EuFMD training course
– Nakuru, Kenya – November 2010
A five day course was convened in Nakuru, Kenya supported by FAO and the EuFMD Commission. Participants included veterinarians from Kenya, France, Latvia, Switzerland, Australia, New Zealand and United States. The course was organized with a one day symposium in Nakuru led by FAO and an FMD technical expert from the Institute on Animal Health Pirbright. Instruction was provided on aging of FMD lesions, biosecurity, sample collection and investigation technique. This was followed by two days of field visits in which three outbreaks were investigated and samples were collected and tested immediately in the Regional Veterinary Laboratory. The remainder of the course consisted of report writing, discussion of laboratory results and the epidemiological information that had been gathered.

Laboratory results yielded serotype O from Farm 2 and 3 visited. Non-structural protein antibody ELISA results were also obtained during the course. These results are presented in Appendix A and discussed in the relevant sections. This document contains laboratory results as of December 1, 2010.

Appendix B displays a map of farms visited and areas discussed in the epidemiology investigation.

Participants had the opportunity to observe clinical cases of FMD, perform sample collection, conduct interviews with farmers, collate epidemiological information, practice biosecurity principles and assess laboratory results. This unique opportunity was made possible by the laboratory staff in Nakuru and Nairobi, farmers, district veterinarians and the EuFMD team.
Background

Veterinary services
The Department of Veterinary Services (VS) in Kenya undertakes disease control, investigation and disease surveillance. Kenya is divided into 8 provinces (Figure 1) each headed by a Provincial Director of Veterinary Services. The private sector performs the clinical services and artificial insemination.

Figure 1: Map of Kenya showing the 8 provinces

![Map of Kenya showing the 8 provinces](image)

KEY:
1. Central
2. Coast
3. Eastern
4. Nairobi
5. North Eastern
6. Nyanza
7. Rift Valley
8. Western

The Rift Valley Province has 64 districts. Nine of these districts (Nakuru, Naivasha, Nakuru North, Rongai, Molo, Njoro, Kuresoi, Subukia and Gilgil) form the Nakuru county where the investigation took place. Each district is headed by a District Veterinary Officer (DVO) who performs the departmental mandate of disease control, vaccination, meat inspection and extension service. The DVO is supported by livestock officers and animal health technicians who are based in the divisions and locations. The regional veterinary laboratory in Nakuru performs disease surveillance and submits samples to the national laboratory in Embakasi, Nairobi where all FMD analysis is performed.
FMD Situation

FMD is endemic in Kenya and most outbreaks are reported in the Rift Valley Province which is the largest of the 8 provinces. To date, serotypes O, A, C, SAT1, and SAT2 have been detected in Kenya. Most common are serotype O and SAT2, however since 2008 SAT1 outbreaks have increased dramatically. Serotype C was last documented in 2004. The situation in wildlife is not well studied, but buffalos are known to harbour SAT serotypes. A random countrywide survey was conducted in 2009/2010 to obtain a better picture of FMD prevalence in the different animal species. Results will be available soon.

In recent years sporadic FMD outbreaks have been reported in all districts. In 2010 FMD outbreaks appear to be more frequent and spreading faster than before. For the current calendar year, twenty three FMD outbreaks have been confirmed by the national FMD laboratory (Table 1). The main serotypes responsible for these outbreaks are SAT1 and O. Information of number of infected farms and species are not available, thus morbidity and mortality in the Rift Valley province cannot be estimated.

Table 1: FMD outbreaks confirmed by national FMD laboratory in Nakuru county and close neighbour districts from 01.01.2010 to 15.11.2010

<table>
<thead>
<tr>
<th>serotype</th>
<th>date</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>02.08.2010</td>
<td>Nakuru Central</td>
</tr>
<tr>
<td>O</td>
<td>02.08.2010</td>
<td>Nakuru Central</td>
</tr>
<tr>
<td>O</td>
<td>30.08.2010</td>
<td>Laikipia West</td>
</tr>
<tr>
<td>SAT1</td>
<td>18.06.2010</td>
<td>Laikipia North</td>
</tr>
<tr>
<td>SAT1</td>
<td>24.06.2010</td>
<td>Laikipia Central</td>
</tr>
<tr>
<td>SAT1</td>
<td>28.06.2010</td>
<td>Laikipia East</td>
</tr>
<tr>
<td>SAT1</td>
<td>10.07.2010</td>
<td>Nakuru North</td>
</tr>
<tr>
<td>SAT1</td>
<td>16.07.2010</td>
<td>Njoro</td>
</tr>
<tr>
<td>SAT1</td>
<td>26.08.2010</td>
<td>Koibatek</td>
</tr>
<tr>
<td>SAT1</td>
<td>26.08.2010</td>
<td>Koibatek</td>
</tr>
<tr>
<td>SAT1</td>
<td>10.09.2010</td>
<td>Naivasha</td>
</tr>
<tr>
<td>SAT1</td>
<td>10.09.2010</td>
<td>Nakuru Central</td>
</tr>
<tr>
<td>SAT1</td>
<td>30.09.2010</td>
<td>Gilgil</td>
</tr>
<tr>
<td>SAT1</td>
<td>01.10.2010</td>
<td>Mogotio</td>
</tr>
<tr>
<td>SAT1</td>
<td>07.10.2010</td>
<td>Marigat</td>
</tr>
<tr>
<td>SAT1</td>
<td>08.10.2010</td>
<td>Nakuru North</td>
</tr>
<tr>
<td>SAT2</td>
<td>16.08.2010</td>
<td>Naivasha</td>
</tr>
<tr>
<td>NVR</td>
<td>15.01.2010</td>
<td>Naivasha</td>
</tr>
<tr>
<td>NVR</td>
<td>08.06.2010</td>
<td>Naivasha</td>
</tr>
<tr>
<td>NVR</td>
<td>22.06.2010</td>
<td>Naivasha</td>
</tr>
<tr>
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<td>22.09.2010</td>
<td>Nakuru Central</td>
</tr>
<tr>
<td>NVR</td>
<td>30.09.2010</td>
<td>Nakuru North</td>
</tr>
<tr>
<td>NVR</td>
<td>30.09.2010</td>
<td>Gilgil</td>
</tr>
</tbody>
</table>

