ASF virus characteristics and epidemiology, importance for trade of live pigs and pig products

Aruna Ambagala, BVSc, PhD

WOAH Reference Laboratory for African & Classical Swine Fever
Canadian Food Inspection Agency-National Centre for Foreign Animal Disease
Winnipeg, Manitoba
Canada

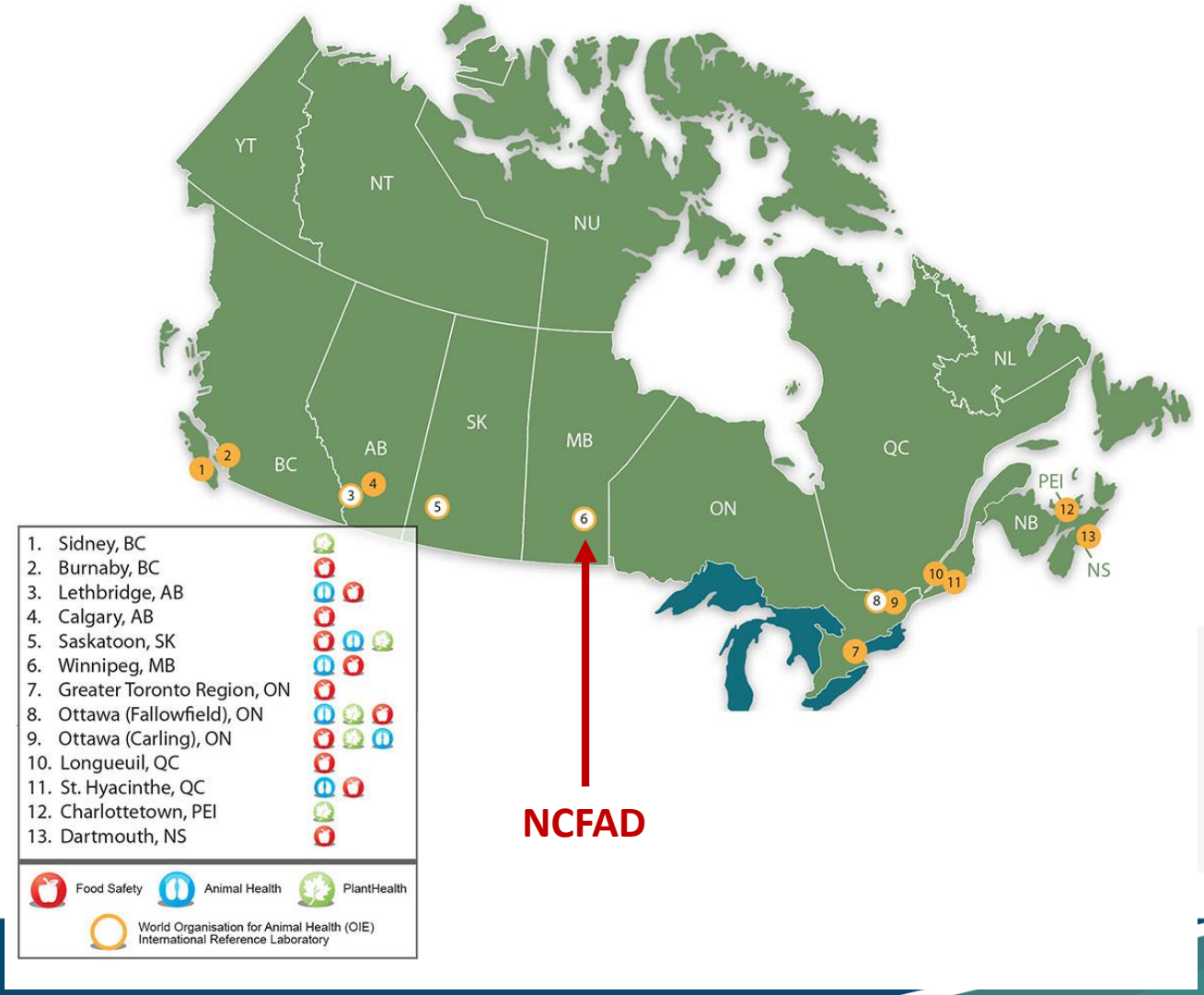
Webinar on WOAH Standards, Trade and African Swine Fever in the Americas
November 22-23, 2022

National Centre for Foreign Animal Disease (NCFAD)

Canadian National Ref. Laboratory for Foreign & Emerging Animal Diseases

- Co-located with the Public Health Agency of Canada - One Health Concept
- High containment BSL3 & BSL4 Laboratory with large animal facilities
- WOAH Reference Laboratories for **ASF, CSF**, High Path. AI & FMD
- FAO Reference Centers for FMD & Zoonotic & Emerging Pathogens

Canadian Food Inspection Agency (CFIA)'s 13 Reference & Research Laboratories Across Canada



