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ANIMAL HEALTH **RISK ANALYSIS** MANAGEMENT No. **2**

# RECOMMENDATIONS FOR THE EPIDEMIOLOGICAL INVESTIGATION OF SARS-CoV-2 IN EXPOSED ANIMALS

## *SARS-CoV-2 detection in farmed and companion animals*


### SUMMARY

- SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) is a zoonotic virus that has been shown to infect susceptible animal species, including farmed and companion animals.
- In the ongoing COVID-19 pandemic, direct and indirect exposure of animals to infected humans when sharing the same space comes as no surprise.
- Findings of viral RNA (ribonucleic acid) in dogs, cats and ferrets from households of human COVID-19 cases, farmed mink as well as big cats and gorillas kept in zoos, have raised concerns about the possible role of animals in amplifying and spreading the virus.
- These recommendations aim to assist national authorities and research institutions to systematically investigate and describe SARS-CoV-2 infection in susceptible farmed and companion animals exposed to COVID-19 human cases or other infected animals.
- The goal is to improve understanding of SARS-CoV-2 infection parameters and risk factors in field situations and adapt suitable risk mitigation measures related to animals.


### BACKGROUND

Acknowledging the zoonotic nature of SARS-CoV-2, investigations conducted into potential animal hosts as a consequence of pandemic spread in humans are very important to the overall study of the virus and to identify possible zoonotic and inter-animal species transmission. In the ongoing COVID-19 pandemic, direct and indirect exposure of animals sharing the same space with infected humans is no surprise. Positive findings in animals by detecting viral RNA in dogs, cats and ferrets from households of COVID-19 human cases, as well as farmed mink and big cats and gorillas at zoos (OIE, 2021) have raised concerns about the possible role farmed and companion animals play in amplifying and spreading the virus and establishing reservoirs in the vicinity of humans. Animal infection studies are ongoing in several laboratories around the world and results published so far suggest that SARS-CoV-2 efficiently replicates in ferrets, cats (Shi *et al.*, 2020) and rabbits (Mykytyn *et al.*, 2021), replicates poorly in dogs, pigs (Shi *et al.*, 2020) and cattle (Ulrich *et al.*, 2020), but does not

replicate in chickens, ducks, geese, turkey and quail (Suarez *et al.*, 2020). Genome analysis strongly suggests zoonotic spillover of SARS-CoV-2 from farmed mink to humans in the Netherlands and Poland (Oreshkova *et al.*, 2020; Rabalski *et al.*, 2021). Other studies looking at ACE-2 receptor presence in different animal species hypothesized the susceptibility of some farmed animal species to SARS-CoV-2 (El Masry *et al.*, 2020).

While these findings help restrict the range of animal species that could act as SARS-CoV-2 hosts, only field studies that demonstrate viral shedding and isolate the virus from several individuals of a presumed host species under settings of natural transmission will confirm hypotheses from laboratory studies. Furthermore, the extensive and extended circulation of SARS-CoV-2 among humans resulted in the emergence of significant mutations and variants associated with increased infection and transmission between humans (CDC, 2021). One of those mutations (D614G) has been shown to replicate at a higher rate on ex-vivo cattle and sheep respiratory tissues (Di Teodoro *et al.*, 2020), whereas B1.351 and P.1 variants, unlike the initial virus, could infect and replicate to high titers in the lungs of common laboratory mice under experimental settings (Montagutelli *et al.*, 2021). Such mutations and variants will continue to emerge and add further complexity to the epidemiological situation in animals, so field studies are needed as a short-term priority, while virus circulation in humans is ongoing in different parts of the world. Using a One Health approach to conduct epidemiological investigations is recommended for events where susceptible farmed, companion and wild animals are in close contact with confirmed human COVID-19 cases, or where animals tested SARS-CoV-2 positive in the absence of information on the infection status of in contact humans. By jointly analysing laboratory and epidemiological information on human and animal cases collected by public health and veterinary services, so-called four-way linking, will greatly enhance our understanding of the epidemiology of COVID-19 and potential transmission between humans and animals.


*Natural SARS-CoV-2 infection has been reported in different species of family mustelidae including otters, ferrets and mink.*

## PURPOSE AND OBJECTIVES OF THE RECOMMENDATIONS

FAO developed this document in consultation with international experts for use by veterinary services or research institutions in countries seeking to investigate SARS-CoV-2 animal infections using a One Health approach. By adopting these recommendations widely it will be possible to compare and analyse data from different countries and geographical regions, nationally, regionally and globally.

The recommendations on epidemiological investigations should be used in conjunction with the World Organisation for Animal Health (OIE) and the Food and Agriculture Organization of the United Nations (FAO) SARS-CoV-2 animal sampling and testing guidance. The list of potentially susceptible species for sampling is based on FAO's SARS-CoV-2 Exposure Risk Assessment.

