



Rift Valley fever in Kenya: Policies to prepare and respond

Erik Millstone, Hannington Odame and Oscar Okumu

RVF



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and Policy

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Rift Valley fever (RVF) is a zoonotic infection incompletely understood by scientists, pastoralists and policy makers. The irregular intervals at which outbreaks occur make it difficult for governments to develop and implement clear intervention strategies. This paper provides an evidence-based analysis of some of the conditions under which the risks posed to Kenya by RVF might be diminished. It is premised on the assumption that public policy-making on an issue such as RVF cannot be decided solely by reference to scientific considerations.

The analysis was developed by studying the knowledge, beliefs and uncertainties about RVF, and the policies and preparations to respond to it, taking into account not only the extent and limits of scientific knowledge, but also the perspectives, knowledge and beliefs about RVF among a diverse range of stakeholder groups. These include nomadic rural pastoralists, sedentary agro-pastoralists, government policy makers, expert advisors and local public officials. The paper aims to understand RVF policy-making and implementation by identifying these diverse perspectives, by assessing their congruencies and/or incompatibilities, and estimating the extent of their influence upon policies and practices. It seeks to explore the conditions under which the diverse understandings are most likely to be mutually re-enforcing, and to appraise the upsides and downsides of alternative responses to the challenges of RVF.

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The Dynamic Drivers of Disease in Africa Consortium is a multidisciplinary research programme designed to deliver much-needed, cutting-edge science on the relationships between ecosystems, zoonoses, health and wellbeing with the objective of moving people out of poverty and promoting social justice. It is focusing on four emerging or re-emerging zoonotic diseases in four diverse African ecosystems – henipavirus infection in Ghana, Rift Valley fever in Kenya, Lassa fever in Sierra Leone, and trypanosomiasis in Zambia and Zimbabwe.

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Acronyms

AFRO	[WHO] Regional Office for Africa
CABE	Centre for African Bio-Entrepreneurship
CAHW	Community Animal Health Workers
CCHF	Crimean Congo haemorrhagic fever
CDC	[US] Centers for Disease Control
DST	Decision Support Tool
DOD GEIS	[US] Department of Defence Global Emerging Infections Surveillance and Response System
DVO	District Veterinary Officer
DVS	Department of Veterinary Services
FAO	Food and Agriculture Organization of the United Nations
IGAD LPI	Intergovernmental Authority of Development Livestock Policy Initiative
ILRI	International Livestock Research Institute
KEMRI	Kenya Medical Research Institute
KMC	Kenyan Meat Commission
KWS	Kenya Wildlife Service
MLD	[Kenya] Ministry of Livestock Development
MoPH	Ministry of Public Health
NDVI	Normalised Difference Vegetation Index
NGO	Non-governmental organisations
OH	One Health
OIE	International Office of Epizootics
R&D	Research and development
RVF	Rift Valley fever
RVF CP	RVF Contingency Plan
USAID	US Agency for International Development

VSDf	Veterinary Services Development Fund
WHO	World Health Organization
YF	Yellow fever
ZDU	Zoonotic Disease Unit

1. Introduction

This report provides an evidence-based analysis of some of the conditions under which the risks posed to Kenya by Rift Valley fever (RVF) might be diminished. The analysis derives from an empirical study that was a collaboration between the STEPS Centre at the University of Sussex and Centre for African Bio-Entrepreneurship (CABE), which is based in Nairobi, Kenya. The analysis was developed by studying the knowledge, beliefs and uncertainties about RVF, and about policies and preparations that are in place or could be established to respond to the challenges posed by RVF. Rather than just concentrating on the extent and limits of scientific knowledge, we sought to ascertain and comparatively review the perspectives, knowledge and beliefs about RVF amongst a diverse range of relevant stakeholder groups, including nomadic rural pastoralists, sedentary agro-pastoralists, government policy-makers, expert advisors and local public officials.

It is widely assumed that national administrations, such as the Government of Kenya, have important responsibilities helping their citizens to cope with threats to their health and livelihoods, including those posed by zoonotic infections such as RVF. This discussion is premised on the assumption that public policy-making on an issue such as RVF cannot be decided solely by reference to scientific considerations; non-scientific considerations are invariably involved. It is nonetheless understandable that, when developing policy responses to the challenges of a sporadic zoonotic infection like RVF, governments take advice from scientists whose expertise is deemed relevant and indispensable. In this context one key issue concerns the question of what information may be in the possession of livestock keepers, and the extent to which it does or could effectively contribute to policy deliberations.

The case of RVF is interesting, in part, because it is a relatively novel disease, with long and irregular periods between outbreaks. RVF is a zoonotic infection that is incompletely understood by scientists, pastoralists or by policy-makers given its long and varied inter-outbreak intervals and expanding areas that are most vulnerable to an outbreak (Britch *et al.* 2013). The challenges posed by RVF to Kenyans are therefore unlike those posed by diseases with which both pastoralists and scientists have long been familiar. RVF outbreaks occur at irregular intervals that make it difficult for governments to develop and implement clear intervention strategies during periods with no visible RVF activity and to set aside resources for responding to outbreaks (Martin *et al.* 2008). Inter-outbreak periods are understandably characterised by declines in levels of awareness and concern, and resources may therefore be re-allocated to other diseases or more pressing problems. Indeed, given the issues of uncertainty and long periods of RVF inactivity, it can be difficult to characterise the extent of preparedness on any particular occasion.

2. Approach

Understanding the evolution and characteristics of RVF policy-making in Kenya needs to take account of which knowledge claims have been deemed relevant and reliable by farmers, veterinarians, public health officials and senior policy-makers. Similarly, in order to understand how policies have been developed and implemented it will be important to appreciate which knowledge claims have been deemed relevant and reliable by those with responsibility for interpreting and implementing those policies. Realizing that emerging and re-emerging diseases such as RVF are not always easy accurately to anticipate, there is considerable scope for characterising and learning from, if not 'best' response practices to other zoonotic diseases then, at least from past outbreaks of RVF. The uneven intervals between outbreaks of RVF can lead to loss of institutional and community memories concerning responses to, and consequences of, RVF outbreaks so when another outbreak occurs, those affected often respond to it as an unanticipated emergency because adequate early warning systems and response preparations were not in place.

The STEPS RVF project had both empirical and normative aims. Empirically, the aim was to understand RVF policy-making and implementation, in part by identifying diverse perspectives on how to respond to the challenges posed by RVF. It also involved assessing their congruencies and/or incompatibilities and estimating the extent of their influence upon policies and practices. The normative aim depended on the empirical aim; it involved exploring the conditions under which the diverse understandings are most likely to be mutually re-enforcing rather than at cross-purposes, and to appraise the upsides and downsides, for the various stakeholders, of alternative possible ways of responding to the challenges of RVF.

The perspectives of groups such as government policy-makers and official veterinarians were initially studied by gathering and analysing documents, and subsequently by conducting key informant interviews. In relation to pastoralists documents are scarce. Consequently their perspectives were identified and characterised predominantly through face-to-face conversations, which involved both individuals and focus groups. Those discussion explored some of the differences amongst pastoralists, for example as a function of gender, or herd or flock size, and as between nomadic and sedentary pastoralists in Ijara and Tana River districts of North Eastern and Coastal regions of Kenya respectively.

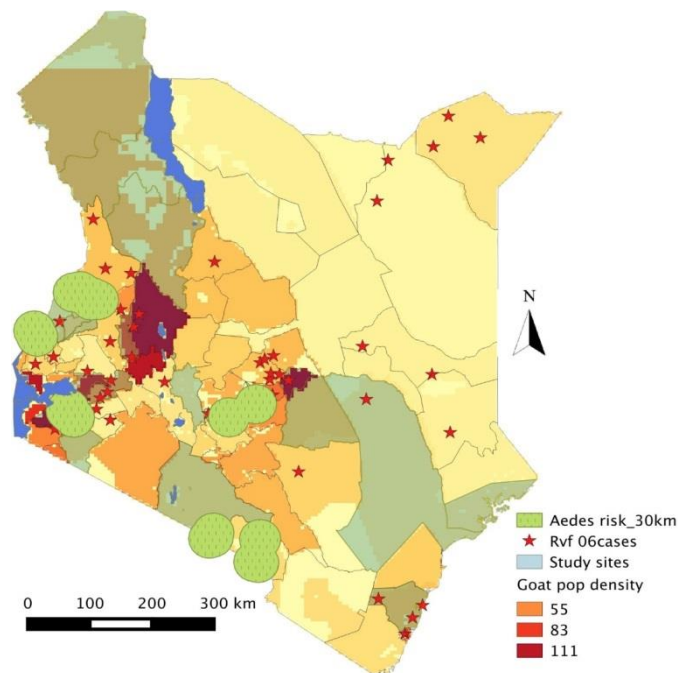
3. Overview of RVF disease dynamics

Rift Valley Fever is a disease which is imperfectly understood, in part because it is unfamiliar to many, even in Kenya, as outbreaks are intermittent and not accurately predictable. Severe outbreaks are provoked by flooding after a protracted period of drought. RVF is a viral zoonotic disease, which can affect domestic livestock, wildlife and humans. During periods of drought the infectious pathogen resides in, for example, the eggs of flood-water *Aedes* mosquitoes, specifically *Aedes mcintoshi*. The Government of Kenya's 2010 RVF Contingency Plan also suggests that, '[...] many mosquito species are efficient vector [and that] other biting insects may transmit the virus mechanically [...]' (MLD 2010: Section 1.5.2, p. 11). The virus is dispersed and transmitted once floods trigger the emergence and reproduction of the insect vectors. Because the climatic conditions that favour the breeding of the vectors tend to occur over large areas, outbreaks can occur simultaneously in adjacent countries. RVF can then be spread to whichever susceptible hosts they subsequently bite. RVF was first reported in Kenyan livestock around 1915, but it was not until 1931 that the virus was identified and isolated (Pepin *et al.* 2010). RVF infections can also be passed from livestock to people if they drink raw milk from infected animals, although thorough heating can diminish that risk. Contact with both meat, blood and waste products from infected animals can also transmit the virus. Those engaged in slaughter, butchery and veterinary occupations can therefore be especially vulnerable during an outbreak of RVF, and they need special training and protective equipment if they are to remain safe and healthy.

Though its emergence is intermittent, RVF has become endemic in several sub-Saharan African countries. In Kenya it has spread far beyond the Rift Valley region. The Ministry of Health as reported that, 'RVF has been reported in humans and animals in 38 of the 69 districts in the country located in 6 of the 8 provinces; leaving Western and Nyanza provinces as the only provinces that have never reported RVF outbreaks in livestock' (MOH 2013: 5).

