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JOURNAL OF SWINE HEALTH AND PRODUCTION

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TABLE OF CONTENTS

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JSHAP SPOTLIGHT

Dr Scott Dee

Pipestone Veterinary Services

Dr Scott Dee earned an MS ('85), DVM ('97), and PhD ('96) from the University of Minnesota and is a Diplomate of the American College of Veterinary Microbiologists. Dr Dee is a veterinary microbiologist and currently directs the division of applied research at Pipestone Veterinary Services. There he focuses on the transmission of viruses of veterinary significance and how to biosecure swine farms both at the domestic and transboundary level. Dr Dee chooses to serve as a reviewer because "JSHAP is the journal of the AASV, and it is my duty to serve the journal in any way possible." Fun fact – Dr Dee published a paper in the very first edition of the journal: *Swine Health Prod.* 1993;1(1).

How much is it costing you to not manage Mhp?

(Mycoplasma hyopneumoniae)

ADG 4.4%[1] ↓

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Wean – to – finish cost / pig $2 – $5[1] ↑

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[1]Yeske, 2016. *Mycoplasma hyopneumoniae* elimination, 2016 AASV Annual Meeting Proceedings, pg. 376–380. https://www.aasv.org/library/swineinfo/item.php?AASV/2016/376_Yeske.pdf

Photo courtesy of National Pork Board and the Pork Checkoff. Des Moines, Iowa USA.

zoetis

Disease elimination

These two words can spark lively debate at any gathering of more than 2 veterinarians. Over the last couple decades of swine veterinary medicine, our collective scientific organization has taken on a variety of complicated programs to eliminate infectious diseases from various growing pig and sow farm populations. We have the ambition and the science to get this done in many ways.

We currently are faced with a significant financial crunch on many producers, unwilling to consider the sizeable investment in time or resources needed to chase down and eliminate some of the costliest problems in our industry. I believe we have an opportunity when gilts are plentiful and market pressures are not pulling resources away. We can focus on targeted diseases and dust off some of the more challenging and successful programs.

While I was not involved in the old days of "hog cholera vaccination," the late Dr KT Wright shared many stories of state and federal veterinary agencies with local accredited veterinarians tasked with attacking the disease with a known effective vaccine to eradicate the pathogen from the United States. Producers, however, grew bitter of the cost. Herd veterinarians grew tired of simply being the technician. The reality in the end was a highly successful disease elimination which came at a high price to the taxpayer and producer. Decades of healthy pigs prove the value, but the perception remained. Producers and veterinarians want to control their own destiny.

The second round of coordinated swine disease elimination also had a highly successful tool with government support. Pseudorabies virus was eliminated in my early career with required vaccination in high-risk populations and routine monitoring for high-risk sow herds and interstate shipment. Again, once down to the last holdout producer, there was some argument and frustration. It was arguably the last major coordinated swine disease elimination program to successfully rid the entire US swine population of a disease. This time vaccination was slightly lower in cost and could be given by farm teams. Extensive testing and herd depopulation was supported by government programs. In the end, swine producers led the debate and through peer pressure, helped stomp out the disease.

Now we come to those diseases we can and have eliminated in certain areas, but still struggle to see a coordinated effort nationwide. Porcine epidemic diarrhea virus has been driven to the finishers and dark corners of unwashed trucks, buying stations, and slaughter plants. It has become a very painful compliance indicator for our biosecurity programs on sow farms. We could identify both effective vaccination strategies (modified live virus) and target growing populations (low individual cost). We really want this disease gone!

"Our industry has enjoyed much success in the pursuit of healthy pigs through disease elimination."

Porcine reproductive and respiratory syndrome virus (PRRSV) is an entirely different monster with decades of suffering through incomplete elimination. We have implemented proven biosecurity technology and complicated gilt introduction strategies to "get by." We could and should keep the elimination of this infectious disease high on the list for debate. Just do not let the virus know I said that out loud. My greatest concern with PRRSV is our collective reluctance to take aggressive elimination as the best course of action. Every time we cut corners or take the path almost good enough, our weakness in gaining control is exposed. It is important to identify timely and specific elimination programs for this disease and continue to speak of the success or failure of these programs openly.

Our industry has enjoyed much success in the pursuit of healthy pigs through disease elimination. We have clients and bosses willing to take risks with capital and see the future of healthy production. We should build on that data with proven results. The AASV must remain in the debate. We have tools and opportunities which may actually fall into the best timing during the worst hog market. Remain encouraged and stay in the fight for healthy pigs.

William L Hollis, DVM
AASV President


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How many Certified Swine Sample Collectors have you trained?

The Certified Swine Sample Collector (CSSC) program was developed to build capacity to facilitate response to a foreign animal disease (FAD) in the United States. Specifically, the program is designed to increase the number of people capable of collecting and submitting diagnostic samples during an FAD outbreak. There are not nearly enough state and federal animal health officials or accredited practitioners to meet the sampling demand required to diagnose disease, determine the disease distribution, and verify negative disease status for the purposes of moving animals and products. This will likely require hundreds of thousands of samples for even a modest outbreak.

Responding to the recent outbreak of highly pathogenic avian influenza (HPAI) has challenged the resources available at the state and federal level. And that outbreak, while devastating, is comparatively small considering the likely distribution of an FAD incursion impacting the swine industry. As dedicated and capable as they are, it is pretty evident that government veterinarians would not be able to handle a large FAD outbreak, let alone two at the same time. They have recognized the need to expand the available resources including the number of boots on the ground.

To help meet this need, the United States Department of Agriculture's (USDA) National Animal Disease Preparedness and Response Program provided funding to develop a certification program aimed at training farm personnel capable of collecting samples at the request of the state animal health official and under the oversight of an accredited veterinarian. The American Association of Swine Veterinarians has participated in the development of this program in collaboration 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.

The success of the program relies heavily on Category II Accredited Veterinarians. Have you taken the time to identify and train any of your producers? I realize everyone is busy and it does take time to contact the state animal health official, identify the appropriate producers, schedule the training, and conduct the training. There is also the added burden of annual recertification, but I can guarantee that it will be time well spent if our industry is impacted by an FAD.

We cannot rely on government veterinarians to do it all. We need to step up and do what we can to help enhance the response capabilities and shorten the time it will take to get back to "normal." The USDA is suffering the same challenges of hiring and retaining veterinarians that we see across the food animal spectrum. Legislation that caps salaries for federal veterinarians further compounds the challenges of responding to an animal health disaster. I have been told that some federal veterinarians responding to the HPAI outbreak received a bill from the government to return as much as $15,000 they received in overtime pay because it exceeded the salary cap. In addition, many have faced multiple deployments away from family and their normal job. Some of that burden can be reduced if we work to ensure that the people on the farm can collect and submit the necessary samples.

"We cannot rely on government veterinarians to do it all. We need to step up and do what we can to help enhance the response capabilities and shorten the time it will take to get back to 'normal.'"

Sherrie Webb wrote an excellent article published in the *Journal of Swine Health and Production* (JSHAP) in 2021 which provides additional information about the program.[1] The program is advertised every week in the AASV e-Letter and in each issue of JSHAP. You can find all of the program details, training materials, and forms on the CSSC webpage (**securepork.org/cssc**).

So, I would like to encourage each of you to think about which of your producers would be good candidates to become a CSSC so they can help respond when needed. Reach out to your state animal health official and see if they are supporting the training program in their state. Recognizing that there is a time requirement to get this done, we are exploring options to facilitate the actual training, but it is still incumbent on you to identify the producers and accept the responsibility of overseeing the collection and submission of samples during an emergency. Please consider taking the first step.

Harry Snelson, DVM
Executive Director

Reference

*1. Webb S. Certified Swine Sample Collector training program [Editorial]. J Swine Health Prod. 2021;29:285-287. **https://www.aasv.org/shap/issues/v29n5/v29n5advocacy.html***

*Non-refereed reference.

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Clinical & Fecal Scores

Study days 58-70:
Clinical Scores: 0 Normal, 1 Mild, 2 Moderate, 3 Severe
Fecal Scores: 0 Normal, 1 Soft, 2 Loose, 3 Watery

Scoring	Saline	ENDOVAC-Porci®	Porcilis® Ileitis
Clinical	24.7[a]	14.6[b]	15.9[ab]
Fecal	27.4[a]	17.1[b]	20.9[ab]

Treatment means with different superscripts differ from each other (P < 0.05)

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- **50.8%** better fecal scores

Clinical & Fecal Scores

Study days 22-35:
Clinical Scores: 0 Normal, 1 Mild, 2 Moderate, 3 Severe
Fecal Scores: 0 Normal, 1 Soft, 2 Loose, 3 Watery

Treatment	Saline	ENDOVAC-Porci®	P-value
Clinical	1.19	0.29	.05
Fecal	1.95	0.96	.05

Effect of treatment (P < 0.01)

Emily's role as proofreader

As I reflect on the past year of working as the proofreader for the *Journal of Swine Health and Production*, my scope of knowledge of the swine industry has broadened. It has also been an honor to take over a portion of the responsibilities Karen Richardson held within the journal when it comes to proofreading. It has been a pleasure to join this amazing team of individuals that help ensure this journal is a success.

My background being in the areas of education and English, this role has had quite the learning curve and one that I have thoroughly enjoyed. From manuscripts on testing diarrhea to the process farmers and visitors undergo to keep pig farms safe and disease free, I welcome the opportunity to gain insight from the wise words shared by these industry professionals. Not to mention, it was an honor to meet so many expert veterinarians at the 2023 AASV Annual Meeting that are on the front lines of these studies.

In the proofreading role, there are quite a few steps that take place before a manuscript shows up in my inbox. Once I receive the notification that there is something to be reviewed via email, I then go into the program that we use to make comments and suggestions throughout. I work closely with Sherrie Webb to identify errors as well as ensure that manuscripts follow the journal style and proper formatting.

I also regularly communicate with Rhea Schirm, the JSHAP publications manager, to ensure that deadlines are being met. Once everything is complete and submitted to Tina Smith for design, Sherrie will order a hard copy of the final draft to look over for final edits. If any additional errors are found, I will then work to correct them with Sherrie and the graphics team. The last step of the process will come directly from the printer. This will be the last time I see the journal before it goes to print. At this point, I will be looking for any formatting issues or errors that stand out in the final version.

"My background being in the areas of education and English, this role has had quite the learning curve and one that I have thoroughly enjoyed."