NVR= No virus recovered
Livestock distribution and movement

In Kenya there are 1.5 million beef cows, 1.25 million dairy cows, 9 million sheep, 12 million goats, 1 million camels and 30000 pigs. The numbers of animals in Nakuru County can be seen in Table 2.

a) Animal movements associated with trade:
   1. Laikipia → Rongai → Baringo
   2. Baringo → Nakuru → Naivasha → Nairobi

b) Animal movements associated with grazing:
   1. Naivasha → Nakuru → Laikipia;
   2. Narok/Kajiado → Navaisha → Nakuru → Rongai /Laikipia

Table 2: Livestock population in Nakuru county (data from 18.11.2010)

<table>
<thead>
<tr>
<th>District</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naivasha</td>
<td>86161</td>
<td>120667</td>
<td>48915</td>
</tr>
<tr>
<td>Nakuru North</td>
<td>53000</td>
<td>23000</td>
<td>17000</td>
</tr>
<tr>
<td>Molo</td>
<td>23550</td>
<td>12580</td>
<td>1756</td>
</tr>
<tr>
<td>Njoro</td>
<td>32970</td>
<td>33550</td>
<td>23564</td>
</tr>
<tr>
<td>Rongai</td>
<td>126950</td>
<td>50847</td>
<td>70155</td>
</tr>
<tr>
<td>Nakuru</td>
<td>11500</td>
<td>2830</td>
<td>5480</td>
</tr>
<tr>
<td>Subukia</td>
<td>10000</td>
<td>14000</td>
<td>12000</td>
</tr>
<tr>
<td>Gilgil</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Kuresoi</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

In Nakuru county there are 4 main livestock routes and about 10 livestock markets where animals move for trade or pasture (nomadic herds) from one district to another.

FMD diagnostics

FMDV antigen is detected using Ag ELISA, virus isolation using baby Hamster kidney cells (BHK) or calf thyroid cells (CTY) or the lateral flow device LFD as a penside test. All 5 serotypes (O, A, C, SAT1, SAT2) circulating in Kenya are screened. For PCR, samples for FMDV antigen detection are sent to the FMD world reference laboratory in IAH, Pirbright, UK. However, it would be useful to establish the PCR method in the local lab in the future to strengthen the diagnostic power in the affected region.

FMDV antibodies are detected using a test for structural proteins (SPs) for example virus neutralisation test (VNT) or liquid phase blocking ELISA (LBPE) which cannot differentiate between vaccinated and naturally infected animals. To be able to differentiate between those two antibodies non-structural proteins tests (the 3ABC and 3D ELISA) are used.

Probang, tissue, saliva and vesicular fluid samples are analysed using Ag ELISA and its results confirmed with samples which show a cytopathogenic effect (CPE) when passaged on BHK or CTY cells.
Serum is analysed using mostly VNT or otherwise LBPE. Animals which are known to be vaccinated, animals which come from an area where vaccination takes place and animals which are going to be exported are tested using 3-ABC or 3-D.

The most likely time for detection of virus is within the first 4 days after clinical lesions appeared, but could be possible up to 7 days and for PCR detection up to 10 days after the first clinical signs. Antibodies can be detected most likely after 7 days post infection (p.i.), and possibly already after 5 days p.i. The figure below represents the window of detection for various techniques or tissues.

Figure 2: This figure depicts the window of detection by different techniques or tissues. From: IAH

**FMD control history and vaccination**

Until the early 1980s, FMD was controlled in designated areas of Kenya, including parts of the Rift Valley province with compulsory and free vaccination for cattle. Small ruminants were not vaccinated. This vaccination service achieved 80% vaccination coverage which enabled Kenya to access international trade markets. However, a change in government policy from 1986 introducing cost sharing with the farmers and an unavailability of government subsidised vaccines meant the vaccination coverage decreased below 10%. This resulted in more frequent FMD outbreaks. Currently, farmers can access more expensive vaccines from the Kenya Veterinary Vaccines Production Institute (KEVEVAPI) to supplement the DVO’s supply. Vaccinations available for use in Kenya are multivalent formulations and contain either 3 or 4 of the serotypes O, A, SAT1 and SAT2.
When an outbreak is declared, quarantine is imposed on a location level. Movement may occur within the location but is restricted into and out of the location. Restrictions are placed on milk and other animal products. Ring vaccination around the outbreak is performed and nearby markets is closed. There are also restrictions on movement of animal feed out of the affected farm. The official in charge of the administrative unit assists with enforcement of quarantine.

Recommendations for further control and investigations of the outbreaks are provided below for each farm. These recommendations are based on the local situation and farm-level biosecurity measures. In contrast to an endemic country, control measures in an FMD free country vary per country and could range from culling all infected animals to vaccination to live based on rate of disease spread and other economic and political factors. Furthermore, all animal movements would cease and all possible movements of animals, animal products, humans and vehicles in the risk period would be traced back and forward to find all farms were the disease might have spread to. Ring vaccination, whenever possible, as well as a vaccination to live strategy, should be considered to control the outbreak. Policy varies per country for disease control measures yet the ultimate goal is to become disease free by OIE standards as rapidly as possible.

