

Insights Into a Common Goal: Stopping the Spread of ASF

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Director, Pipestone Applied Research



1

Acknowledgement of Support



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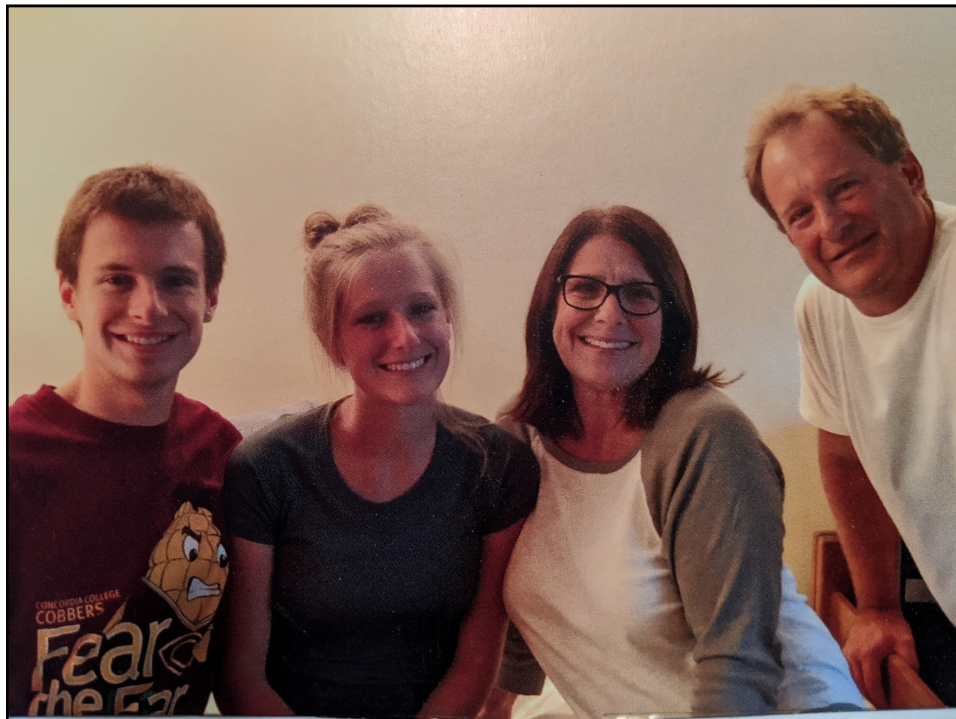
The Story for Today



- **Introductions**
- **ASFV: Review and global perspective**
- **The science of feed as a risk factor for ASFV and other FADs**
- **Actions and impact (so far)**
- **Concluding remarks**



3



4

My Background



- **DVM MS PhD: UMN**
- **Board certification: Veterinary Microbiology**
- **Swine practice: 12 years**
- **Faculty UMN CVM (swine group): 12 years**
- **Pipestone Veterinary Services: 9 years**

5

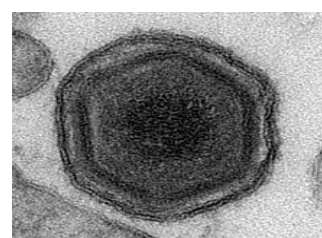
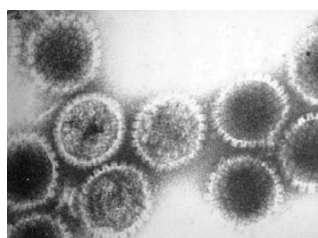
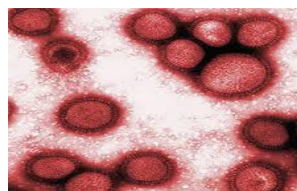
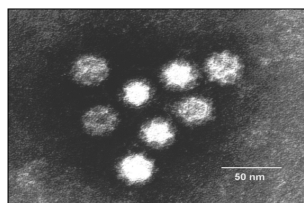
Pipestone Holdings

- **Pipestone Veterinary Services.**
 - 6 clinics, 40 veterinarians (25 swine vets)
 - Pipestone Applied Research
- **Pipestone System**
 - 300,000 sow across 75 managed sow farms.
 - 3rd largest system in US
- **Pipestone Grow-finish**
 - >2M pigs
- **Pipestone Nutrition**
 - Formulation, procurement, research
- **Big Stone Marketing**
 - Contracting
- **Wholystone Foods**
 - Processing
- **Pipestone International**
 - China & Mexico initiatives



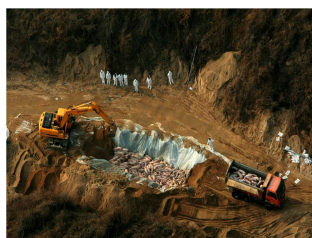
6

4 viruses of concern to North America



7

Justification



8

Impact on US Economy

FMD: 12.9 B

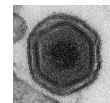
CSF: 9.6 B

ASF: 16.5 B



9

African Swine Fever Virus

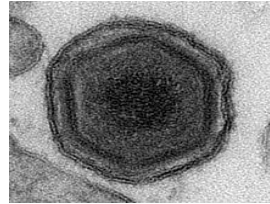


“The world’s worst pig virus”: GD Spronk DVM

10

Facts

- **ASFV does not affect people.**
- **It infects only pigs.**
- **Pork is safe to eat.**
- **ASFV is not in North America.**
- **There is no effective vaccine.**