***Overall objective***

- Investigate and describe SARS-CoV-2 infection in susceptible farmed and companion animals exposed to COVID-19 human cases or other infected animals living in the same setting or other establishments to improve understanding of infection parameters and risk factors in field situations and adapt animal risk mitigation measures (see Annex 4).

***Specific objectives***

- Investigate the extent of SARS-CoV-2 infection among susceptible farmed and companion animals exposed to SARS-CoV-2 by COVID-19 human cases or animals living in the same setting or other establishments.
- Describe the clinical picture of SARS-CoV-2 infection in farmed and companion animals according to species, breed, age, sex and other characteristics (including co-morbidities).
- Describe SARS-CoV-2 infection parameters observed in farmed and companion animals by estimating: incubation period, duration of infection, shedding levels, shedding routes and transmission modes.
- Identify factors (including behaviours and practices) enhancing or reducing the exposure and spread of the infection in farmed and companion animals.

Supplementary recommendations for studies to investigate camel susceptibility to SARS-CoV-2 and the potential recombination of MERS-CoV and SARS-CoV-2 or other coronaviruses in camels are available and provide guidance through One Health field epidemiology investigations and laboratory protocols to detect recombination of Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and SARS-CoV-2 or other coronaviruses in camels. Dromedary camels are the main reservoir species for MERS-CoV and have been shown to be infected by other human or animal CoVs as well. With the pandemic spread of SARS-CoV-2 in humans, it is not a matter of if, but rather when, camels will be exposed to SARS-CoV-2.


*A small number of pets worldwide, including cats, have been reported to be infected with SARS-CoV-2 after close contact with people with COVID-19.*

**Please note that FAO discourages routine sampling surveys as part of active surveillance[1] for SARS-CoV-2 in animal species without a clear rationale as this would reallocate time and resources away from other veterinary responsibilities**. Instead, using a One Health approach, these recommendations guide investigations to target susceptible farmed and companion animal species in contact with COVID-19 human cases and/or with SARS-CoV-2 infected animals of the same or different species to address the above-mentioned objectives. Research studies in wild animals to identify possible animal sources or natural reservoirs of SARS-CoV-2 fall outside the scope of this document.

## PROCEDURES BEFORE CONDUCTING THE INVESTIGATION

- Veterinary services should ensure the investigation team includes personnel with adequate epidemiology and animal sampling skills. If needed, provide physical or online training prior to starting field activities.

The investigation team should have adequate PPE (personal protective equipment, see FAO guidance – SOP9) and receive training in its use, necessary sampling equipment, Epidemiological Investigation Forms (Annex 1) and Standard Sampling Sheets (Annex 2). Please see Annex 6 for a full Checklist.

- Testing each investigation team member for SARS-CoV-2 RNA or antigen a day earlier can be considered if resources allow and the results are available the same day.[2]
- The body temperature of each investigation team member should be taken immediately before deployment to the field. Any team member with close contact to a COVID-19 human case (even if asymptomatic) or showing fever or other signs of COVID-19 should not be allowed to join the field mission. They should instead be isolated and tested according to national regulations.
- Sampling of animals, especially for RNA detection, should start as soon as possible after confirmation of SARS-CoV-2 infection in the contact person(s) or animal(s), otherwise the RNA shedding window in animals may be missed. Our understanding of antibody kinetics is that serological assays targeting anti-SARS-CoV-2 antibodies, in particular IgG, are unable to detect acute infection and therefore are likely to give negative results at this early stage.
- Investigation teams should communicate clearly in advance to all relevant stakeholders and authorities, animal owners and those tending them, on the measures to be taken in case of detection of SARS-CoV-2 virological material in animals (see Annex 4).
- In some settings, the investigation team can use community visits, particularly to remote areas, as an opportunity to deliver public health messaging and communication materials on preventing COVID-19 in humans and animals.
- Depending on national regulations, interviewees may have to sign a consent form prior to collecting information.

## METHODOLOGY

Using a One Health approach, national veterinary and public health services should jointly develop and agree on the study protocol, based on the proposed methodology. The recommendations should be used as guidance, adapting some aspects to country specific contexts, rapidly changing local circumstances as well as existing procedures and legislation. The One Health coordination mechanism, if present in the country, will play an important coordination role by facilitating timely information sharing between public health authorities, e.g. the Ministry of Health (MoH), and veterinary services, the Ministry of Agriculture/Livestock (MoA), as well as other relevant One Health partners.

- **Data collection forms with animal contact information**: To ensure this information is available to public health authorities, national COVID-19 human case data collection forms may need to be updated with questions on the intensity and frequency of contact with farmed or companion animals. This should be developed collaboratively by public health and animal health partners.
- **Identification of households/farms/herd**: Public health authorities will immediately inform veterinary services about COVID-19 human cases reporting close contact with farmed or companion animals (other than birds, which are not thought to be susceptible based on current knowledge) and are willing to take part in the study. The public health authorities will provide basic information, including case address, date of onset of COVID-19 symptoms, description of symptoms, farmed or companion animal species present in the household/farm or in close contact with

1 For the purpose of this document, active surveillance refers to probability based randomized surveillance based on statistical sample size, targeting animals randomly and regardless of any contact with COVID-19 human cases.

