Nutritional Strategies for Viral Mitigation

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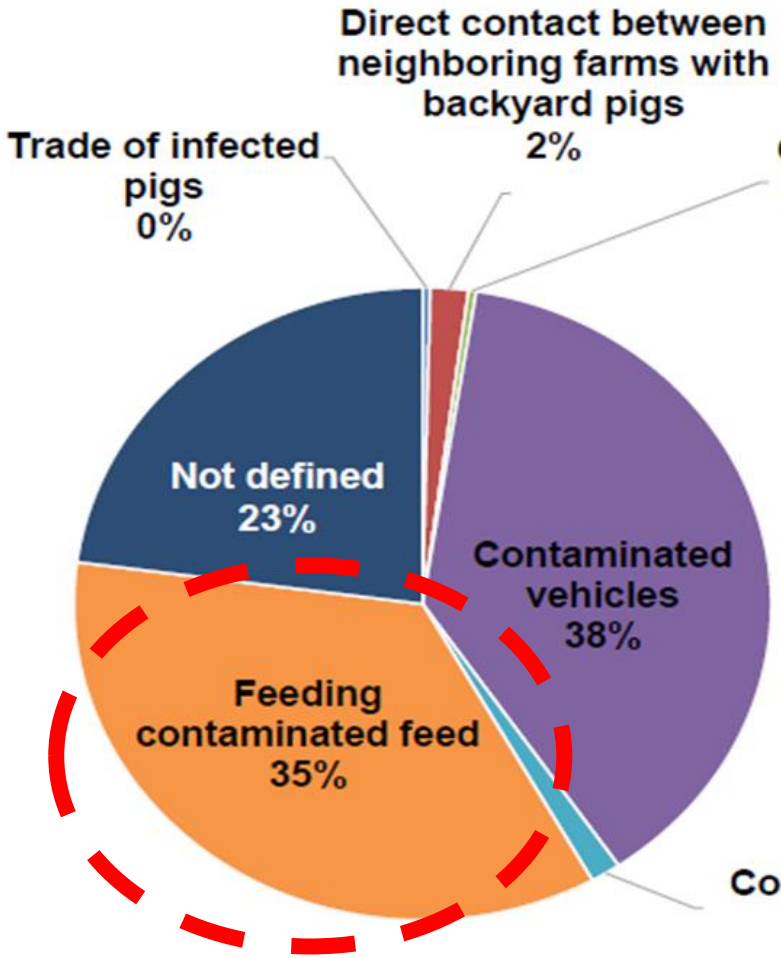
What we learned

Routes of infection



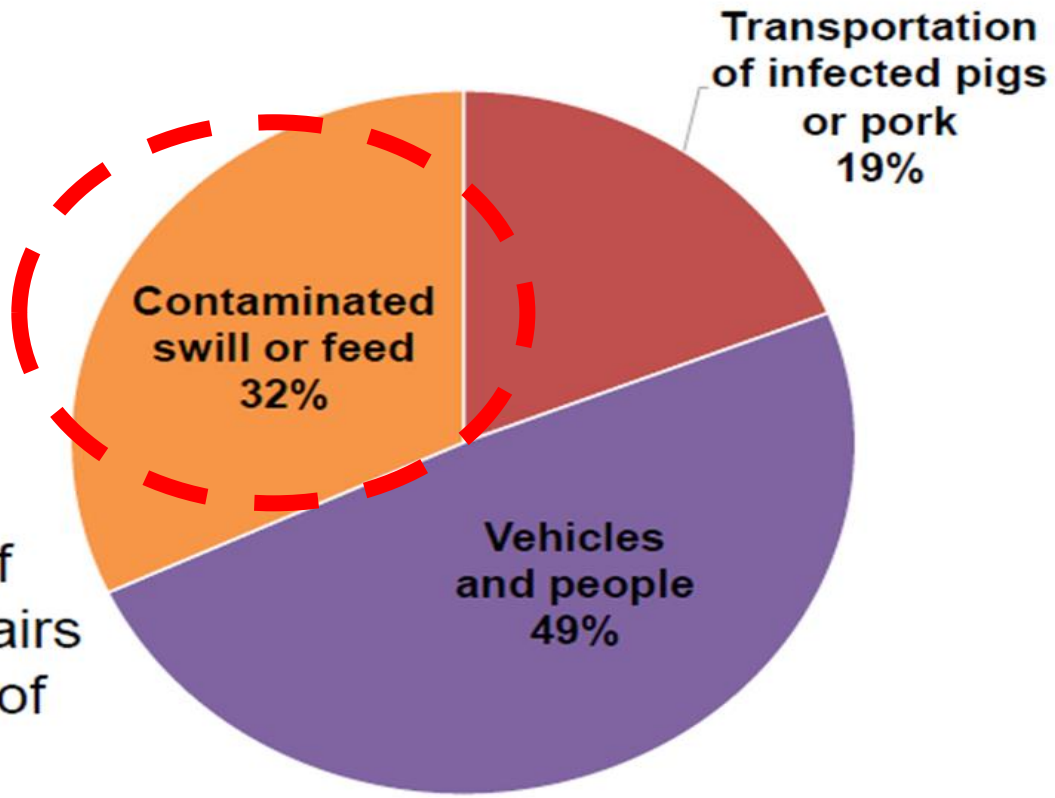
Russia Epidemiological Root Cause (284 outbreaks)

