



United States
Department of
Agriculture

2024 Highly Pathogenic Avian Influenza (H5N1) - Michigan Dairy Herd and Poultry Flock Summary

Epidemiological Investigations of HPAI H5N1 Genotype B3.13 in Michigan Dairy Herds and Poultry Flocks: Observations on viral spread between premises and mitigation recommendations

June 9, 2024

1. Executive Summary

Highly Pathogenic Avian Influenza (HPAI) H5N1 viral infection in dairy cattle was first confirmed on a Texas dairy premises on March 25, 2024. Dairy cattle from an HPAI affected dairy premises in Texas – non-clinical and undetected at the time of the cattle movement – were shipped to Michigan, arriving on March 8, 2024. Clinical signs were first observed in the premises' resident cattle on March 20, 2024. On April 1, 2024, a commercial poultry premises reported clinical signs associated with HPAI. The flock was confirmed infected on April 2, 2024. Whole genome sequencing (WGS) of viruses from the dairy and poultry premises identified Eurasian lineage goose/Guangdong clade 2.3.4.4b, genotype B3.13 on both premises and suggests likely indirect transfer of virus from the dairy premises to the poultry premises.

In early April 2024, the Michigan Department of Agriculture and Rural Development (MDARD) invited a USDA Epidemiological Strike Team into Michigan to investigate the links between HPAI affected dairy premises and evidence of spillover into poultry premises. This report summarizes the findings from field epidemiological investigations of disease spread between premises for 15 dairy herds and 8 poultry flocks confirmed with HPAI genotype B3.13 in Michigan.

After interstate animal movement initially introduced the HPAI genotype B3.13 virus into a Michigan dairy, continued disease transmission within the state is determined to be multifactorial. Transmission between farms is likely due to indirect epidemiological links related to normal business operations such as numerous people, vehicles, and other conveyances frequently moving on and off the affected dairy premises, with many of these indirect links shared between premises. Importantly, disease spread due to independent introduction of the virus onto dairy or poultry premises from migratory waterfowl is not supported based on both genomic and epidemiological data analysis.

Key findings identified to date and potential risk factors for local transmission include:

- Shared personnel between premises
 - 20% of affected dairies' employees and 7% of dairies' employees family members work on other dairy premises
 - 7% of affected dairies' employees also work on poultry premises; 13% of affected dairies' employees have family members who work on poultry premises
 - 31% of dairies have employees who own livestock or poultry at their personal residence
- Shared vehicles between premises

- 62% of affected dairy premises use shared vehicles to transport cattle, with only 12% of premises cleaning vehicles before use
- Frequent visitors on/off premises
 - 100% of affected dairy premises have regular visits by veterinarians, nutritionist/feed consultant, and/or contract haulers (e.g., cattle or manure); the majority of these visitors have direct contact with cattle
 - 40% of affected dairy premises have regular visits for deadstock removal, with 20% having direct contact with cattle
 - 53% of affected dairies utilized the same deadstock removal company and 40% had animals removed from the premises by that company within 30 days prior to clinical onset
 - Milk haulers visit dairy premises, on average, 34 times within a 30-day time period
 - 93.3% of affected dairy premises are part of the same milk co-op with at least one other affected dairy premises within the state (i.e., only one of the affected dairy herds is part of a milk co-op that none of the other 14 affected dairy herds belong to)

Based on the epidemiological findings, the majority of links between affected dairy premises, and between dairy and poultry premises, are indirect from shared people, vehicles, and equipment. As such, HPAI disease spread between dairy and poultry premises can be mitigated by identifying potential interconnections between operations (people, conveyances, etc.) and increasing biosecurity practices on all premises and associated animal businesses (e.g., milk haulers, deadstock/contract haulers and other shared vehicles/trailers between premises, livestock markets). Identifying as many affected herds as possible will assist in assessing the scope of the event and allow decision-makers to better manage the response.

2. Background

After more than a month of investigations into dramatically decreased milk production and changes in milk composition in dairy herds in Texas, on March 25, 2024, the cause was confirmed to be the highly pathogenic avian influenza (HPAI) H5N1 virus of Eurasian lineage goose/Guangdong clade 2.3.4.4b, genotype B3.13. The HPAI H5N1 virus is detected at high levels in milk of infected cows and at lower levels in nasal swabs and urine of infected cows; manure does not appear to be a meaningful viral source and is unlikely to transmit the virus. Whole genome sequencing (WGS) analysis suggests an initial single spillover event of the virus from wild birds to dairy cattle, most likely occurring in the Texas panhandle in December 2023, with onward spread of the virus to eight other states (Nguyen et al, 2024).