I am grateful for the opportunity to be a part of the JSHAP team and look forward to the future of this journal and the swine industry.

Emily Hanna
Proofreader

Nutritional strategies to reduce the impact of *Escherichia coli* in newly weaned pigs

Madie R. Wensley, MS; Mike D. Tokach, PhD; Jason C. Woodworth, PhD; Robert D. Goodband, PhD; Joel M. DeRouchey, PhD; Jordan T. Gebhardt, DVM, PhD

Summary

Low crude protein, added insoluble fiber, and low acid-binding capacity diets, as well as pharmacological zinc oxide (when applicable) are important nutritional strategies that can be used to maintain the gastrointestinal health of weanling pigs exposed to *Escherichia coli*. Feed additives including probiotics, exogenous enzymes, egg yolk antibodies, spray-dried plasma, clays, medium-chain fatty acids, phytogens, and antibiotics may be other options to reduce the impact of *E coli*. Management strategies such as vaccine protocols, colostrum management, barn and water line sanitation, and weaning age should be combined with nutritional interventions to minimize diarrhea caused by *E coli*.

Keywords: swine, *Escherichia coli*, wean pig, postweaning diarrhea, nutrition

Received: May 26, 2022
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Resumen - Estrategias nutricionales para reducir el impacto de la *Escherichia coli* en cerdos recién destetados

Las dietas bajas en proteína cruda, fibra añadida no soluble, y las dietas con baja capacidad de fijación de ácidos, así como el óxido de zinc farmacológico (cuando corresponda) son estrategias nutricionales importantes que pueden usarse para mantener la salud gastrointestinal de lechones destetados expuestos a la *Escherichia coli*. Los aditivos alimenticios como los probióticos, enzimas exógenas, anticuerpos de yema de huevo, plasma secado por aspersión, arcillas, ácidos grasos de cadena media, fitógenos, y antibióticos pueden ser otras opciones para reducir el impacto de la *E coli*. Las estrategias de manejo, como los protocolos de vacunación, el manejo del calostro, el saneamiento de las instalaciones y de las líneas de agua, y la edad al destete deben combinarse con intervenciones nutricionales para minimizar la diarrea causada por *E coli*.

Résumé - Stratégies nutritionnelles afin de réduire l'impact d'*Escherichia coli* chez les porcs nouvellement sevrés

Les régimes à faible teneur en protéines brutes, en fibres insolubles ajoutées et à faible capacité de fixation des acides, ainsi que l'oxyde de zinc pharmacologique (le cas échéant) sont des stratégies nutritionnelles importantes qui peuvent être utilisées pour maintenir la santé gastro-intestinale des porcelets sevrés exposés à *Escherichia coli*. Les additifs alimentaires, y compris les probiotiques, les enzymes exogènes, les anticorps de jaune d'œuf, le plasma séché par pulvérisation, les argiles, les acides gras à chaîne moyenne, les phytogènes, et les antibiotiques peuvent être d'autres options pour réduire l'impact d'*E coli*. Les stratégies de gestion telles que les protocoles de vaccination, la gestion du colostrum, l'assainissement de la bâtisse et des conduites d'eau, et l'âge de sevrage doivent être combinés à des interventions nutritionnelles pour minimiser la diarrhée causée par *E coli*.

Postweaning diarrhea (PWD) is generally characterized by loose, watery stool that occurs in the first 2 weeks post weaning.[1] The incidence of PWD is caused by a combination of different factors, including exposure to infectious pathogens such as rotavirus, *Salmonella*, or *Escherichia coli*, as well as the innate physiological and metabolic changes the young pig's gastrointestinal (GI) system undergoes around the time of weaning. In a recent study by Eriksen et al,[1] the cumulative incidence of diarrhea was estimated in 2 Danish indoor commercial production systems where no zinc oxide (ZnO) was fed. In both systems, PWD displayed a biphasic pattern with diarrhea prevalence increasing up to day 3 post weaning, and then peaking again around day 10 post weaning. Rotavirus prevalence was highest in the first 3 days after weaning, followed by *E coli* at day 10. In the United States, enterotoxigenic *E coli* (ETEC) often results in clinical illness beginning 10 to 14 days post weaning. Upon oral exposure to ETEC, pathogenesis occurs through 2 mechanisms: 1) adhesion to and colonization of the small intestinal epithelium and 2) enterotoxin secretion.[2] Long filamentous proteins called fimbriae, found on the surface of ETEC bacteria cells, adhere to specific enterocyte receptors and begin colonizing the small intestinal epithelium.[2] The 2 most common ETEC strains associated with PWD express F4 (also known as K88) and F18 fimbriae. Once colonization begins, ETEC produces enterotoxins (STa, STb, or LT) that disrupt tight junction integrity, leading to reduced nutrient absorption and increased fluid secretion into the intestinal

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Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. Nutritional strategies to reduce the impact of *Escherichia coli* in newly weaned pigs. *J Swine Health Prod*. 2023;31(5):230-235. **https://doi.org/10.54846/jshap/1318**

lumen.[2] This results in diarrhea, reductions in growth performance, and in severe cases can lead to dehydration, electrolyte imbalances, and death. This practice tip will discuss nutritional strategies that can be used to maintain GI health of newly weaned pigs by reducing the adhesion and proliferation of *E coli* pathogens (Table 1).

Zinc and copper

To minimize pathogen-induced diarrhea in weaned pigs, pharmacological levels of zinc (2000 - 3000 ppm) from ZnO are commonly fed for the first 2 to 3 weeks after weaning.[3] The mode of action of ZnO is not well understood; however, several different mechanisms related to immune system modulation, nutrient absorption, and preservation of intestinal morphology have been identified.[4,5] While ZnO does not appear to have direct antimicrobial effects on *E coli*, it is believed that ZnO works through a multi-faceted approach to inhibit bacterial adhesion to the intestinal mucosa by blocking enterocyte receptor sites, therefore preventing the breakdown of tight junctions.[4] Copper is another mineral that can be fed at pharmacological levels to prevent pathogen induced diarrhea; however, it is less effective than ZnO. Pharmacological levels of copper (125 - 250 ppm) from copper sulfate, tribasic copper chloride, or other copper sources can be fed during early nursery in combination with high ZnO, but additive effects of the 2 minerals are not observed. Therefore, if ZnO is available to feed at elevated levels in early nursery, many producers will wait to feed elevated levels of copper until late nursery. In contrast to zinc, copper has antimicrobial effects which cause oxidative damage to bacterial cell membranes through the release of copper ions resulting in microorganism death.[5-7] In addition to the GI health benefits of zinc and copper when fed at elevated levels, growth promoting benefits have been observed.[8] Unfortunately, this practice has led to increased environmental concerns and issues surrounding bacterial resistance. The European Union has imposed regulations on the level of Zn (≤ 150 ppm) and copper (≤ 25 ppm) that can be included in swine diets. Canada has also started implementing feeding limits and it is expected that potential regulations will continue to be a topic of discussion within the United States. Thus, it is necessary to evaluate alternative feeding strategies to reduce the impact of enteric diseases such as *E coli*.

Alternative zinc sources

Several alternative forms of zinc have been investigated, including organic and inorganic sources and carrier mediated, nanoparticle, or microencapsulated sources.[4] Because many of these sources are more bioavailable than ZnO, alternative forms of zinc do provide an opportunity to reduce zinc inclusion levels in the diet. However, the ability of these sources to inhibit PWD have only shown intermediary effects when fed in comparison to ZnO.[4] Likewise, previous research on alternative zinc sources has only investigated levels above the inclusion limits currently imposed by the European Union. In areas such as Canada, where regulations allow zinc inclusion up to 500 ppm, there may be more opportunity to introduce other zinc sources.

Table 1: Nutritional strategies and their mode of action against *Escherichia coli*

Nutritional strategy	Primary mode of action
Zinc oxide	Inhibits pathogen adhesion by blocking enterocyte receptor sites
Copper	Pathogen death
Low crude protein	Reduces bacterial fermentation by decreasing the amount of undigested protein in the large intestine
High insoluble fiber	Inhibits pathogen adhesion by providing an alternative adhesion site
	Increases the proliferation of good bacteria to out compete pathogenic bacteria
Low acid-binding capacity diets	Reduces pathogen proliferation by decreasing gastric pH
Organic acids	Reduces pathogen proliferation by decreasing gastric pH
	Reduces pathogen proliferation by slowing down their metabolism
Probiotics	Inhibit pathogen adhesion by blocking enterocyte receptor sites
Exogenous enzymes	Inhibit pathogen adhesion by blocking enterocyte receptor sites
	Inhibit pathogen adhesion by decreasing intestinal receptor affinity for *E coli*
Egg yolk antibodies	Inhibit pathogen adhesion by neutralizing the adhesive property of *E coli* fimbriae
Spray-dried plasma	Inhibit pathogen adhesion by neutralizing the adhesive property of *E coli* fimbriae
	Inhibit pathogen adhesion by providing an alternative adhesion site for *E coli* fimbriae
Clays	Inhibit heat-labile enterotoxin absorption through the epithelial mucosa
Medium-chain fatty acids	Pathogen death
Phytogens	Pathogen death
Antibiotics	Pathogen death

Low crude protein, amino acid supplemented diets

Solid feed intake after weaning results in the secretion of hydrochloric acid in the stomach, which is essential for the breakdown and digestion of proteins.[9] However, this process may take time given that pigs experience a period of low voluntary feed intake following weaning. This ultimately results in a lower capacity to digest intact plant proteins, such as soybean meal. Specifically, when feeding a standard diet containing 21% to 23% crude protein (CP), a percentage of undigested proteins enter the large intestine leading to increased microbial fermentation and the production of diarrhetic compounds such as ammonia and amines.[10] This response is often exacerbated if pigs are exposed to pathogens, particularly when ZnO is removed from the diet. Feeding low CP diets during the first 7 to 14 days after weaning is an important strategy that can be used to decrease the amount of protein entering the large intestine for fermentation. Research consistently shows that feeding low CP diets (< 21%) decreases protein fermentation[11-13]; however, reductions in coliform producing bacteria in the ileal digesta of pigs have not accompanied this response, regardless if pigs were exposed to *E coli*.[11,14] Nevertheless, a consistent improvement in fecal dry matter has been observed when low CP diets with no ZnO are fed compared to a standard CP diet with no ZnO signifying a lesser PWD incidence.[12,15,16] In contrast to the health promoting benefits, the biggest challenge with low CP diets is the reduction in growth performance that is often observed.[15,17,18] Supplementing low CP diets with feed-grade amino acids (AA) to meet requirements can recover some losses in performance; however, reducing CP by more than 3% has resulted in conflicting responses.[19] It is likely that large CP reductions lead to AA deficiencies beyond the fifth limiting AA and may begin to limit indispensable AAs. Unfortunately, supplementation with up to 9 essential AAs or indispensable AAs, such as glycine and glutamate, still did not recover growth.[15,20] In addition to low CP diets, another way to reduce the amount of lower-digestible, plant-derived protein is to replace a portion of soybean meal with highly digestible, specialty protein sources such as spray-dried blood products, fish meal, and whey protein concentrates. These ingredients can be gradually replaced with soybean meal as the pig's ability to digest plant-derived proteins becomes more developed. This generally occurs as diets progress through phase 1 and 2 with no specialty proteins included in phase 3 diets. Feed budgets for each diet are typically fed at approximately 4, 12, and 35 lb/pig for phase 1, 2, and 3 diets, respectively.