National Centre for Foreign Animal Disease (NCFAD)

1. Avian Diseases Unit (ADV)
2. **Mammalian Diseases Unit (MDU)**
3. Vesicular Diseases Unit (VDU)
4. Special Pathogen Unit (SPU)
5. CL2 Serology Unit
6. Genomics Unit (GU)
7. Reagent Development Unit (RDU)
8. Animal Care Unit (ACU)
9. Quality Assurance Unit (QAU)
10. The Canadian Animal Health Surveillance Network (CAHSN)

Diagnostics and Research

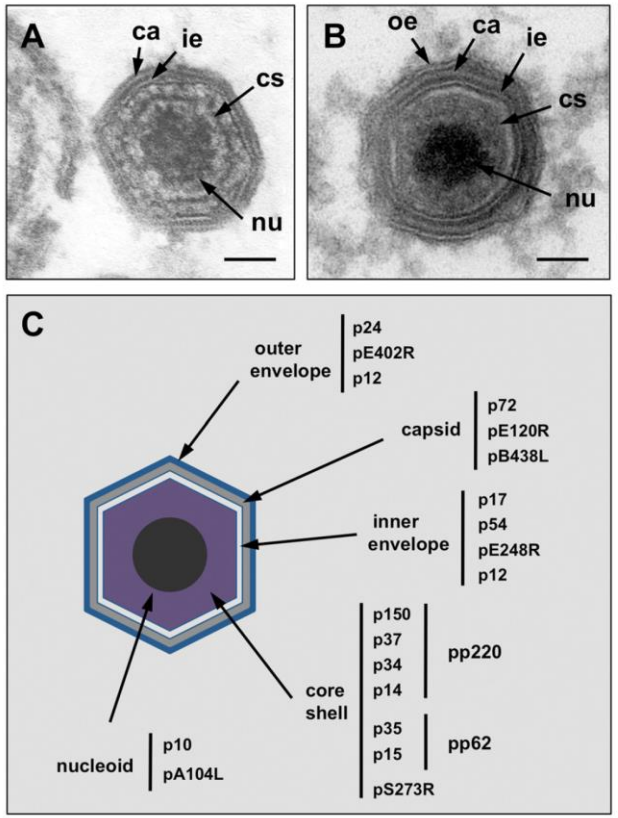
- **African swine fever**
- Classical swine fever
- Rabbit hemorrhagic disease
- Bluetongue
- Epizootic hemorrhagic disease
- Schmallenberg
- Pseudorabies
- Cache valley
- Sheep & goat pox
- Lumpy skin disease

African Swine Fever (ASF)

- A contagious viral disease with a **high fatality rate** in both domestic and wild pigs
- It has greatly challenged pig-raising countries and also negatively **impacted regional and national trade of pork products**
- No commercially available vaccine or antiviral therapy available
- A WOAH listed disease
- Reportable disease in Canada - Animal owners, veterinarians & laboratories are required to **immediately report** the **presence** of an animal that is infected or **suspected** of being infected with ASFV to a **CFIA district veterinarian**

African Swine Fever – The Virus

- Highly complex large enveloped DNA virus (200 nm)
- The only DNA arbovirus known - Tick virus
- Icosahedral multilayer structure, containing about 50 different proteins
- The sole member of the Asfavirus genus in the Family *Asfaviridae*
- Genome: 170 -190 Kb, Encodes 150-167 genes, 1/3 non-essential for *in vitro* replication
- 24 Genotypes (p72). All in Africa. Genotype I – Sardinia & China . Genotype II – Europe, Russia, Asia, DR & Haiti



https://asf-referencelab.info/asf/images/ficherosasf/MORFOGENESIS.pdf

Structure and protein composition of ASFV.
EM of an intracellular full ASFV particle (A) and an extracellular mature ASF virion (B). Outer envelope (oe), inner envelope (ie), capsid (ca), core shell (cs) and nucleoid (nu). Bars, 50 nm.
Panel C: Localization of different ASFV structural proteins inside ASFV.

