

GF-TADs Foot and Mouth Disease Risk Assessment Training Workshop

19 - 21 September 2023 Johannesburg, South Africa



Risk Assessment

Introduction and Concepts

General goals for Risk Assessment

General skills

- Understand broad based Risk Analysis concepts within the Veterinary field including the global frameworks available
- Have the ability to evaluate a risk analysis and classify it according to general principles and pathways
- Understand the roles of personnel linked to risk analysis
- Writing up a risk analysis project

Technical skills

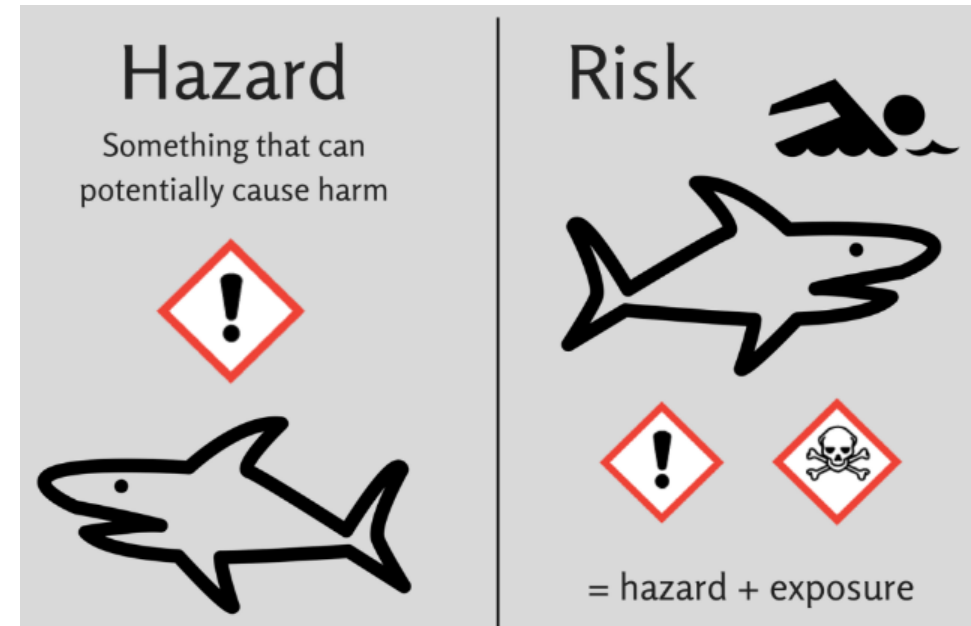
- Understand qualitative risk assessment and can perform one
- Establish estimates for quantitative risk assessment
 - Expert opinion elicitation
 - Probability distributions
- Access data and information for risk analysis

Understand scenario trees and perform quantitative risk assessment

What is risk?

- The likelihood (probability) of the
 - occurrence AND
 - likely magnitude of the
 - **biological** and
 - **economic consequences**
- of an adverse effect or effect to animal or human health

[OIE 2010]



<https://scimoms.com/hazard-risk/>

What is risk?

SOCIETY FOR RISK ANALYSIS GLOSSARY



Overall qualitative definitions:

1. Risk is the possibility of an unfortunate occurrence
2. Risk is the potential for realization of unwanted, **negative consequences** of an event
3. Risk is exposure to a proposition (e.g., the occurrence of a loss) of which one is uncertain
4. Risk is the **consequences** of the activity and associated uncertainties
5. Risk is uncertainty about and severity of the **consequences** of an activity with respect to something that humans value
6. Risk is the occurrences of some specified **consequences** of the activity and associated uncertainties
7. Risk is the deviation from a reference value and associated uncertainties

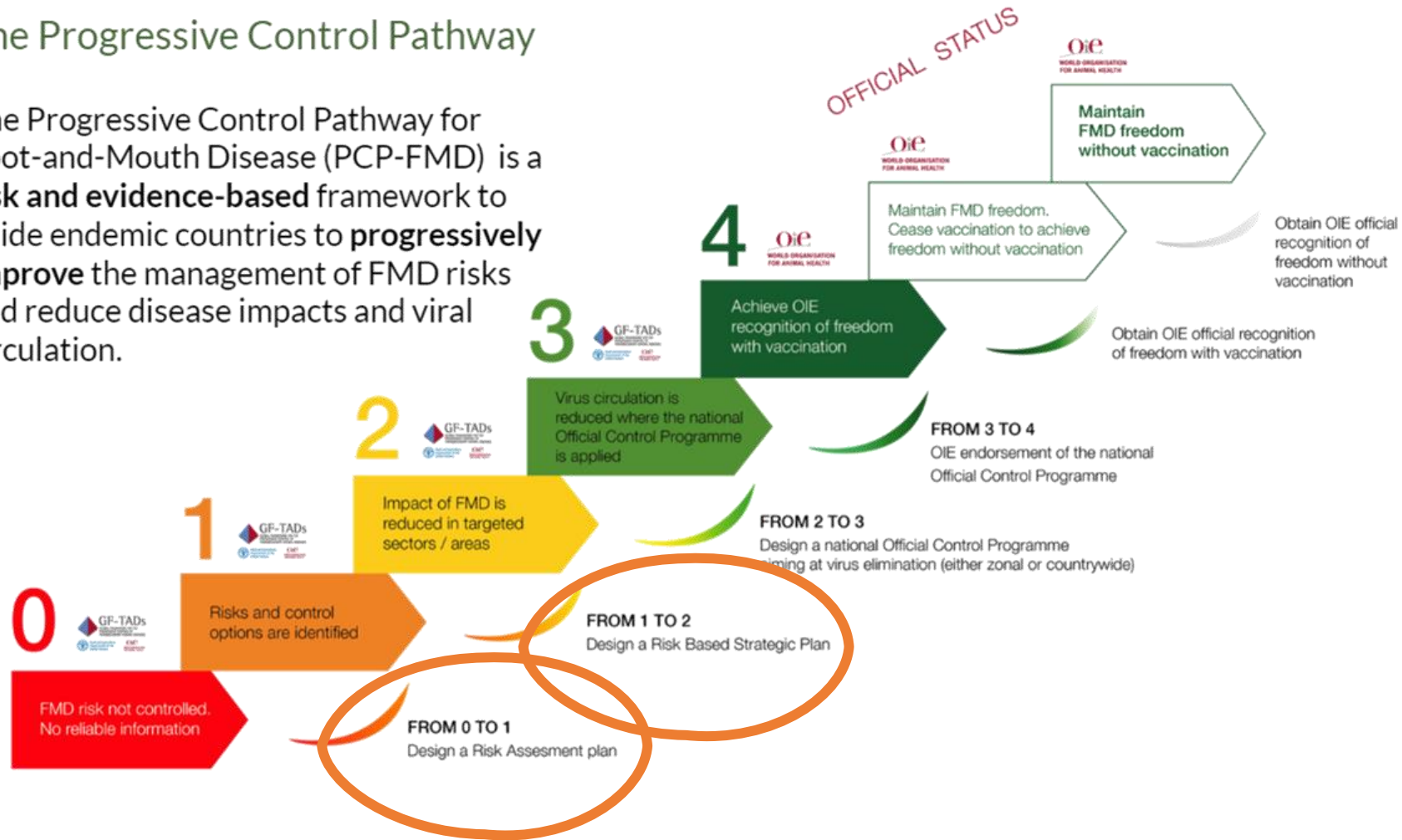
Risk analysis – who's who?



The Progressive Control Pathway

The Progressive Control Pathway

The Progressive Control Pathway for Foot-and-Mouth Disease (PCP-FMD) is a **risk and evidence-based** framework to guide endemic countries to **progressively improve** the management of FMD risks and reduce disease impacts and viral circulation.