**The investigation team**

The NTC2 EU-FMD team was supervised by Nick Juleff (UK), Keith Sumption (FAO), Nadia Rumich (FAO) and consisted of local veterinarians (Eunice Chepkwony, Sabenzia Wekesa, Veronica Wanjohi, Abraham Sangula, Gitnui Kaba, Bernard Rono, William Birgen and Fredrick Mukendi), as well as veterinarians from other countries (Mary Vanandel, NZ; Jennifer Davis, AU; Laurie Fromberg, US; Mara Uzule-Springe, LA; Yann Villagi, FR; Silke Bruhn, CH). Roles were switched between a clinical investigation team taking care of the sampling on the farm as well as aging lesions and an epidemiological team who did interviews of the farmers and DVOs to gather epidemiological relevant information. Animals to sample were chosen based on looking for the oldest lesions on the farm to be able to trace back the highest risk period of FMDV introduction as well as for the youngest lesions to be able to still detect virus. Selection took place relying on the information provided by the owner as well as the appearance of clinical signs.

The epidemiological investigation was performed using a questionnaire developed by the group (Appendix C) aiding in the establishment of the probable timeline of important events. The possible period of introduction of the virus was estimated by subtracting 14 days from the day of the oldest known lesion. The high risk period was estimated at 2-5 days within the incubation period. The period of highest shedding was determined to be day 1 to 4 after the first and last animal displayed clinical signs.

**Biosecurity measures**

On arrival at each of the 3 farms visited, the investigating team vehicles were parked outside the infected area near the farm entrance. Protective clothing was donned by all team members. This consisted of disposable overalls, latex gloves (double gloving with taping at the wrist to the protective suit) and rubber boots.
On departure, the team cleaned the boots thoroughly with a brush with 0.5% Sodium Lauryl Ethyl Sulphate and a second washing with Dettol®. Finally the boots were disinfected by dipping them into 4% sodium bicarbonate solution. The car tyres of the vehicles were washed with 4% sodium bicarbonate solution.

At the end of each day the clothes worn on the farms were soaked overnight in a 0.2% citric acid solution and then laundered by the hotel.
Case farm 1 – Tere Estate

Farm history

Location

The farm is located in the Nakuru North district, Bahati division, Bahati location and Wanyororo B sublocation.

Production system

There were five cattle on the farm, along with approximately 15-20 chickens and 10 dogs. Cattle are dairy cattle and milk is sold.

Animals graze on the farm only. They do not share grazing or water with any other animals. However, they are fed a supplementary feed, a compounded product purchased from Mairu kumi shopping centre. The feed is purchased monthly and carried home from the shop in a bag. The last feed was purchased in late October. Mairu kumi is also in the Bahati division and has been experiencing outbreaks of FMD.

Farm biosecurity

The farm is relatively isolated with coffee plantations surrounding the area where the cattle are kept. However, no biosecurity measures were taken on the farm.

According to the owner of the cattle, there is no contact with wildlife.

Clinical examination and sampling

Only two animals are reported by the farmer to be showing clinical signs—Animal A and Animal C. Four animals were sampled- one cow, one bull, and two calves. Animals displayed clinical signs such
as salivation, lameness, and decreased milk production. All cattle displayed mouth lesions while three of the four cattle had feet lesions, one of which had a secondary infection. One cow also displayed possible scarring on the teats. Age of the mouth lesions ranged from 7 days to greater than 10 days. Serum samples were taken from all four of the cattle. A probang sample was taken on one of the calves. Epithelial tissue was taken from one of the cows and a lateral flow device (penside test) was conducted. The epithelial sample was too old yielding negative results to the penside test. All animals sampled were treated with multivitamins and antibiotics. Further details are provided in Appendix A: Clinical examination form – Farm 1. Serotype for this farm at the time the report was written was unknown.

Preliminary laboratory results yielded negative antigen ELISA results from the epithelial tissue from Animal A as well as negative cell culture from the epithelial tissue from Animal A. These results should be interpreted with caution as the epithelial sample obtained was likely too old. NSP test results yielded negative results from Animal A and weak positive results from Animal B, Animal C and Animal D. Since these lesions were dated between 7-10 days, the weak positives could possibly be due to this outbreak of FMD or due to previous vaccination (impure vaccine containing NSPs), previous exposure to any serotype of FMD or improperly aging the oldest lesions.

Top Left: Animal A (cow) dental pad lesion aged to about 8 days old
Top Right: Animal C (calf) tongue lesion aged to about 7 days old
Bottom Left: Animal C (calf) foot lesion
Bottom Right: Animal D (calf) lower lip and lingual periodontal lesion aged to greater than 10 days old.
**Epidemiological findings**

**FMD & vaccination history**
The animals have no history of vaccination as far as the farmer is aware. Two animals—Animal A and B—were purchased in July 2009 whilst two others were born on the property. The district veterinarian reported that vaccination had not been practiced in this area as there had been no outbreaks in the area.

**Current outbreak**
The farmer reported only two animals showing clinical signs.

Animal A, the first animal to show clinical signs, was observed to be limping on Wednesday 10\textsuperscript{th} November. By Friday November 12\textsuperscript{th} she was salivating and the farmer reported the potential outbreak to a private veterinarian. The outbreak was reported to the district veterinarian on Sunday November 14\textsuperscript{th}; the district veterinarian visited the property on Monday 15\textsuperscript{th} November. A second animal, Animal C, was seen to be limping on Saturday 13\textsuperscript{th} November.

