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# Innovations in Biosecurity Measures for Feed Mills

Dr. Cassie Jones  
Dept. Animal Sciences & Industry  
Kansas State University

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**Feed&Grain**<sup>LIVE</sup>

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AUTOMATION

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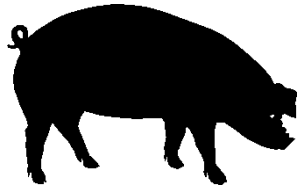
# Biological hazards that have the potential to be carried by feed

- 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 disease transmission

## Reservoir

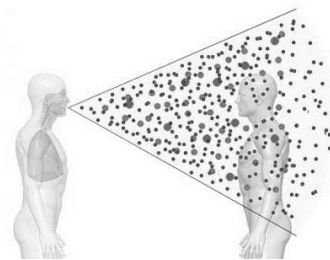
Habitat where agent lives,  
grows, multiplies



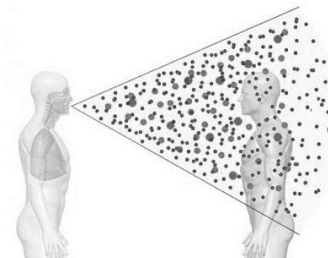
## Transmission

Method of transport from  
reservoir to susceptible host

### Direct

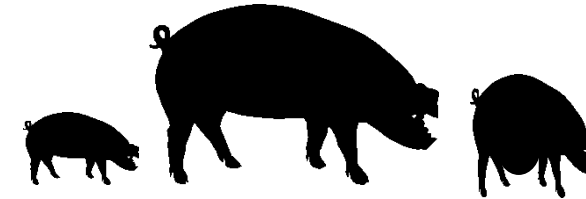


### Indirect



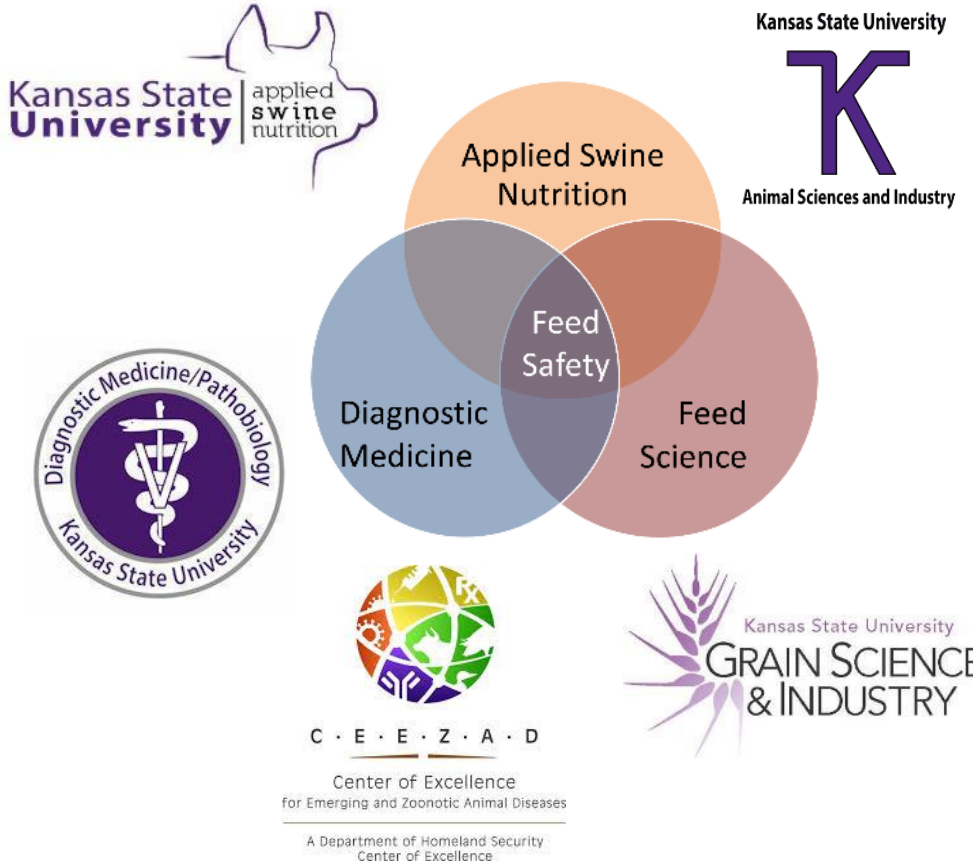
## Host

Individual susceptible to  
the specific agent





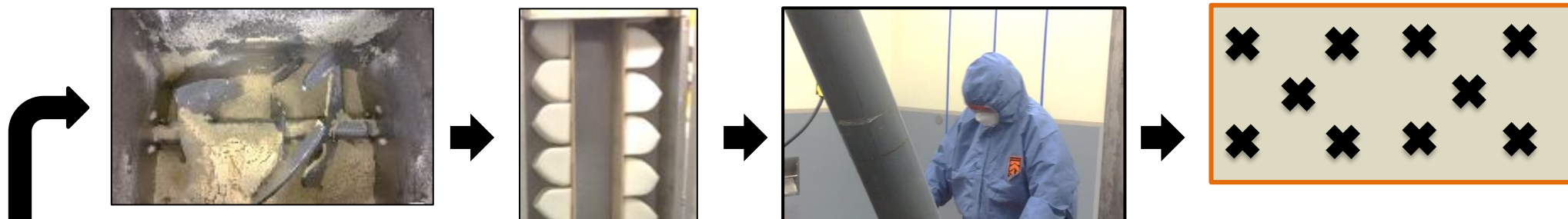
