Decision Support Framework — Outbreak Investigation Tool

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1. Overview

Decision support is a set of transparent, rule-based calculations, not a statistical model or machine learning. It reads everything the investigator enters and produces five outputs. Each is shown with the evidence that produced it, so the officer can check and override every step.

Output	Question it answers	Main inputs
Tracing windows	When could the unit have been infected, and when could it have spread infection?	Day 0, last case, Day C, incubation period of the disease
Probable cause ranking	Which transmission pathway most likely brought the disease in?	Risk factor answers, movement register, epidemic curve shape, case locations, control zones
Epidemic curve reading	Was this one exposure, a continuing exposure, or animal-to-animal spread?	Case onset dates (and, for HPAI, daily mortality)
Clinical fit	Do the recorded signs match the disease selected, or another one?	Signs recorded on each case row
Overall assessment	What needs action now, what needs checking, what is in order?	All of the above plus numbers, specimens, results and control measures

The ranking is a prompt, not a verdict. The officer ticks the causes that fit what was seen on the premises, and only those enter the conclusion (section 8). This follows the standard outbreak investigation sequence: verify the diagnosis, describe cases by time, place and animal, form hypotheses, then test them against further evidence. The tool helps with the hypothesis step; it does not replace laboratory confirmation or an analytical study.

2. What is considered, and where

Yes: cases, the timing of cases, the epidemic curve, mortality and risk factors are all read. But they do not all feed the same output. The table shows exactly which calculation uses each input (Yes = changes that output).

Input	Tracing windows	Probable cause ranking	Curve reading	Clinical fit	Overall assessment
Case rows (count)	No	No	Yes	No	Yes: missing rows, missing onset dates
Time of cases (onset dates)	Yes: Day 0, last case	Yes, through the curve shape (3+ dated cases)	Yes	No	Yes: onset before Day 0, cases after Day C
Epidemic curve shape	No	Yes: +2 / −1 to pathways	—	No	Shown
Case status (suspected, probable, confirmed)	No	No	Stacking only	No	Yes: status vs laboratory result
Signs recorded on cases	No	No	No	Yes	Yes: weak fit flagged
Population, cases, deaths, culled	No	No	No	No	Yes: rates, totals that disagree
Daily mortality (HPAI)	No	No	Own mortality curve	No	Yes: not yet peaked = Act now
Deaths per shed (HPAI)	No	No	No	No	Yes: spread between sheds
Case coordinates	No	Yes: distance between cases	No	No	Yes: furthest case, km per day
Control zones (infected / core 1 km, surveillance / alert 10 km)	No	Yes: cases outside the outer zone	No	No	Yes: cases by zone
Risk factor answers	No	Yes: the main driver	No	No	Yes: unanswered, "don't know"
Movement register	Placed in windows	Yes: inward in source window, outward in spread window	No	No	Yes: movements to trace
Reported, investigation dates	No	No	No	No	Yes: reporting delay

Input	Tracing windows	Probable cause ranking	Curve reading	Clinical fit	Overall assessment
Day C (control measures date)	Yes: closes spread window	Indirectly, through the spread window	Marked	No	Yes: control delay, cases after Day C
Specimens and results	No	No	No	No	Yes: confirmed, negative, awaited
Control measures ticked	No	No	No	No	Yes: none or some missing
Disease selected	Yes: incubation period	Yes: risk list and weights	Yes: incubation period	Yes: compared with the other three	Yes

What this means in practice. The ranking of causes is driven by risk factors and movements, adjusted by curve shape, distance and zones. Mortality, attack rate and case status describe the size and certainty of the outbreak; they are checked, but they do not change which pathway ranks first. That is deliberate in classical source tracing (how many birds died does not tell you how the virus got in), but it is a design choice worth knowing.

Case rows for HPAI. The curve shape needs at least 3 dated case rows. A poultry investigation entered as one row for the whole farm has no curve shape, so the curve adds nothing to the ranking. The daily mortality curve is drawn and read separately, but it is not classified as point source or propagated.

3. Tracing windows: the time frame for everything else

Every window is counted from Day 0, the first clinical signs, using the incubation period of the selected disease. The officer chooses the biological basis or the regulatory (WOAH Terrestrial Code) basis; the regulatory basis replaces only the maximum.

Disease	Minimum (days)	Average (days)	Maximum, biological (days)	Maximum, regulatory (days)
FMD	2	4	14	14
HPAI	1	3	7	14
LSD	4	14	28	28
Glanders	3	28	180	180 (6 months)

Window or date	Formula	Use
Day 0	Entered Day 0, or the earliest case onset if blank	Start of all counting
Source window (trace back)	Day 0 − maximum to Day 0 − minimum	When infection could have entered
Most likely exposure	Day 0 − average	Centre of the priority window
Priority window	Most likely exposure ± max(1, 20% of the average), rounded	The days to trace first
Spread window (trace forward)	Source window opening to Day C (or the last case, or Day 0, if Day C is blank)	When the unit could have passed infection on
Earliest lift of measures	Last case + maximum	No new case for one full incubation period
Conservative lift	Last case + 2 × maximum	Two incubation periods, the usual standard for declaring freedom in a zone

