The use and application of epidemiological clusters in surveillance and control of Rift Valley fever

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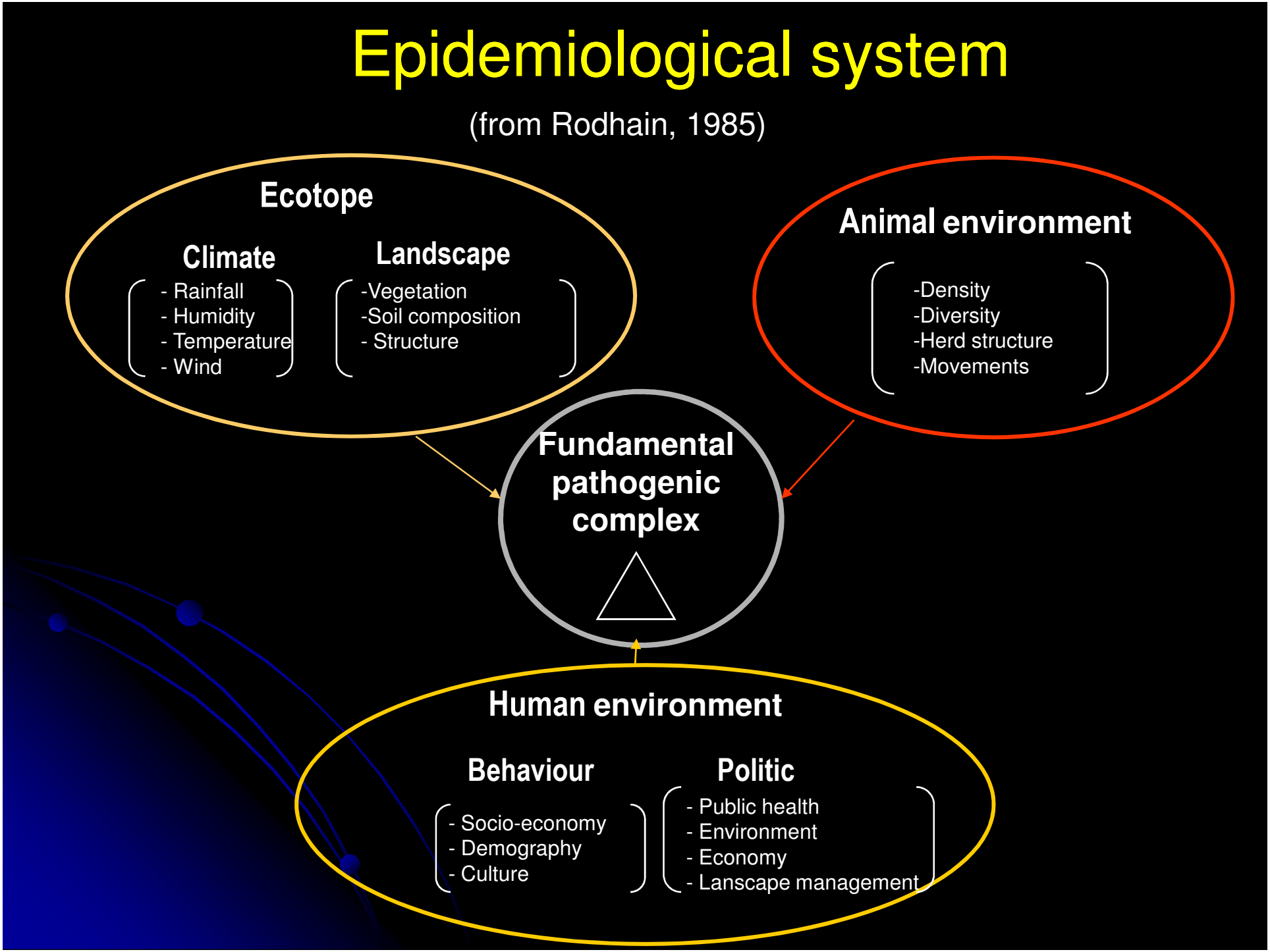
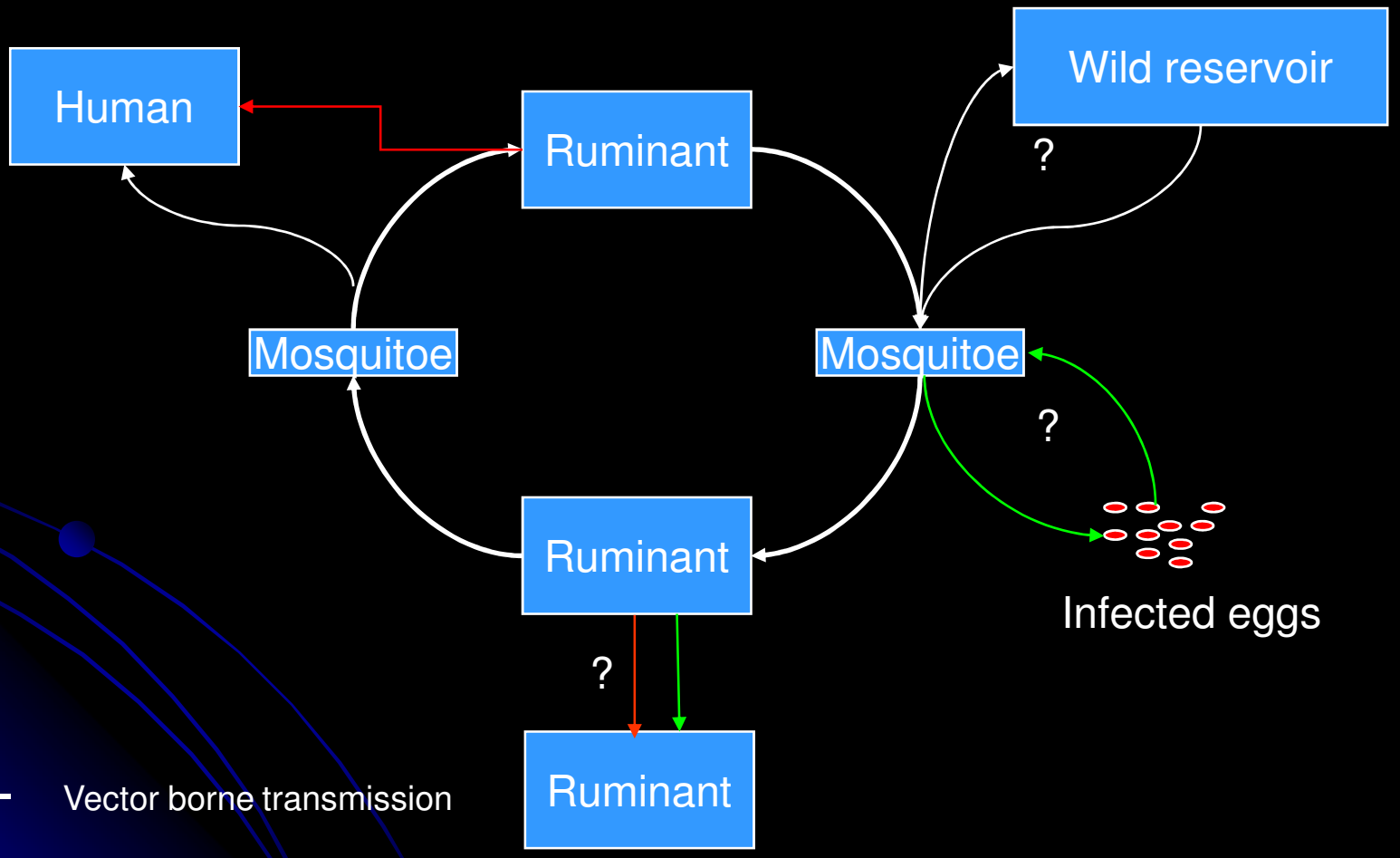
Epidemiological system