African Swine Fever Virus - Stability

https://www.marcusfoodco.com/Pages/Products/Pork

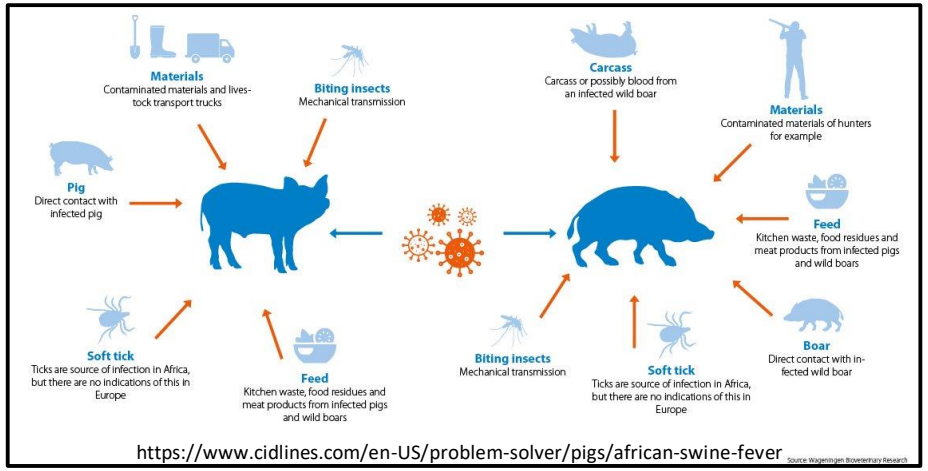
Highly stable at **low temps**, **high humid and organic environments**

Frozen meet	15 weeks	Davies et al., **2017**
Cured ham	6 months	Davies et al., **2017**
Prosciutto	399 days	Davies et al., **2017**
Liquid blood at RT	18 months	Mazur-Panasiuk et al., **2020**
Liquid blood at 4 °C	6 years and longer when frozen	Mazur-Panasiuk et al., **2020**
Salami at 4 °C	18 days	Petrini et al., **2019**
Pork belly at 4 °C	60 days	Petrini et al., **2019**
Tenderloin at 4 °C	83 days	Petrini et al., **2019**

African Swine Fever Virus – Stability

Urine at 37 °C	4 days	Davies et al., 2017
Feces at 37 °C	3 days	Davies et al., 2017
Liquid fertilizer	100 days	Mazur-Panasiuk et al., 2020
Sand or garden soil	Few weeks Few days (swamp) and None (acidic forest soils)	Blome et al., 2020
In Leeches	60-80 days	Karalyan et al., 2019
Flies Mouth	12 h after feeding	Olesen et al., 2018
Soybean meal	112 days at 40°F	Niederwerder et al., 2022
Complete feed	30 days	Niederwerder et al., 2022

African Swine Fever - Transmission



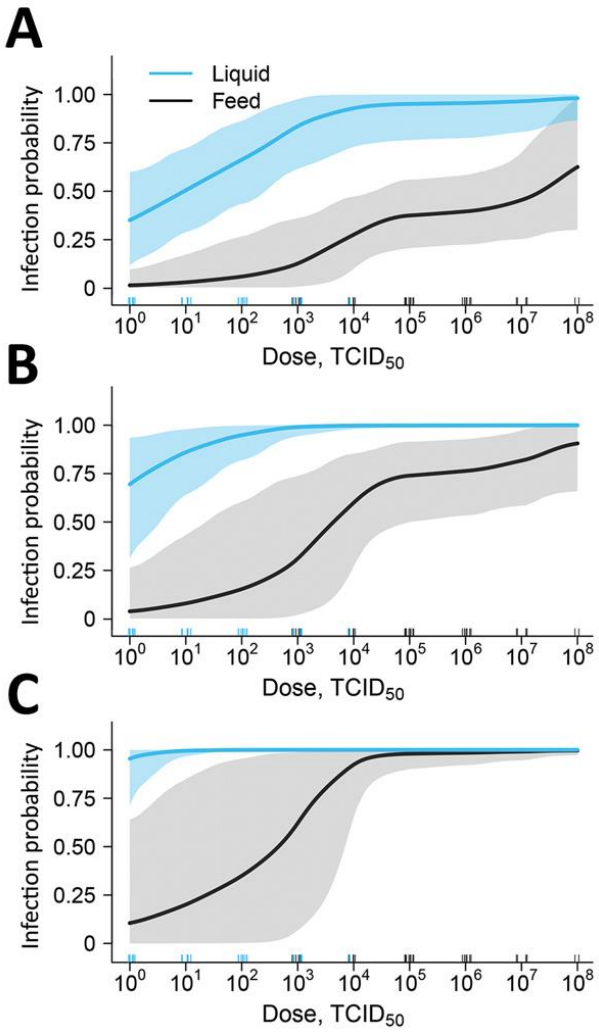
- **Ticks:** In Africa, *O. moubata* ticks are the main reservoir of this virus (sylvatic cycle)

- **Direct contact between sick & healthy animals**: ASFV is shed in **all secretions and excretions** approximately at the same time as the onset of fever

- **Indirect transmission** by ingestion of infected **meat products** or contact with contaminated fomites - feed, food, soil, hunting equipment, transport vehicles, carcasses

  - The **first spread** of ASF outside Africa - Portugal in 1957 (waste from airline flights)
  - The **second spread** of ASF – Georgia in 2007 - (infected pork from a ship at a Black Sea port)
  - *Other possible indirect transmissions: To China in 2008, DR and Haiti in 2021, Belgium in 2018*

