



Sveriges lantbruksuniversitet  
Swedish University of Agricultural Sciences



# **Pest forecasting- Japanese encephalitis, leptospirosis, aflatoxicosis**

CCAFS pest forecasting meeting Hanoi 19-21 March 2015

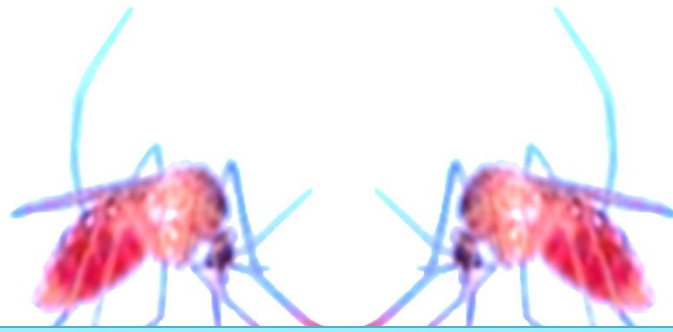
Johanna Lindahl

# This presentation

- Background to the different selected diseases
  - JE
  - Leptospirosis
  - Aflatoxins
  - Etiology and epidemiology



Sveriges lantbruksuniversitet  
Swedish University of Agricultural Sciences



ILRI

INTERNATIONAL  
LIVESTOCK RESEARCH  
INSTITUTE

# Japanese Encephalitis

# A short history

- Japanese borders opened 1853
- Summer Encephalitis 1870
- Outbreak 1924 over 6000 cases, close to 4000 deaths
- Isolated in 1935
- Japanese B Encephalitis ( Von Economo's Encephalitis Lethargica was A)

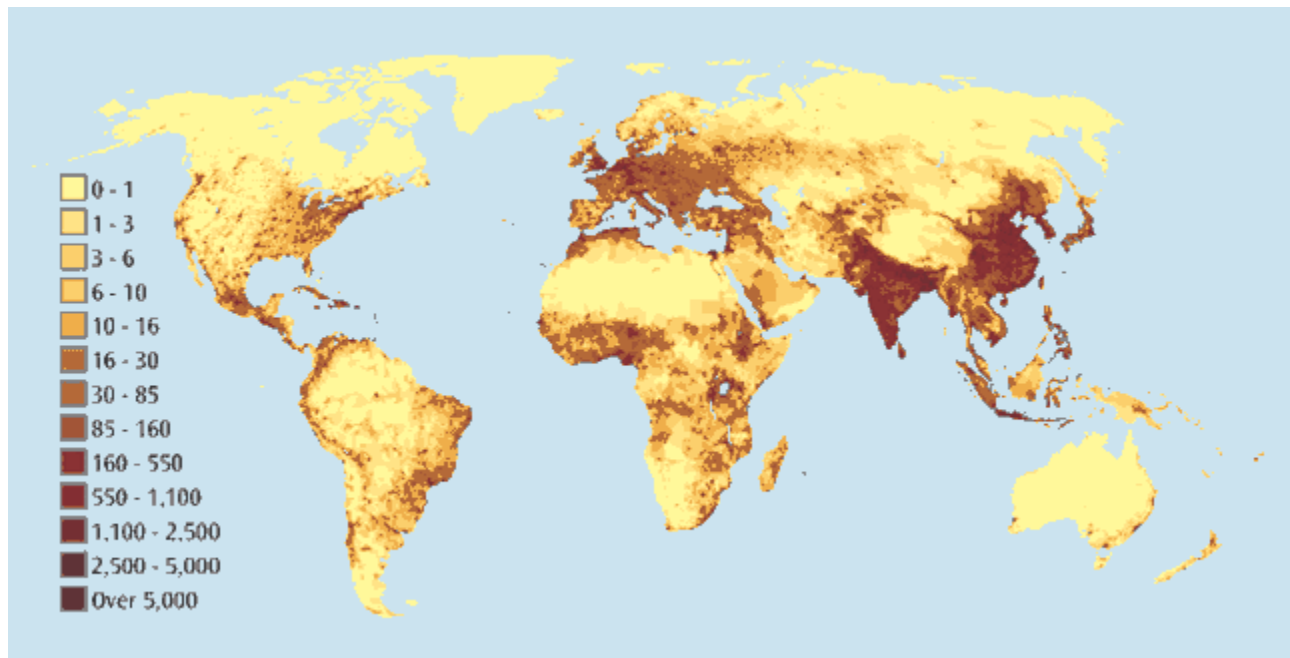
# Japanese encephalitis

A zoonotic disease

Fatal encephalitis in humans and horses- most common cause of viral encephalitis in humans

Reproductive disease in swine- well described in epidemic areas

Population density (FAO stat estimates)



- 3 billion live in endemic areas

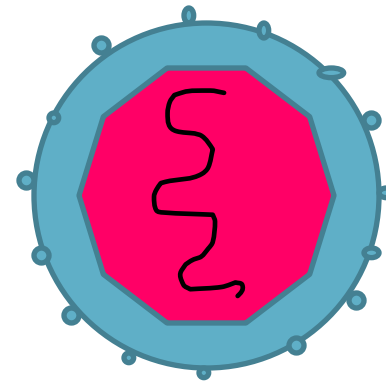
- 60 000 human cases per year

- Case fatality 30%

# The virus

- Enveloped, around 50 nm
- + ssRNA
- 5 genotypes

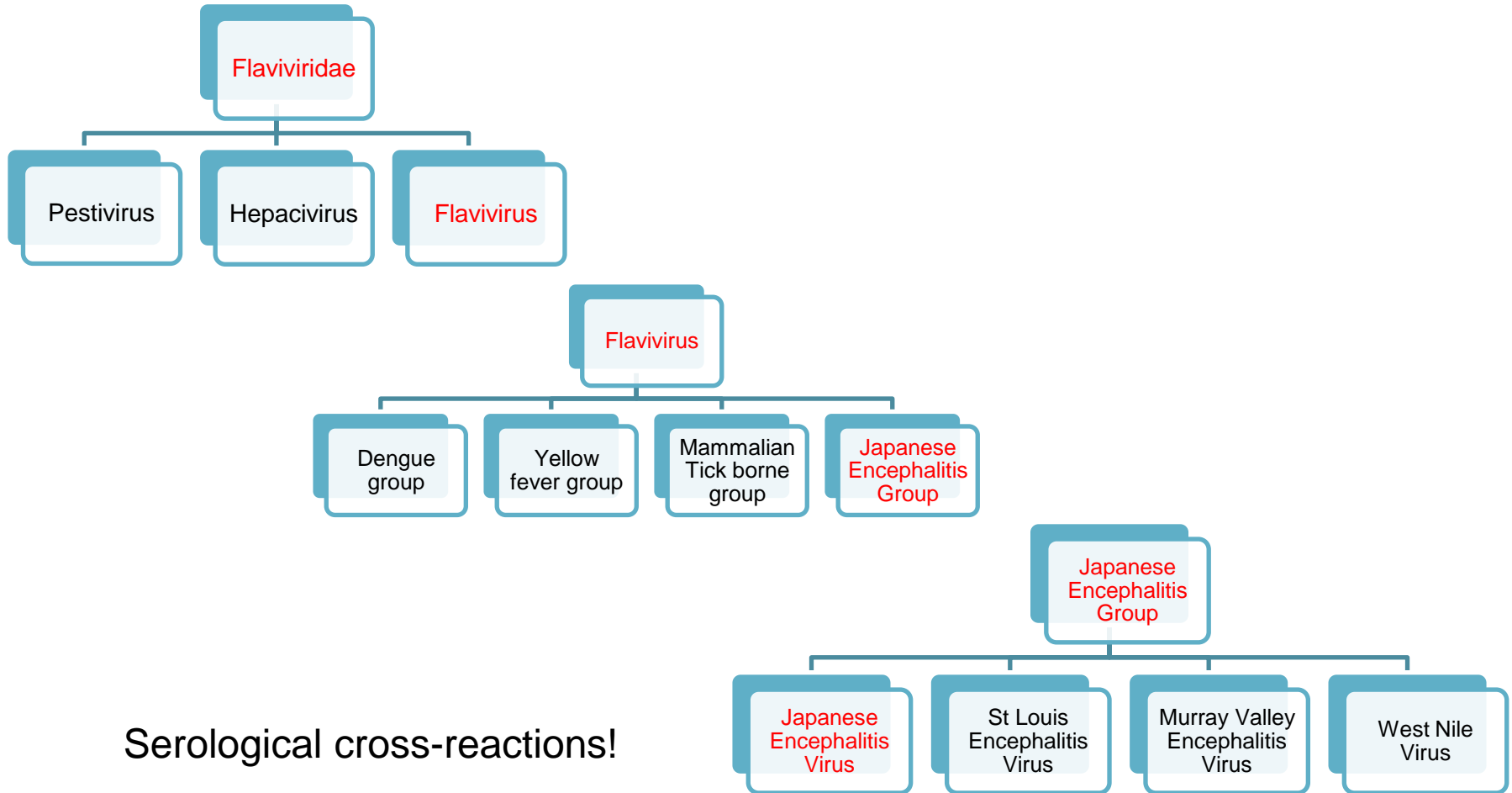
Nucleocapsid  
 Precursor for transmembrane protein  
 Envelope glycoprotein