2 This is to avoid delaying deployment of the investigation team.

the human case (e.g. farm workers, animal minders etc.) and if available, dates including length of time and type of exposure when human cases were in contact with farmed or companion animals.

*Note*: For animals testing SARS-CoV-2 positive, in the absence of information on the infection status of in contact humans, i.e. during animal health investigations by veterinary services or from private practice, the veterinary services should inform the public health authorities. They should provide information[3] such as contact person's address and occupation, farmed or companion animal species in the household/farm or in close contact with personnel (e.g. farm workers, animal minders), date of onset of clinical signs in animals, description of clinical signs, date of sampling and type of samples, date of positive test results and type of test used.

- **Selection of households/farms to be investigated**: Veterinary services should give priority to households/farms with recently confirmed human cases, ideally no longer than 72 hours before the investigation. We do not recommend investigating households/farms holding only non-susceptible animal species[4] (e.g. chicken or duck farms).
- **Interviewees**: If their health status allows, the investigation team should interview COVID-19 human cases remotely through voice/video calls and with others who have been in contact with the same animals, either individually or in a group.
- **Questionnaire**: An Epidemiological Investigation Form (Annex 1) is used to collect key data in a structured way. The form is designed to capture all data necessary for national, regional and global disease reporting platforms. Among these are OIE WAHIS (World Organisation for Animal Health World Animal Health Information System) and EMPRES-i (FAO's Global Animal Disease Information System) as well as data related to potential risk factors. Complete one form only for each household/farm. Whenever possible, conduct separate interviews with each household/farm dweller, employee or visitor who may have come in close contact with the animals, preferably on the same day and prior to sample collection from in-contact animal(s). Example: if the household has three family members, interview each one individually, using a separate form for each. After verification and triangulation of the data collected from the three interviews, enter the verified data into one, final Epidemiological Investigation Form.
- **General veterinary inspection of animals**:[5] The investigation team should not rely solely on data provided by interviewees on the health of their animals. We recommend finalizing interviews before proceeding to animal inspection and sampling. Data provided by interviewees may guide the investigation team to select certain animals, target animal inspection or take specific samples. During household/farm visits for animal sampling, inspect animals thoroughly for temperature, body condition, breathing difficulties, gastrointestinal signs, lymph node swelling, conjunctival congestions/lesions and oral lesions. The investigation team will need suitable animal restraining equipment. The Epidemiological Investigation Form (Annex 1) facilitates inspections and will ensure smooth and structured collection of data on animal health.
- **Sample collection from animals**: The investigation team performing animal sampling may include veterinary clinicians, epidemiologists and/or laboratory specialists, depending on local arrangements and staff technical skills. The team should adhere to biosafety standards while sampling animals in the field (CDC, 2016), using the Epidemiological Investigation Form for animals (Annex 1), in addition to the Standard Sampling Sheet (Annex 2) routinely used for sampling individual animals. The ideal set of samples from live animals include deep nasal swab, throat (oropharyngeal) swab, rectal swab and blood, storing each swab sample separately. NOT suitable are faecal samples and vomit samples or swabs of the animal's coat/fur or other environmental swabs as environmental contamination by an infected human is possible. Depending on clinical signs, additional samples should be taken as follows:
  - conjunctival swab if there is lacrimation or eye lesions;
  - milk in the case of lactating female livestock;
  - foetal fluids or embryo specimens in case of abortion or premature birth;
  - lymph node aspirate if the animal has superficial lymph node swelling;
  - whole blood (on anticoagulant) in case of fever.


*Veterinarian collecting a blood sample from a cow, Nairobi, Kenya, 2019.*

3 National authorities in charge of the One Health investigation study should seek clearance in case privacy laws affect gathering some of the required data.

4 Please see the FAO publication Risk Mitigation Measures for Livestock and Agricultural Professionals for more information on animal species susceptibility: http://www.fao.org/3/cb2549en/cb2549en.pdf.

5 Please see guidance on PPE here: http://www.fao.org/3/a-i2364e.pdf (SOP9).


*Cattle showed low susceptibility to SARS-CoV-2 in experimental settings.*

*Note*: Necropsies of animals suspected of infection with SARS-CoV-2 are not recommended in the field, especially where resources are inadequate for hygienic disposal and decontamination. However, if recently dead animals can be safely delivered to a laboratory, post-mortem specimens[6] from upper and lower respiratory tissues can be taken in the laboratory, in addition to any other organs with gross lesions.