An RVF risk map of Kenya has been published, and is reproduced below as Figure 1.

Figure 1: RVF risk map for Kenya



Source: Nanyingi *et al.* 2014

An outbreak in Egypt from 1977 to 1978 was estimated to have infected some 200,000 people, and to have killed at least 600 (Gerdes 2004). The last outbreaks were in Eastern Africa in 1997/1998 and 2006/2007, with the epicentre reported in Northeast Kenya and Southwest Somalia (CDC 1998; CDC 2007). The deaths of over 400 Kenyans were attributed to an outbreak of RVF in 1998.

In September 2000 an outbreak was confirmed in Saudi Arabia and the Yemen (Shoemaker *et al.* 2002). The response on the Arabian Peninsula was to assume that RVF had entered their territory in animals imported from East Africa and to stipulate that in the event of any future reported outbreaks of RVF in Africa, exports of all livestock from the affected countries would be banned until such time as they were satisfied that the infection no longer posed a risk to their citizens or livestock.

Given that the range over which RVF has emerged has recently expanded, RVF is categorised as an 'emerging infectious disease' by the US Centers for Disease Control (CDC) and the International Office of Epizootics (OIE).

It is clear from, for example the experience of the 2006–07 outbreak, that local, national and regional responses to RVF have so far been inadequate. In particular the International Livestock Research Institute (ILRI), in a report produced in collaboration with the Kenyan Department of Veterinary Services, argued in 2008 that during the 2006/7 outbreak there had been a, '[...] lack of pre-allocated emergency funds, particularly within the livestock sector [...]' which greatly delayed responses (ILRI and DVS 2008).

It was around that time that a growing chorus of experts characterised RVF as an important disease which should be prioritised for an enhanced policy response (Dijkman *et al.* 2010). That view was consistent with the conclusions from other studies, which have categorised RVF as an important disease, infecting a variety of livestock species, especially cattle, sheep, goats and camels in pastoral regions (Jost *et al.* 2010; Munyua *et al.* 2010). RVF constitutes an important public and livestock health problem, causing serious socio-economic harm across regions and borders (WHO 2010).

For many years RVF was not a high priority for public health and veterinary health policy-makers in East African Governments, because it occurred sporadically, and mainly affected pastoralists in relatively remote rural areas. More recently, and especially since restrictions on the livestock trade with the Middle East were imposed, with adverse consequences for economically-influential parts of Kenyan society, the challenges posed by RVF have risen up the Kenyan Government's policy agenda. A conspicuous sign of that higher salience was the publication of the *RVF Contingency Plan* in April 2010 by the Ministry of Livestock Development's Department of Veterinary Services (MLD 2010). That document, which will be referred to below as the *RVF CP*, explained that, 'The last outbreak in Kenya occurred in 2006/2007 and was associated with severe socio-economic consequences that went beyond the immediate effects on producers and public health. A total of 158 people died in the outbreak, and numerous market actors were severely affected' (MLD 2010: 4). Rich and Wanyoike estimated that the economic costs of the last Kenyan outbreak were some US\$32million, including costs of livestock deaths, production losses and lost income of pastoralist households and traders due to market and slaughter bans (Rich and Wanyoike 2010).

Official responses to previous RVF outbreaks had been characterised by considerable delays in investigating and acknowledging outbreaks, and in providing public advice and implementing effective control measures. Some commentators have suggested that, in practice, outbreaks of RVF may not come to the notice of senior Kenyan Government officials until the rate of human deaths from RVF rises conspicuously, which is typically several weeks after the emergence of RVF in livestock. In the 2006-7 outbreak for example, human cases of RVF were in effect 'sentinel' cases, which brought the outbreak to official attention.

At the global level, amongst organisations such as the World Health Organization (WHO) and OIE,¹ there has been a growing articulation of what is termed a 'One Health' (OH) perspective, which is taken to mean the desirability and importance of addressing zoonotic diseases as problems that should be addressed jointly and collaboratively by public health, veterinary health and wildlife organisations and officials. In light of the OH approach, Kenya established the Zoonotic Disease Unit (ZDU), which is a collaboration between the Ministry of Agriculture, Livestock, Fisheries and the Ministry of Public Health.² The ZDU was formed in 2011 and was charged with responsibility for establishing and maintaining active collaboration amongst those responsible for animal, human, and ecosystem health to enhance prevention and control of zoonotic diseases (ZDU undated). One question therefore is: to what extent can the plans and actions of the Kenyan authorities be characterised in terms of One Health?

¹ Also known as the World Organisation for Animal Health, see <http://www.oie.int/>

² See <http://zdukenya.org/about-zdu/>

4. Harm and costs: why a government policy response is needed

Several attempts have been made to identify and estimate the economic and financial costs that arose from the 2006–07 Kenyan outbreak. A report prepared by ILRI for US Agency for International Development (USAID) concluded that in 2006–07:

Households bore four categories of losses, a) animal deaths, b) reduced livestock production, c) loss of income due to market bans, d) the costs of diagnosis and treatment of livestock and contribution to control costs. Abortion and illness of the animal led to reduced annual milk production and emaciation of animals to meat losses.
(ILRI and DVS 2008: 5)

The costs were high because the pastoralists even had to pay for what little veterinary help was available. The RVF Contingency Plan estimated that:

A total of 158 people died in the outbreak, and numerous market actors were severely affected, the financial and economic cost associated with the outbreak was estimated at KSh4 billion and KSh2 billion respectively. The disease impacted heavily on the regional and international trade in livestock and livestock products.
(MLD 2010)

If such losses are not to recur, or even be exceeded, during future outbreaks of RVF, both veterinary and public health interventions will be required, which will need to be suitably planned and resourced. Indeed as ILRI has argued, unless ‘a national RVF emergency fund has been established and procedures and modalities put in place to enable the fund to be made available rapidly in response to predetermined criteria’, no response to future outbreak of RVF in Kenya will be effective (ILRI and FAO 2014). The range of potentially useful veterinary and public health interventions that have been proposed include: enhanced disease surveillance and diagnostic activities; mosquito control programmes including distribution of mosquito nets and use of insecticides; risk communication and awareness creation; as well as livestock vaccination (Amwanyi *et al.* 2010; Jost *et al.* 2010). Those RVF control options would require considerable investment of financial and human resource if the rapid response activities outlined in the RVF Contingency Plan are to occur. (MLD 2010) There is no evidence that a decision has been taken to allocate the necessary funds, in practice RVF is not yet a high priority for the Kenyan authorities. Even in the context of an emergency, it can be difficult to mobilise the required resources.’

Given that many nomadic pastoralists endure some of the poorest livelihoods in rural Kenya, and in East Africa more generally, the health and economic costs of RVF constitute for them a huge problem. Those considerations, individually and even more so in combination, suggest that the communities who are vulnerable to RVF could benefit from effective help from the Kenyan Government, especially from those with responsibility for veterinary and public health, and those with responsibility for ensuring the adequacy and safety of the food supply.

The need to improve responses to the challenges posed by RVF can, moreover, be understood more generally in the context of zoonotic diseases as a class. According to the Kenyan ZDU (a collaboration between the Ministry of Agriculture, Livestock and Fisheries and the Ministry of Health) RVF is just one of six ‘viral haemorrhagic fevers (namely Crimean Congo haemorrhagic fever (CCHF), Dengue, RVF, Yellow fever (YF), Ebola, Marburg), that top the list of 17 types of zoonoses’ (ZDU undated). That suggests that RVF could be addressed as part of a broader set of policies for dealing with zoonoses as a whole.

5. Forecasting outbreaks of RVF

RVF represents a very difficult challenge for pastoralist and farmers in vulnerable areas, as well as for government policy-makers. Eruptions of RVF infectivity are influenced by abrupt changes in the weather and by land-use changes that, for example, introduce cattle in areas not previously used for livestock farming and that change the distribution of ground and surface water (Bett *et al.* 2014). The changes in weather from drought to flood cannot yet be forecast with sufficient reliability to guide rapid preparatory actions.

Outbreaks of RVF in East Africa have been closely associated with the heavy rainfall that occurs during the warm phase of the El Niño phenomenon (Britch *et al.* 2013). That insight has underpinned the development of forecasting models and an early warning system for RVF, using satellite images and weather and climate forecasting data. Some RVF early warnings have been generated through a joint initiative of the NASA Goddard Space Flight Centre and the US Department of Defence Global Emerging Infections Surveillance and Response System (DoD GEIS), which utilises various remotely-sensed data to which these organisations have access. Early warning systems, such as those, could be used to guide surveillance of RVF in livestock at an early stage of a potential outbreak, enabling authorities to implement suitable measures to avert impending epidemics, but only if adequately prepared (WHO 2007a). The initial warnings could reinforce local climate monitoring and disease surveillance in areas known to contain high risks and trigger national and regional response systems to mobilise resources and responses (Clements *et al.* 2006; Clements *et al.* 2007; ILRI and FAO 2009).

Both global meteorologists and members of local communities have access to some relevant information and understanding, but neither group claim that they can reliably predict when and where outbreaks of RVF will emerge. Several climate-based disease prediction models have been developed and piloted for various diseases and in different regions; the Normalised Difference Vegetation Index (NDVI) is one of such models.³ NDVI can identify vegetated areas and several features of their condition. The potential utility in RVF response planning of the NDVI is a consequence of the fact that when water is widely available and vegetation increases, the environment is conducive for mosquito breeding and consequently the transmission of insect vector-borne diseases. There are however regional and localised differences and environmental variables such as changes in weather patterns, which complicate the use of disease-prediction models accurately to forecast RVF (Fastring and Griffith 2009).

Fastring and Griffith argued that for identification of any disease system each of the three components of the epidemiological triangle namely the agent, host and environment, are all important and so will need to be monitored (Fastring and Griffith 2009). However, for remote sensing and epidemiological research the environment is often the most critical component, but it is often not adequately addressed. As some authors acknowledge, this implies that, before a model is developed sufficiently to be able reliably to predict disease outbreaks can be developed, an association must be found between environmental factors and the ecology of the disease agent or host (John 2010). While work on those dynamics processes has been conducted, it has yet to be completed or evaluated.

The 2009 report of a joint FAO-WHO expert consultation on RVF forecasting models acknowledged that, 'RVF warnings are given two months in advance, but six months are needed between the forecasting alert and outbreak onset in order to implement preventive measures, including social awareness and mass animal vaccination' (FAO/WHO 2009: 5).

