PRRS: Science, Application and Risk Assessment

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Disclosure of funding and in-kind

- USDA NRI PRRS CAP 1 and 2
- National Pork Board
- MN Pork Board
- MN Rapid Agricultural Response Fund
- Preserve International
- Midwest Microtek
- Swine Disease Eradication Center partners

SDEC partners

- **Corporate members**
  - PIC
  - Genetiporc
  - Boehringer-Ingelheim
  - Pfizer
  - Novartis
  - Camfill Farr/Filtration Systems Inc.
  - Noveko
  - Clarcor
- **Practice members**
  - Pipestone Vet Clinic
  - Fairmont Vet Clinic
  - Swine Vet Center
  - Clinique Demeter
  - Carthage Veterinary Service
  - Cannon Valley Veterinary Clinic
  - Japanese Association of Swine Veterinarians

Disclosure: Air Filtration

- I do not
  - Receive royalties or commissions on the sales of filters or filtration equipment.
  - Have patents on filtration inventions.
  - Have research contracts or consulting agreements/retainers with filtration/equipment companies.

Topics

- 1. Overview of PRRSV
- 2. Aerobiology of PRRSV
- 3. Air filtration: A means to reduce risk

1. Overview of PRRSV

- Porcine reproductive and respiratory syndrome virus
  - ss enveloped RNA virus
  - Persistent infections
  - Prolonged viremia
  - Transplacental infection
  - Target cell is macrophage
  - Undergoes constant genetic change
    - Collins et al., 1991, Murtaugh et al., 2005
- $560 million/year annual industry cost
  - Neumann et al., 2005


Swine Disease
Eradication Center
University of Minnesota

Transmission and biosecurity (Pitkin et al., 2009)

Route	**Example**	**Intervention**
Genetics	pigs, semen fresh pork	quarantine & test prohibit entry
Fomites	boots, coveralls, containers	disinfection
Personnel	hands	entry protocols
Transport	contaminated trailers	sanitation drying
Insects	mosquitoes, houseflies	screens, insecticides
Airborne	**bioaerosols**	**filtration**

2. Aerobiology of PRRSV

- Aerosol transmission of PRRSV is variant-dependent.
  - Cho et al., 2006 & 2007

- MN-184 (high path) vs. MN-30100 (low path)
  - 1. Viral loads in blood & tissues ($p=0.0005$)
  - 2. Frequency of aerosol shedding ($p=0.0005$, $OR=3.22$)
  - 3. Transmissibility via aerosols ($p=0.04$)

Risk factors associated with airborne PRRSV

(Dee et al., 2010)

- Neighboring source population actively shedding virus via bioaerosols ($p = 0.0002$)
- Directional winds moving from a shedding source to an at-risk population ($p = 0.0003$)
- Winds of low velocity (1.4 to 1.9 m/s) with intermittent gusts (2.8 to 3.7 m/s) ($p = 0.002$)

Meteorological conditions associated with airborne PRRSV (Dee et al., 2010)

- Cool temperatures: -2.6 to 4.8^0 C ($p = 0.01$)
- High relative humidity: 77 to 82% ($p = 0.003$)
- Rising pressure: 979 to 984 hPa ($p = 0.003$)
- Low sunlight levels: ($p = 0.04$)


Otake et al., 2010
6.6 Km (6 x 10^{1})
2.3 Km (1 x 10^{1})
Source
2.3 Km (1.7 x 10^{1})
4.6 Km (3.1 x 10^{2})
9.1 Km (4.2 x 10^{1})