PCP-FMD uses risk analysis principles

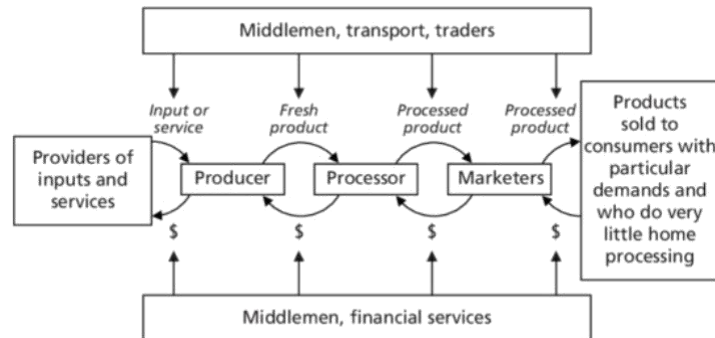
- Risk hotspots
 - in an **Area**
 - Through an **Activity**
 - Associated with a **Production sector**

Risk Assessment Plan – PCP

Key outcomes	Description	Indicator	Target	Risk/ Assumption
Outcome 1	All husbandry systems, the livestock-marketing network, key stakeholders and associated socio-economic drivers are well described and understood for FMD susceptible species (value-chain analysis)			
Outcome 2	The distribution of FMD in the country is well described and understood			
Outcome 3	Socio-economic impact of FMD on different stakeholders have been estimated			
Outcome 4	The most common circulating strains of FMDV have been identified			
Outcome 7	Important risk hotspots for FMD transmission and impact are identified and a ‘working hypothesis’ of how FMD virus circulates in the country has been developed			

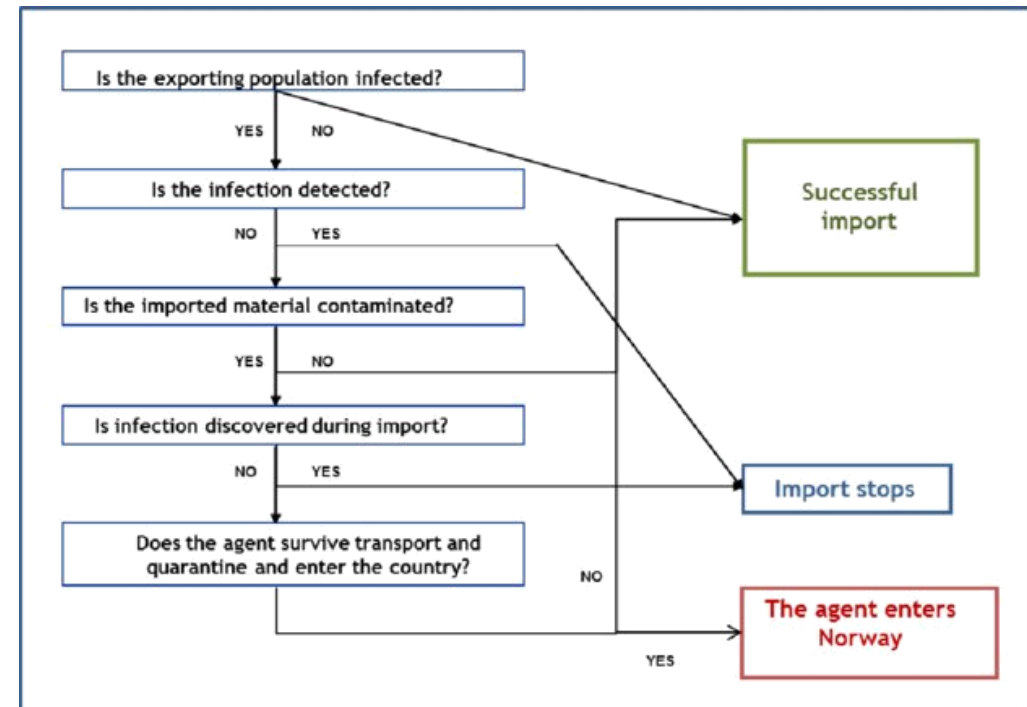
Formal risk assessment intertwined with RAP

Value chain analysis



FAO. 2011. A value chain approach to animal diseases risk management – Technical foundations and practical framework for field application. Animal Production and Health Guidelines. No. 4. Rome.

Risk assessment scenario tree



Risk assessment on import of Australian redclaw crayfish to Norway Opinion of the Panel on Animal Health and Welfare of the Norwegian Scientific

Committee for Food Safety

November 2016

DOI: 10.5281/zenodo.4029289

Report number: 2016:64 · Affiliation: Norwegian Scientific Committee for Food Safety



WOAH guidelines

**Handbook on
Import Risk Analysis
for Animals and Animal Products**

Volume 2
1st Edition, 2004
Quantitative risk assessment



World Organisation
for Animal Health
Founded as OIE

Published by
The World Organisation for Animal Health
(OIE)

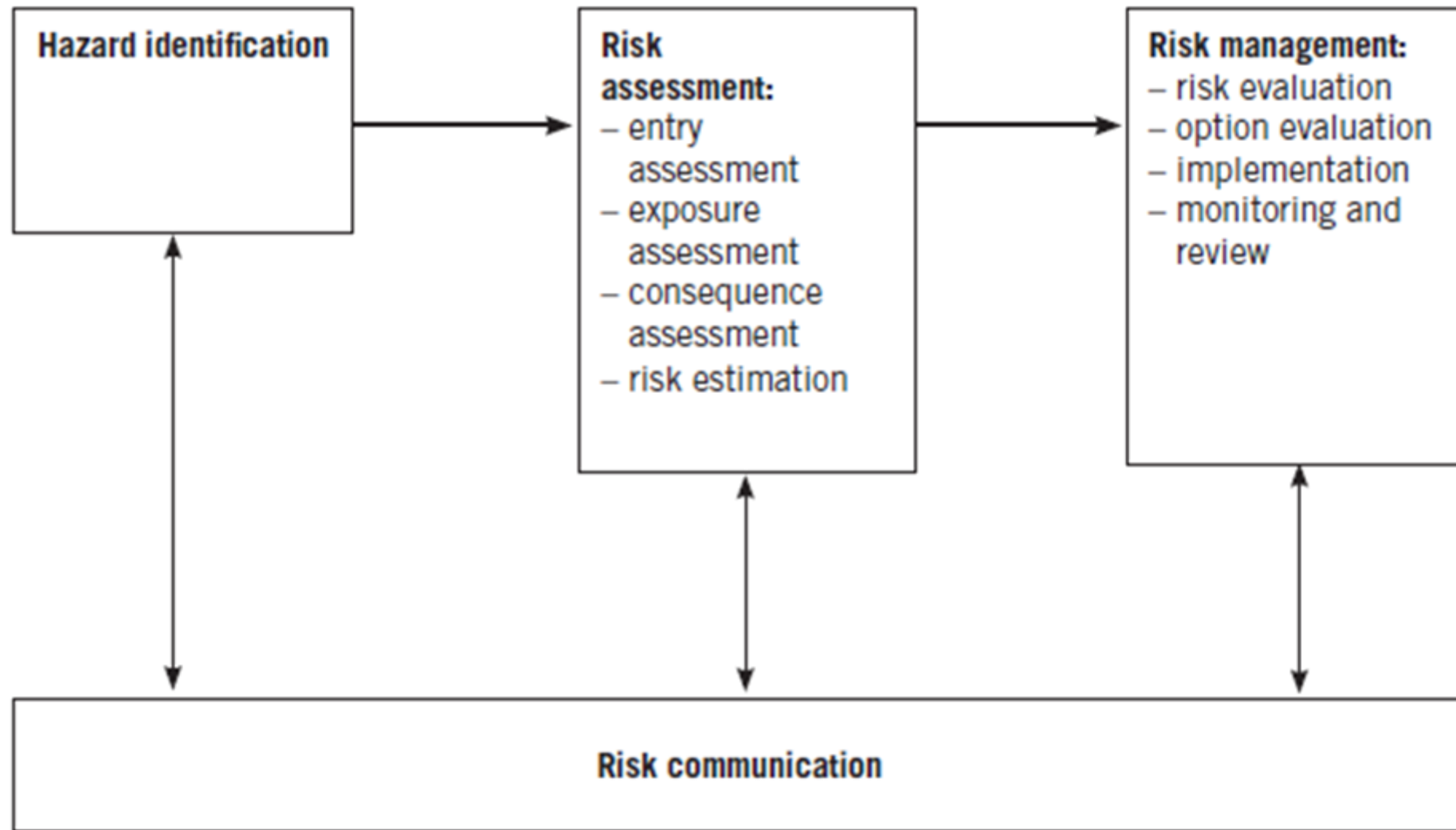
**Handbook on
Import Risk Analysis
for Animals and Animal Products**

