Summary Document

Rapid Qualitative Risk Assessment: The Risk to Dairy Cattle in Canada from Avian Influenza A(H5N1) in Dairy Cattle in the US

August 14, 2024

Note: The findings and conclusions represent the consensual, but not necessarily unanimous, opinions of the group participants and do not necessarily represent the views of the participants' respective organizations.

Key Findings

- Of the three pathways assessed, importation of dairy cattle is of higher concern compared to cattle transport trucks and wild migratory birds.
- Import conditions[1] in place since April 29, 2024, will likely mitigate most of the risk identified for lactating dairy cows.
    - Some residual risk remains due to:
        - The potential for a cow to be too early in the incubation period for detection by PCR, or a cow becoming infected after PCR testing. However, the incubation period is considered of very short duration and given the other import conditions, most of this residual risk should be mitigated.
        - These import conditions not applying to certain import categories of lactating dairy cattle (e.g., Canadian cattle returning to Canada).
- Residual risk may remain regarding the importation of non-lactating dairy cattle given these are currently not required to be tested prior to import. However, significant gaps in information remain at this time:
    - The susceptibility of non-lactating cattle to avian influenza A(H5N1) and subsequent shedding of an infectious dose.
    - The mode of transmission of the virus and the likelihood of non-lactating cattle becoming exposed and infected.
    - The proportion of lactating versus non-lactating dairy cattle that are imported into Canada.
- Although the risk from cattle transport trucks is currently of lower concern, information on the number and movements of cattle transport trucks between the US and Canada is needed to better assess this risk.
- Other key knowledge gaps relevant to Canada include:
    - The true prevalence of avian influenza A(H5N1) in dairy cattle in the US (including subclinical cases) in lactating vs non-lactating cattle.
    - The frequency and length of shedding of infectious virus in subclinical lactating cattle and in clinical and non-clinical non-lactating cattle.

[1] Trade implications for highly pathogenic avian influenza (HPAI) in dairy cattle - inspection.canada.ca

    - The modes of transmission of this virus both within and between farms.
    - The infectious dose for cattle.
    - The number and types of herds in the US that export dairy cattle to Canada.
- Filling these knowledge gaps will greatly help with the assessment of the risk and decrease the uncertainty.

Introduction

At approximately the beginning of February 2024, a decrease in milk production and other signs of disease in dairy cattle were first noted by dairy producers in Texas. On March 25, 2024, the United States Department of Agriculture (USDA) confirmed the first case of avian influenza A(H5N1) in dairy cattle in the United States (US) (USDA, 2024a). The virus was identified as Eurasian lineage goose/Guangdong clade 2.3.4.4b, the virus associated with the current Highly Pathogenic Avian Influenza (HPAI) panzootic. However, the specific genotype, B3.13, has not been reported from any other country (OFFLU, 2024). The outbreak is continuing in the US and as of August 14, 2024, there have been 190 confirmed cases in 13 states. Prior to this outbreak, cattle were not considered to be particularly susceptible to influenza A viruses and cases in dairy cattle in the US were unexpected.

To date, avian influenza A(H5N1) in dairy cattle has not been reported in Canada (CFIA, 2024a). However, as an emerging disease, there is a high level of uncertainty about the risk to dairy cattle in Canada and the possible routes through which this particular genotype of the virus could enter and expose dairy cattle in Canada. As a result, a rapid qualitative risk assessment (RQRA) process was initiated to help better understand the risk to dairy cattle in Canada and inform decisions regarding guidance for producers, and the development of infection prevention, control, and response policies.

This RQRA addresses the following specific risk questions:

1) **Retrospective**: What is the likelihood that at least one avian influenza A(H5N1)[2]-infected dairy cow[3] from the US entered Canada in the previous five months (December 1, 2023 to April 28, 2024)?