Non structural proteins



# Japanese encephalitis virus



Serological cross-reactions!

# Japanese Encephalitis Virus and vectors

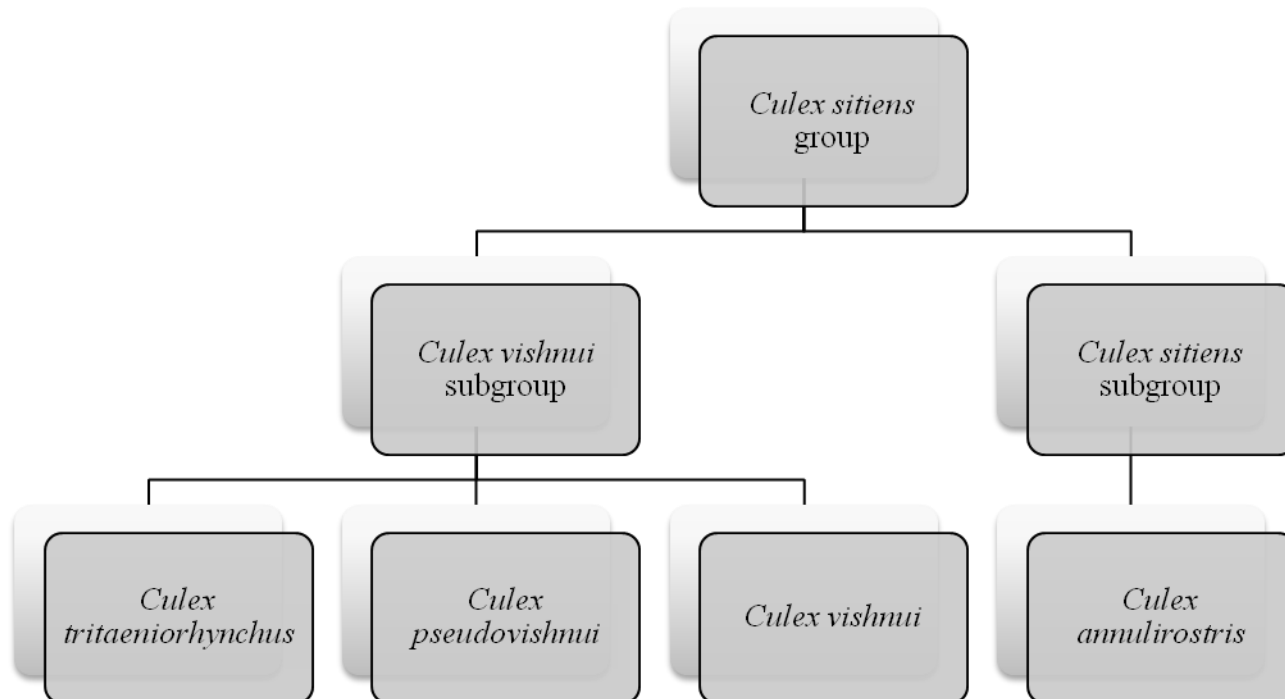
- A vector-borne virus- an arbovirus
- Mosquitoes, *Culex* species
  - *Culex tritaeniorhynchus*
  - *Culex pseudovishnui*
  - *Culex vishnui*
  - *Culex gelidus*
  - *Culex annulirostris*
  - *Culex quinquefasciatus*

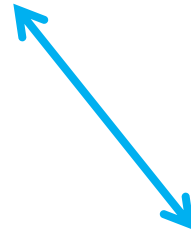
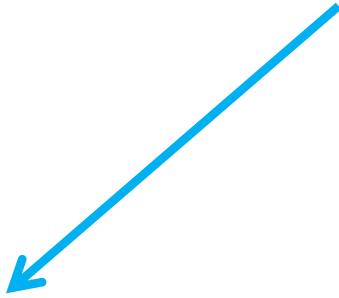
**Ss-RNA virus mutates rapidly- but not when vector-borne**





# Culex vishnui subgroup





## Vector capacity and competence

- $k$  = Probability that a vector feeding on an infected host gets infected.  
 $P_f$  = Probability that a vector survives from one meal to the next.  
 $P_e$  = Probability that a vector survives the Extrinsic incubation period, EIP  
 $Q$  = Probability that a vector feeds from the right host – blood index for the host.  
 $H_{Br}$  = Host biting rate, the number of vectors feeding from an animal per day.  
 $v$  = Probability of pathogens becoming infectious in the vector

