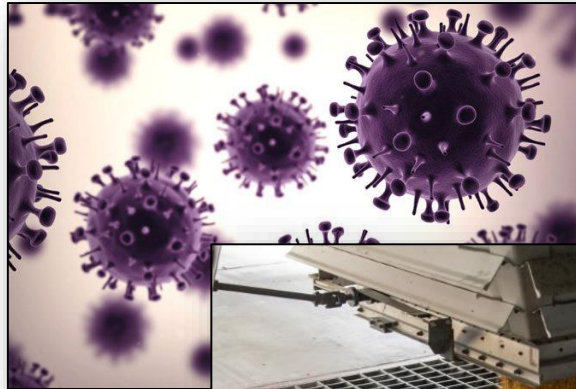


Feed Safety & Feed Mill Biosecurity

What Feed Mills/Ingredient Suppliers can do to Mitigate Risk

Dr. Chad Paulk
Dept. Grain Science & Industry
Kansas State University

Presented to:
NEAFA Annual Meeting and Forum
Northeast Agribusiness & Feed Alliance
February 4, 2020



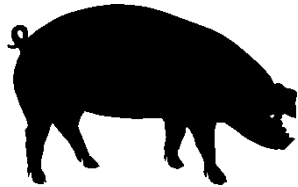
Pathogens associated with potential transmission via feed

- Prions
 - Bovine spongiform encephalopathy and other TSE
- Bacteria
 - *Salmonella* spp.
 - *Listeria monocytogenes*
- Viruses
 - Porcine epidemic diarrhea virus
 - African swine fever virus
 - Foot and mouth disease
- Other agents, such as fungi, protozoa, worms

Methods of Transmitting Disease

Reservoir

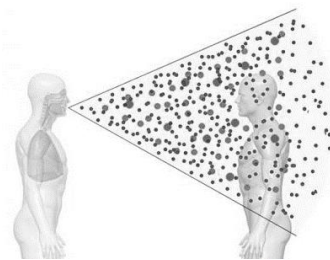
Habitat where agent lives,
grows, multiplies



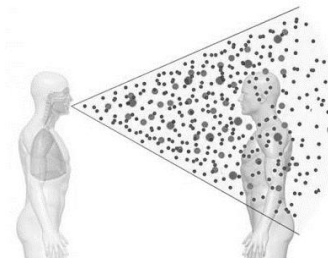
Transmission

Method of transport from
reservoir to susceptible host

Direct

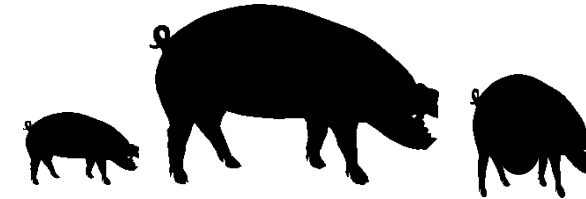


Indirect



Host

Individual susceptible to
the specific agent





As an Animal Food Industry, We Have a Responsibility.

- Animal food is *not* the most likely way that foreign animal disease can enter the U.S.
- It's *possible*. We must take care of our business.
 - Tote bags from China: most likely source of PEDV entry into U.S. (USDA, 2015)
 - Rice straw from China: most likely source of FMDV entry into Japan (Japan Ministry of Agriculture, 2001)
 - Forage and hay from SE Asia: most likely source of FMDV into South Korea (South Korean Animal and Plant Quarantine Agency, 2014)
- If pathogens enter the animal food supply chain, we can move it everywhere, and quickly.

Addressing Feed Safety

1. Is it likely to get infected?

2. Can it survive?

3. Is it infectious?

4. How can it be prevented?

5. How can it be mitigated?

1. Is it likely to get infected?

- What ingredients are at risk for getting infected with the pathogen of concern?
 - Geographical considerations
 - Countries/regions with active disease outbreaks
 - Location of pigs with disease relative to location of ingredient production
 - Agricultural practices
 - Packaging
 - Single use bags or totes vs. re-used totes or bulk trailers



1. Is it likely to get infected?

- What ingredients are at risk for getting infected with the pathogen of concern?
 - Examples:
 - **Higher Risk:**
 - Rice hulls and corn cob carriers from countries with ASFV
 - Porcine-based
 - **Lower Risk:**
 - Synthetic amino acids from same countries packaged in individual, single-use bags



Addressing Feed Safety

1. Is it likely to get infected?

2. Can it survive?

3. Is it infectious?

4. How can it be prevented?

5. How can it be mitigated?

2. Can it survive?

- Insufficient data on pathogen × ingredient × environment



Survived simulated trans-Pacific or trans-Atlantic shipment



Did not survive

Ingredient	FMD	CSF	ASF	PRV	PEDV
Corn					
Soybean meal					
DDGS					
Wheat midds					
Fish meal					
Porcine plasma					
Whey					
Choice white grease					
Monocal P					
Limestone					
Salt					
Vitamin premix					
TM premix					
Choline Cl					
L-Lys					
DL-Met					
L-Thr					
CTC					

Addressing Feed Safety

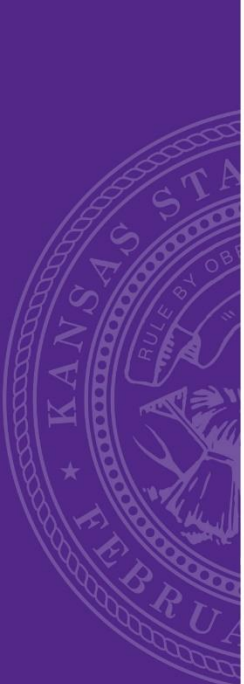
1. Is it likely to get infected?