2) **Prospective**: What is the likelihood and impact of infection of at least one dairy cattle herd in Canada from avian influenza A(H5N1)2 infection in dairy cattle in the US over the next six months (April 29[4] to October 31, 2024), through:
    (a) Dairy cattle imported from the US
    (b) Wild migratory birds from the US
    (c) Cattle transport trucks from the US

[2] Avian influenza A(H5N1) refers to avian influenza A(H5N1) clade 2.3.4.4b, genotype B3.13, specifically
[3] The term "cow" in this instance refers to any bovine dairy calf, heifer, cow, steer, or bull
[4] As of April 29, 2024, all lactating breeding dairy cattle from the US are required to have a negative test for HPAI prior to import to Canada

Further information on the dairy industry in Canada and the current science on avian influenza A(H5N1) in dairy cattle can be found in Appendix A: Background.

Methods

A RQRA process was conducted from May to July 2024 with input from relevant experts from federal and provincial government, academia, veterinary associations, and industry, representing both animal (including wildlife) and public health. A Steering Committee led by the Deputy Chief Veterinary Officer, Canadian Food Inspection Agency (CFIA), helped formulate the risk questions. The assessment followed accepted RQRA methods using a modified Delphi approach (Nasa *et al.*, 2021; WHO-FAO-OIE, 2020; WOAH, 2010). The estimates used in this assessment can be found in Appendix B: Qualitative Estimates.

As an assessment based primarily on expert elicitation, it is important to note that there are several limitations with this method which may have affected the results. These limitations include differing levels of expertise for each risk question by different experts, limited experience with risk assessments by most experts, and some of the likelihood estimates likely capturing uncertainty as well as variability.

It is also important to note that RQRAs are intended to be iterative, and these estimates may be revised as further information becomes available.

Assumptions

- Current import requirements (e.g., testing requirements for lactating cattle) remain in place for the entire prospective time period.

Conclusions

Question 1: **Retrospective**: What is the likelihood that at least one avian influenza A(H5N1)[5]-infected cow[6] from the US entered Canada in the previous five months (December 1, 2023 to April 28, 2024)?

The likelihood of entry of avian influenza A(H5N1) genotype B3.13 via the importation of one dairy cow from the US during the period of December 1, 2023 to April 28, 2024 is **at most very low or low from states with USDA-confirmed cases** and **at most very low from other states**, with **moderate to high uncertainty**. However, this is the likelihood for each cow that is imported and does not take into account the number of animals imported during this time period.

Considering the volume of imported dairy cattle from the US during this time period (approximately 41 to 95 cows from affected states, and 1,003 to 1,345 from non-affected states), the likelihood that at least one infected cow entered Canada is estimated to be **high**, with **moderate to high uncertainty**.

Question 2: **Prospective**: What is the likelihood and impact of infection of at least one dairy cattle herd in Canada from avian influenza A(H5N1)2 in dairy cattle in the US over the next six months (April 29[7] to October 31, 2024), through:

[5] Avian influenza A(H5N1) refers to avian influenza A(H5N1) clade 2.3.4.4b, genotype B3.13, specifically

[6] The term "cow" in this instance refers to any dairy calf, heifer, cow, steer, or bull

[7] As of April 29, 2024, all lactating breeding dairy cattle from the US are required to have a negative test for HPAI prior to import to Canada

a) Dairy cattle imported from the US

The likelihood of infection of at least one dairy cattle herd in Canada with avian influenza A(H5N1) genotype B3.13 from direct or indirect contact with one dairy cow imported from the US is estimated to be **very low for the importation of a lactating dairy cow** but **low for the importation of a non-lactating animal**, from any state, with **high uncertainty**. Additional variability is explained by whether they develop clinical disease. Uncertainty in the estimate is due to not knowing the true prevalence of cases in the US, especially subclinical cases, limited information on the infectious dose for cattle, the amount of shedding by subclinical animals, and the modes of transmission. However, as mentioned for the retrospective question, this is the likelihood for one imported cow and does not take into account the total number of animals imported during this time period.

