WOAH SRR-SEA capacity building on risk analysis for transboundary animal disease control purposes in Southeast Asia

World Organisation for Animal Health

Australian Government
Department of Agriculture, Fisheries and Forestry

UNIT 6
RISK PATHWAYS

Department of Emerging diseases and Global health

Animal Health Research Centre (CISA)

Institute for Agronomic and Food Research (INIA)

Spain's Research Council (CSIC)

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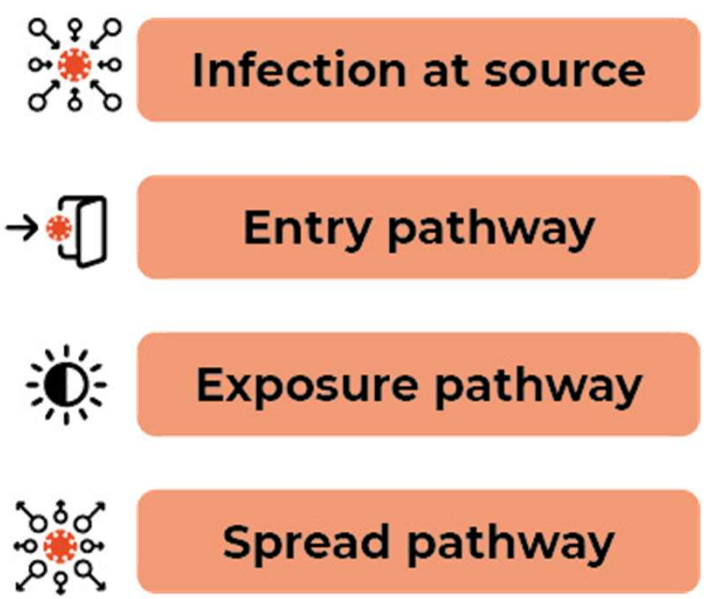
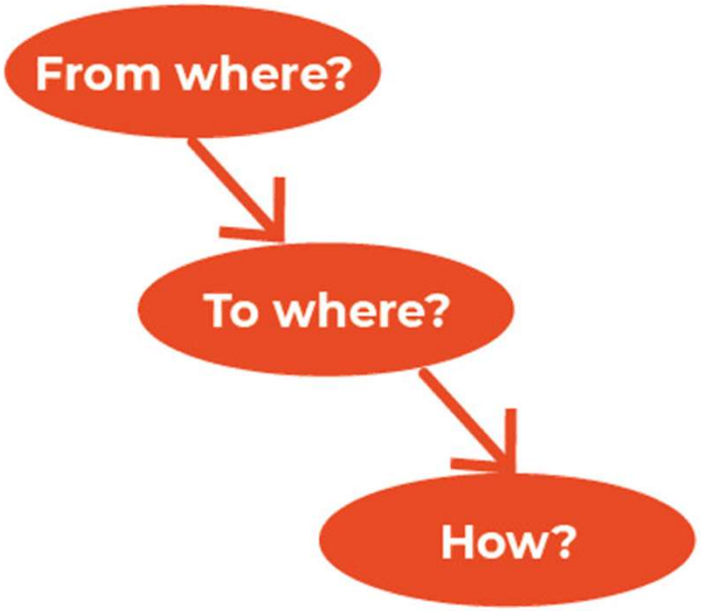
INIA CSIC

Risk pathway for TADs control

How an infection/disease “moves” from a **source** ot a **receptor**





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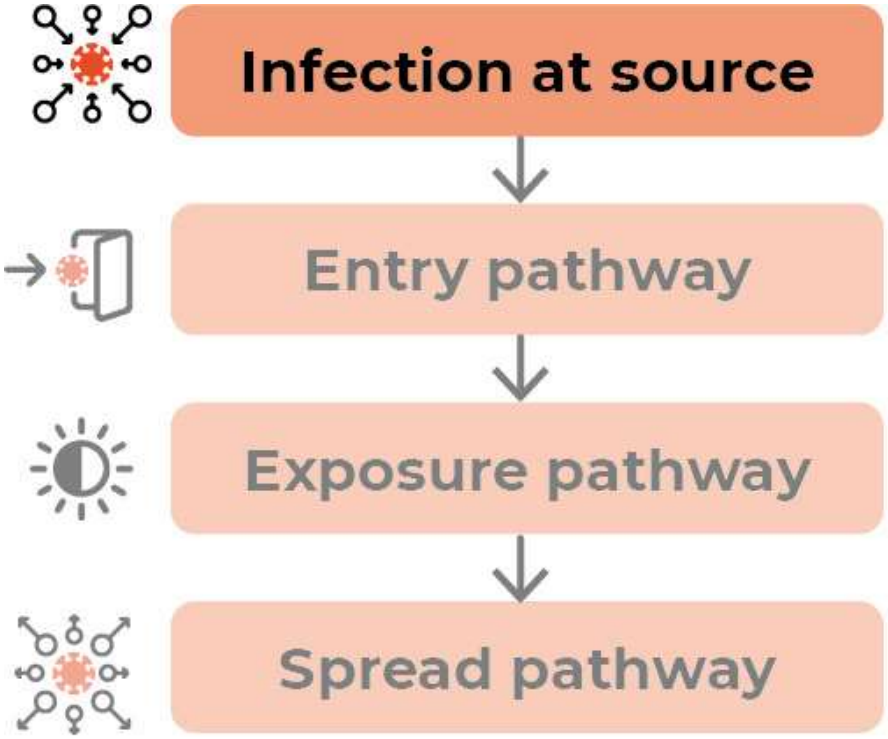

Recall Unit 2

Assessment of the infection situation

- how much infection
- how fast it spreads

Likelihood a 'potential source' is infected

Potential sources:

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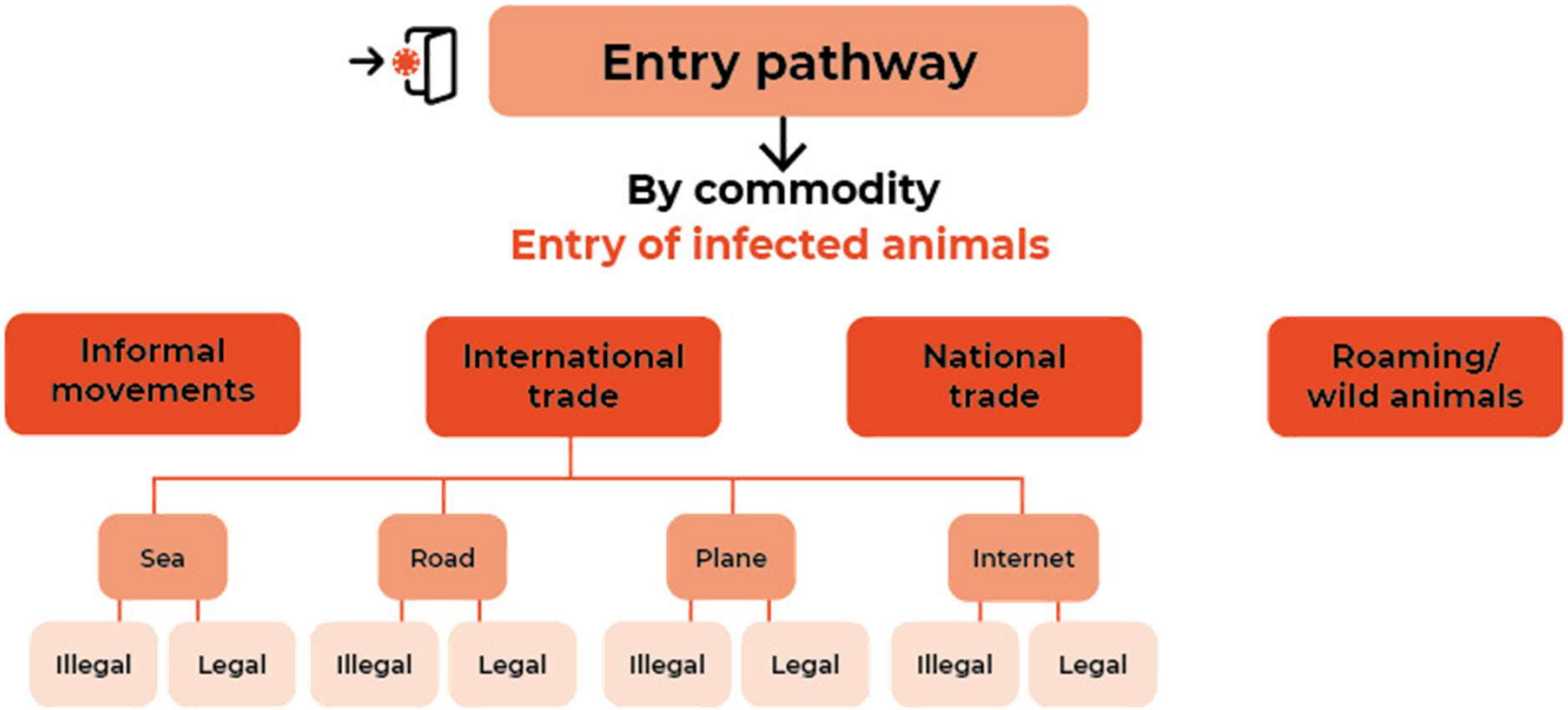