2. Can it survive?

3. Is it infectious?

4. How can it be prevented?

5. How can it be mitigated?



3. Is it infectious?

- In most models, risk of infectivity is based on a single exposure to the contaminant.
- Contamination of a feed supply likely leads to:
 - Initial dilution of the contaminant (less virus per exposure)
 - Multiple exposures to a single animal over time
 - Multiple animals being exposed simultaneously

3. Is it infectious?

- Contamination event into feed most likely occurs in the ingredient or upon receiving
- Ingredients are mixed in ~3-ton batches for several minutes to optimize uniformity of nutrients
 - 0.3 ppm selenium in finished feed
 - 50 g drug per ton of feed with < 10% coefficient of variation (standard deviation/mean)
- Process likely uniformly mixes in any contaminant, including viruses (depends on fomite consistency)
- Finished feed is delivered in batches to farms with ~1,200 pigs/barn
 - Nursery pigs typically eat ~20 meals ranging from 100 to 750 g/day
 - 1 feed batch = 24,000+ exposures (meals) in 36 hours



3. Is it infectious?

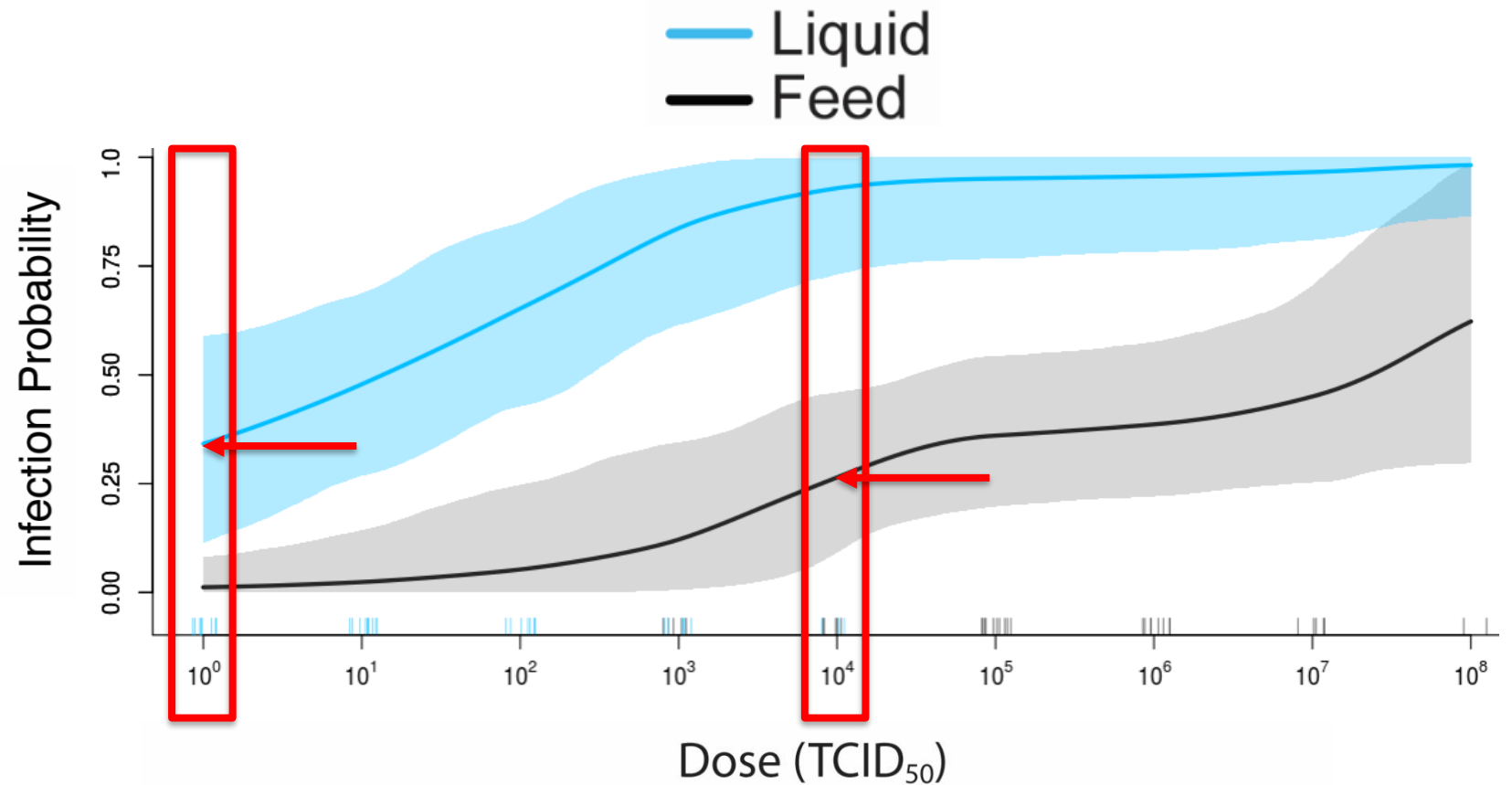
Summary: One contamination 'event' may lead to 1,200 co-housed animals having >20 simultaneous exposures.



- Objective: Understand the probability of infection when a pig consumes ASFV-contaminated feed in a single event or over multiple exposures.