Considering the volume of dairy cattle likely to be imported from the US during this time period (estimated to be 235 from affected states and 5,160 from unaffected states), the likelihood that at least one infected cow will enter Canada and expose and infect at least one dairy herd in Canada is estimated to be **very high**, with **moderate to high uncertainty**.

b) Wild migratory birds from the US

The likelihood of infection of at least one dairy cattle herd in Canada with avian influenza A(H5N1) genotype B3.13 from direct or indirect contact with an infected wild migratory bird from the US during this time period is estimated to be **at most very low to low**, with **moderate uncertainty**. This is due to a very low to low likelihood that a wild migratory bird in the US is currently infected with this genotype. The variability is explained by the bird species involved in migration, the season, and farm management practices. Uncertainty in the estimate was due to no information on the infectious dose for cattle and limited information on the survival of the virus in feed.

c) Cattle transport trucks from the US

The likelihood of infection of at least one dairy cattle herd in Canada with avian influenza A(H5N1) genotype B3.13 from direct or indirect contact with a cattle transport truck from the US is estimated to be **at most low**, with **high uncertainty**. This is due to a low likelihood that a truck is contaminated with virus and a low likelihood that a cow has contact with a contaminated truck. The variability is explained by the season and environmental conditions. Uncertainty in the estimate was due to limited information on the movement of transport trucks between the US and Canada and no information on the infectious dose for cattle.

Assuming the infection of a dairy herd in Canada, the **most likely outcome resulting from this infection is that the virus spreads to other herds in the province** (beyond the local area) but not to other provinces. The likelihood of this outcome occurring is **moderate**, with **high uncertainty**. The **magnitude of the effects** on dairy cattle health as well as to other sectors such as public health, wildlife, and other livestock sectors in Canada with this outcome **is expected to be moderate**, with serious and substantive consequences on the health of the population and industry/health system, but usually reversible.

Impacts on the dairy industry include animal health and welfare concerns, trade and economic impacts, and public concern about the safety of dairy products. A positive impact includes increased infection prevention and control measures which may decrease the impact from other infectious diseases.

Impacts on public health include disease in workers and others in contact with infected dairy cattle or their products. There are also potential food safety concerns, especially with raw milk, raw milk cheeses, and undercooked meat. Although at this time, there are no reports of human infections resulting from consumption of these products. With more affected herds there is the need for more public health resources for follow-up and also the increasing likelihood of the development of a virus with pandemic potential.

It would also be expected that there would be impacts to other animals on the farms, including both domestic animals (e.g., cats and livestock) and wildlife (both wild birds and mammals). There is the risk for spread to poultry farms, as seen in the US, and spread to swine farms is also a concern due to their ability to be a 'mixing vessel'. If at-risk wildlife species became infected or important wildlife habitats were affected, this could have a significant impact on wildlife health in Canada. Increased spread among mammalian species, especially those in closer contact with humans, could allow for increased opportunities for mammalian adaptation and risks to public health.

Importantly, impacts to public health, wildlife, and other livestock sectors, depends on how quickly an affected farm is detected, the specific type of farm, and the control measures implemented and followed. If dairy herds in multiple provinces became infected, control would be much more difficult.

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Appendix A: Background

The Canadian Dairy Industry

In 2023 in Canada, there were a total of 9, 443 dairy farms with 969, 500 dairy cows[8] and 412, 500 dairy heifers[9] (AAFC, 2023). The dairy industry produced 95.9 million hectoliters of milk, with net cash farm receipts totaling $8.56 billion (second leading agriculture industry after red meat). The Canadian dairy sector operates under a supply management system, with planned domestic production and pricing and import controls. Dairy farms are located across the 10 provinces (*Table 1*), with the highest number of farms in Quebec and Ontario. The average herd size in Canada is approximately 100 cows. The national herd is comprised primarily of Holsteins (93%), which produce approximately 37L of milk/day.