**Animal movements and other contacts**
There have been no recent animal movement on or off the farm. No animal products have been moved onto the farm. Milk was moved off the farm prior to the outbreak however since quarantine has been imposed it has not been longer sold (also decreased volume due to production drop).

Temporary workers enter the farm daily and walk along a path shared by cattle. Workers come from surrounding neighbourhoods some of which have been experiencing FMD disease outbreaks.

The last visit by a veterinarian was in April/ May 2010 when a private veterinarian was called out to treat mastitis.

The monthly feed was last purchased in late October from Mairu kumi, where there have been FMD outbreaks in the surrounding area.
**Timeline**

infection timeline

<table>
<thead>
<tr>
<th>date (Oct/Nov)</th>
<th>22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21</td>
</tr>
<tr>
<td>feed purchased</td>
<td>animal A limping</td>
</tr>
<tr>
<td></td>
<td>animal A salivating, reported to private vet</td>
</tr>
<tr>
<td></td>
<td>EuFMD team visit</td>
</tr>
<tr>
<td></td>
<td>visit by DVO</td>
</tr>
<tr>
<td></td>
<td>reported to DVO</td>
</tr>
<tr>
<td></td>
<td>animal C limping</td>
</tr>
<tr>
<td></td>
<td>most likely time of introduction</td>
</tr>
<tr>
<td></td>
<td>possible time of introduction</td>
</tr>
<tr>
<td></td>
<td>highest period of shedding</td>
</tr>
</tbody>
</table>

**Farm summary**

**Most likely source of introduction:**

The purchased feed is considered a highly likely source of introduction due to the known FMD outbreaks in the area that it came from and the direct pathway to the animals.

Introduction by manure/ infectious material on shoes of workers coming onto the farm is considered possible but not the most likely.

**Recommendations:**

More information is required on farms in the locality. Although FMD has not been reported this does not rule out possible cases.

It is recommended that the farm remains under quarantine until the cases are resolved. Animals should be moved off the pathway shared with workers to try and prevent spread to other farms.

The farmer could implement basic biosecurity measures such as separating pathways for workers and trucks coming onto the farm from animals. Routine vaccination of animals should also be practiced against known circulating serotypes.

It is also recommended that feed retailers take measures to minimise spread of disease by avoiding purchase of feed from known infected areas. Farmers purchasing feed should also be aware and purchase feed locally or from areas not experiencing outbreaks of FMD.

Additional information that could be of value in this instance would include a map of the farm showing fences, farm boundaries, extent of resident animal ranges and location of water points. A graphical representation of roads and paths used by workers and stock could clarify local conditions and this information could clarify entry and exit pathways for disease.
Tracing information needs to be obtained if available for milk collection and feed purchases. This could allow neighbouring properties to be prioritised for examination.

Estimated risk of spread:

The farm is isolated and very small, so that virus shedding as well as possible routes to spread disease are minimal.
Case farm 2 – Solai Arus

Farm history

Location
The farm was located in Ruiyabei location and Arusito sublocation in Solai division.

The owner of the farm was Wilbert Mameti. The owner was not present for the visit and his wife answered the questions of the EuFMD team.

Production system
Farm had mixed beef and dairy production with approximately 50 cattle (30 adults and 20 calves/yearlings). There were also dogs and chickens on the farm.

The whole herd grazes together on the farmer’s property only. The animals share a common watering point, on the property, with animals from neighbouring farms.

Farm biosecurity
There is no biosecurity on the farm. Animals from approximately six neighbouring farms enter the property daily for water from the common watering point. Most neighbouring farms have 30-50 cattle and some also have sheep and goats. However, the sheep and goats do not share the watering point.

Clinical examination and sampling
Animals displayed clinical signs such as salivation, nasal discharge, swollen protruding tongue, and lameness. Two animals were sampled including one cow (Animal E) and one bull (Animal F). As most
of the herd was pregnant, the farmer was concerned that the stress of examination and sample collection would further compromise the animal’s condition. As typical lesions were noted in the examined animals and LFD penside testing yielded a positive result, it was decided that further examination was not in the best interest of the herd.

The farmer gave information that first clinical signs were two weeks ago thus it was not possible to examine the oldest lesions.

All animals sampled displayed mouth lesions. Due to being in a crush, foot lesions were not able to be safely visualized. Age of the lesions was estimated to be around one day old without including a margin of error. Serum samples were taken from all animals sampled. The cow sampled had a swollen protruding tongue with a large ruptured blister. While trying to grasp the tongue, the distal end was exfoliated and an epithelial sample was obtained. A Penside test was run with this epithelial tongue sample and yielded positive results. A probang sample was taken from the bull. An epithelial sample was also taken from the bull, but a penside test was not conducted. All animals were treated with multivitamins and antibiotics. Further details are provided in Appendix A: Clinical examination form – Farm 2.

Preliminary laboratory results yielded positive antigen ELISA results from the epithelial tissue from Animal E and Animal F as well as positive cell culture from the epithelial tissue from Animal E and Animal F. The virus was typed as serotype O. NSP test results yielded weak positive results from Animal E and Animal F. Since these lesions were aged at Day 1, the weak positives could possibly be due to previous vaccination with vaccine containing NSPs, previous exposure to any serotype of FMD or improperly aging of the oldest lesions.
Epidemiological findings

FMD and vaccination history
The animals were vaccinated against serotypes O, SAT1 and SAT2 on the 11th September 2010 due to an outbreak of SAT1 in Nakuru and the proximity of this farm to a livestock market (approximately 1 km). Animals from many areas, including Nakuru come to the market to be sold.

