WORLD ORGANISATION FOR ANIMAL HEALTH

REPORT

REGIONAL SEMINAR

"Re-emergence of Rift Valley Fever in Southern Africa : how to better predict and respond"

16.02.2009 – 18.02.2009

Bloemfontein ▼ South Africa

OIE Sub-regional representation for Southern Africa

Gaborone ▲ Botswana

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World Organisation for Animal Health OIE
12, rue de Prony
75017 P A R I S FRANCE

oie@oie.int www.oie.int

Sub-Regional Representation for Southern Africa
BK House (first floor) Plot 1270
Old Lobatse Road
P.o.box 25662
G A B O R O N E BOTSWANA

+ 267 391 44 24 + 267 391 44 17 (fax)

srr.southern-africa@oie.int www.rr-africa.oie.int

ACRONYMS

ABADRL	Arthropod - Borne Animal Diseases Research Laboratory [USDA – ARS]
AFSSA	Agence Française de sécurité sanitaire des aliments [France]
AGAH	Agriculture – Animal Health Division [FAO]
AGID	Agar-Gel Immuno-Diffusion test
APHIS	Animal and Plant Health Inspection Service [USDA]
ARC	Agricultural Research Council [South Africa]
ARS	Agricultural Research Service [USDA]
ASF	African Swine Fever
AU	African Union
AU-IBAR	African Union – Interafrican Bureau for Animal Resources
BHV_1	Bovine Herpes Virus type 1
BP	Base Pair
BSL	Bio-Safety Level
BVD/MD	Bovine Viral Diarrhoea / Mucosal Disease
CBPP	Contagious Bovine Pleuro-Pneumonia
CDC	Centres for Disease Control and Prevention (US)
CI	Confidence interval
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement [France]
CRVOI	Centre de Recherche et de Veille sur les maladies émergentes dans l'Océan Indien [Réunion]
DfID	Department of International Development [United Kingdom]
DG-SANCO	Health and Consumer Directorate General [EC]
DNA	Deoxyribo-Nucleic Acid
DoA	Department of Agriculture [South Africa]
DVS	Department of Veterinary Services
EC	European Commission
ECTAD	Emergency Centre for Trans-boundary Animal Diseases [FAO]
EISMV	Ecole Inter-états de Science et Médecine Vétérinaires [Senegal]
ELISA	Enzyme Linked Immuno-Sorbent Assay
EMPRES	Emergency Prevention System for animal and plant pests and diseases [FAO]
ENSO	El Niño Southern Oscillation
EU	European Union
EUR	Euro
FANR	Food, Agriculture and Natural Resources directorate [SADC]
FAO	Food and Agriculture Organisation [United Nations]
FMD	Foot and Mouth Disease
GALVMed	Global Alliance for Livestock Veterinary Medicines
GDP	Gross Domestic Product
GF-TAD	Global Framework for the progressive control of Trans-boundary Animal Disease
GLEWS	Global Early Warning System
HA	Haemagglutination
HAI	Haemagglutination Inhibition
HPAI	Highly Pathogenic Avian Influenza
IBAR	Interafrican Bureau for Animal Resources [AU]
IF	Immuno-fluorescence
IFOS	Optical Fiber Immune-Sensors
ILRI	International Livestock Research Institute [Kenya]
IMP	Immuno-peroxidase test
IPCC	International Panel on Climate Change [United Nations]
IRD	Institut de Recherche pour le Développement [France]
ISRA	Institut Sénégalais de la Recherche Agronomique [Senegal]
KSA	Kingdom of Saudi Arabia
LNERV	Laboratoire National d'Elevage et de Recherche Vétérinaire [ISRA]
LSD	Lumpy Skin Disease
LSDV	LSD Virus
NASA	National Aeronautics and Space Administration [USA]
NDVI	Normalized Difference Vegetation Index
NGO	Non-Governmental Organisation
NICD	National Institute for Communicable Diseases [South Africa]
NRC	National Reference Centre [Madagascar]
OBP	Onderstepoort Biological products [South Africa]
OIE	World Organisation for Animal Health

OR	Odds ratio
OVI	Onderstepoort Veterinary Institute [ARC]
PACE	Pan-African Control of Epizootics programme
PARC	Pan-African Rinderpest Campaign
PCR	Polymerase Chain Reaction
PVS	Provincial Veterinary Service(s)
PVS	Performance of Veterinary Services [OIE]
RAHC	Regional Animal Health Centre
RIFT-OI	Fièvre de la Vallée du Rift (Rift Valley Fever) – Océan Indien (Indian Ocean)
RNA	Ribo-Nucleic Acid
RP-PCP	Research Platform – Production and Conservation in Partnership
RT-LAMP	Reverse Transcription - Loop-Mediated Isothermal Amplification
RT-PCR	Reverse Transcriptase PCR
RVF	Rift Valley Fever
RVFV	RVF Virus
SADC	Southern African Development Community
SAHSP	Somali Animal Health Services Project [Somalia]
SMLVV	Smithburn modified live virus vaccine
SOP	Standard Operating Procedure
SPS	[Agreement on the application of] Sanitary and Phytosantory Standards [WTO]
SRB	Senegal River Basin
SRR	Sub-Regional Representation [OIE]
SWALIM	Somali Water and Land Information Management project
TAD	Trans-boundary Animal Disease(s)
TCP	Technical Cooperation Programme [FAO]
UAE	United Arab Emirates
USD	United States Dollar
USDA	United States Department of Agriculture [USA]
USA	United States of America
VNT	Virus Neutralisation Test
WAHID	World Animal Health Information Database [OIE]
WAHIS	World Animal Health Information System [OIE]
WHO	World Health Orgnaisation [United Nations]
WTO	World Trade Organisation
ZAR	South African Rand

DISCLAIMER

All weight units expressed in tonnes are metric tons.
All distance and surface area units are expressed in metric units (km and km²)

Edited by Patrick Bastiaensen & Lea Knopf.

12, rue de Prony, 75017 Paris, France

"RE-EMERGENCE OF RIFT VALLEY FEVER IN SOUTHERN AFRICA : HOW TO BETTER PREDICT AND RESPOND"

INTRODUCTION

Since 2006, the *World Organisation for Animal Health* (OIE) is represented in Southern Africa through the establishment of a Sub-regional Representation, based in Gaborone, Botswana. Since late 2007, this office has conducted a series of seminars on capacity building on international standards for veterinary services in the framework of the *SADC - EU Grant Contribution Agreement with the OIE*.

The present seminar, with the title *"Re-emergence of Rift Valley Fever in Southern Africa : how to better predict and respond"*, intended to focus on the apparent recrudescence of the disease in southern Africa since the beginning of the new millennium, and was held in Bloemfontein, in the Free State province of South Africa from February 16th to 18th, 2009.

The seminar was organised in close collaboration with the FAO, in particular its ECTAD *Regional Animal Health Centre* in Gaborone (Southern Africa) and the technical services of FAO-headquarters in Rome (EMPRES) and was attended by 80 delegates from national veterinary and public health services from 18 southern and eastern African and Indian Ocean countries, as well as representatives from regional and international organisations, such as AU-IBAR, FAO, GALVMed, OIE, universities and research centres (ARC-OVI, CIRAD, ILRI, *Institut Pasteur,* IZS, NASA, NICD, UFS, USDA-ARS....*)* and industry representatives (Deltamune, OBP). The meeting was also enriched by contributions from affected countries in West (Senegal) and North (Somalia) Africa, as well as the Middle-East (Yemen).

Participants and guests of honour at the opening ceremony of the OIE seminar © A. Fischer (Kingfischer cc.)

The objective of the seminar was to support a broad consensus between international and regional technical agencies, the main regional economic community (SADC), research centres, diagnostic laboratory facilities, vaccine producers, national veterinary services and public health services, on a regional cross-sectoral approach for a better control, detection and reporting of the disease in animals and humans, based on the epidemiological status (endemic or epidemic) in the various countries.

Repeated failure by national veterinary services to detect disease outbreaks in livestock at an early stage, frequent misdiagnosis, underreporting, limited resources as well as insufficient contingency planning have demonstrated that there is an apparent lack of capacity in some countries to deal with this disease, whether from an enzootic or epizootic viewpoint.

The second objective of the workshop was to identify existing gaps in capacity and opportunities for inter-regional collaboration.

While efficient vaccines are available for prophylactic purposes in animals, the erratic nature of outbreaks makes it almost impossible to predict where and when RVF will hit next. Issues of wildlife reservoirs, teratogenic effects in certain vaccines (and hence low acceptance by farmers) and sub-clinical virus circulation during inter-epizootic phases further complicates the choices for control-tools.

In southern Africa, early warning systems based on correlation with climatic data are less efficient to predict outbreaks (in time and in space) than in the horn of Africa. Surveillance using sentinel animals and herds requires careful and frequent testing of sero-conversion for IgM antibodies. Vector-monitoring (as conducted e.g. in Madagascar in the past) is time-consuming and requires massive numbers of samples due to the very low infection rates in vectors.

A third objective was to enhance the awareness for the development of tools that are urgently needed for a better control of RVF. In terms of diagnostics for example, it is commonly agreed that the development of a rapid test that could be used on the field is a high priority; the development of improved human prophylactic methods is another one.

This document is a compilation of abstracts, based on presentations made by country representatives and invited regional and international experts.

The recommendations of the seminar can be found on page 61 and can be downloaded from the OIE Africa website (www.rr-africa.oie.int), along with the presentations made during the seminar (www.rr-africa.oie.int/en/en_index_annex19.html).

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WELCOMING ADDRESS BY THE OIE SUB-REGIONAL REPRESENTATIVE FOR SOUTHERN AFRICA

Bonaventure J. Mtei

Guests of honour,

Distinguished guests, speakers and participants

Ladies and gentlemen

It is my pleasure and honour, on behalf of the Director General of the OIE and on my own behalf to welcome you to this important meeting on Rift Valley Fever (RVF) in Southern Africa.

Allow me in the first place to thank you most sincerely for accepting OIE's invitation to be here. I also like to express OIE's gratitude to the Government of South Africa through the Department of Agriculture for its generosity to host this meeting and to you Honourable Minister for accepting to come and officiate this opening session.

This is by no means the first meeting of this kind in Africa. Similar workshops and seminars have been held to address RVF problems in Northern, Western and Eastern Africa. OIE wants this meeting to be different. It brings experts from these previous meetings to share their knowledge on this disease with Southern African experts where RVF is re-emerging and posing a threat to both animal and human health; hence the theme of the workshop …. *"to better predict and respond"*.

As you all know RVF virus (RVFV) was first isolated in Kenya in the 1930's and since then it has been associated with substantial peri-natal mortalities and abortions in ruminants in Africa as well as in the Middle East. Epizootics occur periodically after heavy rains allowing the primary vector and reservoir mosquitoes to hatch. The association between climate change and RVF outbreaks is now widely accepted and is a subject for further scientific investigation. It is widely predicted that climate extremes (e.g. drought, floods) will become more frequent and it is possible, therefore, that significant epizootics of vector-borne diseases, such as RVF, could become more common in parts of Africa and Southern Africa for that matter.

High levels of viraemia in animals lead to infection of secondary arthropod vector species with virus amplification in animals and finally collateral infection in humans. It is very unfortunate that in most of the RVF outbreaks so far, humans act as sentinels; a clear indication of failure of national veterinary services to detect the disease in animals at an early stage. Humans normally suffer mild febrile illness, but between 1-2% of infections may be fatal as a result of haemorrhagic fever and or encephalitis. A significantly large proportion of patients end up developing retinitis, with a possibly of losing vision.

In Kenya and Tanzania, more people have died from the 2006 – 2007 RVF epidemic alone, than from human cases of H_5N_1-type avian influenza worldwide over the past 5 years. This does not render avian and human influenza less important, but it justifies putting RVF high on our list of priority diseases

I can therefore not over emphasize the importance of RVF, not only as a zoonosis, but also in terms of its impact on trade of ruminants and subsequent loss of income for livestock owners in affected areas. All the evidence collected to date suggests that there is a change in risk factors favouring outbreaks of RVF in uninfected areas in Southern Africa; hence the need to develop and implement appropriate surveillance systems for early warning and rapid response programmes.

The negative impact of RVF can significantly be alleviated if countries are capacitated through good veterinary governance as per OIE standards and guidelines to develop and apply sanitary measures for disease control and prevention to satisfy the appropriate level of sanitary protection.

RVF interventions in Southern Africa will inevitably require a common approach from national, regional and international organisations. OIE, together with its partners, FAO, WHO and AU-IBAR we are committed to provide technical support to SADC Secretariat and SADC Member States in developing models based on risk parameters, including agro-meteorological data to forecast potential RVFV activities.

Partnerships, collaboration and communication between OIE, FAO and WHO and national veterinary and public health authorities should improve and maintain surveillance of RVF to detect the disease in animals followed by rapid actions to stop further spread and protect humans from being infected.

The research community at large, as well as the pharmaceutical industry, must pursue the development of more and better vaccines, drugs and diagnostics. Ironically, the fact that RVF is now not only threatening Africa and the Middle-East, but also Europe, seems to favour renewed scientific interest in the disease and renewed funding efforts on behalf of governments and donor-institutions.

As a Representative of the OIE, I must also insist on the Member States' compliance to their obligations on animal disease reporting by promptly notifying all outbreaks of RVF to the OIE as part of the *World Animal Health Information System* (WAHIS).

Let me finish by acknowledging the support of the European Commission, which through the *European Development Fund* (EDF) is helping the OIE strengthen the technical capabilities and capacities of veterinary services in this part of the world. As much as this is a scientific forum for exchange of ideas on how to tackle this disease, from the OIE's point of view it also serves as a capacity-building exercice and we would want every senior veterinary official in this room to leave Bloemfontein on Wednesday with a profound understanding of the disease, its prevention and control.

Let me also thank and name the numerous organisations which fielded their experts to this meeting at their own expense : the Department of Agriculture of South Africa, the Food and Agriculture Organisation, GALVMED, Institut Pasteur in Paris, *Istituto Zooprofilattico Sperimentale* in Teramo, the International Livestock Research Institute ILRI, the Onderstepoort Veterinary Institute OVI and Onderstepoort Biological Products, the SADC Secretariat and the United States Department of Agriculture.

We highly appreciate your support in turning this meeting into a success despite the short notice given.

My last words are directed to the representatives of the donor community and the bilateral and multilateral cooperation agencies: finding a cure is one thing, administering it to a large number of patients is still another, and requires considerable technical, logistic and financial support. I cannot predict at this stage of the meeting, what participants will recommend as a way forward to better predict and respond to this disease, but I would be surprised if it wouldn't include an appeal for renewed mobilisation of national and external financial resources to fight RVF and I hope that when the time comes, we will be able to count on your support.

Once again I thank you all for be being here and thank you for your attention.

OPENING ADDRESS BY THE FAO RESIDENT REPRESENTATIVE TO THE REPUBLIC OF SOUTH AFRICA

Rosebud Kurwijila

Distinguished Guests and Excellencies,

This workshop is a unique occasion to bring together expertise from many different disciplines and from many different places around the globe to discuss here together the way forward for prevention and control of RVF, a threat to the Southern African Region and beyond.

As FAO Representative for South Africa, I am very pleased that this meeting takes place in Bloemfontein, since South Africa is one of the few countries in the SADC region that has experienced a disease outbreak in 2008. Though the Veterinary Services have managed well to control the problem, it has become only too evident that little is known about the threat of this disease in the region.

This workshop is also a very good opportunity to demonstrate the close collaboration between OIE and FAO on this important topic. This collaboration falls squarely into the global agreements made between OIE and FAO, such as the *Global Framework for the progressive control of Transboundary Animal Diseases,* in short GF-TADs and the *Global Early Warning and Response System* for major Animal Diseases including Zoonoses, in short GLEWS, in which WHO is also a partner.

Both agreements are very relevant for the subject of this workshop as GF-TADs wishes to strengthen regional approaches to TADs control and GLEWS provides the high-tech tools for early warning systems. This workshop can therefore be seen as a contribution to implementation of both agreements.

More so, the collaboration that takes place regularly between headquarters of our organisations, has now been decentralised in the form of the *Regional Animal Health Centres*, set up in different regions of the continent and in Gaborone, Botswana for Southern Africa. This Centre comprises of representatives and senior animal health experts from FAO, OIE and AU-IBAR. The conceptualisation and organisation of this workshop is one of the Centre's outputs and is surely appreciated.

Given the separation and synergies of mandates on animal health issues for OIE and FAO, the FAO has been one of the major partners in addressing RVF as a threat in the region and beyond.

Looking back over the past 2.5 years, FAO through its own TCP funding alone made USD 1.1 million available to Kenya, Sudan and Madagascar for emergency interventions in affected countries.

FAO also implemented donor funded projects to the tune of USD 3.8 million in Madagascar, East Africa, Somalia, Sudan and Tanzania for projects of short (just 3 months) to medium (1.5 year) duration.

You will certainly notice that these interventions are more of a fire brigade action and are mainly designed to help to cope with an outbreak situation.

Given all the experience available between the 2 organisations and the implementation experience gathered through these projects, it appears opportune to now request for a medium to long term approach for the Southern African region, which, in my understanding, is under threat but not yet extensively affected. Therefore the main focus should be on early warning and prevention rather than fire brigade type emergency control.

It is my understanding that all your deliberations and recommendations resulting from this workshop will be integrated into a proposed framework, already prepared by the colleagues from OIE and FAO, so that we can make utmost use of this wealth of expertise represented by the delegates to this meeting.

I wish you good deliberations.

OPENING ADDRESS BY THE REPRESENTATIVE OF THE MINISTER OF AGRICULTURE AND LAND AFFAIRS OF THE REPUBLIC OF SOUTH AFRICA

Botlhe Michael Modisane

Programme Director,
Representative of AU-IBAR,
Representatives of the OIE,
Representative of FAO,
Representative of the European Commission,
Representative of the Executive Secretary of SADC,
Delegates from SADC Member States,
Ladies and gentlemen,
All protocol observed,

The Minister of Agriculture and Land Affaires would have loved to open this workshop. She is unfortunately not able to be with us today due to other engagements. The workshops come at a time when South Africans are readying themselves for the fourth democratic elections and a couple of days after both the state of the Nation address by President Kgalema Motlanthe and the budget speech by the Minister of finance. It is also coming at a time after of a great happening in Zimbabwe, the swearing in of the Prime Minister and other cabinet members. All will be well in Africa.

I welcome you all on behalf of the Republic of South Africa and my department.

Ladies and gentlemen,

In our endeavours to manage and control animal diseases, we need leadership, clear objectives, strategy and regular communication of empowering information so as to lead to improved or enhanced human resources to do the job. Although many of these are already in place, it is necessary to ensure continued common understanding of concepts to consolidate our knowledge for future use. Both agriculture and conservation has been identified as major regional drivers of economic development. Livestock is one of the key components of integrated agriculture in our continent as it contributes significantly to rural livelihoods of many households. These livelihoods were fragile during the past few years.

These years were characterized by soaring oil and food price and rapidly rising living standards. There have also been droughts, floods, *veld* fires and other adverse weather conditions. The production and productivity of livestock for most agro-pastoralists and pastoralists has been constrained by re-emergence and continued occurrence of many diseases one of which is the subject of discussion today.

We have seen oil prices falling recently, but however the price of food has not necessarily followed. Recently however, we experienced another serious challenge, a global financial crises which continues to pound on the rural poor. Livestock continues to be more important, and the leadership that we alluded to earlier becomes even more critical.

We therefore need to take the animal health sector forward in a coordinated manner in order to:

- strengthen disease surveillance and diagnostics;
- develop much-needed capacity in human and veterinary health systems;
- ensure the availability of veterinary medicines and vaccines;
- increase public awareness; and
- address social and economic impacts – particularly in countries that are at especially high risk of disease infection and that have the greatest resource needs.

In his opening address of the 75th General Assembly, Dr Barry O'Neill stressed that the OIE cannot be a purely veterinary organisation, and that to succeed we need expert scientists from many disciplines including food safety, fish and bee experts, wildlife experts, and animal welfare experts. Considering the important topic to be discussed this week, I believe that this principle will applied since the emergence and re-emergence of diseases could be influenced by many factors, including as I believe we all know, climate change.

I know surely that veterinarians will be in the majority and in the spirit of governance, would also believe that a wide spectrum of veterinary professionals will be participating.

The subject for our coming together is very interesting and needs to be looked into with an open mind.

We are faced with many challenges in our endeavours to manage animal diseases for the benefit of man environment and animals. Some pathogens adapt to our interventions, the environment changes nullifying our interventions or making them less effective. The survival of vectors that help carry some of the pathogens is somehow favoured by the changing environment whereas transport systems improve, carrying some pathogens much further and much faster than the times they take to manifest under normal circumstances. For some reasons the pathogens that where known to be under control re-appear sometimes with much more determination to cause damage than they were known to cause.

Some apparent return in damage causing ability can sometimes be attributed to the tendency of our collective beings to forget how to respond to invasion, but some need some thorough understanding and knowledge sharing as it is now going to happen at this workshop.

Common understanding of animal diseases and regional approaches to control them is important. The bi-directional transmission of some infectious diseases between wild life and domesticated animals is an important component of the triangular interface between human/livestock and wild life, and this is a significant point to take into consideration in disease control.

Our approach to diseases control has led many countries to continue to impose excessive and unjustifiable import barriers due to outbreaks of diseases. This has contributed to unnecessary increase of price for animal products that would have contributed to better nutrition. It is therefore important that this aspect also be discussed.

It is important that disease control measures be harmonised and it is in this common understanding that harmonisation will be made very simple. As the environment changes and the vectors adapt their way of life and the pathogens change, we must become better in our endeavours to manage and control all these factors. The collective of our thinking and strategy formulation will without doubt be our best weapon

To focus a little on the programme, interesting topics will be discussed particularly issues around regional approaches, vaccines, diagnosis and trade. It is my understanding that similar workshops have been held in Dakar and Cairo to particularly look at the challenge of re-emergence of RVF. I believe that the experiences and outcome of those interactions will be shared in this workshop and that in the end, clear action plans to deal with this disease will be in place.

I take this opportunity to thank the OIE Sub-Regional Representation for choosing South Africa, particularly this province, which happens to be one of the major agricultural provinces of this country, to host this workshop.

In conclusion I once more welcome you all and believe that we will have fruitful discussions.

KEY NOTE ADDRESS
RE-EMERGENCE OF RIFT VALLEY FEVER IN SOUTHERN AFRICA : HOW TO BETTER PREDICT AND RESPOND ?

Robert Swanepoel

Special Pathogens Unit, National Institute for Communicable Diseases
Sandringham, South Africa

Regarding the title of the seminar, it is debatable whether RVF is actually re-emerging in Southern Africa: since there has been inadequate monitoring one could argue that there is no scientific evidence that it ever disappeared. Likewise, improving prediction of and response to RVF outbreaks is probably not the best way forward.

A short history of RVF. Between 1910 and 1912, a disease compatible with RVF was described in European breed lambs in the Rift Valley of Kenya, and the virus was first isolated in 1930 from an outbreak of disease in sheep in the same area. It was observed that outbreaks followed heavy rains and that concurrent disease occurred in humans, characterized by transient loss of visual acuity. It was also demonstrated that the disease was transmitted by mosquitoes. Subsequently, the disease and the virus were recognized in many parts of sub-Saharan African, including countries outside the Rift Valley ecosystem. In 1944, an American arbovirologist, Dr K.C. Smithburn, working at what was the *Entebbe Virus Research Laboratory* in Uganda, obtained two isolates of RVF virus from mosquitoes collected in Semliki Forest, in the absence of livestock and human settlements. This led to the hypothesis that RVF is endemic in forests and only spreads to grasslands, and hence livestock and human settlements, after heavy rains. The hypothesis remains partly valid, although it has become clear that the virus is also endemic in livestock rearing areas. Dr Smithburn serially passaged one of his isolates intraperitoneally in mice to give rise to the so-called KCS strain which retained its 'pantropic' properties, and in parallel passaged the same isolate 82 times intra-cerebrally in mice, to give rise to the Smithburn neuro-adapted strain, which was subsequently used for the production of modified live virus vaccine after 106 mouse passes. The *Smithburn modified live virus vaccine* (SMLVV) is only partially attenuated and is known to be abortigenic or teratogenic in about 5-15% of pregnant sheep.