African Swine Fever Virus - Infectious Dose



The lowest dose required to result in ASFV infection ≥1 pig

- **Liquid: 10^0 $TCID_{50}$**
- **Complete feed : 10^4 $TCID_{50}$**

Overall, the probability of infection increased as the dose increased for both feed and liquid

Estimated liquid (blue line) and feed (black line) infection probability at different oral doses when consumed naturally.
A - Single exposure
B - Three exposures
C - Ten exposures

Niederwerder MC, Stoian AMM, Rowland RRR, Dritz SS, Petrovan V, Constance LA, Gebhardt JT, Olcha M, Jones CK, Woodworth JC, Fang Y, Liang J, Hefley TJ. Infectious Dose of African Swine Fever Virus When Consumed Naturally in Liquid or Feed. Emerg Infect Dis. 2019 May;25(5):891-897.

African swine fever - Clinical Forms

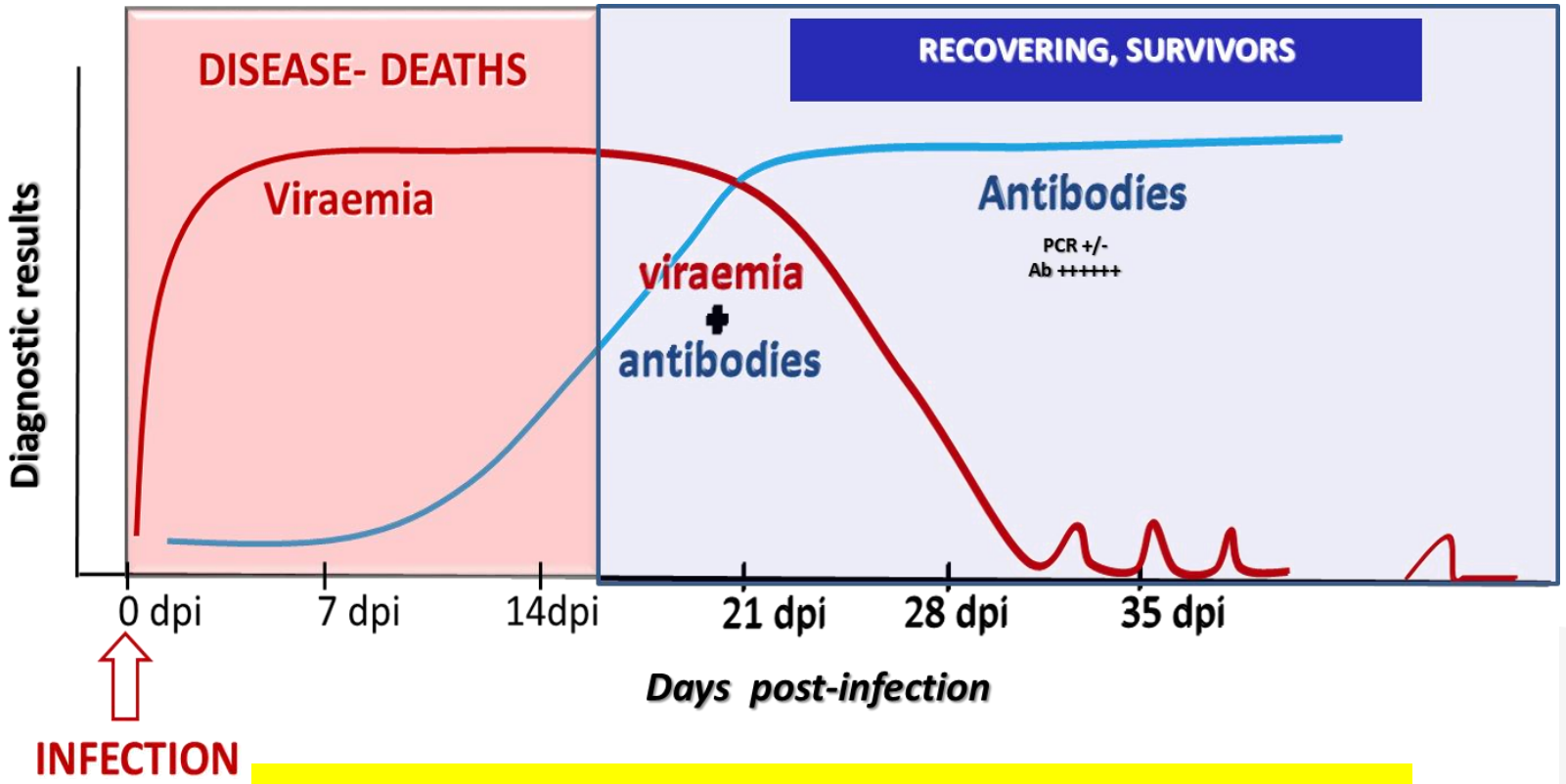
Table 1 Characteristics of the four manifestations of an infection with the African swine fever virus

