OIE/FAO Foot-and-Mouth Disease Reference Laboratory Network

Annual Report 2015

Editors:

Dr Donald King and Dr Mark Henstock,

The Pirbright Institute, UK

Contents

1 OIE/FMD Reference Laboratories Network

1.1 Principle Goals

The Network of OIE/FAO FMD Reference Laboratories has been established with two principal goals:

1) To understand global virus distribution patterns and use these data to inform vaccine recommendations

and

2) To harmonise and improve the quality of laboratory testing carried out by international and national reference laboratories.

These activities require sharing and joint evaluation of surveillance information from laboratory diagnosis, serotyping, genetic characterisation and vaccine matching tests and harmonisation of standards for diagnostic procedures.

This report is divided into two parts providing an update on progress towards each of these goals.

1.2 Reporting Period

1st January 2015 - 31st December 2015

1.3 Collated input from

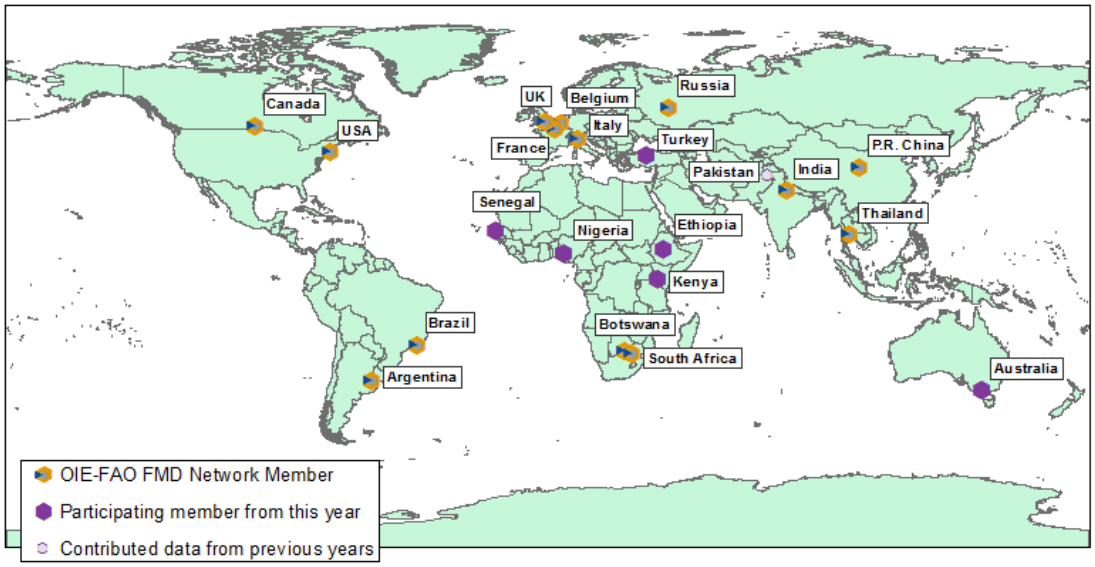


Figure 1-1: Participating laboratories

Centro Panamericano de Fiebre Aftosa (PANAFTOSA) and OIE Reference Laboratory for FMD

Rio de Janeiro, Brazil

FAO Reference Laboratory for FMD in Africa and OIE FMD Reference Laboratory

Transboundary Animal Diseases Programme, ARC-Onderstepoort Veterinary Institute (ARC-OVI), South Africa

FAO Reference Centre for FMD for Central Asia and West Eurasia and OIE Reference Laboratory for FMD

Federal Governmental Institute, Centre for Animal Health (FGI ARRIAH), Vladimir, Russia

FAO Reference Centre for FMD and other vesicular diseases for the Americas and the Caribbean and OIE FMD Reference Laboratory

Foreign Animal Disease Diagnostic Lab, Plum Island Animal Disease Center (PIADC), Greenport, USA

OIE Regional Reference Laboratory for Sub-Saharan Africa (RRLSSA)

BVI, Gabarone, Botswana

OIE collaborating centre for validation, quality assessment and quality control of diagnostic assays and vaccine testing for vesicular diseases in Europe, and FAO Reference Centre for vesicular Diseases

CODA-CERVA, Ukkel, Belgium

OIE Reference Laboratory for Foot and Mouth Disease, Dirección de Laboratorio Animal

SENASA, Argentina

OIE Regional Reference Laboratory for Foot and Mouth Disease in the South East (RRLSEA)

Department of Livestock Development, Pakchong, Thailand

OIE/FAO FMD Reference Laboratory

Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna (IZSLER), Italy

OIE and China National FMD Reference Laboratory

Lanzhou Veterinary Research Institute (LVRI), CAAS, Gansu, People's Republic of China

FAO Reference Centre for FMD in South Asia

Project Directorate on FMD (PDFMD), Indian Council for Agricultural Research, Mukteswar, Nainital (Uttarakhand), India

OIE FMD Reference Laboratory

French Agency for Food and, Environmental and Occupational Health & Safety (ANSES), Maisons-Alfort, Paris, France

FAO FMD Reference Laboratory

National Centre for Foreign Animal Disease National Centres for Animal Disease, Canadian Food Inspection Agency, Winnipeg, Manitoba, Canada

FAO World Reference Laboratory and OIE FMD Reference Laboratory

The Pirbright Institute Pirbright, Surrey, UK

Additional input kindly supplied by:

National Veterinary Research Institute

Vom, Plateau State, Nigeria

NATIONAL Animal Health Diagnostic & Investigation Center (NAHDIC)

Sebeta, Ethiopia

Australian Animal Health Laboratory (AAHL)

Geelong, Australia

Laboratoire National d'Elevage et de Recherches Vétérinaires, l'Inistitut Sénégalais de Recherches Agricoles (ISRA-LNERV)

Dakar, Senegal

Foot and Mouth Disease Laboratory

Embakasi, Kenya

ŞAP INSTITUTE (and WELNET FMD)

Ankara, Turkey

2 Genetic and antigen diversity and global distribution of foot-and-mouth disease viruses

Foot-and-mouth disease (FMD) is a highly contagious viral disease that infects a wide variety of domestic and wildlife cloven-hooved hosts. Its presence impacts upon rural livelihoods and restricts trade opportunities for countries where the disease is endemic, and poses a constant threat to those countries that are free of the disease. FMD virus lineages are not randomly dispersed throughout the world but are associated with particular ecological niches. The distribution of these FMD virus lineages is affected by cyclical upsurges in the prevalence of particular strains that may be associated with the evolution of FMD viruses to escape protective immunity in susceptible livestock populations and/or opportunities presented by movements of animals and their products. These features can give rise to pandemic events where FMDV lineages spread widely to affect new regions. Global surveillance for FMD is necessary to identify the current hazards and to predict heightened risk so that appropriate diagnostic tools and vaccines are available for detection and control. This requires sustained effort directed towards the monitoring of FMD outbreaks and ideally also of FMDV circulation and persistence, along with collection and characterisation of FMD viruses and integration of findings with associated epidemiological intelligence. Such an extensive effort requires a coordinated approach encompassing national and international disease laboratories of the **OIE/FAO FMD Laboratory Network** along with commercial vaccine and diagnostic providers. The worldwide distribution of the different serotypes and variants of FMD virus as compiled in 2015 and the associated activities of the Network laboratories are presented in this report.

2.1 Introduction

Global surveillance undertaken by the OIE/FAO FMD Laboratory Network aims to monitor the distribution of FMD viruses to predict risk for endemic and FMD-free countries. FMDV is unevenly distributed throughout the world reflecting factors such as livestock density and species mix, patterns of husbandry, animal movement and trade, wildlife reservoirs and incentives and capacities for disease control. The virus exists as seven serotypes and multiple subtypes where cross-immunity is absent or incomplete. The situation is dynamic and complex and affected by viral evolution, waxing and waning of host immunity and changing ecosystems and trading patterns. Despite the opportunities for spread of FMDV into new regions, viruses tend to recur in the same parts of the world, presumably reflecting some degree of either ecological isolation or adaptation. On this basis, the global pool of FMD viruses can be subdivided into

seven ‘regional pools’ in which genetically and antigenically distinctive virus strains tend to occur within a defined region.

The seven ‘Regional Pools’ referred to throughout this report are shown below (Figure 2-1) and represent:

Pool 1	Southeast Asia with spill over into Eastern Asia
Pool 2	Southern Asia
Pool 3	EurAsia including the Middle East
Pool 4	Eastern Africa
Pool 5	Western Africa
Pool 6	Southern Africa
Pool 7	South America

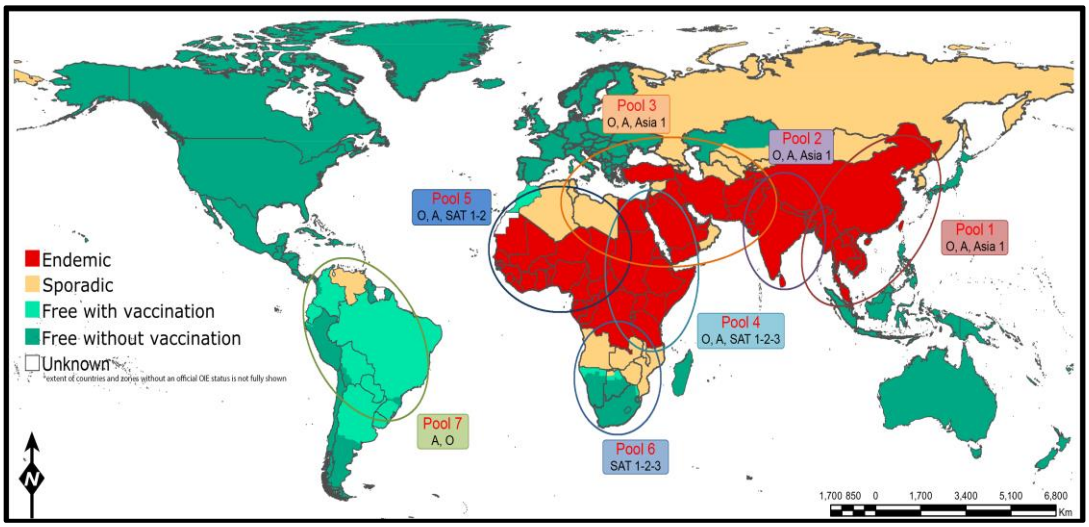


Figure 2-1: Distribution of the seven endemic pools of FMD showing conjectured status of FMD in countries during 2015. Virus circulation and evolution within these regional virus pools results in changing priorities for appropriately adapted vaccines. Periodically, viruses spread between pools and to free regions, and countries at the interfaces between pools (such as in North Africa and Central Asia) often experience FMD outbreaks from different regional sources. Note on Pools 4-6: In Africa there are currently three FMD virus pools loosely defined as covering East Africa (pool 4), West Africa (pool 5) and Southern Africa (pool 6). There is some overlap between pools 4 and 5. It has been suggested to extend pool 4 southwards to include Tanzania and to contract pool 6 to exclude that country.

The clustering of FMD viruses into 7 virus pools, with 3 pools covering West Eurasia, South Asia and Southeast Asia, 3 pools covering East, West and Southern Africa and 1 pool covering the Americas, is now enabling a targeted approach to be applied to the ‘Progressive Global Control of FMD’ initiative overseen by the OIE and FAO and for which the Network laboratories will play a pivotal role.