In 1950–1951, there was a large outbreak of RVF in South Africa, associated with the 'panveld', sheep farming areas on the inland plateau where undrained depressions become flooded after heavy rains. The same occurred in 1974–76, when rainfall was again exceptional. It is interesting to note that the town of Bloemfontein, where the present seminar is being hosted, played an important role in the 1974–76 outbreak, as it is here that patients suffering from hemorrhagic disease were diagnosed as being infected with RVF virus, constituting the first recognition that the disease could be fatal in humans (although there had been a death following an accidental laboratory infection in 1934 which was not ascribed directly to the effects of the virus).

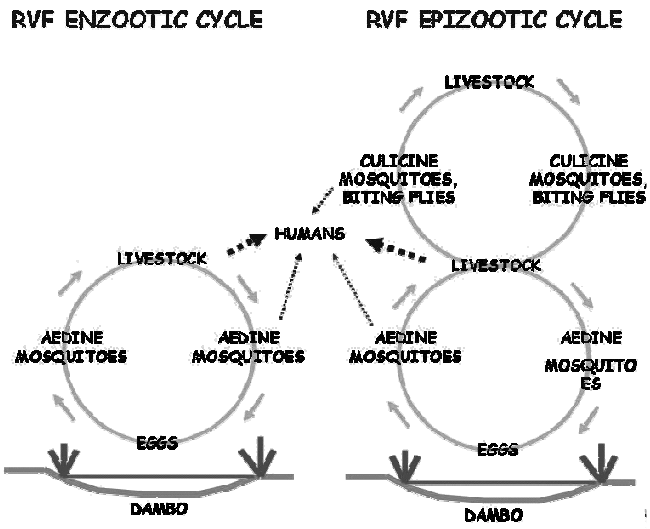
In 1977–1978, the disease was noted to extend beyond sub-Saharan Africa for the first time when more than 200,000 people became infected in Egypt (based on sero-conversion) and nearly 600 patients died. The mortality rate under these circumstances was therefore around 0.3%. Lately health authorities have been reporting mortality rates of up to 40% which seem to be incompatible with the known features of the disease, and are probably due to the fact that only clinical (hospitalized) cases are as used as denominators for the calculations.

In 2000–2001 the disease was recognized outside of Africa and Madagascar for the first time, on the Arabian Peninsula (Saudi Arabia and Yemen) after heavy rains had occurred in the south-west of the peninsula. There had been a large outbreak of RVF in the horn of Africa in 1997–98 and it seems likely that infected animals were exported to the Arabian Peninsula where the infection smouldered in livestock until conditions suitable for an outbreak occurred in 2000.

Epidemiology of RVF. From data collected in Zimbabwe over the 24 years from 1955–1979 (17,000 serum samples and 4,000 virological specimens from 2,354 locations were tested for RVF) it emerged that even in inter-epidemic periods (e.g. the 7 years from 1971–1978) RVF virus circulated every single year within an identifiable endemic area, despite the absence of clinical suspicion reported by farmers or veterinary surgeons. The endemic area, covering the savannah/grasslands, mainly on the central watershed plateau, shows strong correlation with the presence of poorly drained shallow depressions ("*dambos*"), which flood seasonally, and not with the presence of canopy forests as observed in aerial photographs. The endemicity, as was earlier demonstrated in South Africa (1959) and later in Kenya (1985), is probably associated with transovarial transmission of virus in flood-water breeding *Aedes* mosquitoes.

This brings us to the vectors of RVF, of which there are essentially two types:

- Enzootic (endemic) vectors, which are flood-water breeding *Aedes* species (not all *Aedes* species breed in flood water) which lay their eggs in the mud bordering flooded *dambos*. The eggs require a degree of drying (protected by the mud) in order to hatch when the *dambo* is again flooded. Such eggs may survive for years in dry mud and will hatch and produce adults within 5-10 days after rainfall floods the *dambos*. The long-surviving infected eggs are thought to account for the perpetuation of the virus between outbreaks.
- Epizootic (epidemic) vectors, which are mostly *Culex* species and biting flies which acquire virus by taking blood meals from infected (viraemic) livestock and sustain the outbreak by transmitting the virus.



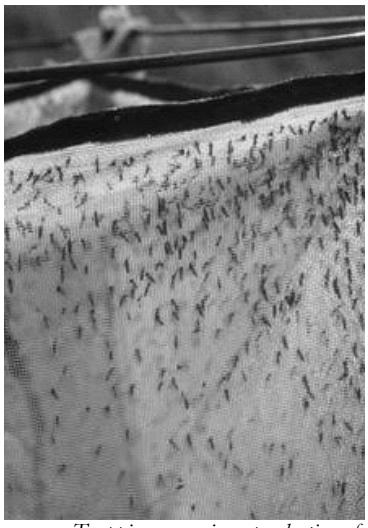
The Free State Province, of which Bloemfontein is the capital, is a perfect example of such breeding grounds for aedine mosquitoes, where broad, shallow pans which are prone to flooding after heavy rains, provide extensive areas for deposition of mosquito eggs. It is important to note that South Africa is at the southernmost limit of the distribution of RVF (because of the relatively cool climate with cold winters, and prolonged droughts). It is in these borderline areas of distribution of the virus that the most explosive outbreaks of the disease tend to occur, probably because herd immunity is lost during the prolonged dry periods when virus activity is minimal.

The two cycles contributing to perpetuation of RVF virus and the generation of outbreaks © NICD (South Africa)

A cross-section of Kenya, extending from the Rift Valley highlands down to the coastline, varies from humid forest vegetation, through extensive bush savanna, to grassland, and semi-desert areas, to coastal bush vegetation. In this cross-section, RVF varies from an endemic, annually-recurring infection with few clinical cases observed, to a less frequent, more epidemic pattern of disease with long inter-epidemic intervals as the environment becomes drier This was demonstrated by, amongst others, Dr Glyn Davies who collated the RVF virus isolations and outbreaks in Kenya according to eco-geographic zones.

	Eco-zone				
Year	**II**	**III**	**IV**	**V**	**VI**
1961	RVF	RVF	RVF	RVF	RVF
1962	RVF	RVF	RVF	RVF	
1963	RVF	RVF			
1967	RVF	RVF	RVF		
1968	RVF	RVF	RVF		
1971	RVF				
1977	RVF	RVF	RVF	RVF	
1978	RVF	RVF			
1981	RVF				
1983	RVF	RVF	RVF		
1989	RVF	RVF	RVF		
1990	RVF	RVF	RVF		
1993	RVF	RVF	RVF		
1994	RVF	RVF			
1997	RVF	RVF	RVF	RVF	RVF
1998	RVF	RVF	RVF	RVF	RVF

Table 1. Detection of RVF virus activity in Kenya between 1961 and 1998, according to eco-geographic zone
© FAO/Glyn Davies



Trapping : massive reproduction of mosquitoes during the 1997 – 1998 outbreaks in Kenya and Somalia © NICD (South Africa)

We can conclude that RVF is endemic is many countries in Africa. From phylogenetic analysis of RVF isolates collected over more than 60 years, it is evident that epidemics arise in one of two ways : (a) there is introduction and spread of a single new strain of virus following heavy rains in areas where the disease is absent or previous strains appear to have died out after decades of prolonged drought, or (b) there is simultaneous re-emergence of multiple strains of transovarially transmitted virus in mosquitoes which hatch after heavy rains in endemic areas. The maximum duration of survival of mosquito eggs in mud or in the soil remains unknown, and hence it is difficult to predict whether the outbreaks of 1976 on South Africa's highveld are likely to reoccur even after 33 years, or whether there has to be progressive re-introduction of the vectors and virus onto the inland plateau, as appears to be occurring from the recent minor outbreaks recorded in the east of the country.

Prediction of outbreaks. Prediction of outbreaks is usually based on remote sensing (satellite imaging) with derivation of rainfall and vegetation indices. However, within 20 days of heavy rains occurring the endemic mosquitoes have flown, fed and laid eggs, and the outbreak is being perpetuated by epidemic/secondary vectors. Meanwhile, there is often considerable delay before warnings reach the relevant veterinary authorities, who in any event may be under-resourced and already committed to annual campaigns such as FMD vaccination. Response is further hampered by the nomadic pastoral system practiced in large tracts of Africa, by inherent mistrust of any government intervention, and by floods which further compromise an already poor transport infrastructure. Most important, supplies of vaccine are invariably limited with a lead time of up to 4 months for preparation, testing and delivery of new batches. In 1973, a mere 13,000 doses of RVF vaccine were sold in South Africa, yet during the outbreak of 1974 – 1976 more than 23 million doses were sold, with devastating consequences primarily due to the teratogenic effects of the SMLVV used. Ironically, there has been no evidence that vaccination alleviated this or any other outbreak of RVF. However, there is usually intense public pressure to vaccinate during epidemics and state authorities have no option but to comply, despite the fact that this usually occurs too late to be of any use, and indeed carries the risk of spread of wild virus by needle. In order to lengthen the early-warning period to 3-5 months there has been a move towards predicting future occurrence of abnormal rainfall based the observation of *El Niño Southern Oceans* (ENSO) temperature oscillations phenomena, but the system is still in process of perfection.

Remote sensing could not have predicted the 1969 outbreak in Zimbabwe when rainfall was below average for the year, but heavy rains which fell twice were sufficient to flood mosquito breeding sites, leading to one of the largest epidemics on record. In 2001–2002, FAO/EMPRES launched an alert for East Africa, but no outbreaks were observed to occur, with consequent loss of credibility for the system. Consequently, health and veterinary authorities probably did not take the next alert in 2006 seriously enough, although they were also hampered by the difficulties enumerated above.

Early recognition and confirmation of outbreaks. Veterinary surveillance, and to a greater extent vector surveillance, are neglected in most countries. Livestock owners and veterinary officials should be alerted to outbreaks by the occurrence of abortion in pregnant livestock (sheep cattle and goats) and deaths of young animals following heavy rains, often accompanied by disease in humans:

Clinical signs in young animals:

- Sudden onset of high fever
- Acute prostration, collapse and death

Clinical signs in adult animals:

- Abortion is the most important sign
- Dystocia, some teratology, hydrops amnii
- Anorexia, dysgalactia, nasal and lachrymal discharges
- Salivation, "vomiting", lymphadenitis
- Colic, haemorragic enteritis, sometimes jaundice

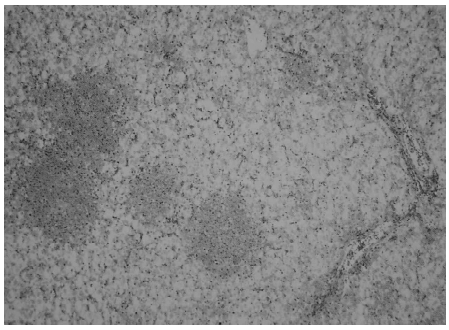
Sheep are the most susceptible species, followed by cattle and goats. Camels are least susceptible, with abortions often being the only clinical sign. The disease is usually most severe in exotic breeds, with indigenous animals being less susceptible, except in arid zones where major epizootics occur. Morbidity varies from 20–90%, and mortality from 40–60% in young animals and 2–5% in adults.
Often the disease in livestock is initially overlooked and the occurrence of an outbreak of RVF is first recognized in humans:

Clinical signs in humans:

- Humans are infected by contact with diseased animal tissues or through mosquito bites (less common in sub-Saharan Africa where vectors are sylvatic and do not usually enter dwellings)
- Incubation period : less than 1 week
- 80% of infections are subclinical or mild
- Less than 0.5% are fatal (hemorrhagic fever, encephalitis)
- Ocular sequelae occur in approximately 5% of cases.

There are several approaches to confirming the diagnosis, but biosafety practices should be borne in mind:

- Anatomical pathology
- Antigen detection (AGID, ELISA, IF)
- RT-PCR detection of viral RNA
- Virus isolation (mouse inoculation, TC)
- Antibody tests (Serology) (HAI, VNT, ELISA IgG and ELISA IgM)
- Histopathology and immunohistochemistry



Pathognomic liver necrosis with primary foci
© Jacobus A.W. Coetzer (U.P. South Africa)

New diagnostic tools under development include the *Loop-Mediated Isothermal Amplification* (RT-LAMP), with results readable by the naked eye, fluorescence, agarose gel electrophoresis or turbidimeter. Also under development are *optical fiber immune-sensors* (IFOS), which will enable pen-side tests to be conducted for an array of viruses, including RVF, using very small quantities of serum, secretions or liver homogenate.

Conclusions. Based on the assumption that RVF virus is probably widely endemic in Africa and circulating at low levels with occasional clinical outbreaks, predicting and responding to epidemics does not make much sense. Many of the worst affected countries, particularly in the horn of Africa, rely heavily on export of slaughter animals. Can one guarantee importing countries that there is zero risk of introducing infected animals during inter-epizootic periods? However sophisticated the early warning systems in use, whether based on remote sensing of climate patterns or sero-surveillance, response invariably occurs too late and has always proved to be ineffective.

What is needed is strategic vaccination, preferably with a new and safer vaccine. There are promising candidates including Clone 13 and its derivative R566, plus vaccines developed by recombinant or reverse genetics technology. These vaccines have the advantage that they incorporate markers to distinguish vaccine immunity from natural infection. However, even sustained use of SMLVV on weaned animals, preferably annually or at slightly longer intervals, could prevent the occurrence of outbreaks and eliminate the danger of export of infected animals. At present it is virtually impossible to convince livestock owners to vaccinate regularly for a disease which is seldom encountered, and no vaccine producer is able to supply short term demands generated by early warning systems. The institution of planned, strategic campaigns would allow vaccine producers to increase capacity without risk of accruing losses from expired stocks, and higher production volumes would facilitate lowering of prices. Regular vaccination campaigns could be incorporated with other veterinary activities, and livestock and traders would benefit from a stabilized industry. The indications are that farmers and traders understand the economic rationale for such a system.

RECENT HISTORY OF THE DISEASE (WORLDWIDE)

RIFT VALLEY FEVER OUTBREAKS AND CONTROL IN WEST AFRICA

Yaya Thiongane [1], Modou Moustapha Lô [1], Baba Sall [2], Pietro Ceccato [3], Stéphane De la Rocque [4], Michèle Bouloy [5] & Jean-Paul Gonzalez [6]

[1] Laboratoire National de l'Elevage et de Recherches Vétérinaires, ISRA-LNERV, Dakar-Hann, Sénégal.
[2] Direction de l'Elevage, Dakar Sénégal
[3] International Research Institute for Climate and Society, The Earth Institute, Columbia University, NY, US.
[4] EMPRES, Animal Production & Health Division (AGAH) FAO, Rome, Italy
[5] Unité de Génétique des Bunyaviridés, Institut Pasteur de Paris, Paris, France
[6] International Centre for Medical Research of Franceville (CIRMF), Libreville, Gabon.

RVF is a viral disease of veterinary and public health importance. Periodic severe animal epizootics are accompanied with human epidemics in Africa (Egypt 1997, 1993, Mauritania 1987, 1993, 1998, Eastern Africa 1997-98) with recent extensions in the Arabian Peninsula (Saudi Arabia and Yemen in 2000). In Senegal, following the first RVF outbreak in 1987 in the Senegal River Delta, a surveillance program of this disease in domestic ruminants was conducted since 20 years (from 1988 to 2008). The main objectives were to establish an early detection of the disease based on sentinel herds sero-monitoring and proper and rapid disease reporting through the country.

A network of sentinel herds (small ruminants) located in potential high risk areas for RVF epizootics were visited during the raining season (June to November) and subject to clinical examination like also several cattle herds, randomly selected during the *Pan African Rinderpest Campaign*, which were sampled. Collected sera were analysed by neutralisation test and ELISA for IgM and IgG antibodies in order to reveal recent and/or past viral infection. Virus isolation from organs and tissues was performed in Vero cells culture and by inoculating suckling mouse.

The serosurveys conducted in sheep and goats showed the following:

- In the *Senegal River Basin* (SRB), the RVF antibody prevalence that reached a peak of 70% after the 1987 epizootic, dropped to 30% in 1988 and, then decreased continuously until 1993. This decrease of RVF prevalence corresponded to period of low rainfall.
- RVF virus activity re-emerged as epizootics in 1994, 1999, 2002 and, 2003 amongst herds in the SRB and bordering areas such as the Ferlo plateau.
- In the Ferlo, an enzootic cycle of RVF virus was shown involving mostly *A vexans* and *A ochraceus* mosquito species as its vectors during the raining season. Others mosquito species were identified as vectors of the virus in the SRB.
- Communication and training materials (10 periodic bulletins, 400 booklets, 200 videos and 2000 posters) were produced and distributed to raise local awareness with regard to RVF burden and cost on livestock and human health.
- A computerized regional database was developed with more than 20,000 data set (serosurveys, suspected cases and, outbreaks notifications) collected in Senegal and neighbouring countries (Mali, Mauritania) from 1988 to 2008.
- Although data obtained from satellite imagery were used in order to assist in predicting and preventing future RVF epizootics and epidemics, the immune status of animal herds, herd movements and, local conditions favouring the mosquito breeding might play a more significant role in the inter-annual variability of outbreaks than environmental factors (i.e. rainfall, land cover).

Our RVF surveillance is done by the clinical and serological survey system according to local settings, specially herd owners agreement, cost and effectiveness. Moreover, the selected diagnostic tools like ELISA assay allowed an efficient IgG and IgM detection, and IgM detection is a helpful indicator of recent infections. Virus circulation increases the risk of epizootic, and subsequently a risk of epidemic due to vector activity. The etiological diagnosis is to be associated with sustained awareness of RVF in order to prevent major RVF emergences.

RIFT VALLEY FEVER OUTBREAKS AND CONTROL IN NORTH AFRICA, WITH SPECIFIC REFERENCE TO SOMALIA

Abdirahman Queliye [1] & Khalid Saeed [2]

[1] Ministry of Livestock, Mogadishu, Somalia
[2] FAO/Somalia - Food and Agriculture Organisation of the United Nations, Nairobi, Kenya

It is believed that the presence of RVF in Somalia is a result of the events which coincided with *El-Niño* in 1997 – 1998 in the region. Targeted surveillance in sero-positive sites in central and south Somalia was carried out by the Somali component of the PACE project in 2004. Following the massive RVF epizootic in north-eastern Kenya in 2006 – 2007, around a 100 human cases were suspected and one confirmed in southern Somalia (WHO/CDC), in parallel with reports of high abortion rates in the small ruminants.

As from January 2007, a targeted survey was initiated in the Afmadow District (South). This was implemented by the SAHSP (*Somali Animal Health Service Project*) and later extended to Central Somalia.

Region	Prevalence in sheep (%)	Prevalence in goats (%)	Targeted sites (N)	Sites sampled (n)
Central Somalia	15.3	5.7	284	270
Southern Somalia	26.6	6.3	348	244

Table 2. Targeted survey in Central and Southern Somalia – SAHSP, 2007 (results)

In September 2008, EMPRES released an alert on prediction of increased precipitation and possible outbreaks of RVF in the greater Eastern Africa region, which was followed by reports from the field as early as October 2008, of moderate to substantial floods occurring in the Shebelle and Juba river valleys of Somalia, believed to have increased the risk of RVF transmission to susceptible livestock population in the area, and hence, posing a risk to human health as well.

The response to this perceived increased risk for RVF has been to raise community awareness and to engage in targeted training in RVF clinical cases detection and risk reduction, as well as the distribution of PPE to commercial slaughterhouses operators (with the support of FAO Somalia). In addition, the risk of vector transmission to livestock was further reduced through the extensive application of pour-on's to a high proportion of the livestock population in the flooded areas (with the support of FAO Somalia and conducted by Ministerial staff).

In conclusion, there is serological evidence of exposure of Somali livestock to RVF virus infection since 2004. The overall prevalence is the highest in Southern and Central Somalia. Spatial analysis of RVF IgG prevalences indicates that a higher risk persists in the Shebelle and Juba River basins in Central and Southern Somalia. It would appear that Somali sheep are more susceptible than goats in all areas sampled.

RIFT VALLEY FEVER OUTBREAKS AND CONTROL IN EAST AFRICA

Jeffrey C. Mariner [1], Christine Jost [1], Keith Sones [1], Karl Rich [1,2] , Bryony Jones [1] & Bernard Bett [1]

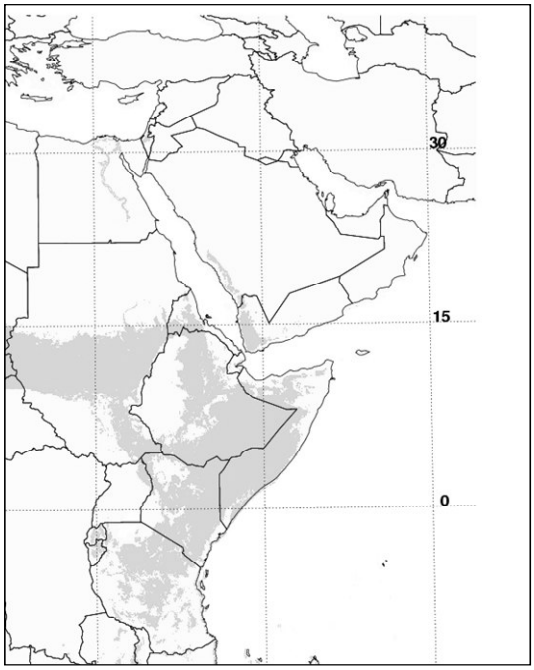
[1] International Livestock Research Institute, Nairobi, Kenya
[2] Department of Economics, American University in Cairo, New Cairo 11835, Egypt

As its name suggests, RVF was first described in the Rift Valley in East Africa in 1930. Research has demonstrated that endemic RVF is maintained in East Africa over inter-epidemic periods by trans-ovarial transmission in mosquitoes of the *Aedes* genus combined with limited occult transmission in local livestock populations.

Major outbreaks of RVF occur in the region every on an average of every 10 years. In recent years, dramatic outbreaks occurred in 1997-1998 and in 2006-2007. Outbreaks are associated with unusually heavy and persistent rainfall causing widespread flooding. In these conditions, dormant eggs of *Aedes* spp. hatch and the emerging adult female mosquitoes transmit the RVF virus to susceptible livestock. The virus is amplified in livestock and subsequently transmitted by a variety of secondary vectors. Once the chain of events is set in motion, local outbreaks peak within a period of 4 to 6 weeks. As the onset of outbreaks is so sudden and outbreak sites are often unreachable due to flooding and the lack of all weather roads, effective suppression of outbreaks is challenging.

The impact of RVF is through losses of livestock, human morbidity and mortality. The economic impact of RVF includes these losses as well as control measures such as slaughter bans and trade restrictions that impinge on the livelihoods of livestock owners and other actors in livestock and livestock product value chains. Sharp declines in consumer demand for beef, sheep meat, and goat meat due to RVF exacerbate these impacts, and indeed, analysis of the national market effect following the 2006-2007 outbreak in Kenya indicated that the drop in such meat consumption had a particularly strong, negative effect on the livelihoods of diverse downstream participants in meat value chains, including those working as casual labour.

As a general principle, decision makers implementing livestock disease control strategies have two options. They can either control the disease itself through livestock case reduction or to mitigate the impact of disease on the livelihoods and health of stakeholders. In the case of RVF, these strategies in turn target vector control, reduction in the size of the susceptible livestock population through vaccination or reduction of human exposure to major risk factors: contact with sick livestock and reduction of high risk activity such as livestock slaughter.



FAO/EMPRES Risk mapping 2006/2007
©Assaf Anyamba and DoD-GEIS & NASA Goddard Space Flight Centre Rift Valley Fever Monitoring Team.

The lessons of recent outbreaks indicate that interventions to control disease in livestock have limited impact unless the ramping up of control activities is started well before outbreaks occur. It has also been seen that mitigation efforts that seek to reduce human exposure can have large, unforeseen economic impacts in the livestock sector as a whole and in related sectors through market forces if the targeting and messaging is not carefully crafted. The collapse of meat consumption in Kenya in 2007, despite the fact that properly processed meat has not been shown to be a major risk factor, illustrates this issue. This suggests that the way forward towards improved response to RVF lies in a greater focus on timely prediction and prevention combined with smarter interventions that directly target the risk factors for human exposure once outbreaks are underway.

