed costs used in this analysis can be found in Table 1.

Sensitivity analysis

Number born alive estimates were averaged over parity groups 1 to 3, 4 to 6, and 7 to 9, as well as year groups 2001 to 2005, 2006 to 2010, and 2011 to 2014. These estimates were used as a means to show how NBA has changed since 2001 across parities. As years 2011 to 2014 were shown to be the most prolific years for sows, records from those years were analyzed using the original NBA and pre-weaning mortality models previously described. The estimates were then used in the budget analysis to assess how greater NBA and pre-weaning mortality affect the recommended parity distribution with all other inputs held constant.

Feed price was assessed in the sensitivity analysis. The two lowest costs for corn and soybean meal over the 14 years were selected, averaged, and then used as the new value for both inputs. This was repeated with the two highest prices for corn and soybean meal. All other factors were held constant.

Results

Figure 1 presents the NBA and pre-weaning mortality estimates by parity that were used as inputs in the economic analysis. Number of piglets born alive was shown to be highest in third-parity sows. An increase in NBA was observed until parity 3, which then steadily decreased until parity 10. Additionally, NBA differed among parities ($P < .05$). Pre-weaning mortality estimates also differed among parities ($P < .05$) except parity 9, which showed a trend toward significant differences with other parities ($P < .10$), and parity 10, which showed a tendency that appears different from other parities ($P < .25$). Average number weaned per birth litter, on the basis of the given parity distribution, is presented in Table 2. Across all parity distributions, an average of 9.65 pigs were weaned per litter on the basis of the given parity distribution.

The number of replacement females needed to maintain 5000 breeding animals is shown in Table 2, with the associated replacement rate for each parity distribution. As sows are retained longer and culled later in life, the replacement rate decreases.

The parity distribution where culling occurs after parity 1 sells fewer weaned pigs per year than any other scenario, as shown in Table 2. The parity distribution that sells the most weaned pigs per year is the scenario that culls sows after their fourth parity (Table 2). Though culling after parity 4 was shown to produce the most saleable weaned pigs, this is not the parity distribution that most minimized the cost per weaned pig, as this is dependent on additional factors such as

Table 1: Market prices, production values, investment costs, and miscellaneous expenses used in the economic analysis of sow retention for a 5000-sow breed-to-wean operation (all prices, costs, and expenses in US$)

Parameter	Value used in analysis
Market price	
Price for weaned pig ($/head)[12]	36.90
Price for cull sow ($/45.4 kg)[18]	43.15
Price for replacement gilts ($/head)[14]	222.48
Production values	
Average age of weaning (days)[19]	21
Average weaning weight (kg)[19]	5.9
Litters/sow/year[19]	2.32
Sow mortality (%)[20]	8.34
Variable costs	
Soybean meal ($/ton)[21]	311.21
Corn ($/0.04 m^3)[22]	3.69
Base mix: vitamins, minerals, etc ($/ton)	677.00
Feed processing ($/ton)[23]	9.09
Utilities (fuel and oil) ($/weaned pig)[24]	1.22
Building and equipment repairs (%)*	2.00
Legal/accounting fees ($/weaned pig)[24]	0.24
Transport and marketing costs ($/weaned pig)[24]	1.00
Labor, annual salary expenses ($)†	34,000.00
Veterinary, drugs, supplies ($/weaned pig)[24]	3.62
Depreciation on breeding herd (%)‡	Varied
Interest on breeding herd (%)[25]	7.19
Semen charge per litter ($)	12.00
Fixed costs	
Interest on buildings and equipment (%)[25]	7.19
Total building and equipment investment ($)§	4,775,811.00

* (Total building/equipment investment/pigs sold/year) × (2% assumed value).
† Average provided by a Midwest US swine company.
‡ Based on the cull and replacement rate of the parity distribution.
§ Calculation based on a 5000-sow herd (building, sow housing, equipment).

the variable costs represented in Table 3. The parity distribution that most cost effectively produced weaned pigs, and had the greatest return over total cost, was culling after parity 6 (Table 3).

Table 3 includes net return on investment, which is based on the parity distribution scenarios. The same trend that was seen in the budget analysis was also observed, as the greatest return on investment was realized by culling sows after parity 6, followed closely by culling after parities 5 and 7, with culling after parities 5 through 8 all showing approximately a 15% return on investment.

As part of the sensitivity analysis in this study, greater NBA, as well as pre-weaning mortality estimates, were used per parity with all other factors held constant. Figure 2 illustrates the increase in NBA by year groups as well as parity groups. Since 2001, NBA has increased across all parities, with parities 1 through 3 realizing the largest increase in NBA. Records from 2011 to 2014 were used to produce more recent estimates of NBA and pre-weaning mortality, which were then used in the sensitivity analysis. These updated estimates are shown in Figure 3. Parity 3 was again the most prolific parity ($P < .05$), but pre-weaning mortality rates were greater than those shown in Figure 1. The results from using the updated NBA estimates described in Figure 3 are presented in Table 4. The parity distribution that culled after parity 6 remained the most profitable distribution on the basis of both returns over total costs and net return on investment, followed closely by culling after parity 7. It was observed that culling after parities 5 through 9 showed greater economic returns than culling after parities 1 through 4 (Table 4).

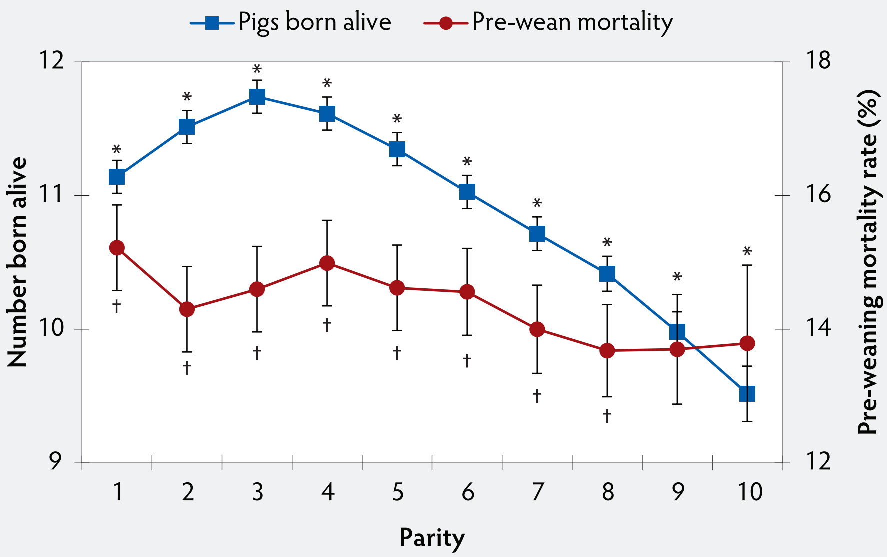
For the low feed price analysis, soybean meal decreased 58%, which equated to a price of $181.54 per ton, and the cost of corn decreased 52%, which equated to a price of $1.92 per cubic meter. The results of the low feed price sensitivity analysis are presented in Table 5. With low feed costs, the optimal parity distribution favors older sows. Specifically, the greatest returns over total costs can be realized by retaining sows through their seventh parity, and retaining sows through their eighth or ninth parity has a greater rate of return over culling before a sow is through her fifth parity. In the high feed price analysis, soybean meal increased 66%, bringing the price to $474.49 per ton, and corn increased 57.6%, bringing the price to $6.41 per cubic meter. None of the parity distributions have positive returns over total costs with high feed prices (Table 5). However, the parity distribution culling after parity 6 was the closest to break-even, followed closely by culling after parity 5.

Discussion

Although older sows have lower NBA, they wean a greater percentage of their pigs than younger sows. Older sows wean approximately the same number of pigs as the younger sows, which can be associated with their lower pre-weaning mortality rate. Older sows' pre-weaning mortality rate fell below 14% in parities 7 through 10, suggesting that older sows are able to maintain and rear more piglets during the lactation period than younger sows.

Litters per sow per year, as well as sow inventory, were held constant across all parity distribution scenarios, thus the number of litters produced per year was constant across all scenarios. However, it has been shown in a previous study[3] that litters per sow per year were lowest in scenarios where culling occurred after the first and second parities, and was consistent in distribution scenarios

Figure 1: Pigs born alive per litter and pre-weaning mortality (least squares means ± standard error) used in an economic analysis of sow retention in a breed-to-wean system, estimates by parity, for parities 1 through 10 from 105,719 sows. Values gathered from 2001-2014. *A significant difference was observed between parities for pigs born alive per litter ($P < .05$; t test).† A significant difference was observed between parities for pre-wean mortality ($P < .05$; t test) except parity 9, which showed a trend toward significant differences with other parities ($P = .09$), and parity 10, which showed a tendency that appears different from other parities ($P = .25$).



culling after parities 3 through 10. Had this been considered, and the litters per sow per year lowered in distributions including only first- and second-parity sows, it would be expected that the optimal parity distributions would still favor distributions having a proportion of older sows. The distributions including older sows would have had more litters per sow per year, thus proving to be even more efficient than that represented in the present study.

Results indicate that retaining sows until later parities, (ie, parity 8 and 9), could be economically advantageous over culling sows after parities 1 through 4, as shown by a higher return over total cost. Though older sows produce and sell slightly fewer pigs per year than younger sows, the cost in producing a weaned pig is lowest when sows are culled after parities 5 through 9. The results shown are similar to those previously observed in other economic analysis studies, ie, that the cost of a weaned pig is highest in first-parity sows and decreases in other parities.[3] With the current average parity of culling in the United States at 3.1 to 3.7,[10] results indicate there is a substantial profit gap that could be reduced by keeping

Table 2: Production values, inputs, and results from the economic analysis of sow retention of a 5000-sow breed-to-wean operation*

				Parity prior to cull†						
	1	2	3	4	5	6	7	8	9	10
Ave parity‡	1.00	1.46	1.90	2.32	2.70	3.07	3.40	3.76	4.05	4.32
Ave removal parity§	1.00	1.86	2.62	3.26	3.79	4.29	4.68	5.08	5.41	5.64
Sow inventory	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Replacement rate (%)	295	158	113	90	78	69	63	58	54	53
Annual purchases	14,764	7909	5642	4508	3902	3445	3164	2918	2723	2636
Total litters/year	11,600	11,600	11,600	11,600	11,600	11,600	11,600	11,600	11,600	11,600
Litters/sow/year	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
Born alive/litter	11.14	11.31	11.44	11.47	11.45	11.41	11.35	11.28	11.21	11.13
Pigs weaned/litter	9.44	9.64	9.75	9.78	9.76	9.72	9.68	9.63	9.57	9.51
Weaned pigs produced/week	2106	2150	2175	2180	2177	2169	2159	2147	2135	2121
Pigs sold/sow/year	21.91	22.37	22.62	22.68	22.65	22.56	22.46	22.34	22.21	22.06
Pigs sold/year	109,559	111,829	113,115	113,391	113,237	112,808	112,299	111,695	111,052	110,319

* Values gathered from 2001 to 2014.
† Represents the parity distribution based on sow culling strategy. For example, "4" indicates that in the parity distribution scenario sows are kept until parity 4 and then culled. Sows bred but do not conceive, or that do not show signs of estrus prior to the final parity in the distribution, are culled.
‡ Average (Ave) parity: weighted average of sows farrowing within each parity of the given parity distribution scenario.
§ Ave parity of removal: weighted average removal parity of sow culls and deaths at each parity of the given parity distribution scenario. Gilts culled prior to having a litter are not included in this value.

Table 3: Budget analysis and net return on investment of sow retention in a 5000-sow breed-to-wean operation on a per weaned-pig basis (all prices, costs, and expenses in US$)*

	Parity prior to cull†									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Variable costs/pig sold										
Grain	5.29	5.36	5.43	5.52	5.62	5.72	5.83	5.95	6.06	6.18
Protein	2.80	2.86	2.91	2.96	3.01	3.07	3.12	3.18	3.24	3.29
Base mix: vitamins, minerals, etc	1.34	1.36	1.38	1.40	1.42	1.45	1.48	1.51	1.54	1.57
Feed processing	0.47	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55
Labor	5.59	5.47	5.41	5.40	5.40	5.43	5.45	5.48	5.51	5.55
Veterinary, drugs, and supplies	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16
Utilities, fuel, and oil	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
Transportation and marketing costs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Building and equipment repairs	0.87	0.85	0.84	0.84	0.84	0.85	0.85	0.86	0.86	0.87
Breeding/genetic charge										
Depreciation	14.42	6.32	4.00	2.97	2.47	2.10	1.89	1.71	1.57	1.52
Semen	1.27	1.24	1.23	1.23	1.23	1.23	1.24	1.25	1.25	1.26
Interest	0.56	0.58	0.58	0.59	0.60	0.60	0.61	0.62	0.62	0.63
Insurance	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09
Professional fees: legal, accounting, etc	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Interest on 1/2 variable costs	0.58	0.45	0.42	0.40	0.40	0.40	0.40	0.40	0.40	0.40
A. Total variable costs	**38.88**	**30.67**	**28.38**	**27.50**	**27.19**	**27.06**	**27.09**	**27.17**	**27.29**	**27.52**
Fixed costs/pig sold										
Depreciation on bldgs and equip	2.51	2.46	2.43	2.42	2.43	2.44	2.45	2.46	2.48	2.49
Interest on bldgs and equip	1.67	1.64	1.62	1.62	1.62	1.62	1.63	1.64	1.65	1.66
Insurance on bldgs and equip	0.44	0.43	0.42	0.42	0.42	0.42	0.43	0.43	0.43	0.43
B. Total fixed costs	**4.62**	**4.52**	**4.47**	**4.46**	**4.47**	**4.48**	**4.51**	**4.53**	**4.56**	**4.59**
C. Total cost/pig sold	**43.50**	**35.20**	**32.86**	**31.97**	**31.66**	**31.55**	**31.60**	**31.70**	**31.84**	**32.11**
D. Gross returns/weaned pig sold	**36.90**	**36.90**	**36.90**	**36.90**	**36.90**	**36.90**	**36.90**	**36.90**	**36.90**	**36.90**
E. Return over variable costs										
(D-A)	-1.98	6.23	8.52	9.40	9.71	9.84	9.81	9.73	9.61	9.38
F. Return over fixed costs (D-B)	**32.28**	**32.38**	**32.43**	**32.44**	**32.43**	**32.42**	**32.39**	**32.37**	**32.34**	**32.31**
G. Returns over total costs $/head (D-C)	**-6.60**	**1.70**	**4.04**	**4.93**	**5.24**	**5.35**	**5.30**	**5.20**	**5.06**	**4.79**
Net return on investment (%)	**-7.0**	**8.3**	**12.8**	**14.5**	**15.1**	**15.3**	**15.1**	**14.9**	**14.6**	**14.0**

* Values gathered from 2001 to 2014.