Prior to this the last routine vaccination was approximately 18 months ago.

Some animals on affected neighbouring farms had been vaccinated and did not show clinical signs of FMD.

Current outbreak
Disease was first noticed in neighbouring farms approximately 3 weeks ago.

The first case on this farm was noticed by the farmer two weeks ago. One calf showed lameness and salivation. Disease then spread through the herd with the majority of cases noticed on Saturday 13th November. The farmer estimates approximately 20 animals appear to be affected.

The date that the outbreak was reported is unknown.
Animal movements and other contacts
Provisional quarantine was imposed on the whole administration unit when the market was closed. We do not know when this occurred.

No animals have recently been purchased or moved off the farm. There is daily movement of animals from neighbouring farms to the shared watering point. Local veterinarians suggested that the farmer may be trading animals and the procedure for return of unsold animals from market was unknown.

Human traffic between neighbouring farms is extensive.

Zebras are seen on the farm approximately once a month. No other wildlife is present on the farm.

The farm shares a spray pump for tick control with the neighbours with animals sprayed weekly.

The milk truck that visits the farm also visits a number of other farms.

Timeline

Date (Oct/Nov) 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

-11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Farm summary
Laboratory results indicate FMD serotype O. Animals were vaccinated against this serotype approximately six weeks prior to the outbreak, antibodies, therefore, should be present. Vaccine failure could have possibly occurred resulting in these cows becoming infected.

We are assuming more than one transmission cycle occurred within the herd as fresh lesions were observed by the team despite the farmer reporting first clinical signs two weeks ago.
Most likely source of introduction

The most likely source of introduction to this farm was neighbouring farms, which showed signs of disease approximately a week before this farm. Introduction of FMD into the area was likely to be from the livestock market as outbreaks have been reported in nearby districts/locations/divisions. Further information on the serotypes and exact locations of these outbreaks would be valuable.

Estimated risk of spread:

The District veterinarian reported that there was usually less spread of FMD during the rainy season (probably due to reduced animal movements) however this was not the case in the recent outbreak which had continued spreading through the rainy season.

Recommendations

Direct and indirect spread of the disease to neighbouring farms is highly likely due to shared water points and equipment. However, the administrative unit had been quarantined and milk from the farm was no longer being sold so extensive further spread is not likely. It is recommended that quarantine of the administrative unit as a whole is maintained until there are no further cases in the unit.

It is recommended that future vaccination is specific for the serotype and strain circulating in the area at the time of the outbreak.

Additional information that could be useful in the epidemiological investigation of this case includes more information about movements of animals and vehicles to stock markets as well as information on how animals that remain unsold at stock markets are treated- (i.e. are they reintroduced to the herd on their return?)

It would be of interest to perform active surveillance at stock markets to determine if clinically affected animals are present there. Sero-prevalence of circulating strains could be evaluated. Related to this point, it would be helpful to assess the knowledge of the market organisers to FMD spread and biosecurity. A sero-prevalence study and examination would also be useful within the herd examined and would create a more complete clinical picture of disease course. This information would address the areas of uncertainty around the vaccination status of the herd and may be able to provide clarity on why infection with type O is present after vaccination for that serotype.

Antibodies should have been sufficient to protect against disease for this herd by around the 25th of September. The animals were reported to have been vaccinated previously 18 months before. Given this information, protective levels of immunity should have been reached by the time of the disease challenge. Information on the reason for vaccination failure is of value both at a district and at a herd level. Obtaining additional information from the manufacturer about the batch of vaccine used on this herd would be helpful. Other herds in the area vaccinated with the same batch could be prioritised for investigation to look for clinical disease and also for serology if necessary. For the sake of completeness, preservation of the cold chain and vaccination technique could be checked. The manufacturer may also wish to conduct testing to ensure efficacy of the vaccine. Another point raised in by the Kenyan veterinarians conveyed that infection with Type O seldom results in such severe mouth lesions as those seen on this farm. The question of the efficacy of the use of sodium
bicarbonate as a topical treatment was also raised. Some felt that application of sodium bicarbonate may have led to more severe mouth lesions.
Case farm 3 – Eden Farms

Farm history

Location
Kampimoto

Production system
This is a dairy operation with 44 bovines on the property. The cattle run as one herd. Currently the bull is kept in a separate camp. Two heifers and two steers are also separated.

There are 11 Dorper-cross sheep on the property. The sheep and cattle co-graze and share a water source.

Dairy meal is bought in weekly from Nakuru for the calves. Other feed for the animals is produced on the farm.

Dogs and poultry are present on the property.

Farm workers are resident on the premises.
Farm biosecurity
The farm is well contained with an electric fence and a hedge. There is only one entrance to the property on a well travelled road. The farm workers live on the premises, therefore, human movements are limited compared with some production units.

The neighbouring farm boundary is approximately 600m away and animal contact with the neighbouring property is unlikely. The neighbouring farm has in excess of 100 bovines and has experienced a severe acute FMD outbreak with reported mortality within the last 3 weeks.

There is no contact with wildlife.