RIFT VALLEY FEVER OUTBREAKS AND CONTROL IN THE MIDDLE-EAST

Shaif Abdo-Salem [1,2], Véronique Chevalier [1], Agnès Waret-Szkuta [1], Anne Lise Tran [1], Guillaume Gerbier [2], Etienne Thiry [4], Marie-Marie Olive [1], Marie Gély [1], Karim Ben Jebara [5], Mohamed Al-Qadasi [6], Khalid Saeed [7], Pascal Bonnet [1], Ghalib Al-Eryani [6] & François Roger [1]

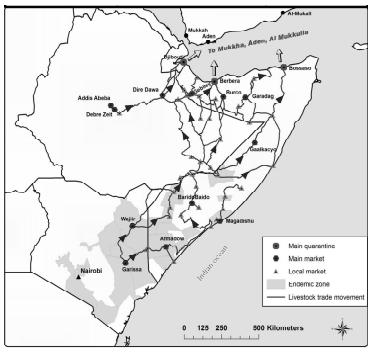
[1] International Centre of Research in Agronomy for Development (CIRAD), Montpellier, France.
(2) College of Agriculture and veterinary Science, University of Dhamar, Yemen.
[3] Veterinary Services Department , Guadeloupe.
[4] Virology and Viral Diseases, Department of Infectious and Parasitic Diseases, University of Liège, Belgium.
[5] Information Department, World Organisation for Animal Health (OIE), Paris, France.
[6] General Directorate of Animal Health & Veterinary Quarantine, MAI, Sanaa, Yemen.
[7] Food and Agriculture Organisation of the United Nations, Nairobi, Kenya.

The *RVF virus* (RVFV) is a member of the genus *Phlebovirus* family *Bunyaviridae* that was first isolated in 1930 in Kenya. It is responsible for one of the major vector-borne zoonosis which occurrence was limited, until recently, to the African mainland. Mortality and abortions induced by RVF cause direct economical impacts. However, the indirect economical consequences are the most important due to international sanitary agreements that impose a very strict embargo on live animals and animal products exportation during and after an outbreak.

In September 2000, for the first time, RVF extended from Africa to the Arabic peninsula causing a severe epizootic in Saudi Arabia and Yemen. This outbreak was responsible for many human and animal cases. In Saudi Arabia, 886 human cases were diagnosed and 123 persons died. A case-fatality rate of 14% was reported. A total of 40,000 livestock died, aborted or were destroyed (Mohammed, 2007). In Yemen, 1083 human cases were recorded and 140 died. Moreover 21,862 animals aborted and 6,653 died (Al Qadasi, 2002). Major parts of the infected villages were located in the irrigated area, around the main northern and southern canals of the Wadi Mawr River. If the spatial distribution of RVF-infected villages seems to correspond to the irrigated area in the Wadi Mawr, the environmental risk factors frequently mentioned in the literature (i.e. rainfall and NDVI) do not seem to be correlated with the RVF outbreak in Yemen in 2000-2001 (Abdo-Salem et al., 2006)

The test results of the sera collected in 1996-1997 from Tihamah coast confirmed that there had been no virus activity in the region before the disease emerged in 2000. The genetic analysis of the RVFV strains isolated from the 2000-2001 outbreaks in Yemen and Saudi Arabia showed that they were closely related to the RVFV that was previously circulating during the outbreak in the Horn of Africa in 1997-1998 (Shoemaker et al., 2002). Thus the virus was thought to have been introduced into the Arabic Peninsula from Kenya by ruminants (Shoemaker T. et al., 2002; Davies F.G. and Nunn M.J., 1998; Madani T.A., 2003).

A risk assessment of the re-introduction of RVF into Yemen and a comprehensive evaluation of the socio-economic impact of the disease in the context of the Middle-East region are currently being performed that should help allocating resources to prevent its re-emergence or at least limit its impact by a better control . This presentation will summarize the past and current situation of RVF in the Middle-East and discuss future possible prevention and control measures in regards to the re-introduction of the disease.



Movement of live animals from Somalia, Kenya, Ethiopia to Yemen through Bossaso, Berbera and Djibouti sea ports
© CIRAD Shaif Abdo-Salem, Marie Gely, Marie-Marie Olive

Abdo-Salem S., Gerbier G., Bonnet P., Al-Qadasi M., Tran A., Thiry E., Al-Eryni G., Roger F. (2006). Descriptive and spatial epidemiology of Rift valley fever outbreak in Yemen 2000-2001. *Ann. N Y Acad. Sci.*, 1081, 240-242.

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Shoemaker T., Boulianne C., Vincent M.J., Pezzanite L., Al-Qahtani M.M., Al-Mazrou Y., Khan A.S., Rollin P.E., Swanepoel R., Ksiazek T.G., Nichol S.T. (2002). Genetic analysis of viruses associated with emergence of Rift Valley fever in Saudi Arabia and Yemen, 2000-2001. *Emerg. Infect. Dis.* 8 (12): 1415-1420.

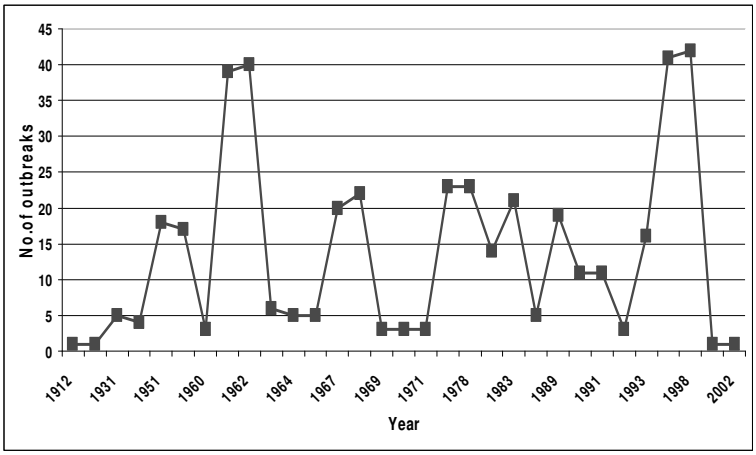
EPIDEMIOLOGICAL DATA FROM RECENT OUTBREAKS IN EASTERN AND SOUTHERN AFRICA

SURVEILLANCE FOR RIFT VALLEY FEVER IN EASTERN AFRICA WITH REFERENCE TO THE OUTBREAKS IN KENYA AND TANZANIA

Jacqueline Kasiiti Lichoti

Department of Veterinary Services, Ministry of Livestock Development, Nairobi, Kenya

RVF was first recognized in the 1900s as a disease in sheep in Rift Valley province, Kenya. Since then, outbreaks have occurred in 5 – 15 year cycles. Epidemics of RVF in Kenya and Tanzania occur when unusually heavy rainfall is observed and the disease is most severe in the arid and semi-arid areas. In the highlands, the endemic nature of the disease is observed, i.e. maintenance of virus activity at low levels and that is only detectable at laboratory level and the outbreaks are less severe. In an epizootic, virus circulates among infected arthropod vectors and mammalian hosts, particularly cattle and sheep which represent the most significant livestock amplifiers of RVF virus. The inter-epizootic survival of RVFV is believed to depend on trans-ovarial transmission of virus in floodwater *Aedes* mosquitoes.



Number of RVF outbreaks in Kenya from 1912-2002 (5-15 year cycles)

From the 2006 -2007 outbreak it was observed that outbreaks occurred in areas that have previously experienced the disease. Surveillance activities included tracing both animal and human, clinical examination of livestock at risk and serological monitoring, vector studies, surveillance in wild ruminants and giving the field personnel a case definition of RVF disease to facilitate faster identification and reporting. Risk areas were identified depending on; proximity to infected areas, historical occurrence of RVF and ecological perceptiveness. Clinical examination of livestock, outbreak investigation was carried out, outbreak investigation form filled and appropriate samples collected. Sites with no evidence of RVF were zero report and geo-references registered for all visited sites. Surveillance was also carried out in all areas where unusual wildlife deaths were reported.

A total of 3,969 samples were submitted and tested at the Central Veterinary Laboratories, Kabete, Kenya.

On impact assessment of RVF disease, during the 1997-1998 RVF epidemic in East Africa, there was a cessation of the lucrative trade in small ruminants to Middle East countries and the loses were estimated to have been USD 250-350 million. In the 2006-2007 outbreak loses were estimated to be USD 51,867,512.70, excluding the value of human lives lost.

To be able to be in control before the disease strikes in future, the Department of Veterinary Services in Kenya has set up a Technical Committee comprising stakeholders jointly chaired by Director of Veterinary Services and Director of Public Health and Sanitation that meets bimonthly, receives weekly weather reports, has prepared a contingency plan for RVF disease and also set up sentinel herds in high risk areas.

A complete S, M and/or L genome segment sequence from 31 RVF virus specimens (period December 2006-May 2007 and different geographic areas) revealed that multiple virus lineages are circulating concurrently; there is virus activity and evolution during the inter-epizootic/epidemic period and evidence of recent increases in genomic diversity and effective population size 2 to 4 years prior to the 2006-2007, indicating ongoing RVF.

RISK FACTORS FOR SEVERE RIFT VALLEY FEVER INFECTION IN KENYA, 2007

Amwayi Samuel Anyangu [(1)], L. Hannah Gould [(2)], Shahnaaz K. Shariff [(1)], Patrick N. Nguku [(1)], Jared Omolo [(1)], David Mutonga [(1)], Carol Y. Rao [(2)], Edith Lederman [(2)], David Schnabel [(3)], Janusz T. Paweska [(4)], Mark Katz [(5)], Allen Hightower [(5)], M. Kariuki Njenga [(5)], Daniel R. Feikin [(5)] & Robert F. Breiman [(5)]

[(1)] Ministry of Public Health and Sanitation, Nairobi, Kenya

[(2)] Centres for Disease Control and Prevention, Atlanta, USA

[(3)] Walter Reed Programme (WRP) US Army Medical Research Unit, Kenya

[(4)] National Institute of Communicable Diseases of the National Health Laboratory Service, Johannesburg, South Africa

[(5)] Global Disease Detection Division, Centres for Disease Control and Prevention, Nairobi, Kenya

A large RVF outbreak occurred in Kenya from December 2006-March 2007. We conducted a risk factor study to define risk factors associated with infection and severe disease. A total of 861 individuals from 424 households were enrolled. Two hundred and two participants (23%) had serologic evidence of acute RVF infection. Of these, 52 (26%) had severe RVF disease characterized by hemorrhagic manifestations or death. Independent risk factors for acute RVF infection were consuming or handling products from sick animals (*Odds ratio* (OR) = 2.53, 95%CI = 1.78-3.61, *Population Attributable Risk* Percentage (PAR %) = 19%) and being a herdsperson (OR 1.77, 95%CI = 1.20-2.63, PAR% = 11%). Touching an aborted animal foetus was associated with severe RVF disease (OR = 3.83, 95% CI = 1.68-9.07, PAR% = 14%). Consuming or handling products from sick animals was associated with death (OR = 3.67, 95% CI = 1.07-12.64, PAR% = 47%). Exposures related to animal contact were associated with acute RVF infection while exposures to mosquitoes were not independent risk factors.

	Univariate comparisons			Multivariable model
Exposure	Acute RVF n = 202	Controls n = 659	OR (95% CI)	Adjusted OR (95% CI)
Consumed or handled products from sick animals	75(37)	117(18)	2.74(1.93-3.88)	2.53 (1.78-3.61);p< 0.0001
Herdsperson	53(26)	97(15)	2.06(1.41-3.01)	1.77 (1.20-2.63);p= 0.0042
Slaughtered animals	50(25)	89(14)	2.11(1.43-3.11)	NS
Skinned animals	51(25)	88(13)	2.19(1.49-3.23	NS
Milked animals	74(37)	44(22)	2.07(1.47-2.91)	NS
Contact with animal blood	62(31)	114(17)	2.12(1.48-3.04)	NS
Animal birth care	34(17)	55(8)	2.22(1.40-3.52)	NS
Consumed raw milk	57(28)	123(19)	1.71(1.19-2.46)	NS
Water source ≤ 100 m of home	141(70)	403(61)	1.47(1.05-2.06)	NS
Slept outside with herd	33(16)	60(9)	1.95(1.23-3.08)	NS
House flooded previous month	95(51)	247(39)	1.57(1.13-2.18)	NS
Male	108(54)	291(45)	1.42(1.03-1.95)	NS

Table 3. Factors associated with acute RVF infection

	Univariate comparisons			Multivariable model
Exposure	Severe RVF n = 52	Controls n =150	OR (95% CI)	Adjusted OR (95% CI)
Touched aborted animal fetus	13 (25)	12 (8)	3.83(1.62-9.07)	3.83(1.62-9.07);p=0.002
Herdsperson	20 (39)	33 (22)	2.22 (1.12-4.37)	NS
Herded animals	23 (44)	42 (28)	2.04 (1.06-3.92)	NS
Birth Cared for animals	15 (29)	19 (13)	2.80 (1.30-6.03)	NS
Clothing covering legs/arms	5 (10)	4 (3)	3.88 (1.00-5.06)	NS

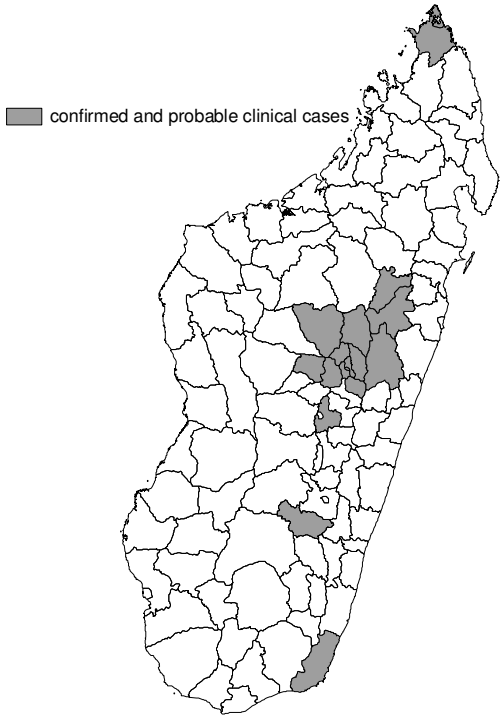
Table 4. Factors associated with severe RVF disease among persons with acute RVF infection

AN EVALUATION OF THE HUMAN : ANIMAL IMPACT OF RVF OUTBREAKS IN THE COMOROS ARCHIPELAGO AND MADAGASCAR

Jean-Marc Reynes

National Reference Centre (NRC) for arbo-viruses and viruses responsible for haemorragic fevers,
Institut Pasteur de Madagascar, Antananarivo, Madagascar

RVFV was isolated for the first time in Madagascar in 1979 from pools of mosquitoes captured in March during the rainy season in the forest of Perinet, Moramanga district (130 km east of Antananarivo). Then animal and human RVF outbreaks occurred during rainy season in Vavatenina and Fenoarivo Ateinana districts (100 km north of Toamasina, on the East coast) in March 1990 and around Antananarivo from February to April 1991. Antigenic and molecular analysis of isolates showed that RVFV strains obtained in 1979 were closely related to Egyptian 1979 isolates but also to Zimbabwean 1974 isolates and those isolated in 1991 were closer to eastern/central African strains.



Re-emergence of the virus was identified 17 years later, in 2008. The first case was a human case. This case was detected on the South coast in January through a fever surveillance sentinel network, and then several animal and human cases were confirmed in early February on the central highlands. RVFV circulated at least till 23 May 2008 with the reporting of the last laboratory confirmed (virus detection) case. Overall, samples from 134 suspected human cases and 119 suspected ruminant cases were received at the NRC from 28 of the 111 Malagasy districts. RVFV laboratory confirmed or probable (IgM) cases were 67 among humans and 22 among animal cases and were reported in 18 of the 27 districts. Fifteen of theses districts were in the highlands, one on the South coast end two in the North coast. Because underreporting was suspected, we are conducting a retrospective sero-survey among people involved in the slaughtering of ruminants. Preliminary results suggest that the virus has circulated in the whole country. Molecular analysis of the isolates obtained during the outbreak showed that they were very similar to those circulating in the region (ie in Kenya) in 2007.

RVFV has been detected circulating again during this rainy season, since December 2008.

Third reported outbreak : January – May 2008 (geographical spread)

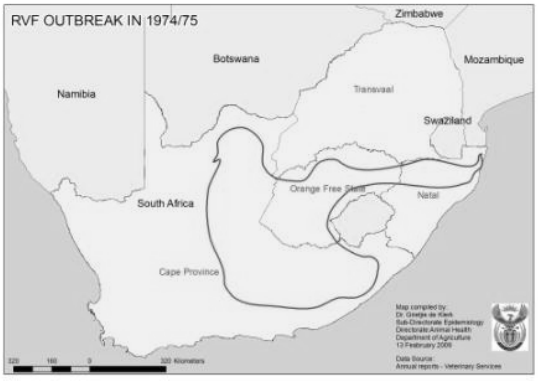
AN EVALUATION OF THE RVF OUTBREAKS IN SOUTHERN AFRICA

Margaretha De Klerk

National Directorate of Veterinary Services, Department of Agriculture, Pretoria, South Africa

RVF was first recorded in South Africa in late 1950 when a severe outbreak occurred in the North Eastern part of the country. Thereafter, outbreaks have always been associated with above average rainfall at irregular intervals of five to fifteen years. A second major outbreak occurred in 1974-1975. Apart from the two major outbreaks, lesser outbreaks of RVF or sporadic isolations of virus were recorded to date.

Geographical extent of the 1950/1951 RVF outbreaks (c) DoA



Geographical extent of the 1974/1975 RVF outbreaks (c) DoA

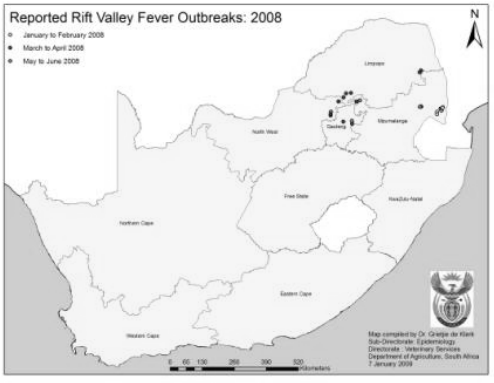
Attenuated live vaccine (Smithburn strain) was introduced in the period July 1954 to June 1955 and the inactivated vaccine in the period July 1974 to June 1975.

An isolated outbreak occurred in 1999, in buffalo, held in an enclosure at Skukuza in the Kruger National Park. The most recent outbreak occurred from January to June 2008. No outbreaks were reported so far in the current season (2008/2009) until 15 February 2009.

RVF is a notifiable disease according to the *Animal Diseases Act (*Act 35 of 1984). Immediate notification reports are sent from the Provincial Directors to the National Director of Veterinary Services where reports are compiled. Information is then distributed internationally, including to the OIE.

Farmers are well advised to vaccinate sheep, cattle and goats regularly in high risk areas, especially in years of high rainfall.

RVF is a zoonosis, but infection of humans by mosquitoes and other alternative vectors are not seen in South Africa. Veterinarians, farmers and farm workers which have direct contact with animals, are most at risk.



Location of the 2008 RVF outbreaks [dots] (c) DoA

Results of work done by Dr. Roy Bengis, State Veterinarian in the Kruger National Park, indicate that RVF appears to have been circulation at low levels of activity in buffalo in the Park. This happens in the absence of any RVF epidemics elsewhere in South Africa, where RVF occasionally surfaces in years with high specific rainfall patterns.

THE USE AND APPLICATION OF EPIDEMIOLOGICAL CLUSTERS IN SURVEILLANCE AND CONTROL

Véronique Chevalier

UR- AGIRs, International Centre of Research in Agronomy for Development (CIRAD), Montpellier, France

Depending on the ecotypes, breeding systems, hosts population, landscapes, and climate patterns, Rift Valley fever virus circulation greatly differs and may emerge in several type of ecological patterns, latter referred as pathosystems; these pathosystems gather specific emergence risk factors and persistence processes. The four known pathosystems are described. These pathosystems have been distinguished according to the epidemiological processes involved, their actual status and potential evolution. Future surveillance and researches proposals need to be adapted to each situation.

Either scanned or targeted surveillance could be established. Scanned surveillance mainly is based on passive reporting by veterinary services. The efficacy and sensitivity of such a system depends on the capacity and budget of a country's official structures and the relevance of the epidemiological methods applied, e.g., well-adapted case-definition, negative reporting, etc.

Targeted surveillance could be carried out using sentinel herds. The lack of sensitivity of traditional sentinel herds may be improved by a risk-based surveillance implementation. This methodology requires epidemiological knowledge that allows the targeting of locations and periods of surveillance.

Accurate predicting models using satellite imagery exist for the "*dambos*" area. This moderately expensive methodology can be applied on a country and regional basis, and may enable preventive measures - such as the vaccination of susceptible stock - to be taken. However, further area studies are required to validate the correlations and extrapolate the methodology to East Africa. In this area, there is a need to implement a risk-based surveillance network, including a denser sentinel herd network. The early warning system should include an early reaction program, planned control measures, and vaccine and insecticide stocks. Farmers and veterinary authorities should be constantly on the alert. Vaccination strategies should be evaluated according to the ecological and socio-economical context as well as the impact of vaccination on the disease pattern in endemic areas.

In arid areas (Senegal, Yemen…), risk areas, key emergence factors, and persistence mechanisms have to be identified. Transmission models using the basic reproduction number (R_0) should be built in order to test different climatic scenarios and the relevance of different vaccination strategies [1]. A traditional scanned surveillance network needs to be implemented to detect increased incidence. This surveillance should be associated with a reinforced targeted surveillance in known risk areas such as the Senegal River Valley and Ferlo area in Senegal [2]

Countries are considered at risk when they have experienced an outbreak, when they share ruminant trade links with endemic area, or when they have endemic neighbours.

How can we evaluate and control the risk efficiently?

The first step will be to quantify ruminant flows and their variations, using quantitative introduction risk analysis. Since global changes are likely to influence vector competence and host behaviours and sensibility, an analysis of the risk of endemisation should be done, including a competent vector census, suitable vector habitat mapping, host density mapping.

Surveillance needs to include a global passive monitoring system to detect viral agent introduction that is associated with sentinel herds located where a vector is present or where an extension of the vector is expected [3].

1. Soti V., Chevalier V., Maura J., Tran A., Etter E., Lelong C., et al. Landscape characterization of Rift Valley fever risk areas using very high spatial resolution imagery : case study in the Ferlo area, Senegal.-. in GISVet Conference 20-24 august 2007. 2007. Copenhagen - Denmark.

2. Chevalier V., Lancelot R., Thiongane Y., Sall B., Mondet B. Incidence of Rift Valley fever in small ruminants in the Ferlo pastoral system (Senegal) during the 2003 rainy season. Emerg Inf Dis. 2005; 11(11):1693-1700.

3. Chevalier V., Martin V., Delarocque S., Roger F., Combating and predicting Rift Valley fever: a scientific and geopolitic challenge for the future?, in Emerging Infections 8, ASM, Editor. 2008, ASM press: Washington. p. 189-212.

THE IMPACT OF WILDLIFE IN THE EPIDEMIOLOGY OF RIFT VALLEY FEVER

Véronique Chevalier [1], Alexandre Caron [1], Marie-Marie Olive [2] , Jean-Marc Reynes [2] & Michel De Garin Wichatitsky [1]

[1] UR- AGIRs, International Centre of Research in Agronomy for Development (CIRAD), Montpellier, France
[2] National Reference Centre (NRC) for arbo-viruses and viruses responsible for haemorragic fevers, Institut Pasteur de Madagascar, Antananarivo, Madagascar

RVF epidemiology is rather complex. Outbreaks occur with 5-15 years intervals in several different ecosystems, and the way the virus persists in the field during inter-epizootic periods remain unknown in most cases. In addition to vertical transmission of the virus that was demonstrated in Kenya, wildlife may be involved as reservoir of the virus.

Many different and often contradicting definitions of reservoir exist, and the demonstration of the role of one or several species in an epidemiological cycle is difficult. Some indicators may be used. The first one is to identify geographical or temporal links between population targets and reservoir. Then more information on transmission risk factors may be obtained from quantitative epidemiological studies. Next step will be to prove the occurrence of natural infection of reservoir (virus isolation, and/or antibody detection). Experimental inoculation and measures of the viraemia level and duration will provide more arguments. The last and the most relevant component to assess is the persistence of the virus in the reservoir population using longitudinal studies (Haydon et al. 2002).

As far as RVF is concerned, many mammals could be involved: rodents, wild ruminants, bats, monkeys . However, the strongest documented suspicion concerns rodents, especially murids as many studies showed that some rodent species may be naturally infected by RVFV and develop a high level viraemia. In addition, in Madagascar, the last two outbreaks occurred in an area where the rodent density is high and in intense contact with livestock. In Zimbabwe and more generally in Austral Africa, the virus could be maintained in wild ruminants and be transmitted to livestock during contacts that occur around the National Park boundaries.

