Rift Valley Fever Outbreaks and Control in East Africa

Re-emergence of Rift Valley fever in Southern Africa: how to better respond
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RVF in East Africa

- **First described in 1930**
- **Endemic sylvatic cycles punctuated by explosive epidemics**
  - Over-wintering through trans-ovarial transmission in Aedes
  - Low level virus circulation
  - Prolonged rainfall
  - Flooding
  - High vector density
  - Amplification in livestock
  - Transmission by secondary vectors
- **Major outbreaks on an average of every 10 years**
  - 1997-98
  - 2006-07

The challenge

- **Rapid course of outbreaks**
- **Inaccessibility of communities**
- **Loss of institutional memory**

  Field staff turn over

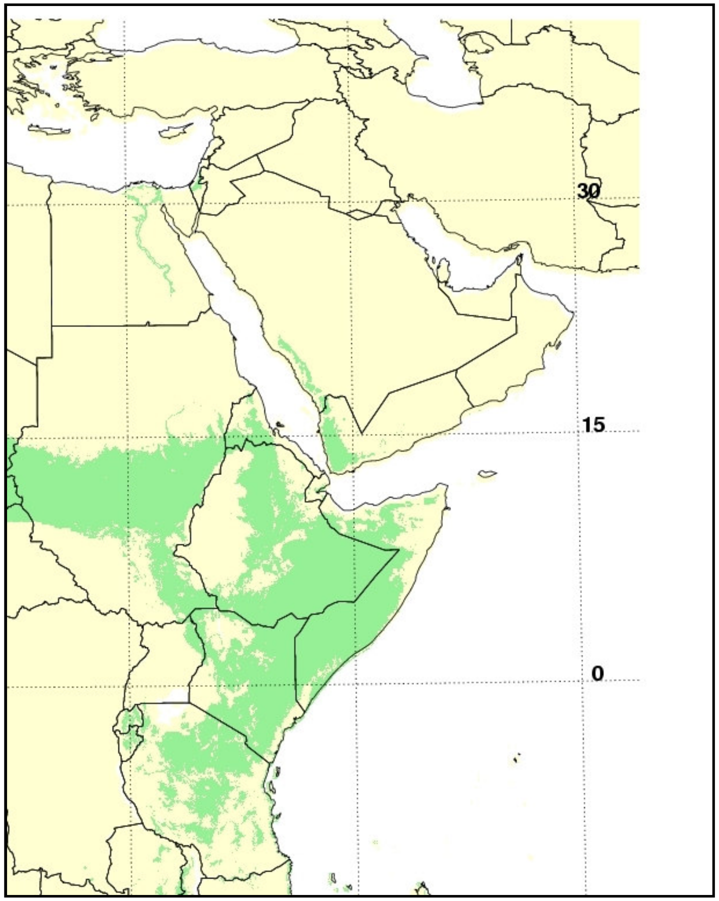
  Decision-makers inexperience with the issue

  ‘Write it on the wall’

- **Economic costs of preparedness**
  - Maintaining trained staff
  - Updating response planning
    - Institutions and technology change
  - Vaccine production capacity and stock piling

Risk Maps and RVF Early Warnings 06/07

Did they help with prevention/ early detection?



Assaf Anyamba and DoD-GEIS & NASA Goddard Space Flight Center Rift Valley Fever Monitoring Team.

EMPRES WATCH

emergency prevention systems

Possible RVF activity in the Horn of Africa

1. Introduction

Rift Valley fever (RVF) is an arthropod-borne viral disease of ruminants, camels and humans. It is a significant zoonosis which may present itself from an uncomplicated influenza-like illness to a haemorrhagic disease with severe liver involvement and ocular or neurological lesions. In animals, RVF may be unapparent in non-pregnant adults, but outbreaks are characterised by the onset of abortions and high neonatal mortality. Transmission to humans may occur through close contact with infected material (slaughtering or manipulation of runts), but the virus (Phlebovirus) is transmitted in animals by various arthropods including 6 mosquito genus (*Aedes*, *Culex*, *Mansonia*, *Anopheles*, *Coquillettidia* and *Eretmapodites*) with more than 30 species of mosquitoes recorded as infected and some of them been proved to have a role as vectors. Most of these species get the infection by biting infected vertebrates, yet some of these (specifically *Aedes* species) transmit the virus to their eggs. These infected pools of eggs can survive through desiccation during months or years and restart the transmission after flooding, and then other species (*Culex* spp.) may be involved as secondary vectors.