On March 29, 2024, HPAI was confirmed on a Michigan dairy cattle premises with disease introduction traced back to movement of lactating dairy cattle from an affected dairy premises in Texas which was non-clinical at the time of animal movement. The Texas dairy herd was detected shortly after cattle movement into Michigan occurred when the Texas herd displayed clinical signs. On April 2, 2024, HPAI was confirmed on a commercial poultry premises in Michigan; WGS supports this premises was infected with the same B3.13 genotype as the first Michigan affected dairy with directional movement of the virus from the dairy premises to the poultry premises.

On April 10, 2024, a team of USDA epidemiologists (Epidemiological Strike Team) was invited by the Michigan Department of Agriculture and Rural Development (MDARD) to deploy to Michigan to rapidly investigate detections of HPAI in Michigan dairies with evidence of spillover into poultry premises. A USDA Incident Management Team (IMT) was also deployed to Michigan at the same time to support the state's HPAI poultry response; epidemiologists from both groups communicated daily during deployment and regularly after demobilization to discuss details about affected premises.

This report summarizes the findings from the Strike Team’s field epidemiological investigations of disease spread between premises for 15 dairy herds and 8 poultry flocks confirmed with HPAI H5N1 genotype B3.13 in Michigan.

3. Epidemiologic Investigation Methods

The focus of the epidemiological investigations was to identify potential transmission routes for disease spread between affected dairy premises and links to affected poultry premises in Michigan. All affected dairy herds in Michigan were identified by reporting sick cattle on their operations to the MDARD. Michigan’s first affected dairy submitted samples from affected cattle to Iowa State University Veterinary Diagnostic Laboratory for preliminary testing and subsequent affected herds submitted samples to the Michigan State University Veterinary Diagnostic Laboratory; both laboratories are members of the National Animal Health Laboratory Network. Confirmatory testing was performed at USDA’s National Veterinary Services Laboratories (NVSL). Initial epidemiological information was collected at the time of reporting of clinical signs, followed by administration of the USDA Dairy Cattle Emerging Health Event: Epidemiological Questionnaire. The questionnaire took 1-2 hours to complete depending on the complexity of the operation and the willingness of the producer. Both WGS analysis and follow-up field epidemiology investigations were then conducted with producers/herd veterinarians on affected dairy premises and associated animal businesses (e.g., deadstock haulers, milk haulers, feed deliveries) to further identify epidemiological links between affected dairy and poultry premises. A subset of affected dairy and poultry premises also agreed to additional on-farm sampling of wild birds and peri-domestic species by USDA Wildlife Services personnel. Data analyses were ongoing and performed as soon as possible after data collection.

4. Epidemiologic Summary

4.1 Summary of HPAI H5N1 Cases

A summary description of the 15 dairy herds and 8 poultry flocks that were confirmed in Michigan between March 29, 2024 and May 16, 2024 is presented in Table 1. On average, dairy premises had approximately 1,000 cattle onsite and poultry premises had approximately 84,000 birds onsite. The range of Euclidean geographic distances between dairy premises is 1 to 93 miles; between dairy and poultry premises is 1 to 93 miles; and between poultry premises is 0.7 to 68 miles.

Clinical signs were first observed in dairy cattle in Michigan on March 20, 2024. The last date that clinical signs were initially reported on affected premises investigated in this report was May 6, 2024 in dairy and May 3, 2024 in poultry. The date ranges of clinical onset are shown in Table 1. The order of clinical signs observed does not match the order the herds/flocks were detected due to variability in the timing of reporting, sample collection, and laboratory confirmation.

Figure 1 provides the timeline of the HPAI H5N1 detections based on the date of clinical onset for each affected dairy herd and poultry flock.

Figure 2 provides the epidemiological timeline curve of HPAI H5N1 detections based on the date of confirmation for affected dairy herds and poultry flocks.

Table 1. Description of 15 dairy herds and 8 poultry flocks affected with HPAI H5N1 genotype B3.13 in Michigan.

