

Epidemiological Considerations for Zoning and Compartmentalisation

Dirk Pfeiffer

Emeritus Professor in Veterinary Epidemiology, Royal Veterinary College, London,
United Kingdom

Adjunct Professor, City University of Hong Kong, Hong Kong SAR, China

#63

[QS] World University
Rankings 2026



#1

[QS] World University
Rankings 2026
Veterinary Science



**Sub -regional training workshop on zoning and compartmentalisation
in the facilitation of safe trade, 28-30 April 2026**



Outline

- Risk management in animal health and production
- Understanding the food system
- Risk assessment
- Epidemiological outbreak investigation
- Dynamic modelling of infectious diseases
- Respond
- Prevent
- Prepare
- Animal health surveillance
- Traceability systems
- Staff competencies



Risk Management in Animal Health and Production



Food and Agriculture
Organization of the
United Nations

ISSN 1810-1119

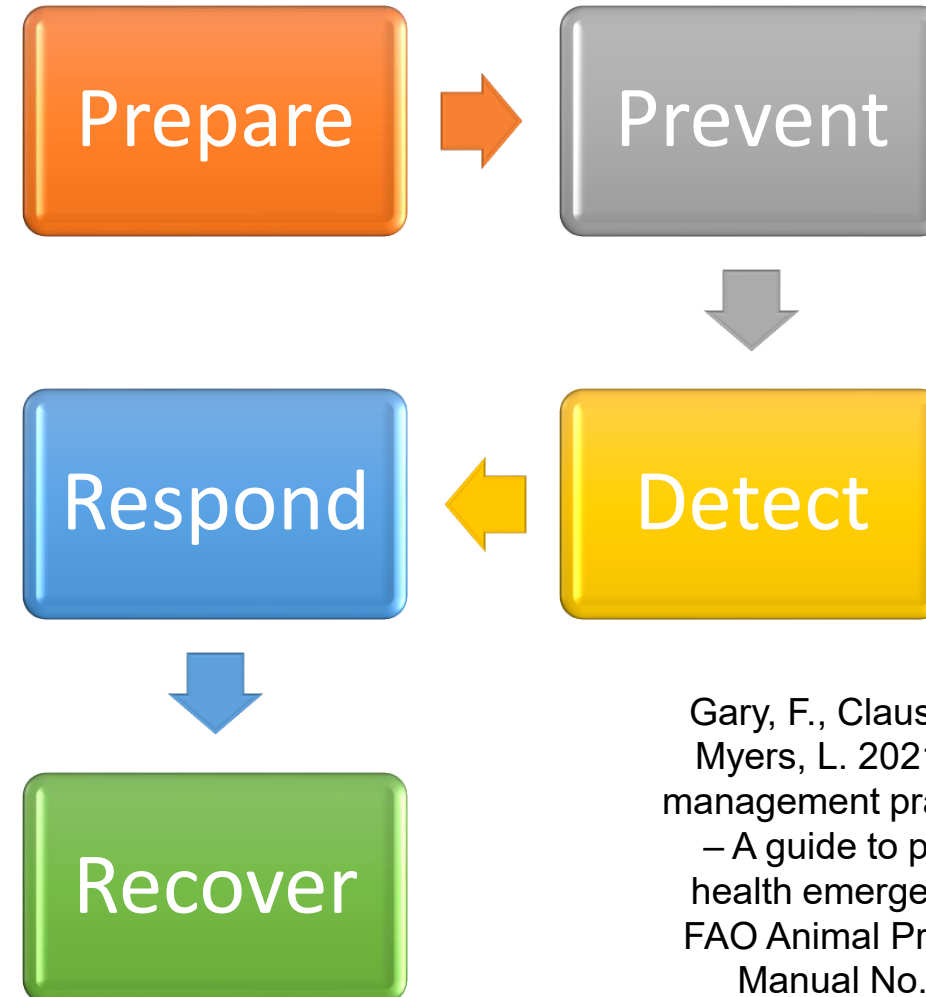
Good emergency management practice: The essentials

A guide to preparing for animal health emergencies
Third edition

FAO ANIMAL PRODUCTION AND HEALTH / **MANUAL 25**



Good Emergency Management Practice (GEMP)



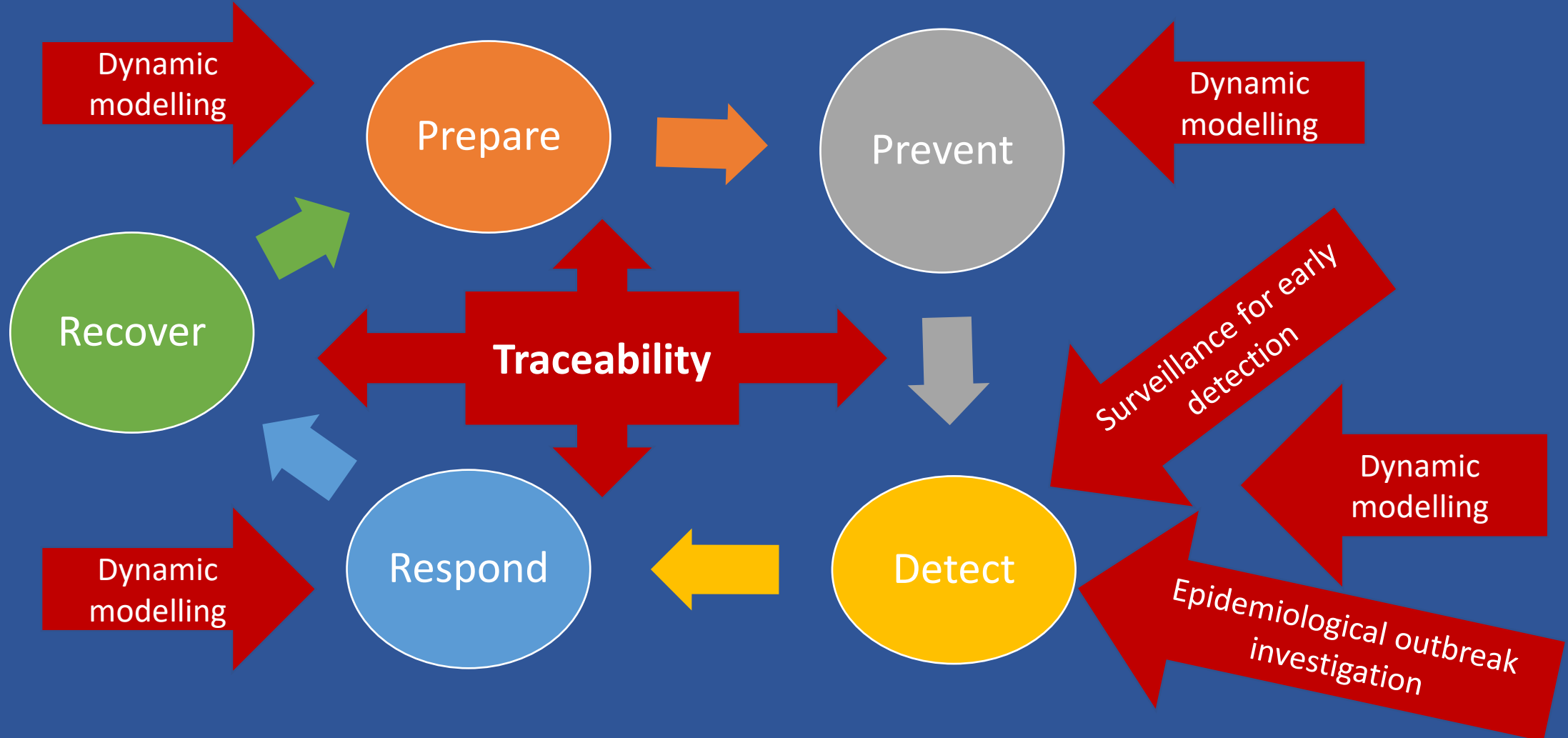
Gary, F., Clauss, M., Bonbon, E. & Myers, L. 2021. Good emergency management practice: The essentials – A guide to preparing for animal health emergencies. Third edition. FAO Animal Production and Health Manual No. 25. Rome, FAO.

<https://www.fao.org/documents/card/en/c/cb3833en>



Good Emergency Management Practice (GEMP) in Animal Health

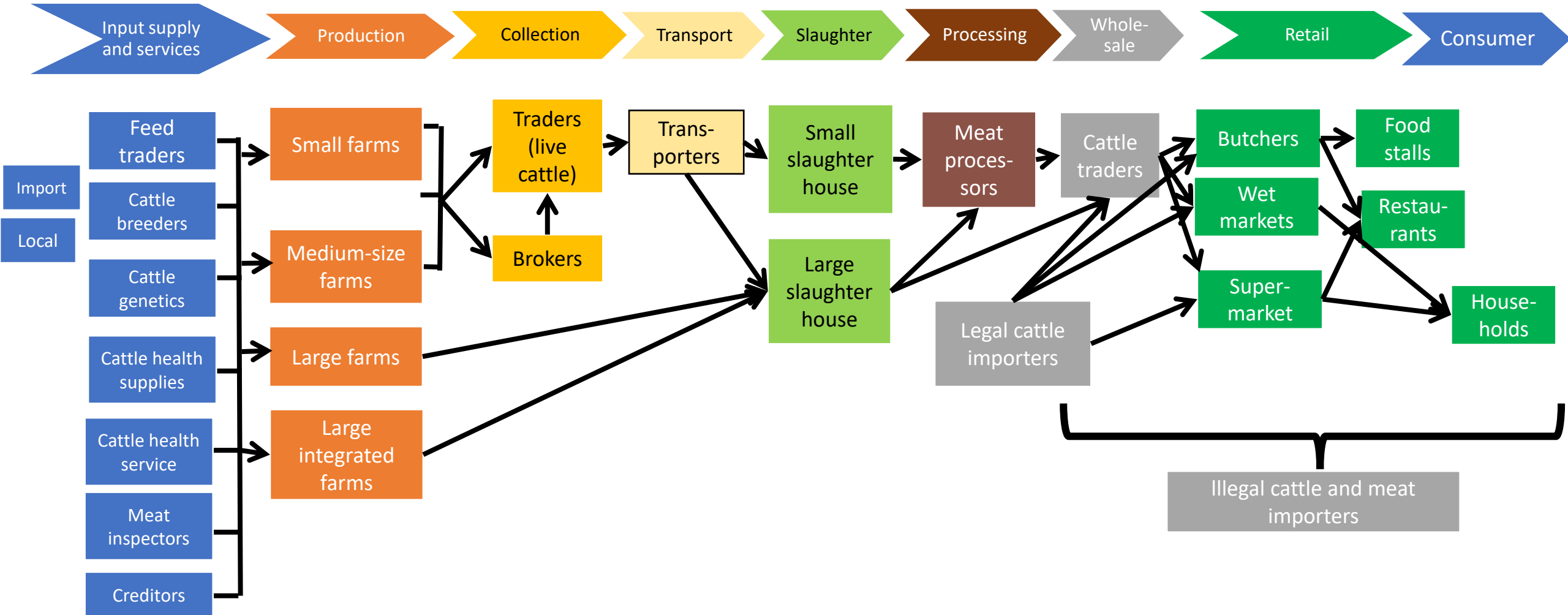
Risk assessment



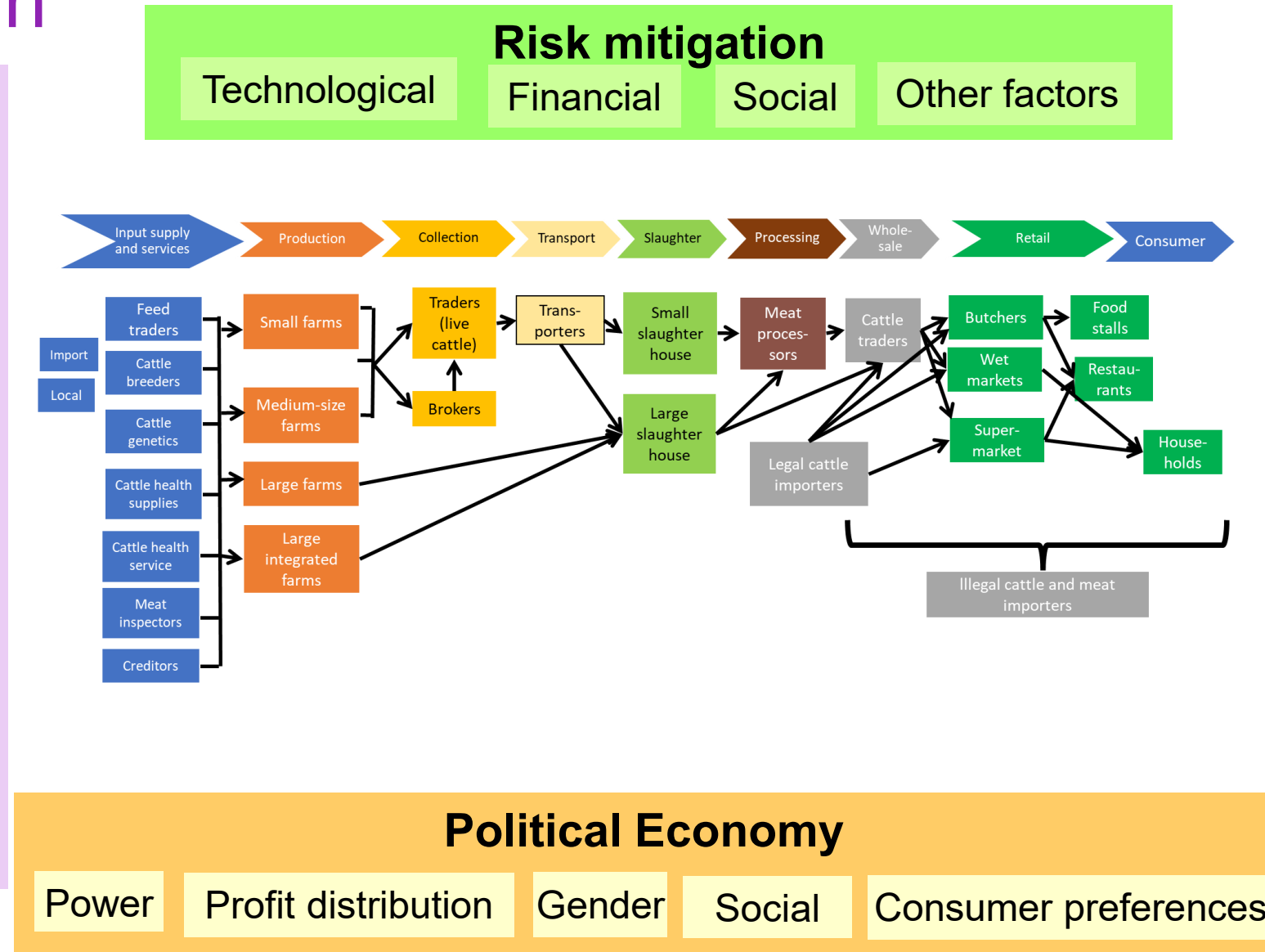
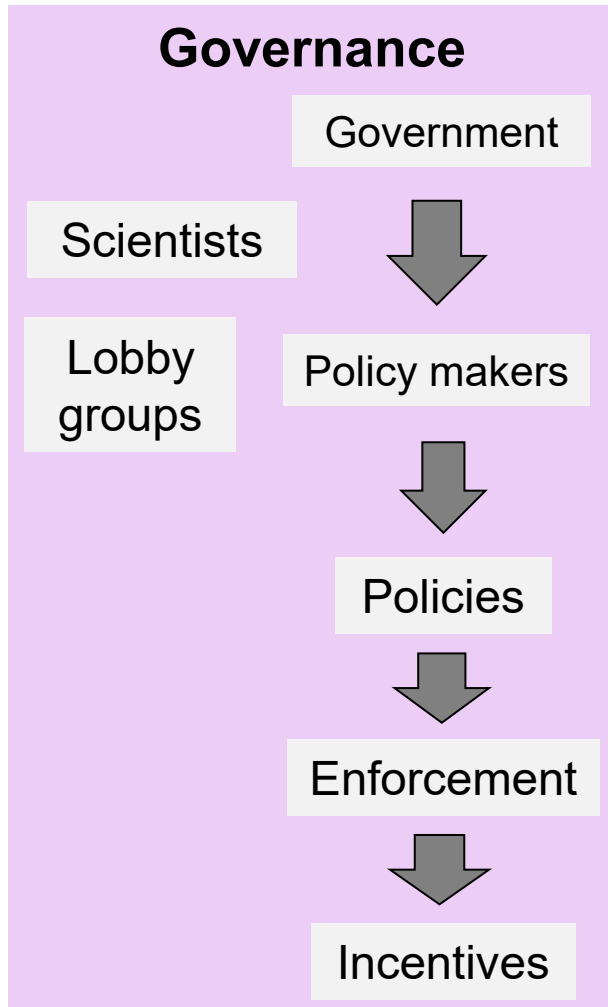


