# Feed Mill Biosecurity

Biosecurity practices are implemented to minimize risk of introducing biological hazards into the feed mill that could compromise swine health status and cause significant economic loss. Therefore, there is increasing interest in opportunities to reduce risk through development and implementation of biosecurity plans for the feed mill. A biosecurity plan requires the identification and evaluation of hazards and implementation of prevention and mitigation strategies.

## Prevention strategies

### *Risk in feed ingredients*

Preventing the introduction of biological hazards into the feed mill is essential and the most effective part of a feed mill biosecurity plan (Table 1). Prevention strategies should be implemented for incoming ingredients, feed manufacturing flow, and visitor and employee flow.

- **Supplier verification**
  - Specify requirements for ingredients being purchased including documentation at receiving.
    - Date, time, lot number, previous hauled ingredient
  - Communicate safety expectation of inbound ingredients.
- **Eliminate highest risk ingredients.**
  - Higher risk ingredients include ingredient that could potentially be contaminated especially those sourced from a country with foreign animal disease (Dee et al., 2016, 2018).
  - A combination of the severity of a possible disease outbreak and probability of a pathogen is present should be used for decision making, which is highly dependent on facility.
  - Evaluate potential risk before accepting ingredients from countries with active foreign animal disease (FAD) outbreaks.
- **If high risk ingredients are necessary**
  - Routine sampling
    - Retain samples for every lot of high-risk ingredients.
    - Use of aseptic technique for pathogen sampling to prevent potential cross-contamination of samples, if applicable.
  - Schedule for high-risk ingredient sampling
    - Dependent on each feed mills assessment of hazards, risk, and analytical capabilities.
    - Necessary high-risk ingredients and sources from high-risk countries should undergo an inventory holding procedure at a supplier warehouse until ingredient risk is reduced, time has passed where pathogens are no longer present, and/or ingredients have undergone a treatment process to destroy pathogens. Holding time calculations are available through the Swine Health Information Center (https://www.swinehealth.org/wp-content/uploads/2020/02/Holding-Time-Calculations-for-Feed-Ingredients-to-Mitigate-Virus-Transmission-Print-02.04.20.pdf)
- **Traceability**
  - Maintaining records for tracking ingredient movement is needed in the possibility of an outbreak.
    - Date, time, lot number, previous hauled ingredient


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## *Feed mill production flow and strategies*

The various points and surfaces that feed and ingredients encounter prior to being shipped makes physical cleaning of the feed mill very challenging once a biological hazard has been introduced. These surfaces and how they are cleaned ultimately impacts the risk of spread via cross-contamination.

- **Receiving**
    - Clear signage should be displayed instructing visitors on feed mill protocols.
        - Ideally, drivers should always stay in the vehicle. If it is necessary for drivers to leave their vehicles, shoe coverings should be provided before exiting the vehicle.
        - Under no circumstances should trucks hauling pigs be weighed on receiving scale.
    - Create cleaning and disinfection stations for delivery vehicles.
        - In extreme scenarios of disease, the use of wet-cleaning and sanitizers can be used to remove debris from the tires, wheels, undercarriage, and exterior of ingredient trucks prior to their entry into the mill.
    - Limit pathogen entry into the receiving pit.
        - Ingredient receiving pits should be covered each time a truck drives across and remain covered until the unloading process is to occur. Receiving pits should be re-covered after the unloading process, before the offloaded truck pulls away.
        - Cones and funneling devices should be used to limit spills in receiving. Additionally, a slower unloading speed will decrease the chance of ingredient spillage.
        - Under no circumstance should spilled ingredients be swept into the receiving pit. Spilled ingredients should be thrown away.
    - Clear documentation should be provided from truck drivers to mill employees.
        - Including date, time, last place traveled, last ingredient hauled.
    - Dust, floor sweepings, screenings, or similar materials should never be swept into pit or added back into feed production to minimize shrink. Therefore, adjustments may need to be made for allowable shrink.
        - Dust is consistently reported to carry high levels of pathogens, and should be composted or discarded, never fed to animals.
        - Creating a raised surface around the unloading pit can deter employees from sweeping into the pit.
- Equipment should be monitored for potential risk of ingredient or feed hang-up, potentially leading to pathogen carryover.
    - Important equipment to monitor and clean include grain cleaners, dust collection equipment, screw conveyers, mixer hand add station, inside coolers, storage bins, and boot pits of bucket elevators.
- **Housekeeping**
    - Sweep or vacuum all dirt and dust from floor, then mop with a 10% bleach solution or an EPA approved FAD disinfectant on a weekly basis to limit the accumulation and spread of virus on non-feed-contact surfaces (https://www.aphis.usda.gov/animal_health/emergency_management/downloads/asf-virus-disinfectants.pdf).
    - Equipment or utensils such as brushes, shovels, brooms, scoops, or barrels should remain in the same area of the