# of Herds/Flocks	Animal Type	Size ¹	Clinical Onset Date Range	Confirmation Date Range
6	Dairy Cattle	Medium	3/30/2024 - 5/6/2024	4/4/2024 - 5/14/2024
9	Dairy Cattle	Large	3/20/2024 - 5/4/2024	3/29/2024 - 5/16/2024
3	Poultry - Layers	Commercial	3/29/2024 - 04/12/2024	4/2/2024 - 4/16/2024
4	Poultry - Turkeys	Commercial	4/15/2024 - 4/29/2024	4/17/2024 - 5/2/2024
1	Poultry - Layers	Backyard	5/3/2024	5/10/2024

¹Size classifications for dairy premises based on the USDA National Agricultural Statistics Service herd size categories: Small (1-99 head), Medium (100-499 head), Large (>500 head). Size classifications for poultry premises based on the National Poultry Improvement Plan classification: Commercial (table egg layer premises with over 75,000 birds, commercial meat-type turkey premises that raise more than 30,000 turkeys annually) or else backyard if the premises has less than these bird numbers.

Figure 1. Graphic representation of the date of clinical signs observed by Michigan HPAI H5N1 genotype B3.13 affected dairy herd or poultry flock. Shedding of HPAI virus occurs before clinical signs appear based on data from herds outside of Michigan.

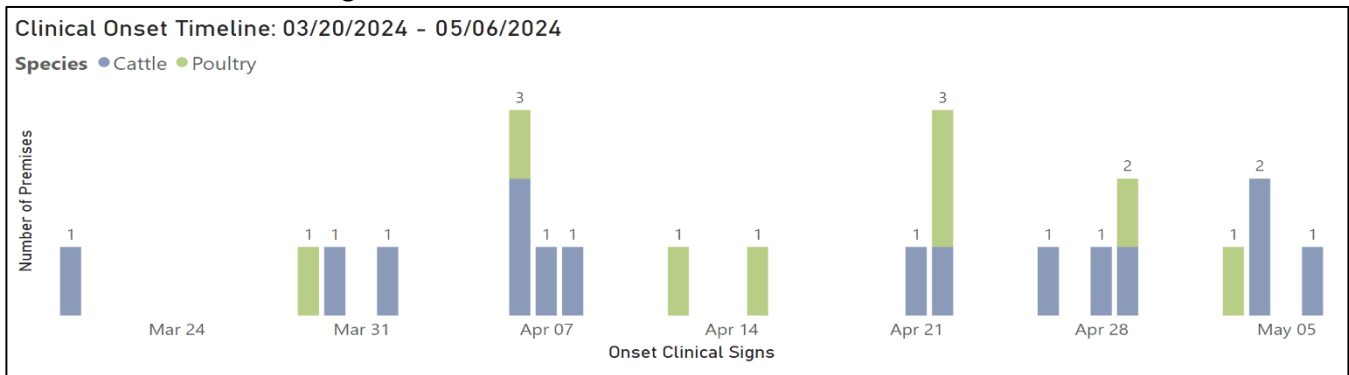
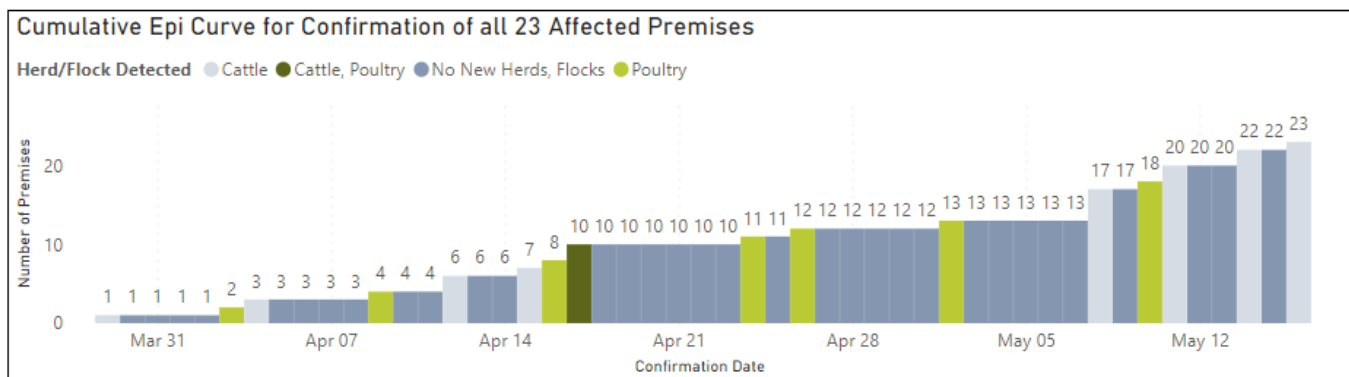


Figure 2. Epidemiological curve of detections of HPAI H5N1 genotype B3.13 in dairy and poultry premises based on the date of confirmation.