Understanding the Food System (Systems Thinking)

Value Chain of Beef Cattle Food System



Complex Systems Perspective on Beef Cattle Value Chain





Diverse Livestock Production Systems



BUSINESS NEWS DECEMBER 7, 2020 / 1:27 PM / UPDATED A MONTH AGO

Flush with cash, Chinese hog producer builds world's largest pig farm

By Dominique Patton

6 MIN READ

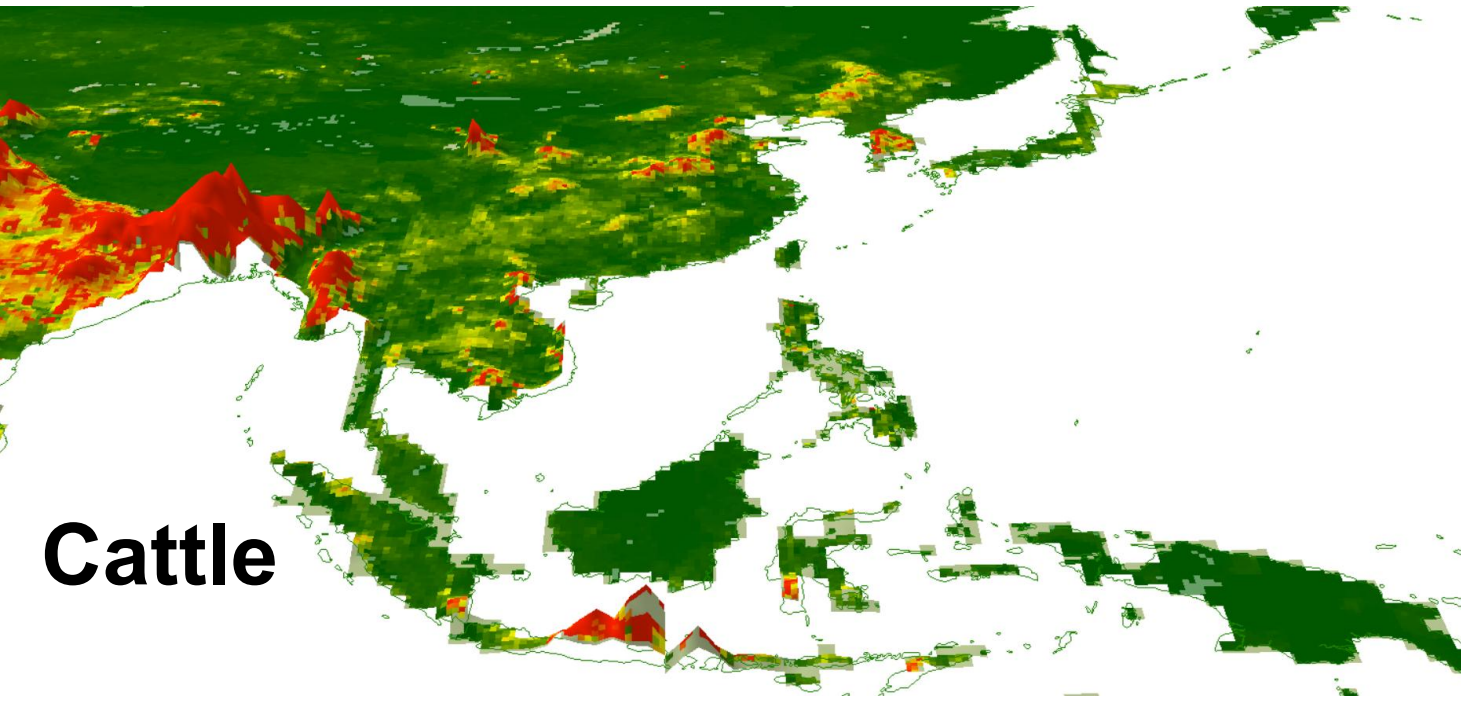
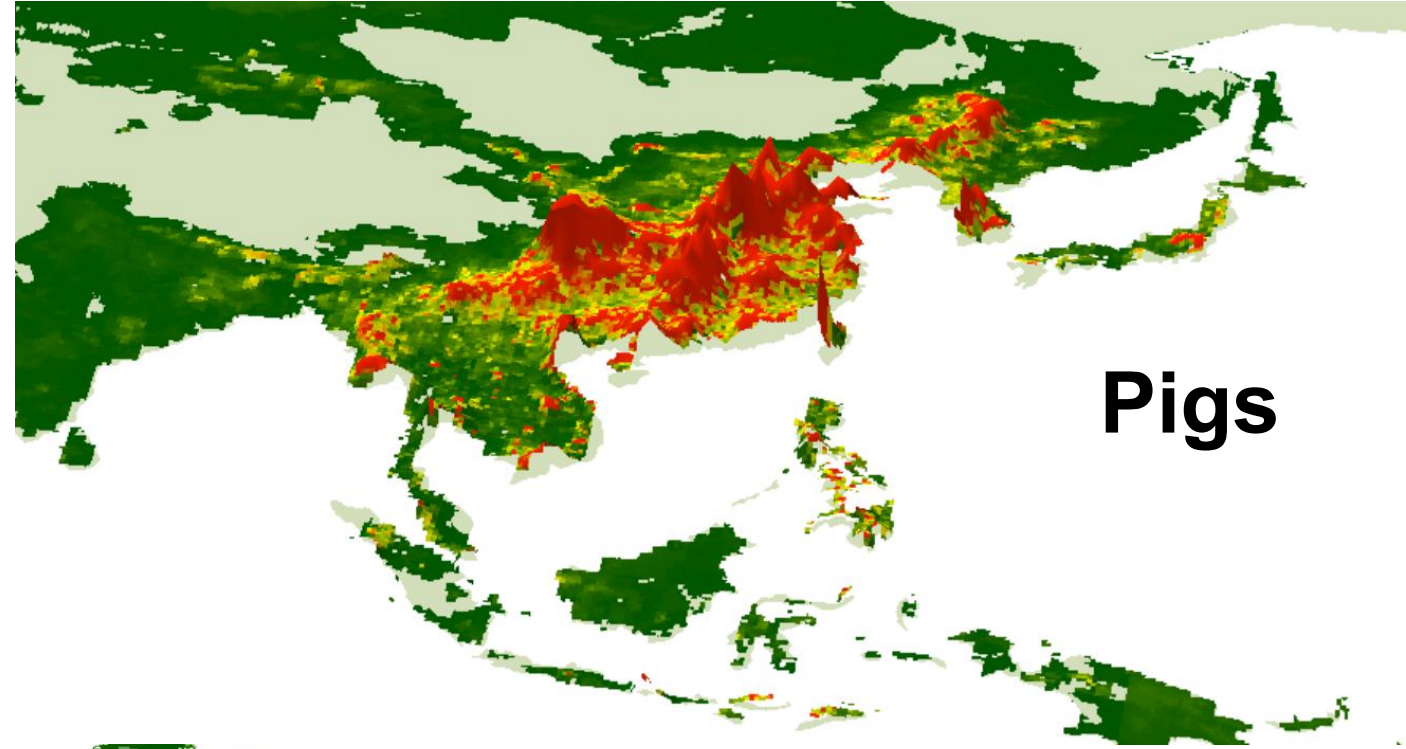


(This December 7 story corrects spelling of Ellermann in para 21, 22)



A drone image shows Muyuan Foods newly built multi-storey pig farm in Neixiang county, Henan province, China November 6, 2020. Muyuan Foods/Handout via REUTERS

Cattle and Pig Density in South-East/East Asia Region in 2020



Source: FAO - GLW 4:
Gridded Livestock Density
(Global - 2020 - 10 km)

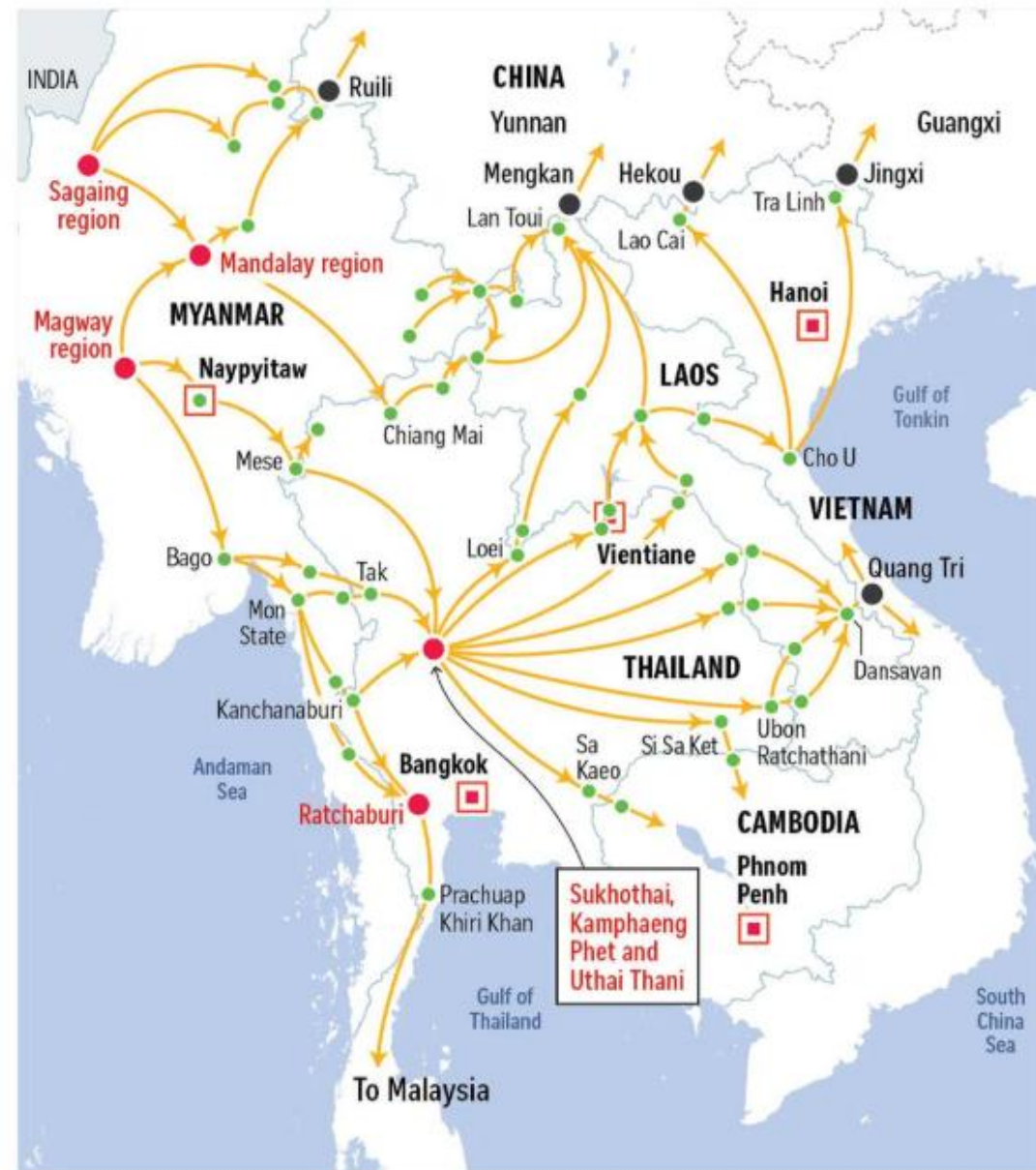
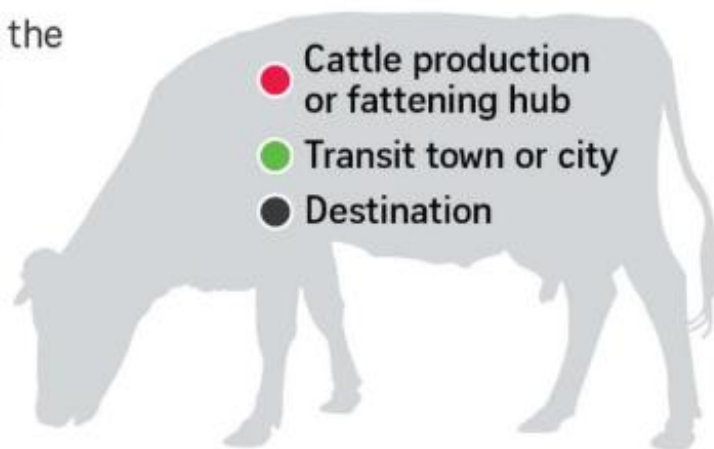


Livestock Trade in Greater Mekong Region

- significant illegal trade flows

Cattle transport routes

Cattle are moved across the Mekong region's porous borders and fattened in several hubs before reaching their final destinations. Smuggled cattle are sometimes mixed with local herds.