(from Rodhain, 1985)



Fundamental pathogenic complex: one virus, many vectors and many hosts



Vector transmission

- Main route of transmission during inter-epizootic period
- Vectors are infecting when feeding on viramic host
- Virus isolated in 6 mosquito genera
  - *Aedes*, *Culex*, *Mansonia*, *Anopheles*, *Coquillettidia* et *Eretmapodites*
- More than 50 potential vectors (ticks ?? *Hyalomma truncatum*)
- Main vectors are ***Aedes* and *Culex genera***
  - Bio-ecology
  - Epidemiological role

Main vectors
Aedes and *Culex*

Aedes

- Mammophilic
- Females lay their eggs in the pond mud
- Eggs survive from one year to the next one in the dry mud
- Need of a dry period before hatching
- Massive eclosion as soon as efficient rain

=> **<u>Need of alternating between filling and emptying</u>**

Dry areas and temporary ponds

Culex

- Ornithophilic
- Colonization from one pond to the next
- Females lay their eggs on the water surface
- Eggs can not survive with dessication

=> Need of permanent water

Permanent water-Irrigated areas

Vertical transmission

- Possibility for an infected female to transmit the pathogen to its descendants
- Demonstrated in *Aedes mcintoshi* (Kenya) (Linthicum, et la, 1995)
- Could explain the persistence of the virus in Sahelian areas and Kenya
  - Infected females lay eggs
  - Eggs survive in the mud for several years
  - With the first rain of the following year, eggs are flooded and hatch : some of these new mosquitoes are infected !!

