Dr Edward Okoth Abworo

Senior Scientist - Epidemiologist

Epidemiology of African swine fever in Africa with emphasis on trade related risks

Regional training course (Africa)
Import risk analysis for African swine fever
9 November – 14 December 2021

Organisation Mondiale de la Santé Animale
World Organisation for Animal Health
Organización Mundial de Sanidad Animal

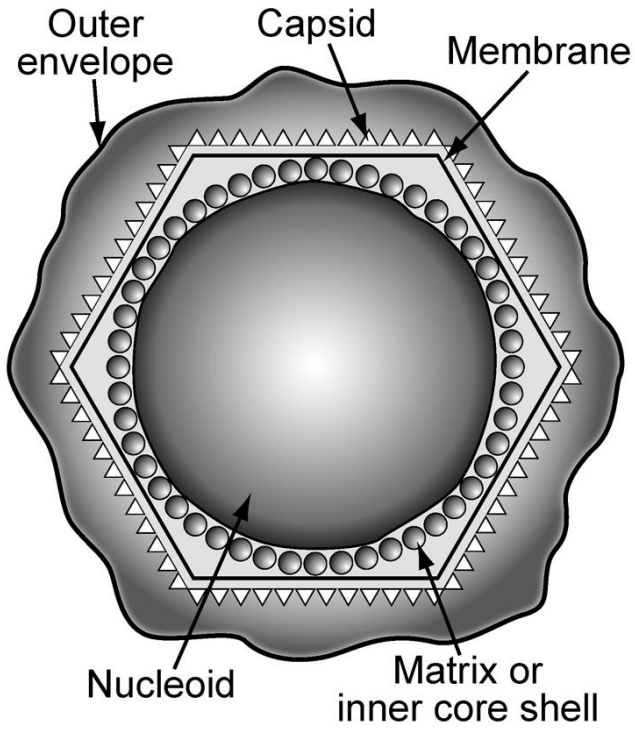
Presentation outline

African swine fever virus transmission and survival

- African swine fever (ASF)
- African swine fever virus transmission
- Distribution and survival of ASFV
- Conclusions

African swine fever

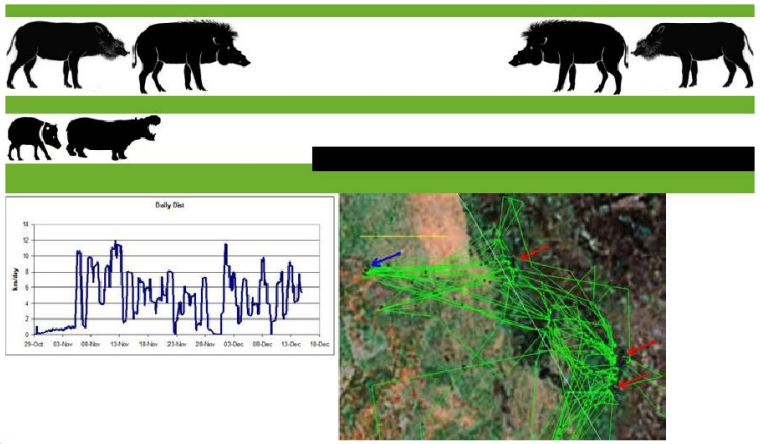
- ASF is a lethal viral disease of domestic pigs and their ancestor the wild boar
- The causative agent is ASFV



African swine fever virus transmission

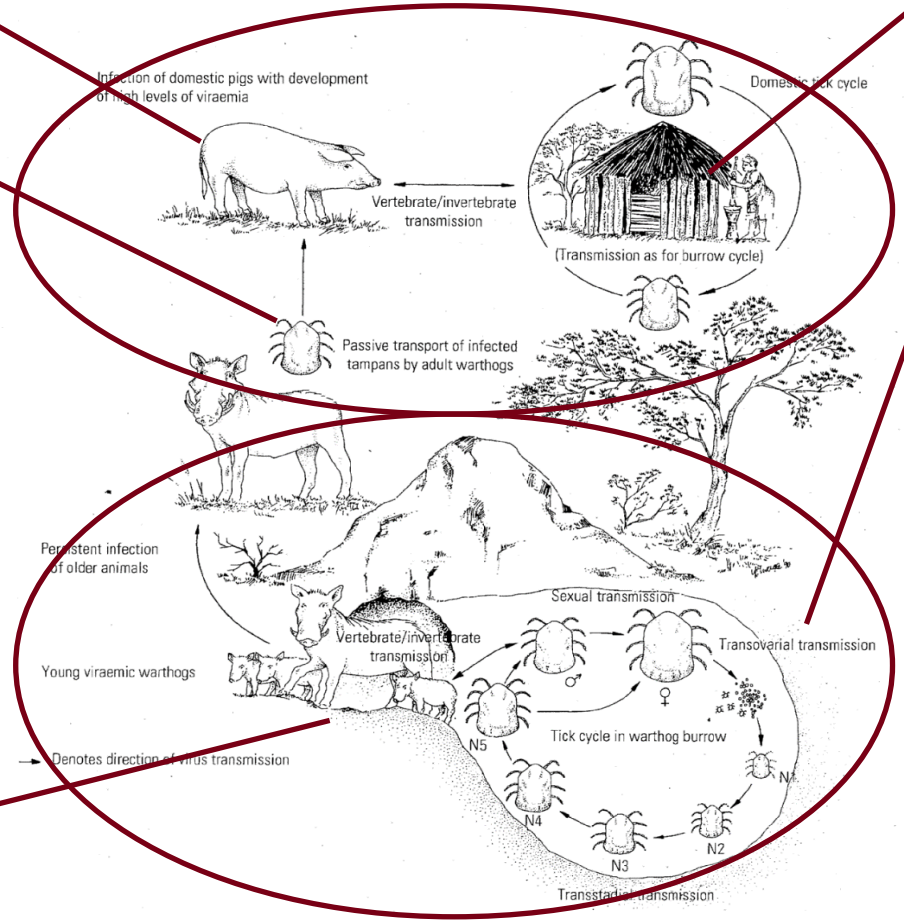
Pig-to-Pig transmission through direct contact