Source: MEKONG EYE
STRAITS TIMES GRAPHICS



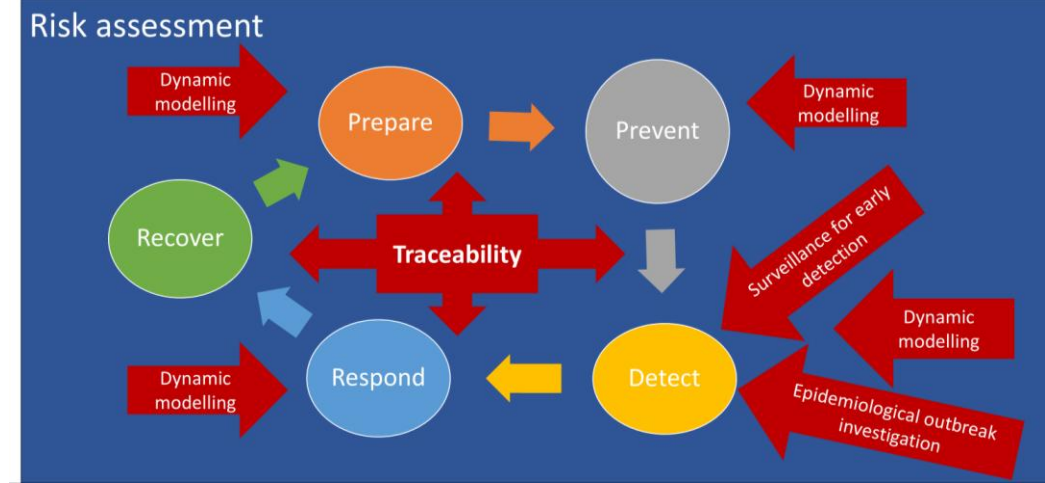
Official and Unofficial Live Pig Movements in SEA (piglets and adult pigs)

Red – unofficial

Green – official

Black – official & unofficial

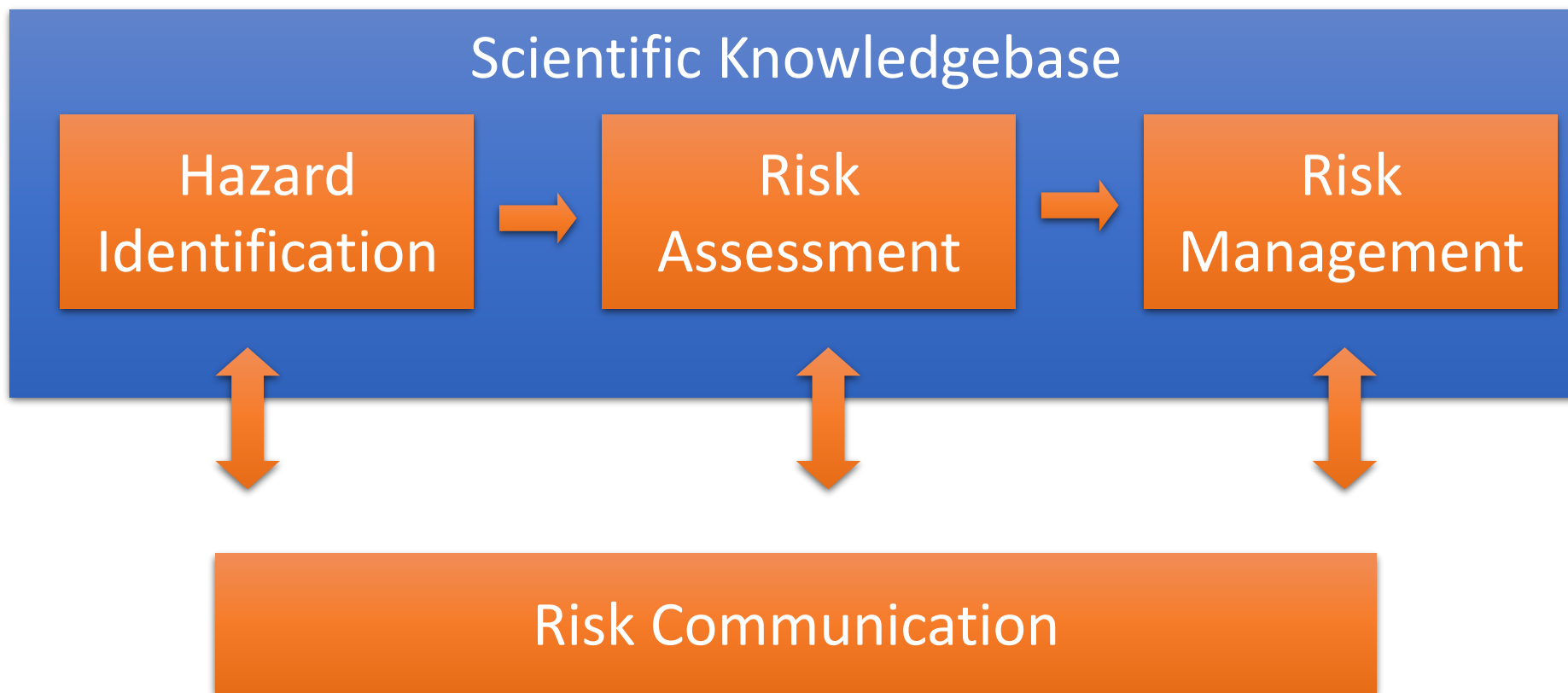
From: Tago Pacheco, FAORAP 2019



Risk Assessment



OIE Risk Analysis Framework



after OIE Animal Health Code



Risk Assessment (based on WOAAH)

- entry, exposure and consequence assessments
 - qualitative, semi-quantitative, quantitative
- methodology
 - define risk question(s)
 - develop risk pathway diagram
 - convert risk pathway diagram to risk assessment model
 - define likelihoods and uncertainties for each step in risk pathway diagram
 - estimate risk or other outcomes



Risk Assessment Components (based on OIE Animal Health Code)

Entry Assessment



Exposure Assessment



Consequence Assessment



Define Risk Questions - Examples

Entry:

What is the likelihood that at least one live pig infected with ASFV will be introduced into compartment A per year?

Exposure:

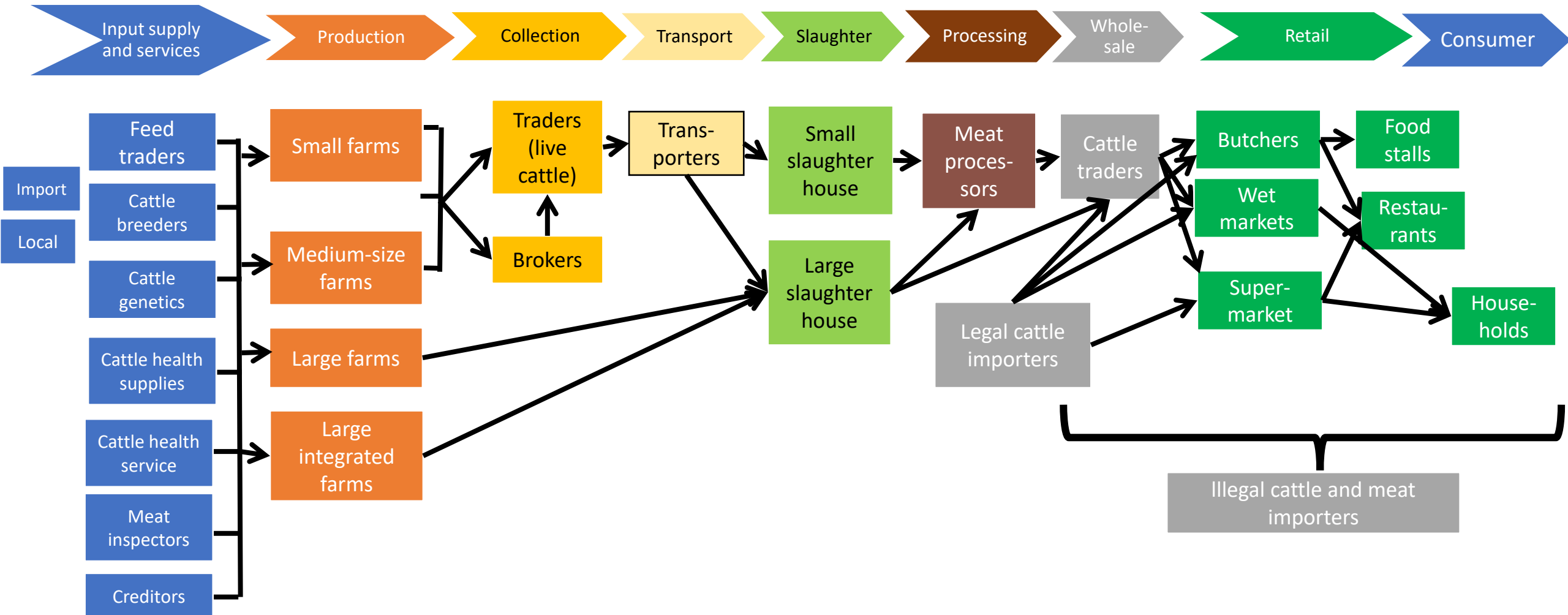
What is the likelihood that at least one susceptible pig in compartment A will become exposed to viable ASFV per year as a result of introduction of an ASFV-infected live pig?

Consequences:

What is the likelihood that at least one susceptible pig in compartment A will become infected with ASFV per year as a result of exposure to viable ASFV?

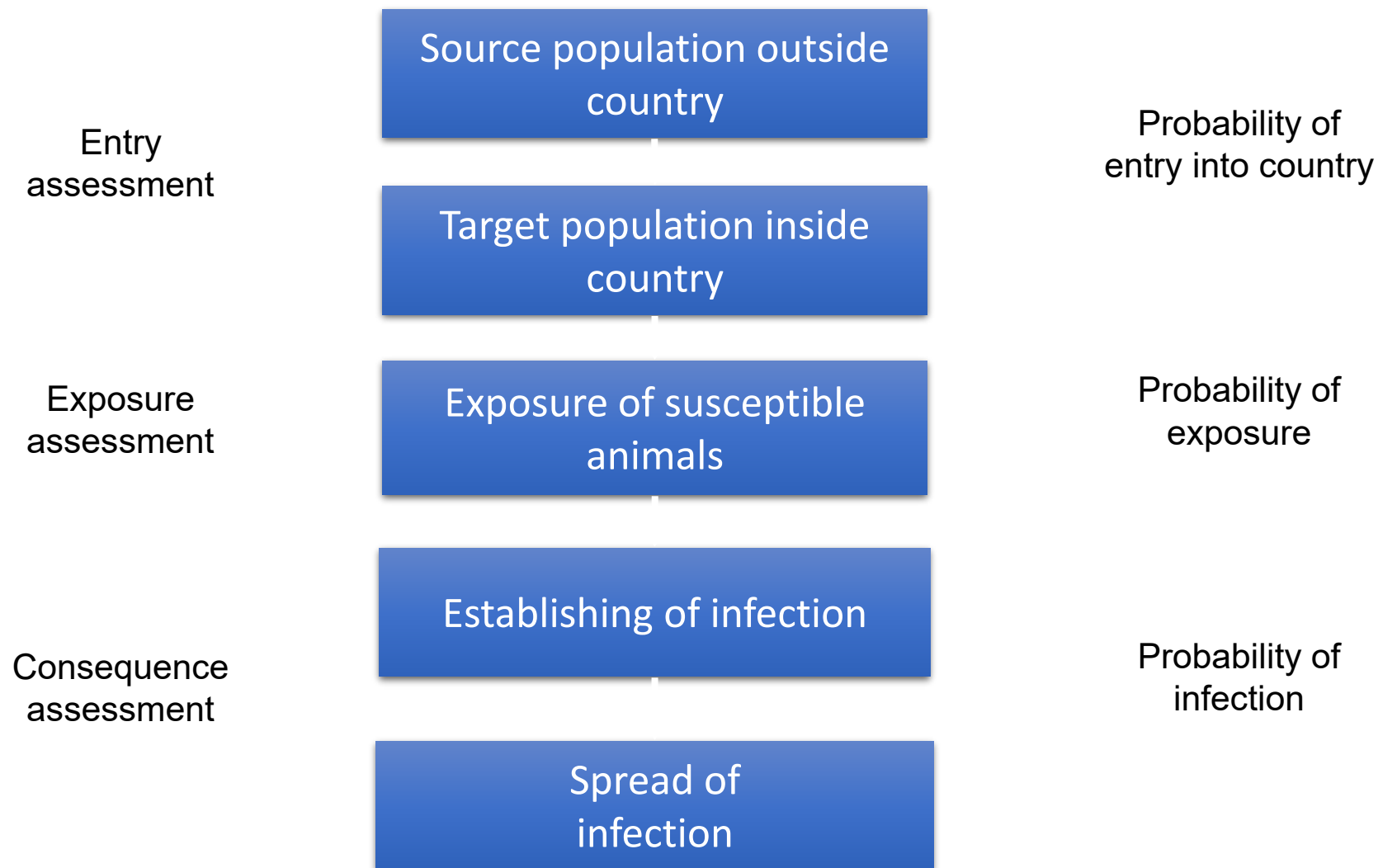
What is the likelihood that at least one output unit of pork products departing compartment A will be contaminated with ASFV per year, as a result of direct or indirect exposure to an ASFV-infected pig?

