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JOURNAL OF SWINE HEALTH AND PRODUCTION

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JSHAP SPOTLIGHT

Dr Glen Almond

North Carolina State University

Dr Glen Almond earned a DVM ('80) and MSc ('83) from Ontario Veterinary College and a PhD ('88) from North Carolina State University. Dr Almond is a Professor at North Carolina State University College of Veterinary Medicine where he is heavily involved in teaching. His research area of interest is anything with direct application to pork production. Dr Almond relies heavily on collaboration to achieve his research goals.

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People and pigs

People. Pigs. Planet. is the newest tagline for the National Pork Board. I love it. So simple, yet it is amazing how those three little words sum up what pork production is all about. We truly have some amazing people in this industry. They are the last people tucked in safely before a storm hits and the first people on the road when it has passed. They venture to the farms to care for the animals, come wind, rain, snow, sleet, hail, or high water and they never missed a beat during the COVID-19 pandemic. Some farm workers did contract the COVID-19 virus which then left farms short staffed, but the other team members picked up the slack to care for their animals without complaint. When you thanked them for their dedication, most would simply express their gratitude for the opportunity to work. Today I want to use this opportunity to remind our membership to make time to appreciate each other, and our co-workers.

As veterinarians we know without question the importance of our agricultural workers. We can roll out the perfect plan to prevent disease entry and implement disease control or elimination procedures, but without the resources to accomplish the task or buy-in from all involved, it will fail without question.

Recently Dr Márcio Gonçalves interviewed Dr Gordon Spronk on the Swine It podcast, where he gave tribute to Dr Bob Morrison.[1] He said the pigs are basically the same around the world; it is the people and the cultures that change. Dr Morrison truly understood the importance of people in the pig production equation. His unique ability to connect with people from different backgrounds, educational levels, and expertise is what made him so very special. I had the opportunity to watch him interact with a couple of my farm managers. He was a joy to watch. He would ask them questions until they had an opportunity to teach him something new, (or so he made it appear). They left the conversation with a sense of pride, and I knew that he had just motivated them to do an even better job the next day. The only difficult part was reminding Bob that we were way behind schedule and needed to get going.

Maybe we can't just *find* that next group of fabulous, dedicated people. Maybe we *develop* them by engaging them in the process, motivating them to excellence, and most importantly, showing them just how appreciated they are.

According to the US Bureau of Labor Statistics report for April 2021, there were 9.8 million unemployed Americans. The number of long-term unemployed (those jobless for 27 weeks or more) was 4.2 million, which was 3.1 million higher than in February 2020. These long-term unemployed accounted for 43.0 percent of the total unemployed in April.[2] Even with these high unemployment numbers, the agricultural sectors are struggling to find dependable labor. Obviously, there are a lot of people not working. Some are not physically capable, and I do not think any of us would begrudge them, but others simple do not have the "want to." What has happened to our society? Where has pride in a hard day's work gone?

The shortage of labor is not just affecting the agricultural sectors, it is creating problems everywhere. One of my coworkers visited a drive-thru restaurant of a popular fast-food chain the other day to get breakfast. It was closed with a sign stating, "Sorry closed, no workers." There are several empty shelves at the grocery store. There is a shortage of workers to make the products, shortage of drivers to deliver them, and shortage of employees to stock the shelves when items do arrive. So, hats off to doers, the American workers who still work!

"Take a moment to thank a worker, see if you can lighten their burden, and most importantly, let them know you appreciate their efforts!"

Please celebrate the people on hog farms, and those who are making feed, washing livestock trailers, delivering feed and supplies, etc. Many are doing extra work to compensate for a labor shortage on their farm or in their department. Take a moment to thank a worker, see if you can lighten their burden, and most importantly, let them know you appreciate their efforts!

Thank you for all you do for this association, this industry, and for feeding the people of the world!

Mary Battrell, DVM
AASV President

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* 1. Gonçalves M. *Swine It*. A tribute to Dr Bob Morrison and lessons on leadership, pig health, and business with Dr Gordon Spronk. May 17, 2021. Accessed June 11, 2021. **https://anchor.fm/swineitpodcast/episodes/A-tribute-to-Dr--Bob-Morrison-and-lessons-on-leadership--pig-health--and-business---Dr--Gordon-Spronk-e1118f8**

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* Non-refereed references.

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Have you hugged a sponsor today?

As I write this in mid-July, I am spending some time reaching out to our allied industry partners to secure sponsorships for activities during the American Association of Swine Veterinarians (AASV) Annual Meeting and to support the AASV e-Letter. During this time of year, I am reminded how important these sponsorships are to enable AASV to provide the range of activities during the Annual Meeting our attendees expect and access to the professional resources our members use. I am grateful to the companies that consistently support AASV through their generous financial support and contributions.

Historically, AASV has drawn a distinction between continuing education and social activities with regards to sponsorship opportunities. It has long been the association's policy to not allow third-party financial support of scientific and educational activities. This policy helps limit conflict of interest and commercial bias in those activities that are key to enhancing our members' professional integrity. Without commercial support, however, we would not be able to provide the high-quality social activities (refreshment breaks, member luncheon, awards reception, student reception, etc) and student opportunities (travel stipends, student seminar and poster scholarships, the AASVF-Merck Veterinary Student Scholarships, and podcast award) without significantly increasing membership dues and meeting registration fees.

In addition to sponsoring specific activities or scholarships, our commercial sponsors also support AASV through their Tech Table exhibits at the Annual Meeting. Their presence in the exhibit area during the meeting provides a significant amount of revenue to help offset the ever-increasing cost of conducting a conference of our size. Again, without this support, we would either have to significantly increase registration fees or scale back the offerings during the meeting. Coffee at $120/gallon and $65 plated lunches adds up fast! In-person gatherings for 1200 people are not cheap.

We were fortunate in 2021 that 60% of our usual Tech Table exhibitors chose to stick with us and support AASV by registering for a virtual Tech Table. We appreciated their continued support and hope they found value in the virtual format. On the other hand, almost 40% of the companies decided that the virtual format did not afford them the quality or amount of customer contact they needed to justify the expense.

I am always concerned that our commercial partners find value in their support. These are for-profit businesses and they look for a return on all their investments. When we ask allied industry representatives what value they seek from support of AASV, the usual answer revolves around the opportunity to interact withour members and support your professional endeavors. I know from my experience in a previous life working for a pharmaceutical company, the financial managers within the company are always asking, "What was the return on that activity?"

It's often hard to measure a direct return to a company's bottom line from placing an advertisement or sponsoring a luncheon. Thus, it is important that the company representative can say that they were able to spend some time with their customer or that the customer can put a name to a face or a product to a company. It is important to develop a relationship with a customer so that when that customer has a need, they will be comfortable turning to a company's technical service representative to ask advice on product selection. Those are tangible opportunities to market a company's products and meet a customer's needs.

> *"The simple act of letting them know their support is appreciated goes a long way to building long-lasting partnerships that benefit the company, AASV, and you."*

I wonder then if we spend enough time recognizing our sponsors for the support they give AASV? Do you take the time during the Annual Meeting to walk through the exhibit hall and talk with the company representatives about their products or the challenges you are facing in the field? Or even just to say thank you for sponsoring the e-Letter, advertising in the journal, or for the nice lunch we were able to provide during the meeting? The simple act of letting them know their support is appreciated goes a long way to building long-lasting partnerships that benefit the company, AASV, and you.

I encourage you to take a minute and hug (or fist bump) a sponsor today. You can also ask those companies that do not support your association, "Why not?" Let them know you recognize and appreciate their support and notice when they are absent.

Harry Snelson, DVM
Executive Director

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Practitioner case reports

As you likely know, the target audience of the *Journal of Swine Health and Production* is broad and encompasses many groups involved in the swine industry including researchers, academics, students, and practitioners, to name a few. The journal aims to publish manuscripts that have an applied focus and to present scientific information that is accessible to this highly varied demographic. As you can probably imagine this is not an easy task given the wide-range of interests and needs in our swine scientific and veterinary community.

The journal strives to publish information that is useful for the busy practitioner. How can a busy practitioner become involved in contributing to the peer-reviewed literature? Consider contributing a case report or case study to the journal.

When I was in practice, I recall thinking, "I should write this up." But I never did make the time using busy appointment schedules and long tiring days as my main excuses. I encourage any practitioner reading this to not be like me! As practitioners you are our "first responders" to seeing novel diseases, novel presentations of common problems, an unexpected complication, or perhaps just something interesting that you feel should be communicated in a formal way to your colleagues.

The journal publishes case reports and case studies and these articles, like all other submissions, are peer-reviewed. I get it, submitting a manuscript for peer-review is a time-consuming task and often daunting to those who do not submit often, or perhaps ever. But if you have an interesting case report or case study, do ask yourself if it is something you would like to share with your colleagues. Keep in mind when considering a case for submission that it is helpful to provide detailed information such as comprehensive notes, diagnostic results and follow-up diagnostic testing, herd/animal production parameters, images, etc.

"I get it, submitting a manuscript for peer-review is a time-consuming task and often daunting to those who do not submit often, or perhaps ever."

There are detailed author guidelines that you can find online at **aasv.org/shap/guidelines.pdf** that outline the format for case report and case study articles. Manuscript templates also can be found at **aasv.org/shap/guidelines/index.htm**. As always, the journal staff are here to help you. Please feel free to contact the journal office if you need any general guidance on how to proceed.

Terri O'Sullivan, DVM, PhD
Executive Editor

ORIGINAL RESEARCH PEER REVIEWED

Evaluation of a staged loadout procedure for market swine to prevent transfer of pathogen contaminated particles from livestock trailers to the barn

Chelsea R. Ruston, DVM; Daniel Linhares, DVM, PhD, MBA; Eli Blay; Megan Nickel, DVM; Kristin Skoland, BS; Heather Kittrell, DVM, PhD; Justin Brown, DVM; Locke Karriker, DVM, MS, DACVPM, Mary Breuer, BA, Lauren McKeen, MS; Derald J. Holtkamp, DVM, MS

Summary

Objective: Evaluate the effectiveness of a staged market pig loading procedure for reducing contaminant transfer from livestock trailers to the barn.

Materials and methods: A conventional loading procedure was compared to a staged procedure, with 10 replicates each. In the staged procedure, one loadout crew member was stationed between two lines of separation and could not cross onto the livestock trailer or into the center alleyway of the barn. The remaining loadout crew members within the barn could not cross into the loadout alleyway or chute. In the conventional procedure, a loadout crew member moved pigs from the center alleyway, through the loadout alleyway, and up the chute, but did not cross onto the livestock trailer. Fluorescent powder was mixed with obstetrical lubricant and wood shavings and spread evenly on the livestock trailer floor, just inside the roll-up door that opens to the chute. After each loadout, fluorescent powder contamination was evaluated at 8 locations: one in the chute, two in the loadout alleyway, and five in the center alleyway of the barn.

Results: Four of five center alleyway locations had significantly lower contamination ($P < .05$) for the staged protocol compared to the conventional protocol. The level of contamination at the fifth center alleyway location was not statistically different ($P = .057$). The contamination level at all other locations was not statistically significant between the two groups ($P > .05$).

Implications: The staged loading procedure effectively reduced the transfer of fluorescent powder from the livestock trailer to the barn.

Keywords: swine, staged loading, biosecurity, loadout

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Resumen - Evaluación de un procedimiento de descarga por etapas para cerdos de mercado para evitar la transferencia de partículas contaminadas con patógenos desde los camiones a los edificios

Objetivo: Evaluar la efectividad de un procedimiento de carga de cerdos de mercado por etapas para reducir la transferencia de contaminantes de los camiones al edificio.

Materiales y métodos: Se comparó un procedimiento de carga convencional con un procedimiento por etapas, con 10 repeticiones de cada uno. En el procedimiento por etapas, un miembro de la cuadrilla de carga se mantuvo estático entre dos líneas de separación y no podía cruzar hacia el camión o hacia el callejón central del edificio. Los miembros restantes del equipo de carga dentro del edificio no podían cruzar hacia el pasillo o a la rampa de carga. En el procedimiento convencional, un miembro de la cuadrilla de carga movía a los cerdos desde el pasillo central, a través del callejón de carga y hacia arriba por la rampa, pero no cruzaba hacia el camión de cerdos. Se mezcló polvo fluorescente con lubricante obstétrico y viruta de madera y se extendió uniformemente en el piso del camión, justo dentro de la puerta enrollable que se abre hacia la rampa. Después de cada cargamento, se evaluó la contaminación por polvo fluorescente en 8 lugares: uno en la rampa, dos en el pasillo de carga y cinco en el pasillo central del edificio.

Resultados: Cuatro de las cinco ubicaciones de los pasillos centrales tenían una contaminación significativamente menor ($P < .05$) para el protocolo por

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

Ruston CR, Linhares D, Blay E, Nickel M, Skoland K, Kittrell H, Brown J, Karriker L, Breuer M, McKeen L, Holtkamp DJ. Evaluation of a staged loadout procedure for market swine to prevent transfer of pathogen contaminated particles from livestock trailers to the barn. *J Swine Health Prod*. 2021;29(5):234-243.

etapas en comparación con el protocolo convencional. El nivel de contaminación de la quinta ubicación en el pasillo central no fue estadísticamente diferente ($P = .057$). El nivel de contaminación en todas las demás ubicaciones no fue estadísticamente significativo entre los dos grupos ($P > .05$).

Implicaciones: El procedimiento de carga por etapas redujo efectivamente la transferencia de polvo fluorescente desde el camión al edificio.

Résumé - Évaluation d'une procédure de chargement par étapes pour les porcs commercialisés afin de prévenir le transfert de particules contaminées par des agents pathogènes des remorques à bétail à la porcherie

Objectif: Évaluer l'efficacité d'une procédure de chargement par étapes des porcs de marché pour réduire le transfert de contaminants des remorques à bétail vers la porcherie.

Matériels et méthodes: Une procédure de chargement conventionnelle a été comparée à une procédure par étapes, avec 10 répétitions chacune. Dans la procédure par étapes, un membre de l'équipe de chargement était stationné entre deux lignes de séparation et ne pouvait pas traverser la remorque à bétail ou dans l'allée centrale du bâtiment. Les autres membres de l'équipe de chargement dans la porcherie n'ont pas pu entrer dans l'allée de chargement ou la goulotte. Dans la procédure conventionnelle, un membre de l'équipe de chargement a déplacé les porcs de l'allée centrale, à travers l'allée de chargement et vers le haut de la goulotte, mais n'a pas pénétré dans la remorque à bétail. De la poudre fluorescente a été mélangée avec du lubrifiant obstétrical et des copeaux de bois et répartie uniformément sur le plancher de la remorque à bétail, juste à l'intérieur de la porte à enroulement qui s'ouvre sur la goulotte. Après chaque chargement, la contamination par poudre fluorescente a été évaluée à huit endroits: un dans la goulotte, deux dans l'allée de chargement et cinq dans l'allée centrale du bâtiment.

Résultats: Quatre des cinq emplacements de l'allée centrale avaient une contamination significativement plus faible ($P < .05$) pour le protocole par étapes par rapport au protocole conventionnel. Le niveau de contamination au cinquième emplacement de l'allée centrale n'était pas statistiquement différent ($P = .057$). Le niveau de contamination à tous les autres emplacements n'était pas statistiquement significatif entre les deux groupes ($P > .05$).

Implications: La procédure de chargement par étapes a effectivement réduit le transfert de poudre fluorescente de la remorque à bétail à la porcherie.

Swine industry efforts to improve biosecurity have been focused on breeding herds, with little attention given to the wean-to-market phase of production. It has been estimated that 55% of growing-pig groups that are negative for porcine reproductive and respiratory disease virus (PRRSV) at placement are positive at marketing, suggesting that PRRSV was introduced sometime during the growing period causing economic losses of approximately $2.29/pig placed due to higher mortality and slower growth.[1] Although information on how frequently groups of growing pigs are infected with porcine epidemic diarrhea virus (PEDV) is not available in the literature, the lateral introduction of the virus in growing pigs adversely affects average daily gain (ADG), average daily feed intake, and reduces growth.[2] In one swine production system, the introduction of PEDV during late finishing reportedly reduced ADG by 21.4%.[3] Additionally, when growing pigs become infected, they serve as a source of the virus that may increase the incidence of outbreaks in swine breeding herds, where economic consequences can be much larger. Data from the Swine Disease Reporting System demonstrates that significantly increased detection of PRRSV in breeding herds is typically preceded by increased detection in growing pigs, supporting the hypothesis that the growing pig population is a major source of virus in the swine industry.[4,5]

One risk event that has the potential to introduce virus into growing pigs is transport to market. In the United States, groups of pigs are typically transported to market over several weeks, creating the opportunity for pigs remaining at the farm to become infected after the first loads are taken from the barn. The pigs remaining in the group are then subject to production losses and become a potential source of virus for other swine farms. It has been demonstrated that livestock trailers can serve as a source of transmission for PRRSV, PEDV,[6,7] and other swine pathogens.

For pigs remaining on feed to become infected during a marketing event, a series of failures is required. First, the livestock trailer, driver, truck, or other pathogen carrying agent associated with the marketing event is contaminated with live infectious virus. Swine harvest plants receive animals from many sources daily, so PRRSV, PEDV, and other swine pathogens are likely present in the unloading area. It has been demonstrated that the livestock trailers used to haul pigs to market are frequently contaminated with virus.[7] The driver, as well as the cab of the truck, may also serve as potential pathogen carrying agents for the viruses. Second, there is a failure to mitigate that contamination. Third, the virus is transferred as the pigs being marketed are loaded from the contaminated carrying agent to the remaining pigs in the group.

Currently, there is much variation in how livestock trailers are handled between transporting loads of market pigs to harvesting plants in the United States. In many cases, the trailers are not washed, disinfected, or dried between loads of market pigs due to the lack of trailers, truck washes, and other swine transport-related infrastructure. Even if livestock trailers were washed, disinfected, and dried, contamination may still occur if these procedures are not done correctly or standard operating procedures are not implemented. If livestock trailers or other pathogen carrying agents associated with the marketing event are not washed, disinfected, and dried, or done so poorly, between loads, it is unlikely that the contamination will be mitigated. Therefore, when the livestock trailers, trucks, and drivers return from a swine harvest plant and enter growing pig sites to load market pigs, contamination with live infectious PRRSV, PEDV, or other swine pathogens may occur. Viral transfer from the contaminated livestock trailer, driver, or other pathogen carrying agents to the pigs must occur during the loadout procedure

for pigs remaining in the barn to become infected. Little research has been done to assess how frequently this failure occurs or to evaluate alternative biosecurity measures to reduce the frequency.

In a previous study conducted by the investigators, a fluorescent powder was used to evaluate if the addition of a bench entry system in a commercial swine facility with a shower reduced the likelihood of personnel introducing environmental contamination into a swine farm.[8] Glo Germ powders and lotions have also been effectively used in the human medical field to represent human fluid and environmental bacteria contamination transfer in doffing of personal protective equipment, washing of hands, and glove removal methods.[9-12]

The objective of this study was to evaluate the effectiveness of a staged vs conventional loading procedure of market pigs for reducing the transfer of contaminants from livestock trailers to the barn using fluorescent powder.

Animal care and use

All study procedures were performed in accordance with the swine production and welfare policy of the production system.

Materials and methods

Preliminary data collection

A pilot study was conducted to see if fluorescent powder could be successfully used to visualize and measure the transfer of environmental contamination from livestock trailer to the barn. Fluorescent powder (216 g) was mixed with 0.5 L of obstetrical (OB) lubricant (Huvepharma, Inc) and 0.25 kg of wood shavings in a large, sealable plastic bag. This mixture was spread evenly on a portion of the livestock trailer floor just inside the roll-up door that opens to the chute. After pig loadout, an ultraviolet light was used to scan the loadout chute, loadout alleyway, center alleyway of the barn, and pens in the barn. Fluorescent powder could be found in the loadout chute, loadout alleyway, center alleyway in the barn, and in the first three pens adjacent to the center alleyway.

Study facility design

The study was conducted at 20 growing pig sites that were owned by a single production system. The study was conducted in July and August 2019. Each of the 20 sites consisted of two attached barns and approximately 1200 pig spaces/barn. Inclusion criteria for the site layout included a loadout chute that was enclosed, immobile, and approximately 4 m long and a center alleyway in the barn at least 7.62 m long that the loadout crew would walk after exiting the loadout area. Seventeen sites had a single loadout chute located in one of the barns, adjacent to a centrally located office. There was one loadout alleyway that led to the center alleyway in the barn and was enclosed on one side by a wall and a 3 ft high solid cement wall on the other side. The loadout alleyway was adjacent to an empty small holding pen. One replicate in the conventional group had a single loadout chute at one end of both attached barns. Two sites, one in the staged and one in the conventional group, had a loadout chute directly connected to a wide central hallway between both barns. The central hallway was enclosed by walls, and no holding pen was present. A standard double deck livestock trailer can hold approximately 170 market swine, therefore loads were excluded if less than 165 pigs were loaded on a single trailer. Replicates were also excluded if personnel stepped completely over the established lines of separation more than twice.

Study design and treatment groups

A conventional (control) and staged loadout protocol were compared in this controlled study. Each group had 10 replicates. A replicate was defined as the last of the scheduled loads for that site in a single day. The final load of the day was chosen to avoid delaying subsequent loads and disrupting market schedules while the measurements were taken. Each growing pig site was used for a single replicate to prevent the possibility of residual contamination from a previous replicate.

The initial allocation of treatment groups was done by blocking on day of the week (Sunday through Friday) and then randomizing replicates within each day of the week. Blocking on the day of the week was done to control for any potential differences in procedures by the day of the week or if employees were more or less rushed to complete the loading procedure on certain days of the week. Randomization was done using the rand function in Excel (2016, Microsoft Corporation). However, the final allocation (Table 1) was altered, and therefore no longer random, because of last-minute changes in the loadout schedule and several replicates were discarded when violations of at least one of the inclusion or exclusion criteria occurred.

For the conventional group, a crew of 3 to 4 people loaded the pigs according to the production system's conventional loading protocol (Figure 1A). Any member of the crew (Person 1) moved pigs from the center alleyway of the barn, through the loadout alleyway, and up the chute. Person 1 was not allowed to cross the line of separation between the livestock trailer and the loadout chute. The driver was confined to the trailer or Zone A and was not allowed to cross the line of separation between the chute and the back of the livestock trailer. The remaining members of the loading crew were restricted to Zone B and moved the pigs to be loaded from the pens down the center alleyway until they were transferred to Person 1. The barn, loadout alleyway, and chute were all part of the same zone (Zone B), and any member of the loadout crew could move freely within the zone.

For the staged group, there were two lines of separation (Figure 1B). The first line of separation was between the livestock trailer (Zone A) and the loadout chute in the loadout area (Zone B). The driver had to remain in the trailer. A single member of the loadout crew (Person 1) was designated to the loadout, or Zone B. The second line of separation was approximately between the loadout alleyway (Zone B) and the remainder of the barn (Zone C). Person 1 stayed in Zone B and the other members of the loadout crew (Persons 2 and 3) stayed in the barn, or Zone C. Person 1 was able to step into the buffer zone, which was considered part of the loadout (Zone B), to let pigs pass.

