

# Welcome to the Feed Mill and Biosecurity Webinar

Learn the best practices for biosecurity and quality assurance  
measurements at feed manufactures.



**KANSAS STATE**  

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**U N I V E R S I T Y**



# Welcome



**Uislei Orlando**  
PIC Global Nutrition Team



**KANSAS STATE**  
UNIVERSITY







## Feed Mill Biosecurity:

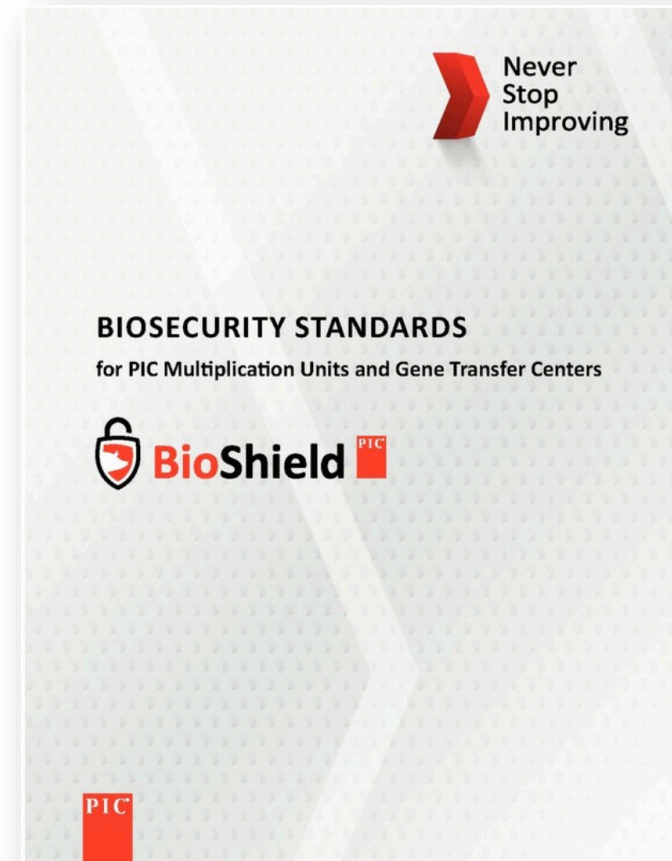
- Biosecurity continues to be at the top of mind for the pork industry. Understanding, identifying, and eliminating risk are key to any biosecurity program - including feed manufacturing

[www.pic.com/resources/nutrition](http://www.pic.com/resources/nutrition)

[www.pic.com/services/bioshield-program/](http://www.pic.com/services/bioshield-program/)

[www.asi.k-state.edu/research-and-extension/swine/calculators.html](http://www.asi.k-state.edu/research-and-extension/swine/calculators.html)

[www.grains.k-state.edu/research/AnimalFeedandPetFood/feed\\_science\\_research\\_extension/index.html](http://www.grains.k-state.edu/research/AnimalFeedandPetFood/feed_science_research_extension/index.html)





# FEED MILL AND BIOSECURITY WEBINAR



**Kara M. Dunmire**  
Kansas State University –  
Feed Science and Management





# Quality Feed Manufacturing

***Kara M. Dunmire, Charles R. Stark, and Chad B. Paulk***

*Kansas State University, Manhattan*

*September 1<sup>st</sup>, 2021*



# Importance of Feed Quality

- Consistent feed quality provides opportunity to minimize cost and meet nutritional goals.
- Feed quality can be considered the most important and the most overlooked factor of feed manufacturing.
- Industry need
  - Emphasis on feed quality
  - No focus on feed quality until something goes wrong
  - Transition from a reactive response to a proactive response



# Primary Audience

- Feed mill managers
  - Target a larger population of the industry
  - Most likely to implement change
  - Can use to help train employees
  - Value quick, easily used resources
- Secondary audience
  - Nutritionists





# Outline of Materials

- Goal: To develop quality feed manufacturing resources entailing the basics of a feed quality assurance program and quality control measures to ensure the production of high quality and consistent feeds for predictable pig performance.

**[https://www.grains.kstate.edu/research/AnimalFeedandPetFood/feed\\_science\\_research\\_extension/index.html](https://www.grains.kstate.edu/research/AnimalFeedandPetFood/feed_science_research_extension/index.html)**

- Guidelines
  - Key concepts
  - Evaluations
  - Visual reminders
- Designed to be supplemental and in no way replace QA manuals, standard operation procedures, or regulatory procedures.



# Quality Feed Manufacturing Guide

## Ingredient Receiving and Sampling

## Particle Size Reduction

## Batching and Mixing

## Pelleting

## Finished Feed

## Feed Mill Biosecurity

**K-STATE** **PIC** **QUALITY FEED MANUFACTURING GUIDE**  
**GENERAL QUALITY PRINCIPLES**

## Guidelines

Nutrient assumptions:  
nutrients needed for maintenance and growth each time they go to the feeder. Factors influencing ingredient distribution in feed include: how ingredients are stored after receiving, order of ingredient addition, scale accuracy, ingredient characteristics, mixer type and mixing time.

### Ingredient Storage

Key factors affecting grain storage include condensation, weather, moisture movement, hot spots, insects, and moisture differences. Optimal growth conditions for insects and spoilage organisms is 70 to 90°F where insects are likely dominant from 50 to 70°F (Fields et al., 2012). Removal of foreign material by sending grain or corn through a screener prior to storage can help mitigate problems with grain storage. Adjustments may need to be made for allowable shrink.

### Bulk

For bulk ingredient storage, bins should be properly labeled on a production board or in the computer automation system. Ingredient bins should be visually inspected prior to changing the bin to a different ingredient. Additionally, slide gates and scale hopper gates should be checked biannually by watching for scale weight fluctuation after weighing an ingredient. This is to ensure gates are closing properly and positive shut-off is achieved.

### Bagged

For bagged ingredient storage, bags should be kept in original packaging with lot numbers for traceability and identification of products. Ingredient bags should be stored in a separate area for feed ingredients. Drugs in mixing areas should be properly identified, stored, handled, and controlled to maintain their integrity. This includes inventory of drug through reconciliation.

1  
Kansas State University Feed Science  
Cite as: Dornier, Kara M., Charles R. Stark, and Chad B. Paulk. 2021. Kansas State University Quality Feed Manufacturing Guide: Batching and Mixing.

**K-STATE** **PIC** **QUALITY FEED MANUFACTURING GUIDE**  
**KEY CONCEPTS**

## Key concepts

### Ingredient

- **Ingredient storage**
  - Bulk ingredient storage bins should be properly labeled and inspected. Removal of foreign material by sending grain or corn through a screener prior to storage can help mitigate problems with grain storage.
  - Bagged ingredient storage should be kept in original packaging with lot numbers for traceability and identification of products. Ingredient bags should be stored in a separate area for feed ingredients.
    - Drugs in mixing areas should be properly identified, stored, handled, and controlled to maintain their integrity. This includes inventory of drug through reconciliation.
  - Liquid ingredients should be stored in original containers or liquid tanks and provided heat until use if specified by supplier.

### Batching

- **Scale resolution**
  - Deviations from specification should not exceed 1% for ingredients with greater than 5 lb inclusion and 2% for ingredients less than 5 lb.
  - Under no circumstance should the overage or shortage of one ingredient be corrected when adding the next ingredient.
- Review each batching report for ingredient discrepancy before shipment of complete feed to compare formulation and actual ingredient addition.
  - Each report should include time and date, formula name and number, ingredient names, ingredient lot numbers (if applicable), ingredient quantities, theoretical and actual weight of ingredients added, where feed was stored, and operator identification.
- Records should be kept for 1 year after production, 2 years if medicated.

### Order of ingredients

- The order of addition of ingredients into the mixer from bins, totes or hand-add stations is important to establish a uniform mix.
  - Order should be major ingredients (greater than 20%), minor (10 to 20%), micro (< 10%) inclusion and hand adds (< 1%).
  - Liquid ingredient should be sprayed on after the pre-determined dry mix time for dry ingredients.
  - The size of the batch of feed should never exceed the volume which the mixer is designed.

### Mixing

- **Mixer**
  - Mixer ribbons and paddles should be inspected monthly to minimize build up from ingredient adhesion. Shaft, paddles, or ribbons should always be visible. Material buildup is a key indication that ribbons and paddles are not functioning properly.
  - Mixer uniformity CVs should be done annually, if not biannually.
  - The feed industry standard is a CV of less than 10%.

1  
Kansas State University Feed Science

**K-STATE** **PIC** **QUALITY FEED MANUFACTURING GUIDE**  
**EVALUATION FORM**

## Evaluations

Feed Mill Name: \_\_\_\_\_  
Manager: \_\_\_\_\_

Instructions  
The following is an evaluation of feed quality measures as outlined in the quality feed manufacturing guide. Evaluator should indicate compliance and provide a score of 0 or 1 - where 0 is never compliant and 1 is always compliant. Please provide comments where necessary. Scores will provide indication for areas of improvement providing data to uphold and observe changes in feed quality. Adjustments to total possible points may need to occur if a question is not applicable. Do not answer the question if it is not applicable. Yearly quality assessments are recommended.

Questions	Score
<b>Sampling</b>	<b>1</b> <b>0</b>
1. Is equipment used for sampling appropriately sized and clean?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2. Are samples taken at equally spaced timed intervals or evenly spaced areas of bags, totes, trucks, etc?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3. Is there a current sample for stored ingredients?	<input type="checkbox"/> Yes <input type="checkbox"/> No
4. Do retained sample labels include label with receiving date, ingredient name, supplier, lot number and sampler ID?	<input type="checkbox"/> Yes <input type="checkbox"/> No
5. Are samples retained and stored while the ingredient is being used and depending on the associated risk of spoilage or disease thereafter?	<input type="checkbox"/> Yes <input type="checkbox"/> No
6. Are samples stored in a cool, dry environment with low humidity free of pests?	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>Comments</b>	
<b>Receiving</b>	
7. Are trucks being visually inspected for leaks, holes and foreign objects that could compromise the lot?	<input type="checkbox"/> Yes <input type="checkbox"/> No
8. Are delivery tickets retained?	<input type="checkbox"/> Yes <input type="checkbox"/> No
9. Have deficiency claims been documented retained?	<input type="checkbox"/> Yes <input type="checkbox"/> No
10. Are receiving pits covered?	<input type="checkbox"/> Yes <input type="checkbox"/> No
11. Are spilled ingredients disposed properly? (i.e. NOT in the receiving pit)	<input type="checkbox"/> Yes <input type="checkbox"/> No
12. Are grab samples being utilized for visual inspection?	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>Comments</b>	
<b>Testing</b>	
13. Is a sample divider being utilized prior to sample analysis?	<input type="checkbox"/> Yes <input type="checkbox"/> No
14. Is moisture content of corn being analyzed?	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>Previous result:</b>	
15. Is whole corn moisture analyzer certified?	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>Certification date:</b>	
16. Is there a mycotoxin testing plan?	<input type="checkbox"/> Yes <input type="checkbox"/> No
What is being tested? _____ How often? _____	
<b>Comments</b>	
<b>Total</b>	<b>____/16</b>

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**K-STATE** **PIC** **QUALITY FEED MANUFACTURING GUIDE**  
**VISUAL REMINDERS**  
**BULK SAMPLING**