2.2 Overview of the Global situation in 2015

Information regarding contemporary FMD outbreaks can be found on the World Animal Health Information Database (WAHID) located on the OIE website (http://www.oie.int/wahis_2/public/wahid.php/Wahidhome/Home), as well as the EMPRES Global Animal Disease Information System (http://empres-i.fao.org/) provided by FAO. Further supplementary data and updates are generated on a monthly basis by EuFMD: (http://www.fao.org/ag/againfo/commissions/eufmd/commissions/eufmd-home/fmd-surveillance/situation-reports/en/).

During 2015, FMD outbreaks have continued to affect countries in the established endemic regions of the world. Particular attention has been focussed upon new FMD outbreaks and events that have occurred at the margins of these endemic regions (summarised in Figure 2-2 and described elsewhere in this report). Additional disease outbreaks in countries in the FMD endemic pools have also been reported to OIE during 2015 (data collated in Table 2-1).

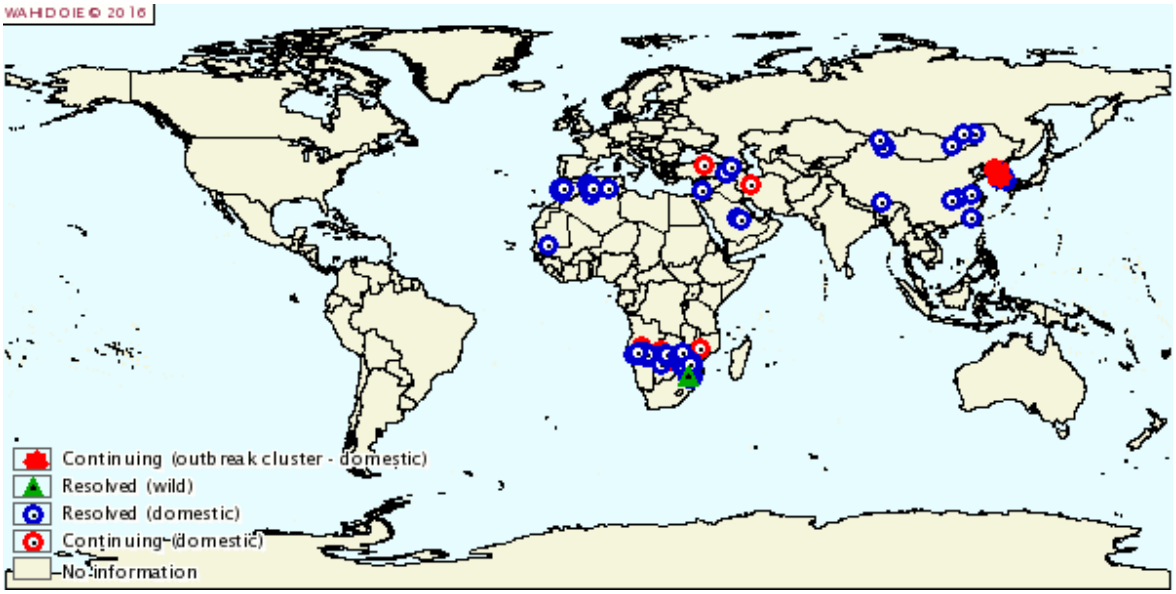


Figure 2-2: Map indicating the location of significant epidemiological events and disease outbreaks reported to OIE in immediate notifications or follow-up reports in 2015 (map generated on WAHID (http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/Diseaseoutbreakmaps) on 8th March 2016).

Table 2-1: New FMD outbreaks reported to OIE during 2015 (data retrieved from WAHID on www.oie.int on 8th March 2016). Note: not all outbreaks shown in Figure 2-2 are collated in this table and data may be incomplete

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Afghanistan	12	25	51	52	62	12	…						214
Algeria			9	3			0						12
Bahrain	1						0						1
Bangladesh	+..						…						+..
Benin	2					5	…						7
Bhutan	3						…						3
Botswana			4	1		1	…						6
Burkina Faso	10	7	5	5	1			3		5	2	5	43
Burundi	66						10						76
Cambodia	1	1	3	3	4	4	3	7	4	2	9	3	44
Central African Republic	+..						+..						+..
China (People's Rep. of)	2				1		…						3
Chinese Taipei				1	1		…						2
Congo (Dem. Rep. of the)	3						…						3
Cote D'Ivoire		1	1				2		1	6			11
Egypt	8	12	8	10	6	5	…						49
Ethiopia	18						…						18
Ghana	6		1	2			…						9
Guinea-Bissau	?						?						?
Hong Kong (SAR - PRC)				2			…						2
Iraq	3	1	21	6	6	7	…						44
Kenya	18	17	25	8	9	4	…						81
Malaysia			1	2		1	…						4
Mongolia		2	2		1		…						5
Myanmar	1						3	7	13	1	2		27
Namibia	1	1			13	10	…						25
Nepal	2	4	5	8	9	8	5	8	8	7	4	6	74
Niger	8						…						8
Nigeria	+..											1	1
Palestinian Auton. Territories		2				1	3	2	9	3	1	2	23
Qatar	7						…						7
Senegal	5						…						5
South Sudan	2		1				…						3
Sudan		1		2			…						3
Tanzania	1	5	4	2	5	8	2	3	4	1	1	1	37
Thailand	10	9	5	5	4	6	…						39
Togo	1	4	3		4	1	…						13
Turkey	6	9	28	10	5	7	…						65
Vietnam	5	3		1	2		2	2	10	13	16	5	59
Zimbabwe	1	11		13	15	38	…						78

Legend for Table 2-1

0	Continuing previous outbreak (s)
...	No information available for this disease
0	Disease absent
?	Disease suspected but not confirmed
+?	Confirmed infection/infestation without clinical signs
+..	Disease present but without quantitative data
+	Disease present with quantitative data but with an unknown number of outbreaks
+()	Disease limited to one or more zones
+?()	Infection/Infestation in one or more zones
?()	Disease suspected but not confirmed limited to one or more zones

Further details of many of the characterisation of viruses retrieved from these outbreaks are provided later in this report.

In South America, there continues to be tangible progress of the regional control programme to achieve FMD-free status since no clinical cases due to FMD have been reported in 2015, and it is now more than three years since any outbreaks have been reported across the entire continent (last reported outbreak in Paraguay in 2012).

2.2.1 Official status of countries and zones during 2015

The official status of OIE member countries is shown in Figure 2-3

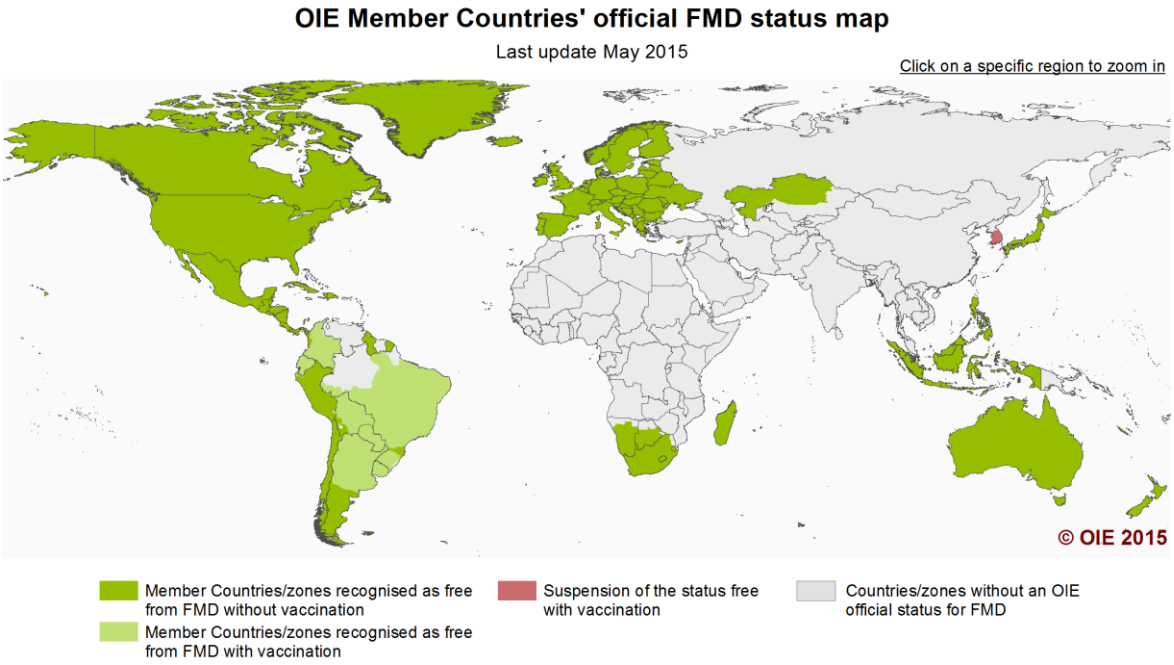


Figure 2-3: Official FMD status for OIE member countries. Data provided from the OIE: http://www.oie.int/en/animal-health-in-the-world/official-disease-status/fmd/en-fmd-carte/

2.3 Overview of the activities of the OIE/FAO FMD Laboratory Network during 2015

The OIE/FAO FMD Reference Laboratory Network is a vital contributor to the global control of FMD and provides opportunities and expertise for developing and sustaining laboratory capacity and capability, exchange of materials and technologies, harmonising approaches to diagnosis and supporting complementary research. Laboratories within the network regularly receive samples for FMD diagnosis from many parts of the world. The *in vitro* antigenic properties of selected isolates are assessed for vaccine matching and nucleotide sequencing allows precise characterisation of new isolates and tracing of their

origin by comparison with viruses held in virus collections. This analysis assists the monitoring of the 'real time' emergence and spread of FMD virus globally.

Over two thousand clinical samples from suspect cases of FMD were tested by laboratories in the Network (and associated laboratories) during 2015. These samples were collected from 41 countries from all 7 FMD endemic pools and include specimens from cases of vesicular disease in Brazil due to a new emerging virus called Senena Valley virus (Figure 2-7). However, sampling within these pools is not equivalent: surveillance within West Africa (Pool 5) is particularly sparse and efforts are currently underway with the network to improve sample collection and testing in this region.

Serotype C has not been detected since 2004 when the last cases due to the serotype were recognised in Kenya and Brazil. At the Annual Network Meeting the situation regarding serotype C was discussed and considered the difficulties of interpreting serotype-specific serological data, and other epidemiological approaches that might be adopted to substantiate the "extinction" of this serotype. The Network has made the following recommendations:

Research priorities to provide evidence that serotype C is no longer circulating

- Follow up investigation of serotype C serologically positive samples:
    - Investigate whether heterologous cross-reactivity (for other serotypes) can account for the signal detected in these positive samples
    - Consider whether or not the positive/negative cut-off adopted in serological tests (often based on "negative" sera from FMD-free settings) is appropriate for use to screen sera (collected in Africa)
    - Evaluate whether or not there is significant spatial or temporal clustering of serotype C positive samples which would indicate active circulation of FMDV
    - Where possible, undertake resampling and testing of animals (and other individuals within the epidemiological units) where serotype C-specific responses have been detected
- Develop serotype C-specific molecular tests for use to pro-actively screen samples collected from the field (particularly those where virus recovery might be challenging)

On the use of serotype C in vaccines

- In-vitro "live" virus work with serotype C should only be performed in facilities that conform to (EU or equivalent) minimum standards (BSL3+)
- In-vivo challenge (and potency tests) studies using serotype C should no longer continue
- Consideration be given to halting the production of serotype C vaccines

Risk-based approaches should consider the continued use of serotype C in vaccines (in South America) and inclusion in vaccine antigen banks (FMD-free countries).

