

# RAPID QUALITATIVE RISK ASSESSMENT (RQRA): SARS Coronavirus 2 (SARS-CoV-2) in Livestock

Iteration #2: September 30, 2020

## Summary

**The primary route for exposure of humans to SARS-CoV-2 is via other humans. It is unlikely that livestock animals play a major role in the spread of this predominantly human disease. However, there is currently a lot of uncertainty related to infection in animals other than humans.** For the purpose of this assessment, “livestock” has been defined as: pigs, poultry, ruminants and horses.

Several experimental studies have been conducted on pigs, poultry, and cattle (Berhane et al., 2020; Meekins et al., 2020; Pickering et al., 2020; Schlottau et al., 2020; Shi et al., 2020; Suarez et al., 2020; Ulrich et al., 2020), and some field surveys have included livestock species (Agence Fédérale pour la Sécurité de la Chaîne Alimentaire, 2020; Deng et al., 2020). All studies on poultry have found that they are not susceptible to SARS-CoV-2. Some studies have shown limited susceptibility in experimentally-infected pigs and cattle, but with no shedding of live virus or transmission to in-contact animals.

It is likely that additional evidence related to infection in livestock, whether positive or negative, will be forthcoming. As a result, this iterative rapid qualitative risk assessment (RQRA) process was initiated. It is intended to inform immediate decisions regarding guidance for producers, and the development of infection prevention, control and response policies. An Emergency Collective Expert Appraisal Group was formed, consisting of volunteers from federal, provincial and territorial departments of public and animal health, veterinary associations and academia. The group meets regularly to discuss updated information and its effect on the risk.

The assessment makes a number of assumptions, including that the source of exposure of livestock would be an infected human, and that the context for the assessment is the current pandemic situation. The animal health component focusses on the risks associated with animal infection and does not evaluate potential animal health and welfare impacts associated with the pandemic in general, such as possible disruptions to the industry. The assessment results could be updated as more information becomes available.

---

*[This assessment was conducted by a multi-jurisdictional Emergency Collective Expert Appraisal Group. The methodology is intended to be used in situations where policy decisions need to be made in the face of high uncertainty. Given the minimal data available on surveillance, research, epidemiology and risk behaviours specifically related to SARS-CoV-2 in animals, the assessment was primarily informed by the group’s collective professional knowledge on such topics as infectious diseases, virology, epidemiology, industry practices, and human-animal interactions. Assumptions, and sources of variability and uncertainty are detailed in the document. The findings and conclusions represent the consensual, but not necessarily unanimous, opinions of the group participants, and do not represent the views of the participants’ respective organizations.]*

Figure 1 describes the scenario pathway for this assessment:

1. In order to become infected, livestock must first be exposed to an infectious dose of the virus through direct or indirect contact with an infected human, and the animal must be susceptible to developing infection.
2. If livestock are exposed and infected, transmission of the virus to a susceptible human via contact is dependent on the infected animal shedding a sufficient amount of the virus in respiratory secretions, vomit, feces, or other bodily fluids, and then having sufficient direct or indirect contact with a non-infected human.
3. Transmission via food, in this scenario, requires that infectious virus be present in the meat, edible tissues, milk or eggs of an infected animal. This is not a complete food safety assessment, and the scope does not include other downstream factors, such as production or consumer controls, or other scenarios, such as cross-contamination from infected food workers.