† Represents the parity distribution on the basis of sow culling strategy. For example, "4" indicates that in the parity distribution scenario, sows are kept until parity 4 and then culled. Sows that are bred but do not conceive or that do not show signs of estrus prior to the final parity in the distribution are culled. Bldgs and equip = Buildings and equipment.

sows until later parities to increase return per weaned pig. The current study showed that a producer may be losing as much as $0.42 per weaned pig by culling at the current industry averages rather than retaining sows until the returns over total costs is higher.

With more pigs sold per year, costs associated with annual production can be distributed among the larger number of pigs sold, thus decreasing cost on a per weaned-pig basis. However, there are other costs associated with each parity distribution, such as age and size of the sows, which must be considered as well. Some additional costs that need consideration are, for example, feed costs, which will be greater for older sows, as they are heavier and have a higher maintenance level feed requirement,[27,28] but depreciation of the breeding herd is minimized in older sows as it is able to be spread over more parities. The cost associated with a higher replacement rate can be observed in the higher cost per weaned pig specifically associated with depreciation of the breeding herd. The depreciation per weaned pig is a function of sow mortality rate per parity distribution and the respective replacement gilt costs that need to spread across pigs weaned throughout her productive lifetime. The lower the replacement rate of the parity distribution, the lower the cost associated with breeding-herd depreciation per weaned pig. With all the previous considered, it was shown that culling after parity 6 minimized costs per weaned pig, even though culling after parity 4 produced the most saleable weaned pigs. The advantage of retaining sows is clearly demonstrated, as retaining a sow until her ninth parity is shown to have a greater rate of return than what most commercial pork producers are currently receiving today by culling sows after their third or fourth parity.

As this study analyzed return over total cost on a per weaned-pig basis, a recommendation on how the optimal parity distribution will be influenced when pigs are followed through finishing cannot be made. However, numerous studies show the benefits of offspring from older sows through finishing. Offspring from primiparous dams have lower average daily gain,[2,29,30] as well as increased mortality in the nursery and finishing phases when compared to offspring from older sows.[30] It has been reported that market hogs from mature sows were significantly more profitable than market hogs from first-parity sows.[31] The difference seen in the offspring from first-parity sows, compared to the offspring from older dams, is due, at least in part, to the poorer health status of the first-parity offspring.[2,29,30] We hypothesize that if this analysis were performed on a per finished-hog basis, the recommended parity distribution would still favor distributions with a greater percentage of older sows.

Return on investment is considered to be an indicator of profitability, and it has been recommended that a company needs a minimum of 10% to 14% return on investment to fund future growth.[32] It has also been shown that investment in a breed-to-wean operation was favorable over other investments given a similar risk profile that is based on the modified internal rate of returns.[33] Approximately a 15% return on investment was realized in the scenarios that culled sows after parities 5 through 8, again emphasizing the value of retaining sows in the breeding herd longer than what is currently being reported.

Through genetic improvement and better management practices, NBA has steadily increased.[34] The sensitivity analysis demonstrating increased NBA also showed a

Figure 2: Number born alive (NBA) per litter estimates by parity groups and year groups (averaged least squares means ± standard error), from 105,719 sows. Estimates were averaged across parity groups (1 through 3, 4 through 6, and 7 through 9) and year groups (2001 to 2005, 2006 to 2010, 2011 to 2014). All year-by-parity NBA estimates were found to be statistically different from each other ($P < .05$; *t* test) (not shown in figure). Parity group estimates were then calculated by averaging year-by-parity estimates within each parity group. Statistical significance was not re-assessed once the estimates had been averaged. Values gathered from 2001-2014.

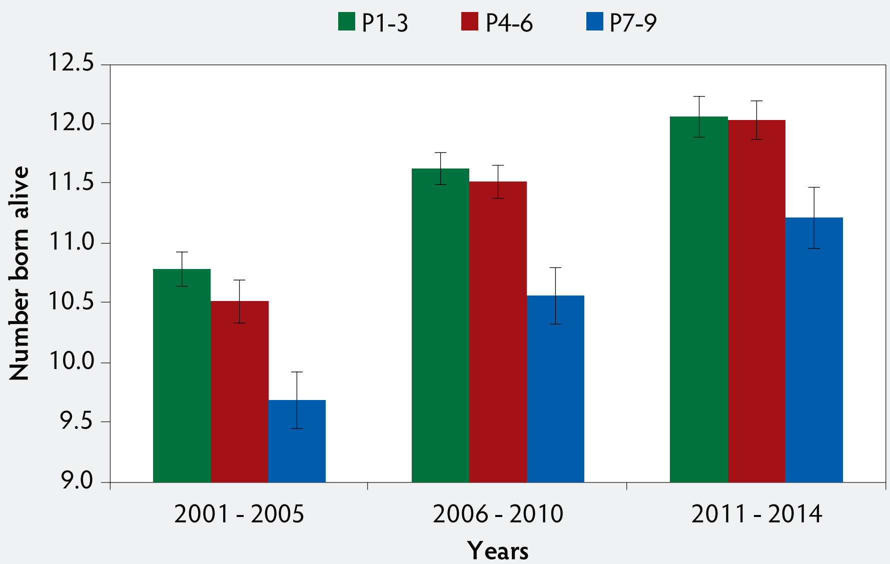


Figure 3: Pigs born alive per litter and pre-weaning mortality (least squares means ± standard error by parity, for parities 1 through 10). * A significant difference was observed between parities for pigs born alive per litter ($P < .05$; *t* test).† A significant difference was observed between parities for pre-wean mortality ($P < .05$; *t* test) except parity 10, which showed a trend different from other parities ($P = .08$). Values gathered from 2011-2014.

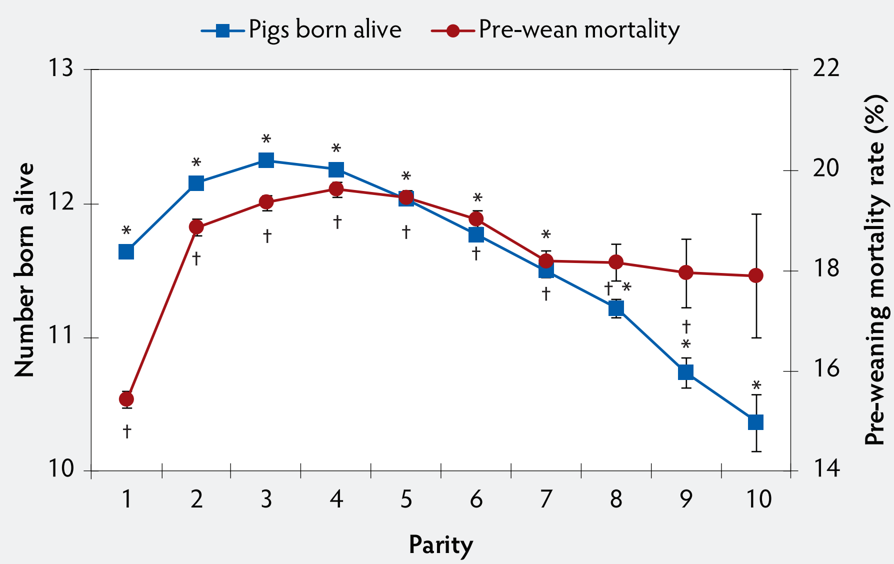


Table 4: Production values, inputs, and outputs used in the economic analysis of sow retention of a 5000-sow breed-to-wean operation in US$*

	Parity prior to cull†									
Parameter	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Pigs born alive/litter	11.64	11.88	12.01	12.06	12.05	12.02	11.98	11.92	11.85	11.79
Pigs sold/sow/year	22.86	22.88	22.94	22.92	22.86	22.78	22.70	22.60	22.48	22.35
Pigs sold/year	114,194	114,281	114,567	114,505	114,206	113,800	113,401	112,878	112,285	111,664
Returns over total costs $/head	-5.06	2.34	4.39	5.19	5.46	5.58	5.56	5.47	5.34	5.11
Net return on investment (%)	-4.6	9.6	13.6	15.1	15.6	15.8	15.7	15.5	15.2	14.7

* Values gathered from 2011-2014.
† Represents the parity distribution, based on sow culling strategy. For example "4" indicates that in the parity distribution scenario sows are kept until parity 4 and then culled. Sows that are bred but do not conceive, or that do not show signs of estrus prior to the final parity in the distribution, are culled.

Table 5: Feed sensitivity economic analysis of sow retention of a 5000-sow breed-to-wean operation on a per weaned pig basis (all prices, costs, and expenses in US$)*

	Parity prior to cull†									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Low feed cost analysis‡										
Grain cost/pig sold	2.76	2.79	2.83	2.88	2.93	2.98	3.04	3.10	3.16	3.22
Protein cost/pig sold	1.64	1.67	1.70	1.73	1.76	1.79	1.82	1.85	1.89	1.92
Total variable costs	35.12	26.86	24.52	23.57	23.19	22.98	22.93	22.94	22.97	23.12
Total costs/pig sold	39.74	31.38	28.99	28.03	27.66	27.47	27.44	27.47	27.53	27.71
Gross returns/pig sold	36.90	36.90	36.90	36.90	36.90	36.90	36.90	36.90	36.90	36.90
Net return on investment (%)	-0.2	15.4	20.1	22.0	22.7	23.0	22.9	22.8	22.6	22.1
Returns over total costs $/head	-2.84	5.52	7.91	8.87	9.24	9.43	9.46	9.43	9.37	9.19
High feed cost analysis§										
Grain cost/pig sold	9.18	9.30	9.42	9.58	9.75	9.94	10.13	10.32	10.52	10.73
Protein cost/pig sold	4.27	4.37	4.44	4.51	4.59	4.68	4.76	4.85	4.93	5.02
Total variable costs	44.32	36.21	33.99	33.21	33.00	32.98	33.11	33.31	33.54	33.90
Total costs/pig sold	48.94	40.73	38.46	37.67	37.47	37.46	37.62	37.84	38.10	38.48
Gross returns/pig sold	36.90	36.90	36.90	36.90	36.90	36.90	36.90	36.90	36.90	36.90
Net return on investment (%)	-17.0	-2.04	2.20	3.72	4.11	4.12	3.83	3.42	2.96	2.26
Returns over total costs $/head	-12.04	-3.83	-1.56	-0.77	-0.57	-0.56	-0.72	-0.94	-1.20	-1.58

* Values gathered from 2001-2014.
† Represents the parity distribution, based on sow culling strategy.
‡ The two lowest feed prices from the years 2001-2014 were averaged for protein (soybean meal) and grain (corn) input prices. All other factors were held constant in the analysis.
§ The two highest feed prices from the years of 2001-2014 were averaged for protein (soybean meal) and grain (corn) input prices. All other factors were held constant in the analysis.

higher pre-weaning mortality. A higher pre-weaning mortality is not advantageous for the producer, as the greater the pre-weaning mortality rate, the fewer pigs are weaned per sow. A large factor in the high pre-weaning mortality rate used was the influence of the porcine epidemic diarrhea virus (PEDV) outbreak that occurred during these years used in this portion of the sensitivity anaylsis.[19] However, even with pre-weaning mortality rates an average of 4% greater per parity in 2011 to 2014, sows still were shown to wean and sell more pigs than in the base scenario due to the increase in NBA. These results follow the same trend that was observed in the base scenario with a lower NBA and preweaning mortality rate, indicating that the increase in sow performance across all parities did not have a large effect on the optimal parity distribution. However, it can be seen that the difference in returns between culling after parity 6 and 7 was smaller in the scenario with higher NBA. If NBA were to increase, it can be hypothesized that older sows (ie, parity 7) become most profitable.

A number of educated assumptions were required as factors impacting the optimal parity distribution for this economic analysis. The validity of those assumptions should be tested over time.

Implications

- By improving sow longevity, the profitability of the breeding herd should improve as costs associated with replacement gilt expenses are reduced.
- The economic benefits of retaining sows into their later parities (parities 5 through 9) include increased returns over total costs, as well as increased net return on investment.
- Producers could increase returns per weaned pig above what is currently being realized in the commercial swine industry by retaining sows in the herd longer.

Conflict of interest

None reported.

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Food and Drug Administration Guidance 209 and 213 and Veterinary Feed Directive regulations regarding antibiotic use in livestock: A survey of preparation and anticipated impacts in the swine industry

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Summary

A convenience sample survey of practicing swine veterinarians was conducted to describe the ways veterinarians and their producers prepared to comply with the Veterinary Feed Directive. The survey provides a benchmark for preparedness and prospective assessment of anticipated costs and ongoing education and training needed.