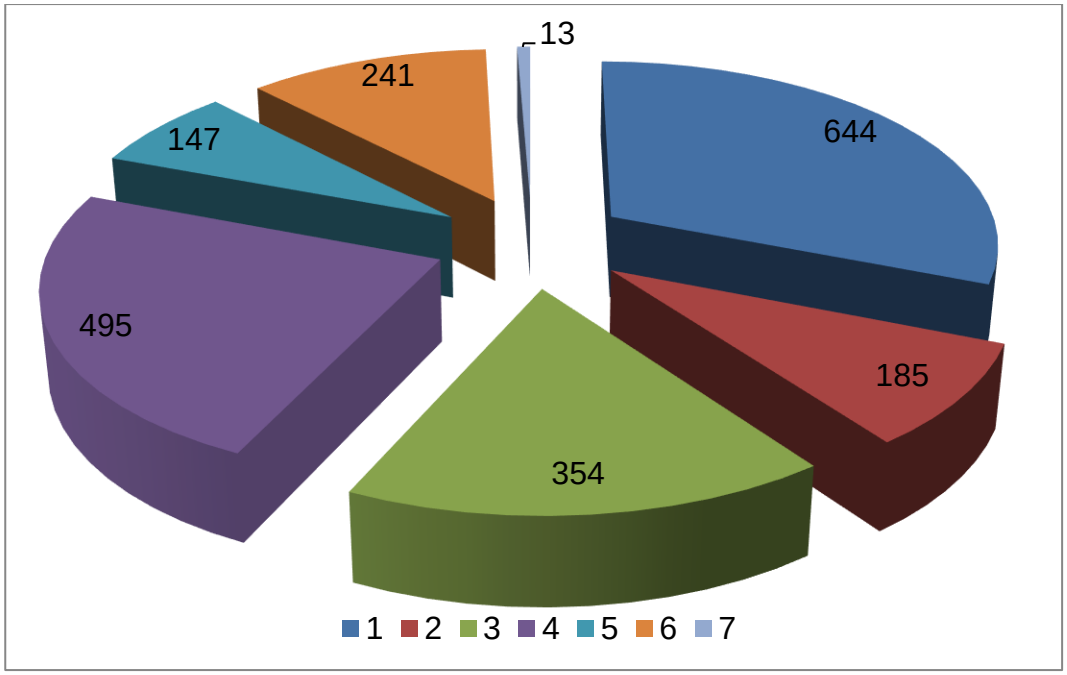


Figure 2-4: Samples (n=2079) tested for FMD investigation (virology) by the OIE/FAO FMD Laboratory Network from FMD endemic countries only during 2015 and their distribution across the seven FMD endemic pools

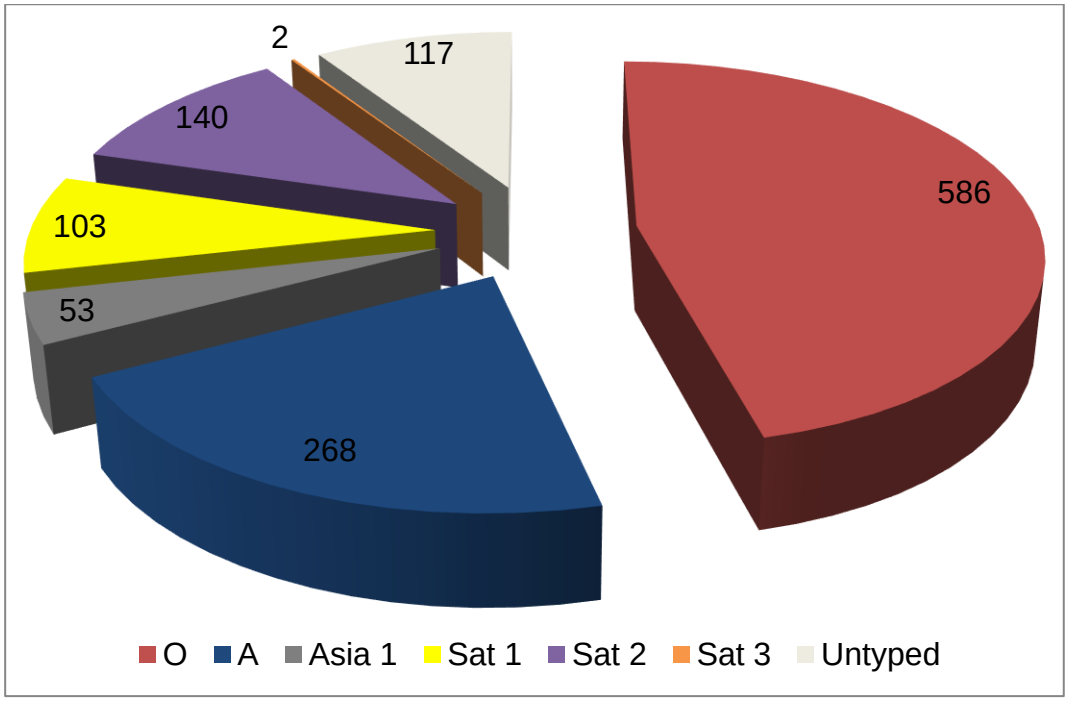


Figure 2-5: Summary of results for characterised isolates from FMD endemic countries were reported by the Network during 2015.

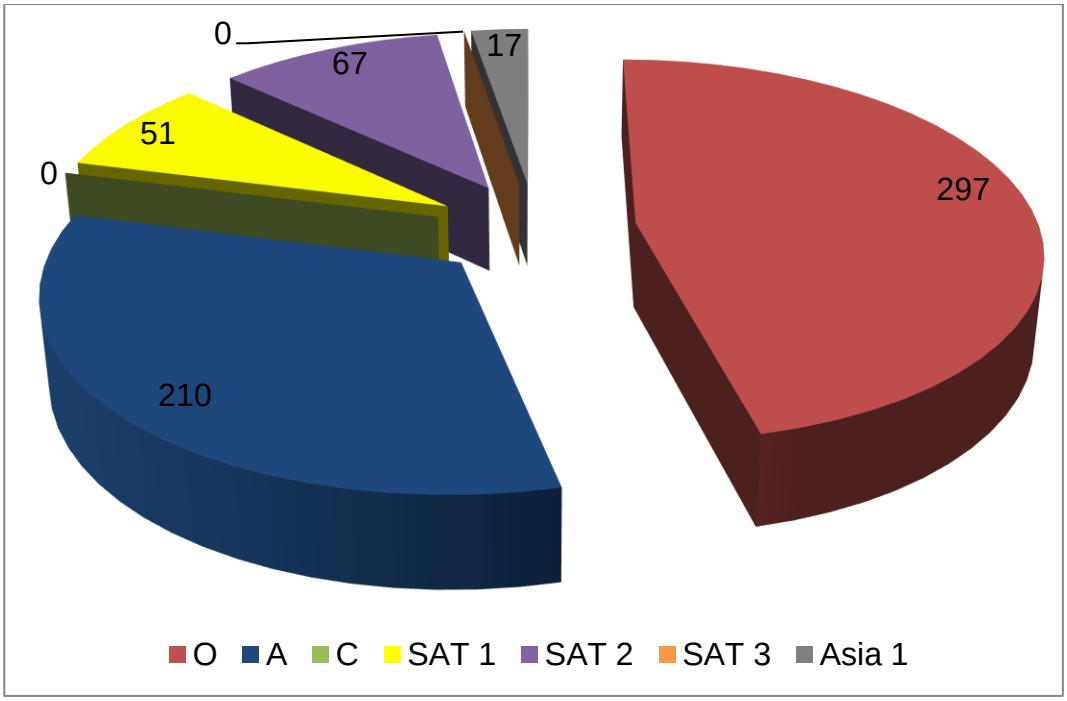


Figure 2-6: Summary of 642 samples (viruses and field isolates) that were sequenced (VP1/capsid/complete genome) during 2015 (see Appendix 3).

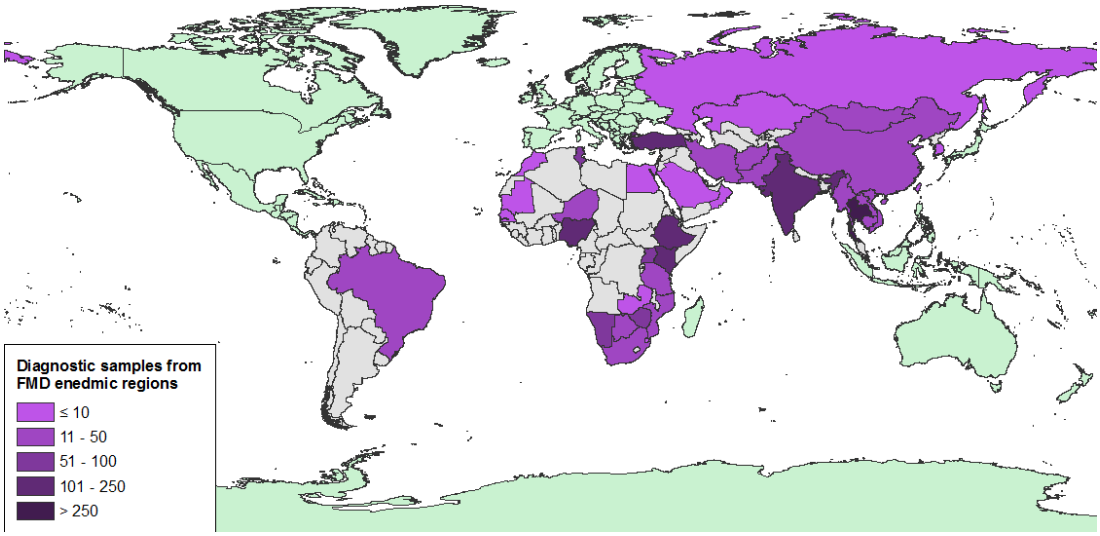


Figure 2-7: Distribution of samples collected from suspect cases of FMD (highlighted in purple) and tested by the OIE/FAO FMD Laboratory network during 2015. NB: Samples from Brazil are due to a new emerging virus causing vesicular disease in pigs called Seneca Valley virus.

The results for the individual samples are reported later in this report (section 2.5). It is also important to note that a much larger number of samples (such as sera, OPF and lymph node samples) were also received and tested by laboratories within the network during this period for surveillance activities: these numbers are also summarised in the tables for each of the individual endemic pools. Characterisation

results obtained on samples received by WRLFMD and PANAFTOSA can also be found respectively at: http://www.wrlfmd.org/ and at: http://new.paho.org/panaftosa.

Long distance trans-pool viral movements

The **OIE/FAO FMD Laboratory Network** has recently detected a number of viral lineages that have emerged from their established endemic pools to cause field outbreaks in geographically distant locations (the main events are summarised in Figure 2-8). There is probably no single factor that underpins these changes, but since 2010 the current dynamic transboundary patterns of FMD virus movements are probably influenced by the migration of people in North Africa and the Middle East due to the escalation of regional political crises, as well as new trading patterns and demand for animal protein that arise due to increased prosperity in East Asian countries. These unexpected outbreaks caused by emerging viral lineages reinforce the importance of surveillance activities undertaken by the Network.