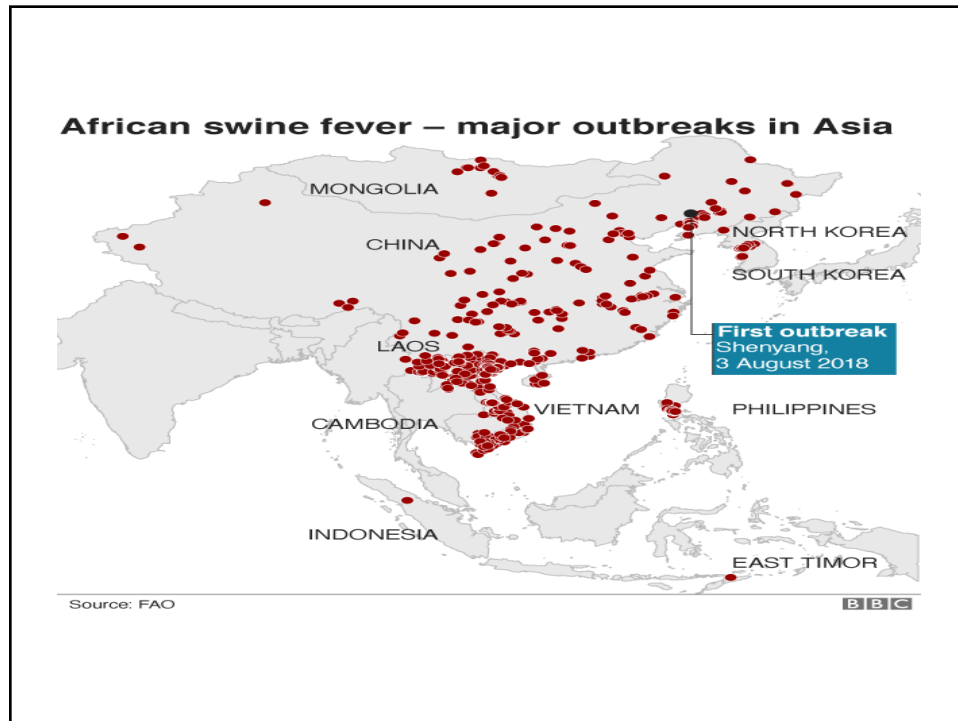
11

ASF: What's new globally?

- **A disease of 3 continents**
 - Africa, Asia, and Europe
- **Continued outbreaks in Eastern European countries**
 - Poland, Romania, Ukraine, Hungary, Latvia, Bulgaria, Slovakia, and Russia
- **Recent entry into Germany from Poland**
 - Wild boar population
- **Wild boar considered primary risk factor**



12



13

ASF: What's new in China? Drs Yaros and Spronk

- **Expansion: RAPID**
 - National herd estimates = 50M to 15M to 30M sows
- **Economics: BIG BUCKS**
 - Weaned pig = \$250 (\$40 COP)
 - Gilt = \$600 (\$100 COP)
- **Eliminate ASFV: NO INTEREST**
 - Wild strains still circulating
- **ASFV vaccines: BLACK MARKET**
 - Minimal QA/QC
- **Feed: MAJOR RISK**
 - ASFV DNA detected in commercial feed
 - Feed cooking: 3 minutes @ 85 degrees C

"wild wild east"



14

Grain Drying in Asia: The Trojan Horse



15

Physical evidence of ASFV in raw feed materials

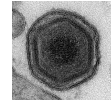
- **Dust samples from bulk feed ingredients on ground were PCR (+).**
- **Results:**
 - **Complete feed & ingredients: 1-2% (+) for ASFV DNA.**
 - **Positive ingredients included:**
 - Corn
 - Soy
 - Rice
 - Wheat
 - DDGS



16

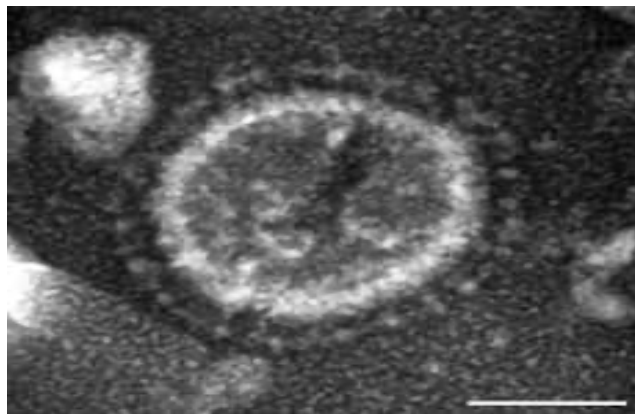
In Addition...