Very important to frame the RA question: WHAT, WHEN, HOW

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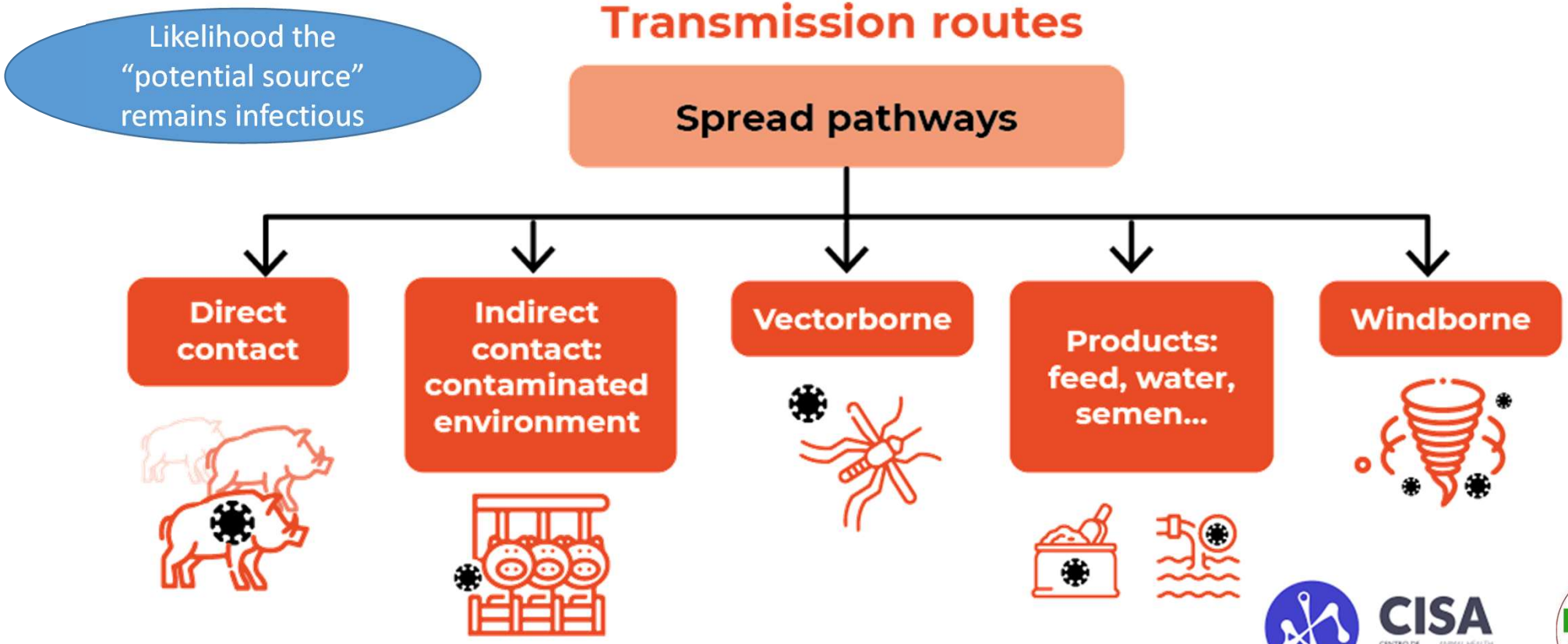


Risk pathway for TADs control

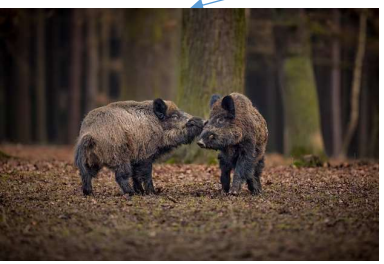
How an infection/disease “moves” from a **source** to a **receptor**

Likelihood the “potential source” remains infectious

Spread pathways

ASF

Transmission routes



Direct contact
- Wild boar movements
- Live pig trade

Indirect contact:
- contaminated trucks

Products:
- Product trade
- Waste food
- Contaminated water

Framing the RA question

What is the risk of entry of ASF in a free area?

HOW

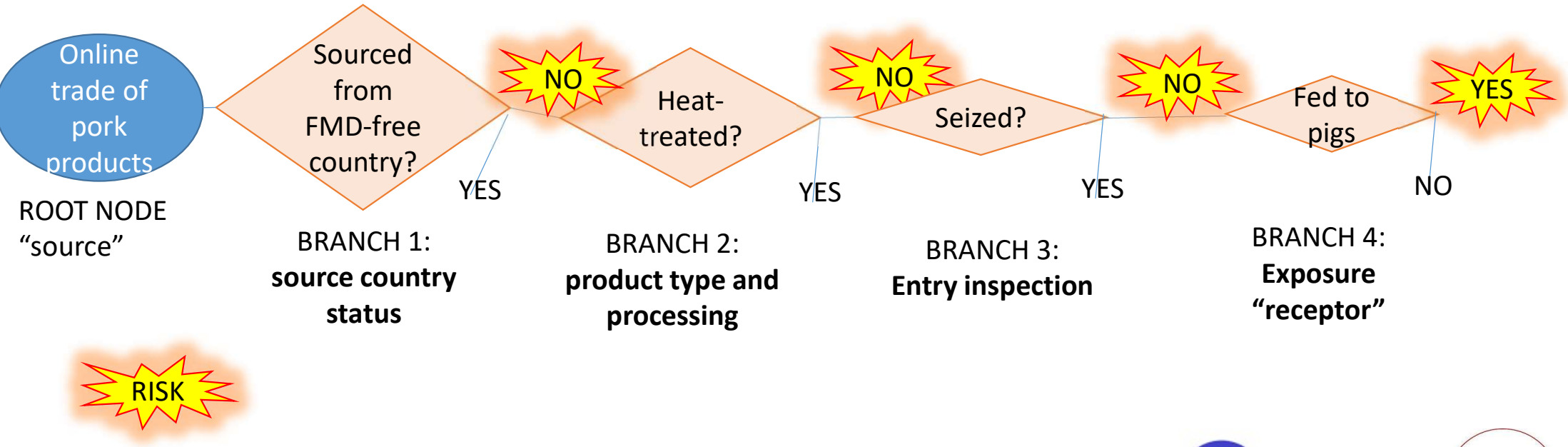
WHAT

What is the risk of entry of ASF **through online trade** of **pork products** in a free area **for the next Chinese New Year**?