³ See eg http://earthobservatory.nasa.gov/Features/MeasuringVegetation/measuring_vegetation_2.php

Critics of the adequacy, reliability and utility of early warning models have argued that such models (developed mainly by international organisations) are inadequate, especially at a local scale. For example Dijkman *et al.* have argued that:

[...] the US team behind the RVF early warning system are both physically and culturally distant from the actual situation on the ground [...] the scientists clearly inhabit a very different world to that of the pastoralists of the Horn. The RVF early warning mechanisms are not embedded in local, national or regional knowledge networks, nor are they provided directly to the pastoralists. Rather, the RVF risk assessments are simply generated on a monthly basis and posted on the DoD GEIS website for anyone to use as they wish.
(Dijkman *et al.* 2010: 24)

Those criticisms of the utility of outbreak prediction models are reinforced by other studies, which point out that while the forecast model used in 2006/07 provided increased accuracy, it delayed the warning until after the apparent onset of the outbreak. As Jost *et al.* have pointed out, '[...] the observation by local communities of climatic, entomologic, and clinical events consistent with RVF within the known risk-prone areas were more timely and definitive risk indicators than the global early warning system in place at the time of the 2006-07 outbreak' (Jost *et al.* 2010). Dijkman *et al.* have argued that, 'It appears that this is an example of a technology seeking an application rather than necessarily the most appropriate solution to a problem' (Dijkman *et al.* 2010: 24).

It has not yet been possible to estimate the predictive reliability and/or precision of the weather forecasting models and early warning systems for RVF that have been developed. Nor is it yet possible to estimate the rates at which they might generate false negatives or false positives (WHO 2009). During the 2006/07 outbreak, by the time the model-based RVF warnings were generated and distributed, more than a month had passed since pastoralists had reported the first suspected cases in their livestock. This implies that even if more reliable forecasts were available, there is relatively little that pastoralists can do, at least in the short run in the face of a threatened outbreak, other than try to relocate into safer areas.

6. Responding to outbreaks of RVF with insecticides

Towards the end of the 2006/7 outbreak, Kenyan government officials were spraying bodies of water suspected of harbouring infected insects with oil-based synthetic pyrethroids, to diminish the spread of infectivity (Ogodo 2007). Once the outbreak had ended the Government had to actively manage the domestic livestock sector to the extent required to satisfy the authorities in states on the Arabian Peninsula that Kenyan herds could reliably be certified as RVF-virus-free (Ogodo 2007).

Although spraying mosquito breeding sites with larvicides is thought by some entomologists to be an effective form of vector control, the tactic can only be applied once specific breeding sites have been identified and if the sites are limited in size and location. The relevance of larvicidal sprays to the lifestyle of nomadic pastoralists is however problematic. They are often dispersed, remote and slowly mobile (Raude and Setbon 2009). In the long run, insecticide spray programmes would need to take account of the likelihood that the virus would mutate by becoming resistant to previously utilised compounds and formulation.

7. Trade and exports

The current livestock trade regimes, and their associated consumer, public and animal health requirements and standards for marketing and export, influence how livestock farming is integrated in local, national and international economies (AU-IBAR 2005). In practice, however, the required standards for marketing and export seem to have more weight than the other requirements (Aklilu and Catley 2009; Dijkman *et al.* 2010; FAO 2011). Reports of outbreaks of trade-sensitive diseases such as RVF have considerable adverse impacts on exports of livestock and meat.

Livestock provides nomadic pastoralists not just with sources of nourishment, it is also their primary source of monetary income. Therefore, in the event of an officially confirmed outbreak of RVF, the pastoralists not only lose their access to export markets, domestic movement restrictions inhibit their ability to access local domestic markets, and consequently their incomes decline abruptly. These considerations must be expected to influence the willingness of at least some pastoralists to report their suspicions that an outbreak of RVF might have started. Their costs can also rise. The DVS's *Standard Operating Procedures For Quarantine Measures For The Control Of Rift Valley Fever Outbreaks* states that, 'The carcasses of all animals dying from disease shall forthwith be either buried, without opening them, at the depth of not less than four feet below the surface of the ground or burnt to ashes at the expense of the owner' (DVS 2014b: para 7.5.h). The incentives currently influencing their behaviour might lead some of them to rapidly try to sell livestock before an outbreak is officially declared, prices collapse and markets closed.

Large animals, such as cattle and camels (when in good condition), are often sold by East African pastoralists into the export trade, which passes through Djibouti, Ethiopia and Somalia. The animal trade between Horn of Africa and Middle East is estimated at about US\$1 billion, which directly impacts on the livelihood and the food security of affected populations (OIE 2007). Middle Eastern and Arabian countries are almost entirely dependent on imported livestock, and consequently meat prices in those countries can be notoriously volatile, especially when supplies fail to meet demand (HotelierMiddleEast.com 2012; Rahman 2013).

Kenyan sheep and goats (also known as shoats) are sold and consumed in Kenya and other East African countries. There is considerable cross-border intra-African trade in shoats, but little information is available on the frequency with which Kenyan shoats are exported from Africa via, for example, Sudan or Somalia. The Kenyan town of Garissa has a large auction market for shoats, from where traders move them north and east. Most of the cattle that are sold for domestic Kenyan consumption pass through livestock markets in Mombasa and Nairobi. Large sedentary herds owned by rich and powerful individuals and companies tend to be closer to urban areas, while the nomadic pastoralists' herds and flocks inhabit more remote areas. A parastatal organisation, the Kenyan Meat Commission (KMC), has large meat processing plants to serve Nairobi and other urban areas. At the KMC's slaughter houses, officials are supposed to inspect the animals prior to slaughter and to inspect meat before it goes into cold-storage. The livestock trade, and its trade routes, imply that RVF is important for many countries and farmers, especially as the pathogens can spread beyond the pastoral regions, even into urban areas.

8. The scope and limits of knowledge of RVF and implications for policy-making

Because of the complexities in the challenges posed by RVF, several of which are reviewed above, stereotypical arguments about whether the knowledge claims of scientists should be privileged over the beliefs of farmers, or *vice versa*, are irrelevant. Pastoralists, virologists, veterinarians, epidemiologists, meteorologists and public health professionals all possess some understanding of RVF, but all can (or should) recognise that their understandings are incomplete and insufficient. The ecology of the RVF virus, for example, remains an area characterised by significant uncertainties.

Field veterinarians are able to recognise the clinical signs of RVF, which they treat as suspect cases, but it can be difficult definitely to differentiate RVF from other viral fevers without laboratory testing and confirmation. The official declaration of an RVF outbreak in Kenya is only made after confirmation of the presence of the infection by the Central Veterinary Laboratory, the Kenya Medical Research Institute (KEMRI) or the CDC. Local level laboratories in the rural areas have limited the capacities or equipment to test specimens and samples for RVF. According to a laboratory technician at a district hospital, 'At the moment, the district hospitals do not have the rapid diagnostic kits. On several occasions, KEMRI has taken samples. The hospital does not have the diagnostic capacity. But if we come across suspicious case symptoms related to RVF, we send samples to KEMRI.'

Despite the limitations of the various understandings of RVF, it is reasonable that senior policy-makers turn to scientific experts for some guidance to help them formulate policies on how to respond to the challenges posed by zoonotic diseases such as RVF. The contributions of scientific experts are evident in for example the 2009 Decision Support Tool (or DST) and the 2010 RVF Contingency Plan (or RVF CP) (ILRI and FAO 2009; MLD 2010). On the other hand, there are several reasons why the information provided by scientific experts on its own cannot be sufficient to decide RVF policy, particularly as many RVF control options such as active disease surveillance and reporting, vaccination programmes, slaughter bans and livestock movement restrictions require pastoralists' cooperation. Developing a plan for responding effectively to the challenges of RVF requires understanding more than virology, epidemiology and immunology, it also requires an appreciation of the practical challenges, incentives and opportunities with which pastoralists are confronted, as well as the challenges confronting those who have responsibility for helping pastoralists, and others, to respond to RVF (see Box 8.1).

Box 1: Logistical and human resources available to respond to RVF

Logistical and human resource challenges have long been a major hindrance to RVF response. For example, during the last outbreak, there were some 10 nurses deployed by the government to the Ijara district. However, the nurses remained in the district only until the outbreak ended. After the outbreak, they returned to their original places of work. The same applied to the veterinary side. Although some Nairobi-based stakeholders may claim adequate preparedness to deal with another outbreak of RVF, the situation on the ground is less reassuring. At the district level, similar institutional, infrastructural and logistical challenges remain as those that prevailed in the 2006/07 RVF outbreak. For example, very few veterinarians are deployed, there are only few nurses in district hospitals, with inadequate transport. The Ijara District Veterinary Officer reported that his office had just one vehicle, which was not in a road-worthy condition because of a lack of maintenance and spare parts. He explained that they had to use donkey carts when transporting equipment to areas suspected to contain outbreaks of RVF and other zoonoses.

Despite some knowledge of the epidemiology of RVF, the 2006/07 outbreak caught the Government of Kenya poorly prepared and it was unable to restrict the outbreak to the local source (Fyumagwa *et*

al. 2011). The management of future outbreaks may be similarly problematic, given the limited investment of resources and the anticipated logistical challenges.

While a multi-disciplinary team of natural and social scientists have developed a mostly-sensible plan for responding effectively to the threat of, or occurrence of, outbreaks of RVF, decisions about the resources to invest in implementing that plan remain the domain of government ministries (MLD 2010). Ministers need to adjudicate between many competing claims on public resources. They not only have to, in effect, rank RVF in relation to other zoonotic infections, but also to rank zoonotic infections against other challenges faced by pastoralists, such as food insecurity, drought and conflicts, and the needs of pastoralists in relation to other needy groups and stakeholder groups who stake claims for official policy support and allocations of resources. RVF policy-making in East African countries such as Kenya constitute therefore exercises in policy-making under conditions of uncertainty in both the natural and social sciences, as well as problems arising from diverse and contesting interests.

9. The extent and limits of science knowledge of RVF and technological responses

A few pioneering virologists have identified and isolated a/the RVF pathogen(s), though as that way of putting it implies, there is some debate about whether RVF is one or several varieties of pathogen. Infectious disease epidemiologists and ecologists have established, what pastoralists knew, that the infection is spread from insectivore reservoirs that emerge soon after heavy floods that follow extended periods of drought.

Programmes of scientific work on RVF have established a useful but incomplete knowledge base on several technical aspects of RVF including virology, aetiology, vaccines, risk factors, epidemiology, socio-economic impacts and surveillance systems. From the previous two Kenyan outbreaks, in 1997/98 and 2006/07, there was evidence that RVF can present as a distinct clinical condition. The characteristic clinical syndromes for RVF, which vary slightly between species, include such common symptoms as fever, weakness, discomfort and headaches, combined with pains in multiple large joints, as well as nausea, vomiting, and stomach pain, followed by tender and enlarged liver, jaundice and delirium (King *et al.* 2010).