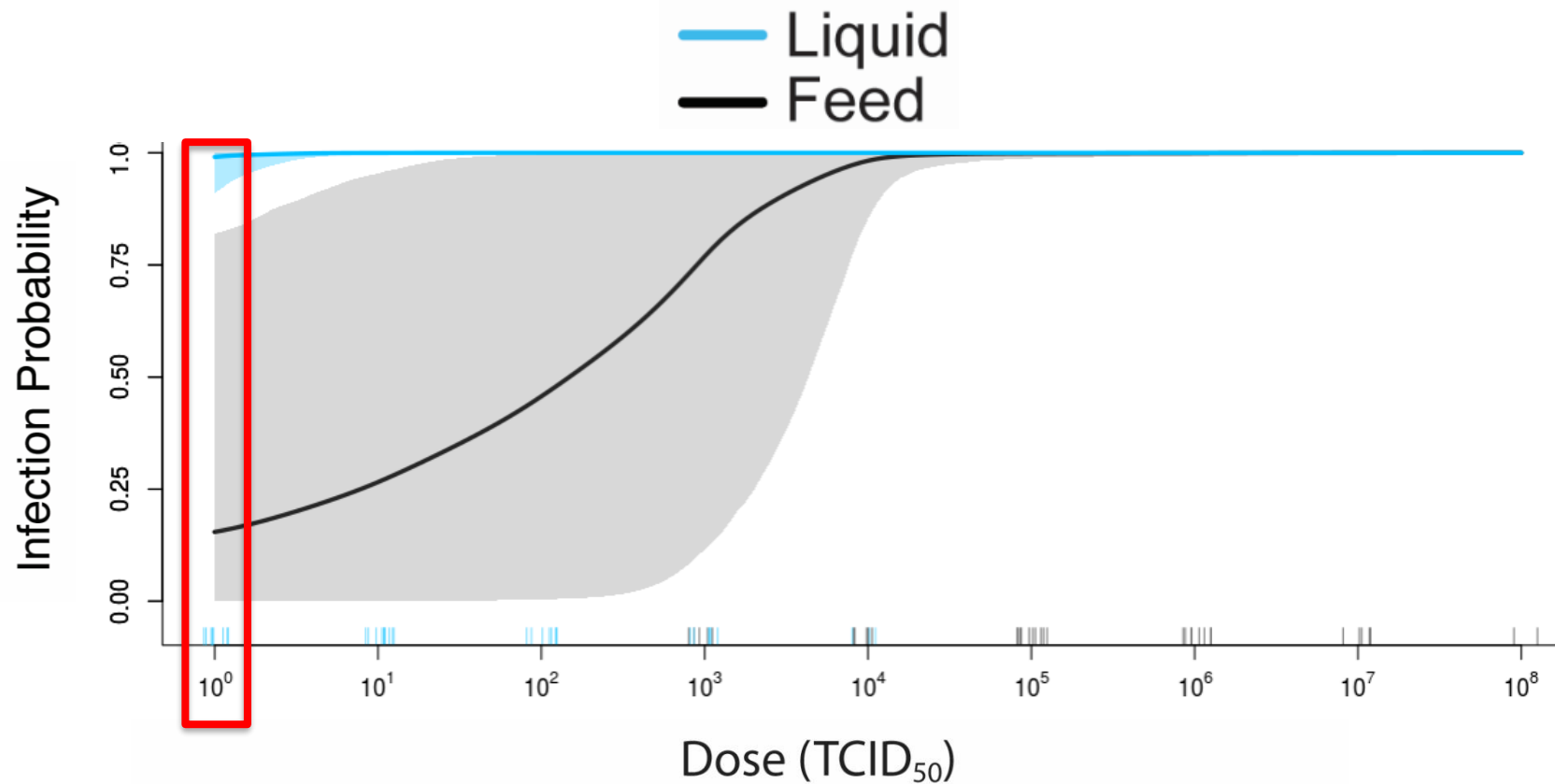
3. Is it infectious?

Single Exposure to a Single Animal (100 g × 1 time)



3. Is it infectious?

Multiple Exposures to a Single Animal (100 g × 20 times)



What Does This Mean?

Feed is just *one of many potential* vehicles for ASFV transmission – BUT
– if ASFV enters the feed supply chain, infectivity is *almost certain*.