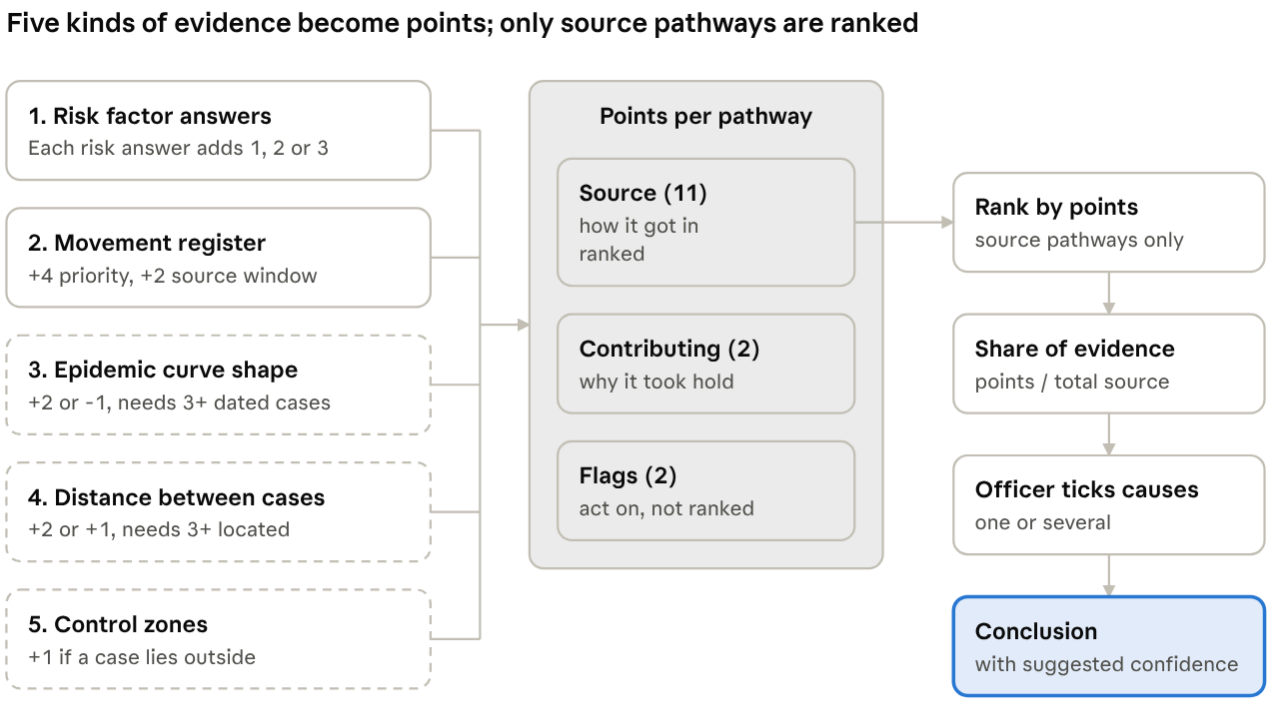
Worked example (DVR Poultry, HPAI, regulatory basis): Day 0 is 28 Sept 2026. The source window is 14 to 27 Sept, the most likely exposure 25 Sept, the priority window 24 to 26 Sept. The spread window runs 14 Sept to 3 Oct (Day C).

Why the spread window opens with the source window. The unit may have been infected on the first possible day and shedding before signs appeared. Opening it later would miss early onward spread.

How the windows feed the ranking. A movement record counts toward a pathway only if its date falls inside a window. Inward movements count in the source window (more in the priority window); outward movements count in the spread window (section 4, step 2).

4. Probable cause ranking: how each variable is weighted

Each possible transmission pathway collects points from five kinds of evidence. The source pathways are then ranked, and each one's share of the total is shown as a percentage. It is a points system: the percentage is the share of the evidence, not a probability that the pathway is true.



probable cause ranking · 5 evidence streams, 15 pathways

Risk answers and movements create points; curve shape, distance and zones only adjust them; the officer makes the final choice.

The pathways

Kind	Pathways	In the percentage?
Source (how the disease got in)	Introduction of an infected or incubating animal; market, fair or gathering; shared grazing, water or environment; vehicles, crates and equipment; people moving between holdings; feed, fodder, swill or water supply; arthropod vectors; iatrogenic (needles, instruments, AI); wildlife, wild birds or strays; local spread from a nearby outbreak; undetected carrier already on the premises	Yes
Contributing (why it took hold)	Population susceptibility (vaccination gap); biosecurity failure	No, shown separately with its score

Kind	Pathways	In the percentage?
Flag (needs action, not a source)	Onward spread (animals, products or materials left the unit); human exposure risk	No, shown separately

Step 1. Risk factor answers (the main driver)

Every question on the Risk factors tab belongs to one pathway and carries a weight of 1, 2 or 3. An answer that indicates a risk adds that weight to its pathway: Yes to a risk practice, or No to a good practice. "Don't know" adds nothing but is counted as unknown. The full list of questions for all four diseases, with pathway and weight, is in `Risk factor weights`.