4.2 Summary of Disease Spread between Premises

A summary of the identified genomic and epidemiological links (Figures 3, 4) between affected dairy and poultry premises are conceptualized in the figures below. Michigan's first affected dairy was infected by the importation of cattle from an affected herd in Texas, which was undetected at the time of movement. Based on movement information and WGS, the virus in this herd likely moved to other Michigan dairy herds and poultry flocks. While the exact mechanism of disease spread onto each premises is unknown, the route of transmission is likely multifactorial based on epidemiological investigations.

4.2.1 Disease Spread Between Dairy Premises

All dairy premises had numerous risk factors for virus introduction, including many visitors within 30 days prior to clinical signs appearing in cattle. Key risk factors shared between dairy premises are summarized below and additional characteristics of affected dairy farms is provided in Table 2. Key findings include the following:

- 6 dairy premises had cattle brought onto the premises in the previous 30 days, although only one of these premises' movements is associated with disease transmission.
- All dairy premises reported visitors having contact with cattle on their premises.
 - 100% of affected dairy premises have regular visits by veterinarians, nutritionist/feed consultant, and/or contract haulers (e.g., cattle or manure); the majority of these visitors have direct contact with cattle.
 - 40% of affected dairy premises have regular visits for deadstock removal, with 20% having direct contact with cattle.
 - 53% of affected dairies (8/15) utilized the same deadstock removal company and 67% of those (6/8) had animals removed from the premises by that company within 30 days prior to clinical onset, 13% (1/8) reported that no animals were removed but that the deadstock hauler they have in common did stop on their property.
 - Milk haulers visit dairy premises on average 34 times within a 30-day time period.
 - 93.3% of affected dairy premises are part of the same milk co-op with at least one other affected dairy premises (i.e., only one of the affected dairy herds is part of a milk co-op that none of the other 14 affected dairy herds belong to).
- 7 dairy premises reported shared personnel between premises.
 - 20% of affected dairies' employees and 7% of dairies' employees family members work on other dairy premises.
 - 7% of affected dairies' employees also work on poultry premises; 13% of affected dairies' employees have family members who work on poultry premises.
 - 31% of dairies have employees who own livestock or poultry at their personal residence.

Figure 3. Conceptual overview of genomic relatedness supported by whole genome sequencing for dairy herds and poultry flocks affected with HPAI H5N1 genotype B3.13 in Michigan. Round shapes represent cattle (blue) and poultry (green) genomic clustering of individual animal samples tested, with increased relatedness as colors darken. Blue boxes represent affected dairies, green boxes represent affected poultry flocks, and orange boxes represent the movement of cattle onto affected dairies from premises with an unknown disease status at time of movement.