## Visual reminders

☐ Ingredient name  
☐ Lot ID  
☐ Sampler ID

2  
3  
Automatic probe for bulk grains

4  
Truck sampling locations

5  
Liquid sampling

From SOP #: \_\_\_\_\_

Kansas State University Feed Science



# Outline: *Introduction and Instructions*

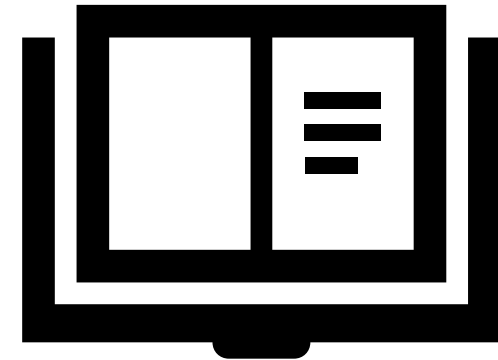
- Communicate the goal of implementing these resources
- Add a brief, general base of the importance of feed quality
  - Example analytical schedule
  - Template for SOP writing



# Outline: *Guidelines and Key Concepts*

- **Section 1: Guidelines**

- To clearly and concisely convey importance of feed quality on pig performance for feed mill managers.
  - Areas within each topic category
    - Collecting
    - Monitoring
    - Interpret data for decision making



- **Section 2: Key concepts**

- One-page of key information from the guidelines, easily digested for quick answers

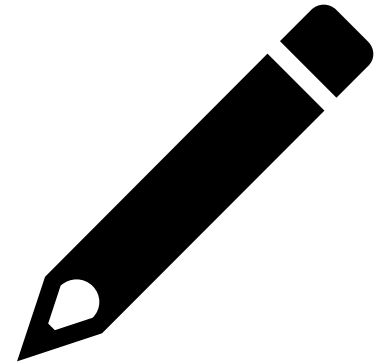


# Outline: *Evaluations*

- Section 3: Evaluations

- To apply knowledge used in established guidelines to monitor practices used for feed quality for feed mill managers.

- Similar to an internal audit
    - Evaluator should indicate compliance and provide a score of 0 or 1
      - Never = 0 points
      - Always = 1 points
    - Use comments to provide further explanation
    - Scores will provide indication for areas of improvement providing data to uphold and observe changes in feed quality.
    - Adjustments to total possible points may need to occur if a question is not applicable.





# Outline: *Visual reminders*

- Section 4: Visual reminders

- To provide a simple reminder to be used on the feed mill for employees.

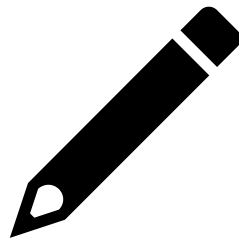
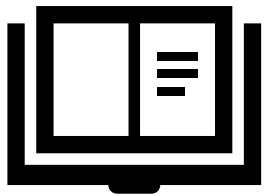
- One page that can be hung on wall
    - Highlight quality steps throughout the feed mill
    - Picture of process flow, checklist, or signage
      - Tools needed for procedure
      - Process
      - End result





# Summary of Materials

- 6 guidelines + 1 supplemental introduction
- 6 one-page key concept sheets
- 6 evaluations + 1 supplemental evaluation
- 31 printable visual reminders across 6 topics





# **Topic 1: Ingredient Receiving and Sampling**



# Ingredient Receiving and Sampling

## Guideline and key concepts



- Sampling
  - Equipment, representative sample, sample frequency, sample labeling and storage
- Receiving procedures
  - Rejection or deficiency, documentation, visual and physical inspection, unloading
- Testing
  - On-site testing options, moisture content, NIRS, fat, mycotoxins



# Ingredient Receiving and Sampling

## Evaluation

- Questions on sampling, receiving and testing
- Summary
  - 16 questions and possible points

QUALITY FEED MANUFACTURING GUIDE  
EVALUATION FORM

### Ingredient Receiving and Sampling

Feed Mill Name: \_\_\_\_\_ Feed Mill Address: \_\_\_\_\_ Manager: \_\_\_\_\_  
 Manager Contact: \_\_\_\_\_ Evaluator: \_\_\_\_\_ Date: \_\_\_\_\_

**Instructions**  
 The following is an evaluation of feed quality measures as outlined in the quality feed manufacturing guide. Evaluator should indicate compliance and provide a score of 0 or 1 – where 0 is never compliant and 1 is always compliant. Please provide comments where necessary. Scores will provide indication for areas of improvement providing data to uphold and observe changes in feed quality. Adjustments to total possible points may need to occur if a question is not applicable. Do not answer the question if it is not applicable. Yearly quality assessments are recommended.

Questions	Score	
	1	0
<b>Sampling</b>		
1. Is equipment used for sampling appropriately sized and clean?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
2. Are samples taken at equally spaced timed intervals or evenly spaced areas of bags, totes, trucks, etc?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
3. Is there a current sample for stored ingredients?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
4. Do retained sample labels include label with receiving date, ingredient name, supplier, lot number and sampler ID?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
5. Are samples retained and stored while the ingredient is being used and depending on the associated risk of spoilage or disease thereafter?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
6. Are samples stored in a cool, dry environment with low humidity free of pests?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<b>Comments</b>		
<b>Receiving</b>		
7. Are trucks being visually inspected for leaks, holes and foreign objects that could compromise the lot?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
8. Are delivery tickets retained?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
9. Have deficiency claims been documented retained?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
10. ★Are receiving pits covered?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
11. ★Are spilled ingredients disposed properly? (i.e. NOT in the receiving pit)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
12. Are grab samples being utilized for visual inspection?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<b>Comments</b>		
<b>Testing</b>		
13. Is a sample divider being utilized prior to sample analysis?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
14. Is moisture content of corn being analyzed?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Previous result:		
15. Is whole corn moisture analyzer certified?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Certification date:		
16. ★Is there a mycotoxin testing plan?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
What is being tested? _____ How often? _____		
<b>Comments</b>	<b>Total: ____/16</b>	



# Ingredient Receiving and Sampling

## Visual reminder

- Ingredient Receiving Checklist, Sampling from bags and barrels, Automatic sampling, Riffle Dividing, Example Moisture Analysis, Example NIR, Example Mycotoxin testing

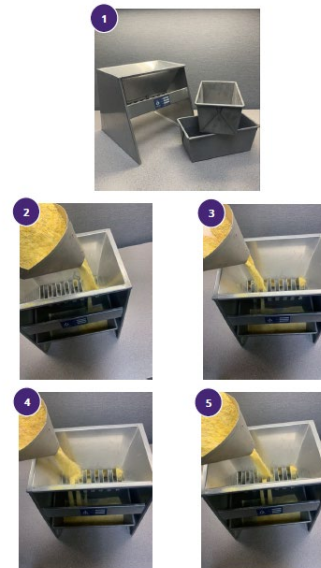
**K-STATE**  **QUALITY FEED MANUFACTURING GUIDE**  
Research and Extension **VISUAL REMINDERS**  
**MOISTURE ANALYSIS AT RECEIVING**



From SOP #:

Kansas State University Feed Science

**K-STATE** **PIG** QUALITY FEED MANUFACTURING GUIDE  
Research and Extension VISUAL REMINDERS  
**RIFFLE DIVIDING FOR SAMPLE PREPARATION**

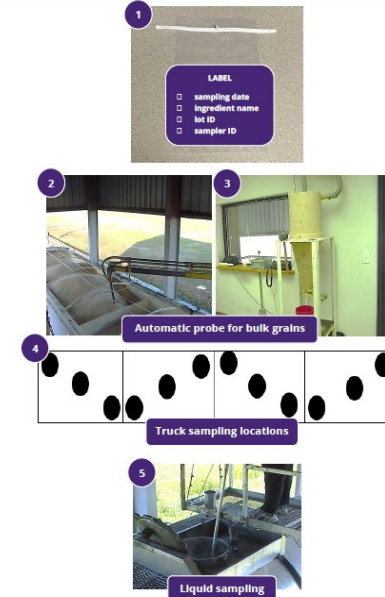


From SOP #:

Kansas State University Feed Science

**K-STATE** **PIC**  
Research and Extension

QUALITY FEED MANUFACTURING GUIDE  
VISUAL REMINDERS  
**BULK SAMPLING**



From SOP #:

Kansas State University Feed Science



# Additional Topics

## 2. Particle Size Reduction

- Hammermills and roller mills
- Monitoring and Testing Particle Size
- Interpreting particle size results

## 3. Batching and Mixing

- Ingredient storage
- Batching
- Mixing
- Feed sequencing and flushing

## 4. Pelleting

- Influence of the pelleting process on ingredient characteristics
- Monitoring and data collection during the pelleting process
- Testing pellet quality

## 5. Finished Feed

- Sample collection
- Feed delivery procedure



# Topic 6: Feed Mill Biosecurity



# Feed Mill Biosecurity

## Guideline and key concepts

- Prevention strategies
  - Risk in feed ingredients, feed mill production flow strategies, employee and visitor flow strategies
- Mitigation strategies



# Feed Mill Biosecurity

## Evaluation

- Questions on prevention feed mill, employee and visitor flow strategies.
- Summary
  - 15 questions and possible points

K-STATE Research and Extension		PIC		QUALITY FEED MANUFACTURING GUIDE EVALUATION FORM	
Feed Mill Biosecurity					
Feed Mill Name: _____		Feed Mill Address: _____		Manager: _____	
Manager Contact: _____		Evaluator: _____		Date: _____	
<b>Instructions</b> The following is an evaluation of feed quality measures as outlined in the quality feed manufacturing guide. Evaluator should indicate compliance and provide a score of 0 or 1 – where 0 is never compliant and 1 is always compliant. Please provide comments where necessary. Scores will provide indication for areas of improvement providing data to uphold and observe changes in feed quality. Adjustments to total possible points may need to occur if a question is not applicable. Do not answer the question if it is not applicable. Yearly quality assessments are recommended.					
Questions		Score			
<b>Prevention strategies</b>		<b>1</b>		<b>0</b>	
1. Is there a biosecurity plan in place?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
2. Are only approved suppliers being used?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
3. Have high risk ingredients been identified?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
4. Is every high-risk ingredient lot sampled? (If no high-risk ingredients are being used check "yes")		<input type="checkbox"/> Yes <input type="checkbox"/> No			
5. *Is there receiving documentation of date, time, lot number, previous hauled ingredient for traceability?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
Comments					
<b>Feed mill production flow strategies</b>					
6. Is there clear signage for visitors and drivers about biosecurity protocols?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
7. Are utensils (brooms) stored off the ground?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
8. *Is there coordination of feed delivery from lower-risk farms to higher risk farms?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
Comments					
<b>Visitor and employee flow strategies</b>					
9. Is foot traffic minimized in high-risk areas (receiving)?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
10. Do visitors and truck drivers wear shoe coverings?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
11. Are visitors always accompanied by an employee?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
12. Is hygienic zoning implemented if possible? (i.e. single point of entry, lines of separation, employee footwear remains onsite)		<input type="checkbox"/> Yes <input type="checkbox"/> No			
13. Are logbooks maintained for visitor entry?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
14. Is there protocol for employees that have contact with pigs?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
15. Is there clear communication between farm site health status and the feed mill?		<input type="checkbox"/> Yes <input type="checkbox"/> No			
Comments		Total: _____		/15	