Keywords: swine, veterinary feed directive, economics

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Resumen - Guía FDA 209, 213, y regulaciones VFD sobre el uso de antibióticos en ganadería: Una encuesta de preparación e impacto anticipado en la industria porcina

Se realizó una encuesta de una muestra adecuada de veterinarios especialistas en cerdos para describir la manera en que los veterinarios y sus productores se preparan para cumplir con la Directiva de Alimento Veterinario. Esta encuesta provee una comparación de la preparación y valoración prospectiva de los costos anticipados, la educación actual, y el entrenamiento necesario.

Résumé - Guides 209 et 213 et Directive sur les aliments vétérinaires du FDA concernant l'utilisation des antibiotiques chez le bétail: Sondage sur la préparation et les impacts anticipés dans l'industrie porcine

Un sondage sur un échantillon de convenance de vétérinaires en pratique porcine a été réalisé afin de décrire les façons dont les vétérinaires et leurs producteurs se préparent afin de se conformer à la Directive sur les aliments vétérinaires. Ce sondage fournit une mesure étalon de la préparation et de l'évaluation prospective des coûts anticipés et de la formation en cours et de l'entraînement requis.

The revised Veterinary Feed Directive (VFD) final rule went into effect on October 1, 2015, and label changes requested in Guidance Documents 209 and 213 took effect on January 1, 2017.[1-3] These guidances direct the use of medically important antibiotics (deemed to be important for human medicine) in livestock for therapeutic purposes only, thereby eliminating medically important antibiotics for growth-promotion purposes. Medically important antibiotics can continue to be used for therapeutic purposes by producers, but only under the guidance of a veterinarian with a valid veterinary-client-patient relationship (VCPR). The Food and Drug Administration (FDA) is relying on stakeholder collaboration (drug companies, veterinarians, producers, and the feed milling sector) to cooperatively implement these new regulations.

Veterinarians will direct the use of all medically important antibiotics via the VFD for use in feed and prescriptions for use in water for prevention, control, and treatment. Much has been done to prepare for these antibiotic-use guidelines. The aim of the study presented here was to conduct a survey of practicing veterinarians and provide a synthesis of the ways veterinarians and their producers prepared and changes they anticipated needing to make in their business operations to comply with the VFD. The survey was designed to provide a prospective view of pertinent measures such as anticipated costs and ongoing education and training needed. With this information, future research comparing expected impacts with those actually incurred could be conducted.

Materials and methods

The procedures for this survey were approved by the Iowa State University Institutional Review Board. The survey questionnaire was designed to capture data on changes in veterinary services. Specifically, the survey assessed basic information on a veterinarian's role in the industry and his or her specific practice and on how the VFD requirements will impact their business operations, including the VCPR, record keeping, education and training, costs of veterinary services, and herd-health and production-plan recommendations.

Per VFD charge and business cost information was collected as an open-ended dollar amount. If respondents provided a dollar value range, we used the midpoint

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to approximate actual dollar amount. Most other information was collected with partially close-ended questions giving respondents flexibility to choose from a relatively exhaustive list of mutually exclusive response options and (or) an "other" response with the opportunity to write in an answer.

The information was collected in a paper survey and compiled in an electronic spreadsheet (Excel 2016; Microsoft, Redmond, Washington). The subjects of the survey were practicing swine veterinarians in the United States. Surveys were distributed at the 2016 Iowa State University (ISU) James D. McKean Swine Disease Conference held in Ames, Iowa, on November 3-4, 2016. The authors attended the conference to describe the study and encourage participation. A drawing for one of three $100 gift cards was offered as an incentive to non-ISU employees for responding to the survey.

The James D. McKean Swine Disease Conference is an annual event that attracts swine veterinarians from all types of practices (corporate, swine, and mixed-animal practices) from the upper Midwest region of the United States. This survey sample provides a representative cross section of the swine industry, with respondents being knowledgeable about the preparation for and anticipated impacts of the VFD regulations in conjunction with guidances 209 and 213.

Results

Response rate and respondent profile

Of the 275 conference attendees receiving a survey, 50 completed the survey (18.18% response rate). Not currently a practicing veterinarian (student, academia, allied industry) was the most common reason heard for non-response to the survey. Respondents' primary practices were located in states with the largest numbers of swine operations and inventories: 24 veterinarians practiced in Iowa, eight in Minnesota, and six in Illinois. Other states represented included Indiana (two), Kansas (two), Missouri (two), Montana (one), Nebraska (one), Ohio (one), South Dakota (one), Virginia (one), and Wisconsin (one). These states represent 43% of US swine operations and 73% of the US hogs and pigs inventory.[4]

Respondents had an average of 20.6 years of experience in swine veterinary practice. The largest segment of swine clients served by these veterinarians were independent producers (57.2%), followed by contract growers or contractees (19.5%), contractors or integrators (18.3%), and other (5.0%). The largest percentage of swine clients were in farrow-to-finish production (28.4%), followed by wean-to-finish (23.8%), finishing (18.3%), breeding-farrowing (18.2%), nursery (6.3%), other (3.3%), gilt developer unit (1.3%), and boar stud (0.5%).

While veterinarians vary in the type of swine clients served and number of hogs marketed from those clients, the average hogs marketed per year were 0 (0.2% of clients), one to 4999 (22.0% of clients), 5000 to 19,999 (25.9% of clients), 20,000 to 49,999 (21.6% of clients), and 50,000 or more (30.3% of clients). Nationally, 87% of operations have annual sales of one to 4999 hogs, while 13% of operations have annual sales of 5000 or more hogs.[4] Thus, the clients served by the veterinarians within our sample had larger operations than the overall US swine operation numbers reported in the 2012 Census of Agriculture.[4] However, this sample does match favorably with annual sales volumes nationally. In 2012, nine percent of sales were of one to 4999 hogs, while 91% of sales were of 5000 or more hogs.[4] Accordingly, veterinarians in our sample provide services for a representative percentage of the hogs sold annually.

Veterinary-client-patient relationship

According to the Electronic Code of Federal Regulations (21 CFR 558.6 Veterinary Feed Directive drugs[5]), in order for a VFD to be lawful, the veterinarian issuing the VFD must be licensed to practice veterinary medicine and be operating in the course of the veterinarian's professional practice and in compliance with all applicable veterinary licensing and practice requirements, including issuing the VFD in the context of a VCPR as defined by the state.

If no applicable and appropriate state VCPR requirements exist, the veterinarian must issue the VFD in the context of a valid VCPR as defined in federal regulations. Federal regulations state (21 CFR 530.3 Definitions[6]), a valid VCPR is one in which a veterinarian has assumed the responsibility for making medical judgments regarding the health of (an) animal(s) and the need for medical treatment, and the client (the owner of the animal or animals or other caretaker) has agreed to follow the instructions of the veterinarian; there is sufficient knowledge of the animal(s) by the veterinarian to initiate at least a general or preliminary diagnosis of the medical condition of the animal(s); and the practicing veterinarian is readily available for follow-up in case of adverse reactions or failure of the regimen of therapy. Such a relationship can exist only when the veterinarian has recently seen and is personally acquainted with the keeping and care of the animal(s) by virtue of examination of the animal(s), and (or) by medically appropriate and timely visits to the premises where the animal(s) are kept.

Ninety-four percent of respondents were aware of their state's VCPR definition, 4.0% were maybe aware, and 2.0% were not aware of their state's VCPR definition (Table 1). In order to fulfil the VCPR requirement for a producer, most veterinarians (56.0%) envisioned visiting two or more sites, but not all the sites, while visiting all sites (40.0%), or one site (4.0%) were less common responses. The frequency of visiting a producer or site varied, but the largest percentage of respondents (45.7%) would fulfil the VCPR requirement for a producer through biannual visits (twice per year). Lower percentages indicated quarterly (28.3%), annually (17.4%), monthly (4.3%), and less than every 2 years (4.3%).

Record keeping

Veterinarians, clients, and distributors have always needed to be diligent in keeping records associated with VFDs and prescription antibiotic use. The new guidance policies add VFD requirements for in-feed use and prescription requirements for water medications for medically important antibiotics to be used in prevention, control, and treatment. The FDA requires that a record of every VFD be kept for a period of 2 years.[3] Veterinarians plan to meet the additional record-keeping requirement by using a third-party electronic record-keeping service (66.7%), using existing staff (25.9%), and hiring new staff (7.4%) (Table 2).

Veterinarians were amenable to providing VFDs to producers in a variety of ways, including third-party electronic service (37.3%), e-mail (20.0%), hard copy (14.5%), and fax (10.9%). Ten percent of veterinarians planned to provide VFDs to producers in any form they preferred, while fewer

Table 1: Survey questions on the veterinarian-client-patient relationship*

	No. reporting	% reporting
Are you aware of your state's VCPR definition?		
Yes	47	94.0
No	1	2.0
Maybe	2	4.0
In order to fulfil the VCPR requirement for a producer how many sites do you envision visiting?		
1 site	2	4.0
2 or more sites (but not all sites)	28	56.0
All sites	20	40.0
In order to fulfil the VCPR requirement how frequently do you envision needing to visit a producer or site?		
Monthly	2	4.3
Quarterly	13	28.3
Biannually	21	45.7
Annually	8	17.4
Every 2 years	0	0.0
Less than every 2 years	2	4.3
I don't know	0	0.0

* Conference attendees at the 2016 ISU James D. McKean Swine Disease Conference were surveyed regarding their opinions of and plans for managing the VFD. Fifty practicing veterinarians (of 275) returned completed surveys.
VCPR = veterinarian-client-patient relationship; VFD = Veterinary Feed Directive.

(6.4%) were willing to provide VFDs in any form the feed suppliers preferred.

Most veterinarians planned to use a premade VFD: either an electronic VFD service (78.8%) or a VFD provided by a drug sponsor (7.7%). Only 13.5% of veterinarians planned to create a VFD form for their clinic.

Education and training

Much has been done to prepare for these antibiotic-use guidelines. Veterinarians and staff have attended meetings (including Webinars) (40.7%), read literature (38.1%), and created information bulletins to distribute to staff (21.2%) (Table 3).

To prepare clients for the changes the VFD brought about, veterinarians sponsored in-clinic meetings (including Webinars) (24.0%), met in person with clients (35.5%), sent a notice of changes in a regular newsletter (23.1%), and created an information bulletin (15.7%). Only 1.7% of veterinarians did not do anything to prepare their swine clients.

The frequency of updated training for staff and clients varied, but the largest percentage of respondents believed updated training should occur every 6 months or at least every year.

Costs

Although a number of the veterinarians that participated in the survey provided estimates of charges for writing VFDs and business costs attributed to the VFD, non-response was likely attributed to the challenge of arriving at a reasonably accurate estimate before January 1, 2017, or after, when VFD charges have been made and costs to business operations incurred. Thus, these estimates should be viewed as only anticipated. Still, this information can help inform budget evaluators and suggest strategies and resource requirements for business operations and provide a base for comparison once annual costs are incurred.

In an effort to compare the sizes of clients' operations served with the charges for writing VFDs and business costs attributed to the VFD, the weighted average swine client marketings per year were calculated and estimates were summarized across size categories: one to 4999; 5000 to 19,999; 20,000 to 49,999. Four survey respondents had swine clientele with annual marketings of 50,000 or more, but did not report charges for writing VFDs and business costs attributed to the VFD. The primary reason for this is likely that veterinarians who are employed directly by large swine producers are writing VFDs as part of their daily job responsibilities. One respondent did not report swine client marketings, but did include charges for writing VFDs for existing clients.

Across all respondents, the mean estimated per VFD charge for new clients was $30.38 (Table 4). The estimated per VFD charge for new clients was predominately in the ranges of $21 to $30 (42.4% of respondents) and $11 to $20 (approximately 30.3% of respondents). For existing clients, the estimated per VFD charge was lower, with a mean of $27.46. The estimated per VFD charges for existing clients were, again, predominately in the ranges of $11 to $20 (45.0% of respondents) and $21 to $30 (32.5% of respondents). The median estimated per VFD charge for both new and existing clients was the same at $25.00.

Annual marketings of clientele affected the estimated per VFD charge. In general, VFD charges were expected to be less for larger clients, with the biggest difference being between clients that have one to 4999 marketings per year (mean of $40.83 per VFD for new and existing clients) and clients with 5000 to 19,999 marketings per year (mean

Table 2: Survey questions on record keeping and VFD delivery to producers*

	No. reporting	% reporting
The FDA will require that a record of every VFD be kept for a period of 2 years. How do you plan to meet the additional record keeping requirement?†		
Use existing staff	14	25.9
Hire new staff	4	7.4
Use a third-party service (eg, GVL)	36	66.7
Other	0	0.0
How do you plan to provide VFDs to producers?†		
Whatever the producer prefers	11	10.0
Whatever the feed supplier prefers	7	6.4
Third party electronic service (eg, GVL)	41	37.3
Fax	12	10.9
E-mail	22	20.0
Hard copy	16	14.5
Other‡	1	0.9
Do you plan on using a pre-made VFD or creating your own?†		
Use electronic VFD service (eg, GVL)	41	78.8
Use VFD provided by a drug sponsor	4	7.7
Create VFD form for your clinic	7	13.5
Other	0	0.0

* Study details described in Table 1.
† Percentages may reflect multiple answers.
‡ Internal record system.
VFD = Veterinary Feed Directive; GVL = GlobalVetLINK.

of $32.00 per VFD for new clients and $26.45 for existing clients). The mean estimated per VFD charge for new and existing clients with 20,000 to 49,999 marketings per year were $28.00 and $26.90, respectively.

This suggests evidence of economies of size in issuing VFDs. Larger producers will tend to have more VFDs than smaller producers due to the probability of having more sites. Capital and labor costs per VFD would be much less for veterinary practices serving larger clients because they are able to spread fixed units of these resources over a greater number of VFDs.

