ASFV Update: Pipestone Perspective

SCOTT DEE DVM MS PHD DIPL;ACVM
DIRECTOR, PIPESTONE APPLIED RESEARCH
Topics

1. Pipestone in US.

2. Pipestone in China.
   ◦ Pipestone China biosecurity
   ◦ Pipestone ASFV experience

3. Feed risk.
   ◦ What do we know?
   ◦ What do we do?

4. Additional Pipestone efforts.
   ◦ Pork and people

5. Working together to “Keep it Out”.
   ◦ What would Bob, Al and Carlos say?
Pipestone in US

Pipestone Veterinary Services
- 6 clinics, 40 vets
- Pipestone Applied Research

Pipestone System
- >250,000 sows of managed production

Pipestone Grow-Finish
- >1.5 M pigs managed WTF
- nutrition

Big Stone Marketing
- marketing

WholeSTONE foods
- processing

Pipestone International
- China and Mexico
Pipestone in China

15 years experience
>300 visits
30,000 managed sows
20,000 owned sows
Office in Shanghai
Pipestone Sow Farm Biosecurity in China

Concrete wall with barbed wire/broken glass
- Guarded entry

Shower-in facility
- 2x to enter animal airspace

Internal truck wash
- Designated transport

Internal compost & quarantine

Internal AI center

Dorm & kitchen
- No pork, Labor force: 30 day stays

Air filtered

All critical access points
- Managed as in US
Pipestone ASFV experience

2 sow farms became infected.
   ◦ Depopulated

Multiple nursery: finishers became infected.
   ◦ 2500 head = 100 survivors
     ◦ 96% mortality
     ◦ Mortality rate accelerated 14 days after first case.

Confirmed ASFV at all sites.

Government inspection and conclusion:
   ◦ “You have CSFV and PRRSV. You do not have ASFV”.

Suspected source: Feed or vegetables?
Feed risk: What do we know?

PEDV
- Transmission in feed: proof of concept
  - Dee et al, BMC Vet Res 2014
- Survival in feed ingredients
  - Dee et al, BMC Vet Res 2015
- Survival in transport: Transboundary model
  - Dee et al, BMC Vet Res 2016

What about ASFV?
China: Physical evidence of ASFV in raw materials

Dust samples from bulk feed ingredients were tested (drying on-ground).

Extensive sampling was conducted.
  ◦ Several thousands of samples collected.
  ◦ 250 samples collected/day!

Results:
  ◦ Complete feed & ingredients: 1-2% (+) for ASFV DNA.
  ◦ Positive ingredients included:
    ◦ Corn
    ◦ Soy
    ◦ Rice
    ◦ Wheat
    ◦ DDGS
In Addition...

ASFV DNA was also detected in dust from:

1. Feed mill environment.
2. Feed trucks and trailers.
3. Complete feed in bins.
4. Personnel hair and soles of shoes.
5. Fresh market environment...
We have experimental evidence of ASFV survival in feed ingredients (Dee et al PLOS ONE 2018)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>SVA (FMDV)</th>
<th>ASFV</th>
<th>PSV (SVDV)</th>
<th>PEDV</th>
<th>FCV (VESV)</th>
<th>PCV2</th>
<th>BHV-1 (PRV)</th>
<th>PRRSV 174</th>
<th>BVDV (CSFV)</th>
<th>VSV</th>
<th>CDV (NiV)</th>
<th>IAV-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean meal-Conventional</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Soybean meal-Organic</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Soy oil cake</td>
<td>(+)</td>
<td>(+)</td>
<td>NT</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>DDGS</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>NT</td>
<td>(-)</td>
<td>(-)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Lysine</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Choline</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(-)</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Moist cat food</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>NT</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Moist dog food</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>NT</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Dry dog food</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>NT</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Pork sausage casings</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>NT</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Complete feed (+ control)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>NT</td>
<td>(+)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Complete feed (- control)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Stock virus control</td>
<td>(-)</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Ingredient</td>
<td>SVA titer</td>
<td>SVA T ½</td>
<td>ASFV titer</td>
<td>ASFV T ½</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------</td>
<td>----------</td>
<td>------------</td>
<td>----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean meal-Conventional</td>
<td>10*4.5</td>
<td>22.3</td>
<td>10*3.0</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean meal-Organic</td>
<td>Neg</td>
<td>Neg</td>
<td>10*3.1</td>
<td>4.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soy oil cake</td>
<td>10*3.5</td>
<td>7.4</td>
<td>10*3.2</td>
<td>4.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDGS</td>
<td>10*4.25</td>
<td>14.9</td>
<td>Neg</td>
<td>Neg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lysine</td>
<td>10*3.25</td>
<td>5.9</td>
<td>Neg</td>
<td>Neg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choline</td>
<td>Neg</td>
<td>Neg</td>
<td>10*3.2</td>
<td>5.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td>10*2.25</td>
<td>3.9</td>
<td>Neg</td>
<td>Neg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moist cat food</td>
<td>10*4.25</td>
<td>14.9</td>
<td>10*3.0</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moist dog food</td>
<td>10*3.25</td>
<td>8.9</td>
<td>10*2.8</td>
<td>4.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry dog food</td>
<td>10*3.25</td>
<td>6.4</td>
<td>10*2.8</td>
<td>4.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pork sausage casings</td>
<td>10*4.25</td>
<td>12.7</td>
<td>10*2.9</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete feed</td>
<td>10*3.75</td>
<td>8.9</td>
<td>10*2.9</td>
<td>4.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
We have experimental evidence of ASFV transmission through feed