$C$  = Vector capacity

$$C = H_{Br} Q v k P_e / (1 - P_f)$$



# Uptake of the pathogen

- Foregut
- Midgut
- Peritrophic membrane
- Gut barrier
- Hindgut

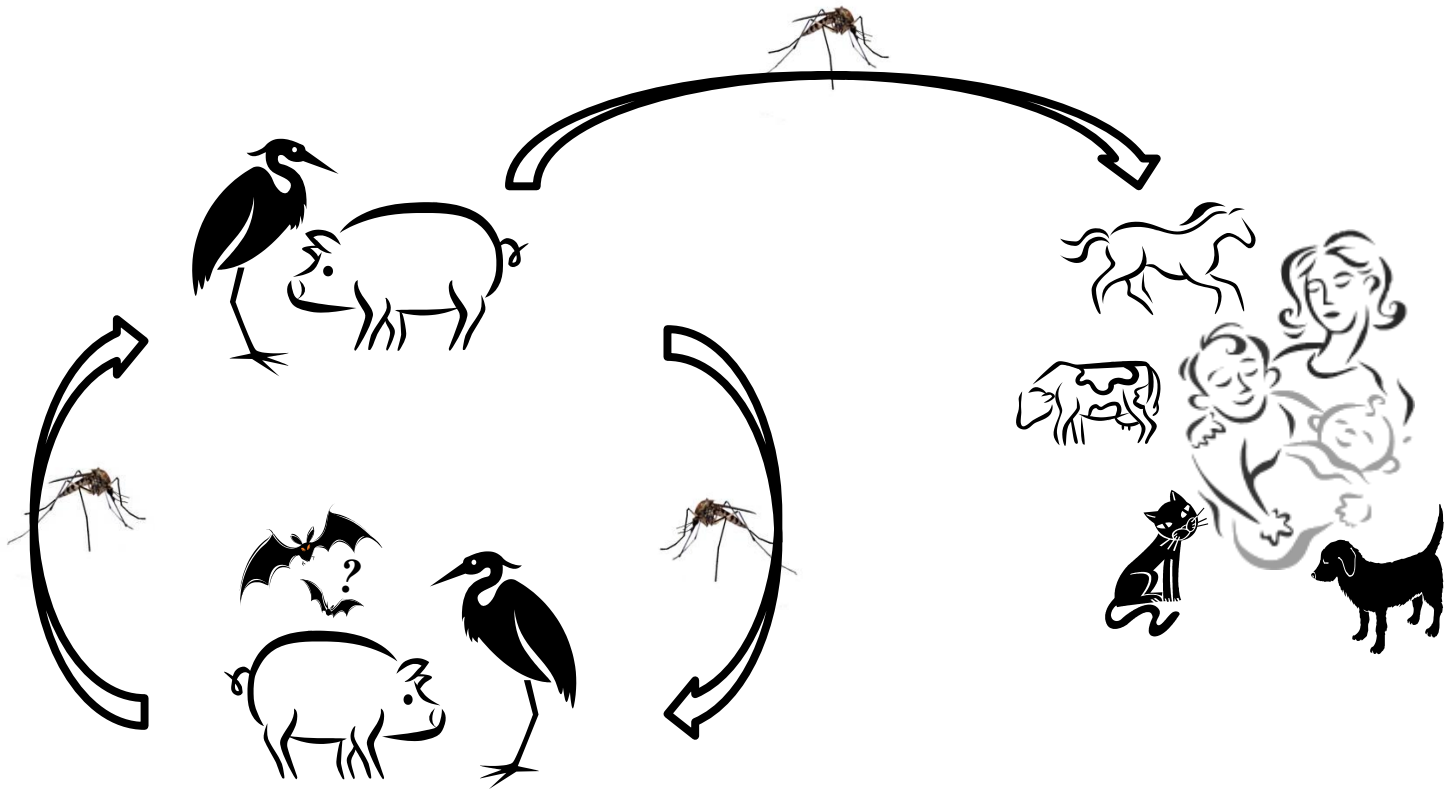




# Vertical transmission

- Due to infections of the eggs while virus circulates in haemolymph
- Showed in experiments
- Naturally infected *Mansonia* and *Culex* males found





# Pig keeping in the Mekong area

- Majority smallholders 1-2 sows
- Growing number of larger commercial farms
- Often a combination of gardening, aquaculture, livestock and rice fields
- Almost half of Vietnamese rural households have pigs
- In 2008 26.8 million pigs in Vietnam, 3.6 million in Mekong delta
- Pork is 70% of meat consumption in Vietnam, over 50% in Cambodia



# The importance of pigs

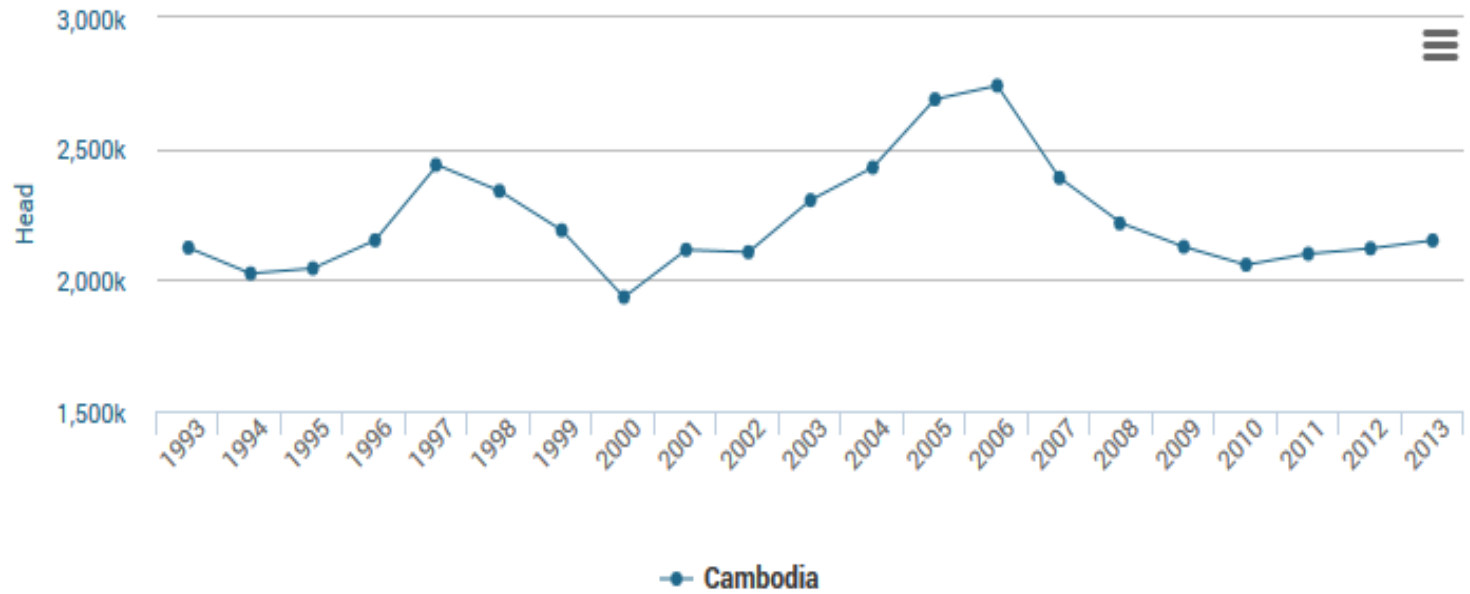
- Pigs important for smallholders
- Popular in Southeast Asia
- In Vietnam common with family farms
- Increasing number of large commercial farms
- More exotic breeds and AI