As reported by Belyanin, 2013

Routes of infection

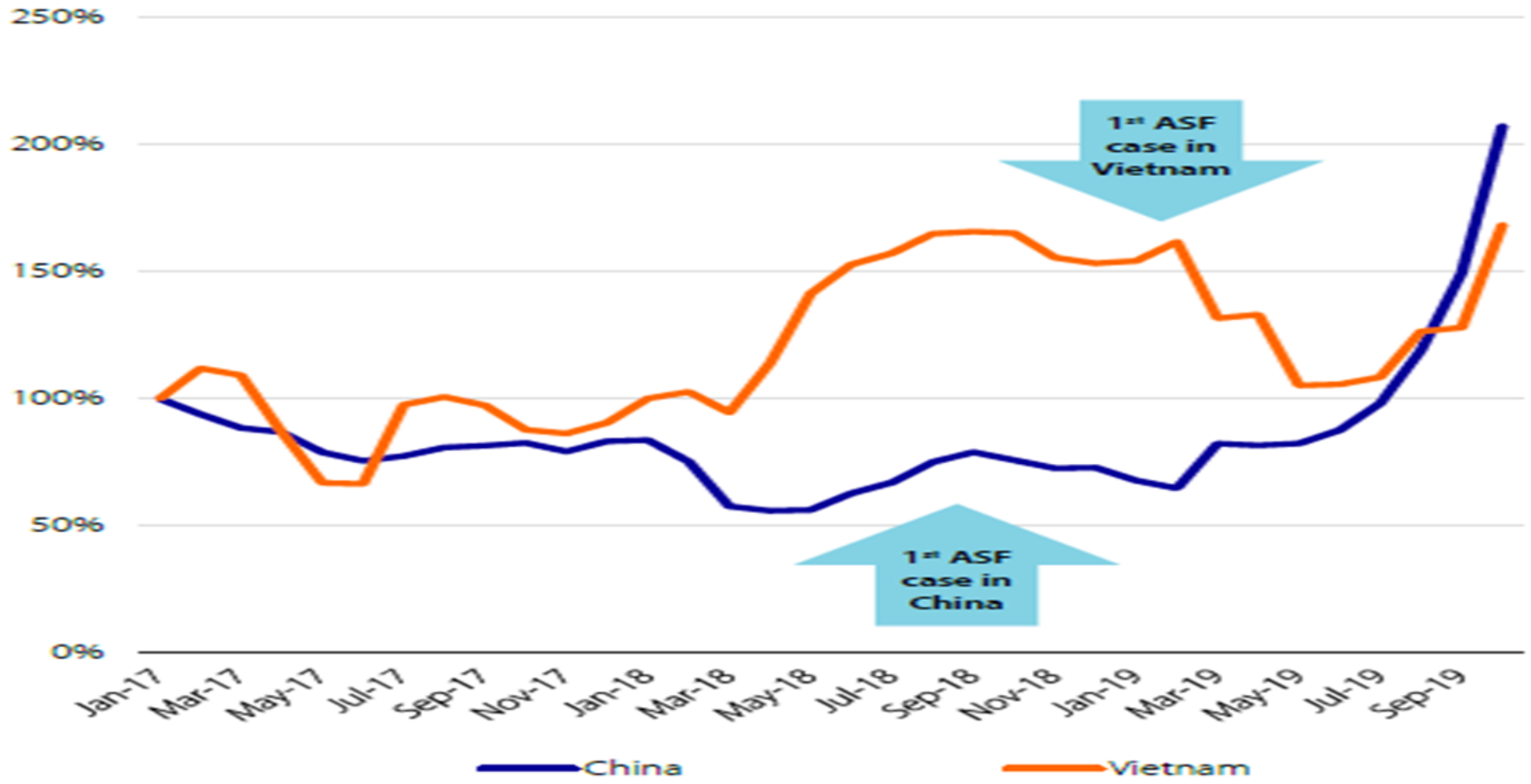
China Epidemiological Root Cause (68 outbreaks)