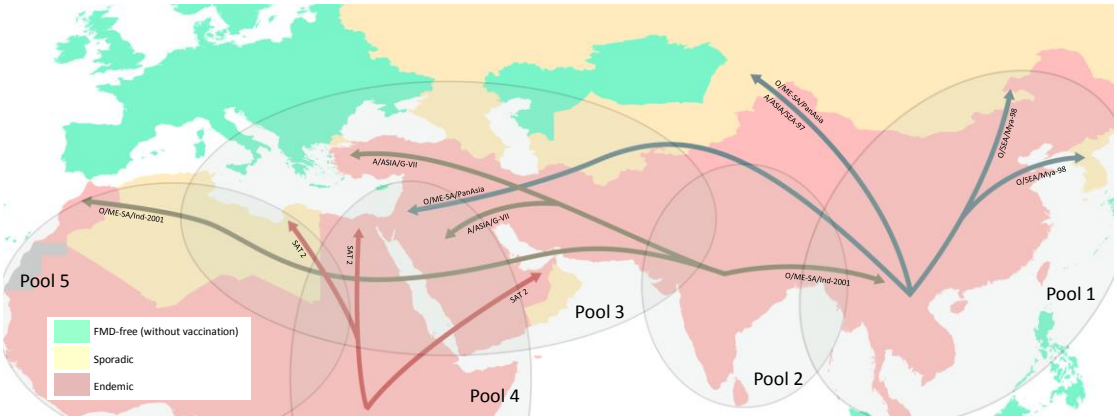


Figure 2-8: Long distance FMD virus movements within Asia and Africa (2009-2016). The different coloured arrows represent viruses from sub-Saharan Africa (red), Indian sub-continent (brown), and Southeast/East Asia (blue) that have moved into new geographical locations outside of the endemic pools (represented by shaded ovals) where they usually circulate.

2.4 Vaccine matching and recommendations

These take two forms: Regional recommendations and details of locally produced vaccines for each of the FMD endemic pools are summarised later in this report, whilst the WRLFMD recommendations for FMD free countries are given in Table 2-2 below. Details of vaccine matching work undertaken by the OIE/FAO FMD Laboratory Network are summarised in Appendix 2.

Table 2-2: Recommendations from WRLFMD on FMD virus strains to be included in FMDV vaccine antigen banks.

High Priority	A/ASIA/G-VII(G-18)* O Manisa O PanAsia-2 *(or equivalent)* O BFS or Campos A24 Cruzeiro Asia 1 Shamir A Iran-05 *(or A TUR 06)* A22 Iraq SAT 2 Saudi Arabia *(or equivalent i.e. SAT 2 Eritrea)*
Medium Priority	A Eritrea SAT 2 Zimbabwe SAT 1 South Africa A Malaysia 97 *(*or Thai equivalent such as A/Sakolnakorn/97*)* A Argentina 2001 O Taiwan 97 *(pig-adapted strain or Philippine equivalent)*
Low Priority	A Iran '96 A Iran '99 A Iran 87 or A Saudi Arabia 23/86 *(or equivalent)* A15 Bangkok related strain A87 Argentina related strain C Noville SAT 2 Kenya SAT 1 Kenya SAT 3 Zimbabwe

NB: Discussions are currently underway to adopt a risk-based approach for different FMD viral lineages to identify priority vaccines for use in Europe and other FMD-free settings.

*Recent in-vitro data from WRLFMD for serotype A viruses from Saudi Arabia and Iran highlights an apparent gap in vaccine coverage. Work is urgently required to evalute whether there is adequate in-vitro match with Indian vaccine strains (A/IND/40/2000) or whether in-vivo protection may be provided by high potency international vaccines.

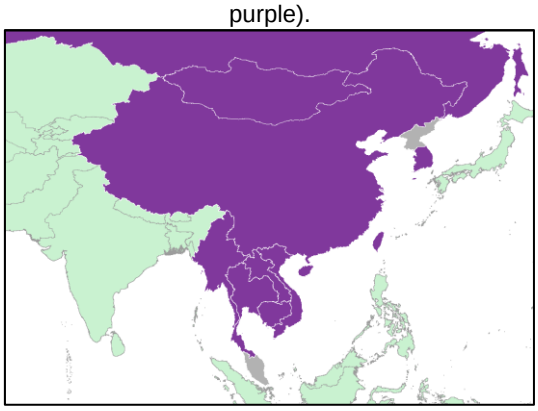
2.5 Network activities in each of the regional endemic pools

2.5.1 Pool 1 Regional synopsis

Conjectured circulating FMD viral lineages in Pool 1 during 2015:

- Serotype O (4 viral strains):
  - SEA/Mya-98
  - ME-SA/PanAsia
  - ME-SA/Ind2001d
  - CATHAY
- Serotype A:
  - ASIA/Sea-97
- Serotype Asia-1:
  - not detected in the region since 2005 (Myanmar) and 2006 (Vietnam, P.R. China) – see point below regarding recent samples collected from Cambodia

Table 2-3: Overview of samples collected and tested from pool 1 during 2015

Laboratory	Countries of Origin	Number of Samples		
		Clinical Field Cases	Surveillance Activities	Countries within Pool 1 that have provided samples to FMD reference centres during 2015 (in purple).
LVRI, Lanzhou, China	China	38	> 10,3728	
FGBI ARRIAH, Russia	Mongolia & Russia	13	63	
RRL Pakchong, Thailand	Cambodia, Lao PDR, Myanmar, Thailand & Vietnam	522	0	
WRLFMD, UK	Cambodia, Hong Kong SAR of PRC, Lao PDR, Mongolia, Myanmar, South Korea, Taiwan, Thailand & Vietnam	71	0	

Pool 1: Changes to FMD status in 2015:

- Emergence of the O/ME-SA/Ind-2001 lineage from the Indian sub-continent to cause field cases of FMD in Laos and Vietnam
  - Potential of this lineage to spread in the region (as has occurred recently in Pool 2 and North Africa).
- Endemic strains normally found in southeast Asia continue to cause FMD outbreaks in neighboring countries:
  - Continued FMD cases in Republic of Korea and Mongolia due to the O/SEA/Mya-98 lineage
  - Outbreaks in China and Russia due to the A/ASIA/Sea-97 viral lineage
  - Field cases in Mongolia due to the O/ME-SA/PanAsia viral lineage
- Reports of serotype Asia-1 circulation in Cambodia
  - Sequence data is urgently required to confirm these cases

Vaccine recommendations for Pool 1:

- Internationally produced vaccines:
  - O-Manisa
  - O-PanAsia (or suitable alternative)
  - O-TAW
  - A-MAY/97
  - A22-IRQ,
  - Asia 1-Shamir
- Locally produced vaccines (at RRL SEA):
  - Thailand O Udornthani 189/87
  - Thailand A Sakolnakorn/97
  - A Saraburi/87
  - A Lopburi/12
  - Thailand Asia1/85
- Locally produced vaccines (at FGBI ARRIAH):
  - A/Zabaikalsky/RUS/2013
  - O PanAsia-2
  - Asia-1 Shamir/89
- Locally used vaccine strains (by Chinese manufactures):
  - O/Mya-98 (O/Mya98/BY/2010)
  - O/PanAsia (O/China99)
  - AF72
  - Re-A/Sea-97 (Re-A/WH/09)
  - Asia1/GV (Asia1/JSL/06).

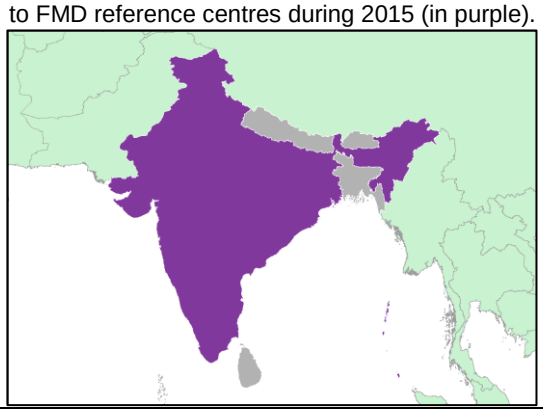
These are produced as: Type O and Type A (monovalent vaccines), Type O-A and Type O-Asia1 (bivalent vaccine), Type O-A-Asia1 (multi-valent vaccine) and a synthetic peptide vaccine (Type O for use in pigs only). In China vaccination occurs 2 times a year (in spring and autumn). More than 700 million doses are used at each time implying up to 1.5 billion doses are produced and administered in China per year

2.5.2. Pool 2 Regional synopsis

Conjectured circulating FMD viral lineages in Pool 2 during 2015:

- Serotype O:
  - ME-SA/Ind-2001
  - ME-SA/PanAsia-2 (last detected in 2011 in Sri Lanka)
- Serotype A:
  - ASIA/IND (genotype VII also known as genotype 18)
- Serotype Asia-1:
  - lineage C subdivided into Eastern and Western clusters

- **Table 2-4:** Overview of samples collected and tested from pool 2 during 2015

Laboratory	Countries of Origin	Number of Samples		
		Clinical Field Cases	Surveillance Activities	Countries within Pool 2 that have provided samples to FMD reference centres during 2015 (in purple).
PD-FMD, India	India	185	Numbers not reported	

Vaccine recommendations for Pool 2:

Pool 2: Changes to FMD status in 2015:

- FMDV serotype O is now dominant in the region accounting for 97% of the total specimen submissions into the Indian FMD Reference Laboratory (PD-FMD, Mukteswar) over the past three years
- Two viral lineages that are endemic in Pool 2 have spread beyond this pool to cause FMD outbreaks in other regions
  - O/ME-SA/Ind-2001 in the Gulf States, North Africa and Southeast Asia
  - A/ASIA/G-VII in the Middle East (Saudi Arabia, Turkey)
  - Precise routes by which these viruses are being spread need to be defined
- Real-time updates can be obtained from: https://www.fmd-dss.res.in/

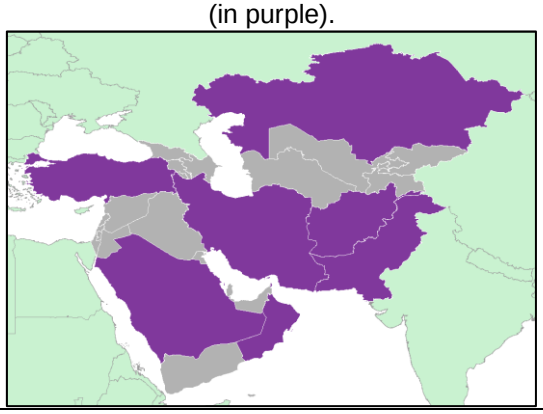
- Internationally produced vaccines:
  - O/ME-SA/PanAsia-2 (or suitable alternative). *In vitro* vaccine matching data for O/ME-SA/Ind2001 provides evidence for an antigenic match with O/TUR/09 vaccine (MSD) and O-3039 (Merial).
- Locally produced vaccines (by Indian suppliers):
  - O/IND/R2/1975
  - A/IND/40/2000
  - Asia1/IND/63/1972