Summary statistics and distribution of annual cost estimates regarding writing and delivery of VFDs, maintaining records for VFDs, educating clients and others (eg, nutritionists, feed suppliers), training staff on VFD requirements, and other components are presented in Table 5. Across all respondents, the lowest anticipated annual cost to business operations was training staff on VFD requirements (mean of $1840; median of $1000). Writing and delivering VFDs was the largest anticipated annual cost with a mean value of $8757 and a median value of $4000. The total annual cost, calculated as the sum of the mean annual component costs, was estimated at a mean of $23,930 and median of $10,750.

With respect to client's annual marketings and business costs attributed to the VFD, survey results were mixed. Each component cost, except "other," was anticipated to be the smallest for the 5000 to 19,999 swine client marketings per year category. For the one to 4999 category, the cost for writing and delivery of VFDs was expected to be similar to costs of the 5000 to 19,999 category, while costs incurred for maintaining records, educating clients and others, and training staff were expected to be larger. The 20,000 to 49,999 swine client marketings per year category had the highest anticipated costs.

The variation in expected business costs attributed to the VFD was anticipated. First, these were predicted impacts. Once costs are actually incurred and records kept, veterinarians will be able to provide more precise business cost estimates. Second, cost structures and services provided can vary considerably across veterinary practices. For example, maintenance of records, educating clients and others, and training staff can be performed in-house or through a third-party service, often dependent upon which is the lowest cost. Furthermore, veterinary practices may approach their costs for writing VFDs differently, depending on whether they are just writing VFDs for clients or if the VFD becomes part of the total veterinary services package that is offered.

Undoubtedly, the administrative costs associated with the writing and storage of VFDs and prescriptions are the ones that veterinarians are passing on to their clients in the form of charges for VFDs and additional site visits in order to ensure that the VCPR definition is being properly adhered to in case there is an inspection. Producers

Table 3: : Survey questions on education and training for the changes the VFD entails*

	No. reporting	% reporting
What are you doing to prepare yourself and staff for the changes the VFD entails?†		
I have not done any preparation yet	0	0.0
Attend meetings to learn about the VFD	48	40.7
Read literature on the VFD	45	38.1
Create an information bulletin on the VFD to distribute to staff	25	21.2
Other	0	0.0
What are you doing to prepare your swine clients for the changes the VFD will bring about?†		
I have not done any preparation yet	2	1.7
Sponsored in-clinic meetings to present information and discuss changes	29	24.0
Meet in person with clients to discuss changes	43	35.5
Sent a notice of changes to clients in a regular newsletter	28	23.1
Create an information bulletin to distribute to clients	19	15.7
Other	0	0.0
How frequently do you think staff and clients will need to have updated training?		
Staff		
6 months	22	46.8
1 year	23	48.9
2 years	2	4.3
5 years	0	0.0
Never	0	0.0
Clients		
6 months	12	24.5
1 year	35	71.4
2 years	2	4.1
5 years	0	0.0
Never	0	0.0

* Study details described in Table 1.
† Percentages may reflect multiple answers.
VFD = Veterinary Feed Directive.

may struggle with justifying the costs of site visits, if their animals are apparently healthy, in order to fulfill the "timely visit" clause in the VCPR definition. There will most likely also be economies of scale in play that will challenge smaller clinics and producers in comparison to larger swine production systems and veterinarians, as they will be able to spread these administrative costs over more animals.

Recommendations

The reality of FDA's antibiotic-use guidelines is that producers will have more conversations about judicious antibiotic usage with veterinarians if they want to use medically important antibiotics in feed and (or) water. This inevitably will include changes to herd health and production plans. Veterinarians were advising clients to modify biosecurity (18.8%), increase vaccinations (20.6%), increase non-antibiotic feed additives (12.4%), modify nutrition (9.6%), modify housing (10.1%), modify animal-purchasing strategies (10.6%), modify population density (14.7%), and other (3.2%) (Table 6). Other advice included cleaner water; improving employee knowledge regarding disease recognition; hiring more veterinarians; using more phytogenetics, probiotics, and prebiotics; increasing weaning age; and management to better stabilize sow-herd health, pig flow, and disease elimination strategies. Regarding advice on growth promotant use, most respondents (52.9%) were advising to move to non-medically important growth promotants for producers who want to continue to use antibiotics for growth-promotion purposes. Some respondents were advising clients to eliminate all uses of antibiotics for growth promotion (35.3%) or eliminate some uses of antibiotics for growth promotion (11.8%).

Most respondents believed swine producers in the United States will reduce the use of antibiotics in feed as a result of the VFD. However, the magnitude of the reduction varied. The largest percentage of surveyed veterinarians (34.7%) indicated

Table 4: Survey questions on VFD charges for new and existing clients*†

Per VFD	Observations	Mean (US$)	Median (US$)	SD (US$)
1 to 4999 marketings per year				
New clients	3	40.83	30.00	30.24
Existing clients	3	40.83	30.00	30.24
5000 to 19,999 marketings per year				
New clients	10	32.00	25.00	17.35
Existing clients	11	26.45	25.00	9.07
20,000 to 49,999 marketings per year				
New clients	20	28.00	25.00	11.12
Existing clients	25	26.90	25.00	13.28
All respondents				
New clients	33	30.38	25.00	15.20
Existing clients	40	27.46	25.00	14.02

All respondents	New clients		Existing clients	
Per VFD (US$)	**No. reporting**	**% reporting**	**No. reporting**	**% reporting**
0	0	0.0	0	0.0
1 to 10	0	0.0	0	0.0
11 to 20	10	30.3	18	45.0
21 to 30	14	42.4	13	32.5
31 to 40	5	15.2	5	12.5
41 to 50	1	3.0	2	5.0
More than 50	3	9.1	2	5.0

* Study details described in Table 1.

† The survey instrument collected swine-client marketings per year using categorical variables, ie, the percentage that would fall into each size category: 0; 1 to 4999; 5000 to 19,999; 20,000 to 49,999; 50,000 or more. For this analysis, the midpoint of each category (and end-point of the upper and lower bound category) was used to calculate the weighted average marketings per year. One survey respondent did not report swine client marketings per year but did report VFD charges for existing clients; this response is included in "all respondents." Four survey respondents had swine clients with 50,000 or more marketings per year but did not report VFD charges for new and existing clients.

VFD = Veterinary Feed Directive; SD = standard deviation.

an estimated 21% to 30% reduction in the use of antibiotics in feed as a result of the VFD. About 20% of respondents expected a 51% to 100% reduction, while the remaining 80% expected the reduction to be 50% or less.

Discussion

The FDA published the final versions of Guidance Documents 209 and 213 and the VFD in late 2013. Livestock producers and their veterinarians had approximately 3 years to prepare for the implementation of these regulations. While veterinarians have a good feel for the requirements of the VCPR, there is still quite a bit unknown about how veterinarians will satisfy the "timely visit to the premises" requirement. While there is federal language that must be included in each state's VCPR requirements, the interpretation of "timely visits" will ultimately fall within each state's board of animal health. Some states have already publically stated that they consider annual visits to each premises as satisfying the "timely visit" requirement, while others have left this vague.

There are biosecurity and financial concerns about veterinarians needing to make annual (or more frequent) visits to every site when there may not be any on-going disease issues in order to fulfill the VCPR requirement and the costs associated with it. Certainly, these costs are being passed on to producers in the form of charges for writing VFDs and additional site visits. The charges associated with writing a VFD, incurred as a cost by a producer, was anticipated to be in the $11 to $30 range. These will assuredly be continually re-evaluated as the market gets established. Over time, the costs would be expected to merge toward the cost of providing the service.

One of the key requirements of the new regulations is that the producer, veterinarian, and feed distributor will all have to keep copies of the VFD for 2 years. Also, with all the information that the veterinarian is legally responsible for, most veterinarians are likely going to use an online VFD generation tool (eg, GlobalVetLINK) to ensure that a proper and legal VFD is generated. The primary advantage of systems like these are that they have smart engine technology that

Table 5: Survey questions on anticipated per year costs to veterinary business operations*†

Per year	Observations	Mean (US$)	Median (US$)	SD (US$)
1 to 4999 marketings per year				
Writing and delivering VFDs	2	3375	3375	2298
Maintaining records for VFDs	2	2750	2750	3182
Educating clients and others on VFD requirements	1	2500	2500	ND
Training staff on VFD requirements	1	2000	2000	ND
Other‡	1	1500	1500	ND
5000 to 19,999 marketings per year				
Writing and delivering VFDs	9	3244	1000	4806
Maintaining records for VFDs	8	684	400	777
Educating clients and others on VFD requirements	8	1275	650	1434
Training staff on VFD requirements	7	414	500	322
Other§	1	2500	2500	ND
20,000 to 49,999 marketings per year				
Writing and delivering VFDs	18	12,111	4500	14,569
Maintaining records for VFDs	16	3025	2000	3227
Educating clients and others on VFD requirements	15	6700	2500	9397
Training staff on VFD requirements	16	2453	2000	2487
Other¶	1	15,000	15,000	ND
All respondents				
Writing and delivering VFDs	29	8757	4000	12,439
Maintaining records for VFDs	26	2283	1000	2830
Educating clients and others on VFD requirements	24	4717	2250	7828
Training staff on VFD requirements	24	1840	1000	2223
Other‡§¶	3	6333	2500	7522

* Study details described in Table 1.

† The survey instrument collected swine-client marketings per year using categorical variables, ie, the percentage that would fall into each size category: 0; 1 to 4999; 5000 to 19,999; 20,000 to 49,999; 50,000 or more. For this analysis, the midpoint of each category (and end-point of the upper and lower bound category) was used to calculate the weighted average marketings per year. Four survey respondents had swine clients with 50,000 or more marketings per year but did not report anticipated costs to veterinary business operations.

‡ "Other" was not listed.

§ "Other" was travel to and from farms for VCPR requirements.

¶ "Other" was additional staff.

ND = not done, standard deviation (SD) is not meaningful for N of 1; VFD = Veterinary Feed Directive; VCPR = veterinary-client-patient relationship.

Table 6: Survey questions on recommendations for dealing with antibiotic regulations and growth promotant use*

	No. reporting	% reporting
How do you plan to advise clients to deal with potential new antibiotic regulations?†		
Modify biosecurity	41	18.8
Increase vaccinations	45	20.6
Increase non-antibiotic feed additives	27	12.4
Modify nutrition	21	9.6
Modify housing	22	10.1
Modify animal purchase strategies	23	10.6
Modify population density	32	14.7
Other‡	7	3.2
How do you plan to advise clients on growth promotant use?†		
Eliminate all uses of antibiotics for growth promotion	18	35.3
Eliminate some uses of antibiotics for growth promotion	6	11.8
Move to non-medically important growth promotants	27	52.9
Other	0	0.0
What percentage (%) do you expect swine producers in the United States to reduce the use of antibiotics in feed as a result of the VFD?		
0	1	2.0
1 to 10	5	10.2
11 to 20	9	18.4
21 to 30	17	34.7
31 to 40	4	8.2
41 to 50	3	6.1
51 to 60	5	10.2
61 to 70	2	4.1
71 to 80	1	2.0
81 to 90	1	2.0
91 to 100	1	2.0

* Study details described in Table 1.
† Percentages may reflect multiple answers.
‡ "Other" included cleaner water; improve employee knowledge regarding disease recognition; hire more veterinarians; use more phytogenetics, probiotics, and prebiotics; increase weaning age; management to better stabilize sow-herd health; pig flow; and disease elimination strategies.
VFD = Veterinary Feed Directive.

makes it virtually impossible to write a VFD that is not in legal compliance. Several precautionary statements must be included on a VFD, and these online tools allow the VFD to be automatically populated with precautionary statements to ensure legal compliance. Another advantage of these services is that they can automatically e-mail copies to the producer and feed distributor once the VFD is generated. These tools also allow for easy retrieval of a specific VFD upon request, such as for an FDA inspection.

These antibiotic-use guidelines are designed to change the way medically important antibiotics are to be used in livestock production. Producers and veterinarians will be encouraged to look at implementing other strategies, such as adjusting stocking density and using antibiotic alternatives and vaccines as methods to decrease antibiotic usage. These regulations will also force veterinarians and producers to have timely discussions about the need for antibiotics, whereas in the past the producer could just procure these items for in-feed or in-water use without veterinary authorization.

The FDA continues to state that during the initial implementation of these guidelines, the compliance officers are going to focus on education during visits, so collectively the industry is learning together. It is clear that the VFD regulations have increased the number of on-site visits; therefore, veterinarians are working with their producers to get these scheduled. When inspectors come on site, they have been looking for evidence of any VFDs that would have been written over the past 2 years, as well as the evidence of feeding records that tie back to the VFD. This will help ensure that the medically important antibiotics are being fed for the prescribed duration and to the approximate number of animals listed, and that the feed was fed while the VFD was still valid (ie, not expired). While on the site, inspectors may also want to see evidence of current and complete treatment records and view the inventory of antibiotics that are on site and check their storage conditions as well as expiration dates.

Implications

- Practitioners can use this information to perform a benchmark assessment of their individual preparedness and anticipated impacts.
- Preliminary evidence suggests the industry will go beyond simply complying with the federal guidance for judicious use of antibiotics by collectively implementing more completely and stringently suggested herd-health and production plans.

Conflict of interest

None reported.

Disclaimer

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Severe outbreak of adventitious sternal bursitis in a pig herd in Central Italy

Giuseppe Marruchella, DVM; Francesco Mosca, DVM; Andrea Di Provvido, DVM; Giorgio Salvadori, DVM; Pietro G. Tiscar, PhD; Giorgio Vignola, PhD

Summary

This case report describes the main features of an outbreak of adventitious sternal bursitis that severely affected a pig herd in Central Italy between April and May 2016. All cases involved pigs aged 4 to 5 months, originating from the same farm and sharing the same genetic background. Concurrent infections with beta-hemolytic streptococci were observed. The intrinsic and extrinsic causative factors, as well as the significance of this disease in pigs, are herein reviewed and discussed.