Dietary fiber

Dietary fiber inclusion is another strategy that can be used to improve the GI health of weaned pigs. Fiber has prebiotic properties that stimulate the proliferation of "good" bacteria such as *Bifidobacterium*, *Lactobacilllus*, and *Eubacterium*, which are thought to out-compete pathogenic bacteria.[10] Furthermore, because dietary fibers are relatively indigestible, some believe they may act as alternative adhesion sites for *E coli*, therefore inhibiting *E coli* adherence to enterocytes.[21] Sources of fiber are generally divided into 2 categories: soluble and insoluble non-starch polysaccharides (NSP). Soluble fibers tend to have a higher fermentation capacity than insoluble fibers. This is of particular concern in newly weaned pigs because they have a limited capacity to ferment fiber and an accumulation of nonfermentable material in the large intestine can occur, increasing the incidence of PWD.[22] Furthermore, soluble fibers increase intestinal viscosity, which has been shown to decrease digesta passage rates leading to increased proliferation of pathogenic *E coli*.[23] Conversely, insoluble fibers have a relatively low fermentation capacity, decreased intestinal viscosity, and increased digest passage, which have been shown to increase fecal bulk.[24] Therefore, insoluble fiber sources that are high in cellulose, such as oat hulls and wheat bran are commonly used in starter diets to promote GI health.[22,25] Generally, including these fiber sources at levels to achieve an insoluble fiber inclusion of 20 to 80 g/kg is recommended.[26] As feed intake increases and their GI system becomes more developed after weaning, the pig's ability to ferment NSP increases and soluble fiber sources can be fed in place of insoluble fiber sources. Thus, early nursery pigs should be fed insoluble fiber, while late nursery pigs should be fed soluble fiber. Supplementing starter diets with 4% wheat bran has been shown to block the adhesion of *E coli* K88 to the ileal mucosa, reduce coliform counts in microbial populations, and improve fecal scores.[27,28] Feeding coarse-ground wheat bran has shown additional benefits to fine-ground wheat bran.[27] Because insoluble fibers are continuously interacting with the intestinal epithelium due to increased digesta passage rate, it is believed that coarse-ground insoluble fibers, such as wheat bran, act to "wash out" mucous-bound microbes.[26] Likewise, the larger particle size of course-ground wheat bran has a greater water holding capacity than fine-ground wheat bran, further increasing the solubility, passage rate, and fecal bulking potential of the diet.[29] Diluting the energy density of starter diets through fiber inclusion has also been shown to increase feed intake, and therefore, reduce digesta *E coli* counts and improve fecal scores.[30]

Dietary acid-binding capacity

Complete diets can alter the pigs stomach pH based on the individual ingredients fed and their capacity to bind gastric acid. Acid-binding capacity (ABC) is defined as the amount of acid required to produce a unit change in pH of a complete feed or ingredient.[31] Minerals (ie, ZnO and calcium carbonate) have a higher ABC value compared to cereal grains and bind acid more readily. A high ABC in combination with low hydrochloric acid secretion increases stomach pH leading to decreased protein digestion. Therefore, the ABC of complete diets is important to prevent enteric health challenges. The manipulation of stomach acidity can be achieved through diet formulation strategies to decrease complete feed ABC values including the reduction of minerals, such as calcium and phosphorus from calcium carbonate and sodium phosphate, or the addition of acidifiers to the diet.[31] Both have shown positive effects on pig growth performance and feed efficiency.[32-34] In addition to decreasing gastric pH, some organic acids, including butyric, formic, acetic, and propionic, also have bacteriostatic properties that act directly on gram-negative bacteria cell walls to slow down pathogen metabolism and subsequent proliferation.[35] Specifically, benzoic acid has been shown to positively influence the weight gain and fecal scores of weaned pigs inoculated with *E coli*.[36,37] In addition, the improvement in growth performance appears to remain after benzoic acid is removed from the diet[34,36] suggesting that acids may provide prolonged GI benefits. Some data also suggests that feeding coarse-ground particles improves acid production in the stomach and hindgut, therefore reducing gastric pH.[38]

Feeding diets with a low ABC has an opportunity to improve weaned pig GI health while offering protection against pathogen proliferation; however, more research is needed to make definitive recommendations on specific ABC values for each dietary phase. In addition to feed, lowering the pH of drinking water (between 4 and 6) with organic acids can improve stomach acidity and reduce *E coli* shedding in nursery pigs.[39] Periodically evaluating drinking water pH is a practical way to know when water acidification may be necessary. Likewise, cleaning barn water lines is a sanitary precaution that can be implemented to decrease the buildup of bacterial colonization in drinking water delivery systems.

Diet particle size and feed form

Based on the existing data, providing feed with particle sizes between 0.5 and 1.6 mm is recommended to optimize nutrient utilization and GI health.[38] This can be accomplished by feeding fiber-rich cereal byproducts (wheat bran) or coarse-grinding cereal grains.[40] While limited data is available regarding the influence of diet form on clinical disease associated with *E coli*, a study conducted by Longpré et al[41] reported increased cecal and colon *E coli* loads but improved growth performance in pigs fed pelleted diets compared to mash.

Feed additives

Several feed additives have been investigated for their potential to mitigate the effects of *E coli*. While many of the additives appear to be multifaceted in nature, only their primary mode of action to protect weaned pigs against enteric disease will be discussed. Modes of action can be subdivided into 2 categories: 1) pathogen adherence inhibition or 2) pathogen cell death.

Pathogen adherence inhibition

Probiotics are live microbial feed supplements that alter the microbiota of the GI tract through the direct feeding of beneficial bacteria. Therefore, it is believed that probiotic microorganisms adhere to the intestinal epithelium inhibiting the attachment of pathogenic bacteria.[42,43] Exogenous enzymes, such as xylanase, have been shown to increase the abundance of *Lactobacillus* and other microbial populations through the hydrolysis of dietary NSP which would result in a similar mode of action of probiotics against *E coli*.[44] The breakdown of NSP has also been shown to decrease digesta viscosity and improve nutrient digestibility which could aid in reducing *E coli* diarrhea. Conversely, other exogenous enzymes, such as protease or trypsin, appear to inhibit *E coli* adherence by increasing intestinal proteolytic activity. This improves protein digestion and has been shown to decrease intestinal receptor affinity for *E coli*.[45,46] Egg yolk immunoglobulin Y antibodies are another feed additive that has been shown to neutralize the adhesive property of *E coli* fimbriae preventing the attachment of *E coli* to the intestinal enterocytes,[47,48] although a relatively high dose of antibody is required.[48] Spray-dried plasma has shown similar effects to egg yolk antibodies on the growth performance and fecal consistency of pigs challenged with *E coli*.[49] Because spray-dried plasma contains immunoglobulins, this may suggest a similar mode of action. Likewise, the glycoprotein receptors found on spray-dried plasma may be responsible for binding *E coli* fimbriae, preventing their attachment to enterocyte receptors.[46,50,51] Lastly, clays act by adsorbing the heat-labile enterotoxin of *E coli* and inhibiting their absorption through the epithelial mucosa. This has been shown to alleviate PWD in *E coli*-challenged pigs.[52,53]

Pathogen cell death

Medium-chain fatty acids (MCFA) and their monoglyceride derivatives have direct antimicrobial properties that typically improve the GI health and growth performance of pigs when supplemented in the diet; although, the magnitude of response observed appears to be driven by the specific MCFA fed and inclusion level.[54] Medium-chain fatty acids act by penetrating the phospholipid membrane that surrounds bacterial and viral pathogens causing cell death.[54,55] Within the individual derivatives of MCFA, the monoglyceride has been shown to have a more potent antimicrobial effect than the fatty acids themselves.[54] Phytogens such as essential oils have also been shown to express antimicrobial properties[56] that, when fed in combination with MCFA, resulted in increased *Lactobacillus* and decreased Enterobacteriaceae fecal counts and decreased diarrhea frequency.[57] Lastly, antimicrobials such as enrofloxacin, apramycin, ceftiofur, neomycin, gentamicin, amoxicillin, and colistin can be used to treat enteric diseases.[58] However, not all these antimicrobials listed are approved for treatment of colibacillosis in the United States and care must be taken to abide by regulatory standards. Water-soluble gentamicin continues to be a common antimicrobial selection for the control and treatment of postweaning colibacillosis in the United States.[58]

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Conflict of interest

None reported.

Disclaimer

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* Non-refereed reference.

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

Strategies to minimize fallback pigs in the nursery

Madie R. Wensley, MS; Mike D. Tokach, PhD; Jason C. Woodworth, PhD; Robert D. Goodband, PhD; Joel M. DeRouchey, PhD; Jordan T. Gebhardt, DVM, PhD

Summary

Preweaning strategies to minimize fallback pigs in the nursery include cross fostering, creep feeding, and weaning an older pig. Postweaning strategies to minimize fallback pigs in the nursery include optimum barn temperature and ventilation set points, easy access to feed and water, and proactive placement strategies. Phase-feeding programs to match the nutrient requirements and digestive abilities of weaned pigs are also crucial. Managing fallback pigs can be accomplished by minimizing drafts in removal pens, providing supplemental heat sources, having multiple feed access points by providing gruel and mat feed, and ensuring more intensive observations of pigs in removal pens.