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This vertical infection explains how the disease can persist between outbreaks.

RVF virus (RVFV) is recorded to occur from South Africa to Saudi Arabia including Madagascar, in varied bioclimatic ecotypes, ranging from wet and tropical countries such as the Gambia, irrigated regions such as the Senegal River Valley or the Nile Delta, to hot and arid areas such as Yemen or Chad. The occurrence of RVF can be endemic or epidemic, depending on the climatic and vegetation characteristics of different geographic regions. In the high rainfall forest zones in coastal and central African areas it is reported to occur in endemic cycles which are poorly understood. Currently available evidence suggests that this may happen annually after heavy rainfall, but at least every 2-3 years otherwise. In contrast, in the epidemic areas in East Africa, RVF epidemics appear at 5 to 15 year cycles. These areas are generally relatively high rainfall plateau grasslands, which may be natural or cleared from forests. In the much drier bushed Savannah grasslands and semi-arid zones, which are characteristic for the Horn of Africa, epidemic RVF has manifested itself only a few times in the past 40 years, in 1961-62, 1982-83, 1989 and in 1997-1998.

In addition the possibility exists that RVFV may spread outside traditionally endemic areas, or even out of the continent of Africa, mostly due to the large range of vectors capable of transmitting the virus and requires a level of viraemia in ruminants and humans that is sufficiently high to infect mosquitoes. Such a situation occurred following the unusual floods of 1997-1998 in the Horn of Africa countries, and subsequently the disease spread to the Arabian Peninsula in 2000.

2. Disease ecology and climatic drivers in the horn of Africa

The ecology of RVF has been intensively explored in East Africa. Historical information has shown that pronounced periods of RVF virus activity in Africa have occurred during periods of heavy, widespread and persistent

Livestock Owner Description of RVF (*Sandik*)

- Sheep and goats
  - Froth, salivation, bloody diarrhea, abortion, fever, cough
- Cattle
  - Abortion, froth, bloody diarrhea,fever, cough,salivation
- 12 of 17 indicated *sandik* last ocurred in 1997-8

Associated with flooding and mosquitoes with white legs

Traditional Somali institutions didn’t forget!

Clinical Case Definition: RVF Compatible Event

- Abortion
- Heavy rains and mosquitoes
- Froth from the nose, often with epistaxis
- Salivation
- Fever
- Death, particularly in young animals

An outbreak in sheep and goats involving abortions during periods of heavy rain and abundance of mosquitoes, with two or more other listed clinical symptoms being observed in the herd, should be reported as RVF compatible disease to public health authorities. Cattle in the same area will be affected with similar but less severe symptoms, and rarely camels.