Tick-to-Pig through tick bite



Sylvatic Transmission (Tick-to-Warthog) – Reason for virus persistence

Recap of Transmission Cycles



Indirect contact through contaminated shelter, vehicles, fomites and equipment

Tick-to-tick Transmission

- Trans-stadial
- Trans-sexual
- Trans-ovarian

JGV Journal of General Virology

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African swine fever viruses with two different genotypes, both of which occur in domestic pigs, are associated with ticks and adult warthogs, respectively, at a single geographical site

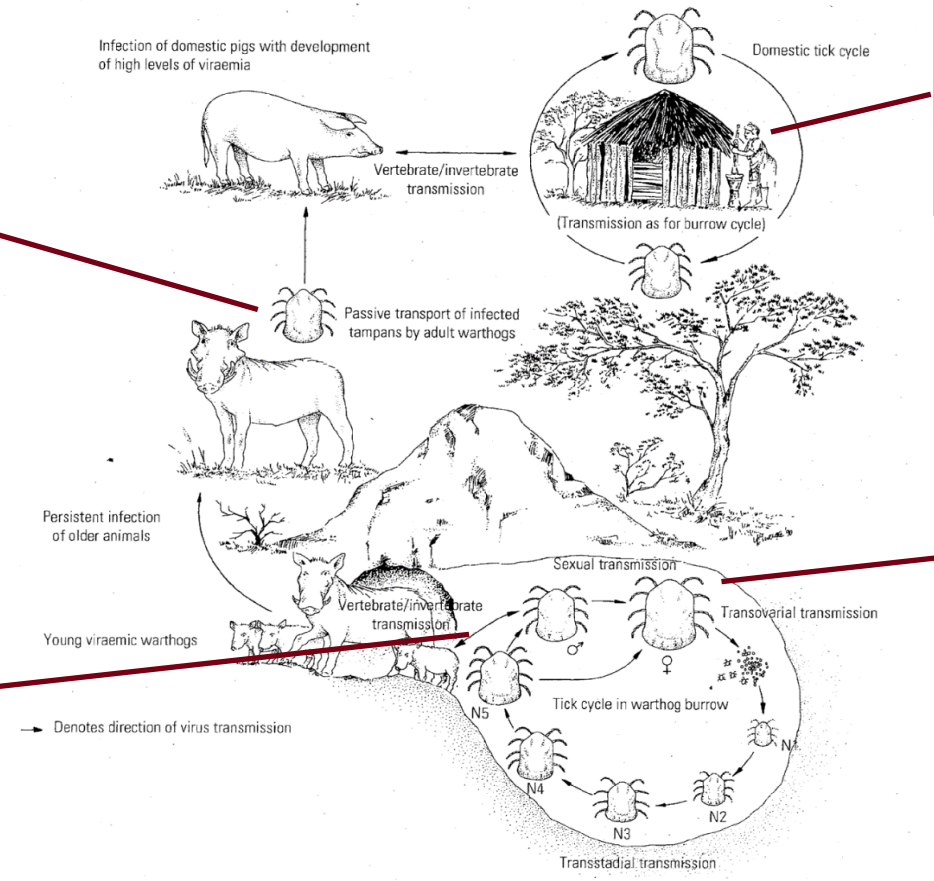
Carmina Gallardo[1], Edward Okoth[2], Virginia Pelayo[1], Raquel Anchuelo[2], Elena Martin[1], Alicia Simón[1], Alicia Llorente[1], Raquel Nieto[1], Alejandro Soler[1], Raquel Martín[1], Marisa Arias[1] and Richard P. Bishop[2]

African swine fever virus transmission

Key features in Sylvatic, Tick-pig and Domestic transmission cycles

Tick-to-Pig transmission
- Through tick bite
- Larvae, nymphs and adults crawl through the nest to find hosts
- Feed fast and at night
- Don't spend much time attached to a host
- Study in Kenya show 17% pig exposure to the ASF tick vector using tick specific ELISA (rtTSGP1)

Sylvatic Transmission (Tick-to-Warthog)
- Young warthogs infested
- Followed by viremia and transmission to naïve ticks during feeding
- Warthogs are asymptomatic and remain infected for life
- No horizontal and vertical transmission in warthogs



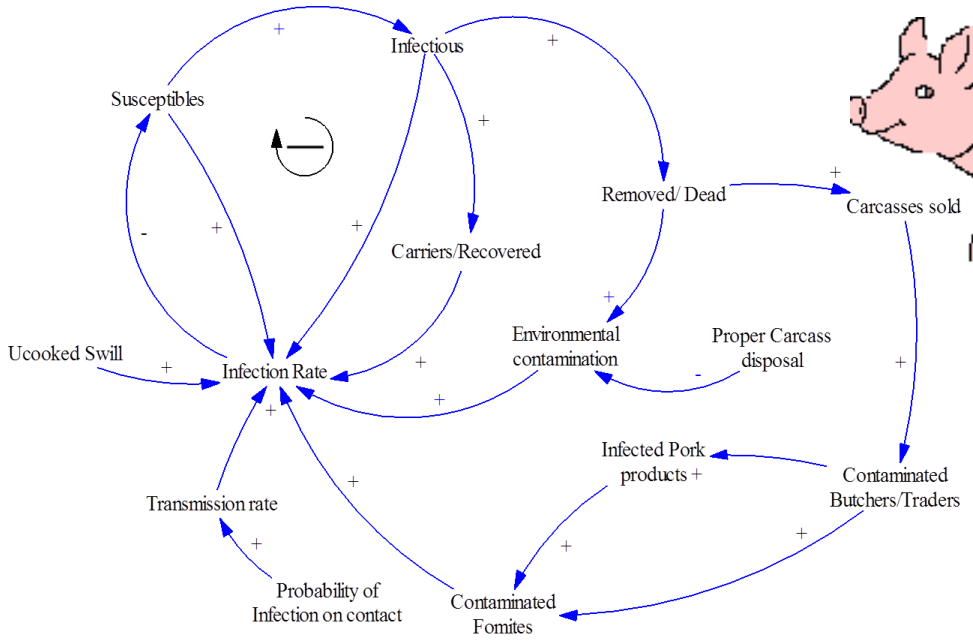
Domestic cycle transmission
- Pig to pig through direct contact
- Indirect contact through contaminated shelter, vehicles, fomites and equipment