Several epidemiological studies are currently performed to assess the role of potential reservoir in RVF cycle. In Madagascar, the RIFT-OI project aims at understanding the processes involved in the re-emergence of the disease in a pilot area, Anjozorobe. The goals of field studies are to estimate the transmission incidence on livestock and risk factors, to identify the potential vectors and assess their population dynamic and to identify the potential reservoir.

In Zimbabwe, where a history of RFV outbreaks has been documented, reoccurrence happens in areas where wild ungulate populations occur or not. Under the RP-PCP platform and in collaboration with the veterinary services, a research programme is currently looking at multi-host/multi-pathogen interactions (including RVF) at the wildlife/livestock interface in the South-East Lowveld (close to recent buffalo RVF outbreaks in South Africa in 2008). There is potential to test the hypothesis of maintenance of the RVFV in systems with or without a wild ungulate reservoir.

Identifying the potential reservoir is not sufficient to be able to control the disease. There is a need of understanding the whole ecosystem behaviour and the role of the reservoir in this system. Then, in term of control and surveillance, and given the reservoir is identified, several questions arise:

Can we reach an acceptable level of control without dealing with the reservoir? If not, can we be efficient at dealing only with the target population? Or do we have to apply a transmission blocking strategy as it is performed with FA or transmission of malignant catarrhal fever in East Africa? Or can we control the disease only acting on the reservoir population?

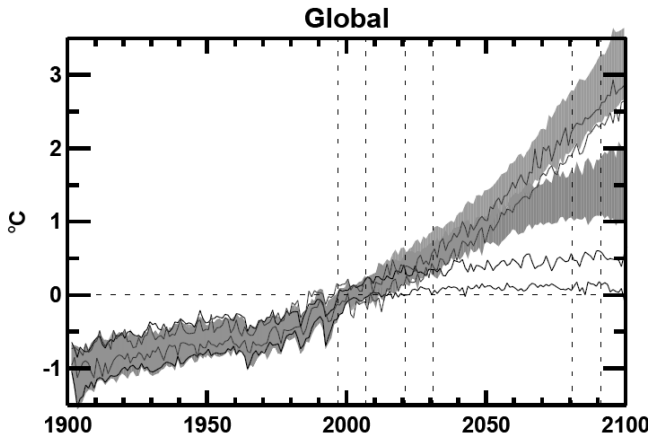
Haydon, D. T., Cleaveland, S., Taylor, L. H. & Laurenson, K., 2002. Identifying reservoirs of infection : a conceptual and practical challenge. Emerg Inf Dis; 8 (12): 1468-1473.

GLOBAL WARMING – THE IMPACT AND PREDICTIVE VALUE ON RIFT VALLEY FEVER PREVENTION AND CONTROL

Stéphane De La Rocque

EMPRES / Animal Production & Health Division (AGAH)
FAO - Food and Agriculture Organisation of the United Nations, Rome, Italy

Climate change may likely affect the geography of infectious diseases, in which vector-borne diseases such as RVF, yellow fever and dengue may be strongly affected in term of spatial distribution and incidence.



Time series of annually and globally averaged surface temperature from climate model simulations following various emissions scenarios as anomalies from the 1997-2006 average © IPCC Report 2007, D. Stone, Rev Scient Techn OIE.

These vector-borne diseases are sensitive to changes in the environment in general, and in climatic conditions in particular. While it is clear that climate is not the unique determinant of their prevalence or range, it can be speculated that under global warming conditions, climate tolerance limits of vectors might expand in altitude and latitude, creating favourable conditions for vectors to colonize new ecosystems and animal populations in today's temperate regions. It is anticipated that RVF could expand its geographical range northwards and cross the Mediterranean and Arabian seas with likelihood to occur at more regular intervals because of the rainfall patterns predicted in the IPCC report.

March 2008, Carion, Madagascar : 50 human confirmed cases, all exposed to one single zebu

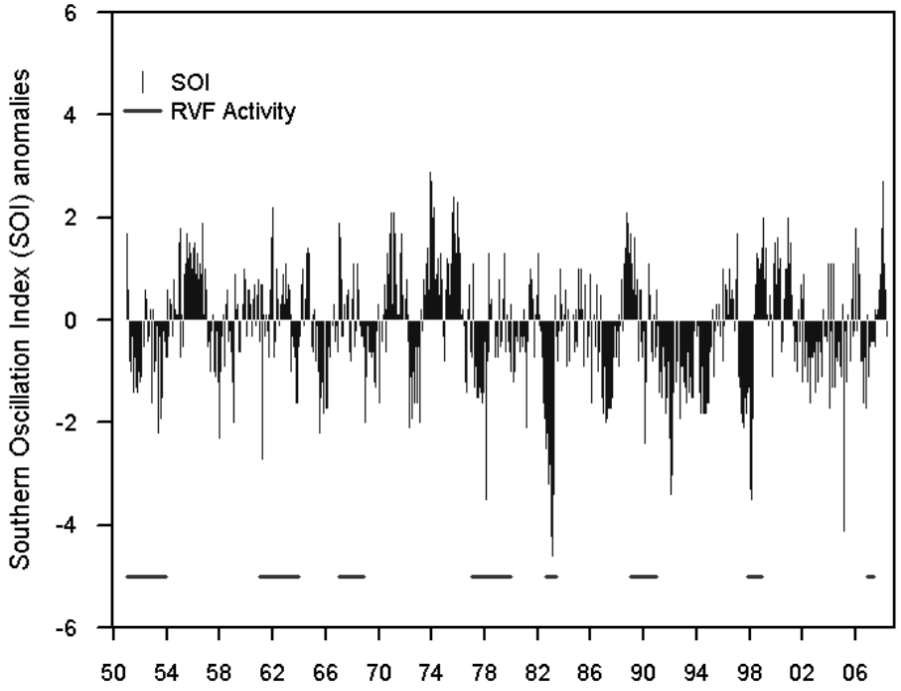
The impact on the animal and human health in newly affected countries is difficult to evaluate but will be high. The author will also insist on the diversity of the eco-epidemiological situations observed with RVF during the last outbreaks, in conjunction with various landscape and livestock breeding systems and mosquitoes dynamics. Forecasting such changes should be envisaged at international level through the strengthening of global, regional and national early warning systems supported by coordinated research programs and subsequent prevention and intervention measures.

THE APPLICATION OF REMOTE SENSING AND EARLY WARNING SYSTEMS FOR RIFT VALLEY FEVER SURVEILLANCE AND CONTROL

Assaf Anyamba [1], Kenneth J. Linthicum [2], Jennifer Small [1], Robert Swanepoel [5], Seth C. Britch [2], Edwin W. Pak [1], Pierre Formenty [4], Stephane de La Rocque [3], Compton J. Tucker [1] & Mathew M. Smith [1]

[1] NASA Goddard Space Flight Centre, Biospheric Sciences Branch, Greenbelt, Maryland.
[2] USDA-ARS Centre for Medical, Agricultural & Veterinary Entomology, Gainesville, Florida.
[3] EMPRES / Animal Production & Health Division (AGAH)
FAO - Food and Agriculture Organisation of the United Nations, Rome, Italy.
[4] Epidemic and Pandemic Alert and Response Department (HSE/EPR) World Health Organisation , Geneva, Switzerland.
[5] National Institute for Communicable Diseases, Sandringham, South Africa.

RVF is a zoonotic viral disease that occurs throughout sub-Saharan Africa, Egypt and the Arabian Peninsula, primarily affecting domestic animals and humans. Epizootics/epidemics of the disease are episodic and closely linked to climate variability, especially widespread elevated rainfall that facilitates elevated populations of various species of vector mosquitoes that transmit RVF. Periodic disease outbreaks are closely linked with inter-annual variability in rainfall associated with the *El Niño/Southern Oscillation* (ENSO). In this study we evaluate an operational RVF risk mapping model based upon satellite-derived *normalized difference vegetation index* (NDVI) data and rainfall anomalies during the 2007-2008 period over Southern Africa. Model outputs are compared against the actual spatial and temporal distribution of the RVF outbreak. The results indicate that the RVF outbreak during this period was a result of above normal rainfall creating the ideal ecological habitats for the production of mosquito vectors associated with RVF, and demonstrate the value of systematic satellite observations of the land biosphere in developing early warning systems for episodic zoonotic disease outbreaks.



Recognized Rift valley fever epizootics and related events

SECOND GENERATION SEQUENCING
A POWERFUL NEW TOOL FOR EXPLORING ARBOVIRUS EPIDEMIOLOGY

Steve J. Kemp & Philip Toye

International Livestock Research Institute (ILRI), Nairobi, Kenya

454 GSFLX
- 500 Mbases in 7 hours
- GBP 6,000 per run
- 500 bp reads

ABI Solid
- 30Gbases in 5 days (->90Gb)
- GBP 10,000 per run
- 35 bp reads

Types of second generation DNA sequencers

In order to improve our understanding of the biology of RVF virus, we intend to use second generation sequencing to identify the inter-epidemic distribution and diversity of the virus. We shall analyse complex biological mixes such as potential vectors complete with virus and blood meals as well as samples from potential animal and human hosts. In this way we hope to understand more fully the population dynamics of virus, vector and host and their interactions.

Although the focus of our studies will be RVF virus, the sequencing technology and sampling approach is expected to reveal other known and previously unknown viruses.

In principle, this approach can be used to explore the biology of any number of other pathogens within their biological context.. We believe that this will become a paradigm for providing fundamental information on diversity, distribution and interaction to support epidemiology, modelling and interventions such as diagnostic assays and vaccination regimes.

DIAGNOSIS OF RIFT VALLEY FEVER

THE PATHOGENESIS, CLINICAL DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS IN ANIMALS

Björn Reininghaus

Directorate of Veterinary Services, Mpumalanga Province, Nelspruit, South Africa

Named after the Rift Valley in Kenya and isolated for the first time in 1930, RVF is a peracute or acute zoonotic disease, belonging to the *Phlebovirus* genus of the family *Bunyaviridae*, whose transmission is mainly via winged arthropods.

Pathogenesis

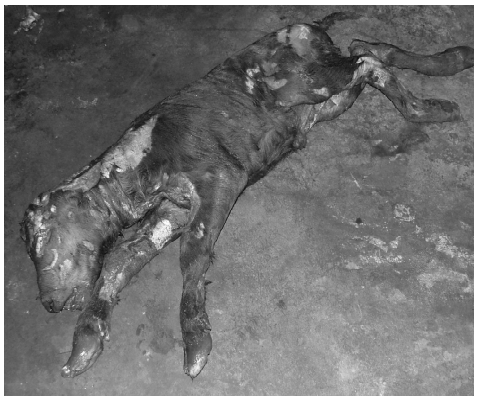
The virus spreads from its port of entry and initial replication sites to vital organs such as spleen, liver and brain, causing damage either directly or via the resulting immune-pathological reactions. After initially replicating in local lymph nodes, it spills into the circulation, causing a first viremia and systemic infection. After further replication in preferred target organs (most notably liver and spleen), a second viremia follows. Specific and unspecific immune response are important for the outcome of the infection, apart from differences in resistance and susceptibility on a species specific and individual level.

The hight of viremic titres, speed of viral spread, severity of organ lesions and thus disease manifestation correspond with different degrees of susceptibility, ranging from a high percentage of severe peracute hepatic disease in extremely susceptible animals (young lambs and kids) to variable percentages of more acute severe hepatic disease in highly (sheep and calves) and moderately susceptible hosts (e.g. cattle, goats and African buffalo), which mostly experience benign infection, to unapparent infection in resistant hosts (e.g. pigs and equips).

Abortions are mainly caused by foetal infection and subsequent death, showing signs of extensive hepatocellular damage, and representing the key clinical symptom of the disease.

The tissue preferences of the virus (*inter alia* macrophages, hepatocytes, renal glomeruli and endothelial cells) correspond with respective organ lesions (e.g. lymphoid and hepatocellular necrosis) and subsequent clinical manifestations.

Pathogenic effects can be caused directly by virus-induced lysis of target cells, e.g. in the peracute hepatic manifestation of new-born lambs. Haemostatic derangements due to endothelial lesions, vasculitis, DIC, as well as the diminished production of coagulation proteins and reduced clearance of activated coagulation factors caused by hepatic damages, results in a drop of tissue perfusion, subsequent organ damage, extensive haemorrhages and fatalities through anemia, shock and hepatorenal failure.



Abortion in captive African buffalo (11 months female foetus)
© B. Reininghaus.

Clinical Diagnosis

Individual/sporadic and/or index cases are often not diagnosed, concurrent factors that should point to RVF have been given as: abortion storms and disease in ruminants, as well as flu-like disease in humans in risk categories after extensive rains. A comprehensive history, including such abiotic factors as season, climate, region etc. is a valuable help in the diagnostic approach.

Most clinical symptoms in ruminants are rather unspecific, with the key symptom being abortion(s).

Other symptoms can be found with numerous other diseases and must be interpreted together with other findings, environmental factors etc., though the described pathogenesis causes a complex of clinical signs that include febrile viremia, lymphadenopathy, hepatopathy, icterus/jaundice and intestinal haemorrhages, against which other potential disease etiologies must be evaluated.

A marked leucopoenia occurs, even in benign infections, simultaneously with peak fever and viremia, as well as increased serum concentrations of certain liver enzymes.

New-born lambs are prone to a peracute course with listlessness, increased respiration, abdominal pain, biphasic fever. Older lambs (over two weeks) can show an unapparent, acute (most) or peracute course, with fever, listlessness, increased respiration and abdominal pain. Other findings can include melaena or bloody diarrhea, muco-purulent nasal discharge, icterus, and enlarged lymph nodes.

The disease affects goats in the same manner as sheep, but regional differences in susceptibilities have been reported. Cattle show lower rates of morbidity and mortality than the small ruminants, with calves reacting similar like goats and kids, though icterus might be seen more often due to prolonged course and thus presentation of liver damage. Adult cattle frequently show an unapparent course. Acute disease occurs though in some individuals, with fever, bloody/fetid diarrhoea, weakness, discharge from cranial mucous membranes, dysgalactia and icterus.

Other reported (unusual) findings, which are suspected to be primarily caused by concurrent infections, e.g. bluetongue, encompass *dermatitis crustosa*, catarrhal and erosive stomatitis, coronitis, laminitis and exungulation.

It appears, that infection in animals classified as moderately susceptible hosts (e.g. cattle and African buffalo) can be of opportunistic character, with clinical disease and fatal outcomes in individuals of lower fitness and/or concurrent other health impairments, due to e.g. advanced age, environmental stress, presence of other infectios agents etc..

Pathological findings on (and sample opportunities during) post-mortems are of great value in establishing a diagnosis, which is especially true for hepatic lesions (variance according to age/species/susceptibility) such as hepatomegaly, disseminated to focal necrosis, subcapsular haemorrhages, congested patches, fibrinous perihepatitis; oedema and haemorrhages in gall bladder wall, blood-tinged bile. Other findings that can be encountered are systemic icterus, enlarged and oedematous lymph nodes, haemorrhages in abomasum with dark luminal content (new born lambs), blood in intestinal lumen (adult sheep and cattle), splenomegaly, marginal splenic infarcts, disseminated haemorrhages (subcutaneous, on serosae and visceral surfaces), bloody effusions into body cavities, lung oedema, lung congestion and nephrosis.

Stillbirth in captive African buffalo : petechiae and oedema of the gallbladder wall © B. Reininghaus

Differential diagnosis

Other (infectious) causes of abortions (apart from poisonous plants) include, amongst others, brucellosis, trichomoniasis, campylobacteriosis, listeriosis, leptospirosis, chlamydiosis, salmonellosis, fungal infections (e.g. *Aspergillus* spp., *Absidia* spp., *Mukor* spp., *Rhizopus* spp., etc.), BHV1, BVD/MD, babesiosis and neosporosis, which must be differentiated by (herd) history, epidemiological traits, foetal development stage, macroscopic findings of the aborted material (foetus and placenta) and further testing.

Other diseases, which must be differentiated clinically include a.o. bacterial septicaemias, such as pasteurellosis (e.g. hemorrhagic septicaemia), salmonellosis and anthrax, enterotoxaemia of sheep, poisonous plants (e.g. *Crotalaria* spp., *Senecio* spp., *Lasiospermum bipinnatum* and *Mycrocystis aeruginosa*), BVD/MD, bluetongue, Wesselsbron disease, Nairobi sheep disease, rinderpest, *peste des petits ruminants* and certain tick-borne diseases (e.g. bovine babesiosis).

For the confirmation of a presumptive diagnosis or suspicion, sampling should include serum or plasma, heparinised or clotted blood from live animals, and tissue samples (most importantly liver, spleen and lymph nodes) in formalin (histopathology very characteristic, can be backed up by IMP), on ice and or in glycerol-saline (PCR, culture, strain identification) from dead animals and abortions.

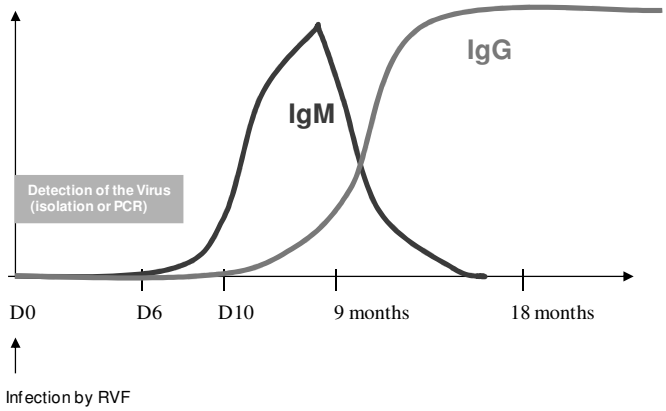
It is of high importance to regard any abortive material as potentially infective/contagious, handle any such material respectively and to spread this information amongst the relevant stakeholders, potential contact persons and animal owners, while simultaneously raising awareness and promoting cooperation with such, especially with regard to the reporting of abortions and diseases amongst their animals

LABORATORY DIAGNOSIS : SAMPLING, SEROLOGY, VIRUS-ISOLATION AND CONSTRAINTS

Catherine Cêtre-Sossah

Dept. Control of Exotic and Emerging Animal Disease, BIOS UMR15,
International Centre of Research in Agronomy for Development (CIRAD), Montpellier, France

RVF is an emerging arthropod-borne viral zoonosis caused by a RNA virus named *Rift Valley Fever Virus* (RVFV) and belonging to the *Bunyaviridae* family, *Phlebovirus* genus. The disease was primarily reported to infect sheep, cattle and goats, producing high mortality in new-borne animals' and abortion in pregnant animals. It is also a zoonosis causing more recently serious epidemics in human population across Africa.



The classical methods for the diagnosis of RVF are, on one hand the isolation and the identification of the virus in tissue and blood samples and on the other hand the detection of antibodies anti-RVFV in the sera of infected animals or human beings.

The isolation of the virus is usually performed on embryonated chicken eggs and on cell culture on different types of cell lines such as Vero, BHK-21 and identification of the virus itself, and can also be done by injecting the suspected tissue sample in baby mice, 1 to 5 days old intra-cerebrally, intra-peritoneally on hamsters and on 2 to 3 days old lambs.

Time frames for detection of the agent by virus isolation or PCR and detection of antibodies (serology) © CIRAD.

Different techniques of PCR (real-time or nested conventional) based on the 3 different segments of RVF are now the bases for the identification of the virus itself. Bird et al., 2007 and Peyrefitte et al., 2008 developed a real-time PCR on the L segment whereas Drosten et al., 2002 described a probe based real-time PCR on the Gn gene in the M segment. Naslund et al., 2008 worked on a Sybrgreen quantitative PCR on the N gene based on the N segment: The gene NSs included in the S segment has been the target of nested conventional PCR (Sall et al., 2001; Sall et al., 2002) and a probe based quantitative PCR (Garcia et al., 2001). Specificity and sensitivity of these PCR techniques will be discussed.

The detection of antibodies to RVFV includes haemagglutination-inihibition, complement fixation, indirect immuno-fluorescence, virus neutralisation tests and ELISA (Swanepoel et al., 1986). Different indirect enzyme linked immuno-sorbent assays (ELISA) have been developed. They are either based on the nucleocapsid protein (Fafetine et al., 2005; Jansen Van Vuren et al., 2007; Paweska et al., 2007; Paweska et al., 2008) or on the crude Rift valley fever virus antigen for the detection of IgG or IgM antibodies (Paweska et al., 2003; Paweska et al., 2005b). They are specific of the animal species tested. The aim of this presentation is to review the different possibilities given to the animal and human health department dealing with RVF in terms of laboratory diagnosis of the disease.

FIELD DIAGNOSIS : RAPID TESTS - NEW DEVELOPMENTS

G. H. Gerdes

Onderstepoort Veterinary Institute (OVI), Agricultural Research Council (ARC), Pretoria, South Africa

In a quote from the popular press, we are reminded that *"...prior to 1977, Rift Valley fever was considered to be a largely veterinary disease of bovine and ovine stock"*.

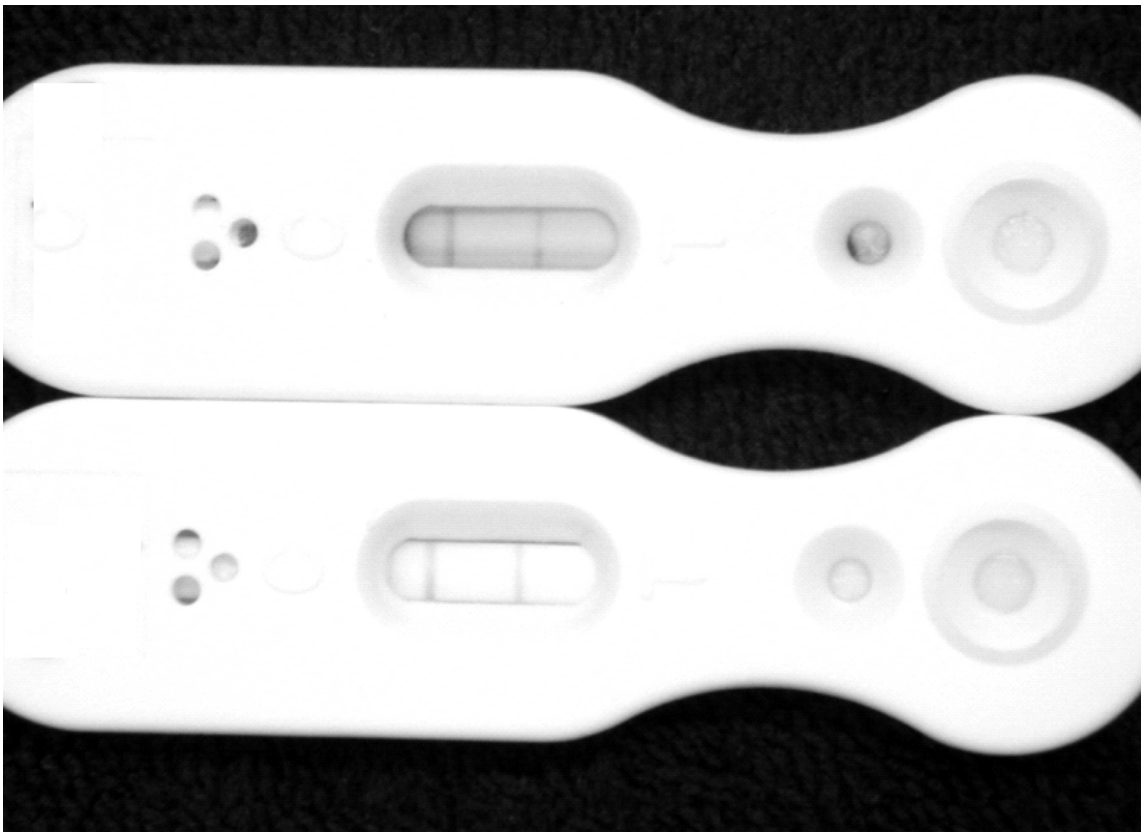
The disease was first recognized in Kenya during an abortion storm in sheep in 1930. The construction of the Aswan High dam in Egypt changed the ecology of the Nile and precipitated a "people epidemic" in 1977. A rapid diagnosis is therefore essential particularly as the human is often the sentinel in a RVFV outbreak.

Laboratory tests are divided into antibody and antigen. There are good, well validated Elisa's available for both IgG and IgM and as there is an early IgM response, serology is a sound diagnostic choice.

Antigen detection is a confirmatory test but exposure must be carefully managed.

Virus isolation may be done in laboratory animals or a number of cell lines and is rapid and easy although staff should be vaccinated or work in BL3 conditions. Organs in formalin are safe and useful. Liver lesions are recognizable on histopathology and an IMP – immunoperoxidase test on pathology sections is confirmatory. A PCR is safe and rapid and is probably the test of choice for antigen.