The same loadout crew, made up of 4 members, loaded 18 of the 20 replicates. They completed all 10 of the staged replicates and 8 of the 10 conventional replicates. Two other loadout crews loaded the 2 conventional replicates to accommodate loadout schedules. These two loadout crews had 3 members per crew. On day 1 of the study, the study investigators conducted a session to train the loadout crews how to perform the staged loading procedure. Two diagrams with instructions in English and Spanish on how to perform the staged and conventional loadout procedures were given to the loadout crews and loadout

Table 1: Treatment group allocation per day of the week throughout the study

Day of the Week	Conventional	Staged
Sunday	1	2
Monday	0	1
Tuesday	3	2
Wednesday	3	3
Thursday	2	1
Friday	1	1
Total	**10**	**10**

crew managers and explained in detail. Before each loadout, the loadout crews were told which procedure they needed to perform and reminded of the directions for that procedure.

Fluorescent powder

A fluorescent powder (Glo Germ; Glo Germ Company) was used to visualize contamination from the livestock trailer to the barn. The fluorescent powder simulated the behavior of pathogens from fomites and is similar in size to bacteria, approximately 1 to 5 microns or less.[8] The powder appears white under natural light and fluoresces when exposed to ultraviolet light.

Outcome variables

A single grid was constructed to measure the level of contamination (Figure 2). The grid was 120 × 55 cm^2 and divided into 264 squares, each measuring 5 × 5 cm. The grid was made of polyvinyl chloride (PVC) pipe and flat fluorescent plastic string (Rexlace plastic craft lacing; Pepperell Braiding Company) placed at 5 cm intervals in the PVC pipe grid. The grid was coated with a fluorescent paint that was visible under long-wave ultraviolet light (UV-A), but a different fluorescent color than that of the fluorescent powder. Measurement of contamination was taken using the grid at 8 different locations shown in Figure 3. The measurement locations included: 1 ft in front of the end of the loadout chute adjacent to the trailer; 1 ft in front of the beginning of the loadout chute; 1 ft behind the second line of separation within the loadout area; directly in front of the line of separation in the center alleyway; and 4 locations in the center alleyway spaced 3 ft apart from the previous measurement. Measurements for each location were recorded by counting the number of 5 × 5 cm squares with any amount of fluorescent powder present.

Also recorded were major, minor, and necessary violations of the protocols, and number of loadout crew members present for the procedure. A minor violation was defined as a loadout tool crossing the line of separation or a person partially crossing a line of separation, such as half a boot. A major violation was defined as a person walking completely across a line of separation. A necessary violation occurred when an animal required assistance on the loadout chute, trailer, or between the loadout chute and trailer. The necessary violations occurred when a member of the loadout crew or the driver stepped completely over the line of separation to help the animal.

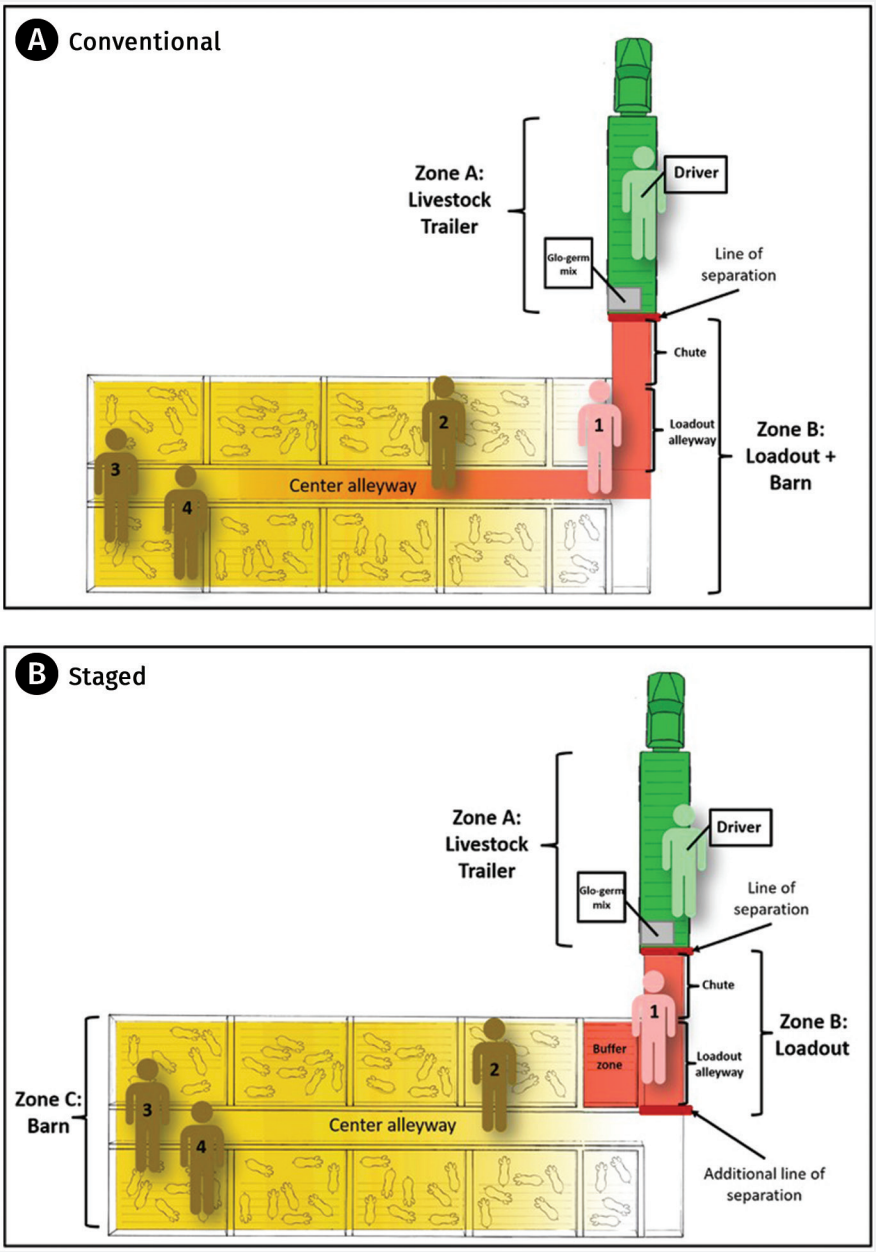
Study procedures

Immediately before each scheduled site visit, 216 g of fluorescent powder was mixed with approximately 0.5 L of OB gel and 0.25 kg of wood shavings in a large, sealable plastic bag. Before pigs were loaded on the last scheduled load for the evening, the fluorescent powder mixture was spread evenly on a portion of the livestock trailer floor just inside the roll-up door that opens to the chute (Figure 4). When the staged protocol was followed, the location of the second line of separation was determined based on the design of the barn and marked with commercially available red livestock spray paint (Quik shot spray paint, LA-CO Industries). On the nights where the conventional protocol was followed, the location of the second line of separation was determined prior to loadout for the purpose of determining measurement locations, but not marked to avoid confusion with the loadout crew as to what protocol they needed to follow. The second line of separation was typically at the end of the loadout alley in the barn. In 3 instances, the barn's loadout alleyway was a central hallway with no buffer zone. In these cases, the second line of separation was at the end of the central hallway, where the barn and hallway met. If there was not an appropriate buffer zone for Person 1 of the loadout crew during a staged loading replicate, the second line of separation was extended approximately two feet past the loadout area so Person 1 could establish an appropriate buffer zone to move out of the travel pathway of pigs being loaded into the chute. After the fluorescent powder mixture was spread evenly on the back of the livestock trailer, and the second line of separation was determined, the loadout procedure was observed. Violations were recorded and deemed as minor, major, or necessary violations. After the loadout was complete, Person 1 put on plastic boots by elevating their feet while standing in the loadout area and then stepping back into the barn. They were to avoid stepping on the floor of the loadout area once the plastic boots were on and return to the office to avoid cross-contamination after crossing the second line of separation. When the loadout crew exited the barn, the measurement grid was used to measure the contamination level at each of the locations shown in Figure 3. The lights were turned off and a UV-A flashlight (Lights of America) was used to illuminate any fluorescent powder present in the grid coordinates. If there was any powder inside the cell of the grid, it was counted as contaminated. This was repeated for each location. A primary investigator and 1 of the 6 secondary investigators were present to observe the loadout and to take measurements for all but 2 replicates. For these 2 replicates, 2 secondary investigators were present to observe the loadout and take measurements. Both investigators present would count the number of contaminated squares, and after counting, the secondary investigator would record the number of contaminated squares. An effort was made to take measurements in the evening, after sundown, or in the mornings before sunrise to visualize the fluorescent powder more easily.

Statistical analysis

All data was analyzed using PROC GLIMMIX (SAS version 9.4). A generalized linear mixed effects model with the Poisson response distribution and log link was used to model the number of contaminated cells as the response variable. Fixed effects included treatment

Figure 1: A) Conventional and B) staged protocol for market pig loadout. For conventional loadout, Zone A included the livestock trailer and Zone B included the loadout area plus the barn. There was only one line of separation between the livestock trailer and loadout chute. All members of the loadout crew were free to move between the loadout chute, loadout alleyway, and barn. For staged loadout, Zone A included the livestock trailer, Zone B included the loadout, and Zone C included the barn. There were two lines of separation, with the additional line of separation located between the loadout area and the rest of the barn. Loadout crew member 1 could not pass back into the barn, and loadout crew members 2, 3, and 4 could not pass into the loadout alleyway and chute.



(conventional or staged), sampling point (chute, in front of the chute, second line of separation, or center alley in barn 1-5), major violations (0 or 1), loading crew size (3 or 4), and minor violations (analyzed as a continuous variable). Interaction terms for treatment and sampling point, major violations and sampling point, and minor violations and sampling point were also included. The barn was analyzed as a random effect to account for repeated grid measurements at a single point in time for each load. Sampling points were treated as categorical variables. Only 1 of 20 replicates had 2 major violations, all others had either 0 or 1. Therefore, major violations were analyzed as a binary variable (0 for no major violations or 1 for one or more major violations). A pairwise comparison was performed on differences between the treatment groups at each sampling points, and differences in sampling point and major violations. A P value $< .05$ was considered significant.

Results

Three replicates were discarded and repeated. One because the number of animals loaded onto the truck was less than 165, one because there were over 2 major violations from the staged loading protocol, and one because the measurement grid did not fit in the loadout alleyway and an accurate measurement could not be obtained. At least 1 major violation occurred in 7 of the 20 replicates. Five of these replicates were the staged group, and 2 replicates were the conventional group. There were 0 necessary violations observed throughout the study. At least 1 minor violation occurred in 6 of the 20 replicates, 5 of which were the staged group and 1 was the conventional group. Data was successfully captured for 10 replicates for both treatments.

A summary of main fixed effects used in the model is displayed in Table 2. Treatment and sampling point were both statistically significant in the model ($P = .01$ and $P < .001$, respectively). Major violations and minor violations were not statistically significant ($P = .14$ and $P = .16$, respectively). The number of crew members was also not statistically significant ($P = .31$). When there were 4 crew members present during the conventional loadout procedure, the member that ran pigs up the loadout chute usually walked back into the barn at least 7.62 m in the center alleyway until the next group of pigs was brought to them. When there were 3 crew members, the member that ran the pigs up

Figure 2: A 120 × 55 cm^2 PVC pipe grid divided into 264 squares, each measuring 5 × 5 cm, was constructed to measure the level ofcontamination at 8 different locations after each loadout.

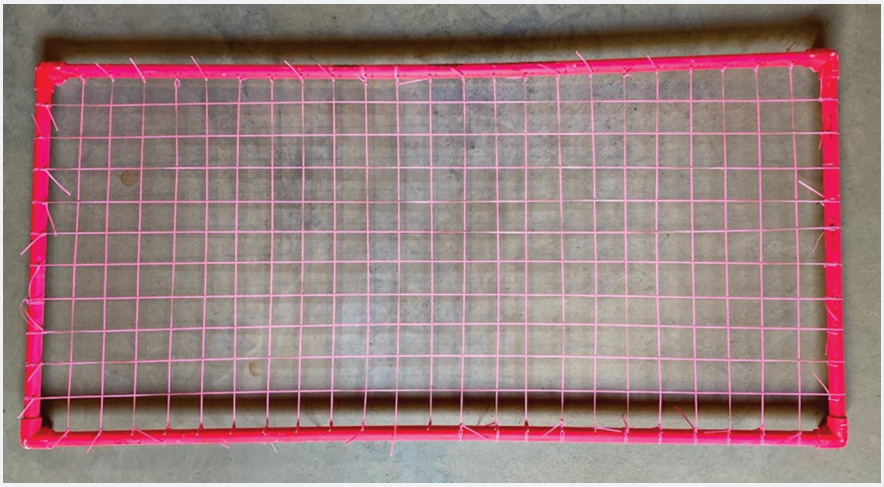
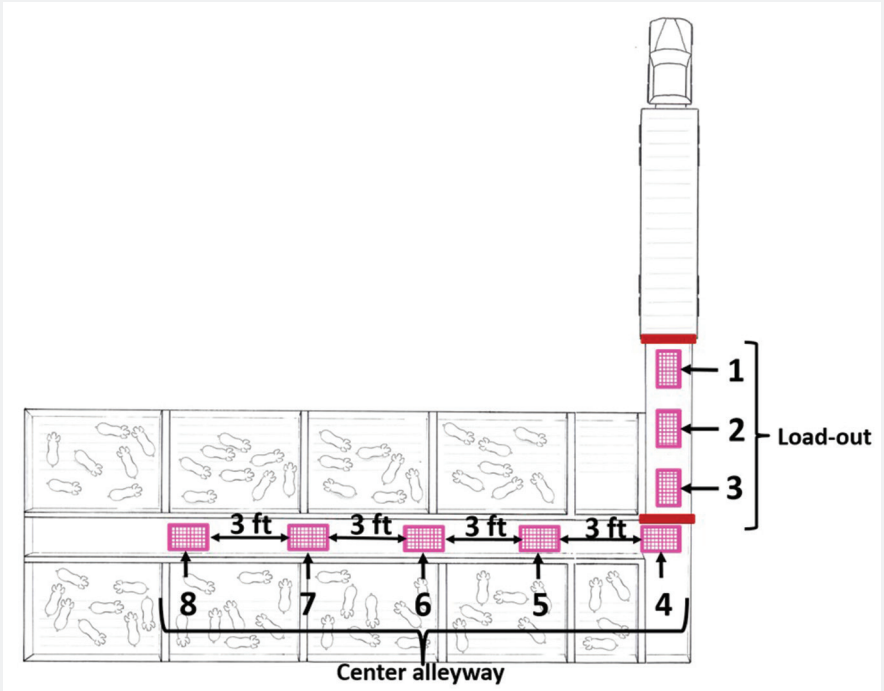


Figure 3: Contamination was measured in 8 locations throughout the loadout and barn area. Locations 1-3 were within the load-out: 1) 1 ft in front of the end of the loadout chute adjacent to the trailer; 2) 1 ft in front of the beginning of the loadout chute; and 3) 1 ft behind the second line of separation within the loadout area. Location 4 was directly in front of the line of separation in the center alleyway and locations 5-8 were in the center alley, approximately 3 ft apart.



the loadout chute also walked back into the barn at least 7.62 m into the center alleyway. The only observable difference between the 3-member loadout crew and the 4-member loadout crew was that the member in the 3-member loadout crew moving the pigs up the loadout chute sometimes traveled further than the 7.62 m back into the center alleyway to receive the next group of pigs. Both crew sizes (3 vs 4) covered the same area that was measured in the center alleyway.

The interaction between treatment and sampling points was statistically significant ($P = .04$) however, the interaction between major violations and sampling point and minor violations and sampling point were not statistically significant ($P = .20$ and $P = .07$, respectively). A comparison of the number of contaminated cells between each treatment group at each location is shown in Figure 5. The number of contaminated squares at center alleyway locations 1, 2, 3, and 4 were significantly lower for the staged group compared to the conventional group ($P = .02$, $P = .007$, $P = .005$, and $P = .009$, respectively). While the number of contaminated squares at center alleyway location 5 was lower for the staged group than the conventional group, the difference was not statistically significant ($P = .057$). The contamination at all other locations, the chute, in front of the chute, and the second line of separation, were not statistically significant ($P = .24$, $P = .73$, and $P = .63$, respectively) between the conventional and staged groups. It was not expected that measurements in the chute and loadout alleyway would be statistically significant from each other. The staged loading procedure should not affect how much contamination is conveyed from the trailer to the chute and loadout alleyway. The standard errors in the center alleyway for the conventional group were greater than those for the staged group (Figure 5).

The measurements taken in the loadout chute had consistently high levels of contamination, with at least 75% of the grid squares contaminated. Least squares means of contaminated cells for no major violations and 1 or more major violations across all treatment replicates were 15.75 and 22.96, respectively. At each sampling point, differences between replicates that had no major violations or 1 or more major violations, were not significant ($P > .05$) except for the center alleyway location 4 ($P = .01$).

Figure 4: The mixture of fluorescent powder (Glo Germ), wood chips and obstetrics gel placed just inside the roll up door of the livestock trailer. The fluorescent powder appears white in sunlight and fluoresces when the primary light source is long-wave ultraviolet.

Discussion

The staged loading procedure significantly reduced the amount of contamination, as simulated with fluorescent powder, from the back of the trailer to the barn alleyway at all center alleyway locations except for location 5, which was nearly significant. This could be due to center alley location 5 being the furthest measurement away from the trailer and distance could be a factor in contamination levels. In contrast, there were no significant differences between sampling points and major violations at any center alleyway location except for location 4. A possible explanation could be that contamination fell off a boot or loadout tool at this spot when moving through the barn. There is a large amount of variation in the conventional loading procedures in comparison to the staged loading procedure, suggesting that the amount of contamination that is conveyed from a livestock trailer to the barn is inconsistent and likely depends on several factors, including how frequently the line of separation between the trailer and chute is violated or the conventional loading procedure itself.

In both groups, the locations in the loadout chute consistently had a high level of contamination. This demonstrates that the load crew member(s) that are walking on the chute, most likely were picking up contamination on their boots, sorting panels, and other pig handling tools. The contamination level on the chute is not only due to violations of the line of separation from personnel, but also from pigs lunging onto the trailer from the loadout chute and losing traction. To accelerate quickly or to go up an incline, pigs will lunge with their hind limbs. When they lose traction while lunging, bedding and contamination is ejected backwards onto the chute. This was observed in almost every loadout of the study and is a likely source of transfer of contamination from the livestock trailer back into the loadout chute. Also, as more pigs are loaded, feces and urine accumulate on the loadout chute causing the wood shavings that are kicked from the trailer to stick to the boots of the loadout crew, allowing them to pick up contaminated particles and bring them back into the barn. An additional source of contamination frequently observed in the loadout chute was from pigs turning around from the livestock trailer and returning onto the chute throughout the study. Another factor observed during the study contributing to the contamination of the loadout chute and loadout alleyway were minor violations of the procedure. Throughout the duration of the study, the loadout crew had several minor and major violations noted in both the staged and conventional loading procedures. Some of these minor violations included a sorting panel crossing over a line of separation, possibly picking up contamination and bringing it back into the barn. Twice during the duration of the study, the driver exited the livestock trailer via the loadout chute when the loadout was complete, accounting for two of the major violations.

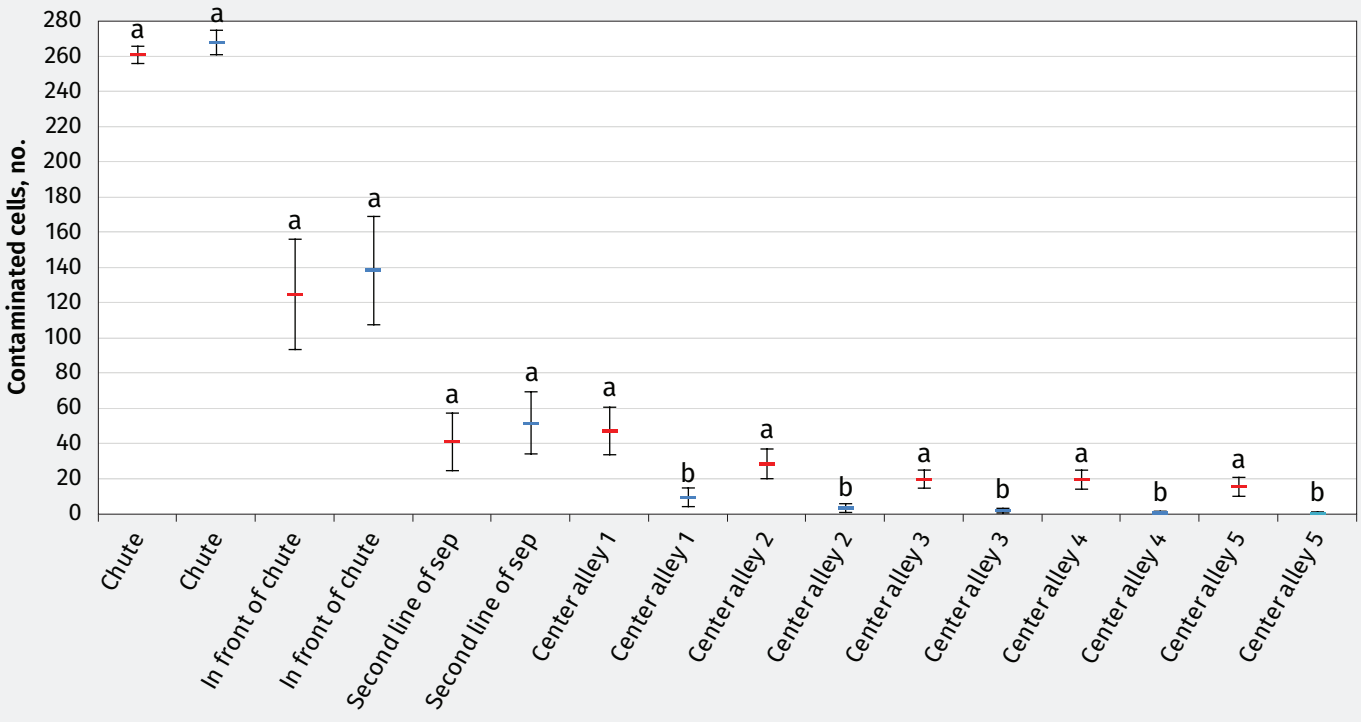
In one staged loading replicate, there was no contamination in the 5 center alleyway locations of the barn. However, in all other staged loading replicates, the procedure did not eliminate contamination in the center alleyway of the barn. The results of this study suggest that the staged loading procedure may reduce the likelihood of contamination, but it is not clear to what extent that likelihood is reduced and to what extent the level of contamination is clinically significant. Contamination may have resulted from pigs turning around in the loadout alleyway or chute and crossing the second line of separation to return to the barn alleyway. An exact count was not taken on number of pigs that turned around past the second line of separation for each treatment replicate. However, it is noted that at least one or more pigs

Table 2: Summary of the parameter estimates (SE) for the main fixed effects when comparing conventional vs staged loadout protocols for market pigs

Effect	Level	Estimate (SE)	*P* value*
Intercept		3.67 (0.46)	< .001
Treatment	Conventional	-0.25 (0.50)	.01
	Staged	0	
Sampling point	Center alley 1	-1.26 (0.44)	< .001
	Center alley 2	-2.31 (0.54)	
	Center alley 3	-2.59 (0.62)	
	Center alley 4	-3.30 (1.04)	
	Center alley 5	-4.48 (1.75)	
	Chute	1.89 (0.45)	
	In front of chute	1.24 (0.32)	
	Second line of separation	0	
Major violations (Binary)	0 (no violations)	0.33 (0.55)	.14
	1 (more than 1 violation)	0	
Crew size	3	0.05 (0.04)	.31
	4	0	
Minor violations	Continuous variable	0.21 (0.15)	.16

* All data was analyzed using PROC GLIMMIX. A generalized linear mixed effects model with the Poisson response distribution and log link was used to model the number of contaminated cells as the response variable.