- **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.



17

The Science Behind the Risk of Feed It all started with PEDV...



18

Temporal relationship of feed delivery, consumption and diagnosis of PEDV in affected breeding herds

Farm	A	B	C
Feed outage	West gestation Room 2 GDU	West farrowing	North gestation
Delivery and consumption	January 6	January 8	January 9
Index cases	West gestation Room 2 GDU	West farrowing	North gestation
PEDV diagnosis	January 9	January 11	January 13
PEDV Ct in feed	20.25	22.60	19.50



19

Can feed transmit PEDV?



20

Proof of Concept



Dee et al, BMC Vet Res, 2014



21

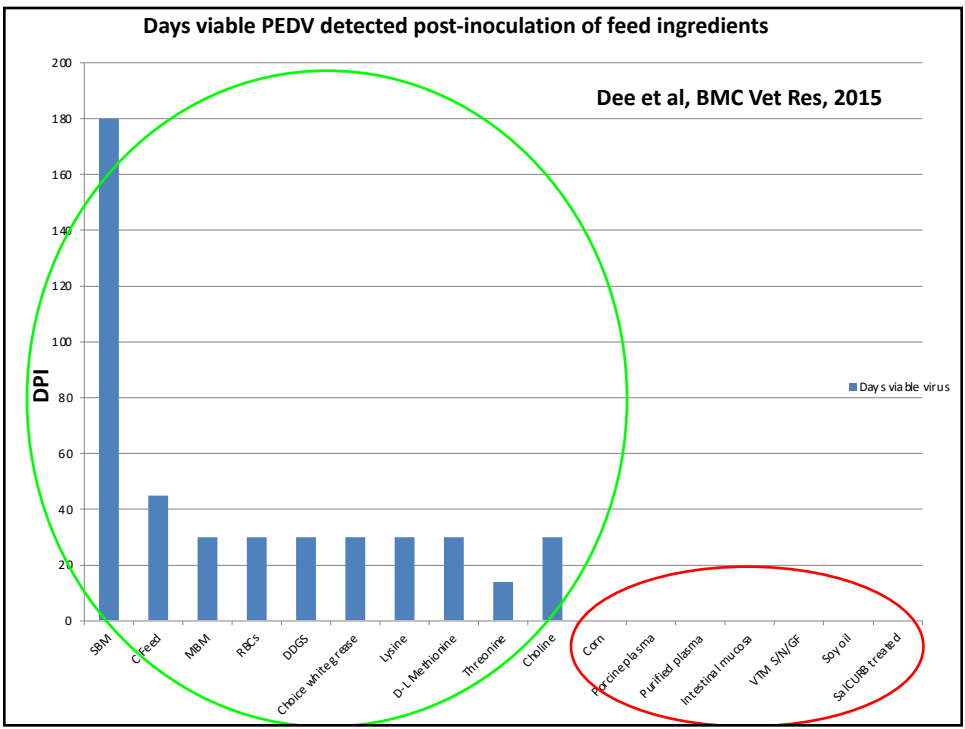
What about ingredient survival?



22

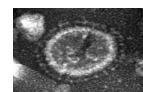


23



24

How did PEDV enter the US?



25

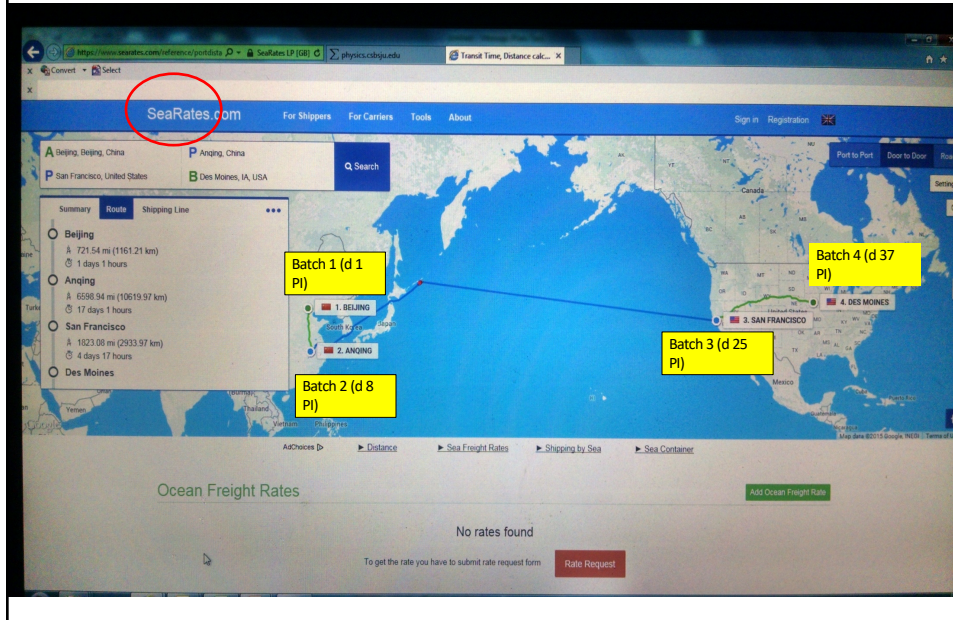
Metric Tons of Agricultural Products Imported from China to the US Over the Past 5 1/2 Years.