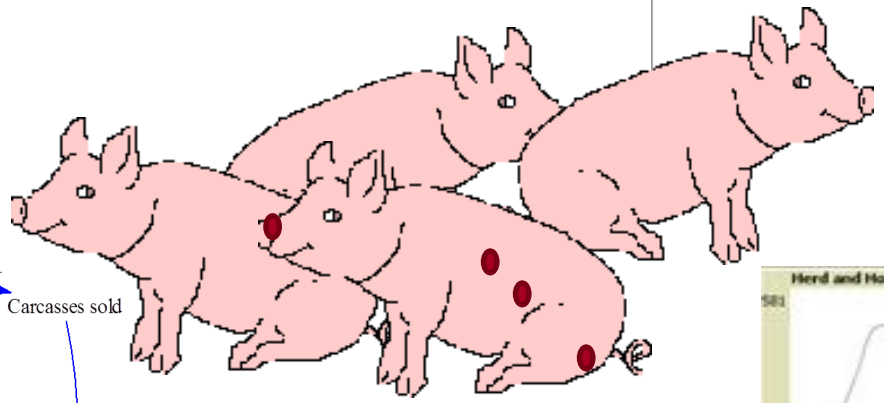
Tick-to-tick Transmission
- Soft ticks generally live in animals' nests and burrows
- Females lay their eggs in their host's nest
- Virus transmission is trans-stadial, trans-sexual, trans-ovarian
- Tick colonies can maintain the virus infection for up to 15 months in absence of blood meals and for years with blood meal

African swine fever transmission

Agent based model with demographics

- Susceptible pigs peak at 13 days
- Epidemic peaks day 28
- Epidemic dies out within 60 days



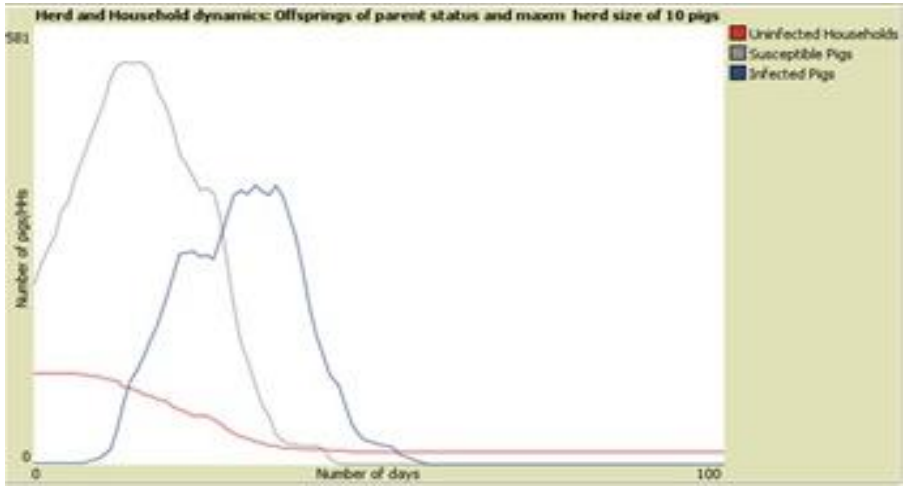


PLOS ONE

RESEARCH ARTICLE

A Mathematical Model that Simulates Control Options for African Swine Fever Virus (ASFV)

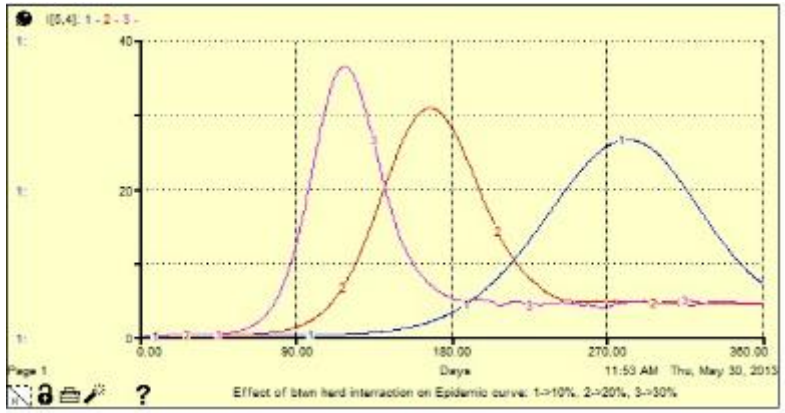
Mike B. Barongo[1¤a*], Richard P Bishop[1], Eric M Fèvre[1,2], Darryn L Knobel[3¤b], Amos Ssematimba[1,4]