Those symptoms leave unresolved the question of whether RVF is caused by a single serotype of a virus, or whether the pathogen has differentiated, indicating a gap in knowledge about RVF, as posited by an Ijara District Veterinary Officer (DVO),

[...] so far, what we know is that one strain of RVF affects different animal species, which exhibit different responses and clinical manifestations. Hence, there is need to carry out more research on the possibility of RVF being caused by different strains of viruses, or the possibility of the virus mutating in other forms [...].
(Personal Communication, 5 September 2013)

Further, the DVO indicated that:

[...] there is a lot we don't know about the disease. This disease is a minefield of research waiting to be mined. Who knows the full extent of the reservoir of this disease and who knows why the disease survives in eggs or mosquito larvae for many years? So much is yet to be revealed about this disease.
(Personal Communication, 5 September 2013)

Important areas of technological strength concern the identification of the pathogen and methods for testing blood or tissue samples from people or animals to confirm or refute provisional diagnoses of RVF. The OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*, as of April 2014, referred to seven distinct methods that can be used to test for the RVF pathogen (OIE 2013). Several of them have been developed into portable Rapid Diagnostic Kits which, while reliable, are not yet cheap. Several of the types of tests have rates of false positives and false negatives estimated to be below five per cent (LaBeaud *et al.* 2007). The potentially most relevant technologies for managing the challenges from RVF that scientists have yet developed are vaccines.

10. RVF vaccinations: a control strategy in animals and humans?

The number and severity of outbreaks of RVF in animals can be diminished, but not prevented, by a sustained programme of animal vaccination. So far, effective and sustained RVF vaccination programmes have not been implemented in most areas prone to RVF epidemics (Breiman *et al.* 2010). Two main types of RVF vaccines have been developed, both intended for veterinary use. A safe and effective vaccine for humans has not yet been developed. One type of vaccine used is a modified live attenuated virus while the other type uses an inactivated virus. If the live vaccine is used, only one dose is required to provide animals with long-term immunity, but the currently available live viral vaccine is known to increase significantly rates of spontaneous abortions when administered to pregnant animals (Munyua *et al.* 2010; LaBeaud *et al.* 2010; Jost *et al.* 2010). Administering the inactivated viral vaccine does not have that adverse consequence, but multiple doses are required to provide sustained protection, but that is difficult to achieve with nomadic herds.

To be effective and safe at preventing an outbreak of RVF, livestock would need to be immunised before any outbreak could emerge. There may be brief intervals between the moment when meteorologically and geographically based warnings are issued, indicating that an outbreak is likely and where the risks are highest, and the subsequent occasion when cases of RVF start to emerge in livestock or humans. Once an outbreak has started animal vaccinations become increasingly problematic. Firstly there is a risk that vaccination might intensify the outbreak, and secondly once flooding occurs, it is no longer possible to reach the livestock in the most vulnerable areas so vaccination would be impractical, even if the technical problems alluded to above could be resolved.

The WHO explicitly recommends that, 'Once an outbreak has occurred animal vaccination should NOT be implemented' (WHO 2007b). The WHO explained that if, during mass animal vaccination campaigns, animal health workers inadvertently transmitted the virus between animals, through the use of multi-dose vials and the re-use of needles and syringes, then vaccination would be counter-productive. If some of the animals are already infected and viraemic, but not overtly symptomatic, the virus would be transmitted amongst the herd, and the outbreak will be amplified (WHO 2007b). Another problematic feature of the available vaccines is that, even if stored in stable refrigerated conditions, they have a shelf life of only about six months, and there are very few refrigerators in the most vulnerable districts.

According to Ogodo, during the last outbreak of RVF in Kenya in 2007, there was a significant shortfall in funding for a programme of vaccinating livestock in vulnerable districts of Kenya. In 2007 Kenya had some 1.5 million doses of vaccine, when in practice 3 million doses would have been required to cover vulnerable livestock. The Government's response had been slow, in part because funds designated for use during emergencies had already been exhausted dealing with the preceding drought (Ogodo 2007). It has not yet been possible to establish the level of stocks of RVF vaccine currently held in Kenya, or East Africa more generally. Nonetheless, a draft *DVS Standard Operating Procedure For Livestock Vaccination Against Rift Valley Fever* states that:

Livestock vaccination will be conducted annually in high risk areas. In medium risk areas, targeted vaccination will be conducted ahead of predicted outbreaks. Vaccination will also be conducted during localised outbreaks in low risk areas and in export animals where the importing country specifies.

(DVS 2014a, Section 1)

And that:

Annual revaccination is recommended and should be carried out at least one month before the seasons when outbreaks of the disease are expected’
(DVS 2014a: Section 8.3).

In order to ensure effective control of RVF, it is essential to create awareness about the disease amongst livestock owners in the high-risk areas, as well as amongst the general public. Before the 2006/07 RVF outbreak there were low levels of awareness about the importance of vaccination. During a focus group discussion with pastoralists in Ijara district, we learnt that pastoralists hold diverse views about vaccines against RVF (Personal communication September 2013). One farmer explained that he had assumed that vaccinating all his animals would result in the death of some of them. Consequently, he separated his healthy animals and drove them into the bush, but left those that appeared weak or sick to be vaccinated. Unfortunately, many of those that were not vaccinated and were taken to the bush died of RVF, while most of his vaccinated animals survived, despite their prior weaknesses. Such experiences have changed the pastoralists’ perception and some are consequently more receptive to vaccination in the event of an RVF alert than they were previously. Nonetheless, some pastoralists remain resistant to vaccination, especially during dry seasons because their livestock are then rather weak and so might be less able to withstand the effect of the vaccine.

Following the last outbreak, pastoralists in RVF-prone areas have remained alert for, and concerned about, RVF. Our discussions with pastoralists indicated that many pastoralists would be willing to vaccinate their animals. For example, during a focus group discussion it was said that:

the pastoralists and village elders were involved in mobilising and moving livestock to central places for vaccinations and reporting RVF suspect cases to the veterinary department and the human health clinics. After the 2007 RVF outbreak, we learnt that in order to protect ourselves during RVF outbreaks, we have to avoid having meat and milk, avoid moving our animals to infected areas, vaccinate our animals and isolate sick people. Nowadays, we vaccinate our animals when called upon to do so by the veterinary department.
(Personal communication, Jalish, Ijara)

Similarly during a discussion in Hara, it was said that:

[...] for the Government to help protect us against RVF or to control it when it occurs, we propose and recommend the following: control of the mosquitoes by using bed nets and spraying of the whole house because mosquitoes are more during rains; the veterinary and health department should regularly carry out animal vaccinations and advise on the safe time to have meat and milk following vaccination. We believe that the same way *shifow* (Rinderpest) was managed through regular vaccination, is the same way RVF could be managed or eradicated completely.⁴
(Personal communication, Hara)

⁴ Kenya gained accreditation of ‘freedom from Rinderpest’ in 2009. Some of the achievements of the eradication programmes included the operationalisation of active disease surveillance, the use of Community Animal Health Workers in difficult terrains and situations, forming epidemiological networks, capacity building for diagnosis and inclusion of wildlife in national animal disease surveillance programmes (AU-IBAR 2012).

However, little is known about whether the same might be true in other areas with potential for future RVF outbreaks but where RVF has not previously emerged. As well as those positive responses to vaccination, there have been proposals for increased coordination and collective resource mobilisation for vaccination efforts. Both the RVF CP and One Health Strategic Plan recommend action plans for various stakeholders, such as government departments and non-governmental organisations (NGOs), who have interests in vaccines, and resources for vaccination, before and/or during RVF outbreaks. Unfortunately many stakeholders with responsibilities for RVF control, especially those at the grassroots-district level, are entirely unaware of policy response documents such as the RVF Contingency Plan, the Decision Support Tool or the One Health Strategic Plan. A low level of awareness of the policies and documents, and their contents, is likely to hinder their implementation during RVF outbreaks.

Strategies for vaccination initiatives need to be ready to be implemented when there are indicators of an RVF outbreak. The Department of Veterinary Services (DVS) is responsible for buying and distributing vaccines to DVOs. During vaccination drives, the resources available have never been adequate. An Ijara DVO said that:

When we suspect that there will be heavy rains and floods, we would vaccinate in the risky areas. We have 25,000 doses of RVF vaccine in store. These doses are not enough when we need to vaccinate all animals. In case of any signs of RVF risk factors, we only vaccinate sheep and goats.
(DVO, Ijara)

The shortage of vaccines results in hard decisions about which species of animals to target (either small or large ruminants) and in which region(s). Many of the local veterinary officers have difficulty identifying the patterns of livestock movements, so they are unable to be sure which areas and animals to emphasise or avoid. Since the 2006/07 outbreak risk maps have been developed indicating high RVF risk areas to avoid vaccinating all the livestock in the country. That should facilitate targeting of livestock in high risk areas, thus making better use of the available resources. It remains to be seen however how reliable and useful these maps will be.

Prior to the 2006/07 outbreak of RVF, many pastoralists had low levels of confidence in the safety or efficacy of RVF vaccines. Frequently their confidence that the central government and local district authorities were always supportive of their interests was also low. Their collective understanding and appreciation of the efficacy and safety of RVF vaccines improved when they learnt that vaccinated animals, even weaker ones, had higher survival rates than un-vaccinated counterparts. On the other hand, pastoralists would be keener on vaccinations if effective formulae could be provided that protected their livestock without repeated inoculations and which did not cause pregnant animals to miscarry.

Historically, pastoralists in many parts of Africa have been less than entirely trusting of government officials, especially because of their concern that officials might try to restrict or tax their activities. If high levels of cooperation between pastoralists and government officials are to be achieved, it would be very helpful if pastoralists were provided with greater incentives to cooperate with official plans for responding to RVF. For example, if pastoralists draw the attention of officials to an outbreak of RVF, and if their suspicions are confirmed by a laboratory, the pastoralists know that the consequences will include movement restrictions and closure of both local markets and the export trade. They will bear considerable costs. If pastoralists were provided with some form of government-supported livestock insurance scheme or compensation for loss of diseased livestock and/or livelihoods, or assistance with re-stocking, then governments could be far more confident of high levels of co-operation on the part of pastoralists. Pastoralists also complained that in previous outbreaks they never received feedback

on the results of the officially-conducted laboratory tests. If procedures were changed to ensure that pastoralists routinely received the results of laboratory tests, that would enhance levels of cooperation and the pastoralists' ability accurately to diagnose and differentiate between symptomatically-similar infections.