# How can feed serve as a vector of disease?



C.G. Elijah, J.D. Trujillo, C.K. Jones, N.N. Gaudreault, C.R. Stark, K.R. Cool, C.B. Paulk, T. Kwon, J.C. Woodworth, I. Morozov, J.T. Gebhardt, and J.A. Richt  
with appreciation expressed to: Hilda Calderoncartagena, Chance Fiehler, and the BRI staff



# Impact of African swine fever virus-contaminated ingredients on contamination of subsequent batches of feed manufactured in the same equipment



<u>Batch</u>	<u>Ingredients</u>
1	Negative
2	Positive
3	Negative
4	Negative
5	Negative
6	Negative

# Impact of African swine fever virus-contaminated ingredients on contamination of subsequent batches of feed manufactured in the same equipment

## Detection of African swine fever virus (ASFV) p72 DNA in feed samples

	Batch of feed
	1
<b>Ingredients</b>	Negative
<b>Non-detected</b>	10
<b>Suspect</b>	0
<b>ASFV present</b>	0

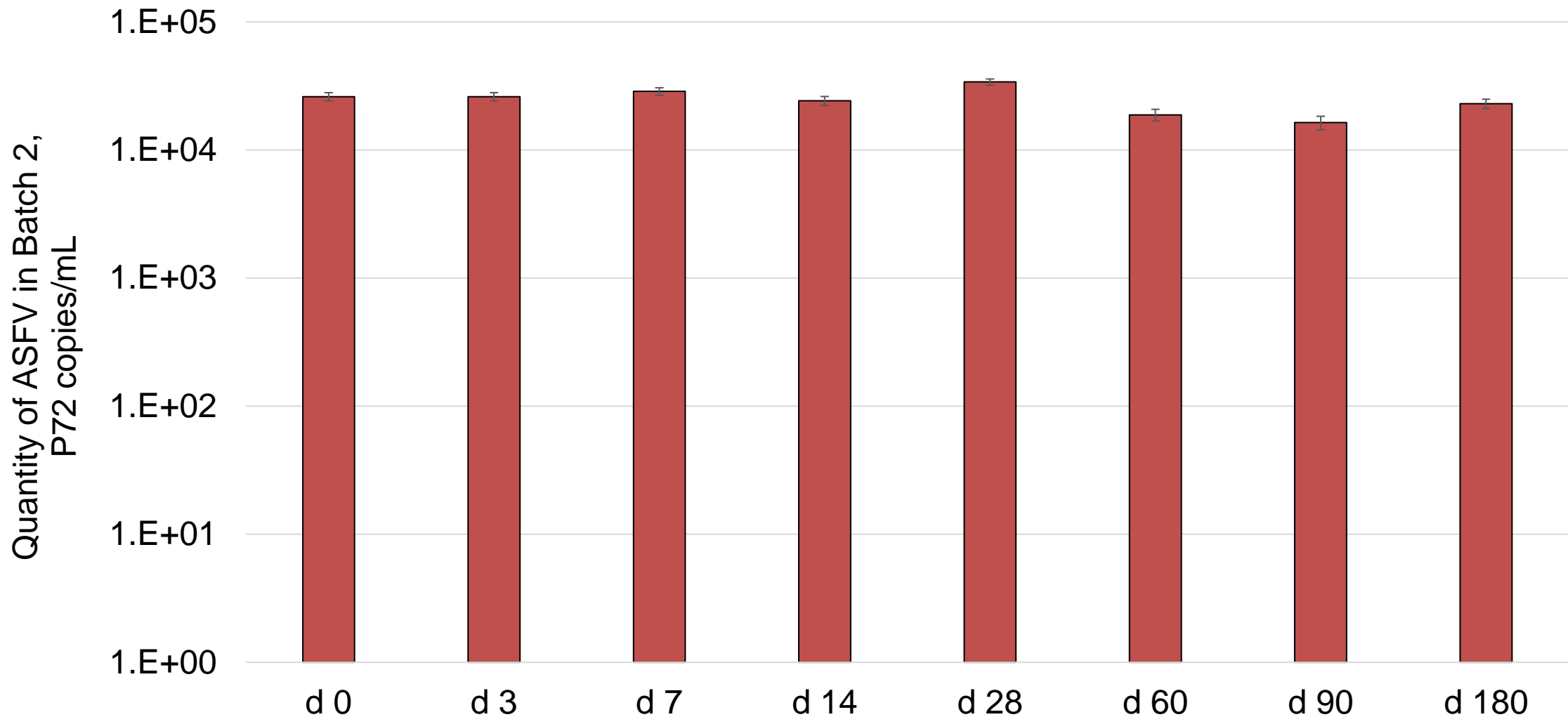
# Impact of African swine fever virus-contaminated ingredients on contamination of subsequent batches of feed manufactured in the same equipment