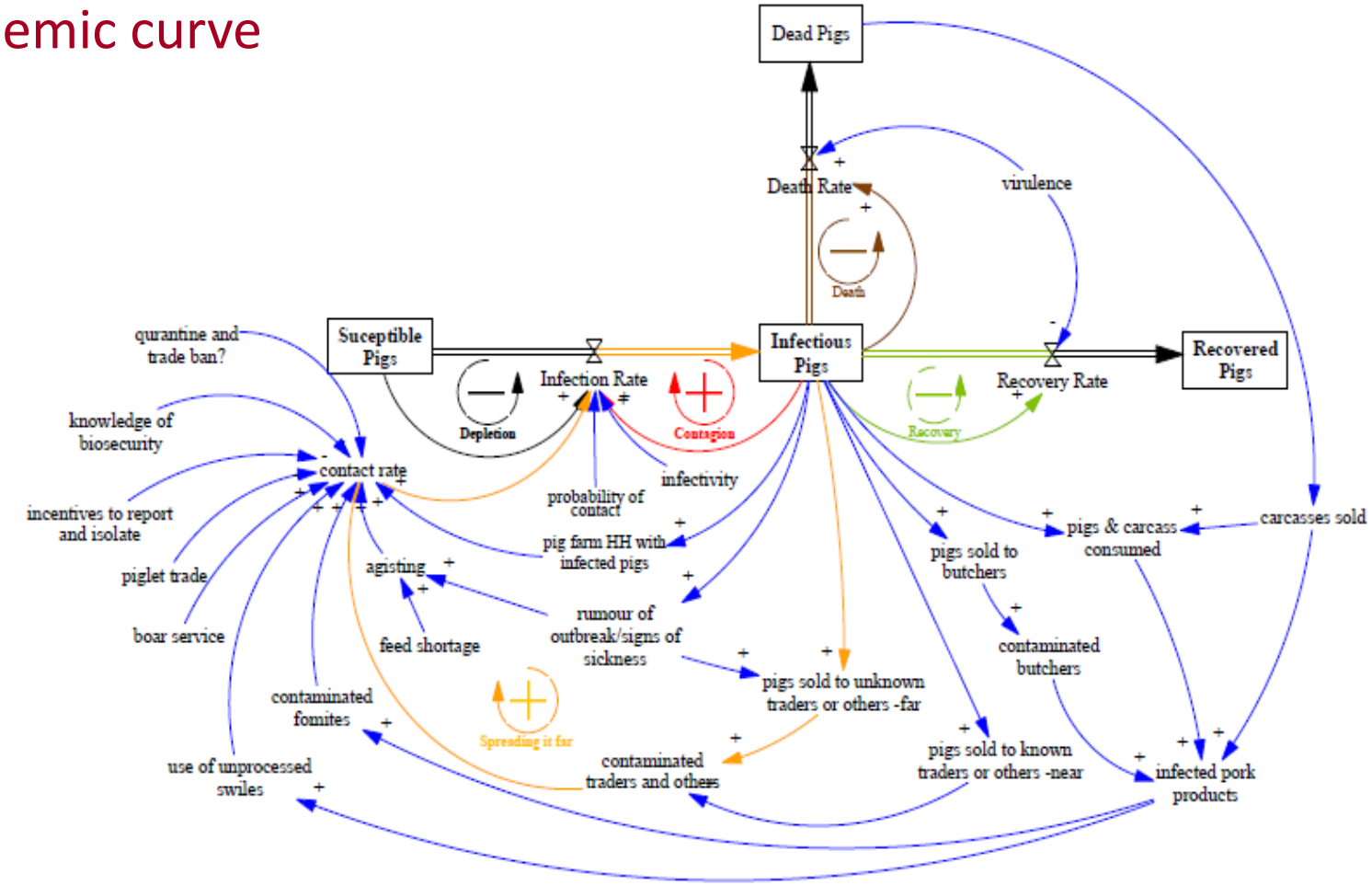


African swine fever transmission

Effect of herd interaction on epidemic curve

- Higher interaction results in earlier peaks.
- By reducing interaction from 30% to 10%, disease peak is traded for onset.
- Peaks increase with interaction





African swine fever virus transmission

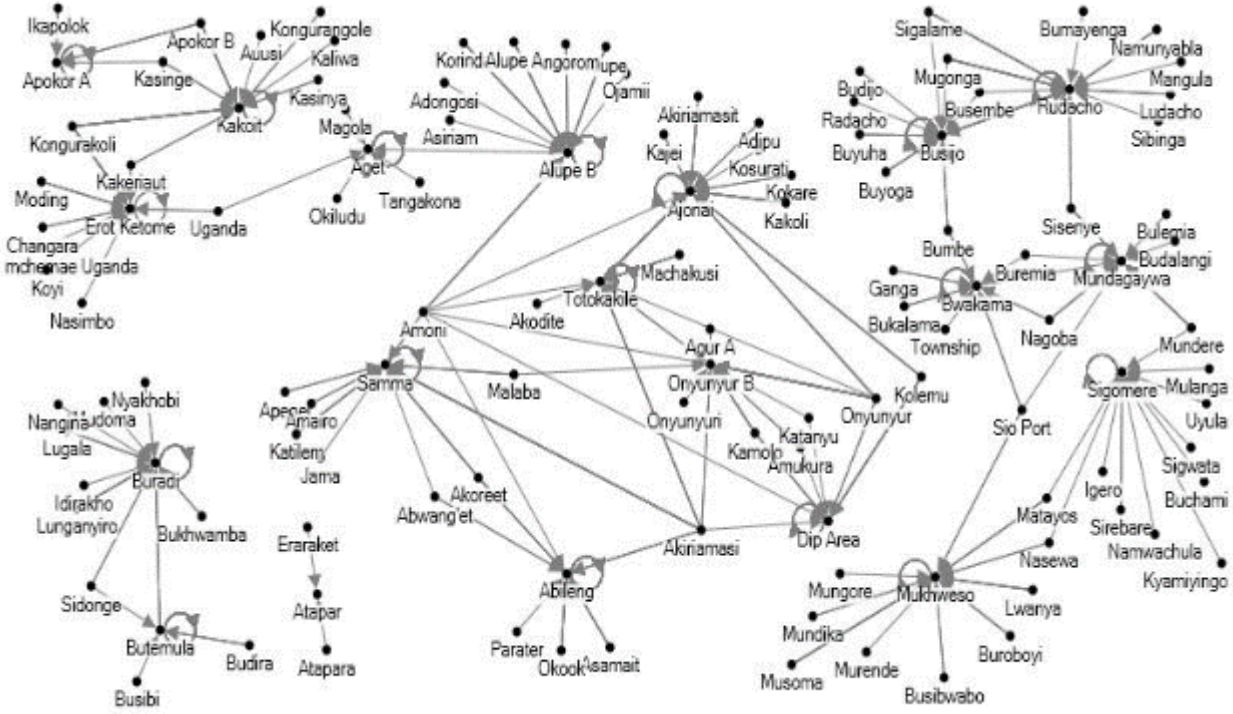
Interactions and pig value chain actors

- Pig movement network very diverse –
  - Purchase of pigs for rearing and slaughter
  - Agistment
  - Boar service
  - Traders/Butchers
  - Animal health service providers
- Buying and selling of pigs occur between people who most likely are familiar to each other – near distance
- During outbreaks, sale is mostly to unknown persons who come from far off villages
- The key drivers of far distance disease spread in trading nodes are traders, transporters and butchers

Preventive Veterinary Medicine
Volume 126, 1 April 2016, Pages 1-10

Social network analysis provides insights into African swine fever epidemiology

Jacqueline Kasiiti Lichoti [a, c], Jocelyn Davies [b], Philip M. Kitala [c], Samuel M. Githigia [d], Edward Okoth [e], Yiheyis Maru [b, e], Salome A. Bukachi [f], Richard P. Bishop [b, e]



African swine fever transmission

Role of carrier pigs

- Role of carrier pigs not well understood –possible virus sequestration in tissues
- What is the window within which an infected carrier pig can shed the virus and transmit it to naïve pigs?
- Can pork and pork products from a carrier pig effect ASFV transmission?