Value Chain of Beef Cattle Food System

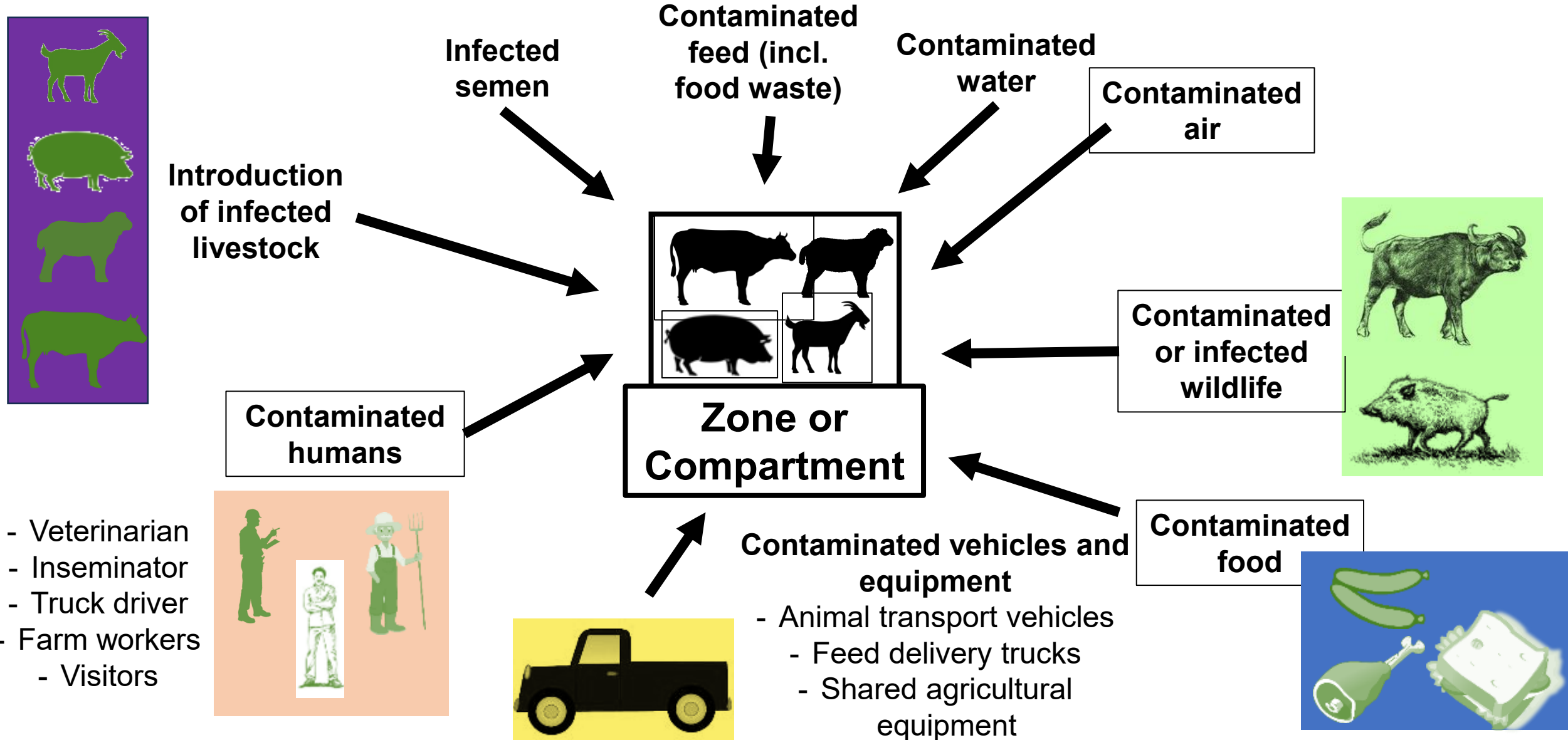




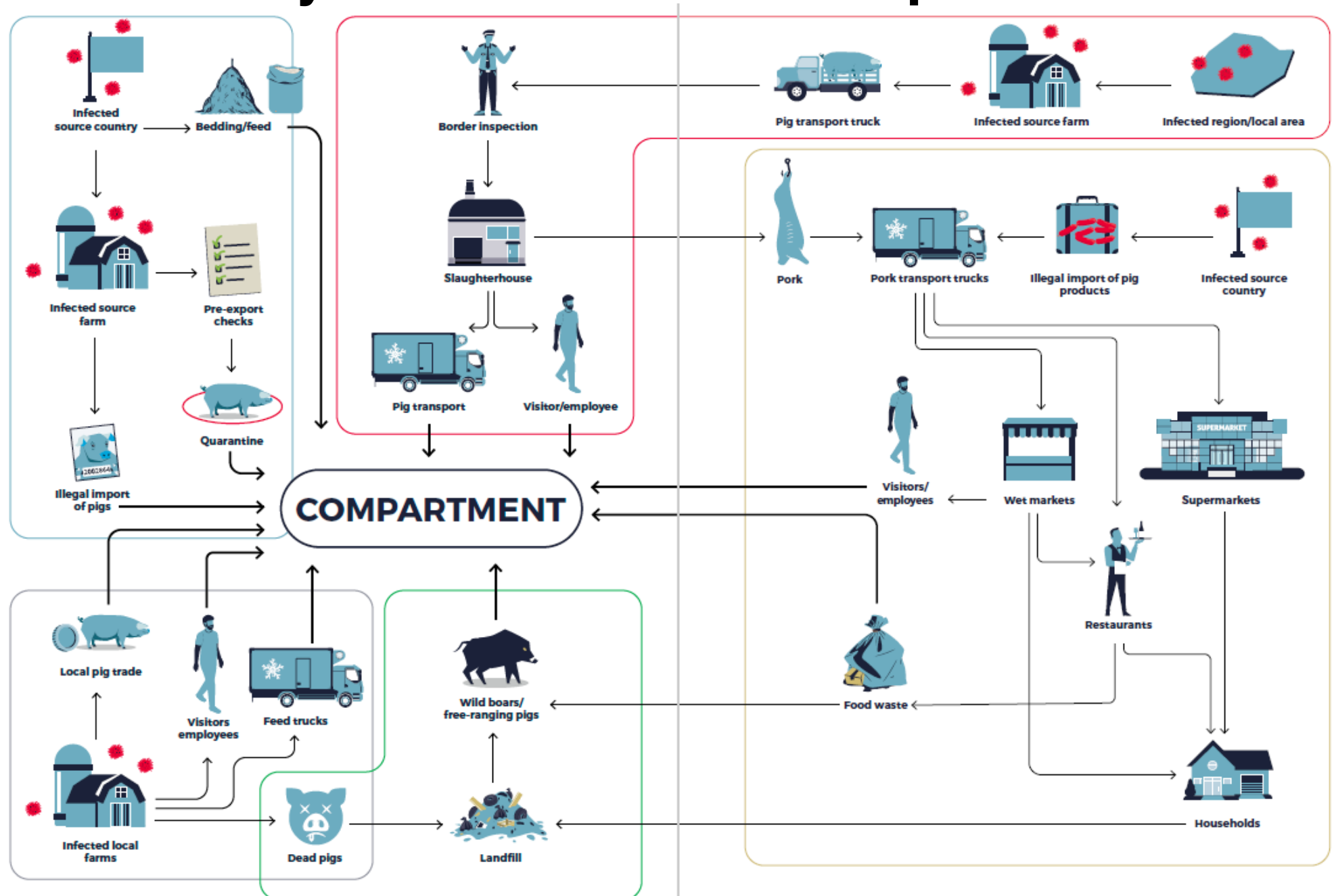
Generic Risk Pathway Diagram



Example of Potential Mechanisms for Introduction of Infectious Pathogens to a Zone or Compartment

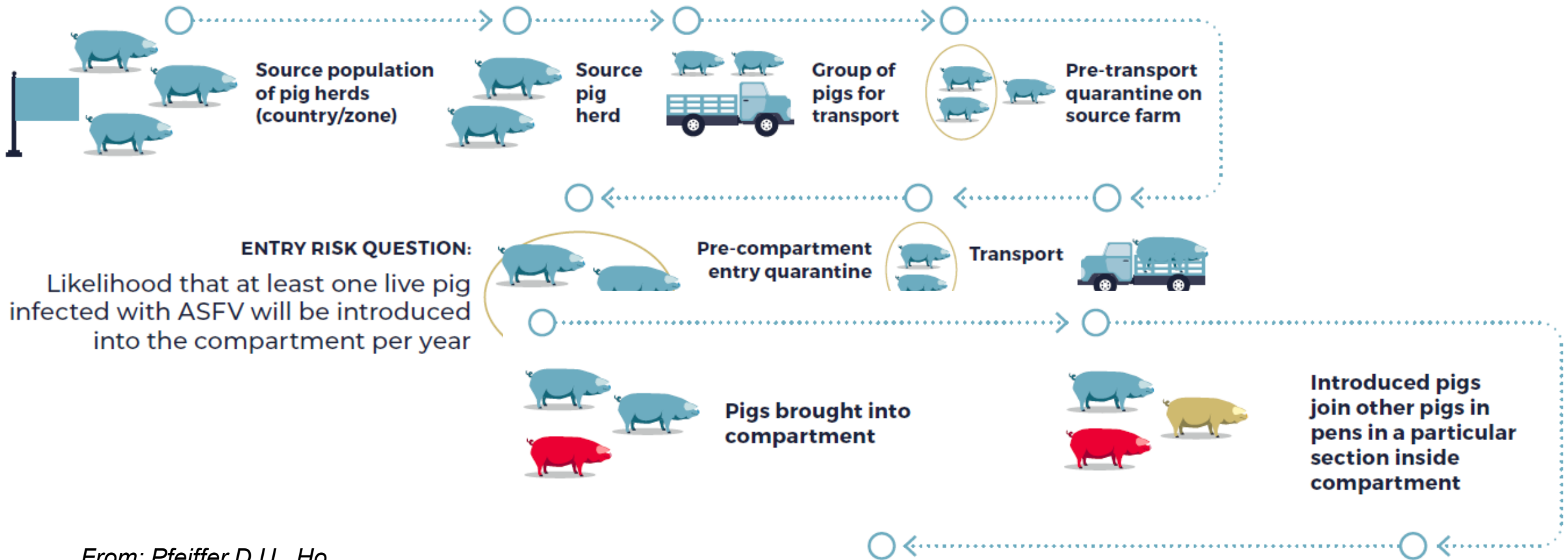


Risk Pathways for ASF-free Compartment



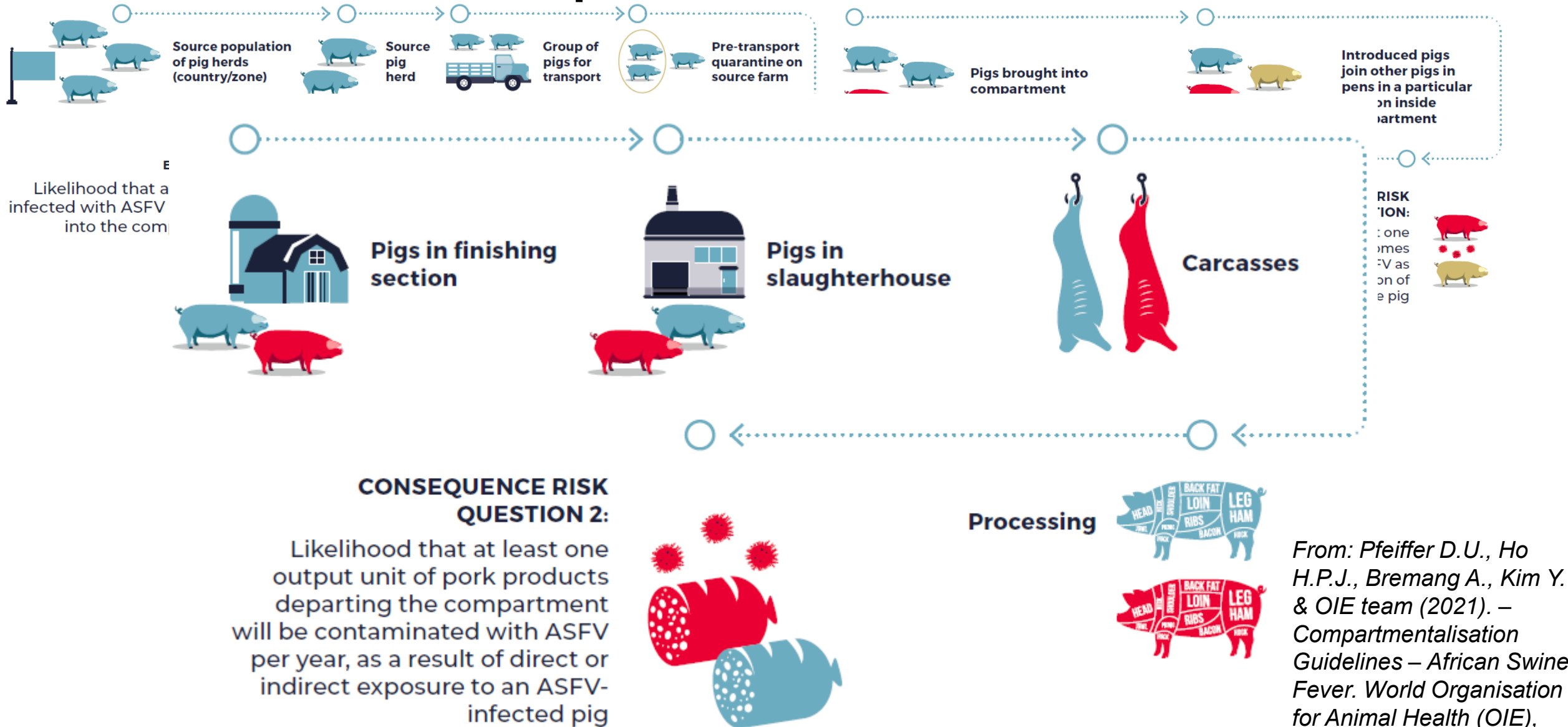
From: Pfeiffer D.U., Ho H.P.J., Bremang A., Kim Y. & OIE team (2021). – *Compartmentalisation Guidelines – African Swine Fever*. World Organisation for Animal Health (OIE), Paris, France, 148 pp.

Risk Pathways associated with Introduction of Live Pigs into ASF-free Compartment



From: Pfeiffer D.U., Ho H.P.J., Bremang A., Kim Y. & OIE team (2021). – *Compartmentalisation Guidelines – African Swine Fever*. World Organisation for Animal Health (OIE), Paris, France, 148 pp.

Risk Pathways associated with Introduction of Live Pigs into ASF-free Compartment



From: Pfeiffer D.U., Ho H.P.J., Bremang A., Kim Y. & OIE team (2021). – *Compartmentalisation Guidelines – African Swine Fever*. World Organisation for Animal Health (OIE), Paris, France, 148 pp.



WORLD ORGANISATION FOR ANIMAL HEALTH
Protecting animals, preserving our future

Compartmentalisation Guidelines



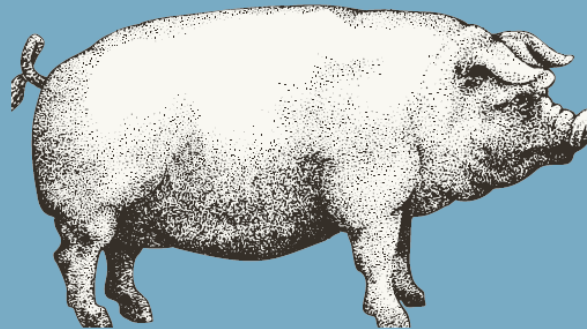
AFRICAN SWINE FEVER



WORLD ORGANISATION FOR ANIMAL HEALTH
Protecting animals, preserving our future

AFRICAN SWINE FEVER

CROSS-BORDER RISK
ASSESSMENT MANUAL:
SOUTH-EAST ASIA



Joint Risk Assessment Operational Tool (JRA OT)

An Operational Tool of the Tripartite Zoonoses Guide
*Taking a Multisectoral, One Health Approach:
A Tripartite Guide to Addressing Zoonotic Diseases
in Countries*



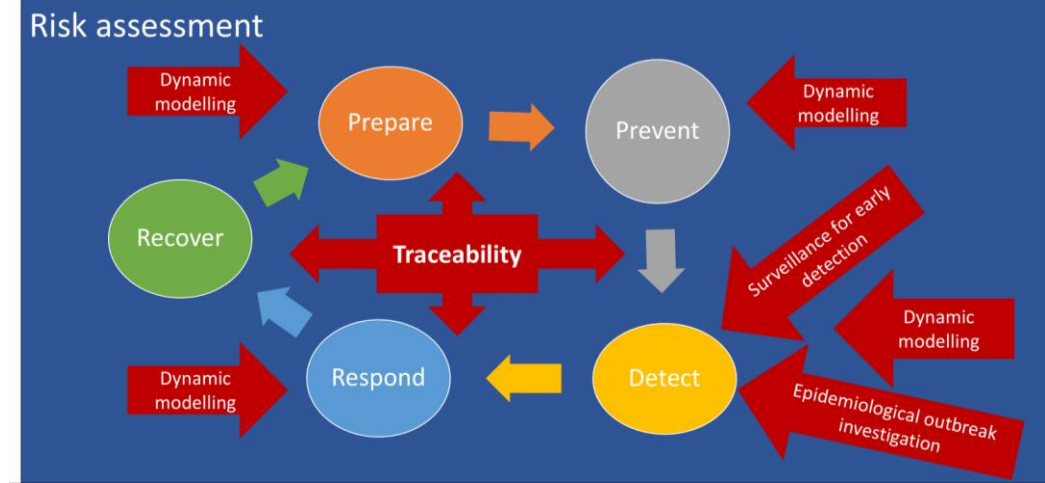
Food and Agriculture
Organization of the
United Nations



WORLD ORGANISATION
FOR ANIMAL HEALTH



World Health
Organization



Epidemiological Outbreak Investigation

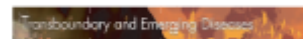


Epidemiological Outbreak Investigation

- problem
 - unexpected series of disease/welfare/poor productivity events clustered in time
 - can be observed in single herds or across several herds -> influences unit of interest
- objectives
 - identify pattern of disease occurrence
 - determine cause
 - design control strategy
 - design prevention strategy
 - inform forward and backward tracing



ORIGINAL ARTICLE



WILEY

African Swine Fever in a commercial pig farm: Outbreak investigation and an approach for identifying the source of infection

Yin Li^{1,2}  | Mo Salman³ | Chaojian Shen¹ | Honglin Yang¹ | Youming Wang¹ | Zhengjun Jiang¹ | John Edwards^{1,2,4} | Baoxu Huang^{1,2}

¹China Animal Health and Epidemiology Center, Qingdao, China

²Murdoch University, Perth, WA, Australia

³Animal Population Health Institute of Colorado State University, CO, USA

⁴Ausvet, Fremantle, WA, Australia

Correspondence

Baoxu Huang, China Animal Health and Epidemiology Center, Qingdao, Shandong, China.