WHEN

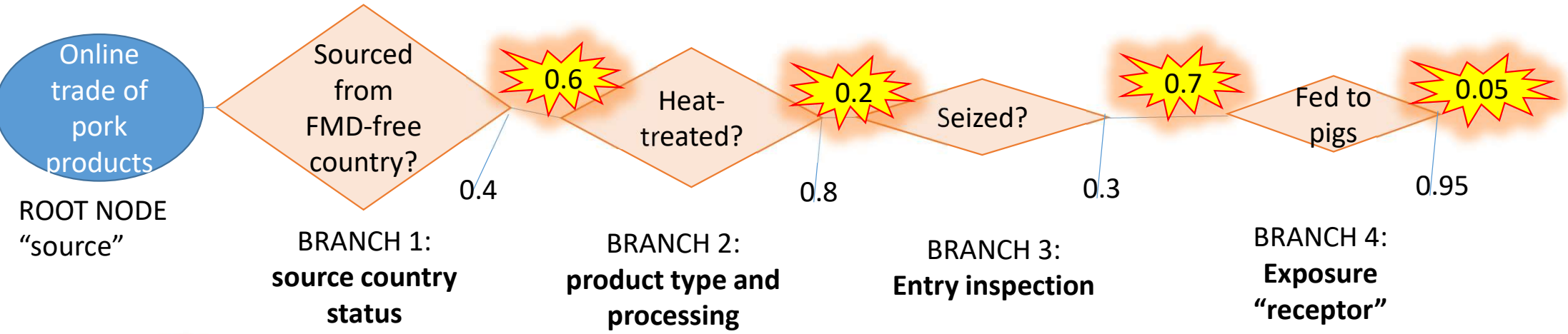
Scenario tree analysis

What is the risk of entry of ASF **through online trade** of **pork products** in a free area **for the next Chinese New Year**?



Scenario tree analysis

What is the risk of entry of ASF **through online trade** of **pork products** in a free area **for the next Chinese New Year**?