2.5.3 Pool 3 Regional synopsis

Conjectured circulating FMD viral lineages in Pool 3 during 2015:

- Serotype O:
  - ME-SA/PanAsia-2 (predominantly from ANT-10 and FAR-09 sub-lineages)
  - ME-SA/Ind-2001 (recent incursion during 2013/14 from the Indian sub-continent)
- Serotype A:
  - ASIA/Iran-05 (from SIS-12, SIS-10, FAR-11 and BAR-08 sub-lineages)
  - ASIA/G-VII
- Serotype Asia-1: (Sindh-08 lineage)

Table 2-5: Overview of samples collected and tested from pool 3 during 2015

Laboratory	Countries of Origin	Number of Samples		Countries within Pool 3 that have provided samples to FMD reference centres during 2015 (in purple).
		Clinical Field Cases	Surveillance Activities	
FGBI ARRIAH, Russia	Central Asia,	1	0	
SAP Institute, Ankara, Turkey	Turkey	205	0	
WRLFMD, UK	Afghanistan, Bahrain, Iran, Kazakhstan, Oman, Pakistan, Saudi Arabia & Turkey	148	0	

Pool 3: Changes to FMD status in 2015:

- Established viral lineages (O/ME-SA/PanAsia-2, A/ASIA/Iran-05 and Asia-1) continue to cause FMD outbreaks across the region
- A new A/ASIA/G-VII (aka G-18) FMD viral lineage has emerged into the region from the Indian sub-continent
    - Poor *in-vitro* antigen-matching test results indicate that vaccines (based on the A/ASIA/Iran-05 strain) that are currently used are unlikely to provide protection
    - *In-vivo* studies are planned within the Network to evaluate the response of vaccines that could be deployed to the region
    - It will be essential to monitor the spread of this lineage during the next 12 months
- New FMD cases due to the O/ME-SA/Ind2001 lineage (Bahrain and UAE)
    - Sequence data provides evidence for multiple introductions of this viral lineage from the Indian sub-continent
- Detection of FMD virus serotype SAT 2 (topotype VII) in Oman

Vaccine recommendations for Pool 3:

- Internationally produced vaccines:
    - O/ME-SA/PanAsia-2 (or suitable alternative)
    - O/Manisa
    - A Iran-05 (or A TUR 06)
    - A22/Iraq
    - Asia-1 Shamir
- Locally produced vaccines (ARRIAH):
    - O/PanAsia-2
    - Asia-1 Shamir/89
    - A/ASIA/Iran-05 (from the Russian isolate /Krasnodarsky/RUS/2013)
- Other suppliers in the region:
    - SAP FMD Institute, Ankara, Turkey (particularly tailored for the A/ASIA/G-VII lineage)

- JOVAC, Jordan, Iran and Egypt

2.5.4 Pool 4 Regional synopsis

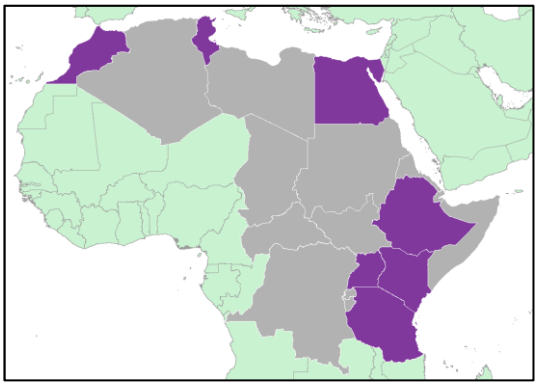
Conjectured circulating FMD viral lineages in Pool 4 during 2015:

- Serotype O:
  - EA-2 (Kenya, Tanzania, DR Congo, Uganda)
  - EA-3 (Ethiopia, Eritrea, Sudan, Egypt)
  - EA-4 (Ethiopia, Kenya, Uganda)
  - ME-SA/Sharqia-72 (detected in samples collected in Egypt in 2009)
  - ME-SA/Ind2001 (in Libya, Tunisia, Algeria and Morocco)
- Serotype A
  - AFRICA/I (Kenya, Tanzania, D.R. Congo)
  - AFRICA/IV (Sudan, Eritrea, Egypt)
  - AFRICA/VII (Ethiopia, Egypt)
  - ASIA/Iran-05^{BAR-08} (Egypt)
- Serotype SAT 1
  - I (Kenya, Tanzania)
  - IX (Ethiopia)
- Serotype SAT 2:
  - IV (Kenya, Tanzania)
  - VII (Sudan, Egypt, Mauritania)
  - XIII (Ethiopia, Sudan)
- Serotype SAT 3
  - Only detected in African buffalo in the south of the Queen Elizabeth National Park, Uganda in 1970, 1997 and 2014)

Table 2-6: Overview of samples collected and tested from pool 4 during 2015

Laboratory	Countries of Origin	Number of Samples	
		Clinical Field Cases	Surveillance Activities
RRLSS, BVI, Botswana	Uganda	20	0
NAHDIC, Ethiopia	Ethiopia	131	9585
ANSES, France	Tunisia	54	0
IZSLER, Italy	Egypt & Tunisia	10	635
FMD Laboratory, Kenya	Kenya & Uganda	224	1257
WRLFMD, UK	Ethiopia, Morocco, Tanzania & Uganda	56	0

Countries within Pool 4 that have provided samples to FMD reference centres during 2015 (in purple).



Pool 4: Changes to FMD status in 2015:

- The O/ME-SA/Ind-2001 viral lineage has continued to spread in North Africa
  - New outbreaks in Morocco (November 2015) that was previously FMD-free (since 1999)
  - No evidence for spread in Egypt or elsewhere in the region
  - Discussions regarding a regional vaccine bank for North Africa
- Elsewhere, serotypes O, A, SAT 1, SAT 2 outbreaks circulate

Vaccine recommendations for Pool 4:

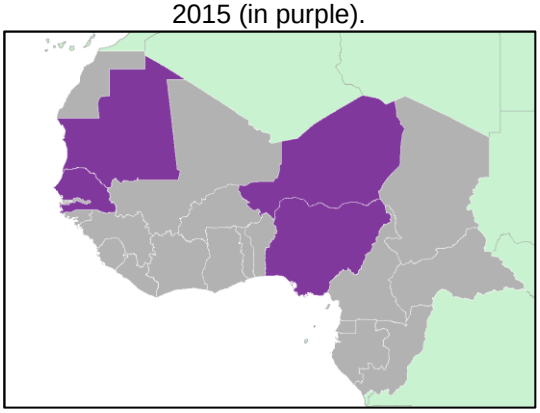
- Internationally produced vaccines:
  - O/Manisa
  - O/PanAsia-2 (or equivalent)
  - A/Eritrea
  - SAT2/Eritrea
- Locally produced vaccines from KEVIVAPI (Kenya):
  - O/Kenya 77/78
  - A/Kenya 5/80
  - SAT1 Tanzania T155/71
  - SAT2 Kenya 52/84
- Locally produced vaccines from NVI (Ethiopia):
  - O Ethiopia O 281
  - A Ethiopia A110
- Locally produced vaccines from BVI (Botswana)

2.5.5 Pool 5 Regional synopsis

Conjectured circulating FMD viral lineages in Pool 5 during 2015:

- Serotype O:
  - WA and EA-3 (Nigeria)
- Serotype A:
  - AFRICA/IV & VI
- Serotype SAT 1 (Nigeria)
- Serotype SAT 2:
  - Topotype VII (Mauritania)

Table 2-7: Overview of samples collected and tested from pool 5 during 2015

Laboratory	Countries of Origin	Number of Samples		
		Clinical Field Cases	Surveillance Activities	Countries within Pool 5 that have provided samples to FMD reference centres during 2015 (in purple).
NVRI, Nigeria	Nigeria	22	36	
CODA-CERVA, Belgium	Nigeria	88	354	
ISRA-LNERV, Senegal	Senegal	2	0	
RRLSS, BVI, Botswana	Niger	26	10	
WRLFMD, UK	Mauritania, Niger	9	0	

Pool 5: Changes to FMD status in 2015:

- New outbreaks due to serotype SAT 2 (topotype VII) reported in Mauritania
- Analysis of samples (O/EA-3 topotype) collected from Nigeria highlight intimate epidemiological connections between West Africa and East Africa
- Recognised priority to increase sampling and laboratory testing to improve our understanding of the epidemiology of FMD in the region

Vaccine recommendations for Pool 5:

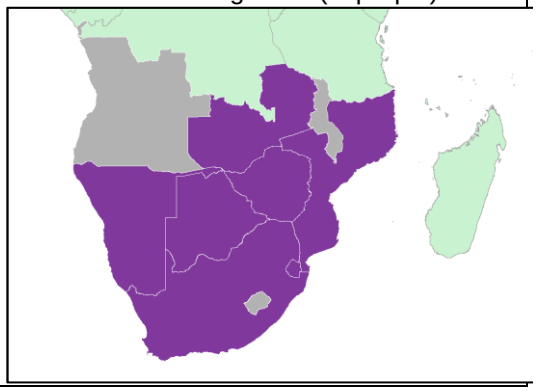
- Internationally produced vaccines:
  - O/Manisa
  - O/Maghreb
  - O/PanAsia-2 (or equivalent)
  - A/Eritrea
  - SAT2/Eritrea

2.5.6 Pool 6 Regional synopsis

Conjectured circulating FMD viral lineages in pool 6 during 2015:

- Serotype SAT 1:
  - Topotypes I, II and III
- Serotype SAT 2:
  - Topotypes I, II and III
- Serotype SAT 3:
  - Topotypes I, II and III)

Table 2-8: Overview of samples collected and tested from pool 6 during 2015

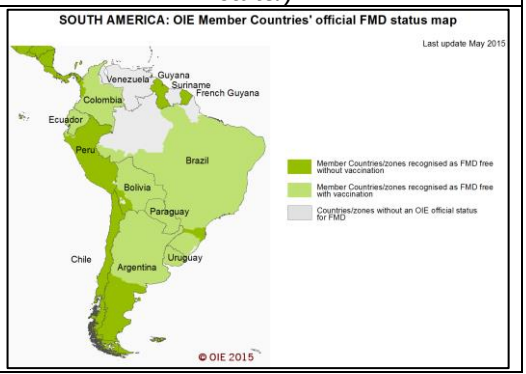
Laboratory	Countries of Origin	Number of Samples		Countries within Pool 6 (in grey) that have provided samples to FMD reference centres during 2015 (in purple).
		Clinical Field Cases	Surveillance Activities	
RRLSS, BVI, Botswana	Botswana, Mozambique, Namibia, Zambia & Zimbabwe	146	0	
ARC-OVI, South Africa	Namibia, Mozambique, South Africa, Swaziland	63*	15621	
WRLFMD, UK	Botswana, Mozambique, Namibia & Zimbabwe	32		

Pool 6: Changes to FMD status in 2015:

- Drought has led to increased cattle movements, with resultant spread of FMD over wider geographical areas
  - New SAT 1 outbreaks in Botswana (including re-emergence in the Northwest of the country), Namibia and Zimbabwe
  - New SAT 2 outbreaks in Angola*, Botswana, Namibia (close to the border with Angola) and Mozambique, Zambia and Zimbabwe
  - New SAT 3 outbreaks in South Africa and Zambia

*Reported to the OIE

2.5.7 Pool 7 Regional synopsis

Laboratory	Countries of Origin	Number of Samples		FMD status of countries of South America (downloaded from the OIE website: http://www.oie.int/en/animal-health-in-the-world/official-disease-status/fmd/en-fmd-carte/).
		Clinical Field Cases	Surveillance Activities	
PANAFTOSA, Brazil	Brazil	13*	0	

* These samples represent a cases of vesicular disease in pigs due to an emerging picornavirus called Seneca Valley Virus

.