Email: huangbx@cahec.cn

Funding information

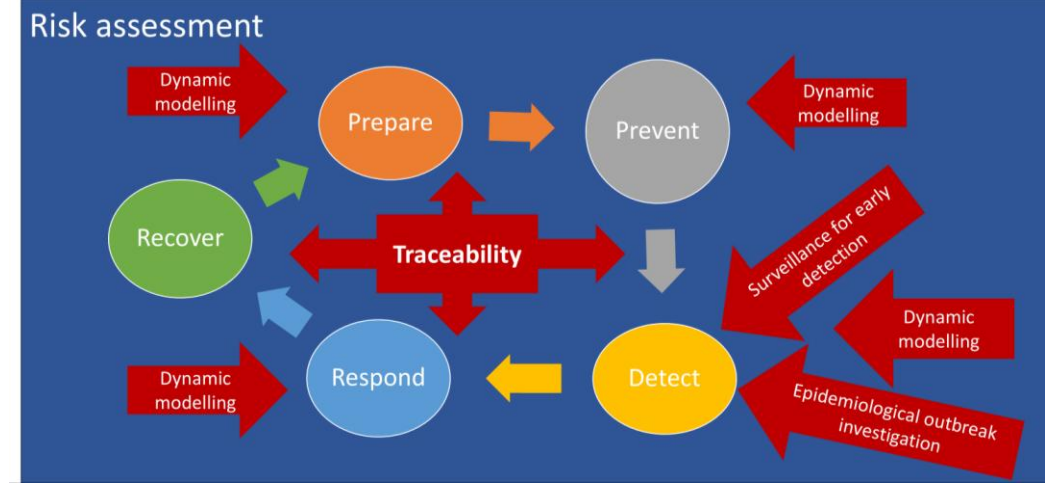
the Innovation Funding of China Animal Health and Epidemiology Center, Grant/Award Number: 201606; National Key R&D Program of China, Grant/Award Number: 2017YFC1200500

Abstract

African Swine Fever (ASF) is a contagious disease of domestic and wild pigs caused by the African Swine Fever Virus (ASFV). The disease has spread globally in recent years with serious economic consequences to pork production. This report describes an ASF outbreak that occurred in a large-scale Chinese commercial pig farm. The outbreak started in 2018 and presents the spatial and temporal spread of infection in an intensive pig farm. Pig houses adjacent to exit rooms had a higher risk of infection (Odds ratio = 14.4, 95%CI: 1.5–140). Introduction of disease is presumed to have occurred through a contaminated vehicle used in the sale of pigs with poor productivity. This investigation shows the process of ASFV infection and spread in a facility with presumed adequate biosecurity measures. These findings may benefit others in the control of ASF in large-scale pig farms.

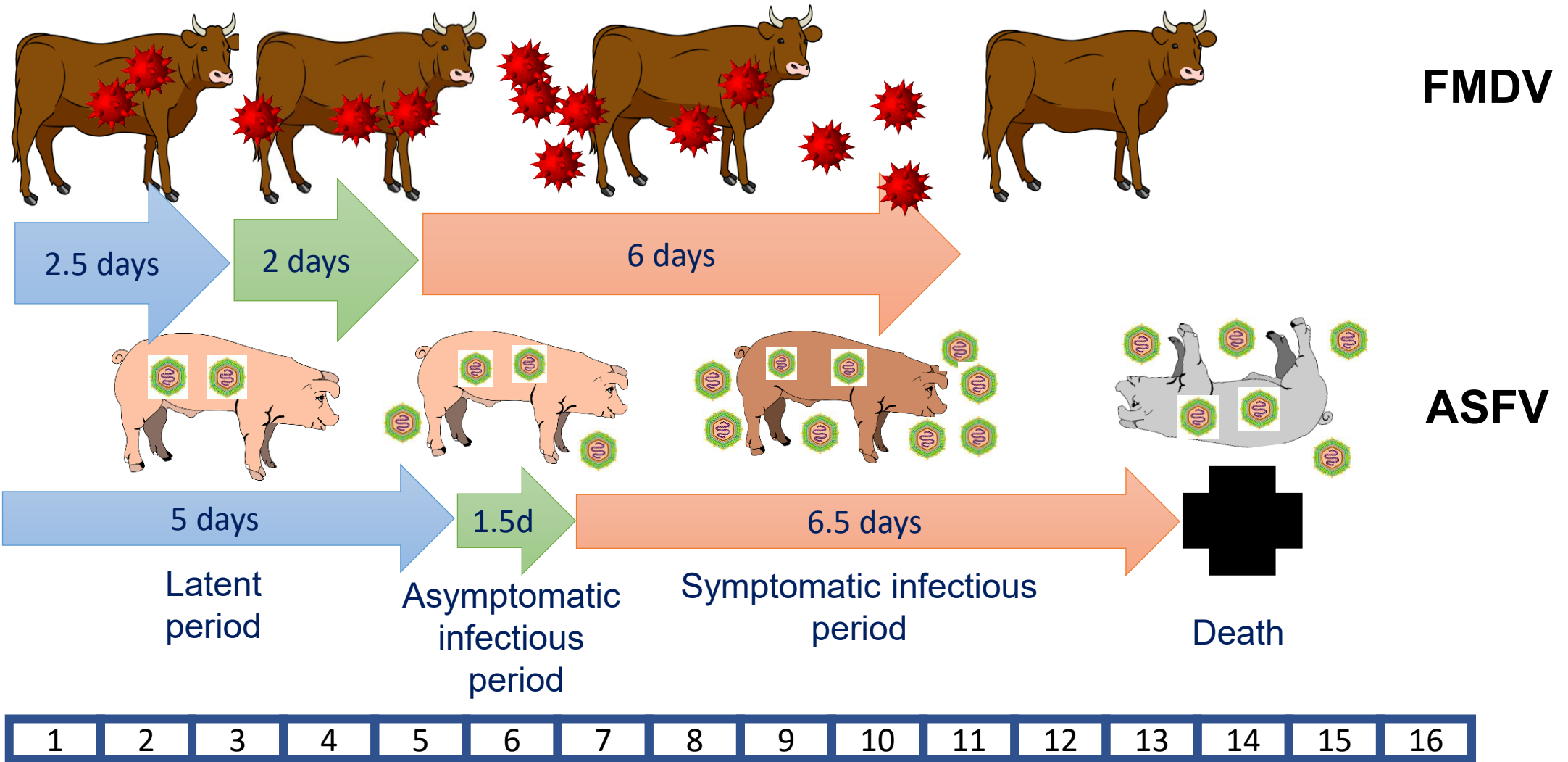
KEYWORDS

African swine fever, biosecurity, outbreak investigation, pig farm, swine disease, veterinary epidemiology

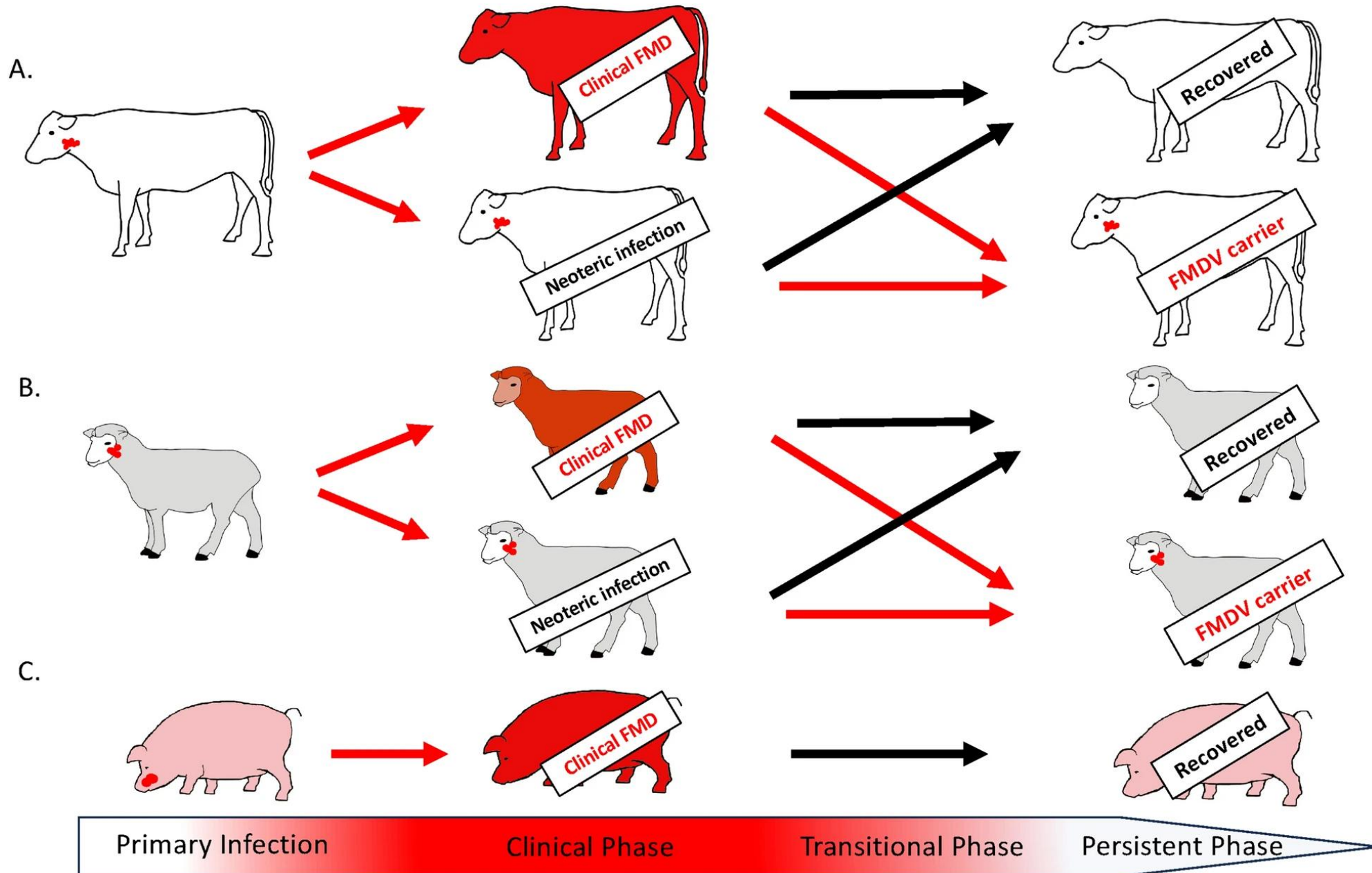


Dynamic Modelling of Infectious Diseases

Mean Duration of Different Infection and Disease States for FMDV and ASFV



FMDV Progression in Different Domestic Livestock Species



From: Stenfeldt, C.,
Eschbaumer, M.,
Humphreys, J. et al. The
pathogenesis of foot-and-
mouth disease virus: current
understandings and
knowledge gaps. *Vet
Res* **56**, 119 (2025).
<https://doi.org/10.1186/s13567-025-01545-5>



Mathematical Modelling Tool



EPI-interactive

[About](#) [Contact](#)



<https://epidemix.app/>

Visually explore spatiotemporal trends in disease transmission and improve your understanding of disease modelling.

Epidemics 23 (2018) 49–54



ELSEVIER

Contents lists available at [ScienceDirect](#)

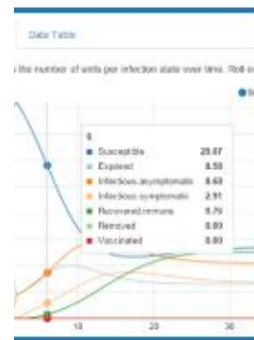
Epidemics

journal homepage: www.elsevier.com/locate/epidemics



epidemix—An interactive multi-model application for teaching and visualizing infectious disease transmission

Ulrich Mueller^{a,1}, Guillaume Fournié^{b,*,1}, Petra Mueller^a, Christina Ahlstrom^a, Dirk U. Pfeiffer^{b,c}



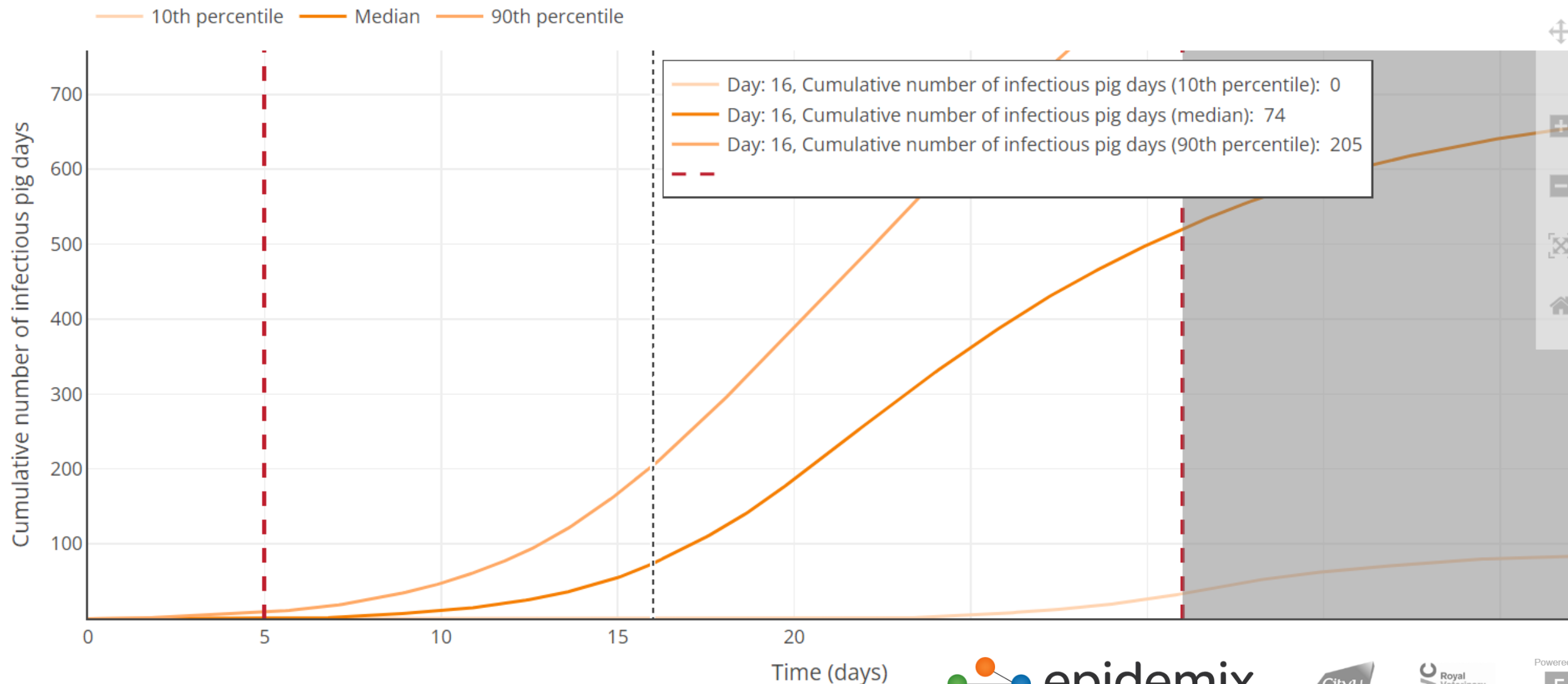
antaneous data visualisation

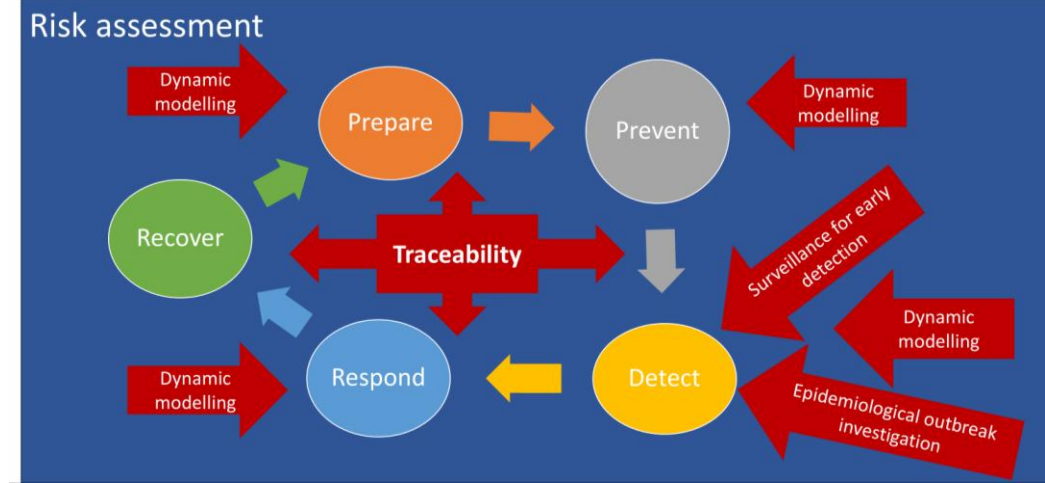
Visualisation Data Table Parameters & Depe										
Number of units per infection state per timestep. Additionally units removed due to disease [ReD] and vac										
Download data Info										
	S	E	Ia	Is	R	ReD	V			
0	40.00	10.00	0.00	0.00	0.00	0.00	0.00	0.		
0.5	40.50	7.12	2.38	0.00	0.00	0.00	0.00	0.		
1	40.05	6.00	3.72	0.23	0.00	0.00	0.00	0.		
1.5	39.05	5.78	4.61	0.55	0.02	0.00	0.00	0.		
2	37.79	6.02	5.31	0.91	0.07	0.00	0.00	0.		
2.5	36.15	6.43	5.97	1.25	0.15	0.00	0.00	0.		