	Peracute form	Acute form	Subacute form	Chronic form
Virulence	High	High/moderate	Moderate	Low
Clinical signs	High fever, appetite loss, lethargy, hyperpnoe	High fever, appetite loss, lethargy, gastro-intestinal signs	See acute form but less pronounced	Respiratory signs, lameness
Pathology	Erythema	Erythema, petechial haemorrhages in several organs, lung oedema, abortion	Erythema, petechial haemorrhages in several organs, haemorrhagic lymph nodes, abortion	Arthritis, necrotic skin, pneumonia, pericarditis, abortion
Mortality	High	High	Variable	Low

Partly adapted from Sanchez-Vizcaino et al. [20]

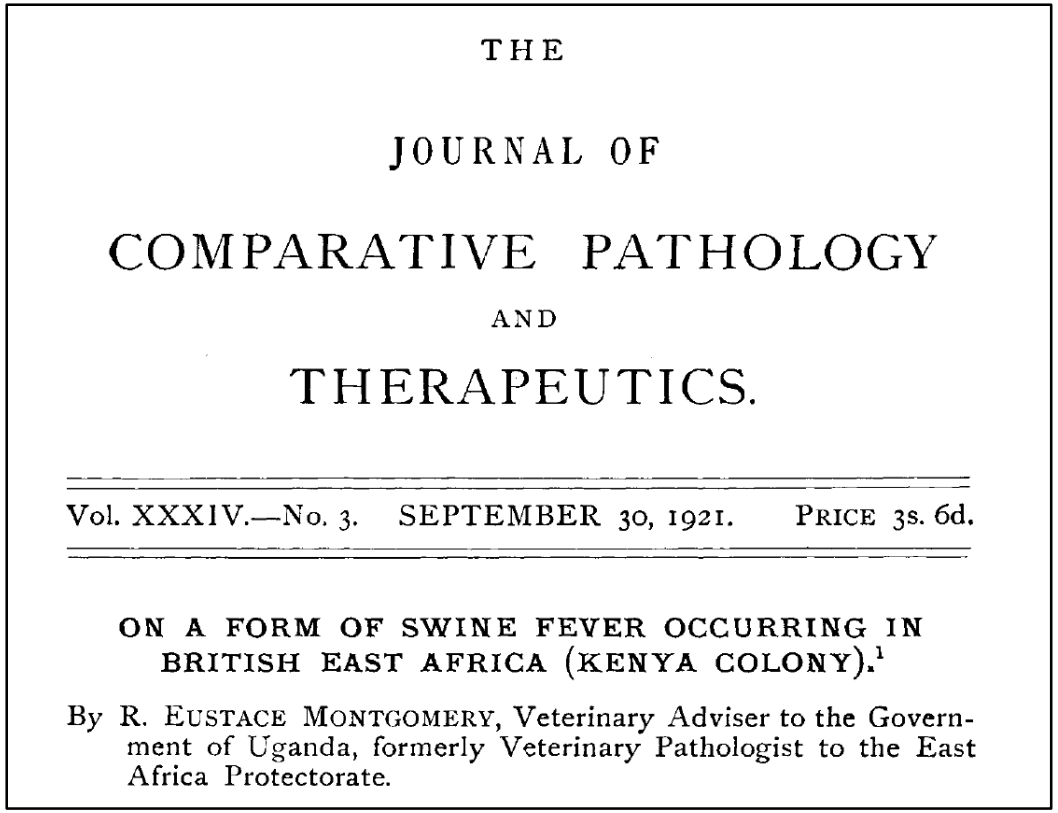
- Naturally attenuated viruses
- Illegal vaccines

African swine fever - Infection Dynamics



- Viremia develop within 12-24 hpi
- Peaks within 48 h - 1×10^{7} copies/µl

African Swine Fever – In Africa



THE

JOURNAL OF

COMPARATIVE PATHOLOGY

AND

THERAPEUTICS.

Vol. XXXIV.—No. 3. SEPTEMBER 30, 1921. PRICE 3s. 6d.

ON A FORM OF SWINE FEVER OCCURRING IN BRITISH EAST AFRICA (KENYA COLONY).[1]

By R. EUSTACE MONTGOMERY, Veterinary Adviser to the Government of Uganda, formerly Veterinary Pathologist to the East Africa Protectorate.