## Detection of African swine fever virus (ASFV) p72 DNA in feed samples

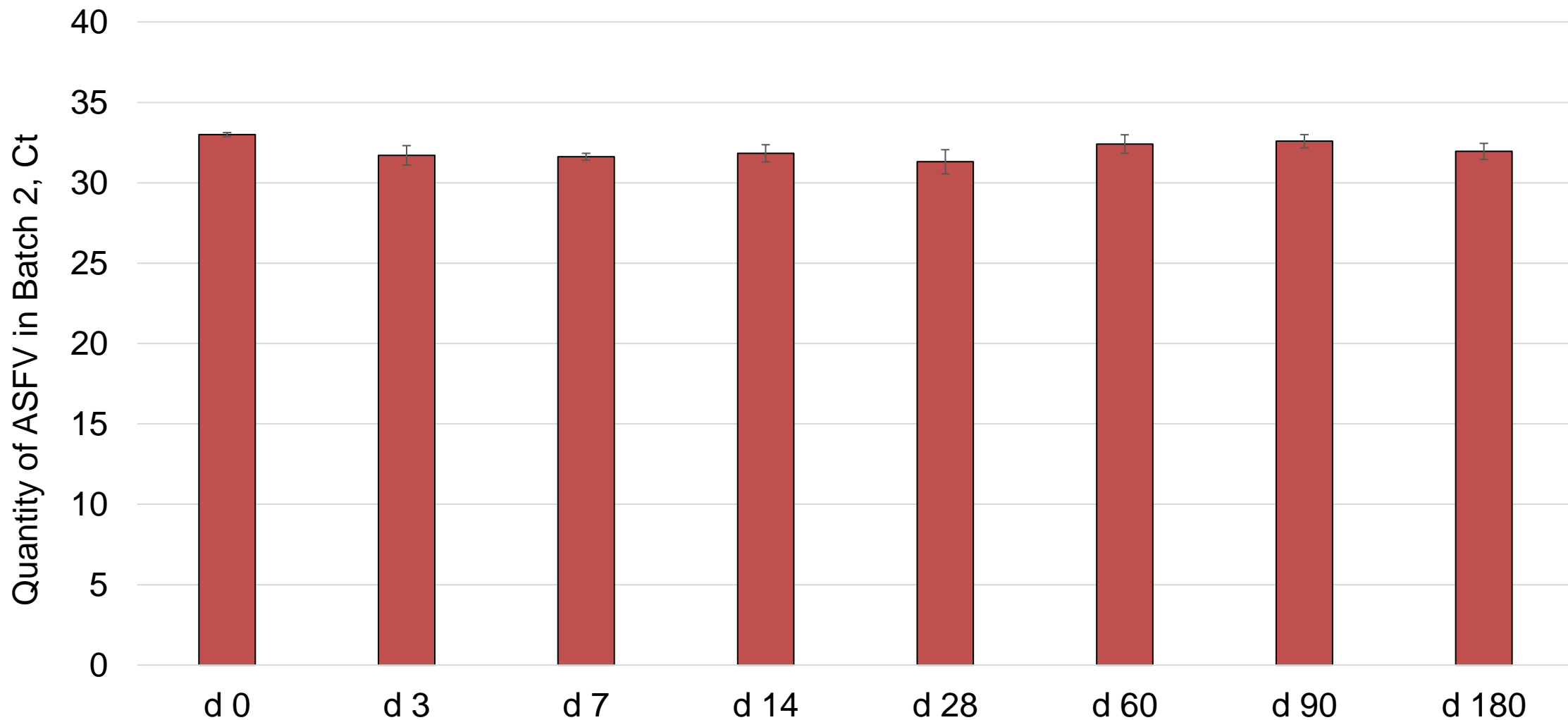
	Batch of feed					
	1	2	3	4	5	6
<b>Ingredients</b>	Negative	Positive	Negative	Negative	Negative	Negative
<b>Non-detected</b>	10	0	0	0	0	0
<b>Suspect</b>	0	0	0	1	1	3
<b>ASFV present</b>	0	10	10	9	9	7
<b>Ct</b>	45.0	33.0	37.5	39.5	39.3	40.1
<b>Copies, log<sub>10</sub>/g</b>	0.0	4.74	3.62	3.11	3.07	2.77