3 Improving the quality of laboratory tests from international and international reference laboratories

3.1 Proficiency testing (PT) schemes organised by the OIE/FAO FMD Laboratory Network Partners

PANAFTOSA, Brazil

- FMD/VSV typing by PCR (13 lab participants)

FGI ARRIAH, Russia

- Republic of Kazakhstan (2 laboratories), Kyrgyzstan(2 laboratories), Tajikistan, Moldova, Belarus, Armenia
    - inactivated antigen panels (4 samples) as well as blood serum samples from convalescent and FMD vaccinated animals (5 samples)

PIADC, USA

- Produced and distributed inactivated panels (using phage particles) to 45 NAHLN State veterinary laboratories within the USA

RRLSEA, Thailand

- Fourth round of inter-laboratory comparison testing was undertaken (Dec'14 – Jun'15)
    - *ELISA Typing test, FMD serology by Liquid Phase Blocking ELISA (LPBE) and Non-Structural Protein test.*
    - *Participating laboratories included 8 FMD laboratories from Southeast Asia countries (Cambodia, Lao PDR, Malaysia, Myanmar, Thailand, Singapore, Vietnam (Hanoi and Ho Chi Minh) and 7 Regional Veterinary Research and Development Centers within Thailand (including National Institute of Animal Health and Regional Reference Laboratory for FMD in South East Asia (RRL), Pakchong).*
    - *Regional Reference Laboratory (RRL) provided a set of reference materials: ELISA reagents kit, unknown antigen and serum samples, and questionnaires to each participatory Lab.*
- The outcome of participatory test results indicated that test variability was caused by personal competency and familiarity within inter-laboratory comparison process such as poor technique in making serial dilutions, buffer preparation, buffer pH checking, etc.

IZSLER, Italy

- PT scheme organised for Bulgaria, Republic of Macedonia and Serbia (in the framework of an FMD simulation exercise planned and supported by EuFMD).
    - *Two sample panels (1 with 10 bovine sera, one with 6 epithelium homogenates)*

LVRI, People's Republic of China

- LPB-ELISA for type A antibody
    - *CADC and FMDRL jointly organised*
    - *32 province-level vet labs invited*
    - *6 blind samples provided*
    - *28/32 reach ref. value*

WRLFMD, UK

During 2014 and 2015, the WRLFMD has coordinated a PTS for virology and serology diagnostic methods for FMD. Swine vesicular disease (SVD) was not included in 2015 due to this disease no longer being a notifiable disease. The main purpose of these exercises has been to assess whether laboratories can correctly interpret the virological and serological status of the samples that are sent. Two minimum criteria agreed by EU NRLs (at the meeting in May 2014) have been adopted for the PT exercise: [1] firstly, laboratories should be able to detect FMD virus in clinical specimens and [2] secondly, laboratories should be able to use a serological test to correctly identify animals previously exposed to FMDV. However, particular tests and assays are not specified: rather laboratories are invited to select tests that they believe are appropriate, and use them to interpret the status of the samples.

The format of the PT panels has been similar over the last few years and comprises 4 panels of specimens:

- Panel 1: Infectious materials from pigs with a vesicular condition for FMD/SVD virus detection. These samples can be tested using a wide range of assay formats, but are only suitable for laboratories that have adequate containment facilities.
- Panel 2: Non-infectious materials comprising FMDV and SVDV that have been inactivated using binary ethyleneimine (BEI) and inocuity tested by two passages in primary bovine thyroid cells with negative results. These samples can be used outside of the most specialised high-containment laboratories and can be tested using antigen detection ELISA and molecular methods such as RT-PCR.

- Panel 3: Non-infectious serum samples for FMDV antibody assays. The laboratories have been asked to interpret the status of these samples in context of possible vaccination histories with FMDV vaccines.
- Panel 4: Non-infectious serum samples for SVDV antibody assays. In 2015 panel 4 was not distributed due to the delisting of SVD as a notifiable disease.

All samples undergo 10x testing at WRLFMD to demonstrate consistent assay results prior to sending these materials to the participating laboratories. Once the samples have been tested by the different laboratories, results are sent to WRLFMD and collated together. In addition, laboratories are given individual feedback on their results including observations and non-conformities according to predefined criteria (see Table below).

	2014	2015
Total invited laboratories[1]	91	91
Total number of shipments[1]	66	66
Participants from European Union (funded by EURL for FMD)	26 (EU member states)	27 (EU member states)
% of labs meeting target performance[4]	Cat-1 0 % Cat-2 0 % Cat-3 69 % Cat-4 31 %	Cat-1 0 % Cat-2 0 % Cat-3 67 % Cat-4 33 %
EUFMD funded participants		
Participants from Global Network Labs[2]	BVI, Botswana: OVI, South Africa: NAHDIC, Ethiopia: Embakasi, Kenya: Pakchong, Thailand; Lanzhou, China: Panaftosa, Brazil; NVRI Nigeria; LNERV, Senegal; USDA, USA[3]	Panaftosa Brazil, Pakchong Thailand, BVI Botswana, OVI South Africa, ARRIAH Russia, NVRI Nigeria, LNERV Senegal, Emabakasi FMD laboratory Kenya, NAHDIC Ethiopia, USDA USA[3]
% of labs meeting target performance[4]	Cat-1 0 % Cat-2 10 % Cat-3 40 % Cat-4 40 % One laboratory did not report results	Cat-1 0 % Cat-2 10 % Cat-3 60 % Cat-4 30 %
Participants from EuFMD Member states (non-EU)	Albania, Bosnia, Georgia, FYRO Macedonia, Norway, Serbia, Switzerland, Turkey	Serbia, Albania, FYRO Macedonia, Turkey, Georgia, Switzerland, Norway, Israel
% of labs meeting target performance[4]	Cat-1 0 % Cat-2 0 % Cat-3 62 % Cat-4 38 %	Cat-1 0 % Cat-2 0 % Cat-3 88 % Cat-4 13 %
Participants from neighbourhood countries	Algeria, Armenia, Azerbaijan, Belarus, Egypt, Iran, Kosovo, Morocco, Moldova, Tunisia, Montenegro, Lebanon	Montenegro, Armenia, Azerbaijan, Ukraine, Egypt, Lebanon, Morocco, Algeria
% of labs meeting target performance[4]	Cat-1 0 % Cat-2 0 % Cat-3 83 % Cat-4 17 %	Cat-1 0 % Cat-2 0 % Cat-3 63 % Cat-4 38 %
Summary of EUFMD funded participants		
Invited	40	
Panels shipped	Panel 1 2 Panel 2 19 Panel 3 17 Panel 4 4	Panel 1 7 Panel 2 23 Panel 3 25 Panel 4 -
Total number of participants funded by EUFMD	**29**	**26**

[1] *Additional countries participate in the PTS at their own expense (not funded via the EURL for FMD or EuFMD)*

[2] *Not including IZSLER and CODA-CERVA who participate as European NRLs*

[3] *USA are self-funded*

[4] *Scored according criteria agreed by the NRLs within Europe, each laboratory receives a personalized anonymous feedback letter to highlight areas in which they could improve, and performance of each laboratory is broadly categorized into one of four groups: (**Category 1**) to emphasize critical issues where immediate action is required that impact upon the laboratory to correctly identify FMD virus (virology tests) or FMDV infected animals (serological tests), (**Category 2**) laboratories with serious issues with the performance of individual tests that need to be addressed, (**Category 3**) to record additional observations which may need to be considered by the laboratory to improve the local performance of individual tests and (**Category 4**) laboratories whose tests which are fit for purpose and where no further action is required.*

Data generated by participating laboratories is presented (in a coded manner) at the EURL for FMD meeting (annually) and at EUFMD (bi-annually). An overview of the results for the PT exercise that started in 2014 (and was concluded in 2015) was reported at the EuFMD Open Session Meeting in Portugal.

ANSES, France

A PTS is organized for national laboratory network on NSP and type O antibodies detection

3.2 Supply of reagents

PANAFTOSA, Brazil

Diagnostic kits and reagents supplied during 2015

Type of reagent	Quantity	Recipient countries
FMDV antibody detection kits	NSP Ab: 187000 SP Ab: 474000	South American countries
FMDV antigen detection kits	Ag ELISA: 7800	South American countries
Cell lines	BHK, MDBK, PK15, IBRS-II	Brazil, Venezuela
FMDV/VSV RNA	110 tubes distributed	South American countries, Panamá, Mexico, USA

FGI ARRIAH, Russia

Diagnostic kits and reagents supplied during 2015

Type of reagent	Quantity	Recipient countries
FMDV antibody kits	4043	Russia, Kazakhstan, Kyrgyzstan, Armenia, Moldova, Belarus, Tajikistan
FMDV antigen kits	11	Russia, Kazakhstan, Kyrgyzstan, Armenia, Moldova, Belarus, Tajikistan

PIADC, USA

Diagnostic kits and reagents supplied during 2015

Type of reagent	Quantity	Recipient countries
FMDV antibody kits	1	COPEG (LADIVES), Panama
FMDV antigen kits	1	COPEG (LADIVES), Panama

RRLSSA, Botswana

Diagnostic kits and reagents supplied during 2015

Type of reagent	Quantity	Recipient countries
FMDV antibody kits	250ml	CVRL - Zimbabwe
FMDV antigen kits	200ml	CVRL - Zimbabwe

SENASA, Argentina

Diagnostic kits and reagents supplied during 2015

Type of reagent	Quantity	Recipient countries
Hyper immune guinea pig sera A24 Cruzeiro-A arg 2001- O1 Campos-	124 vials (1 ml)	Argentina, Paraguay
FMD challenge viral suspension for PPG test A24 Cruzeiro -Arg 2001- O1 Campos-	8 vials	Argentina
27 DPV Bovine sera (monovalent vaccine O1 Campos)	32 vials (1ml)	Argentina
LP-ELISA	347 five plate kits	Argentina, Colombia, Paraguay and China
Typing ELISA	24 x five plates	Argentina and Paraguay
3 ABC ELISA	6 x one hundred plates	Argentina
Hyper immune guinea pig sera A24 Cruzeiro-A arg 2001- O1 Campos-	124 vials (1 ml)	Argentina, Paraguay
FMD challenge viral suspension for PPG test A24 Cruzeiro -Arg 2001- O1 Campos-	8 vials	Argentina