    => initiation of a new cycle

Direct transmission

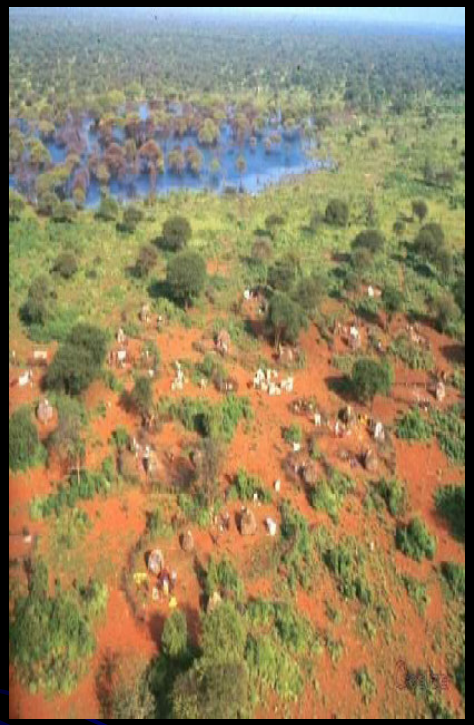
- Main route of transmission during epizootic period
  - Animal => animals
  - Animal => humans
- Virus source
  - secretions (nasal, ocular, vaginal)
  - foetus, placenta, meat and blood of ill animals
- The infection occurs when handling infected products, ill animals, or with infectious aerosols
- Humans are dead-end hosts

Potential reservoirs

Persistence of the virus during inter-epizootic ???

- Virus identified in some wild species
  - African buffaloes (*Syncerus caffer*)
  - Springboks (*Antidorcas marsupialis*)
  - Damaliscus (*Damaliscus albifrons*)
  - Wild boars (*Phacochoerus aethiopicus*)
- Antibodies anti-RVF detected in
  - Rodents (*Mastomys erythroleucus*, *Aethomys namaquensis* et *Arvicanthus niloticus)*
  - Bats

Several epidemiological systems …



Fundamental pathogenic complex

⇒ components
⇒ transmission mechanisms
⇒ risk factors

Dambos (Kenya)