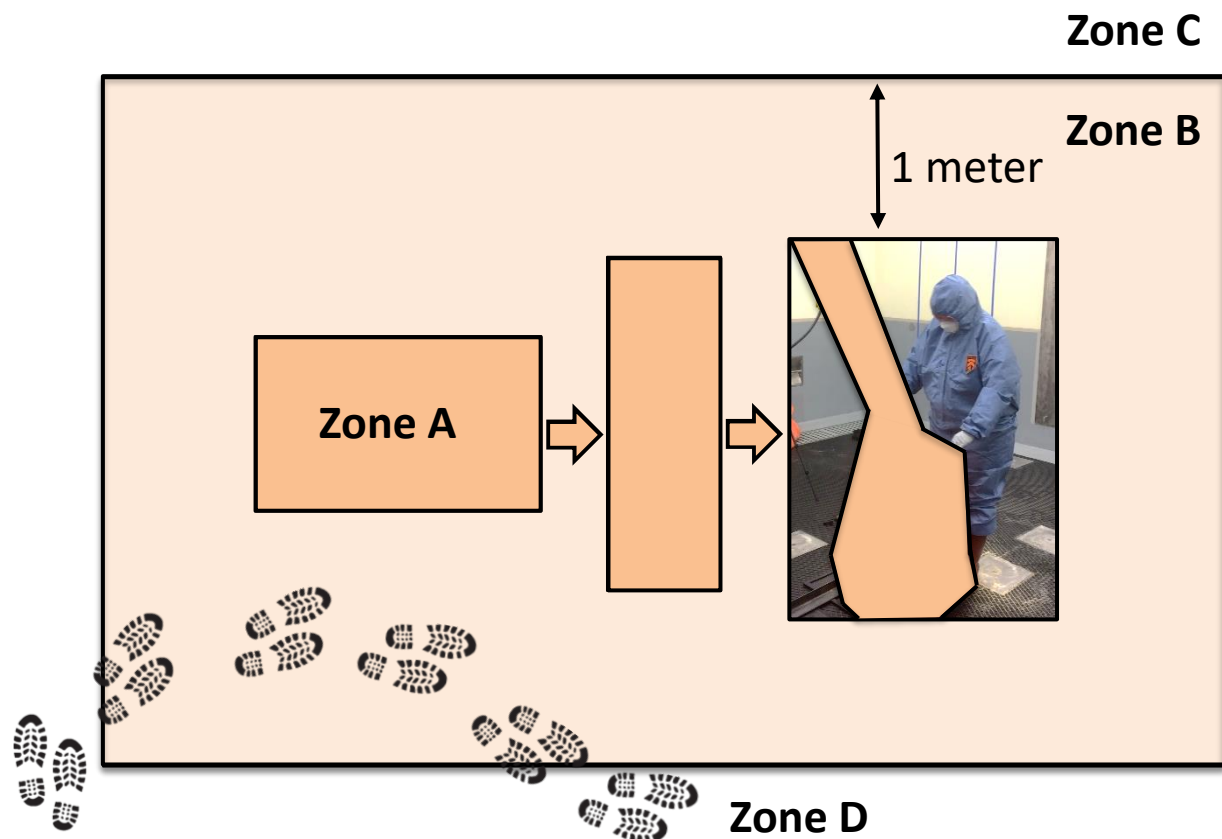
# Survival of African swine fever virus in contaminated feed over time