Table 1: Number of dairy farms in Canada by province, 2023 (AAFC, 2023)

Year	Province										Canada
	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
2023	437	477	150	232	3,233	4,384	164	198	145	23	9,443

Approximately 60% of dairy herds in Canada are housed in tie-stalls and 40% in free-stalls, although there are regional differences, with approximately 90% in tie-stalls in Quebec and almost 100% in free-stalls in western Canada. In tie-stalls, cows live and are milked in the stall, although should be allowed daily access to an exercise area. In free-stalls, cows can mix freely and are milked in a parlor. Cows are milked 2-3 times/day, every day that they are lactating. The dairy cow production cycle is dynamic, with animals regularly moving in and out of the milking herd and being replaced by new animals. Approximately 1/3 of the herd is replaced each year.

Dairy Farmers of Canada operate a national quality assurance program, proAction, which is mandatory for all Canadian dairy farms (DFC, 2024). The proAction program consists of six components: milk quality, food safety, animal care (animal welfare), traceability (animal ID and movement), biosecurity (infectious disease control), and environment. Through this program, bulk tank milk samples are routinely collected at milk pickup (every day or every other day) and tested for milk quality and safety as well and for payment purposes. In addition, regular farm inspections are conducted to ensure proper animal welfare and biosecurity programs are in place.

The Current Science on Influenza A(H5N1) in Dairy Cattle

Cases in Dairy Cattle

- Since the end of March 2024, the number of affected dairy cattle herds in the US has increased on a weekly basis. As of August 14, 2024, there have been a total of 190 dairy cattle herds infected with avian influenza A(H5N1) in thirteen states (Idaho [30], Colorado [63], Michigan [27], Texas [24], Iowa [13], New Mexico [8], Minnesota [9], South Dakota [7], Kansas [4], North Carolina [1], Ohio [1], Oklahoma [2], and Wyoming [1]) (USDA, 2024a). Updated information on the number of affected herds can be found on the USDA website.

[8] In this instance, cow is referring to an adult female animal that has given birth to a calf previously
[9] A heifer is a young female animal that is pregnant with her first calf

- Clinical signs in dairy cattle can include a significant decrease in milk production with changes in the milk (e.g., colostrum-like milk), anorexia and decreased rumen motility, changes in manure consistency, fever, respiratory signs including clear nasal discharge, and abortion (USDA, 2024a). Subclinical infections have also been reported.
- Approximately 10% of a herd is affected on average (range 3-40%), but mortalities (including culling) are only 2% or less (Caserta *et al.*, 2024; Durst, 2024; USDA, 2024b). Clinical signs last an average of 6 days (range 0-17 days) but milk drop lasts an average of 8 days (0-15 days). On one farm, the average daily milk production dropped by 5 lbs for the first nine days of the outbreak, and by day 12 the decrease in milk production was 21 lbs less than the average of 95-100 lbs per cow per day (Durst, 2024). Most of the cattle (approximately 95%) return to near normal production. However, within-herd transmission is still being understood and to date, relatively few herds have been cleared of infection.

Cases in Humans

- As of July 31, 2024, there have been four human cases of A(H5N1) associated with contact with infected (or likely infected) dairy cattle in the US: one in Texas reported on April 1, 2024, two in Michigan reported on May 22 and 30, 2024, and one in Colorado reported on July 3, 2024 (CDC, 2024; Garg *et al.*, 2024; Uyeki *et al.*, 2024). Symptoms in three of the cases were restricted to conjunctivitis/eye symptoms, however the third case also had respiratory signs. Treatment included antiviral medication and isolation. All cases recovered.
- To date, there has also been 9 cases of this genotype in poultry workers in Colorado working on two separate farms. The cases all had mild symptoms (conjunctivitis and respiratory signs) and are recovering with antiviral drug treatment (oseltamivir). The poultry farms are believed to have acquired the infection from nearby affected dairy farms.
- The US Centers for Disease Control and Prevention (CDC) has assessed the risk to the US general public from avian influenza viruses as low, although higher for those who have contact with infected birds or animals, including cows (CDC, 2024).