Table view and export options



Modelling of Cumulative Number of ASFV Infectious Pig Days over Time in Group of 100 Susceptible Pigs





Respond



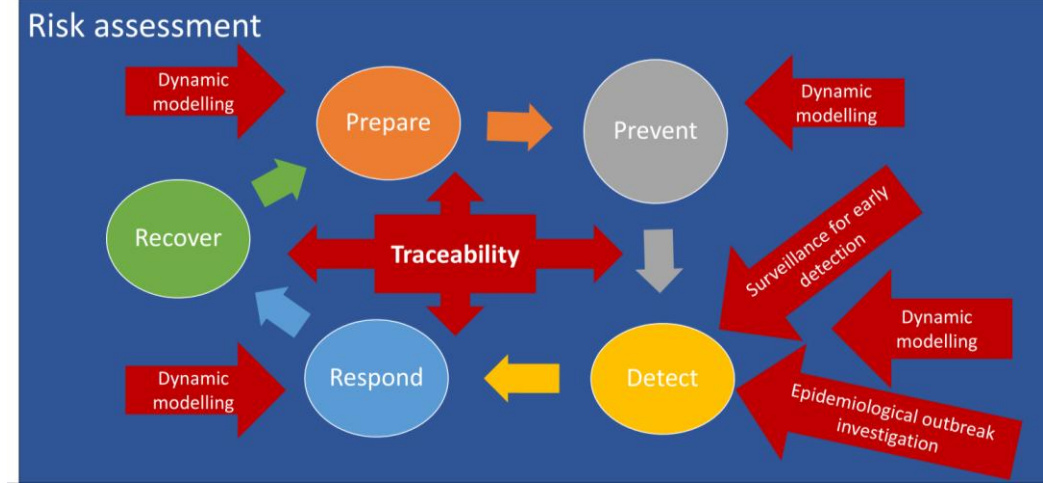
Infection Control Measures from a Dynamic Infectious Disease Modelling Perspective

- need to change transmission parameters
 - reduce number of susceptibles
 - reduce contact rate
 - reduce probability of transmission during contact
 - reduce period of infectiousness
 - reduce level of infectiousness
 - remove infected
 - etc etc



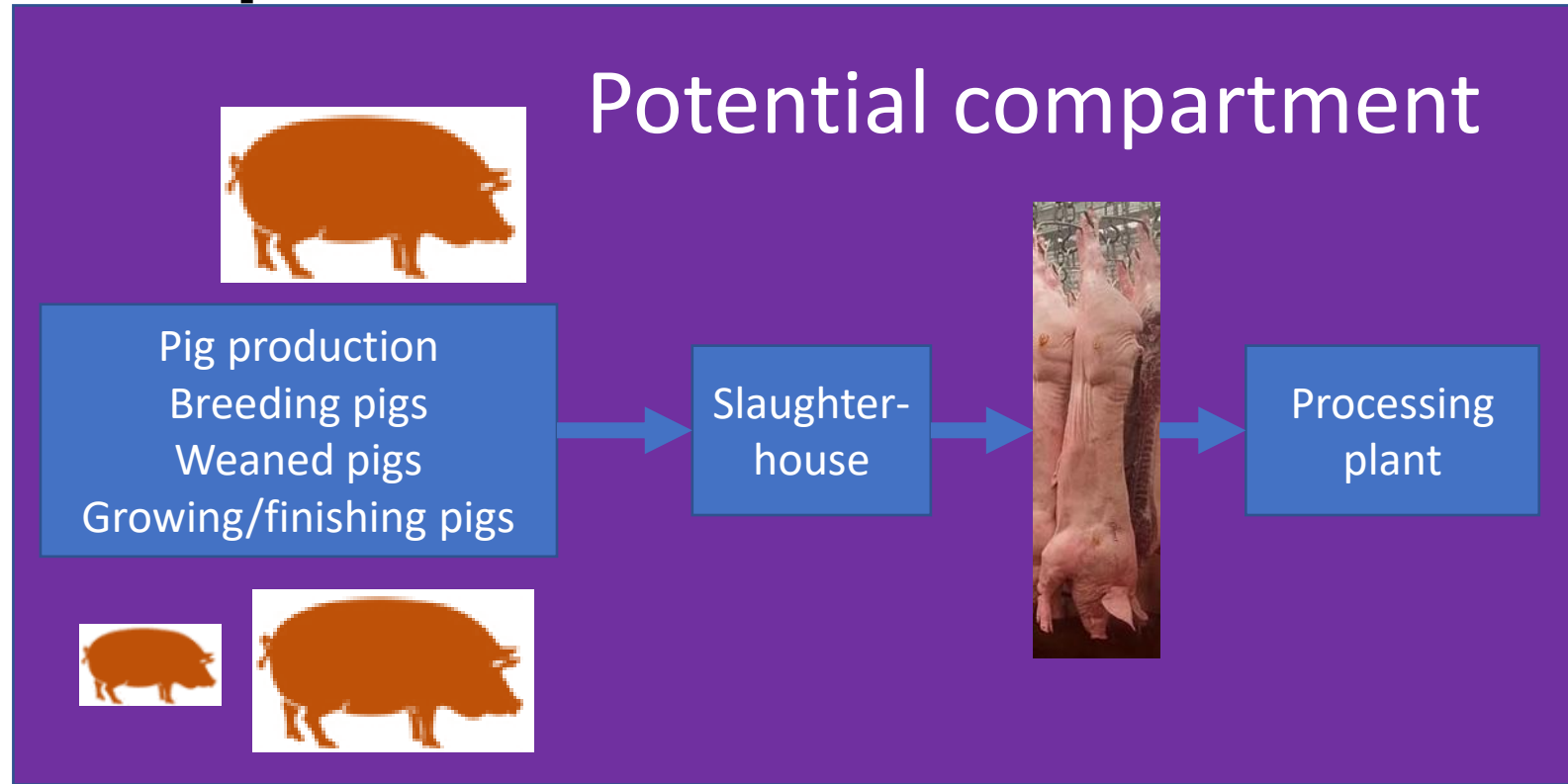
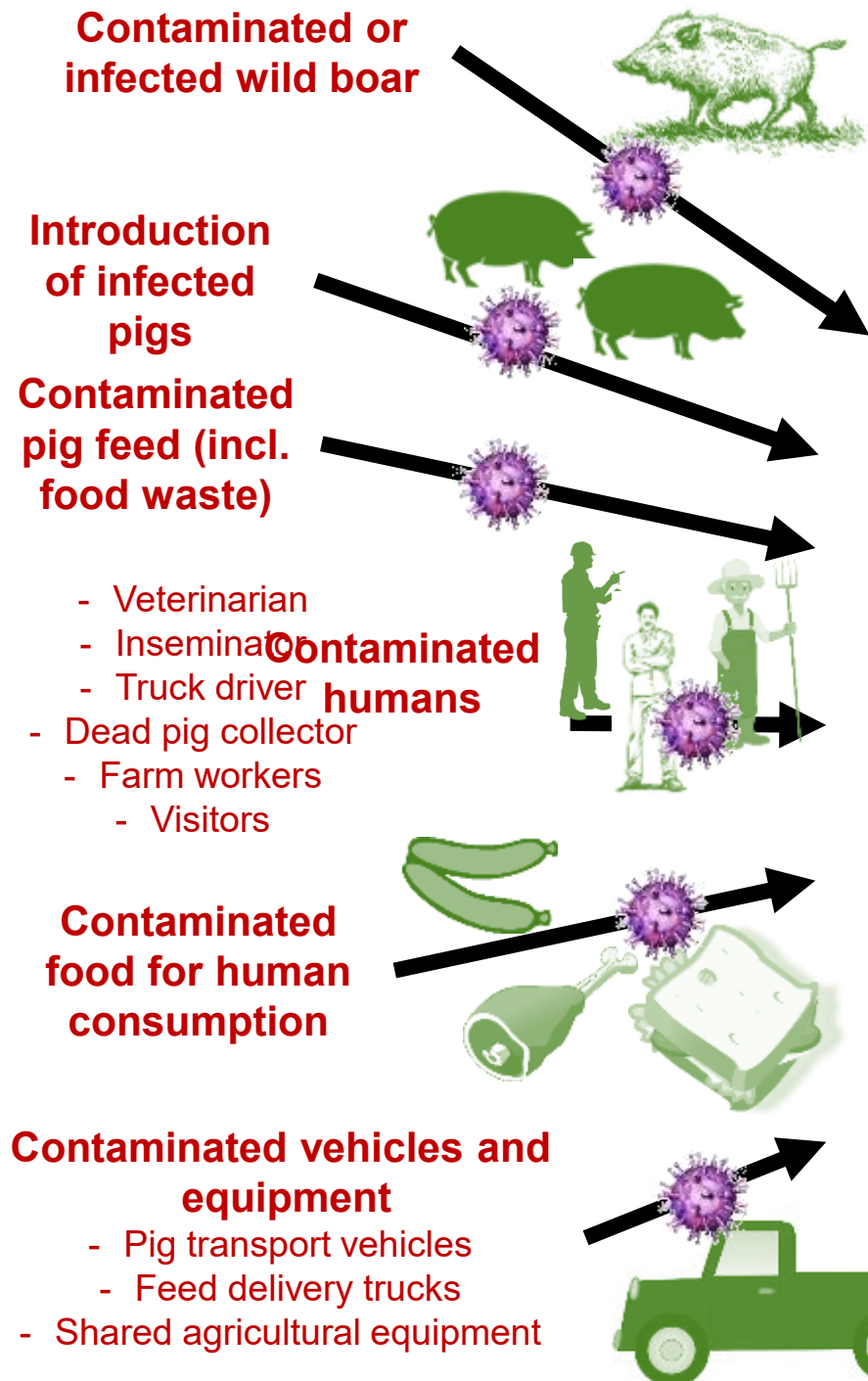
Possible Control Measures

- movement restriction and zoning
- bio-containment and bio-exclusion
 - within establishment and/or beyond
- surveillance
- vaccination
- culling
- and combinations of the above
- supported by rapid diagnostic testing



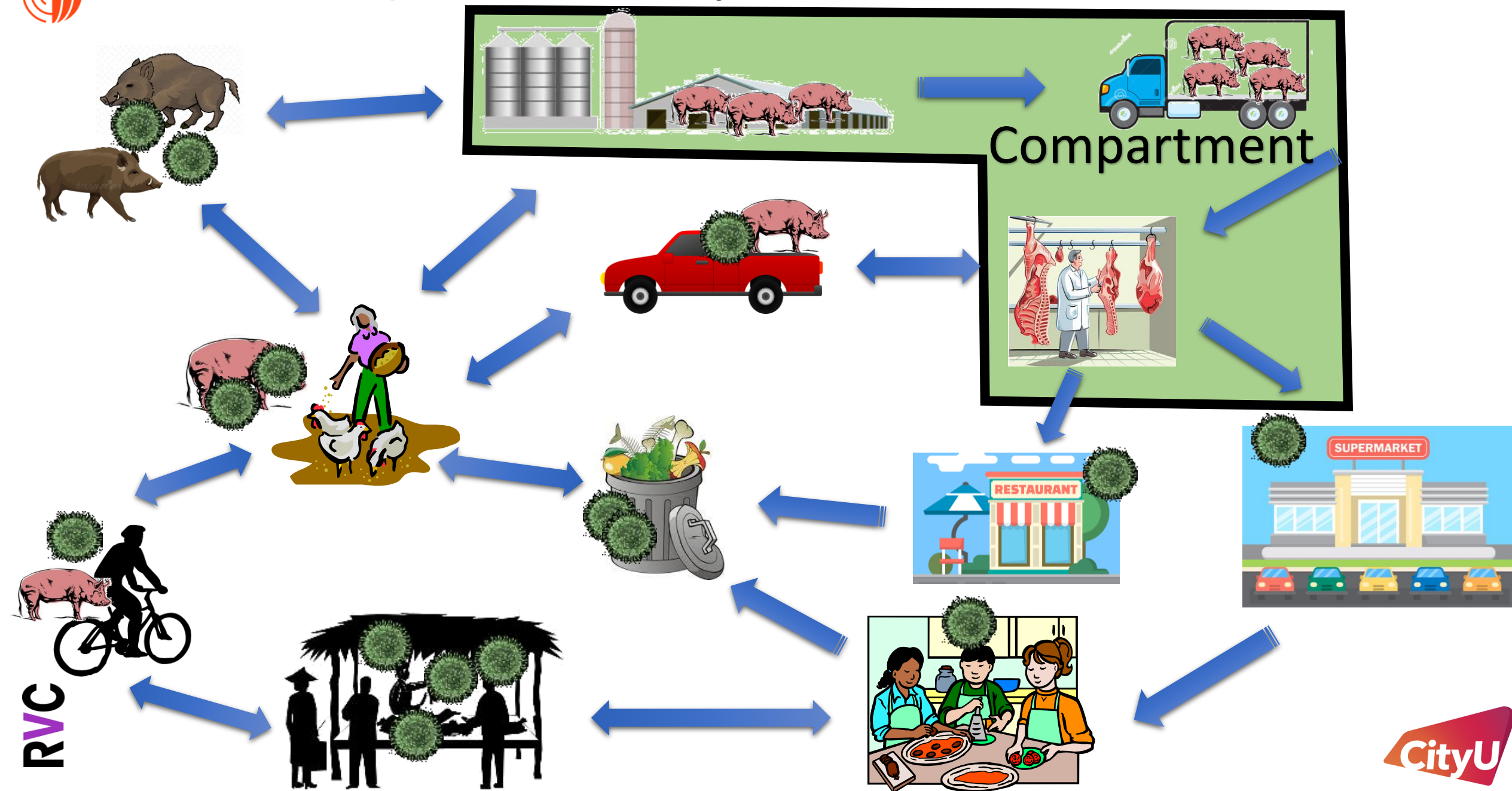
Prevent

Potential Risk Pathways for ASF Virus Introduction into Compartment





ASFV- Free Compartment in Food Systems in South-East and East Asia





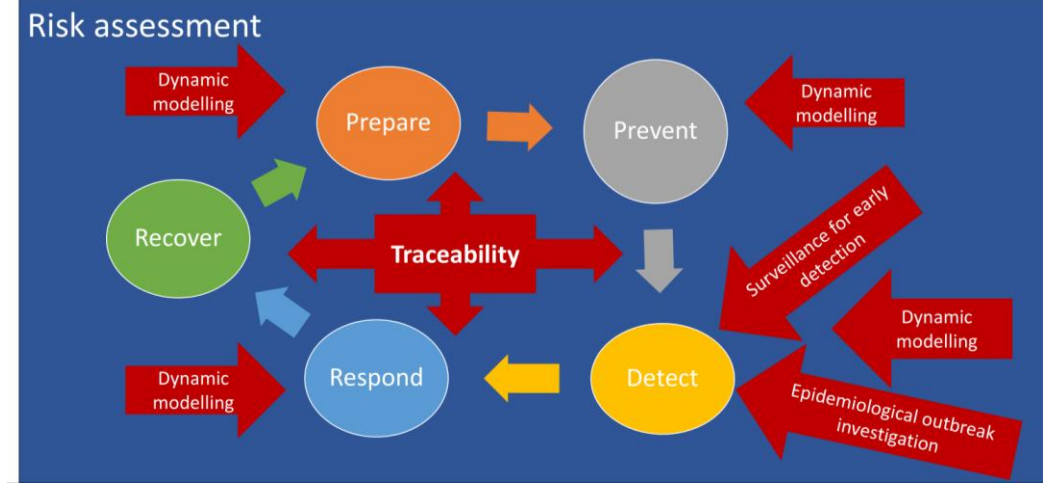
Prevention of Infectious Diseases in Livestock