Figure 5: Pairwise comparison of the count of contaminated grid cells at each sampling point for the conventional (red) and staged (blue) groups. The error bars represent the standard error estimate for each least squares means. Different superscripts (^{a,b}) within a sampling point indicates significant differences between the number of contaminated cells between the conventional and staged groups ($P < .05$ GLM).



turned around in each replicate either from the chute back into the loadout alleyway or from the loadout alleyway into the barn. Therefore, using appropriate gates or barriers may be warranted for staged loading to ensure that pigs cannot cross back over into the barn past the second line of separation. This may reduce the likelihood that the pigs would carry some contamination back into the barn from the livestock trailer. Other sources of contamination in the center alleyway of the barn were some minor violations, similar to those mentioned previously at the first line of separation. These minor violations, such as a sorting panel or boot crossing the second line of separation, were also observed.

Another challenge in the study was barn design. Some site designs were more complex and impacted the application of the staged loading procedure. Several of the study barns did not have a feasible buffer zone that was isolated from other pigs in the barn for the crew member designated to the loadout area to step into while pigs were being moved into the loadout area from the center alleyway of the barn. This did not interfere with the study, since a pen of pigs could be designated as the buffer zone therefore all measurements of contamination were taken in the center alleyway of the barn. However, this would defeat the purpose of using a staged loading procedure in practice. Ideally, a buffer zone would be adjacent to the loadout area, easy for Person 1 of the loadout crew to access and be isolated from other pigs in the barn. It would be beneficial for a buffer zone to be away from pigs in the barn so that cleaning and disinfection of the loadout area and buffer zone could be accomplished without contaminating the remaining pigs in the barn. Barn design must be considered when implementing a staged loading protocol.

There were several complications that took place during the study. Ideally, sites would have been randomly blocked by day of the week as initially planned. However, due to 3 replicates being discarded, last-minute changes in the production system loadout schedule, and lack of feasible buffer zones to accomplish a staged loading replicate, the replicates were unable to be blocked by day of the week. Day of the week may be important to account for when production systems wash livestock trailers and possibly if loadout crew members are more relaxed on rules or more likely to have violations the day after a weekend or the day before a weekend. More research may be needed to determine if day of the week has an impact on loading protocols.

Three loadout crews were used in this study. This did not impact the study results and was not statistically significant. All loadout crews were trained in the same procedures. The main objective of this study was to compare the level of contamination within the center alleyway of the barn between the two protocol groups.

The grid was a novel measurement approach first used in a study looking at the addition of a bench entry system to reduce the level of contamination.[8] As in the previous study, the grid was used to quantify the level of contamination at the measurement points within the barn. However, if any fluorescent powder was observed in any 5 × 5 cm square, the square was counted as contaminated. The coverage within the square may have ranged from a small particle to complete coverage in the square.[8] A higher resolution grid would result in a more precise measurement of contamination. High-quality photographs of the grid measurements may also be a viable option for future research to obtain more precise measurements of contamination and confirm contamination levels.

The sample size of 10 replicates/group was not based on a power calculation. Because this study was novel, reasonably good estimates of the mean differences and the standard deviation of the outcome measurements could not be made. Because the study assessing the bench entry system was conducted under entirely different conditions, the results were not considered useful for making such estimates for this study.[8] Therefore, the sample size was selected arbitrarily.

The study was conducted in the summer, and even though temperature does not affect the fluorescent powder itself, it could affect the consistency of feces, urine, and organic material which would affect the outcome of the study. Since all the replicates were completed in the summer months, whether seasonality matters was beyond the scope of the study. The objective was to evaluate the staged loading protocol to reduce contamination levels, and not to take time of the year into account, although this may be important with wind and snow in the winter months.

The primary investigator was present for 18 of 20 replicates to measure and record for consistency. For 2 of the replicates, a secondary investigator took the place of the primary investigator. There is a possibility that there could be some inter-observer error, but this was believed to be nonsignificant due to the primary investigator being present a majority of the time.

Under the conditions of this study, staged loading reduced the amount of contamination conveyed from livestock trailers to the barn but did not eliminate it. This study highlights the importance of additional layers of biosecurity. Adding layers of biosecurity can reduce the frequency that contamination is conveyed from the livestock trailer to the barn, similar to the addition of a bench and shower upon farm entry.[8] When contamination crosses the first line of separation, the second line of separation serves as a backup to reduce contamination transfer from the loadout chute to the center alleyway in the barn.

Implications

Under the conditions of this study:

- Staged loading reduced contamination transfer to the barns.
- Staged loading is an additional layer of biosecurity to reduce contamination.
- Evaluating barn design and employee training are warranted before implementing.

Acknowledgments

This study was funded by the Swine Health Information Center (Project No. 19-219 SHIC). The authors thank Iowa Select Farms for permitting access to their facilities and providing in-kind support from their veterinarians and marketing transportation supervisor. Special thanks to the members of the loadout crews for their time and efforts to learn and execute the staged loading procedures.

Conflict of interest

None reported.

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* Non-refereed references.

Conversion tables

Weights and measures conversions

Common (US)	Metric	To convert	Multiply by
1 oz	28.35 g	oz to g	28.35
1 lb (16 oz)	0.45 kg	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)	0.3 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	35.3
1 gal (128 fl oz)	3.8 L	gal to L	3.8
0.26 gal	1 L	L to gal	0.26
1 qt (32 fl oz)	0.95 L	qt to L	0.95
1.06 qt	1 L	L to qt	1.06

Temperature equivalents (approx)

°F	°C
32	0
50	10.0
60	15.5
61	16.1
65	18.3
70	21.1
75	23.8
80	26.6
82	27.7
85	29.4
90	32.2
102	38.8
103	39.4
104	40.0
105	40.5
106	41.1
212	100.0

°F = (°C × 9/5) + 32
°C = (°F - 32) × 5/9

Conversion calculator available at: amamanualofstyle.com/page/si-conversion-calculator

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	136
	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

Evaluation of Sow Caliper for body condition measurement of gestating sows

Yuzhi Li, PhD; Shiquan Cui, PhD; Samuel K. Baidoo, PhD; Lee J. Johnston, PhD

Summary

Objectives: To evaluate correlation between Sow Caliper measurement and backfat depth (BFD), and to determine the ideal caliper measurement that predicts optimal BFD prefarrowing to support performance of lactating sows.

Materials and methods: Multiparous sows (n = 928, Parity 1-9) were group housed in pens from day 35 to 109 of gestation. Caliper measurements, BFD, visual body condition scores (BCS), and body weight were recorded upon sows' entry and exit of gestation pens. Subsequent farrowing performance was recorded. Caliper measurements were classified into five categories: category 1 = 4.0 to 8.0 units, category 2 = 8.5 to 10.0 units, category 3 = 10.5 to 12.0 units, category 4 = 12.5 to 14.0 units, and category 5 = 14.5 to 18.0 units.

Results: Caliper measurement was correlated positively with BFD (r = 0.71-0.75; P < .001) and BCS (r = 0.67-0.75; P < .001) on days 35 and 109 of gestation. Based on sow performance over one reproduction cycle and BFD recommendations, caliper category 4 on day 109 of gestation was deemed ideal for prefarrowing sows. The estimated lower and upper limits of BFD for prefarrowing sows in caliper category 4 were 15.6 and 18.0 mm, respectively. Caliper measurements explained about 55% of variation in BFD of gestating sows prefarrowing.

Implications: The Sow Caliper can be used to evaluate body condition of gestating sows. To maintain body condition and reproductive performance, caliper measurements of 12.5 to 14.0 units are recommended for prefarrowing sows across parities, excluding gilts.

Keywords: swine, backfat, body condition score, performance, Sow Caliper

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Resumen - Evaluación del Caliper para Hembras para medir la condición corporal de cerdas gestantes

Objetivos: Evaluar la correlación entre la medición del Caliper para Hembras y la profundidad de la grasa dorsal (BFD), y determinar la medición ideal del caliper que predice la BFD óptima antes del parto para respaldar el rendimiento de las cerdas lactantes.

Materiales y métodos: Se alojaron en corrales grupos cerdas multíparas (n = 928, paridad 1-9) desde el día 35 al 109 de gestación. Las medidas del Caliper, la BFD, el puntaje de condición corporal visual (BCS) y el peso corporal se registraron cuando las cerdas entraron y salieron de los corrales de gestación. Se registró el rendimiento del siguiente parto. Las medidas del Caliper se clasificaron en cinco categorías: categoría 1 = 4.0 a 8.0 unidades, categoría 2 = 8.5 a 10.0 unidades, categoría 3 = 10.5 a 12.0 unidades, categoría 4 = 12.5 a 14.0 unidades y categoría 5 = 14.5 a 18.0 unidades.

Resultados: La medición del Caliper se correlacionó positivamente con la BFD (r = 0.71-0.75; P < .001) y la BCS (r = 0.67-0.75; P < .001) en los días 35 y 109 de gestación. Según el rendimiento de la cerda durante un ciclo reproductivo y las recomendaciones de la BFD, la categoría 4 del caliper en el día 109 de gestación se consideró ideal para las cerdas en preparto.

Los límites inferior y superior estimados de la BFD para cerdas preparto en la categoría 4 del Caliper fueron 15.6 y 18.0 mm, respectivamente. Las mediciones del Caliper explicaron aproximadamente el 55% de la variación en la BFD de las cerdas gestantes antes del parto.

Implicacións: El Caliper para Hembras se puede utilizar para evaluar la condición corporal de las cerdas gestantes. Para mantener la condición corporal y el desempeño reproductivo, se recomiendan medidas de caliper de 12.5 a 14.0 unidades para cerdas antes del parto en todas las paridades, excluidas las primerizas.

Résumé - Évaluation du calibre pour truie pour la mesure de l'état corporel des truies gestantes

Objectifs: Évaluer la corrélation entre la mesure du calibre pour truie et la profondeur du gras dorsal (BFD), et déterminer la mesure idéale du calibre qui prédit le BFD optimal pré-mise bas pour soutenir la performance des truies en lactation.

Matériels et méthodes: Des truies multipares (n = 928, parité 1 à 9) ont été hébergées en groupe dans des enclos du 35e au 109e jour de gestation. Les mesures du calibre, du BFD, les scores de l'état corporel visuel (BCS) et le poids corporel ont été enregistrés à l'entrée et à la sortie des truies des enclos de gestation. Les performances de mise bas ultérieures ont

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été enregistrées. Les mesures du calibre ont été classées en cinq catégories: catégorie 1 = 4.0 à 8.0 unités, catégorie 2 = 8.5 à 10.0 unités, catégorie 3 = 10.5 à 12.0 unités, catégorie 4 = 12.5 à 14.0 unités et catégorie 5 = 14.5 à 18.0 unités.

Résultats: La mesure du calibre était corrélée positivement avec le BFD (r = 0.71-0.75; P < .001) et le BCS (r = 0.67-0.75; P < .001) aux jours 35 et 109 de la gestation. Sur la base des performances des truies sur un cycle de reproduction et les recommandations de BFD, la catégorie de calibre 4 au jour 109 de la gestation a été jugée idéale pour les truies avant la mise bas. Les limites inférieures et supérieures estimées de BFD pour les truies avant la mise bas de la catégorie 4 étaient respectivement de 15.6 et 18.0 mm. Les mesures du calibre pour truie expliquent environ 55% de la variation de BFD des truies gestantes avant la mise bas.

Implications: Le calibre pour truies peut être utilisé pour évaluer l'état corporel des truies gestantes. Pour maintenir la condition corporelle et les performances de reproduction, des mesures de 12.5 à 14.0 unités sont recommandées pour les truies avant la mise bas dans toutes les parités, à l'exclusion des cochettes.

Sows are managed to maintain body condition which optimizes welfare, performance, and longevity.[1] Sows that are too thin or too fat are usually removed from the breeding herd sooner than desired due to either compromised animal welfare or poor reproductive performance. Thin sows may farrow and wean lighter weight pigs due to insufficient nutrients for litter development and milk production, and have prolonged wean-to-estrus intervals due to suppressed hormone levels.[2,3] Sows that suffer from severe malnutrition with poor body condition experience compromised welfare and should be euthanized.[4] On the other hand, excessive body condition of sows during gestation can negatively affect litter size, litter weight, and litter uniformity at parturition.[1,3,5] In addition, fat sows are vulnerable to lameness that compromises animal welfare and reproductive performance.[6]

Body condition is important to sow welfare and performance, but it is not easy to measure accurately. Traditionally, sow condition has been evaluated by visual scoring, which is subject to human errors resulting in low repeatability (agreement among measurements by the same observer) and reproducibility (agreement among observers).[1,7,8] Measuring backfat depth (BFD) is another way to evaluate sow condition, which is more reproducible than visual scoring,[1,8,9] but requires equipment and added labor. Previous work[8,9] demonstrated that BFD is poorly or moderately correlated (r = 0.30-0.60) with visual body condition score (BCS), suggesting that visual scoring is not a reliable measurement of body condition for sows. Regardless, visual scoring is still used widely in the swine industry due to its simplicity and no need for specialized equipment.

Recently the Sow Caliper, a simple mechanical tool, has been used by pork producers across the world to measure body condition of sows.[10,11] The Sow Caliper is supposed to measure both backfat and muscle mass which dictate body condition.[10] Compared to visual condition scores, caliper measurements are more objective, which may result in a better measurement of body condition. However, limited research has been conducted to evaluate how Sow Caliper measurements are related with BFD and performance of sows. This study was conducted to evaluate the correlation between Sow Caliper measurement and BFD. In addition, the optimal range of Sow Caliper measurements prefarrowing for sows to maintain reproductive performance and BFD was assessed.

Animal care and use

The University of Minnesota Institutional Animal Care and Use Committee reviewed and approved the experimental protocol for this project (IACUC No. 1406-31590A).

Materials and methods

Animals, housing, and management

This study was part of a larger project conducted at the University of Minnesota's Southern Research and Outreach Center in Waseca, Minnesota using 928 pregnant sows from 20 contemporary breeding groups. Details about animal management in this study have been described previously.[12] During data collection, the sow herd did not have major health issues and all sows enrolled in the study were deemed healthy by visual assessment.

Briefly, gestating sows (Large White × Danish Landrace; TOPIGS Inc; Parity 1-9) were housed in pens (42-51 sows/pen) with an electronic sow feeder (ESF) on fully slatted floors from day 35 of gestation. Sows remained in their designated ESF pens and were managed as static groups[13] until day 109 of gestation. Throughout the gestation period, each sow was provided 2.25 kg of a gestation diet daily, which was adjusted biweekly according to BCS of the sow to try to achieve a visual condition score of 3 at parturition.[14] For sows with body condition below or above the desired score, 227 g feed per day was added or reduced, with the maximal daily feed addition or reduction of 454 g. On day 109 of gestation, sows were moved to confinement farrowing accommodations with *ad libitum* access to water and fed 2.25 kg daily of a lactation diet in a dry feeder. After parturition, sows were allowed *ad libitum* access to the lactation diet and water throughout lactation. To keep the feed fresh, sows were fed twice daily to their appetite, and feed intake was monitored.

Piglets were crossfostered within 24 hours after birth to achieve a litter size between 11 and 13 piglets. The mean (SD) piglet weaning age was 18 (1.5) days. All diets were corn-soybean meal based in mash form and were formulated to meet or exceed nutrient requirements of the National Research Council for gestating and lactating sows.[15] Room temperature was controlled by a heating system and exhaust fans and maintained as close as possible to thermoneutral conditions for sows in both gestation and lactation accommodations. Lights in each room were on for 10 hours daily starting from 6 AM in both gestation and lactation accommodations.

Data collection

Body weight, BFD, BCS, and caliper measurement. Individual body weight (BW) and BFD were recorded for sows on days 35 and 109 of gestation, and on the day of weaning. Backfat depth was measured at the last rib, 6 to 7 cm off the midline on both left and right sides[16] using an ultrasonic scanner (Lean-meater, Renco Corp) by the same trained employee throughout the study. Visual assessment of BCS and caliper measurement were recorded on days 35 and 109 of gestation after measurement of BFD. The method for visual assessment of BCS followed those of Coffey et al[14] using a scoring system of 1 to 5: score 1 = emaciated; score 2 = thin; score 3 = ideal; score 4 = fat; and score 5 = obese, with 0.5 as a minimum score.[8]

The Sow Caliper used in this study has been described by Knauer and Baitinger.[10] The arms of the caliper were 3.5 cm long, and the maximal distance between the two arms was 26.0 cm. The range of caliper measurement was between 1.0 and 30.0 units, with each unit equal to 5.0 mm. The caliper measurement was taken at the same location where BFD was measured.[10] Both visual assessment of BCS and the caliper measurement were conducted by the same researcher throughout the study to avoid discrepancy among researchers. The researcher recorded BCS before taking the caliper measurement, and did not have any knowledge about BFD of the sow at the time of BCS assessment. Measurements of BFD using the ultrasonic scanner and body condition using the caliper were carried out in gestation stalls the day before sows entered ESF pens and in farrowing stalls on the day that sows entered farrowing rooms and at weaning.

Reproductive performance and lactation feed intake. Standard production data including farrowing rate (number of sows farrowed/number of sows assigned to the study × 100), total and live litter size, stillborn pigs per litter, litter size after crossfostering, litter size at weaning, and litter weight at birth and at weaning were collected for all sows. Sows that farrowed and weaned a litter and were mated within one week after weaning were considered to have completed the study. Completion rate (number of sows completing the study/number of sows assigned to the study × 100) was recorded. Feed added to each feeder was weighed and recorded daily from the day of farrowing to the day of weaning. Average feed intake during lactation was calculated for each sow by dividing the total feed provided by the number of days between farrowing and weaning.

Data analysis

Data were analyzed using the SAS software version 9.4 (SAS Institute Inc). The Correlation procedure with Spearman coefficient was used to analyze correlation of caliper measurement with BFD, BCS, and BW for days 35 and 109 of gestation separately. The Regression procedure was performed to predict BFD using caliper measurements for days 35 and 109 of gestation separately, with a quadratic regression based on goodness of fit for each statistical model.

To evaluate the optimal caliper range for BFD and sow performance, caliper measurements were classified arbitrarily into five categories based on caliper measurements in this study. Caliper measurements were classified as: category 1 = 4.0 to 8.0 units; category 2 = 8.5 to 10.0 units; category 3 = 10.5 to 12.0 units; category 4 = 12.5 to 14.0 units; and category 5 = 14.5 to 18.0 units. Descriptive data for BFD and BCS for each caliper category were summarized for days 35 and 109 using the Univariate procedure and are presented in box whisker plots. Sow caliper category on day 109 was used to evaluate effects of caliper category prefarrowing on sow reproductive performance.

The FREQ procedure with Chi-square test was used to analyze farrowing rate and completion rate. Data were tested for normal distribution using the Univariate procedure. The Glimmix procedure was used to analyze BFD, BCS, and litter size with the Gaussian, Poisson, or negative binomial regression distribution to fit the data. The Mixed procedure was used to analyze the data of sow feed intake during lactation, sow weight, and litter weight.

Sow parity was classified into 4 categories: parities 1 and 2; parities 3 and 4; parities 5 and 6; and parities 7 to 9. All models include caliper category, parity classification, and their interaction as fixed effects, pen as a random effect, and sow as the experimental unit. Differences among means were tested by the Tukey test adjusted for multiple comparisons. Significant differences were identified at $P < .05$ and trends at $P < .10$. Data are reported as least squares means (SE).

Results

Caliper measurements, BFD, BCS, and BW on day 35 of gestation were recorded for 898 of 928 sows. Thirty sows with missing caliper measurements were excluded from data on day 35 of gestation. On day 109 of gestation, the same measurements were recorded for 871 sows. Fifty-seven sows were culled due to health or animal welfare problems or failed pregnancy between days 35 and 109 of gestation and were excluded from data collection on day 109 of gestation.

Caliper measurement, BFD, BCS, and BW on days 35 and 109 of gestation

Descriptive data. Medians of BFD increased with caliper category on days 35 (Figure 1A) and 109 (Figure 1B) of gestation. Within each caliper category, BFD varied about 10.0 to 15.0 mm from the minimum to the maximum for both days. Fifty percent (25 to 75 percentile) of sows in caliper category 4 had BFD between 14.5 and 20.0 mm on day 109 of gestation, which is close to the recommended range for BFD.[8,16,17] Similar to BFD, BCS medians increased with caliper category on days 35 (Figure 2A) and 109 (Figure 2B) of gestation. A wide range of BCS was observed within each caliper category for day 35 of gestation. For sows in caliper categories 2, 3, and 5, BCS varied from the minimum 1.5 to the maximum 4.5 on that day. On day 109 of gestation, 50% of sows in caliper category 4 had BCS between 3 and 4.

Correlations and predicting BFD from caliper measurement. Caliper measurement was correlated positively with BFD, BCS, and BW on days 35 and 109 of gestation ($P < .001$ for all coefficients; Table 1). Spearmen correlation coefficients indicate strong correlations between caliper measurement and BFD for both days. Similarly, strong positive correlations between caliper measurement and BCS were observed for days 35 and 109 of gestation. Correlations between caliper measurement and BW were moderate for both days. Quadratic equations for predicting BFD with caliper measurements were BFD (mm) = 6.458 + 0.052 × [Caliper measurement (unit)]^2 for day 35 of gestation, and BFD (mm) = 6.244 + 0.060 × [Caliper measurement (unit)]^2 for day 109 of gestation. The coefficients of determination (R^2; both $P < .001$) were 0.524 and 0.553 for days 35 and 109 of gestation, respectively.

Effects of caliper category on BFD, BCS, and BW. On day 35 of gestation, BFD, BCS, and BW increased with caliper category (all $P < .001$; Table 2). Similarly, on day 109 of gestation as caliper category increased, BFD, BCS, and BW increased (all $P < .001$). Sows in caliper category 4 had average BFD 15.8 and 17.2 mm for days 35 and 109, respectively, which are close to the recommended BFD for gestating sows.[1,9,16]

Effects of prefarrowing caliper category on farrowing and lactation performance

There were no differences in farrowing rate or completion rate among sows in different caliper categories measured on day 109 of gestation (Table 3). As caliper measurements increased, average daily feed intake (ADFI) of sows during lactation decreased ($P < .001$). Feed intake was

Figure 1: Distribution of backfat depth within each caliper category for sows on days A) 35 and B) 109 of gestation (x = median; box = 25 to 75 percentile; whisker = minimum to maximum; dot = outliers). Caliper readings were categorized as: Category 1 = 4.0-8.0 units; Category 2 = 8.5-10.0 units; Category 3 = 10.5-12.0 units; Category 4 = 12.5-14.0 units; and Category 5 = 14.5-18.0 units. 1 unit = 5 mm.