Cases in Other Animals

- Cases in other animals on the affected farms, such as cats, wild birds, and wildlife (e.g. raccoons, skunks, opossums, and foxes) have also been reported (USDA, 2024a). Cats on affected farms fed raw colostrum/milk developed acute neurologic disease as well as blindness and had an approximately 50% mortality rate (Burrough *et al.*, 2024). Wild birds found dead on the farms have been reported to include pigeons/doves, grackles/blackbirds, and starlings.
- USDA has reported lateral transmission from affected dairy herds to nearby poultry flocks based on epidemiologic and genomic analysis (USDA, 2024a). Genotype B3.13 has also been reported in alpacas, and mice on an infected poultry farm, both thought to be due to spillover from affected dairy farms (USDA, 2024a; c).

Transmission

- Based on epidemiologic and genomic analysis, current evidence suggests a single spillover event from wild birds, likely in December 2023, with subsequent cow-to-cow transmission (Caserta *et al.*, 2024; Nguyen *et al.*, 2024; USDA, 2024a). Prior to being identified in cattle, this genotype was detected in a Canada goose from Wyoming (January 2024), a peregrine falcon from California (February 2024), and a skunk in New Mexico (February 2024). It has also been detected in wild peridomestic birds (e.g., starlings) on affected cattle farms.

- Epidemiological information indicates that spread between farms is now multifactorial due to dairy cattle movements (including apparently healthy cattle), shared equipment and personnel, frequent visitors, and potentially other animals on the farm acting as fomites (USDA, 2024a).
- Infected cows may shed virus in milk for up to 2-3 weeks. Viral RNA was still detectable in some animals on days 16 and 31 post-clinical diagnosis, but infectious virus could only be recovered on day 3 (Caserta *et al.*, 2024).
- H5N1 virus in unpasteurized milk has been found to remain infectious on stainless steel and rubber for more than 1 hour, indicating a risk of spread to cattle and workers through milking equipment (Le Sage *et al.*, 2024).

Diagnostics

- In a recent study, virus RNA was detected consistently in milk samples for up to 31 days but also sporadically in nasal swabs, whole blood, serum, and urine from affected cattle at 3 days after onset, as well as non-clinical animals (Caserta *et al.*, 2024). Virus was isolated from lung, lymph nodes, trachea, small intestine, mammary glands, spleen, colon, and heart, with high tropism of the virus for the mammary gland of infected cows. Seroconversion was seen in paired serum samples from affected cows.

Virus Characteristics

- The virus has been identified as H5N1, Eurasian lineage goose/Guangdong clade 2.3.4.4b, the virus associated with the current HPAI panzootic (Caserta *et al.*, 2024; Nguyen *et al.*, 2024). It is a B3.13 genotype, which resulted from a reassortment between genotype B3.6 or B3.7 and a low pathogenic avian influenza virus. Genotype B3.13 has not been reported from any other country (OFFLU, 2024).
- The last two genes to be incorporated in the B3.13 virus genome prior to its spillover to cattle were PB2 and NP, suggesting that incorporation of these genes could have resulted in a host range expansion (Caserta *et al.*, 2024).

US Retail Milk Sampling/Food Safety Studies

- The USDA announced on May 1, 2024, that no virus was detected by polymerase chain reaction (PCR) in 30 retail beef samples. H5N1 virus particles were detected in a muscle sample from one dairy cow out of 109 condemned cull dairy cows sampled at select USDA-inspected facilities (USDA, 2024d).
- The US Food and Drug Administration (FDA) found the presence of HPAI by PCR testing in 1 in 5 pasteurized retail milk samples (FDA, 2024). The samples were collected at retail locations in 17 states, representing products produced at 132 processing locations in 38 states. Testing included PCR screening, followed by egg inoculation testing on samples positive for H5N1 viral nucleic acid. Final results from the FDA's national commercial milk sampling study have found all 297 samples to be negative for viable virus.

Key US and Canada Control Measures

US

- As of April 29, 2024, the US requires mandatory testing for the interstate movement of lactating dairy cattle and mandatory reporting of positive results to USDA (USDA, 2024e).

Canada

- HPAI is a federally reportable disease in any species, including cattle (CFIA, 2024b).