Keywords: swine, adventitious bursitis, beta-hemolytic streptococci

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Resumen - Un brote severo inesperado de bursitis esternal en un hato de cerdos en Italia Central

Este reporte de caso describe las características principales de un brote inesperado de bursitis esternal que afectó severamente a un hato de cerdos en Italia Central entre abril y mayo de 2016. Todos los casos incluyeron cerdos entre 4 a 5 meses de edad, provenientes de la misma granja y con la misma genética. Se observaron infecciones simultáneas por estreptococo beta hemolítico. Los factores causantes intrínsecos y extrínsecos, así como la importancia de esta enfermedad en los cerdos, se revisan y discuten aquí.

Résumé - Éclosion sévère de cas de bursites sternales accidentelles dans un troupeau porcin de l'Italie centrale

Ce rapport de cas décrit les principales caractéristiques d'une éclosion de cas de bursites sternales accidentelles qui ont affecté sévèrement un troupeau porcin en Italie centrale entre avril et mai 2016. Tous les cas ont impliqué des porcs âgés de 4 à 5 mois qui provenaient de la même ferme et partageaient le même bagage génétique. Des infections concomitantes par des streptocoques β-hémolytiques ont été observées. Les facteurs causals intrinsèques et extrinsèques, ainsi que la signification de cette condition chez les porcs sont revus et discutés.

Under conventional (ie, intensive) breeding conditions, pigs are often exposed to stressful and harmful environments. As a consequence, traumatic lesions are commonly observed in pigs of different ages, from the farrowing crates to the abattoir. Among those are pressure-induced injuries due to inappropriate flooring, which include calluses, focal skin necrosis, claw fissures and erosions, decubitus ulcers, and "bursitis."[1,2]

Strictly speaking, bursitis means inflammation of a bursa, which is a small sac-like cavity lined with a synovial membrane and filled with synovial fluid.[3] Bursae are physiologically located around joints and serve to decrease friction where muscles and tendons glide over bones.[4] Although used improperly, the terms "adventitious bursa and bursitis" indicate an acquired fluid-filled sac which develops within the subcutis – where "normal" bursae do not exist – after persistent trauma to the skin overlying the bony prominences.[3,5]

Adventitious bursitis can affect piglets as young as 1 to 2 weeks old and becomes more evident in growing pigs (body weight 30 to 70 kg), when the lesions increase in size and large amounts of fluid accumulate.[1,6,7]

We report herein the main and peculiar features of a severe outbreak of adventitious bursitis that affected a pig herd in Central Italy.

Case description

The present outbreak occurred in a medium-sized farrow-to-finish pig farm. The herd consisted of two barns (A and B), located approximately 5 km apart and under the same management. Barn A housed approximately 500 sows (Landrace × Large White) and their piglets, which were weaned at 28 to 35 days and therein reared up to 2 months of age. Pigs were then moved to Barn B and raised to market weight. As usual for the Italian pork industry, pigs were marketed at 9 to 10 months of age (average body weight 160 kg) to produce typical seasoned hams and salami.

The herd was free from pseudorabies and vesicular disease, and positive for porcine reproductive and respiratory syndrome (PRRS) virus, *Mycoplasma hyopneumoniae,* and *Actinobacillus pleuropneumoniae*. Sows were regularly vaccinated against pseudorabies, erysipelas, and porcine parvovirus,

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This article is available online at `http://www.aasv.org/shap.html`.

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while pigs were vaccinated only against pseudorabies. Both barns had slatted floors without bedding. No all in-all out strategy was carried out.

During the previous few months, the farm's management had undergone major changes. Gilt replacement ceased, greatly reducing the number of sows. At the same time, in April 2016, 2500 growing pigs (commercial hybrids, approximately 25 kg body weight), were purchased and housed in Barn B.

Also in Barn B, between April and May 2016, a relevant number of pigs (approximately 30 of 2800) developed impressive swellings in the sternal region. The prevalence of these lesions is likely to have been higher, since they were often discrete and detectable only after careful inspection. Sternal lesions affected only the newly introduced pigs, becoming evident within the few weeks after their arrival (Figure 1). Herd history showed that sternal swellings had occasionally occurred in Barn A in suckling and weaned piglets, which usually recovered within a few weeks (Figure 2). In two pigs, such lesions were so severe as to require euthanasia (Figure 3). Both euthanized pigs were necropsied and submitted to cytological (MGG quick stain; Bio-Optica, Milano, Italy) and bacteriological investigations (culture and antimicrobial sensitivity). In addition, lesions were sampled, fixed in 10% buffered formalin, and routinely processed for histopathology (hematoxylin and eosin stain).

At necropsy, the lesions appeared well circumscribed and surrounded by enlarged lymph nodes. On cut section, the lesions consisted of a thick fibrotic wall and contained many liters of a watery, brownish, fetid exudate (Figure 4). Cytology revealed that such exudates contained a large number of neutrophils and bacterial aggregates (cocci). Histologically, the lesion wall consisted of dense connective tissue embedded with a number of foci of purulent inflammation and bacterial aggregates, and lined with a continuous layer of necrotic tissue on the inner side.

A few days later, three more pigs were sampled for diagnostic purposes. Approximately 10 mL of fluid, aseptically collected by means of a needle and syringe, was submitted to the diagnostic laboratory of the University of Teramo (Faculty of Veterinary Medicine, Teramo, Italy) for cytological and standard bacteriological investigations.

Figure 1: Pigs in a farrow-to-finish farm into which 2500 growing pigs (25 kg body weight) had recently been introduced (Barn B). Both pigs had developed impressive, symmetrical swellings at the cranial end of the thorax within a few weeks after their arrival. Similar lesions affected approximately 30 pigs. The pig on the left had a very large lesion shaped like a soccer ball, which rubbed on the floor and developed traumatic injuries. Skin injuries foster bacterial infections, worsening the outcome of such lesions.

In all pigs under study, bacteriological culture on sheep blood agar yielded isolation of pure cultures of beta-hemolytic, Gram-positive, catalase-negative and oxidase-negative cocci, which were identified as *Streptococcus agalactiae* by means of biochemical tests (API 20 STREP; bioMèrieux Italia, Bagno a Ripoli, Firenze, Italy). Results were interpreted using the API 20 STREP V8.0 software. The API 20 STREP profile is shown in Figure 5. Antimicrobial susceptibility disk diffusion tests showed that isolates were susceptible to β-lactams (amoxicillin plus clavulanic acid), cephalosporins (cefazolin, cefoperazone), and quinolones (enrofloxacin).

On the basis of the obtained results, the diagnosis of adventitious bursitis, complicated by secondary streptococcal infection, was made. Approximately 30 pigs with severe lesions were sent to slaughter before they reached market weight. No additional cases of sternal bursitis were observed. However, in a high percentage of finishing pigs (approximately 50%) large swellings occurred below the hock. In most pigs, the lesions regressed after treatment with ampicillin by intramuscular injection.

Discussion

Adventitious bursae and bursitis are considered to be the result of "pathological responses to an environment that is less than ideal.[7]" Although adventitious bursitis can develop anywhere, it most commonly arises on the boney prominences of the hocks and elbows.[1,8,9] The etiology and pathogenesis of adventitious bursitis is considered multi-factorial. A growing body of evidence indicates that a key role is played by the floor type and, more generally, by floor quality and pen conditions that increase the likelihood of injuries. Further extrinsic and interrelated factors include stocking density and the presence of bedding in the resting area.[1,3,5,6,10]

As a consequence, adventitious bursae or bursitis can represent a relevant issue for pig

Figure 2: Piglet from a farrowing crate (Barn A). A prominent swelling was evident at the sternal region in a 4-week-old suckling piglet. On palpation, the fluid content could be easily appreciated.

farms by causing economic losses (low body weight, poor quality of carcasses, rejection of breeding stock), and raising serious animal welfare concerns, especially when secondary infection occurs.[1,5,10,11] In fact, the "Welfare Quality Assessment Protocols"[12] consider bursitis among the most relevant animal-based measures to evaluate good housing in pig herds.

Genetic effects have also been identified, and white breeds appear to be at higher risk of bursitis, their mean heritability being estimated at 25% and 30%, respectively.[13,14] Rapid growth has been suggested as a further intrinsic predisposing factor.[1]

A kind of sternal bursitis (so-called "breast blister") is recognized in chickens and turkeys, caused by prolonged pressure from sitting. The morbidity of breast blisters in poultry can exceed 50% and is often exacerbated by *Staphylococcus* species infection.[15] To the best of the authors' knowledge, no data are currently available concerning the etiology, occurrence, or prevalence of adventitious sternal bursitis in pigs. It may be assumed that the described mixture of intrinsic and extrinsic factors caused the present outbreak, which so severely involved a large number of pigs in quite a short time. The concurrent onset of hock bursitis further supports such an assumption.

Improving the quality of flooring surfaces is explicitly considered by the European legislation for the protection of pigs (Council Directive 2008/120/EC),[16] which lays down the design requirements for the various categories of animals. The farm herein investigated complies with such rules. However, the present report suggests that improving floor quality may not be sufficient to ensure animal welfare and makes adoption of additional measures desirable (eg, the use of straw bedding).

The time course in this outbreak might support an etiological role also for the genetic background of the pigs, although that is difficult to prove, assess, and explain. Moreover, the farm manager reported that the affected pigs spent more time than usual lying on the floor; such behavior, probably linked to foot and (or) leg injuries and discomfort, might have further contributed to the onset of bursitis.

According to the literature,[1] bacterial infections likely exacerbate sternal lesions, which often reached an impressive size as in this case. *Streptococcus agalactiae* (Lancefield's group B streptococcus) is known to be a major agent of contagious mastitis in cattle and is considered a human health hazard. Biomolecular and serological typing indicate that human and bovine *S agalactiae* represent largely distinct populations.[17] Occasionally, *S agalactiae* has been isolated from lesions in pigs.[18] However, concerns still remain about the true identity of streptococci isolated from such lesions. There may be some confusion in distinguishing *S agalactiae* from *Streptococcus porcinus* and *Streptococcus pseudoporcinus*.[19,20] The wide zone of hemolysis, along with some biochemical features observed in these isolates (negative reaction to the hippurate hydrolysis test, positive reactions to the pyrolidonylarylamidase and Voges Proskauer tests) might argue against identification of *S agalactiae* and stimulate further serological and biomolecular investigations.[19-22]

Implications

- This case report documents that the sternal region can be severely affected by adventitious bursitis.
- Streptococcal infections can be identified in adventitious sternal bursitis lesions, but the routine biochemical characterization of streptococci may be misleading and should be complemented by additional investigations.

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Conflict of interest

None reported.

Disclaimer

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Figure 3: Pig in the growing-finishing unit (Barn B). A very large swelling severely affected the health status of this pig and made euthanasia necessary.

Figure 4: Excised lesion from the pig in Figure 3. After excision, the lesion measured 40 cm in diameter and weighed 15 kg. Cut section showed that it contained many liters of fluid.

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Figure 5: Biochemical profile of the bacterial isolates from the fluid in the lesion shown in figures 3 and 4. Biochemical tests were carried out by means of the API 20 STREP method (bioMèrieux Italia, Bagno a Ripoli, Firenze, Italy) and interpreted by the API 20 STREP V8.0 software. *Streptococcus agalactiae* was confirmed with a high percent of identity (85.2%). Assuming that *S agalactiae* contributed to the development of adventitious bursitis in this case, most relevant unexpected results were negative hippuric acid hydrolysis (HIP; 99%) and positive pyrrolidonyl arylamidase (PYRA; 1%). VP = Voges Proskauer (acetoin production); HIP = hippuric acid hydrolysis; ESC = β-glucosidase hydrolysis; PYRA = pyrrolidonyl arylamidase; αGAL = α-galactosidase; βGUR = β-glucuronidase; βGAL = β-galactosidase; PAL = alkaline phosphatase; LAP = leucine aminopeptidase; ADH = arginine dihydrolase; RIB = D-ribose acidification; ARA = L-arabinose acidification; MAN = D-mannitol acidification; SOR = D-sorbitol acidification; LAC = D-lactose acidification; TRE = D-trehalose acidification; INU = inulin acidification; RAF = D-raffinose acidification; AMD = starch acidification; GLYG = glycogen acidification.

+	-	-	+	-	+	-	+	+	+
VP	HIP	ESC	PYRA	αGAL	ßGUR	ßGAL	PAL	LAP	ADH
+	-	-	-	+	+	-	-	+	-
RIB	ARA	MAN	SOR	LAC	TRE	INU	RAF	AMD	GLYG

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Research Review Newsletter

Evaluating effects of transport conditions on weaned and feeder pig performance: Weaned pigs require more care in transport

In this Checkoff-funded project, Jay Harmon, Iowa State University, and his fellow researchers reviewed data from more than 7000 loads of weaned and feeder pigs, looking for possible mortality relationships and the long-term impact of transport stress on piglets and the environmental characteristics within the trailer.

Researchers found that weaned pigs had significantly greater death loss during transport than did feeder pigs (0.0333% versus 0.0243%), likely due to the combined stress of weaning and transport. In addition, weaned pigs were more susceptible to transport stress during hot weather (above 77°F) than feeder pigs. More specifically, the longer the travel distance, the higher mortality was in weaned pigs. Elevated death loss was highest in feeder pigs that traveled the longest distances. For both classes of pigs, mortality rates during shipping were lowest in mild weather (59°F to 77°F). Therefore, greater measures to reduce heat stress for weaned pigs may be necessary.

There was a holdover effect, as weaned pigs that faced transport stress tended to have higher death loss in their second week in the finisher. During the first week, mortality rates were 0.050%, 0.050%, and 0.045% for cold, mild, and hot weather transport, respectively. In the second week, mortality rates were 0.354%, 0.300%, and 0.272% for cold, mild, and hot transport. This may be due to starve-out of pigs that failed to thrive in the first week, but succumbed in the second week. Researchers noted the cause-effect linkage to transport environment is not clear-cut and other effects are certainly involved. For more details, find all past editions of "*Research Review Newsletter*" at **www.pork.org/publications**.