p

P= 0.6 X 0.2 x 0.7 x 0.4= 0.033

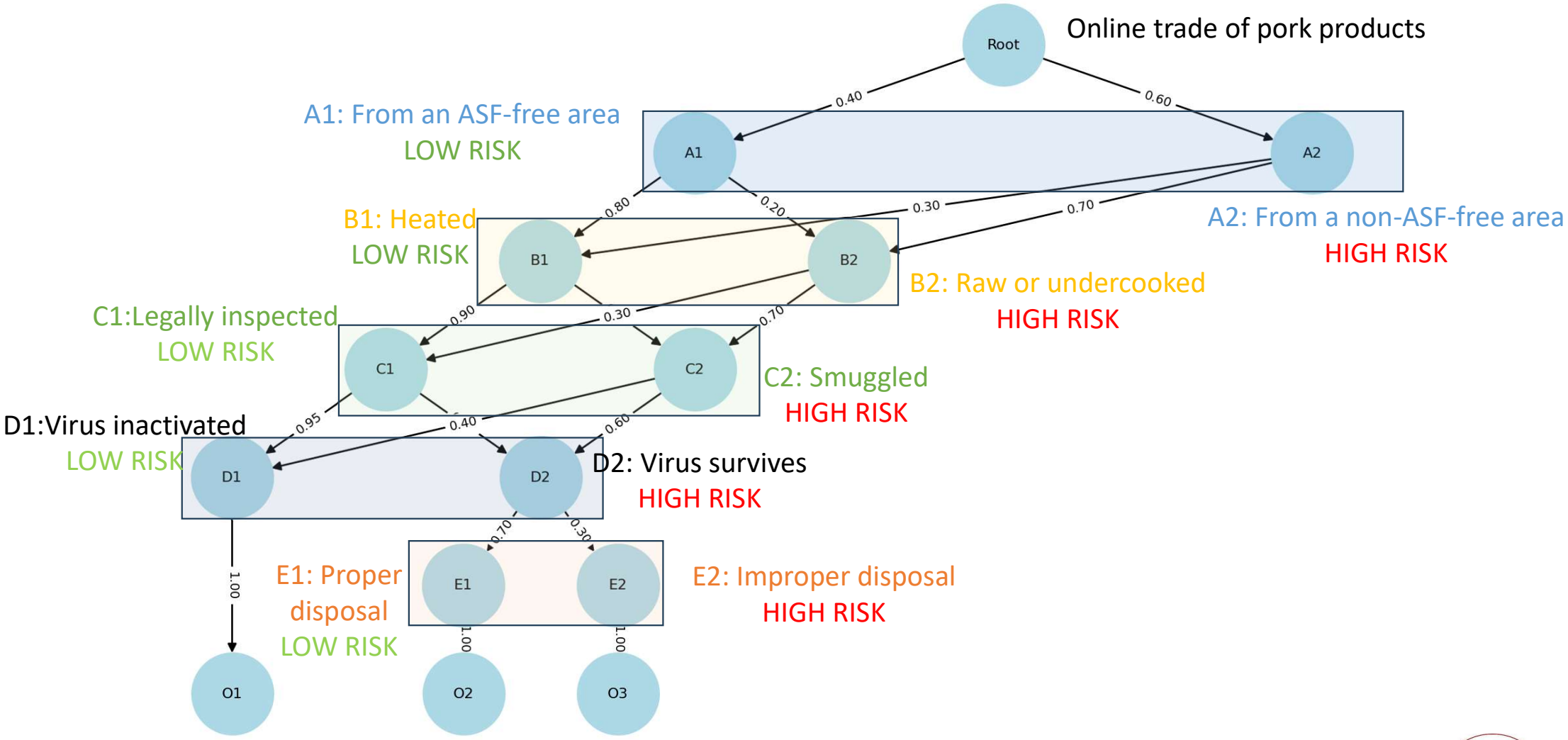
Scenario tree analysis

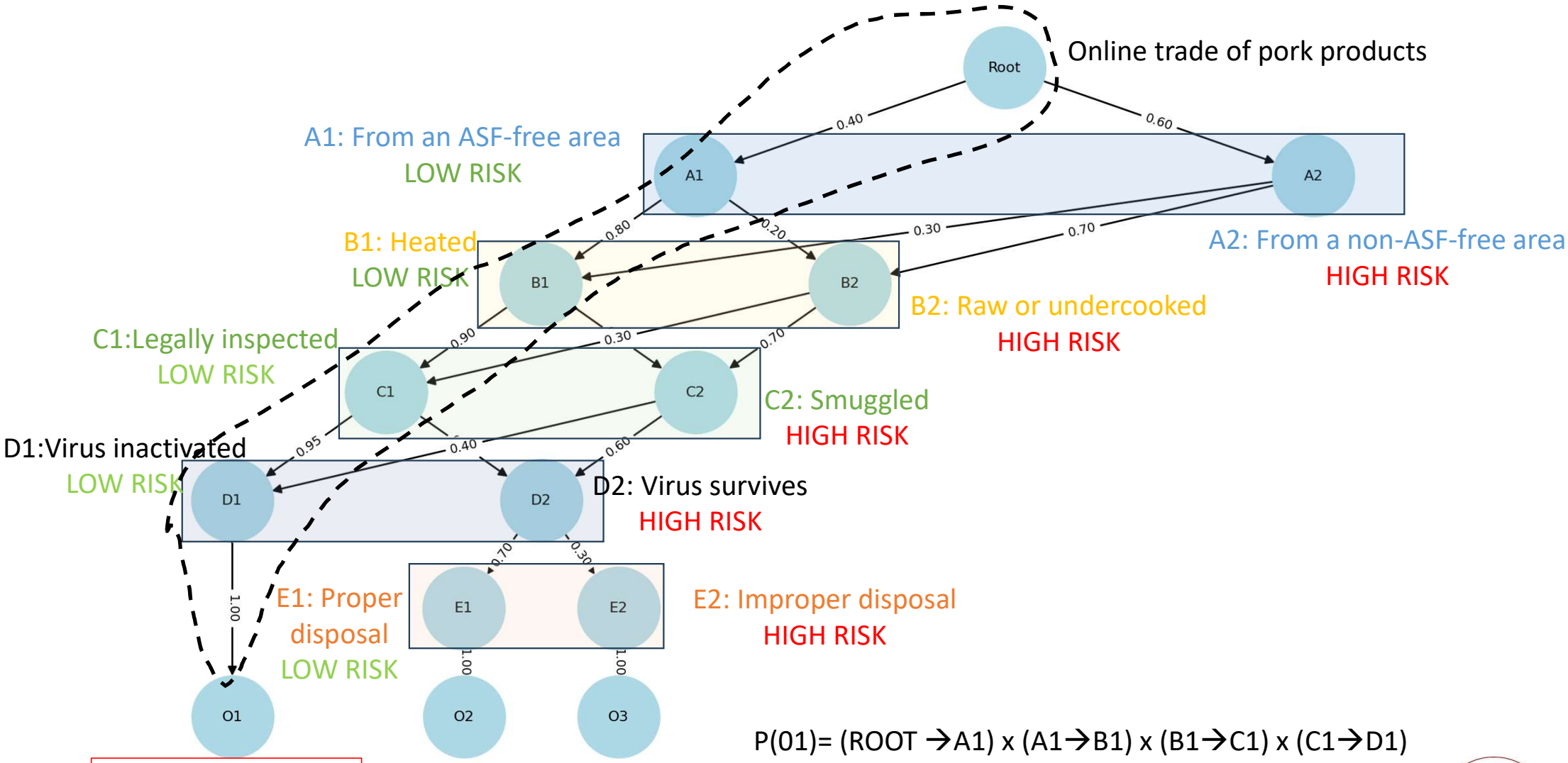
What is the risk of entry of ASF **through online trade** of **pork products** in a free area **for the next Chinese New Year**?

Building the scenario tree, **considering all the what-ifs** is far more important than the final probability risk value.

What other branches can you think of in the above RA question?

Feedback: probability that FMDV continues to be infectious

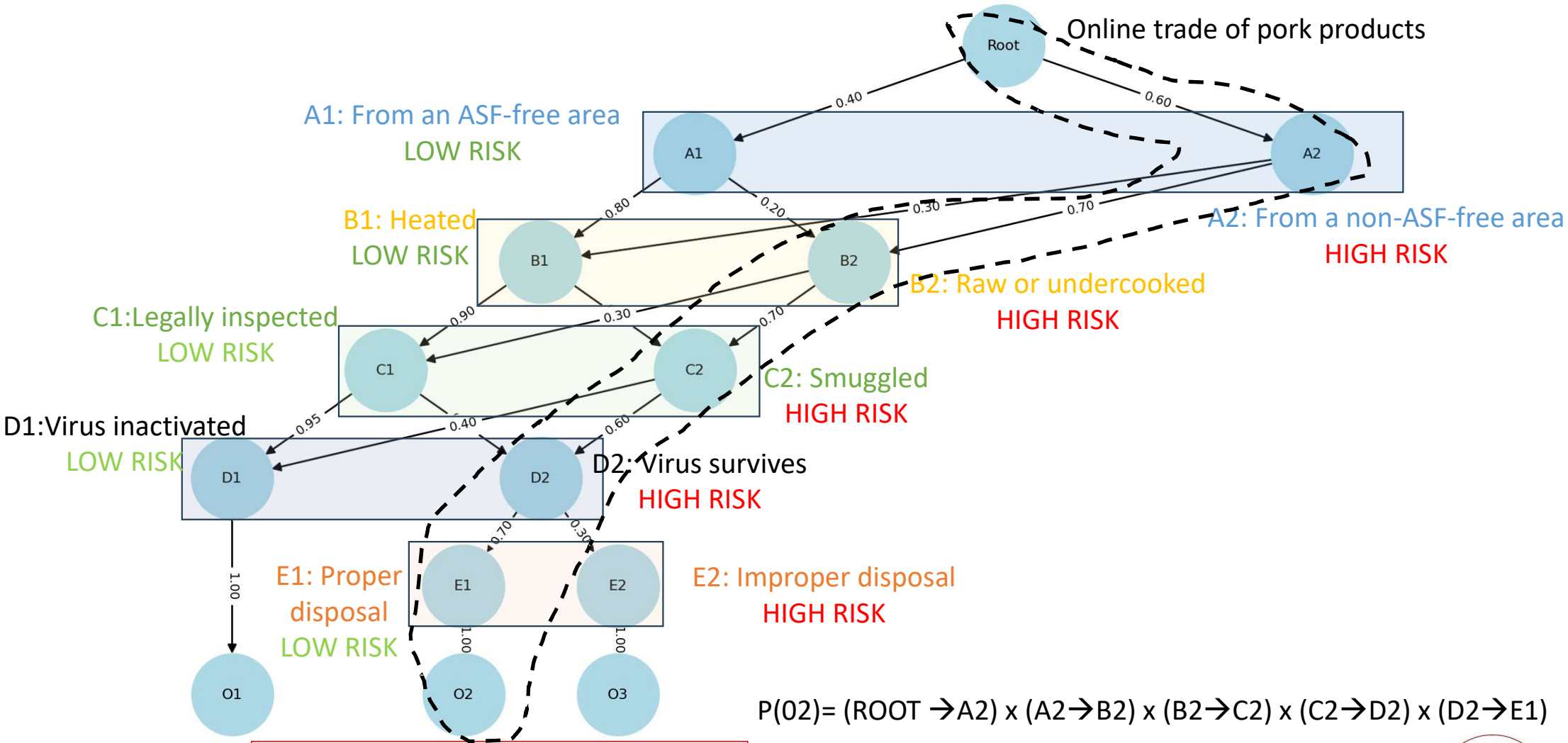

Root
Online trade of pork products
0.40
0.60
A1: From an ASF-free area
LOW RISK
A1
A2
A2: From a non-ASF-free area
HIGH RISK
0.80
0.20
0.30
0.70
B1: Heated
LOW RISK
B1
B2
B2: Raw or undercooked
HIGH RISK
C1:Legally inspected
LOW RISK
0.90
0.30
0.70
C1
C2
C2: Smuggled
HIGH RISK
D1:Virus inactivated
LOW RISK
0.95
0.40
0.60
D1
D2
D2: Virus survives
HIGH RISK
0.70
0.30
E1: Proper
disposal
LOW RISK
E1
E2
E2: Improper disposal
HIGH RISK
1.00
1.00
1.00
O1
O2
O3



Outcome1:
No ASF introduced
LOW RISK

P(01)= (ROOT →A1) x (A1→B1) x (B1→C1) x (C1→D1)