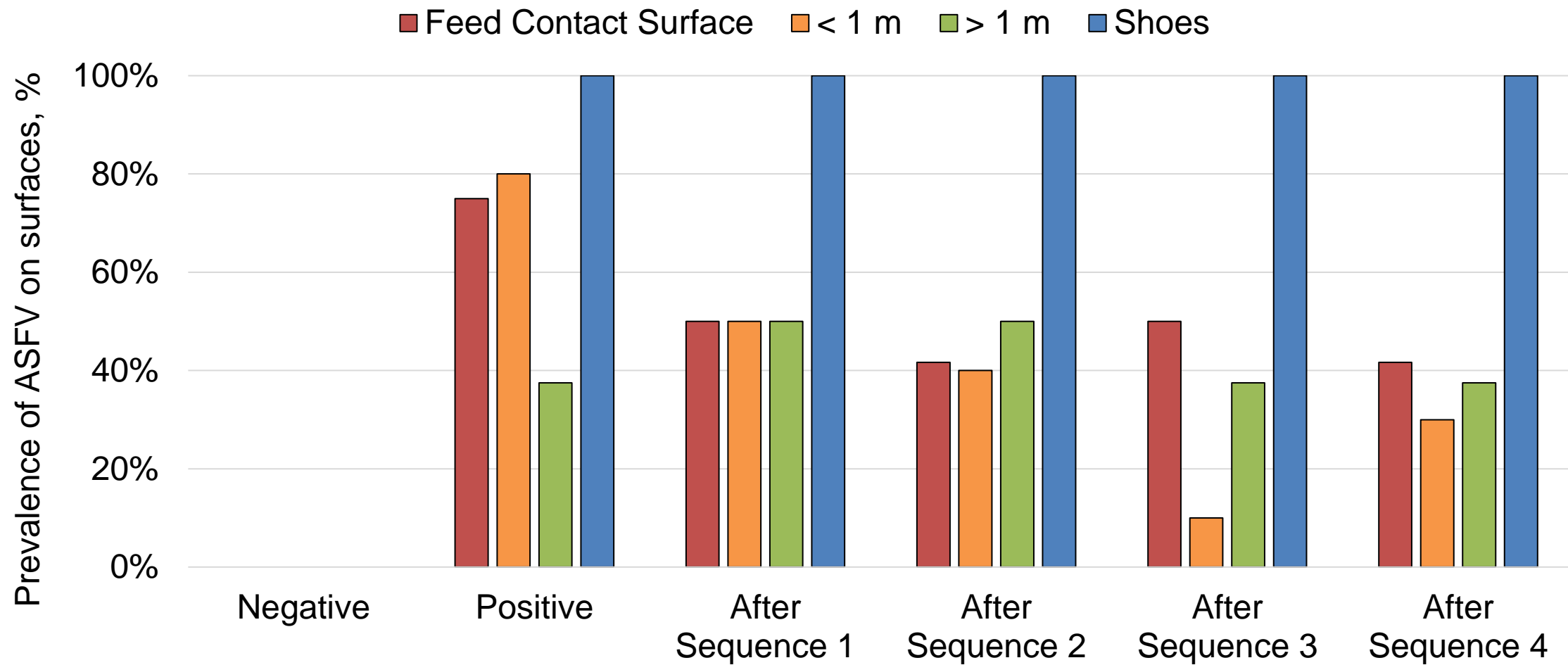
# Survival of African swine fever virus in contaminated feed over time