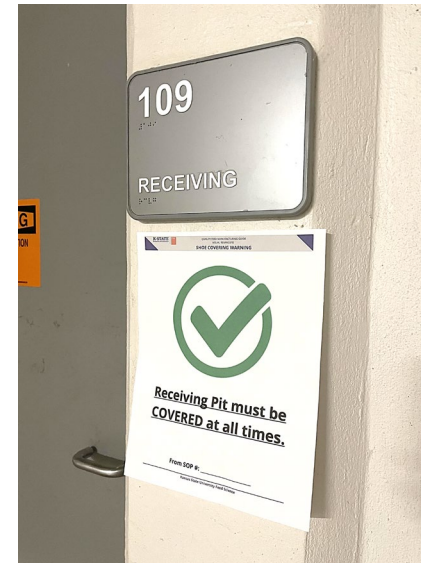
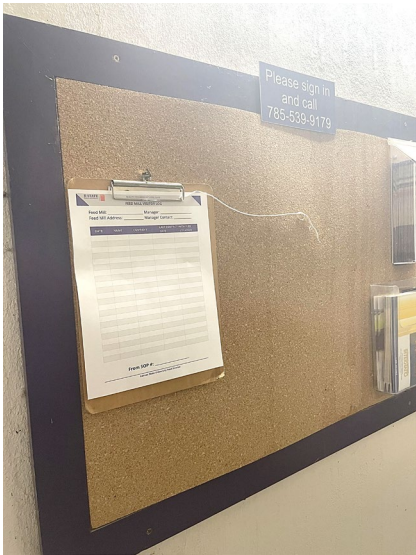


# Feed Mill Biosecurity

## Visual reminders

### – Printable signage

- Feed mill visitor log, feed mill visitor responsibility, ingredient driver responsibility, finished feed driver responsibility, stops and checks





# Additional Resource Links

- AAFCO Official Publication
- Feed Additive Compendium
- AFIA Quality Manual Template
- AFIA Electronic Feed Ingredient Guide
- AAFCO Feed Inspectors Manual
- AFIA Resource Center
- Particle Size of Feedstuffs – Kansas State University
- Feed Pelleting Reference Guide
  - (<https://www.feedstrategy.com/feed-pelleting-reference-guide/>)
- PIC Bioshield
- K-State Swine Feed Mill Biosecurity Audit
- Swine Health Information Center AFIA Guide: “Developing Biosecurity Practices for Feed & Ingredient Manufacturing”
- FDA Guidance for Industry #235: “Current Good Manufacturing Practice Requirements for Food for Animals.”
- FDA Guidance for Industry #245: “Hazard Analysis and Risk-Based Preventive Controls for Food and Animals”
- FDA Guidance for Industry #246: “Hazard Analysis and Risk-Based Preventive Controls for Food for Animals: Supply-Chain Program”
- FDA Guidance for Industry #239: “Human Food By-Products for Use As Animal Food”



# Opportunity: Feed Mill Data

Subject	Total Possible Points	FM1 Score	FM2 Score	FM3 Score	FM Total	Percent of total
1. Ingredient Receiving and Sampling	16	10	15	16	41	83.3
2. Particle Size	6	8	5	6	<b>19</b>	47.9
3. Batching and Mixing	13	6	12	13	31	50.0
4. Pelleting	15	15	13	6	34	40.5
5. Finished Feed	16	11	10	10	31	32.3
6. Feed Mill Biosecurity	15	2	2	3	7	6.9
<b>Total</b>	<b>81</b>	<b>52</b>	<b>57</b>	<b>54</b>	<b>163</b>	<b>36.8</b>
<b>Percent of total</b>	<b>100</b>	<b>64.2</b>	<b>70.4</b>	<b>66.6</b>		



# Summary of Quality Feed Manufacturing Guide

## Ingredient Receiving and Sampling

## Particle Size Reduction

## Batching and Mixing

## Pelleting

## Finished Feed

## Feed Mill Biosecurity

## Guidelines

nutrients needed for maintenance and growth each time they go to the feeder. Factors influencing ingredient distribution in feed include how ingredients are stored after receiving, order of ingredient addition, scale accuracy, ingredient characteristics, mixer type and mixing time.

### Ingredient Storage

Key factors affecting grain storage include condensation, weather, moisture movement, hot spots, insects, and moisture differences. Optimal growth conditions for insects and spoilage organisms is 70 to 90°F where insects are likely dormant from 50 to 70°F (Fields et al. 2012). Removal of foreign material by sending grain or corn through a screener prior to storage can help mitigate problems with grain storage. Adjustments may need to be made for allowable shrink.

**Bulk**

For bulk ingredient storage, bins should be properly labeled on a production board or in the computer automation system. Ingredient bins should be visually inspected prior to changing the bin to a different ingredient. Additionally, slide gates and scale hopper gates should be checked biannually by watching for scale weight fluctuation after weighing an ingredient. This is to ensure gates are closing properly and positive shut-off is achieved.

**Bagged**

For bagged ingredient storage, bags should be kept in original packaging with lot numbers for traceability and identification of products. Ingredient bags should be stored in a separate area for feed ingredients. Drugs in mixing areas should be properly identified, stored, handled, and controlled to maintain their integrity. This includes inventory of drug through reconciliation.

Liquid ingredients should be stored in original containers or liquid tanks and provided heat until use as specified by supplier. The storage temperature of liquid fat should be monitored and maintained to prevent solidification, often target storage temperature is between 140°F and 145°F. Lower ambient temperatures will require more energy to heat the fat to a usable temperature where higher temperatures can contribute to fat rancidity. Liquid molasses should be stored between 70 and 80°F. Storage at higher temperatures will result in oxidation and charring resulting in nutritional value and damaging the system. Liquid fat should be used as quickly as possible to uphold fat quality, therefore inventory should not exceed a monthly need. Liquid tanks and equipment should be inspected frequently and inspected when tanks become empty to prevent ingredient spoilage.

## Batching

Under-addition of ingredients can lead to poor animal performance while over-addition of ingredients can lead to deviation in inventory, diluted nutrients and added cost.

### Scale resolution

Keeping scales within specification limits of the required quantities is key to getting precise diets in front of the pig. Time, screw conveyor diameters, and the use of variable frequency drives (VFD) at multiple speeds determine the accuracy of ingredient addition (Stark and Jones, 2015). Deviations from specification should not exceed 1% for ingredients with greater than 5 lb inclusion and 2% for ingredients less than 5 lb. Under no circumstance should the overage or shortage of one ingredient be corrected when adding the next ingredient. Smaller ingredient inclusions like concentrated enzymes, vitamins and minerals

## Key concepts

### Ingredients

- Bulk ingredient storage bins should be properly labeled and inspected. Removal of foreign material by sending grain or corn through a screener prior to storage can help mitigate problems with grain storage.
- Bagged ingredient storage should be kept in original packaging with lot numbers for traceability and identification of products. Ingredient bags should be stored in a separate area for feed ingredients.
  - Drums in mixing areas should be properly identified, stored, handled, and controlled to maintain their integrity. This includes inventory of drug through reconciliation.
- Liquid ingredients should be stored in original containers or liquid tanks and provided heat until use if specified by supplier.

## Batching

- **Scale resolution**
  - Deviations from specification should not exceed 1% for ingredients with greater than 5 lb inclusion and 2% for ingredients less than 5 lb.
    - Under no circumstance should the overage or shortage of one ingredient be corrected when adding the next ingredient.
- **Review each batching record for ingredient discrepancy before shipment of complete feed to compare formulation and actual ingredient addition.**
  - Each report should include time and date, formula name and number, ingredient names, ingredient lot numbers (if applicable), ingredient quantities, theoretical and actual weight of ingredients added, where feed was stored, and operator identification.
- **Records should be kept for 1 year after production, 2 years if medicated.**
- **Order of ingredients**
  - The order of addition of ingredients into the mixer from bins, totes or hand-d add stations is important to establish a uniform mix.
    - Order should be major ingredients (greater than 20%), minor (10 to 20%), micro (<10%) inclusion and hand adds (<1%).
    - Liquid ingredients should be sprayed on after the pre-determined dry mix time for dry ingredients.
    - The size of the batch of feed should never exceed the volume which the mixer is designed.

### Mixing

- Mixer ribbons and paddles should be inspected monthly to minimize build up from ingredient adhesion. Shaft, paddles, or ribbons should always be visible. Material buildup is a key indication that ribbons, and paddles are not functioning properly.
  - Mixer uniformity CVs should be done annually, if not biannually.
  - The feed industry standard is a CV of less than 10%.

## Evaluations

Feed Mill Na  
Manager Cor

### Instructions

The following is an evaluation of feed quality measures as outlined in the quality feed manufacturing guide. Evaluator should indicate compliance and provide a score of 0 or 1 – where 0 is never compliant and 1 is always compliant. Please provide comments where necessary. Scores will provide indication for areas of improvement providing data to uphold and observe changes in feed quality. Adjustments to total possible points may need to occur if a question is not applicable. Do not answer the question if it is not applicable. Yearly quality assessment are recommended.

Questions	Score
<b>Sampling</b>	<b>1</b>
1. Is equipment used for sampling appropriately sized and clean?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
2. Are samples taken at equally spaced timed intervals or evenly spaced areas of bags, totes, trucks, etc?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
3. Is there a current sample for stored ingredients?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
4. Do retained sample labels include label with receiving date, ingredient name, supplier, lot number and sampler ID?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
5. Are samples retained and stored while the ingredient is being used and depending on the associated risk of spoilage or disease thereafter?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
6. Do samples stored in a cool, dry environment with low humidity free of pests?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<b>Comments:</b>	

11

Receiving			
7.	Are trucks being visually inspected for leaks, holes and foreign objects that could compromise the lot?	<input type="checkbox"/> Yes	<input type="checkbox"/>
8.	Are delivery tickets retained?	<input type="checkbox"/> Yes	<input type="checkbox"/>
9.	Have deficiency claims been documented retained?	<input type="checkbox"/> Yes	<input type="checkbox"/>
10.	*Are receiving pits covered?	<input type="checkbox"/> Yes	<input type="checkbox"/>
11.	*Are spilled ingredients disposed properly? (i.e. NOT in the receiving pit)	<input type="checkbox"/> Yes	<input type="checkbox"/>
12.	Are grab samples being utilized for visual inspection?	<input type="checkbox"/> Yes	<input type="checkbox"/>

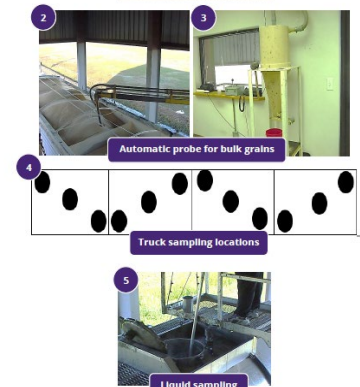
Comment
---------

Testing		
13. Is a sample divider being utilized prior to sample analysis?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
14. Is moisture content of corn being analyzed?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Previous result:		
15. Is whole corn moisture analyzer certified?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Certification date:		
16. Is there a mycotoxin testing plan?	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
What is being tested?	How often?	Each

Comment
---------

## Visual reminders

- ingredient name
- lot ID
- sampler ID



From SOP #: \_\_\_\_\_

Kansas State University Feed Science



# Final Thoughts

- The key to feed quality
  - *Identify* the most valuable aspects of quality
  - *Monitor* that they are done correctly
- Resources and tools for success