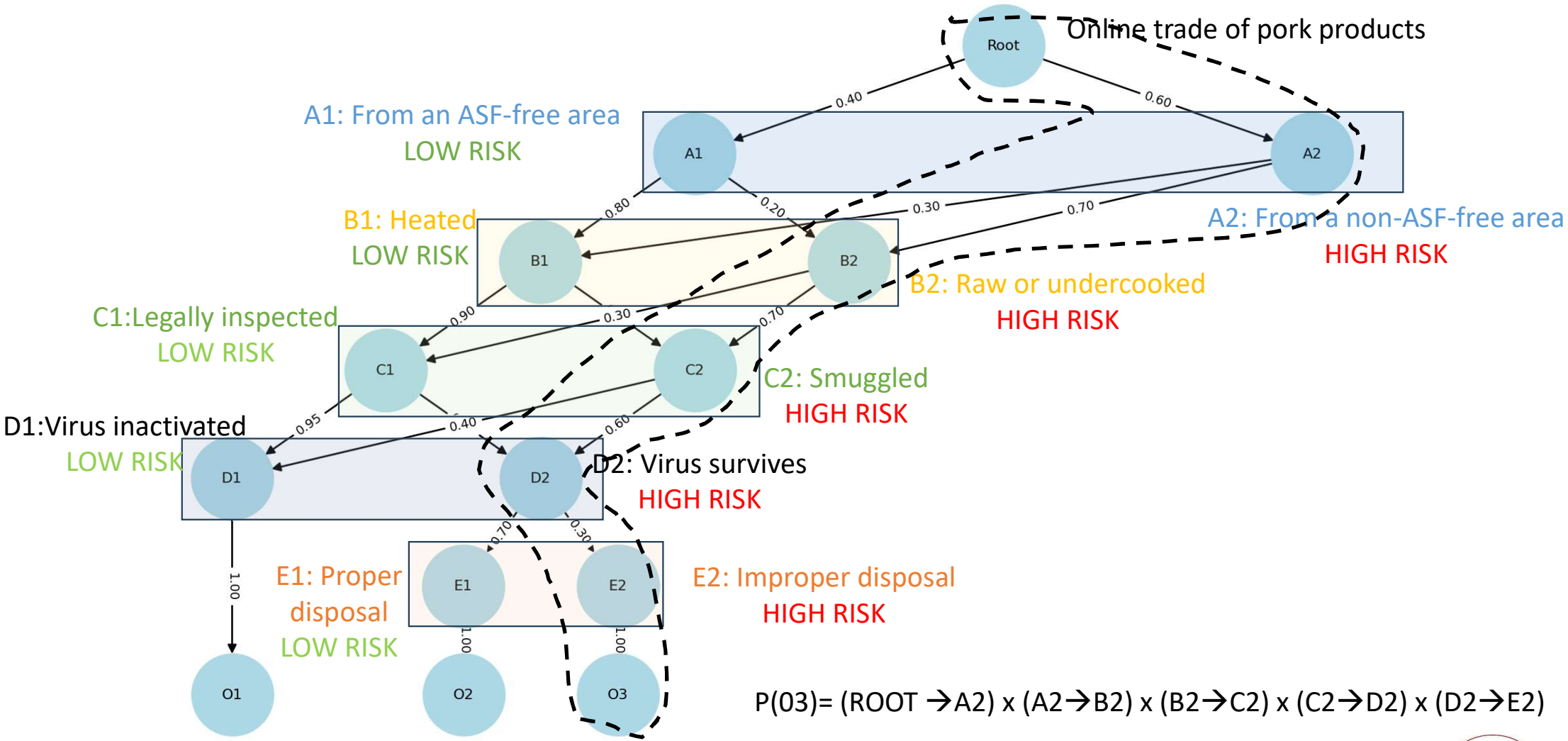
P(01)= 0.4 x 0.8 x 0.9 x 0.95 =0.2736
(27.4%)



P(02)= (ROOT →A2) x (A2→B2) x (B2→C2) x (C2→D2) x (D2→E1)

Outcome2:
ASF introduced, but no OUTRBEAK
INTERMEDIATE RISK

P(02)= 0.6 x 0.7 x 0.7 x 0.6 x 0.7 =0.1235
(12.4%)



P(03)= (ROOT →A2) x (A2→B2) x (B2→C2) x (C2→D2) x (D2→E2)

Outcome3:
ASF introduced and prob of OUTRBEAK
HIGH RISK

P(03)= 0.6 x 0.7 x 0.7 x 0.6 x 0.3 =0.053
(5.3%)

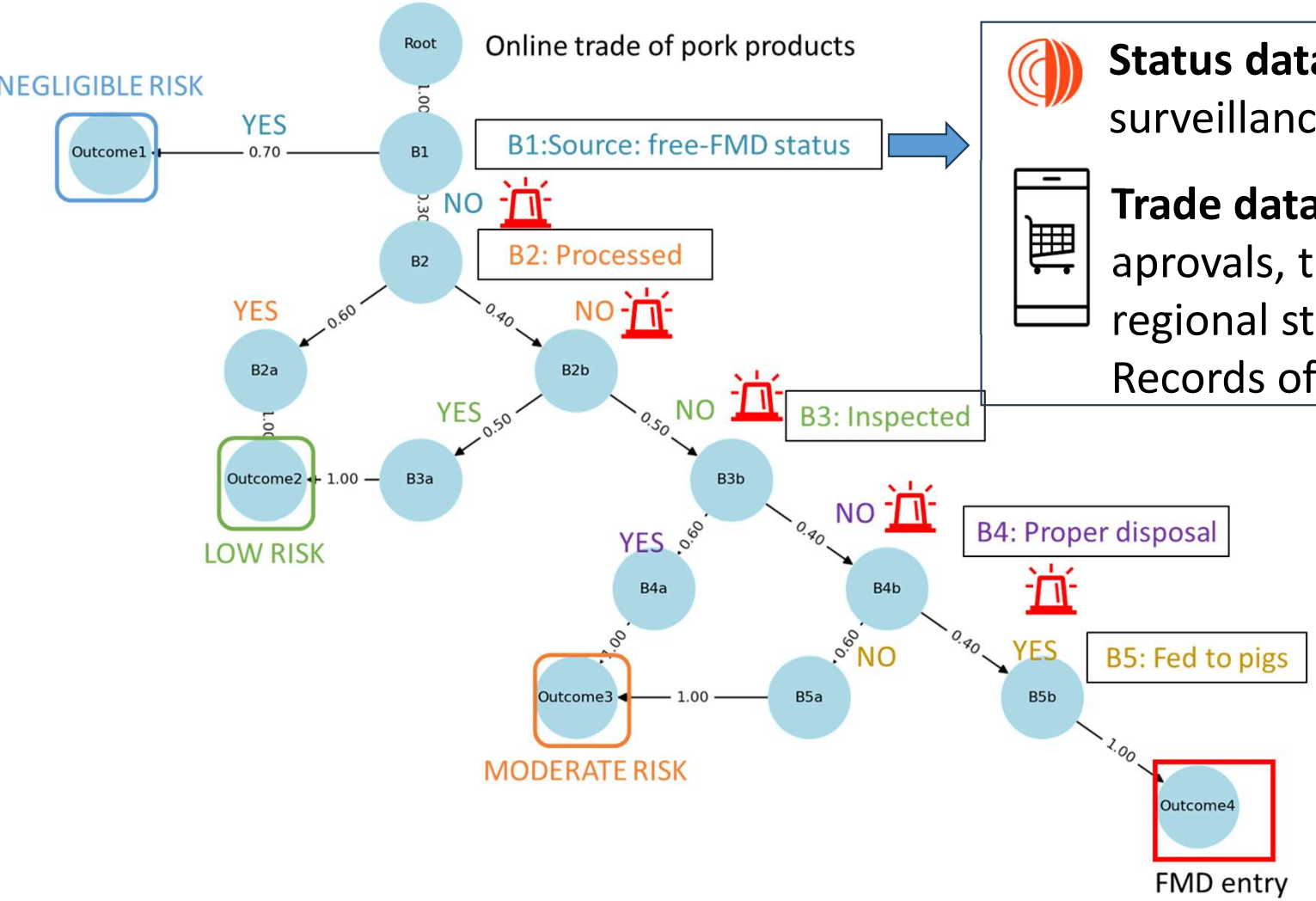
Scenario tree analysis

Final Outcome	Probability
No ASF Introduction (P(O1))	**27.4%**
ASF Entry Without an Outbreak (P(O2))	**12.3%**
ASF Outbreak (P(O3))	**5.3%**

INTERPRETATION:

This suggests that while the likelihood of an outbreak is relatively low (5.3%), there is a notable risk (12.3%) of ASF virus entering without causing an outbreak. Meanwhile, the highest probability (27.4%) corresponds to scenarios where no ASF introduction occurs.