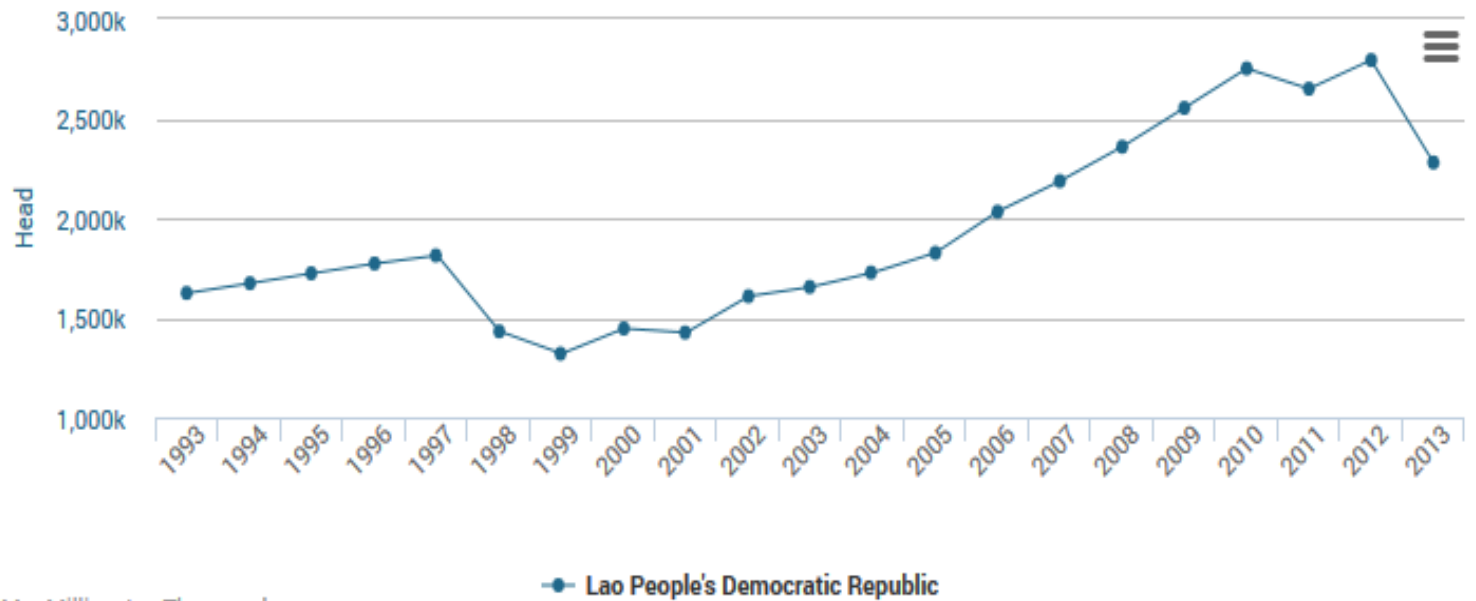




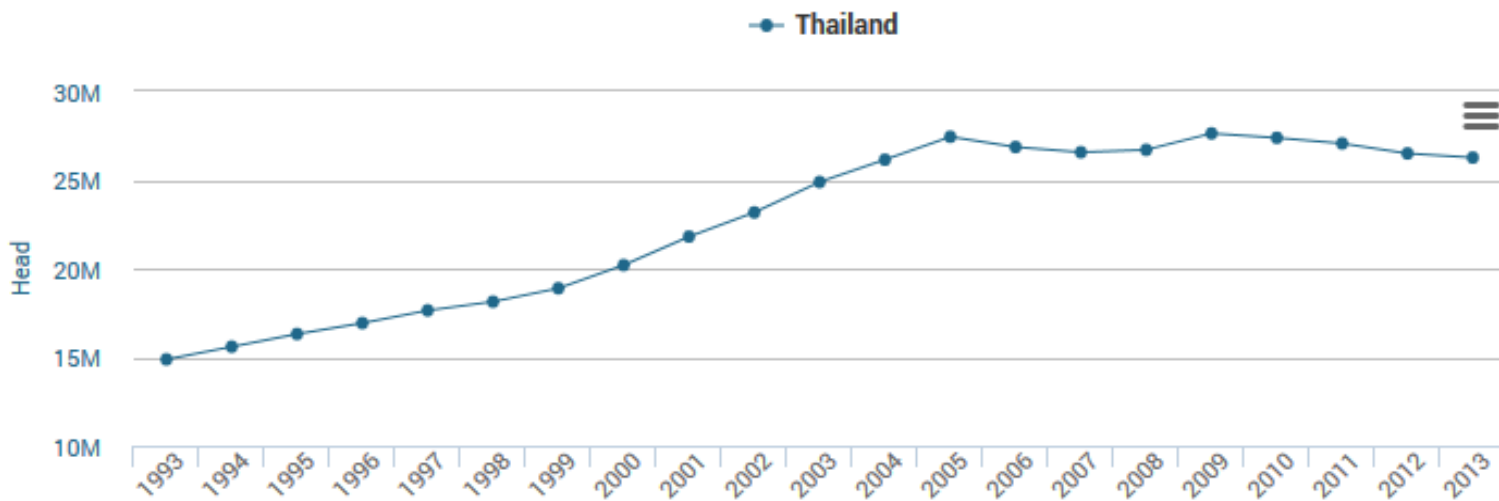
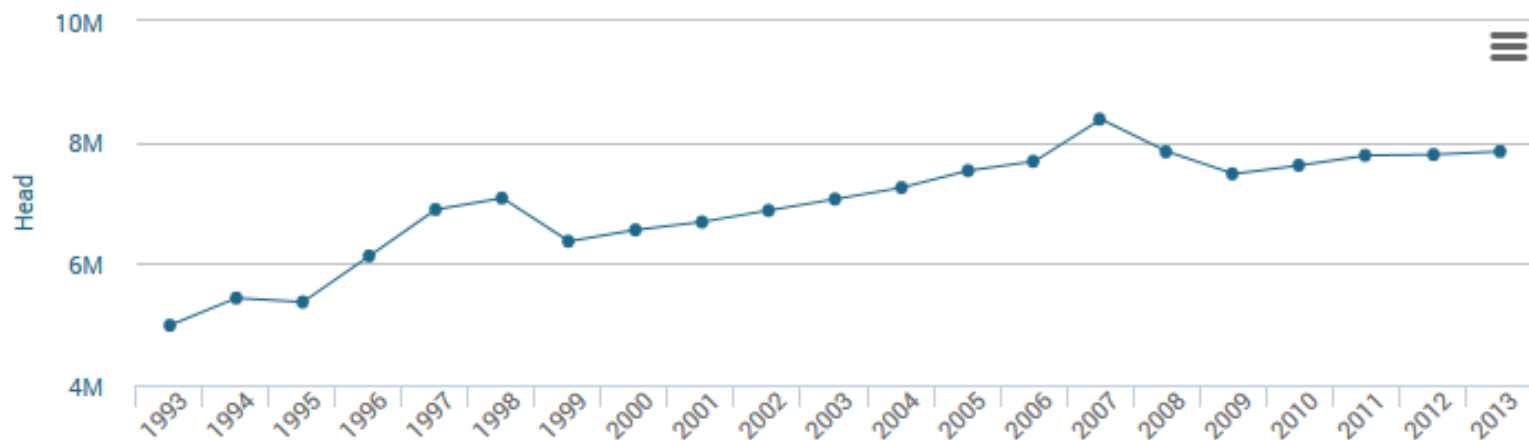
FAO statistics  
[www.fao.org](http://www.fao.org)



FAO statistics



number of heads in selected country 1993 - 2013



M = Million, k = Thousand

— Viet Nam

# How do people keep pigs, and why is it important?

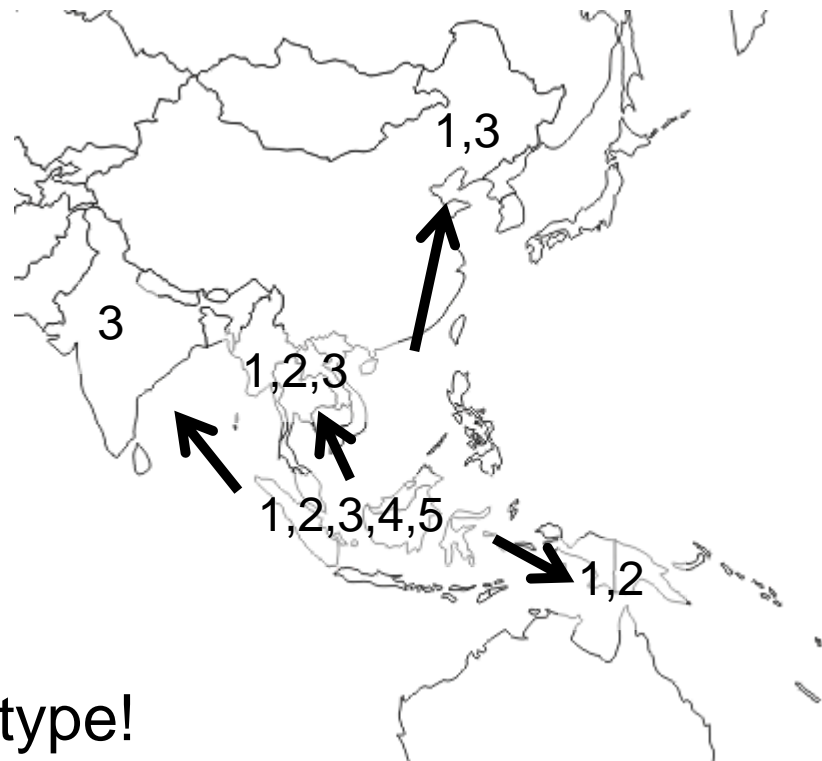




- Keep it close to home for fear of theft, or because you have to take care of it
- Keep it in the house because no other space
- Keep it scavenging because there is no feed



# Genotypes distribution and spread



Only one serotype!