<https://bit.ly/KStateFeedGuidelines>



# Thank you!

<https://bit.ly/KStateFeedGuidelines>

Kara M. Dunmire – karadunmire@ksu.edu

Charles R. Stark – crstark@ksu.edu

Chad B. Paulk – cpaulk@ksu.edu



# FEED MILL AND BIOSECURITY WEBINAR



**Jason Pooley**

PIC Health Programs Manager



**KANSAS STATE**  
UNIVERSITY





Never Stop Improving

*Health Assurance Technical Services*

## Updates in Bioshield Feed Section

Jason Pooley  
PIC North America

PIC®

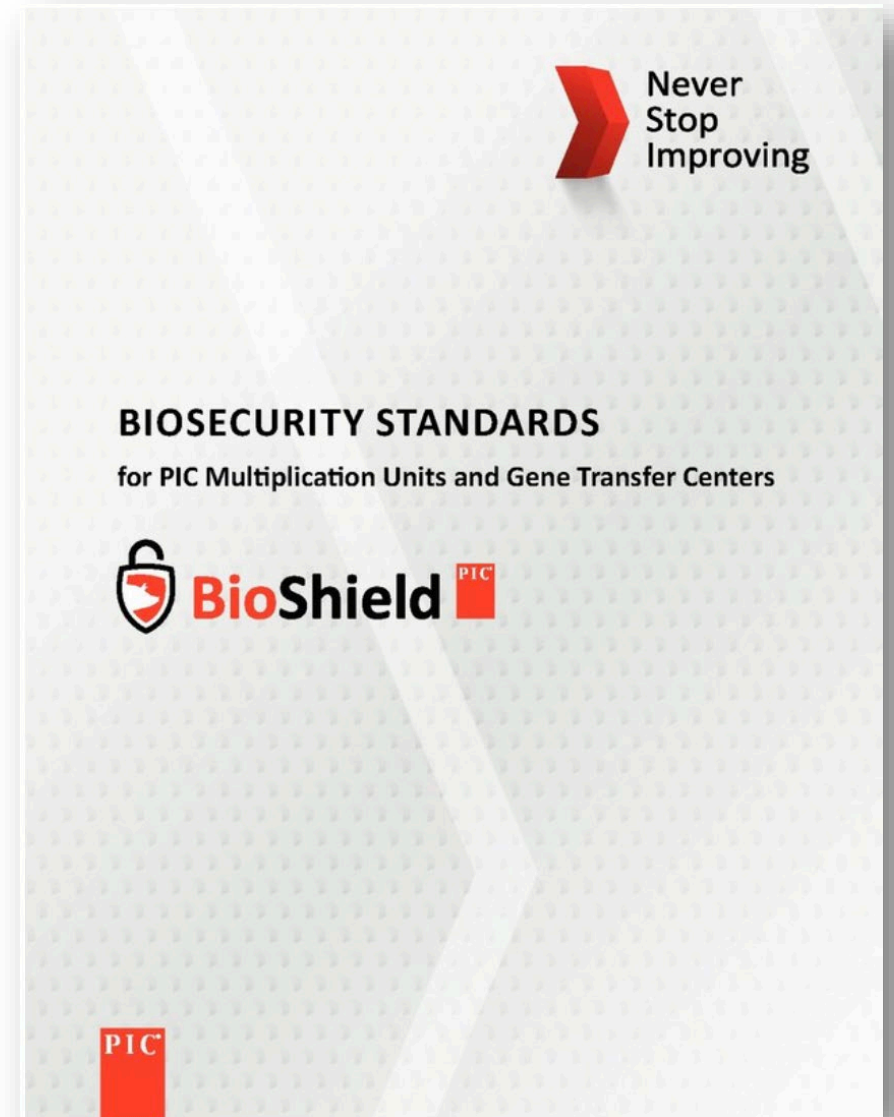


# Introduction



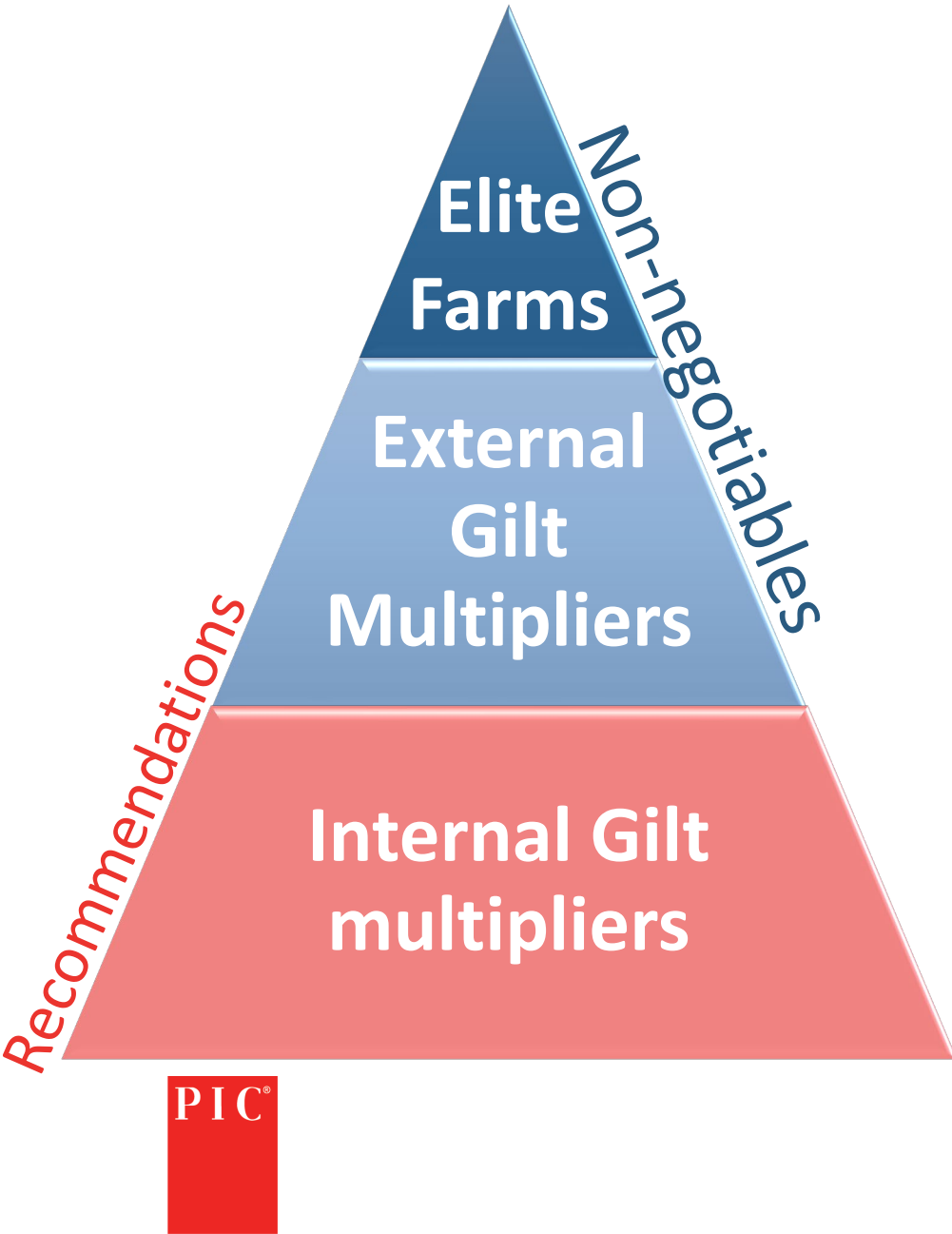
- Proper execution of biosecurity protocols at PIC associated feed mill facilities is essential to:
  - Reduce the likelihood that pathogens will be introduced into the feed chain
  - Prevent the spread of animal disease through feed or feed ingredients.
- BioShield is an evolving program that will be continuously updated as new science-based information and industry knowledge become available.

PIC®





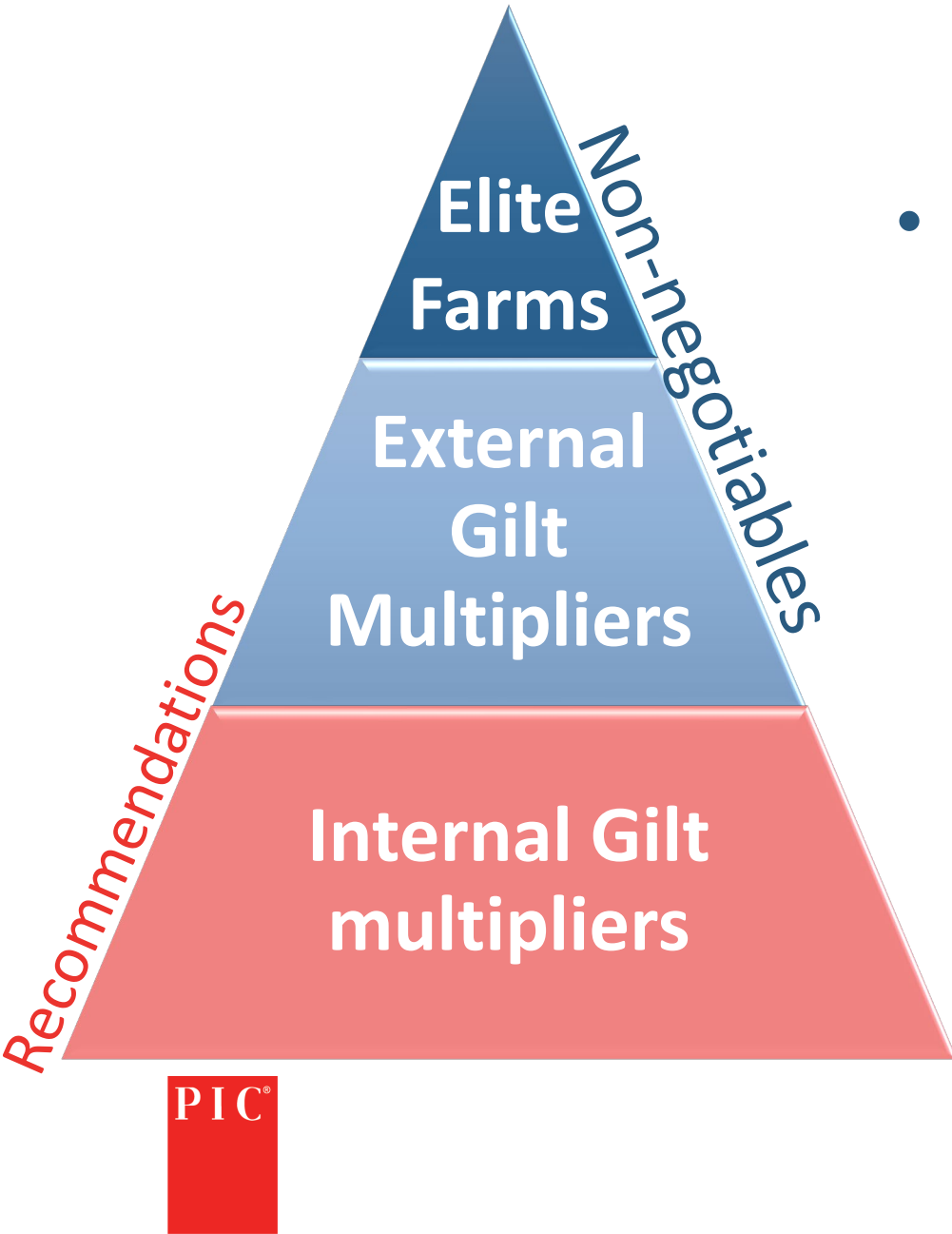
# Ingredients and Complete Feed



- Prohibited:

- Use of porcine origin ingredients.
- Feed manufacturing in mills that utilize porcine origin ingredients in non-PIC diets
- Use of porcine origin fat source.





- **Conditionally allowed:**

- By-product sources of non-porcine origin **if** no porcine products are processed at the plant of origin, transported in the same vehicles, or stored in the same container.
- Dried distillers' grain with solubles (DDGS) **if** stored in bird-proof facilities or with bird-control protocols.