Weight	Meaning	Examples (HPAI)
3	A direct, well-documented route of introduction	Live-bird or feed vehicle entered the farm; untreated surface water used for drinking
2	A recognised route, less direct or less consistently implicated	Farm within 3 km of a wetland; egg collection vehicle entered; multi-age flocks
1	An indirect or weak association, or a condition that makes another route easier	Open-sided sheds; other poultry farms 1 to 10 km away; pigs on site

Step 2. Movement register

Each movement type maps to a pathway (animal moved or purchased → introduction; vehicle, milk collection, dead bird or litter collection, shared equipment → vehicles; person, visitor, veterinary visit, shared staff → people; feed delivery, shared feed, carcass or product → feed; shared grazing or water → shared environment; market → market; semen or AI → iatrogenic).

Movement	Points	Adjusted by the risk rating given
Inward (or two-way, or direction not given) inside the priority window	+4 to its pathway	High +1, Low −1, never below 1

Movement	Points	Adjusted by the risk rating given
Inward inside the source window, outside the priority window	+2 to its pathway	High +1, Low −1, never below 1
Outward or two-way inside the spread window	+2 to the onward spread flag	High +1, Low −1, never below 1
Outside both windows, or undated	Nothing	Undated records are flagged for correction

A dated movement in the priority window outweighs any single risk answer. That is intentional: a documented event on the right day is stronger evidence than a general practice.

Step 3. Shape of the epidemic curve (only with 3 or more dated cases)

Curve reading	Raised by +2	Lowered by −1
Point source	Introduction, market, vehicles, iatrogenic, people	Shared environment, feed, vectors
Continuous common source	Shared environment, feed, vectors, carrier	Introduction, market
Propagated	No change; a caveat is shown that the ranking explains only the first case	—
Propagated or intermittent, mixed or prolonged	No change	—

Step 4. Distance between cases (only with 3 or more cases with coordinates)

Finding	Effect
Furthest case more than 5 km from the index case	+2 to introduction and market (too far for local spread)
All cases within 1 km of the index case	+1 to local spread, shared environment, vectors, carrier

Step 5. Control zones

Any case lying outside the outer control zone adds +1 to introduction, market, vehicles and people, because it was carried there by a movement rather than local contact.

Steps 3 to 5 only adjust pathways that already have points. They never create a pathway from nothing, because a curve shape or a distance on its own does not identify a route.

Step 6. From points to percentages

Only source pathways with more than zero points are ranked. Each share is its points divided by the total of all ranked source pathways, rounded to a whole percentage.

```
\text{share}_p = \frac{\text{points}_p}{\sum_{\text{source pathways}}
\text{points}} \times 100
```

Worked example: DVR Poultry, Siddaramapuram (HPAI)

All 36 questions answered, 1 "don't know", no movements recorded, one dated case row (no curve shape), one case location (no distance check).

Pathway	Risk answers that scored	Points	Share
Vehicles, crates and equipment	Feed vehicle 3, dead bird or litter vehicle 3, live bird vehicle 3, egg vehicle 2	11	61%
Wildlife, wild birds or strays	Untreated surface water 3, wetland within 3 km 2, open-sided sheds 1	6	33%
Local spread from a nearby outbreak	Other poultry farms 1 to 10 km 1	1	6%
Biosecurity failure (contributing)	Multi-age 2, no shower or boot change 2, visitors 1, no rodent control 1, dead birds not removed 1, other animals 1	8	Not in the share

Total source points 18, so vehicles 11 ÷ 18 = 61%. Had a vehicle visit (movement type Vehicle) been recorded on 25 Sept with a High rating, vehicles would gain 4 + 1 = 5 more points (16 of 23, 70%).

5. Epidemic curve and mortality curve

The epidemic curve is read by comparing how spread out the cases are, and how far apart any peaks are, with the incubation period of the disease. The rules use one bar per day, from the first onset to the last case (or Day C if later). Cases stack by status but all count equally.

Finding the peaks

- A peak is a day whose count is at least as high as the days either side, and at least max(2, 35% of the highest day).
- Peaks closer together than max(2, half the average incubation period) days are merged into one.

Classifying the curve

Condition	Reading	What it means
Two or more peaks, average gap within max(2, 60% of the average incubation) of the average incubation period	Propagated	Each peak is a new generation of animal-to-animal spread
Two or more peaks, gap does not match the incubation period	Propagated or intermittent common source	A source switched on and off, such as a recurring delivery or market day
One peak, all cases within max(maximum − minimum incubation, average incubation) days	Point source	One exposure event affected everyone at once
One peak, cases spread over no more than 2 × maximum incubation	Continuous common source	An exposure that stayed in place: water, vectors, feed
One peak, spread over more than 2 × maximum incubation	Mixed or prolonged	Treat early and late cases as separate questions

The reading is shown on the Epi curve tab with every curve. It changes the ranking (section 4, step 3) only when 3 or more case rows have an onset date.

The HPAI daily mortality curve

For HPAI the flock, not the bird, is the unit, so case rows are usually one per shed and the case curve is too thin to read. The tool therefore draws a separate curve of birds dying each day, from the Daily mortality table.