As reported by Ministry of Agriculture and Rural Affairs of the People's Republic of China



Pork prices will rise

Live hog prices in China and Vietnam highlight the complex responses to ASF and the inevitability of rising prices



Decrease in demand vs oversupply in the market = lower pork prices

Rabobank, 2020

What we learned in China and Vietnam

- Survival of the fittest
  - Big farms have a higher survival rate than the small to medium scale farms
- China promoted the “corporate-farmer” model which led to the closure of small farms
- Increase in importation to meet demand (pork AND poultry)
- In Vietnam, the rush to find solutions (the cheaper the better)
- Focus on restocking but remains slow due to recontamination
- Biosecurity is key: farm, feed and water

Feed and Water Biosecurity

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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?

https://animalagriculture.org/resources/Documents/Scrapie/Scott%20ASFV%20NIAA.pdf

ASFv and Multiple Viruses Can Survive in Feed and Its Ingredient

Ingredient	SVA (FMDV)	ASFV	PSV (SVDV)	PEDV	FCV	PCV2	BHV-1 (PRV)	PRRSV
Soybean meal-conventional	(+)	(+)	(+)	(+)	(+)	(-)	(+)	(+)
Soybean meal-Organic	(-)	(+)	(+)	(+)	(-)	(-)	(+)	(-)
Soy oil cake	(+)	(+)	(+)	(+)	(-)	(-)	(+)	(-)
DDGS	(+)	(-)	(-)	NS	(-)	(-)	(-)	(+)
Lysine	(+)	(-)	(+)	(+)	(+)	(+)	(-)	(-)
Choline	(+)	(+)	(-)	(+)	(-)	(+)	(-)	(-)
Vitamin D	(+)	(-)	(+)	(+)		(+)	(-)	(-)
Complete feed (+positive)	(+)	(+)	(+)	NS	(+)	(+)	(-)	(-)
Complete feed (+negative)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)

Dee, 2018. PLOS one

A red-colored box with a (+) indicates that virus was recovered in a viable form from a specific ingredient, while a green-colored box with a (-) indicates that viable virus was not recovered by VI and/or swine bioassay. NS denotes that these ingredients were not used in this study.

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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

PIPESTONE®

https://animalagriculture.org/resources/Documents/Scrapie/Scott%20ASFV%20NIAA.pdf

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Experimental evidence of 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”

https://animalagriculture.org/resources/Documents/Scrapie/Scott%20ASFV%20NIAA.pdf

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Infectious Dose of African Swine Fever Virus When Consumed Naturally in Liquid or Feed