Clinical examination and sampling
Seven animals were examined; five cattle and three sheep. Clinical signs observed were salivation, nasal discharge and limping. Lesions were observed on four cattle and one sheep. The age of lesions on the cattle ranged from three days to more than seven days. The lesions observed on the sheep were approximately ten days old. Serum was collected from all sheep and four of the cattle. Epithelium was collected from three cattle and penside tests were conducted. Two tests were positive for foot and mouth disease virus antigen while one was negative. A probang sample of orophangeal fluid was collected from one cow. All animals sampled were treated with multivitamin and antibiotics. Further details are provided in Appendix A: Clinical examination form – Farm 3.

Preliminary laboratory results yielded positive antigen ELISA results from the epithelial tissue from Animal 2 and Animal 3 as well as positive cell culture from the epithelial tissue from Animal 2 and Animal 3. The virus was typed as serotype O. NSP test results yielded a strong positive from Animal 1 and Animal 3, weak positives for Animal 4, Animal 5 and Animal 6 (sheep). NSP test was negative for Animal 2, Animal 7 (sheep) and Animal 8 (sheep). Since these lesions were aged between day 3 to greater than 10 days, the positives could possibly be due to previous vaccination with vaccine containing NSPs, previous exposure to any serotype of FMD or improperly aging of the oldest lesions.
The animals kept separate from the main herd, included the bull, two heifers and two steers also displayed clinical signs of FMD despite of being kept separate from the herd.

**Epidemiological findings**

**FMD & vaccination history**
Bovines on this farm were vaccinated by the district veterinarian as a routine measure last year. The vaccination took place more than 6 months ago. The vaccination was performed with a trivalent vaccination containing O, A and SAT1 serotypes.

Good biosecurity measures have prevented any previous outbreaks on this property.
Current outbreak
The farmer reported the first clinical signs appeared on the farm on the 15th of November (2 days before the EuFMD team visit). The clinical signs noted were salivation, anorexia and depression. Only two days after the appearance of the first clinical signs, 37 of the 44 bovines present on the property were affected.

The sheep on the property were reported to be limping.

Animal movements and other contacts
Movements on and off the property were well documented by the farmer.

As previously noted, farm workers reside on the property. Some visitors to the farm workers may have gone unrecorded.

Milk is collected daily by Brookside, a local dairy purchaser.

Hay is purchased by neighbouring farmers on the farm. This is a daily occurrence.

Hay was harvested starting on the 29th of October and the harvesting is ongoing at this time. Harvesting is performed by a contractor who also performs this service on neighbouring farms. Cattle were moved onto the field where hay was harvested on the 13th of November.

Weather conditions two weeks ago were cool and humid.

A veterinary practitioner visits this farm every fortnight. No artificial insemination services have been used on this property in the last 9 months. The bull which was examined was brought onto the property in place of the artificial insemination between 9 months and one year ago.

Heifers were sold off the property on the 3rd of November and collected by a livestock transport company. These animals were taken to the Karichu district.

There is no record of any new animals being brought onto the farm in the last month.
Farm summary

Potential sources of introduction are listed in order of likelihood.

The livestock transport truck is considered to be high risk both because of the temporal location of the visit and because of the high levels of exposure to large numbers of animals. From the age of the lesions examined and the history given by the farmer, it seems that the sheep were infected first. However it is possible that older and less severe lesions have gone unnoticed in the cattle herd.

The vehicles used to purchase hay from the property are also possible in the disease pathway. Introduction by manure/ infectious material on the wheels of the vehicles and the shoes of people coming onto the farm is considered possible.

The contractor who harvested the hay from the property is also a possible point of infection. Equipment used for cutting and baling hay may have been a mechanical vector for infectious material.

The milk collection vehicle is a possible vector of disease though less likely.

Human movements onto the property are not logged and are a possible entry pathway.

The neighbouring farm is reported to be involved in an acute, severe outbreak with some cows having died. This property should be regarded as a possible source of aerosol transmission. In the preceding 3 weeks, the weather has been humid and rainy. These conditions could be consistent with aerosol transmission whilst the likelihood of infection to this farm by aerosol transmission is low.
Recommendations:

More information is required on farms in the locality. It would be beneficial to know the strain present on the neighbouring farm. Further tracing is required to clarify the disease state of the heifers transported off the property and the other animals present on the farm that they were taken to.

It is recommended that the farm remain under quarantine until the cases are resolved. Contact with any outside animals should be eliminated and animal-human contact limited as much as possible. Ideally sales of hay and milk should be halted although this may not be feasible. The sale of hay from the farm is a high risk pathway of spread to further properties.

To prevent future outbreaks the farmer could implement further biosecurity measures such as a vehicle disinfection station on the single access road. Additionally, routine vaccination of all bovines at 6 month intervals with a quadri-valent vaccination containing O, A, SAT1 and SAT2 would provide a further level of protection. However, tri-valent vaccines are much more common and less expensive in Kenya.

It is also recommended that feed retailers take measures to minimise spread of disease by avoiding purchase of feed from known infected areas. Farmers purchasing feed should also be aware and purchase feed locally or from areas not experiencing outbreaks of FMD.

Additional information that would be of benefit in this case includes accurate information on the locations that the heifers that were moved off the farm were relocated to. Heifers were sold to Kerichu and they should be traced to investigate if the outbreak spread from Farm 3 to other farms. The truck which picked the heifers up on Farm 3 may have introduced FMD on Farm 3. This truck came from Kipkelion, a city close to the area Kerichu which has been experiencing a type O FMD outbreak. Sequencing the isolates obtained on Farm 3 and from the outbreak in the Kerichu area would provide evidence of a link between the outbreaks.