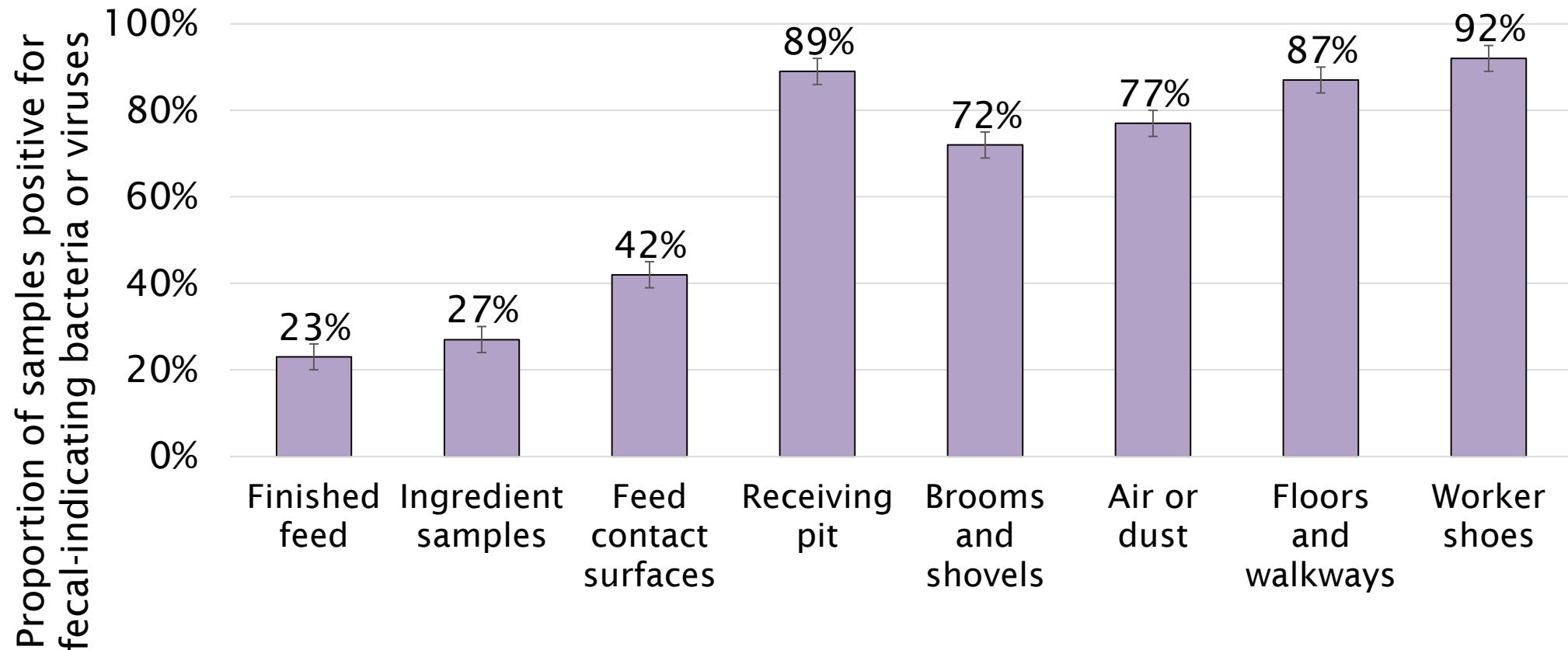


3. Is it infectious?

- Context:
 - Feed and ingredients are one of **many** potential vectors
 - BUT, the magnitude of infectivity is extreme
 - 1 gram of feces from an acutely infected pig can contaminate 500 tonnes of feed – with EACH GRAM being infective

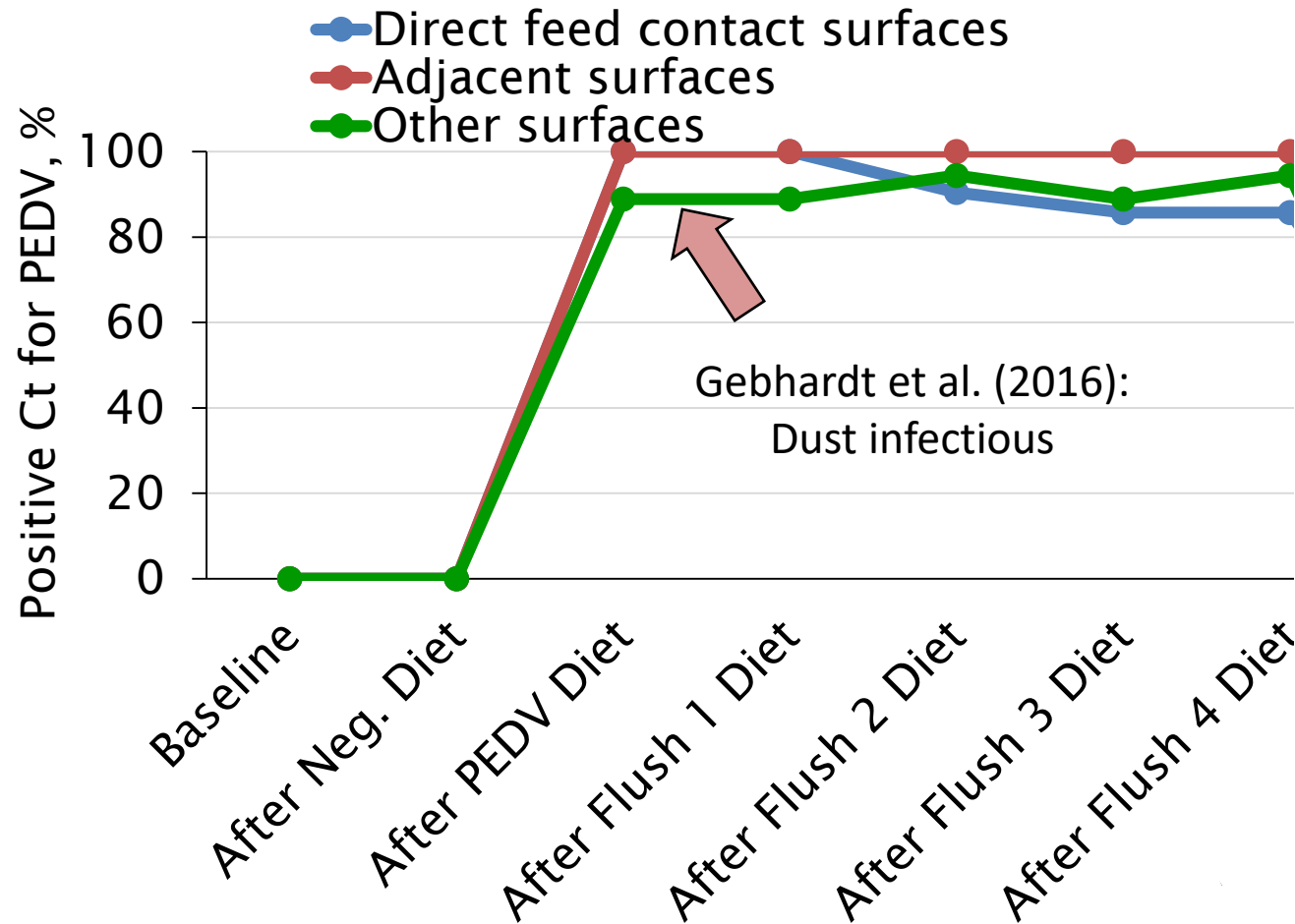


How can feces enter the feed supply chain?