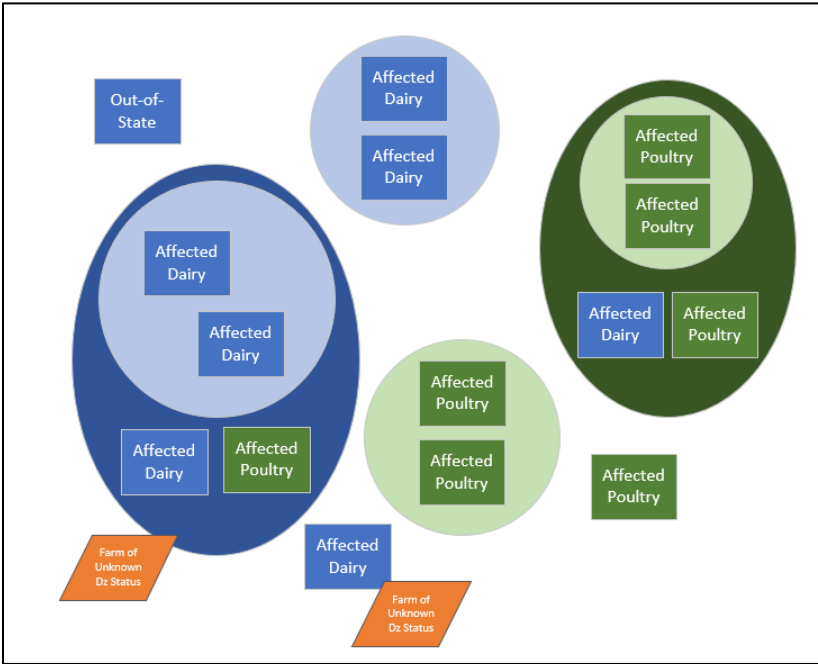


Figure 4. Potential transmission pathways supported by identified epidemiological links including animal and human movements and shared vehicles and equipment for the 15 dairy herds and 8 poultry flocks affected with HPAI H5N1 genotype B3.13 in Michigan.



Table 2. Additional characteristics of HPAI genotype B3.13-affected dairies in Michigan.

Characteristic	Response - % of Premises (Count), <i>unless otherwise specified</i>	
	Yes	If yes, % Commingled
Dairy heifers raised offsite during the 30 days prior to clinical signs	31 (4/13)	75 (3/4)
Other animals present on the operation	Yes	If yes, any sick or died?
Chickens	40 (6/15)	13 (2/6)
Cats	80 (12/15)	58 (7/12)
Waste milk fed to calves on the dairy	33 (5/15)	
Pasteurized?	40 (2/5)	
No treatment?	60 (3/5)	
Waste milk disposed in lagoons	73 (11/15)	
No treatment	91 (10/11)	
Combination of not treated and pasteurized	9 (1/11)	
Disposition of manure		
<i>Within 30 days of clinical signs</i>	Yes	No
Stored on premises	87 (13/15)	13 (2/15)
Composted for bedding	7 (1/15)	80 (12/15)
Applied to land management by this premises	73 (11/15)	13 (2/15)
Removed, sold, or given away	20 (3/15)	67 (10/15)
<i>After clinical signs were observed</i>		
Stored on premises	80 (12/15)	--
Composted for bedding	--	73 (11/15)
Applied to land management by this premises	53 (8/15)	20 (3/15)
Removed, sold, or given away	7 (1/15)	67 (10/15)
Cattle added to the operation in the 30 days prior to clinical signs	Yes	If yes, average number added
Preweaned dairy or beef calves	0 (15/15)	N/A
Weaned but not bred dairy heifers	7 (1/15)	30
Bred dairy heifers	13 (2/15)	5
Fresh dairy heifers	27 (4/15)	31
Lactating dairy cows	20 (3/15)	--
Dry dairy cows	0 (15/15)	N/A

Characteristic	Response - % of Premises (Count), unless otherwise specified		
Beef cows, bulls, steers, heifers	0 (15/15)	N/A	
Dairy bulls	0 (15/15)	N/A	
Any cattle added	40 (6/15)	--	
	Yes	Cleaned prior to use?	
Shared transport vehicles with other operations	62 (8/13)	12 (1/8)	
	Always	Never	N/A
Cattle were isolated prior to commingling with resident cattle	21 (3/14)	21 (3/14)	57 (8/14)
Access to cattle feed	Yes		
Wild birds had access to cattle feed	100 (15/15)		
Wild animals had access to cattle feed	100 (15/15)		
Rodents had access to cattle feed	100 (15/15)		
Shared personnel	Dairy workers	Family members	
Dairy workers/family also employed at other dairy operations	21 (3/14)	7 (1/14)	
Dairy workers/family also employed on swine farms	7 (1/14)	7 (1/14)	
Dairy workers/family also employed at poultry operations	7 (1/14)	14 (2/14)	
Dairy workers/family also employed on other livestock operations	14 (2/14)	7 (1/14)	
Employees own livestock or poultry	31 (4/13)	--	
	Yes	Average number of visits	If Yes, % contact with cattle
Visitors to the operation within 30 days prior to clinical signs			
Veterinarians	93 (13/14)	4	100 (13/13)
Nutritionist or feed consultant	92 (11/13)	2	82 (9/11)
Breed technician	25 (3/13)	30	100 (3/3)
Feed or feed ingredient deliveries	100 (14/14)	8	7 (1/14)
Milk hauler	100 (13/13)	34	0 (15/15)
Contract hauler (e.g., cattle or manure)	92 (12/13)	4	58 (7/12)
Dead stock/ renderer	43 (6/14)	4	50 (3/6)
Hoof trimmer	69 (9/13)	4	100 (9/9)
	Yes		
Any sick or dead wild birds within the 30 days prior to clinical signs	15 (2/13)		