JOURNAL OF GENERAL VIROLOGY

RESEARCH ARTICLE

Abworo *et al.*, *Journal of General Virology*

DOI 10.1099/jgv.0.000848

MICROBIOLOGY SOCIETY

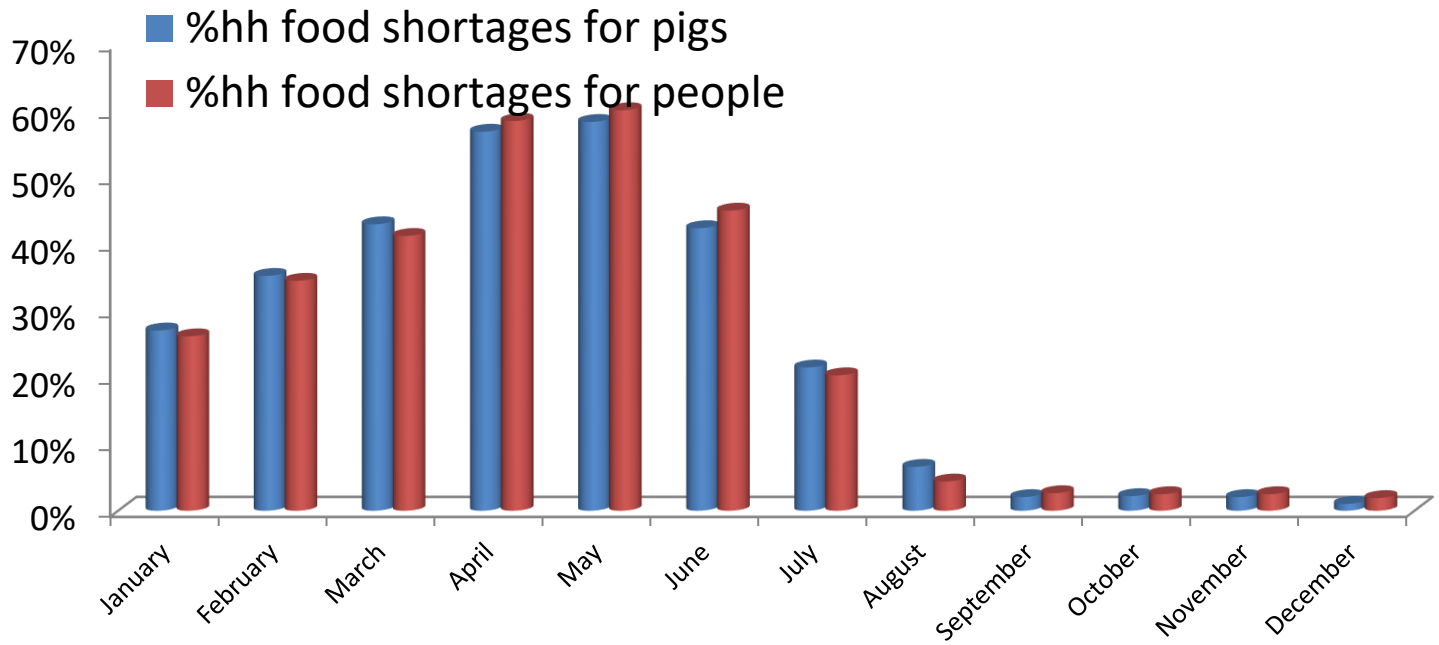
Detection of African swine fever virus in the tissues of asymptomatic pigs in smallholder farming systems along the Kenya-Uganda border: implications for transmission in endemic areas and ASF surveillance in East Africa

Edward Okoth Abworo,[1,*] Cynthia Onzere,[1] Joshua Oluoch Amimo,[2] Victor Riitho,[1] Waithaka Mwangi,[3] Jocelyn Davies,[4,5] Sandra Blome[6] and Richard Peter Bishop[1]

African swine fever virus transmission

Role of seasonal food shortages

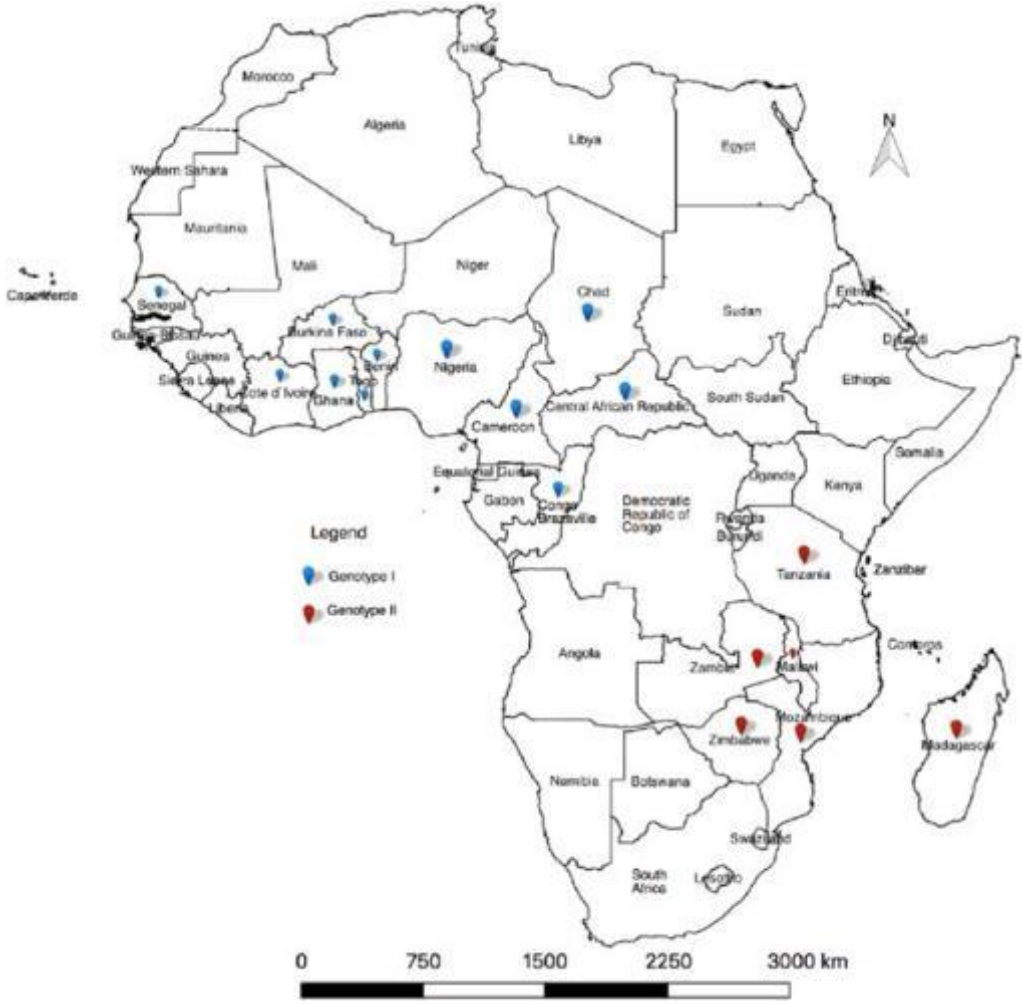
- Small holder farmers sell their pigs when food is in short supply
- And buy a new piglet either immediately, or when food is again available on farm