Keywords: swine, weaning, fallback, nursery pig, livability

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Resumen - Estrategias para minimizar el retraso de los cerdos en la transición

Las estrategias previas al destete para minimizar el retraso de los cerdos en la transición incluyen las adopciones cruzadas, la alimentación de los lechones en la maternidad, y destetar lechones de mayor edad. Las estrategias post destete para minimizar el retraso de los cerdos en la transición incluyen mantener temperaturas optimas en el edificio y puntos de ajuste de la ventilación, fácil acceso al alimento y agua, así como estrategias proactivas de reacomodo. También son cruciales, los programas de alimentación por fases para satisfacer los requisitos de nutrientes, y la capacidad digestiva de los cerdos destetados. El manejo de los cerdos rezagados se puede lograr minimizando las corrientes de aire en los corrales de retrasados, proporcionarles fuentes de calor suplementarias, ofrecer múltiples puntos de acceso al alimento mediante la administración de papilla, alimentación en tapetes, y asegurando una observación constante de los cerdos en estos corrales.

Résumé - Stratégies pour minimiser les porcs retardataires en pouponnière

Les stratégies de présevrage pour minimiser les porcs retardataires dans la pouponnière comprennent le placement croisé, l'alimentation complémentaire, et le sevrage d'un porc plus âgé. Les stratégies post-sevrage pour minimiser le nombre de porcs retardataires dans la pouponnière comprennent des points de consigne de température et de ventilation optimaux, un accès facile aux aliments et à l'eau, et des stratégies de placement proactives. Les programmes d'alimentation par phases pour correspondre aux besoins en nutriments et aux capacités digestives des porcs sevrés sont également cruciaux. La gestion des porcs retardataires peut être accomplie en minimisant les courants d'air dans les enclos de retrait, en fournissant des sources de chaleur supplémentaires, en ayant plusieurs points d'accès aux aliments en fournissant du gruau et des tapis d'alimentation, et en assurant des observations plus intensives des porcs dans les enclos de retrait.

Nursery pigs may be removed from the general pig population due to acute, subacute, or chronic illness. However, this population of pigs may have a wide range of clinical presentations including lameness, gaunt flanks, rough hair coat, difficult breathing, droopy eyes, or listless ears that may be the result of several different conditions such as physical injury, sickness, or failure to consume feed. Pigs with low feed intake that fail to achieve similar performance to the general population are referred to as fallback pigs. This response is likely based on the pigs physiological and behavioral reaction to weaning stress, particularly during a vulnerable time when their gastrointestinal system is undergoing extensive maturation. While it is not fully understood why some pigs have a more challenging time adapting to weaning than others, it is important to have procedures in place to help fallback pigs when they are identified. Therefore, the strategies covered in this practice tip will focus on practical ways to reduce stress, improve piglet growth and development, encourage pen exploration, and promote earlier feed intake after weaning. A summary of strategies to minimize the number of fallback pigs in the nursery is summarized in Table 1.

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Table 1: Strategies to minimize the number of fallback pigs in the nursery

Area	Action
Minimizing fallback pigs preweaning	Floor mats and heat lamps in place and on prior to farrowing.
	Room temperature (22°C) and ventilation set points appropriate.
	Understand sow herd health status.
	Litters with > 9 pigs should be split suckled.
	Pigs from large or small litters should be cross fostered to achieve litters with similar counts.
	If creep feeding, proper management of creep feeders should allow for continued access to clean feed.
	Understand weaning ages and spread in weaning ages within weaning group.
Minimizing fallback pigs post weaning	Floor mats and heat lamps in place and on prior to pig arrival.
	Feed in feeders and adjusted to ensure easy feed flow prior to pig arrival.
	Water turned on and waterers adjusted to the correct height and checked to ensure adequate flow rates.
	Room temperature (23°C to 29°C) and ventilation set points appropriate.
	Sort the lightest 10% of the population into uniform body weight groups and the rest of the population into mixed groups.
	Mat feed all pens of pigs up to 4 times per day for the first 3-10 d post placement, depending on pig health status.
	Gruel feed pens of small pigs up to 4 times per day for the first 3-10 d post placement, depending on pig health status.
	Pens of pigs should be observed and encouraged to get up at least 2 times per day.
Intensive care pen management	Located at the center of the room away from external walls.
	Floor mats and heat lamps in place.
	Mat and gruel feeding should be done until full bellies are observed and pigs can be transitioned to recovery pens.
	Fence line panels or plastic covers/tarps should be used to minimize drafts if necessary.
	Pigs should be observed and encouraged to move 4 times per day.

Minimizing fallback pigs

Preweaning strategies

Because most challenges observed from wean to finish are linked back to the sow farm, strategies to minimize fallback pigs in the nursery should begin prior to weaning. The health status and productivity of the sow farm has been shown to be inversely associated with incidence of mortality.[1] Therefore, managing sow herd health and gilt introduction protocols should be top priority to ensure piglets are born and weaned as healthy as possible.

Adequate colostrum intake during the first 24 hours after birth is essential for short-term survival and long-term growth and immune health.[2] Creating a microenvironment within each crate through proper management of room temperature (22°C) and ventilation set points, as well as floor coverings and heat lamps, is necessary to prevent piglet chilling and encourage colostrum intake after birth. The location of heat lamps has not been shown to affect colostrum consumption or piglet survival; however, placing newborn piglets at the udder reduces the time from birth to first suckle (Kara Stewart, PhD, email, October 15, 2022). Another way to ensure colostrum intake is through split suckling which can be accomplished by temporarily removing the heaviest pigs in the litter or the first half of pigs born in the litter for approximately 2 hours. This allows pigs in large litters increased opportunity to receive colostrum. Cross fostering is another strategy that can be used to manage teat space. Most research suggests that cross fostering should occur 12 to 24 hours after birth, after piglets have had a chance to consume colostrum but before teat order has been established.[3] When cross fostering, the age and body weight of both the pig being fostered and the receiving litter should be considered, as well as litter size. Ideally, light-weight pigs (< 1.0 kg) should be fostered into small litters (< 9 pigs) of other light-weight pigs, whereas heavy-weight pigs can be fostered into mixed litters.[3-6] Likewise, piglets should be fostered into litters of a similar age to prevent decreased suckling activity.[7]

Flavor exposure through the maternal diet, followed by re-exposure of the same flavor in nursery starter diets may offer an opportunity to minimize fallback pigs. Some data suggests that flavor learning has the potential to reduce feed neophobia post weaning, therefore improving feed intake.[8,9] However, the impact on pig removal rates has not been determined.

Creep feeding is another strategy that has been shown to improve feed intake and minimize fallback pigs in the nursery. Providing creep feed to litters during the suckling period allows pigs to become acclimated with solid feed in a safe, familiar environment while still receiving nutrients from the sow and reducing feed neophobia post weaning.[10] However, on-farm application can be challenging because creep feeders are often difficult to clean and maintain. Some have attempted to supply creep feed directly onto farrowing stall mats rather than using creep feeders. Improved growth performance on a closeout basis has been observed when providing a pelleted phase 1 diet onto farrowing stall mats as creep feed, whereas providing sow lactation feed as the creep feed was not beneficial.[11] Regardless of application method, providing a complex diet or one that is similar to the diet pigs will be weaned onto can maximize the effects of creep feeding on piglet feed intake and growth after weaning.[11-13] Feeding a large, pelleted creep diet (12 mm) is another opportunity to increase creep feed consumption and intake after weaning.[14] Positive effects on nursery removal rates have also been observed when feeding large pellets (12.7 mm).[11] Furthermore, creep feed intake is dependent on weaning age, with greater intake observed as weaning age increases. Considering modern weaning ages (approximately 21 days), litter feed intake remains relatively low (< 150 g) up until the last 3 days prior to weaning.[15] However, providing creep feed for > 3 days may increase the percentage of pigs that consume creep feed.[16] Thus, duration of creep feeding should occur for a minimum of 3 days. Use of an extended feeding window must be assessed based on the cost of creep feed and labor capacity. The number of pigs consuming creep feed can also be increased by providing creep feed in rotary feeders with hoppers or play feeders.[17,18] Water supplementation through a piglet nipple in addition to creep feed may provide further benefits particularly when weaning an older pig.

Mixing litters in the farrowing facility prior to weaning has been shown to reduce manipulative behaviors and improve postweaning feed intake and body weight gain.[19,20] Some anecdotal evidence also suggests improved health and survivability post weaning due to decreased stress and increased pathogen exposure prior to weaning.

Increased weaning age can better prepare pigs for weaning and provides the greatest opportunity to improve wean-to-finish performance and decrease nursery removal rates.[21,22] Weaning pigs prior to 24 days of age has been linked to greater intestinal permeability, which may exacerbate health challenges such as *Escherichia coli* leading to chronic, recurring diarrhea that persists into later life.[23-25]

Postweaning strategies

Environmental factors have a large impact on how pigs begin to consume feed after weaning. Therefore, barn preparation is key to ensure a more successful transition. This includes making sure nipple waterers are turned on and cup waterers are full, feed is available in feeders, barn temperature (23°C to 29°C) and ventilation are at the appropriate set points with adequate airflow while avoiding animal chilling, mats are in place, and supplemental heat is available. As genetics companies have selected for increased finishing pig performance, starting newly weaned pigs on feed has become more challenging. Therefore, pigs with low feed intake may require higher temperature set points and more intensive care during the first 7 to 14 days after weaning. Likewise, knowing the expected feed intake and growth of the genetic lines used will help caretakers better track how pigs are performing.