To date, there are no licensed commercially available vaccines to protect people against RVF. Because veterinarians and laboratory workers are especially vulnerable to RVF infection, they have been amongst the occupational groups most keen on the development of a safe and effective human vaccine. Nonetheless, no such vaccine has yet deemed both safe and effective. As long ago as 2002 an FAO report, on how an RVF Contingency Plan could and should be developed claimed that an experimental inactivated tissue culture vaccine for human use, manufactured in the USA, may be made available for this purpose (FAO 2002). One was then being tested in South Africa, but it has not subsequently been deemed acceptable. Breiman *et al* have argued that the vaccines under development in 2010 were unlikely to be licensed for human use, partly because of safety concerns but also because their market value to the pharmaceutical enterprises was judged insufficient (Breiman *et al*. 2010).

Given that no licensed vaccine or anti-viral medication is available for human use, travellers to vulnerable areas have been advised always to wear long sleeves and pants and to use insect repellents and bed nets to protect against bites from mosquitoes and other blood-sucking insects (Western Cape Government undated). People who work with animals in areas where the virus is present should avoid exposure to the blood or tissues of potentially infected animals. In the absence of any specific treatment and an effective human vaccine, raising awareness of the risk factors of RVF infection as well as the protective measures individuals can take to prevent infection or transmission, is the only way to reduce human cases of RVF.

Perspectives on vaccination measures to control of RVF vary amongst Nairobi-based policy makers as amongst pastoralist communities. A recent draft document being prepared by the Ministry of Health suggested that, 'Outbreaks of RVF in animals can be prevented by a sustained programme of animal vaccination' (MoH 2013: Section 3, 22). Although the same document acknowledges that, 'Animal immunization must be implemented prior to an outbreak if an epizootic is to be prevented. Once an outbreak has occurred animal vaccination should NOT be implemented because there is a high risk of intensifying the outbreak' (MoH 2013: Section 3, 22).

The suggestion that outbreaks of RVF can be prevented by a sustained programme of vaccination has not however been endorsed by a recent document being prepared by ILRI and the UN FAO, under the auspices of the USAID Office of U.S. Foreign Disaster Assistance. In 2014, the document argued that:

Vaccination against RVF in the Greater Horn of Africa presents a number of challenges. Indeed some experts consider that these are so great that they effectively preclude the use of vaccines to prevent/control RVF outbreaks in this region – although they are effectively used in other regions where the epidemiology of the disease, environmental conditions and infrastructure are different, e.g. southern Africa.

Most viral vaccines have a shelf-life of 2–4 years, while the interval between RVF outbreaks in the Greater Horn tends toward 10 years, although it has been closer to 20 years during some inter-epizootic periods. Hard pressed veterinary authorities with many demands on their scarce resources are understandably reluctant to maintain vaccine stocks for a disease which occurs intermittently and which are likely to expire before they are used. For sound commercial reasons the manufacturers also avoid maintaining large stocks which are likely to reach their expiry dates before they can be sold. However, the lead time needed by

manufacturers to produce new batches of vaccine can be several months. Waiting until an RVF outbreak is highly likely or actually occurring will leave too little time for the manufacturers to respond. Even if the manufacturers did have adequate vaccine stocks, waiting until the heavy rains and flooding have begun means that it is very difficult, often impossible, to transport and distribute vaccine in remote areas which often have no all-weather roads.

One possible way forward is for a regional organization and/or donor(s) to fund a strategic regional vaccine stock, which could be rapidly deployed in times of need. This would remove the burden from national veterinary authorities to maintain costly vaccine stocks. One option would be for the vaccine manufacturer to be paid to maintain a minimum stock of vaccine (likely to be tens of millions of doses) at all times. Modelling future requirements for vaccines could be a useful approach to help predict the size of the strategic stock required.

In the longer term, new and improved vaccines, for example ones that have longer shelf-lives, may be developed that help overcome this problem, or earlier early warning systems may be developed that provide manufacturers with the lead time they require. Meanwhile veterinary authorities need to develop clear policies and guidelines for vaccination against RVF and to have these in place before the next RVF outbreak. This will entail balancing the cost of vaccination, including maintaining strategic stocks, against the periodic risk of an outbreak and the associated threat to lives, livelihoods and national economies.

In determining if and how to use vaccination to prevent or control a forecasted outbreak of RVF, this decision support framework encourages an understanding of outbreak risk, the identification of zones at highest risk, a realistic estimation of delays caused by logistical constraints, and planning for the time needed for vaccinated animals to develop a protective immune response...the joint ILRI/GoK DVS participatory assessment of the 2006/7 RVF outbreak (ILRI 2008) found that, although an FAO EMPRES early warning was issued in November, the earliest cases in livestock occurred in mid-October in North Eastern Province. This means that vaccination campaigns would have had to been established by the end of September. However, these early outbreak areas had already been subject to heavy rains by mid-September that made them inaccessible, pushing the need to have completed the vaccination campaigns to early-September.

(ILRI and FAO 2014)

Those detailed caveats constitute a problem for the less nuanced perspective set out in the Ministry of Health's draft document. Unless the Ministry of Health can convincingly respond to all those complications, it might be prudent for that Ministry to accept the guidance that the ILRI and FAO report has provided.

On the other hand, while ILRI/FAO refer to, '[...] a regional organization and/or donor(s) [...]' consideration could be given to addressing requests for donor support to countries in the Arabian Peninsula that welcome imports of livestock from the Horn of Africa during the lengthy periods when no RVF outbreaks are occurring. During outbreaks of RVF, countries in the Arabian Peninsula ban imports of livestock from affected areas, which create meat shortages in those countries and raise their domestic meat prices. There might be a good case for seeking donor support for vaccination programmes from wealthy countries in the Arabian Peninsula, on the grounds that sustained vaccinations of vulnerable livestock in East Africa would help stabilise their meat supplies and domestic food prices.

11. What do both scientists and pastoralists know?

Pastoralists and scientists agree that RVF is most likely to emerge following long dry periods interrupted by rains that are sufficiently heavy to cause flooding. They agree that the infection is spread by biting insects especially a particular type of mosquito, which some pastoralists characterise as 'dotted'. Equally, both scientists and pastoralists rank almost similar factors as predisposing risk factors for RVF outbreaks, the major ones being prevalence of mosquitoes, heavy rains (or floods), and contact with infected animal materials.

Both the pastoralists and the meteorologists struggle to provide reliable, accurate and precise forecasts of when and where RVF outbreaks will occur and, so although official plans of the Kenyan authorities are framed in terms of incremental measures to be implemented when RVF is anticipated, those expectations may have wide margins of error. Pastoralists and livestock officials also recognise that climate change is provoking large movements of people and livestock, while the Kenyan authorities ability to monitor or control livestock movements is weak. If and when outbreaks of RVF have been officially confirmed, and movement controls have been introduced, lorry loads of livestock travelling by road are far easier to restrict than animals herded on foot and hooves across terrain remote from roads and urban settlements, even when crossing district and country borders. Moreover roadside controls are less common at night time than during the day, a fact that is well understood by livestock traders and transporters.

An Ijara DVO explained that:

If you look at all risk factors, we are just sitting on powder keg. In the past, animal disease control and response was 'perfect', there was effective quarantine, restricted animal movement, but now there is nothing. I can assure you if RVF occurs today, it will still kill people and livestock. We are always reactive.

(Personal communication, 6 Sept 2013)

While the suggestion that there once was a previous 'golden age' of perfection may be implausible, the DVO's comments indicate that there are serious weaknesses in the enforcement of movement restrictions, despite both the scientists and pastoralists acknowledging that it is one way of controlling the spread of RVF.

12. What do pastoralists know about RVF?

Although there are a number of diseases that may be diagnostically confused with RVF, most of the sample of pastoralists with whom we worked could articulate the symptoms by reference to which they would diagnose RVF in their livestock or communities, and by which they differentiate it from other infectious zoonoses. Our data were collected in 2013, which was some five years after the last officially reported outbreak of RVF in Kenya. Recollections of the last outbreak of RVF undoubtedly informed their knowledge and beliefs. Pastoralists explained that the most distinctive symptom of RVF is nose bleeding, in livestock and people (as well as abortions in pregnant females), while the other symptoms are characteristic of many different fevers. Our findings therefore reinforce the account provided by ILRI in 2008 and 2010. (ILRI and DVS 2008; Jost *et al.* 2010).

During and after the 2006/7 outbreak of RVF many local NGOs, official bodies and international organisations invested in providing RVF training and awareness raising to veterinary and public health staff and to pastoralists in some of the worst affected areas. It is difficult to estimate the impact of those efforts, but when our data were collected in 2013 pastoralists were relatively well-informed about RVF. In particular they knew enough to be able to contribute effectively to disease surveillance. In 2008 ILRI reported that. 'Herders recognise that outbreaks [of RVF] are associated with large black and white mosquitoes [...] as opposed to, for example, the smaller mosquitoes associated with malaria' (ILRI and DVS 2008). In our study, pastoralists explained that they recognise that 'dotted' mosquitoes as those that are most likely to carry RVF. They were also aware that moving animals can spread the infection, as is the case with other infectious diseases.

There is evidence of cultural and religious differences in practices concerning eating meat across diverse groups and regions. Cultural and religious taboos against eating meat from sick animals, to which Muslims subscribe, are perceived as a measure that can protect against zoonotic diseases such as RVF. Pastoralists in the Ijara district articulated diligent conformity with the rule of never eating the meat of 'fallen' stock, irrespective of the cause of their death. A pastoralist in Ijara district explained, 'We Muslims don't butcher dead animals. When we feel like eating an animal, we slaughter and butcher a healthy one at home.' They say that when they suspect one of their animals has succumbed to RVF, they bury the corpse quite deeply and in a safe location, for example away from water courses.

The pastoralists also have some traditional methods for reducing exposure to biting insects, such as enclosing their livestock overnight, if only with rudimentary barriers, and setting fires downwind to use the smoke, especially with material from acacia trees, to repel insects. When RVF erupted, they tried using their traditional remedies in the form of herbal ointments on fevered animals, but subsequently reported that they found those remedies to be ineffective.

Pastoralists in Ijara district explained that, in the face of the challenges posed by RVF, they do look to the Kenyan Government and its local official representatives for help. Their experience of the 2006/7 outbreak was that they had been provided with information and advice by veterinary and public health officials and from Community Animal Health Workers (CAHWs). More recently however there have been pressures from professional veterinary organisations to persuade the government to rely more on professionals and less on CAHWs.