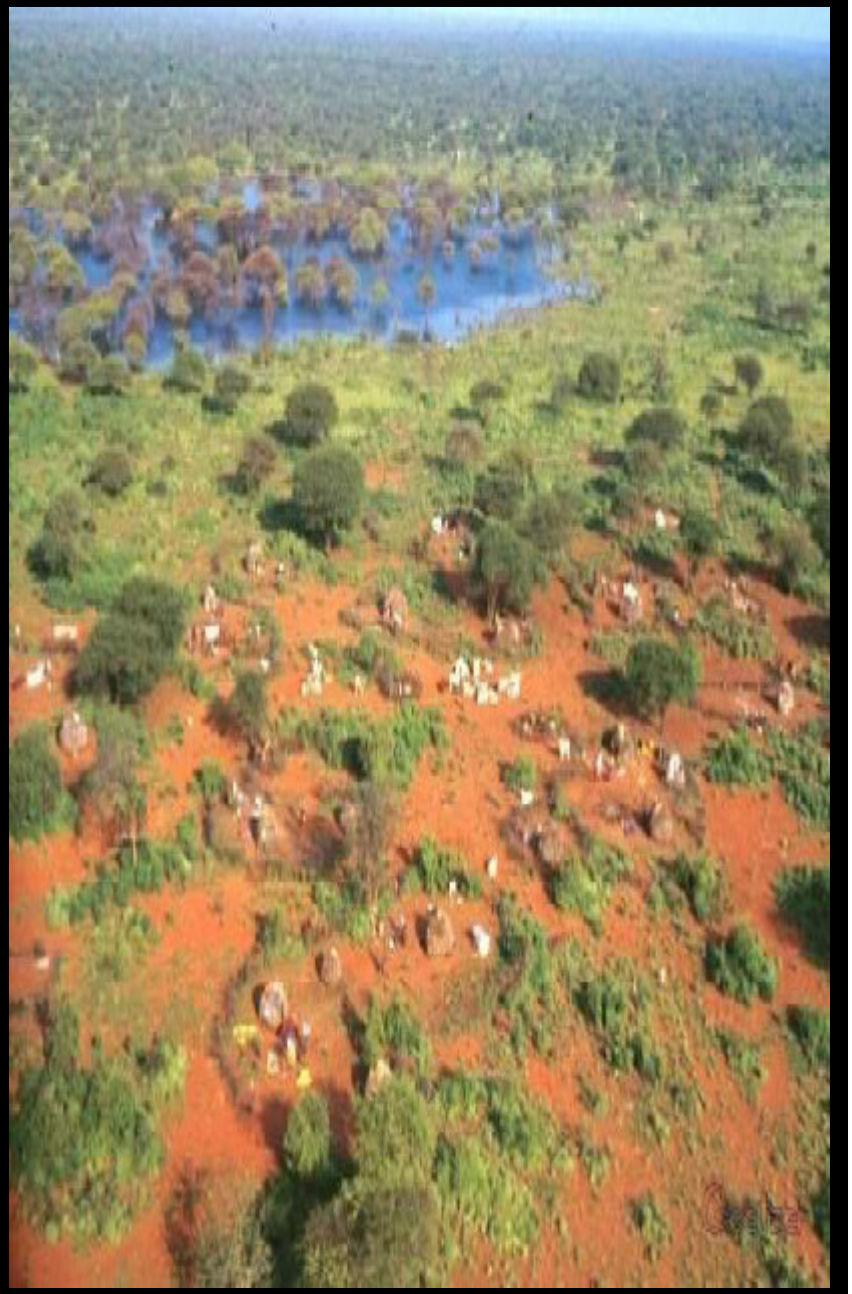
- Intense rainfall events

=> pullulation of ***Aedes***, some may hatch being infected

- ***Culex*** take over for the virus transmission when *Aedes* population decreases and inundated areas are permanent.

⇒ Correlation between heavy rainfall and RVF outbreaks

⇒ Persistence by vertical transmission in *Aedes mcintoshi*



Irrigated areas

- Hot and dry climate
- Particularly low rainfall levels
- Permanent water = suitable habitats for *Culex* mosquitoes
- Egypt : viral circulation in 1993, 1997, 1999 and 2003 => endemicity
- Senegal river basin : endemicity
- Yemen : low level endemic circulation?
- *Egypt :Culex pipiens* and *C. antennatus* suspected
- Senegal River basin: *Ae. vexans* + *C. poicilipes*
- Yemen?
- Persistence mechanism ??
  - « overwintering » infected *Culex*?
  - Rodents?
  - Regular introduction by animal trade ?

Yemen

Egypt

Temporary pond areas
Ferlo (Senegal)

- Sahelian climate and landscape
- Annual rainfall between 300 and 500 mm, from July and et October
  - Strong inter and intra annual variations

Temporary pond areas

- Similarity to Dambos ?
  - Dry season / wet season
  - Vectors = *Aedes* and *Culex*
- Emergence risk factors ?
  - Risk intensity varies from one pond to the next
  - => role of ecological factors? Pond structure? Vegetation?
- Persistance mechanisms unknown
  - Vertical transmission with *Aedes vexans*?
  - Rodents ?
  - Introduction via nomadic herds?

Forest ecosystem
ex : Madagascar

- Tropical climate
  - Fresh in highlands-
  - Hot in East Coast
  - High annual rainfall level
- First RVFV isolates (1979) and first epidemic was reported
- Outbreak in 1991
- Outbreak in 2008
- Vectors?
  - *Culex univittatus*? *pipiens*? *quinquefasciatus*?
- Virus persistence?
  - Rodents?
  - Animal movements