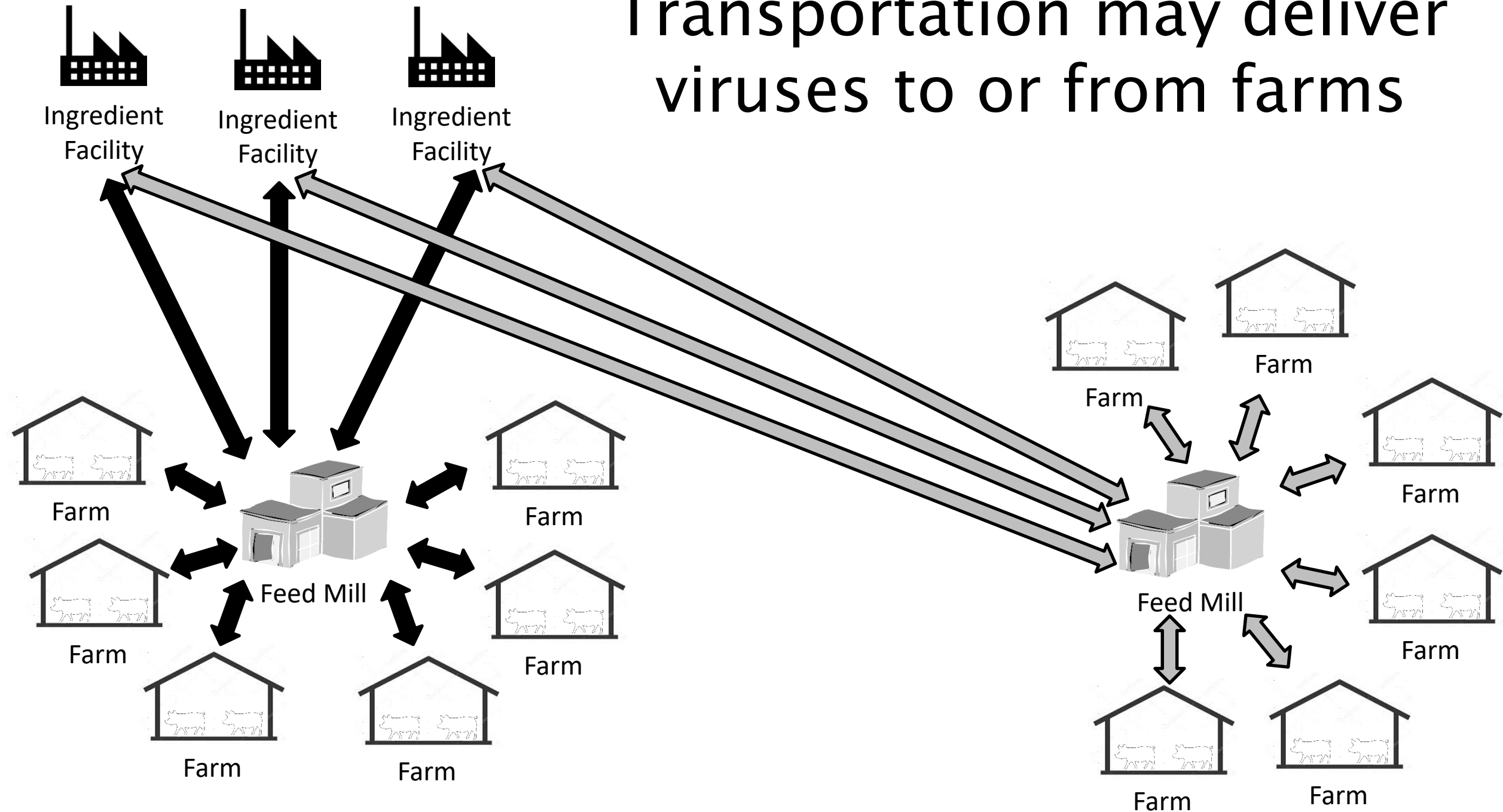
Location $P < 0.05$

If viruses enter an animal food facility, they stay



Huss et al., 2017
Schumacher et al., 2017
Schumacher et al., 2018

Transportation may deliver viruses to or from farms



By the Time you Know, it Might be too Late

Pathogen	Time Between Exposure and Clinical Signs
African swine fever virus	4 to 19 Days
Classical swine fever virus	3 to 7 Days
Foot and mouth disease	2 to 14 Days
Porcine deltacoronavirus	4 to 5 Days
Porcine epidemic diarrhea virus	1 to 8 Days
Porcine reproductive and respiratory virus	3 to 37 Days

Addressing Feed Safety

1. Is it likely to get infected?

2. Can it survive?

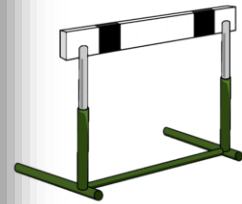
3. Is it infectious?