During the 2007 outbreak CAHWs were recruited to assist with the vaccination programme but, once the outbreak subsided, CAHWs were increasingly marginalised and ignored. The evidence gathered for this study indicates that CAHWs are predominantly volunteers who often receive no official support, and while their services might be called upon in the event of a fresh outbreak of RVF, they would then require re-training as well as, for example, supplies and allowances.

Representative of professional veterinarians have argued that farmers should benefit from the services of trained professionals rather than poorly trained or equipped CAHWs. Some veterinarians evidently consider CAHWs as competitors who undercut their prices while providing inferior services. On the other hand pastoralists, especially nomadic ones, see professional veterinarians as scarce and prohibitively expensive. If professional veterinarians had greater incentives to train, equip and supervise CAHWs, pastoralists' communities might obtain enhanced veterinary support that would be accessible and affordable to prevent and/or manage diseases. Such changes could also enable DVOs to gather and share larger and more reliable sets of data. This scenario implies institutional changes, based on a One Health concept, to enhance capacities to mitigate and respond to outbreaks of zoonoses.

Recently-settled communities of sedentary agro-pastoralists located in the Tana River District, especially those who are able to farm on irrigated land, have mostly come from arable farming communities, and so have less experience of livestock than traditional mobile pastoralists. The evidence indicates that they are often less well-informed about RVF than the pastoralists in Ijara district, they had scant knowledge of the symptoms of RVF or how to respond to an outbreak. They are far more dependent on veterinary expertise and services than are their more mobile and experienced counterparts.

13. Local innovations

Within pastoralist communities, there have been some 'grassroots innovations' as members of those communities have experimented, learnt and modified their practices to try to diminish the harm RVF can cause. In several small settlements, where local pastoralists bring their livestock for sale and slaughter, changes have been introduced to the design, layout and practices at the site of slaughter. Pastoralists and others, such as veterinarians and laboratory workers, realised that they were amongst the groups with the highest incidence of RVF, consequently pastoralists were as keen on finding ways to diminish the risks that RVF posed to them as were the professionals.

13.1. Innovative slaughter facilities and practices

Traditionally in the Ijara district, individual pastoralist households would slaughter and butcher their own animals. During the most recent outbreak of RVF, pastoralists realised however that if they relocated their slaughtering to shared facilities that were better-designed and equipped than their domestic facilities they could, with suitable training, significantly reduce their risks of exposure to RVF. Several such slaughter facilities were built after the 2007 outbreak in Ijara district. They were configured to diminish the risks to those working in the facility, who were also equipped with, for example, protective gloves and trained in safe use of the new facilities. They changed the ways in which they handling the animals before slaughter, as well as ways of handling carcasses, meat and waste, thus avoiding exposure to high levels of infectivity. Those innovations were encouraged by the local veterinary officers and other local officials, who also have responsibility for licensing suitable facilities. While several individuals took initiatives to invest in those new facilities, they did so on concessionary terms. In some localities, the communities refunded the butchers' investments and adopted forms of collective ownership of the facility, where the butchers remain as custodians and service providers. In others they paid for the service at, for example, a rate of 20 KSh per goat, and 100 KSh for cattle and camels. More recently however the use of protective gloves has apparently diminished.

13.2. New water sources

Innovations around water pans were also introduced. Water sources have long been key locations for human-wildlife-livestock interactions. There have, moreover, been more frequent and closer interactions between wildlife and agricultural livestock during dry periods, especially in fall-back grazing areas. The grazing areas and watering points are, however, themselves also changing. The number of water sources and the amounts of water available have also declined due to environmental changes and increased numbers of livestock.

In the 2006/07 outbreak RVF did not affect wildlife as much as it infected livestock. A Kenya Wildlife Service (KWS) Warden explained that wildlife populations in the Ijara district had previously been increasing. In areas with sufficient pasture and water, such as the Boni forest, there are frequent interactions between people, livestock and wildlife, which were problematic once an RVF outbreak began. To address this problem, several water pans were constructed away from Boni forest. The Warden explained that, ' [...] fewer water pans lead to congregation of livestock, wildlife and humans at water points. As a result of this interaction, it was possible for RVF to spread with ease' (Personal communication, KWS Warden, September 2013).

Donor and aid organisations, such as World Vision, endeavoured to improve the livelihoods of pastoralists by constructing separate water pans for humans and for livestock, or in some locations water pans for animal use and boreholes for human water use, to diminish the risks of cross-infection (Personal communication, KWS Warden, September 2013).

14. The Kenyan Government's *Contingency Plan for RVF*: how it came to be created and what is proposed

The clearest and most comprehensive statement of the Kenyan Government's policy in respect of RVF emerged in April 2010 from the DVS, which is located in the Ministry of Livestock Development (MLD). It was entitled, *Contingency Plan for Rift Valley Fever*, and it is referred to in this document as the *RVF CP* (MLD 2010). Shortly after publication, it was officially adopted by the Government of Kenya. Its creation can be understood in large part as a reaction to the 2006/2007 outbreak of RVF.

Two years later, in 2012, the Kenyan Ministry of Public Health and Sanitation issued a document concerning surveillance of infectious diseases entitled *Technical Guidelines for Integrated Disease Surveillance and Response in Kenya*. Those guidelines had previously been drafted in October 2010 by the WHO Regional Office for Africa (AFRO) and the CDC, and then adapted by the Kenyan Ministry of Public Health and Sanitation in 2012.⁵ One noticeable feature of that document is that it made no mention whatsoever of pastoralists, and referred to farmers only as groups upon whom surveillance should be conducted. It provided no evidence that the Ministry recognised that effective disease surveillance and response cannot be accomplished without the active participation of groups such as farmers and pastoralists.

The *RVF CP*'s characteristics also drew on the 2002 UN FAO document entitled *Preparation of Rift Valley Fever Contingency Plans* (FAO 2002). In March 2008 another influential contribution emerged jointly from the DVS and ILRI, reporting the findings of a study funded by USAID that sought to identify lessons from the 2006/7 outbreak. It recommended that:

The Department of Veterinary Services and the Ministry of Health should work together to develop a contingency plan based on cost-benefit assessments of interventions and practicality. A contingency plan should address strategy, actors, command chain, coordination and collaboration, and the optimal use of resources.
(ILRI and DVS 2008)

It is puzzling therefore that the *RVF CP* emerged from the DVS with no conspicuous contribution from the Ministry of Health.

The March 2008 ILRI document reported that its:

[...] participatory epidemiologic study found that livestock owners could clearly identify the clinical signs and risk factors associated with RVF, and distinguish RVF from other livestock diseases. Livestock owners are a key information source for RVF early warning and early detection. Herders recognize RVF based on clinical symptoms, and 12 of 17 groups interviewed recognised the 2006/2007 outbreak as being the same disease as that which occurred in 1996/97
(ILRI and DVS 2008)

In other words, pastoralists were, understandably, being cast in the role of information providers. The *RVF CP* was, on the other hand, less clear about what the pastoralists could expect to receive in return for their contributions to disease surveillance. It is also notable that the expression 'livestock owners'

⁵ See <http://1.usa.gov/1x10jy8>

was used in a way that failed to acknowledge that not all owners are herders and not all herders are owners. While many poor pastoralists herd the livestock they own, there is a significant but influential minority of urban owners who employ others to tend their flocks and herds. In those cases the animal herders may know far more about the livestock than do their owners.

While Appendix 1 of ILRI's 2008 Report recommended enhanced collaboration between the DVS and the Ministry of Health, and recommended enhancing the roles of CAHWs, it also stated:

Most of the participants interviewed indicated that the first cases of RVF were not reported because the livestock owners were unaware of the outbreak. Moreover, they indicated that cases are often reported when they fail to respond to their treatments.
(ILRI 2008)

The authors also recognised that:

Livestock owners would only participate in the surveillance system if they can benefit from it. This could be through improved delivery of veterinary services by strengthening the roles of CAHWs especially in areas where the DVS is thinly spread through focussed trainings. The CAHWs would then play a role of linking the livestock owners with the DVS.
(ILRI 2008: 29)

Those remarks are important because they show that some contributors to the deliberations, upon which the ILRI Report was based, appreciated that pastoralists would be far more likely to contribute to RVF surveillance for the DVS if there were incentives for them to do so. If reporting suspected cases of RVF entails the imposition of local movement controls, compulsory vaccinations and bans on the export of livestock from East Africa to lucrative markets in the Middle East then it is understandable why pastoralists might hesitate before reporting their earliest suspicions, and why they might be reluctant to comply fully with subsequent movement restrictions.

The 2008 ILRI Report asserted that:

The lack of an effective surveillance system and preparedness plan – acknowledged by virtually all contacted key informants and participants of the stakeholder workshop – needs to be translated in a national contingency plan that ensures timely decision-making and allows for a rapid response to future outbreaks. The line ministries will need to consult key partners of provincial administration and communities, international organizations, NGOs active in rural development and health, funding agencies and research to identify and describe the most efficient and equitable prevention and control measures. There will not be one best option but rather interplay between different measures that are appropriate from early detection to avoidance of disease in people.
(ILRI 2008: 8)

One month after the emergence from ILRI of *Learning the Lessons of Rift Valley Fever*, the *RVF CP* was published. The *RVF CP* was prepared by MLD's DVS, but with support from the FAO and USAID and by specialists working at the Nairobi-based offices of the International Livestock Research Institute (MLD 2010).

The *RVF CP* envisaged a sequence of four decision points or stages for action mainly, but not entirely, by central government organisations.

In this contingency plan key decision points have been identified, subdivided into **normal**, **prediction** (investigation and alert), **outbreak** (operational) and **step-down** phases. Key

activities during the normal phase include capacity building, disease surveillance, developing early warning systems (sentinel herds and climatic monitoring) and building livestock immunity through mass annual vaccinations in high risk areas. Early warning systems that will be set in the normal phase will enable accurate prediction of a potential disease outbreak at which point implementation measures will be taken. In addition, mosquito surveillance and control will be critical especially when heavy and prolonged rains result in flooding. Once the outbreak occurs in animals, measures will be geared towards preventing human infections through animal movement restrictions, closure of livestock markets and slaughter bans. (MLD 2010: Executive Summary, 4 (emphases added))

Subsequently, it emerged that the capacities envisaged for development during the normal phase would be ones that should serve to deal, not just with RVF, but also with the entire range of zoonotic infections of livestock. That in part might account for relatively high estimated cost of those preparations (MLD 2010: 48–49 and 59–60). Nonetheless there is very little evidence that capacities for active surveillance and effective outbreak control have yet been created, mainly because resources required have yet to be allocated, let alone invested.