Once pigs arrive at the nursery or wean-to-finish facility, sorting strategies can help ensure a successful transition and prevent fallback pigs. Sorting light-weight pigs (approximately 10% of the population) into uniform body weight groups and the rest of the population into mixed groups reduces initial aggression in heavy-weight pigs and provides greater feeding opportunities for light-weight pigs.[26,27] Sorting by sex is another option that also has been shown to decrease mixing aggression.[28] Likewise, decreasing the number of pigs per feeder hole (approximately 3.75 pigs), particularly at high stocking densities (15 pigs/pen) or low floor space allowance (≤ 0.25 m^2), has been shown to result in more rapid onset of feeding and reduced removals.[29,30] The most important factor of feeder design is ease of feed access and management. Typically, wet/dry feeding systems are not recommended because newly weaned pigs have a difficult time dispensing feed and often overfill the feed pan with water. In addition to floor and feeder space, drinker space should also be considered.[31] The Swine Housing and Equipment Handbook[32] recommends 10 nursery pigs per nipple drinker space; however, most production barns are closer to 25:1.[33] While young pigs prefer nipple waterers, push-lever bowl drinkers are recommend to decrease wastage and have no impact on performance.[34]

In addition to sorting strategies, having an appropriate phase-feeding program to match the nutrient requirements and digestive abilities of weaned pigs is crucial.[35] Dietary phases are typically matched with the weight of pigs at weaning, such that heavy weaned pigs receive less of the starter diet compared to light weaned pigs. This is because starter diets are often more expensive due to diet form and complexity. Weaning age data suggest that matching starter diet feed budgets with pig age rather than weight would be more beneficial, as digestive abilities are more closely related to pig age than weight. However, this hypothesis has not been tested. When possible, starter diets should be provided in pelleted form to improve feed efficiency. Pigs prefer course ground corn and pellets with a larger diameter.[20,36,37] In pens where lightweight or removal pigs are housed, an intensive care diet with highly palatable ingredients may need to be provided before the starter diet to encourage earlier feed intake.

Increasing accessibility to feed beyond standard trough feeding through mat and gruel feeding strategies is another opportunity to prevent fallbacks.[38-40] When pigs are weaned around 24 days of age these strategies may be less critical. However, in young (≤ 21 days) or health challenged flows, providing mat or gruel feed 2 to 4 times per day up to 10 days post placement should increase pen exploration and eating activity by stimulating group feeding behavior similar to suckling. Mat feed is a practice that can be accomplished by taking 1 to 2 handfuls of feed from the feeder and placing it directly on mats specifically designated for mat feeding. Having a separate

mat available under supplemental heat is helpful to minimize drafts and provide a warm, dry resting place for pigs. Gruel feeding by adding water to feed in designated gruel feeders is another way to provide multiple feed access points. Gruel feeding should start with a more liquid mixture and gradually transition to a dry mixture over time (3-10 days post weaning). The act of caretakers getting into pens at each feeding time also creates an opportunity to get pigs up and observe pigs more than twice per day. This is particularly important during the first 3 to 10 days post weaning.

Managing fallback pigs

Fully preventing fallback pigs is challenging. Therefore, it is important to know how to properly care for fallbacks when identified and removed from the general population. Early identification is key. Intensive care pens should be equipped with a supplemental heat source to keep pigs warm and dry. Limiting drafts to these pens is also critical, hence, the location of intensive care pens in relation to wall fans and ceiling inlets needs to be considered. Typically, it is recommended to place these pens at the center of the room, away from outside walls. In some cases, this may still require a solid partition be added to the fence lines of pens to prevent excessive drafts. For this reason, mats are also important as they provide a solid place for pigs to sleep while reducing pit drafts. Plastic covers or tarps may also be used to create a microenvironment in the back of pens. Furthermore, mat and gruel feeding this population of pigs for an extended period is necessary until full bellies are observed and pigs can be transitioned to recovery pens. Each of these management strategies are only successful when available to the pig. Therefore, ensuring pigs do not have to travel far to find feed, water, or supplemental heat, especially in large pens, needs to be top priority. This may require multiple resources positioned at different locations throughout the pen or dividing larger pens into multiple small pens. Frequent observations of intensive care pens throughout the day should be a priority and the caretaker should be focused on getting pigs up and moving them towards feed and water, while also observing animal progress to ensure timely euthanasia is applied when necessary.

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Conflict of interest

None reported.

Disclaimer

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Biological sample collection and handling methods for fat-soluble vitamin and trace mineral analysis

Sarah Elefson, MS; Scott Radke, DVM; Laura Greiner, PhD

Summary

Diagnostic reports of biological samples submitted from farms are essential to correctly identify any underlying issues in a herd, including disease and improper nutrition. Proper sample collection, handling, and storage are critical to most accurately diagnose health complications or nutritional status. When possible, sample pigs before they eat, keep tissue samples frozen, avoid hemolyzed blood samples, and minimize transport time to the diagnostic laboratory. Concerns regarding sample collection and storage can be addressed with a veterinary diagnostic laboratory.

Keywords: swine, vitamin, sampling, pre-analytical

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Resumen - Métodos de colecta y manipulación de muestras biológicas para el análisis de vitaminas liposolubles y minerales traza

Los reportes de diagnóstico de las muestras biológicas enviadas desde las granjas son esenciales para identificar correctamente cualquier problema importante en una piara, incluidas las enfermedades y la nutrición inadecuada. La recolección, el manejo, y el almacenamiento adecuados de las muestras son fundamentales para diagnosticar con mayor precisión las complicaciones de salud o el estado nutricional. Cuando sea posible, tome las muestras de los cerdos antes de que coman, mantenga las muestras de los tejidos congeladas, evite las muestras de sangre hemolizada, y minimice el tiempo de transporte al laboratorio de diagnóstico. Las dudas relacionadas con la recolección y el almacenamiento de muestras se pueden abordar con un laboratorio de diagnóstico veterinario.

Résumé - Méthodes de collecte et de manipulation d'échantillons biologiques pour l'analyse des vitamines liposolubles et des oligo-éléments

Les rapports de diagnostic des échantillons biologiques soumis par les fermes sont essentiels pour identifier correctement tout problème sous-jacent dans un troupeau, y compris les maladies et une mauvaise alimentation. La collecte, la manipulation, et l'entreposage appropriés des échantillons sont essentiels pour diagnostiquer avec le plus de précision possible les complications de santé ou l'état nutritionnel. Dans la mesure du possible, il faut échantillonner les porcs avant qu'ils ne mangent, conserver les échantillons de tissus congelés, éviter les échantillons de sang hémolysé, et minimiser le temps de transport vers le laboratoire de diagnostic. Les préoccupations concernant la collecte et l'entreposage des échantillons peuvent être discutées avec le personnel d'un laboratoire de diagnostic vétérinaire.

Sample collection is a crucial component of research and diagnostics. Sample analysis can help determine the root cause of disease issues or the nutritional status of the animal. When evaluating nutritional status, it is essential that samples are collected, handled, and stored appropriately so that nutrient analysis is accurate. Incorrect sample handling may result in misleading analytical results ranging from false deficiencies to toxicities. Specifically, factors that can influence the vitamin analysis of samples include blood tube type, time of collection after a meal, hemolysis, storage, and the animal sampled.

Blood tube type

Blood tube types differ depending on whether the collection is for serum, plasma, or if a specific coagulation method is desired (Table 1). Serum is the liquid portion of the blood that remains after the blood is allowed to clot and then centrifuged. Plasma is the liquid portion centrifuged from unclotted blood. The serum fraction will have lower protein concentrations and a lower number of platelets, erythrocytes, and leukocytes than plasma.[2] It is imperative that samples meant to provide plasma are not allowed to clot because the clotting process will utilize proteins in the sample which will lower the protein content,[2] thus compromising the analytical results of the sample. To avoid plasma samples clotting, collect the blood in a timely manner, and immediately invert the blood tube 8 to 10 times to properly distribute the anticoagulant additives throughout the sample. Serum blood

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Table 1: Blood tube types and functions*

Blood tube top color	Additive	Mode of action	Sample type and considerations
Solid red or red tiger top	Silicon coated sides; red tiger top will have a gel separator	Clot activator will ensure that blood clots in a timely manner	Serum determinations, such as vitamins and other chemistries
Purple/lavender	EDTA	Forms insoluble calcium salts and will prevent clot formation	Hematology and immunohematology
Green	Sodium or lithium heparin	Antithrombin and anti-thromboplactin prevent clot formation	Plasma determination and blood gas analysis
Light blue	3.2% sodium citrate	Forms the insoluble salt calcium citrate and will prevent clot formation	Coaguation determination and platelet function
Grey	Sodium fluoride, and sodium or potassium oxalate	Forms the insoluble salt calcium oxalte and prevents clot formation	Glucose determinations
Royal blue (red stripe)	No preservative	Clot activator will ensure that blood clots in a timely manner	Trace element, toxicology, and nutritional testing
Royal blue (purple/lavender stripe)	Potassium EDTA	Prevents clot formation	Trace element, toxicology, and nutritional chemistry analysis

* Table adapted from Benjamin[1] and BD Vacutainer.[5]

tubes (red, red tiger stripes, or gold tops) allow the collected blood to clot, while plasma (purple or green tops) contain additives, such as sodium or lithium heparin, that prevent blood from clotting.[1]

Using serum versus plasma tubes can affect the analysis of the nutrient in question.[3] For example, Elefson and Greiner[3] showed that vitamin D (25-hydroxyvitamin D_3 metabolite) concentrations were significantly lower when using plasma tubes compared to serum tubes (31 ng/mL vs 34 ng/mL, respectively). Furthermore, it was found that gilts had lower vitamin D metabolites than barrows,[3] which could be due to sexual maturity. Reporting which blood tube was used to the diagnostic laboratories will help to ensure proper reports and interpretations made for the conducted analysis. Additionally, care should be taken when collecting blood for trace minerals, as many components of blood tubes are made with minerals, such as zinc, which can lead to misleading results.[4] Royal blue topped blood tubes are made specifically for either serum or plasma mineral analysis.[5]

Time of collection

In general, pigs have *ad libitum* access to feed. However, there are situations, such as with sows and boars, when pigs are limit fed to help maintain an ideal body condition.[6] When pigs are limit fed, there is a potential for a bolus of nutrients to pass through the bloodstream resulting in nutrient spikes.[3] However, digestion, absorption, nutrient interaction with transporters during absorption, and redistribution of nutrients occur at different rates depending on the nutrient in question. For example, iron and copper have been known to compete for epithelial transporters, thus affecting how much of the other is absorbed.[7] Additionally, the form in which a nutrient is fed to an animal can also affect absorption. For instance, it has been reported that free amino acids are absorbed more quickly than protein-bound amino acids.[8-10] Faster absorption results in the free amino acids appearing in circulation faster than the protein-bound amino acids. Thus, it is best to take blood samples before a given meal to avoid any potential peaks in nutrients in limit-fed animals.