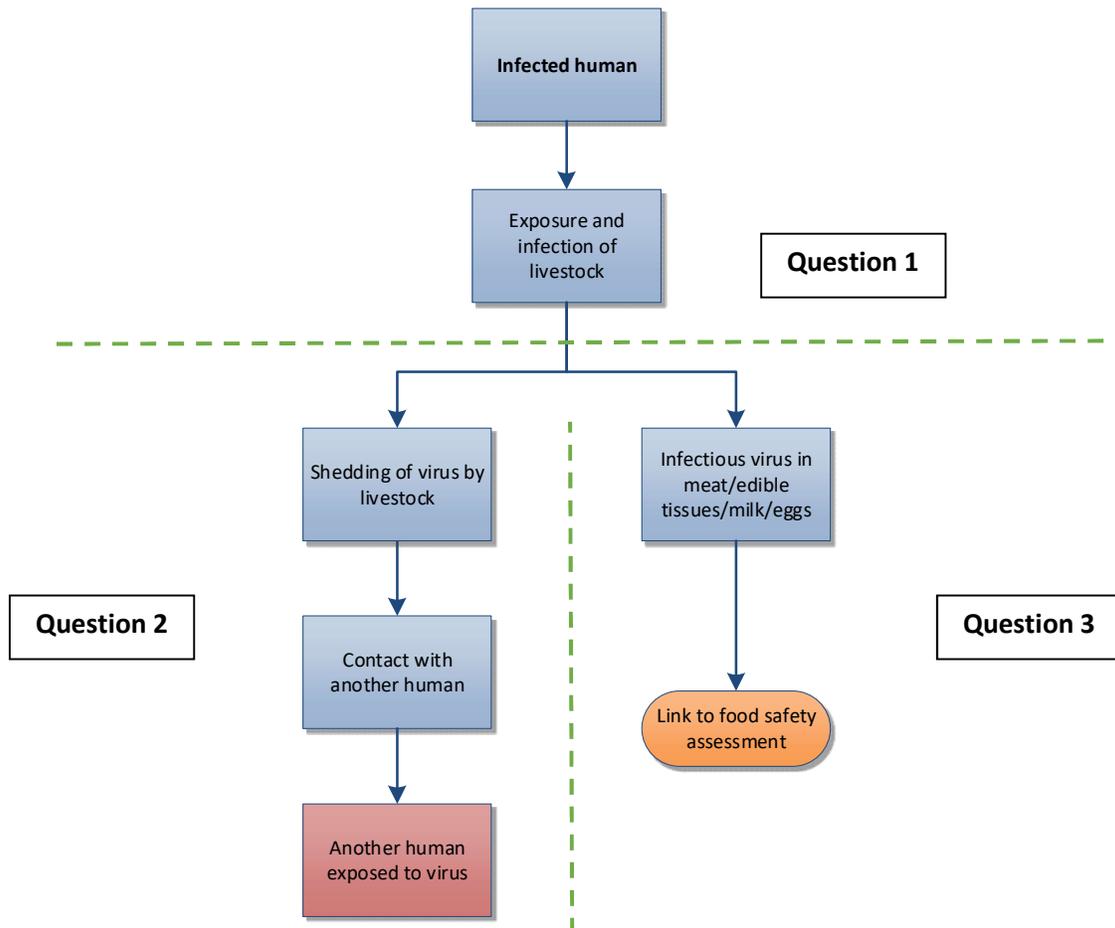


Figure 1: Scenario pathway illustrating the potential infection of livestock with SARS-CoV-2, and potential subsequent exposure of susceptible humans. The dashed lines indicate the focus of different risk questions.

This assessment addresses the following specific risk questions:

**Question 1: What is the probability of exposure of Canadian livestock to SARS-CoV-2, and subsequent infection, through direct or indirect contact with infected humans (i.e., human-livestock transmission), and what is the resulting animal health impact at the national level?**

The probability of the exposure and infection of Canadian livestock to SARS-CoV-2 from infected humans is:

- **Most likely very low for pigs**, but ranging from negligible to low due to variability. Experimental studies suggest no or very little susceptibility, and the lack of reports of natural infection in the face of the ongoing pandemic supports these experimental findings. The uncertainty is moderate.
- **Most likely negligible for poultry**. All studies conducted so far are in agreement that birds are not susceptible to infection, and the lack of reports of natural infection in the face of the ongoing pandemic supports these experimental findings. The uncertainty is low.
- **Most likely very low for ruminants**, but ranging from negligible to low due to variability. There are very few experimental study results with SARS-CoV-2 in these animals, but there has been a lack of reports of natural infection in the face of the ongoing pandemic and some field testing has revealed negative results. Studies with the related virus, SARS-CoV, also suggested a lack of susceptibility of ruminants. The uncertainty is high.
- **Most likely very low for horses**, but ranging from negligible to low due to variability. There have not yet been any experimental study results with SARS-CoV-2 in these animals, but there has been a lack of reports of natural infection in the face of the ongoing pandemic. The uncertainty is high.

If one of these animals were to become infected, they are unlikely to spread infection to a large number of animals because they are unlikely to shed any significant amount of virus. In addition, clinical signs, if any, would likely be mild. **The overall national-scale impact on animal health of this scenario is therefore considered to be negligible to very low.**

Variability in the estimate is dependent on risk factors, such as: type of farm and level of biosecurity, use of the animal (in the case of horses), exposure dose and host-related factors. Commercial farms typically have limited human-to-animal contact. Key uncertainties that will affect the probability estimate include: infectious dose, and the probability of infection of the animal.

