HPAI Epidemiology Update

Amy Delgado, Director
Center for Epidemiology
and Animal Health

May 31, 2023

Avian Influenza Risk and Protective Factors

Avian Influenza Risk Factors over Time

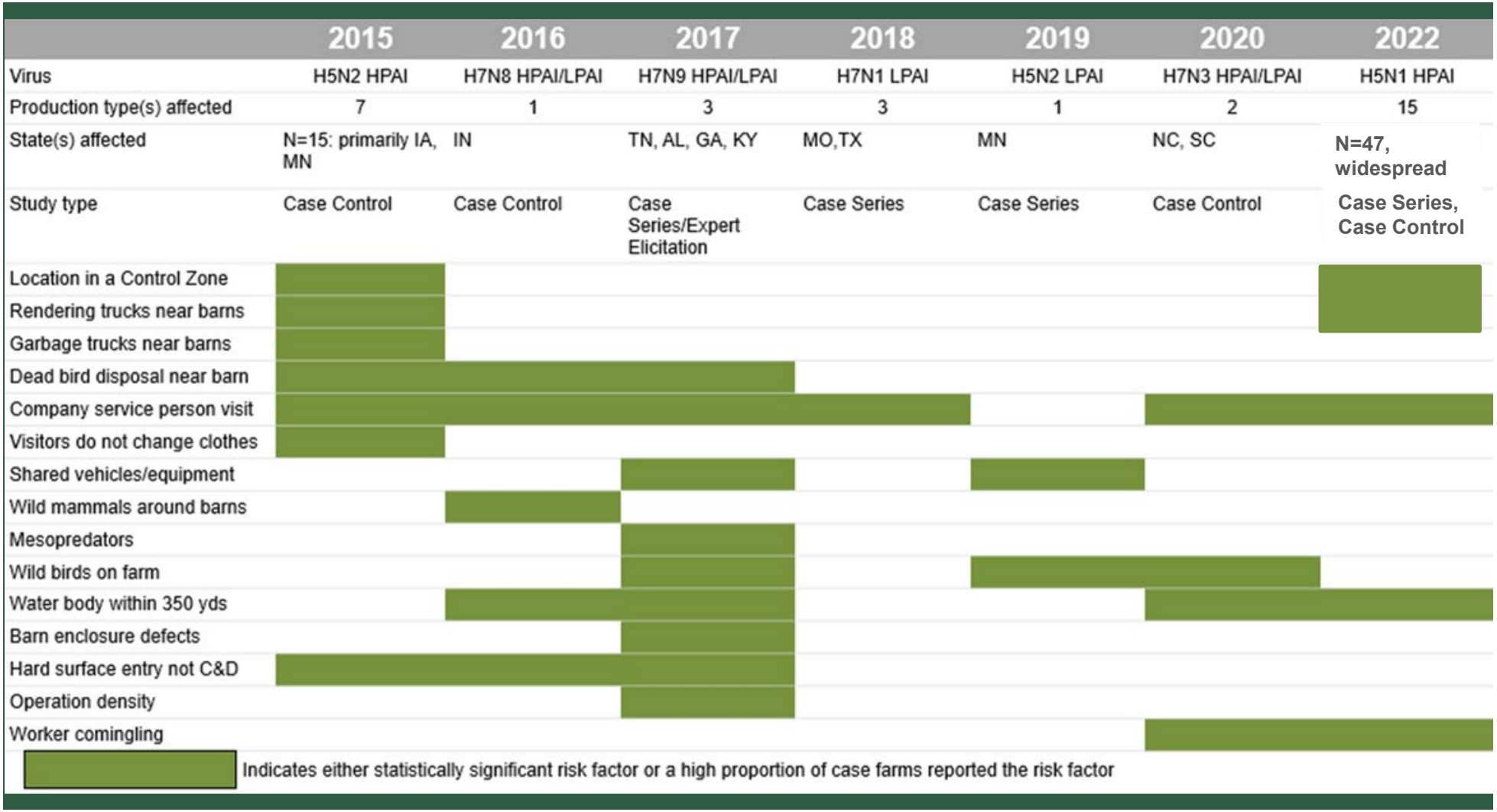


Table Egg Case-Control Study

40 participants in 8 states

- 18 cases (11 wild bird introduction, 7 lateral spread)
- 22 controls in same states as case farms

Eligible control premises had:

- 50,000 or more birds
- Birds on-site for at least two-week window of risk

Questionnaire: farm characteristics, wild bird sightings, worker-, visitor-, and equipment-related practices, and egg handling, manure handling, and disposal practices

What Risk Factors Best Explain the Odds of Becoming Infected?