Latest productivity report card shows progress, hiccups

Continuous progress is a hallmark of US pork production, and keeping data is its centerpiece, according to Chris Hostetler, director of animal science for the Pork Checkoff. To that end, he points to the work that the Checkoff's Animal Science Committee had funded that gathers and disseminates productivity data.

Each year, a data collection company and Ken Stalder, swine extension specialist at Iowa State University, compile and analyze production data from about 35% of the US sow herd and offspring. All production phases (sow farm, nursery, wean-to-finish, and conventional finisher facilities) are included. Highlights of the results are published annually in the "*Industry Productivity Analysis*."

The latest industry report card (Table 1) shows both progress and hiccups. "While there have been gains in the overall production efficiency of the US swine herd, the analysis points to areas producers can tweak for additional improvement, such as pre-weaning mortality," Hostetler said. With the latest data set, he noted, producers must take the impact of the porcine epidemic diarrhea virus into account. Porcine epidemic diarrhea began in 2013 and affected herds more broadly in 2014 and 2015.

"Producers need to compile and analyze their farm's data and then compare it to the national database," Hostetler said. "That is how you really get a feel of where you stand and how much progress you need to make to stay competitive today."

For the full report, go to **www.pork.org/animalscience** or contact Chris Hostetler at **CHostetler@pork.org** or 515-223-2606.

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Table 1: Productivity data compiled from approximately 35% of the US sow herd and offspring, including all production phases*

	Average sow farm productivity					
	2011	2012	2013	2014	2015	2016
Pigs/mated sow/year	24.1	23.9	23.7	22.2	23.4	23.6
Litters/mated sow/year	2.33	2.31	2.30	2.26	2.27	2.28
Total born	13.4	13.4	13.6	13.5	13.5	13.7
Number born alive	12.1	12.3	12.4	12.3	12.1	12.4
Number weaned	10.2	10.3	10.2	9.7	10.0	10.2
Pre-weaning mortality (%)	15.5	15.5	17.3	20.5	17.4	17.3
Weaning weight (pounds)	13.1	13.2	13.4	13.6	13.9	13.9
Weaning age (days)	20.9	21.5	21.9	21.7	22.0	22.1

* Full report available at **www.pork.org/animalscience**.

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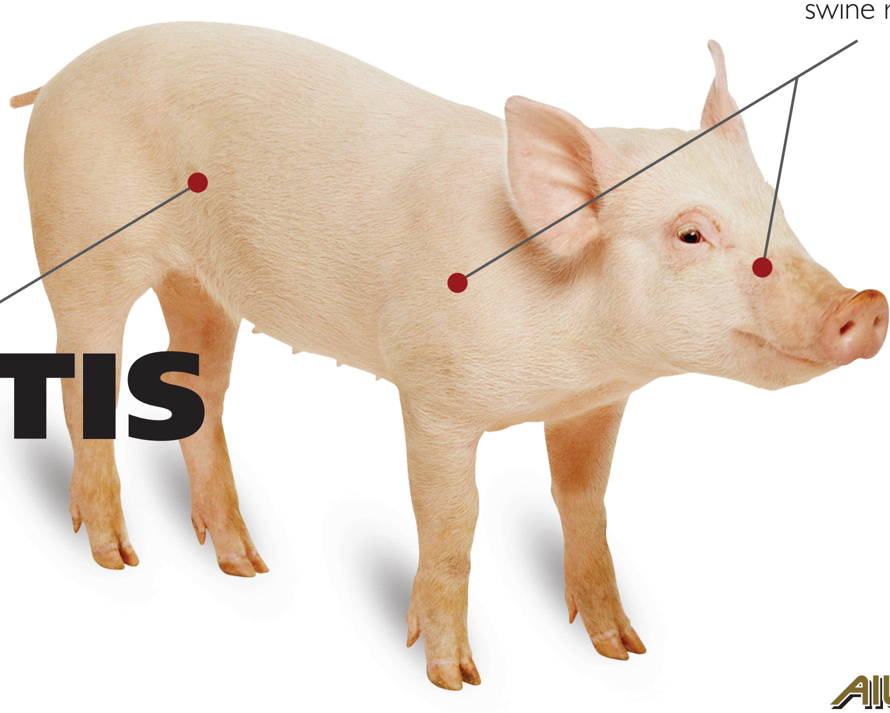

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NPB news continued from page 261

National Pork Board adds funds for secure pork supply, creates checklist

The National Pork Board recently approved an additional $1.6 million in funding to help support the USDA in creating a "Secure Pork Supply Plan" to help America's pig farmers respond quickly and successfully to a major threat, such as a foreign animal disease. The plan will enhance communication and coordination of all pork chain segments to help producers keep their farms operating and all related business activities functioning.

"We're thankful that our country has not experienced a disease such as foot-and-mouth disease (FMD) since 1929," said Terry O'Neel, National Pork Board president from Friend, Nebraska. "However, if we get the news that FMD, African swine fever, or another FAD has arrived, the Secure Pork Supply Plan will pay big dividends by getting pork production back to normal much faster."

Basics of the plan that will help producers achieve this include implementing sound biosecurity, using premises identification tags, keeping detailed production records, and maintaining all necessary health papers and certificates. Producers can find all of these steps and more in Checkoff's new FAD Preparation Checklist available on **pork.org** by searching for FAD checklist.

For more information, contact Dr Patrick Webb at **PWebb@pork.org** or 515-223-3441.

Checkoff's Pig Welfare Symposium coming in November

The National Pork Board is holding its first-ever Pig Welfare Symposium on November 7-9, 2017, in Des Moines, Iowa. The objectives of the symposium are to improve the well-being of pigs by disseminating recent research findings and recommendations, raising awareness of current and emerging issues, and identifying potential solutions. To accomplish this, the symposium provides a forum for sharing ideas, learning from other segments of the industry, and fostering dialogue on pig welfare-related issues.

The dynamic program is intended for producers, veterinarians, academicians, packers, processors, and allied industry partners. To register for the symposium and optional interactive workshops, visit **www.pork.org/pws** or contact Sherrie Webb at **SWebb@pork.org** or 515-223-3533.

Repositioning pork for changing audience

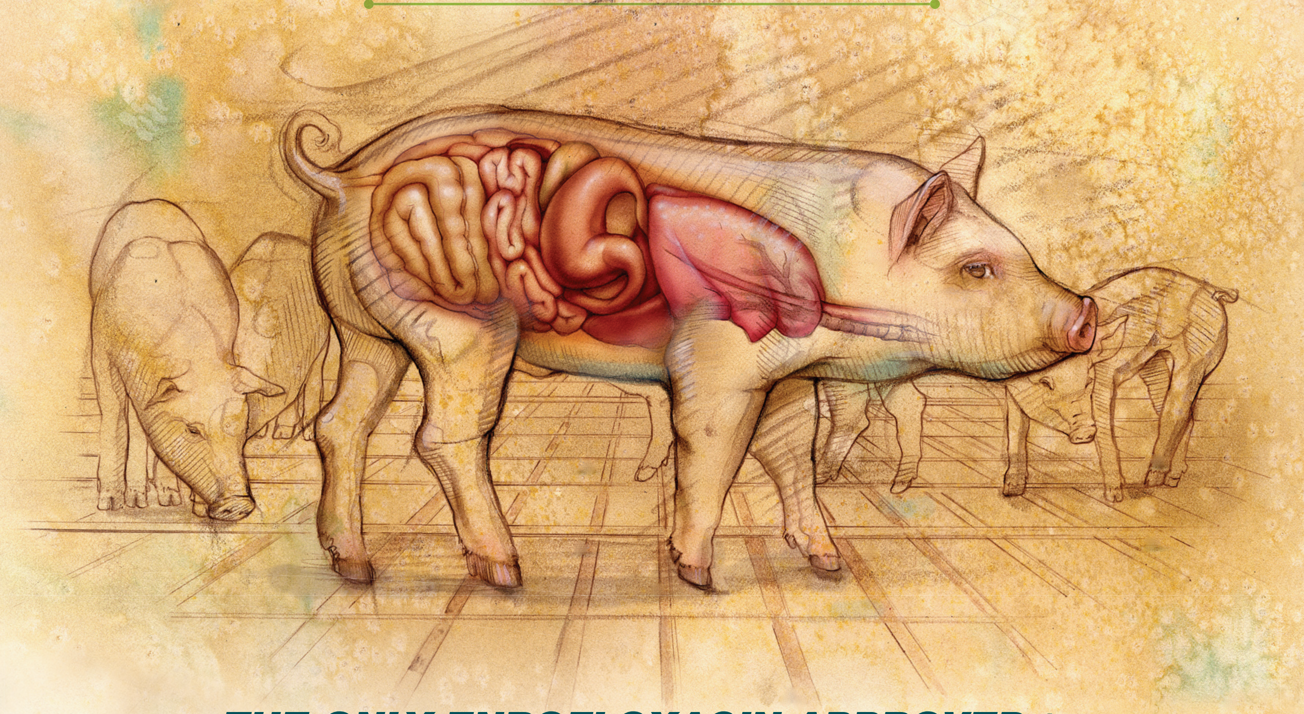
With the consumer market for pork and other protein sources shifting rapidly, the Pork Checkoff is putting the final changes on a plan to capitalize on those changes by repositioning pork marketing, Terry O'Neel, president of the National Pork Board, told an audience at World Pork Expo in June. "The Pork Checkoff has embarked on a journey to determine how best to market pork today," O'Neel, a pork producer from Friend, Nebraska, said. "The direction may be drastically different than we've seen in the last quarter century."

The National Pork Board's chief executive officer, Bill Even, said the big changes that require a new marketing plan are driven by "the three Ms:" **Millennials:** America's largest generation has increasing buying power and makes buying decisions differently than its predecessor generations; **Mobile:** The speed of communication and access to information fuels demand, requiring constant attention to new means of communication; and **Multicultural:** Currently 36% of the US population, the newest arrivals to the US and their families, will make up 50% of the population by 2050.

Even said that responding to those drivers in a way that assures pork demand remains strong prompted the National Pork Board to spend the past year conducting extensive research to define the critical needs of pork marketing. The research has included in-depth discussions with producers, packers, processors, retailers, food service, and consumers.

For more information, contact Jarrod Sutton, vice president of domestic marketing, at **JSutton@pork.org** or 515-223-2766.

GOING WHOLE HOG



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BL16014

Conversion tables

Weights and measures conversions

Common (US)	Metric	To convert	Multiply by
1 oz	28.35 g	oz to g	28.4
1 lb (16 oz)	453.59 g	lb to kg	0.45
2.2 lb	1 kg	kg to lb	2.2
1 in	2.54 cm	in to cm	2.54
0.39 in	1 cm	cm to in	0.39
1 ft (12 in)	0.31 m	ft to m	0.3
3.28 ft	1 m	m to ft	3.28
1 mi	1.6 km	mi to km	1.6
0.62 mi	1 km	km to mi	0.62
1 in^2	6.45 cm^2	in^2 to cm^2	6.45
0.16 in^2	1 cm^2	cm^2 to in^2	0.16
1 ft^2	0.09 m^2	ft^2 to m^2	0.09
10.76 ft^2	1 m^2	m^2 to ft^2	10.8
1 ft^3	0.03 m^3	ft^3 to m^3	0.03
35.3 ft^3	1 m^3	m^3 to ft^3	35
1 gal (128 fl oz)	3.8 L	gal to L	3.8
0.264 gal	1 L	L to gal	0.26
1 qt (32 fl oz)	946.36 mL	qt to L	0.95
33.815 fl oz	1 L	L to qt	1.1

Temperature equivalents (approx)

°F	°C
32	0
50	10
60	15.5
61	16
65	18.3
70	21.1
75	23.8
80	26.6
82	28
85	29.4
90	32.2
102	38.8
103	39.4
104	40.0
105	40.5
106	41.1
212	100

$°F = (°C \times 9/5) + 32$

$°C = (°F - 32) \times 5/9$

Conversion chart, kg to lb (approx)

Pig size	Lb	Kg
Birth	3.3-4.4	1.5-2.0
Weaning	7.7	3.5
	11	5
	22	10
Nursery	33	15
	44	20
	55	25
	66	30
Grower	99	45
	110	50
	132	60
Finisher	198	90
	220	100
	231	105
	242	110
	253	115
Sow	300	135
	661	300
Boar	794	360
	800	363

1 tonne = 1000 kg
1 ppm = 0.0001% = 1 mg/kg = 1 g/tonne
1 ppm = 1 mg/L

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- ***EMULSIBAC***-APP has been shown to protect susceptible swine against intranasal challenge with virulent serotypes 1, 5, and 7 of *Actinobacillus pleuropneumoniae.*
- ***EMULSIBAC***-APP contains ***Emulsigen***®
    - Unique emulsified oil-in-water adjuvant
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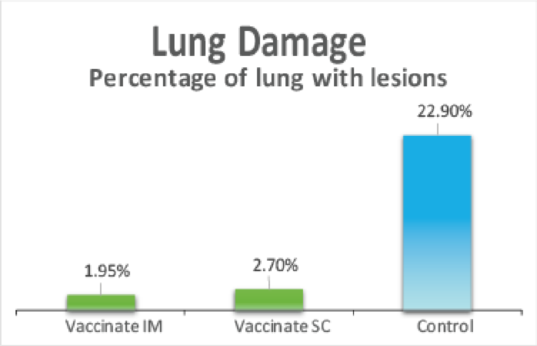

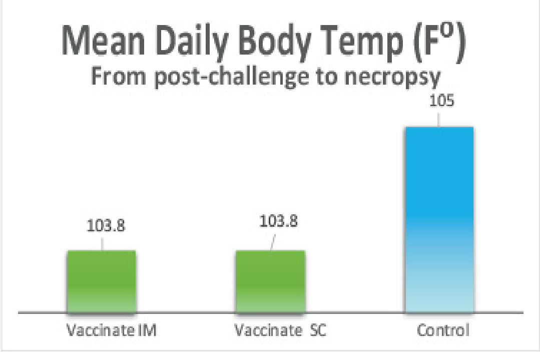

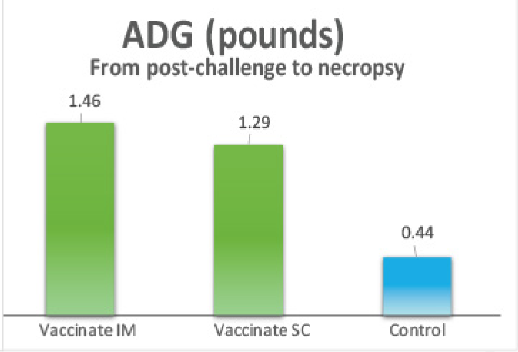

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AASV NEWS

AASV seeks young energetic talent

As you know, AASV represents the interests of our membership and that of the pig on a wide variety of topics. We are frequently asked to offer up some names of our members to serve on working groups, professional associations, committees, etc. We would really like to encourage a younger generation of our membership to start getting involved in these opportunities. It's important that we start transferring this wealth of institutional memory to our next generation of leaders and that we engage some new thoughts and inputs into solving the problems facing our profession and the swine industry we serve. If you're interested in serving the association and the profession in this manner, we would love to hear from you. Please e-mail us (snelson@aasv.org) and include any particular topic area of interest (such as welfare, antimicrobials, foreign or emerging swine diseases, etc) or special skill set you might possess (such as welfare, pharmacology, epidemiology, government policy, genetics, etc). We'll put your name on a list and contact you the next time we have an opportunity. Also, let us know if you are interested in serving on an AASV committee. Come on, stop being a waiter and start serving.