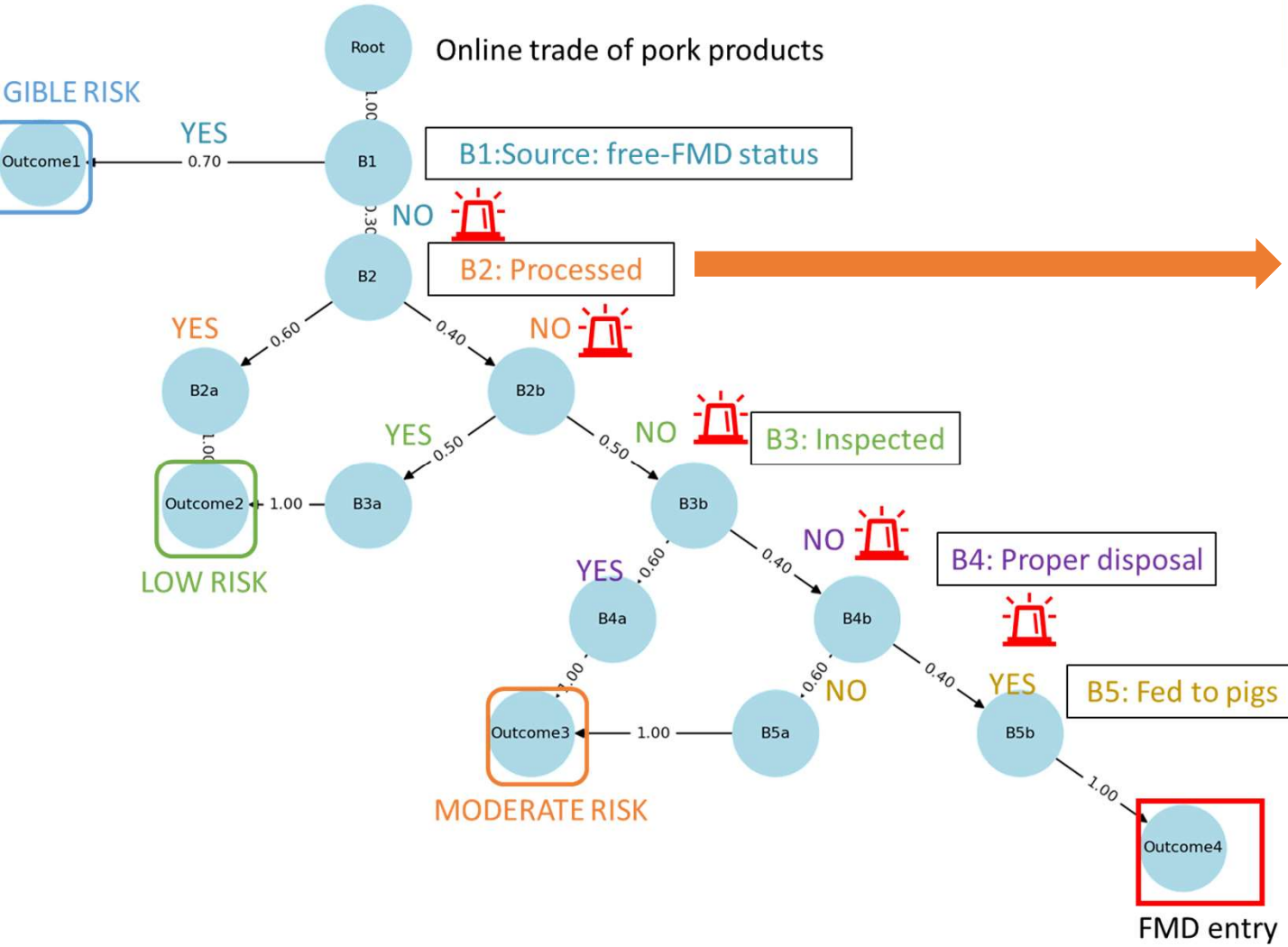
Data for analysis



Status data: WOAH, National surveillance

Trade data: import records, import aprovals, trade statistics (national or regional statistics, FAO). Online?? Records of online websites??

Data for analysis

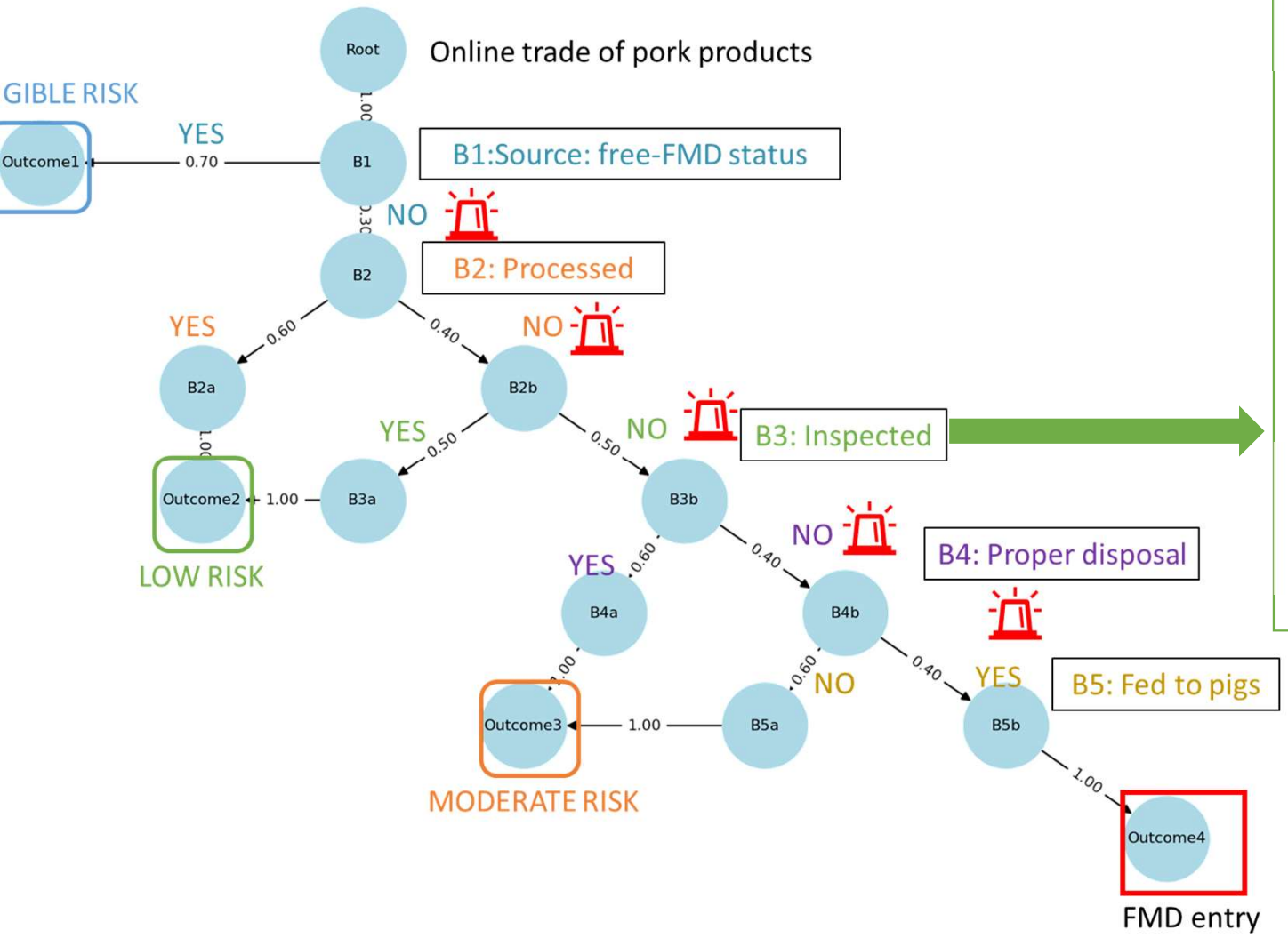


FMD survival data in different products: scientific articles, research studies

Guidelines on FMD risk management for pork imports (WOAH, FAO, EUFMD…) and health regulations specifying required processing levels