2013	2014	2015	2016	2017	2018 (Jan-Jun)
1.9 M	1.6 M	1.9 M	1.9 M	1.7 M	~1 M

How do we demonstrate the risk of Chinese imports?

26

Model: Trans-Pacific route and sampling points



27

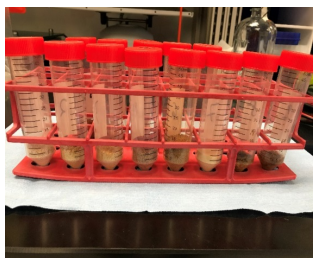
Ingredients Imported: China to San Francisco*

Ingredients	2012 (Kg)	2013 (Kg)	2014 (Kg)	2015 (Kg)	2016 (Kg)
Soy oil cake	15,126,647	7,977,560	13,545,880	24,201,390	36,962,316
DDGS	4,008,000	2,640,000	2,808,000	2,416,363	1,738,182
Pet food	4,075,353	3,068,722	623,734	51,587	1,412,165
Soybean meal	1,832,561	1,816,100	1,340,270	979,627	185,400
Pork sausage casings	129,365	216,845	457,427	420,005	582,093
Lysine	33,000	95,000	19,764	2,325,236	2,393,915
Choline	19,000	400	0	0	0
<u>Vitamin D</u>	<u>26,000</u>	<u>21,000</u>	<u>14,000</u>	<u>0</u>	<u>0</u>
TOTAL (Kg)	25,249,926	7,198,012	18,809,075	30,394,208	43,274,071