At the present time, there are a battery of good diagnostic tests available although the cyclical nature of the disease is still not well understood and disease outbreaks are difficult to predict.



A rapid immune-chromatographic test (lateral flow strip test) that can be used for all species (including man), using blood or serum, detects both IgG and IgM and has a specificity of 97% and a sensitivity of 100% © ARC-OVI.

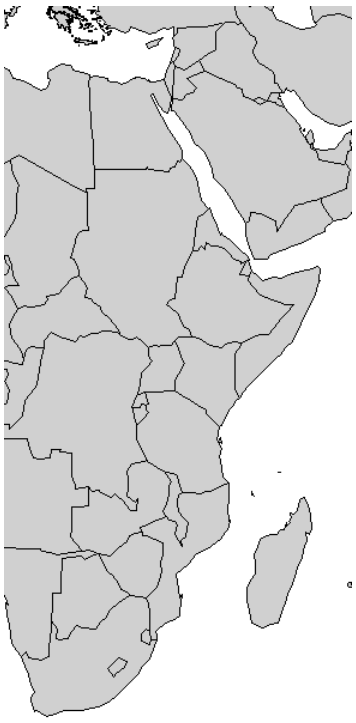
VACCINATION FOR RIFT VALLEY FEVER

CURRENT VACCINES AVAILABLE FOR RIFT VALLEY FEVER

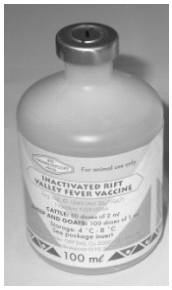
Jacob Modumo

Onderstepoort Biological Products (OBP), Pretoria, South Africa

RVF is a zoonotic virus disease which occurs sporadically in Southern Africa when conditions are favourable. However, the disease seems to has had serious socio-economic impact in other regions such as in East Africa and North-Eastern African countries. The current control measures employed by most countries are vaccination using both the inactivated RVF and the live RVF vaccine. Over 18 million doses of vaccine have been distributed in the last 5 years with more than 70% being in Africa. Less than 4 million doses of inactivated RVF have been, used with Southern African countries using 80% of the product. Though the live RVF vaccine has been effective in reducing the infection rate concerns have been raised over its safety such as abortion, post vaccination teratogenic effects and its usage during outbreak situations. Though the inactivated RVF vaccine has fewer side effects, its immunogenicity has always been in doubt. This poses a challenge for new generation vaccines to be developed.



Region	Doses supplied	Type of vaccine
Middle east	4,000,000	Live attenuated
Horn of Africa, including Sudan, Somalia and Djibouti	8,000,000 340,000	Live attenuated Inactivated
East Africa, including Kenya, Uganda and Tanzania	2,700,000	Live attenuated
Southern Africa, including Madagascar	3,100,000 < 1,000,000	Inactivated Live attenuated



OBP inactivated vaccine

OBP live attenuated (Smithburn) vaccine

Onderstepoort Biological Products (OBP) sales figures per region and per type of vaccine (between January 2005 and January 2009) © OBP Ltd.

Baptiste Dungu

Global Alliance for Livestock Veterinary Medicines, Bush Loan, Edinburgh, United Kingdom

Although endemic in most regions of the African continent, RVF's irregular occurrence has brought veterinary authorities to device different control strategies, based on local circumstances. Three approaches are broadly employed on the continent: continuous yearly vaccination, emergency vaccination at the first signs of an outbreak and no vaccination. In Southern and Eastern Africa, RVF control has relied on vaccination since the 1950s. Millions of doses of the cell cultured RVFV Smithburn vaccine have been produced in Kenya and South Africa, and used over the years. While in Southern Africa, yearly vaccination has been part of disease management programs at farm level, in East Africa vaccination in recent years has been conducted or recommended at the first signs of or during outbreaks. In West Africa, where several outbreaks have occurred over the last 15 years, no vaccination is conducted. In Egypt large scale vaccination is conducted with the inactivated RVF vaccine. Due to safety concerns associated with the live Smithburn vaccine, interventions during outbreaks require very close monitoring. The Smithburn vaccine tends also to generate limited antibody response in cattle.

Discovery Research	Development	Registration	Marketing	Sustained Delivery
Technical challenges	Lack of funding for development studies	Unclear and varied regulatory requirements.	Lack of market pull-through	Inconsistent supply
Lack of appropriate product profiles	High risk, high cost	Lack of QA/QC	Poor estimates of need or demand	Counterfeit products
Ill-designed proofs-of-concept	Poorly designed, poorly controlled field trials.	Multiple regulatory authorities.	Inappropriate pack-sizes	Lack of patent protection
			Lack of knowledge or education on proper use	Poor quality and efficacy

Barriers to the availability of appropriate new products © GALV-Med / B. Dungu.

In an attempt to address the above problems, formalin-inactivated and aluminium hydroxide adjuvanted RVF vaccines based on wild type viruses have been developed, and used. Although suitable for most susceptible animal species at all physiological stages, as well as the generation of colostral immunity, the inactivated RVF vaccines have limited efficacy and are expensive to produce and implement. Several attempts have been made to address the safety and efficacy problems of the above vaccines. These have included subunit, recombinant, virus vectored and DNA vaccines as well as natural and induced mutants. One of the most advanced developments is the RVF Clone-13 vaccine, based on a natural mutant virus, isolated from a non-fatal human case in the Central African Republic. The RVF Clone-13 has been extensively tested in South Africa and is undergoing the registration process.

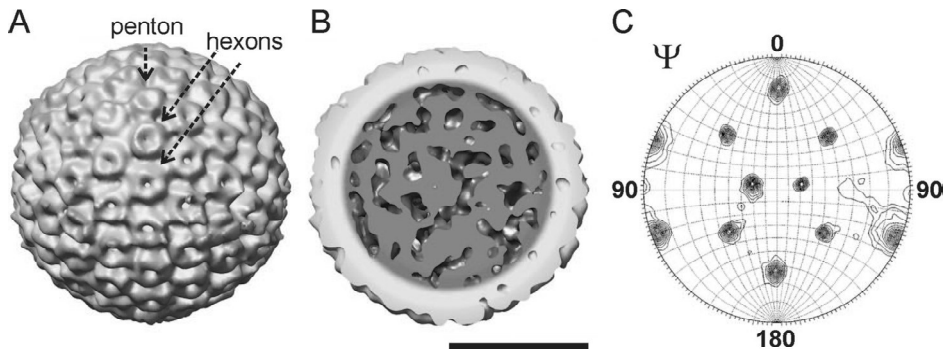
While RVF vaccines are clearly effective in controlling RVF, the yearly vaccination strategy is unlikely to be widely adopted in most regions due to the high cost involved and the irregular occurrence of the disease. One strategy currently being explored in order to address the problem is the development and subsequent use of multivalent or combination vaccines, containing the RVF antigen together with the antigen of a different vaccine that is more likely to be used regularly (such as *Lumpy Skin Disease* [LSD], sheep pox etc.).

The different vaccine technologies and overall contribution of animal vaccination in the control of RVF will be discussed.

David Wallace

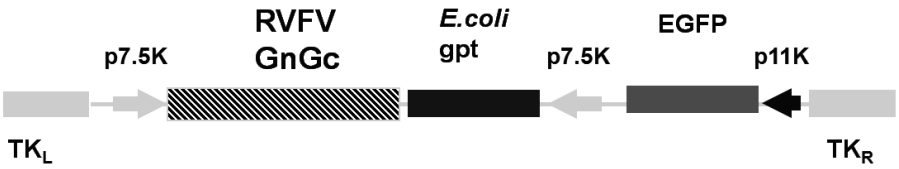
Onderstepoort Veterinary Institute (OVI), Agricultural Research Council (ARC), Pretoria, South Africa

As the continued threat of the spread of RVF into new territories and its potential for use as a bioterrorist weapon is ever-present, research laboratories worldwide are involved in the quest to develop better vaccines utilising new advances in vaccine technology. Most incorporate molecular approaches – controlled mutagenesis (MV P12), reassortments (R566), subunit (baculovirus, E. coli-expressed antigen), DNA and viral-vectored (poxvirus, Sindbis). Reverse genetics is the next stage in directed-mutagenesis and attenuated virus production, and has helped to elucidate possible roles for viral proteins such as the NSm.



RVF-virus structure © Freiberg et al., 2008

Poxviruses have been developed as vectors for recombinant vaccines and both vaccinia virus and the cattle poxvirus, *Lumpy skin disease virus* (LSDV), have been evaluated as vectors for RVF vaccines. Animal trials at the *Onderstepoort Veterinary Institute* (South Africa) with a LSDV-vectored construct protected both mice and sheep from virulent *Rift valley fever virus* (RVFV) challenge. This construct has dual-protective potential for RVF and LSD (and, possibly sheep and goatpox).



Lumpy skin disease virus-vectored RVFV experimental vaccine (c) D. Wallace, OVI-ARC.

New developments in delivery systems (nanoparticles) and adjuvants allow specific immune responses to be targeted, and improve the levels and duration of immunity.

CONTROL OF RIFT VALLEY FEVER

OIE STANDARDS FOR RIFT VALLEY FEVER CONTROL, VACCINES AND DIAGNOSIS

Lea Knopf

Scientific and Technical Department, World Organisation for Animal Health (OIE), Paris, France

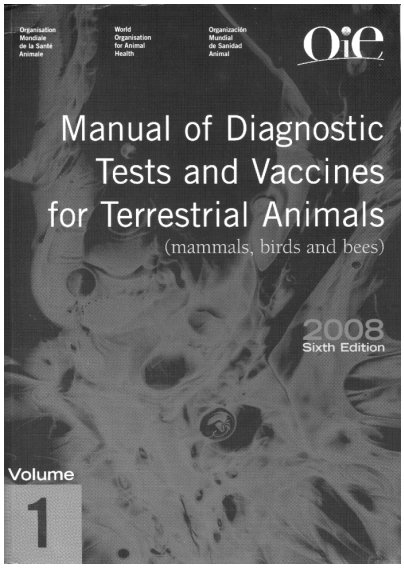
The OIE biological standards, the *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* (Manual), provide a harmonised approach to disease diagnosis by describing internationally agreed laboratory diagnostic techniques. The (Terrestrial) Manual also includes requirements for the production and control of biological products (mainly vaccines). These recommendations are complementary to the provisions described in the *Terrestrial Animal Health Code.*

In view of the zoonotic nature of RVF, the Manual recommends to apply preventive measures to protect any (laboratory) personnel from infection while handling live RVF virus, be it in the form of samples containing virus or during vaccine production.

Identification of the agent in live animals may be achieved through collection of blood samples during the febrile phase. Additionally or alternatively, samples from liver, spleen or brain of dead animals or aborted fetuses can be harvested. Cell culture, immuno-histochemistry or –diffusion and reverse-transcriptase PCR are described for RVF virus identification.

In terms of serological tests; the prescribed test for international trade is the *Virus Neutralisation Test* (VNT). This highly specific test can be used in serum samples of any species and will record early immune response. A number other serological tests such as indirect ELISAs, haemagglutination-, AGID-, immuno-fluorescence-techniques are available. However, when using these tests, cross-reactions may occur between RVF virus and other phleboviruses. The advantage of these tests is that they can be performed with inactivated virus antigen thereby avoiding contamination with live virus and infection.

Depending on the epidemiological situation of RVF in the country or zone, any control strategy should be designed taking into account factors such as geography, climate and other agro-environmental aspects, ruminant and mosquito population distribution, livestock husbandry practices and proximity to areas where epidemics have recently occurred. The implementation of control measures or their combination needs to be adapted to the situation encountered. Attempts to control RVF outbreaks may imply a strong common commitment and collaboration between the veterinary services, other sectors and the veterinary services of neighbouring countries. Vaccination is one of the tools that support veterinary services in the control of the disease. Vaccination against RVF is mainly aiming at reducing the occurrence of clinical disease and depending on the vaccine and species can considerably reduce the risk of infection.



The Manual contains general guidelines for veterinary vaccine production and quality control. Both inactivated and attenuated live vaccines are available. Inactivated vaccines are more suitable for the vaccination of pregnant animals and are recommended to be used in RVF free countries. Attenuated vaccines have a better potential to protect the animals with a lifelong immunity against clinical disease, but are teratogenic in pregnant ruminants. When using the inactivated vaccine, after the initial vaccination a booster dose has to be and annual re-vaccination is recommended. When conducting mass vaccination campaigns, countries should consider monitoring the vaccination coverage in the susceptible animal population.

The latest version of the Manual, in two volumes (2008)

FAO GUIDELINES ON EMERGENCY PREPAREDNESS FOR RIFT VALLEY FEVER, ALTERNATIVE STRATEGIES FOR THE DEVELOPMENT AND APPLICATION OF NATIONAL DISEASE CONTROL PROGRAMMES

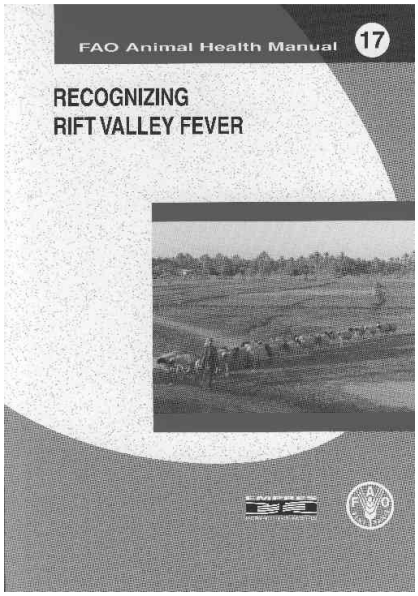
Stephane de La Rocque

EMPRES / Animal Production & Health Division (AGAH)
FAO - Food and Agriculture Organisation of the United Nations, Rome, Italy

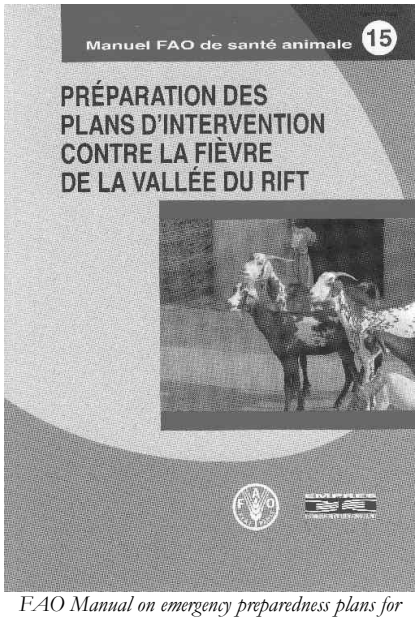
Since the last outbreaks in the late 90th, FAO has developed standardised guidelines described in its manual on RVF control implementation strategies. In brief, these guidelines follow six principles:

- detection and establishment of the magnitude of the RVF epidemic (active and passive surveillance activities and rumours investigations),
- control of animals and animal product movements,
- reduction of human infection through public awareness campaigns,
- vaccination of livestock when appropriate,
- vector control when feasible and appropriate,
- promotion of preventive measures in professionals at risk.

The speaker will present some practical example of what has been set up in different countries (Kenya, Tanzania, Sudan and Madagascar) during the last outbreaks, and how emergency action plans have been elaborated in collaboration with the national authorities, international organisations and others actors including donors.



FAO Manual on the recognition of RVF (FAO, Rome, 2003).



FAO Manual on emergency preparedness plans for RVF (French version) FAO, Rome, 2003

REGIONAL STRATEGIES. THE EXAMPLE IN THE INDIAN OCEAN

Matthieu Roger [1,2] *& Eric Cardinale* [1,2]

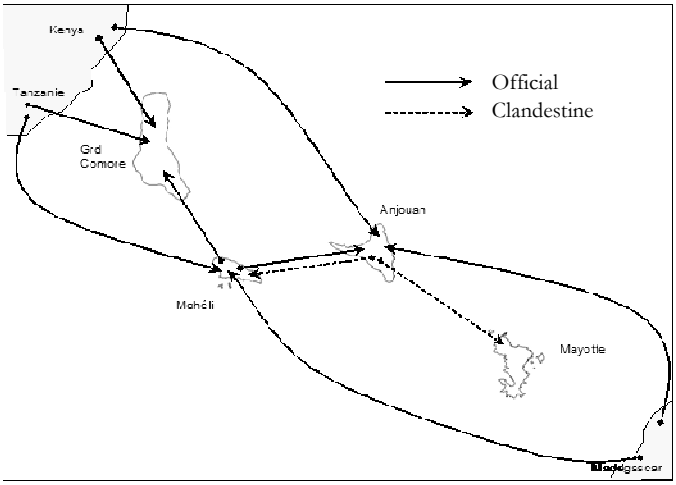
[1] International Centre for Research, Development and Agronomy (CIRAD), Montpellier, France
[2] Centre for research and surveillance of emerging diseases in the Indian Ocean (CRVOI), Sainte Clotilde, La Reunion

The Centre for research and surveillance of emerging diseases in the Indian Ocean (CRVOI), is a scientific association between the French state and 8 scientific French organisations. This centre was established in 2007 following the chikungunya epidemic, and is located in the Indian Ocean area, on *La Réunion* island.

The CRVOI action programme is centreed around : (i) investigating infectious diseases of interest for the Indian Ocean area in order to obtain technical and scientific intelligence *("data mining")* regarding these diseases, (ii) lead a regional co-operation on emerging infectious diseases with the other Indian Ocean countries and (iii) propose training sessions.

As a research operator, CRVOI developed a new scientific co-operating programme on animal emerging diseases within the Indian Ocean : "Animal Risk". This programme is conducted on the Indian Ocean islands of Madagascar, Comores, Mayotte, Seychelles, Mauritius and Réunion.

"Animal Risk" has a particular focus on diseases of great importance, i.e. with an impact on human health or livestock economy (HPAI, Newcastle Disease, Classical and African Swine Fever, West Nile Fever and Rift Valley Fever). This programme has four objectives, particularly for RVF control, (i) to update the epidemiological data in the Indian Ocean islands, (ii) to understand the way of introduction or spread of this disease within the Indian Ocean, (iii) to propose the relevant control measures taking to account the socio-cultural and economic context of each country, and (iv) to develop useful diagnosis tools to be used in the field.



Risk assessment : legal and illegal introduction routes between the mainland, Comoros, Mayotte and Madagascar © CIRAD.

Expectations of "Animal Risk" are, (i) to fulfill a data base accessible online for the country, (ii) to define and estimate the introduction/spread risk for particular disease (ie RVF), (iii) to develop quick diagnostic tests for field decision, (iv) to build up new surveillance/research projects, and (v) to publish reports for countries and financers and scientific communications.

Besides the expectations described before, this program aimed at strengthening the collaboration between the different veterinary authorities in order to build up an early warning system and a common response to tackle any new disease entity that could be a threat in the Indian Ocean.

RESPONDING TO POTENTIAL OUTBREAKS AND RISK-BASED DECISION MAKING

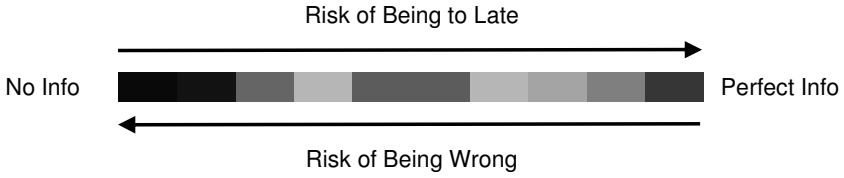
Jeffrey C. Mariner [1], Christine C. Jost [1], Keith Sones [1], Bernard Bett [1], Simon Kihu [1], Serge Nzietchueng [1], George Njogu [2], Emmanuel Swai [3], Bruno Minjauw [4], Juan Lubroth [4], William Amanfu [4], Stephane de La Rocque [4] & Vincent Martin [4]

[1] International Livestock Research Institute (ILRI), Nairobi, Kenya
[2] Department of Veterinary Services, Nairobi, Kenya
[3] Veterinary Investigation Centre, Department of Veterinary Services, Arusha, Tanzania
[4] United Nations Food and Agriculture Organisation (FAO), Rome, Italy

In East Africa, RVF endemism is punctuated by explosive disease outbreaks associated with flooding due to periods of unusually heavy rain fall, livestock abortion storms, mortality in young livestock and wide spread human infection leading to death in a small percentage of cases. The rapid course of outbreaks and their infrequent and irregular occurrence pose special challenges to mounting effective emergency responses. Historically, decision making regarding RVF and many disease emergencies has been relied on an all or none approach based on a confirmed diagnosis of an index case.

The 2006-2007 RVF outbreak in East Africa brought forward important lessons concerning early warnings, risk-based decision making in responding to the threat and reality of RVF outbreaks. Retrospective analysis of outbreaks using participatory epidemiology and standard questionnaire techniques indicated that livestock owners were aware of risk factors associated with RVF and the clinical presentation and course of the disease in livestock. In Somalia areas, RVF was referred to as "*sandik"* and was associated with flooding, swarms of mosquitoes with white legs, abortion and hemorrhage. Livestock owners indicated that they had observed the onset of risk factors and cases of disease in livestock before the international RVF early warning was issued in November 2006.

Construction of timelines of events indicated that most response interventions occurred as the outbreak was naturally resolving and suggested a number of decision points where more timely preparatory action could have been taken. If a phased approach to decision-making had been used where actions were taken in proportion to evolving risk levels, the impact of mitigation interventions may have been increased. In addition, it was noted that early warning indicators needed to be reassessed and increased emphasis placed on predictive indications as opposed to certainty of outcome. Many of these lessons were taken up in the 2008 East African RVF early warning and the response to the warning. This resulted in a higher level of preparedness.



Decision making trade-off © J. Mariner, ILRI.

OIE STANDARDS WITH RESPECT TO RIFT VALLEY FEVER AND TRADE (THE CODE)

Lea Knopf

Scientific and Technical Department, World Organisation for Animal Health (OIE), Paris France

The *World Organisation for Animal Health* (OIE) is mandated in terms of the *Sanitary and Phytosanitary Agreement* (SPS Agreement) of the *World Trade Organisation* (WTO) to develop minimum standards, guidelines and recommendations to facilitate the trade in terrestrial and aquatic animals and their products. The impact of these standards are however, not only related to trade facilitating measures but also to serve the overall objective of the OIE in promoting global animal and human health. These science-based standards are developed through elected Specialist Commissions and are adopted democratically by OIE Members during the annual OIE General Session consisting of the official Delegates of the 172 Members of the OIE. The OIE trade standard, the *Terrestrial Animal Health Code*, aims to assure the sanitary safety of international trade in terrestrial animals and their products. The international standards are recommendations and may serve as guidelines for any veterinary services in the world to develop their own national provisions. The OIE international standards have evolved successfully from focusing originally on safe trade standards, towards standards that promote the capacity to control animal diseases and zoonoses worldwide, if the measures proposed are implemented accordingly.

OIE standards are dealing with generic aspects, such as ethics in international trade, guidelines for animal health surveillance or the quality of national veterinary services, a condition for importing countries to trust the reliability of health certificates accompanying consignments of animals and products in cross-border trade as these certificates must be issued exclusively by the veterinary services under the full responsibility of the government of the exporting country.

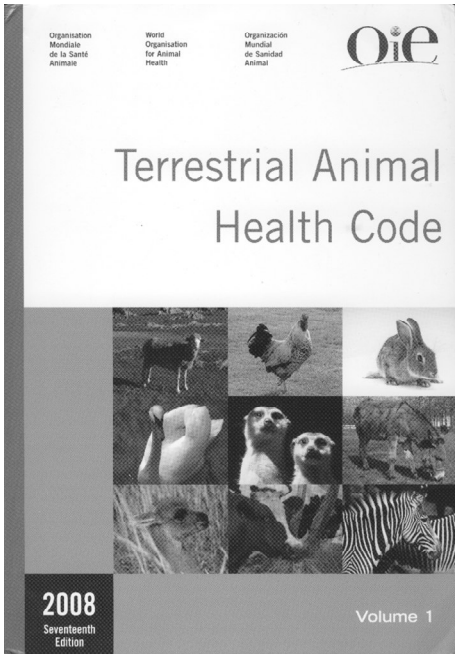
The standards address recommendations on each of the animal diseases and zoonoses which are listed by decision of the General Assembly of OIE Members. In most cases the recommendations describe the methods to be applied by national veterinary services to conduct surveillance for these diseases, detect them more easily and control them, before a Member Country or Territory can, if appropriate, be considered free from a given disease. The chapter on RVF includes recommendations aimed at avoiding any trans-boundary spread of the disease during the export of live ruminants or ruminant products such as meat, meat products and embryos. The international standards for zoonotic diseases, such as RVF, although also aiming at the prevention of international spread of the disease between animals, by implication also aim to enhance the protection of human health through control of the disease in the animals.