What is read from it	Rule	Where it shows
Total deaths and share of the flock	Sum of daily deaths ÷ susceptible population	Curve text, report summary
Peak day	The day with the highest count	Curve text
Deaths by the day of laboratory confirmation	Running total on the confirmation date	Curve text, key findings
Not yet peaked	The last recorded day is the highest, over more than one day	Act now in the assessment
Totals disagree	Daily table total ≠ total deaths entered	Check in the assessment
Spread between sheds	Sheds on the same premises falling ill on different days	Check in the assessment

The mortality curve is marked with Day 0, samples collected, samples sent, laboratory confirmation and Day C, so delays are visible against the die-off. It is not classified as point source or propagated and does not change the ranking (see section 10).

6. Clinical fit

The signs typed in the Signs column of the case rows are compared with nine expected sign groups for each of the four diseases. A group counts as recorded if any of its keywords appears; the fit is the share of groups recorded. The case definition is deliberately not read, because it describes what is expected, not what was seen.

Disease	The nine expected sign groups (first keyword of each)
HPAI	Sudden death; comb and wattle cyanosis; swollen head; egg drop; respiratory signs; nervous signs (torticollis); diarrhoea; haemorrhages on shanks; reduced feed and water intake

Disease	The nine expected sign groups (first keyword of each)
FMD	Vesicles; drooling; lameness; tongue and mouth lesions; erosions; milk drop; fever; teat lesions; sudden death in young stock
LSD	Nodules; skin lesions; enlarged lymph nodes; sitfasts and scabs; oedema; fever; eye and nasal discharge; milk drop; abortion
Glanders	Nasal discharge; nasal septum ulcers or scars; farcy (corded lymphatics); nodules or abscesses; submaxillary lymph nodes; cough; weight loss; fever; orchitis or limb oedema

- All four diseases are scored. A disease that does not affect the species recorded is left out of the comparison.
- If another disease matches at least 2 more groups than the one selected, a warning is shown that the signs fit it better.
- In the assessment, a fit under 30% without laboratory confirmation is a Check: keep other diseases in mind.
- The fit does not change the ranking of causes. It checks the diagnosis, not the source.

In the DVR Poultry record, the signs mention sudden death and rising mortality only, so the fit is 1 of 9 (11%). That reflects sparse notes, not a poor diagnosis: the laboratory result settles it. Recording comb cyanosis, swollen heads or egg drop where seen would raise it.

7. Overall assessment: every check

The assessment runs a fixed list of checks across seven areas and tags each result with one of four levels. Every Act now item is copied to the top of the Decision support tab and to the report's first page.

Level	Meaning
Act now	Something is missing or happening that affects control today
Check	Incomplete, inconsistent, or a delay longer than it should be
In order	Checked and acceptable

Level	Meaning
Note	A worked-out figure for information

Area	Check	Trigger	Level
Cases and numbers	Rates	Population and cases entered: attack rate, mortality, case fatality	Note
Cases and numbers	Rates missing	Population or total cases blank	Check
Cases and numbers	Totals disagree	Cases > population, deaths > cases, or deaths + culled > population	Check
Cases and numbers	No cases	No case rows	Act now
Cases and numbers	Undated cases	Case rows without an onset date	Check
Cases and numbers	Status vs laboratory	Positive result but no row Confirmed; row Confirmed with no positive result; rows still Suspected after confirmation	Check
Cases and numbers (HPAI)	Spread between sheds	Sheds on the same premises (within 1 km) fell ill on different days	Check
Cases and numbers (HPAI)	Shed totals	Shed dead total ≠ total deaths	Check
Cases and numbers (HPAI)	Not yet peaked	Last recorded day has the highest deaths	Act now
Cases and numbers (HPAI)	No daily mortality	Daily table empty	Check
Dates and delays	No Day 0	Day 0 blank and no onset dates	Act now
Dates and delays	Onset before Day 0	Any onset earlier than Day 0	Check

Area	Check	Trigger	Level
Dates and delays	Reporting delay	Report date − Day 0 > minimum incubation	Check (else In order)
Dates and delays	Control delay	Day C − Day 0 > minimum incubation	Check (else In order)
Dates and delays	Cases after control	Onset more than the maximum incubation after Day C: measures not holding	Act now
Dates and delays	No Day C	Day C blank	Act now
Dates and delays	Dates in the future	Day 0, Day C or last case after today	Check
Locations	No coordinates	No case has coordinates	Check
Locations	Index farm far from cases	Index farm coordinates far from the nearest case	Check
Locations	No zone radii	No infected or surveillance zone radius	Check
Locations	Case outside the zones	Any case outside the outer zone	Act now (else In order)
Risk factors	Not started	No question answered	Act now
Risk factors	Incomplete	Some questions unanswered	Check (else In order)
Risk factors	Many unknowns	3 or more "don't know"	Check
Tracing and movements	Empty register	No movements recorded	Act now
Tracing and movements	Priority window movements	Inward movement in the priority window	Act now
Tracing and movements	Outward in spread window	Outward movement with no action recorded	Act now (Check if all actioned)
Tracing and movements	Risk answers without movements	A movement-type pathway is ranked but no matching movement is recorded	Check
Tracing and movements	Undated movements	Movement without a date	Check