4. How can it be prevented?

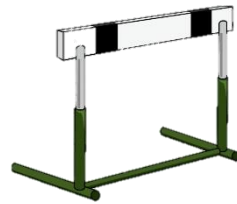
5. How can it be mitigated?

4. How can it be prevented?

Hurdles to Prevent Pathogen Transfer through Feed



Exclude High
Risk Ingredients



Extend
Biosecurity
Practices from
Farms to Mills



Active
Mitigation



4. How can it be prevented?

- Exclude high risk ingredients
 - Know and trust your supplier (and their supplier... and their supplier...)
 - Do not use grains or oilseeds from regions with foreign animal disease
 - Use porcine-based ingredients with caution
 - If using other ingredients from regions with foreign animal diseases, take steps to ensure they are at low risk for disease transmission
 - If delivered in bulk, require new bags and/or washout tickets or proof of low-risk previous loads in all containers prior to arrival at your facility.
 - If delivered in totes, obtain proof that bags were new and inspect/sanitize bags prior to use.

4. How can it be prevented?

- **Extend Biosecurity Practices to Feed Mills**
 - Develop a feed mill biosecurity plan and audit to it
 - Sanitize floors routinely (10% bleach or 1% Virkon S)
 - Do not use dust as an ingredient.
 - Use receiving mats or funnels to limit pathogen entry via the receiving pit
 - Clean & disinfect vehicles before returning to the mill from deliveries
 - Create lines of separation

Feed mill biosecurity plans: A systematic approach to prevent biological pathogens in swine feed

Roger A. Cochrane, MS; Steve S. Dritz, DVM, PhD; Jason C. Woodworth, MS, PhD; Charles R. Stark, MS, PhD; Anne R. Huss, MS, PhD; Jean Paul Cano, DVM, PhD; Robert W. Thompson, DVM, MS; Adam C. Fahrenholz, MS, PhD; Cassandra K. Jones, MS, PhD

KANSAS STATE UNIVERSITY

Swine Feed Mill Biosecurity Audit

This audit has not pass/fail score. Instead, the intent is for producers to use this audit as a method of engaging in discussion with feed manufacturers about potential methods that may be employed to maximize feed safety from biological hazards.

Feed Mill Name and Address: _____ Date: _____

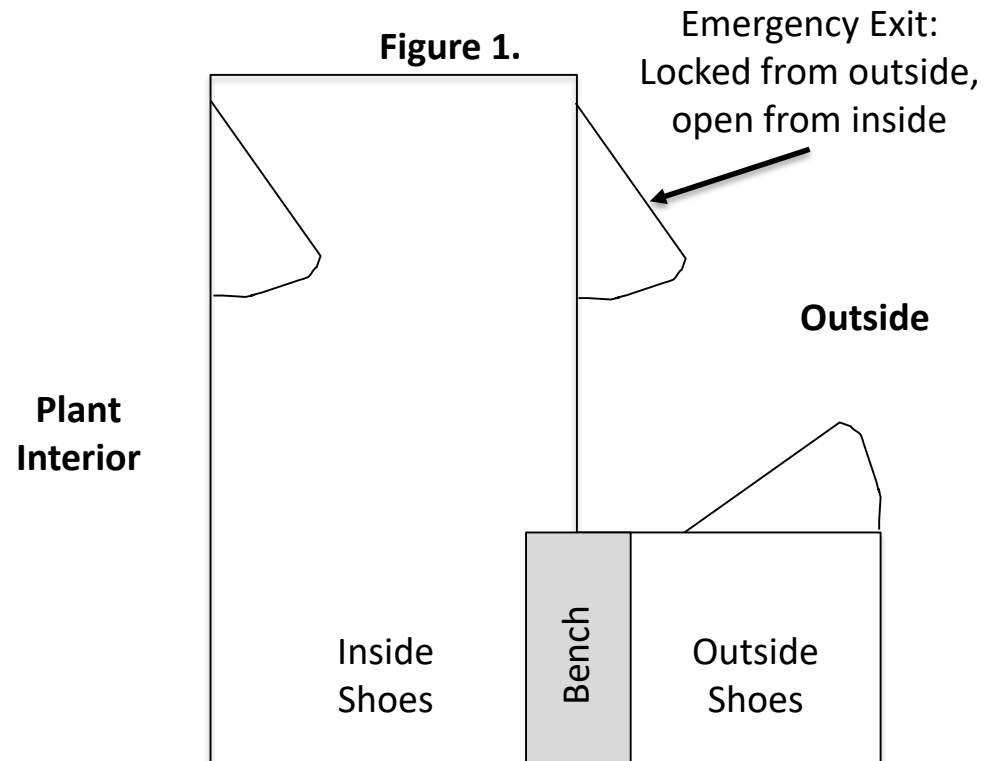
Distance of nearest pigs: < ½ mile ½ to 1 mile > 1 mile

Is the mill in compliance with the Food Safety Modernization Act (FSMA)?
Yes No

Does the mill have any hazards requiring a preventive control? Yes No
If Yes, describe: _____

What Can We Do?