Variables	% Case farms	% Control farms	Odds ratio
Farm in an existing control zone on the reference date	**44.4**	**9.1**	**10.3**
Wild waterfowl or shorebirds in closest crop field during the 14-day reference period	44.4	9.5	5.8
No farm entrance gate	77.8	26.4	3.8
No specific/dedicated barn personnel	>90	77.3	6.2
Flock size ≥ 500,000 birds	61.1	50.0	2.6

Top Risk Factors from Model Averaging

Variables	% Case farms	% Control farms	Odds Ratio
Control zone	**44.4**	**9.1**	**10.3**
No farm entrance gate	**77.8**	**26.4**	**7.0**
Waterfowl presence	**44.4**	**9.5**	**6.2**
Wild bird access to feed	50.0	27.3	5.0
Flock size ≥ 500,000 birds	61.1	50.0	5.9
Off-site disposal	50.0	27.3	4.1
No specific/dedicated barn personnel	>90	77.3	6.4
At least some rodent problems	72.2	45.5	3.1
Change of clothing not always required for workers	33.3	9.1	4.5
Sharing trucks/trailers	38.9	27.3	3.1
Mowing less than 4 times a month	64.7	40.9	2.8
Lower level of vehicle washing*	88.9	68.2	2.7

What Risk Factors Best Explain the Odds of Becoming Infected with a Wild Bird Introduction Virus?

Variables	Odds Ratio
Waterfowl sighted in field closest to farm (10s to 1000s vs. none)	44.4
Feed spills cleaned up immediately	0.06
Wild bird access to feed (sometimes, most of the time, always vs. never)	11.4

Ignoring Route of Introduction, did Ventilation Differ Between Cases and Controls?

Variables	% Case farms	% Control farms
Barn has ventilation system updates	11.8	26.3
Ventilation Features:		
• Curtain or tunnel ventilation	11.1	18.2
• Side wall inlet	27.8	40.9
• Ceiling or eaves inlet	61.1	40.9

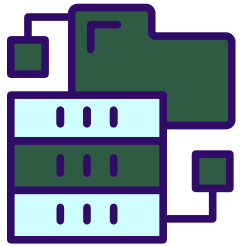
No statistically significant differences between cases and controls.

For Wild Bird Virus Introductions, Did Ventilation/ Wind Breaks Differ Between Cases and Controls?

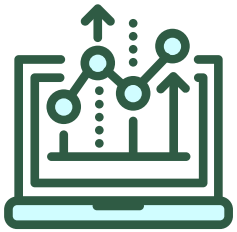
Characteristic	% Case farms	% Control farms
Barn has ventilation system updates	9.1	17.7
Ventilation Features:		
• Curtain or tunnel ventilation	18.2	15.0
• Side wall inlet	36.4	45.0
• Ceiling or eaves inlet	45.5	40.0
Structural windbreak on farm (hill, natural break)	0.0	30.0

Table Egg Case-Control Study Limitations

Response/
recall bias



Small datasets limit
power to detect
associations



Analysis only possible
when sufficient variation
in responses is reported

With 18 case farms in the dataset,
only 2 to 3 variables advisable for
multivariable modeling – doesn't mean
other variables aren't important

Turkey Case-Control Study

125 participants in 12 states

- 66 case farms and 59 control farms across 12 states

Eligible control premises had:

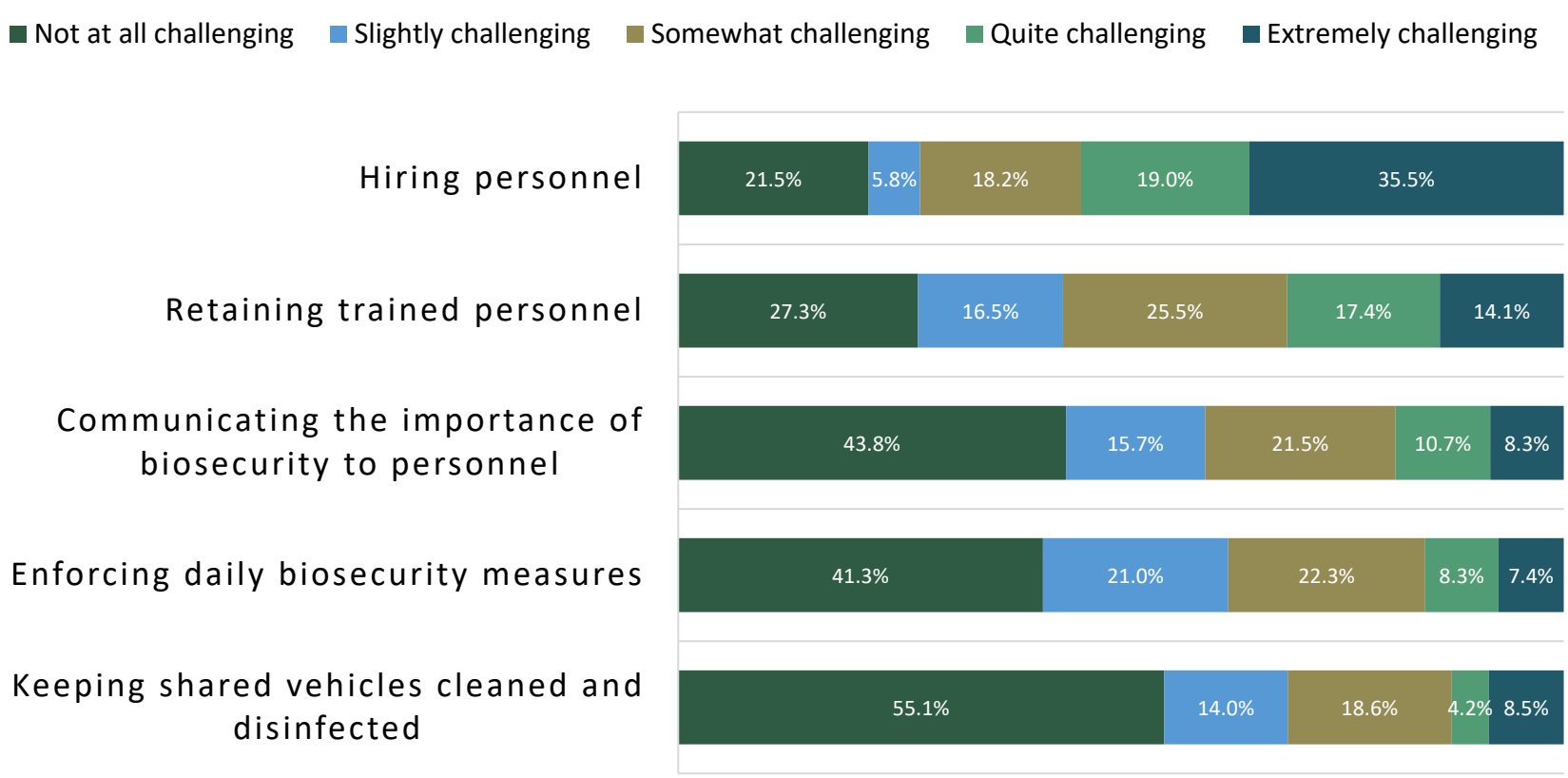
- Commercial turkey farms that raised meat turkeys
- Farms with birds on-site for at least two-week window of risk

Questionnaire: farm characteristics, wild birds and wildlife, biosecurity, personnel, visitors, vehicles and equipment, and management practices

What Risk Factors Best Explain the Odds of Becoming Infected?

Characteristic	% Case farms	% Control farms	Odds ratio
In an existing control zone	57.6	23.7	7.24*
Both brooder and grower stages on farm	51.5	27.1	9.17*
Sex: toms	86.4	67.8	7.50*
Waterfowl/shorebirds seen in closest field	30.3	11.9	8.11*
Worker biosecurity includes shower before entering barn[A]	10.6	27.1	0.26*
Restroom facility available to crews visiting farm	45.5	69.5	0.39*
Render dead birds	30.3	13.6	9.06*

How Challenging are the Following Issues?



What Investments Paid off?

Turkey producers who invested in the following reduced their likelihood of contracting HPAI in 2022:

Permanent barn ventilation improvements or renovations

Temporary wild bird mitigation structures or infrastructure

Permanent vehicle wash stations improvements or renovations

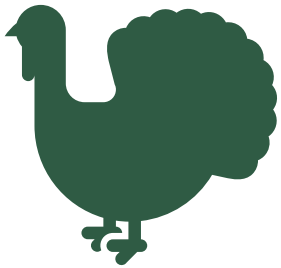
Permanent wash stations for employees in older barns

How Did Investments Differ among Turkey Producers?

Control farms spend more ($27,657 vs. $21,159) on temporary measures. Examples: gates, parking areas, temporary wild bird migration, temporary air intake inlet covers, or temporary vehicle wash stations.

NPIP participation **increased likelihood of investing in temporary biosecurity measures by 26.9%.**

HPAI Turkey Case Control Study:
Preliminary Economic Results



Dual sex farms were **0.2%** **more likely** to spend more each month on biosecurity costs than single sex farms.

Case farms were **87.7%** **more likely** to have plans to make permanent changes to biosecurity.

Farms that had permanently invested in improvements or renovations in the last year less likely to plan for future permanent investments.

Did Ventilation Vary Between Cases and Controls?

Ventilation Features	% Case farms	% Control farms
Curtain	60.4	55.0
Environmental/ tunnel	33.3	35.0
Side doors (such as tip outs)	6.3	10.0

No statistically significant differences between cases and controls.