3. Air filtration: A means to reduce risk

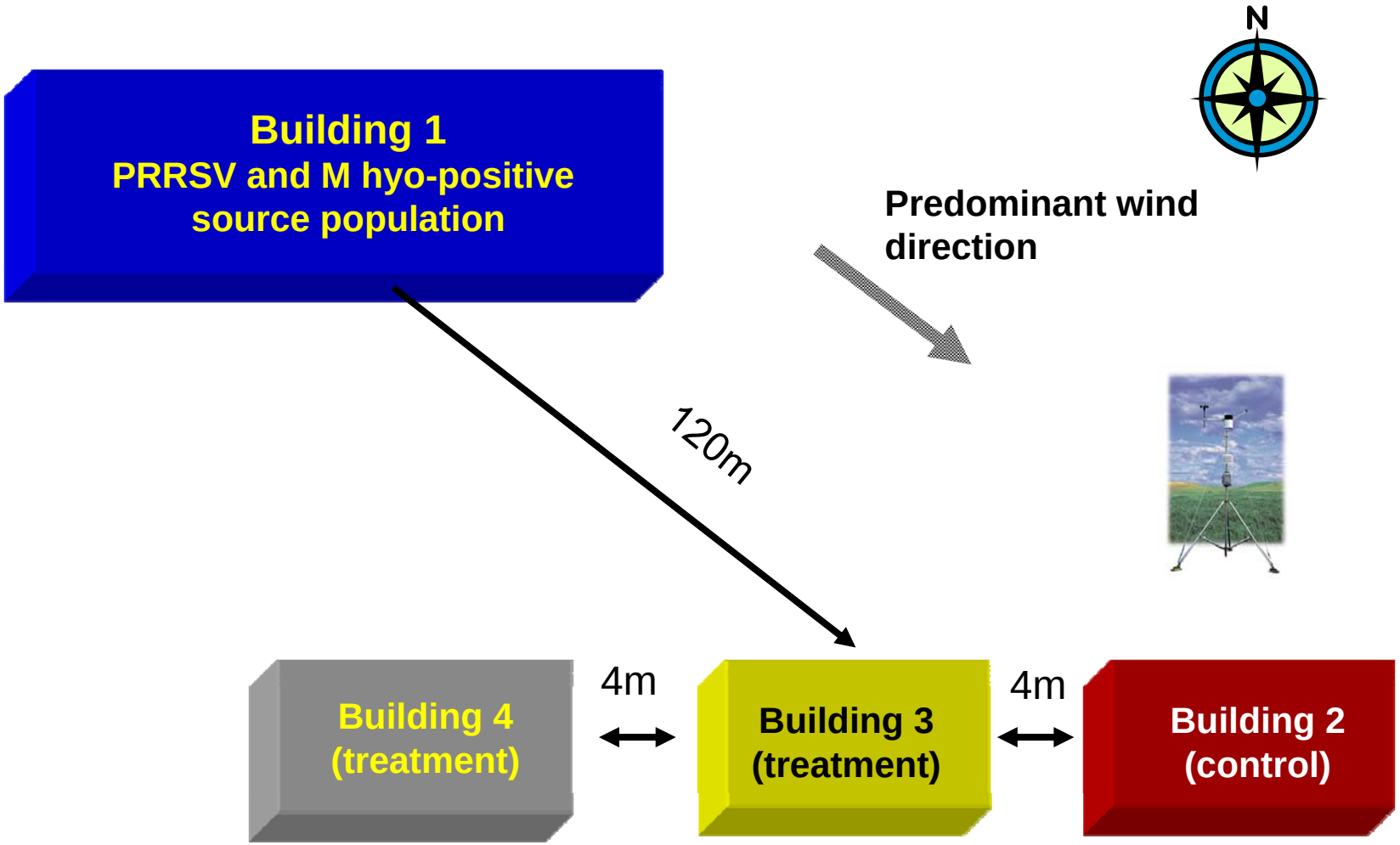
- A French innovation
  - Interesting clinically
  - Lacked controlled data
  - Costly
  - Positive pressure/HEPA filter systems
- Research questions
  - How to test?
  - How to apply?

The Production Region Model

(Pitkin et al., 2009, Dee et al., 2010)

- **Objective**
  - To develop a model of a swine production region that is endemically infected with PRRSV to evaluate routes of transmission and protocols of biosecurity.