# Ingredients and Complete Feed

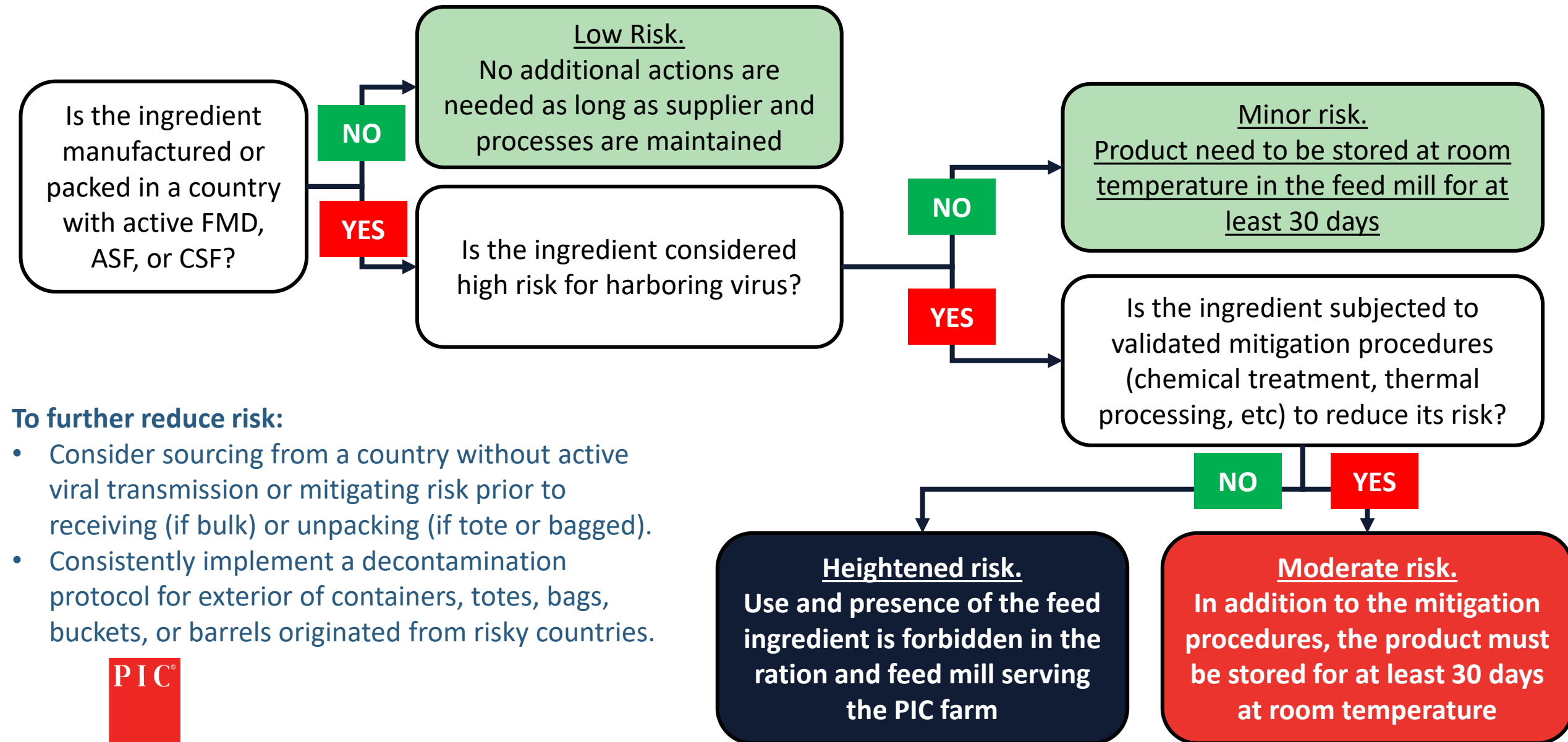


- Purchase and handle ingredients in a bio secure manner.
- Transport ingredients in in power units /trailers that have not had contact with swine.
- Attempt to purchase grains from producers with no swine.
- Maintain and control feed ingredients to prevent exposure to contaminated materials.
- Have a feed ingredient risk assessment for all imported ingredients.
- Implement appropriate mitigation strategies for imported ingredients, if required.





# Decision tree to Assess and Minimize FAD Transmission Risk from Feed Ingredients



## To further reduce risk:

- Consider sourcing from a country without active viral transmission or mitigating risk prior to receiving (if bulk) or unpacking (if tote or bagged).
- Consistently implement a decontamination protocol for exterior of containers, totes, bags, buckets, or barrels originated from risky countries.



# Use receiving processes that reduce risk

 Never Stop Improving

Don't sweep dirt  
into pit

Stay in truck, or use  
disposable shoe covers  
and limit traffic

Keep receiving pit  
covered



Picture: Cochrane et al., 2016



Picture: Cochrane et al., 2016



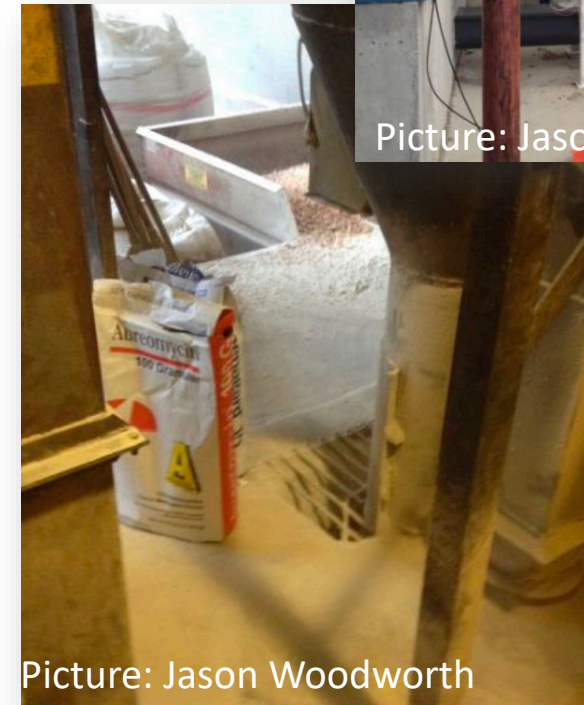
# Manufacturing best practices

 Never Stop Improving

- Defining clean/dirty lines
- Daily cleaning of manufacturing areas
- Flushing of feed manufacturing and delivery equipment
- Sequencing by species and biosecurity pyramid
- Maintaining a pest control protocol
- Disposing of collected dust

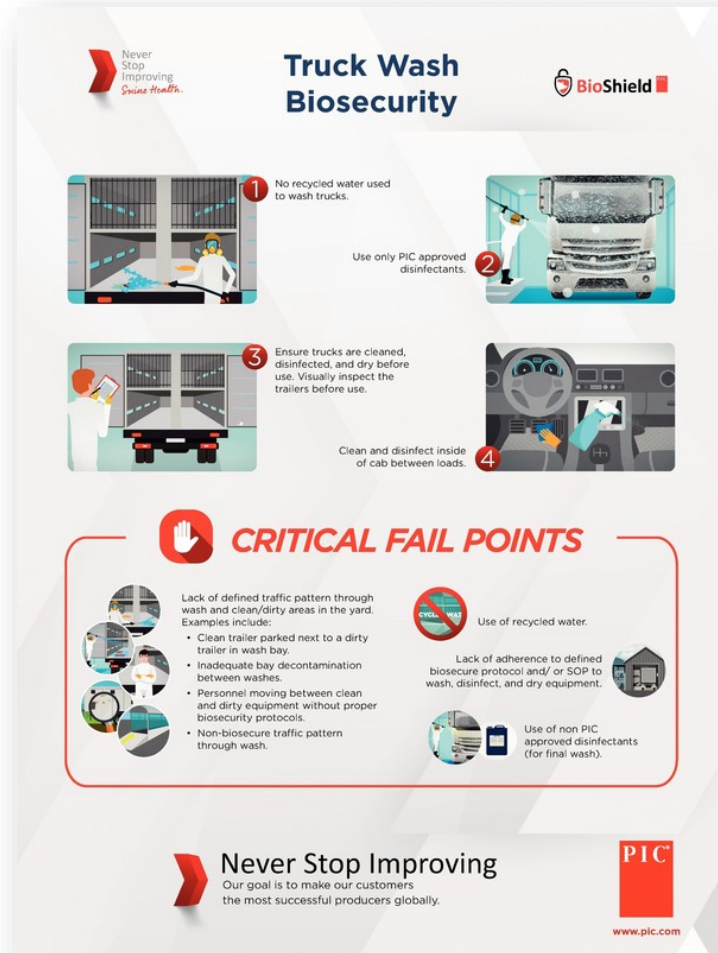


Picture: Jason Woodworth



Picture: Jason Woodworth





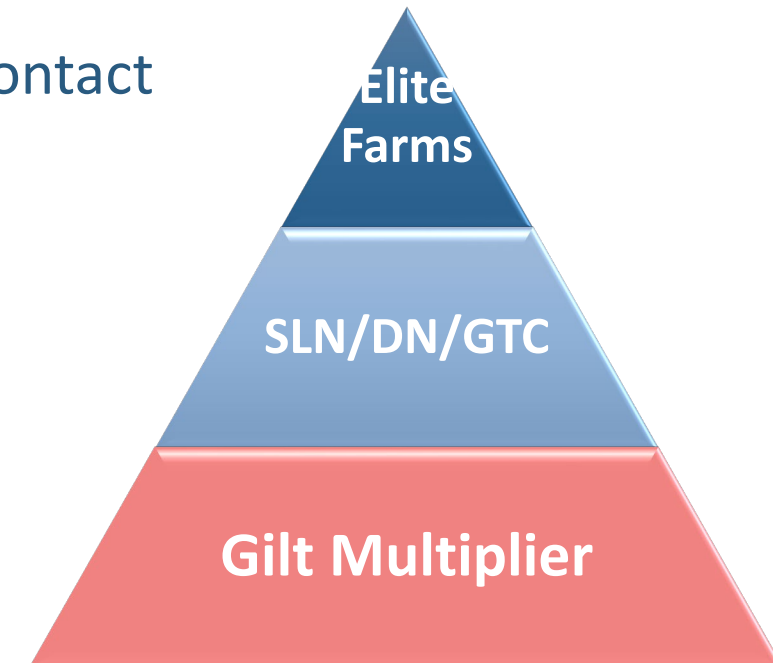
## Elite Farms, SLN and GTC:

Dedicated feed trucks  
or an inner-sanctum  
truck.

## Other herds:

Segregated feed trucks  
between multiplication  
and commercial herds.

- Feed trucks to follow a dynamic biosecurity pyramid.
- Wash, disinfect, dry and inspect when needed.
- Truck drivers never come in contact with the feed.
- Dispose of any feed spillage.