Area	Check	Trigger	Level
Laboratory	No specimens	Nothing recorded	Act now
Laboratory	All negative	Every result negative	Act now
Laboratory	Awaited	Results awaited (Act now if never sent)	Check
Laboratory	Confirmed	Positive result	In order
Laboratory	Dates out of order	Collected, sent, result not in sequence	Check
Laboratory	Weak clinical fit	Fit under 30% and not confirmed	Check
Control measures	Measures applied	None ticked: Act now; some: Check; all: In order	As stated

The thresholds use the incubation period because a delay longer than the shortest incubation means newly infected animals could already be incubating elsewhere.

8. From ranking to conclusion

The officer, not the tool, decides the conclusion. The tool drafts wording only for the causes the officer ticks.

1. Tick one or more probable causes under "Include in my conclusion".
2. Press "Use these causes as my conclusion". The draft lists each ticked cause with its share and up to four pieces of evidence, then the likely exposure date and source window, the curve reading, laboratory status, rates and anything still open (unknown risk factors, outward movements to trace).
3. Edit the wording freely; the report prints whatever is saved.

Suggested confidence	Rule
Probable: strong circumstantial evidence	Ticked causes together hold 55% or more of the ranking, and no more than 2 risk answers are "don't know"
Possible: consistent but unconfirmed	Otherwise
Confirmed: laboratory or documented trace	Only chosen by the officer, when a trace or test links the source directly

Suggested confidence	Rule
Unknown: no source identified	Only chosen by the officer

Laboratory confirmation of the disease does not raise the confidence in the source, because it proves what the disease is, not how it arrived.

9. Scientific rationale and references

The structure of the framework follows published outbreak investigation methods and WOAH standards. The specific numbers inside it (the 1 to 3 weights, the +4 and +2 for movements, the curve thresholds, the 55% confidence cut-off) are expert judgement set when the tool was built. They are not taken from a published scoring system, because none exists for these four diseases. A government reviewer should be told this plainly.

Status	Meaning
Published standard	The tool applies a value or rule as published
Published method, tool numbers	The approach is published; the cut-offs are the tool's own
Expert judgement	No published source for the rule; based on epidemiological reasoning

Component	What the tool does	Basis	Status
Overall sequence	Describe cases by time, place and animal; form hypotheses; compare with laboratory results; control	CDC 13-step outbreak investigation (Lesson 6): "perform descriptive epidemiology", "develop hypotheses", "compare and reconcile with laboratory"	Published method
Regulatory incubation periods	HPAI 14 days (flock level), FMD 14, LSD 28, glanders 6 months	WOAH Terrestrial Code Articles 10.4.1, 8.8.1, 11.9.1, 12.10.1	Published standard

Component	What the tool does	Basis	Status
Biological incubation ranges	Minimum, average, maximum per disease	WOAH disease information as noted in the tool; glanders range consistent with CFSPH (2 to 6 weeks, up to months)	Published values, not re-verified for all four in this review
Exposure (source) window	Day 0 minus maximum to minus minimum incubation	WOAH South-East Asia field manual: count back the incubation period from cases to find the likely exposure period	Published method
Priority window ±20%	Most likely exposure ± 20% of the average incubation	Same manual: "widen your period of investigation by 10% to 20% on either side"	Published method; the manual counts back from the peak or median case, the tool from Day 0
Spread window	From earliest possible infection to Day C	Trace-forward principle in the same manual	Published method, tool boundaries
Curve types	Point source, continuous, intermittent, propagated	CDC Quick Learn on epi curves; WOAH South-East Asia manual (propagated = peaks about one incubation period apart)	Published concept
Curve thresholds	Peak = 35% of the top day; gap within 60% of the incubation; point source if span ⩽ incubation range	Chosen to put the published shapes into rules	Expert judgement
Case status	Suspected, probable, confirmed	CDC Lesson 6 case classification; USDA APHIS avian influenza case definition	Published method

Component	What the tool does	Basis	Status
HPAI control zones	Infected (core) zone 1 km, surveillance (alert) zone 10 km; a case beyond the zones = possible new focus	DAHD Action Plan for Avian Influenza (Revised 2021): infected zone 1 km, surveillance 1 to 10 km, cases beyond 3 km treated as a fresh outbreak	Published standard (India)
Lifting dates	Earliest: last case + maximum; conservative: + 2 × maximum	WOAH Article 10.4.6: HPAI freedom may be regained 28 days (two flock-level incubation periods) after stamping-out and disinfection of the last establishment	Consistent in principle; see caution below
HPAI pathways and weights	Wild birds and surface water weighted high; biosecurity as a contributing factor	EFSA 2017 opinion: wild birds the most likely source of introductions; access to water bodies a key factor; high biosecurity reduces entry about 44-fold	Pathways published; weights expert judgement
HPAI vehicles weight 3	Feed, live-bird and dead-bird vehicles weighted 3	EFSA addresses vehicles, equipment and people through ranked control measures, not entry weights	Expert judgement
LSD pathways	Vectors (6 questions), animal introduction, semen and needles	Bianchini et al. 2023 systematic review: insect vectors (mainly stable flies) the main route; cattle trade for long distance; semen possible; direct contact minor	Pathways published; weights expert judgement