RVF at the Household Level

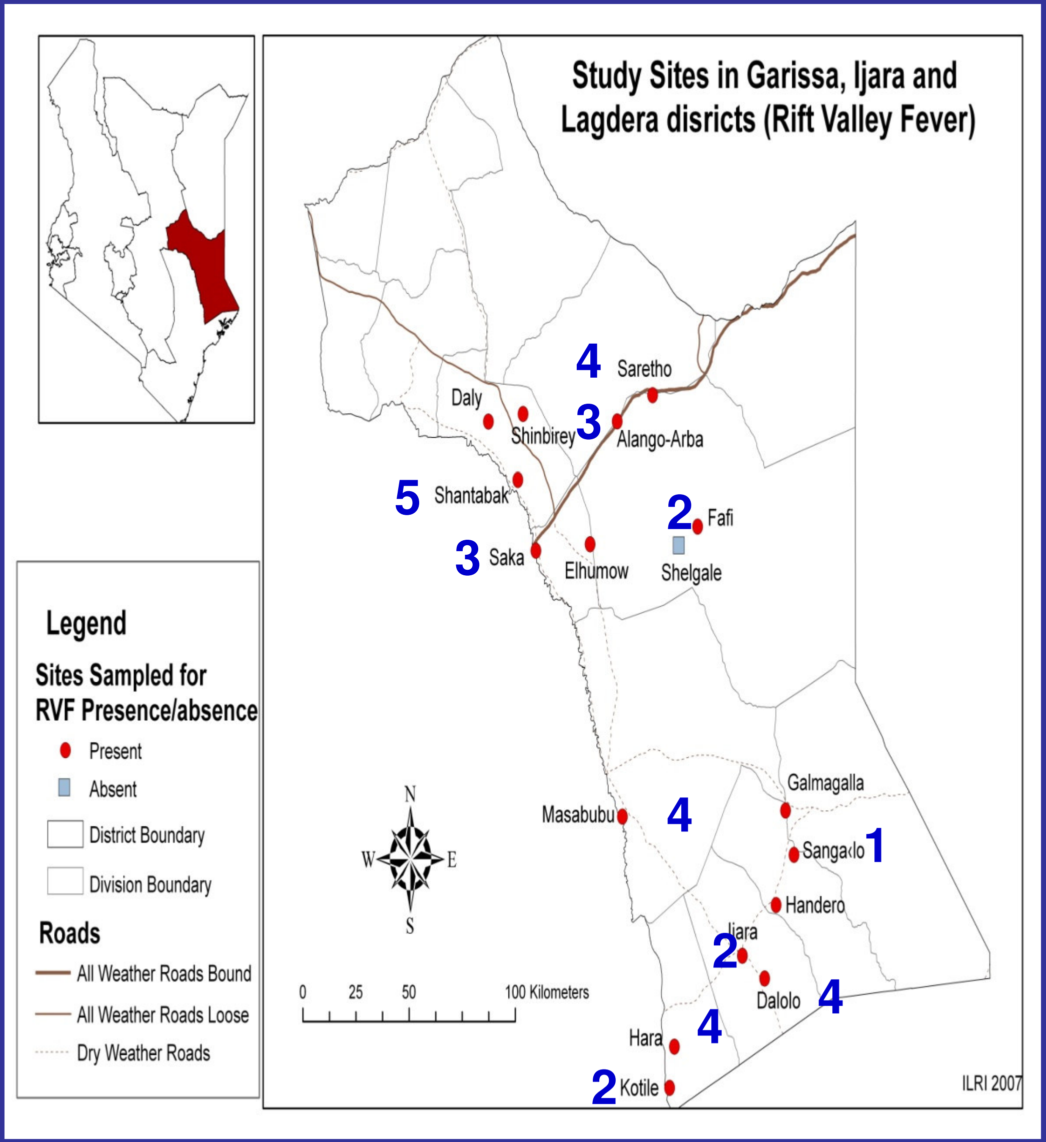
- 89% of the households reported that RVF had affected their herds
- 18.5% reported a case of human RVF in their own households
  - nose bleeding & bloody diarrhoea
  - 3 were from Kilifi, positive on laboratory
- Two-thirds described human cases within the vicinity of the households

Kenya 06/07 RVF Cases by Wealth Group

Wealth Rank	Garissa	Kilifi
Very poor	50%	40%
Poor	35%	40%
Middle	15%	15%
Wealthy		5%

- Majority were less than forty years
- Resided in rural areas of the districts
- 20-60% loss of work productivity reported in surviving cases

Sequence of Events



Timeline in NE Kenya

- Onset of rains to mosquito swarm: **23. 6 days (11)**
  - Start of heavy rains
    - Average reported start date: mid-October 06
    - Earliest reported state date: mid-September 06
  - Appearance of mosquito swarms
    - Average start date: late-October 06
    - Earliest state date: early-October 06

- Mosquito swarm to first animal case: **16.8 days (11)**
  - First suspected RVF case in livestock
    - Average date: mid-November 06
    - Earliest date: late-October 06

Timeline

- First livestock case to first human case: **17.5 days (8)**
  - First suspect RVF case in humans
    - Average date: late-November 06
    - Earliest date: early-November 06

- First livestock case to veterinary service intervention: **61.6 days** (6)
  - First veterinary service response
    - Average and earliest date: mid-January 07