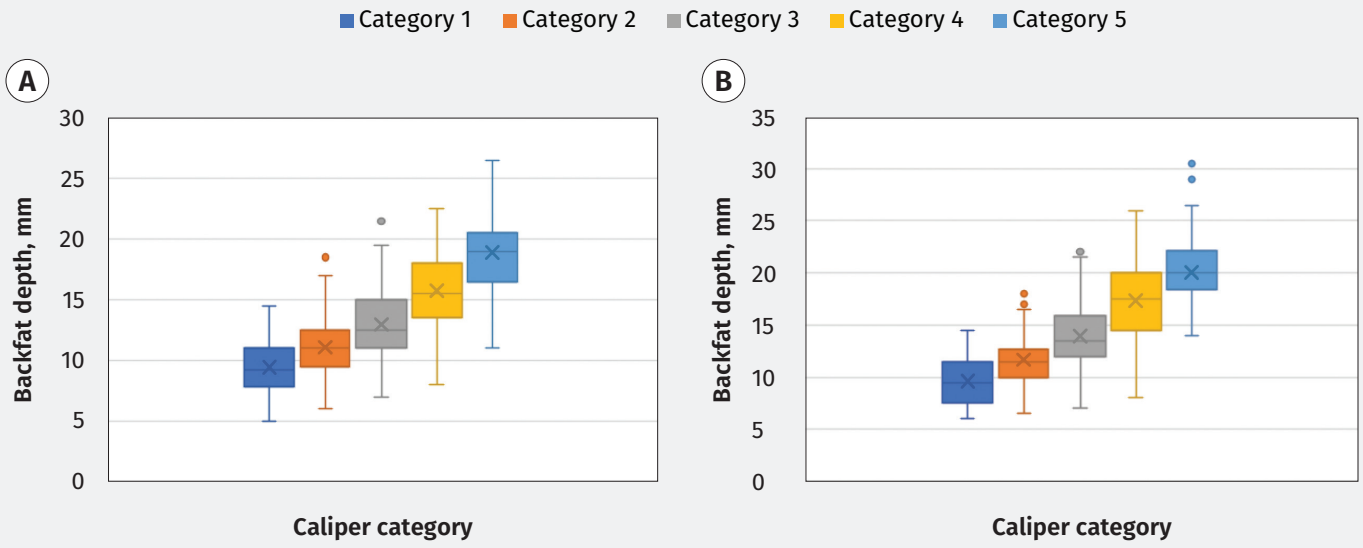
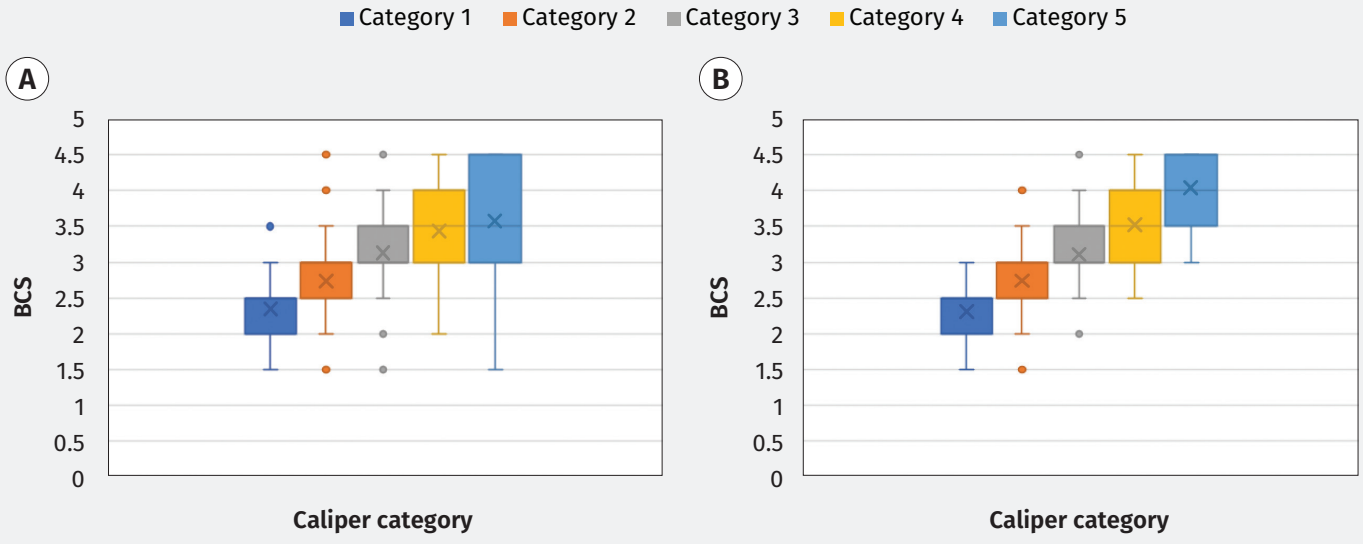


Figure 2: Distribution of visual body condition score (BCS) within each caliper category for sows on days A) 35 and B) 109 of gestation (x = median; box = 25 to 75 percentile; whisker = minimum to maximum; dot = outliers). Category readings were categorized as: Category 1 = 4.0-8.0 units; Category 2 = 8.5-10.0 units; Category 3 = 10.5-12.0 units; Category 4 = 12.5-14.0 units; and Category 5 = 14.5-18.0 units. 1 unit = 5 mm. Visual body condition score: Score 1 = emaciated; Score 2 = thin; Score 3 = ideal; Score 4 = fat; and Score 5 = obese (Coffey et al[14]), with a minimum score of 0.5.



highest for sows in category 1, and lowest for sows in caliper categories 4 and 5. At weaning, BFD and BW increased with caliper category ($P < .001$). Loss in BFD and BW during farrowing and lactation was lowest for sows in caliper category 1 and highest for sows in caliper categories 4 and 5. Sows in caliper category 2 tended ($P = .055$) to have more stillborn pigs than sows in caliper category 5. Caliper category did not affect litter size, litter weight at birth, or litter size after crossfostering, except that sows in caliper categories 1 and 2 weaned heavier litters than sows in caliper category 5 ($P = .03$). There were no interactions between caliper category and parity classification for any variables measured.

Discussion

In this study, we evaluated whether a Sow Caliper can accurately measure body condition of gestating sows by examining associations of caliper measurement with BFD, BCS, and BW. Data were collected at two stages of gestation: early gestation (day 35) and prefarrowing (day 109 of gestation). Strong positive correlations between caliper measurement and BFD indicate that caliper measurements reflect BFD at both stages of gestation. Quadratic equations were developed to estimate BFD from caliper measurement for early gestation and again prefarrowing. The coefficients of determination (R^2) indicate that caliper measurement explains 52% and 55% of variation in BFD early in gestation and prefarrowing, respectively. In general, the predicted BFD from these equations is consistent with descriptive data (Figure 1) and the data in Table 2, indicating that the predictions are acceptable. These equations may be specific to the genotype of sows involved in this study because body conformation of individual sows[18] may contribute to variation in caliper measurements. Indeed, these equations need to be further tested, but they provide a simple tool for producers to predict BFD from caliper measurements.

The BFD associated with each caliper category was not consistent across both stages of gestation. A specific caliper unit was related to a lower BFD in early gestation compared with prefarrowing.

Table 1: Correlation of Sow Caliper measurement with backfat depth, visual body condition score (BCS), and body weight of gestating sows

		Spearman coefficient*		
Caliper measurement	**No. of sows**	**Backfat**	**Visual BCS**	**Body weight**
D 35 of gestation	898	0.713	0.665	0.517
D 109 of gestation	871	0.751	0.750	0.516

* All coefficients are significant ($P < .001$).

Table 2: Mean (SE) backfat depth, visual body condition score (BCS), and body weight of sows in different Sow Caliper categories on days 35 and 109 of gestation

	Caliper category*					*P* value
	C1	**C2**	**C3**	**C4**	**C5**	
Mean parity (SD)	5.1 (2.2)	4.7 (2.3)	4.5 (2.3)	4.2 (2.5)	4.3 (2.5)	-
Day 35 of gestation						
No. sows	102	225	259	241	71	-
Backfat depth, mm	9.5 (0.3)^a	11.1 (0.2)^b	13.0 (0.2)^c	15.8 (0.2)^d	19.3 (0.4)^e	< .001
Visual BCS†	2.4 (0.1)^a	2.8 (0.1)^b	3.1 (0.1)^c	3.4 (0.1)^d	3.8 (0.1)^e	< .001
Body weight, kg	184.8 (1.9)^a	198.8 (1.4)^b	209.0 (1.4)^c	222.5 (1.4)^d	240.4 (2.6)^e	< .001
Day 109 of gestation						
No. sows	83	186	253	260	89	-
Backfat depth, mm	9.8 (0.4)^a	11.8 (0.3)^b	14.0 (0.3)^c	17.2 (0.3)^d	20.5 (0.4)^e	< .001
Visual BCS†	2.4 (0.1)^a	2.8 (0.1)^b	3.1 (0.1)^c	3.5 (0.1)^d	3.9 (0.1)^e	< .001
Body weight, kg	214.8 (2.4)^a	229.9 (1.8)^b	240.8 (1.7)^c	252.7 (1.7)^d	267.5 (2.6)^e	< .001

* Sow Caliper measurements were recorded on days 35 and 109 of gestation separately. C1 = 4.0-8.0 units; C2 = 8.5-10.0 units; C3 = 10.5-12.0 units; C4 = 12.5-14.0 units; and C5 = 14.5-18.0 units. 1 unit = 5 mm.

† Score 1 = emaciated; Score 2 = thin; Score 3 = ideal; Score 4 = fat; and Score 5 = obese (Coffey et al[14]).

^{abcde} Least squares means within a row without a common superscript differ ($P < .05$). Comparisons were performed using the Tukey-Kramer test adjusted for multiple comparisons. The Glimmix procedure was used for analysis of backfat depth and visual BCS. The Mixed procedure was used for analysis of body weight.

Table 3: Least squares means (SE) of performance parameters of sows in different Sow Caliper categories

	Caliper category*					*P* value
	C1	C2	C3	C4	C5	
No. sows assigned†	91	200	267	274	96	-
No. sows weaning a litter§	81	182	245	254	85	-
Farrowing rate, %‡	91.2	93.0	94.4	95.3	90.6	.41¶
Completion rate, %**	75.8	84.5	82.0	84.7	79.2	.29¶
Lactation ADFI, kg††	7.29 (0.17)[a]	6.85 (0.14)[b]	6.63 (0.13)[b]	6.08 (0.12)[c]	5.77 (0.18)[c]	< .001
At weaning§§						
Backfat, mm	9.3 (0.4)[a]	10.7 (0.3)[b]	12.7 (0.3)[c]	15.0 (0.3)[d]	18.1 (0.4)[e]	< .001
Body weight, kg	214.2 (2.7)[a]	224.0 (1.9)[b]	235.0 (1.8)[c]	243.6 (1.8)[d]	257.3 (2.9)[e]	< .001
Change during farrowing and lactation‡‡						
Backfat, mm	-0.6 (0.3)[a]	-1.0 (0.2)[ab]	-1.3 (0.2)[b]	-2.1 (0.2)[c]	-2.4 (0.3)[c]	< .001
Body weight, kg	-0.5 (1.8)[a]	-6.2 (1.4)[bc]	-5.8 (1.4)[b]	-9.2 (1.3)[cd]	-10.0 (2.0)[d]	< .001
Litter size, No.						
Total born	14.7 (0.4)	14.9 (0.3)	14.5 (0.2)	14.3 (0.2)	14.8 (0.5)	.49
Born alive	12.6 (0.4)	12.5 (0.3)	12.3 (0.2)	11.9 (0.2)	12.7 (0.5)	.33
Stillborn	1.5 (0.2)[fg]	2.0 (0.2)[f]	1.7 (0.1)[fg]	1.7 (0.1)[fg]	1.2 (0.2)[g]	.055
After crossfostering	11.1 (0.4)	11.3 (0.3)	11.1 (0.2)	11.2 (0.2)	11.1 (0.4)	.94
Weaned§§	10.3 (0.4)	10.5 (0.2)	10.2 (0.2)	10.4 (0.2)	10.1 (0.4)	.90
Litter weight, kg						
At farrowing¶¶	16.9 (0.5)	17.3 (0.3)	16.8 (0.3)	16.5 (0.3)	17.4 (0.5)	.19
At weaning§§	64.0 (1.3)[a]	63.5 (0.9)[a]	61.6 (0.8)[ab]	62.0 (0.8)[ab]	58.8 (1.5)[b]	.03

* Sow Caliper measurements recorded on day 109 of gestation were used. C1 = 4.0-8.0 units; C2 = 8.5-10.0 units; C3 = 10.5-12.0 units; C4 = 12.5-14.0 units; and C5 = 14.5-18.0 units. 1 unit = 5 mm.

† For sows that were culled before day 109 of gestation, caliper measurements recorded on day 35 of gestation were used for categorization.

§ Sows that farrowed and weaned a litter.

‡ Sows that farrowed as percentage of the total number of sows assigned to the study.

¶ Chi-square test (χ^2 = 2.5, *df* = 4 for farrowing rate; χ^2 = 5.0, *df* = 4 for completion rate).

** Sows that completed the study as percentage of the total number of sows assigned to the study. Sows that farrowed and were subsequently mated within a week after weaning their litters for the next breeding cycle were considered to have completed the study.

†† From the day of farrowing to the day of weaning.

§§ Mean (SD) weaning age of piglets was 18 (1.5) days.

‡‡ From day 109 of gestation to the day of weaning.

¶¶ Weight of live born.

[abcde] Least squares means within a row without a common superscript differ (*P* < .05). Comparisons were performed using the Tukey-Kramer test adjusted for multiple comparisons. The Glimmix procedure was used for analysis of backfat depth and litter size. The Mixed procedure was used for analysis of ADFI, body weight, and litter weight.

[fg] Least squares means within a row without a common superscript tend to differ (*P* < .10).

ADFI = average daily feed intake.

For instance, the mean BFD corresponding to caliper category 4 was 15.8 mm at day 35 of gestation and 17.2 mm at day 109. The quadratic regression equations also predict lower BFD on day 35 than on day 109 for the same caliper measurement. This discrepancy suggests that gestation stage may influence the relationship between caliper measurement and BFD. Thus, results from this study may only be applicable for sows in early gestation and prefarrowing. Relationship between BFD and caliper measurement during other stages of production needs to be assessed in future research.

Backfat depth between 18 and 20 mm is recommended for gestating sows before farrowing.[16,17] Generally, it is recommended that a commercial herd should have less than 20% sows with BFD lower than 15 mm before farrowing.[8] In the current study, caliper category 1 represents emaciated condition of sows, with more than 50% of the sows in this category having BFD lower than 10.0 mm on day 109. Backfat depth below 10 mm may represent emaciation,[8] and emaciated sows present animal welfare concerns.[3] Sows in caliper category 2 are also considered thin because about 50% of sows in this category had BFD lower than 11.6 mm prefarrowing. On the other hand, sows in caliper category 5 represent over condition, with 50% of the sows in this category having BFD greater than 20.1 mm prefarrowing. According to recommendations for BFD, sows in caliper category 4 were deemed optimal for body condition in the current study, with 75% in this category of sows having BFD above 14.5 mm. Using the quadratic equation at day 109 of gestation, the estimated lower and upper limits of BFD for sows in caliper category 4 are 15.6 and 18.0 mm, respectively.

Sows in caliper category 4 had lower ADFI and lost more BFD and BW during lactation, compared to sows in caliper category 3. However, these differences between sows in both caliper categories did not influence their litter performance. The number and weight of piglets farrowed and weaned were similar between sows in caliper categories 3 and 4. While sows in caliper category 3 performed well, their BFD was lower than the recommendation, with more than 50% of the sows in that category having BFD lower than 14 mm prefarrowing. It is worthwhile to note that in this study we only evaluated sow performance over one lactation. Severe loss in ADFI, BFD, and BW during lactation can be detrimental to subsequent reproductive performance, such as reduced litter weight and litter uniformity.[2,19] The long-term effect of Sow Caliper category on performance of lactating sows needs to be evaluated in future research.

Caliper category 4 (12.5 to 14.0 unit) is slightly lower than the caliper range of 14 to 15 units recommended by Knauer and Baitinger[11] based on litter size at weaning. We did not observe any difference in litter size weaned among sows in different caliper categories in the current study. One must recognize that the current study only included sows (parity 1-9) and did not include gilts. The recommended Sow Caliper range from this study may only apply to sows that have farrowed at least once and does not apply to gilts. Gilts need more backfat than mature sows to support maternal development and litter performance.[20,21] Therefore, the fact that no gilts were included in the current study may partially explain the recommended caliper range lower than that recommended by Knauer and Baitinger.[11]

In general, caliper measurement reflects BCS as indicated by positive correlations between the two variables on days 35 and 109 of gestation. The average BCS corresponding to the optimal caliper category 4 at prefarrowing was 3.5, which was slightly higher than the optimal BCS 3.0. This suggests that visual body condition scoring may overestimate body condition of gestating sows. Similar results were reported previously[8,9] that BCS overestimated body condition on commercial farms. For instance, the average BFD for sows in BCS 3 was 13.7 mm during gestation,[8] which is lower than the recommendations for BFD of gestating sows.[16,17] Apparently, the Sow Caliper can measure body condition of gestating sows more accurately compared to visual body condition scoring. Caliper measurement was only moderately correlated with BW in the current study, suggesting that caliper measurement is not a good indicator of BW. Moderate correlations between caliper measurement and BW were reported previously.[11]

Implications

Under the conditions of this study:

- Sow Caliper measurements were correlated strongly with BFD and BCS.
- The recommended caliper range for prefarrowing sows is 12.5 to 14.0 units.
- Sow Caliper measurement explains about 55% of variation in prefarrowing BFD.

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Conflict of interest

None reported.

Disclaimer

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PEER REVIEWED ORIGINAL RESEARCH

Development of effective and minimally invasive surgical techniques for the preparation of intact, sterile boars

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Summary

Objective: The objective of this study was to evaluate three surgical procedures to produce intact, sterile boars.

Materials and methods: Boars (n = 39) were allocated to one of four treatment groups: no surgery (control), epididymectomy by removal of the epididymis tail (TE), vasectomy via scrotal access (VS), and vasectomy via inguinal access (VI) at 63 days of age. Selected physiological, hematological, and endocrine responses were monitored after surgeries to evaluate the different techniques' relative safety and effectiveness.

Results: Libido and testosterone concentrations were not affected by surgical treatment and were similar to those observed in the control group. The TE and VS procedures required the least and most time to complete, respectively, while VI was intermediate ($P < .001$). Both lactate and cortisol concentrations were elevated at the time of surgery compared with the control group, but had decreased by 2 days post surgery ($P = .02$).

Implications: Considering the surgical time and ease, the TE procedure is suggested as the choice technique for producing intact, sterile boars. The swine industry is shifting from individual crates to the use of group pen housing of sows. Use of intact, sterile boars could be implemented to improve estrus detection in group pen housing systems.

Keywords: swine, teaser boar, vasectomy, epididymectomy, estrus detection.

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Resumen - Desarrollo de técnicas quirúrgicas eficaces y mínimamente invasivas para la preparación de sementales intactos y estériles

Objetivo: El objetivo de este estudio fue evaluar tres procedimientos quirúrgicos para producir sementales intactos y estériles.

Materiales y métodos: Los sementales (n = 39) se asignaron a uno de cuatro grupos de tratamiento: sin cirugía (control), epididimectomía mediante extracción de la cola del epidídimo (TE), vasectomía por acceso escrotal (VS) y vasectomía por acceso inguinal (VI) a los 63 días de edad. Se seleccionaron y monitorearon respuestas fisiológicas, hematológicas y endocrinas después de las cirugías para evaluar la seguridad y la efectividad relativas de las diferentes técnicas.

Resultados: La libido y las concentraciones de testosterona no se vieron afectadas por el tratamiento quirúrgico y fueron similares a las observadas en el grupo de control. Los procedimientos TE y VS requirieron el menor y mayor tiempo, respectivamente, mientras que el VI fue intermedio ($P < .001$). Tanto las concentraciones de lactato como de cortisol estaban elevadas en el momento de la cirugía en comparación con el grupo de control, pero habían disminuido 2 días después de la cirugía ($P = .02$).

Implicaciones: Considerando el tiempo quirúrgico y la facilidad, se sugiere el procedimiento TE como la técnica de elección para producir sementales intactos y estériles. La industria porcina está pasando de las jaulas individuales al uso de corrales grupales de cerdas. Se podría implementar el uso de sementales intactos y estériles para mejorar la detección del estro en los sistemas de alojamiento de corrales grupales.

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Résumé - Développement de techniques chirurgicales efficaces et minimalement invasives pour la préparation de verrats intacts et stériles

Objectif: L'objectif de la présente étude était d'évaluer trois procédures chirurgicales pour produire des verrats intacts et stériles.

Matériels et méthodes: Des verrats (n = 39) ont été répartis dans l'un des quatre groupes de traitement: pas de chirurgie (témoin), épididymectomie par ablation de la queue de l'épididyme (TE), vasectomie par accès scrotal (VS) et vasectomie par accès inguinal (VI) à 63 jours. Certaines réponses physiologiques, hématologiques et endocriniennes ont été suivies après les chirurgies pour évaluer l'innocuité et l'efficacité relatives des différentes techniques.

Résultats: La libido et les concentrations de testostérone n'ont pas été affectées par le traitement chirurgical et étaient similaires à celles observées dans le groupe témoin. Les procédures TE et VS exigeaient le moins et le plus de temps pour compléter, respectivement, tandis que VI était intermédiaire ($P < .001$). Les concentrations de lactate et de cortisol étaient élevées au moment de la chirurgie par rapport au groupe témoin, mais avaient diminué 2 jours après la chirurgie ($P = .02$).

Implications: Compte tenu du temps et de la facilité de la chirurgie, la procédure TE est suggérée comme technique de choix pour la production de verrats intacts et stériles. L'industrie porcine est en voie de passer des cages individuelles à l'utilisation des enclos de groupe pour les truies. L'utilisation de verrats intacts et stériles pourrait être mise en œuvre pour améliorer la détection des œstrus dans les systèmes de logement en enclos de groupe.

Brazil is the fourth largest producer and exporter of pork meat in the world. This became possible due to intensive management systems, the climate, and the country's animal health status. Despite the significant advance in the Brazilian pig industry's productivity, reproductive management failure is common. The most frequent failures are associated with estrus detection and insemination timing resulting in increased re-cycle rates and reduced farrowing rates and number of pigs born alive.[1] In addition, advances in pig production and reproduction are constantly forcing producers to adapt to new systems and technologies.[2]

Gestating-sow housing systems using individual crates is a topic of discussion due to animal welfare concerns surrounding the limited freedom to express natural animal behavior.[3] The use of group housing for sows at different gestational stages has been emphasized to minimize stress[4] and maximize animal welfare.[5] In this group system, animals have a larger walking area allowing them to interact with other animals creating a better social environment. Group housing positively affected herd productivity and reduced the risks for metabolic and locomotor problems.[6] Besides affecting other reproductive parameters, the breeding housing system may influence estrus expression. Estrus expression and detection may be reduced when housing sows adjacent to boars[7] or weaned into groups.[8] Therefore, housing a large number of females in groups post weaning may exacerbate existing reproductive problems and may be challenging to use intact males to detect estrus. As a consequence, reproductive management needs to be adapted to reduce reproductive failures.

Among the strategies to improve reproductive management is the use of intact, sterile males, or teasers. Teaser males are often used in other animal species, such as sheep and cattle, to improve estrus detection,[9] and their use in swine farms is already implemented.[10] Furthermore, teaser animals are known to stimulate estrus in females and induce early puberty since teasers are surgically modified males with the natural production and expression of male hormones and behavior, but without sperm release in seminal fluid.[11]

Techniques for creating teaser animals mostly use significant surgical interventions, limiting their use in pig farms. The objective of this study was to evaluate three surgical techniques for the preparation of intact, sterile pigs for their use to detect estrus of the females in swine farms.