Volume 1
2nd Edition, 2010
Introduction and qualitative risk analysis

Published by
The World Organisation for Animal Health
(OIE)

Risk analysis is systematic

1. Scope
2. State the question
3. Assemble a team
4. Develop a communication strategy
5. Determine what information is required and what data is available
6. Determine the approach
 1. Step 5 for each step of RA
 1. Population/Commodity of interest
 2. Hazard
 3. Risk Assessment
 1. Pathway/Entry assessment
 2. Exposure assessment
 3. Consequence assessment
 4. Risk estimation
7. Examine risk management strategies available
8. Formulate programme of risk management
9. Document assumptions, evidence, data and uncertainties
10. Peer review of communicating document
11. Publication



Different types of Animal Health risk Analysis

Import Risk Analysis – Between country




Preventive Veterinary Medicine

Volume 30, Issue 1, April 1997, Pages 49-59



A risk-assessment model for foot and mouth disease (FMD) virus introduction through deboned beef importation

Peter Yu^a , Tsegaye Habtemariam^a, Saul Wilson^b, David Oryang^a, David Nganwa^a,
Mike Obasa^a, Vinaida Robnett^a

Import Risk Analysis – Trans-zonal

ORIGINAL RESEARCH article

Front. Vet. Sci., 19 March 2019

Sec. Veterinary Epidemiology and Economics

Volume 6 - 2019 |

<https://doi.org/10.3389/fvets.2019.00078>

This article is part of the Research Topic

Risk Assessment, Decision Modelling, and Evidence-Based
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Quantitative Risk Assessment of Foot-and-Mouth Disease (FMD) Virus Introduction Into the FMD-Free Zone Without Vaccination of Argentina Through Legal and Illegal Trade of Bone-in Beef and Unvaccinated Susceptible Species



Andrea Marcos^{1*}

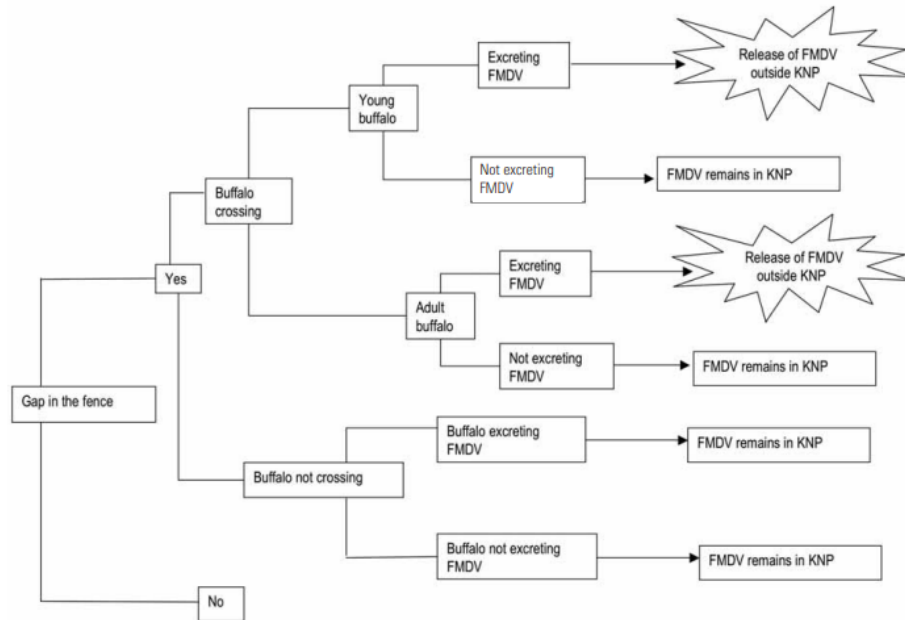


Andrés M. Perez²

Import Risk Analysis – Trans-zonal

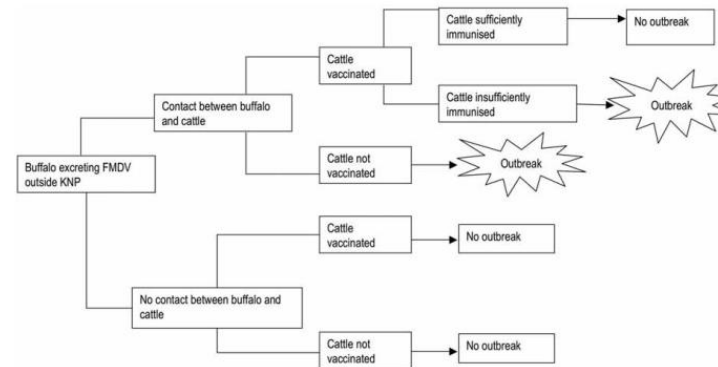
A qualitative risk assessment of factors contributing to foot and mouth disease outbreaks in cattle along the western boundary of the Kruger National Park

F. Jorj^(1,2), W. Vosloo^(5,6), B. Du Plessis⁽³⁾, R. Bengis⁽⁴⁾, D. Brahmhatt⁽⁸⁾, B. Gummow^(2,9) & G.R. Thomson⁽⁷⁾



FMDV: foot and mouth disease virus
KNP: Kruger National Park

Fig. 2
Possible pathway of release of the foot and mouth disease virus outside the boundaries of the Kruger National Park by escaped buffalo



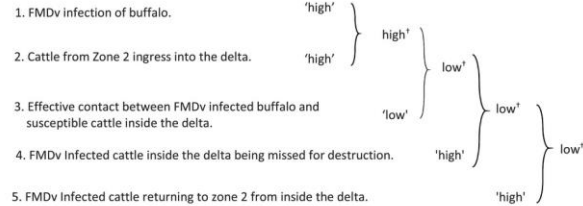
FMDV: foot and mouth disease virus
KNP: Kruger National Park

Fig. 3
Possible pathway of transmission of foot and mouth disease virus from buffalo to cattle and subsequent spread outside Kruger National Park