The normal phase was also planned to include, ‘building livestock immunity through mass annual vaccinations in high risk areas’, but that has not happened. It is not even clear that even if the Kenyan Government or donors were to invest in sufficient doses of annual (i.e. inactivated) vaccine, there would be sufficient staff to deliver the vaccinations and keep reliable records, or a sufficiently high level of cooperation on the part of the pastoralists, for herd immunity to be achieved, without which outbreaks cannot be prevented from spreading.

The *RVF CP* also assumed that by the time the next outbreak emerges, it will be possible to provide sufficiently reliably and accurate early warnings of critical meteorological changes, but at the time of writing, October 2014, that was not yet possible, and may even be a remote possibility. It is not that computer models cannot be built, the problem is rather that many different equally plausible computerised models can accommodate historical data and yet provide conflicting forecasts. In the event of an outbreak the *RVF CP* also envisages, ‘measures [...] geared towards preventing human infections through animal movement restrictions, closure of livestock markets and slaughter bans’ (MLD 2010: 4). Effectively controlling animal movements would, however, also be difficult.

The document continues:

To mitigate potential socio-economic impacts of a future outbreak, it is important that measures for preparedness during the normal phase are taken seriously, as little can be done once an outbreak occurs. Enhancing the response capacity of veterinary services as spelt out in the resource plans in this contingency plan will be critical. Financing of RVF prevention and control requires an increased budgetary allocation during normal times while some emergency funds will be set aside through the Veterinary Services Development Fund. This will assist implementation of heightened measures at prediction phase while awaiting access for contingency funds from treasury once the chance of an outbreak is very likely. In addition to finances this contingency plan highlights the gaps in technical personnel capacity which will be addressed during the normal phase. (MLD 2010: 4)

The *RVF CP* is right in that once an outbreak begins, there is little that can then be done to stop it from spreading, and prior investments in capacity-building will be crucial. The pastoralists, with whom we worked, emphasised that RVF typically erupts at times of flooding, but that is precisely when road transport becomes exceptionally challenging. If relevant resources and skills are not in place at the

start of an outbreak, they will be very difficult to deliver when and where they will be needed. It is important to note therefore that, as of October 2014, i.e. more than four years from the publication of the *RVF CP*, there is no evidence that the necessary resources have been allocated or that preparedness has been significantly enhanced.

While the Ministry of Livestock did establish its Veterinary Services Development Fund (VSDF), which gained revenue for meat inspection services to the livestock and slaughterhouse trades, the size of that fund is dwarfed by the magnitude of the task of preparing for RVF and other threatening zoonoses. No explanations for the lack of investment have been provided by official bodies, but their reasons may well have included competing demands on limited resources and the anticipated up-front costs. Moreover, given that during the 2006/07 outbreak, some resources were eventually provided by international donors, there might be some concern that early domestic investments might diminish the impact of subsequent calls for urgent aid. McSherry *et al.* have, though, characterised the Kenyan Ministry of Livestock Development as marginal and weak (McSherry *et al.* 2007: 9).

The *RVF CP* was framed from a conspicuously top-down perspective, which was understandable given that it had been based on an FAO template. The focus was on the responsibilities of government departments and officials. It was almost entirely a plan for what the Government should do. It did, towards the end, refer to rural communities, but only at the bottom of its 'tree' and only in terms of, 'Community based animal disease surveillance and response groups', under the leadership of, 'Chiefs and their assistants, Community leaders, departmental animal health staff' (MLD 2010: 40).

During the 2006/07 RVF outbreak, contingency teams were formed. They were called Disaster Rapid Response Teams and drew, for example, on the local representatives from the Ministry of Health, the Ministry of Public Health (MoPH), the District Veterinary Office and a representative of District Commissioner. Some resources were mobilised and the teams trained. The Ijara team was reportedly re-trained in 2012. It is difficult to estimate how long it could take to re-establish such arrangements in the event of future outbreaks, but in the absence of a serious and widespread outbreak of RVF few preparations could be discerned. Evidence gathered during our project suggested that even some District Veterinary Officers had little familiarity with the *RVF CP*, if any.

15. The *RVF Contingency Plan* from the pastoralists' perspective

While there is no evidence that the vast majority of pastoralists have any awareness of the existence, let alone the content, of the *RVF CP*, it remains important to ask how the plan intersects with their perspectives. The *RVF CP* contains many provisions, for example on capacity-building and resource provision that, if delivered, would be beneficial for, and welcomed by, pastoralists. On the other hand, from the pastoralists' perspective, even if the plan was adequately resourced, it would nonetheless remain imperfect and incomplete. Some of those imperfections are technological, while others are socio-economic.

When asked, the pastoralists with whom we worked had other priorities and criteria of appraisal of plans to deal with risks from zoonotic diseases. They explained that the most serious challenge they face comes from climate change and the consequent growing unreliability of water and pasture. The challenge they ranked second most important was the threat to their physical security from aggressive heavily-armed groups. Diseases of livestock, and consequent risks to their health and livelihoods were ranked third, but of those zoonotic infections RVF came third, behind brucellosis and foot and mouth disease. The *RVF CP* frames RVF as essentially veterinary and public health problems, while for the pastoralists it is a massive threat to their entire livelihoods – it is not just a challenge to veterinary and public health.

The attitude of the *RVF CP*, which is implicit in the document's wording, towards the pastoralists, who are those most vulnerable to RVF, is that the active assistance of pastoralists should ensure that they are actively alert to, and promptly report, the earliest signs of an outbreak of RVF. Beyond that, the *RVF CP* casts pastoralists in the roles of compliant and obedient citizens, ready and willing to implement any and all instructions and advice provided by officialdom. There is nothing in the text to suggest that the pastoralists might not entirely trust officialdom, and may even have incentives to delay (or even refuse) compliance and to ignore or discount some of the official advice and instructions.

One problem with the perspective implicit in the *RVF CP* is that there is little prospect of the pastoralists being provided with much in exchange for the surveillance data they are supposed to deliver. Even when samples have been taken from fallen stock, surviving herds and human tissue by local veterinary and/or public health officials, the results obtained in subsequent laboratory tests were never reported back to the people from whom they have been gathered. There has not even been that minimal degree of reciprocity. If, for example, the results of those tests had been shared with those from whom they were gathered, it would have enhanced their ability to distinguish cases of RVF from other viral fevers. They could consequently become more sensitive and reliable in their disease surveillance and diagnoses. If reciprocity between pastoralists and officialdom were to be enhanced, by measures of that sort amongst others, then information could be expected to flow more freely, rapidly and reliably, and higher levels of compliance and implementation might be anticipated.

Reciprocal obligations between the government and the pastoralists, in exchange for better information and enhanced co-operation, could extend to some form of publicly supported insurance and/or compensation scheme for victims of outbreaks of RVF. Under those conditions, the pastoralists' incentive structure would be significantly transformed. Instead the *RVF CP* characterises the terms of reference for District Disease Control Committees as, '[...] to galvanize local support and public compliance with the control measures as well as to coordinate epizootic mitigation measures' (MLD 2010: 41).

Another important omission concerns the contributions that CAHWs could provide. If, as the *RVF CP* envisages, capacities to respond effectively to outbreaks of RVF are to be built at the local level, then that could be far more readily accomplished with enthusiastic contributions from CAHWs than could be the case without them. Nonetheless the *RVF CP* fails to refer to CAHWs. From the pastoralists' perspective, that would be a puzzling omission. Our fieldwork indicated that CAHWs can play an important role in bridging between officials working for the Veterinary and Livestock Services and the pastoralists. The pastoralists explained that CAHWs are especially helpful in the event of emergencies, but once those emergencies are over they are ignored by the official system. Not only do they receive no resources, they are not even provided with relevant information. Consequently if there is to be sustained active surveillance for diseases such as RVF and prophylactic vaccination programmes, then there could be an important big role for CAHWs, and one about which local veterinary officials were enthusiastic.

While the links between the national authorities on the one hand and their local representatives and the pastoralists on the other may be weak, there are corresponding weakness in the links between those responsible for veterinary health and those responsible for public health. It would be premature to suggest that Kenyan Government policy-making on zoonotic infections such as RVF has become sufficiently integrated that it could be labelled as embodying a 'one-health' approach. The *RVF CP* was prepared by the Department of Veterinary Services, without any evident input from the health ministry. Since then, while the ZDU has been established, and the Ministry of Health has prepared a document entitled *Guidelines for Rift Valley Fever Preparedness and Response*, there remain significant differences between the Ministry of Health and experts at ILRI concerning the potential impacts of a vaccination strategy to combat RVF. There is also scant evidence of improved communication between professional groups with distinct types of expertise, or between the central government and either local officials or representatives of pastoralist communities.

In 2008 ILRI reported that:

The comparison between resource capacity, tasks and constraints between [public and veterinary health] sectors showed that the ratio of deployed staff was 1 livestock staff to 5 public health staff - the veterinary services were understaffed to fulfil the broad range of assigned tasks [...] The calculated costs of allowances in two Provinces alone were higher than the amount that has been immediately mobilised by the veterinary services for all affected districts.

(ILRI and DVS 2008: 5)

The same report also stated that. 'There is a disparity in resource allocations between the different public sectors. Veterinary resources cannot adequately match those that can be mobilized by health' (ILRI and DVS 2008: 7). Given the centrality of the health of their livestock to the livelihoods of pastoralists, it is evident that pastoralists would be amongst those who could benefit most from increased support for veterinary services, especially if they were provided by trained qualified professionals working in collaboration with Community Animal Health Workers.

As Butcher *et al.* have argued:

Traversing borders and boundaries, RVF could wreak devastating outcomes once more unless stringent local and regional public health collaborations are established. It is therefore necessary to empower livestock owners and instate them in national and regional early detection, as part of a strengthened detection and response mechanism.

(Butcher *et al.* 2012)

16. The implications of Kenya's new constitution

The *RVF CP* was published before Kenya's new Constitution was adopted, but the restructuring of Kenyan domestic governance entailed by the adoption and implementation of this Constitution, will have implications for how the re-allocation of responsibilities might impact on plans to deal with diseases such as RVF.⁶

In principle, the emergence of the *RVF CP* and the provisions of the new 2010 Constitution could create some opportunities for local perspectives to contribute to and enrich the *RVF CP* and increase the prospects of it being implementable. On the other hand, it is officially expected to take until 2017 fully to implement the new Constitution, so how those developments will unfold cannot yet be reliably predicted.