Animal care and use

This study was approved (CEUA No. 004/2016) by the EMBRAPA Institutional Animal Care and Use Committee, Office of Research Assurances.

Materials and methods

Animals

A total of 39 males of a composite breed Embrapa MS115 (Large White × Duroc × Pietrain) with a mean (SD) age of 63 days and weight of 32 (3) kg were used. Animals were randomly allocated to four different treatment groups and housed in individual pens. The 4 treatment groups were: no surgery (control; n = 9), epididymectomy by removal of the epididymis tail (TE; n = 10), vasectomy via scrotal access (VS; n = 10), and vasectomy via inguinal access (VI; n = 10). According to their age, they received a complete daily diet based on corn and soybean meal to achieve the nutritional requirements proposed by Rostagno et al.[12] Animals had free access to water using an automatic nipple drinker designed for pigs.

Animals were clinically examined before the beginning of the study to assess animal health status. The procedures were always performed on four animals, one from each experimental group: 3 surgical techniques and 1 control group. The animals remained on the farm until 7 months of age when they underwent a breeding soundness examination and blood sample collection for hormone evaluation.

Preoperative examinations and procedures

In the preoperative period, water and food was withheld for 12 hours. Blood samples were collected following the clinical examination and evaluation of physiological parameters. The animals were then anesthetized with Tiletamine + Zolazepam (Virbac; 5 mg/kg, intramuscular) and Azaperone (Janssen Animal Health; 2 mg/kg, intramuscular)[13] and transferred to the operating room. To remove dirt, sweat, epithelial cells, and transient skin bacteria, thus reducing contamination, the surgical site was cleaned with 20 mL of 2% chlorhexidine solution in water. Skin antisepsis in and around the incision site was performed with a 10% dilution of iodine using a sterile compress. Further, local anesthesia was carried out by infiltration with lidocaine without epinephrine (Bravet; 1.5 mg/kg).

Body temperature was measured, and blood samples were collected in all animals at three different time points: 1) day 0 (D0), 20 minutes before sedation

and surgical procedure; 2) day 2 (D2), 48 hours after the procedure; and 3) day seven (D7) post surgery. These collections were always conducted between 8 AM and 8:30 AM. For all procedures, the surgery duration was recorded for later comparison between the techniques.

Surgical Procedures

TE procedure. The epididymis tails were located by exerting pressure at the scrotum base, as previously described by Althouse and Evans.[14] Constant pressure was applied to stabilize the testis and to better visualize the location of the epididymal tail. An incision was made on the scrotum skin 1 to 2 cm directly over the greater curvature of the epididymal tail, deepened through the tunica muscular dartos and parietal vaginal tunica. The epididymis tail was removed by cutting the ligament to the testis and the epididymis body using a scalpel blade. Pressure was then exerted at the scrotum base so the testis could return to its normal anatomical position. The procedure was then repeated in the other testicle. At the end of the procedure, a suture with a maximum of three single isolated stitches using a nonabsorbable nylon 3-0 thread was performed.

VS procedure. A 3 cm incision was made in the skin parallel to the long axis of each testicle (1-2 cm lateral to the medial septum and 3-4 cm caudal to the tip of the epididymis head) as described by Althouse and Evans[15] with some modifications. The incision extended through the tunica muscular dartos and vaginal parietal tunica, exteriorizing the vas deferens. The vas deferens were then isolated from the pampiniform plexus, ligated with nonabsorbable nylon thread, and a 2 cm fragment was removed. Only the skin was sutured with a single isolated stitch pattern using a nonabsorbable nylon 3-0 suture. The same procedure was repeated on the contralateral side. After the vasectomy procedure, the tissue was sent for histological examination to confirm that the vas deferens was sectioned.

VI procedure. This technique was performed according to Godke et al[16] with some modifications. A 3 cm midline incision was made in the skin in the space between the last pair of teats, 2 cm above the scrotum. The vas deferens was then separated from the other tissues with blunt surgical scissors. After the isolation, two ligatures were made approximately 0.5 cm apart with nonabsorbable nylon thread and the cord between the two ligatures was removed. The skin was approximated with a nonabsorbable nylon thread, with a pattern of single isolated spots. The same procedure was repeated in the other cord.

Control. The animals in this group underwent 12-hour fasting without water and food. All the parameters were investigated. Animals were submitted to the anesthesia, but not to any surgical procedure.

Assessments of physiological parameters

Blood tests. Blood samples were collected from the vena cava with a 5 mL syringe and 40 × 12mm needle and placed in 4-mL glass tubes containing EDTA. The blood was sent to a commercial laboratory (Santa Catarina, Brazil) for a complete hematological profile, which were performed using a Neubauer chamber under a microscope. Lactate concentration was measured immediately after collection in the lactometer (Accutrend Plus; Roche Diagnostics) using a drop of whole blood on the test strip.

Cortisol. Cortisol concentrations were measured in the plasma by radioimmunoassay using a commercial kit (MP Biomedicals). Cortisol was not measured at D7 because of the long interval post procedure and the results may be influenced by other factors, such as environment and management. The cortisol assay had 15,260 counts per minute (CPM), with a 44% capacity of ligation and 0.17% of nonspecific ligation with 90% sensitivity. The intra- and inter-assay variation was 6.88% and 9.62%, respectively.

Testosterone. When the males reached 7 months of age, blood was collected from the vena cava. Testosterone concentration was measured in the plasma by radioimmunoassay (kit IM1119; Immunotech) in duplicate. The testosterone assay had 10,098 CPM, with a 60% capacity of ligation and 1.09% of nonspecific ligation with 91% sensitivity. The intra- and inter-assay variation was 6.81% and 4.49%, respectively.

Andrological examination. After the animals reached puberty, at approximately 7 months of age, they were submitted to andrological examinations. The genitalia were thoroughly evaluated by palpation of the testicles for pain, adhesion, or enlargement. Internal genitalia lesions, mucosal color, and penile pruritus were evaluated. Measurements of the testicular perimeter were measured at the largest diameters using a manual caliper. The formula of the sphere/cylinder model[17] was used to calculate the testicular volume: $(VT = \pi (Dt)^2 (3Ct - Dt) / 12$.

After clinical examinations, males were taken to an individual area with a "dummy sow" for semen collection using the gloved-hand method. A drop of ejaculate was examined through light microscopy, using magnification ×400, to determine presence of spermatozoa. Sperm morphology and motility were also assessed in the control animals. Libido evaluations were subjective, based only on the interest of the male to copulate.

Statistical analysis

All data were evaluated by Statistical Analysis System (SAS, 2012). The Kolmogorov-Smirnov test assessed the normal distribution. Comparisons between variables and the interactions were performed for hematological parameters, rectal temperature, lactate, and cortisol. Comparisons only between variables were performed for testosterone concentrations and testicular parameters. All analyses were performed using PROC MIXED. The least squares means was used to calculate the adjusted means for each treatment, with comparisons using the Tukey test with 5% significance. Data are presented as least squares means of the percentages (SEM).

Results

No interaction was identified between the time of evaluation and treatment groups for rectal temperature ($P = .52$), hematocrit ($P = .91$), platelets ($P = .19$), leukocytes ($P = .85$), lymphocytes ($P = .67$), monocytes ($P = .34$), serum lactate ($P = .98$), and cortisol ($P = .37$). Therefore, the classifying variables (surgical procedure and time) were evaluated separately for each variable response.

There was no difference in the body temperature between the treatment groups ($P = .40$) or day ($P = .14$; Table 1).

For hematocrit, leukocytes, and monocytes, there were no differences between the treatment groups ($P = .06$, $P = .06$, and $P = .25$, respectively) and the time of evaluation ($P = .39$, $P = .88$, and $P = .92$, respectively; Table 1).

While there were no differences observed in platelet count among the surgical groups when compared with the control group (TE: 366,226 [29,477] cells/mm^3, $P = .059$; VS: 421,945 [27,610] cells/mm^3,

P = .76; VI: 492,675 [29,055] cells/mm^3, P = .75; and control: 456,256 [29,436] cells/mm^3), the TE and VI groups did differ (P = .005; Figure 1A). In addition, there was no time effect on D0 (429,594 [24,256] cells/mm^3), D2 (459,862 [26,530] cells/mm^3), or D7 (413,372 [27,174] cells/mm^3, P = .31).

For lymphocytes, none of the surgical treatment groups (TE: 9837.54 [605.13] cells/mm^3, P = .24; VS: 9345.31 [566.77] cells/mm^3, P = .06; and VI: 11,786 [596.49] cells/mm^3, P = .87) differed from the control group (11,214 [612.53] cells/mm^3). However, a difference was observed between the VS and VI groups (P = .008; Figure 1B). There were no differences between times (D0: 10,420 [497.94] cells/ mm^3; D2: 10,845 [550.14] cells/mm^3; and D7: 10,372 [557.84] cells/mm^3; P = .72).

No difference in serum lactate was observed among the surgical treatment groups. While the TE group (42.21 [3.02] mmol/dL) did not differ from the control group (32.36 [3.30] mmol/dL; P = .13), the lactate concentrations in the VS (47.13 [2.91] mmol/dL) and VI (45.23 [3.08] mmol/dL) treatment groups were significantly higher (P = .006 and P = .02; respectively; Figure 1C). There was no effect of time on lactate concentrations (D0: 41.96 [2.69] mmol/dL; D2: 43.52 [2.59] mmol/dL; and D7: 39.71 [2.73] mmol/dL; P = .60).

There was no difference in cortisol concentration between the treatment groups (TE: 3.87 [0.35] µg/dL; VS: 3.85 [0.31] µg/dL; VI: 3.27 [0.33] µg/dL; and control: 3.42 [0.37] µg/dL; P = .45). However, a difference in cortisol concentration was identified between D0 (3.97 [0.15] µg/dL) and D2 (3.24 [0.24] µg/dL; P = .02; Figure 1D).

No differences in testicular measurements (Table 1) were observed between the treatment groups (testicular length P = .10, width P = .33, and volume P = .12). There was also no difference between the testosterone concentrations among treatment groups at 7 months of age (P = .98; Table 1).

A difference in surgical duration was observed between the surgical techniques performed (P < .001). The fastest surgical technique was TE (18.16 [1.32] minutes), followed by VI (25.78 [1.25] minutes), and VS the most time consuming (32.53 [1.19] minutes) as described in Figure 2. All boars in the 3 surgical procedure groups presented healthy libido without sperm cells in the ejaculate.

Discussion

All surgical procedures used in the experiment effectively produced intact, sterile boars to be used for estrus detection in sows. Estrus detection is the process of identifying which females are receptive to mating.[9] In the swine industry, sexually mature sows should cycle every 3 weeks and estrus can last for 48 to 64 hours.[2] The most common external estrus signal is standing estrus, a physical sign of oxytocin release, increased estrogen levels, state of ovulation, and receptivity to mating.[9] Estrus expression and duration can be affected by several factors including age, parity, season or temperature, genetic composition, body condition, nutrition, and previous boar exposure.

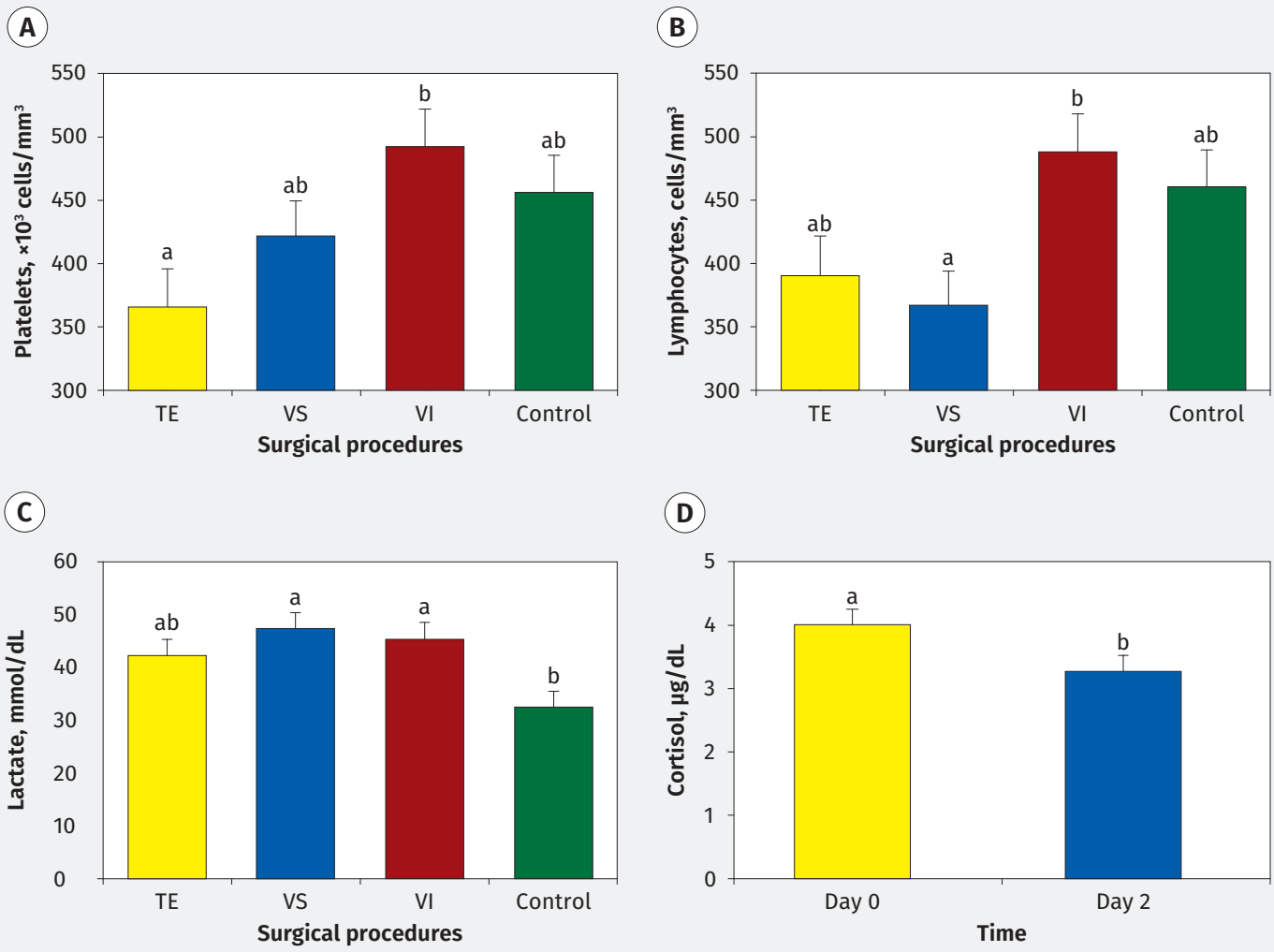
Sus scrofa has a large number of functional olfactory receptors.[18] Once stimulated, the olfactory signals can alter the brain, changing the physiology and behavior of sows. Thus, the ideal boar exposure would involve physical contact where the boar is allowed to nudge, sniff, and fully stimulate the female to help with gilt development and identify sows in estrus.[19] In individual sow crate housing systems, the boar walks in front of the females while the worker checks the sow for estrus. Ideally, estrus must be detected twice a day and performed 8 to 12 hours apart to identify the onset accurately. However, many farms struggle with sow longevity in the herd due to a decreased ability to detect estrus and complete successful mating. Low-quality estrus detection, stimulation, and mating are reflected in the breeding herd records as reproductive failures, negative pregnancy checks, or a low number of piglets born alive. Sows not accurately detected to be in estrus and subsequently inseminated are subject to a

Table 1: Least squares means (SEM) of hematological and endocrine parameters and testicular measurements of intact, sterile boars created using three different surgical techniques and control males

	Rectal temperature, °C	Hematocrit, %	Leukocytes, cells/mm^3	Testicular length, cm	Testicular width, cm	Testicular volume, cm^3	Testosterone, ng/dL
TE (n = 10)	37.80 (0.47)	41.17 (0.76)	18713 (1353.66)	12.80 (0.63)	6.33 (0.23)	343.52 (35.29)	6.25 (1.92)
VS (n = 10)	38.77 (0.33)	42.28 (0.71)	19472 (1267.66)	14.63 (0.61)	6.86 (0.22)	463.05 (33.65)	5.92 (1.74)
VI (n = 10)	37.98 (0.46)	41.29 (0.75)	22977 (1334.28)	14.48 (0.63)	6.34 (0.23)	422.76 (35.29)	6.14 (1.82)
CONTROL (n = 9)	37.96 (0.46)	43.53 (0.76)	21025 (1352.78)	14.91 (0.67)	6.42 (0.25)	423.70 (37.20)	5.29 (2.02)
DAY 0	38.27 (0.39)	41.49 (0.62)	20110 (1113.89)	NA	NA	NA	NA
DAY 2	38.59 (0.39)	42.11 (0.68)	21014 (1218.33)	NA	NA	NA	NA
DAY 7	37.53 (0.39)	42.60 (0.72)	20515 (1247.91)	NA	NA	NA	NA

TE = tail epididymectomy; VS = vasectomy via scrotal access; VI = vasectomy via inguinal access; NA = not applicable.

Figure 1: Least squares means (SEM) of A) platelets, B) lymphocytes, and C) lactate parameters of boars undergoing different surgical procedures and control males and D) cortisol concentrations before and after surgery. Lower case letters represent a significant difference ($P < .05$). TE = tail epididymectomy; VS = vasectomy via scrotal access; VI = vasectomy via inguinal access.



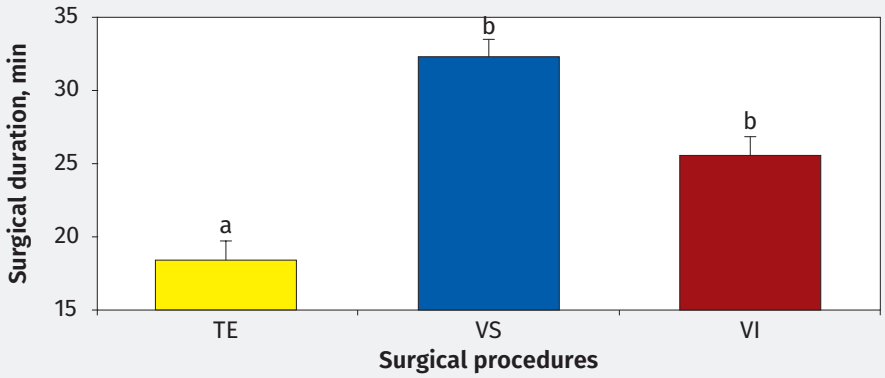
reduced farrowing rate and litter size.[20] In addition, several studies have shown numerous poor-quality matings result in considerable variation in the number of times sows are mated and overworked boars. Only 35% of all copulations lasted 2 minutes or more, and 63% of all copulations were disrupted, mainly by competitor boars.[21]

This scenario is changing with the shift from individual crates to the use of group pen housing of sows.[22] This will impact the success of estrus detection due to several risk factors associated with using an intact boar to detect estrus in a group of sows. An alternative is the use of a teaser animal. Teaser animals are males that have had their reproductive system surgically altered to render them sterile.[23] The primary purpose of these animals is to assist in estrus detection to better manage when artificial insemination occurs. The procedure to create intact, sterile males is commonly used on bulls and rams; however, there is limited information on the best technique to produce an intact, sterile boar. Vasectomy is one of the procedures used to produce a teaser boar and has been recognized as a useful tool in manipulating estrus in sows.[24]

To produce an intact, sterile animal, sedation is necessary. In our study, the sedation protocol used proved to successfully immobilize the animals and help with muscle relaxation and sedation. Lower doses were required in comparison with other drugs, with more desirable results.[25] This sedation protocol was used in all the animals for all the surgical groups (TE, VI, and VS) and very efficient according to the evaluated parameters.

The hematological measures are of great importance for evaluating changes in blood cells as a result of the procedures. Our experiment showed no difference in hematocrit between the treatment groups because none of the surgical techniques used caused an incision capable of leading to significant blood loss. The VI group presented higher values for platelets than the TE group, which is probably related to the incision site, a region with a thicker lipid layer and a higher number of capillaries. This region bleeds more when disrupted, is a site of constant movement due to walking, and is often in direct contact with the floor when the animal is lying down. However, the higher platelet value in the VI group was not significantly different from the platelet value in the control group. There were no identified

Figure 2: Duration of the different surgical procedures. Lower case letters represent a significant difference ($P < .05$). TE = tail epididymectomy; VS = vasectomy via scrotal access; VI = vasectomy via inguinal access.



differences in the number of leukocytes or monocytes among the treatment groups or time from surgery.

The VI group showed a significant increase in lymphocytes as compared to the other groups. Lymphocytes are markers of the inflammatory process and defense system with the role of presenting antigens. The lymphocyte increase was possibly associated with the surgical location and manipulation during the procedure due to the difficulty of cleaning the inguinal region, therefore increasing the chance of infection.

Lactate has been used to evaluate stress responses in animals. Serum lactate concentrations differed with surgical techniques, but there was no time difference. All surgical treatment groups showed increased values due to the surgery and healing process. However, the inflammatory response was minimal. Tissue hypoxia occurs around the incision injury, increasing lactate in the body. The only group that did not differ from the control group was the TE group, which, had a shorter surgical time and less tissue manipulation compared to the other techniques, resulting in reduced cell injury and faster healing process. This could indicate that increased animal manipulation was possibly responsible for increased lactate levels among the surgical groups.

As expected, there was an effect of time in relation to plasma cortisol concentrations. Cortisol was higher on the day of the surgery than 48 hours after the procedure. This was possibly related to physical restraint of the animals for blood collection and other parameter evaluations.[26] In our study, no differences in cortisol were observed between treatment group, suggesting that the cortisol increase observed on D0 was due to restraint and sample collection.

The use of vasectomized boars is an efficient tool to improve gilt reproduction parameters. Faster gilt response to boar stimulation is indicative of a more developed hypothalamic-pituitary-ovarian axis.[27] van Wettere at al[28] demonstrated that gilts mated at first estrus with a vasectomized boar had a higher farrowing rate and a larger first litter size than gilts not mated by a vasectomized boar on the first estrus. Our data show that all the vasectomy procedures were efficient for producing intact, sterile boars. However, the VS technique was the most invasive and time-consuming procedure compared with the others.

The VS procedure allowed for greater ease of reaching the sperm duct than the VI approach because there was less adipose tissue. On the other hand, it was observed that manipulation of tissues to expose the spermatic duct for the VS technique generated edema that momentarily made it difficult to visualize and differentiate structures. The VS procedure was the most time consuming, lasting approximately 35 minutes, in contrast with the VI procedure, which lasted approximately 25 minutes.

Vasectomized bulls have been reported to show increased teasing and mounting behaviors, but less aggressive behaviors compared with nonvasectomized bulls.[29] In addition, libido of these vasectomized animals varied.[30-33] In our study, we did not observe any differences among the testosterone levels, libido, or sexual interest during the boar soundness exam among the different surgical methods. This was also confirmed in other species.[30,32] The epididymectomy procedure is an efficient and easy technique already used in domestic pigs,[14] and is efficient to maintain the libido.

Studies in humans have shown that epididymectomy following a vasectomy reduced scrotal pain.[34] In our study, this technique was the easiest to perform, mainly due to the position of the anatomical structures. The epididymis tail was easily accessible and resulted in less tissue manipulation and a smaller skin incision. Removing the epididymis tail was also the most straightforward and economical procedure for creating a teaser bull.[35] Some complications have been identified after surgery, such as infection, reconnection of the spermatic duct, and removal or partial ligation of the artery along with the duct. To reduce the risk of contamination, all the animals in the present work were housed in a clean pen during the postoperative period to reduce the risk of infections.