- As of April 29, 2024, Canada requires testing for HPAI with negative result on imported lactating breeding dairy cattle from the US (CFIA, 2024c). This includes a requirement to not have been exposed to HPAI in the past 60 days or, if from an affected herd, a 60 day waiting period with a negative test result.
- As of May 24, 2024, Canada requires an export certificate for lactating dairy cattle imported from the U.S. for immediate slaughter (CFIA, 2024d). This includes a requirement to not have been exposed to HPAI in the past 30 days or, if from an affected herd, a 30 day waiting period with a negative test result.

Appendix B: Qualitative Estimates

The following tables provide descriptive definitions for the qualitative estimates used in this assessment. Table 2 defines the likelihood (qualitative) and probability (quantitative) estimates and Table 3 defines the uncertainty estimates. Table 4 defines the estimates of the magnitude of the effects, which can be used for multiple levels (e.g., local effects, regional effects, national effects).

Table 2 – Likelihood Definitions[10]

Likelihood of event occurring	Descriptive Definition	Subjective probability scale of event occurring	Likelihood of event NOT occurring	Subjective probability scale of event NOT occurring
Almost certain	The situation described in the question is almost certain to occur.	99 – 100%	Negligible	0 – 1%
Very high	The situation described in the question is very likely to occur.	90 – 99%	Very low	1 – 10%
High	The situation described in the question is likely to occur.	66 – 90%	Low	10 – 33%
Moderate	The situation described in the question is about as likely as not to occur	33 – 66%	Moderate	33 – 66%
Low	The situation described in the question is unlikely to occur.	10 – 33%	High	66 – 90%
Very low	The situation described in the question is very unlikely to occur.	1 – 10%	Very high	90 – 99%
Negligible	The situation described in the question is almost certain not to occur but could occur under exceptional circumstances. The likelihood is virtually zero.	0 – 1%	Almost certain	99 – 100%

[10] Adapted from: Tripartite JRA Operational Tool; CFIA Animal Health Risk Assessment Methodology; and Table 2 in EFSA Panel on Animal Health Welfare, Nielsen SS, Alvarez J, Bicout DJ, Calistri P, Canali E,[…] Michel V, 2021. Welfare of sheep and goats at slaughter. 19(11): e06882.

Table 3 – Uncertainty categories[11]

Uncertainty category	Interpretation
Low	There are reliable data and information available; strong evidence is provided in multiple references, and authors report similar conclusions. Several experts have multiple experiences of the event, and there is a high level of agreement between experts.
Moderate	There are some gaps in availability or reliability of data or information; evidence is provided in a small number of references, and/or authors report conclusions that vary from one another. Experts have limited experience of the event and/or there is a moderate level of agreement between experts.
High	There are scarce or no reliable data or information available, and/or authors report conclusions that vary considerably between them. Very few experts have experience of the event and/or there is a very low level of agreement between experts. Results are based on educated guess or crude speculation.
Too high to allow assessment	The estimate is just as likely to be negligible as high, and estimates would not provide any useful information to risk managers at this stage. [If at least half of voters choose this option, then no estimates will be reported for that component of the pathway, though other components of the pathway may still be estimated to provide a maximum estimate for the overall pathway.]

Table 4 – Description of the magnitude of the effects[12]

Magnitude of the effect	Description of the effect
Indiscernible	Not usually distinguishable from normal day-to-day variation
Minor	Recognisable, but marginal, insignificant and/or reversible
Moderate	Serious and substantive consequences on the health of the population and health system, but usually reversible
Severe	Extremely serious and/or irreversible

[11] Adapted from: Tripartite JRA Operational Tool; and Fournie G, Jones BA, Beauvais W, Lubroth J, Njeumi F, Cameron A & Pfeiffer DU, 2014. The risk of rinderpest re-introduction in post-eradication era. *Prev Vet Med* 113 (2): 175-184.

[12] Adapted from: Tripartite JRA Operational Tool; and Biosecurity Australia, 2009. Draft Import risk analysis report for horses from approved countries: final policy review [Internet]. Available at: http://www.daff.gov.au/__data/assets/pdf_file/0018/1410651/2009_28_Horses_draft_IRA_report.pdf