Transport of goats in Namibia © advocacy.britannica.com

The Code chapter on RVF is based on general provisions for minimum requirements for Veterinary Services and RVF specific aspects. The recommendations include provisions for ruminants including camels and their products. The Code provides for the purpose of trade, a definition of a *"RVF infection free country or zone"* and provisions for safe trade in domestic and wild ruminants for both categories, *"RVF infection free country or zone"* and *"infected country or zone"*. For trade purposes different risk mitigating measures (diagnostic tests, vaccination, quarantine and other shipment conditions) apply for trade with infected countries or zones depending on the presence or absence of RVF (clinical) disease.

A country or zone can be considered free from RVF infection when: RVF is a notifiable disease and (a) either the country or zone are not adjacent to or situated outside historically infected regions, or (b) in case of a RVF infection in the past, a country or zone can be re-considered free from infection as soon as a surveillance programme has demonstrated no evidence of RVF infection in humans, animals or mosquitoes in the country or zone during the minimum past 4 years. A RVF infection free country or zone, as defined above, may not loose its free status when importing seropositive animals if those are permanently marked or destined for direct slaughter.

The historic distribution of RVF is currently limited to the sub-Saharan African continent, Madagascar and the Arabian Peninsula. Due to the nature of the disease this may change over time. In the absence of clinical disease, the RVF status of a country or zone within the historically infected regions of the world should be determined by a surveillance programme focusing on mosquitoes and serology of susceptible mammals. The programme may target high risk areas considering trade patterns, historical, geographic and climatic factors, ruminant and mosquito population distribution, and proximity to areas where epidemics have recently occurred. All claims for disease/infection freedom or disease/infection absence should be verified by sound epidemiological surveillance and laboratory confirmation of animal (and human) cases. The monitoring of wildlife requires interdisciplinary approaches and may not follow classical methods of surveillance. General guidelines for insect vector surveillance were developed and will shortly be proposed for adoption by the General Assembly of the OIE Members.



Latest version of the OIE Terrestrial Animal Health Code, in two volumes (17th edition, 2008).

The OIE encourages its Members to facilitate and mandate national and international notification of outbreaks. Epidemiological data should be collected, processed, analysed and disseminated rapidly, also between different administrative levels. The OIE, along with other international organisations such as the WHO and FAO, encourages close collaboration, including exchange of disease data, between the human public health sector, environmental / wildlife conservation agencies and the veterinary authority to improve the knowledge on RVF occurrence and its epidemiology within a country or a region to identify risk areas.

RIFT VALLEY FEVER RELATED TRADE ISSUES IN THE MIDDLE-EAST

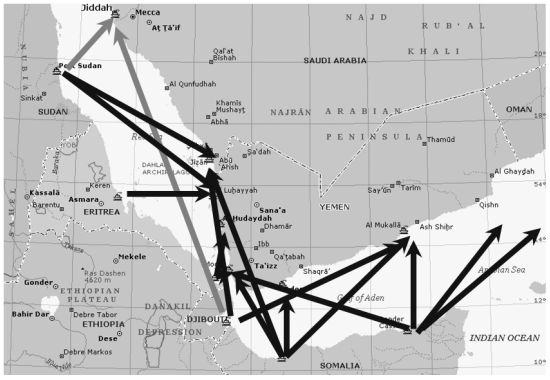
Ghazi Yehia

Regional Representation for the Middle East, World Organisation for Animal Health (OIE), Beirut, Lebanon

An important traditional livestock trade exists between countries in the Horn of Africa and countries in the Middle-East. Each year, about 15 millions cattle, goat, sheep are imported from the Horn of Africa to the Gulf Peninsula, most of them for the holy periods (*Hadj – Eïd*). Several constraints affect this trade and a major challenge is to manage the risk of disease spreading with such livestock shipments, such as new strains of FMD, CBPP, RVF.

RVF is of great concern in that it is still spreading in Africa, killing more than 400 people since 2006 and its re-occurrence in East and South Africa, and it has already been introduced in the Middle-East. The introduction of RVF into Yemen and Saudi Arabia in 2000, its first appearance outside the African continent, was of particular concern related to its impacts on public health, causing human suffering and mortalities (around 200 people died). Introduced with the trade movement of animals from the Horn of Africa, RVF persisted until 2001 notably with the movement of animals in a northerly direction from Yemen into Saudi Arabia, probably continued unaltered for centuries. Since that period, no more outbreaks were observed in the Middle East despite ecological environment favourable for the persistence of the virus.

To face this important challenge, the good governance of Veterinary Services, in compliance with OIE international is a key factor to minimize the threat of the disease. Relevant epidemiological surveillance, contingency planning, early detection, rapid response and transparent notification are essential to be implemented both for importing and exporting countries in order to control and prevent the spread of the disease.



For trade purposes, the respect of OIE international trade standards on RVF is a guarantee to secure the trade of animal and animal products. To this end, the OIE Regional Representation for the Middle East has established model of sanitary certificates in compliance with the OIE *Terrestrial Animal Health Code.*

Livestock trade with the Horn of Africa © map : Microsoft.

At higher level, regional and international strategies for RVF prevention and control need to be maintained and strengthened.

The implementation of new OIE reference laboratories for the diagnostic of the disease, notably using the OIE twinning procedure, is a priority as well as the establishment of an adapted regional predicting model for the Middle East with scientific support.

The coordination between all actors, International Organisations, national Veterinary Services, and NGO's is essential. In such matters, the project to implement large pre-export quarantine premises in the Horn of Africa is exemplary.

In conclusion, importing countries in the Middle-East must be given adequate safety assurances with respect to OIE standards on RVF, while the livestock trade, vital to the livelihood of agro-pastoralists in Africa and in the Middle-East, should be permanently maintained on a safe basis.

THE WAY FORWARD

FUTURE RESEARCH NEEDS FOR RVF CONTROL – VACCINES, VECTOR MONITORING AND DIAGNOSTICS

James O. Mecham, Myrna M. Miller, Kristine E. Bennett, Will K. Reeves, Barbara S. Drolet & William C. Wilson.

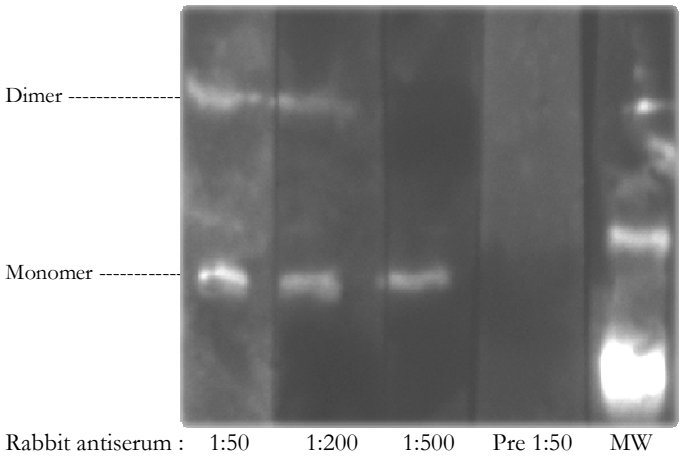
USDA, ARS, Arthropod-Borne Animal Diseases Research Laboratory, Laramie, Wyoming, USA

The control of RVF outbreaks requires sensitive and specific diagnostics, effective vector monitoring and management, and vaccination of humans and animals. The *Arthropod-Borne Animal Diseases Research Laboratory* has a multidisciplinary scientific team comprised of microbiologists, entomologists, molecular biologists and veterinarians, who are addressing these three aspects of RFV control.

The objectives of the research are threefold : (1) determine which North American species of mosquitoes could serve as competent vectors for both wild type RVFV and attenuated RVFV vaccine candidates; (2) develop expression and delivery systems to advance the discovery of diagnostics and vaccines; (3) develop operator-safe diagnostic tests for sensitive and specific detection of RVFV, including the differentiation of infected from vaccinated animals.

To accomplish these research objectives, the ABADRL has established a number of national and international collaborations. Vector competence studies with North American mosquito species have shown that both infection and dissemination of virus in the insect are required for effective transmission of RVFV to a susceptible vertebrate host. These studies also suggest vector competence is variable between populations of mosquitoes.

In an initial study, a potential North American vector (*Aedes aegypti*) for RVFV failed to transmit an attenuated vaccine strain of this virus (MP12) from vaccinated sheep to hamsters. A second potential vector (*Culex quinquefasciatus*) was not infected after feeding on blood from vaccinated sheep.



Western Blot of MP12 and dilutions of rabbit antiserum to expressed RVFV nucleocapsid protein © USDA-ARS.

On the diagnostic front, RVFV gene expression plasmids have been received from various collaborators and proteins expressed, purified, and incorporated into a binding enzyme-linked immuno-sorbent assay (b-ELISA). This assay detected specific anti-nucleocapsid and anti-glycoprotein antibody in the serum of sheep that had been experimentally infected with wild type RVFV. The expressed proteins, as well as MP12, are being used to produce antibody reagents for immuno-histochemistry, and to develop additional diagnostic assays- such as a competitive ELISA. The laboratory is also developing multiplex real-time RT-PCR assays targeting all three RNA genome segments of RVFV. In cooperation with international collaborators, both the nucleic acid and antibody-based assays will be evaluated and validated with field specimens.

RECOMMENDATIONS FROM THE DAKAR (2004), SHARJA (2004) AND CAIRO (2007) MEETINGS

Bonaventure J. Mtei & Patrick Bastiaensen

Sub-Regional Representation for Southern Africa, World Organisation for Animal Health (OIE), Gaborone, Botswana

Reference is made to the recommendations and resolutions of three regional meetings on RVF which took place in Africa and Middle-East since 2004 (a) the Dakar meeting (Senegal), from 20 – 22 January 2004, organized by PACE (AU-IBAR) with the support from CIRAD, EISMV, FAO, IRD, ISRA, OIE and Institut Pasteur. Participating countries (5) included Chad, Gambia, Mali, Mauritania and Senegal; (b) the Sharja meeting (United Arab Emirates), from 21 – 22 November 2004, organised by AU-IBAR with the assistance of the OIE and the Red Sea Commission (LTC) ; and (c) the Cairo meeting (Egypt), from 13 – 15 June 2007, organised by both the OIE Regional Representations for Africa and the Middle-East, with the support from ARC-OVI, AU-IBAR, CIRAD, FAO, GALV-med and USDA-APHIS. For the latter two meetings, participating countries (14) included Bahrain, Egypt, Eritrea, Kenya, Oman, Qatar, Saudi Arabia (KSA), Somalia, Sudan, Uganda, United Arab Emirates (UAE), Yemen and others.

Looking closer at the outcomes of these meetings may shed some light on the possible way forward for the management of the disease in Southern Africa, and possible pitfalls that must be avoided, e.g. in terms of vector control, recommendations highlight the use of practical measures : pour-on, repellents, smoke, as well as evasive measures (for semi-transhumant or pastoral livestock), the need for information – communication and capacity (building) of veterinary staff on vector species, biology, and ecology.

While vaccination issues are always discussed, recommendations are not usually straightforward, nor binding, raising cost–benefit concerns, pros and cons of commercial vaccines versus 'home grown' products and the need for the development of better vaccines and vaccine strains. In terms of surveillance, recommendations very much refer to the OIE surveillance guidelines, the need for capacity-building and technical assistance, the effects of climate change, the use of predictive epizootic models and the need for regional cooperation/networking. The need for agreed and harmonized regional strategies is paramount when dealing with early warning, with recommendations further pointing at the need for thresholds for alerts, based on abortions, IgM detection and/or virus isolation. Recommendations also highlight the need for rapid diagnostic tests (pen-side field tests), the need to prioritise high risk areas and define climatic triggers in view of epizootic model predictions and forecasts.

Specific to OIE mandates, such as transparency in reporting and trade implications, recommendations underline the overall requirement of good governance of veterinary administrations, including the immediate reporting of exceptional disease events to neighbouring countries, OIE (WAHIS), FAO, AU-IBAR ànd the national public health administration, which is expected to further report to WHO. No mention is made of GLEWS in any of the recommendations. As far as trade implications are concerned, recommendations focus on the need for agreed regional containment strategies (based on OIE standards and guidelines), harmonisation of RVF-related trade regulations, the introduction of health certificates for intra-regional trade and the need to impose reasonable trade-restrictions (in scope and in time) after an outbreak is declared in a trading partner's country.

Outbreak management requires established emergency preparedness plans, a coordination mechanisms between veterinary and public health authorities, a legal foundation to impose internal/domestic movement bans, epidemio-surveillance and professional information – communication. Whether the recommendations emanating from some of these meetings to vaccinate in the course of an outbreak, are still defendable remains subject of scientific debate. When referring to post – outbreak management, participants emphasised the need for serological surveys.

RECOMMENDATIONS FROM THE RVF SYMPOSIUM IN CAIRO (JANUARY 2009)

William Wilson

USDA, ARS, Arthropod-Borne Animal Diseases Research Laboratory, Laramie, Wyoming, USA

The USDA, ARS, sponsored the workshop entitled *"Rift Valley Fever Workshop : An Integrated Approach to Controlling Rift Valley Fever in Africa and the Middle East"*, January 26-29, 2009, in Cairo, Egypt.

The Workshop aim was to explore the causes behind the emergence RVF in the Middle-East and identify the research needed to effectively prevent, control and eradicate RVF. The workshop sought to engage RVF experts towards mitigating RVF with focus on the three pillars of RVF control : (1) vectors of disease transmission, (2) animal health, and (3) human health. The workshop examined the premise that research in these areas will generate novel ideas for an integrated approach for controlling RVF in the Middle-East and Africa.

The outcome of the workshop will be a report that identifies for each of the three pillars: (1) gaps that can be addressed by research, (2) steps that must be taken to address those gaps, and (3) establishing strategic research collaborations to close the gaps.

This workshop, organized by Drs. Cyril Gay and Dan Strickman (USDA-ARS Office of National Programmes), and Dr. Ibrahim Shaqir (USDA-ARS Office of International Research Programmes), succeeded in allowing scientists from seventeen countries to make contacts with numerous individuals and institutions involved with RVF research.

Participants at the RVF workshop : an integrated approach to controlling RVF in Africa and the Middle East", January 2009, Cairo, Egypt.

The meeting will result in a report summarizing the main discussion points including a comprehensive research gap analysis and recommended research projects to address high priority gaps. It is anticipated that the results of this workshop will lead to collaborative "One Health" research that will not only help the U.S. prepare for a potential introduction of this zoonotic disease but perhaps control the disease at the source.

DEVELOPING A REGIONAL STRATEGY FOR RVF CONTROL IN SADC : OPPORTUNITIES AND CONSTRAINTS

Susanne Münstermann [1], Patrick Bastiaensen [2] & Bonaventure Mtei [2]

[1] ECTAD Southern Africa, Food and Agriculture Organisation of the United Nations (FAO), Gaborone, Botswana

[2] Sub-Regional Representation Southern Africa, World Organisation for Animal Health (OIE), Gaborone, Botswana

RVF is a vector-borne zoonosis and *trans-boundary animal disease* (TAD). The disease is especially challenging to detect and to control because of its episodic nature, with outbreaks occurring on average at intervals of around a decade but sometimes twice as long, In the intervals between outbreaks there is a tendency for veterinary departments' institutional memories to be lost. A wealth of knowledge has been collected on the disease and its vectors and together with WHO, FAO is working on forecasting systems, based on scientific information such as RVF risk maps developed by the NASA Goddard Space Flight Centre and issue early warning messages under "EMPRES WATCH". FAO has also engaged in many projects in support of developing surveillance and control mechanism for the animal health aspects of the disease, often in close collaboration with WHO for the human health aspects. The *World Organisation for Animal Health* (OIE) in its *Terrestrial Animal Health Code* has laid down standards and regulations for disease declaration and trade. On the African continent, the disease occurs in clusters of countries in North, West, East and Southern Africa. Although only five countries in Southern Africa have been affected over the past years, there is an imminent threat of invasion of more countries due to the presence of the disease in East Africa and other risk factors, such as climate change with associated flooding and changes in rainfall patterns. In recognition of this risk and in an attempt to strengthen the SADC region's capacity to control all major TADs, a regional workshop has brought together experts from all fields that are involved with RVF control, both in animal and human. OIE, FAO and AU-IBAR under the umbrella of the Regional Animal Health Centre for Southern Africa have come up with a proposed framework for the development of a regional strategy for the control of RVF. This proposal was presented at the regional workshop for validation and further improvement through integration of the workshops' recommendations into the proposal.

Five countries in the SADC region have experienced outbreaks of RVF in the past three years, and it is believed that other countries in the region are also at risk. RVF is a classical TAD with zoonotic character that can bring about drastic economic and social hardship to the affected areas. This disease calls for a regional approach in terms of regional policies and strong technical and diagnostic support from regional service institutions. The SADC region is determined to improve control of the major TADs such as FMD, CBPP, ASF in order to improve conditions for intra-regional and international trade. RVF as an important zoonosis and TAD needs to be integrated into this effort and strategies for regional and national control should include this disease.

The overall objective is to prevent introduction and spread of RVF for the benefit of public health in the SADC region, while the specific objectives are :

- To capacitate Veterinary Services in SADC Member States in early detection and diagnosis of RVF
- To determine the best approaches to prevention and control for SADC countries at different risk levels

The expected results are :

1. Risk levels of SADC Member States are determined. The 15 MS in the region fall into different ecological zones and are therefore at different levels of risk for RVF. It is envisaged to carry out a risk assessment and to categorise these countries into different risk clusters. Surveillance systems based on environmental zonation will be introduced at country level and early warning systems for each risk cluster will be developed.

2. The SADC region is better prepared for early diagnosis, early warning and risk communication. Regional diagnostic service provision by the existing OIE-FAO Reference Laboratory (OVI in South Africa) will be strengthened, but the identification and upgrade of a second regional service laboratory will also be promoted. A regional early warning system hub will be set up to issue timely warnings to SADC Member States. The role of the *Regional Animal Health Centre* (RAHC) for Southern Africa in the coordination of the proposed framework will enhance the regional approach of this proposal. Dissemination of results will use established SADC livestock sector bodies, such as the *Livestock Technical Committee* and its Sub-Committees, e.g. the Laboratory Sub-Committee for sustainability and ownership of the activities,

3. Capacity building for the different risk categories will be implemented. The capacity building program will be designed differently for the countries in each risk group. The following elements will be included to different extend for the different risk groups: laboratory personnel (diagnosis, bio-security), veterinary field personnel (surveillance, control, bio-security); risk groups (meat inspectors, abattoir workers, vendors) and policy makers (through SADC bodies).

4. Improved vaccine availability and use will be promoted. RVF vaccines are available but are not widely used. This result will address the pro's and con's of vaccination use and options and will come up with guidelines for optimised vaccine us.

5. A regional control strategy for SADC will be developed. It is envisaged to develop one regional control strategy with different chapters for the different country risk clusters that have been identified under result 1. The project will support the transformation of this regional strategy into national emergency preparedness plans. It will follow the approaches that have been taken successfully for HPAI for which SADC developed a regional preparedness and response plan as well as guided Member States in developing national plans.

In addition to the five results directly addressed by this proposal, there could be additional areas that could be added, if interested stakeholders would like to collaborate and co-fund them in order to complement the core proposal. They are mainly research based proposals.

- New vaccines developed. Research into Vaccine development could be an added element to this proposal. Vaccine candidates could be field-tested using the project structure.

- Improved understanding of vector distribution and ecology. Entomological research could be an added element to this proposal with the aim to increase the knowledge base of potential vectors, their distribution and ecology in the SADC region.

- Improved understanding of the role of wildlife as a reservoir for RVF. The SADC region is abundant with wildlife that could act as a reservoir for the virus. Research into this topic could be an added element to the proposal.

In conclusion, it is suggested that the Scientific Committee of this Workshop assists the RAHC in the finalisation of this proposal through the integration of the recommendations. Interested cooperating partners for the proposed additional results should liaise with the RAHC in due time. A finalised proposal should be submitted to the donors not later than mid 2009.

RECOMMENDATIONS

RECOMMENDATIONS

(endorsed by the OIE Director-General and the OIE Regional Commission for Africa in February 2009)

CONSIDERING THAT

01. There are indications that the *Rift Valley Fever virus* (RVFV) is present in many countries in Southern Africa.

02. There is a potential risk of spread of *Rift Valley Fever* (RVF) to new territories through animal movements.

03. RVF is one of the major zoonotic diseases, affecting most countries in Africa and may further spread to, or emerge in other continents.

04. RVF outbreaks have a considerable negative socio-economic impact on the national economies and rural population's livelihoods of southern African countries by reducing income from their livestock and additional economic loss due to trade barriers and control measures.

05. The control of the disease requires a harmonised effort from national authorities, regional and international organisations, and the negative impact on regional and intercontinental trade can be significantly alleviated if countries are capacitated through good veterinary governance to develop and apply appropriate sanitary measures for disease control and prevention.

06. The southern African region is characterised by a heterogeneity with regard to climate, ecology, livestock husbandry practices and epidemiological situation of RVF, therefore it would be useful to group the region into sub-regions.

07. Failure to prevent and control RVF in one country can seriously endanger the rest of the region.

08. The FAO-OIE initiative on GF-TADs (*Global framework for the progressive control of trans-boundary animal diseases*) and the RAHCs *(Regional animal health centres)* can provide the opportunity to coordinate and put in place prevention and control programmes for trans-boundary animal diseases such as RVF.

09. The current knowledge on RVF and its control revealed remaining gaps on diagnostic tools, including deployment of molecular epidemiology tools, vaccines and vaccination strategies, environmental data, risk modelling tools and the epidemiological role of wildlife and insect vectors.

10. Previous meetings on RVF in Northern, Western, and Eastern Africa and the Middle-East have been held and recommendations in relation to animal health measures adopted.

11. There is a need for an officially recognized human vaccine to protect laboratory and other frontline staff.

THE WORKSHOP ON RIFT VALLEY FEVER IN SOUTHERN AFRICA RECOMMENDS THAT

01. Southern African countries should promote and practice good veterinary governance in order to effectively prevent and control RVF, in accordance with international standards.

02. Ecological sub-regions that share similar characteristics with regard to RVF risk factors be defined and in consequence develop harmonized and customized preventive approaches in disease and risk management, in line with international standards and guidelines and GF-TADs programmes for Southern Africa and supported by the *Regional Animal Health Centres*.

03. The OIE and FAO continue to support research, accelerated development and registration of new diagnostic tests (including rapid tests), safe and efficacious vaccines, and strategies for control.

04. Research on the epidemiology of RVF, including molecular epidemiology, should be strengthened in Southern Africa, with particular emphasis on entomological studies, viral dynamics, environmental factors and the elucidation of the role of wildlife.

05. The impact of RVF outbreaks and implementation of control programmes should be assessed on a socio-economic level including social and cultural considerations regarding implementation of sanitary measures through an appropriate communication strategy

06. In line with the *"One World One Health"* concepts, strengthen and formalise inter-sectoral collaboration and data sharing, to ensure that the surveillance and control of RVF be followed by rapid response after detection of disease either in animals or humans.

07. All Southern African countries prepare and update emergency preparedness plans against RVF in accordance with international standards, guidelines and recommendations in particular those of FAO and WHO.

08. Southern African countries should ensure compliance with their obligations on animal disease reporting by promptly reporting all exceptional epidemiological events of RVF to the OIE for incorporation into the *World Animal Health Information System* (WAHIS).

09. OIE is encouraged to continue to update the current Terrestrial Manual and Code chapters related to RVF according to the latest scientific evidence available, as well as the acquired experiences of affected countries.

10. The OIE should support, in partnership with FAO and SADC, capacity-building efforts, aimed at strengthening or establishing diagnostic capacity for RVF in national veterinary laboratories.

11. The OIE should support twinning agreements between OVI and other competent national veterinary laboratories in the region and seek harmonisation with SADC –Secretariat priorities in view of identifying a second reference laboratory for the region.

12. OIE and FAO support countries in the Southern African region in developing a model based on risk parameters, including agro-climatic factors, to forecast potential RVF virus activities, particularly within the framework of the related *Regional Animal Health Centre* with the support of the *Global Early Warning System* (GLEWS) of FAO, OIE and WHO.