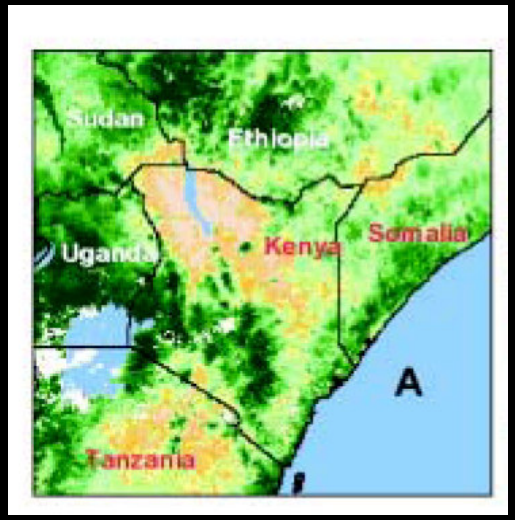
Surveillance Tools availability

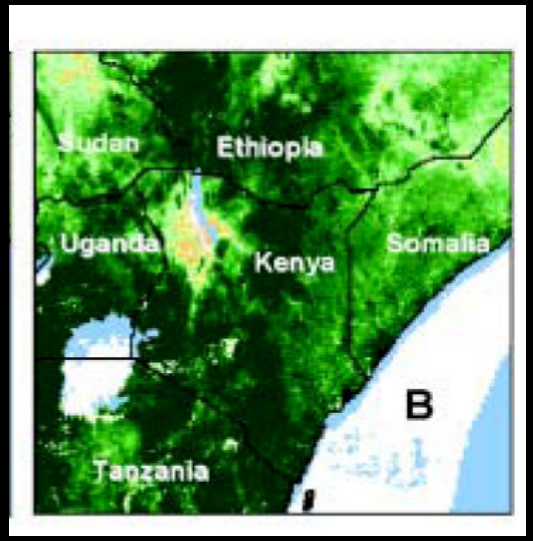
- Passive Surveillance
  - passive reporting of abortions by veterinary services
    =>awarness
    =>constant information of breeders, technicians, vets etc..
- Targeted Surveillance = Sentinel herds
  - Targeting of locations and periods of surveillance.
  - Need a dense network for a good sensibility
  - Diagnostic accurate and rapid
  - Strong link between field and sanitary authorities
- Entomological Surveillance = mosquito trapping
  - Accurate knowledge of ecological areas
  - Regular trapping
  - Abundance dynamic => identification of risky periods => warning
  - Detection of new potential vectors
- Methodology should be adapted according to the epidemiological processes involved, the actual status and potential evolution of the considered area

East Africa-dambos

- Correlation between heavy rainfall and outbreaks = accurate predictive models

- In addition:
  - Early reaction program
  - Planned control measures
  - Vaccine and insecticide stocks
  - Constant alert of farmers and veterinary authorities
  - Evaluation of vaccination strategies according to the ecological and socio-economical context a
  - Evaluation of the impact of vaccination on the disease pattern in endemic areas.





Irrigated areas
Egypt, Senegal River basin..

- Transmission models using the basic reproduction number (R0) => to test different climatic scenarios and the relevance of different vaccination strategies.
- Evaluation of the impact of vaccination on the disease pattern
- constant alert of farmers and veterinary authorities
- Traditional passive surveillance network to be implemented to detect increased incidence
- Vaccine stocks

Temporary pond areas

- Risk areas, key emergence factors, and persistence mechanisms remain to be identified
- Potential evolution unknown
- =>Transmission models using the basic reproduction number (R0) to test different **climatic scenarios** and the relevance of different **vaccination strategies**.
- =>Traditional passive surveillance network to be implemented to detect increased incidence
- => Reinforced targeted surveillance in known risk areas such as the Ferlo area

Forest systems

- Risk areas, key emergence factors, and persistence mechanisms remain to be identified
- Traditional passive surveillance network to be implemented to detect increased incidence
- Information of breeders, technicians …

Free but at risk areas

- Countries that have experienced an outbreak
- Countries that share ruminant trade links with endemic areas
- Countries with endemic neighbours

=>How can we evaluate and control the risk efficiently ?

- Quantification of ruminant flows and their variations
- Analysis of the risk of endemisation
  - a competent vector census
  - suitable vector habitat mapping
  - host density mapping
- Minimum information of health actors
- Passive surveillance?

At the continental and international scale…

- a global surveillance network should be implemented in order to:
  - gather together available scientific information, identify risk areas, and catalogue the ecosystems and environmental conditions considered or predicted to be at risk (“emerging disease hot-spots”)
  - share information about virus circulation and guarantee the transparency of countries' RVF status .
  - identify, test, and harmonize control measures (vaccination, insecticides treatments) to be implemented in case of introduction


Merci de votre attention !
Thank you for attention