**Question 2: What is the probability of exposure of humans to SARS-CoV-2 in Canada through direct or indirect contact with livestock (i.e., human-livestock-human transmission), and what is the resulting human health impact at the national level?**

SARS-CoV-2 is primarily a human disease. The probability of human exposure to SARS-CoV-2 from infected livestock in Canada is first dependent on the livestock becoming infected from exposure to an infected human, as in question 1. The animal must then shed sufficient virus, and have sufficient exposure to a susceptible human, to transmit the infection. The probability of this overall pathway (i.e., human-animal-human transmission) is:

- **Most likely very low for pigs**, but ranging from negligible to very low due to variability. In one study, some pigs shed low levels of viral RNA for short periods of time, but no live virus was detected. Even studies with SARS-CoV suggest very little, if any, shedding. The uncertainty is moderate.
- **Most likely negligible for poultry**. All studies conducted so far are in agreement that birds are not susceptible to infection; therefore, the probability of shedding and infectious contact were considered not applicable. The uncertainty is low.
- **Most likely very low for ruminants**, but ranging from negligible to low due to variability. There are very few experimental study results related to shedding of SARS-CoV-2 in these animals, but the likelihood of infection is considered very low as mentioned in question 1. The uncertainty is high.
- **Most likely very low for horses**, but ranging from negligible to low due to variability. There have not yet been any experimental study results related to shedding of SARS-CoV-2 in these animals, but the likelihood of infection is considered very low as mentioned in question 1. The uncertainty is high.

Given the current context of a global pandemic, with a vast number of cases resulting from exposure to sources other than livestock, **the overall national-scale impact on human health associated with this hazard is considered to be negligible to low**. The impact could be higher in cases involving highly susceptible individuals, though, on average, these individuals are less likely to have contact with livestock than with companion animals.

Variability in the estimate is dependent on risk factors, such as: type of farm and level of biosecurity, use of the animal (in the case of horses), exposure dose, host-related factors, and the occupation of the person (i.e., general public versus veterinarians). The probability of a person being infected by another person is notably higher than any probability of being infected via livestock. Key uncertainties that will affect the probability estimate include: infectious dose, and the probability of infection and shedding of an infectious dose by the animal.

### **Question 3: What is the probability of the presence of infectious (SARS-CoV-2) virus in the meat, edible tissues, milk or eggs of livestock at the beginning of processing?**

In order to inform food safety risk assessments, the probability of SARS-CoV-2 presence in meat, edible tissues, milk or eggs at the beginning of processing was examined. As with question 2, this is first dependent on the livestock becoming infected from exposure to an infected human. The virus must then be present in sufficient quantities in certain parts of the infected animal. The probability of this scenario is:

- **Most likely negligible for pigs**, but ranging from negligible to very low due to variability. Even if one of these animals becomes infected, systemic infection and spread beyond respiratory and gastrointestinal tracts is unlikely. The uncertainty is moderate.
- **Most likely negligible for poultry**. All studies conducted so far are in agreement that birds are not susceptible to infection; therefore, the probability of virus being present in meat, edible tissues or eggs was considered not applicable. The uncertainty is low.

- **Most likely very low for ruminants**, but ranging from negligible to low due to variability. Even if one of these animals becomes infected, systemic infection and spread beyond respiratory and gastrointestinal tracts is unlikely. The uncertainty is high.

In addition to the sources of variability and uncertainty listed above, there is uncertainty associated with the pathophysiology of infection in these species, especially ruminants.