- Add in clean/dirty lines and lines of separation



Could be improved

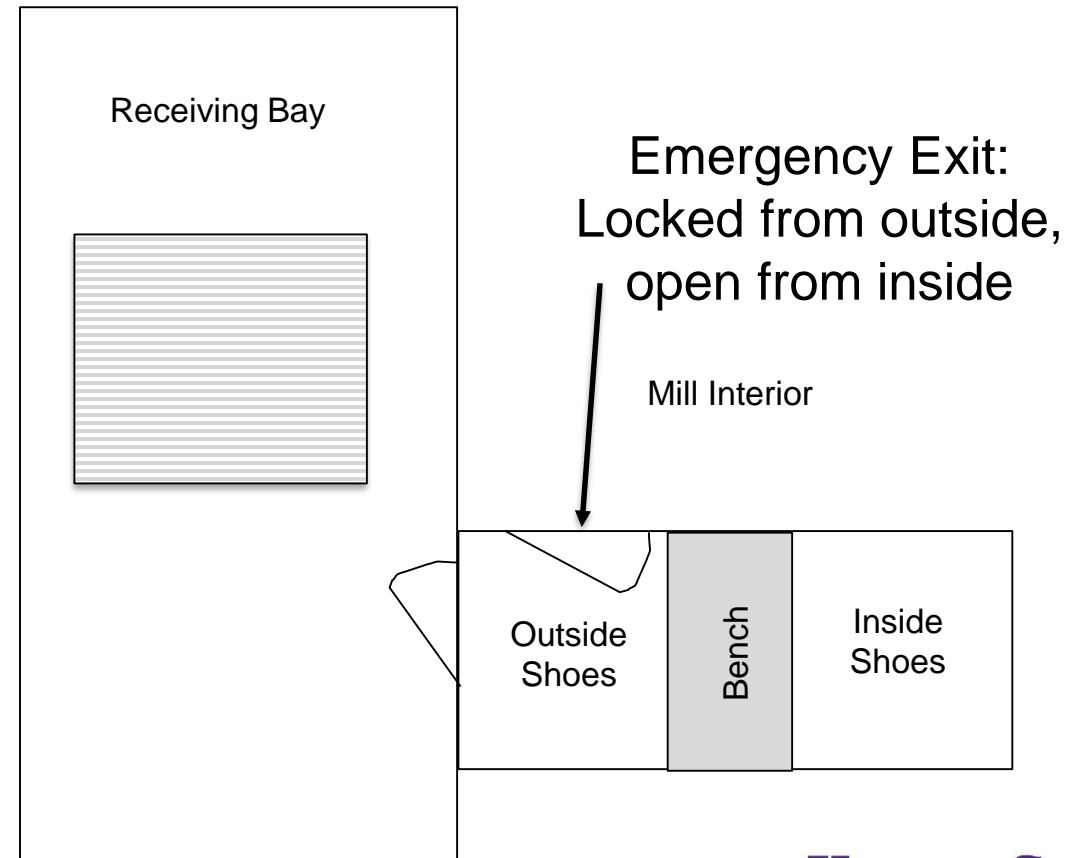


Good

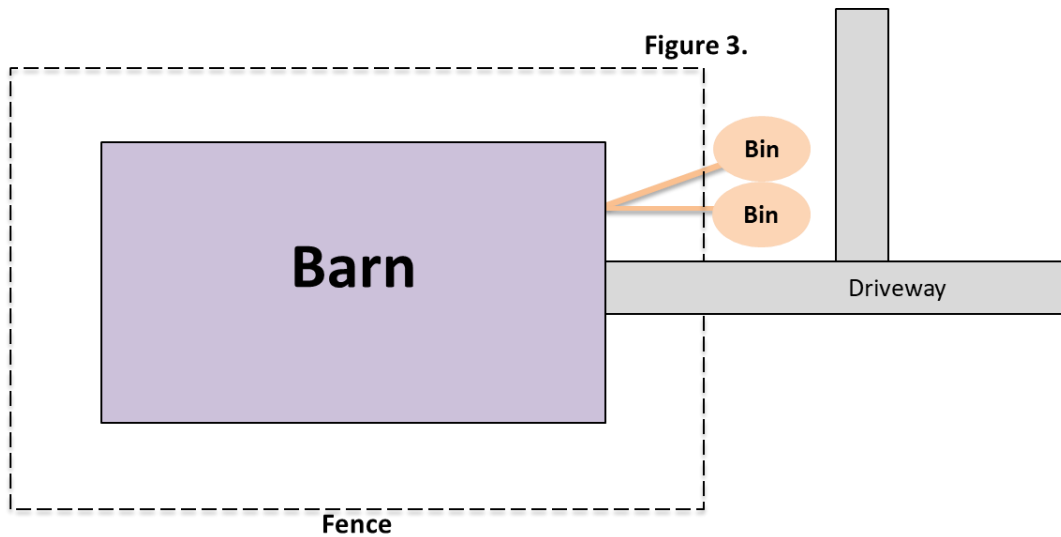


What Can We Do?

- Add in clean/dirty lines and lines of separation



Feed Delivery: A Continued Problem Area for Disease Transmission



March 30, 2019 Testing	PED PCR ct
Farm Feed Truck Cab	32.38
Farm Feed Truck Tire FR	35.91
Farm Feed Truck Tire FL	Neg
Farm Feed Truck Tire RR	33.76
Farm Feed Truck Tire RL	Neg

Location	PED PCR ct
Feed Truck	Neg
Feed Truck floor Mats	Neg
Feed Truck Tires	Neg

Note: Lower PCR ct = More Virus

4. How can it be prevented?

What Does Feed Safety Look Like in Endemic Countries Today?