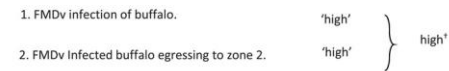
Import Risk Analysis – Trans-zonal

A. Probability of release

(i) Cattle ingress into delta and return

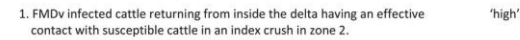


(ii) Buffalo egress to zone 2

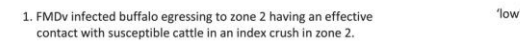


B. Probability of exposure

(i) Cattle ingress into delta and return

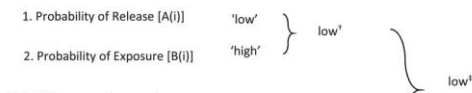


(ii) Buffalo egress to zone 2

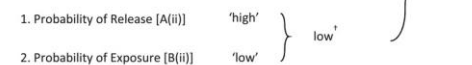


C. Probability of occurrence of hazard

(i) Cattle ingress into delta and return



(ii) Buffalo egress to zone 2

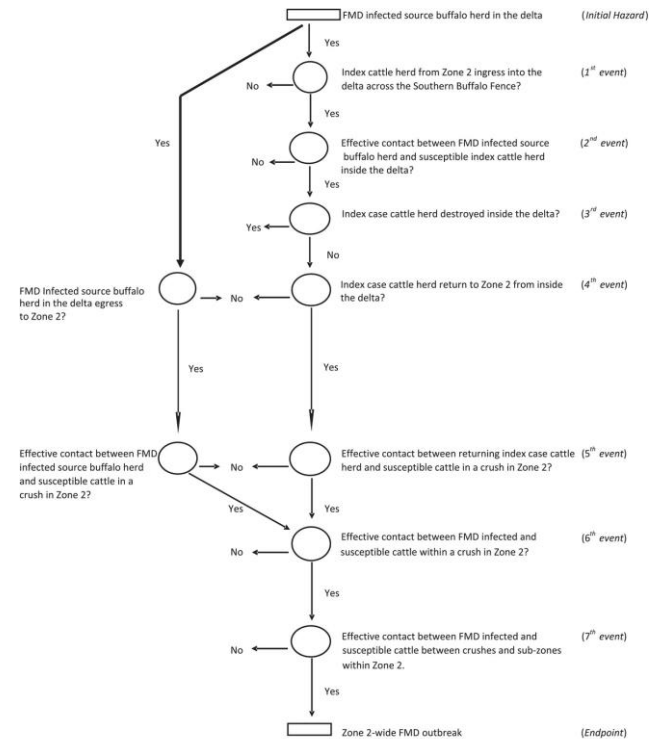


[†] Table 2 combination matrix adopted.
[‡] Table 3 combination matrix adopted.

A qualitative risk assessment indicates moderate risk of foot-and-mouth disease outbreak in cattle in the lower Okavango Delta because of interaction with buffaloes

Nlingisisi Dombolo Babayani ✉ Odireleng Idy Thlolwane

First published: 21 December 2021 | <https://doi.org/10.1111/tbed.14436>



Component specific – Risk factors

The landscape epidemiology of foot-and-mouth disease in South Africa: A spatially explicit multi-agent simulation

Elise Dion^{a,*}, Louis VanSchalkwyk^b, Eric F. Lambin^{a,c}

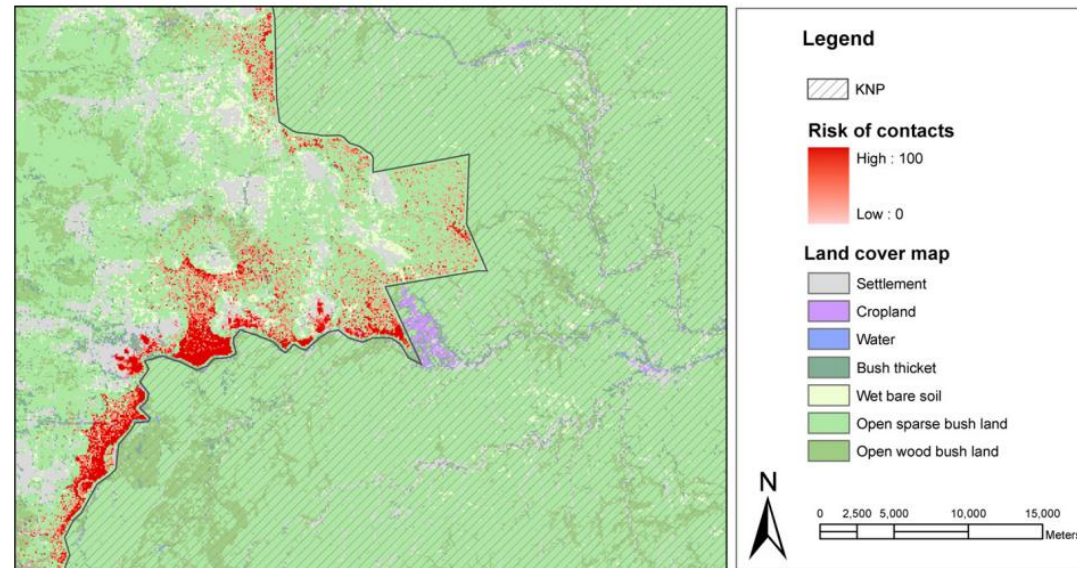
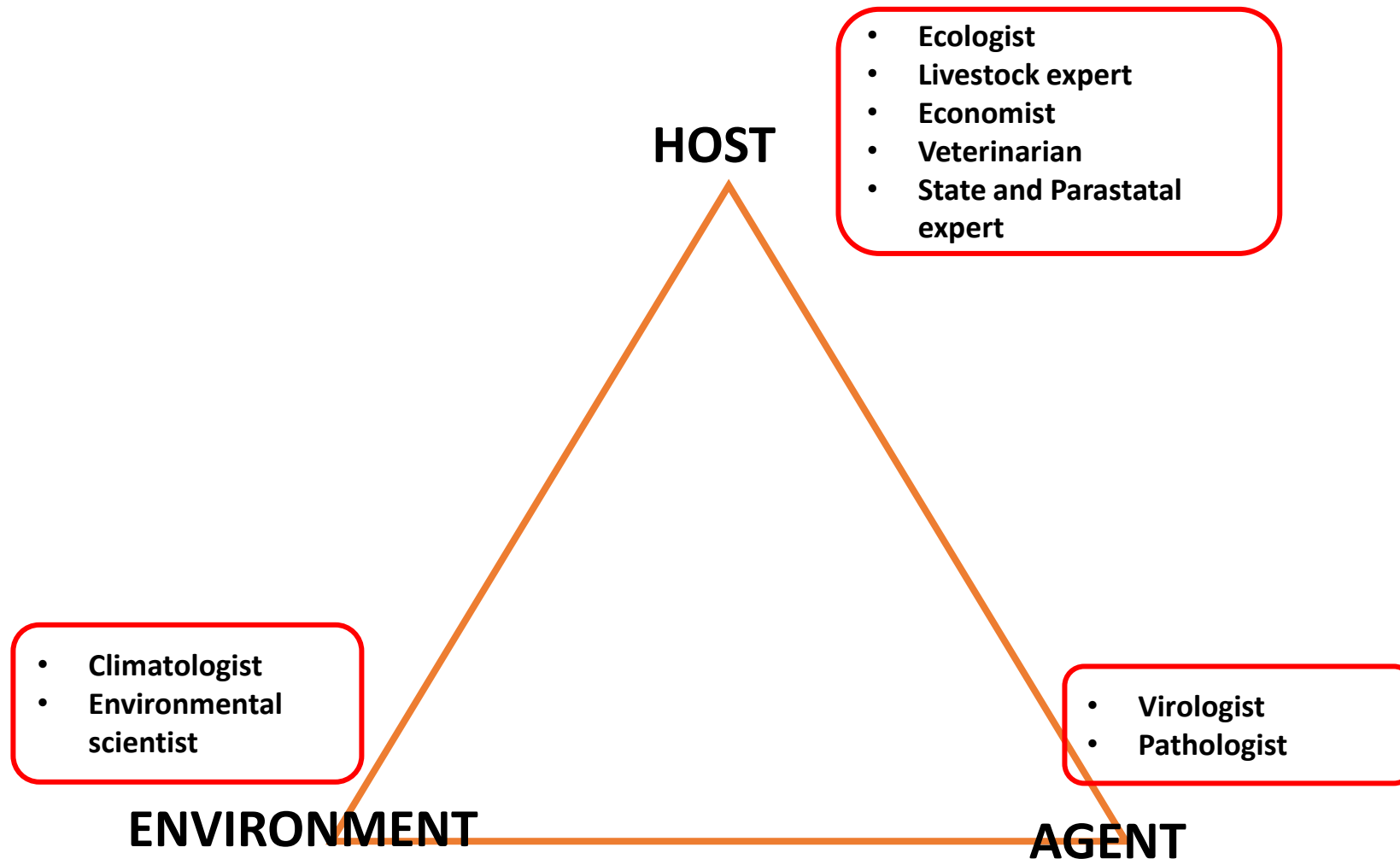


Fig. 7. Map of high contact areas showing the presence of buffaloes outside the park.