RRLSEA, Thailand

Diagnostic kits and reagents supplied during 2015

Type of reagent		Amount	Recipient countries
A. Liquid Phase Blocking ELISA (LP ELISA) *Also used for antigen capture (ELISA typing) r-value by LP ELISA*			
Rabbit trapping antibody	type O	1.5 ml 7.9 ml	Myanmar Thailand
	type A	0.5 ml 8.4 ml	Myanmar Thailand
	type Asia 1	6.9 ml	Thailand
Guinea pig detecting antibody	type O	1.5 ml 11 ml	Myanmar & Cambodia Thailand
	type A	1 ml 13.3 ml	Myanmar & Cambodia Thailand
	type Asia 1	10.5 ml	Thailand
Inactivated concentrate FMDV antigen	type O	5.5 ml 82 ml	Cambodia Thailand
	type A	2 ml 54 ml	Myanmar & Cambodia Thailand
	type Asia 1	1 ml 76 ml	Cambodia Thailand
B. Liquid Phase Blocking ELISA (LP ELISA)			
Control serum C++	Strong	21 ml 171 ml	Myanmar Thailand
Control serum C+	weak	21 ml 168 ml	Myanmar Thailand
Control serum C-	negative	21 ml 143 ml	Myanmar Thailand

IZSLER, Italy

Diagnostic kits and reagents supplied during 2015

Country or organisation		FMDV antigen detection ELISA		NSP Ab ELISA	SP antibody ELISA kit			
		O, A, SAT1, SAT2	*O, A, C, Asia1*	*3ABC*	*O*	*A*	*Asia1*	*SAT2*
EUFMD / Rome		2	1		1	1		1
Asia	Myanmar		5					
	Nepal		8		1	1	1	
	Taiwan		1					
	China				232	91	40	
Central Asia	Pakistan		103	10	3	3	3	
	Kazakhstan				3	3	3	
	Georgia				3	3	3	
	Afghanistan		14	16	6	6	6	
Middle East	Oman				6	6	6	
	Kuwait		3		1	1	1	
Africa	Egypt	20	3	25	12	12		12
	Kenya	17		7	2	2	2	2
	Senegal				3	3		3
	Ghana	4			1	1		1
	Algeria	3		10	2	5		
	Tunisia				7			
	Morocco			52	9			
	Ethiopia	1						
	Uganda	1						
	Tanzania	1			1	1	1	1
FMDV-free countries	Eire	1	1					
	New Zealand				1	1		
	Croatia	1	1		1	1	1	1
	Slovenia				1			
	Greece		2		1	1	1	
	Poland	1	1			1	1	1
Total Number of Kits		**52**	**143**	**120**	**297**	**143**	**69**	**22**

LVRI, People's Republic of China

Diagnostic kits and reagents supplied during 2015

Type of reagent		Quantity	Recipient countries
Antibody kit	LPBE-O	7092 kits	
	LPBE-Asia1	3940 kits	
	LPBE-A	3708 kits	
	IHA (type O)	6637 kits	
	NSP-3ABC-ELISA	3293 kits	
Antigen kit	Mult-RT-PCR	321kits	
	Real-time PCR	356kits	

PDFMD, India

Diagnostic kits and reagents supplied during 2015

Type of reagent	Quantity	Recipient countries
LPB ELISA kit for serotype O, A and Asia1	For testing 271960 samples	AICRP on FMD, India
3ABC NSP ELISA kit	For testing 79800 samples	AICRP on FMD, India
FMDV antigen kits (for serotype O, A and Asia1)	3000	AICRP on FMD, India

WRLFMD, UK

Diagnostic kits and reagents supplied during 2015

Country	Ag ELISA Kit	Ab LPBE kit	Reagents	Serotype/comments
Australia	0	0	1	Mabs (O Manisa IB11)
Botswana	0	1	0	Serotypes SAT1 & SAT3
Ireland	0	0	1	Serotype Asia1
Lithuania	0	1	0	Serotypes O, A, C & Asia1
Mongolia	0	1	0	Serotypes O, A & Asia 1
Morocco	0	0	1	Reagents for serotype O and reference panel NSP/Negative
Poland	0	0	1	NSP
Poland	0	4	0	Serotypes O, A, C & Asia1
Romania	0	0	1	Serotypes SAT1 & Asia1
Singapore	0	1	0	Serotype A & C
Singapore	0	1	0	Serotypes O and Asia 1
South Korea	0	1	0	Serotype O
Switzerland	0	0	1	NSP
Taiwan	0	0	3	NSP
UAE	0	1	0	Serotypes O & A
USA	0	0	1	Serotype A
USA	0	0	1	NSP panel
Vietnam	0	6	0	Serotype O
Vietnam	0	10	0	Serotypes O & A

ŞAP Institute , Turkey

Diagnostic kits and reagents supplied during 2015

Type of reagent	Quantity	Recipient countries
FMDV antibody kits (BVS against 6 strain for use in r1)	~100 ml	WRL-FMD

ANSES, France

Type of reagent	Quantity	Recipient of the reagent
FMDV 3D rtRT-PCR reagents	250 tests	Kenya
NSP and Type O positive sera	3 x 2 ml	France

3.3 Training courses organised by Network partners

PANAFTOSA, Brazil

- Training offered (organized)
  - Serosurveillance: NSP antibodies detection by I-ELISA 3ABC/EITB
  - Molecular Diagnostics: Use of PCR for the differential diagnostic of vesicular diseases
  - Laboratory Biorisk Management

FGI ARRIAH, Russia

- 10 veterinary specialists from the Central and Regional laboratories of the Republic of Kazakstan received training on LPB ELISA for the detection of antibodies against FMDV using ARRIAH kit.
- EUFMD webinar

PIADC, USA

- 56 Participants to International Transboundary Animal Disease (ITAD)
  - April: Uganda, Jordan, Malaysia, Ghana, Cameroon, Vietnam, Japan, Kenya, South Africa, Philippines, India, Georgia, Armenia, Tunisia and Mexico.
  - September: (PANAFTOSA) Argentina, Colombia, Brazil, Bolivia, Venezuela, Paraguay, Suriname, Peru, Chile and Panama.

- 63 Participants to Foreign Animal Disease Diagnostician Courses
    - 18 Federal Veterinarians
    - 24 State Veterinarians
    - 21 Military Veterinarians
- 22 Participants to Veterinary Laboratory Diagnostic Course
    - Veterinary Pathologists and Professors

RRLSSA, Botswana

- BNVL 3 scientists for FMD diagnostics
- Mozambique 1 scientist FMD molecular diagnostics
- BITRI scientists FMD diagnostics
- Niger PhD student FMD diagnostics
- Zimbabwe LPBE troubleshooting
- Namibia LPBE test

CODA-CERVA, Belgium

- Several laboratory training courses for FMDV were organized at the CODA-CERVA in the framework of the Collaborative Projects with the NVRI, Nigeria and with BVI, Botswana.

SENASA, Argentina

- August 2015: Training in Vietnam
    - *Health Animal Department, Regional Animal Health, (RAHO)Nº 6 (Ho Chi Minh)*
    - *NAVETCO*
    - *Institute for Animal Sciences of South Vietnam (IASVN)*
- Outbreak Simulation Exercise on Foot and Mouth Disease
    - *Corrientes, Argentina, 25th-28th August 2015*
- Foot and Mouth Disease Diagnosis Workshop
    - *Chaco-Formosa, Argentina, September 2nd 2015*
    - *Collection, preparation and submission of samples for disease diagnosis and differential. Clinical and laboratory diagnosis.*
- OIE Laboratory Twinning Project
    - *SENASA Laboratory-Argentina as Parent Reference Laboratory and AGROCALIDAD Laboratory-Ecuador*
    - *FMD diagnosis and Vaccine quality control*

RRLSEA, Thailand

- Australia, vaccine matching, 20th April – 1st May 2015
- Myanmar, FMD Diagnostics Capacity, 14th Sep. – 6th Nov. 2015
- Russia's Federal Service for Veterinary and Phyto Sanitory Surveillance of the Russian Federation (FSVPS). Visited RRL on 29th July 2015
- Taiwan Delegates, visit RRL on the project exchange of diagnostic techniques and experiences in FMD Reference Laboratory under the Taiwan-Thailand Agricultural Cooperation, on 18th August 2015

IZSLER, Italy

- 20th-30th April: 10-day lab training - all diagnostic techniques and Lab Biosecurity
    - *Attendees: two young vets from AHRI – Cairo, Egypt*
    - *Supported by FAO project (donor: Italian Ministry of foreign affairs)*
    - *Venue: IZSLER-Brescia*
- 8th-17th April: Study visit of Dr. Ibrahim Eldaghayes, Tripoli, National Committee for Animal Health - EUFMD visiting scientist
- Algeria – Twinning (supported by EU: Accord d'association Algérie-Union Européenne) Renforcement des diagnostics virologiques et moléculaires pour certaines maladies
    - *Two missions of IZSLER scientists to Algeri and Tlemcen (Laboratoire Central Vétérinaire d'Alger, Laboratoire vétérinaire régional de Tlemcen) to train on molecular and immunological diagnostic tests for FMD (May and June 2015)*
    - *Study visit of 4 Algerian trainees to FMD laboratories at IZSLER (one week in November 2015)*

LVRI, People's Republic of China

- National wide training
    - *Diagnosis, sampling & vaccination*
    - *>20 provinces training course*
- 3 visitors from DPRK
    - *Bio-security*
    - *Diagnosis /VI, ELISA & PCR*
    - *Infectious materials transmission*
- 21st Meeting of SEACFMD Manila, Philippines, 10th-13th March 2015
- SEACFMD Animal Movement Meeting, Qingdao, China, 24th to 29th August 2015
- 4th Coordination Committee Meeting and 2nd FMD Scientific Meeting for East Asia, Under the OIE/JTF Project on FMD Control in Asia Tokyo, Japan, 6th-9th June 2015
- The Workshop on the Technology of Prevention and Control of FMD from China, Japan and Korea. Seoul, Korea, November 2015

PDFMD, India

- 12 training programme/refresher courses
  - 21 personnel from All India Co-ordinated Research Project (AICRP) on FMD (India) were trained for:
    - FMD sampling
    - FMD Virus diagnosis
    - FMD serology (SP and NSP)
    - Disease reporting and data management through online reporting system (www.fmd-dss.res.in)

WRLFMD, UK

- Kazakhstan – hosted scientist for two week training course on laboratory diagnostics
- Kazakhstan – ran training course in Astana on FMD control and laboratory tests
- Mongolia – ran training course in Mongolia on serological ELISA tests

FMD Laboratory, Kenya

- EUFMD/FAO Nakuru real-time training courses (NTC 20-23) for EU vets

ŞAP Institute , Turkey

- Kazakhstan (PCR Diagnosis and phylogenetic analysis)
- Pakistan (FMD vaccine control)
- Regular training activities for veterinary services of Turkey

LISRA-LNERV , Senegal

- Epidemiosurveillance and laboratory capacity
  - *Dakar, 3rd-4th June 2014*
  - *FAO/ANSEE*

ANSES, France

- Training on FMD diagnosis was provided in Morocco
- Training on FMD diagnosis was provided for one trainee at Anses
- Participation to workshop in Tunisia: implementation of biosecurity and biosafety measures in laboratories

3.4 Collaborative projects

PANAFTOSA, Brazil

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
All South American countries	PHEFA: *Hemispheric Plan for FMD Eradication*. FMD eradication from the subcontinent	All South American countries

ARC-OVI, South Africa

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
The Pirbright Institute	NSF-EID funded project investigating Persistence of FMD in African buffalo	Understanding of how FMDV is maintained and transmitted by buffalo
PIADC, USDA, ARS	USDA funded project to develop antigenically improved vaccines and adenovirus vaccines for FMD control	Novel vaccine strategies for control on FMD in endemic region Publications
INTA	Implementation of novel in vitro assays to assess protection	Avidity, IgG isotype, Interferon, IgM ELISAs Publications
Dr K. de Clercq	3ABC ELISA for southern Africa	3ABC ELISA Publication