# Disease in humans and horses

- Incubation period 6-10 days
- Fever, headache and meningitis
- Coma, death



# JEV and reproduction- pigs

- SMEDI: Stillbirth, mummification, embryonal death, infertility
- Middle third of pregnancy most affected
- Immunocompetence after 65-70 days
- Boars: orchitis, aspermia
- Differential diagnoses: PRRS, AD, CSF, leptospirosis, parvo



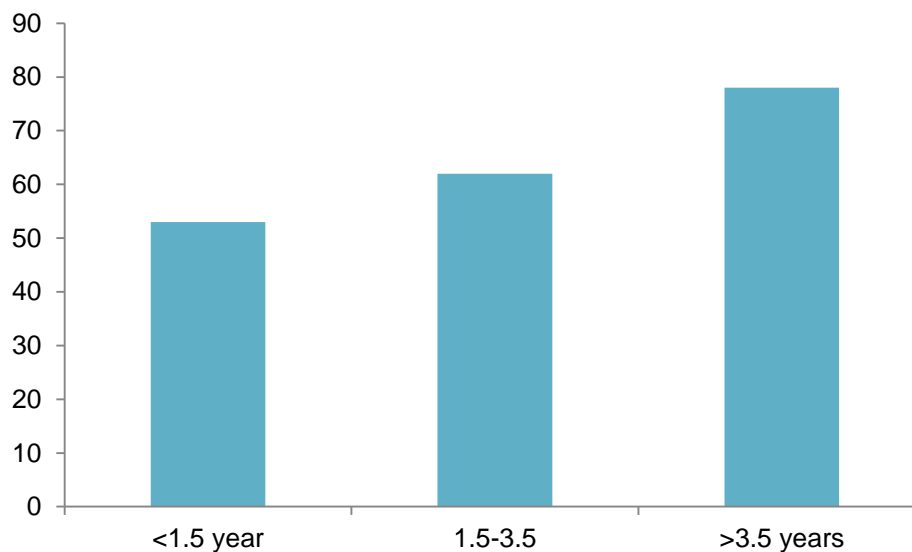


# How much impact on reproduction in an endemic area?

## Sows sampled 1999

- 315 serum samples analyzed with IgG ELISA
- 60% had antibodies
- Increasing odds for seropositivity with increasing age

Seroprevalence



# Association with stillborn piglets

- There was no association when all sows were included
- In sows <1.5 years more stillborn piglets with increasing OD-values



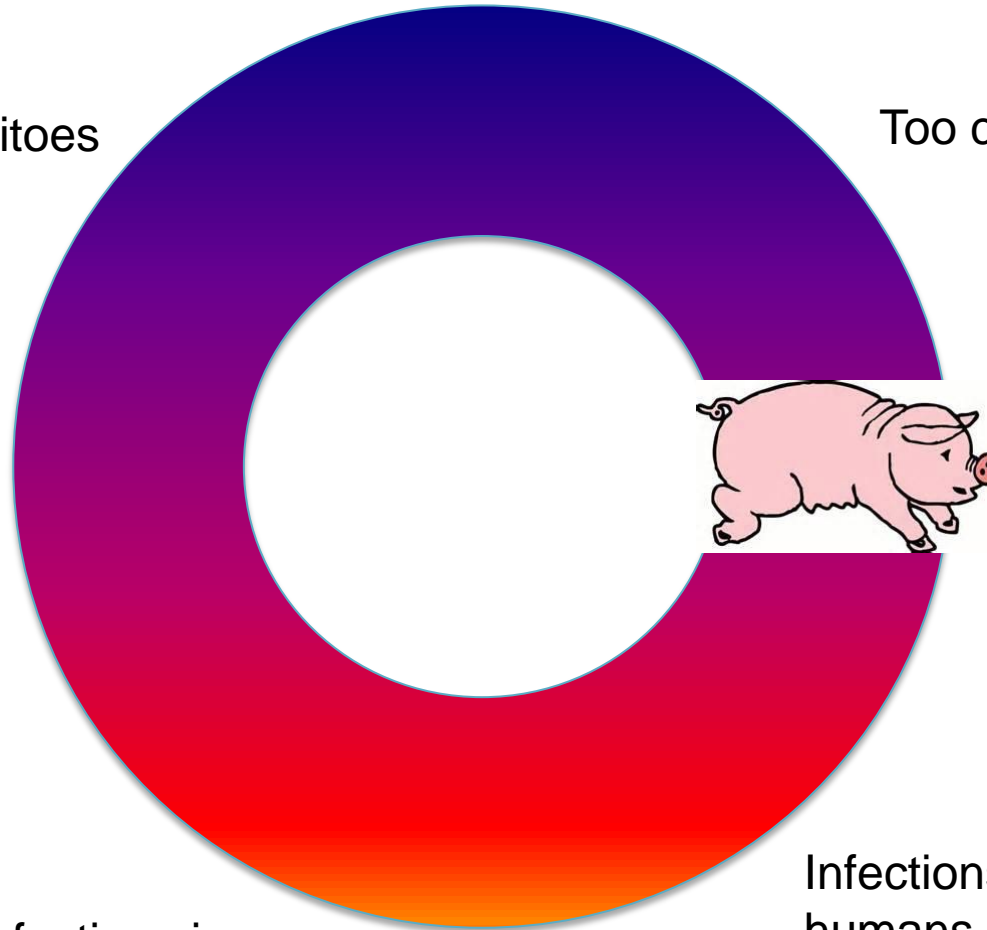
Too cold for mosquitoes

Too cold for mosquitoes

Mosquitoes start  
breeding

Infections in  
animals

Infections in  
humans

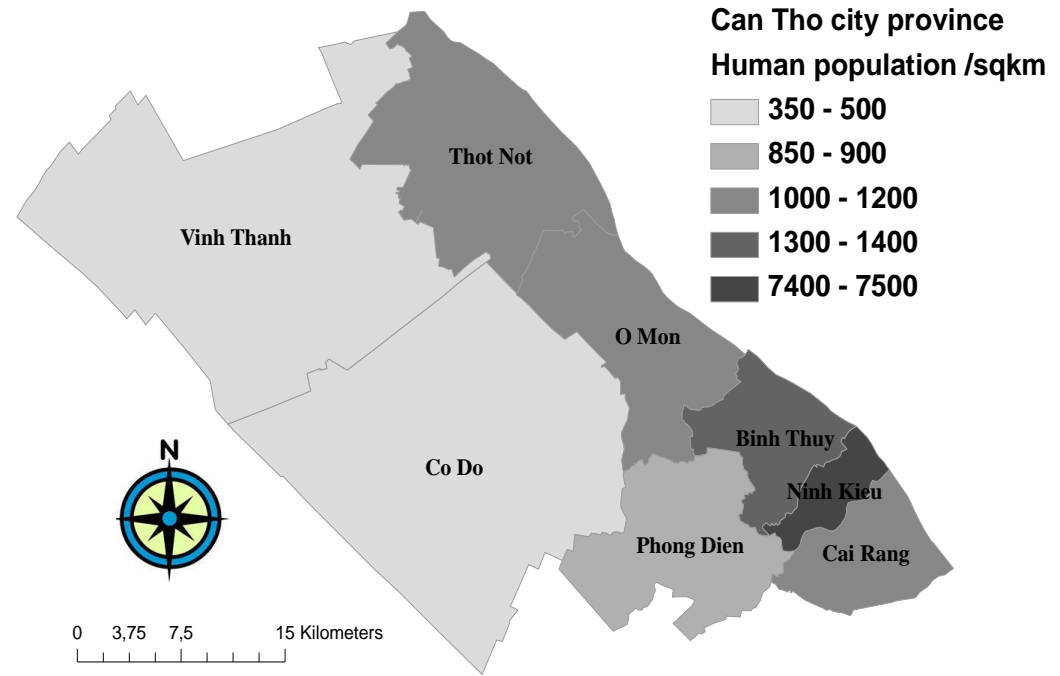


# Implications for human epidemiology

- When JEV is newly introduced- many clinical cases, of all ages
- When endemic- most adults are immune, mainly children sick
- When childhood vaccination- fewer cases, but if low infection pressures, may see cases among elderly