Risk Analysis is One Health



The Hazard

- *“A risk source where the potential consequences relate to harm. Hazards could, for example, be associated with energy (e.g., explosion, fire), material (toxic or eco-toxic), biota (pathogens) and information (panic communication).” **Glossary: SRA***
- *“means a biological, chemical or physical agent in, or a condition of, an animal or animal product with the potential to cause an adverse health effect.” **WOAH***
- *“A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.” **Codex Alimentarius***

The Hazard

Food safety risk analysis A guide for national food safety authorities

ISSN 0254-4725

FAO
FOOD AND
NUTRITION
PAPER

87

Box 1.3. Examples of hazards that may occur in foods

Biological hazards

- Infectious bacteria
- Toxin-producing organisms
- Moulds
- Parasites
- Viruses
- Prions

Chemical hazards

- Naturally occurring toxins
- Food additives
- Pesticide residues
- Veterinary drug residues
- Environmental contaminants
- Chemical contaminants from packaging
- Allergens

Physical hazards

- Metal, machine filings
- Glass
- Jewellery
- Stones
- Bone chips

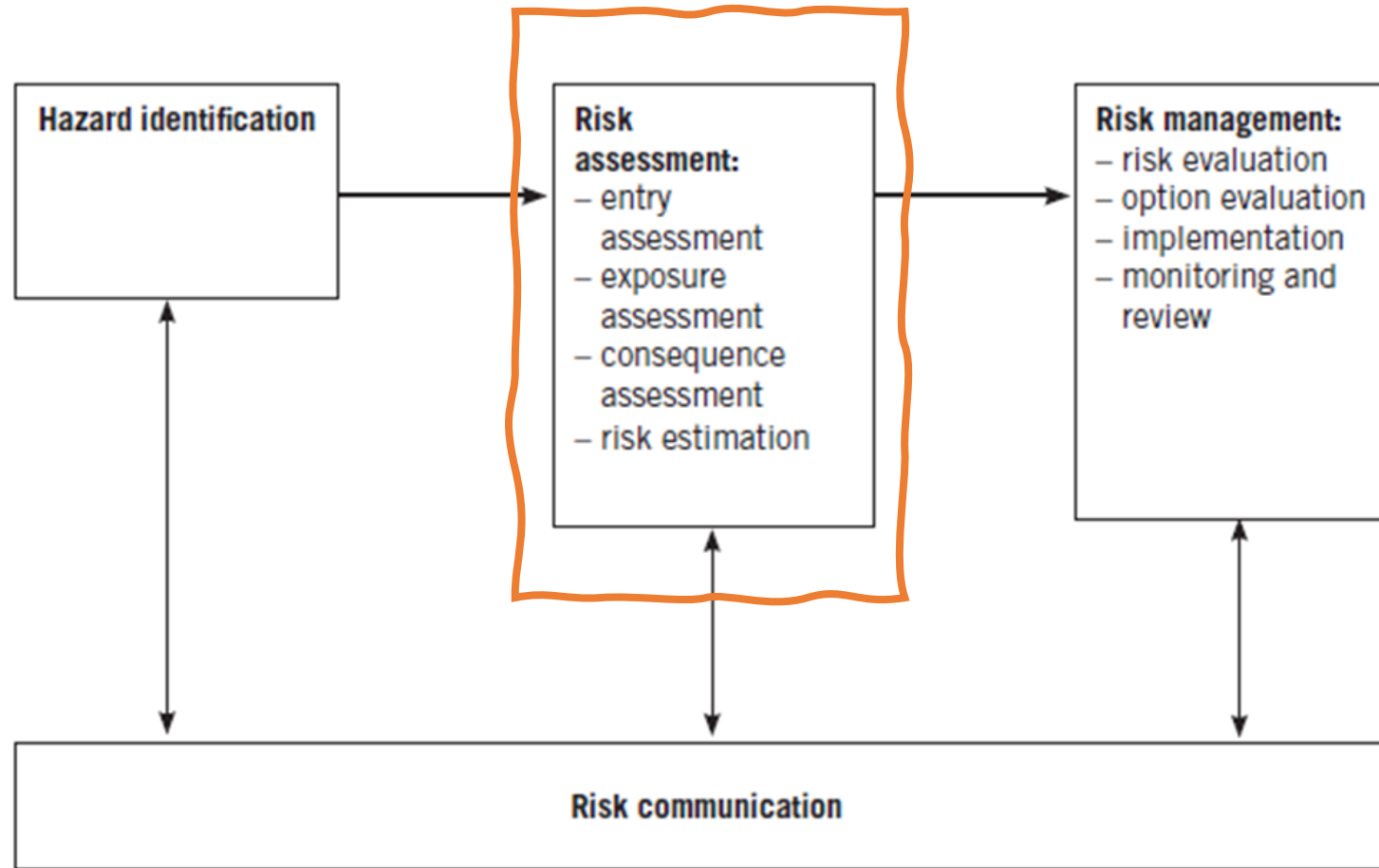


World Health
Organization



Food and Agriculture
Organization of
the United Nations

Risk Assessment



Different approaches to Risk assessment

Qualitative Risk assessment

- An assessment where the outputs (likelihood of outcome or magnitude of consequence) expressed qualitatively (e.g. low, med, high)

Quantitative risk assessment

- An assessment where the outputs are expressed numerically
- Categorised semi-quantitatively or quantitatively
- Approaches can be stochastic or deterministic

Qualitative Risk Assessment

Rev. sci. tech. Off. int. Epiz., 2009, 28 (3), 917-931

A qualitative risk assessment of factors contributing to foot and mouth disease outbreaks in cattle along the western boundary of the Kruger National Park



Table 1
Combination of occurrence probabilities of the parameters considered in the qualitative risk assessment of factors contributing to foot and mouth disease outbreaks in cattle along the western boundary of the Kruger National Park (43)

Risk of release	Risk of exposure			
	Negligible	Low	Moderate	High
Negligible	Negligible	Low	Low	Moderate
Low	Low	Low	Moderate	Moderate
Moderate	Low	Moderate	Moderate	High
High	Moderate	Moderate	High	High

Semi-Quantitative Risk Assessment

Table 2. Qualitative scale for assessing consequences at each level

Consequences	Score
Inconsequential	0
Minor impact	1
Significant impact	2
Major impact	3
Extreme impact	4

For example, assume a hazard has the following consequence profile:

- individual farm level = 3
- local level = 2
- provincial level = 2 and
- national level = 1

The overall consequence score for this hazard is $(1 \times 3 + 2 \times 2 + 3 \times 2 + 4 \times 1) / \text{sum of weights (10)} = (3 + 4 + 6 + 4) / 10 = 17 / 10 = 1.7$, rounded to 2 = significant impact.

Quantitative Risk Assessment - deterministic

The Foot-and-Mouth Epidemic in Great Britain: Pattern of Spread and Impact of Interventions

NEIL M. FERGUSON, CHRISTL A. DONNELLY, AND ROY M. ANDERSON [Authors Info & Affiliations](#)

SCIENCE • 12 Apr 2001 • Vol 292, Issue 5519 • pp. 1155-1160 • DOI: [10.1126/science.1061020](https://doi.org/10.1126/science.1061020)



Quantitative Risk Assessment - stochastic

ORIGINAL RESEARCH article

Front. Vet. Sci., 19 March 2019
Sec. Veterinary Epidemiology and Economics
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 Andrea Marcos^{1*}  Andrés M. Perez²

Analyses were conducted running 10,000 simulations implemented in the @ Risk version 5.5.1 software (Palisade Corporation, 2010. Ithaca, NY, USA). Sensitivity of the results to the model parameterization was assessed, for each scenario, by measuring Spearman's rank correlation between the model output (i.e., the predicted risk) and the model parameters.