Industry reports from key product exporters, particularly if they trade online

Data for analysis

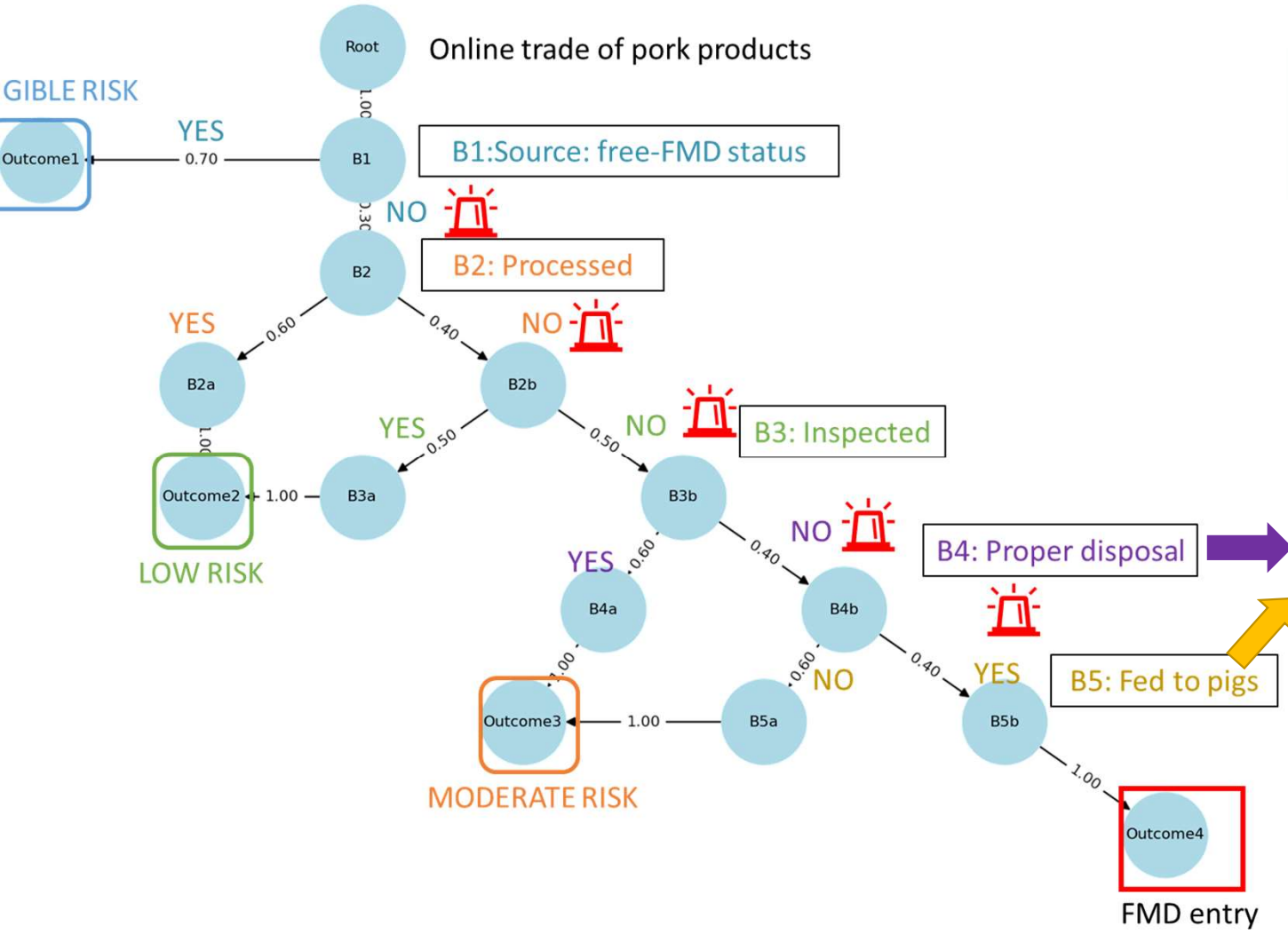


Customs seizures reports: enforcement data, Interpol or other international sources

Scientific studies on detection efficiency of smuggled products

Expert judgement customs and animal health officers

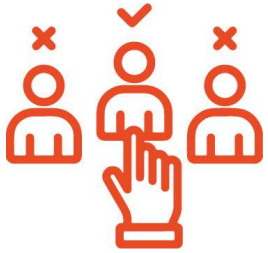
Data for analysis



Consumer or biosecurity surveys: enforcement data, Interpol or other international sources

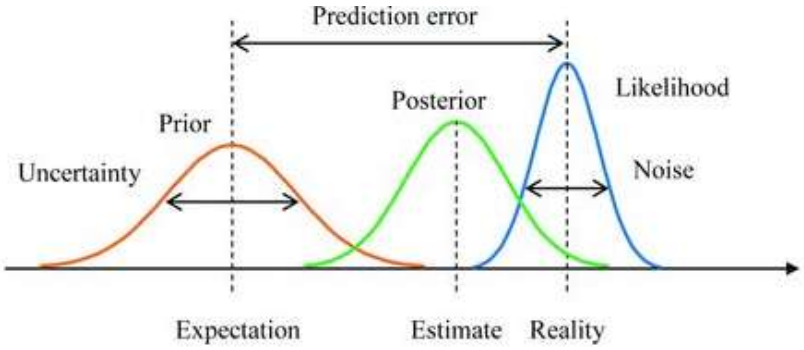
Risk assessment based on geospatial data (distance from animals to potential food sources), past FMD outbreaks…

When exact data is not available….



EXPERT elicitation
(Hoffman et al., 1995; O'Hagan et al., 2006)

Monte Carlo SIMULATIONS of different scenarios
(ie. @RISK software)



BAYESIAN inference, combining existing data with expert opinion

DOI: 10.3389/fncom.2019.00002

Uncertainties

Natural randomness (i.e. variability in detection rates)

We don’t know or we don’t have enough data to know with a degree of certainty (i.e. unknown volumen illegal pork trade)

Methods to handle uncertainties

A. CONFIDENCE SCORING

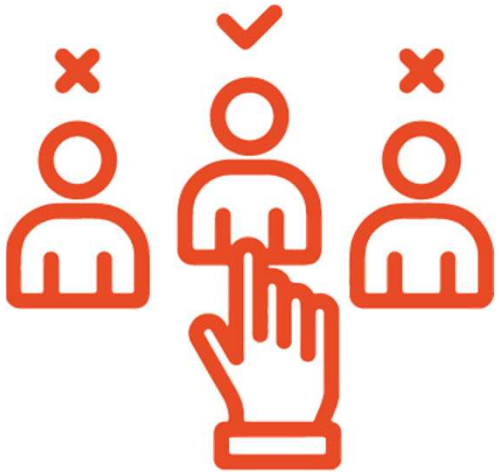
Low Uncertainty (High Confidence) → Strong data, multiple sources agree
Moderate Uncertainty → Some missing data, limited studies.
High Uncertainty (Low Confidence) → Lack of reliable data, conflicting information.