# Urban presence of JEV?

- 43 female pigs sampled in the urban Ninh Kieu district
- 31 female pigs sampled in the rural Co Do district
- 73/74 were seropositive in an IgG ELISA
- 0/74 positive in an IgM ELISA

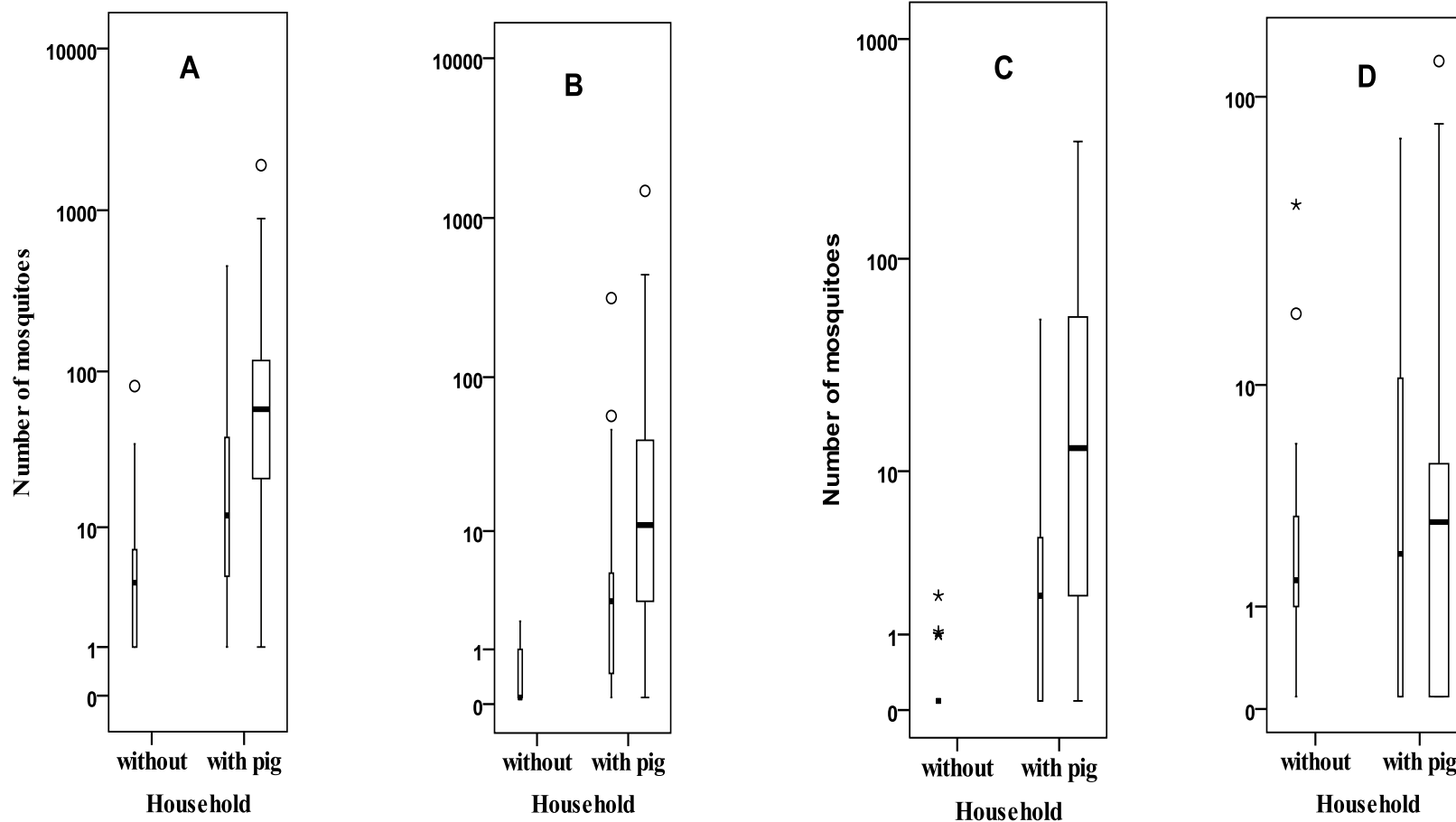


# Collected mosquitoes

- *Culex tritaeniorhynchus* (36%)
- *Culex gelidus* (24%)
- *Culex quinquefasciatus* (15%)



# Pigs and mosquitoes



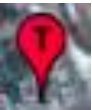
Graphs showing the mosquitoes collected in households with and without pigs in Ninh Kieu district, Can Tho city, Vietnam. Collections made close to humans are shown with thin boxes and collections close to pigs are shown with thick boxes.

A; total number of mosquitoes, B; *Culex tritaeniorhynchus* C; *Culex gelidus* D; *Culex quinquefasciatus*.

Circles depict outliers > 1.5 x the interquartile range and stars extreme outliers > 3 x the interquartile range.



# JEV- infected mosquitoes



Household with JEV-positive mosquito pool close to pigs



Household with pigs, no positive pools



Household without pigs, no positive pools



- Most mosquitoes at urban households are potential vectors
- Pig keeping increase the number of vectors
- Close to pigs-higher risks of vectors



# Should we not keep pigs?

- Food versus risks
- Badu Island: Moved Pigs 2.5 km from the urban area: reduced the JE cases, but still could detect virus in the city
- Same situation in Singapore
- Japan increased pig numbers- decreased JE incidence

# Questions remaining

What is the reservoir in nature?

Which are all the possible vectors?

How are vectors affected by climate change?



Infection in other animals?



What is the risk for emergence, especially in urban areas?