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manufacturing process. These may be labeled, or color coordinated to represent a manufacturing step.

- For example, red brooms at receiving, blue brooms at loadout.

- Utensils should be stored off the ground via a broom holder or set of hooks.
- Daily cleaning and sanitization should be done for utensils not designated to any one area and weekly for utensils which permanently stay in one area of the mill.

- **Feed truck delivery**
  - Feed delivery is logistically difficult due to the number of farms needing feed each week and the changing health status of each farm. Below are risk mitigation strategies which would ideally be followed each day.
    - Coordination of delivery should be from farms at higher risk of disease to those with lower-risk of disease, especially if a single load must visit multiple locations.
      - Feed should be delivered to negative farms first and positive sites at the conclusion of the week. Sow farms should be served before growing sites.
      - Specific directions for driver routes should be provided to minimize route cross over of trucks driving too and from contaminated sites.
      - If possible, trucks should be segregated to only deliver to multiplication sites or commercial production sites.
    - Drivers and trucks should never encounter animal housing areas, animal disposal areas, or site employees.
    - Drivers must wear provided shoe coverings on farm sites if leaving the truck is necessary.
      - If donning and doffing shoe convers as entering and exiting the feed truck is not practical at the farm, drivers should not enter the feed mill without shoe coverings. Preferably different shoes would be worn at the feed mill than those worn during feed deliveries.
  - In the event of a FAD, more stringent biosecurity measures may need to be considered:
    - Drivers should ideally stay in vehicle and on-site worker should open bin lids.
    - Create cleaning and disinfection stations for feed trucks.
      - The use wet-cleaning and sanitizers can be used to remove debris from the tires, wheels, undercarriage, and exterior of ingredient trucks prior to their entry into the mill. If possible, hoses and pump sprayers of disinfectant can also be made available as trucks enter and exit farms.
      - Cleaning and disinfecting may not be practical after each farm but utilizing a truck wash and/or thermo-assisted decontamination drying at the end of each day or after diseased farms can reduce pathogen transmission. Disinfect the interior of the truck cab as well focusing on pedals, gear shifts, the steering wheel, floor mats, and door handles.
    - If the farm bins are close to the property edge of fence line, consider unloading feed across a line of segregation or fence into another feed


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truck or extend bin augers so bins can be filled on the exterior of the line of segregation, as shown in Figure 3.

- **Physical cleaning of feed mills is extremely challenging.**
    - Therefore, physical, and chemical cleaning may be necessary and most effective with chemical sanitizers.
    - Cleaning of non-animal food contact surfaces should not be overlooked as biological hazards can efficiently spread throughout a facility through dust and other airborne particulates.

## *Visitor and employee flow and strategies*

The feed mill is a hub for movement of people; employees, visitors, guests, truck drivers, and subcontractors; all of which can introduce feed contaminants. The most likely vector is the bottom of employee shoes. Therefore, zoning of the feed mill is a low-cost contamination prevention strategy.