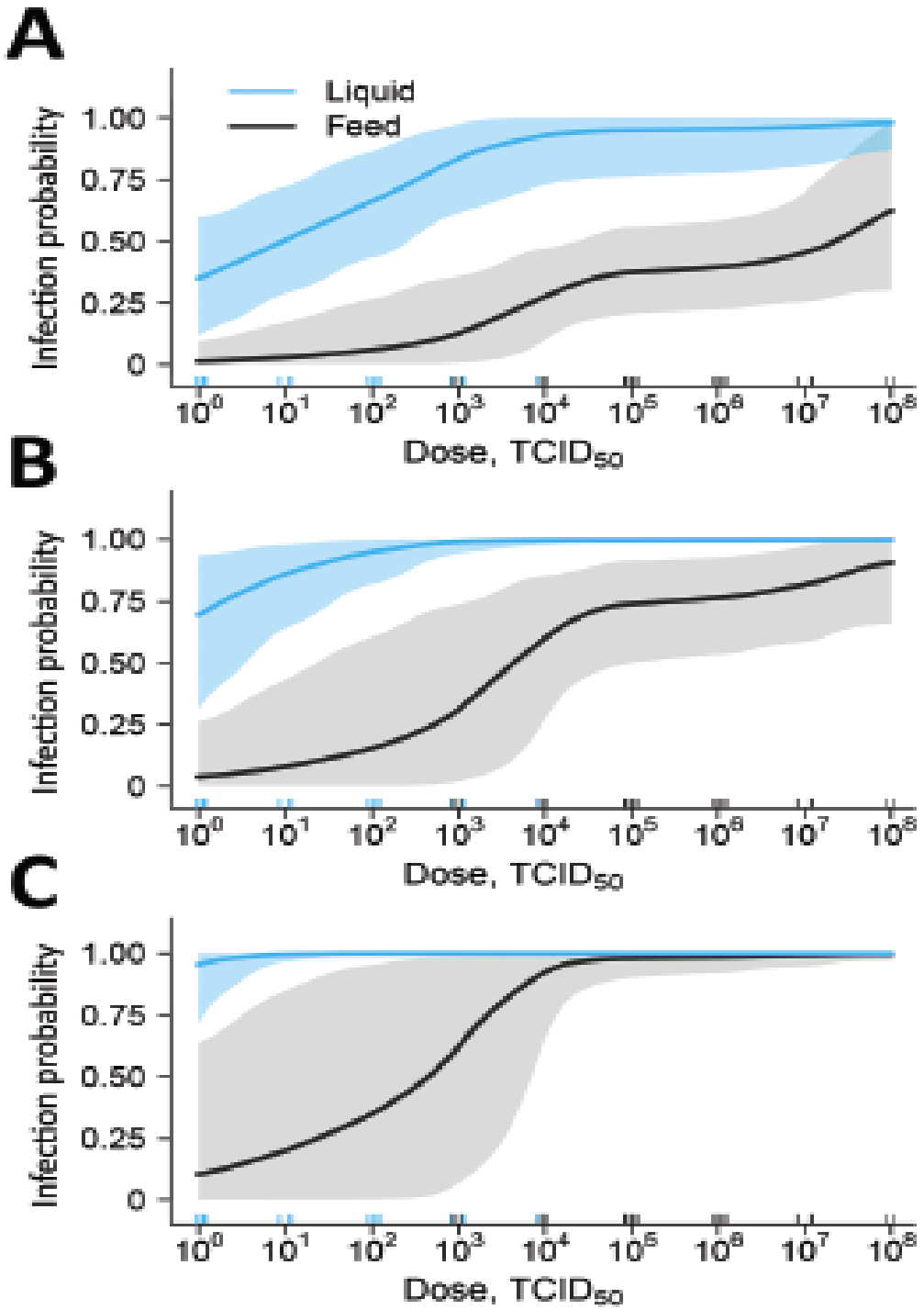

Figure 1. Estimated liquid (blue line) and feed (black line) infection probability at different oral doses of ASFV based on experimental data to determine the infectious dose of ASFV when consumed naturally. Data are shown for 1 exposure (A), 3 exposures (B), and 10 exposures (C). Shading indicates 95% CIs. Numbers of individual pig dosages are represented by the blue and black tick marks above the horizontal axis. Repeated exposures can be viewed interactively online (https://trevorhefley.shinyapps.io/asfv).

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 25, No. 5, May 2019

What we know on mitigation

- Most are using formaldehyde to improve feed hygiene
  - Dry vs liquid?