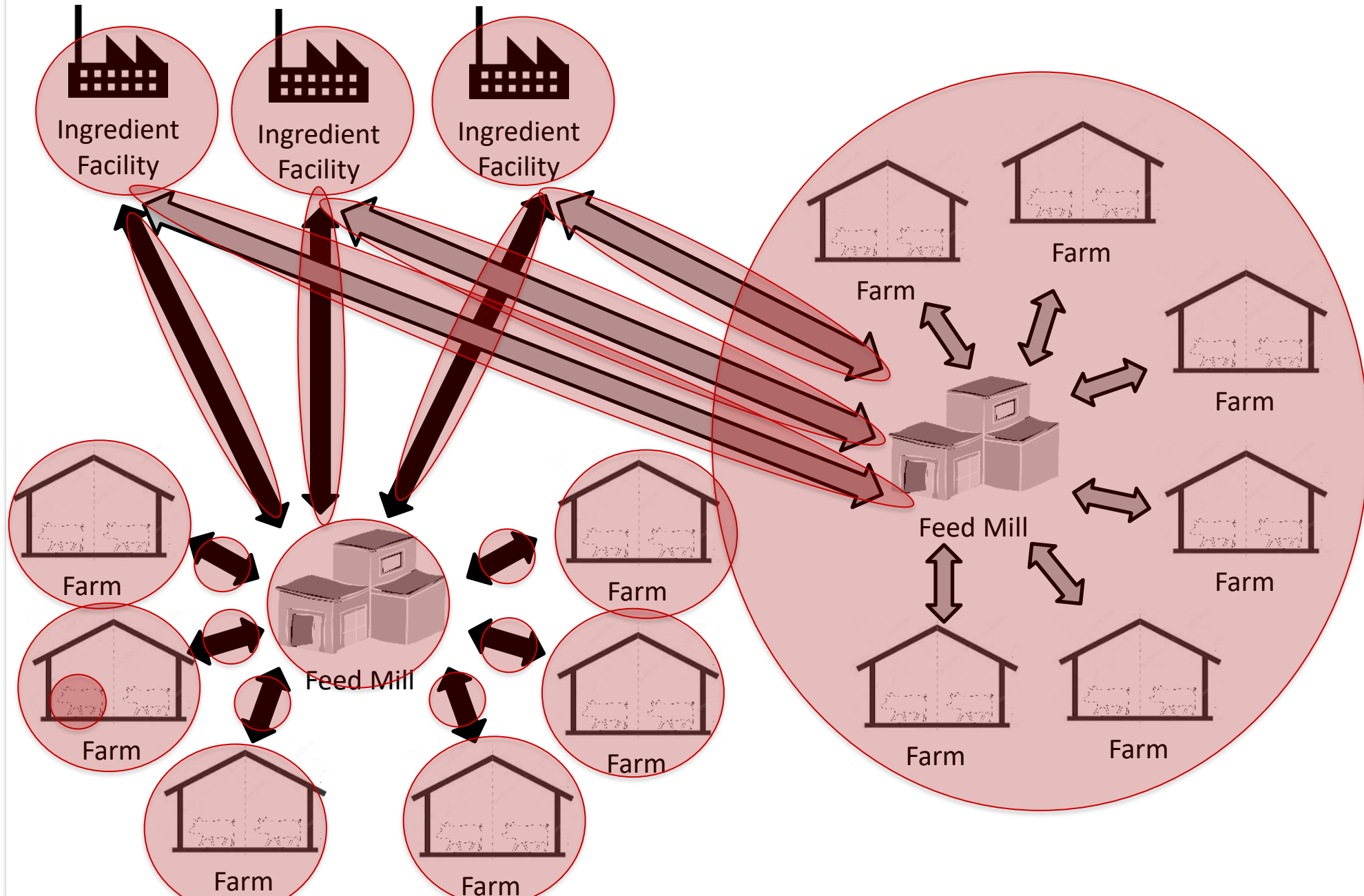
# Impact of manufacturing feed with African swine fever virus-contaminated ingredients on contamination of feed manufacturing equipment and environment



# Impact of manufacturing feed with African swine fever virus-contaminated ingredients on contamination of feed manufacturing equipment and environment