* US Govt. Harmonized Tariff schedule

28

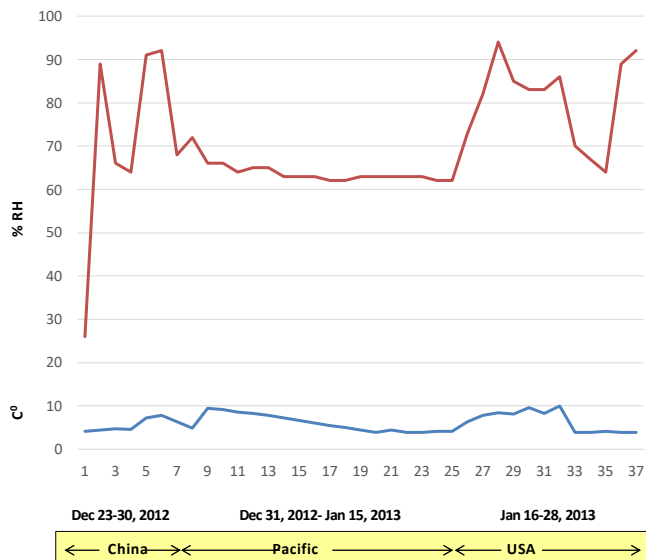
Sample Management



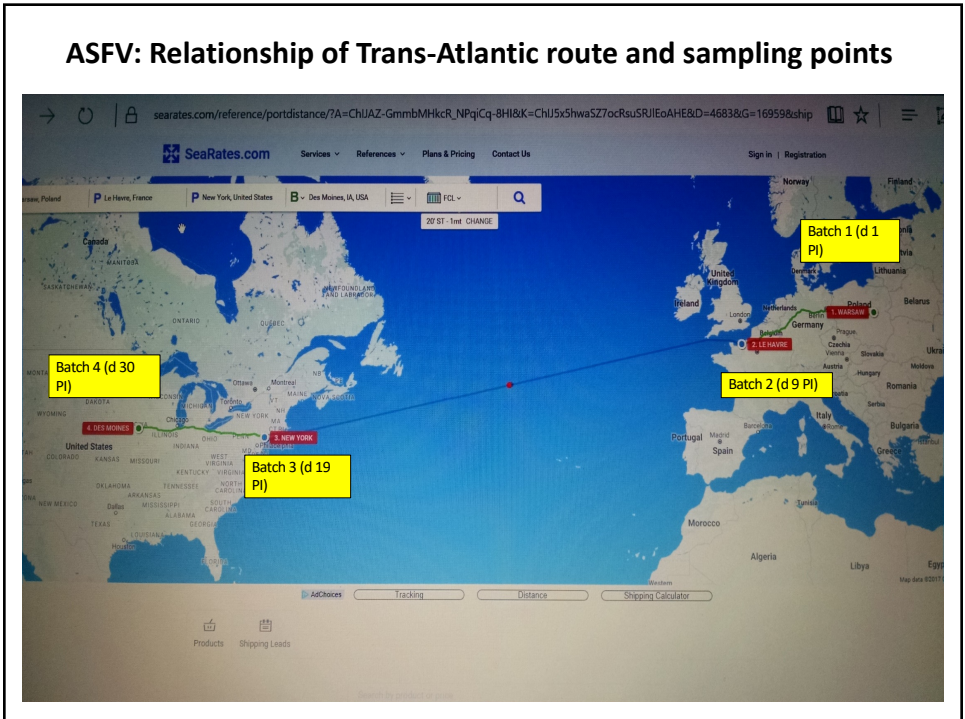
Dee et al, BMC Vet Res, 2016

29

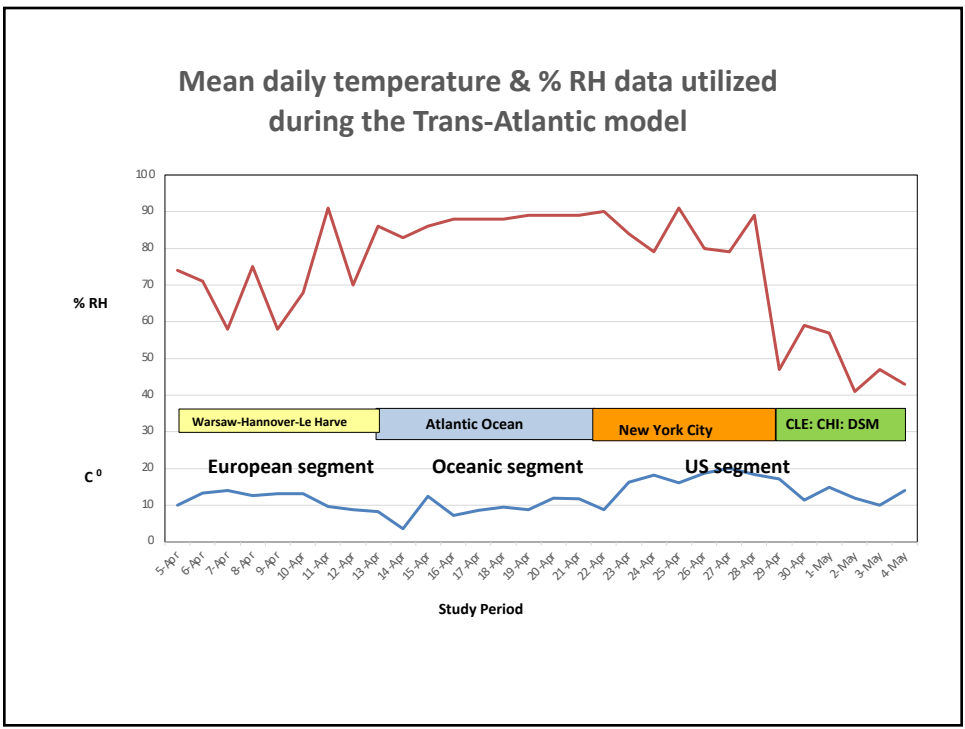
Mean daily temperature & % RH data utilized during the Trans-Pacific model



30




31



32

Survival for Trans-Pacific (37 DPI) and Trans-Atlantic (30 DPI) Models (Dee et al PLOS ONE 2018, Stoian TBED 2020)										
Ingredient	SVA (FMDV)	ASFV	PRV	PEDV	PSV (SVDV)	CSFV	PCV2	PRRSV 174	VSV	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	(-)	(+)	(+)	(-)	(-)	(-)	(-)	(-)	(-)	(-)

33



RESEARCH ARTICLE

Survival of viral pathogens in animal feed ingredients under transboundary shipping models

Scott A. Dee^{1*}, Fernando V. Bauermann², Megan C. Niederwerder^{3,4}, Aaron Singrey², Travis Clement², Marcelo de Lima^{2,5}, Craig Long², Gilbert Patterson⁶, Maureen A. Sheahan³, Ana M. M. Stoian³, Vlad Petrovan³, Cassandra K. Jones⁷, Jon De Jong¹, Ju Ji⁸, Gordon D. Spronk¹, Luke Minion¹, Jane Christopher-Hennings², Jeff J. Zimmerman⁹, Raymond R. Rowland⁹, Eric Nelson², Paul Sundberg¹⁰, Diego G. Diez²

PLOS ONE | <https://doi.org/10.1371/journal.pone.0194509> March 20, 2018 1 / 18

34

ASFV transmission through feed and water

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”.**



35

ASFV T $\frac{1}{2}$ in feed

Stoian et al, Emerging Infectious Diseases, 2019

- 1. Trans-Atlantic model (30 days)
- 2. ASFV Georgia strain



Outcomes:

- 1. Survival study replicated.
 - ASFV survived in 9/14 ingredients for 30 days
 - Titers decayed from 5 logs to 3 logs TCID50 over this time
- 2. Mean T $\frac{1}{2}$ across all 9 ingredients = 12 days
 - Range = 9.6-14.2 days

“ASFV survives much longer than 30-day study period.”