- **Laboratory testing**: SARS-CoV-2 RNA detection should be based on standardized, validated reverse transcriptase polymerase chain reaction (RT-PCR) or equivalent assay. Further studies on PCR positive specimens by conducting genomic sequencing and virus isolation (especially from specimens with important/distinct changes in the RNA sequence and/or rapidly spreading outbreaks or other unusual epidemiological events) are strongly recommended. The sera should be tested with reliable serological assays specific to SARS-CoV-2, whenever available.

  Where samples test positive for virus RNA according to the criteria defined in the OIE case definition, repeat sampling of the animal and other animals in the same household/farm is recommended at least every 4-7 days, but more frequently if possible. This will help establish how long infected animals test positive, ideally until there are negative PCR results. Whenever possible, follow up serological testing of seropositive animals to understand longevity of the antibody response and antibody kinetics.

  To allow for additional studies in national or international laboratories, store samples with positive or inconclusive results in a manner that ensures their integrity and traceability.

- **Presentation of laboratory results**: RT-PCR and serology results should be reported both qualitatively (positive, negative, inconclusive) and quantitatively, i.e. threshold cycle (Ct) value for RT-PCR and titre/optical density (OD) for serology or other means, depending on the assay used.
- **Data entry**: The veterinary services department will set up a simple Excel database or other data platform to enter collected data.[7] If several Epidemiological Investigation Forms (Annex 1) are used for the interview, the investigation team will combine and summarize the answers into one form, entered for each household/farm. If interviewees from the same household/farm provide contradictory answers, it will be necessary to verify the information through follow up calls or repeat interviews.
- **Data analysis and reporting**: Analyse data according to the variables outlined in Annex 3 and write a summary report with conclusions for each investigated event (see Annex 5 for an outline of the Epidemiological Investigation Report). Even if animal infection with SARS-CoV-2 is not a notifiable disease in your country, you should share any positive test results in animals and the outbreak investigation findings within the national One Health coordination mechanism and the international scientific community (e.g. through OIE WAHIS and publication). All data generated from these investigations are valuable for joint One Health risk assessments at the animal-human-environment interface. For tripartite guidance on joint risk assessment (JRA) please consult the JRA Operational Tool (FAO/OIE/WHO, 2020), published under the Tripartite Zoonoses Guide (FAO/OIE/WHO, 2019).

6 For further guidance please visit the US Coronavirus Postmortem Examination (Necropsy) Sample Inventory Check List and Photo Log (link).

7 Please note that FAO can assist in setting this up, on request. Please contact empres-animal-health@fao.org.

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# Annex 1
# EPIDEMIOLOGICAL INVESTIGATION FORM (2 pages)

## EPIDEMIOLOGICAL INVESTIGATION FORM 1/2

**Date:** ……/……/……  **Type of interview:** ☐ Individual ☐ Group (indicate number of people)

**Interviewee/s:** ☐ COVID-19 human case ☐ Others (specify relationship with the human case and role in the household)

……

### *COVID-19 human case data (collected from PH authorities, human case/s and/or cohabitants)*

| | | | |
|---|---|---|---|
| **1. ID of the initial COVID-19 human case** (i.e. very first SARS-CoV-2 positive sample in the household/on premises) | | **2. Human case address** | Country<br>Province<br>District |
| **3. Interviewee name** | | | |
| **4. Family size** | ☐ Human case alone<br>☐ Specify number …… | **5. Family cluster of infection** | ☐ Yes ☐ No<br>☐ NA |
| **6. Number of confirmed/probable infections among family members** | | **7. Clinical status of the initial human case/s (specify number of cases)** | ☐ Asymptomatic ( )<br>☐ Symptomatic ( ) |
| **8. Isolation place of the initial human case** | ☐ In the family's house<br>☐ Hospital | **9. Starting date of isolation for the initial human case** | ……/……/…… ☐ NA |
| **10. Date of first clinical sign/s observed** | ……/……/…… | **11. Date of first laboratory confirmation / type of test used** | ☐ PCR<br>☐ Virus isolation<br>☐ Serology<br>……/……/…… |
| **12. Human case/s occupation/s** | | **13. Type (and species) of in-contact animal/s prior to symptom/s onset** | ☐ Wildlife (……)<br>☐ Companion (……)<br>☐ Farmed (……) |
| **14. Location of potential exposure of initial human case from animals specified in question 13** | ☐ Market ☐ Farm<br>☐ House ☐ …… | **15. Date of last visit to the location specified in question 14 before symptom/s onset** | ……/……/…… |