Risk level

	LOW	MODERATE	HIGH
Low uncertainty (high confidence)	Low concern	Monitor	Action needed
Medium uncertainty	Monitor	Caution	Precautionary control
High uncertainty (low confidence)	Data gap	Precautionary approach	Urgent action

Methods to handle uncertainties

B. EXPERT ELICITATION

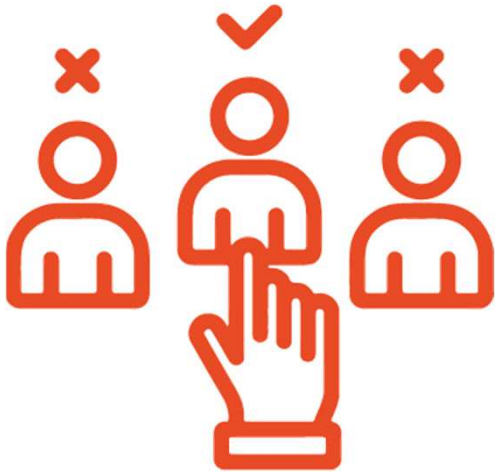


- **Delphi Method** → Multiple rounds of anonymous expert feedback until a consensus is reached.
- **Pairwise Comparison** → Experts rank risk factors in relative importance.
- **Nominal Group Technique (NGT)** → Structured discussions where experts vote on risk levels.

Example of pairwise comparison:
Ask a group of expert to vote, then choose the option with higher votes
Illegal trade is…than legal trade
a) More important
b) Equally important
c) Less important

Methods to handle uncertainties

C. SENSITIVITY ANALYSIS



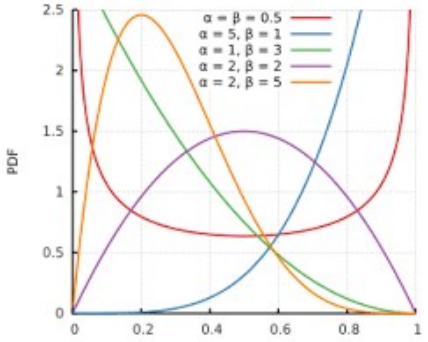
- **Scenario analysis**→ Best-case, worst-case, most likely.
- **Threshold analysis**→ Identify key risk factors, that, if changed, would alter risk classification

Example of qualitative sensitivity analysis:
If **customs detection efficiency** is highly uncertain, analyze how **different assumptions** (e.g., "High Detection" vs. "Low Detection") affect the **final risk rating**.

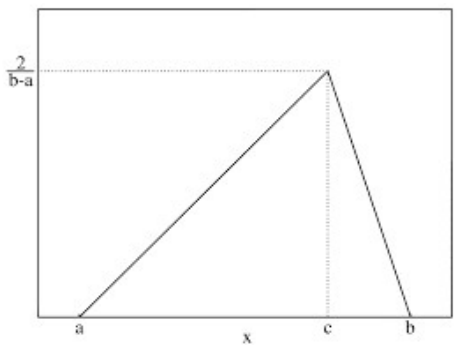
Methods to handle uncertainties

D. PROBABILITY DISTRIBUTIONS AND MONTE CARLO SIMULATIONS

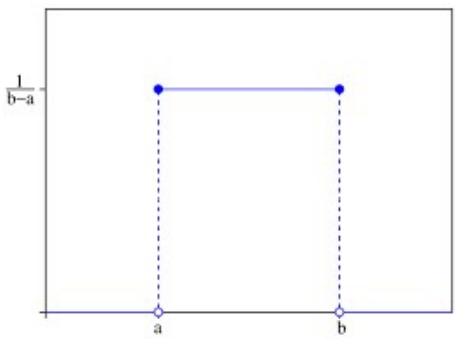
Example of quantitative simulations:
Instead of assuming **P(FMD Entry) = 0.96%**, run **10,000 simulations** where customs detection varies between **40%-60%** and analyze the average and confidence intervals.



Beta distribution



Triangular distribution



Uniform distribution

Example of probability distributions: If P(B2b) = 40% but could be anywhere from 30%-50%, assign a triangular distribution with:

- Min = 30%
- Most Likely = 40%
- Max = 50%

Decision making under uncertainty

Once uncertainty is **quantified**, we can apply **decision frameworks**:

- ***Expected Utility Theory*** → Weighs risks based on potential **economic & health impacts**.
- ***Precautionary Principle*** → If uncertainty is **high**, apply **stricter controls** (e.g., ban high-risk pork sources).
- **Cost-Benefit Analysis** → Compares the **costs of control measures** vs. **potential outbreak losses**
- ***Risk Communication*** → Ensure that **decision-makers understand** the **uncertainty level** in the assessment
- ***Adaptive Risk Management*** → Update the risk assessment as **new data becomes available**

Transparency and documentation

Clearly document which assumptions were made and **why**.
Specify:

- What **data sources were used**.
- Where **knowledge gaps exist**.
- How **uncertainty affects the conclusions**.

✅ **Example Application:**
If the **risk of FMD via online pork trade** is **"Moderate"**, but **data on swill feeding is missing**, explicitly state:
"Due to limited data on swill feeding practices, the uncertainty level is high, and the risk estimate may change with new information.

References

- OIE Handbook on Risk Analysis, 2010
- O'Hagan et al. 2006. Uncertain Judgements: Eliciting Experts' Probabilities. ISBN:9780470029992. John Wiley & Sons, Ltd
- Hoffman et al. 1995. Eliciting Knowledge from Experts: A Methodological Analysis. Organizational Behavior and Human Decision Processes, Volume 62, Issue 2, Pages 129-158, ISSN 0749-5978, https://doi.org/10.1006/obhd.1995.1039.
- Vose, 2008. Risk analysis: a quantitative guide. John Wiley & Sons. ISBN 978-0-470-51284-5
- Scientific articles:
  - Wieland et al., 2015. Foot and mouth disease risk assessment in Mongolia—Local expertise to support national policy. Preventive Veterinary Medicine 120, 115–123 http://dx.doi.org/10.1016/j.prevetmed.2014.11.017
  - Kwan et al., 2016. Quantitative risk assessment of the introduction of rabies into Japan through the illegal landing of dogs from Russian fishing boats in the ports of Hokkaido, JapanPrev Vet Med. 1;128:112-23. doi: 10.1016/j.prevetmed.2016.04.015
  - Hernández-Jover et al., 2015. Evaluating the risk of avian influenza introduction and spread among poultry exhibition flocks in Australia. Prev Vet Med. 2015 Jan 1;118(1):128-41. doi: 10.1016/j.prevetmed.2014.11.018.
  - Hernández-Jover et al., 2016. A Comparative Assessment of the Risks of Introduction and Spread of Foot-and-Mouth Disease among Different Pig Sectors in Australia. Front Vet Sci. 2016 Sep 22;3:85. doi: 10.3389/fvets.2016.00085.
  - Pearson et al., 2016. Evaluating the risk of pathogen transmission from wild animals to domestic pigs in AustraliaPrev Vet Med. 2016 Jan 1;123:39-51. doi: 10.1016/j.prevetmed.2015.11.017.
  - Scott et al., 2018. LPAI exposure risk assessment in Australian commercial chicken farms. Front.Vet. Sci, 5:68. doi: 10.3389/fvets.2018.00068