36

Connecting the dots

ASFV in raw materials.



ASFV survival in transport.



ASFV transmission via feed.



37

Soy Imports: High risk sources

- **Source of information:**
 - US Gov't Tariff schedule
- **Questions:**
 - How much soy-based product did the US import from ASFV positive countries in 2018-2019?
 - What are the primary POE?
 - What are the POE trends over time?

Patterson et al, TBED accepted



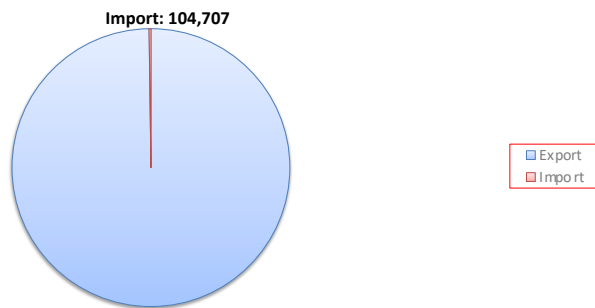
38

Total volume and country of origin of soy-based imports in 2018-2019

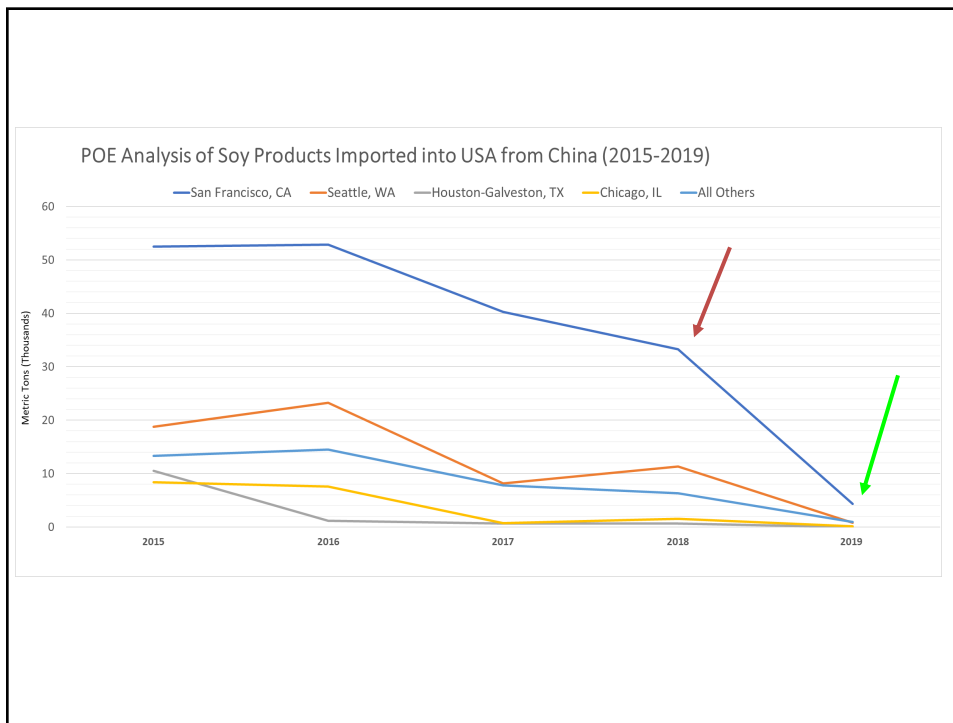
Country of Origin	Sum of 2018 (MT)	% of Total 2018	Sum of 2019 (MT)	% of Total 2019
Ukraine	44,776	42.9%	40,143	54.7%
Russia	3,396	3.3%	20,661	28.2%
China	55,039	52.7%	6,182	8.4%
Moldova	0	0.0%	5,986	8.2%
Belgium	143	0.1%	244	0.3%
Togo	22	0.0%	113	0.2%
Vietnam	0	0.0%	1	0.0%
Uganda	990	0.9%	0	0.0%
Grand Total	104,366	100.0%	73,331	100.0%