# Potential Transmission in the Feed Supply Chain







# 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 quickly.

# What can we do to limit pathogen entry or transmission by the feed supply chain?

Contamination of Ingredient Destined for United States Pigs



Transboundary Survival of the Pathogen



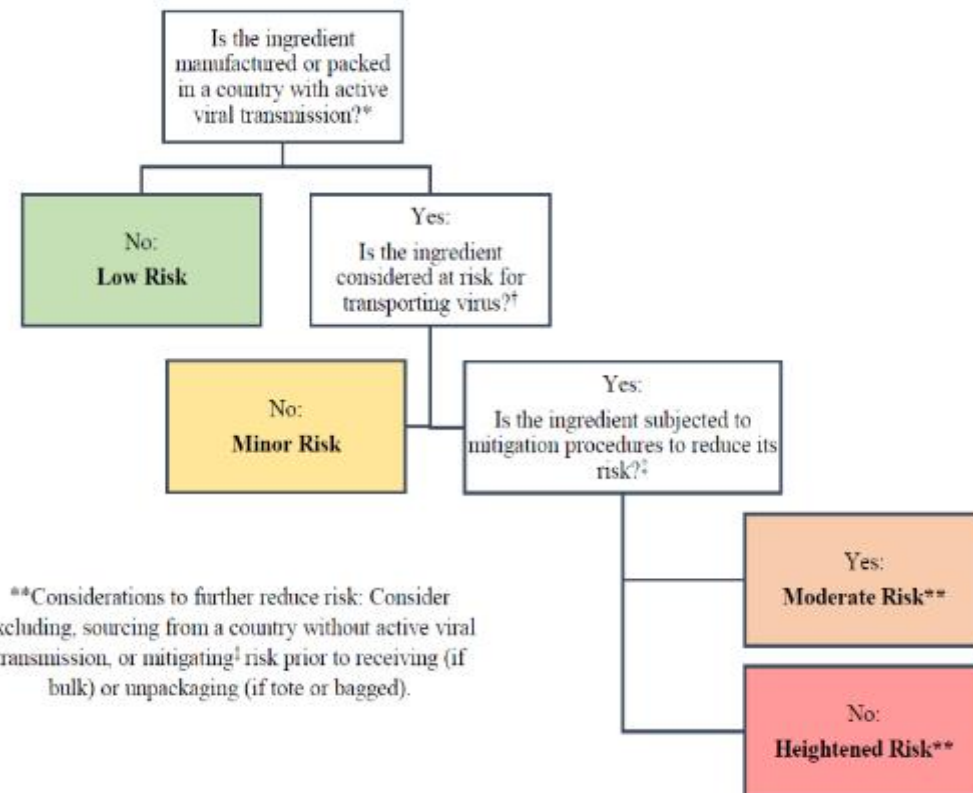
Capability to Cause Infection



# What can we do to limit pathogen entry or transmission by the feed supply chain?

## 1. Exclude high-risk ingredients altogether

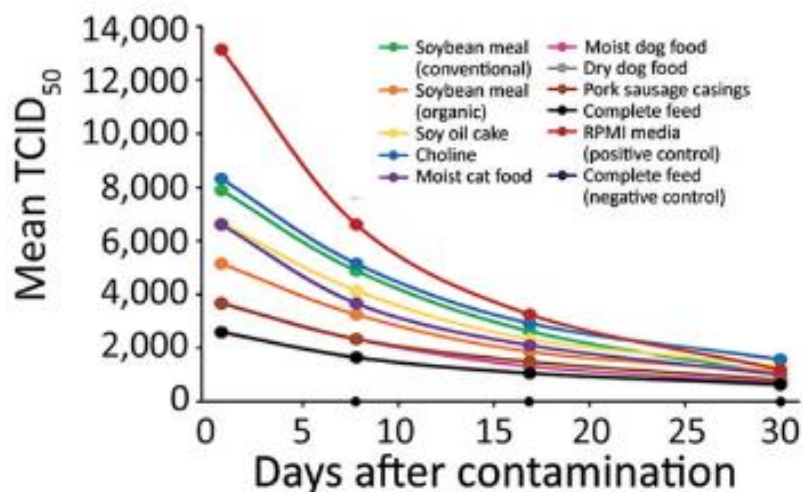
- Know your supplier... and their supplier... and their supplier
- Require biosecurity during manufacture, storage, and transport
- Exclude high risk ingredients altogether