Sveriges lantbruksuniversitet  
Swedish University of Agricultural Sciences

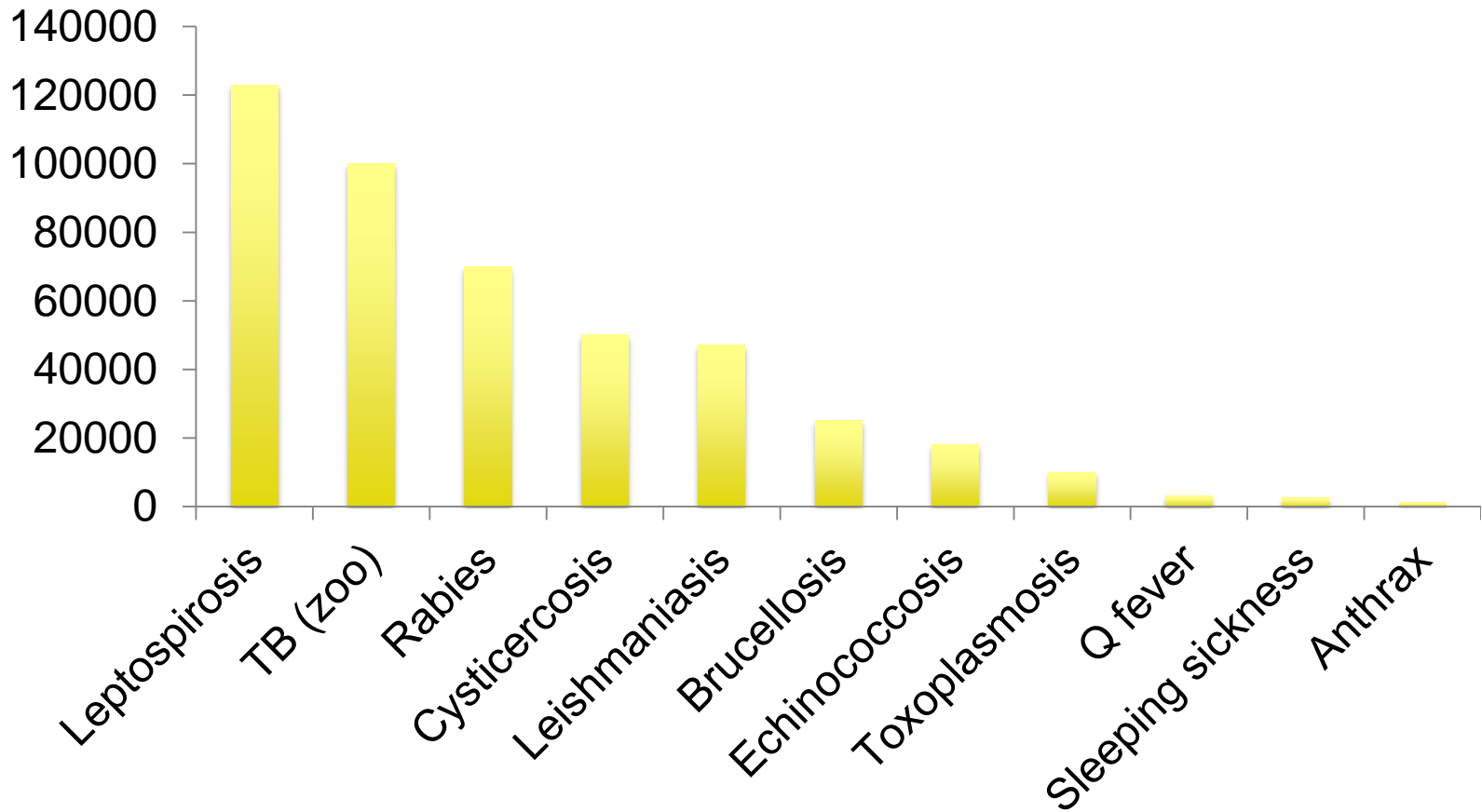
ILRI

INTERNATIONAL  
LIVESTOCK RESEARCH  
INSTITUTE

# Leptospirosis

# Neglected zoonoses

## Deaths - annual



# ***Leptospira spp***

- Spirochete- motile, aerobic, and similar to both Gram + and Gram -
- Multiple species and serovars
- Most mammals but also other animals
- Colonizes renal tubules in carriers
- Penetrates mucosal or skin abrasions
- Direct or indirect transmission

## Reservoir host Serovar(s)

- Pigs *pomona*, *tarassovi*
- Cattle *hardjo*, *pomona*
- Horses *bratislava*
- Dogs *canicola*
- Sheep *hardjo*
- Raccoon *grippotyphosa*
- Rats *icterohaemorrhagiae*, *copenhageni*
- Mice *ballum*, *arborea*, *bim*
- Marsupials *grippotyphosa*
- Bats *cynopteri*, *wolffi*

# Clinical symptoms

- Affinity for kidney, liver, lung
- Pigs: Often subclinical in young pigs. Diarrhea, jaundice, anorexia, reproductive failure, abortions.
- Humans: Jaundice, fever, myalgia, headache, vomiting/diarrhea, liverdamage
- Case fatality in dogs can be up to 20%



# Risk factors

- Water contact, poor sanitation, rainfalls and floodings
- Leptospire can survive for weeks in optimal condition, warm and wet, neutral to slightly alkaline water.
- In dogs, a lag period of 3 months after rainfall
- Some studies in pigs show association with season, some not.



Sveriges lantbruksuniversitet  
Swedish University of Agricultural Sciences

ILRI

INTERNATIONAL  
LIVESTOCK RESEARCH  
INSTITUTE

# Aflatoxins

# Aflatoxins are a major issue

- Estimated that total mycotoxin losses in the states are 1.4 billion USD annually
- Some years farmers are forced to dispose of half their crops of corn and peanuts
- Thailand, Indonesia, Phillipines total market loss: 200 million USD (and 700 million USD costs for livestock losses and health costs)

# Major effects on trade

When EU harmonized the limits:

- Decrease to 4 ppb: saves 2 lives per billion
- Europe receives 57% of African and Middle eastern exports
- Estimated to decrease African exports by 64% (670 million USD)
- Peanuts one of Africa's few export commodities (Gambia, Senegal, South Africa)

# .. And that is only the monetary values

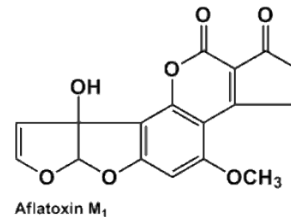
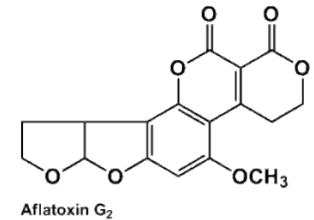
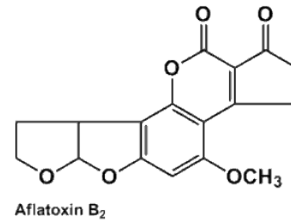
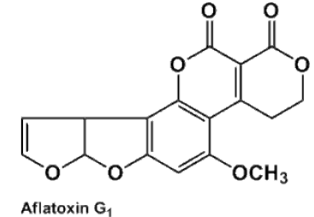
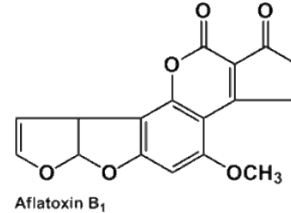
- Acute outbreaks can claim 100s of lives (Kenya outbreak 2004-2005 150 known fatal cases)
- 4.5 billion people chronically exposed (estimate by US CDC)
- Aflatoxin one of the most potent carcinogens known
- Immunosuppression
- Stunting



# What are aflatoxins?

- Toxin produced by *Aspergillus* spp, mainly *Aspergillus flavus* and *Aspergillus parasiticus*
- Metabolic by-product from certain strains

- *Aspergillus flavus* toxin



Mycotoxin	Main fungi	Impact on animal health
Aflatoxins	Aspergillus spp	All livestock susceptible to different degrees. Acute toxicity, hepatotoxic and nephrotoxic. Carcinogenic and mutagenic. Growth impairment. Immunosuppression.
Ochratoxin A	Aspergillus spp, Penicillium spp	Nephrotoxic Immunosuppression Possibly carcinogenic
Fumonisin	Fusarium spp	Toxic to liver and central nervous system Possibly carcinogenic
Zearalenone	Fusarium spp	Swine highly sensitive, cattle less sensitive. Endocrine disruption. Estrogenic effects, reduced reproduction, feminisation, malformations.
Trichotecenes	Fusarium spp	Gastrointestinal disturbance. Reduced feed intake. Ill-thrift. Immunosuppression.

# What is so tricky?

- Invisible toxin
- Odourless
- Heat-stable



Clean maize or fungus-free maize cobs. Photo by IITA.