Estimated risk of spread:

The timelines show that farm 3 was infected before farm 2. Although the two farms were infected with serotype O it is not likely that farm 3 infected farm 2. Further tracing information would be needed to try to link these farms, if possible.
Appendix A:

Clinical examination form– Farm 1

<table>
<thead>
<tr>
<th>Animal ID</th>
<th>Species</th>
<th>Age of animal</th>
<th>Vaccination Status of Animal</th>
<th>Clinical Signs</th>
<th>Temp</th>
<th>Vesicular Lesions on Mouth and/or Feet</th>
<th>Age of Lesions</th>
<th>Samples Taken</th>
<th>Penside NSP Results</th>
<th>Epithelial sample results:</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Bovine cross breed cow</td>
<td>4</td>
<td>Not vaccinated</td>
<td>BCS 2, lameness, not lactating</td>
<td>37.9</td>
<td>Y(M&amp;F)</td>
<td>8d old</td>
<td>Tissue from the lesions on the foot and serum sample</td>
<td>Negative-sample too old</td>
<td>-ve (14%)</td>
<td>Ag ELISA: negative</td>
</tr>
<tr>
<td></td>
<td>Bovine cross breed bull</td>
<td>2</td>
<td>Not vaccinated</td>
<td>BCS 3.5</td>
<td>38.1</td>
<td>Y (M)</td>
<td>8d Plus</td>
<td>Serum sample</td>
<td>Not done</td>
<td>+ (79%)</td>
<td>Small lesions filling up already and healing</td>
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<tr>
<td></td>
<td>Bovine cross breed calf</td>
<td>18mo</td>
<td>Not vaccinated</td>
<td>BCS 3 Lame and salivating</td>
<td>38.9</td>
<td>Y(M&amp;F)</td>
<td>7d mouth 7d foot</td>
<td>Serum sample, probang ++</td>
<td>Not done</td>
<td>+ (74%)</td>
<td>2 notable lesions on the tongue, one small on the tip and one large on the dorsum of the tongue, concurrent joint effusion hind limb at the level of the hock</td>
</tr>
<tr>
<td></td>
<td>Bovine cross breed calf</td>
<td>1yoa</td>
<td>Not vaccinated</td>
<td>BCS 2</td>
<td>39.4</td>
<td>Y (F&amp;M)</td>
<td>10d plus</td>
<td>Serum sample</td>
<td>Not done</td>
<td>+ (79%)</td>
<td>Healing lesions in the mouth, this animal has a history of eating plastic packets and appears to have an impacted rumen.</td>
</tr>
</tbody>
</table>
**Clinical examination form – Farm 2**

**CLINICAL EXAMINATION FORM**

Name of Owner/ Household:  **Solai Arus**  
Date:  **16 November 2010**

<table>
<thead>
<tr>
<th>Animal ID:</th>
<th>Species</th>
<th>Age of animal</th>
<th>Vaccination Status of Animal</th>
<th>Clinical Signs</th>
<th>Temp</th>
<th>Vesicular Lesions on Mouth and/or Feet</th>
<th>Age of Lesions</th>
<th>Samples Taken</th>
<th>Penside</th>
<th>NSP Results</th>
<th>Epithelial tissue results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>E (Pembe)</td>
<td>Bovine cross breed cow</td>
<td>3 years</td>
<td>serotypes O, SAT1 and SAT2 on the 11&lt;sup&gt;th&lt;/sup&gt; September 2010</td>
<td>BCS 2.5 Salivation, nasal discharge, painful, protruding tongue</td>
<td>41.5</td>
<td>Y(M)</td>
<td>D1</td>
<td>Tissue from the lesions in the mouth serum sample</td>
<td>Positive result</td>
<td>+ (75%)</td>
<td>AgELISA: positive Cell culture: positive</td>
<td>On exam, the tongue has a blister ruptured leaving the most distal part of the tongue without epidermis. The owner reports that this animal is gravid.</td>
</tr>
<tr>
<td>F</td>
<td>Bovine cross</td>
<td>4 years</td>
<td>serotypes O, SAT1</td>
<td>BCS 3.5, salivating,</td>
<td>40.5</td>
<td>Y (M)</td>
<td>D1</td>
<td>Serum sample Probang</td>
<td>Not done</td>
<td>+ (79%)</td>
<td>AgELISA: Positive</td>
<td>Lesions present on</td>
</tr>
<tr>
<td>(Chetakampuni) breed bull</td>
<td>and SAT2 on the 11th September 2010</td>
<td>lame</td>
<td>sample of oropharyngeal fluid</td>
<td>Tissue sample from the mouth</td>
<td>Cell culture: positive</td>
<td>the dental pad Fluid aspirated from the vesicle and tissue samples collected from the the region.</td>
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</tbody>
</table>
### Clinical examination form – Farm 3