Hemolysis

Hemolysis occurs when red blood cells lyse and their contents interact with the serum or plasma. Hemolysis often occurs post blood draw when shear force is applied to the blood sample. For example, when a blood sample is taken via a syringe and then transferred to a blood tube through the needle, the red blood cells are subjected to a shear force. Additionally, freeze-thaw cycles can also cause hemolysis,[11] and thus freeze-thaw cycles should be avoided. When the contents of red blood cells are released, the serum or plasma components change, such as increasing levels of zinc and iron[12] and altered results for sodium, potassium, and phosphorous.[13] Furthermore, it has been documented that both iron and zinc can form complexes with vitamin A, thus impacting the measured vitamin A concentration within the body.[14,15] It has been shown that hemolysis can decrease vitamin A (retinol) concentration in plasma samples.[3] Additionally, vitamin E (alpha-tocopherol) concentration has been shown to decrease due to red blood cell hemolysis.[16]

Storage

The standard storage method for biological samples is to process and freeze samples as quickly as possible once collected and keep the sample frozen until the time of analysis. Keeping samples frozen helps to prevent any degradation that might occur to the organic components,

such as vitamins.[17] It is common in the United States for samples collected on farm to be processed and submitted frozen in a cooler with ice packs or dry ice, which is shipped overnight to the diagnostic laboratory of choice. However, weather or human error can result in a delay of sample reception at the diagnostic laboratory. The longer samples are not frozen, the greater the chance for an altered vitamin status to occur. Recent work by Elefson and Greiner[3] showed that samples can be stored in a Styrofoam cooler with ice packs for 2 days without significant change to vitamins A (retinol) and E (alpha-tocopherol) in serum and liver.

Animals sampled

If a nutritional issue is suspected on a farm, biological samples provide information regarding nutritional status of the herd. However, sampling only unhealthy animals may not reflect the herd's nutritional status as the animal may not have been consuming food for an extended period. Animals will mobilize reserves to preserve homeostasis. For example, if a diet is deficient in vitamin A, liver vitamin A reserves are mobilized to keep circulating vitamin A levels constant.[17] Furthermore, this mobilization from the liver will result in lower liver vitamin A levels in an ill animal that is not eating compared to healthy animals, regardless of vitamin A concentration in the feed. There may also be sex differences for some nutrients[3] that will also influence how diagnostic results can be interpreted.

Depending upon the suspected deficiency or toxicity, the veterinarian may need to collect samples from both affected and unaffected animals, as unaffected individuals offer a comparative baseline. In addition, information on the nutrient composition of the diet should be provided. Identifying and understanding individual nutrient levels of the pigs within a herd is critical due to the variation from farm to farm in diets fed as well as pig age, health status, and environment.

Feed samples

There are many factors to consider when taking a feed sample to optimize the sample being representative of what the animal is consuming. Factors include size of the sample collected, equipment used for the collection, location of sample collection, and sample storage. Collecting a large feed sample will increase the likelihood that the sample is representative of the batch of feed that is being mixed. Feed samples from different rations or mixed batches should never be pooled so that any nutritional issues cannot be correctly linked back to the source. A hand-grab collection or the use of a probe are common ways to collect feed from either a feeder or mixer.[18] Samples collected with a probe have been documented to have less variability.[19] When using a probe to collect a feed sample, the probe should be able to reach the bottom of the bulk carrier where the feed is located.[18] Furthermore, at least 10 samples from 10 evenly-spaced locations in the bulk carrier should be collected to ensure an accurate representation of the feed.[18] Collection of feed should never be based on ease of collection (ie, side of grain bin where grain is not actively flowing for milling and animal consumption). Additionally, a sample of the premix should be collected along with a complete feed sample to ensure accurate analysis of the premix. For example, vitamins have low inclusion levels in the diet resulting in greater incidence of vitamin-level variation when testing complete feed samples compared to vitamin premixes. Vitamins in feed have different sensitivities to temperature, humidity, and light, with fat-soluble vitamins being some of the most senstive.[20] Thus, after a sample is collected, it should be stored in a cool and dark location to help prevent degradation of organic compounds in the feed. More information on collecting feed samples can be found on the Iowa Pork Industry Center website[21] and the Kansas State University Animal Science and Industry website.[18]

Recommended Sample Process

Knowing how much sample is needed and what type of sample should be collected is essential to help diagnose any disease or nutritional issues. Questions about collecting samples should be directed to a veterinary diagnostic laboratory. In general, there are a few key points to remember when a sample is being collected (Table 2). If a plasma sample is being collected, ensure blood is collected in the blood tube in a timely manner, and the blood tube is inverted to mix the anticoagulant to prevent clotting. To avoid hemolysis in blood samples, do not force blood through a needle and syringe into a blood tube. Instead, a blood collection needle attached to a vacutainer hub allowing for direct collection of blood is ideal, as the vacuum of the tube is such that it provides a constant flow rate that prevents shearing of blood cells. The time of sample collection should be noted if sampled animals are limit fed and samples should be collected before the animal is fed to avoid any nutrient spikes. Samples should be processed and frozen as quickly as possible. Processing samples includes centrifuging blood samples so that plasma or serum can be aliquoted off from red blood cells prior to being frozen. If samples are being shipped to the diagnostic laboratory, then ice packs should be included in the cooler with the samples to keep samples as cool as possible. A sample from healthy animals and ill animals is critical to know what is expected within the herd in question so that a diagnosis is easier to determine for unhealthy animals.

Acknowledgments

Conflict of interest

None reported.

Disclaimer

Scientific manuscripts published in the *Journal of Swine Health and Production* are peer reviewed. However, information on medications, feed, and management techniques may be specific to the research or commercial situation presented in the manuscript. It is the responsibility of the reader to use information responsibly and in accordance with the rules and regulations governing research or the practice of veterinary medicine in their country or region.

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Table 2: Key concepts of sample collection

Topic	Take-home point
Blood	There are different components of blood, such as serum or plasma, that will need to be isolated based on the analysis in question.
Blood tube type	The type of blood tube used will help to isolate either serum or plasma. Certain blood tube types are used for specific analysis over others. Consult with a veterinary diagnostic laboratory to confirm which blood tube would be best to use.
Timing of collection	For pigs that are limit fed, there could be nutrient spikes in blood samples from the nutrients being redistributed to the peripheral tissues after meal consumption.
Hemolysis	When red blood cells reputure, their contents are released and can interfere with the nutrient analysis of a blood sample. It is best to avoid hemolysis by avoiding freeze-thaw cyles and shear force being applied to the sample.
Storage	All samples should be processed, including centrifugation, and frozen as quickly as possible to help prevent any degradation.
Animals being sampled	Both healthy and ill animals should be sampled to help take into consideration what "normal" is on a farm and how the sick animal compares.
Feed samples	A large feed sample should be collected from multiple locations in the mixer or feeder and stored in a cool and dark location to help ensure the analyzed feed is an accurate representation of the feed that is being consumed. Sampling the premix in addition to complete feed can help provide information on nutrients included in a small quantity.

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Tabletop exercise focuses on FAD response in the show pig industry

Coming together as an industry to practice and test a response plan is a critical component of foreign animal disease (FAD) preparation. Simulated situations and guided discussions highlight areas of preparation for both farmers and veterinarians. Dr Patrick Webb, assistant chief veterinarian for National Pork Board (NPB), along with his colleague Bruce Spence, has executed more than 150 tabletop exercises over 20 years.

"The original intent was to raise awareness for key stakeholders and drive action for producers," explained Webb. "Throughout the years and especially since African swine fever (ASF) emerged in China in 2018, there has been a lot of planning for an FAD outbreak. It is great on paper, but until you experience it, you do not know if the plan is workable."

A recent tabletop focused on the show pig community. Everyone was assigned a section of the table to manage. These simulated activities demonstrate a mix of facilities including a packing plant, sow farm, wean-to-finish operation, feed mill, fairgrounds, or dairy and beef farms. The people managing these realistic entities needed to respond and operate in a confirmed FAD outbreak.

"The cardinal rule of emergency planning is you must have more than one plan for every situation," warned Webb. "There will not be enough resources for every producer, so it will be up to producers and their veterinarians to make a suitable plan for their operation, and then adapt as needed."

In tabletop exercises, each group develops an operational plan, submits their plan for approval, and seeks supplies. However, if supplies are not available, adjustments are mandatory. Webb describes these activities as a "fog of war" with so many decisions and potential obstacles, but it also approximates the need for an emergency operations center and reaffirms that producers and veterinarians need to be part of the FAD response.

Exercise participants use the tabletop setup to simulate responding to an FAD outbreak in show pigs at a fairground.

"As swine veterinarians, we are often immersed in FAD discussions, but many producers, especially those in show pig and niche production, have not been quite as involved in those discussions," said Dr Amy Woods, veterinarian with AMVC Swine Health Services.

Scenarios given at the June tabletop included an outbreak at fairgrounds, impacting the show pig community who frequently travel to different states. "This exercise was also extremely beneficial in fostering the relationship between NPB and the show pig industry, bridging the gap in communication and understanding between the show pig and commercial industries. Those two sectors have very different business purposes and goals. However, we need to determine how to work together for common industry goals during animal health emergencies," Woods continued.

A veterinarian's role during an FAD response may vary depending on their type of veterinary practice and the types of farm operations they serve. For example, animal health staff in an integrated system will focus on their pigs and contract farmers, while veterinarians with clients may have different roles and responsibilities with multiple production systems or independent operations.

"When we first started these exercises, business continuity was not part of the discussion," Webb reflected. "With the good things the Pork Checkoff has done, we now have tools giving people hope." Tools used in an outbreak include AgView, an opt-in, pig contact-tracing technology funded by Pork Checkoff.