Risk Assessment: Process

1. Conceptualise the problem

1. Ask the question/s

- 2. Gather information
- 3. Assess the risk

ORIGINAL RESEARCH article

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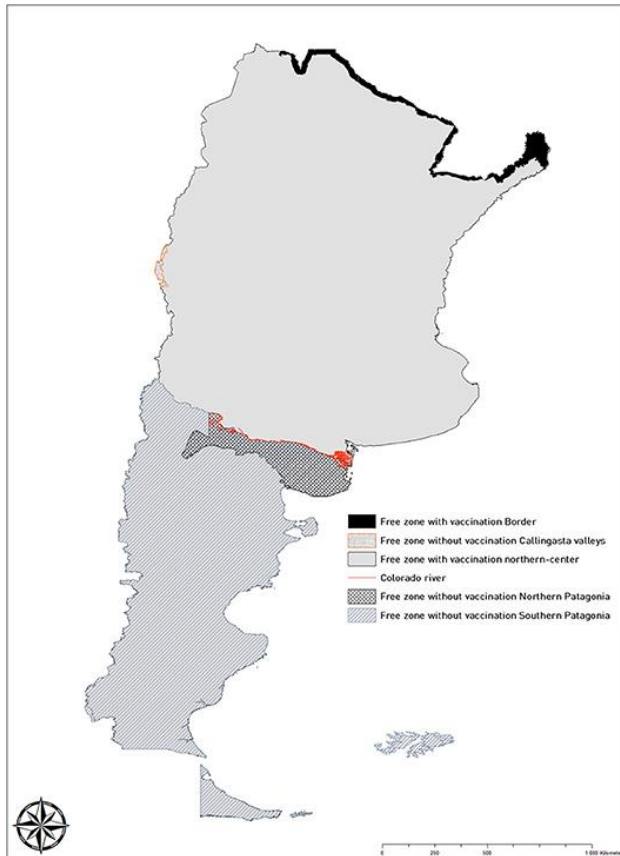


Andrea Marcos^{1*}

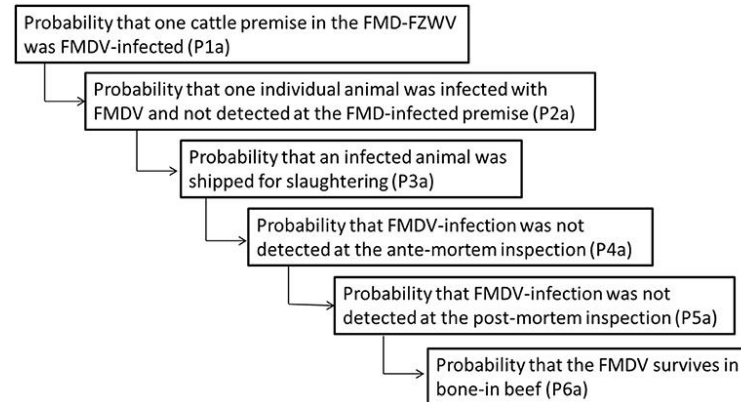


Andrés M. Perez²

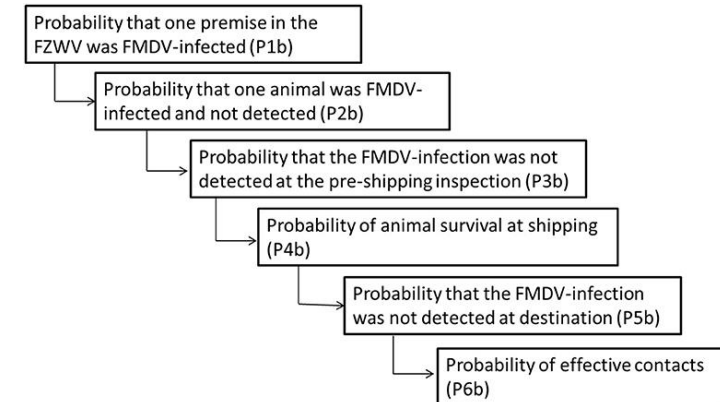
Conceptualise the problem



Meat



Animals



Gather information and Assess risk

	Result associated to trade of bone-in beef assuming an outbreak in the FMD-FZVV		Result associated to introduction of swine				Result associated to introduction sheep and goat	
			Assuming an outbreak in the FMD-FZVV with a bovine-adapted strain		Assuming an outbreak in the FMD-FZVV with a swine-adapted strain		Assuming an outbreak in the FMD-FZVV with a bovine-adapted strain	
	According to the ratio bone-in to deboned beef entering Northern Patagonia A until 2012	Considering illegal trade of bone-in beef	Without serological testing	With serological testing	Without serological testing	With serological testing	Without serological testing	With serological testing
Mean	0.0017	0.000018	0.08	0.0075	0.14	0.0148	0.006	0.0007
CI (95%)	(0.00025, 0.00457)	(0.0000012, 0.0000431)	(0.002, 0.359)	(0.0001, 0.04)	(0.04, 0.597)	(0.0001, 0.083)	(0.0001, 0.0165)	(0.00001, 0.00326)

Mean values higher than the maximum level of risk acceptable for the country (0.01) are bolded.

The release assessment

- Description of the biological pathways necessary for the use of an antimicrobial in animals to release resistant bacteria or resistance determinants into a particular environment, and estimating the probability of that complete process occurring either qualitatively or quantitatively

Risk Assessment: Process – Release Assessment

Risk Analysis, Vol. 29, No. 4, 2009

DOI: 10.1111/j.1539-6924.2008.01183.x

Foot-and-Mouth Disease Entrance Assessment Model Through Air Passenger Violations

Xiao-Wei Lin,¹ Chin-Tsang Chiang,¹ Tai-Hwa Shih,² Yan-Nian Jiang,³
and Chin-Cheng Chou^{4,5*}

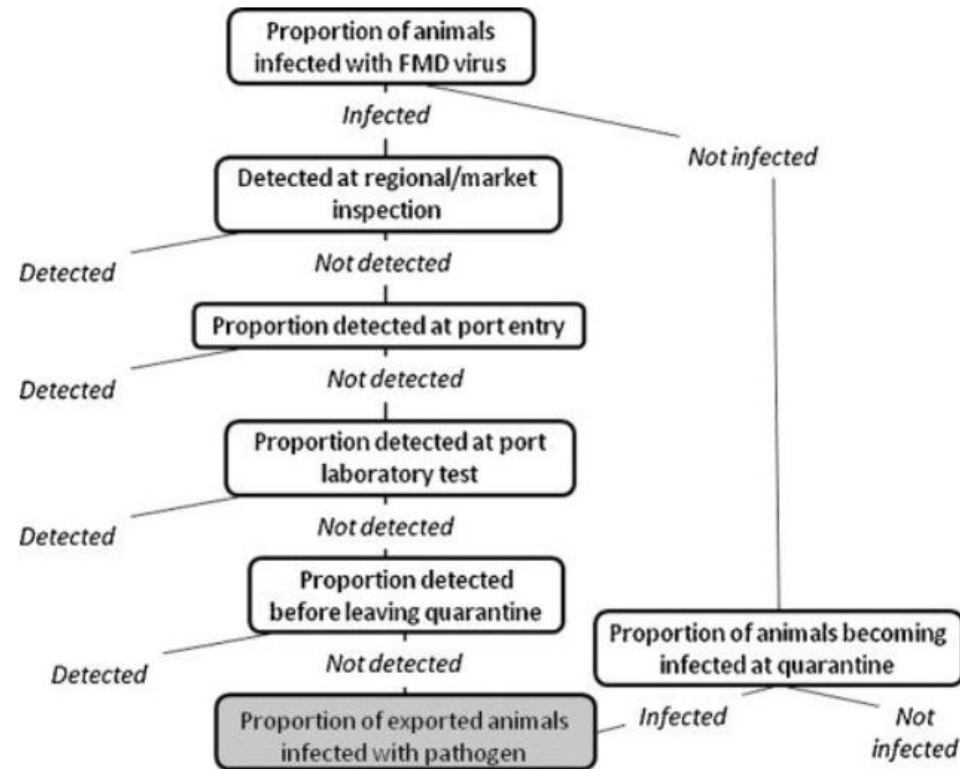
Biological Factors

- Species, age, class
- Agent predilection
- Δ infectivity post quarantine/slaughter
- Treatments/vaccination/processing Δ risk?