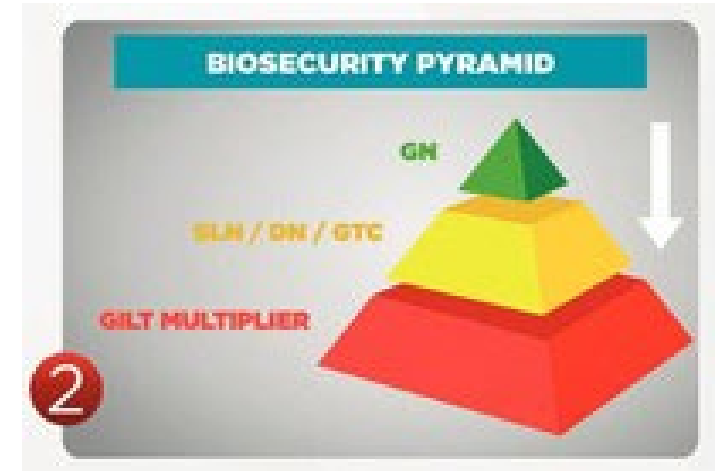
# Critical risk factors at the feed mill level

 Never Stop Improving



Use of prohibited ingredients,  
e. g. porcine protein origin  
ingredients

Lack of  
biosecurity  
pyramid flow



Lack of  
ingredient  
reception protocol

Unverified origin of  
high-risk ingredients





- **Risk mitigation strategies**
  - Contamination can occur at numerous points during feed manufacturing:
    - The use of contaminated ingredients
    - Contamination during ingredient reception
    - Cross-contamination during manufacturing at the feed mill
    - By delivery vehicles and personnel
- **Routine monitoring and Proactive Communication**
  - Periodical educational and problem-solving sessions:
    - Feed mill ownership/management, the
    - Multiplier ownership/veterinarian
    - PIC



Thanks!





# FEED MILL AND BIOSECURITY WEBINAR



**Jordan Gebhardt**

Kansas State University –  
Diagnostic Medicine/Pathobiology



**KANSAS STATE**  
UNIVERSITY



# Latest research in feed mill biosecurity



*Jordan Gebhardt*  
*Assistant Professor*  
*Diagnostic Medicine/Pathobiology*  
*Kansas State University*

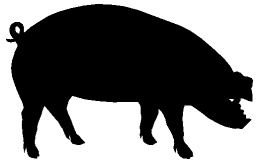




# Mechanics of disease transmission

## Infected host

Habitat where agent lives,  
grows, multiplies



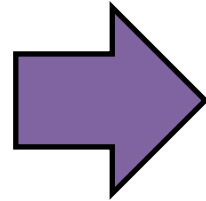
Domesticated swine



Wart hog



Wild boar



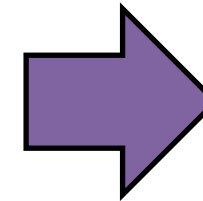
## Transmission

Method of transport from reservoir  
to susceptible host

### Direct

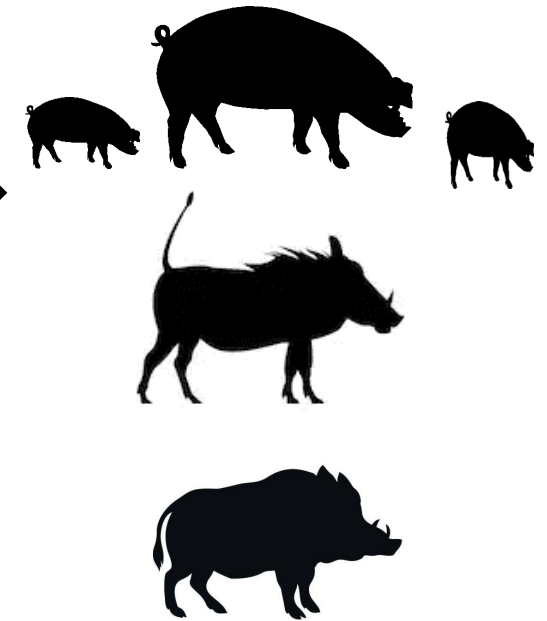


### Indirect



## Susceptible host

Individual susceptible to  
the specific agent



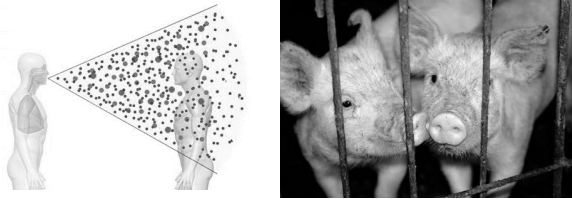


# Mechanics of disease transmission

## Transmission

Method of transport from reservoir  
to susceptible host

### Direct



What do we influence  
on a daily basis?

### Indirect



Exclude High  
Risk  
Ingredients



Biosecurity  
practices



Active  
Mitigation





# Research partnership

Production system located in Vietnam

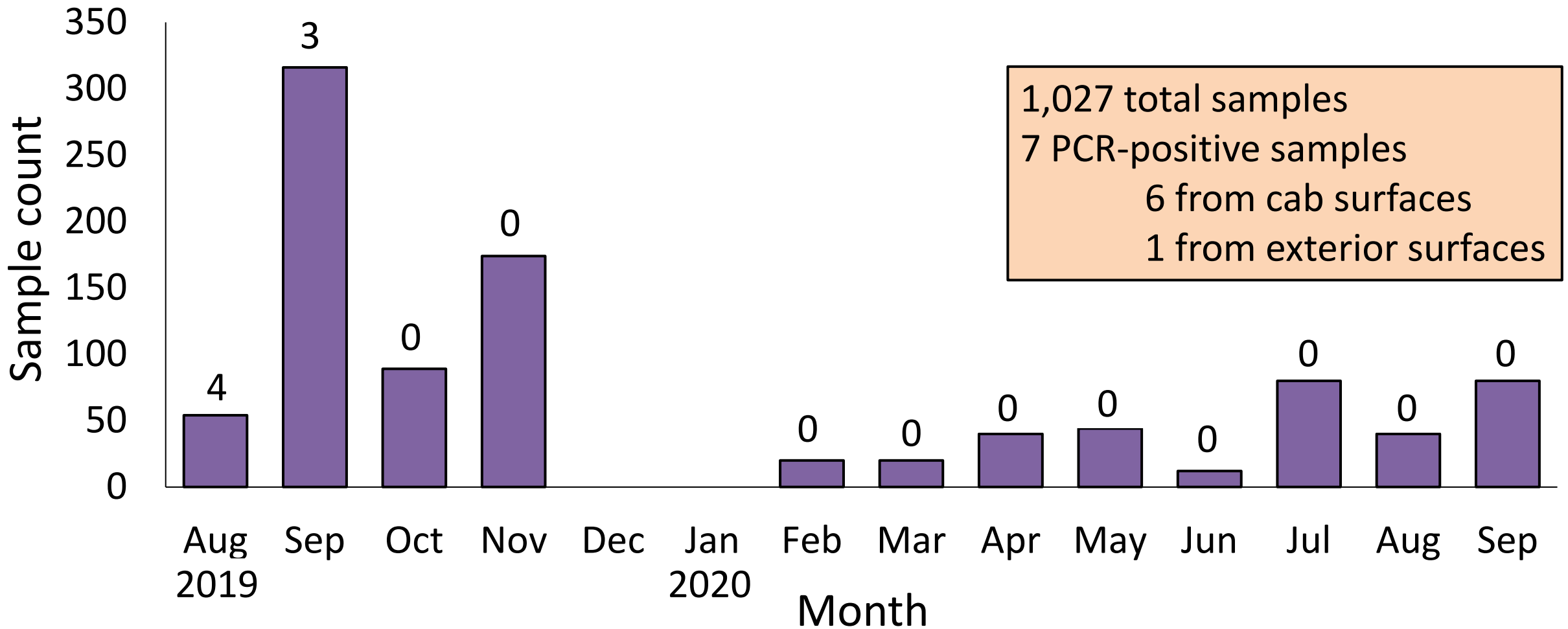
Goal: Use diagnostic testing capabilities to understand the risk of ASFV spread within their production system

1. Feed production system
  - a. Feed mill
  - b. Ingredients and finished feed
  - c. Feed trucks
2. Live animal transport
3. Market animal transfer center





# Feed delivery vehicles





# How can this be accomplished?



Step 1:  
Remove organic material



Step 2:  
Dry



Step 3:  
Apply disinfectant



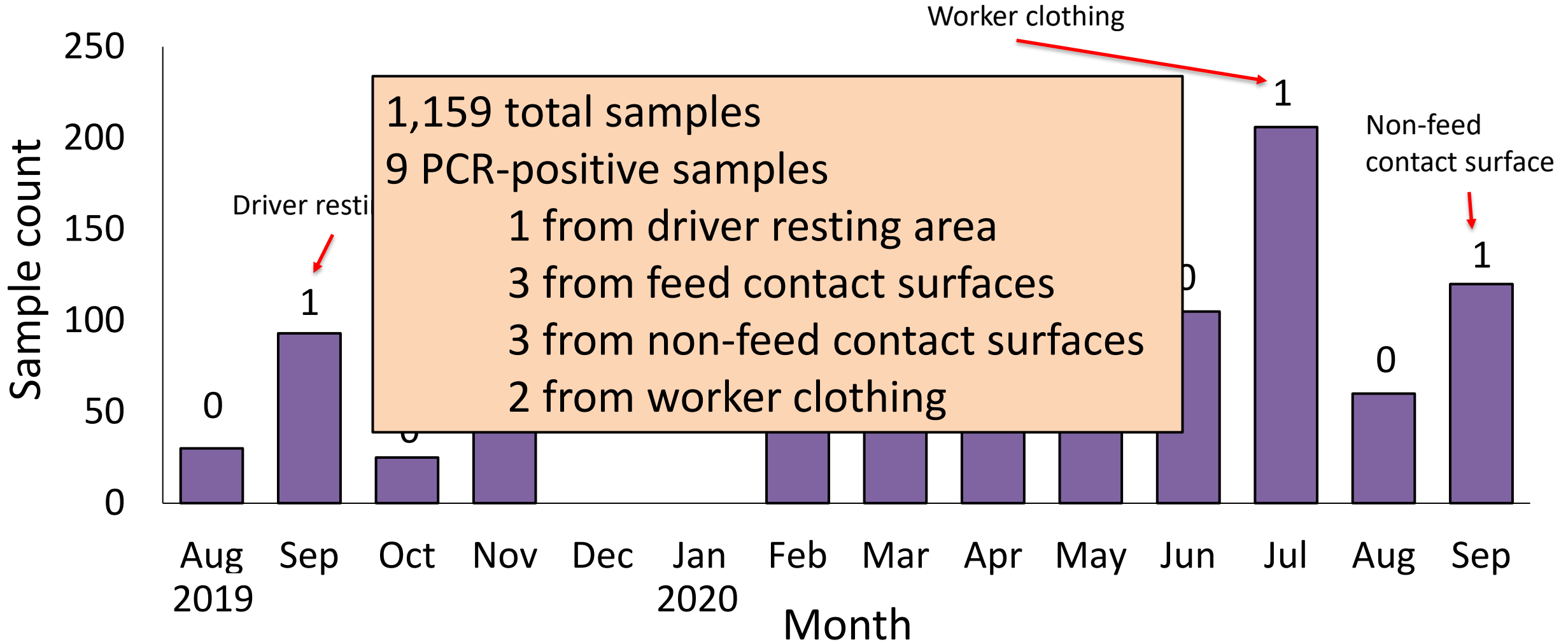
# How can this be accomplished?