African swine fever virus transmission

Spread of ASFV outside Africa

- The first spread of the disease outside Africa was into Europe (Portugal) in 1957 - near Lisbon airport associated with feeding swill
- Further outbreaks occurred in 1960 in Lisbon
- ASF remained endemic in the Iberian peninsula until the mid-1990s
- Other ASF outbreaks in Europe during the 20th century; Malta (1978), Italy (1967, 1980), France (1964, 1967, 1977), Belgium (1985), and the Netherlands (1986)
- The disease was eradicated from each of these countries but has remained endemic in Sardinia since its introduction in 1978
- During the 1970s, ASFV spread to the Caribbean and South America. An outbreak in south Brazil in 1978–1979 was eradicated by stamping out, and Brazil regained its ASF-free status in December 1984
- These outbreaks of ASF, mainly caused by movement of contaminated meat products



African swine fever virus transmission

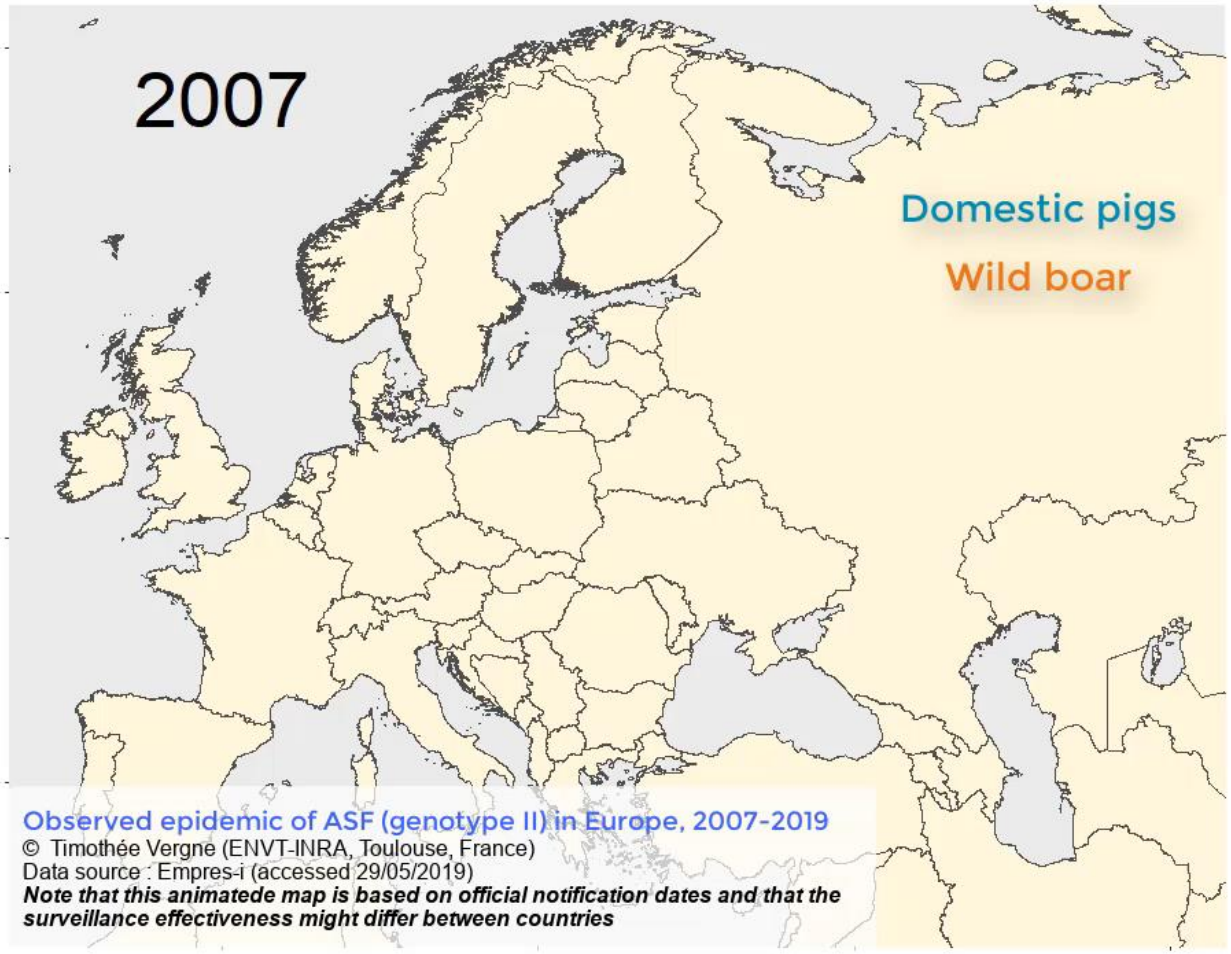
Spread of ASFV outside Africa

- In June 2007 ASF was confirmed in pigs in the former Soviet republic of Georgia in the Caucasus region
- Source of infection was catering waste, including infected pig meat from ships in the Black Sea Port of Poti
- These outbreaks of ASF, mainly caused by movement of contaminated meat products and wild boar movement

RESEARCH

African Swine Fever Virus Isolate, Georgia, 2007

Rebecca J. Rowlands, Vincent Michaud, Livio Heath, Geoff Hutchings, Chris Oura, Wilna Vosloo, Rahana Dwarka, Tinatin Onashvili, Emmanuel Albina, and Linda K. Dixon