### *Data on animal/s*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **16. Address of the site of investigation** (where animals are kept) | ☐ Same as human case address<br>☐ Other (specify) …… | | | | | | | | |
| **17. Reason for selecting the investigation site** | ☐ Human case's residence site ☐ Human case's workplace ☐ Nearby human case exposure site<br>☐ Others (specify) …… | | | | | | | | |
| **18. Husbandry system** | ☐ Open ☐ Semi-closed ☐ Closed ☐ Other (specify) …… | | | | | | | | |
| **19. Animals present*** | ☐ Feline | ☐ Canine | ☐ Bovine | ☐ Ovine/Caprine | ☐ Equine | ☐ Mustelids[1] | ☐ Lagomorphs[2] | …… | …… |
| **20. Species/breed of animals** | | | | | | | | | |
| **21. How long has the human case owned the animals present?** | | | | | | | | | |
| **22. Underlying/ongoing health issues in animals** | | | | **23. Sex** (specify number for > 1 animal) | | | ☐ Male ( )<br>☐ Female ( ) | | |
| **24. Animal health status 14 days prior to onset of symptoms in the contact human/animal case** | ☐ Mortality<br>☐ Sick<br>☐ Apparently healthy | | | **25. Physiological status of females** (specify number in case of having > 1 animal) | | | ☐ Gravid ( )<br>☐ Lactating ( )<br>☐ NA | | |
| **26. Clinical signs** (specify number of animals) | ☐ None ( )<br>☐ Symptomatic ( ) Complete Standard Sampling Sheet (Annex 2) for details** | | | | | | | | |

*(Cont.)*

* See Glossary in Annex 7 for description.

** Such as fever, coughing, difficulty breathing or shortness of breath, lethargy, sneezing, nasal discharge, ocular discharge, vomiting, diarrhoea

[1] A mammal of the family *Mustelidae*, including ferrets, mink, weasels, badgers, otters, martens, and wolverines

[2] A mammal of the order *Lagomorpha*, which comprises hares, rabbits, and pikas

## EPIDEMIOLOGICAL INVESTIGATION FORM 2/2

### *Movement tracing (14 days before disease onset)*

| | | | |
|---|---|---|---|
| **27.** Number of days between last visit to veterinary clinic or visit by vets/animal health workers and disease onset | ……. ☐ NA | **28.** Number of days between last contact with or introduction of new animals (any species) and disease onset | ……. ☐ NA<br>Species ……..…….. |
| **29.** Do you allow your animals to roam freely outside the household/ farm? | ☐ Yes ☐ No | **30.** If yes, specify number of days between the last interaction with other animals outside the household/farm and disease onset | ……. ☐ NA |
| **31.** Number of days between animal/s visit to a public place (markets, pastures, etc.) and disease onset | ……. ☐ NA | **32.** If yes, specify the preventive measures taken upon their return | ☐ Isolation /quarantine<br>☐ Other ……<br>☐ No action |
| **33.** Were there any animals sold since disease onset? | ☐ Yes ☐ No | **34.** If yes, specify the destination | …… |
| **35.** Animal rearing/housing place | ☐ Backyard (specify species) …… ☐ Household (specify species) ……<br>☐ Farm (specify species) …… ☐ …… (specify species) …… | | |

### *Risk behaviour and practices (companion animals) within 14 days prior to laboratory confirmation of the initial human case*

| | | | |
|---|---|---|---|
| **36.** Animal-human case interactions | ☐ Licking<br>☐ Sniffing<br>☐ Pawing<br>☐ Other …… | **37.** Human case-animal interactions | ☐ Kissing<br>☐ Sharing bed/sofa<br>☐ Sharing food<br>☐ Sharing utensils<br>☐ Other …… |

### *Area investigation (to be completed where animal-animal transmission is suspected/confirmed)*

| | | | |
|---|---|---|---|
| **38.** Outbreak spread pattern among animals in the area | ☐ Massive<br>☐ Scattered<br>☐ Focal<br>☐ Unknown | **39.** Approximate date of the index animal case(s) | ……/……/…… |
| **40.** Main animal market(s) serving the area (where susceptible animals are sold) | ……..<br>……..<br>……..<br>☐ NA | **41.** Other areas served by the same market | ……..<br>……..<br>……..<br>☐ NA |
| **42.** Have animals in the area been part of a vaccination campaign in the 14 days PRIOR to onset of index case? | ☐ Yes (specify date) ……/……/……..<br>☐ No<br>☐ Unknown | **43.** Have animals in the area been part of a vaccination campaign in the 14 days AFTER onset of index case? | ☐ Yes (specify date) ……/……/……..<br>☐ No<br>☐ Unknown |

*Notes*

……

……

……

**Interviewee name:** …….. **email** …… **Tel**……

**Interviewee name:** …….. **email** …… **Tel**……

**Interviewee name:** …….. **email** …… **Tel**……

**Interviewee name:** …….. **email** …… **Tel**……

**Names of investigation team members** ……

# Annex 2
## EXAMPLE OF STANDARD SAMPLING SHEET FOR ANIMAL DISEASE INVESTIGATION
(to be used together with the Epidemiological Investigation Form)