CLINICAL EXAMINATION FORM

Name of Owner/ Household: Eden Farms

Date: 17 November /11/2010

<table>
<thead>
<tr>
<th>Animal ID</th>
<th>Species</th>
<th>Age of animal</th>
<th>Vaccination Status of Animal</th>
<th>Clinical Signs</th>
<th>Temp</th>
<th>Vesicular Lesions on Mouth and/or Feet</th>
<th>Age of Lesions</th>
<th>Samples Taken</th>
<th>Penside</th>
<th>NSP Results</th>
<th>Epithelium Test Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bovine, Holstein cross cow</td>
<td>Older than 5 years old</td>
<td>Serotypes O, A and SAT1 about 1 year ago</td>
<td>No lesions</td>
<td>40.94</td>
<td>No lesions</td>
<td>Serum</td>
<td>Not done</td>
<td>++ (83%)</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>2</td>
<td>Bovine Holstein cross bull</td>
<td>3 yoa</td>
<td>Unknown</td>
<td>BCS 3 Salivation, nasal discharge</td>
<td>40.39</td>
<td>Y (M) D3</td>
<td>Serum sample Epithelial sample</td>
<td>positive</td>
<td>-ve (44%)</td>
<td>AgELISA: positive Cell Culture: positive</td>
<td>Mouth treated with sodium bicarbonate yesterday – lateral flow device penside test still positive. Lesions on the tongue are about 1 day old and those on the dental pad about 3d old</td>
<td></td>
</tr>
<tr>
<td>Case</td>
<td>Breed</td>
<td>Serotypes</td>
<td>Age</td>
<td>Signs</td>
<td>Temperature</td>
<td>Sex</td>
<td>Serology</td>
<td>Pathology</td>
<td>Test Results</td>
<td>Diagnosis</td>
<td>Notes</td>
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<tr>
<td>3</td>
<td>Bovine Holstein cross breed cow</td>
<td>Serotypes O, A and SAT1 about 1 year ago</td>
<td>39.36</td>
<td>Y(M)</td>
<td>D5</td>
<td>Epithelium</td>
<td>negative</td>
<td>++</td>
<td>87%</td>
<td>AgELISA: positive</td>
<td>Cell culture: positive</td>
<td>Lesion present on the dental pad granulating lesion with fibrin still present</td>
</tr>
<tr>
<td>4</td>
<td>Bovine Holstein cross cow</td>
<td>Serotypes O, A and SAT1 about 1 year ago</td>
<td>39.1</td>
<td>Y(M)</td>
<td>D7+</td>
<td>Serum Orophangeal fluid collected with probang</td>
<td>Not done</td>
<td>+</td>
<td>64%</td>
<td>It is reported by the farmer that this animal was the first affected and started with clinical signs on the 15th of November</td>
<td></td>
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<tr>
<td>5</td>
<td>Bovine Holstein cross calf</td>
<td>Unknown</td>
<td>8 months</td>
<td>Salivating, limping</td>
<td>40.3</td>
<td>Y(M&amp;F)</td>
<td>D5</td>
<td>Serum, Epithelial tissue from the mouth lesions (used for Penside only)</td>
<td>positive</td>
<td>+</td>
<td>59%</td>
<td>Lesions on the upper lip, the dental pad and the tip of the tongue, fibrin filled and starting to granulate. Granulating foot lesions between the cleats.</td>
</tr>
<tr>
<td>6</td>
<td>Dorper cross ovine, ram</td>
<td>Not vaccinated</td>
<td>Nasal discharge, limping</td>
<td>NT</td>
<td>No lesions</td>
<td>Serum</td>
<td>Not done</td>
<td>+</td>
<td>(59%)</td>
<td>Abscess on the foot, no mouth lesions</td>
<td></td>
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<tr>
<td>7</td>
<td>Dorper cross ovine, ewe</td>
<td>Not vaccinated</td>
<td>Nasal discharge</td>
<td>NT</td>
<td>Y (M)</td>
<td>D10+</td>
<td>Serum</td>
<td>Not done</td>
<td>-ve</td>
<td>(37%)</td>
<td>No foot lesions noted. The mouth lesions are present on</td>
<td></td>
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</table>
the dorsum of the tongue, with no lesions on the dental pad (expected location for sheep)

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<thead>
<tr>
<th></th>
<th>Dorper cross ovine ewe</th>
<th>Not vaccinated</th>
<th>Nasal discharge</th>
<th>NT</th>
<th>No lesions</th>
<th>Serum</th>
<th>Not done</th>
<th>-ve (42%)</th>
<th>No lesions on the feet or in the mouth</th>
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Appendix B:
Overview map of farms visited (Aru Farm, Tere Farm and Eden Farm). Kipkelion is where the truck which obtained heifers from Farm 3 originated. The heifers were delivered in Kerichu. Outbreaks have been confirmed as serotype O in Kerichu many weeks prior to the outbreak on Farm 3.
Appendix C:

People to interview
District official veterinarian
farmer of outbreak farm
animal technician (animal health assistance) of this village – reported outbreak
private livestock officer

History
FMD (last year and last outbreak) what serotypes?
   Levels: Province, District, village, Farm

Vaccination (incl. what serotypes?)
Routine vaccination:
Outbreak vaccination:
   Levels: District, village, Farm

Animal movements
   - In and out
     a) Levels: District(in the last 3 months), village (in the last month), Farm(in the last 3 weeks,
        depending on age of lesions)

Map
number of farms incl. number of susceptible species in the 1km zone
   A) number of farms incl. number of susceptible species in the 3km zone
   B) number of farms incl. number of susceptible species in the 10km zone
   C) markets, coming water places, common grazing, common dippings
   D) wildlife (national parks)?

Case history:
Report from clinical team
How many animals (species, age distribution) on farm,
date of first clinical signs (what kind)
Source of feed (for the 1 week before day of most likely introduction)
Other farmers with ill animals, when?
Shared equipment with other farmers
Animal products traded
Biosecurity measures on farm (in general and after outbreak, especially vermins)
Other animals on farm and are they moving? Where?
Contact to wildlife (how often, what species)?
Personnel movements (especially those who have direct contact to animals) – 2 weeks before first
   clinical sign
      - In and out
Animal products (milk, meat, by-products (incl. dead animals)) – 2 weeks before first clinical signs
      - In and out
### Timeline

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