Nominate exceptional colleagues for AASV awards

Do you know an AASV member whose dedication to the association and the swine industry is worthy of recognition? The AASV Awards Committee requests nominations for the following five awards to be presented at the upcoming AASV Annual Meeting in San Diego.

Howard Dunne Memorial Award – Given annually to an AASV member who has made a significant contribution and rendered outstanding service to the AASV and the swine industry.

Meritorious Service Award – Given annually to an individual who has consistently given time and effort to the association in the area of service to the AASV members, officers, and staff.

Swine Practitioner of the Year – Given annually to the swine practitioner (AASV member) who has demonstrated an unusual degree of proficiency in the delivery of veterinary service to his or her clients.

Technical Services/Allied Industry Veterinarian of the Year – Given annually to the technical services or allied industry veterinarian who has demonstrated an unusual degree of proficiency and effectiveness in the delivery of veterinary service to his or her company and its clients, as well as given tirelessly in service to the AASV and the swine industry.

Young Swine Veterinarian of the Year – Given annually to a swine veterinarian who is an AASV member, 5 years or less post graduation, who has demonstrated the ideals of exemplary service and proficiency early in his or her career.

Nominations are due December 15. The nomination letter should specify the award and cite the qualifications of the candidate for the award. Submit to AASV, 830 26th Street, Perry, IA 50220; Fax: 515-465-3832; E-mail: aasv@aasv.org.

Call for papers – AASV 2018 Student Seminar

Veterinary Student Scholarships

The American Association of Swine Veterinarians announces an opportunity for veterinary students to make a scientific presentation during the Student Seminar at the AASV Annual Meeting in San Diego, California, on Sunday, March 4, 2018. Interested students are invited to submit a one-page abstract of a research paper, clinical case study, or literature review for consideration. The submitting student must be a current (2017-2018) student member of the AASV at the time of submission, and must not have graduated from veterinary school prior to March 4, 2018. Submissions are limited to one (1) abstract per student.

Abstracts and supplementary materials must be ***received*** by Dr Maria Pieters (pieters@aasv.org) by **11:59 PM Central Daylight Time** on **Wednesday, September 20, 2017** (firm deadline). All material must be submitted electronically. Late abstracts will not be considered. Students will receive an e-mail confirming the receipt of their submission. If they do not receive this confirmation e-mail, they must contact Dr Maria Pieters (pieters@aasv.org) by Friday, September 22, 2017, with supporting evidence that the submission was made in time; otherwise, the submission will not be considered for judging. The abstracts will be reviewed by an unbiased, professional panel consisting of private practitioners, academicians, and industry veterinarians. Fifteen abstracts will be selected for oral presentation in the Student Seminar at the AASV Annual Meeting. Students will be notified by October 13, 2017, and those selected to participate will be expected to provide the complete paper or abstract, reformatted for publication, by November 15, 2017.

AASV news is continued on page 269

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Iron(III) Dextran

AASV news continued from page 267

As sponsor of the Student Seminar, Zoetis provides a total of $20,000 in support to fund travel stipends and the top student presenter scholarship. The student presenter of each paper selected for oral presentation receives a $750 stipend to help defray the costs of attending the AASV meeting.

Each veterinary student whose paper is selected for oral presentation competes for one of several veterinary student scholarships awarded through the AASV Foundation. The oral presentations will be judged to determine the amount of the scholarship awarded. Zoetis funds the $5000 scholarship for the student whose paper, oral presentation, and supporting information are judged best overall. Elanco Animal Health provides $20,000 in additional funding, enabling the AASV Foundation to award $2500 each for 2nd through 5th place, $1500 each for 6th through 10th place, and $500 each for 11th through 15th place.

Abstracts that are not selected for oral presentation in the Student Seminar will be considered for participation in a poster session at the annual meeting. Zoetis and the AASV fund a stipend of $250 for each student who is selected and participates in the poster presentation. In addition, the presenters of the top 15 poster abstracts compete for awards ranging from $200 to $500 in the Veterinary Student Poster Competition, sponsored by Newport Laboratories.

Complete information for preparing and submitting abstracts is available on the AASV Web site at **www.aasv.org/annmtg/2018/studentseminar.htm**. Please note: the rules for submission should be followed carefully. For more information, contact the AASV office (Tel: 515-465-5255; Fax: 515-465-3832; E-mail: **aasv@aasv.org**).

Call for submissions – Industrial Partners

The American Association of Swine Veterinarians invites submissions for the Industrial Partners portion of the 49th AASV Annual Meeting, to be held March 3-6, 2018, in San Diego, California. This is an opportunity for commercial companies to make brief presentations of a technical, educational nature to members of the AASV.

As in the past, the oral sessions will consist of a series of 15-minute presentations scheduled from 1:00 to 5:00 PM on Sunday afternoon, March 4. A poster session will take place on the same day. Poster authors will be required to be stationed with their poster from 12:00 noon until 1:00 PM, and the posters will remain on display throughout the afternoon and the following day for viewing by meeting attendees.

Restricted program space necessitates a limit on the number of presentations per company. Companies that are members of the *Journal of Swine Health and Production* Industry Support Council (listed at **www.aasv.org/aasv/aasvisc.php**) may submit two topics for oral presentation. All other companies may submit one topic for oral presentation. Sponsors of the AASV e-Letter may submit an additional topic for oral presentation. In addition, every company may submit one topic for poster presentation (poster topics must not duplicate oral presentations). All topics must represent information not previously presented at the AASV Annual Meeting or published in the meeting proceedings.

To participate, send 1) company name, 2) presentation title, 3) a brief description of the presentation content, and 4) contact information for the presenter (name, mailing address, telephone number, and e-mail address) to AASV by **September 29, 2017**. Please identify whether the submission is intended for ORAL or POSTER presentation. Send submissions to **aasv@aasv.org**.

Presenters will be notified of their acceptance by October 13, 2017, and must submit the paper for publication in the meeting proceedings by November 15, 2017. Companies failing to submit papers in a timely manner may not be eligible for future participation in these sessions.

There is no charge for participation in the Industrial Partners sessions, but all presenters are required to register for the meeting (nonmember participants may register at the AASV regular member rate). The AASV does not provide a speaking stipend or travel reimbursement to Industrial Partners presenters.

Do you have a practice tip to share?

What's one thing you do that makes you more efficient? Impresses your clients? Helps you communicate? Makes a repetitive task quicker and easier? Simplifies sample submission? Keeps your day, equipment, or records organized?

Whatever it is that makes you a better swine veterinarian, why not share it at the 2018 AASV Annual Meeting? There is no paper required, and you might even win a cash prize!

The 2018 Practice Tips Seminar will be held in San Diego on Saturday afternoon, March 3. Please contact Dr Jeff Harker (**jharker@amvcms.com**) or the AASV office (**aasv@aasv.org**) to volunteer – or encourage a colleague to do the same.

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AASV past presidents compete for new donors

In the effort to increase the AASV Foundation endowment to $2 million by the 2019 AASV Annual Meeting, Foundation Chairman Dr John Waddell has issued the AASV Foundation Past Presidents' Challenge. Waddell is calling upon each of his fellow AASV past presidents to recruit at least three new Leman, Heritage, or Legacy donors. To count towards the goal, the donors can be members who have yet to support the foundation at any level, or those wanting to increase their support from Leman to Heritage or from Heritage to Legacy.

Waddell will recognize the past presidents who achieve the goal of three new donors, and plans to give special recognition to those who secure the most donors within each giving category.

What are you waiting for? Here's your opportunity to honor your favorite past president and support the AASV Foundation at the same time! A brief description of each foundation giving level follows, and the shaded box contains the roster of AASV past presidents. When you enroll (or increase your contribution to the next level), specify which past president should receive the credit for your participation.

Leman

Named for the late industry leader and former AASV president Dr Allen D. Leman, this giving program confers the title of "Leman Fellow" upon those who make a contribution of $1000 or more to the foundation endowment. Send your check to the AASV Foundation, 830 26th Street, Perry, IA 50220-2328 or contribute online at `http://ecom.aasv.org/foundation`.

Heritage

The Heritage Fellow program recognizes contributions of $5000 or more. In addition to monetary donations, other giving options such as life insurance policies, estate bequests, and retirement plan assets may be utilized. To enroll, complete the Heritage Letter of Intent available at `https://www.aasv.org/foundation/documents/heritageform.pdf`.

Legacy

A donor, multiple donors, or a veterinary practice may establish and name a Legacy Fund with a gift of $50,000 or more. The fund may be named after the donor or another individual or group. The donor designates which of three foundation mission categories the fund's proceeds will support: 1) research, 2) education, or 3) long-range issues. For details, see `https://www.aasv.org/foundation/legacy.php`.

For more information about the AASV Foundation's endowment giving programs, or to make a contribution, see `https://www.aasv.org/foundation`, or contact the foundation: Tel: 515-465-5255; E-mail: `aasv@aasv.org`.

AASV past presidents

1969-70	Dr Vaylord Ladwig	1986	Dr Bernard Curran	2002	Dr Lisa Tokach
1971	Dr Thomas Keefe	1987	Dr Wayne Freese	2003	Dr Rick Sibbel
1972	Dr Wallace Brandt	1988	Dr Joseph Connor	2004	Dr John Waddell
1973	Dr David Bechtol	1989	Dr L. Kirk Clark	2005	Dr Tom Gillespie
1974	Dr John Berthelsen	1990	Dr James D. McKean	2006	Dr Scott Dee
1975	Dr Allen Leman	1991	Dr Jack Anderson	2007	Dr Daryl Olsen
1976	Dr Robert Glock	1992	Dr Gary Dial	2008	Dr Kerry Keffaber
1977	Dr John Coltrain	1993	Dr Timothy Loula	2009	Dr R. B. "Butch" Baker
1978	Dr Ralph Vinson	1994	Dr David Reeves	2010	Dr Paul Ruen
1979	Dr Alex Hogg	1995	Dr Max Rodibaugh	2011	Dr Randy Jones
1980	Dr J. R. Randolph	1996	Dr Howard Hill	2012	Dr Tara Donovan
1981	Dr James Bailey	1997	Dr Larry Rueff	2013	Dr Matt Anderson
1982	Dr Steven Henry	1998	Dr Rick Tubbs	2014	Dr Michelle Sprague
1983	Dr LeRoy Biehl	1999	Dr Alan Scheidt	2015	Dr Ron Brodersen
1984	Dr Roy Schultz	2000	Dr Robert Morrison	2016	Dr George Charbonneau
1985	Dr Rodney Johnson	2001	Dr David Madsen		

AASV Executive Committee visits DC

The AASV Executive Committee, Drs Alex Ramirez, Scanlon Daniels, Nate Winkelman, and George Charbonneau, joined Drs Tom Burkgren, AASV executive director, and Harry Snelson, director of communications, May 8 and 9 in Washington, DC. The group joined the American Association of Bovine Practitioners' leadership for an annual visit hosted at the American Veterinary Medical Association Government Relations Division headquarters.

The purpose of the trip was to provide the AASV leadership an opportunity to interact with federal regulators, government agency personnel, legislators, and swine researchers to discuss issues of concern to swine veterinarians. In addition, the executive committee heard from the bovine practitioners and representatives from the National Pork Producers Council (NPPC) as well as other livestock producer groups.

Drs Bill Flynn and Mike Murphy represented the Food and Drug Administration (FDA). Also present was Dr Steven Solomon, the new director for FDA's Center for Veterinary Medicine.

The Veterinary Feed Directive (VFD) was a main topic of discussion with FDA. The FDA representatives reported few problems with the adoption of the revised VFD rule. The agency continues to operate in an "education mode" while producers, veterinarians, and distributors become accustomed to the additional antimicrobial oversight. The FDA did note, however, that enforcement would be ramping up as stakeholders and inspectors become more familiar with the regulation.