Observed epidemic of ASF (genotype II) in Europe, 2007-2019
© Timothée Vergne (ENVT-INRA, Toulouse, France)
Data source : Empres-i (accessed 29/05/2019)
Note that this animatede map is based on official notification dates and that the surveillance effectiveness might differ between countries

African swine fever virus transmission

Spread of ASFV within or into Africa

- Genotype II isolate clusters very tightly with genotypes II covering the Asian and European continents (from Georgia 2007, to the more recent outbreaks in Russia, Eastern Europe and China)
- Genetic diversity of historical Genotype II isolates in southern Africa is higher than in other parts of the world including East Africa, Russia and Asia

www.nature.com/scientificreports

scientific reports

Check for updates

OPEN

The first genotype II African swine fever virus isolated in Africa provides insight into the current Eurasian pandemic

Emma P. Njau[1,2,4,7✉], Jean-Baka Domelevo Entfellner[1,7], Eunice M. Machuka[1], Edwina N. Bochere[1], Sarah Cleaveland[2,3], Gabriel M. Shirima[2], Lughano J. Kusiluka[2,5], Chris Upton[6], Richard P. Bishop[1], Roger Pelle[1] & Edward A. Okoth[1]

AMERICAN SOCIETY FOR MICROBIOLOGY | Microbiology Resource Announcements

GENOME SEQUENCES

Check for updates

First-Time Presence of African Swine Fever Virus Genotype II in Nigeria

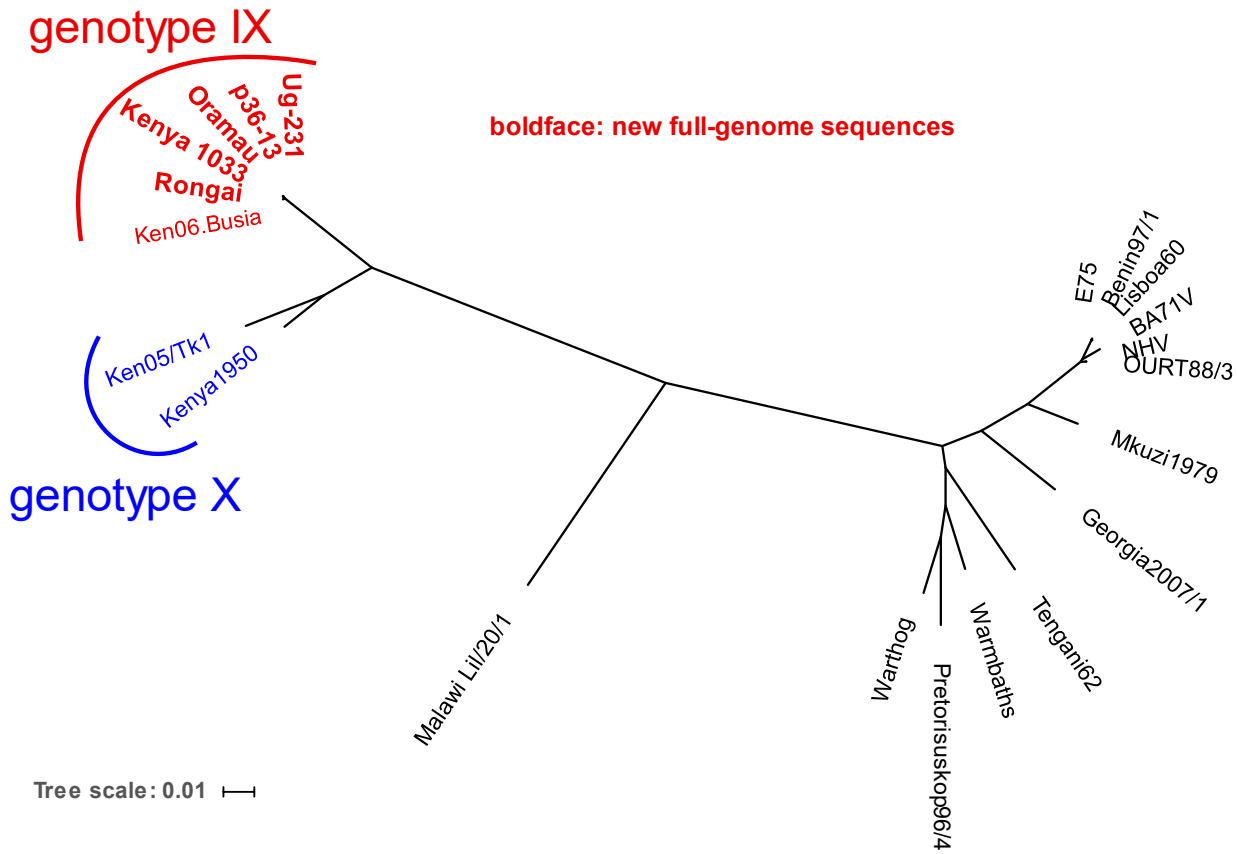
Adeyinka J. Adedeji,[a,e] Pam D. Luka,[a] Rebecca B. Atai,[a] Toyin A. Olubade,[a] Dupe A. Hambolu,[b] Mary A. Ogunleye,[c] Vincent B. Muwanika,[d] Charles Masembe[e]

[a]National Veterinary Research Institute, Vom, Nigeria
[b]Federal Department of Veterinary and Pest Control Services, Lagos, Nigeria
[c]Ministry of Agriculture, Ikeja, Lagos State, Nigeria
[d]College of Agricultural & Environmental Sciences, Makerere University, Kampala, Uganda
[e]College of Natural Sciences, Makerere University, Kampala, Uganda

African swine fever virus transmission

Virus tracking using phylogeny derived from full genome alignment

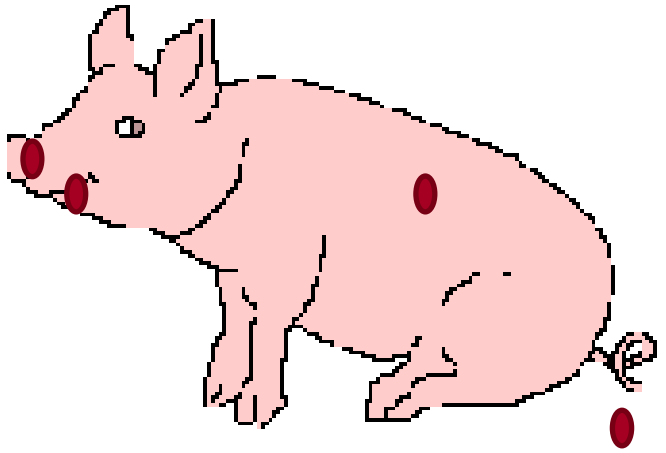
- Molecular Phylogeny of full ASFV genomes is used in disease surveillance to track transmission/spread of ASF viruses
- Molecular Phylogeny of full ASFV genomes of genotype IX and X show clustering of the East African Africa