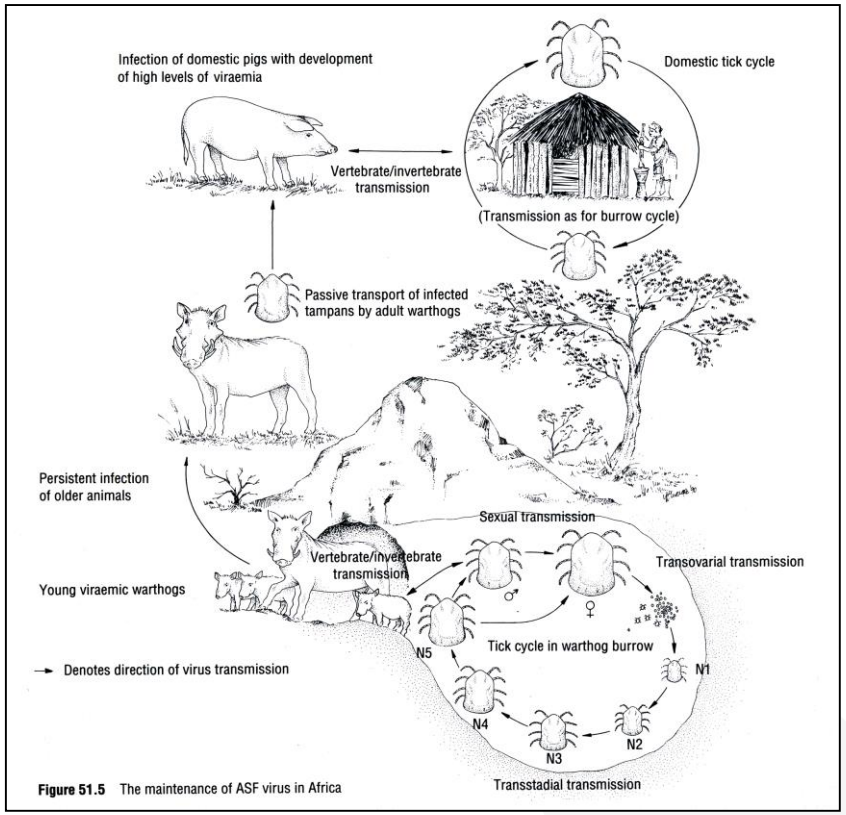


Figure 51.5 The maintenance of ASF virus in Africa

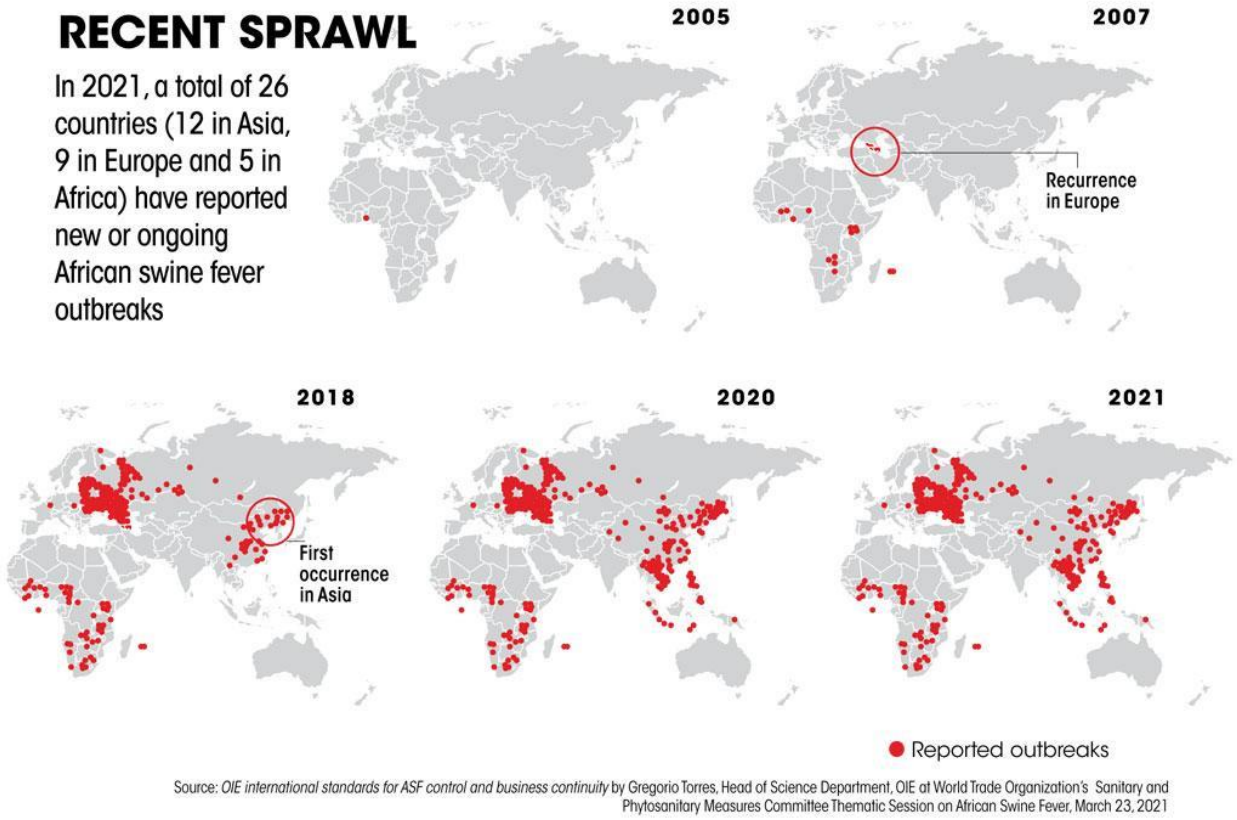
- First reported in Kenya in **1910 by Dr. R.E. Montgomery**
- **Endemic in Africa** - Subclinical infection in wild *suid* species + soft ticks (sylvatic cycle)
- Restricted to Africa until 1957