NPB news continued on page 249

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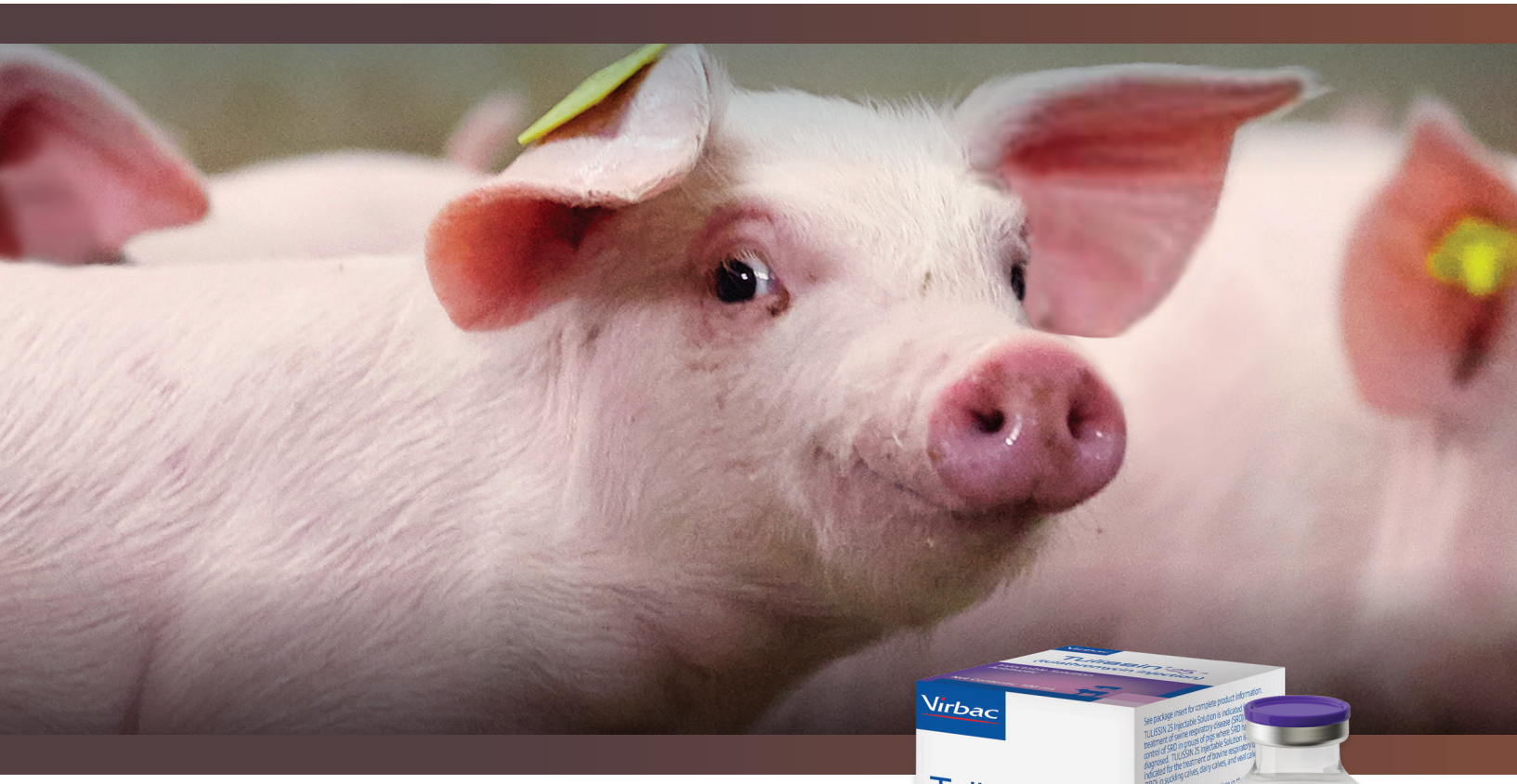

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NPB news continued from page 247

The tabletop exercises allow participants to practice using AgView and see its value firsthand. Plus, tools are developed or enhanced because of knowledge gaps identified and situational analyses, which are valuable outcomes of these exercises.

Visit **porkcheckoff.org** for more information about the industry's commitment to FAD prevention, preparedness, and response.

Operational plan considerations for an FAD response may include, but are not limited to:

- **Packing plant** - Pigs on the road when the stop-movement order is implemented will be allowed to continue to the plant. Harvesting could continue until all pigs in the lairage have been harvested. Processing and packaging could continue.
- **Finishing farm** - Supply chain implications of holding pigs past market weight.
- **Feed mill** - Biosecurity and transportation of feed to a disease control zone or mass demand for feed once a stop-movement order ends.
- **Fairgrounds** - Holding pigs longer if an outbreak is confirmed at a fairground in addition to potential containment measures.

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Students: Apply by September 13 for AASV presentation and scholarship opportunity

The American Association of Swine Veterinarians announces an opportunity for veterinary students to make a scientific presentation at the AASV Annual Meeting in Nashville, Tennessee on Sunday, February 25, 2024. 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 (2023-24) student member of the AASV at the time of submission and must not have graduated from veterinary school prior to February 25, 2024. Submissions are limited to one (1) abstract per student.

Abstracts and supporting information must be submitted online at **cmt3.research.microsoft.com/AASV2024**. Submissions must be completed before 11:59 PM Central Daylight Time on Wednesday, September 13, 2023 (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 15, 2023 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 16, 2023, and those selected to participate will be expected to provide the complete paper or abstract, reformatted for publication in the conference proceedings, by November 15, 2023.

Student Seminar

The Zoetis Foundation has provided a grant for a total of $26,250 for awards and the top student presenter scholarship. The grant will go towards a $750 award for the student presenter of each paper selected for ORAL presentation 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. As part of the Zoetis Foundation grant, the AASV Foundation will award 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. Those who participate in the poster session will receive a $500 presentation stipend funded by the Zoetis Foundation grant and AASV. All students selected to make a poster presentation will be expected to supply a brief paper, formatted for publication in the conference proceedings, by November 15. The guidelines for preparing posters for the display are available at **aasv.org/annmtg/2024/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/2024/postercomp** 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/2024/studentseminar**. 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 253


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AASV news continued from page 251

Who is leading AASV into the future? Nominate them for an award!

As nominations open for the AASV awards to be presented at the 2024 AASV Annual Meeting, it seems especially appropriate to keep the meeting theme - *Leading AASV into the Future* - in mind. Do you know a member who has demonstrated exemplary leadership and vision as they carry out their role in practice, technical services, academia, research, or another area? Someone whose actions are benefiting and leading AASV and the swine veterinary profession into the future? Nominate them for one of the following 6 awards to be presented in Nashville, Tennessee!

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.

Outstanding Swine Academic of the Year – Given annually to an AASV member employed in academia who has demonstrated excellence in teaching, research, and service to the swine veterinary profession. Faculty members, graduate students, and researchers are eligible to receive this award.

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. Those AASV members who received their veterinary degree in 2018 through 2022 are eligible to be considered for the 2024 award.

Are you wondering who has been recognized in the past? See **aasv.org/aasv/awards** for a list of the previous recipients of each award.

Nominations are due December 11. The nomination letter should specify the award and cite the qualifications of the candidate for the award. Submit nominations to AASV by mail, 830 26th Street, Perry, Iowa 50220, or email: **aasv@aasv.org**.

2023 AASV Award Winners

Swine Practitioner of the Year

Dr Tara Donovan

Howard Dunne Memorial Award

Dr Joseph Connor

Meritorious Service

David Brown

Outstanding Swine Academic

Dr Gary Althouse

Technical Services/ Allied Industry Veterinarian

Dr Lisa Becton

Young Swine Veterinarian of the Year

Dr Jessica Davenport

AASV news continued on page 255

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AASV news continued from page 253

Industrial Partners submissions due September 29

The American Association of Swine Veterinarians invites submissions for the Industrial Partners oral and poster sessions at the 55th 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 24-27, 2024, in Nashville, Tennessee.

The oral sessions consist of a series of 15-minute presentations scheduled from 1:00 to 5:00 PM on Sunday afternoon, February 25. A poster session takes place the same day. Poster authors will be required to be stationed with their poster from noon until 1:00 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 September 29.

SUBMISSION LIMIT: 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* (JSHAP) Industry Support Council **and** sponsor the AASV e-Letter may submit 3 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 2 topics. All other companies may submit 1 topic for oral presentation. In addition, every company may submit 1 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 September 29, 2023:

1) Company name
2) Presentation title
3) Brief description of the presentation content
4) Presenter name (one only) and contact details (mailing address, telephone number, and e-mail 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 16 and must submit a paper by November 15 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.

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Interested in becoming board certified in animal welfare? The AASV Foundation can help!

The AASV Foundation offers a scholarship program for AASV members seeking board certification in the American College of Animal Welfare (ACAW). Applicants must have either a DVM or VMD and at least 5 years of continuous membership in the AASV.

The ACAW scholarship provides annual reimbursement for actual expenses related to the board certification program. Reimbursable expenses include travel, course fees, and textbooks, but not lost income. The maximum amount of reimbursement is $20,000. An additional incentive payment of $10,000 will be paid upon successful and timely completion of ACAW board certification. A selection committee reviews and selects scholarship recipients as applications are received.

To be considered for the scholarship, the applicant must provide a curriculum vitae, an ACAW-approved program plan, and three letters of reference (one of which must come from the applicant's mentor). Accompanying these materials, the applicant's letter of application should provide a brief description of the applicant's background and interest in animal welfare and reasons for pursuing board certification in ACAW, how the scholarship funds will be utilized if awarded, and how the applicant anticipates serving the swine industry and AASV as a result of becoming board certified in ACAW.

Submit applications to:

AASV Foundation
830 26th Street
Perry, Iowa 50220
foundation@aasv.org

For more information, contact the AASV Foundation by phone, 515-465-5255, or email, **foundation@aasv.org** or visit **aasv.org/foundation/ACAW_Scholarship.php**.

New AASVF-Zoetis Foundation Student Debt Relief Grants

The AASV Foundation (AASVF) is pleased to announce that it has partnered with the Zoetis Foundation to initiate the AASVF-Zoetis Foundation Student Debt Relief Grant program. Thanks to funding provided by the Zoetis Foundation, the AASVF will award ten $7500 grants to swine veterinarians.

The goal of the program is to help relieve some of the student debt burden associated with the significant financial cost of completing a veterinary medical education. The grants are funded through a $75,000 award provided by the Zoetis Foundation. The AASV Foundation will select the grant recipients and present the awards during the 2024 AASV Annual Meeting.

The AASVF-Zoetis Foundation Student Debt Relief Grants will be in addition to the Dr Conrad and Judy Schmidt Family Debt Relief Scholarship program already in place, which will continue to offer debt relief awards to AASV members engaged in private practice. The new program not only increases the number and amount of grants to be awarded, it also broadens the applicant criteria to enable a larger subset of the membership to apply for and receive debt relief.

For additional information or to apply, see **aasv.org/foundation** or contact **foundation@aasv.org.**

AASV Foundation news continued on page 261

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African Swine Fever Virus (ASFv),
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AASV Foundation news continued from page 259

Student poster presentation awards increase

In recognition of the ever-increasing costs associated with preparing the high-quality poster presentations we have come to expect from AASV student members, the Zoetis Foundation has increased their support of the student poster presentations at the AASV Annual Meeting. As a result, the AASV Foundation will award $500 to each student poster presenter, a substantial increase from the previous award of $250. The award recognizes the student's participation and helps offset the costs involved in preparing the poster and traveling to the AASV Annual Meeting.