- Organic acids effect on PEDv and delta coronavirus
  - Trudeau et al, PLOS One, 2016)
  - Cottingim et al, Porcine Health Management 2017

Organic Acid + HMTBa mitigation against ASFv in feed

- Research facility: Military veterinary institute
- ASFv strain: isolated from Northeast China, Shen 2018 strain
- Qualification: P4 Lab, able to conduct ASFv research

- 0.6% (w/w) organic acid blend + HMTBa added to the feed
- Control: feed without organic acid blend + HMTBa

- ASFv inoculation dose: 10^6 $TCID_{50}$/ml in feed
- Place at Room temp and take sample per week
- Using qPCR to test nucleic acid of virus and the TCID50 was determined by virus titration and then convert to PFU/ml

Novus' own research

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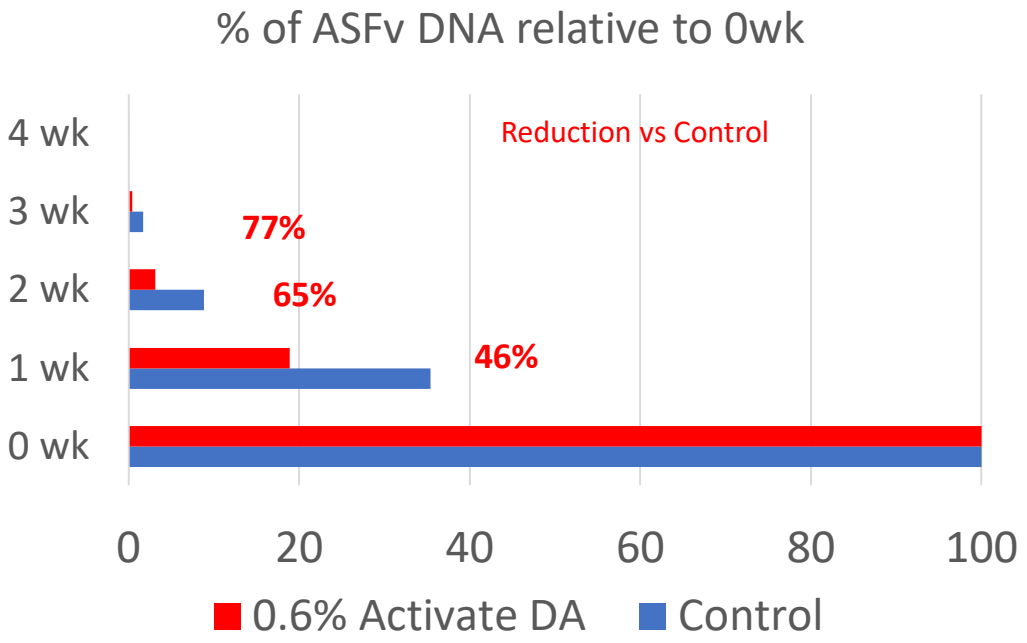
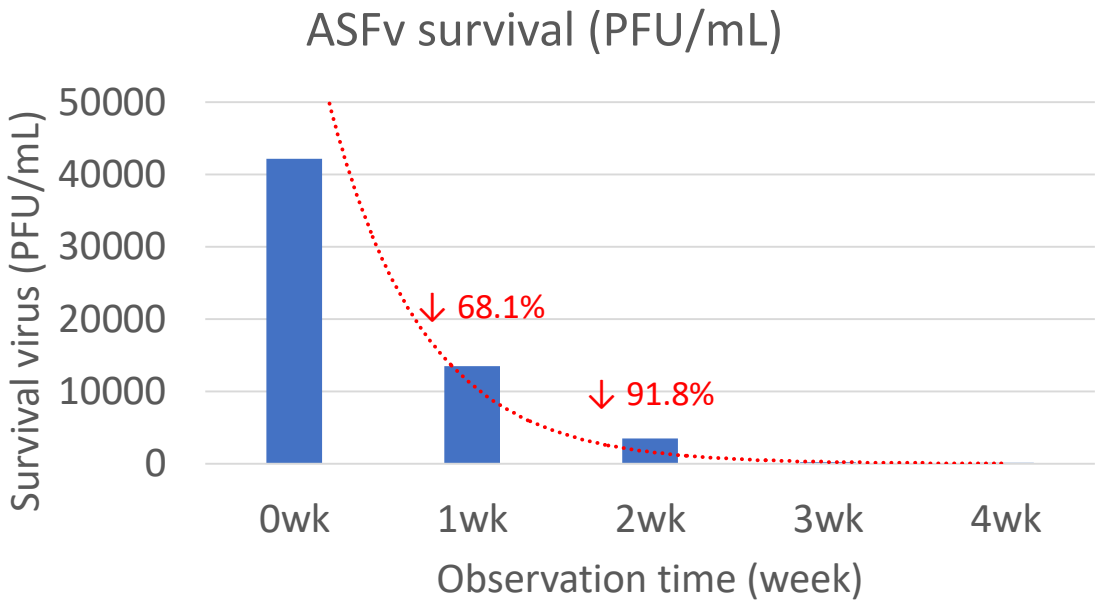
Organic acid + HMTBa mitigation against ASFv in feed