# What can we do to limit pathogen entry or transmission by the feed supply chain?

## 2. Take advantage of opportunities to reduce the survival of infectious virus in contaminated ingredients

- Holding time
- Thermal processing
- Chemical additives, if approved



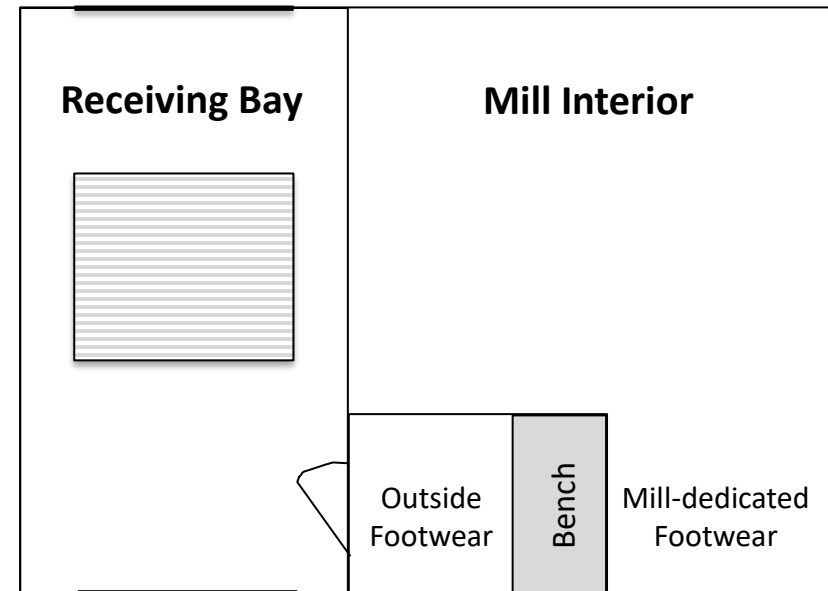
Ingredient	SVA (FMDV)	ASFV	PSV (SVDV)	PEDV	FCV (VESV)	PCV2	BHV-1 (PRV)	PRRSV 174	BVDV (CSFV)	VSV	CDV (NiV)	IAV-S
Soybean meal-Conventional	(+)	(+)	(+)	(+)	(+)	(-)	(+)	(+)	(-)	(-)	(-)	(-)
Soybean meal-Organic	(-)	(+)	(+)	(+)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Soy oil cake	(+)	(+)	(+)	NT	(-)	(-)	(+)	(-)	(-)	(-)	(-)	(-)
DDGS	(+)	(-)	(-)	NT	(-)	(-)	(-)	(+)	(-)	(-)	(-)	(-)
Lysine	(+)	(-)	(+)	(+)	(+)	(+)	(-)	(-)	(-)	(-)	(-)	(-)
Choline	(+)	(+)	(-)	(+)	(-)	(+)	(-)	(-)	(-)	(-)	(-)	(-)
Vitamin D	(+)	(-)	(+)	(+)	(-)	(+)	(-)	(-)	(-)	(-)	(-)	(-)
Moist cat food	(+)	(+)	(+)	NT	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Moist dog food	(+)	(+)	(+)	NT	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Dry dog food	(+)	(+)	(+)	NT	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Pork sausage casings	(+)	(+)	(+)	NT	(+)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Complete feed (+ control)	(+)	(+)	(+)	NT	(+)	(+)	(-)	(-)	(-)	(-)	(-)	(-)
Complete feed (- control)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Stock virus control	(-)	(+)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)

Fig 4. Virus viability in feed ingredient from Batch 4 samples, inclusive of previous PEDV results [14]. A red-colored box with a (+) indicates that virus was recovered in a viable form from a specific ingredient, while a green-colored box with a (-) indicates that viable virus was not recovered by VI and/or swine bioassay. Finally, a blue-colored box with NT denotes that these ingredients were not used in this study and therefore, no results are available.

# What can we do to limit pathogen entry or transmission by the feed supply chain?

## 3. Prevent the potential for farm-mill-farm contamination

- Feed mill biosecurity





# What can we do to limit pathogen entry or transmission by the feed supply chain?

## 3. Prevent the potential for farm-mill-farm contamination

- Feed mill biosecurity



# What does feed biosecurity look like today?



## Current projects

- Impact of showering, Danish benches, and foot baths on preventing the entry of contaminants
- Strategies to decontaminate the interior of feed truck cabs
- Development of an in-vitro model to evaluate the infectivity of swine viruses in feed or ingredients
- Quantification of soy imports into the United States from ASFV-endemic regions
- Facilitating the development of a proposal for a gateway program for importing non animal-origin feed and ingredients from ASFV-endemic regions

# Innovations in Biosecurity Measures for Feed Mills

- 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 pathogen entry and spread.  
Do your part!
  - Exclude high risk ingredients
  - Consider active mitigation to further minimize risk of disease survival and infectivity
  - Implement feed mill biosecurity
  - Continue to help us understand the problem and potential solutions

[jonesc@ksu.edu](mailto:jonesc@ksu.edu)