Component	What the tool does	Basis	Status
Glanders pathways	Shared feed and water, latent carriers, fomites, human exposure flag	CFSPH glanders factsheet (2025): communal feeding and watering, subclinical carriers, harness and troughs, zoonotic risk	Pathways published; weights expert judgement
FMD pathways	Introduction, markets, shared grazing, vehicles, people, feed	Standard FMD epidemiology; no source opened in this review	Expert judgement until reviewed
Movement points (+4 / +2 / ±1)	A dated movement in the exposure window outweighs a general practice	Reasoning: a documented event on the right day is direct evidence for the pathway	Expert judgement
Distance (5 km, 1 km) and zone adjustments	Far cases favour animal movement; tight clusters favour local routes	Reasoning from transmission range	Expert judgement
Assessment thresholds	Delays compared with the minimum incubation period; cases after Day C + maximum = measures not holding	Reasoning from incubation periods	Expert judgement
Confidence 55%	Probable if ticked causes hold 55% or more and ⩽ 2 unknowns	Chosen as "more than half the evidence"	Expert judgement

Caution on lifting dates. WOAH counts the 28 days from disinfection of the last affected establishment, not from the last case. The DAHD plan also requires three months of post-operation surveillance after the sanitisation certificate before declaring freedom. The tool's dates are an epidemiological guide, not a regulatory release date.

Sources

- CDC. Principles of Epidemiology, Lesson 6, Section 2: Steps of an outbreak investigation.
- CDC. Quick Learn: Using an epi curve to determine mode of spread.
- WOAH Sub-Regional Representation for South-East Asia (2018). A Field Manual for Animal Disease Outbreak Investigation and Management.
- WOAH Terrestrial Animal Health Code. Chapter 10.4, Infection with high pathogenicity avian influenza viruses (Articles 10.4.1, 10.4.6).
- WOAH Terrestrial Animal Health Code. Chapter 8.8, Foot and mouth disease (Article 8.8.1).
- WOAH Terrestrial Animal Health Code. Chapter 11.9, Lumpy skin disease (Article 11.9.1).
- WOAH Terrestrial Animal Health Code. Chapter 12.10, Glanders (Article 12.10.1).
- Department of Animal Husbandry and Dairying, Government of India. Action Plan for Prevention, Control and Containment of Avian Influenza (Revised 2021).
- EFSA AHAW Panel (2017). Avian influenza. EFSA Journal 15(10):e04991, doi:10.2903/j.efsa.2017.4991.
- Bianchini J, Simons X, Humblet M-F, Saegerman C (2023). Lumpy skin disease: a systematic review of mode of transmission, risk of emergence and risk entry pathway. Viruses 15(8):1622.
- Spickler AR, CFSPH, Iowa State University (2025). Glanders factsheet.
- USDA APHIS. Avian influenza in poultry case definition (used for case status, from earlier work on the tool).

10. Limitations and validation before government use

The framework is transparent and traceable, but its weights have not been validated against real outbreaks. These are the points a technical reviewer is likely to raise, and what would answer them.

Limitation	Effect	What would address it
Weights are expert judgement	The ranking is only as good as the weights	A Delphi panel of state and central epidemiologists to agree weights per disease

Limitation	Effect	What would address it
Pathways with more questions can collect more points	HPAI has 9 vehicle and 8 wild bird questions but 1 feed question, so vehicles can outscore feed on volume alone	Cap or normalise each pathway's points by its number of questions
Good practices in place do not subtract	A farm with strong controls on one route still ranks that route on its other answers	Let a protective answer lower its pathway
"Don't know" adds nothing	Unknowns are invisible in the percentage	Already flagged when 3 or more; could widen a confidence band
Mortality, attack rate and case status do not affect the ranking	The size and speed of the outbreak do not inform the source	Use the mortality rise (for example doubling time) to separate a single introduction from repeated ones
HPAI curve needs 3 or more dated case rows	A one-row farm gets no curve shape in the ranking	Classify the daily mortality curve for poultry
Percentages look like probabilities	Users may read 61% as "61% likely"	Label as "share of the evidence" on screen and in the report
No retrospective test	Unknown hit rate	Run 20 to 30 closed investigations with an established source through the tool and record how often the true source ranks first or second

Studies identified for calibrating weights, not yet reviewed: a 2022 United States case–control study of HPAI H5N1 introduction onto table egg farms; a 2022–23 Japanese case–control study of H5N1 on commercial layer farms; a review of epidemiological risk models for FMD. Their reported odds ratios could replace expert weights where they apply.

Recommended position for the pitch: decision support organises the evidence the way published investigation methods require, ties every suggestion to the data that produced it, and leaves the conclusion with the officer. The scoring is a structured aid pending field validation, not a validated diagnostic or source-attribution model.