Despite no genomic evidence that migratory birds are spreading HPAI genotype B3.13 within Michigan, the potential for resident wild birds or peri-domestic species to move and transmit the virus between dairy herds cannot be ruled out, especially for dairy premises located in close proximity. All dairy herds reported wild bird, wild animal, or rodent presence on farms, with these species always having access to cattle feed. HPAI H5N1 genotype B3.13 detections in pigeons, a starling, cats, racoons, opossums, and foxes have occurred on 5 affected dairy premises and 1 affected poultry premises that participated in on-farm sampling. Still, it was a small number of individual animals and species that were detected from the large number of samples collected.

4.2.2 Disease Spread Between Dairy and Poultry Premises

Apart from the potential for resident wild birds or peri-domestic species to move and transmit the virus, as discussed above, the only other potential transmission routes found from dairy herds to the poultry flocks were through shared employment, housing, or movement of employees. Approximately 22 employees of 3 poultry flocks worked weekend shifts at 2 different dairy premises. Shared housing between dairy and poultry workers was identified between 3 poultry premises and 2 dairy premises. It is also possible that dairy employees have social contact with poultry premises employees.

5. Recommendations to Mitigate Disease Spread Between Premises

The intensive, integrated, and specialized nature of the dairy industry results in biosecurity risks that are not completely avoidable, but these risks can be mitigated. Given that disease spread between dairy and poultry premises is multifactorial, mitigation measures that are integrated and target multiple risk factors are needed. The USDA Federal Order requires premovement testing for interstate movement of lactating dairy cattle (as of April 29, 2024) which greatly reduces the risk of premises-to-premises disease spread. Since 9 of 15 of the affected dairy herds in Michigan were closed herds which did not bring any new cattle into the herd, restriction of live cattle movements would not have prevented disease in these herds. Movement restrictions on cattle in some Michigan affected herds may result in serious animal welfare issues since these specialized operations do not have the facilities to manage all classes of dairy cattle and rely on an integrated network of operations to raise and manage the different classes of cattle. However, testing before moving cattle would help limit premises-to-premises transmission from cattle movement within the state and may identify additionally affected herds.

The biosecurity practices outlined in the Secure Milk Supply's "Enhanced Biosecurity Plan" include not moving cattle if possible, restricting visitors' access to the premises, cleaning and disinfecting vehicles and equipment moved on/off the premises – especially those having contact with cattle or cattle areas, requiring use of personal protective equipment and/or changing or cleaning and disinfecting footwear, and implementing a line of separation to mitigate virus movement; are all applicable in this event. In addition, reducing wild bird/animal exposure to unpasteurized or waste milk, cattle feed, and other areas of the premises, as is possible, would also mitigate this transmission route. The MDARD Director signed a "Determination of Extraordinary Emergency - HPAI Risk Reduction Response Order" on May 1, 2024 to further protect Michigan's poultry and livestock industries from the ongoing threat of the virus. The order requires dairy and poultry premises to implement the above biosecurity practices; prohibits all cattle from affected dairy herds and lactating or late pregnancy cattle from unaffected dairy herds from being exhibited until at least 60 days have passed with no new dairy detections; and prohibits all poultry from being exhibited until at least 30 days have passed with no new poultry detections. Implementation of this order will also greatly mitigate disease exposure and spread within the state.

Finally, testing dairy cattle as early as possible after onset of clinical signs or changes in production metrics within the herd (e.g., decreased milk production, decreased rumen motility) allows earlier detection of affected dairy herds and evaluation if the above mitigation measures can be implemented.

6. Conclusion

The investigations discussed in this report, including the respective WGS information, indicate that HPAI H5N1 genotype B3.13 was introduced into Michigan through animal movement and subsequently spread within the state between dairy premises with spillover into poultry premises through multiple possible routes. Factors that appear to be of greater risk for introduction into a dairy premises may be mitigated through enhanced biosecurity, increased animal testing, and potentially through within-state animal movement restrictions if they can be implemented without impacting animal welfare.

The willingness of Michigan producers to participate in these investigations has greatly increased the body of knowledge of HPAI H5N1 B3.13 detections in Michigan and throughout the nation; this report could not have been completed without them.

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