39

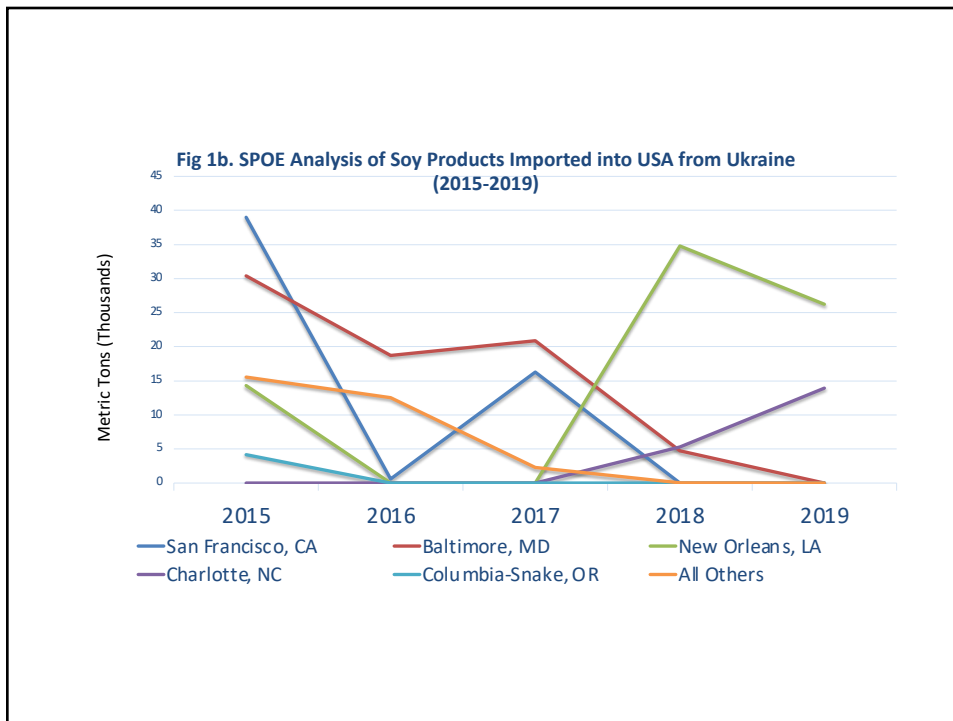
US soy: exports vs imports (metric tons/2018)



40



41



42

Actions

Responsible Imports



Objective: Develop a science-based plan to safely import essential ingredients from countries of high risk.

Principles

1. What is the ingredient and the country of origin?
2. Are there alternatives?
3. What is the virus of concern?
4. Do we know its T_{1/2} in feed?
5. What is the transport time from the source country to the mill?
6. Has any mitigation been applied?
7. What is the storage period (time & temp)?...

“Feed Quarantine”

Patterson et al, JAVMA, 2019

43

Pipestone RI: China phase

- **Feed ingredient focused:** AAs and VTMs from China
- **Leadership:** Dr Arkin Wu
- **China:** Manufacturing plant and port warehouse oversight
 - Mechanical biosecurity protocols at both sites
 - Lines of separation, PPE, etc
 - One time use totes
 - Containers sealed at the plant, sealed until final US destination
 - **Audited 2x/year**

44



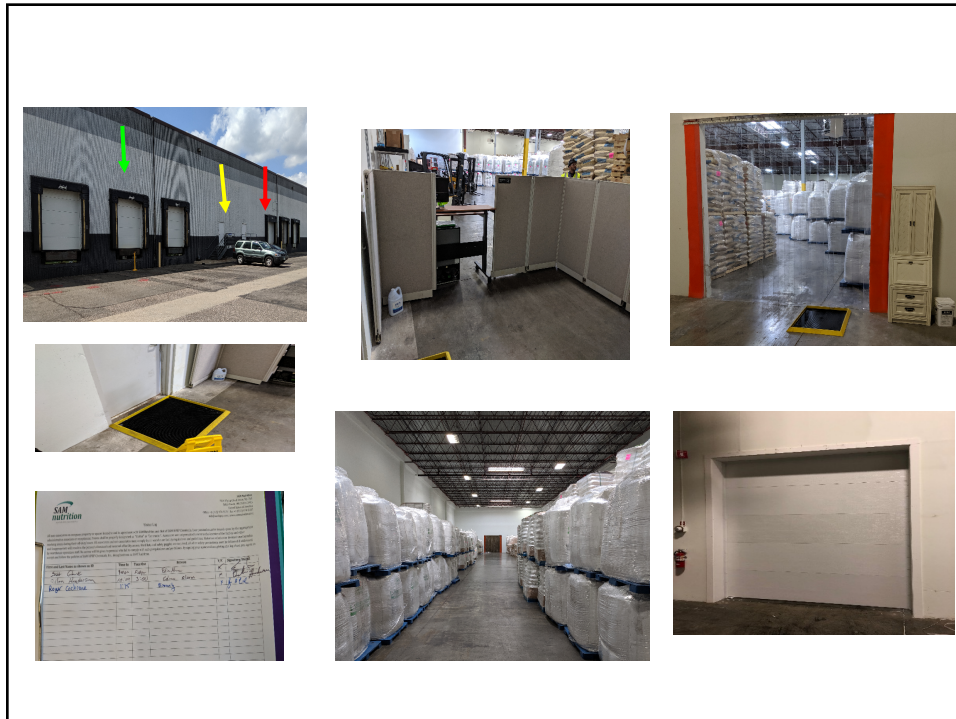
45

Pipestone RI: US phase

- **Import warehouse, Leadership: Dr. Roger Cochrane**
 - Separate entry and exit points for people & products
 - Sign in + product certification required upon entry
 - Mechanical biosecurity protocols practiced throughout facility
 - **Quarantine room**
 - Separate entry point and designated forklift
 - Designated holding time (minimum 30 days) & temp (20°C)
 - True AIAO space
 - **Storage area**
 - Products labeled with names and dates
 - Heated year-round
 - **Audited 2x/year**