Risk factor weights

Every question on the Risk factors tab, the pathway it scores and its weight. Risk practice: Yes adds the weight. Good practice: No adds the weight. Sorted by weight, highest first.

Highly Pathogenic Avian Influenza (36 questions)

Question	Type	Pathway	Weight
Birds introduced from another farm, hatchery, exhibition, market or fair?	Risk practice	Introduction of animal	3
Outbreak reported within 10 km in the previous month?	Risk practice	Local spread	3
Birds sourced from or sold to a live bird market?	Risk practice	Market or gathering	3
Birds, eggs or other materials sent out to another farm, hatchery, abattoir, fair, market or exhibition?	Risk practice	Onward spread (flag)	3
Veterinarian, technician, vaccinating crew, debeaker, dealer or catching crew entered the farm?	Risk practice	People	3
Farm staff or visitors had previously been on another poultry farm, or keep poultry at home?	Risk practice	People	3
Staff shared with another poultry establishment?	Risk practice	People	3
Feed transport vehicle entered the farm?	Risk practice	Vehicles and equipment	3
Egg trays or crates returned from a market or another farm?	Risk practice	Vehicles and equipment	3
Vehicle collecting dead birds, litter or manure entered the farm?	Risk practice	Vehicles and equipment	3
Vehicle transporting live birds entered the farm?	Risk practice	Vehicles and equipment	3

Question	Type	Pathway	Weight
Wild or migratory birds can come into contact with the flock, shed, range or feed store?	Risk practice	Wildlife or wild birds	3
Untreated surface water used for drinking or cleaning?	Risk practice	Wildlife or wild birds	3
Wild bird die-off reported locally in the tracing window?	Risk practice	Wildlife or wild birds	3
Multi-age flocks on one site?	Risk practice	Biosecurity (contributing)	2
Shower, clothing change or boot change required at entry?	Good practice	Biosecurity (contributing)	2
Perimeter fencing present and intact?	Good practice	Biosecurity (contributing)	2
Weekly mortality was already rising in the 6 weeks before the first clinical signs?	Risk practice	Carrier on premises	2
Feed shared with, or obtained from, another poultry establishment?	Risk practice	Feed or water supply	2
Another poultry farm within 1 km?	Risk practice	Local spread	2
Spent hens sold or collected during the window?	Risk practice	Market or gathering	2
Equipment shared with, or borrowed from, another poultry establishment?	Risk practice	Vehicles and equipment	2
Egg collection vehicle entered the farm?	Risk practice	Vehicles and equipment	2
Vehicle shared with another poultry establishment?	Risk practice	Vehicles and equipment	2
Litter collected by, or recycled with, another poultry establishment?	Risk practice	Vehicles and equipment	2
Farm within 3 km of a wetland, lake, canal or migratory stopover?	Risk practice	Wildlife or wild birds	2

Question	Type	Pathway	Weight
Other bird species present on the site, captive or free — ducks, geese, pigeons, pet birds?	Risk practice	Wildlife or wild birds	2
Bird-proof nets present and intact on the sheds?	Good practice	Wildlife or wild birds	2
Ponds, lakes or other water reservoirs on or next to the farm?	Risk practice	Wildlife or wild birds	2
Visitors allowed into sheds without recorded permission?	Risk practice	Biosecurity (contributing)	1
Rodent and fly control maintained?	Good practice	Biosecurity (contributing)	1
Dead birds removed and safely disposed of every day?	Good practice	Biosecurity (contributing)	1
Pigs or other animals kept on the site?	Risk practice	Biosecurity (contributing)	1
Other poultry farms located between 1 km and 10 km from the outbreak?	Risk practice	Local spread	1
Fuel, gas or other service vehicle entered the farm?	Risk practice	Vehicles and equipment	1
Sheds ventilated naturally (open-sided) rather than by a closed, artificial system?	Risk practice	Wildlife or wild birds	1

Foot and Mouth Disease (22 questions)

Question	Type	Pathway	Weight
Swill or kitchen waste fed to animals, especially to pigs?	Risk practice	Feed or water supply	3
New animal purchased or introduced into the herd?	Risk practice	Introduction of animal	3
Animals brought in from a district with a known or rumoured outbreak?	Risk practice	Introduction of animal	3

Question	Type	Pathway	Weight
Outbreak reported within 10 km in the previous month?	Risk practice	Local spread	3
Animal returned from a livestock market, fair or mela?	Risk practice	Market or gathering	3
Visit by a veterinarian or para-vet who had visited an affected unit?	Risk practice	People	3
Common grazing ground shared with other herds?	Risk practice	Shared grazing or water	3
Herd vaccinated against FMD within the last 6 months?	Good practice	Susceptibility (contributing)	3
Visit by a milk collector, tanker or milk van to the premises?	Risk practice	Vehicles and equipment	3
Footbath, boot change or vehicle disinfection in use at entry?	Good practice	Biosecurity (contributing)	2
Green fodder cut from a field grazed by outside animals?	Risk practice	Feed or water supply	2
Shared bull for natural service, or unverified AI semen?	Risk practice	Iatrogenic	2
Introduced animals quarantined or isolated for 14 days or more?	Good practice	Introduction of animal	2
Common draught or transport animals moving between villages?	Risk practice	Introduction of animal	2
Fence-line or roadside contact with neighbouring stock?	Risk practice	Local spread	2
Visit by a livestock trader, butcher or broker?	Risk practice	People	2
Common water source — pond, canal, trough shared with other herds?	Risk practice	Shared grazing or water	2
Feed, fodder or bedding vehicle entered the animal area?	Risk practice	Vehicles and equipment	2
Carcass or offal of a dead animal disposed of near the premises?	Risk practice	Feed or water supply	1