- behaviour change amongst actors along value chain
- enhanced biosecurity along value chain
- geographical or operational/epidemiological separation
 - zoning / compartmentalisation
- risk-based decision making in relation to cattle movement
- surveillance (passive and active)
- strategic use of technical tools
 - diagnostics
 - vaccination
- need to design integrated infectious disease risk management programme based on
 - clear objectives defined in consultation with key stakeholders
 - understanding of
 - local value chains and key actors
 - local infectious disease epidemiology
 - performance characteristics of vaccines and diagnostics

OIE Compartmentalisation Guidelines for ASF

- tool to establish and maintain a swine compartment free from ASF for the purposes of facilitating **safe national and international trade**, and promoting **disease prevention and control**
- for Veterinary Authorities, private sector, third parties and technical service providers
- organisation
 - principles and implementation of ASF compartmentalisation
 - appendices and tools
 - compartmentalisation as applied by OIE Members



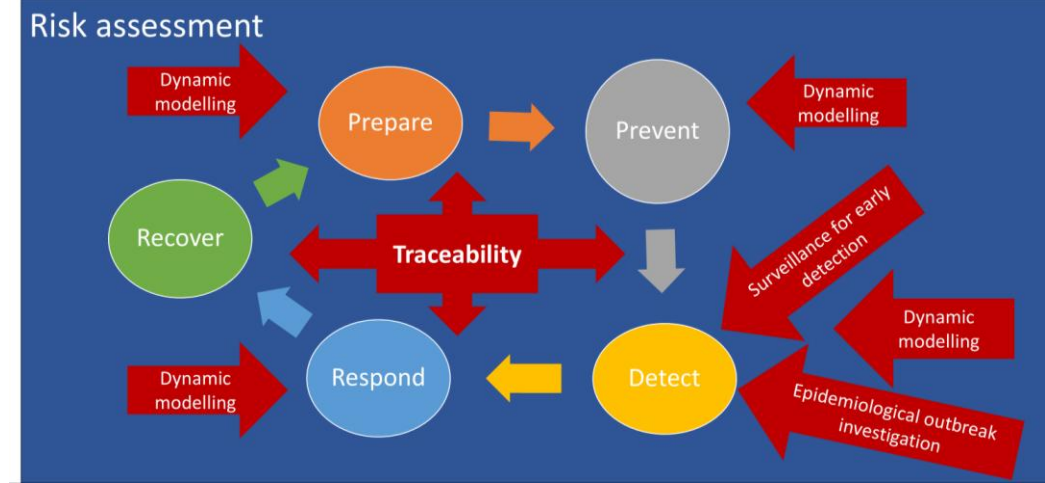


Prepare



How to Prepare

- up-to-date understanding of food system and its dynamics
- effective communication between industry and veterinary authorities
- legislation
- funding
- diagnostic laboratories
- capacity development
- simulation exercises



Animal Health Surveillance



Animal Health Surveillance Objectives

- can be one or several of the following
 - early detection of exotic, new (emerging) and re-emerging diseases
 - demonstration of freedom from diseases and infections
 - determination of disease frequency and detection of cases of endemic animal diseases



Surveillance System and Surveillance System Component

- surveillance system
 - „A method of surveillance that may include one or more component activities that generates information on the health, disease or zoonosis status of animal populations.“
 - OIE Terrestrial Animal Health Code 2007
- surveillance system component
 - contributes to demonstrating evidence for disease freedom
 - has capacity to detect disease if it occurs
 - includes ,active‘ and ,passive‘ surveillance
 - Martin et al. 2007: Prev Vet Med 79, 71-97



Examples of Surveillance Component Activities

early warning/scanning (passive)

- laboratory submissions / veterinary reporting
 - participatory surveillance
 - community animal health service
- expert opinion
- syndromic surveillance
 - abattoir or other production monitoring
- event-based surveillance
- molecular surveillance

strategic (active)

- probability-based
 - observational and intervention studies
- purposive
 - risk-based surveillance
 - sentinel surveillance
 - targeted surveillance
 - participatory surveillance



Guide to Terrestrial Animal Health Surveillance



WORLD ORGANISATION FOR ANIMAL HEALTH
Protecting animals, preserving our future



BEST PRACTICES

for risk-based and cost effective
animal health surveillance
in the European Union

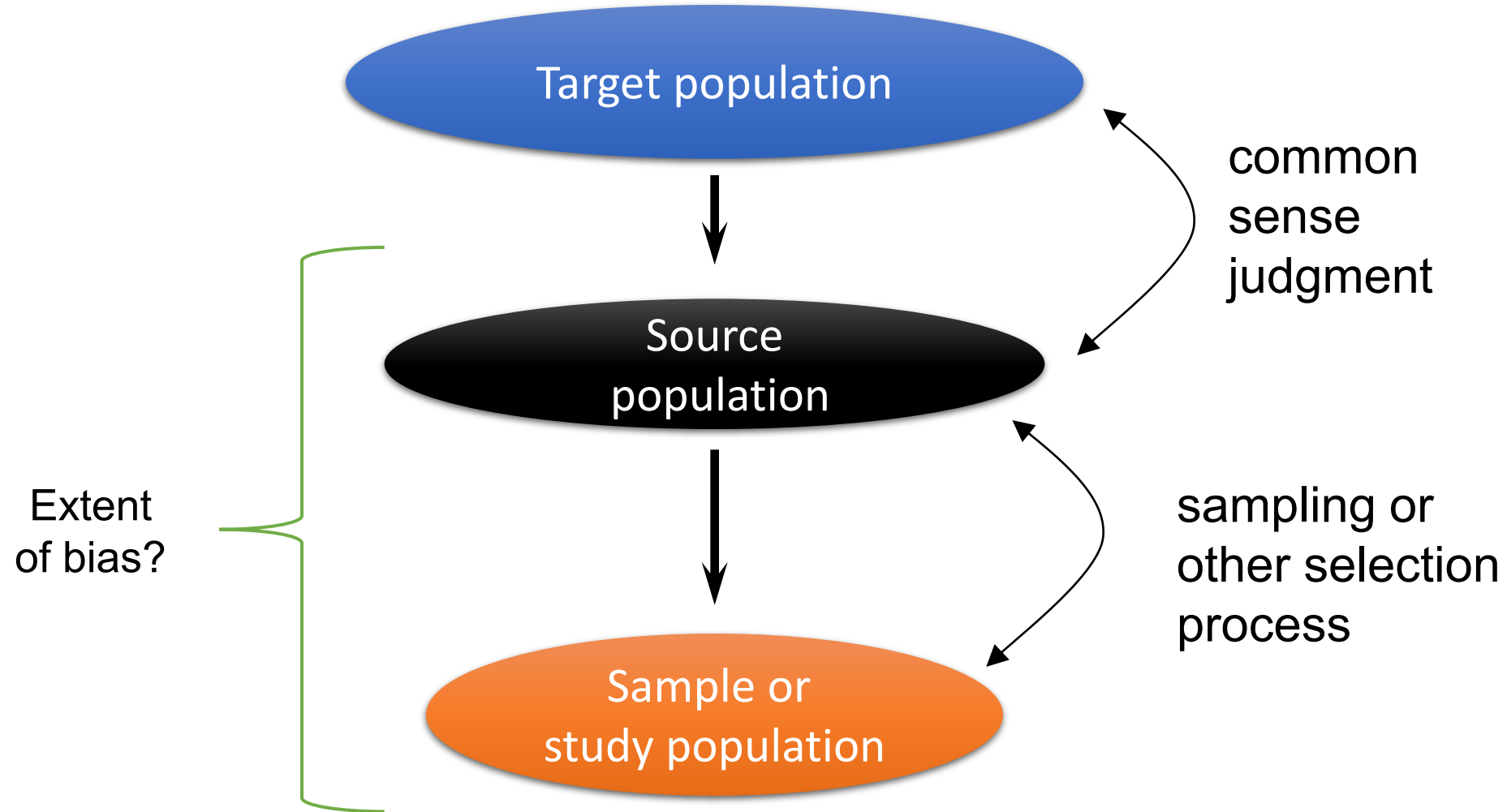


This project has received funding from the
European Community's Seventh Framework Programme
under grant agreement N° 310806.

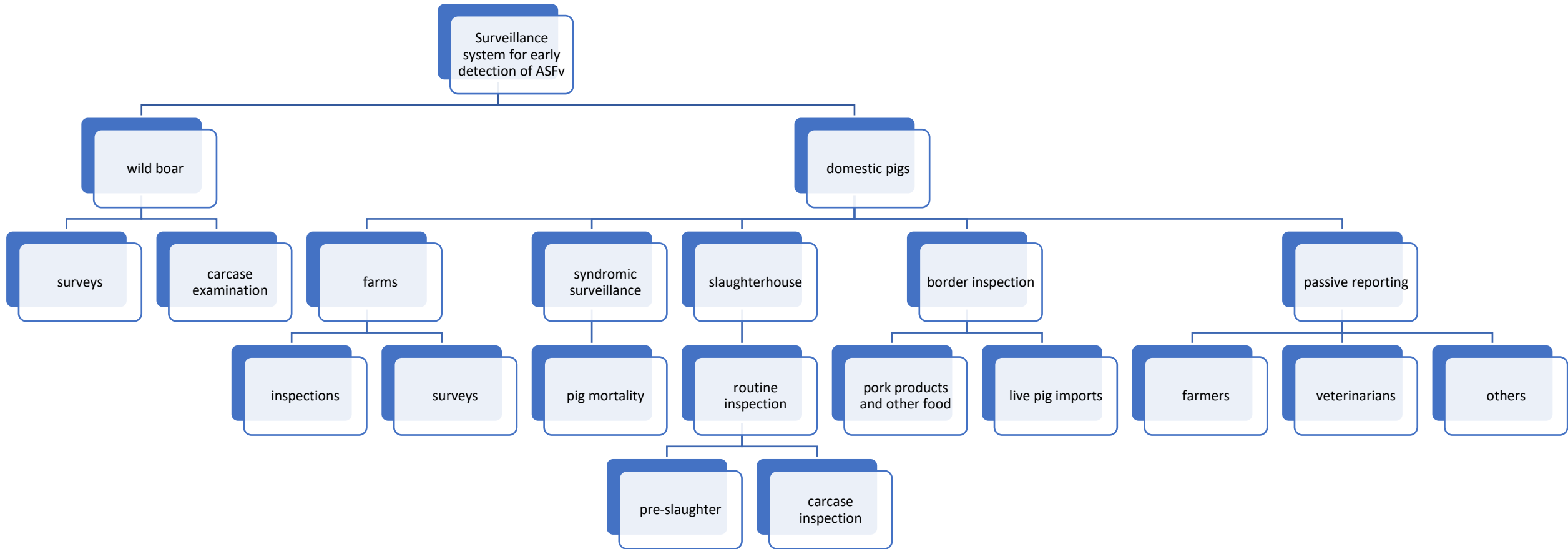




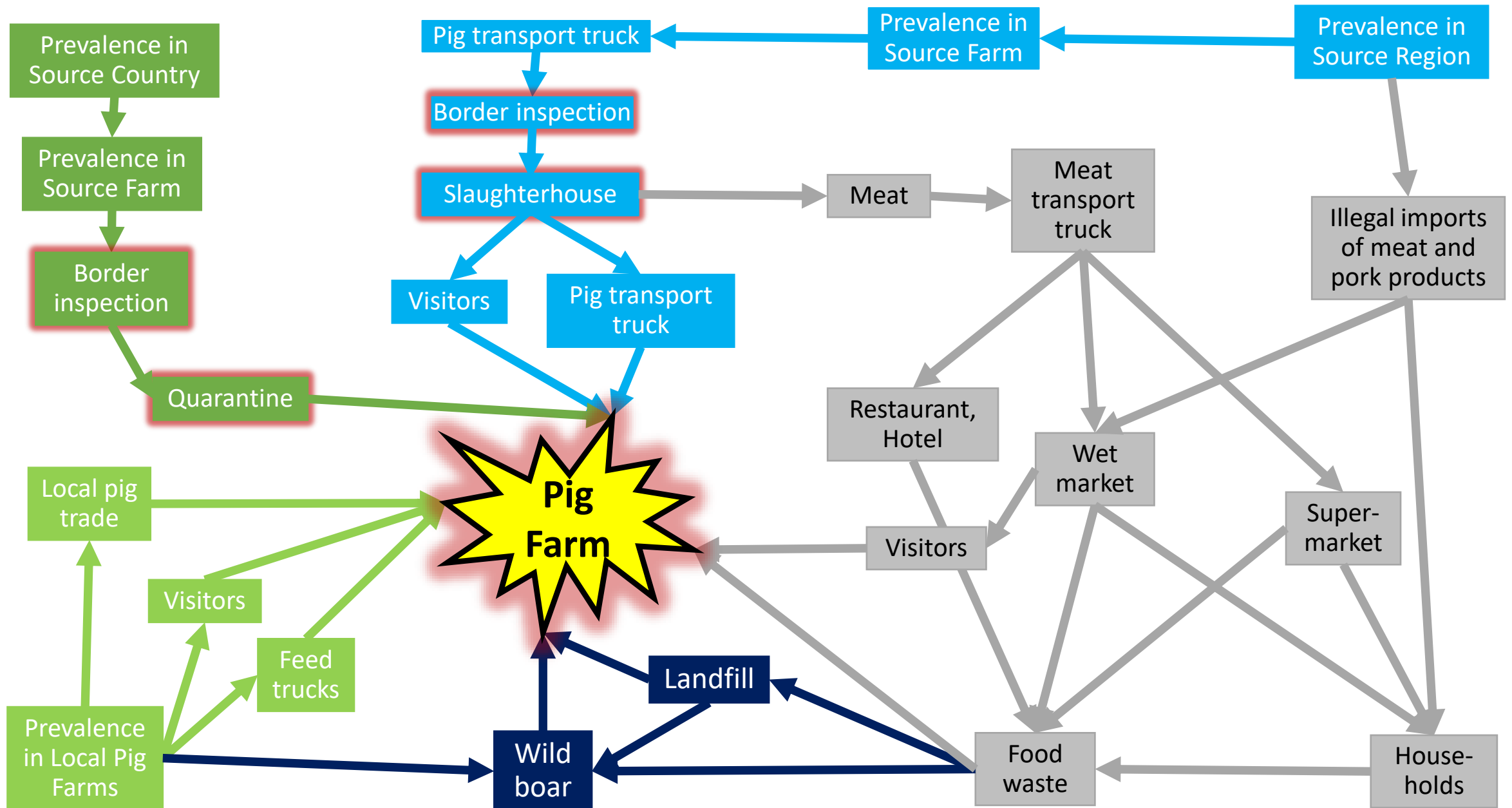
Validity of Surveillance Data - Sampling