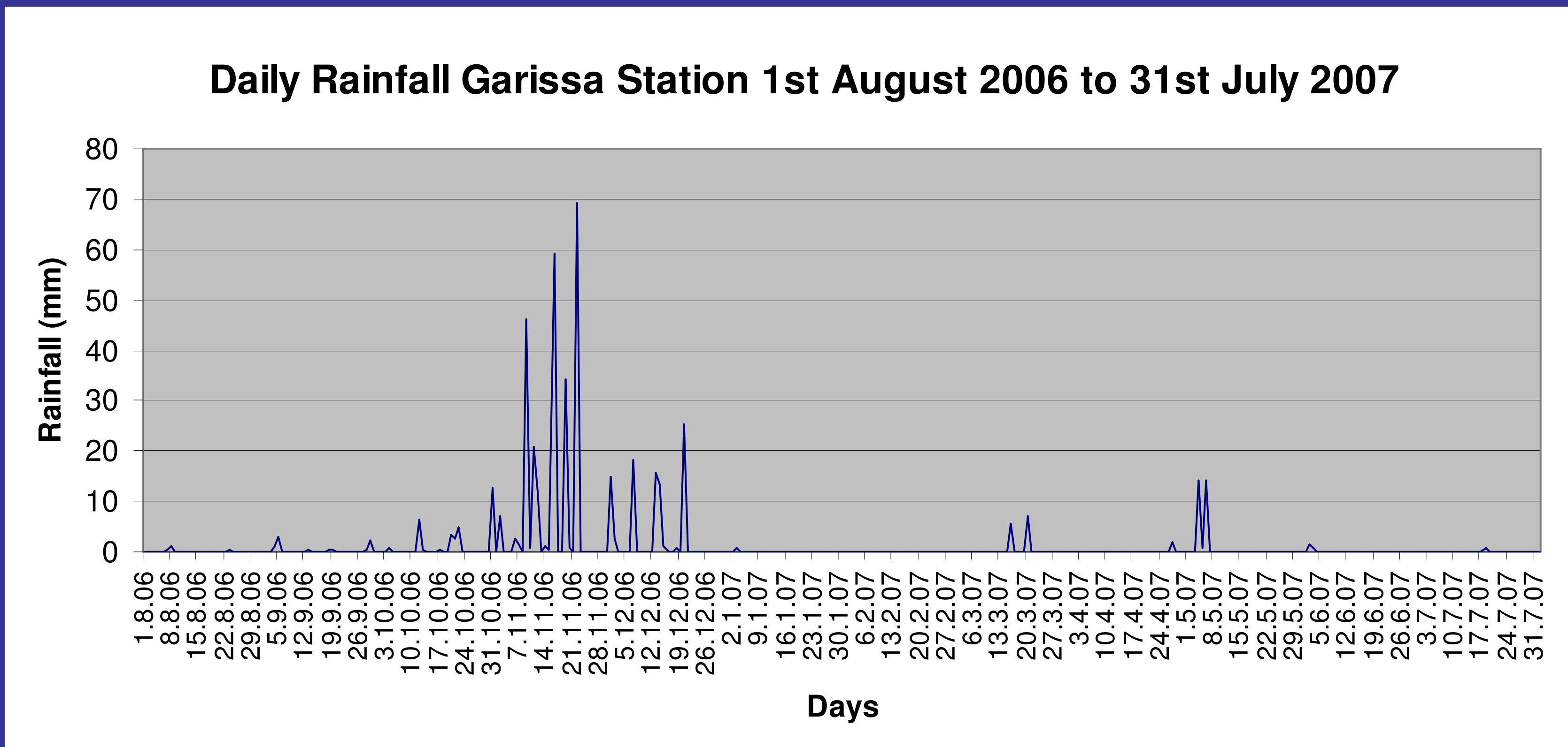
- First livestock case to public health intervention: **50.4 days (4)**

First public health service response
Average and earliest date: mid-December 06

  - First public health service response
    - Average and earliest date: mid-December 06

- First suspected human case to public health intervention: 30.0 days (4)

Rainfall



Daily Rainfall Garissa Station 1st August 2006 to 31st July 2007
Rainfall (mm)
0
10
20
30
40
50
60
70
80
1.8.06
8.8.06
15.8.06
22.8.06
29.8.06
5.9.06
12.9.06
19.9.06
26.9.06
3.10.06
10.10.06
17.10.06
24.10.06
31.10.06
7.11.06
14.11.06
21.11.06
28.11.06
5.12.06
12.12.06
19.12.06
26.12.06
2.1.07
9.1.07
16.1.07
23.1.07
30.1.07
6.2.07
13.2.07
20.2.07
27.2.07
6.3.07
13.3.07
20.3.07
27.3.07
3.4.07
10.4.07
17.4.07
24.4.07
1.5.07
8.5.07
15.5.07
22.5.07
29.5.07
5.6.07
12.6.07
19.6.07
26.6.07
3.7.07
10.7.07
17.7.07
24.7.07
31.7.07
Days