Avoid this



# Feed mill surfaces





# Feed and ingredients

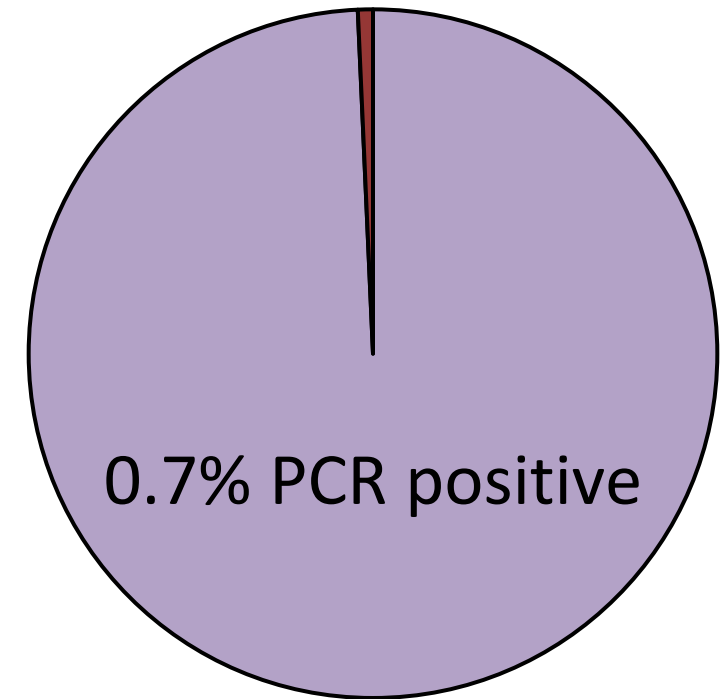
142 total samples so far

40 ingredient and water samples

102 complete feed samples

1 complete feed sample PCR positive

- Batch of feed did not contain added formaldehyde-based product



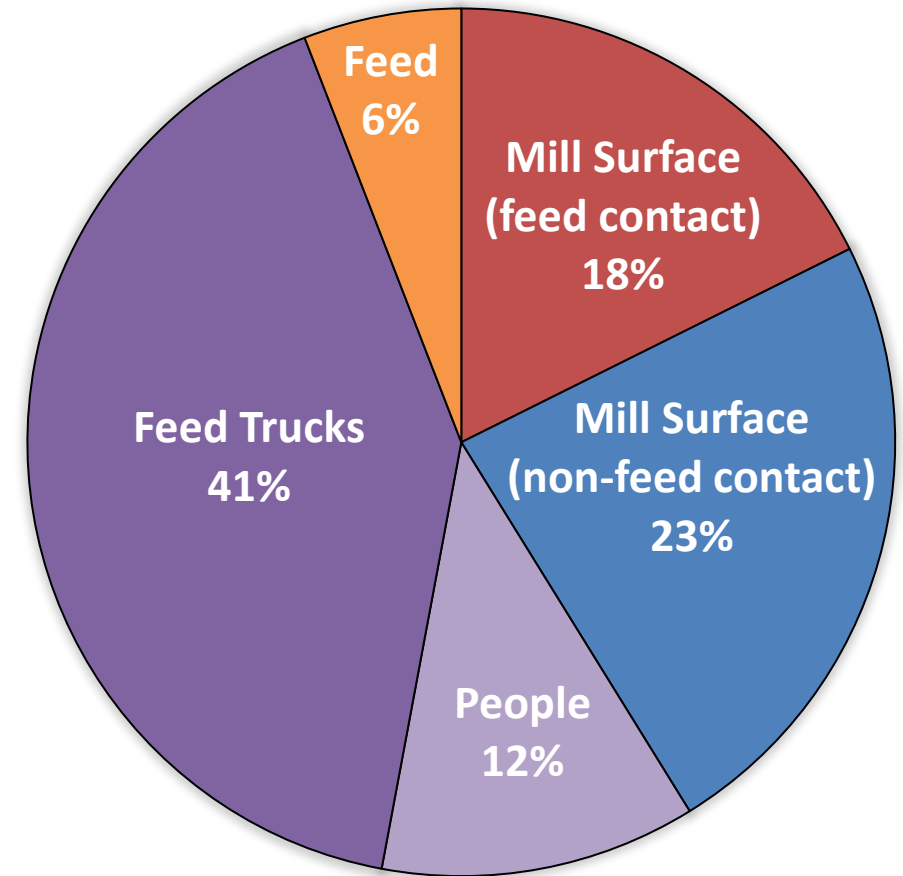
■ PCR-negative ■ PCR-positive



# Where is the contamination at?

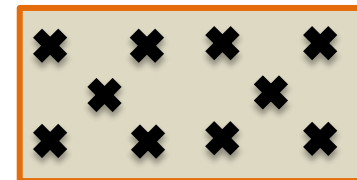
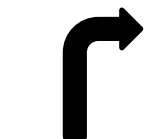
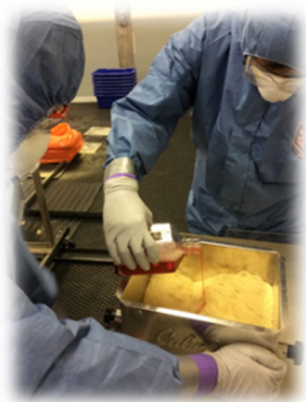
- 17 of 2,328 samples (0.7%) from the feed supply chain contain ASFV DNA as determined by PCR
  - 3 Feed-Contact Surfaces in Mill
  - 4 Non-Feed-Contact Surfaces in Mill
  - 2 Employee clothing in Mill
  - 1 Complete Feed
  - 7 Feed Trucks

Key finding: People and fomites are incredibly important!





# Risk of ASFV carryover if feed after contaminated batch



## Batch

1  
2  
3  
4  
5  
6

## Ingredients

Negative  
ASFV Inoculated  
Negative  
Negative  
Negative  
Negative

**pork**  
checkoff





# Risk of ASFV carryover if feed after contaminated batch

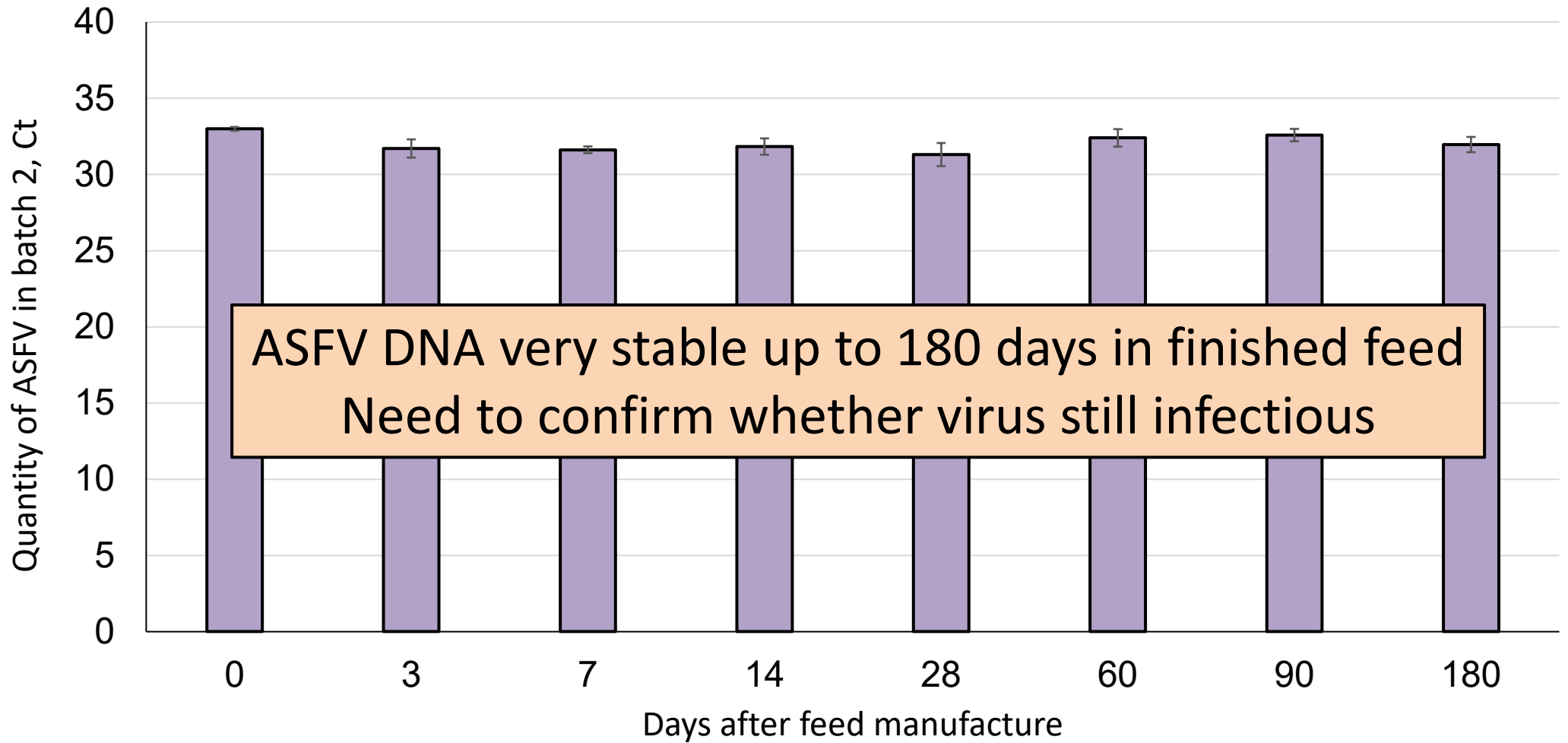
Detection of African swine fever virus (ASFV) p72 DNA in feed samples						
	Batch of feed					
	1	2	3	4	5	6
Batch	Negative	Positive	Negative	Negative	Negative	Negative
Non-detected	10	0	0	0	0	0
Suspect	0	0	0	1	1	3
ASFV detected	0	10	10	9	9	7