The VI procedure should be chosen for use in animals with lower weights. Boars with thicker lipid layers make it challenging to locate the structures and require increased tissue manipulation, surgical time, and capillary damage leading to more significant bleeding and alteration of some hematological parameters as seen in the current study. Each male was observed an average of 10 to 15 minutes for the andrological exam performed at 7 months of age. Some males in this study did not perform mating, which is common and has no relation to the surgical techniques. All pigs had testosterone concentrations typical for their age. The testicular measurements and volume did not differ among animals from different treatment groups.

In conclusion, all the surgical techniques evaluated were efficient in producing intact, sterile boars with no alteration of the physiological parameters to prevent their use. The TE procedure was the fastest and least invasive procedure to produce intact, sterile boars.

Implications

Under the conditions of this study:

- Intact, sterile boars can be used for estrus detection in group housing.
- The 3 techniques used in this study effectively produced intact, sterile boars.
- The TE procedure was the most practical for producing intact, sterile boars.

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Conflict of interest

None reported.

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Proposed modifications to porcine reproductive and respiratory syndrome virus herd classification

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Summary

A standardized system for classifying the porcine reproductive and respiratory syndrome virus (PRRSV) status of swine herds is necessary for communication between veterinarians and producers. The 2011 classification system has been widely adopted by producers and veterinarians worldwide. In 2018, a working group met to revisit the system and make recommendations for changes. The most significant modification was to the classification of positive unstable and positive stable breeding herds. Recommended diagnostic protocols for promotion of herds to each status were modified and recommended diagnostic protocols to maintain a status were added. The growing pig classification for PRRSV was also modified.

Keywords: swine, porcine reproductive and respiratory syndrome virus, herd classification, disease status, modification

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Resumen - Modificaciones propuestas a la clasificación del virus del síndrome reproductivo y respiratorio del cerdo

Es necesario un sistema estandarizado para clasificar el estatus del virus del síndrome respiratorio y reproductivo porcino (PRRSV) en las piaras de cerdos para la comunicación entre veterinarios y productores. El sistema de clasificación de 2011 ha sido ampliamente adoptado por productores y veterinarios de todo el mundo. En 2018, un grupo de trabajo se reunió para revisar el sistema y hacer recomendaciones para cambios. La modificación más significativa fue la clasificación de las piaras de reproductores positivas inestables y positivas estables. Se modificaron los protocolos de diagnóstico recomendados para la promoción de piaras a cada estatus y se agregaron protocolos de diagnóstico recomendados para mantener un estatus. También se modificó la clasificación del PRRSV para los cerdos en crecimiento.

Résumé - Modifications proposées à la classification des troupeaux en lien avec le virus du syndrome reproducteur et respiratoire porcin

Un système normalisé de classification du statut des troupeaux de porcs relativement au virus du syndrome reproducteur et respiratoire porcin (VSRRP) est nécessaire pour la communication entre les vétérinaires et les producteurs. Le système de classification de 2011 a été largement adopté par les producteurs et les vétérinaires du monde entier. En 2018, un groupe de travail s'est réuni pour revoir le système et faire des recommandations de changements. La modification la plus significative concernait la classification des troupeaux reproducteurs positifs instables et positifs stables. Les protocoles de diagnostic recommandés pour la promotion des troupeaux à chaque statut ont été modifiés et les protocoles de diagnostic recommandés pour maintenir un statut ont été ajoutés. La classification des porcs en croissance pour le VSRRP a également été modifiée.

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In 2009, a committee met to discuss constructing terminology to classify swine herds according to porcine reproductive and respiratory syndrome virus (PRRSV) status. Their work culminated in a peer-reviewed paper titled "Terminology for classifying swine herds by porcine reproductive and respiratory syndrome virus status" published in the *Journal of Swine Health and Production*.[1] Before publication, the classification system was reviewed and approved by the board of directors of the American Association of Swine Veterinarians (AASV).

The classification system developed consisted of four categories for breeding herds: Positive Unstable (I), Positive Stable (II), Provisional Negative (III), and Negative (IV). Category II was further subdivided into II-A for herds not undergoing elimination and II-B for herds undergoing elimination. The system was built using two criteria: virus shedding and previous exposure to the virus. The supporting evidence for a herd to be promoted to each category was based solely on objective diagnostic results. Expected clinical signs and other subjective information for each category were noted but not included in the supporting evidence. Supporting evidence needed to maintain a herd in a category, after it had been promoted to that category, was not delineated. The most contentious debate regarding the original classification system centered on the definition of stable and the supporting evidence for the promotion of a breeding herd to the Positive Stable (II-A or II-B) category. The committee defined the term "stable" as a breeding herd with sustained and confirmable lack of detectable viremia in weaning-age pigs and promotion to Positive Stable (II-A or II-B) was based on testing serum for PRRSV by reverse transcriptase-polymerase chain reaction (RT-PCR). For supporting evidence, the committee recommended testing 6 pools of 5 serum samples from 30 weaning-age pigs monthly for 4 consecutive months with no positive results. The 30 samples needed each time the herd was tested was based on the number of samples required to detect an expected prevalence of 10% with 95% confidence for any population size greater than 1000, assuming a diagnostic test sensitivity greater than 95% and random sampling from a population with a homogenous distribution of positive animals.[2] The committee considered the tradeoff between the cost and inconvenience of testing and the confidence and ability to detect a low prevalence. A larger sample size with more frequent testing would have been preferred to detect a lower prevalence and increase the confidence level, however, the cost and inconvenience would limit adoption of the classification system.

The value of the system to classify the PRRSV status of swine herds is evident in how the 2011 system[1] has been used. Producers and veterinarians have used the classification system as a road map for managing PRRSV. It has facilitated communications between producers and veterinarians about health status, treatment and vaccination recommendations, and management of replacement animal introductions. The classification system has also been used to better manage biosecurity, including the establishment of down times, strategic placement of pigs, and strategic scheduling of pig movements, feed deliveries, and other activities. Having a standard classification has also provided researchers with a valuable tool with which to conduct research. Since it was published in 2011, the article summarizing the classification system has been cited over 100 times by researchers.[3] As an example, it was used in a study published in 2012 to estimate the annual cost of PRRSV in the United States.[4] The classification system has also facilitated PRRSV monitoring efforts to determine PRRSV infection status in US pig herds. Since 2011, the Morrison Swine Health Monitoring Project[5] has used the classification system to monitor and report the incidence of PRRSV outbreaks and the proportion of swine breeding herds by PRRSV status in the United States. Finally, the classification system has been used to set premiums and discounts for weaned pigs according to the PRRSV status of the source sow farm (P. E. Yeske, DVM, meeting notes, 2020). The benefit of the classification system, when used for the purpose of setting premiums and discounts, arises from better pricing signals to more accurately set a price that reflects the real value of the pigs, and to incentivize the production of pigs that are negative for PRRSV.

Following the publication of the original classification system, several developments have led to calls for modifications to the system. For example, challenges with consistently weaning groups of pigs that are truly negative for PRRSV from breeding herds classified as Positive Stable (II), have led some to question the criteria and supporting evidence for those herds as some may have been falsely classified as stable. The evolution of new PRRSV isolates in the United States and other countries that, when present, make it more challenging to stabilize sow farms may have contributed to the challenge of consistently weaning groups of pigs that are truly negative for PRRSV. Development of new diagnostic sample types, such as oral fluids and processing fluids, and new diagnostic tests have presented opportunities to establish the status of herds more accurately and at a lower cost with less effort.

Objectives

Because of these new developments and the lessons learned from adoption of the original classification system, the AASV PRRS Task Force Committee voted to revisit the classification guidelines at the 49th AASV Annual Meeting in March of 2018. A working group, composed of the authors of this publication, was formed to propose modifications to the PRRSV classification system.

Methods

The working group met twice to discuss changes to the 2011 classification system.[1] The first working group meeting took place in Saint Paul, Minnesota at the University of Minnesota College of Veterinary Medicine on January 24 and 25, 2019. A summary of the first meeting was presented to the AASV PRRS Task Force Committee at the 50th AASV Annual Meeting in Orlando, Florida on March 9, 2019, and input from the committee was obtained. A second and final working group meeting was held in Ames, Iowa at Iowa State University College of Veterinary Medicine on June 5, 2019. The working group was made up of representatives from the swine industry including veterinarians from private practice, production systems, and industry, academia, and representatives from AASV and the National Pork Board. The modifications to the PRRSV classification system described in this publication were reviewed and approved by the board of directors of the AASV in the fall of 2019.

Consensus on modifications

The working group, with input from the AASV PRRS Task Force Committee, reached a consensus on the following proposed changes.

Category modifications for breeding herds

The Positive Unstable (I) category is split into two categories, representing high and low PRRSV prevalence, respectively. Category I-A represents positive unstable herds with a relatively high prevalence of pigs that are positive for PRRSV at weaning. Herds with unknown PRRSV status are classified as Category I-A by default. Category I-B represents positive unstable herds with a relatively low prevalence of pigs that are positive for PRRSV at weaning, characterized by intermittent detection of PRRSV in samples collected from suckling pigs, defined as piglets of any age from birth to weaning.

The Positive Stable (II) category will still represent herds that have achieved stability from PRRSV infection. The definition of stability is unchanged and includes herds with sustained and confirmable lack of detectable viremia in weaning-age pigs (ie, pigs within seven days of weaning), regardless of weaning age. The previous subcategories of Category II, Positive Stable Not Undergoing Elimination (II-A) and Positive Stable Undergoing Elimination (II-B), will no longer be used. Instead, Category II-vx is used to delineate positive stable herds where replacement animals, sows, and piglets may be immunized with a modified-live virus vaccine. Herds in which PRRSV-naive gilts are intentionally acclimated with live-virus inoculation could be included in II-vx as long as the criteria and supporting diagnostic evidence from the breeding herd in which they are introduced are met. Acceptable diagnostic samples to produce the supporting evidence include blood or other bodily fluids from suckling pigs. Processing fluids may be used to support the promotion and maintenance of a herd into this category, but it is not sufficient evidence alone. The diagnostic recommendations for promotion to this category were made more stringent to increase confidence that true herd stability has been achieved. The working group agreed that stable must be more explicitly defined to provide uniformity and ease of communication throughout the industry. The Provisional Negative (III) and Negative (IV) categories remain unchanged from the original 2011 paper.[1]

Modification to supporting evidence required to move into a category

The working group stipulated that any modifications to the classification system must be practical, affordable, reliable, and straightforward to be adopted. However, there is generally a tradeoff between the cost and sensitivity of testing protocols. This tradeoff factored heavily in the final recommended modifications. With the addition of a second Positive Unstable category (I-B), the working group strengthened the supporting evidence required to promote a herd into the Positive Stable (II or II-vx) categories by increasing the number of serum samples tested from weaning-age pigs. This change was made to increase the likelihood of detecting positive pigs in herds with low prevalence and reduce the likelihood of falsely classifying herds as stable. For supporting evidence to promote a herd into the Positive Stable (II or II-vx) category, the working group recommended testing 6 pools of 10 serum samples from 60 weaning-age pigs by RT-PCR monthly for 4 consecutive months with no positive results. The number of samples doubled from the 30 samples recommended in the original classification system. The size of the pools tested also doubled from 5 to 10 serum samples per pool leaving the number of tests needed unchanged and, therefore, potentially reducing the diagnostic sensitivity of detecting individual positive pigs in the larger sample of 60 pigs from which sera were collected. The 60 pig sample size was based on the number of samples required to detect an expected prevalence of 5% with 95% confidence for any population size greater than 1000 assuming a diagnostic test sensitivity greater than 95% and random sampling from a population with an homogenous distribution of positive animals.[2]

In addition, the use of alternative population-based sample types to screen herds for PRRSV was incorporated. The working group viewed testing alternative sampling types as an easier, lower cost means to provide additional supporting evidence to increase the confidence of detecting positive pigs in the population. They include processing fluids,[6-9] family oral fluids,[10] udder wipes, and environmental sampling.[11] One advantage of these new sample types is that they enable relatively easy and inexpensive sampling of more pigs, which lowers the cost of diagnostic testing per pig sampled. Testing more pigs more frequently may increase the sensitivity of the herd monitoring program, leading to a lower probability of falsely classifying a herd as stable. A recent report documented the increased use of processing and oral fluids for PRRSV diagnostics in the United States.[9] The working group considered whether to recommend incorporating these new sample types and sampling schedules into the supporting evidence required to move into or remain in a category. Processing fluids, and family oral fluids in a limited way, were incorporated as alternatives sample types to serum. Environmental samples and udder wipes were deemed not sufficiently validated or lacking sensitivity, specificity, or both and were not included.

Testing piglet processing fluids by RT-PCR for PRRSV has become a useful screening tool to assess viral shedding in the breeding herd.[6-9] It is an easy sample to collect, and a large number of pigs can be tested at a relatively low cost. Consequently, the working group included testing of processing fluids as a means to supplement serum testing from weaning-age pigs whenever possible. However, because pigs may become infected with PRRSV between processing and weaning, testing piglet processing fluids within the first week of age for PRRSV is insufficient to assess the shedding status of piglets at weaning, and therefore, cannot stand alone as diagnostic evidence to establish the shedding status of these pigs.

The use of family oral fluids is another sample type that can be used as supporting evidence to maintain a herd in a category and can be used to test a large number of animals at relatively low cost.[10] However, success in collecting family oral fluids across systems can be variable, which limits the reliability of its use. Consequently, the working group included family oral fluids testing to be used as supporting evidence recommended to maintain a herd in a category.

Proposed new PRRSV herd classification

The description of each category provided here is a general characterization of a typical herd in each category.

Category I-A: Positive Unstable, High Prevalence

Herds that do not meet the criteria for any other category (I-B through IV) or do not have supporting diagnostic evidence are in the Positive Unstable, High Prevalence (I-A) category by default. Herds that have recently weathered an outbreak or herds where viral shedding and infection rates remain persistently high in the suckling piglet population will be in Category I-A. Clinical signs suggestive of PRRSV infections, including increased abortions, off-feed sows, stillborns, mummies, and preweaning mortality, are likely present. A large percentage of the breeding herd and suckling pigs are positive for antibodies to PRRSV and positive for PRRSV RNA by RT-PCR in serum, processing fluids, oral fluids, or all sample types. Replacement animals, sows, and piglets within this category may or may not be immunized with wild-type virus, modified-live virus vaccine, or inactivated PRRSV vaccine.

Category I-B: Positive Unstable, Low Prevalence

After 90 days of diagnostic testing to demonstrate a low prevalence of PRRSV infection in weaning-age pigs, a herd may be promoted to the Positive Unstable, Low Prevalence (I-B) category. The detection of PRRSV RNA by RT-PCR in serum from weaning-age pigs is intermittent, indicating low levels of viral shedding and transmission. The supporting diagnostic evidence for a herd to be promoted to Category I-B is in Table 1. Detection of PRRSV in the piglet population may be demonstrated with alternative sample types, including processing fluids. Few, if any, replacement breeding animals or sows will be positive for PRRSV by RT-PCR, and antibodies to PRRSV may be detected in all age categories of animals within the herd. Testing of diagnostic samples from the replacement breeding female and sow populations is not required as supporting evidence to promote a herd to Category I-B. Breeding replacement animals, sows, and piglets may or may not be immunized with a modified-live virus or inactivated vaccine. If a sample from a herd vaccinated with a modified-live virus vaccine tests positive for PRRSV by RT-PCR, other validated molecular diagnostic methods, such as open reading frame 5 (ORF-5) sequencing, whole-genome sequencing, or PCR clamping assays,[12] may be used to distinguish whether positive RT-PCR results were due to wild-type virus or vaccine-like virus. If the ORF-5 sequence or other molecular diagnostic results indicates that the PRRSV isolate is vaccine-like, the result is considered negative for the purpose of changing categories. Deliberate exposure to wild-type PRRSV (ie, live virus inoculation) may be used for acclimation of replacement animals and resident sows but is not used on piglets.

Most commonly, herds in Category I-B exhibit mild or no clinical signs of PRRSV infection and have returned to near baseline levels of productivity as measured by pigs weaned per sow, number of pigs born, born alive, and farrowing rates. In herds where the goal is to control PRRSV, and where achieving stability is not considered feasible, Category I-B may be the target herd status. In herds where the goal is to control PRRSV and where achieving stability is considered feasible, Category I-B may be a transitional status to attaining stability with (Category II-vx) or without (Category II) the use of a vaccine to maintain some level of immunity against PRRSV in the herd. When PRRSV elimination is the goal, Category I-B is a transitional category for herds that are eliminating the virus by herd closure and rollover with Category IV as the target herd status.

Category II: Positive Stable

After 90 days of diagnostic testing to demonstrate a sustained lack of viremia in pigs at weaning, a herd may be promoted to Category II. The defining characteristic of herds in this category is producing weaning-age pigs that are consistently negative for PRRSV. This requirement must be supported by a consistent lack of detection in serum from weaning-age pigs tested for PRRSV RNA by RT-PCR (Table 1). In the new classification, the supporting evidence to promote a herd to Category II was elevated by recommending testing monthly serum samples from 60 weaning-age piglets by RT-PCR in pools of 10 instead of 30 samples tested in pools of 5. The larger 60 pig sample size is sufficient to detect a positive animal in a population with at least a 5% prevalence and 95% confidence.[2] However, testing in pools of 10 may result in some reduction in the diagnostic sensitivity[13] which may offset some of the benefit of testing more animals. The committee that developed the original classification system and the working group that proposed the modifications described in this paper both recognized that when a herd is transitioning to a Positive Stable (Category II) status, the expected prevalence of positive animals will be very low. In those cases, a balance between the cost, the inconvenience of sampling, and the increased confidence of detecting a very low prevalence was sought. In the new classification system, the addition of population-based testing of processing fluids or other sample types as they become available, such as family oral fluids or udder wipes, may be used to provide additional evidence to support the PRRSV negative status of the pigs at weaning, but they cannot stand alone to promote or maintain a herd in this category. Breeding herds with very low PRRSV prevalence typically exhibit very mild or no clinical signs suggestive of PRRSV infection and have returned to their baseline levels of productivity. Replacement and breeding animals are expected to be negative for PRRSV by RT-PCR. All, or nearly all, breeding females are positive for PRRSV antibodies. Breeding replacements may be positive or negative for PRRSV antibodies. A vaccine is not used in any subpopulation of animals in the breeding herd, however modified-live virus vaccine or deliberate exposure to wild-type PRRSV (ie, live virus inoculation) may be used to acclimate breeding replacement animals as long as they are no longer actively shedding virus when they enter into the breeding herd. In herds where the goal is to control PRRSV, Category II may be the target herd status. When elimination of PRRSV is the goal, Category II is a transitional category for herds that are eliminating the virus by herd closure and rollover and, at some point, replacement animals that are naive to PRRSV would be introduced to move to Category III and eventually Category IV as the target herd status.

Category II-vx: Positive Stable With Vaccination

The criteria for promoting a herd into the Positive Stable With Vaccination (II-vx) category is similar to the criteria for promoting a herd in the Positive Stable (II) category. After 90 days of diagnostic testing to demonstrate a sustained lack of viremia of wild-type PRRSV in

weaning-age pigs, a herd may be promoted to Category II-vx. The defining characteristic of herds in Category II-vx is that piglets at weaning are consistently negative for PRRSV RNA by RT-PCR. In Category II-vx this requirement must be supported by a consistent lack of detection of wild-type PRRSV in serum from weaning-age piglets tested by RT-PCR and other validated molecular diagnostic methods to distinguish whether positive RT-PCR results were due to wild-type virus or vaccine-like virus (Table 1). As with Category II, testing of other sample types may be used to provide additional evidence but they cannot stand alone to promote or maintain a herd into Category II-vx.

The primary difference between Category II-vx and Category II is that replacement breeding animals, sows, and piglets may be immunized with a modified-live virus vaccine. If a modified-live virus vaccine is used on suckling piglets, diagnostic samples should be collected before administering the vaccine. Additionally, live virus inoculation, or any other administration of wild-type virus, may be used as an immunization strategy for replacement breeding animals to acclimate them before being entered into the breeding herd. If wild-type virus is used to inoculate sows in the breeding herd, the herd will achieve a status no higher than Positive Unstable, Low Prevalence (Category I-B). Detection of only modified-live vaccine virus is considered a negative result for the purpose of promoting a herd to a new category or maintaining a herd in a category. Any herd administering a modified-live virus vaccine may be given a grace period of two weeks post vaccine administration where any PRRSV-positive result by RT-PCR is assumed to be a detection of vaccine virus only. If, after the grace period, a sample from a vaccinated herd tests positive for PRRSV by RT-PCR, other molecular diagnostic methods, such as ORF-5 sequencing, whole-genome sequencing, or PCR clamping assays, may be used to distinguish whether positive RT-PCR results were due to wild-type virus or vaccine-like virus. If the ORF-5 sequence or other molecular diagnostic results indicate that the PRRSV isolate is vaccine-like, the result is considered negative for the purpose of promoting a herd to a new category or maintaining a herd in this category. If the ORF-5 sequence or other molecular diagnostic results indicates that the PRRSV isolate is a wild-type PRRSV, the result is considered positive. Vaccinated herds typically exhibit transient minor or no clinical signs following vaccination events and have returned to their baseline levels of productivity. Replacement and breeding animals are expected to be negative for PRRSV by RT-PCR although occasionally may test positive to the vaccine virus that was used. All, or nearly all, breeding females are positive for PRRSV antibodies. Breeding replacement animals may be positive or negative for PRRSV antibodies. In herds where the goal is to control PRRSV with vaccination in the breeding herd, Category II-vx is the target herd status.

Category III: Provisional Negative

The Provisional Negative (III) category is unchanged from its initial description in the 2011 publication.[1] Category III is specific to herds that have eliminated PRRSV by herd closure and rollover, or similar methods. To demonstrate that PRRSV has been eliminated from the herd, PRRSV-naive breeding replacement animals, which serve as sentinels, must be introduced into the herd and remain seronegative by enzyme-linked immunosorbent assay (ELISA) at least 60 days following their introduction (Table 2). To serve as effective sentinels, the PRRSV-naive breeding replacement animals should have nose-to-nose contact opportunities and be housed in the same air space as the breeding females already in the herd. No animals in Category III herds are actively shedding virus, but they may have been exposed to the virus. Category III is a transitional category for herds that are eliminating the virus by herd closure and rollover, which will eventually advance to Category IV as the target herd status.

Category IV: Negative

This category also remains the same as described in the 2011 publication.[1] These herds have negative exposure and shedding status. The supporting diagnostic evidence for a herd to be promoted to Category IV is presented in Table 2. Category IV is the target status for herds that are eliminating the virus by herd closure and rollover or complete depopulation and repopulation with replacement animals that are naive to PRRSV. New herds stocked with animals that are PRRSV naive are also classified as Category IV.

Addition of supporting evidence required to stay in a category

In the original classification system, once a breeding herd achieved a status, additional evidence collected periodically was not required for a herd to remain in that category. Herds would generally only move to a lower category when a PRRSV outbreak occurred in the herd. However, it was the consensus of the working group that diagnostic testing should be done periodically to reconfirm that a herd remains in a category. Therefore, the supporting evidence to stay in a category was developed for all the categories. The supporting evidence to remain in Categories I-B, II, and II-vx is presented in Table 1 and the supporting evidence to remain in Categories III and IV is presented in Table 2. In the absence of supporting evidence to maintain a herd in any category, the default is the Positive Unstable, High Prevalence (I-A) category. No supporting evidence is required to maintain a herd in Category I-A.