A key feature of the new Constitution is that it envisages the devolution of many powers from central government to the newly established Counties. In 2008, ILRI had argued that devolving powers to deal with RVF to local communities would be beneficial. ILRI argued that:

Decision making power should be entrusted at the appropriate level so that early prevention and control actions are possible. In the case of RVF in Kenya, the authority of local level decision makers in the districts to declare and take actions to control a potential RVF outbreak based on local early warning indicators [...] needs to be recognized.
(ILRI and DVS 2008: 6–7)

Under the new dispensation, 47 newly designated Counties will replace the Provinces (which are being abolished) and the Districts. The location and control of borders between local jurisdictions are important, because movement restrictions in the event of an outbreak of RVF were on traffic across District borders, during the 2006/07 outbreaks permits were not required to move livestock within Districts.

With the Counties in place, it is not clear who will be mandated to deal with veterinary services and disease control. As was recently seen in Bomet County during an outbreak of Foot and Mouth Disease, the County Governor publicly announced closure of markets after an FMD outbreak, saying it would help to restrict livestock movements and reduce the spread of the disease:

As the county government we bought vaccination medicine and our agriculture staff will carry out the exercise in the two constituencies at a subsidized fee from the normal rates [...] We are not leaving out the other constituencies in the County but as a control measure we opted to start in the two constituencies due to its prevalence before extending the service to the other constituencies.
(Kimutai 2013)

This raised debates concerning the division of responsibilities for disease control, under the new Constitution, between the County governments and the Directorate of Veterinary Services. It remains to be seen in which authority responsibility to impose movement restrictions on livestock will be located. In any case however, local areas that are deemed disease free will be keen to ensure that their status can be sustained. In the autumn of 2014 the Directorate of Veterinary Services of The Ministry

⁶ See <https://www.kenyaembassy.com/pdfs/The%20Constitution%20of%20Kenya.pdf>

of Agriculture, Livestock and Fisheries prepared a set of *Standard Operating Procedures* covering for example Livestock Vaccination Against RVF, Quarantine Measures for the Control of RVF, and for Surveillance of Animal Diseases, both passive and active (DVS 2014a; DVS 2014b; DVS 2014c: DVS 2014d; DVS 2014e). A conspicuous feature of those documents is that they attributed to Country-level authorities numerous responsibilities for setting and enforcing control measures but without any indication that resources would be made available to the counties to enable them effectively to meet those responsibilities.

It is quite possible that some Counties may choose to allocate resources to preparations for meeting the challenges of RVF, but it is too soon to tell. Some in central government assume that they will provide advice while the Counties would be expected to allocate funds and implement actions. But it remains to be seen whether the counties will perceive someone from outside the County as an interfering outsider. As the allocation of revenues between districts is, at the time of writing, not yet settled, it is too soon to estimate the impact of the New Constitution on preparations for outbreaks of RVF, and other zoonotic diseases. On the other hand, leaving all plans and responsibilities unchanged seems the least likely outcome.

17. Summary of findings and conclusions

The overarching objective of this project has been to provide an evidence-based analysis of some of the conditions under which the risks posed to Kenya by RVF might be diminished. The foregoing sections provided a review of the evidence we gathered, and this section highlights some conclusions concerning those conditions.

Building an adequate and sustainable human and animal health infrastructure in Kenya that could effectively diminish the harm RVF causes will not be a simple task. The infrastructure would need to include vital components such as risk analysis and preparedness, disease surveillance, enhanced diagnostic capacities, and a range of effective precautions, as well as a set of measures that can be implemented and enforced to control outbreaks. It would also benefit from research and development, all of which will require investing financial resources, which should be used to enhance levels of human capital in scientific and pastoralist communities.

RVF prevention and control measures in Kenya will, nonetheless, be selected and implemented in a context in which the Government of Kenya does not have large amounts of spare money, and faces numerous diverse and competing calls on its scarce resources. The more persuasive arguments can be that the more investments in, for example, disease surveillance, enhanced diagnostic capabilities and outbreak controls can be seen as cost-effective, the more likely they are to be funded. It would appear that the arguments in the 2010 *RVF CP* were insufficiently persuasive.

An effective set of measures to diminish the risks posed by RVF to Kenya will require fostering collaborations amongst, for example, public health and veterinary professionals and between professionals on the one hand and community workers and representatives on the other. There may also be scope for improved co-operation between public and private sectors, for example in relation to the manufacture of vaccines and stock-holding.

The design for an improved RVF response system in Kenya therefore needs to take account of virological, epidemiological, meteorological, economic and socio-cultural considerations. A low level rate of investment in resources almost certainly imposes restrictions on the extent and viability of vaccination initiatives, not only due to the technical characteristics and costs of vaccines, but also because of the logistical and infrastructural requirements needed to deliver acceptable and effective outcomes.

There is also scope for improved collaboration and planning for RVF outbreaks between the Government of Kenya and aid and development agencies, for example in relation to research and development. One priority should be research and development (R&D) aimed at improving the efficacy, safety and durability of RVF vaccines. There may also be some scope for Kenyan authorities to request resource support from more affluent countries in the Arabian Peninsula, which normally rely on importing livestock from East Africa. A collective approach from East African countries to affluent Middle Eastern and Arabian States, which import livestock from the countries in the Horn of Africa, to support RVF control programmes might be appropriate. If for example Middle Eastern and Arabian States helped provide a sustained programme of preventative vaccination of vulnerable livestock in the Horn of Africa, they could consequently anticipate uninterrupted meat supplies and domestic price stability.

Policy development regarding RVF responses in Kenya could benefit from engaging more effectively with pastoralists' and farmers' knowledge, beliefs and interests and the characteristics of the broader socio-cultural and ecological contexts in which they live. Any effective RVF response needs to be

tailored to local situations. To maximise the likely success of RVF control options, effective coordination will be critical, alongside adequate infrastructure, trained personnel nationally and locally with effective enforcement of the regulations.

The incentives for pastoralists to report an RVF outbreak, whether economic, cultural, or political, affect whether and when a zoonotic disease outbreak is officially recognised. Both scientific experts and pastoralists know some RVF symptoms and risk factors, as well as measures that can help control the disease. Without active surveillance of sentinel herds in vulnerable areas for RVF infections and prompt reporting of RVF outbreaks, in settings where local communities have limited diagnostic skills and weak incentives to report outbreaks or suspicions, efforts to prevent the rapid spread of RVF are unlikely to be successful.

Quality disease surveillance and reporting goes beyond just a confirmation or denial. In order to respond effectively, policymakers will need clear assessments of developments, based on reliable information. There remain however several uncertainties and gaps in knowledge about RVF outbreaks and their persistence. Several gaps in knowledge have been identified, which have not been explored to date. Given the unpredictability of virus dispersion and uncertainties about RVF epidemiology, there is a need to fill the scientific gaps by developing targeted agendas for RVF research and development. Aid agencies and donors have a role to play in supporting vital R&D efforts.

The Kenyan Government's 2010 *Contingency Plan for RVF* contained many promising provisions, but it is in several important respects incomplete. Much of that incompleteness arose as a consequence of failing to engage adequately with the perspectives of the pastoralists, who are those at greatest risk from RVF. Moreover, the Government of Kenya has yet to show a willingness to allocate the resources necessary to equip the veterinary, public health and local administrative officials to implement key elements of the plan. Effective solutions will require high levels of local co-operation between those stakeholder groups, with financial and practical support from central government.

There is insufficient clarity as to the precise conditions under which the Kenyan Government would declare an official outbreak of RVF. The implications for the domestic livestock and meat trade are substantial, and the impact on the export trade may also be important. How many cases of RVF, judged by reference to which kinds of epidemiological data and to which kinds of laboratory-based confirmation, would be deemed necessary and/or sufficient for an outbreak to be declared, have yet to be officially clarified. If decisions in those regards have been taken but not published, the lack of clarity is unhelpful. On the other hand, no decisions may have yet been taken to set those benchmarks, but in midst of an incipient outbreak, taking such decisions in stressful conditions would be particularly difficult.

Given that initiatives to vaccinate vulnerable livestock may be beneficial, even though supplies of vaccines are inadequate, one option might be to use the available stock to vaccinate the most vulnerable livestock in the high risk areas to try to achieve some local herd immunity, which might inhibit the spread of RVF to other areas. That option will, however, only be able to be implemented if sufficient stocks of viable vaccines are in store in suitable facilities in key locations, from which they can be effectively distributed and administered.

While national, regional and local capacities need to be enhanced and co-ordinated, the costs of doing so remain difficult to estimate, as do the potential costs of failing to implement an effective plan. An effective plan could only be implemented if there were enhanced reciprocal flows of information between national and local officials, in both veterinary and public health areas, and between officials and local communities. If those conditions were satisfied the chances of effective and speedy

responses to early warnings of an outbreak of RVF would be enhanced and the resultant costs diminished.

If policy-makers and public officials were to engage more effectively with the perspectives of pastoralists, they would recognise that pastoralists have incentives and some means to innovate. Providing them with resources and incentives to do so, and showing willingness to adapt their plans to take account of such innovations, would almost certainly be beneficial to all groups.

Significant benefits could be derived from establishing and supporting Community-Based Early Warning Systems, and if CAHWs and other local stakeholders received official support. Enhancing the resources for, and responsibilities of, CAHWs, perhaps under the supervision of professional veterinarians, could enable Kenyans to improve their ability to withstand the challenges posed by zoonotic infections such as RVF. CAHWs might themselves contribute innovatively and facilitate learning and innovating on the part of their pastoralist communities.

Professional veterinarians often maintain that farmers should benefit from the services of trained professionals rather than poorly trained or equipped CAHWs. Some veterinarians consider CAHWs as competitors who undercut their prices while providing inferior services. On the other hand pastoralists, especially nomadic ones, see vets as scarce and prohibitively expensive. If professional vets had greater incentives to train, equip and supervise CAHWs, pastoralists communities might obtain enhanced veterinary support that would be accessible and affordable to prevent and/or manage diseases. Such changes could also enable District Veterinary Officers to capture and share larger and more reliable sets of data. This scenario implies institutional changes, based on a One Health concept, to enhance capacities to mitigate and respond to outbreaks of zoonoses.

The ability of Kenyans and other East Africans to withstand the challenges of diseases such as RVF could be substantially improved if investments were made into research and development of, for example, suitable vaccines. Thermo-stable vaccines that could be stored, transported and administered at ambient temperatures would be remarkably helpful. If vaccines could be developed that could provide sustained protection, without regular re-inoculation, and which did not threaten adverse reactions such as spontaneous miscarriages, they would be enthusiastically welcomed by pastoralists and settled livestock farmers alike. Science-based innovations may therefore have a lot to contribute, but mutually reinforcing innovations as between farmers and scientists could be even more beneficial, although no immediate prospect of their emergence in Kenya could be discerned.

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