- The organic acid blend + HMTBa can mitigate the viral activity of ASF in feed.
- The organic acid blend + HMTBa can inactivate more than 90% of ASFv within 2wks

Novus' own research

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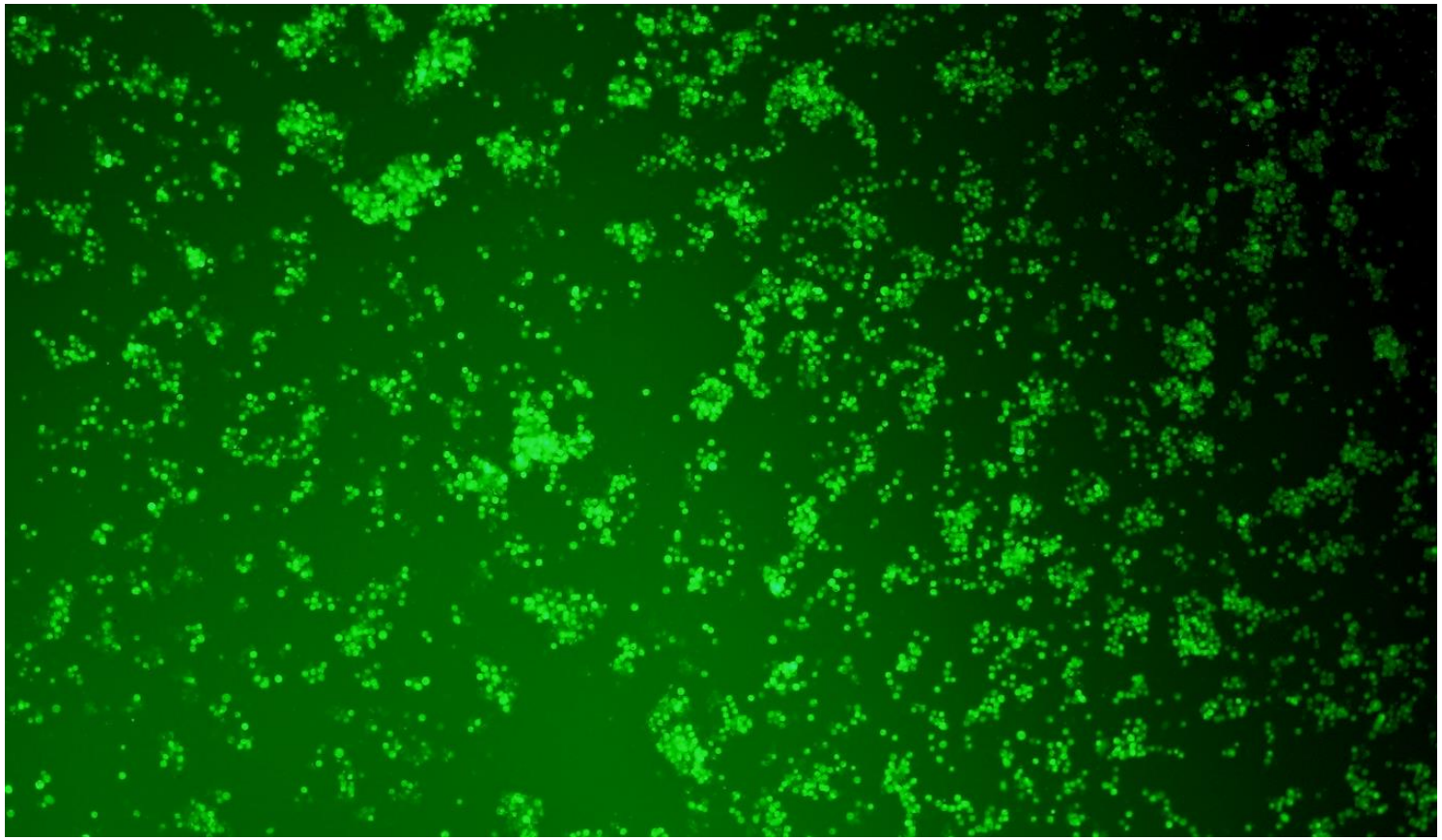