Grow-finish classification

The working group also made a change to the classification of growing pigs published in 2011.[1] The new system is shown in Table 3 and features four categories: Positive; Seropositive, non-shedding; Vaccinated; and Negative. The system classifies a group of pigs at a point in time during the growing period, from weaning to market. Therefore, a single group of pigs may fall into more than one category during the growing period. The status of a group of pigs, as illustrated in this system, would be determined by testing 6 oral fluid samples collected from ropes geospatially distributed among all pens, barns, and rooms in which the group of pigs, as defined by the producer, are housed. In groups of growing pigs that are not vaccinated against PRRSV with modified-live virus vaccine, the status of the pigs may be determined by testing individual oral fluid samples for PRRSV antibodies by ELISA or other validated serological tests and for the virus RNA by RT-PCR. In groups vaccinated against PRRSV with a modified-live virus vaccine, the status of the pigs may be determined by testing individual oral fluid samples for the virus by RT-PCR. If a sample from a vaccinated group of pigs tests positive for PRRSV by RT-PCR, other validated molecular

Table 1: Summary of supporting diagnostic evidence required to promote and maintain a herd in PRRSV Categories I-B, II, and II-vx*

	Category	I-B		II and II-vx	
	Description	Positive Unstable, Low Prevalence		Positive Stable and Positive Stable With Vaccination	
	Testing purpose	To promote into	To maintain in	To promote into	To maintain in
Option 1	Animals and sample tested†	Serum from weaning-age pigs	Serum from weaning-age pigs	Serum from weaning-age pigs	Serum from weaning-age pigs
	Minimum number sampled	30 pigs	30 pigs	60 pigs	30 pigs
	Pooling recommendation	5 pigs/pool	5 pigs/pool	10 pigs/pool	5 pigs/pool
	Test used	Test pools by RT-PCR	Test pools by RT-PCR	Test pools by RT-PCR	Test pools by RT-PCR
	Testing frequency‡	Monthly for 90 days or at least 4 batches	Monthly or by batch	Monthly for 90 days or at least 4 batches	Monthly or by batch
	Herd test interpretation¶	One or more pools positive means herd test is positive	One or more pools positive means herd test is positive	One or more pools positive means herd test is positive	One or more pools positive means herd test is positive
	Requirement to promote or maintain status	75% (3 of 4) of monthly or batch herd tests are negative	75% (3 of 4) of rolling monthly or batch herd tests are negative, if <75%, revert to I-A	100% (4 of 4) of monthly or batch herd tests are negative	Monthly or batch herd tests are negative If any positive, revert to I-B or lower
Option 2	Animals and sample tested†	Processing fluids	Processing fluids	Concurrently; 1) Serum from weaning-age pigs 2) Processing fluids	Concurrently; 1) Serum from weaning-age pigs 2) Processing fluids
	Minimum number sampled	Majority of litters from one week of farrowing	Majority of litters from one week of farrowing	1) 30 pigs 2) Majority of litters from one week of farrowing	1) 30 pigs 2) Majority of litters from one week of farrowing
	Pooling recommendation	1 or more pools	1 or more pools	1) 5 pigs/pool 2) 1 or more pools	1) 5 pigs/pool 2) 1 or more pools
	Test used	Test pool(s) by RT-PCR	Test pool(s) by RT-PCR	Test pool(s) by RT-PCR	Test pool(s) by RT-PCR
	Testing frequency‡	Weekly for 90 days or at least 4 batches	Monthly or by batch	1) Monthly for 90 days or at least 4 batches 2) Weekly for 90 days or at least 4 batches	1) Quarterly 2) Monthly or by batch
	Herd test interpretation¶	One or more pools positive means herd test is positive	One or more pools positive means herd test is positive	One or more pools positive means herd test is positive	One or more pools positive means herd test is positive
	Requirement to promote or maintain status	75% (10 of 13) of weekly or batch herd tests are negative	75% (3 of 4) of rolling monthly or batch herd tests are negative, if <75%, revert to I-A	1) 100% (4 of 4) of monthly or batch herd tests are negative 2) 100% (13 of 13) of weekly or batch herd tests are negative	1) Quarterly herd test is negative 2) Monthly or batch herd test is negative If any positive, revert to I-B or lower

Table 1: Continued

	Category	I-B		II and II-vx	
	Description	Positive Unstable Low prevalence		Positive Stable and Positive Stable with Vaccination	
	Testing purpose	To promote into	To maintain in	To promote into	To maintain in
Option 3	Animals and sample tested†		Family oral fluids from litters of weaning-age pigs		Concurrently; 1) Serum from weaning-age pigs 2) Family oral fluids from litters of weaning-age pigs
	Minimum number sampled		20 litters		1) 30 pigs 2) 20 litters
	Pooling recommendation		5 litters/pool		1) 5 pigs/pool 2) 5 litters/pool
	Test used		Test pools by RT-PCR		Test pools by RT-PCR
	Testing frequency‡		Monthly or by batch		1) Quarterly 2) Monthly or by batch
	Herd test interpretation¶		One or more pools positive means herd test is positive		One or more pools positive means herd test is positive
	Requirement to promote or maintain status		75% (3 of 4) of rolling monthly or batch herd tests are negative, if <75%, revert to I-A		1) Quarterly herd test is negative 2) Monthly/batch herd test is negative If any positive, revert to I-B or lower

* In the absence of supporting evidence to promote or maintain a herd in any category, the default is the Positive Unstable, High Prevalence (I-A) category. No supporting evidence is required to promote or maintain a herd in Category I-A.

† Processing fluids are collected from piglets seven days of age or younger. Weaning-age pigs are within seven days of weaning. Family oral fluids are collected from litters within seven days of weaning.

‡ In herds where a multi-week batch-farrowing system is used, a single herd test is performed per batch. A herd test must be performed for at least 4 batches, even if more than 90 days is required to do 4 herd tests. For 3-week, 7-group batch farrowing systems, five herd tests should be conducted over 12 weeks (84 days) which is sufficiently close to 90 days.

¶ A positive RT-PCR test result within 2 weeks of administration of modified-live virus vaccine in the herd is assumed to be detection of vaccine virus only and deemed a negative herd test for the purpose of the classification as Category I-B and II-vx. After the two-week grace period, other molecular diagnostic methods, such as ORF-5 viral sequencing, whole genome sequencing or RT-PCR clamping assays, may be used to distinguish whether positive RT-PCR results were due to wild-type virus or vaccine-like virus. If the ORF-5 sequence or other molecular diagnostics results indicate that the PRRSV isolate is vaccine-like, the result is considered negative for the purpose of promoting a herd into or maintaining a herd in Category I-B or II-vx.

PRRSV = porcine reproductive and respiratory syndrome virus; RT-PCR = reverse transcriptase-polymerase chain reaction; ORF-5 = open reading frame 5.

Table 2: Summary of supporting diagnostic evidence required to promote and maintain a herd in PRRSV Categories III and IV

	Category	III		IV	
	Description	Provisionally Negative		Negative	
	Testing purpose	To promote into	To maintain in	To promote into	To maintain in
Option 1	Animals and sample tested	Serum from PRRSV naive replacement breeding animals that have been in herd for at least 60 days	Serum from PRRSV naive replacement breeding animals that have been in herd for at least 60 days	Serum from adult breeding animals	Serum from adult breeding animals
	Minimum number sampled	60 animals	30 animals	60 animals	30 animals
	Pooling recommendation	None allowed	None allowed	None allowed	None allowed
	Test used	Test individual samples by ELISA	Test individual samples by ELISA	Test individual samples by ELISA	Test individual samples by ELISA
	Testing frequency	Once	Semi-annually	Once	Semi-annually
	Herd test interpretation*	One or more positive samples after ruling out false positives means herd test is positive	One or more positive samples after ruling out false positives means herd test is positive	One or more positive samples after ruling out false positives means herd test is positive	One or more positive samples after ruling out false positives means herd test is positive
	Requirement to promote or maintain status	One-time herd test is negative	Semi-annual herd test is negative, if positive, revert to Category I-B or lower	One-time herd test is negative†	Semi-annual herd test is negative, if positive, revert to Category I-B or lower
Option 2	Animals and sample tested		Processing fluids from litters of PRRSV-naive replacement breeding animals that have been in herd for at least 60 days		Processing fluids
	Minimum number sampled		Majority of litters from one week of farrowing		Majority of litters from one week of farrowing
	Pooling recommendation		1 or more pools		1 or more pools
	Test used		Test pools by ELISA		Test pools by ELISA
	Testing frequency		Semi-annually		Semi-annually
	Herd test interpretation*		One or more positive samples after ruling out false positives means semi-annual test is positive		One or more positive samples after ruling out false positives means semi-annual test is positive
	Requirement to promote or maintain status		Semi-annual herd test is negative, if positive, revert to Category I-B or lower		Semi-annual herd test is negative, if positive, revert to Category I-B or lower

Table 2: Continued

	Category	III		IV	
	Description	Provisionally Negative		Negative	
	Testing purpose	To promote into	To maintain in	To promote into	To maintain in
Option 3	Animals and sample tested		Family oral fluids at weaning-age from litters of PRRSV-naive replacement breeding animals that have been in herd for at least 60 days		Family oral fluids from litters of weaning-age pigs
	Minimum number sampled		20 litters		20 litters
	Pooling recommendation		None allowed		None allowed
	Test used		Test individual samples by ELISA		Test individual samples by ELISA
	Testing frequency		Semi-annually		Semi-annually
	Herd test interpretation*		One or more positive samples after ruling out false positives means herd test is positive		One or more positive samples after ruling out false positives means herd test is positive
	Requirement to promote or maintain status		Semi-annual herd test is negative, if positive, revert to Category I-B or lower		Semi-annual herd test is negative, if positive, revert to Category I-B or lower

* Serial testing using another antibody-based test with greater specificity may be used to rule out false positives.

† For herds that are eliminating the virus by herd closure and rollover, removal of all previously infected animals from the herd may be confirmed with production records. All breeding animals present in the herd on the first day the herd was classified as Category III are no longer on the list of animals inventoried.

PRRSV = porcine reproductive and respiratory syndrome virus; ELISA = enzyme-linked immunosorbent assay.

Table 3: Classification of growing pigs for PRRSV status

Classification	ELISA status	Wild-type PRRSV RT-PCR status	MLV PRRSV RT-PCR status
Positive	+	+	+/-
Seropositive, non-shedding	+	-	-
Vaccinated	+	-	+
Negative	-	-	-

PRRSV = porcine reproductive and respiratory syndrome virus; ELISA = enzyme-linked immunosorbent assay; RT-PCR = reverse transcriptase-polymerase chain reaction; MLV = modified-live virus

diagnostic methods, such as ORF-5 viral sequencing, whole-genome sequencing, or PCR clamping assays, may be used to distinguish whether positive RT-PCR results were due to wild-type virus or vaccine-like virus. If the ORF-5 sequence or other molecular diagnostic results indicates that the PRRSV isolate is vaccine-like, the result is considered negative for the purpose of classifying the group of pigs.

Implications

- New system classifying PRRSV status of herds addresses developments since 2011.
- Value of system to classify PRRSV status of herds is evident in how it is used.
- Diagnostic testing is necessary to objectively classify herds for PRRSV status.

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Conflict of interest

None reported.

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AMERICAN ASSOCIATION OF SWINE VETERINARIANS

This fact sheet from the National Pork Board provides key insights into AgView, a Checkoff-funded, opt-in software platform that is free to use for anyone raising pigs.

AgView: A New Tool for a Unified, Real-Time Approach for Foreign Animal Disease Response

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AgView's Value to the Industry

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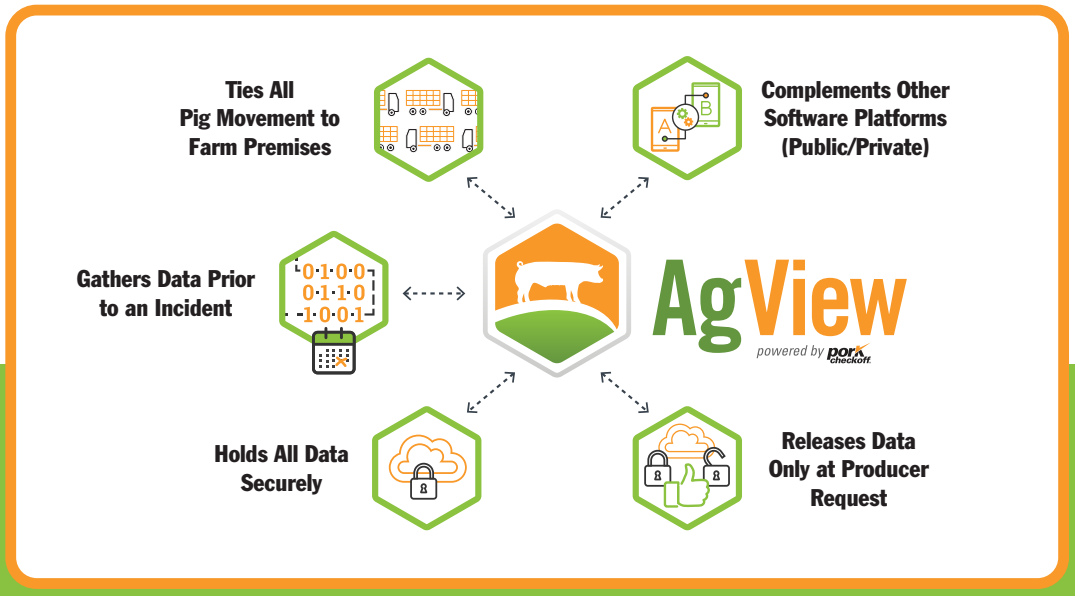

In the event of an African swine fever (ASF) or another FAD outbreak, state veterinarians and other animal health officials will rely on reviewing a massive amount of important data from producers to assist in contact tracing of infected animals/herds. AgView is a permission-based system that is able to rapidly share disease data from producers to animal health officials. Once the data-sharing is approved, AgView can quickly share this vital information, including:

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- Compliance with the U.S. Secure Pork Supply plan
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FLEX CircoPRRS® is the first and only single-shot vaccine that protects against PCV2 and PRRS by combining Ingelvac CircoFLEX® and Ingelvac PRRS® MLV. It's all made possible by our state-of-the-art DiaTEC purification process, which results in a non-virucidal[1] INGELVAC CIRCOFLEX. It's the latest example of how our FLEX Family of vaccines provides the ultimate in flexibility and customized control. Now, caring for your herd is easier on you and your animals. Because when it comes to vaccinations, one shot is greater than two.

Learn more at **SwineResource.com.**

Boehringer Ingelheim | **FLEX CircoPRRS®**

[1] Bautista E, Schlesinger K, Gassel M. Boehringer Ingelheim Animal Health USA Inc. Data on file, Study No. 2017044.

Call for abstracts – Industrial Partners sessions

The American Association of Swine Veterinarians invites submissions for the Industrial Partners oral and poster sessions at the 53rd AASV Annual Meeting. This is an opportunity for commercial companies to make brief presentations of a technical, educational nature to members of the AASV. The conference will be held February 26 through March 1, 2022 in Indianapolis, Indiana.

The oral sessions consist of a series of 15-minute presentations scheduled from 1 to 5 PM on Sunday afternoon, February 27th. A poster session takes place the same day. Poster authors will be required to be stationed with their poster from noon until 1 PM, and the posters will remain on display throughout the afternoon and the following day for viewing.

SUBMISSION PREREQUISITE: All companies submitting topics for presentation during the Industrial Partners sessions must register to participate in the AASV Technical Tables Exhibit before October 1st.

Restricted program space necessitates a limit on the number of presentations per company. Companies that are a member of the *Journal of Swine Health & Production* Industry Support Council **and** sponsor the AASV e-Letter may submit three topics for oral presentation. Companies that are **either** a member of the *JSHAP* Industry Support Council **or** sponsor the AASV e-Letter may submit up to two topics. All other companies may submit one topic for oral presentation. In addition, every company may submit one topic for poster presentation, but the topic must not duplicate the oral presentation. All topics must represent information not previously presented at the AASV Annual Meeting or published in the meeting proceedings.

To participate, send the following information to aasv@aasv.org by October 1, 2021:
1) Company name
2) Presentation title
3) Brief description of the presentation content
4) Presenter name and contact details (mailing address, telephone number, and email address)
5) Whether the submission is intended for oral or poster presentation

Receipt of submissions will be confirmed by email. Presenters will be notified of their acceptance by October 15th and must submit a paper by November 12th for publication in the meeting proceedings. Failure to submit the paper in a timely manner will jeopardize the company's future participation in these sessions.

The presenting author is required to register for and attend the meeting in person to make the presentation. Recorded or virtual presentations will not be accepted unless the meeting converts to an entirely virtual event.

Presenters may register for the meeting either as a Tech Table representative, or as an individual registrant (nonmember oral and poster presenters are eligible to register at the AASV regular member rate). AASV does not provide a speaking stipend or travel reimbursement to Industrial Partners presenters.

Nominate 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 awards – including a new one – to be presented at the 53rd AASV Annual Meeting in Indianapolis.

The association is establishing a new award for **outstanding members engaged in academia** to recognize faculty, graduate students, and researchers who have demonstrated excellence in teaching, research, and service to the swine veterinary profession. The specific award title and description will be determined by the AASV Board of Directors at the end of September, so watch for details in the e-Letter and the next issue of JSHAP and prepare to nominate an outstanding academician!

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, AASV officers, and the AASV 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, Iowa 50220, E-mail: **aasv@aasv.org**.

AASV news continued on page 277

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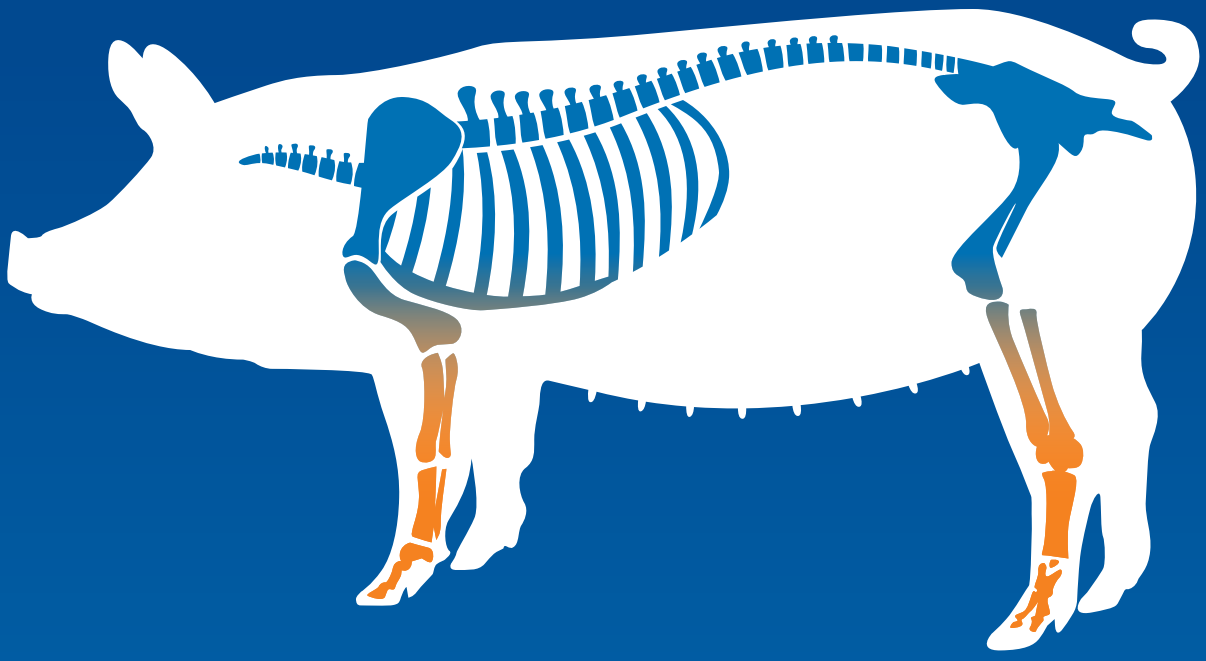

Is your sow herd's vitamin D status high enough to ensure strong skeletal development, bone health and mobility? Hy•D®, a pure and proprietary vitamin D metabolite called 25-OH D3, works better than supplementing with vitamin D alone. Its unique mode of action eliminates the need for the conversion of D3 in the liver, allowing 25-OH D3 to be absorbed more quickly and consistently. Help your sows Stand Strong with Hy•D, your vitamin D solution for improving lifetime productivity.

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AASV news continued from page 275

Call for abstracts – Student Seminar

The American Association of Swine Veterinarians announces an opportunity for veterinary students to make a scientific presentation at the AASV Annual Meeting in Indianapolis, Indiana, on Sunday, February 27, 2022. 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 (2021-2022) student member of the AASV at the time of submission and must not have graduated from veterinary school prior to February 27, 2022. Submissions are limited to 1 abstract per student.

Abstract submission

Microsoft Conference Management Toolkit will be used to receive and review student abstract submissions. Abstracts and supporting information must be submitted online at **https://cmt3.research.microsoft.com/AASV2022.** Submissions must be completed before **11:59 PM Central Daylight Time** on **Wednesday, September 15, 2021** (firm deadline). Late submissions will not be considered.

Students will receive an email confirmation of their submission. If they do not receive the confirmation email, they must contact Dr Andrew Bowman (**bowman.214@osu.edu**) by Friday, September 17, 2021 with supporting evidence that the submission was made in time; otherwise the abstract 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 of the review results by October 15, 2021, and those selected to participate will be expected to provide the complete paper or abstract, reformatted for publication in the conference proceedings, by November 12th.

Student Seminar and Scholarships

As sponsor of the Student Seminar, **Zoetis** provides a total of $20,000 to fund awards and the top student presenter scholarship. The student presenter of each paper selected for ORAL presentation receives a $750 award when they make the presentation at the meeting. These students also compete for one of several scholarships awarded through the AASV Foundation. The oral presentations will be judged to determine the amount of the scholarship awarded. **Zoetis** funds a $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 scholarships of $2500 each for 2nd through 5th place, $1500 each for 6th through 10th place, and $500 each for 11th through 15th place.

Student Poster Session

Abstracts that are not selected for oral presentation in the Student Seminar will be considered for presentation in a poster session at the annual meeting. **Zoetis**, sponsor of the Student Poster Session, has joined with AASV to provide a $250 award for each student poster presenter at the meeting. Students selected to make a poster presentation will be expected to supply a brief paper, formatted for publication in the conference proceedings, by November 12th. The guidelines for preparing posters for the display are available at **aasv.org/annmtg/2022/posters.php**.

Veterinary Student Poster Competition

The presenters of the top 15 poster abstracts compete for scholarship awards ranging from $200 to $500 in the Veterinary Student Poster Competition, sponsored by **United Animal Health**. See **aasv.org/annmtg/2022/postercomp.htm** for poster judging details.

In all cases, the student presenter is required to attend the meeting in person to make the presentation. Recorded or virtual presentations will not be accepted unless the meeting converts to an entirely virtual event.

Complete information for preparing and submitting abstracts is available at **aasv.org/annmtg/2022/studentseminar.htm**. The rules for submission should be followed carefully. For more information, contact the AASV office by phone, 515-465-5255, or email, **aasv@aasv.org**.

AASV news continued on page 279

2022 AASV Annual Meeting: in-person, on-site

The AASV is moving forward with plans to hold the 2022 AASV Annual Meeting on-site in Indianapolis on February 26 – March 1.