Students: Swine externships, grant funds available

Veterinary students, are you planning a swine-based externship experience? The AASV Foundation provides grants of up to $500 to students who complete an externship of at least two (2) weeks in a swine practice or a mixed animal practice with a considerable swine component. Any AASV student member in veterinary school who fulfills the requirements is eligible to apply. More information can be found at: **aasv.org/students/externgrant**.

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

AASV members, does your veterinary practice host students? Please contact AASV's Alternate Student Delegate Alexis Berte (**studentdelegate@aasv.org**) to have your internship and externship opportunities included in AASV's online listing. Make sure students who visit your practice are aware of the opportunity to join AASV and apply for the grant!

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SCAN QR

Psst, are your vulnerabilities showing?

My leisure reading is usually dictated by my mood and what is readily available at my library or through the Libby app. This past May, I read 2 novels in the political thriller genre. The first book told the story of a US intelligence agent working against time to find an individual extremist plotting an attack on the United States by creating a synthetic smallpox virus and covertly introducing it into the vaccine supply chain.[1] The plot of the second book centered on a cyberattack targeting the US power grid as an act of revenge.[2] Both books were suspenseful and entertaining works of fiction.

I quickly became unsettled when I attended the Agriculture Threats Symposium hosted by the US Federal Bureau of Investigation (FBI) in early June and learned just how closely my fictional reads could mirror reality. This 2-day symposium was attended by approximately 400 individuals representing various sectors of agriculture, academia, and state and federal law enforcement and government agencies. Speakers covered topics including foreign terrorist threats, domestic violent extremist threats, cyber threats, threats of foreign malign influence from nation states, threats to the agricultural supply chain, safeguarding the bioeconomy, and information sharing between agriculture and the law enforcement and intelligence communities.

The accidental or intentional introduction of a foreign animal disease (FAD) is considered to be one of the biggest threats to the swine industry. And for good reason: the impacts of an FAD introduction on animal health, public health, and the agriculture economy would be catastrophic. However, as global politics and technology continue to evolve, so too have the possible types and sources of threats to animal agriculture. For the sake of resiliency our scope of prevention, preparedness, and response must also expand to account for these new types of threats, including cyber threats.

Think of all the elements of veterinary practice and pig production that are dependent on digital devices, connected/internet-enabled equipment, and the generation and storage of electronic data. Now imagine if one of those components was suddenly taken offline, did not work, or was stolen. What if your feed mill was taken offline? What if your company, production, or animal health data was stolen and held for ransom? The proliferation and implementation of precision livestock farming technology nets many advantages for swine production but does increase the industry's "digital surface area" creating more possible entry points for cyberattacks. If it is connected, there is a risk it can be controlled, manipulated, or shut down. Cyber risk is business risk.

In 2022, the FBI estimated financial losses from reported cybercrimes to be $10.3 billion.[3] The primary cyber threats to the food and agriculture sector are:

- **Business email compromise** (BEC) scams target businesses or individuals by compromising email accounts, phone numbers, texts, or virtual meeting applications through social engineering or computer intrusion techniques with the goal of conducting unauthorized transfer of funds.[3] These types of scams are likely to evolve with the evolution of artificial intelligence and deep fake capabilities.
- **Ransomware** is malicious software that encrypts data, making it unusable, or blocks access to a computer system. The perpetrator holds the data hostage and threatens to destroy the data or release it to the public until a ransom is paid.[3]
- **Data theft** uses computer intrusion to acquire confidential or secured personal or business information.[3]
- **Denial of service** attacks flood the target host or network with traffic until the target cannot respond or crashes, preventing legitimate users from accessing information systems, devices, or other network resources.[4]

These cyber threats are not mutually exclusive, nor is this list all inclusive, so investing in cybersecurity is not only good for business security, but also national security. The scope, complexity, and impact of cyberattacks are increasing. At the same time, the level of technical knowledge and resources required to conduct cyberattacks is decreasing.

There are 3 key steps you can take to protect yourself and your business against cyber threats. First, know your self and business – identify and protect your most important assets and biggest risks. Second, focus on basic cyber hygiene[5]:

- Download updates for all devices, applications, and operating systems to limit flaws in the system.
- Use strong passwords that are at least 15 characters long, are unique and not used elsewhere, and are randomly generated. I admit I was guilty of reusing memorable passwords until I started using a password manager tool.
- Turn on multifactor authentication. In addition to strong passwords, this extra step helps verify it is you by asking for two forms of information: something you know (eg, pin numbers or security questions), something you have (authentication application or confirmation text), or something you are (eg, fingerprint or faceID).

Advocacy continued on page 265


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Advocacy continued from page 263

- Think before you click to avoid phishing schemes, which is where more than 90% of successful cyberattacks start.

And third, do not go it alone. Did you know there is an entire government agency dedicated to understanding, managing, and reducing risk to our cyber and physical infrastructure? Operating within the US Department of Homeland Security as a nonregulatory agency, the Cybersecurity and Infrastructure Security Agency (CISA) has 10 regional offices and cybersecurity and protective security advisors located in each state. The CISA advisors work to connect critical infrastructure owners and operators to resources, analyses, and tools to help build cyber and physical security and resilience. You can find your regional office and state advisors by visiting **cisa.gov/about/regions**. A full list of the resources and services offered by CISA can be found at **cisa.gov/cyber-resource-hub**. Best of all, these resources and services are available at no cost to you. Contact your state cybersecurity advisor for an initial discussion on where to start on your cybersecurity journey.

If you or your business do become a victim of cybercrime, a report should be filed with the Internet Crime Complaint Center (IC3; **ic3.gov**) to initiate an investigation. The IC3 is run by the FBI, the lead federal agency for investigating cybercrime. Additionally, tip information about suspicious activity in or around food and agriculture production sites can be submitted to the FBI by phone (1-800-225-5324) or web (**tips.fbi.gov**). Better yet, locate your nearest FBI field office (**fbi.gov/contact-us/field-offices**) and build a relationship with them as you would with your local law enforcement agencies. You can be as helpful to them as they are to you when it comes to identifying and addressing potential threats to the food and agriculture sector. As the adage goes: see something, say something!

Sherrie Webb, MSc
JSHAP Associate Editor

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*1. Hayes T. *I am Pilgrim*. Atria. 2014.

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*4. Cybersecurity and Infrastructure Security Agency. Understanding denial-of-service attacks. CISA blog. February 1, 2021. Accessed June 14, 2023. **https://www.cisa.gov/news-events/news/understanding-denial-service-attacks**

*5. Cybersecurity and Infrastructure Security Agency. 4 things you can do to keep yourself cyber safe. CISA blog. December 18, 2022. Accessed June 14, 2023. **https://www.cisa.gov/news-events/news/4-things-you-can-do-keep-yourself-cyber-safe**

* Non-refereed references.

Are you and your clients prepared to respond to a Foreign Animal Disease?

Get ready with the
CERTIFIED SWINE SAMPLE COLLECTOR
training program

1. **Contact the State Animal Health Official (SAHO) in the state(s) in which you plan to train or use Certified Swine Sample Collectors (CSSCs) to confirm participation eligibility prior to participating in the program.**
2. **Review the CSSC Program Standards.**
3. **Identify individuals who could be trained to collect and submit samples on your behalf.**
4. **Access CSSC training materials at securepork.org/cssc.**
5. **Conduct classroom and hands-on training.**
6. **Submit a list of trained individuals to SAHO(s) in state(s) trainees will be collecting samples.**

CSSC

For more information on the training program

If you are ready to start training, contact the state animal health officials in the state in which you wish to train individuals

For additional information or if your state isn't listed, please contact Pam Zaabel at pzaabel@pork.org.

UPCOMING MEETINGS

Allen D. Leman Swine Conference

September 16 - 19, 2023 (Sat-Tue)
Saint Paul, Minnesota

For more information:
Web: **lemanconference.umn.edu**

Pig Research Summit - THINK Piglet Health & Nutrition 2023

September 21 - 22, 2023 (Thu-Fri)
Crowne Plaza Copenhagen Towers
Copenhagen, Denmark

For more information:
Danish Agriculture & Food Council
Web: **tilmeld.dk/thinkpiglet2023/conference**

Pain in Animals Workshop 2023

September 26 - 27, 2023 (Tue-Wed)
National Institutes of Health
Bethesda, Maryland

For more information:
Web: **paw2023.com**

127th US Animal Health Association Annual Meeting

October 12 - 18, 2023 (Thu-Wed)
Gaylord National Resort and Convention Center
National Harbor, Maryland

For more information:
Web: **usaha.org/meetings**

2023 Leman China Swine Conference

October 20 - 22, 2023 (Fri-Sun)
Xi'an International Convention and Exhibition Center
Xi'an City, CHINA

For more information:
Tel: +86 13718913262
Email: **andyzhang@shixin-expo.com**
Web: **lemanchina.com**

21st Century Animal Health Symposium

October 27, 2023 (Fri)
Memorial Stadium
Champaign, Illinois

For more information:
Web: **vetmed.illinois.edu/21st-century-ahs**

2023 NAPRRS/NC229: International Conference of Swine Viral Diseases

December 1 - 2, 2023 (Fri-Sat)
Intercontinental: Chicago Magnificent Mile
505 N. Michigan Avenue
Chicago, Illinois

For more information:
University of Illinois
Office of Public Engagement
Tel: 217-333-2907
Email: **ICSVD@vetmed.illinois.edu**
Web: **vetmed.illinois.edu/education/continuing-education/north-american-prrs-symposium**

Banff Pork Seminar

January 9 - 11, 2024 (Tue-Thu)
Banff, Alberta, Canada

For more information:
Tel: 780-492-3651
Email: **pork@ualberta.ca**
Web: **banffpork.ca**

American Association of Swine Veterinarians 55th Annual Meeting

February 24 - 27, 2024 (Sat-Tue)
Gaylord Opryland Resort and Convention Center
Nashville, Tennessee

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

27th International Pig Veterinary Society Congress & 15th European Symposium of Porcine Health Management

June 4 - 7, 2024 (Tue-Fri)
Congress Centre Leipzig
Leipzig, Germany

For more information:
Web: **ipvs2024.com**

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

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