**STANDARD SAMPLING SHEET FOR ANIMAL DISEASE SURVEILLANCE**

| | | | | | |
|---|---|---|---|---|---|
| **Date** ……/……../……..…… | **County** …… | **District** …… | **Village/township** …… | **Latitude** ……<br>**Longitude** …… | **Event ID** …… |
| **Owner name** ……..……<br>**Owner Tel** ……..……..…… | | **Surveillance method**<br>☐ Active, randomized ☐ Active, risk-based<br>☐ Passive ☐ Syndromic ☐ Other ……..…… | | **Site**<br>☐ Farm ☐ Household ☐ Market<br>☐ Abattoir ☐ Other (……..……) | |
| **Animal species present** | | | | | |
| **Date of disease onset** | | | | | |
| **Date of full recovery** (when no illness observed) | | | | | |
| **Number of animals on date of disease onset** | | | | | |
| **Number of dead animals since disease onset** | | | | | |
| **Number of sick animals on date of investigation** | | | | | |

| **Animal ID** | **Species** | **Sex** | | **Age (in months)** | **Clinical signs** *(type the corresponding NUMBER)*<br>**1.** no signs **2.** death **3.** fever<br>**4.** lethargy **5.** dyspnea **6.** coughing<br>**7.** sneezing **8.** nasal discharge **9.** ocular lesions<br>**10.** ocular discharge **11.** vomiting **12.** diarrhoea<br>**13.** oral lesions **14.** nervous signs **15.** other (……) | **Medications or vaccines recently used (over the past 4 weeks)** | **Sample type**[1] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Male** | **Female** | | | | B | N | R | T | Other* |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |
| | | | | | | | | | | | …… |

Sample code = Animal ID. Sample type [1] B=blood, N=nasal swab, R=rectal swab, T= Throat swab * Other: (specify in the corresponding cell in the table)

**Notes:** ……

……

**Reporting officer(s):** …… **Tel:** ……..……

## Annex 3
## RECOMMENDATIONS FOR DATABASE DESIGN AND DATA ANALYSIS

- The central epidemiology unit should provide a database to include all variables of interest, as mentioned in the Epidemiological Investigation Form (Annex 1) and the Standard Sampling Sheet (Annex 2), with drop down menus for categorical variables.
- Calculation of additional variables:
  - Interval (days) between onset of symptoms in the COVID-19 human case (if any, Question 10, Annex 1) and clinical signs in the animal(s), if any (Annex 2). This variable is important to estimate the incubation period in animals.
  - Interval (days) between onset of symptoms in the human case (Question 10, Annex 1) and recovery of infected animal(s) (turning PCR negative). This is important to estimate the duration of infection in the animal(s).
  - Interval (days) between onset of symptoms in the human case and sampling of the animal(s): this variable may help explain situations where an animal tests serologically positive but PCR negative, this is likely due to delayed sampling.
  - Interval (days) between onset of clinical signs in animals and interaction with other animals from outside the household or recently introduced. In addition to other variables this will help to investigate potential modes and direction of SARS-CoV-2 transmission to animals.
  - Interval (days) between date of laboratory result from the human case and sampling of animal(s), to help interpret findings, e.g. when an animal tests positive in serology but negative in PCR due to late sampling.
  - Interval (days) between date of human case isolation and onset of clinical signs in animals; this will help to interpret the investigation results and describe the possible mode of virus transmission to animals (direct vs indirect contact).
- The data will be summarized using pivot tables to show number and proportion of infected and non-infected animals against all variables of interest.
- The final narrative report of each household investigation should clearly address the specific objectives of the study as outlined earlier. Annex 5 provides a template report structure.
- If investigating a representative[1] number of cases in each epidemiological unit (the targeted village or city), the final report of aggregated investigation data could include epidemiological tools of relative risk, measures of association and regression analysis.

*Note*: Both positive and negative animal test results should be communicated to all participants interviewed in the household/farm, including any necessary measures or follow up actions (e.g. re-testing of positive animals). See Annex 4 for recommendations on measures to take if animals test PCR-positive.

1 Between 75-80 percent of events with close human-animal contact during a specific time period is representative, with a margin of error of around 5 percent.

## Annex 4
## MITIGATION MEASURES RECOMMENDED WHERE SARS-COV-2 GENETIC MATERIAL IS DETECTED IN ANIMALS

Recommended mitigation measures include:

- Isolation of infected animals or herds, banning movement outside the premises and preventing introduction of any new animals until affected animals have negative PCR tests (see below). However, if follow up testing is not feasible, countries may justify lifting movement restrictions by other parameters based on risk assessment tailored to local conditions.
- Minimize human contact with infected animals. When taking care of animals, wear a mask or cloth face covering, goggles or an eye protection device, gloves and wash your hands before and after interacting with them or cleaning up after them.
- When possible, re-test affected animals every 4-7 days until PCR results are negative, after which the isolation may be lifted.
- Conduct cleaning and disinfection of the infected premises (see recommendations by WHO, 2020c).

*Note*: Confirmation of animal infection by virus isolation and/or serology is essential, beyond positive PCR. (Please refer to OIE's SARS-CoV-2 animal sampling and testing guidance.)