4. How can it be prevented?

Case Study: Swine Production System in Vietnam

- Production system:
 - ASFV first reported in Vietnam in February 2019
 - Fall 2019: Samples collected at multiple sites within a single integrated swine production system that had cases of ASFV and was located in one of the most pig-dense provinces in Vietnam
 - Production system used Sal CURB in all diets

4. How can it be prevented?

Case Study: Swine Production System in Vietnam

- 40 feed/ingredient samples collected
 - None contained detectable levels of ASFV via qPCR
- 724 environmental samples collected from feed manufacture/delivery and analyzed for ASFV
 - 1.1% contained detectable levels of ASFV via qPCR
 - Nearly all were from feed delivery trucks
 - **ONE** of the 175 feed mill environmental samples was positive (floor surface where feed delivery truck drivers wear footwear previously exposed to surfaces outside the feed mill)

4. How can it be prevented?

Case Study: Swine Production System in Vietnam

- **Conclusions**

- ASFV-contaminated feed ingredients did not play a significant role in ASFV transmission or entry into new populations *in this case*
- Significant risk was found in feed delivery and cross-traffic, especially inside delivery truck cabs and associated footwear
- The use of a chemical mitigant likely contributed to the epidemiology in this case

Addressing Feed Safety

1. Is it likely to get infected?

2. Can it survive?

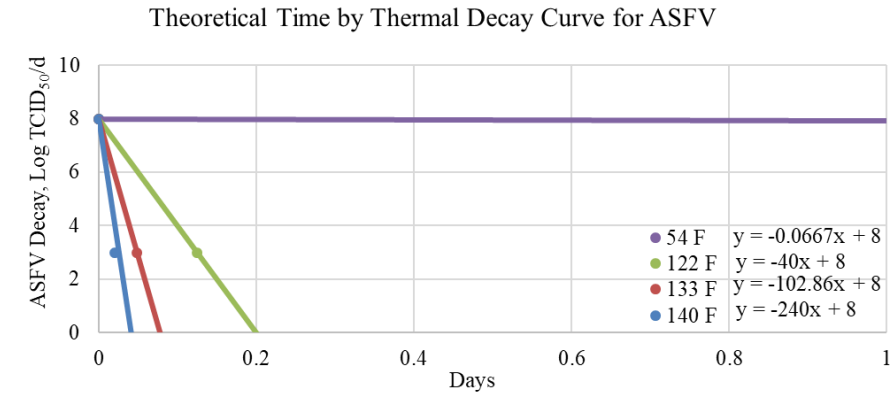
3. Is it infectious?

4. How can it be prevented?

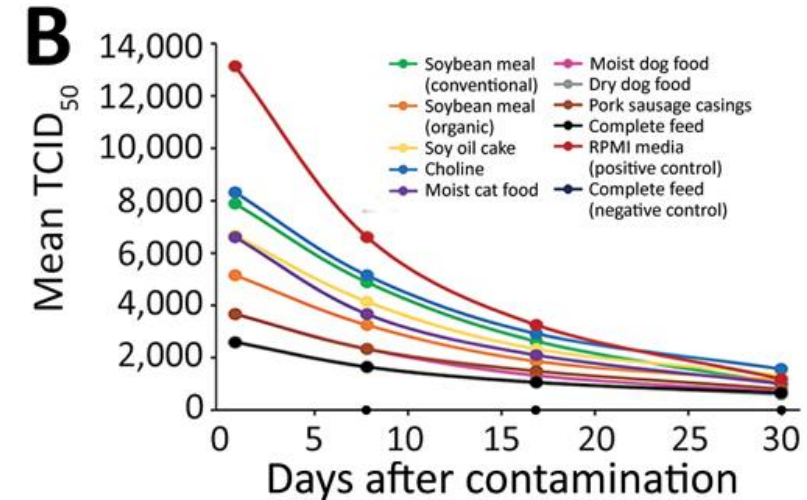
5. How can it be mitigated?

5. How can it be mitigated?

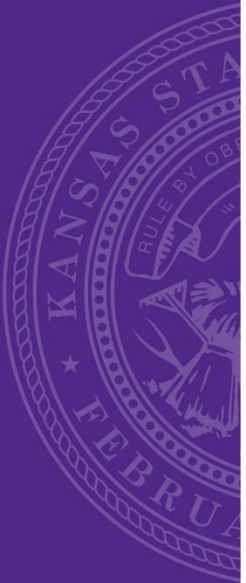
- Chemical additives (under appropriate FDA use)
 - 0.5% blend of C6:0, C8:0, C10:0
 - Sal CURB
 - Other acids being tested
- Viral decay
 - Time × temperature dependent
 - *Minimal* data, from which we must extrapolate and draw conclusions
 - Thermal processing: sensitive pathogens 175°F for 30 s (if 100% of product reaches this)
 - Quarantine time?
 - New study suggests even longer is needed (half-life of 1.3-2.2 in ingredients is now reported to be 9.6-14.2 d)
 - Does not protect against post-processing cross-contamination



Diseases of Swine, 2012
EFSA, 2010
Dee et al., 2018



Niederwerder et al., 2019



- Other important parts of this research question:
 - How to collect a representative sample in bulk ingredients/feed if the virus is not uniformly distributed (Jones et al., 2019)
 - What tool to use for environmental swabbing (Stewart et al., 2020)
 - Methods to improve nucleic acid recovery of viruses in feed and ingredients

Foreign Animal Diseases and Animal Food

- The feed supply chain is not the most likely route of viral entry into animals, but it can quickly spread disease.
- We all play a role in preventing foreign animal disease entry and spread. Do your part!
 - Exclude high risk ingredients
 - Implement feed biosecurity
 - Consider active mitigation

www.ksuswine.org/feedsafetyresources

cpaulk@ksu.edu