Sequence of Events Relative to Early Warnings

- September 2007
  - GEIS (provisional)
  - Rains observed by herders
  - Mosquito swarms observed by herders
- October 2007
  - GEIS (warning)
  - First RVF compatible events in livestock (October)
- November 2007
  - EMPRESS warning
  - First RVF compatible events in humans (November)

Kenya 06/07 RVF Timeline

September			October			November (EMPRES warning)			December			January		
early	mid	late	early	mid	late	Early	mid	late	early	mid	late	early	mid	late
	1st significant rains, Saingilo, according to herders		1st mosquito swarms according to herders		1st livestock cases, Ijara, Kotile, Fafi, according to herders	1st human cases Ijara, Kotile, Fafi, according to herders		30 Nov human index case according to WHO trace back	4 Dec First DVO record of herder report, outbreak start date as reported to OIE	17 Dec First vet service intervention (Garissa market closure)	22 Dec Vet lab confirmation	8 Jan Start of livestock vaccinations as part of MOH, MOA, NGO mixed team response using helicopters provided by MOH		

Livestock Response

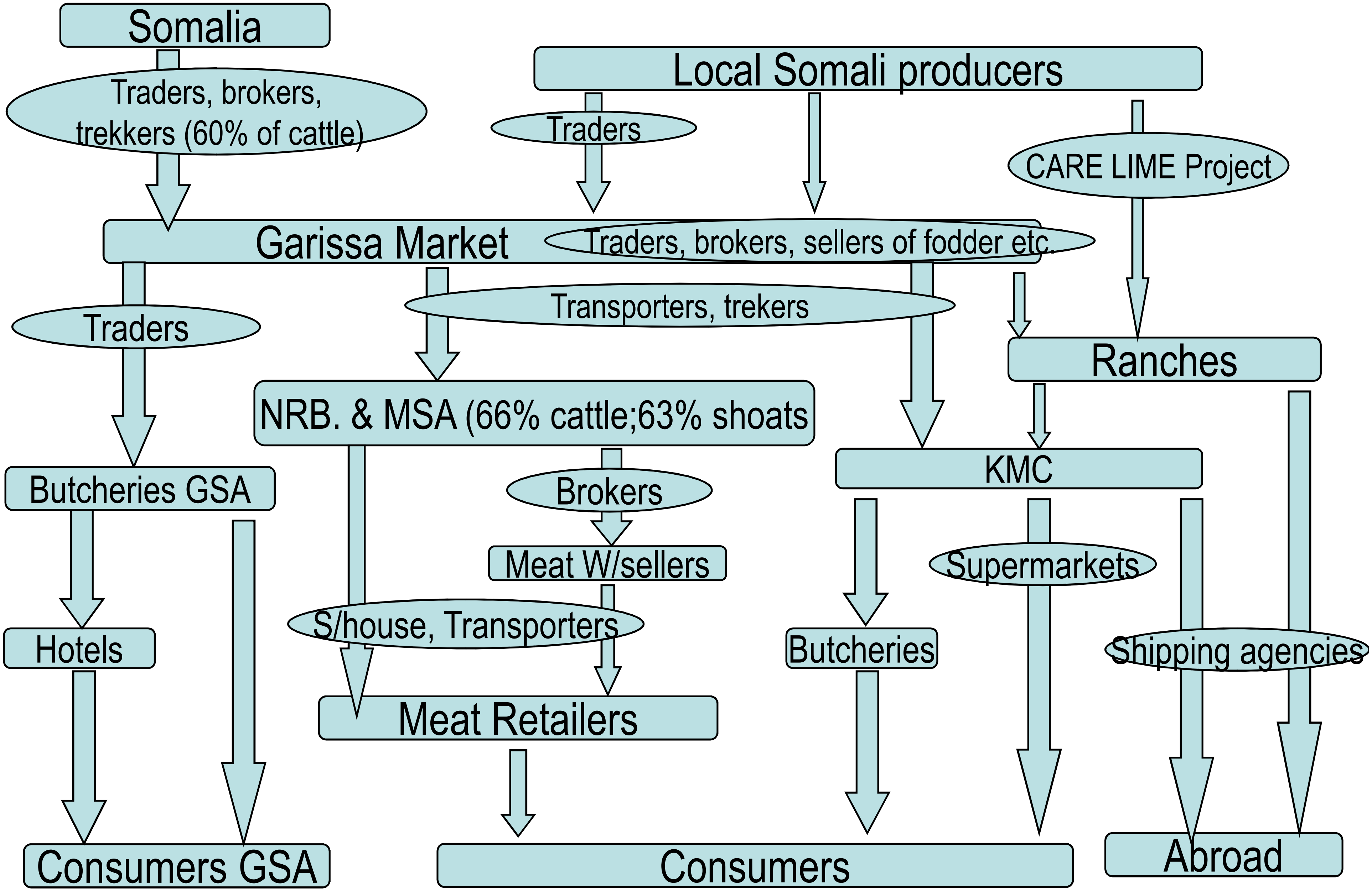
- Mostly after outbreak
  - Supportive treatment
  - Public relations tool
- Inadequate stocks and production of vaccine
  - A few million doses available in the world
  - Uneconomic for labs or governments to stock
  - Unlikely to change
  - Trade impacts of preventive mass vaccination?
- Strategic vaccination ahead of outbreak
- Slaughter ban
  - One of the main economic impacts
  - Was slaughtering or consumption of meat a hazard?
  - Better communication messages needed