Niederwerder et al, Emerging Infectious Diseases, 2019

1. Varying doses of ASFV provided to pigs via water or complete feed
2. Natural feeding behavior

Outcomes:

1. Transmission of ASFV was demonstrated through oral consumption of feed or water.
2. Infection easier to transmit via water than feed.
3. Probability of infection driven by frequency of exposure, not dose
   “The more often a pig consumes contaminated feed or water, the lower the dose of virus necessary to infect”.
Feed risk: what do we do?

ASFV in raw materials.

ASFV survival in transport.

ASFV transmission via feed.
We change behavior.

**Responsible Imports:** A science-based plan to safely introduce essential products from countries of high risk.

**Variables in the Equation:**
1. Necessity of the ingredient
2. Level of contamination at the source
3. T ½ of virus in feed
4. Transport time
5. Storage time
6. Mitigant effect on viral load
We collect data.

**Objectives:** Evaluate select feed additives as viral mitigants under controlled field conditions.

**New model: “Simulate the real world”**
- BSL-2 facility
- 6 rooms with independent air spaces (filtered in/out)
- 100 pigs/room
- Designated feed bin/room
- Mitigated and non-mitigated feed (tons)
Ice Block Challenge Model: PRRSV 174, PEDV and SVA
Metrics

Ante-mortem
- Swiffer samples of feeders
- Oral fluids

Post-mortem
- Tonsil (SVA)
- Serum (PRRSV)
- Rectal swab (PEDV)

Average Daily Gain
Conclusions and Next Steps

Results:
1. All 3 viruses were transmitted via non-mitigated feed.
2. Promising results (Kemin & Novus).

Next Steps:
1. Further testing underway: 10 additional mitigant candidates.
2. Identify promising candidates.
3. Communicate to KSU for ASFV follow up.
Strengthen pork industry efforts to prevent foreign animal diseases (FADs) from entering the United States. Separate resolutions were adopted, directing NPPC to:

1. Work with the USDA and FDA on restricting imports of soy-based animal feed products from countries with a high risk of transmitting FADs;

2. Urge USDA and other public and private research institutions to evaluate FAD virus viability in pig feed and feedstuffs and to develop hold times for imported feed; and

3. Work with the NPB, USDA, FDA and the DHS on coordinating with Canada and Mexico development of practices to protect the North American swine herd from FADs.
The CFIA takes the first step!

A science-based plan to responsibly manage imports of high risk feed ingredients from ASFV (+) countries

1. What is the country of origin?
   ◦ 43 countries listed

2. What is the nature of the product?
   ◦ Meals, raw grains, oilseeds

3. What processes and treatments have been applied to the product?
   ◦ Recommended heat and storage times (mitigants)

4. What is its end use?
   ◦ Animal feed vs. human food

5. What is the potential for cross-contamination?
   ◦ Risk management
Additional Pipestone Efforts to Protect the Border..
Working together to “Keep ASFV out”.

[Image of a map of North America with flags of Canada, the United States, and Mexico, and portraits of people.]