- **Minimize foot traffic, especially in high-risk areas.**
    - High risk areas include pits, grates, and hand add stations.
    - Designating no-walk zones is a clear way to demonstrate to employees and visitors. importance of disease prevention.
- **Protocols should be established for employees that have come into contact with pigs. Including:**
    - Amount of down time before returning to the feed mill.
    - Clothing and shoe change from items that were on the farm.
    - Showering before returning to the mill.
- **Visitors should always be accompanied by a mill employee.**
    - Visitors should remain in vehicles if possible.
        - If visitors are necessary, alternative footwear, plastic boots, or boot coverups should be provided.
    - Logbooks should be kept for entry of visitors.
    - Signage should be clearly displayed for off-limit areas.
- **Create hygienic zoning by treating a feed mill similarly to a farm.**
    - Create one point of entry into the feed mill.
        - At this entry, employees should be changing shoes (Figure 4).
        - In situations with higher health concern, implementing a change of clothes or coveralls over clothing are steps for further prevention practices.
    - Create lines of separation at all doors to minimize contamination from footwear.
        - This involves employees and visitors changing shoes to keep exterior shoes on one side of the line and interior shoes on the other. Examples of how facilities may implement lines of separation are shown in Figures 1 and 2. In both examples, additional exits are available in case of emergency to satisfy OSHA requirements.
        - If lines of separation cannot be developed, consider zoning to standardize traffic patterns, with foot baths or food-grade dry sanitizing powder placed in high traffic areas.
- **Communication between infected sites and the feed mill is paramount. This allows for the feed mill schedule planned delivery routes to prevent disease spread to other sites.**


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## Mitigation strategies

- **Feed mitigation**
  - Mitigation can occur via physical or chemical processes. However, chemical is most promising because of residual mitigation potential, unlike thermal processing which could be re-contaminated in post pelleting.
    - Point-in-time mitigation (pelleting):
      - Pelleting with conditioning temperatures greater than 55°C (131°F) with a 30 second conditioner retention time reduced the risk of porcine epidemic diarrhea virus (PEDV) infection (Cochrane et al., 2017).
      - Detectable PEDV, Seneca Valley virus 1 (SVV1), and porcine reproductive and respiratory syndrome virus (PRRSV) RNA was observed in feed samples and the environment following conditioning at 82°C (180°F) with a 30 second retention time and pelleting, which increases the risk of product re-contamination (Harrison et al., 2023b)
      - Conditioning temperatures of 82°C (180°F) reduced the risk of both PEDV and SVV1. PRRSV infection was observed in a swine bioassay after feed was conditioned to 82°C (Harrison, et al., 2023b).
    - Residual mitigation (chemical)
      - Inclusion of multiple chemical mitigants have been found to reduce the risk of infection for PEDV, PRRSV, and SVV1 (Dee et al., 2021).
      - Inclusion of either formaldehyde or medium chain fatty acids reduced the infectivity of African swine fever virus (ASFV) (Niederwerder et al., 2021).
      - Updated information about chemical mitigants can be found in "K-State Feed Additive Summary" at https://www.asi.k-state.edu/research/feedsafetyresources/.
- **Facility decontamination**
  - Use of sequencing or flushing may need to be used but should only be considered as risk reduction, not risk elimination. Complete cleanout and sanitation may be best.
    - Sequencing utilizes a preplanned order of production, storage, and distribution of feed.
      - PEDV RNA was reduced beyond detectable limit following the third batch of virus-free feed after the initial contamination (Schumacher et al., 2018).
      - Elijah et al., (2022) continued to detect ASFV DNA in the feed four batches after the initial contamination.
      - Environmental presence of either PEDV or ASFV remained detectable in the feed manufacturing environment after the initial contamination which increases the risk of cross-contamination if non-feed contact surfaces remain untreated (Schumacher et al., 2017; Elijah et al., 2021)
    - Flushing involves running an abrasive-type ingredient through manufacturing equipment.
      - Data suggest that PEDV risk can be reduced after the use of a chemically enhanced flush with


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either formaldehyde or medium chain fatty acids (Gebhardt et al., 2016).