40 days from Rains to 1st Cases - Prevention with Vaccine?

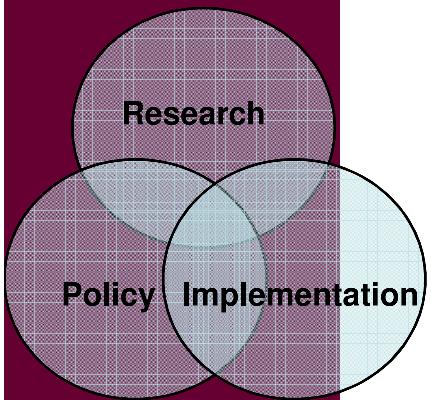
Time between each pair of outcomes (days)	Outcome
141	**Total days lapsed before herd immunity achieved**
7	Target livestock population immune
20	Completion of vaccination campaign
7	Start of vaccination campaign in targeted high risk area: 100,000 animals, 2 vaccination teams each of 5 persons; 2,500 animals vaccinated per day per team
7	Movement of vaccine from central store to high risk area
3	Vaccine delivery and stock management at central level
90	Shipment of vaccine
7	Manufacturer receives order and starts vaccine production
	Vaccine ordered

7 May

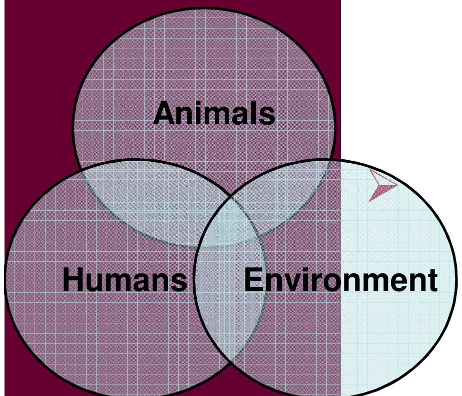
Garissa Livestock Marketing Value Chain



Lessons Learnt



- **Adaptation and Mitigation**
  - ✓ ***Focus*** on ***Preparation, Prevention and Mitigation***
  - ✓ ***Predictive early warning*** not based on NDVI
  - ✓ ***Risk based decision making*** in animal and public health institutions with phased responses geared to escalating risk levels
  - ✓ ***Appropriate level of technology***
    - Technology should be ***accessible and timely***
    - Most important are functional institutions (***systems and policies)*** for disease surveillance and control
    - ***Participatory approaches***
      - Empowerment of field staff - Rapid tests and cell phones



- **Advocacy** – ***soft skills***
  - ✓ Communication and prioritization skills are just as important as technical skills, and are key to ***institutional change***
  - ✓ ‘Smart’ mitigations that target true risk factor
- **Approach** – ***One Health in the field and HQs.***

2008 – have we learned?