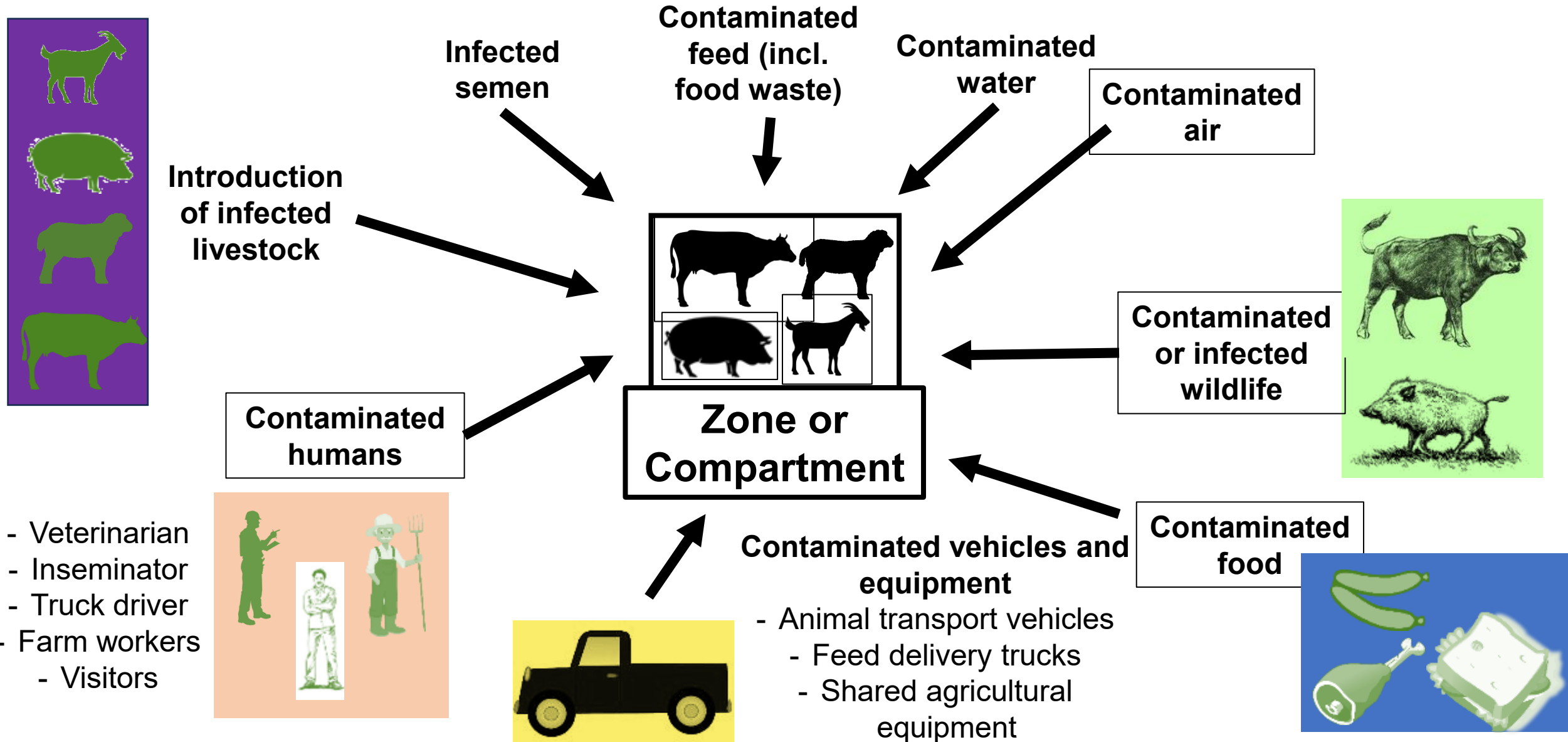
Potential Surveillance System Components for Early Detection of ASFv



Risk Pathways for Introduction of ASF Virus to Pig Farms



Example of Potential Mechanisms for Introduction of Infectious Pathogens to a Zone or Compartment





Example of Surveillance System for Early Detection of ASFv and Surveillance System Components for a ASFV-free Zone

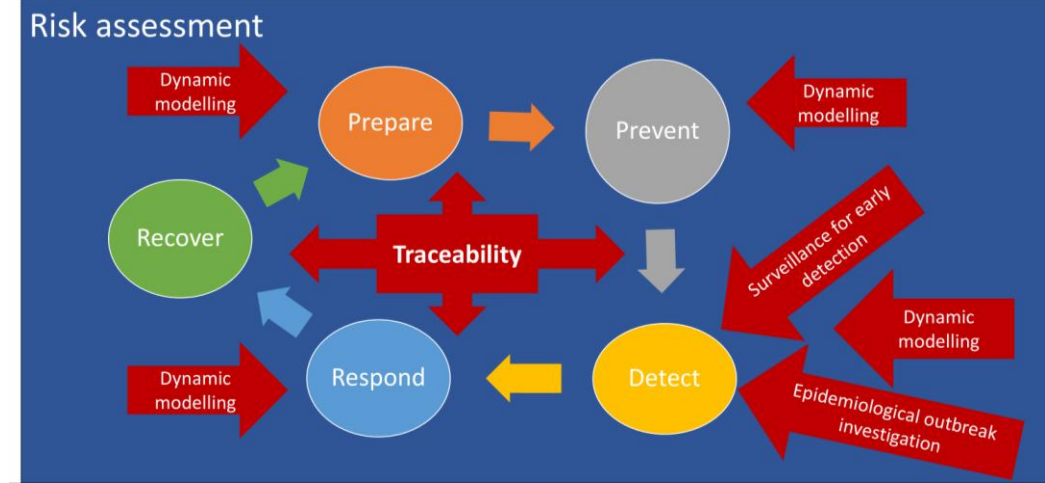






Unusual Mortality as Trigger for Reporting

- effectiveness depends on
 - incentives for actors involved in value chain (not just farmers)
 - level of 'normal' background mortality in herds
 - average pig mortality during finishing phase (in 2018)
 - 2.9% in European Union
 - 4.5% in USA
 - pigs spent 111 days on average in finishing section (in 2018 in EU),
= daily average pig mortality of 0.03% (3 pigs per 100)



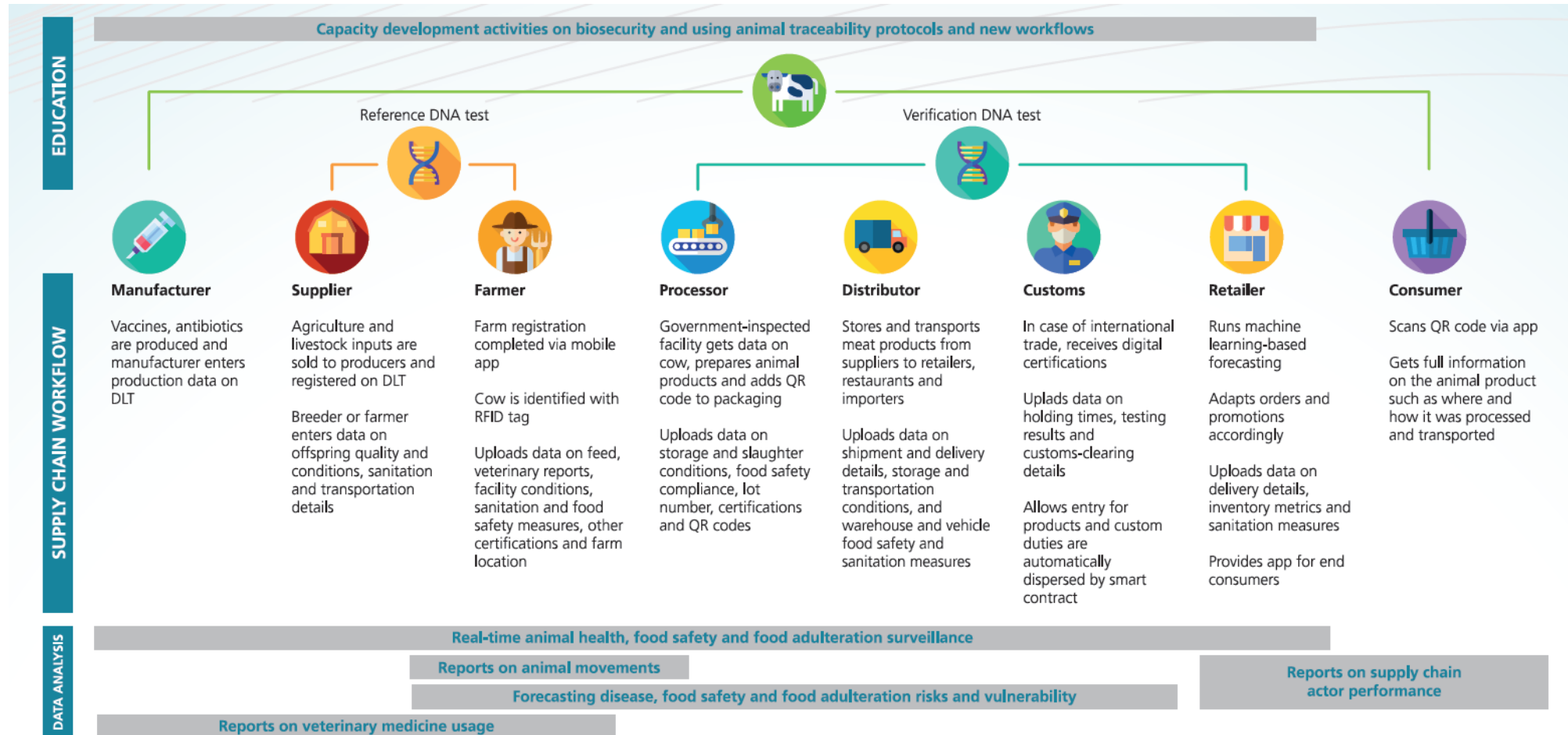
Traceability Systems



Traceability Systems

- used in animal disease outbreaks as part of
 - prevention
 - detection
 - response
 - recovery
- elements of identification
 - establishment (assembly centres (e.g. agriculture shows and fairs, sporting events, transit centres, breeding centres), markets, slaughterhouses/abattoirs, rendering plants, dead stock collection points, transhumance areas, centres for necropsy and diagnosis, research centres, zoos, border posts, quarantine stations)
 - individual animals or groups
 - from birth to slaughter or sale
 - from last holding to slaughter or sale
 - movement of animals or groups to and from establishment
- technologies
- more detail in WOAHA Animal Health Code Ch 4.2: Design and Implementation of Identification Systems to achieve Animal Traceability

Use of Digital Technologies in Livestock Traceability and Trade

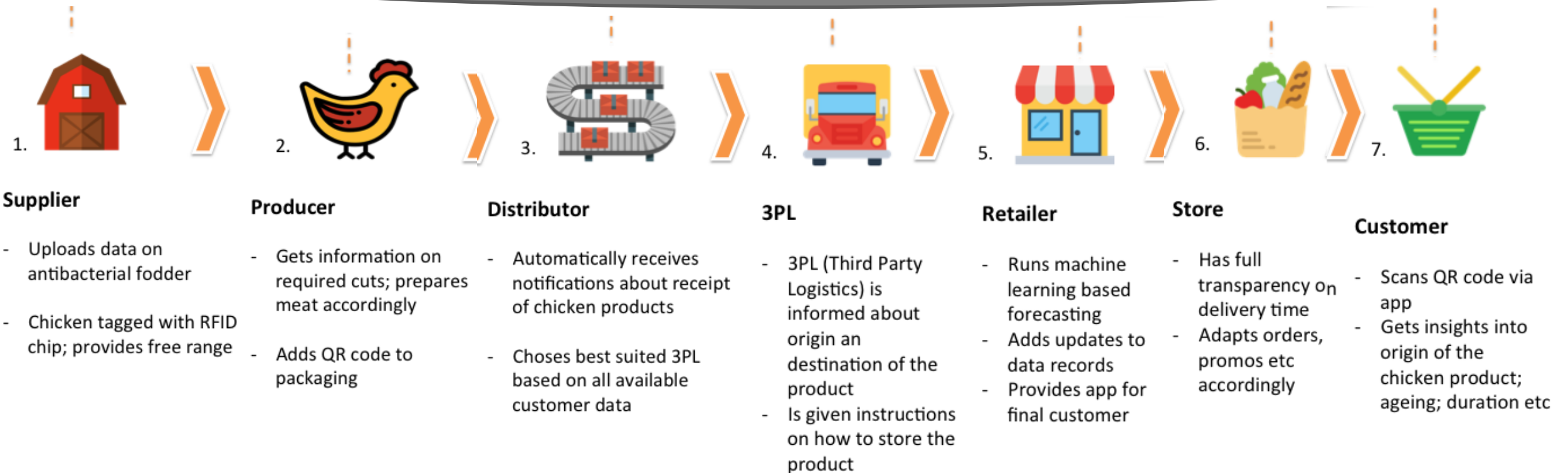


Source: Tripoli & Schmidhuber, 2020

From: Tripoli M. & Schmidhuber, J. 2020. Optimizing Traceability in Trade for Live Animals and Animal Products with Digital Technologies. In Ensuring Safe Trade in Animals and Animal Products (C. Wolff & A. Hamilton, eds) Rev. Sci. Tech. Off. Int. Epiz., 39 (1). doi:10.20506/rst.39.1.3076. In Tripoli – FAO Trade Policy Brief No. 36

Blockchain in Chicken Meat Production

BLOCKCHAIN



(The diagram is adapted for chicken meat production context from a diagram by Oliver Wyman. Icons by <https://goo.gl/5JyE4k>)



Staff Competencies in Animal Disease Control and Prevention for Effective Implementation of Zoning and Compartmentalisation



ASF Risk Management Guidelines for Smallholder Farms in Asia



Guidelines for
African swine fever (ASF)
prevention and control in
smallholder pig farming in Asia

CULLING AND DISPOSAL OF PIGS IN AN ASF OUTBREAK



Guidelines for
African swine fever (ASF)
prevention and control in
smallholder pig farming in Asia

MONITORING AND SURVEILLANCE OF AFRICAN SWINE FEVER



Guidelines for
African swine fever (ASF)
prevention and control in
smallholder pig farming in Asia

FARM BIOSECURITY, SLAUGHTERING AND RESTOCKING



Guidelines for
African swine fever (ASF)
prevention and control in
smallholder pig farming in Asia

CLEAN CHAIN APPROACH FOR ASF IN SMALLHOLDER SETTING





Asia Pacific Consortium of Veterinary Epidemiology

APCove

Freely available eLearning modules:

- A – Fundamental competency
- B – Outbreak investigation and response
- C – Surveillance and data analysis
- D – Risk assessment and disease control
- E – One Health and biosecurity
- F – Leadership and communication



Conclusions



Conclusions

- need system understanding
 - food system (national, regional, global)
 - political economy
 - understanding of epidemiology in a real-world context
- adopt strategy based on “prepare -> prevent -> detect -> respond -> recover” components
 - underpinned by sound risk assessment
 - epidemiological outbreak investigation
 - use dynamic modelling to understand and to inform about what to do
 - surveillance
 - know where your herds and animals are, and where they have been (traceability)
 - diagnostic tools
- partnership with industry, but veterinary authorities need to maintain their independence from industry to be able to perform credible audits
- capacity building in veterinary epidemiology essential for veterinary authority staff involved with zoning and compartmentalisation activities

Good Emergency Management Practice (GEMP) in Animal Health

Risk assessment