*Considering that:*

There is insufficient evidence to date about any potential role livestock or companion animals play in spreading COVID-19 to humans and the only instance where human infection from animals is thought to have happened involved mink farms (Oude Munnink *et al.*, 2021).

The risk of zoonotic spillover, if evidenced at a later date, can be effectively mitigated through appropriate measures.

Culling or abandoning animals testing positive for SARS-CoV-2 is neither recommended nor justified in the absence of evidenced zoonotic transmission or demonstrated failure of other containment measures to limit its spread between animals or to humans. Culling should therefore be the very last risk mitigation option and only adopted after thorough risk and economic assessments.

*In addition:*

- The culling process will increase the exposure of people to any virus present.
- Culling will increase economic losses for governments and communities, and subject livelihoods to strains.

*For further reading:*

FAO Risk Mitigation Measures for Livestock and Agricultural Professionals: http://www.fao.org/3/cb2549en/cb2549en.pdf

OIE Guidance on Working with Farmed Animals Susceptible for SARS-CoV-2: en-oie-guidance-farmed-animals-.pdf

# Annex 5.
## PROPOSED CONTENTS OF THE EPIDEMIOLOGICAL INVESTIGATION REPORT

- **Title**: will include these terms: investigation, the agent SARS-CoV-2, the affected/investigated population (i.e. animal species), location of investigation (i.e. farm, household, other) and date (or time frame).
- **Reported by**: indicate the names of the investigation team members.
- **Date written**: insert date of completing the investigation report.
- **Distribution list**: who will receive the report; should include relevant offices in veterinary services, public health authorities and other relevant ministries.
- **Narrative report**:
  1. **Executive summary** (1-2 pages): includes a brief event description, objectives of the investigation, results and recommended actions.
  2. **Historical background**: provides details on the notification date and COVID-19 human case data provided by the public health authorities, in addition to the date and place of the investigation conducted by veterinary services.
  3. **Objectives**: as indicated in the FAO Recommendations or the country specific plans.
  4. **Methodology**: includes data on who was interviewed, method used for the interview (face to face, voice/video call), details on inspection of animals and sampling process.
  5. **Timeline/chronology of epidemiological events**: includes dates (in ascending order) of: (i) human case exposure to animals prior to symptom/s onset (if any); (ii) onset of clinical signs in human case and animals; (iii) human case isolation; (iv) human case's full recovery or death; (v) animal death (if relevant); (vi) animal movement, as described in the Epidemiological Investigation Form, Annex 1).
  6. **Timeline of the One Health milestones**: includes dates (in ascending order) of: (i) onset of symptom/s in COVID-19 human case; (ii) human case sampling by public health authorities; (iii) lab confirmation of human case infection; (iv) public health authorities sharing information with veterinary services; (v) epidemiological investigation by veterinary services; (vi) animal sampling by veterinary services; (vii) laboratory results for animal/s including follow up testing if any; (viii) veterinary services sharing the results with public health authorities; (ix) interventions conducted, if any, for example decontamination or isolation.
  7. **Descriptive findings**: includes detailed description of the investigated site, animals in contact with the human case/s including species, numbers, age, sex and clinical picture observed, type and number of samples collected and the laboratory that tests the samples.
  8. **Analytical findings**: as described in Annex 3 Guidelines for database design and data analysis.
  9. **Conclusions**: should be in compliance with the objectives.
  10. **Recommended actions**: both specific mitigation measures (see Annex 4 for guidance) for the investigated case or recommendations for improvement of further/ future investigations.

# Annex 6
## CHECKLIST FOR CONDUCTING THE EPIDEMIOLOGICAL INVESTIGATION OF SARS-COV-2 IN EXPOSED ANIMALS

| When | Check | Items to be checked |
|---|---|---|
| **Before moving to the field** | ☐ | Monitoring COVID-19 symptoms in the investigation team prior to field visits |
| | ☐ | Enough sets of PPEs |
| | ☐ | Enough sampling kits (for swab and blood collection) |
| | ☐ | Cold chain device(s) with enough capacity to keep collected samples |
| | ☐ | Appropriate animal restraining devices |
| | ☐ | Enough copies of the Standard Sampling Sheet (Annex 2) |
| | ☐ | Enough copies of the Epidemiological Investigation Form (Annex 1) |
| | ☐ | Indelible pens for sample coding and pens to fill out the sheets/forms |
| | ☐ | Contact the human case or his/her cohabitants by phone to arrange timing of the animal sampling |
| **During the field investigation** | ☐ | Wear PPE |
| | ☐ | Start with the interviews and fill the Epidemiological Investigation Form (Annex 1). ***DO NOT start with sampling*** |
| | ☐ | Inspection of each live animal before sampling, including body temperature |
| | ☐ | Collect samples from sick or freshly dead animals, to be completed after sampling live animals |
| | ☐ | Collect at least: deep nasal swab, throat (oropharyngeal) swab, rectal swab and blood from each animal |
| | ☐ | Collect additional samples if there are specific lesions or signs of illness |
| | ☐ | Code the samples and complete the Standard Sampling Sheet |
| | ☐ | Remove and safely dispose of PPE |
| **After the investigation** | ☐ | Deliver the samples to the relevant laboratory |
| | ☐ | Enter the data collected and the laboratory results in the Excel database (Annex 3) |
| | ☐ | Communicate the results to the relevant offices/authorities, including public health authorities |
| | ☐ | Communicate the results to the human case/owner of the animal(s) |
| | ☐ | Write the Epidemiological Investigation Report (Annex 5) |