Question	Type	Pathway	Weight
Premises within 3 km of a livestock market, slaughterhouse or highway halt?	Risk practice	Local spread	1
Second-hand or shared equipment brought onto the premises?	Risk practice	Vehicles and equipment	1
Wild or feral cloven-hoofed animals access the premises or grazing area?	Risk practice	Wildlife or wild birds	1

Lumpy Skin Disease (21 questions)

Question	Type	Pathway	Weight
Needles reused across animals for injection or vaccination?	Risk practice	Iatrogenic	3
New cattle purchased or introduced?	Risk practice	Introduction of animal	3
Animals brought from another district or state?	Risk practice	Introduction of animal	3
Outbreak reported within 10 km in the previous 2 months?	Risk practice	Local spread	3
Animals attended a market, fair or cattle camp?	Risk practice	Market or gathering	3
Herd vaccinated against LSD at least 3 weeks before onset?	Good practice	Susceptibility (contributing)	3
High biting fly or mosquito burden observed on the animals?	Risk practice	Vectors	3
Stagnant water, pond, irrigation channel or waterlogging adjacent to the shed?	Risk practice	Vectors	3
Insecticide, repellent or fly control used during the window?	Good practice	Vectors	3
Ear tagging, dehorning or surgical instruments shared without disinfection?	Risk practice	Iatrogenic	2

Question	Type	Pathway	Weight
Natural service by an outside bull, or AI with unscreened semen?	Risk practice	Iatrogenic	2
Introduced animals quarantined for 28 days?	Good practice	Introduction of animal	2
Stray or abandoned cattle mixing with the herd?	Risk practice	Introduction of animal	2
Common grazing ground shared with other herds?	Risk practice	Shared grazing or water	2
Common water trough or pond shared with other herds?	Risk practice	Shared grazing or water	2
Manure or slurry allowed to accumulate near animals?	Risk practice	Vectors	2
Tick burden present on the animals?	Risk practice	Vectors	2
Warm, humid or post-monsoon conditions during the window?	Risk practice	Vectors	2
Herd housed at high density or tethered close together?	Risk practice	Biosecurity (contributing)	1
Carcass or hide of an affected animal handled or disposed of nearby?	Risk practice	Feed or water supply	1
Premises near a highway, cattle transport route or market?	Risk practice	Local spread	1

Glanders (22 questions)

Question	Type	Pathway	Weight
Any equid on the premises with chronic nasal discharge or ill thrift?	Risk practice	Carrier on premises	3
Any unexplained equid death on the premises in the previous 6 months?	Risk practice	Carrier on premises	3
Carcass of a dead equid opened, skinned or fed to dogs?	Risk practice	Human exposure (flag)	3

Question	Type	Pathway	Weight
New equid purchased, hired or introduced?	Risk practice	Introduction of animal	3
Animal brought from a district with known glanders?	Risk practice	Introduction of animal	3
Equids tested serologically before introduction?	Good practice	Introduction of animal	3
Glanders confirmed within 10 km in the previous 6 months?	Risk practice	Local spread	3
Animal returned from a fair, race, procession or wedding season work?	Risk practice	Market or gathering	3
Communal water trough used by equids from other owners?	Risk practice	Shared grazing or water	3
Shared feed manger or nosebag?	Risk practice	Shared grazing or water	3
Watering at a public tank, pond or roadside point?	Risk practice	Shared grazing or water	3
Working in a tonga, brick kiln, or transport line with mixed ownership?	Risk practice	Shared grazing or water	3
Harness, bits or saddlery shared between animals or owners?	Risk practice	Vehicles and equipment	3
Poorly ventilated, crowded stabling?	Risk practice	Biosecurity (contributing)	2
Premises screened serologically within the last year?	Good practice	Biosecurity (contributing)	2
Handlers with skin lesions, fever or respiratory illness in the window?	Risk practice	Human exposure (flag)	2
Gloves and protective equipment used when handling discharges?	Good practice	Human exposure (flag)	2
Needles or instruments reused between animals?	Risk practice	Iatrogenic	2
Introduced equids quarantined before mixing?	Good practice	Introduction of animal	2

Question	Type	Pathway	Weight
Animals stabled or tethered in close contact with equids of other owners?	Risk practice	Local spread	2
Contact at a common work site, market or construction site?	Risk practice	Market or gathering	2
Grooming brushes, buckets or rugs shared?	Risk practice	Vehicles and equipment	2