# Why is the toxin there?

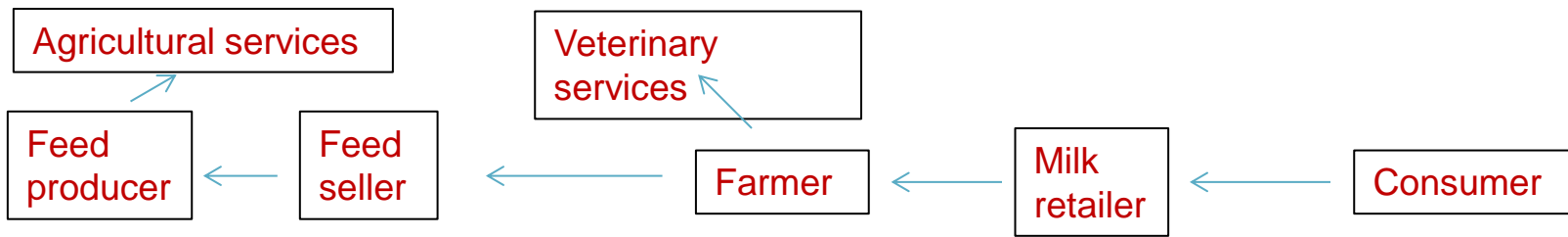
- Fungi infect stressed crops pre-harvest, during harvest or during storage
- Especially susceptible crops: maize, groundnuts
- Optimum temperature 37°C (range 12-48)
- Mainly tropical disease



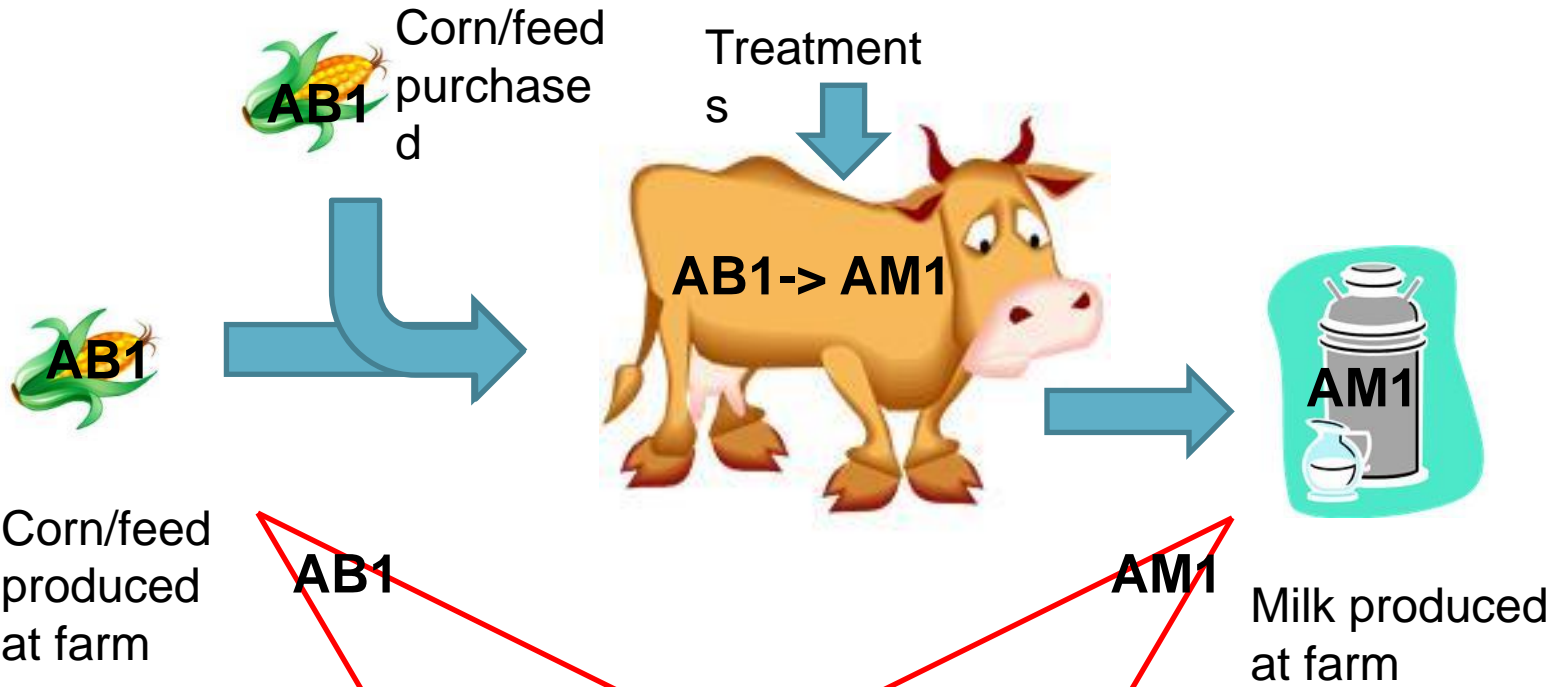
Photo by IITA. Aspergillus naturally infected groundnuts in



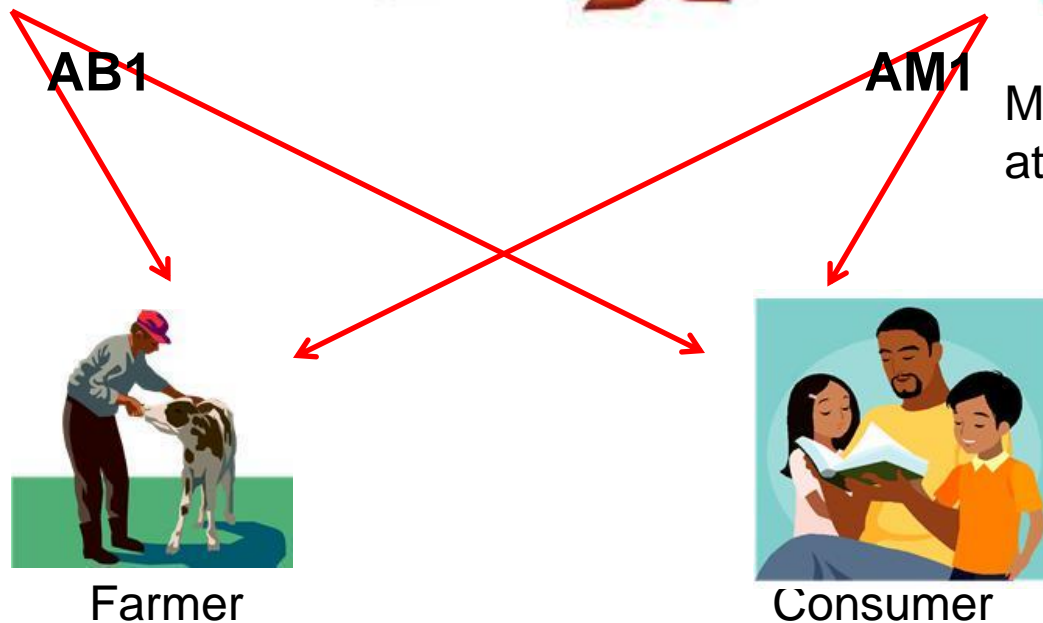
Photo by CIMMYT.



Aflatoxin flow



Human exposure



# What promotes the fungal growth?

- Pre-harvest: damage by insects, draughts
  - Insects cause damage and are mechanical vectors
- Post-harvest: Poor storage conditions



Improper drying of grains - Different grains being dried on roadside with rains looming in the horizon. Photo by IITA

# The consequences of export barriers

- The best products are exported
- The bad products are left to the national markets



Photo by IITA.



Sveriges lantbruksuniversitet  
Swedish University of Agricultural Sciences

ILRI

INTERNATIONAL  
LIVESTOCK RESEARCH  
INSTITUTE

# Climate change

# Climate change and emergence

- Warmer- more mosquitoes? More aflatoxins? More bacteria surviving?
- More irregularities in rain seasons
  - Floodings
  - Droughts

# Emergence of diseases

- Population growth
- Increasing globalization
- Increased urbanization
- Climate changes
- Agricultural changes





# Socio-economic drivers

- If you live on the streets:
- Can you protect yourself?
- Will you be reached by health measures?
- Will your cause of death be reported?

- Living standards decrease risks
- Proper building
- Mosquito nets
- Air condition





# Suspected challenges

- JEV: High vaccination levels in Vietnam. Most infections subclinical. Vaccination only good prevention.
- Lepto: Underdiagnosed. Un-controlled rodent populations. What can we do with forecasting?
- Aflatoxins: Virtually unknown status. What can we do to mitigate?

# One



# Health

Food safety and security

Livelihood



Zoonoses



**Thank you for your attention!**