Check **aasv.org/annmtg** for updated information and revisions.

Take **tail biting off the plate.**

"When caught early, we've had 100% success rate with them recovering after using Bite B-Gone and going on to be full market value pigs."

Tim Chancellor,
Finishing Supervisor,
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Tail biting is not only painful for the pigs but can be costly to operations due to treatment expenses and unexpected culling prior to full value.

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A quick spray on the tail can help eliminate the bite out of your client's bottom line.

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TechMix **Redefining hydration** to keep animals **drinking, eating & producing.**

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AASV news continued from page 277

Member leadership opportunities

Are you interested in leadership positions within AASV? You are perfect for the job! Listed below are a few volunteer opportunities to get you started.

AASV Committees

The AASV Board of Directors recognizes that the committees form the backbone of our organization. The Board relies on the committees as "issue experts" and seeks their input regarding issues of importance to swine veterinarians. Committees are called upon to examine an issue and advise the Board on official positions the association should take or to develop additional resources to educate our membership.

Each AASV committee typically conducts a face-to-face meeting on Saturday morning during the AASV Annual Meeting. Additional committee activity is generally handled virtually during the remainder of the year.

Learn about each committee, read their reports and workplans, and review committee guidelines at the AASV committee page: **aasv.org/aasv/committee.php**. All AASV members and student members are welcome to attend any committee meeting, but only committee members are eligible to vote. If you are interested in joining a committee, please contact the committee chair or the AASV office.

Not sure which committee to join? Let us know! Some committees have open seats!

AASV representation to the AVMA

AASV designates representatives for several committees of the American Veterinary Medical Association. Current representatives are listed at **aasv.org/members/only/AVMAreps**. Visit **avma.org/membership/volunteering-avma/avma-volunteer-opportunities-vacancies** for more details and descriptions of each committee.

AASV Board of Directors

The AASV is governed by a Board of Directors representing each of the 11 North American districts. Potential candidates must be Active (veterinarian) AASV members residing in the district for which they wish to represent. Directors are elected on a rotating basis to ensure leadership continuity on the board. In the coming months, Districts 3 (MO, KY, AR) and 7 (western US) will nominate and vote on candidates to fill the positions currently occupied by Drs Greg Cline and Megan Potter, who have each served 2 terms and are not eligible for re-election. In each district, the two nominees receiving the most nominations will be placed on the ballot, subject to their consent to serve.

Each newly elected director will serve a three-year term of office that begins in the spring.

The AASV district directors (eleven in all) along with the officers form the governing board of the AASV. The Board of Directors meets twice annually in the spring and fall to set policies and conduct association business. The AASV reimburses travel expenses to attend the board meetings. Occasionally, the board conducts additional conference calls or email discussions.

For more information, view the AASV **Bylaws at aasv.org/aasv/bylaws.htm**.

AASV Executive Officers and Committee

The AASV Board of Directors prepares a slate of candidates for the office of president-elect and vice president. President-elect and vice president officers are elected by the AASV membership each year. The AASV Executive Committee is composed of the president, immediate past president, president-elect, and vice president. Each officer's term is one year beginning at the close of the annual business meeting.

For more information, view the AASV Bylaws at **aasv.org/aasv/bylaws.htm**.

NOTE: Affiliate, Associate, and Student Members are not eligible to hold office or vote.

PROVEN IMPACT AGAINST *MYCOPLASMA HYOPNEUMONIAE*.[1]

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LINCOMIX® (*lincomycin*) from Zoetis has a broad dosage range to provide pork veterinarians and producers with greater flexibility in reducing *M. hyopneumoniae* challenges. See how LINCOMIX — the only Type A Medicated Article approved for the reduction of the severity of the effects of *M. hyopneumoniae* in the U.S. — can improve health and economic outcomes at **ZoetisUS.com/LINCOMIX**.

CAUTION: Federal law restricts medicated feed containing this veterinary feed directive (VFD) drug to use by or on the order of a licensed veterinarian.

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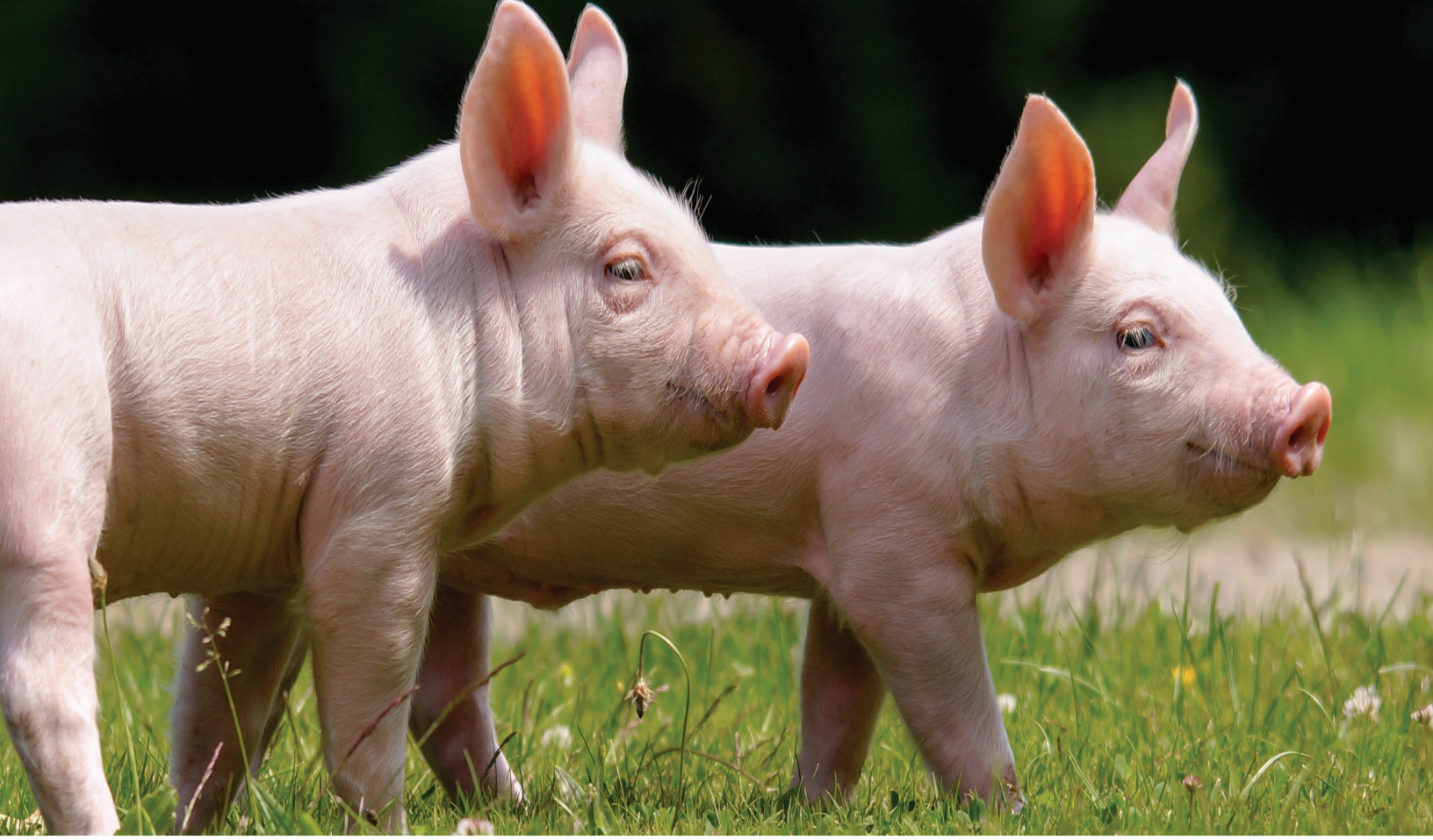
53rd AASV Annual Meeting

February 26 – March 1, 2022
Indianapolis, Indiana

AMERICAN ASSOCIATION OF SWINE VETERINARIANS

aasv.org/annmtg



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Students: Offset externship expenses with $500 grant

Veterinary students, would you like to obtain experience in swine practice? The AASV Foundation can help! Students who complete an externship of at least two (2) weeks in a qualifying practice can receive up to $500 in expense reimbursement. Any AASV student member in veterinary school who fulfills the requirements is eligible. Access complete details and the application at **aasv.org/students/externgrant.htm**.

To help locate the perfect opportunity, check out the roster of practices and companies willing to mentor students at **aasv.org/internships/index.php**.

Does your practice host students? AASV members who would like their internship and externship opportunities included in AASV's online listing are invited to contact Sydney Simmons, AASV alternate student delegate (**aasvstudentdelegate@gmail.com**) for more information.

Who decides how the money is spent?

In 1989, the AASV Foundation was established as a charitable nonprofit organization, with its leadership and mission (see sidebar) separate from that of AASV. Since its humble beginnings, generous donations and favorable investment returns have swelled the foundation's financial resources to over $2.5 million, thanks to the oversight and guidance of the Investment Committee and the AASV Foundation Board.

At the beginning of 2021, the foundation held nearly $1.2 million in endowed member contributions, which have been invested at the direction of the foundation's Investment Committee. The endowed investments alone have generated approximately $670,000 of income that is available to support the foundation's programs, in addition to unrestricted donations and proceeds from the auction and golf outing fundraisers.

So, who decides which programs the foundation should support and how much to spend on each?

That is the job of the dedicated volunteers who make up the AASV Foundation Board of Directors. The board is structured to include the current AASV president and immediate past president, each of whom serve a 2-year term. They are joined by 6 AASV-member volunteers who serve up to two 3-year terms. The AASV Executive Director also participates on the foundation board as its Secretary-Treasurer.

The board meets once or twice each year to review the programs actively receiving funding and consider requests for new or additional support. The foundation's mission and the amount of available funds guide the board's decision making.

In addition to participating in the board meetings, board members often assume responsibility for specific foundation programs. For example, Dr Teddi Wolff has served as chair of the Scientific Research Review Committee for the past 3 years. She assembles and coordinates the committee that reviews the research proposals submitted for funding consideration.

Similarly, during her recent tenure as chair of the foundation board, Dr Lisa Tokach assembled and oversaw the committees that selected recipients of the Dr Conrad and Judy Schmidt Family Student Debt-Relief Scholarships and the AASV Foundation – Merck Animal Health Veterinary Student Scholarships. She also established a rotating committee to consider applicants for the Hogg Scholarship.

Are you interested in serving on the AASV Foundation Board? Would you like to be considered for one of the reviewer teams that selects scholarship recipients or research for funding? Are you aware of a project that addresses the foundation's mission that should be considered for support? Contact a member of the AASV Foundation Board to let them know – and while you're at it, thank them for their service!

For more information about the AASV Foundation's current giving programs and funded projects, see **aasv.org/foundation**.

AASV Foundation Board

Dr Ross Kiehne, Chair
Dr Jeff Harker, Vice chair
Dr Mary Battrell
Dr Tom Gillespie
Dr Brett O'Brien
Dr Brian Roggow
Dr Lisa Tokach
Dr Teddi Wolff

AASV Foundation Mission

The mission of the American Association of Swine Veterinarians Foundation is to empower swine veterinarians to achieve a higher level of personal and professional effectiveness by:

- enhancing the image of the swine veterinary profession,
- supporting the development and scholarship of students and veterinarians interested in the swine industry,
- addressing long-range issues of the profession,
- supporting faculty and promoting excellence in the teaching of swine health and production, and
- funding research with direct application to the profession.

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EASE™

Enhanced Antigen Surface Expression

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A new and improved bacterial growth procedure for Autogenous Vacccines

Phibro is implementing the use of EASE technology to grow bacteria such as *Salmonella spp.*, *E. coli* and other Gram-negative organisms for production of autogenous vaccines.

- EASE results in an upregulation of proteins on the bacterial surface in its natural form.
- EASE ensures a higher ratio of immunogenic proteins to other superficial proteins leading to a more focused immune response from the host animal.
- EASE implementation leads to a more defined vaccine product.

*Potency and efficacy of autogenous biologics have not been established.
Phibro Autogenous Vaccines are developed with MVP Adjuvants®

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Certified Swine Sample Collector training program

Once a foreign animal disease (FAD) has been detected in the US swine herd, the primary response goals will be to detect, control, and contain the FAD as quickly as possible by using surveillance and diagnostics. Enhanced biosecurity and increased sample collection quantity and frequency will make it difficult or impossible for the few FAD diagnosticians and swine-focused veterinarians to efficiently collect samples and perform diagnostic investigations for the large number of swine farms involved in a timely way. This high demand for sample collection creates a bottleneck in the response process. An inadequate disease response inflicts great harm on the industry long-term, negatively impacts animal welfare, jeopardizes livelihoods, threatens food security for consumers, and significantly hinders the US economy.

With funding from the US Department of Agriculture's National Animal Disease Preparedness and Response Program, the American Association of Swine Veterinarians collaborated with the Center for Food Security and Public Health and Swine Medicine Education Center at Iowa State University, the National Pork Board, and the Multistate Partnership for Security in Agriculture to develop the Certified Swine Sample Collector (CSSC) training program. The CSSC training program aims to increase capacity by allowing the current on-farm labor force to be a critical asset during an FAD response and assist in critical diagnostic sample collection and submission. The new program also assures state and federal animal health officials that producers and caretakers have been trained prior to an outbreak through a standardized process to correctly collect, handle, and submit samples.

For USDA Category II accredited veterinarians with swine experience who wish to train individuals to become CSSCs, the first step is to contact the State Animal Health Officials (SAHO) in the state(s) where they plan to train or use CSSCs to confirm their eligibility to participate in the program and any additional requirements that exist. In addition to being a USDA Category II accredited veterinarian, trainers must:

- have a business relationship with the owner of the pigs on farms where individuals are trained **or**
- perform training by request of the site's Category II accredited veterinarian under whose direction the collectors will be submitting samples.

Trainers can conduct trainings in any state regardless of where they are accredited. However, the veterinarian under whom the samples are submitted is required to be licensed and accredited in the state where the samples are collected.

The next step is to access the training materials at **securepork.org/training-materials/disease-monitoring-sample**. Here you will find handouts and videos for each sample collection type in both English and Spanish. To become a CSSC, trainees must be approved by a Category II accredited veterinarian with swine experience, have a valid Pork Quality Assurance Plus certification, and complete the CSSC curriculum. The curriculum includes classroom instruction, a written exam, and hands-on training. Through the program, CSSCs are trained to recognize clinical signs associated with African swine fever, classical swine fever, and foot-and-mouth disease; use good biosecurity practices; and correctly collect, package, and ship diagnostic samples.

"The CSSC training program aims to increase capacity by allowing the current on-farm labor force to be a critical asset during an FAD response and assist in critical diagnostic sample collection and submission."

There are two tiers of diagnostic sample types a CSSC may become trained to collect.

- Tier 1 sample types include blood, blood swab, oral fluid, nasal swab, and processing fluid.
- Tier 2 sample types include all the sample types from Tier 1 and tonsil, spleen, lymph node, tracheal swab, and vesicular fluid.

Once the classroom training is complete, an individual passes the written exam, and the individual successfully completes the hands-on evaluation demonstrating competency, certification stays with the individual even if they change employment or move to a different state. A CSSC can collect samples:

- from any swine operation as requested by the Category II accredited veterinarian under whom the samples will be submitted.

Advocacy in action continued on page 287

Advocacy in action continued from page 285

- from more than one state if the Category II accredited veterinarian they are submitting samples under is licensed and accredited in the state where the samples are collected.
- for multiple Category II accredited veterinarians.

Category II accredited veterinarians who perform the training will be required to record and retain the information of trained individuals and share this information with the SAHO in the state where the individual will be collecting samples. Certification in the program is valid for 1 year with recertification required annually. Immediate recertification is required if a veterinary diagnostic lab informs the USDA Category II accredited veterinarian that submitted samples are deemed unacceptable. To become recertified, the CSSC must demonstrate competency collecting samples as determined by their trainer. Recertifying individuals must also receive training on any new sample collection types added to the curriculum to maintain their certification. Category II accredited veterinarians are encouraged to work with their SAHO to make sure the list of CSSCs is routinely updated.

During an FAD outbreak, SAHOs determine when CSSCs will be allowed to collect samples in their state and where the samples will be sent for testing. Training candidates prior to an outbreak and maintaining their sample collection proficiency on a continual basis ensures they are prepared to respond as an outbreak unfolds. Ultimately, building capacity for diagnostic sample collection will result in a more efficient response to an FAD outbreak.

Sherrie Webb, MSc
Director of Swine Welfare

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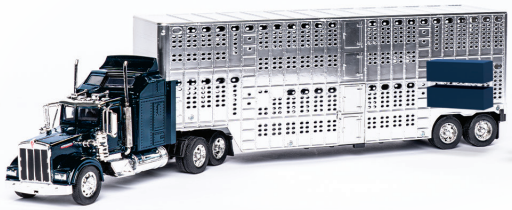
Iron(III) Dextran

The #1 iron dextran (III) for baby pigs



1,400

200 mg = 1,109

2 x 200 mg = 427

x (-$2.77) = ?

Opitmal* ≥ 110 g/L | Deficient* <90 g/L

Q: A truck holds an average of 1,400 baby pigs. If given a single 200 mg dose of iron 1,109 baby pigs will be subject to iron deficiency anemia. If given a second 200 mg dose, only 427 baby pigs will be subject to iron deficiency anemia, which is an increase of 682 optimal-iron baby pigs. If baby pigs subject to iron deficiency anemia bring $2.77 less at market per head,[1,2,3] how much money is a pork producer leaving on the table with every truckload if they don't use a second dose of Uniferon®?

A: $1,889

Change the math by adding a second dose of Uniferon®.

1: Perri A et al. An investigation of iron deficiency and anemia in piglets and the effect of iron status at weaning on post-weaning performance. JSHAP. 2016;24:10–20.

2: Fredericks L et al. Evaluation of the impact of iron dosage on post- weaning weight gain, and mortality. AASV. 2018;315

3: Olsen, C. (2019) The economics of iron deficiency anemia on US swine production: An annual impact of 46-335 million US dollars. American Association of Swine Veterinarians. Orlando. Florida.

* Industry Standards for Blood Hb Levels (g/L)

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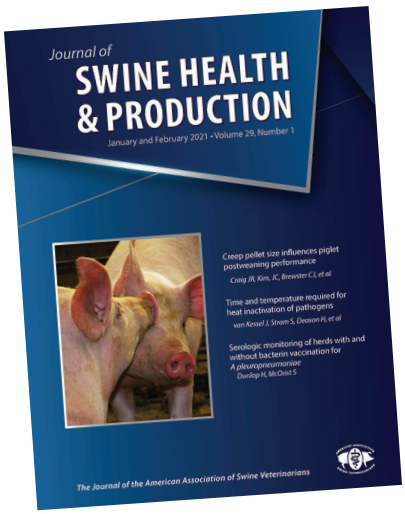
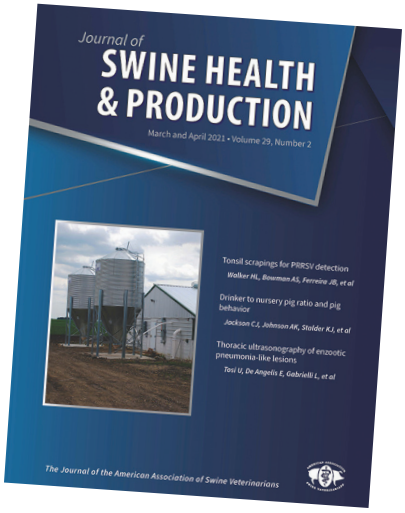
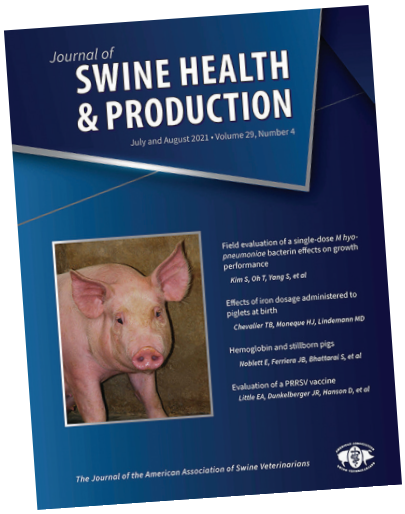
Pigs of #instaham







Share your pig photos for the JSHAP cover

Submissions by readers are welcome!

- Photos must represent healthy pigs and modern production facilities and not include people.
- Photos must be taken using the camera's largest file size and highest resolution.
- Please send the original image(s); do not resize, crop, rotate, or color-correct the image prior to submission.
- Submit photos with your name and affiliation to **tina@aasv.org**.

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PRRSGard® is an innovative approach to modified-live vaccine construction.

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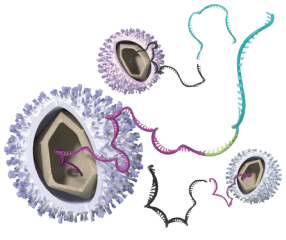
- Demonstrated efficacy against lung lesions and performance loss from pneumonia associated with the PRRS virus in growing pigs
- Unique genetic marker for use in diagnostic assays
- 1 mL dose



Take the next step to protect your pigs from the ever-changing PRRS challenge. Visit PRRSGard.com

UPCOMING MEETINGS

Allen D. Leman Swine Conference

September 18 - 21, 2021 (Sat-Tue)
A hybrid conference
Saint Paul RiverCentre
Saint Paul, Minnesota

For more information:
Email: **vetmedccaps@umn.edu**
Web: **lemanconference.umn.edu**

US Animal Health Association 125th Annual Meeting

October 21 - 27, 2021 (Thu-Wed)
Gaylord Rockies Hotel
Denver, Colorado

For more information:
United States Animal Health Association
4221 Mitchell Ave
Saint Joseph, MO 64507
Tel: 816-671-1144
Web: **usaha.org/meetings**

International Conference on Pig Survivability

October 27 - 28, 2021 (Wed-Thu)
Omaha, Nebraska

For more information:
Dr Joel DeRouchey
Email: **jderouch@ksu.edu**
Web: **piglivability.org/conference**

ISU James D. McKean Swine Conference

November 4 - 5, 2021 (Thu-Fri)
Scheman Building
Iowa State University
Ames, Iowa

For registration information:
Registration Services
Iowa State University
1601 Golden Aspen Drive #110
Ames, Iowa 50010
Tel: 515-294-6222
Email: **registrations@iastate.edu**

For questions about program content:
Dr Chris Rademacher
Conference Chair
Iowa State University
Email: **cjrdvm@iastate.edu**

AASV Early Career Swine Veterinarian Conference

November 5, 2021 (Fri)
Scheman Building
Iowa State University
Ames, Iowa

For more information:
Email: **aasv@aasv.org**
Web: **aasv.org/earlycareer**

American Association of Swine Veterinarians 53rd Annual Meeting

February 26 - March 1, 2022 (Sat-Tue)
JW Marriott Indianapolis
Indianapolis, Indiana USA

For more information:
American Association of Swine Veterinarians
830 26th Street
Perry, Iowa 50220 USA
Tel: 515-465-5255
Email: **aasv@aasv.org**
Web: **aasv.org/annmtg**

26th International Pig Veterinary Society Congress

June 2022 - Date to be determined
Rio de Janeiro, Brazil

For more information:
Tel: +55 31 3360 3663
Email: **ipvs2020@ipvs2020.com**
Web: **ipvs2020.com**

For additional information on upcoming meetings: aasv.org/meetings

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