# Annex 7
## GLOSSARY (For the purpose of this document)

**Animal case**: see **Infected animal**

**Bovine**: A member of the cattle group (e.g. cattle, bison, buffalo, water buffalo, oxen, yak)

**Canine**: A dog or member of the family *Canidae*

**Caprine**: Goat or subfamily *Caprinae, Genus Capra*

**Close contact**: Frequent (e.g. daily) direct, unprotected contact with a COVID-19 human case or with the contaminated environment during the human case's incubation period and/or illness

**Companion animals**: Dogs and cats, in addition to rodents, ferrets and other **exotic pets** (see below); service or working dogs including e.g. guide dogs, police or military working dogs

**COVID-19 human case/infected person**: A person with laboratory confirmation of SARS-CoV-2 infection, irrespective of clinical signs or symptoms (WHO, 2020a)

**COVID-19**: The disease caused by SARS-CoV-2

***Cricetidae***: A family of rodents that includes hamsters, voles, lemmings, and New World rats and mice

**Exotic pets**: Includes more uncommon pets, such as mammals, birds, reptiles or invertebrates, e.g. ferrets, rodents and turtles

**Equine**: A horse, donkey or their crossbreed member of the family *Equidae, genus Equus*

**Establishment**: The premises in which animals are kept (OIE, 2019)

**Feline**: A member of the family *Felidae* (e.g. cat, lion, tiger, jaguar, leopard)

**Farmed animals**: Domestic animals belonging to poultry, rabbit, ovine, caprine, bovine, equine, camelid and swine species (FAO, 1994), including farmed fur animals as well as dogs and cats[1]

**Infected animal**: Individual animal with confirmed SARS-CoV-2 infection, compliant with the OIE case definition

***Lagomorph***: A mammal of the order *Lagomorpha*, which comprises hares, rabbits, and pikas.

***Mustelid***: A mammal of the family *Mustelidae*, including ferrets, mink, weasels, badgers, otters, martens and wolverines

**Ovine**: Sheep or subfamily *Caprinae, Genus Ovis*

**Human case**: see COVID-19 human case/infected person

**Reservoir**: The host in which the virus normally survives (= **maintenance host**) and multiplies (= **amplifying host**) without requiring repeat introduction from another species; possible reservoir hosts include humans and wild, companion or farmed animal species

**SARS-CoV-2**: Name of the virus associated with coronavirus diseases 2019 (COVID-19)

**Susceptible animals/hosts**: Animals that can be infected by SARS-CoV-2, shed virus or harbour it in their tissue after efficient virus replication, regardless of whether or not they show clinical signs

**Wildlife**: Captive wild animals and those having a phenotype unaffected by human selection and living independently of direct human supervision or control (OIE, 2019)

1 Include dogs and cats kept as pets on farms or roaming on farms in the investigation.


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## NOTES

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## RISK ANALYSIS IN ANIMAL HEALTH

Risk analysis is a procedure, which we all do intuitively in our everyday life as we also do in our professional work to assess the risk of any hazard or threat. In animal health, risk analysis has been most widely used as a decision tool to help select the most appropriate health interventions to support disease control strategies, guide disease surveillance and support disease control or eradication strategies.

It should be remembered that risk is not equal to zero and never stays static. Risk changes as drivers or factors of disease emergence, spread or persistence change such as intensification of livestock production, climate change, civil unrest and changes in international trading patterns. Risk analysis should therefore not be seen as a "one off" but as good practice for animal health systems as part of their regular activities. Therefore, the risk analysis process should be repeated and updated regularly.

Risk analysis comprises the following components:

**Hazard identification:** the main threats are identified and described.

**Risk assessment:** risks of an event occurring and developing in particular ways are first identified and described. The likelihood of those risks occurring is then estimated. The potential consequences or impact of the risks if they occur are also evaluated and are used to complete the assessment of the risk.

**Risk management:** involves identifying and implementing measures to reduce identified risks and their consequences. Risk can never be completely eliminated but can be effectively mitigated. The aim is to adopt procedures that will reduce the level of risk to what is deemed to be an acceptable level.

**Risk communication:** an integrated process that involves and informs all stakeholders within the risk analysis process and allows for interactive exchange of information and opinions concerning risk. It assists in the development of transparent and credible decision-making processes and can instil confidence in risk management decisions.



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