- The use of high levels of formaldehyde, in either liquid or dry form, reduced the risk of PEDV and SVV1 infectivity, and decreased the presence of both viruses on environmental surfaces following the initial contamination. PRRSV presence was also reduced in the following feed batches and the environment, but PRRSV was noticed during a swine bioassay (Harrison et al., 2023a).

- Ceasing mill production to completely clean out and sanitize all feed manufacturing equipment is time consuming and could potentially damage equipment as feed manufacturing equipment is not designed to be repeatedly power-washed.
  - Huss et al. (2017) found that power-washing, disinfecting with quaternary ammonium/glutaraldehyde followed by disinfection with sodium hypochlorite and heating the facility to 60°C (140°F) and maintaining that temperature for 48 hours was necessary to eliminate PEDV from a feed manufacturing facility. This protocol was also capable of eliminating PRRSV and SVV1 from the same manufacturing facility (Harrison et al., *unpublished data*).
  - Fumigation with chlorine dioxide had little effect on the quantity of detectable RNA when applied to a feed manufacturing facility contaminated with SVV1 and PEDV. However, SVV1 and PEDV infectivity was reduced following application of chlorine dioxide. PRRSV presence was reduced, but infection was still noticed in a bioassay following application of chlorine dioxide (Harrison et al., *unpublished data*).
  - The use of portable heaters have been used in feed mills to reduce insect populations (Mahroof et al., 2003). Utilizing portable electric heaters for 48 hours (range: 42.9-50.7°C; 109-123°F) did not reduce SVV1, PEDV, or PRRSV RNA, but did reduce the risk of SVV1 and PEDV infection in a swine bioassay. The application of heat did not reduce the risk of PRRSV infection during the bioassay (Harrison et al., *unpublished data*).

## Summary

Implementing a biosecurity plan to prevent or mitigate biological hazards in a feed mill is challenging because of differences in facility design, manufacturing operations, and significant risk factors among feed mills. The first step toward minimizing risk is to develop a feed mill biosecurity plan and implement prevention strategies. While, the success of biosecurity practices will never be known, practicing good prevention strategies and utilizing the appropriate feed and facility mitigation techniques can decrease the risk of pathogen transmission

1. Identify and evaluate hazards.
2. Implement and assess prevention strategies for people and production.
3. Understand and implement applicable mitigation techniques.


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**Figure 1.** Example of zoning at feed mill entry

