African Swine Fever Virus

• The Good
  o Humans cannot contract disease by consuming pork
  o Not transmissible to other non-swine species

• The Bad
  o Can be transmitted from wild boar or ticks to domestic pigs
  o High case fatality
    ▪ Initial infection: low mortality (1-2 mortalities, many ASFV-exposed animals test negative), symptoms similar to Salmonella
    ▪ Later infection: highly contagious, 90% mortality

• The Ugly
  o No available vaccine or treatment
  o Survives in fomites for extensive periods
  o Virus is spreading faster than the speed of research
Methods of Transmitting Disease

**Reservoir**
Habitat where agent lives, grows, multiplies

- Domesticated swine
- Wart hog
- Wild boar

**Transmission**
Method of transport from reservoir to susceptible host

- Direct
- Indirect

**Host**
Individual susceptible to the specific agent

- Domesticated swine
- Wart hog
- Wild boar
How Has ASFV Entered Naïve Populations?

Russia Epidemiological Root Cause (284 outbreaks)
- As reported by Belyanin, 2013
How Has ASFV Entered Naïve Populations?

China Epidemiological Root Cause  
(68 outbreaks)
• As reported by Ministry of Agriculture and Rural Affairs of the People’s Republic of China

- Transportation of infected pigs or pork 19%
- Contaminated swill or feed 32%
- Vehicles and people 49%
How Has ASFV Entered Naïve Populations?

- USDA APHIS Qualitative assessment of the likelihood of African swine fever virus entry to the United States: Entry Assessment

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Legal</th>
<th>Illegal</th>
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<tbody>
<tr>
<td>Live Pigs</td>
<td>Negligible, with low uncertainty</td>
<td>Negligible to low, with moderate uncertainty</td>
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<td>Semen</td>
<td>Negligible, with low uncertainty</td>
<td>Low, with moderate uncertainty</td>
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<td>Swine products and by-products</td>
<td>Negligible to low, with moderate uncertainty</td>
<td>High, with low uncertainty</td>
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<tr>
<td>Wildlife: Meat and Trophies</td>
<td>&lt;Not reviewed&gt;</td>
<td>Low to moderate, with high uncertainty</td>
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<td>Feed (animal origin)</td>
<td>Low to moderate, with high uncertainty</td>
<td>Negligible to low, with high uncertainty</td>
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<td>Feed (plant origin)</td>
<td>Negligible to moderate, with high uncertainty</td>
<td>Low, with high uncertainty</td>
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<td>Feed (supplements)</td>
<td>Negligible to low, with high uncertainty</td>
<td>&lt;No data to evaluate&gt;</td>
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<td>Fomites</td>
<td>&lt;Not reviewed&gt;</td>
<td>Negligible to moderate, with high uncertainty</td>
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<td>Regulated Garbage</td>
<td>Low, with moderate uncertainty</td>
<td>&lt;Not applicable&gt;</td>
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Questions Regarding Safety of Feed

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 do we know about the contamination risk of ingredients from ASFV-endemic countries?


  • “The current body of scientific knowledge has yet to provide conclusive evidence for the source(s) of contamination of non-animal origin feed ingredients with swine viruses and the epidemiology of virus transmission to swine under field conditions. If the primary concern of the swine industry and associated stakeholders lies in the importation of contaminated feed and feed ingredients, then additional research and investigative studies of how ingredients are sourced, processed, and transported prior to importation into the United States are needed. However, the lack of feed and feed ingredient diagnostic assays capable of detecting virus in large volumes of material limits our ability to determine if and at what point non-animal origin feed or feed ingredients may become contaminated with viruses and limits our ability to establish critical control points in feed production, distribution, and storage to mitigate risk(s). Until these data are available, it is difficult to evaluate the biosecurity risk posed by non-animal origin feed and feed ingredients.”
1. Is it likely to get infected?

• What do we know about the contamination risk of ingredients from ASFV-endemic countries?
  – Gebhardt et al. (2020) Submitted
    • Case study from Vietnam
    • 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
1. Is it likely to get infected?

- What do we know about the contamination risk of ingredients from ASFV-endemic countries?
  - Gebhardt et al. (2020) *Submitted*
    - 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
      - 1 of the 175 feed mill environmental samples positive (floor surface where feed delivery truck drivers wear footwear previously exposed to surfaces outside the feed mill)
    - Conclusion: ASFV-contaminated feed ingredients did not play a significant role in ASFV transmission or entry into new populations *in this case*
2. Can it survive?

- Insufficient data on pathogen × ingredient × environment

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<tr>
<th>Ingredient</th>
<th>FMD</th>
<th>CSF</th>
<th>ASF</th>
<th>PRV</th>
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<td>Complete Feed</td>
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Survived simulated trans-Pacific or trans-Atlantic shipment

Did not survive

Not tested/no reported data

Cochrane et al., 2016; Dee et al., 2016, 2018; Stoian et al., 2020
3. Is it infectious?

- 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

- Example:
  - Ingredients are mixed in ~3-ton batches for several minutes to optimize uniformity of nutrients
    - 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
Summary: One contamination ‘event’ may lead to 1,200 co-housed animals having >20 simultaneous exposures.

Research Funded by the National Pork Board; Niederwerder et al., 2019
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**.
Hurdles to Prevent Pathogen Transfer through Feed

4. How can it be prevented?

- Exclude High Risk Ingredients
- Extend Biosecurity Practices from Farms to Mills

5. How can it be mitigated?

- Active Mitigation
Summary

• The feed supply chain is not the most likely route of disease entry into the U.S., but it can quickly spread disease.

• What do we need?
  o Continued and additional support
  o Collaboration and dialogue
  o Access to both controlled research and naturally-contaminated environments

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