Primary pig lung macrophages（PAM）of swine infected by ASFV under fluorescence microscope

Inactivation of ASFv in water using a liquid organic acid + HMTBa

Objective:

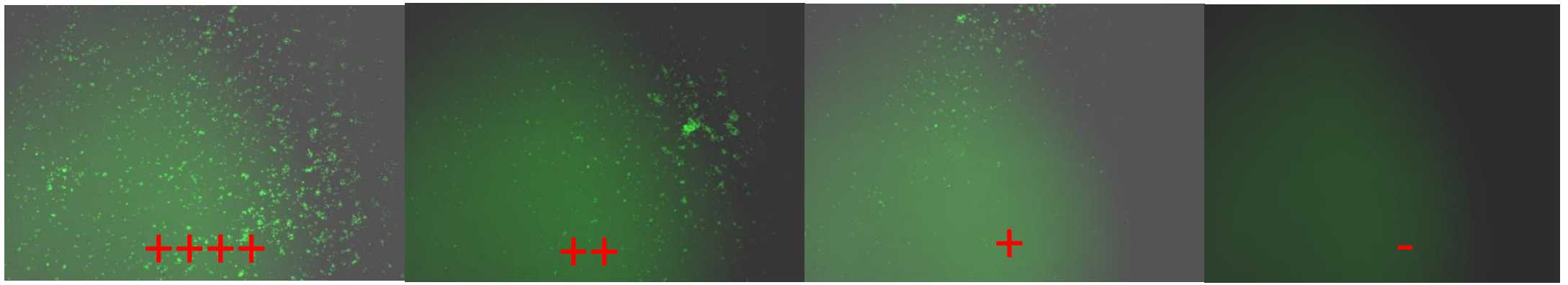
- To evaluate the effect of Activate WD Max on the inactivation of ASFv in water

Experimental design

- Virus selection: by Indirect Immunofluorescence test (IFI) using Green Fluorescent protein (GFP)
- Infection dose: 1000 TCID50/m
- Dose of liquid OA + HMTBa: 0, 0.08%, 0.1%, and 0.15%
- Observation period: 10 ~ 120 minutes

Inactivation of ASFv with organic acid + HMTBa in water

Incubation	Concentration of Activate WD in water			
	0	0.08%	0.10%	0.15%
10min	++++	++++	++++	++/-
30min	++++	++++	++++	- /-
60min	++++	++++	+++	+/-
90min	++++	++++	++/-	-/-
120min	++++	++++	++	-/-



Incubation and observation of PAM for 96 hours after inactivation with/without OA + HMTBa

Novus' own research

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Why does it work?

- Combination of acids and their virucidal activity
  - Viral structure can be dissolved by OAs
  - Damages specific viral receptors
  - Activity depends on molecular polarity and additional COOH or OH group

- HMTBa (2-hydroxy-4-(methylthio) butanoic acid:
  - unique molecule
  - Due to its lipophilic character, can easily disperse through the envelope and disrupt
  - organic acid and a methionine source
  - Supplies additional cysteine (for defense and activation of T cells) especially under stress

What’s next?