ASF Outside Africa - Portugal in 1957

- First outbreak outside Africa - Portugal in 1957. Later spread to Spain, France, Italy, Holland etc.
- Remained in Spain and Portugal for >20 years. Eradicated from Portugal (1994) & Spain (1995)
- Arrived in the Dominic Republic in 1978. Within a year, killed nearly ½ of the pigs and spread to Haiti. Eradicated from DR in 1980 and Haiti in 1984
- Remained endemic in Sardinia since 1978

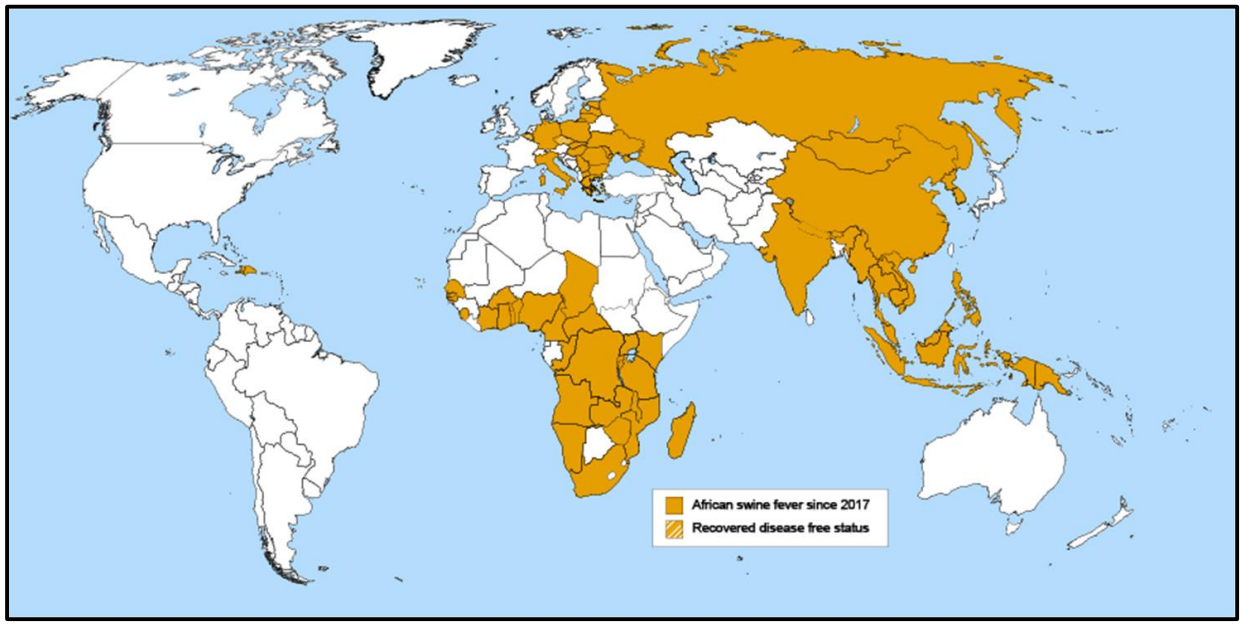
African Swine Fever – Global Epidemic

- The second ASF outbreak outside Africa - **Georgia in 2007**
- Spread rapidly to Armenia, Azerbaijan and the Russian Federation, Eastern Europe, China, Vietnam, Philippines, Germany, India…



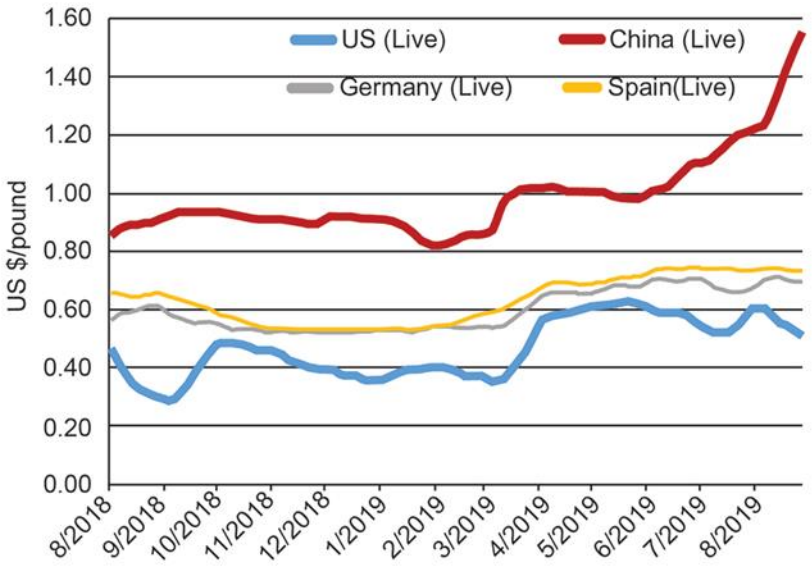
Source: *OIE international standards for ASF control and business continuity* by Gregorio Torres, Head of Science Department, OIE at World Trade Organization's Sanitary and Phytosanitary Measures Committee Thematic Session on African Swine Fever, March 23, 2021