SAM
nutrition

46



47

Actions

Feed additives as mitigants

Dee et al, TBED 2020

- **Objectives:** Evaluate select feed additives 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)



48

Participating companies & products tested

- **Novus:** Activate DA (2 inclusions)
- **Kemin:** SalCURB, SalCURB K2, CaptiSURE (2 inclusions)
- **ADM:** Daafit S (2 inclusions), Daafit PLUS
- **PMI:** Dominnate
- **Anitox:** Finio
- **Alltech:** Guardian*
- **FeedNRG:** R2 liquid
- **DSM:** VVC
- **Cargill:** Vigilex**
- **Anpario:** pHorce
- **Ralco:** Dual Defender
- **McNess:** FURST PROTECT

49

Ice Block Challenge Model: PRRSV 174, PEDV, and SVA



50



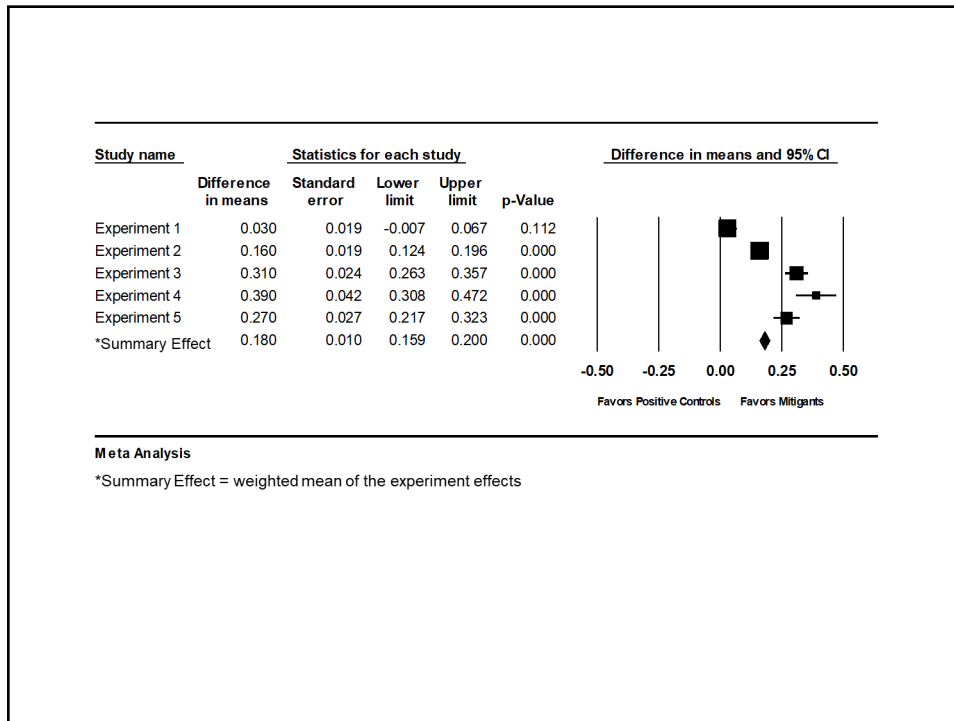
51

Sample Data: Experiment 5

Product (rate)	ADG (kgs)	% mortality
pHorce (0.3%)	0.58 ^a	1%
DaaFit PLUS (0.3%)	0.52 ^a	0%
Dual Defender (0.1%)	0.57 ^a	0%
FURST PROTECT (0.4%)	0.59 ^a	0%
Vigilex (0.4%)	0.28 ^b	7%
+ control	0.24 ^b	6%

$p < 0.0001$

52



53

Conclusions

- **Improved health and performance observed with mitigated feed vs. non-mitigated feed, even in the face of infection.**
 - Viral load
 - Clinical disease
 - Growth rate
 - Mortality

“Ameliorative effect”

- **Repeated observations across 14 of 15 products tested.**
 - One product performed at a substandard level
- **Outcomes:**
 - Diverse chemistries
 - Different inclusion rates/costs
 - Options for producers and mills

Dee et al, TBED 2020

54

Impact

- **Governance level**
 - **CFIA program**
 - In place since March 2019
 - **Responsible Imports**
 - Policy approved at National Pork Forum
 - **NPPC letter to Secretary Perdue**
 - 31 state and national organizations

55

Interesting times....



56

Conclusions

- There is a growing body of scientific evidence that certain feed ingredients can support the transport and transmission of ASFV and other FADs.
- Scientifically validated options to mitigate this risk are now available.
- This information has brought about positive change in human behavior at the level of the veterinary profession and the swine industry.
- It has not, however, affected change at the federal level.

57

Our motivation: Working together to “Keep ASFV out”.



PIPESTONE

VETERINARY SERVICES

58