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We expect…

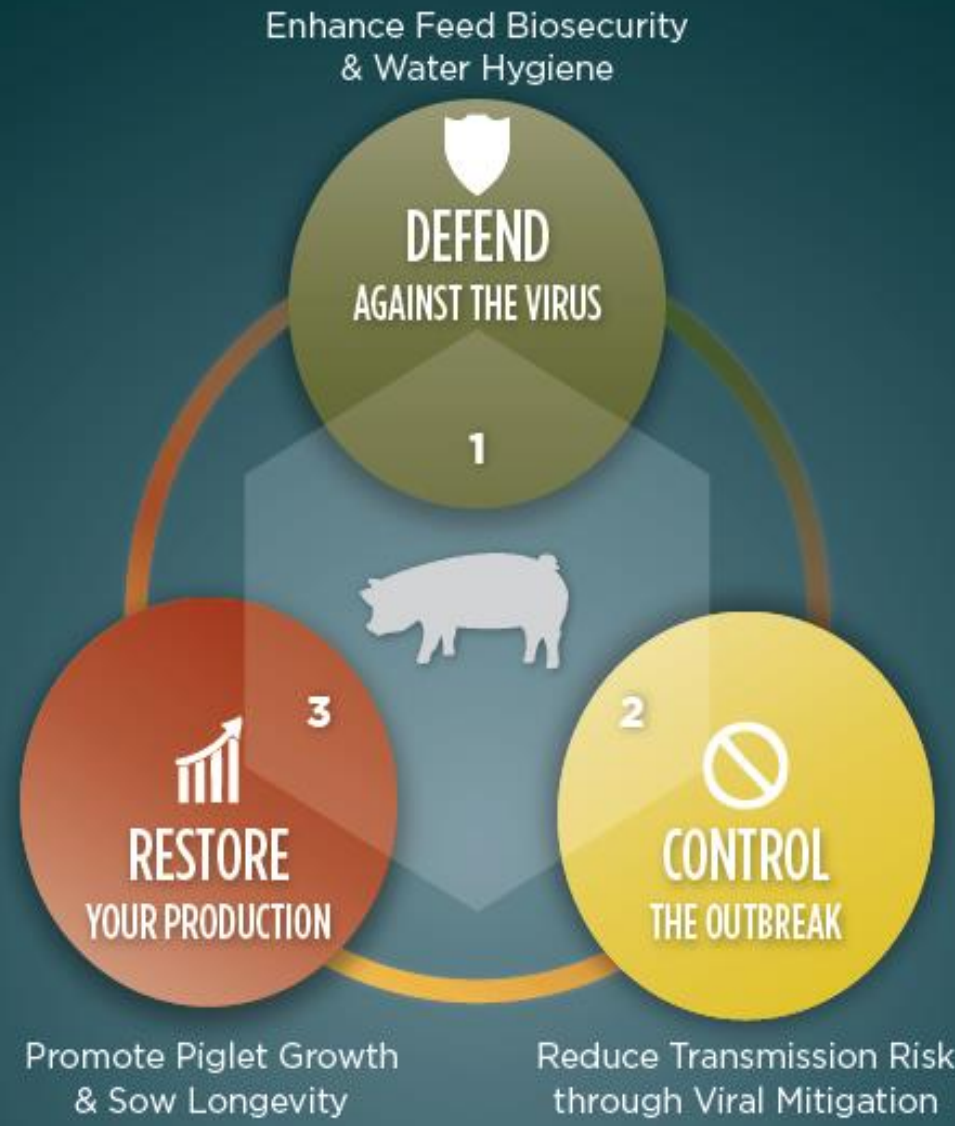
- ASF will be here for the long run (or until a vaccine is developed)
- Continue improving our farm structures and slaughterhouse facilities
  - Consolidation of the value chain
- Geographical redistribution of hog farming
- Pork consumption will decline as there will be a shift to other protein sources
- Start thinking of your repopulation strategy (gilts/sow/piglets)

What can we do?

- Biosecurity, biosecurity, biosecurity (1-7-10, checkpoints etc)
- All stakeholders should be involved and concerned: educate as many as you can (print, social, broadcast
- Connect with the experts on current updates
- Communicate

Swine Viral Mitigation

IMPROVE FEED BIOSECURITY, WATER HYGIENE & PRODUCTION PERFORMANCE



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FEED BIOSECURITY & WATER HYGIENE

Formycine Gold Px — Fast acting formaldehyde for protection of feed & raw material from virus contamination

Activate® — Organic acid combination containing HMTBa for altering viral capsid structural protein [ACTIVATE DA: In Feed, ACTIVATE WD: In Water]

3

PRODUCTION PERFORMANCE

CIBENZA® DP100 — Protease feed enzymes for piglet growth promotion

MINTREX® — Organic trace mineral (Zn, Cu, Mn) for sow longevity performance

Activate® — Organic acid combination containing HMTBa for growth promotion in feed & water

THANK YOU

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