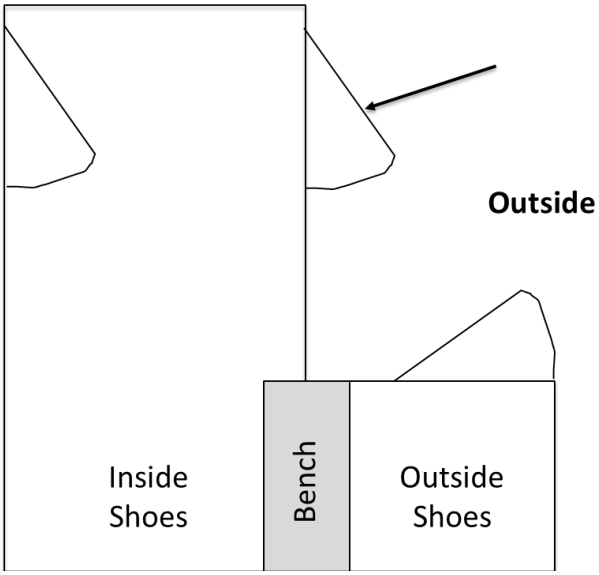


**Figure 2.** Example of zoning at receiving

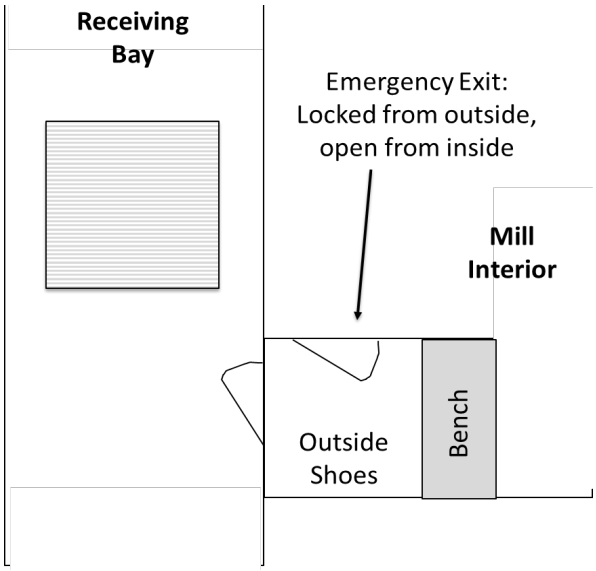


**Figure 3.** Example of zoning for drivers on farm site

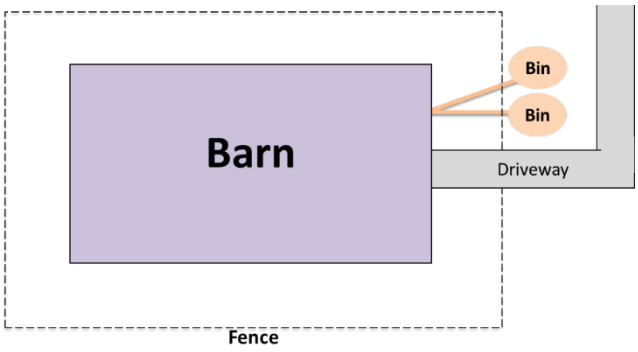


**Figure 4.** Implementation of shoe change from dirty (upper side of bench) to clean (bottom side of bench). Notice the lack of florescent powder on the clean side of the bench, signaling successful implementation of the shoe change as the powder did not spread.

**Table 1. Biosecurity implementation[1]**

| Practical steps for all feed mills | More challenging implementation |
|---|---|
| ☐ Covering pits when not in use | ☐ Truck washing after visiting health compromised sites |
| ☐ No sweeping into pits | ☐ Employee shoe changing |
| ☐ Supplier verification | ☐ High risk ingredient holding time |
| ☐ Housekeeping | ☐ Chemical mitigation |
| ☐ Drivers remain in trucks at receiving or have shoe coverings | ☐ Thermal Processing |
| ☐ Pre-planned finished feed routes | |
| ☐ Employee zoning (especially at receiving) | |
| ☐ Warehouse first-in first-out sectioning | |

[1] Examples images from mills are available in Appendix 1.


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## Appendix 1. Images and practical applications for feed mills: examples of mills in need of improvement and best practices

Images are from various feed mills and appreciation is expressed for those who provided and released these images.

### Ingredient Receiving pits

#### In need of improvement

- Keep surfaces free of organic matter.
- Do not sweep spills into the pit.

#### Best practices

- Ingredient pits are covered when not in use.
- Funnels/barriers can be useful in preventing ingredient overflow.



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## Hand-add stations

### In need of improvement

- Avoid designs flush with the floor.
  - Too easy to sweep debris and potential pathogens into mixer.

### Best practices

- Use hand-add stations that are raised above floor level.
  - Prevents sweeping floor contamination into mixer.


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## Warehouse management

**In need of improvement**

**Best Practices**

- Avoid spills.
- Clean spills up promptly and discard in the trash

## Additional best practices

- Utilize boot baths (either dry or liquid) or bench systems to create physical barriers between certain areas.


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