- Kenya RVF contingency plan
- Decision support tool
- **EMPRES warning in September**
- **Kenya technical coordination committee** – GoK (MOPHS, DVS, Meteo, KEMRI, KARI, KWS), KVA, IBAR, FAO, ILRI, NGOs, donors, bilaterals….
  - Response project concept paper for donors
  - Monitoring and surveillance
  - RVF alerts to field staff
  - Vaccination protocol
  - Quarantine protocol
  - Vector control protocol
  - Weekly forecast updates
- EWS closer to empowering decision makers

EMPRES WATCH

emergency prevention systems

Climate models predict increased risk of precipitations in the Horn of Africa for end of 2008

FAO and WHO warn countries in Africa and the Arabian Peninsula that Rift Valley Fever may strike again at the end of 2008

1. INTRODUCTION

Rift Valley Fever (RVF) is an arthropod-borne viral disease associated with high rates of abortion and neonatal mortality in ruminants and influenza-like illness in humans that may progress to neurologic, ocular, or hemorrhagic disease and death. The vast majority of human infections result from direct or indirect contact with the blood or organs of infected animals. Human infections have also resulted from the bites of infected mosquitoes. Ruminant infections occur in areas of high competent vector populations. Adult animals may be asymptomatic or develop mild disease that is typically first noted with the occurrence of abortions in the flock but some breeds, especially local ones, are more resistant to disease. Neonatal and young animals are more severely affected with a high mortality rate. The disease is transmitted by several different types of arthropod vectors (*Culex*, *Aedes*, *Anopheles*, *Mansonia*, *Eretmapodites*, *Culicoïdes*), with mosquitoes of the *Aedes* genus serving as the virus reservoir in nature through transovarial transmission. These infected eggs can survive through years of drought or desiccation. During increased precipitation, low-lying mosquito-breeding habitats are flooded, and the reservoir vectors re-emerge. Then the virus is amplified in domestic ruminant hosts, additional arthropod species can transmit the virus to other susceptible hosts including man. This increase of viral activity initiates a rapid spread of the disease.

RVF has been documented in most sub-Saharan African countries, as well as Egypt and the Arabian Peninsula. The virus occurs in a variety of ecotypes and can spread to new geographic areas with animal movement. Previously affected areas must be considered endemic. In rainforest ecological zone, such as central African countries, the disease can be observed regularly with low incidence of disease. In semi-arid and arid regions of the Horn of Africa, large epidemics of RVF occur following periods of unusually high rainfall and flooding in 5 to 15 year cycles that have been associated with global climatic events and especially El Niño. Once spread to a new area, RVF can cause significant disease and economic loss in an immunologically naïve animal population. This scenario has occurred several times in newly affected areas, such as the emergence of RVF in 1977 in Egypt or in 2000 in the Arabian Peninsula.

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2. CLIMATIC FORECASTING OF DISEASE

The disease ecology of RVF in East Africa has been extensively studied. Following a period of persistent, heavy rainfall, the breeding habitats of *Aedes* floodwater species, such as the temporary ground pools known as *dambos* in Kenya, become flooded and promote the hatching of mosquito eggs. Eggs lain by RVF infected females harbour the virus and produce adult mosquitoes capable of infecting vertebrate hosts and propagating disease outbreak.

Historical data regarding sea-surface temperatures (SST) have found an association between anomalous SST, where the difference between weekly SST and historical average SSTs is measured, and heavy rainfall in East Africa. Concurrent positive western Indian Ocean SST anomalies and equatorial Pacific SST anomalies have occurred in conjunction with significant disease outbreaks in 1982-3, 1997-8, and 2006-7. Such events have also been associated with *El Niño* events and more recently with a positive Indian Ocean Dipole (IOD) event, which may occur in concert with or independent of an *El Niño* event. A positive IOD occurs when the Western Indian Ocean experiences abnormally high sea-surface temperatures and the Eastern Indian Ocean shows abnormally low sea-surface temperatures, causing a change in tradewind patterns to concentrate precipitation over the North Western Indian Ocean and bordering land areas (Figure 1). Such positive IOD events have been linked to prolonged heavy rainfall in East Africa and subsequent positive anomalies in vegetation indices, leading to disease outbreaks of Rift Valley Fever due to a surge in vector populations in flooded areas.

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