- **Hypothesis**
  - The frequency of PRRSV infections via the aerosol route will be significantly lower in treatment facilities versus controls .


Building 1
PRRSV and M hyo-positive source population
N
Predominant wind direction
120m
Building 4 (treatment)
4m
Building 3 (treatment)
4m
Building 2 (control)

Size and Scope

- Summary:
  - 1438 days of study (June 2006-Nov 2010)
  - 4744 pigs utilized
  - Multiple pathogens tested
    - PRRSV 184, 1-26-2, 1-18-2
    - M hyo
  - 3 types of filters evaluated
    - Mechanical
    - Antimicrobial
    - Electrostatic
  - 38,519 samples collected
    - Air, personnel, fomites, transport, insects, pigs (sera, nasal)

Airborne transmission data by filter type

Pathogen	Control	MERV 16	MERV 14	Anti-microbial	Electrostatic
PRRSV	28/65	0/39 (p <0.0001)	0/13 (p <0.0001)	0/26 (p <0.0005)	0/13 (p < 0.0001)
M hyo	17/39	0/13 (p <0.0001)	0/13 (p <0.0001)	0/26 (p <0.0001)	0/13 (p < 0.0001)

Application (Spronk et al., 2010, Dee et al., 2010)

- **Objective:**
  - To evaluate the efficacy of air filtration for reduction of external PRRSV introduction to large sow herds located in swine dense regions
- **Project Participants:**
  - UMN, SDSU PVC, FVC, SVC
- **Selection criteria:**
  - ≥ 2400 sows
  - ≥ 4 external virus introductions over the past 4 years
  - ≥ 4 pig sites within 4.7 km radius of candidate herd
  - Industry standard biosecurity
- **Duration of study:**
  - 4 years
- **Outcomes measured:**
  - External virus introduction
  - Cost-benefit