Did Ventilation Improvement Investments Matter?

Invested in permanent improvements to barn ventilation since 2015

82% Less Likely to Become Positive for HPAI

As barns get older (>13 years) we may not see the same protective effect

Could be related to building materials, design, other issues, etc. from the time in which it was built.

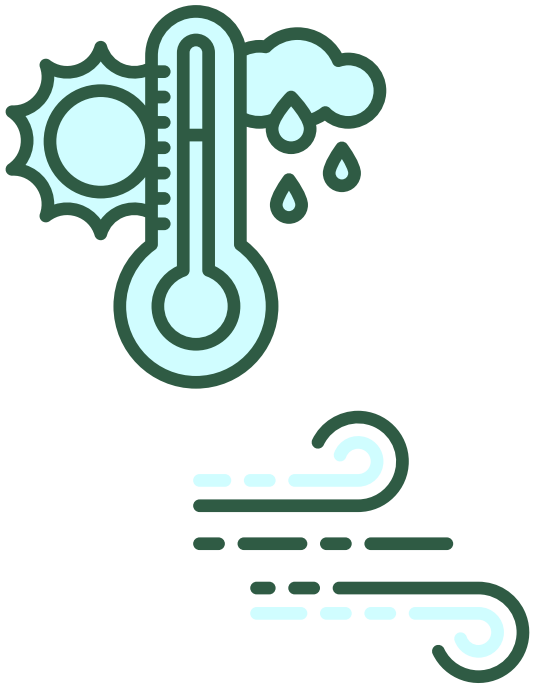
Did the Use of Windbreaks Vary Between Cases and Controls?

Variables	% Case farms	% Control farms
Any windbreak present	40.0	27.6
Evergreen or juniper windbreak present	18.5	10.3
Deciduous tree windbreak present	25.0	17.2
Structural windbreak present	13.9	15.5

No statistically significant differences between cases and controls.

Does Weather Affect HPAI Risk?

Weather Variables Considered

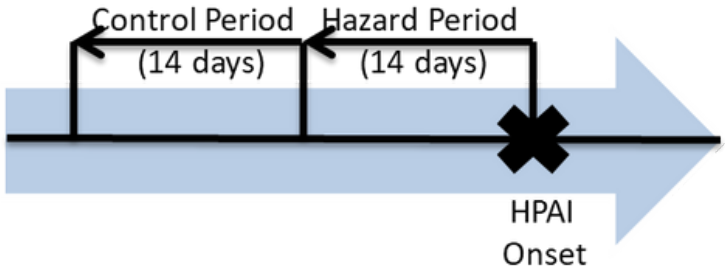


- Daily maximum temperature
- Daily minimum temperature
- Daily precipitation
- Daily maximum relative humidity
- Daily minimum relative humidity
- Daily average wind velocity
- Daily specific humidity
- Downward shortwave radiation

(source: gridMET)

Methods

- Case-crossover study design
- Commercial turkey[1] and layer[2] farms
- Each HPAI-affected farm serves as its own control
- Compare weather during hazard and control period



[1] *Includes turkey breeder and turkey meat production farms*
[2] *Includes layer breeder, pullet, and table egg layer farms*

Preliminary Univariate Analysis

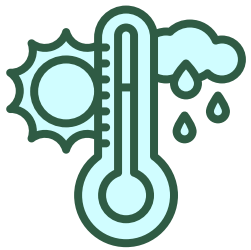
Commercial Turkey Farms (n=218)

Variable (14-day average)	P-Value	Odds Ratio
Precipitation (mm)	0.004	1.28
Minimum temperature (°C)	0.006	1.08
Average wind speed (m/s)	<0.001	4.25

**Maximum temperature has a p-value of 0.09 and might be important in the multivariate model*

Commercial Layer Farms (n=37)

Variable (14-day average)	P-Value	Odds Ratio
Precipitation (mm)	0.038	1.52



Weather variables often have complex interactions, so multivariable modeling is needed before drawing final conclusions.

Acknowledgements

Map Creation:

- Christopher Kizer, Geospatial Analysis, Products, & Services
- BirdCast (Cornell University, Colorado State University & University of Massachusetts Amherst)

Virus Phylogenetics and Source of Virus:

- Jared Luxton, Philip Riggs & Carolann Knutson – Center for Informatics
- Mia Torchetti, Kris Lantz, Jess Hicks, Cameron Norris, Todd Stuber – National Veterinary Services Laboratories

Case Control Study Work:

- Jada Thompson, University of Arkansas
- Producers
- State Partners
- Turkey Federations and Associations
- National Agricultural Statistics Service
- National Veterinary Services Laboratories
- APHIS VS Field Operations
- Center for Epidemiology and Animal Health Staff

Questions?