Country/Zone Factors

- Environment impacts risk?
- Veterinary services – VPH/AH
- Diagnostic test capacity

Risk Assessment: Process – Release Assessment



The exposure assessment

- Describing the biological pathways necessary for exposure of animals and humans to the hazards released from a given source, and estimating the probability of the exposure occurring, either qualitatively or quantitatively.

Risk Assessment: Process – Exposure Assessment

RESEARCH ARTICLE

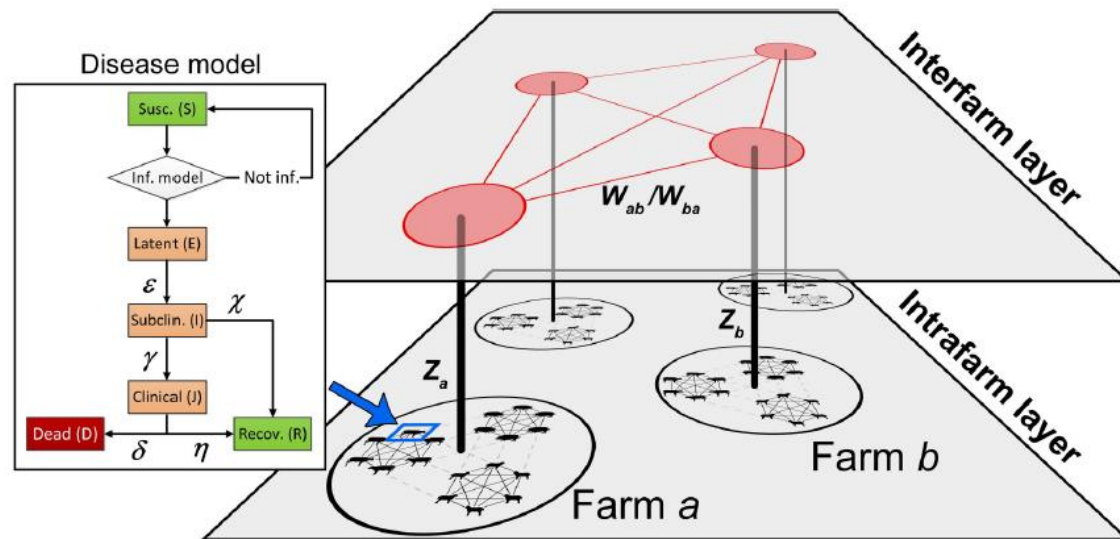
Multilevel model for airborne transmission of foot-and-mouth disease applied to Swedish livestock

Oscar Björnham^{*,} Robert Sigg^{*,} Jan Burman^{*}

Swedish Defence Research Agency, Umeå, Sweden

* These authors contributed equally to this work.

* oscar.bjornham@foi.se



Biological Factors

- R_0
- Mixing of animals
- Incubation of hazard

Country/Zone Factors

- Environment impacts spread
- Movement of animals
- Population at Risk impacts potential spread
- Control at border posts for IRA
- Biosecurity

The consequence assessment

- Description of the relationship between specified exposures to a biological agent and the consequences of those exposures. A causal process must exist by which exposures produce adverse health or environmental consequences, which may in turn lead to socio-economic consequences. The consequence assessment describes the potential consequences of a given exposure and estimates the probability of them occurring. This estimate may be either qualitative or quantitative.

Risk Assessment: Process – Consequence Assessment

Table 2. Qualitative scale for assessing consequences at each level

Consequences	Score
Inconsequential	0
Minor impact	1
Significant impact	2
Major impact	3
Extreme impact	4

- A framework of scale is helpful here

For example, assume a hazard has the following consequence profile:

- individual farm level = 3
- local level = 2
- provincial level = 2 and
- national level = 1

Risk Assessment: Process – Consequence Assessment

- IRA – SPS
- *‘Members shall take into account as relevant economic factors;*
 - *the potential damage in terms of loss of production or sales in the event of entry,*
 - *establishment or spread of a pest or disease;*
 - *the costs of control or eradication in the territory of the importing Member;*
 - *And the relative cost-effectiveness of alternative approaches to limiting risk’*

Risk Assessment: Process – Consequence Assessment

Direct consequence

- Domestic and wild animals
 - Direct health
 - Future offspring
 - Carrier status
- Public health
- Environmental health

Indirect consequence

- Economic (incl. surveillance)
- Environmental

Risk Assessment: Process – Consequence Assessment



World Organisation
for Animal Health
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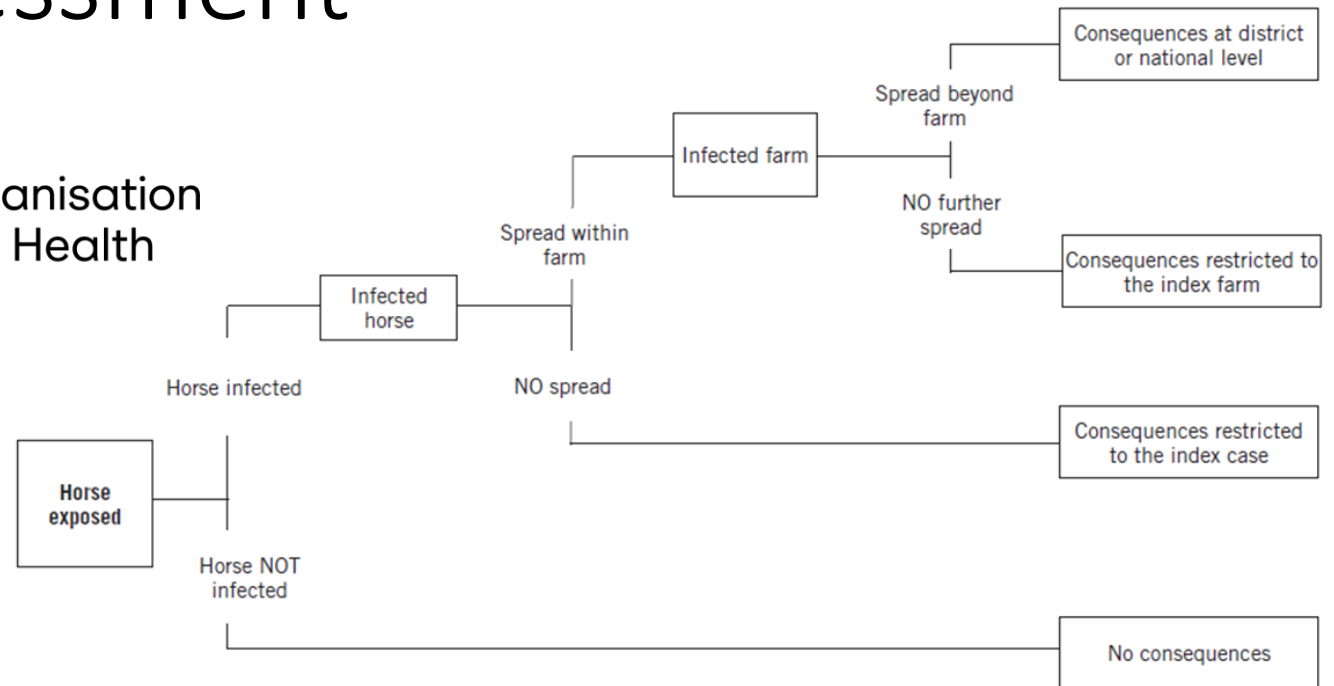


Figure 12 A scenario tree illustrating the biological consequences of local horses being exposed to an imported viraemic horse

Risk Assessment: Process – outcome

- Integration of Risk at the entry, exposure and consequence level to produce overall probability (Quant) or likelihood (Qual)
- Sensitivity analysis if quantitative approach taken
 - Assists in Risk management decision making