13. A draft proposal entitled *"Regional RVF control strategy"* be developed by the *Regional Animal Health Centre* for Southern Africa in collaboration with SADC and funding possibilities should be explored. This project shall address the main recommendations of the OIE workshop held in Bloemfontein and invite other interested partners to contribute to areas not covered by the core proposal. Progress on putting such a programme in place should be reported on regularly.

14. The OIE should consult with the WHO to enact the necessary research and swift official registration of a human vaccine.

15. These recommendations should be presented at the OIE Regional Commission for Africa Conference for endorsement.

Endorsed by all participants on February 18th , 2009 in Bloemfontein, South Africa.

ANNEXES

SEMINAR PROGRAMME

Monday 16 February 2009

08:30	Registration	
09:00	**Opening session** :	Welcoming address by CVO/OIE Delegate of South Africa OIE Sub-Regional Representative for Southern Africa Representative of FAO for the Rep. of South Africa Representative of AU – IBAR Southern Africa Representative of the Executive Secretary of SADC Representative of the European Commission Representative of the Minister of Agriculture of South Africa
	Group photograph	
10:00	Break	
10:30	Keynote address : Re-emergence of Rift Valley Fever in southern and eastern Africa: how can we better predict and how can we better respond ? (followed by discussion)	
		Prof Dr Robert (Bob) Swanepoel (NICD)

Session 1 : Recent history of the disease (worldwide) *Chaired by : Unesu Ushewokunze (ZW)*

11:00	RVF outbreaks and control in West Africa	Dr Yaya Thiongane (LNERV SN)
11:20	RVF outbreaks and control in North Africa	Dr. Khalid Said (DVS SO)
11:40	RVF outbreaks and control in East Africa	Dr. Jeff Mariner (ILRI)
12:00	RVF outbreaks and control in the Middle-East	Dr Shaif Al-Shawafi (DVS/CIRAD YE)
12:20	Discussion	
12:40	Lunch	

Session 2 : Epidemiological data from recent outbreaks in eastern and southern Africa

Chaired by : Amwayi Samuel Anyangu (KY) and Florência Massango – Cipriano (MZ)

13:40	Surveillance for RVF in eastern Africa with reference to the outbreaks in Kenya and Tanzania	Dr Ms. Jacqueline Lichoti Kasiiti (DVS KY)
14:00	Risk factors for severe Rift Valley Fever infection in Kenya, 2007	Dr. Amwayi S.Anyangu (Ministry of Health KY)
14:20	Current status of Rift Valley Fever in Tanzania	Dr Deusdetit Tinuga (DVS TZ)
14:30	Current status of Rift Valley Fever in the Democratic Republic of Congo	
		Dr Léopold Mulumba (Laboratoire vétérinaire de Kinshasa DC)
14:40	An evaluation of the human : animal impact of RVF outbreaks in the Comoros archipelago and Madagascar	Dr. Jean-Marc Reynes (Inst. Pasteur MG)
15:00	Current status of Rift Valley Fever in Mayotte	Dr Fabienne Biteau (DVS YT)

15:10	Current status of Rift Valley Fever in the Comoros	Dr Abdurahim Faharoudine (DVS KM)
15:20	Current status of Rift Valley Fever in Swaziland	Dr Roland X. Dlamini (DVS SZ)
15:30	An evaluation of the RVF outbreaks in Southern Africa	Dr. Ms. Grietjie De Klerk (DoA ZA)
15:50	Break	
16:20	The use and application of epidemiological clusters in surveillance and control	Dr. Ms.Véronique Chevalier (CIRAD)
16:40	The impact of wildlife in the epidemiology of RVF	Dr. Ms.Véronique Chevalier (CIRAD) Dr. Alexandre (Alex) Caron (CIRAD)
17:00	Discussion	

Tuesday 17 February 2009

Session 2 : Epidemiological data from recent outbreaks (continued)

08:30	Global warming – the impact and predictive value on RVF prevention and control	Dr Stéphane de la Rocque (FAO)
09:00	The application of remote sensing and early warning systems for RVF surveillance and control	Dr Asaph (Assaf) Anyamba (University of Maryland)
09:30	Second generation sequencing – a powerful new tool for exploring arbovirus epidemiology.	Prof. Dr. Steve Kemp (ILRI KY)

Session 3 : ***Diagnosis of Rift Valley Fever*** *Chaired by : Leopold Mulumba (DC)*

09:50	The pathogenesis, clinical diagnosis and differential diagnosis in animals	Dr Björn Reininghaus (PVS Mpumalanga Province ZA)
10:10	Laboratory diagnosis : sampling, serology, virus-isolation and constraints	Dr Ms.Catherine Cêtre - Sossah (CIRAD FR)
10:40	Field diagnosis : rapid tests - new developments	Dr G.H. (Truuske) Gerdes (OVI ZA)
11:00	Break	

Session 4 : ***Vaccination for Rift Valley Fever*** *Chaired by : Mmeta Yongolo (TZ)*

11:30	Current vaccines available for RVF	Dr Jacob Modumo (OBP ZA)
11:50	New vaccines and vaccine development	Dr Baptiste (Baty) Dungu (GALVmed UK)
12:10	New avenues for vaccine development	Dr David Wallace (OVI ZA)
12:30	Discussion	
13:00	Lunch	

Session 5 : *Control of Rift Valley Fever* *Chaired by : Marosi Molomo (LS)*

14:00	OIE standards for RVF control, vaccines and diagnosis	Dr. Ms. Lea Knopf (OIE FR)
14:20	FAO Guidelines on emergency preparedness for RVF	Dr Stéphane de la Rocque (FAO IT)
14:40	Alternative strategies for the development and application of national disease control programmes	Dr Stéphane de la Rocque (FAO IT)
15:00	Regional strategies. The example in the Indian Ocean	Dr. Matthieu Roger (CIRAD FR)
15:20	Regional strategies : Responding to potential outbreaks and risk-based decision making	Dr Jeff Mariner (ILRI KY)
15:40	Break	
16:10	OIE standards with respect to RVF and trade (the Code)	Dr Ms. Lea Knopf (OIE FR)
16:30	RVF related trade issues in the Middle-east	Dr Ghazi Yehia (OIE LB)
16:50	Discussion	

Wednesday 18 February 2009

Session 6 : ***The way forward*** *Chaired by : Peter Sinyangwe (ZM)*

09:00	Future research needs for RVF control – vaccines, vector monitoring and diagnostics	Dr James O. Mecham (USDA US)
09:20	Recommendations from the Dakar (2004), Sharja (2004) and Cairo (2007) meetings	Dr Bonaventure Mtei (OIE BW)
09:40	Recommendations from the RVF symposium in Cairo (January 2009)	Dr William (Bill) Wilson (USDA US)
10:00	SADC Secretariat joint statement	Mr Beedeeanan Hulman (FANR BW)
10:20	Developing a Regional strategy for RVF control in SADC : opportunities and constraints	Dr Ms. Susanne Münstermann (FAO BW)
10:40	How to move forward with a multidisciplinary approach for RVF control in the human : animal interface ?	Panel discussion
11:10	Break	
11:40	Presentation and adoption of recommendations	
12:10	Closing ceremony	
12:30	Lunch and departures	

SCIENTIFIC COMMISSION

1. Gideon Bruckner, OIE Deputy Director General, France

2. Véronique Chevalier, UR- AGIRs, CIRAD, France

3. Stéphane de la Rocque, EMPRES, FAO, Italy

4. Baptiste Dungu, Director Research and Development, GALV-med, United Kingdom

5. G.H. (Truuske) Gerdes, OIE Reference Laboratory for RVF, ARC-OVI, South Africa

6. Lea Knopf, OIE Scientific and Technical Department, France

7. Bonaventure Mtei, OIE Sub-Regional Representative, Botswana

8. Jean Marc Reynes, Institut Pasteur de Madagascar, Madagascar

9. William Wilson, Arthropod-Borne Animal Diseases Research Laboratory, USDA ARS, United States

Rift Valley Fever is a zoonotic disease caused by a vector-borne RNA virus (*Phlebovirus*) transmitted by several species of arthropods, in which mosquitoes of the genera *Aedes* and *Culex* play a major role. The disease affects wild and domestic ruminants (sheep, goats, bovines), with high mortalities in young animals (lambs: sudden death, up to 95% mortality rate) and abortion in females (ewes: 50% abortion rate, 20% mortality rate).

Animal to animal transmission during an outbreak (epizootic phase) can be direct through contacts such as licking or inhalation of aerosols from infected tissues and fluids from abortions. Milk from RVF infected animals has been shown to contain virus, but its role in the transmission of the disease remains unclear. The virus is also transmitted by numerous species of blood feeding arthropods, through biological and mechanical transmission.

Man can get the infection through mosquito bites, but mostly through blood and other secretions and excretions (during slaughtering, manipulation of sick animals and of aborted lambs for example). In most cases, humans develop flu-like symptoms and the mortality rate ranges between 1 – 3%. Sever syndromes include (a) the ocular form, (b) the meningo-encephalic form and (c) the hemorrhagic form. The latter is deadly with a mortality rate close to 100%. Human are considered and dead-end hosts, as the infection is not transmitted further. However, the disease affects different types of people, including breeders, workers in slaughtering facilities, animal-health professionals and laboratory-personnel.

The apparent maintenance of the infection at sub-clinical levels during so called inter-epizootic phase, has been attributed to the maintenance of the host-vector cycle. This cycle is usually not detected in the absence of active surveillance . The virus circulates at low dose between domestic animals and in some part of Africa wildlife could also be involved (buffalo, springbok, bontebok and warthogs). Antibodies against *RVF virus* (RVFV) have also been found in bats and some species of rodents, but the role of the latter two in the epidemiology of the disease remains unclear. The activity of the RVFV increase when the environmental conditions are favourable for the multiplication of the vectors, and the level of immunity of the animals is low. In total 6 types of mosquitoes are involved (more than 50 species), in which *Culex* and *Aedes* are the most common. The role of ticks (*Hyalomma* spp) is under investigation.

Aedes spp. are mammophile and require an alternation of wetting and drying-up of water resources and are therefore mostly encountered in arid areas. *Culex* spp. are primarily ornithophile and require perennial water resources, typically found in irrigated areas. As a principle, the infection is maintained by a vector – host cycle, but vertical transmission in certain *Aedes* spp. (*A. macintoshi* in Kenya) has been demonstrated. Typical eco-systems associated with RVF outbreak therefore include (a) the "*dambos*" in Kenya (high density of mosquitoes), (b) irrigation areas such as the Assouan Dam on the Nile (outbreaks in 1977, Egypt) and the Diama Dam in Senegal (1985, 1987) and (c) arid areas with a lower density of mosquitoes (*Aedes* mostly) and an almost enzootic cycle such as e.g. in the Ferlo in Senegal.

Over the past decade, flooding of breeding sites as a consequence of high rainfall events and increased trade of living animals have led to numerous outbreaks in the Arabic peninsula (Yemen and KSA, 2000) and the African continent where 4 clusters are now recognized : (a) Senegal-Gambia-Mauritania, (b) Sudan-Egypt-Djibouti, (c) Kenya-Tanzania and (d) Southern Africa-Madagascar.

Diagnosis of the disease is based on clinical observation (abortion) with differential diagnosis including brucellosis, leptospirosis, salmonellosis, hemorrhagic septicaemia and bluetongue, to name but a few. Laboratory diagnosis is largely based on the detection of antibodies and the isolation of the virus that may also serves as the basis for phylogenetic variation studies. Serological tests include (a) virus neutralisation tests, (b) HA and (c) ELISA . The latter are developed to detect old infections (Immunoglobuline G, competition-ELISA) or recent/ongoing infections (IgM, capture-ELISA). Commercial kits are available from BDSL (OVI protocol), while CDC and Institut Pasteur have customised kits, targeting detection in

humans. Virus identification is now made easier with the use of conventional PCR (qualitative), increasingly being replaced by the quantitative, automated and very specific Real Time-PCR.

Control of RVF is based on vaccination of animals, vector control, and movement control. In terms of vaccines, the Smithburn live attenuated vaccine (produced by OBP, South Africa) is highly immunogenic, its remanence is high but some undesirable effects (teratogenic and abortive in pregnant ewes) make its use delicate. Inactivated vaccines are also available, these vaccines are safe and without any undesirable effects but are expensive, poorly immunogenic and therefore require boosters. In both cases, vaccination of livestock in infected areas is usually not recommended because of the common practice of re-using needles, which can transfer the virus from infected animals to naïve animals. Institut Pasteur and OVI, in collaboration with CIRAD, are working on a recombinant vaccine which would be vectored by a lumpy skin disease virus and would in addition be effective against goat and sheep pox.

Surveillance of RVF is based on active surveillance of sentinel animals, passive surveillance (based on reporting of abortions) and entomological monitoring. Climate-based predictions are established through the monitoring of key indexes related to rainfalls (ENSO index, NDVI index).

Recent outbreaks in Africa and the Middle-East

RVF was first described in 1930 in the Rift Valley of Kenya. The disease has since occurred irregularly in Kenya every 3 to 10 years. Egypt experienced a severe epizootic in 1977 that resulted in huge losses among the domestic animal populations and caused significant human disease. The total morbidity in people was thought to be in the hundreds of thousands, and the resources of the hospitals in the affected areas were severely strained by the numbers of cases presented daily. Most cases were thought to arise from mosquito bites, but many of the other human cases followed close contact with infected animals, particularly during slaughter or abortion. In September 2000, following a massive East African RVF outbreak, the disease was reported in Yemen and Saudi Arabia, representing the first RVF cases identified outside Africa (USDA, Gay, Cairo concept note, 2008 ; Madani TA, Al-Mazrou YY, Al-Jeffri MH, et al.: 2003, Rift Valley fever epidemic in Saudi Arabia: epidemiological, clinical, and laboratory characteristics. Clin Infect Dis 37:1084-1092 ; Al-Hazmi A, Al-Rajhi AA, Abboud EB, et al.: 2005, Ocular complications of Rift Valley fever outbreak in Saudi Arabia. Ophthalmology 112:313-318).

Abdi Ali, 18, being treated for Rift Valley fever in Garissa, Kenya, December 2007 © Daud Yussuf / Reuters (The New York Times).

Since then, outbreaks have been reported in Cameroon (2003), Gambia (2002) Kenya (2002, 2006, 2007), Mauritania (2002, 2003) Senegal (2002, 2003, 2004) Sudan (2007), Tanzania (2000, 2007) and Zimbabwe (2001). (OIE, WAHID, 2008). In Somalia, between December 2006 and February 2007, a total of 114 cases including 51 deaths (case-fatality rate, 45%) of Rift Valley Fever were reported (WHO, 2007).

In 2008 RVF was been reported from Madagascar, Mayotte, South Africa, Sudan, and Swaziland. The disease is known to have occurred in the Comoros, but has never been reported to OIE.

The best documented outbreak is the one in Madagascar which erupted in January 2008. Two previous episodes had already been reported and well-documented in 1979, and in 1990-1991. The first two outbreaks occurred on Madagascar's east coast less than 100 km apart. In 2008, the first detected case was a human case in the south-east and then the virus was detected in humans and cattle in the highlands and in the North of the country. The last confirmed case was a human case deceased in May 2008. Overall 519 human cases were suspected and reported out of which 19 died. Madagascar's veterinary authority only declared the outbreak to OIE in April 2008. There are strong suspicions that outbreaks in ruminants were reported in late 2007 but were not investigated and remained undiagnosed. Investigations carried out in June 2008 by FAO in the South, indicated massive abortions in April-May 2007 among sheep and goats, and 23 out 34 ruminant blood samples taken contained IgG antibodies, indicative of past infections (IgM are indicative of ongoing infections).

Mayotte's Veterinary Services conducted serological studies in March 2008. Out of 79 animals tested (zebu), 13 were sero-positive, of which 3 showed IgM. Out of 18 animals re-tested later, one showed a sero-conversion. In tests conducted on illegal imports of goats, 37% tested sero-positive and 14% tested positive for IgM. A retrospective study conducted on 301 sera from the national serum bank, 32 tested positive (11%). Geographically, RVF antibodies were encountered in 50% of municipalities in Mayotte. Today, surveillance for RVF is conducted using 13 sentinel herds (caprine), previously tested sero-negative, and the sensitisation of farmers to declare any abortion to the veterinary services. The OBP-produced Smith-burn vaccine (live attenuated) is not authorized in Mayotte, but advice is awaited from the French food safety agency AFSSA on possible temporary authorisation to use this vaccine in the future.

In the Comoros, very little (reliable) information is available to date, except for the one case of RVF reported in a 12-year old boy from Moroni (*Grande Comore*) in September 2007 and confirmation of RVF in zebu cattle (IgM, performed by CIRAD) in November 2007.

In South Africa, repeated outbreaks (initially linked to buffaloes in the Kruger Park area, Mpumalanga province) over the past year have led the veterinary authority to declare the disease endemic (November 2008) and refer any new outbreaks to the six-monthly reports to OIE. Disease occurred in buffaloes, cattle, goats and sheep and ended up affecting 4 provinces (Mpumalanga, Limpopo, Gauteng and North-West provinces). Vaccination was applied and covered some 2,000 cattle, 430 buffaloes, 320 sheep and 140 goats.

In Swaziland, the precise origin of the outbreak of RVF on a dairy farm in Serec in July remains unclear to date. The declaration was made based on an abortion storm which swept through the herd, accompanied by mortalities in calves, starting two weeks after the vaccination of animals against RVF. Animals had been vaccinated with an inactivated vaccine and the assumption was made that this was indeed a natural infection. As a result of this, a 10-km-radius surveillance zone surrounding the infected farm was established, involving a population of 3,799 cattle, 709 goats and 9 sheep. By September 2008, 233 bovine and caprine serum samples had been screened for RVF with negative results with IgM ELISA. Results are still awaited for IgG ELISA. These findings suggest the absence of active infection. Quarantine and movement restrictions were later lifted. Vaccination was considered in the early stages of the outbreak, but was never implemented.

BOTSWANA

Dr Jaone Jayson Mazebe Sebina
Senior Veterinary Officer
Veterinary Services
Ministry of Agriculture
P.o.box 19 FRANCISTOWN
E-mail : jjmsebina@yahoo.co.uk
Telephone 1 : 00 267 241 3425
Telephone 2 : 00 267 7111 2555
Telefax : 00 267 241 3415

COMOROS

Dr Abdourahim Faharoudine
Director
Livestock (Elevage)
Ministry of Agriculture
BP 774/BP 41 MORONI
E-mail : fahar1951@yahoo.fr
Telephone 1 : 00 269 333 27 19
Telephone 2 : 00 269 773 50 52
Telefax : 00 269 773 82 35

DEMOCRATIC REPUBLIC OF CONGO

Dr Leopold Mulumba
Director
Central Veterinary Laboratory
Ministry of Agriculture
Avenue Wangata en face de l' Hopital Central
P.o.box 8842 KINSHASA 1
E-mail : leopold_mulumba@yahoo.com
Telephone : 00 243 81 59 14 48

Dr Honoré N'Lemba Mabela
Directeur Chef de Service
Production et Sante Animales
Ministère de l'Agriculture
B.P. 8722 KINSHASA 1.
C/o FAOR B.P. 16096 KINSHASA 1
E-mail 1 : dr_nlemba@yahoo.fr
E-mail 2 : kaben2004@yahoo.fr
Telephone 1 : 00 243 99 990 29 67
Telephone 2 : 00 243 81 512 65 64

KENYA

Dr Samuel Amwayi Anyangu
Medical Epidemiology
Provincial Medical Office
Ministry of Health and Sanitation
Afya House Cathedral Road
P.o.box 30016 NAIROBI
E-mail 1 : amwayi2004@yahoo.com
E-mail 2 : amwayi2007@gmail.com
Telephone 1 : 00 254 0715 606 855
Telephone 2 : 00 254 046 210 2349
Telefax : 00 254 046 210 3254

Dr (Ms) Jacqueline Lichoti Kasiiti
Principal Veterinary Officer
Veterinary Services Department
Ministry of Livestock Development
Central Veterinary Labs Kabete
P.o.box 00625, Kangemi, NAIROBI
E-mail 1 : lichoti@yahoo.com
E-mail 2 : kasiiti.orengo@gmail.com
Telephone 1 : 00 254 733 707 685
Telephone 2 : 00 254 202 021 273

LESOTHO

Dr (Ms) Marosi Molomo
Director of Livestock Services
Department of Livestock Services
Ministry of Agriculture and Food Security
P/Bag A 82 MASERU
E-mail : marosi_molomo@yahoo.com
Telephone 1 : 00 266 223 24843
Telephone 2 : 00 266 223 12318
Telefax : 00 266 223 11500

MADAGASCAR

Dr (Ms) Lanto Tiana Razafimanantsoa
Director of Veterinary Services
Ministry of Agriculture, Livestock & Fisheries
P.o.box 291 ANTANANARIVO 101
E-mail : tianarazalabo@yahoo.fr
Telephone : 00 261 320 235 534

Dr Samuël Peter Fenozara
Veterinary service Department
Chef de Division Surveillance et lutte contre les maladies animales
Ministère de l'Agriculture, de l'Elevage et de la Pêche
Ampandrianomby
B.P. 291 ANTANANARIVO 101
E-mail : peterfenozara@yahoo.fr
Telephone : 00 261 331 169 819

MALAWI

Dr Patrick Benson Chikungwa
Deputy Director
Department of Animal Health & Livestock Development
Ministry of Agriculture & Food Security
P.o.box 2096 LILONGWE
E-mail 1 : pchikungwa@yahoo.com
E-mail 2 : dahi@sdnp.org.mw
Telephone 1 : 00 265 1 75 3038
Telephone 2 : 00 265 8 37 1509
Telefax : 00 265 1 25 1349

MAYOTTE

Dr (Ms) Fabienne Biteau - Coroller
Directeur adjointe des services vétérinaires
Service Vétérinaire de Mayotte
Zi Kaweni
B.P. 40 MAMOUDZO 97600
E-mail 1 : fabienne.biteau-coroller@agriculture.gouv.fr
E-mail 2 : facoroller@gmail.com
Telephone 1 : 00 33 2 69 61 11 41
Telephone 2 : 00 33 6 39 69 54 75
Telefax : 00 33 2 69 61 11 47

Dr Tamime Madi
Directeur Laboratoire Vétérinaire
Laboratoire Départemental de Mayotte
Rue du Lycée
B.P. 003 CHIRONGUI 97620
E-mail 1 : madi.tamime@cg976.fr
E-mail 2 : tamime_2000@yahoo.fr
Telephone 1 : 00 262 269 64 95 50
Telephone 2 : 00 262 639 69 03 00
Telefax : 00 262 269 61 73 29

MOZAMBIQUE

Dr (Ms) Florência M. Cipriano
Director
National Directorate of Veterinary Services
Ministry of Agriculture
Praça dos Herois Moçambicanos
P.o.box 1406 MAPUTO
E-mail : flor.cipriano@gmail.com
Telephone : 00 258 21 460 082
Telefax : 00 258 21 460 479

REUNION

Dr Laurent Lasne
Vétérinaire Officiel
Directeur des services vétérinaires
Antenne Sud,
1 Chemin de l'IRAT
97410 SAINT PIERRE
E-mail : laurent.lasne@agriculture.gouv.fr
Telephone 1 : 026 233 3671
Telephone 2 : 069 268 6908
Telefax : 026 233 3607

SEYCHELLES

Dr Simon Laurette
Veterinary Technician
Seychelles Agriculture Agency
Ministry of of Environment, Transport & Natural Resources
VICTORIA
E-mail 1 : vetmamr@seychelles.net
E-mail 2 : laurette1965@hotmail.com
Telephone 1 : 00 248 285 950
Telephone 2 : 00 248 574 762
Telefax : 00 248 225 245

SOMALIA

Dr Khalid Saeed
FAO- Somalia / Consultant (Epidemiologist)
Livestock
FAO - Somalia
P.o.box 30470 NAIROBI 00100
KENYA
E-mail 1 : khalid4123@yahoo.com
E-mail 2 : khalid.saeed@fao.org
Telephone 1 : 00 254 73 598 4340
Telephone 2 : 00 254 17 35 984 340

Dr Abdirahman Qeyliye
Director General
Ministry of Livestock
MOGADISHU
E-mail : garish01@hotmail.com
Telephone 1 : 00 252 15 13 24 63
Telephone 2 : 00 254 72 93 75 810