In addition to the VFD, the group discussed the need to better understand FDA's role in protecting animal agriculture from imported ingredients that could be harboring pathogenic organisms. The FDA requested a follow-up meeting to explore how the agency monitors imported ingredients and approves facilities for export, and how the new Food Safety Modernization Act might address concerns regarding imported ingredients.

Another topic of discussion was the FDA's proposed ban on the use of carbadox on the basis of concerns about the drug's carcinogenicity. In April 2016, the agency filed a "Notice of Opportunity for Hearing" which provides the manufacturer of carbadox with an opportunity to request a hearing on whether the approval should be withdrawn. In response, the drug's manufacturer, Phibro Animal Health, filed a request for a hearing and has provided study results supporting the safety of carbadox. The FDA is currently reviewing those studies to determine whether to allow a hearing. The decision to allow a hearing could take months or years. In the meantime, it remains legal to continue marketing and using carbadox as labeled.

The FDA is also seeking comments on how the agency should regulate gene editing in livestock. Guidance for Industry #187 clarifies FDA's requirements and recommendations for producers and developers of genetically engineered (GE) animals and their products. It describes how the new animal drug provisions of the Federal Food, Drug, and Cosmetic Act apply with respect to GE animals. The AASV Board of Directors has reviewed this issue and provided comments supporting the technology and requested restrictions be based on a sound scientific examination of the safety of gene editing.

In addition, the FDA is also seeking comments on a proposal to modify label directions to include a duration of use statement on those medically important feed grade antibiotics that do not currently have one. The AASV Pharmaceutical Issues Committee reviewed this request for information and provided feedback for comments submitted by the AASV. The executive committee described how these products were used in swine medicine and the need to retain the flexibility for veterinarians to utilize the drugs in a judicious manner to treat, control, and prevent disease. The agency is reviewing the comments received and will decide how to move forward over the next few months.

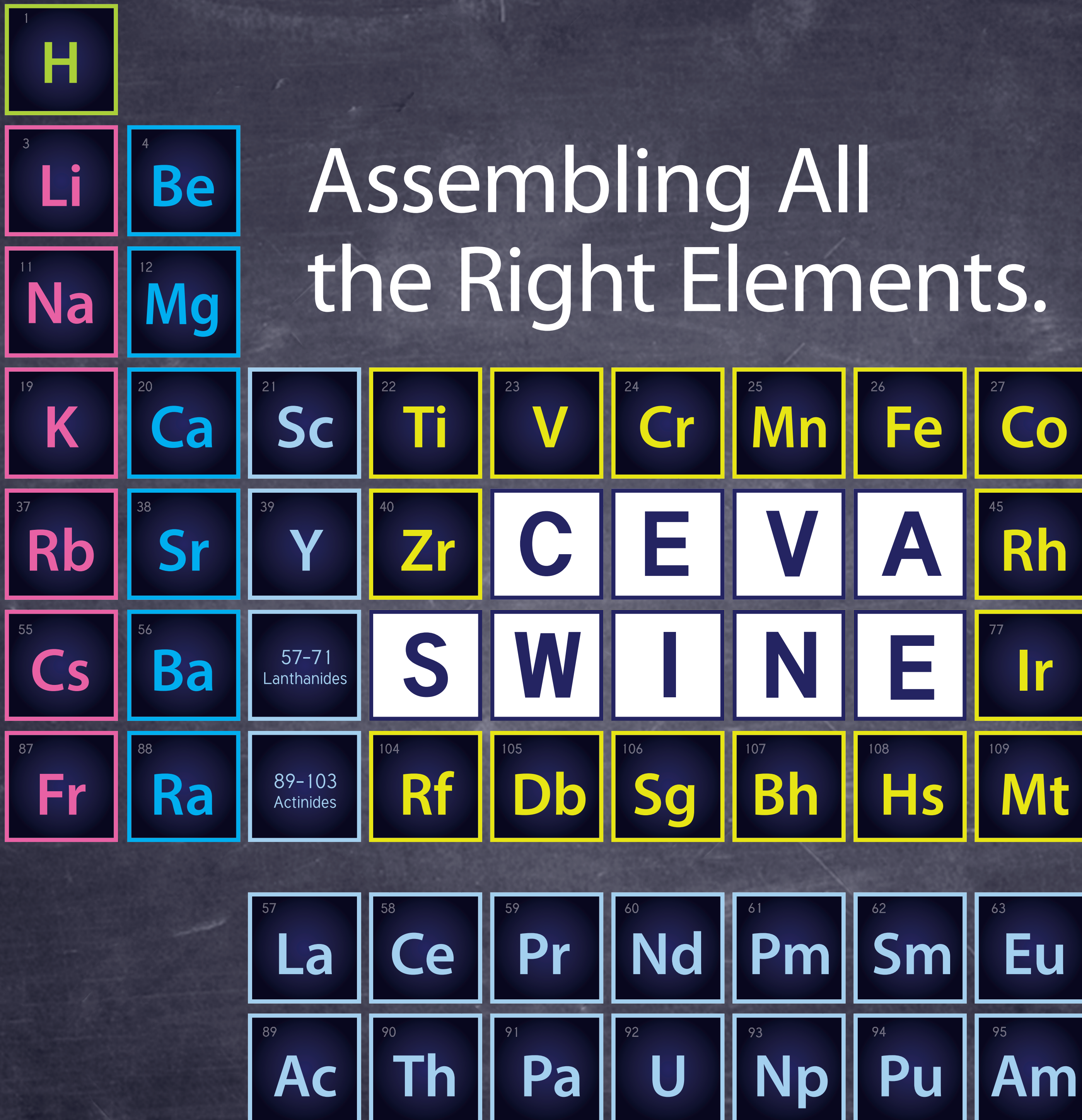
The group received an update on the following from the Department of Homeland Security (DHS):

- National Bio and Agro-Defense Facility (NBAF). The facility is projected to receive full operating capability by 2023 at a cost of $1.25 billion.
- Foot-and-mouth disease vaccine development. The DHS funded research and development of a vectored foot-and-mouth disease vaccine which is ready to be turned over to Merial for production.
- Enhanced Passive Surveillance project. Designed to enhance the nationwide surveillance capability to detect and identify endemic, transboundary, and emerging disease outbreaks.
- AgConnect. Development of a tool to allow for the visualization and sharing of data housed in disparate databases such as laboratories and producer databases. The DHS funded research to explore this proof of concept and is working to transition the technology to industry.

The executive committee talked extensively with Richard Sellers, Senior VP, American Feed Industry Association, about feed-related concerns such as imported ingredients and disease transmission risks via feed-associated sources, as well as the feed industry's perspective of the recent VFD changes. Mr Sellers indicated that the VFD transition had gone relatively smoothly for the swine industry. He was aware of the research showing that imported feed ingredients could theoretically serve as a source for the transmission of pathogenic organisms and noted that the

Advocacy in action continued on page 277

Assembling All the Right Elements.



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Ceva

Advocacy in action continued from page 275

feed industry would continue to work with livestock groups and regulators to minimize potential disease risks.

This year's visit also included discussions with Dr Jack Shere, deputy administrator USDA APHIS Veterinary Services, chief veterinary officer. Topics of discussion included the VFD, antimicrobial resistance, National Animal Health Laboratory Network (NAHLN) funding, and electronic messaging of laboratory data. The group emphasized the importance of adequately funding the NAHLN and expressed some concerns with the variability between laboratories in their ability to reliably message disease information to the USDA. Dr Shere expressed his support for projects designed by the Center for Epidemiology and Animal Health to address antimicrobial resistance. The AASV and the pork industry have worked closely with the USDA to develop these projects and support additional funding to undertake implementation.

On Tuesday, the AASV Executive Committee visited the National Institutes for Food and Agriculture (NIFA) headquarters to meet with NIFA and Agriculture Research Service (ARS) swine researchers. The group discussed federal funding for swine research and the swine-related projects ongoing at NIFA and ARS.

The group then attended a congressional briefing sponsored by the Animal Health Institute on antibiotic oversight and resistance before traveling to Capitol Hill to meet with legislators on behalf of NPPC.

Harry Snelson, DVM
Director of Communications

The AASV leadership (L-R): Drs Nate Winkelman (vice president), Scanlon Daniels (president-elect), Alex Ramirez (president), and George Charbonneau (past president)

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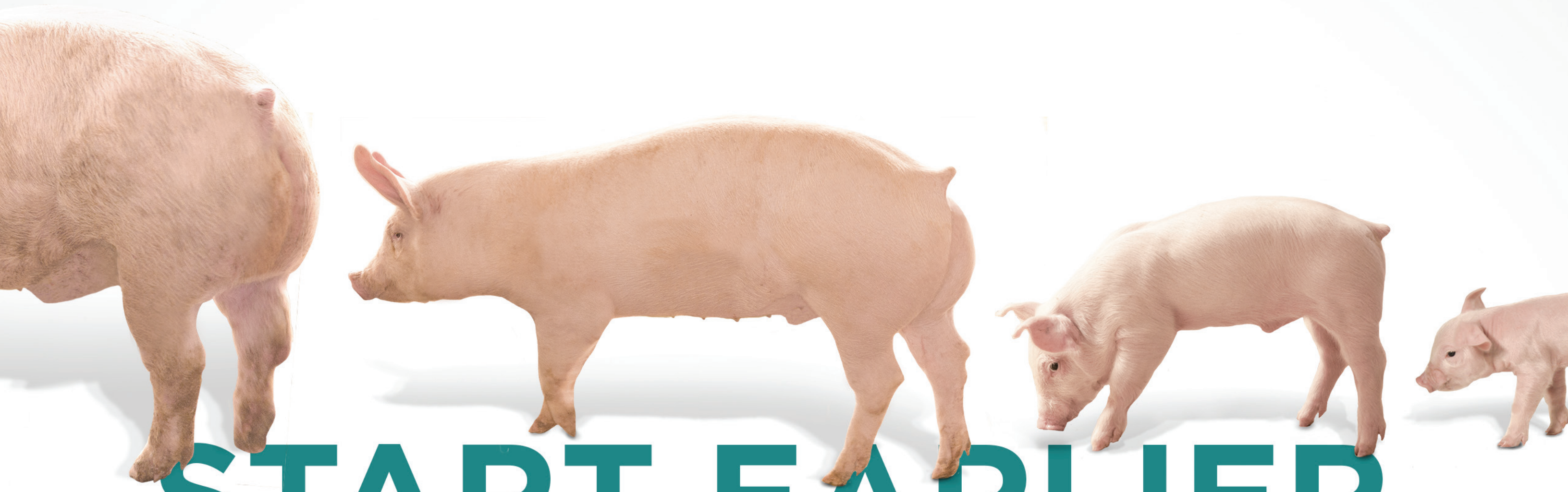

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Upcoming meetings

Allen D. Leman Swine Conference

September 16-19, 2017 (Sat-Tue)
Saint Paul RiverCentre, Saint Paul, Minnesota

For program information:
Tel: 612-624-4972; E-mail: cceconf4@umn.edu
Web: http://cceevents.umn.edu/allen-d-leman-swine-conference

For registration information:
Tel: 612-625-2900; E-mail: ccereg@umn.edu
Web: http://cceevents.umn.edu/allen-d-leman-swine-conference

US Animal Health Association 121st Annual Meeting

October 12-18, 2017 (Thu-Wed)
Town and Country Hotel, San Diego, California

For more information:
Web: http://www.usaha.org

2017 ISU James D. McKean Swine Disease Conference

November 2-3, 2017 (Thu-Fri)
Ames, Iowa

Hosted by Iowa State University

For more information:
Registration Services
Tel: 515-294-6222; Fax: 515-294-6223
E-mail: registrations@iastate.edu

For questions about program content:
Dr Chris Rademacher, Conference Chair
Iowa State University
E-mail: cjrdvm@iastate.edu

Pig Welfare Symposium

November 7-9, 2017 (Tue-Thu)
Des Moines Marriott Downtown
700 Grand Avenue
Des Moines, Iowa

Hosted by the National Pork Board

For more information:
Web: http://www.pork.org/pig-welfare-symposium/

Australasian Pig Science Association 16th Biennial Conference (APSA 2017)

November 19-22, 2017 (Sun-Wed)

For more information and to register:
Dr Cameron Ralph, APSA Secretary
Tel: +61 8 8313 7781
E-mail: cameron.ralph@sa.gov.au
Web: http://www.apsa.asn.au/

2017 Joint Meeting: North American PRRS Symposium and National Swine Improvement Federation

December 1-3, 2017 (Fri-Sun)
Intercontinental Chicago Magnificent Mile
505 N Michigan Avenue, Chicago, Illinois

For more information:
http://www.vet.k-state.edu/na-prrs/index.html

Passion for Pigs 2017 Tour

Here are the dates and locations for the 2017 tour series:

September 7, 2017 (Thurs), Orange City, Iowa

November 15, 2017 (Wed), Mankato, Minnesota

November 2017, Findlay, Ohio

December 5, 2017 (Tues), Columbia, Missouri

For more information:
Julie A. Lolli, Executive Coordinator
Tel: 660-651-0570; E-mail: julie.nevets@nevetsrv.com
Web: http://www.passionforpigs.com/

American Association of Swine Veterinarians 49th Annual Meeting

March 3-6, 2018 (Sat-Tue)
Manchester Grand Hyatt, San Diego, California

For more information:
American Association of Swine Veterinarians
830 26th Street, Perry, IA 50220-2328
Tel: 515-465-5255; E-mail: aasv@aasv.org
Web: http://www.aasv.org/annmtg

10th European Symposium of Porcine Health Management (ESPHM)

May 9-11, 2018 (Wed-Fri)
Barcelona (Spain)

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25th International Pig Veterinary Society Congress

June 11-14, 2018 (Mon-Thu)
Chongqing, China

For more information:
Web: http://www.ipvs2018.net/

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Photo Corner

Nap time for two Iowa sows

Photo courtesy of Tina Smith