Q&A and Practical: Classifying Risk Analysis

Classification

Component	Sub-section	Classification
Approach		Qualitative/Quantitative (semi)
Scope		Trans-country/zone/risk factor
Species		
Commodity		
Route		
Hazard		
Assessment performed	Entry/Release	True/False/Unknown
	Exposure	True/False/Unknown
	Consequence	True/False/Unknown
Risk Management		

Mapping

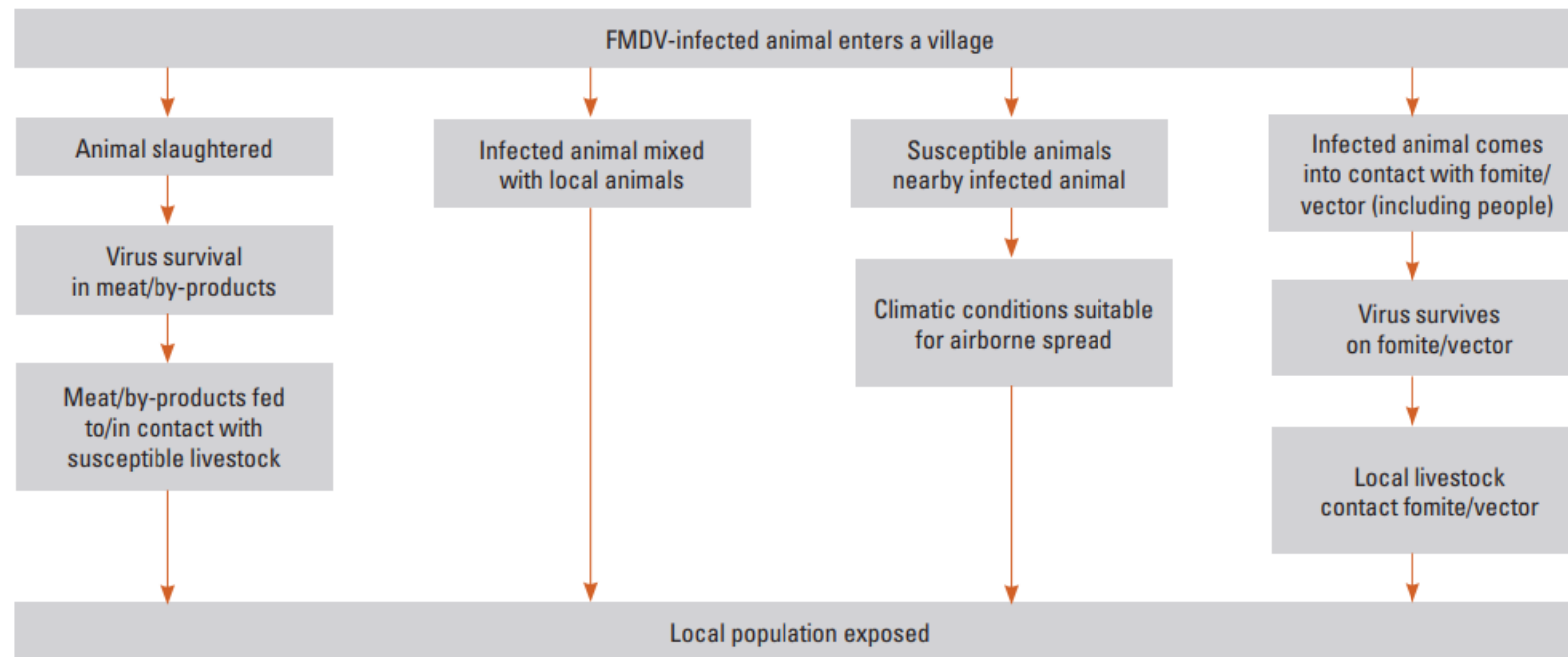


Figure 2: FMD entry risk pathways for a livestock market in Thailand

Using a participatory qualitative risk assessment to estimate the risk of introduction and spread of transboundary animal diseases in scarce-data environments: A Spatial Qualitative Risk Analysis applied to foot-and-mouth disease in Tunisia 2014-2019



This article presents a participative and iterative qualitative risk assessment framework that can be used to evaluate the spatial variation of the risk of infectious animal disease introduction and spread on a national scale. The framework was developed through regional training action workshops and field activities. The active involvement of national animal health services enabled the identification, collection and hierarchization of risk factors. Quantitative data were collected in the field, and expert knowledge was integrated to adjust the available data at regional level. Experts categorized and combined the risk factors into ordinal levels of risk per epidemiological unit to ease implementation of risk-based surveillance in the field. The framework was used to perform a qualitative assessment of the risk of introduction and spread of foot-and-mouth disease (FMD) in Tunisia as part of a series of workshops held between 2015 and 2018. The experts in attendance combined risk factors such as epidemiological status, transboundary movements, proximity to the borders and accessibility to assess the risk of FMD outbreaks in Tunisia. Out of the 2,075 Tunisian imadas, 23 were at a very high risk of FMD introduction, mainly at the borders; and 59 were at a very high risk of FMD spread. To validate the model, the results were compared to the FMD outbreaks notified by Tunisia during the 2014 FMD epizootic. Using a spatial Poisson model, a significant alignment between the very high and high-risk categories of spread and the occurrence of FMD outbreaks was shown. The relative risk of FMD occurrence was thus 3.2 higher for imadas in the very high and high spread risk categories than for imadas in the low and negligible spread risk categories. Our results show that the qualitative risk assessment framework can be a useful decision support tool for risk-based disease surveillance and control, in particular in scarce-data environments

A risk-assessment model for foot and mouth disease (FMD) virus introduction through deboned beef importation

Peter Yu ^a , Tsegaye Habtemariam ^a, Saul Wilson ^b, David Oryang ^a, David Nganwa ^a,
Mike Obasa ^a, Vinaida Robnett ^a

We present a risk-assessment model to assess the risk of introduction of foot and mouth disease (FMD) virus associated with deboned beef importation. The model was developed in accordance with the risk-reduction procedures proposed by the European Community for meat importation. The risk reduction procedures include farm-level inspection, ante-mortem inspection, post-mortem inspection, chilling and deboning. The risk assessment was based on the prevalence of FMD-infected cattle in herds as well as the prevalence of infected herds in the exporting country. Computer simulations were carried out to evaluate the probability of FMD virus introduction by importing 100 tons of deboned beef in relation to FMD prevalence, number of cattle selected from each herd, and sample sizes in ante-mortem and post-mortem inspections. The effects of the risk-reduction procedures on the probability of FMD virus introduction were examined.

Quantitative risk assessment of foot-and-mouth disease introduction into Spain via importation of live animals

B. Martínez-López^a  , A.M. Perez^{b,c}, A. De la Torre^d, J.M. Sánchez-Vizcaíno Rodríguez^a

Spain has been a foot-and-mouth disease (FMD)-free country since 1986. However, the FMD epidemics that recently affected several European Union (EU) member countries demonstrated that the continent is still at high risk for [FMD virus](#) (FMDV) introduction, and that the potential consequences of those epidemics are socially and financially devastating. This paper presents a quantitative assessment of the risk of FMDV introduction into Spain. Results suggest that provinces in north-eastern Spain are at higher risk for FMDV introduction, that an FMD epidemic in Spain is more likely to occur via the import of [pigs](#) than through the import of cattle, [sheep](#), or [goats](#), and that a sixfold increase in the proportion of premises that quarantine pigs prior to their introduction into the operation will reduce the probability of FMDV introduction via import of live pigs into Spain by 50%. Allocation of resources towards surveillance activities in regions and types of operations at high risk for FMDV introduction and into the development of policies to promote quarantine and other [biosecurity](#) activities in susceptible operations will decrease the probability of FMD introduction into the country and will strengthen the chances of success of the Spanish FMD prevention program.