SOUTH AFRICA

Dr George Akol
Manager Vet Labs
Department of Agriculture
Provincial Vet Labs
P/Bag X 14 STUTTERHEIM 4930
E-mail 1 : george.akol@agr.ecprov.gov.za
E-mail 2 : labhq@telkomsa.net
Telephone 1 : 00 27 43 683 1004
Telephone 2 : 00 27 82 659 8863
Telefax : 00 27 43 683 1011

Prof (Ms) Felicity Burt
National Health Laboratory Services
Department of Medical Virology , School of Medicine
University of the Free State
P.o.box 339 BLOEMFONTEIN
E-mail : BurtFJ.MD@ufs.ac.za
Telephone 1 : 00 27 51 405 3162
Telephone 2 : 00 27 76 850 5160
Telefax : 00 27 51 444 2433

Dr Luxolo Mnqeta Cebisa
Senior Manager
Directorate Veterinary Services
Eastern Cape Province
Dukumbana Building
P.o.box 308 BHISHO
E-mail 1 : qtnvet@telkomsa.net
E-mail 2 : mtayise@webmail
Telephone 1 : 00 27 83 457 7948
Telephone 2 : 00 27 83 457 7948
Telefax : 00 27 86 697 4523

Dr (Ms) Grietjie De Klerk
Chief State Veterinarian : epidemiology
National Directorate of Veterinary Services
Department of Agriculture (DoA)
Cnr Annie Botha & Union Av, Riviera
P/Bag X 138 PRETORIA 0001
E-mail : GrietjiedK@nda.agric.za
Telephone : 00 27 12 319 7412
Telefax : 00 27 12 319 7470

Dr (Ms) Sophette Gers
Diagnostic Pathologist
Directorate Veterinary Services
Western Cape Province
Western Cape Provincial Veterinary Lab
P/Bag X5020 STELLENBOSCH 7599
E-mail : sophetteg@elsenburg.com
Telephone 1 : 00 27 21 887 0324
Telephone 2 : 00 27 83 285 1919
Telefax : 00 27 21 886 5341

Dr Joule-Gaby Kangumba
Head : Laboratory Services & Epidemiology
Directorate Veterinary Services
North-West Province
P/Bag X 939 POTCHEFSTROOM 2520
E-mail : Jkangumba@nwpg.gov.za
Telephone 1 : 00 27 18 294 3232
Telephone 2 : 00 27 82 562 1858
Telefax : 00 27 18 293 2385

Dr (Ms) Petra Kitshoff
State Veterinarian
Directorate Veterinary Services
Free State Province
Dan Pienaar Drive 36A
P.o.box 6252 BLOEMFONTEIN 9300
E-mail : petra@glen.agric.za
Telephone : 00 27 51 436 3677

Mr Gideon Kriel
Animal Health Technician
Directorate Veterinary Services
Northern Cape Province
162 George Street
P/Bag X5018 KIMBERLEY
E-mail 1 : dkriel@agri.ncape.gov.za
E-mail 2 : dkriel@agrikim.ncape.gov.za
Telephone 1 : 00 27 53 839 7822
Telephone 2 : 00 27 83 255 8827
Telefax : 00 27 86 614 8023

Dr L.S. Madyibi
Acting Director
Directorate Veterinary Services
North-West Province
15 Minerva Av., Riviera Park
P.o.box 23358 MAFIKENG 2745
E-mail 1 : EModimogale@nwpg.gov.za
E-mail 2 : madyivi@nwpg.gov.za
Telephone 1 : 00 27 18 381 5102
Telephone 2 : 00 27 82 577 3382
Telefax : 00 27 18 389 5090

Dr Kgaugelo Mashishi
Deputy Director
Directorate Veterinary Services
Free State Province
14 Birdsview, Woodlandshills
P.o.box 6252 BLOEMFONTEIN 9300
E-mail 1 : kmashishi@glen.agric.za
E-mail 2 : kmashishi@yahoo.com
Telephone 1 : 00 27 51 436 3677
Telephone 2 : 00 27 82 788 3597
Telefax : 00 27 51 436 5870

Dr Botlhe Michael Modisane
Chief Director Food & Veterinary Services
Food Safety & Biosecurity
Department of Agriculture (DoA)
P/Bag X 138 PRETORIA 0001
E-mail : CDFAHDM@nda.agric.za
Telephone : 00 27 12 319 6503
Telefax : 00 27 12 319 6281

Dr (Ms) Tiroyamodimo Violet Modungwa
Deputy Director : Disease Control
Directorate Veterinary Services
Department of Agriculture (DoA)
P/Bag X 138 PRETORIA 0001
E-mail : Tirom@nda.agric.za
Telephone : 00 27 12 319 7428
Telephone : 00 27 83 959 1096
Telefax : 00 27 12 329 0499

Dr Luba Mrwebi
Provincial Senior Manager
Directorate Veterinary Services
Eastern Cape Province
832 Dukumbana Building
P/Bag X0040 BHISHO 5605
E-mail : lubabalo.mrwebi@agr.ecprov.gov.za
Telephone : 00 27 406 09 3547
Telephone : 00 27 82 781 0217
Telefax : 00 27 406 36 3558

Dr Dumisani Mtshali
Manager
Directorate Veterinary Services
Kwazulu-Natal Province
P/Bag X 1048 RICHARDS BAY 3900
E-mail 1 : mtshalid@daerbay.kzntl.gov.za
E-mail 2 : lyonsa@daerbay.kzntl.gov.za
Telephone : 00 27 35 780 6705
Telefax : 00 27 35 789 6405

Dr Hannes Pienaar
Chief State Veterinarian : zoonotic diseases
Directorate Veterinary Services (Animal Health)
Department of Agriculture (DoA)
P/Bag X138 PRETORIA 0001
E-mail : HannesP@nda.agric.za
Telephone : 00 27 12 319 7606
Telefax : 00 27 12 319 7470

Dr Björn Reininghaus
State Veterinarian
Directorate Veterinary Services
Mpumalanga Province
P.o.box 741 NELSPRUIT 1200
E-mail 1 : bjorn@laeveld1.agric.za
E-mail 2 : isbjorn7@yahoo.com
Telephone 1 : 00 27 013 753 3247/752 4568
Telephone 2 : 00 27 84 85 28133
Telefax : 00 27 13 752 4606

Dr Johan Walters
Deputy Director
Department of Agriculture, Veterinary Services
Gauteng Province
P.o.box 33132 PRETORIA 0010
E-mail : johan.walters@gauteng.gov.za
Telephone 1 : 00 27 123551976
Telephone 2 : 00 27 82 373 7726

SWAZILAND

Dr Roland X. Dlamini
Deputy Director
Veterinary Department
Ministry of Agriculture, Dept of Veterinary & Livestock Services
By-pass Road Mbabane
P.o.box 162 MBABANE
E-mail 1 : dlaminirol@gov.sz
E-mail 2 : rolandx@realnet.co.sz
Telephone 1 : 00 268 404 2731/9
Telephone 2 : 00 268 606 2602
Telefax : 00 268 404 9802

Dr Mduduzi Patrick Dlamini
Epidemiologist
Dept of Veterinary & Livestock Services
Ministry of Agriculture,
Corner Mancishana & Sandlane Streets
P.o.box 3287 MANZINI
E-mail 1 : epiunit@africaonline.co.sz
E-mail 2 : patrick_dlamini@yahoo.co.uk
Telephone 1 : 00 268 505 2113
Telephone 2 : 00 268 604 1444
Telefax : 00 268 505 6443

Dr Muzi Mzwandile Dube
Veterinary Officer Diagnostics
Veterinary Department Diagnostics
Ministry of Agriculture, Veterinary & Livestock Services
P.o.box 4192 MANZINI
E-mail 1 : mnqobi1@yahoo.com
E-mail 2 : epiunit@africaonline.co.sz
Telephone 1 : 00 268 505 2204
Telephone 2 : 00 268 641 4767
Telefax : 00 268 505 6443

Dr (Ms) Thembinkosi Ndlangamandla
Regional Veterinary Officer
Veterinary Department
Ministry of Agriculture, Veterinary & Livestock Services
P.o.box 10 MBABANE
E-mail 1 : thembiemntungwa@yahoo.com
E-mail 2 : epiunit@africaonline.co.sz
Telephone 1 : 00 268 404 5776
Telephone 2 : 00 268 624 1934
Telefax : 00 268 505 6443

TANZANIA

Dr Deusdedit Tinuga
Epidemiologist
Veterinary Service
Ministry of Livestock Development & Fisheries
P.o.box 9152 DAR ES SALAAM
E-mail : drtinuga@yahoo.com
Telephone 1 : 00 255 22 286 2592
Telephone 2 : 00 255 784 45 5949
Telefax : 00 255 22 286 1908

Dr Mmeta Yongolo
Head of Virology Department
Central Veterinary Laboratory
Ministry of Livestock Development & Fisheries
P.o.box 9254 DAR ES SALAAM
E-mail : myongolo@yahoo.co.uk
Telephone : 00 255 754 374 873

YEMEN

Dr Shaif Abdu Salem Abdullah Al-Shawafi
Department of Animal Health
Ministry of Agriculture
SANA'A
E-mail 1 : shaifal_shawafi@hotmail.com
E-mail 2 : abdo-salem.shaif@cirad.fr
Telephone 1 : 00 33 4 67 59 39 06
Telephone 2 : 00 33 6 32 74 75 43
Telefax : 00 33 4 67 59 37 54

ZAMBIA

Dr Peter Sinyangwe
Director
Department of Veterinary and Livestock development
Ministry of Agriculture and Cooperatives
P.o.box 50060 LUSAKA
E-mail 1 : pgsinyangwe@maff.gov.zm
E-mail 2 : pgsinyangwe@zamnet.zm
Telephone 1 : 00 260 211 25 6679
Telephone 2 : 00 260 977 41 9677
Telefax : 00 260 211 25 6679

ZIMBABWE

Dr (Ms) Unesu Hildah Ushewokunze-Obatolu
Director
Department of Veterinary Field Services
Ministry of Agriculture
Bevan Building,, 18 Borrowdale Road
P.o.box CY 56
Causeway HARARE
E-mail 1 : dvfs@mweb.co.zw
E-mail 2 : newazvo@hotmail.com
Telephone 1 : 00 263 473 8645
Telephone 2 : 00 263 486 1535
Telephone 3 : 00 263 912 2197 63
Telefax : 00 263 470 0327

AU-IBAR

Dr Baboucarr Jaw
Regional Representative for Southern Africa
Interafrican Bureau for Animal Resources
AU-IBAR
BK House (1st floor)
Old Lobatse Road, 1270
P.o.box 25662 GABORONE
BOTSWANA
E-mail 1 : baboucarr.jaw@au-ibar.org
E-mail 2 : baboucarr.jaw@yahoo.com
Telephone 1 : 00 267 391 44 24
Telephone 2 : 00 267 744 76 998
Telefax : 00 267 391 24 17

CIRAD

Dr Alexandre Caron
Researcher
Environments & Societies
CIRAD
37 Arcturus Road
Highlands, HARARE
ZIMBABWE
E-mail : anorac@hotmail.com
Telephone : 00 263 4 443 422

Dr (Ms) Catherine Cêtre-Sossah
Virologiste
Bios /UMR15
CIRAD
Campus International de Baillarguet TA A 15/G
34398 MONTPELLIER
F R A N C E
E-mail : cetre@cirad.fr
Telephone : 00 33 4 67 59 39 11
Telefax : 00 33 4 67 59 37 98

Dr (Ms) Véronique Chevalier
Epidemiologiste
ES Deputy UR Agirs
CIRAD
Campus International de Baillarguet TA A 15/E
34398 MONTPELLIER
F R A N C E
E-mail : chevalier@cirad.fr
Telephone : 00 33 4 67 59 3706
Telefax : 00 33 04 67 59 37 99

Dr Matthieu Roger
Veterinaire Epidemiologiste
CIRAD / CRVOI
Technopole 2, rue Maxime Rivière
B.P. 80005
97430 SAINTE CLOTILDE
REUNION (France)
E-mail 1 : matthieu.roger@cirad.fr
E-mail 2 : mattewrog@yahoo.fr
Telephone 1 : 00 262 93 88 00
Telephone 2 : 00 262 693 945 692
Telefax : 00 262 93 88 01

FAO

Dr Stéphane De la Rocque
EMPRES
FAO
Viale delle Terme di Caracalla
00100 ROME
ITALY
E-mail : stephane.delarocque@fao.org
Telephone : 00 39 346 501 0392
Telefax : 00 39 570 53 023

Ms Rosebud Kurwijila
Resident Representative for South Africa
Food and Agriculture Organisation
FAO
6th floor, Metropark Building
351, Schoeman Street
P.o.box 13782
The Tramshed 0126 PRETORIA
SOUTH AFRICA
E-mail : rosebud.kurwijila@fao.org
Telephone 1 : 00 27 12 354 85 30
Telephone 2 : 00 27 12 354 58 40
Telefax : 00 27 12 354 85 31

Dr (Ms) Susanne Münstermann
ECTAD Regional Manager
Southern Africa
FAO
BK House (1st floor)
Old Lobatse Road, 1270
P.o.box 80598 GABORONE
BOTSWANA
E-mail 1 : susanne.munstermann@fao.org
E-mail 2 : sm_gabs@yahoo.de
Telephone 1 : 00 267 395 3100
Telephone 2 : 00 267 72 734346
Telefax : 00 267 395 3104

DELTAMUNE

Dr Louis Maartens
Research Veterinarian
Vaccine Development
Deltamune
P.o.box 14167
0140 LYTTELTON
SOUTH AFRICA
E-mail 1 : louism@deltamune.co.za
E-mail 2 : lohema@3gi.co.za
Telephone 1 : 00 27 82 8998 056
Telephone 2 : 00 27 12 808 2777
Telefax : 00 27 12 808 3544

GALVMED

Dr Baptiste (Baty) Dungu
Senior Director Research & Development
GALVmed
Doherty Building, Pentlands Science Park
Bush Loan
EH260PZ EDINBURGH
UK
E-mail 1 : dungu@galvmed.org
E-mail 2 : louise.gordon@galvmed.org
Telephone 1 : 00 44 131 445 6264
Telephone 2 : 00 44 77 66 90 5009
Telefax : 00 44 131 445 6222

ILRI

Dr Steve Kemp
Scientist Biotechnology
International Livestock Research Institute
ILRI
Old Naivasha Road
Uthiru, Kabete
P.o.box 30709 NAIROBI
KENYA
E-mail : kempsj@liv.ac.uk
Telephone 1 : 00 254 20 422 3000
Telephone 2 : 00 254 733 39 8531
Telefax : 00 254 20 422 3001

Dr Jeffrey (Jeff) Mariner
Operating Project Leader
International Livestock Research Institute
ILRI
Old Naivasha Road
Uthiru, Kabete
P.o.box 30709 NAIROBI
KENYA
E-mail : j.mariner@cgiar.org
Telephone 1 : 00 254 20 422 3000
Telephone 2 : 00 254 733 39 8531
Telefax : 00 254 20 422 3001

INSTITUT PASTEUR

Dr Marc Grandadam
Deputy Director
Centre National des Arbovirus
INSTITUT PASTEUR
25/28 Avenue du Docteur Roux
75015 PARIS
F R A N C E
E-mail : marc.grandadam@pasteur.fr
Telephone 1 : 00 33 1 406 13 295
Telefax : 00 33 1 443 89 418

Dr Jean-Marc Reynes
Chef de l'Unité de Virologie
Institut Pasteur de Madagascar
INSTITUT PASTEUR
Route de l' Institut Pasteur
B.P. 1274 ANTANANARIVO 101
MADAGASCAR
E-mail : jmreynes@pasteur.mg
Telephone : 00 261 20 22 412 72
Telefax : 00 261 20 22 415 34

Dr Noël Tordo
Chef de l'Unité de Biologie
Infections Virales Emergentes
Département de Virologie
INSTITUT PASTEUR
21 avenue Tony Gannia
69365 LYON - Cedex 05
F R A N C E
E-mail : noel.tordo@pasteur.fr
Telephone 1 : 00 33 6 830 99 756
Telephone 2 : 00 33 4 372 82 440
Telefax : 00 33 4 37282441

ISRA

Dr Yaya Thiongane
Director
Institut Senegalais de la Recherche Agronomique
LNERV
Route de Front de Terre
P.o.box 2057 DAKAR
SENEGAL
E-mail 1 : yayathiongane514@hotmail.com
E-mail 2 : thiongane@orange.sn
Telephone 1 : 00 221 776 429 754
Telephone 2 : 00 221 338 323 679
Telefax : 00 221 338 323 679

IZS

Dr (Ms) Federica Monaco
Veterinarian
Exotic Diseases
Istituto Zooprofilattico Sperimentale
dell'Abruzzo e del Molise *"G. Caporale"*
64100 TERAMO
ITALY
E-mail 1 : f.monaco@izs.it
E-mail 2 : a.dedominicis@izs.it
Telephone : 00 39 0861 332446
Telefax : 00 39 0861 332251

KINGFISHER

Ms Adrie Fischer
Kingfischer Conferences and Events cc.
P.o.box 27144 SUNNYSIDE 0132
SOUTH AFRICA
E-mail : kingfischer@lantic.net
Telephone 1 : 00 27 12 991 87 88
Telephone 2 : 00 27 83 633 45 00
Telefax : 00 27 12 991 87 12

NASA

Dr Assaf (Asaph) Anyamba
Associate Research Scientist
Biospheric Sciences Branch
NASA
Goddard Space Flight Centre
Biospheric Sciences Branch 6144
20771 GREENBELT (MD)
USA
E-mail 1 : assaf@ltpmail.gsfc.nasa.gov
E-mail 2 : Asaph.Anyamba-1@nasa.gov
Telephone : 00 1 301 614 6601

NICD

Prof. Robert (Bob) Swanepoel
Special Pathogens Unit
National Institute for Communicable Diseases
1, Modderfontein Road
P/Bag X 4
Sandringham 2131
SOUTH AFRICA
E-mail 1 : bobs@nicd.ac.za
E-mail 2 : lynetted@nicd.ac.za
Telephone 1 : 00 27 11 386 6000
Telephone 2 : 00 27 11 386 6335
Telefax : 00 27 11 882 3741

OBP

Dr Jacob Modumo
Technical Manager
OBP Ltd. (Prod Vaccines)
Onderstepoort Biological Products
100 Soutpan, Onderstepoort
P/Bag X 07 PRETORIA 0110
SOUTH AFRICA
E-mail : jacob@obpvaccines.co.za
Telephone : 00 27 12 522 1500
Telefax : 00 27 12 522 1591

OIE

Dr Patrick Bastiaensen
Programme Officer
Sub-Regional Representation for Southern Africa
OIE
BK House (1st floor)
Old Lobatse Road, 1270
P.o.box 25662 GABORONE
BOTSWANA
E-mail : p.bastiaensen@oie.int
Telephone 1 : 00 267 391 44 24
Telephone 2 : 00 267 729 236 31
Telefax : 00 267 391 44 17

Dr (Ms) Lea Knopf
Officer Official Disease Status Recognition
Scientific and Technical Department
OIE
12, rue de Prony
75017 PARIS
F R A N C E
E-mail 1 : l.knopf@oie.int
E-mail 2 : leaknopf@gmx.net
Telephone 1 : 00 33 14 42 52 855
Telephone 2 : 00 33 63 34 07 930
Telefax : 00 33 14 26 70 987

Dr Bonaventure Mtei
Sub-Regional Representative
Sub-Regional Representation for Southern Africa
OIE
BK House (1st floor)
Old Lobatse Road, 1270
P.o.box 25662 GABORONE
BOTSWANA
E-mail : b.mtei@oie.int
Telephone : 00 267 391 24 44
Telefax : 00 267 391 24 17

Ms Nomsa Thekiso
Secretary
Sub-Regional Representation for Southern Africa
OIE
BK House (1st floor)
Old Lobatse Road, 1270
P.o.box 25662 GABORONE
BOTSWANA
E-mail : n.thekiso@oie.int
Telephone : 00 267 391 44 24
Telefax : 00 267 391 44 17

Dr Ghazi Yehia
Regional Representative
Regional Representation for the Middle-East
OIE
Kfarchima, Old Od Saida Silk officeblg
Takieddine solh Ave. Koreitem
P.o.box 3234 BEIRUT
LEBANON
E-mail : g.yehia@oie.int
Telephone 1 : 00 961 543 0741/30338
Telephone 2 : 00 961 361 9154
Telefax : 00 961 543 0742/181 3868

OVI

Dr (Ms) Truuske Gerdes
OIE Reference Laboratory for RVF
Onderstepoort Veterinary Institute (OVI)
ARC
Old Soutpan Rd
Onderstepoort
P/Bag X5 PRETORIA 0110
SOUTH AFRICA
E-mail : OneillM@arc.agric.za
Telephone : 00 27 12 529 9114
Telefax : 00 27 12 529 9418

Dr David Wallace
Project Manager Vectored Vaccines & Delivery Systems
Onderstepoort Veterinary Institute (OVI)
ARC
Old Soutpan Rd
Onderstepoort
P/Bag X5 PRETORIA 0110
SOUTH AFRICA
E-mail 1 : wallaced@arc.agric.za
E-mail 2 : david.wallace@up.ac.za
Telephone : 00 27 12 529 9442
Telefax : 00 27 12 529 9249

SADC

Dr Berhanu Bedane
Technical Assistant
PRINT - Livestock Project
SADC Secretariat (FANR)
Kgale View
P/Bag 0095 GABORONE
BOTSWANA
E-mail : bbedane@sadc.int
Telephone : 00 267 395 18 63 ext 5124
Telefax : 00 267 395 98 34/392 4099

Dr Pascal Bonnet
Chief Technical Assistant
PRINT - Livestock Project
SADC Secretariat (FANR)
Kgale View
P/Bag 0095 GABORONE
BOTSWANA
E-mail 1 : pbonnet@sadc.int
E-mail 2 : pascal.bonnet@cirad.fr
Telephone 1 : 00 267 727 34 789
Telephone 2 : 00 267 395 18 63 ext 5124
Telefax : 00 267 395 98 34/392 4099

Dr Vegesai Pious Makaya
Chairperson
Sub-Committee on Vet. Laboratory Diagnosis
SADC
18 Borrowdale Road
P.o.box CY 551
Causeway HARARE
ZIMBABWE
E-mail 1 : piousv@hotmail.com
E-mail 2 : vetlabs@africaouline.co.zw
Telephone 1 : 00 263 4 70 58 85
Telephone 2 : 00 263 1 16 08 337
Telefax : 00 263 4 70 79 52

Dr Zacarias Elias Massicame
Deputy-Chairperson
Sub-Committee on Epidemiology & Informatics
SADC
Direcção Nacional dos Serviços Veterinarios
P.o.box 1406 MAPUTO
MOZAMBIQUE
E-mail 1 : zmassicame@yahoo.co.uk
E-mail 2 : uevdinap@teledata.mz
Telephone 1 : 00 258 21 460494
Telephone 2 : 00 258 21 460080
Telefax : 00 258 21 460 479

Dr Gift Wiseman Wanda
Veterinary Epidemiologist
PRINT - Livestock Project
SADC Secretariat
P/Bag 0095 GABORONE
BOTSWANA
E-mail : gwanda@sadc.int
Telephone : 00 267 395 1863
Telefax : 00 267 395 9834

USDA

Dr James O. Mecham
Research Microbiologist
Arthropod-Borne Animal Diseases Research Laboratory
USDA ARS
1000 E. University Ave , Dept 3354 (5031 Ag Bldg)
LARAMIE 82071
WYOMING
USA
E-mail : james.mecham@ars.usda.gov
Telephone : 00 1 307 766 3600
Telefax : 00 1 307 766 3500

Miss Azwifaneli Muavhi
Agricultural Specialist
Department of Agriculture
USDA APHIS
877 Pretorius Street
Arcadia
PRETORIA 0001
SOUTH AFRICA
E-mail : azwifaneli.r.muavhi@aphis.usda.gov
E-mail : rejoice.muavhi@yahoo.com
Telephone 1 : 00 27 12 430 2877
Telephone 2 : 00 27 82 858 0619
Telefax : 00 27 12 342 3385

Dr William (Bill) Wilson
Research Microbiologist
Arthropod-Borne Animal Diseases Research Laboratory
USDA ARS
1000 E. University Ave , Dept 3354 (5031 Ag Bldg)
LARAMIE 82071
WYOMING
USA
E-mail 1 : william.wilson@ars.usda.gov
E-mail 2 : wcwilson@uwyo.edu
Telephone 1 : 00 1 307 766 3622
Telephone 2 : 00 1 307 760 3104
Telefax : 00 1 307 766 3500


IKE E: /XARRA //KE


FAO
FIAT PANIS