ASFV was still detected after 4 subsequent batches of feed



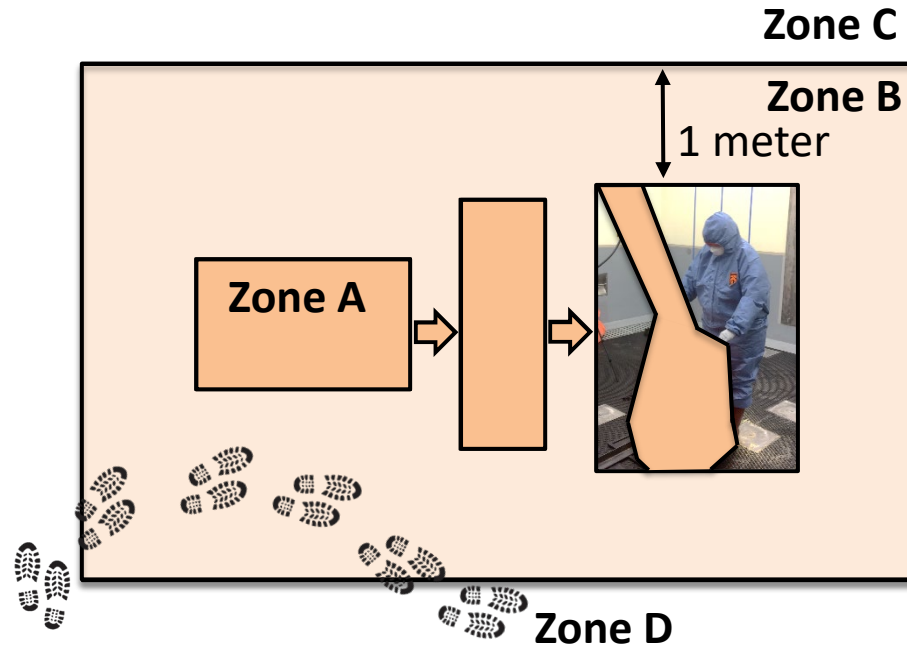


# Detection of African swine fever virus in contaminated feed over time



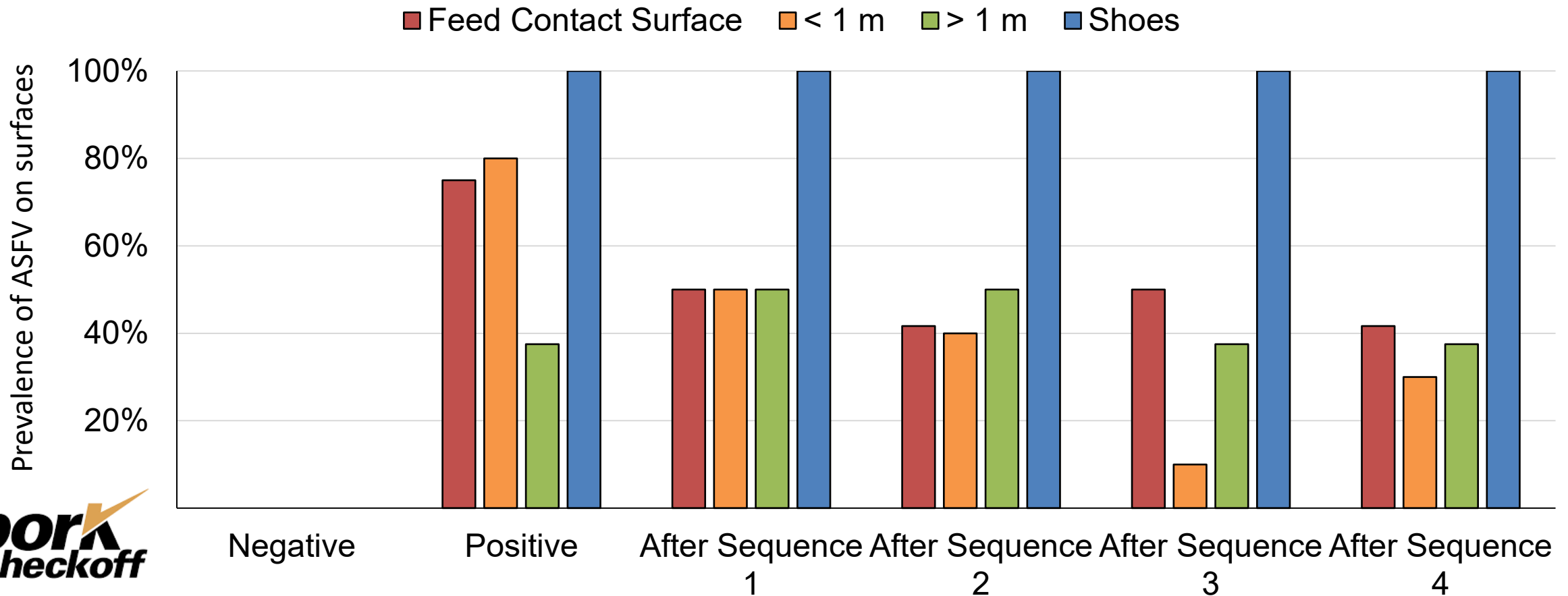


# Risk of ASFV carryover on feed surfaces and within environment after contaminated batch





# Risk of ASFV carryover on feed surfaces and within environment after contaminated batch





# Recent research with ASFV

- Key findings:
  - ASFV has similar characteristics to PEDV within a feed mill
    - Can be found on surfaces and in environment after mixing known inoculated feed
    - High traffic areas
  - Contamination of feed and surfaces can be detected after multiple batches of feed pass through the equipment
  - People are extremely important to consider!





# Investigating methods for decontamination of interior surfaces (cabs) of transportation vehicles

- PRRSV and PEDV
- 4 chemical treatments applied via spray, fumigation, or gaseous application
  - Bleach
  - Synergize
  - Intervention
  - Chlorine dioxide
- Rubber, plastic, and fabric surfaces



**Final results to be discussed at 2021 KSU Swine Day**



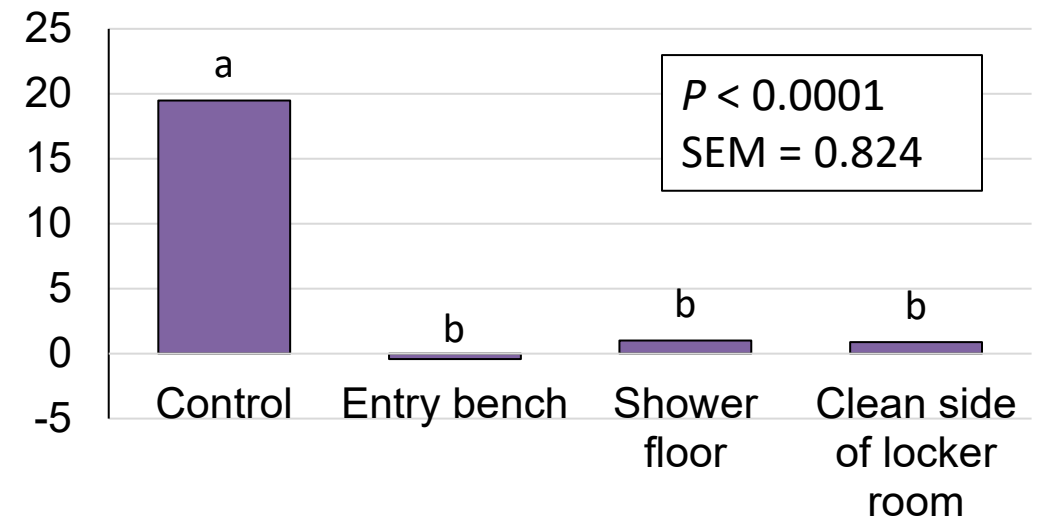


# Visual training aid – Glo Germ



The percent difference in Glo Germ coverage after increased people traffic through an area

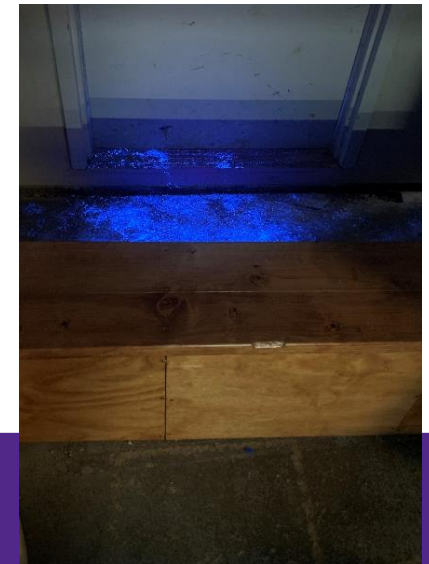
% difference in Glo Germ coverage





# What has the research told us?

- Prevent contamination of ingredients/feed/fomites
  - Ingredient sourcing (manufacture, storage, delivery)
  - Biosecurity in feed mill and transportation
    - **PEOPLE AND TRUCKS**
      - Surveillance and visual training tools extremely helpful
- Reduce pathogen survival
  - Holding time, use of active intervention strategies
  - Avoid recontamination





# Kansas State University Feed Safety Team

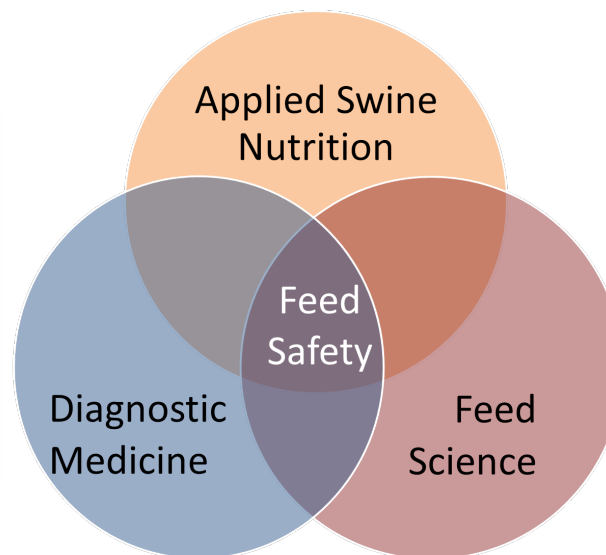
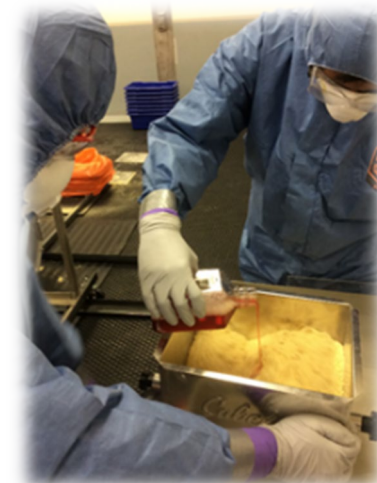
Dr. Jordan Gebhardt – Diagnostic Medicine/Pathobiology

Dr. Cassie Jones – Animal Sciences & Industry

Dr. Chad Paulk – Feed Science

Dr. Jason Woodworth – Animal Sciences & Industry

[www.ksuswine.org](http://www.ksuswine.org) → Feed Safety Resources





# FEED MILL AND BIOSECURITY WEBINAR



**Connor Livingston**

Livingston Enterprises Inc. – Mills



**KANSAS STATE**  
UNIVERSITY





# Feed Mill Bio-Security



# Feed mill zones

- ▶ Implemented zones in our feed mill to minimize foot traffic and cross contamination
- ▶ Load out zone (Green Zone)
- ▶ Manufacturing, office, control room and warehouse zone (Blue Zone)
- ▶ Ingredient receiving zone (Red Zone)
- ▶ Corn receiving zone (Yellow Zone)



# Bench System

- ▶ All mill team members, visitors and maintenance personnel are required to use the bench system when entering the manufacturing, office and warehouse zone (Blue Zone)
- ▶ Mill team members change into the provided clean clothing
- ▶ Visitors put provided coveralls over their clothing
- ▶ Designated shoes are only worn in the manufacturing, office and warehouse zone





# Ingredient Receiving

- ▶ A funneling cone is used to unload each load of product
- ▶ Any product that has spilled over the funneling cone is left on the scale and is disposed of at the end of each day
- ▶ Limits risk of having pathogens tracked or dropped into ingredient receiving pit





# Additional Bio-Security Measures

- ▶ All brooms and shovels are color coded and can only be used in the designated zone
- ▶ Feed mill was designed to implement bio-security measures and have a seamless flow, which has three bays with scales in each
- ▶ Use an industrial floor scrubber to thoroughly clean the warehouse floor
  - ▶ Load out, ingredient receiving pit and corn receiving pit
- ▶ 72-hour downtime for visitors who have had contact with swine
- ▶ Restrooms
  - ▶ Trucker restroom
  - ▶ Restroom inside of blue zone
- ▶ Buffer zones are in place for new equipment such as rollers, motors and other special items
  - ▶ These are set inside the outlined area and are disinfected before going into production
- ▶ Pallet ingredients
  - ▶ We disinfect our loading dock, back of delivery trailer and tires of the forklift during the unloading process to limit risk of tracking pathogens into the mill





# Questions?



**Kara M. Dunmire**  
Kansas State University –  
Feed Science and Management



**Jason Pooley**  
PIC Health Programs Manager



**Jordan Gebhardt**  
Kansas State University –  
Diagnostic Medicine/Pathobiology



**Connor Livingston**  
Livingston Enterprises Inc. –  
Mills



**Uislei Orlando**  
PIC Global Nutrition Team



**Chad Paulk**  
Kansas State University –  
Feed Science and Management



**Charles Stark**  
Kansas State University –  
Feed Science and Management



**Steve Dritz**  
PIC Global Technical Services



# Thank you for joining!

Feed Mill & Biosecurity Webinar