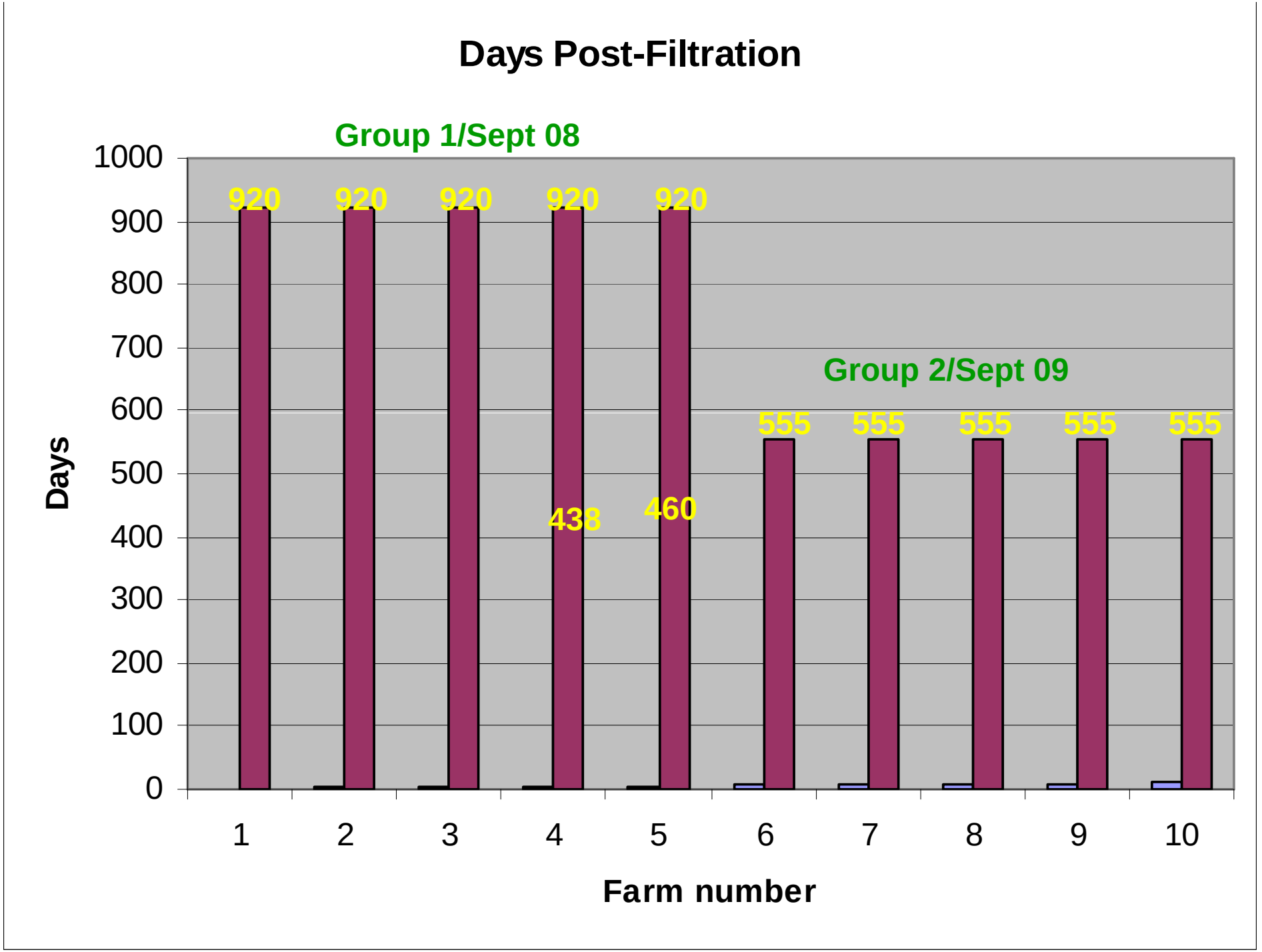

o sites of Three 41x120 W-F Barns
Two 1,000 head barns
Three Four Barn Sites
Three Four Barn Sites
Four 41 x 120 W-F Barns
Four 41 x 120 W-F Barns
20 nurs in mid finish on both ends
Three 41x120 nurs in mid finish on both ends
Ceylon
Two 41 x 120 W-F Barns
Two barn finisher??
Hawkeye II
wo barn finisher??
20 Nurs in mid-finish on both sides
New 50x200 W-F Barn
<100 head in outside lot
36 x 80 Bldg 360 head?
Google
43°31'01.95" N
94°41'12.45" W
Jun 2003
Eye alt 47162 ft

Attic installation of filter boxes

Photos courtesy of Dr. Spronk

Filter bank

Photos courtesy of Dr. Reicks


Days Post-Filtration
Group 1/Sept 08
Group 2/Sept 09
920
920
920
920
920
555
555
555
555
555
438
460
1000
900
800
700
600
500
400
300
200
100
0
Days
1
2
3
4
5
6
7
8
9
10
Farm number

Frequency of infection pre- and post- filtration across the 2 infected filtered herds

BHI	# sites 4.7km	# infections pre-filter (**48 months**)	infection frequency pre-filter	# infections post-filter (**30 months**)	infection frequency post-filter
3128	17	7	**1 infection every 6.8 months**	1	**1 infection every 30 months**
3240	9	4	**1 infection every 12 months**	1	**1 infection every 30 months**

Control herd data (30 months)

- Re-infection has occurred in **28/30** (93%) of non-filtered herds.
- Of the 28 herds infected:
  - 17/28 (62%) have experienced **1** new virus introduction
  - 7/28 (25%) have experienced **2** new virus introductions
  - 4/28 (13%) have experienced **3** new virus introductions
- Re-infection less likely in filtered herds versus non-filtered herds
  - ($p = 0.0001$)

In Closing

- 1. The routes of PRRSV transmission within and between herds are well understood.
- 2. Science-based biosecurity protocols are available to reduce these risks.
- 3. Air filtration is an essential component of an effective biosecurity plan for herds in swine-dense regions.