## References

- Agence Fédérale pour la Sécurité de la Chaîne Alimentaire, 2020. Risque zoonotique du SARS-CoV2 (Covid-19) associé aux animaux de compagnie : infection de l'animal vers l'homme et de l'homme vers l'animal. Available at: <http://www.afsca.be/comitescientifique/avis/2020/> (last accessed 31 March 2020).
- Berhane Y, Suderman M, Babiuk S & Pickering BS, 2020. Susceptibility of turkeys, chickens and chicken embryos to SARS-CoV-2 virus. *Authorea Pre-Prints* <https://doi.org/10.22541/au.159620977.72227010>.
- Deng J, Jin Y, Liu Y, Sun J, Hao L, Bai J,[...] Tian K, 2020. Serological survey of SARS-CoV-2 for experimental, domestic, companion and wild animals excludes intermediate hosts of 35 different species of animals. *Transboundary & Emerging Diseases* <https://doi.org/10.1111/tbed.13577>.
- Meekins DA, Morozov I, Trujillo JD, Gaudreault NN, Bold D, Artiaga BL,[...] Richt JA, 2020. Susceptibility of swine cells and domestic pigs to SARS-CoV-2. *BioRxiv* <https://doi.org/10.1101/2020.08.15.252395>.
- Pickering BS, Smith G, Pinette MM, Embury-Hyatt C, Moffat E, Marszal P & Lewis CE, 2020. Susceptibility of domestic swine to experimental infection with SARS-CoV-2. *BioRxiv* <https://doi.org/10.1101/2020.09.10.288548>.
- Schlottau K, Rissmann M, Graaf A, Schön J, Sehl J, Wylezich C,[...] Beer M, 2020. Experimental transmission studies of SARS-CoV-2 in fruit bats, ferrets, pigs and chickens. *The Lancet Pre-Print*: [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3578792](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3578792).
- Shi J, Wen Z, Zhong G, Yang H, Wang C, Liu R,[...] Bu Z, 2020. Susceptibility of ferrets, cats, dogs, and different domestic animals to SARS-coronavirus-2. *BioRxiv* <https://doi.org/10.1101/2020.03.30.015347>.
- Suarez DL, Pantin-Jackwood MJ, Swayne DE, Lee SA, DeBlois SM & Spackman E, 2020. Lack of susceptibility of poultry to SARS-CoV-2 and MERS-CoV. *BioRxiv* <https://doi.org/10.1101/2020.06.16.154658>.
- Ulrich L, Wernike K, Hoffmann D, Mettenleiter TC & Beer M, 2020. Experimental infection of cattle with SARS-CoV-2. *BioRxiv* <https://doi.org/10.1101/2020.08.25.254474>.

## Appendix: Definitions of qualitative estimates

Table 1 - Likelihood Definitions

Likelihood of event occurring	Descriptive Definition	Likelihood of event NOT occurring
<b>Negligible</b>	The likelihood of the event is virtually zero	High
<b>Very low</b>	The event is very unlikely	Moderate
<b>Low</b>	The event is unlikely	Low
<b>Moderate</b>	The event is fairly likely	Very low
<b>High</b>	The event is likely	Negligible

Table 2 – Uncertainty categories<sup>1</sup>

Uncertainty category	Interpretation
<b>Low</b>	There are solid and complete data available; strong evidence is provided in multiple references; authors report similar conclusions. Several experts have multiple experiences of the event, and there is a high level of agreement between experts.
<b>Moderate</b>	There are some but not complete data available; evidence is provided in a small number of references; 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.
<b>High</b>	There are scarce or no data available; evidence is not provided in references but rather in unpublished reports or based on observations, or personal communication; 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.

Table 3. Description of the magnitude of the effects

Magnitude of the effect	Description of the effect
<b>Indiscernible</b>	Not usually distinguishable from normal day-to-day variation
<b>Minor</b>	Recognisable, but minor and/or reversible
<b>Significant</b>	Serious and substantive, but usually reversible
<b>Severe</b>	Extremely serious and/or irreversible

<sup>1</sup> Source: 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.

Table 4. Guidelines for determining the overall, national-scale impact of establishment and/or spread<sup>2</sup>

Overall impact	Description of impact
<b>Extreme</b>	The effects are likely to be severe at the national level. Implies that economic stability, societal values or social well-being would be significantly affected.
<b>High</b>	The effects are likely to be significant at the national level and severe within affected zones. Implies that the effects would be of national concern. However, significant effects on economic stability, societal values or social well-being would be limited to a given zone.
<b>Moderate</b>	The effects are likely to be minor on a national level and significant within affected zones. The effects are likely to be severe for directly affected parties.
<b>Low</b>	The effects are likely to be minor within affected zones and significant to directly affected parties. The effects are likely to be minor at the national level.
<b>Very low</b>	The effects are likely to be minor to directly affected parties. The effects are likely to be indiscernible at any other level.
<b>Negligible</b>	The effects are likely to be indiscernible at any level within Canada.

<sup>2</sup> Modified from: 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](http://www.daff.gov.au/__data/assets/pdf_file/0018/1410651/2009_28_Horses_draft_IRA_report.pdf) (last accessed 2014-04-04).