Distribution and survival of ASF virus in various tissues/commodities

Domestic pigs

- After infection, domestic pigs may shed infective amounts of ASFV for 24-48 hours before clinical signs appear
- During the acute stage of disease, enormous amounts of virus are shed in all secretions and excretions, and high levels of virus are present in tissues and blood
- Pigs that survive the acute disease remain infected for several months, but do not readily shed virus for more than 30 days
- Infective levels of virus are found only in lymph nodes, and other tissues are unlikely to contain infective levels of virus for more than two months post infection



Distribution and survival of ASF virus in various tissues/commodities

Vectors and reservoirs

- Tick colonies can maintain the virus infection for up to 15 months in absence of blood meals and for years with blood meal
- Wild pigs in Africa are asymptomatic and remain infected for life
- ASFV carrier state has been shown in domestic pigs where tissues from animals show minimum virus prevalence of 15.9%, based on positivity in four different PCR assays, supported by virus isolation
- Locally adopted pig, bush pig and warthog show strongest signals of selection, while such extremes are absent in the commercial pig breeds - evidence of introgression of bush pigs into locally adopted domestic pig genes

JOURNAL OF GENERAL VIROLOGY

RESEARCH ARTICLE
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MICROBIOLOGY SOCIETY

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PLOS ONE

RESEARCH ARTICLE

Genetic diversity, breed composition and admixture of Kenyan domestic pigs

Fidalis Denis Mujibi[1,2]*, Edward Okoth[3], Evans K. Cheruiyot[2], Cynthia Onzere[4], Richard P. Bishop[4], Eric M. Fèvre[3,5], Lian Thomas[6], Charles Masembe[7], Graham Plastow[8], Max Rothschild[9]

Distribution and survival of ASF virus in various tissues/commodities

Inactivation of ASFV in tissues and environment

ASFV is very resistant to inactivation:

- Stable at PH 4-10 and thus not affected by meat maturation
- Requires heating at 60^0C for 20 minutes to be inactivated
- Smoked sausages and air-dried ham require smoking at 32-49^0C for 12 hours and 25-30 days of drying to be free from the virus
- Pork cured pork products can remain infectious for several months
- The virus can persist in the environment in fomites such as clothing, shoos, equipment and vehicles for several days
- ASF virus, in a suitable protein environment, is stable over a wide temperature and pH range. It has been shown to survive in serum at room temperature for 18 months, in refrigerated blood for 6 years, and in blood at 37°C for a month.
- Putrefaction does not necessarily inactivate the virus, which may remain viable in faeces for at least 11 days, decomposed serum for 15 weeks, and in bone marrow for months

Best ASFV inactivation:

- Sodium hypochlorite, glutaraldehyde, caustic soda and potassium peroxymonosulfate

African swine fever virus transmission

Disease impact

Documented ASF outbreaks

1980-2017 in ECSA

Received: 9 October 2018 | Revised: 21 March 2019 | Accepted: 24 March 2019

DOI: 10.1111/tbed.13187

REVIEW

Transboundary and Emerging Diseases WILEY

African swine fever: Update on Eastern, Central and Southern Africa

Léopold K. Mulumba-Mfumu[1,2] | Claude Saegerman[2] | Linda K. Dixon[3] | Kapanga C. Madimba[1] | Eric Kazadi[1] | Ndeji T. Mukalakata[1] | Chris A. L. Oura[4] | Erika Chenais[5] | Charles Masembe[6] | Karl Ståhl[5] | Etienne Thiry[7] | Mary Louise Penrith[8]

[1]Department of Clinical Sciences, Faculty of Veterinary Medicine, University of Kinshasa, Kinshasa, Democratic Republic of the Congo

Abstract

Control of African swine fever (ASF) in countries in Eastern, Central and Southern

Location	Year	Pigs lost	Financial loss	Source
Cameroon, W Province	1982	54,432	$2.5 million	Nana-Nukechap & Gibbs, 1985
Chad, Bassin Logone	2010	139,810	Not specified	Ban-Bo et al., 2012
DRC, Boende	2007	4,500	$1 million	DRC CVL, unpublished report
DRC, Kinshasa	2010	>3,500	Not specified	DRC CVL, unpublished report
Kenya, Nairobi area	1997	5–6,000	Not specified	FAO, unpublished reports
Madagascar	1997–1999	>50% of ca 1.5 million	€21 million p.a.	Thierry & Capo-Chichi, 2008
Mauritius	2007	Ca. 15,300	$1 million	Lubisi et al., 2009
Mozambique, South	1993	20,000	Not specified	FAO, unpublished reports
Tanzania, Rombo	2013	4,462	$133,860	Swai & Lyimo, 2014
Uganda, Lira (one farm)	2014	>138 (herd)	$20,000	Chenais, Sternberg-Lewerin, et al., 2017
Zambia, Kabwe (one farm)	1989	2,000	$39,965	Samui et al., 1996
Zambia, Lusaka	2013	6,500	Not specified	Yabe et al., 2015

Conclusions

- ASFV is very stable and can persist in hosts through varied transmission cycles
- Simple biosecurity measures can reduce ASF transmission
- Farmers need to invest in pig keeping in order to implement biosecurity (housing, feed), with co-benefits for increased productivity, higher returns and reduced zoonotic infection
- Farmers will act in their own self-interest to implement changes on farm if they trust that benefits are likely (requiring new knowledge) and have means to make changes (requiring capital, new feed sources, information and more open market access)
- Whether or not farmers have taken action to reduce risk of ASF entering their farms, if they do experience an outbreak, they will continue to act in their own self-interest by selling their pigs before they die, thus perpetuating ASF transmission, unless they have clear incentives not to (such as insurance or compensation)

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Food and Agriculture Organization of the United Nations

WORLD ORGANISATION FOR ANIMAL HEALTH

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