2022



2021: DR and Haiti after 40 years
2022: Italian mainland, West Germany, Nepal & Kerala

African Swine Fever – Impact

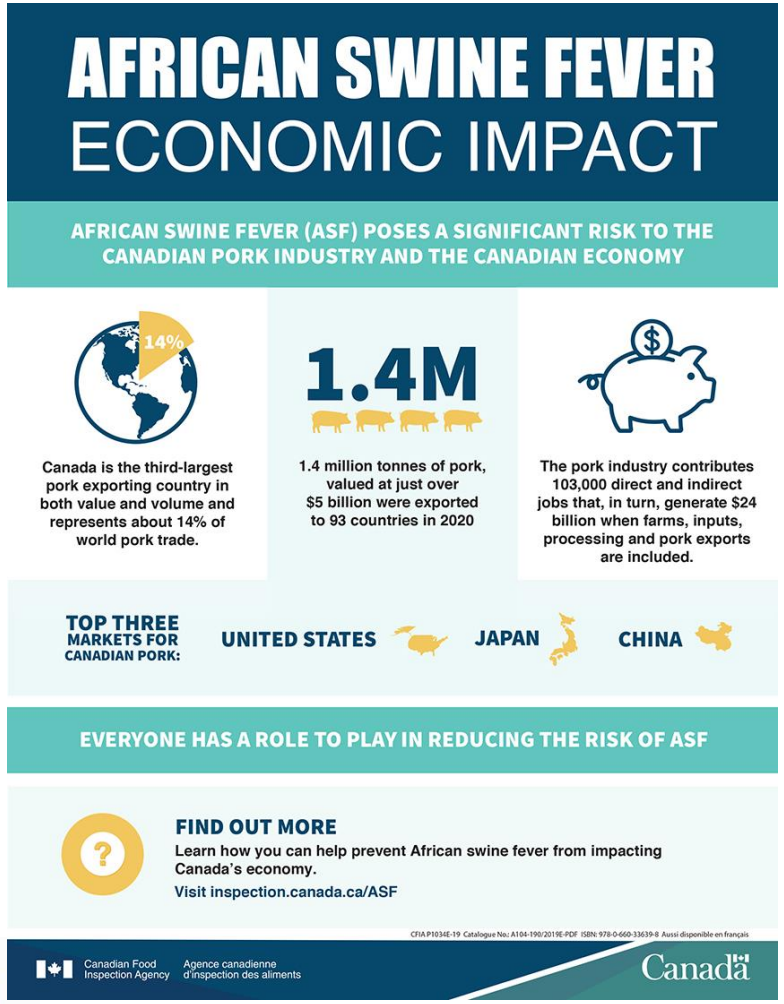


https://www.businessinsider.com/dead-pigs-found-floating-in-chinese-river-2013-3

https://twitter.com/bbcworld/status/1146559616320462848

- **Financial losses** to small holder farmers - loss of animals, poor compensation
- **Increased price** of pork and pork products
- **Psychosocial impacts** - sudden loss of pigs, massive euthanasia
- **Environmental challenges** - carcasses discarded in the rivers etc.
- **Switch to alternative animal species** - Goats and duck
- **International Trade restrictions**

African Swine Fever – Impact on International Trade



If ASF reaches the US, it would cost $50 billion

Summary

- ASF continues to spread and is now an **imminent threat** to swine population in the Americas
- **Anthropogenic factors** primarily contributes to long-distance spread of ASF
- The causative agent, ASFV, is a **highly complex** large DNA virus
- ASFV is **highly stable** at low temperatures and in the presence of organic matter
- Pigs can get infected with **relatively low dose** of ASFV
- ASFV replicates to extremely high titers– pork & pork products from infected pigs contains **large amounts** of virus

Facilitate Spread

African swine fever: On the move

aruna.ambagala@inspection.gc.ca

https://www.forbes.com/sites/daviddawkins/2019/06/13/ubs-economist-forced-to-apologize-after-chinese-pig-comments-trigger-outrage/?sh=136dc2483979