FGI ARRIAH, Russia

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
EuFMD	Development of the ARRIAH draft FMD Surveillance Program for Caucasian Countries, EUFMD, FAO, OIE and ARRIAH	Meeting was held on 19-21/01/2015 in Ankara Participants from the RF (FGBI ARRIAH), Armenia, Azerbaijan, Turkey Needs and mechanisms for regional cooperation on FMD surveillance and control were identified
FAO	Fifth Meeting on Strengthening the Collaboration on Transboundary Animal Diseases and Emerging Infectious Diseases by Mongolia, China and the Russian Federation	Meeting was held on 11-12/09/ 2015 The three sides built a relationship of trust, and found understanding through the exchange of information and discussion of information on FMD, HPAI, ASF and other TADs and Zoonoses

PIADC, USA

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
OIRSA	Enhancement of FMD surveillance program in Central America	Proposal and Budget Training program Lab Equipment
EuFMD/Pirbright	International Vaccine Trial Study Design Working Group	Recommendations for FMD Vaccine Study Design and International field trials

RRLSSA, Botswana

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
WRLFMD Pirbright Institute, UK	ILC, PTs, and Genotyping	Methods validated
CODA-CERVA	Capacity building in Bio-informatics and WGS	Improved capacity
OVI-RSA	Diagnostic collaboration	MoU signed in November 2015
Botswana National Vet lab (BNVL)	Implementation of LMS towards ISO17025 accreditation	Tests accredited
Botswana Institute for Technology Research and Innovation (BITRI)	Development of a rapid test for FMD	Development of diagnostic tools

CODA-CERVA, Belgium

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
National Veterinary Research Institute (NVRI) from Vom, Nigeria	OIE Laboratory Twinning Program	OIE Laboratory Twinning Program for capacity building via a technical and scientific collaboration with the National Veterinary Research Institute (NVRI) from Vom, Plateau State, Nigeria.
Botswana Vaccine Institute (BVI), Botswana		Bilateral collaboration with the Botswana Vaccine Institute (BVI) for quality assurance in diagnostics and sequencing.

SENASA, Argentina

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
RIIDFA	Development of FMD new generation vaccines based on no infection viral capsids	Development, validation and application of immunoenzymatic methods for the characterization of FMD risk in support of vaccination policies for life
IAEA	Control of FMD	
AAHL CSIRO	Testing the early protection of O1Manisa Double Oil Emulsion Emergency Vaccine in Cattle against Heterologous Challenge	
PROCC-FioCruz-Brazil-ICT	FMDV proteins modeling studies	
University of San Pablo, Brazil-ICT	Activity Assessment of FMD antival compounds	

RRLSEA, Thailand

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
Australian Animal Health Laboratory	Foot and Mouth Disease risk Management for Australia and South East Asia (2014-2016)	Laboratory capacity building through training and transfer of disease diagnosis capabilities for regional virus circulation in SEA region.
National Institute of Animal Health (Japan)	Scientific Meeting and MOU documents between two institutions preparation under OIE support for collaborating projects including “FMDV Full Genome Sequencing” between NIAH - Japan and RRL.	Sharing information and FMD research by both institutions’ researchers, leading to good continued and sustained future collaborations. Development of young researchers to gain knowledge and advanced technology, enhance experience and promote creativity to contribute the innovation in research and diagnostics.
Bureau of Veterinary Biologics Bureau of Disease Control and Veterinary Services	Study of the efficacy of FMD vaccine and vaccination program in Thailand	To improve the vaccination program in Thailand and induce the higher herd immunity for FMD
Kasetsart University, Thailand	Development of recombinant 3ABC-based ELISA to differentiate vaccinated from FMD infected animals.	Modified NSP test kit.

IZSLER, Italy

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
The Pirbright Institute	Development of new and continuous validation and improvement of diagnostic assays and reagents	Ready-to-use Ag detection and serotyping ELISA kit for six serotypes and Ab-detection and serotyping ELISA kits for five serotypes.
Institut de la Recherche Vétérinaire de Tunisie ANSES, France	Genetic (NGS) and antigenic (MAbs profiling) characterization of FMD viruses from 2014 epidemic	Full genome sequence MAbs profile N. 12 selected isolates
AHRI, Egypt	Genomic and antigenic characterization of re-emergent FMD viruses responsible of recent epidemics in Egypt Strengthen relationships between IZSLER (Italy) and AHRI (Egypt)	Phylogenetic relationships between circulating viruses. Evaluation of differences in cells susceptibility to different FMD serotype viruses. Application to the call «Science and Technology Development Funds», Italy-Egypt
Institut de la Recherche Vétérinaire de Tunisie	Field vaccination study (2014-2015) Objective: Predict efficacy of O-BFS vaccine in the Tunisian context	In previously vaccinated cattle and sheep the vaccination with O-BFS vaccine elicited a strong and fast increase of protecting antibodies against both vaccine and field strains (booster effect). In naïve animals, a single vaccination with O-BFS induced seroconversion but a proportion of 30% sheep and 15% cattle did not achieve a protective immunity against the heterologous field virus.
USDA ARS PADC Plum Island NY, US	“Study of interaction between FMDV and host proteins during infection”	Production of a new MAbs panel specific to the 2B NSP

LVRI, People's Republic of China

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
SEACFMD	FMD control in SEA	SEACFMD roadmap 2020
China-Russia-Mongolia FAO	Cross Border Trade and TADs Risk Reduction between China, Mongolia and Russia	Information platform Surveillance Joint prevention and control
East Asia (JPN,KOR) OIE/JTF	FMD control in East Asia	Information sharing Joint prevention and control Research cooperation
IAEA/FAO	Engineering FMD Vaccine with Increased Antigenic Match and Broadened Coverage of Antigen for the Development of effective Vaccine	Vaccine strains: Re-A, Re-O
IAEA (CRP16025)	TDS on diagnosis, vaccination, risk anylis and control	Training/workshop

PDFMD, India

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
Department of Animal Husbandry, Dairying and Fisheries (DAH&DF) Government of India	**FMD Control Programme** Providing scientific inputs to the vaccination based FMDCP. Providing kits, training, scientific inputs, and data analysis for FMD epidemiology and Serology	FMD epidemiology and serology
ARS-USDA	"Understanding FMD viral ecology and landscape epidemiology towards control and eradication" to understand the ecology of FMDV in endemic setting to provide the basis for effective control strategies	Designing effective control strategies

WRLFMD, UK

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
NAHDIC, Ethiopia	OIE twining project	Building the capacity of NAHDIC for FMD diagnosis
EUFMD ANSES , France FMD Lab, Kenya	FMD Real-Time PCR validations	Capacity for FMD diagnostics
IZSLER, Italy	Development of new and continuous validation and improvement of diagnostic assays and reagents	Ready-to-use Ag detection and serotyping ELISA kit for six serotypes and Ab-detection and serotyping ELISA kits for five serotypes.
RRLSSA, Botswana	ILC, PTs, and Genotyping	Methods validated
EuFMD PIADC, USA	International Vaccine Trial Study Design Working Group	Recommendations for FMD Vaccine Study Design and International field trials
ARC-OVI, South Africa	NSF-EID funded project investigating Persistence of FMD in African buffalo	Understanding of how FMDV is maintained and transmitted by buffalo
FLI, Germany; INTA, Spain; ANSES, France, UCM, Spain, CODA-CERVA, Belgium; SVA, Sweden and commercial partners	Rapid Field Diagnostics and Screening in Veterinary Medicine (Rapidia-Field)	Development of new diagnostic tools for livestock diseases
CODA-CERVA (Belgium), FLI (Germany), SLU (Sweden), IZSVe (Italy) and University of Glasgow (UK)	Molecular epidemiology of epizootic diseases using next generation sequencing technology	Apply new technologies for molecular epidemiology

NVRI, Nigeria

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
Coda-Cerva, Belgium	Twinning project	

NAHDIC, Ethiopia

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
The Pirbright Institute	OIE twining project	Building the capacity of NAHDIC for FMD diagnosis
EuFMD	Provide FMD proficiency test	• Capacitate the efficiency detecting FMD in our laboratory • Help us to assure quality management system in our laboratory in FMD antibody detection

FMD Laboratory, Kenya

Collaborative projects during 2015

Collaborators	Purpose of collaboration	Outcomes
NADDEC, Uganda DTU, University of Copenhagen Makerere University	Capacity for FMD lab diagnostics and research	1. Molecular diagnostics capacity at Embakasi 2. Serological diagnostics capacity at NADDEC Uganda
DVS Kenya EUFMD	FMD Real-Time training	EU and Kenyan Vets capacity for FMD outbreak investigation
Kenya Wildlife Service University of Minnesota	FMD Livestock-wildlife interphase research	Understanding FMD transmission dynamics
EUFMD ANSES , France WRLFMD, UK	FMD Real-Time PCR validations	Capacity for FMD diagnostics

LISRA-LNERV , Senegal

Collaborators	Purpose of collaboration	Outcomes
FAO/ EUFMD	FMD Serosurveillance Training of field staff LNERV diagnostic capacity	• 3000 sera collected in 2015 • Serotype cartography • Epidemiological patterns
ANSES	Q_RT-PCR Technology transfer Genotyping of field 'isolates Sequencing	• 6plex Q-RT-PCR Validation • ID of fields isolates

ANSES, France

Collaborators	Purpose of collaboration	Outcomes
IZSLER (Brescia) IRVT (Tunisia)	Characterization of FMDV strains circulating in Tunisia in 2014	Virus isolation Genetic characterization Antigenic Characterization Relationship between outbreaks
EuFMD	Development of a safe and low cost way to transport FMDV suspected samples	Validated protocol
INRA SLU FLI CODA-CERVA MERIAL	Improvement of FMD vaccines	Knowledge on immune response

Appendix 1 - Details of clinical samples from field cases from countries in FMDV endemic regions tested during 2015

Laboratory	Samples from	Total	O	A	Asia 1	Sat 1	Sat 2	Sat 3	NVD	Untyped / FMDVGD	Comments
Belgium	Nigeria	88	13	2		10	26			47	10 samples dual positive for O & SAT1
Botswana	Botswana	36				3	14		19		
	Mozambique	5					1		4		
	Namibia	60				18	8		34		
	Niger	26	10						16		
	Uganda	20							20		
	Zambia	9					5	2	2		
	Zimbabwe	36					13		23		
China	China	38		14					24		
Ethiopia	Ethiopia	131	46			?	16		75		
France	Tunisia	54	21						33		
India	India	185	75	3	4				103		
Italy	Egypt	10	8	2							
Kenya	Kenya	190	11	16		20	21		89	33	
	Uganda	34	1			9			24		
Nigeria	Nigeria	22	1	6		5	2		8		
Russia	Central Asia	1		1					0		
	Mongolia	12	6						3	3	
	Russia	1		1					0		
Senegal	Senegal	2		2							
South Africa	Mozambique	4					2		2		
	Namibia	2					1		1		
	Swaziland	7							7		
	South Africa	50									
South America	Brazil	13							13		Samples positive for Senecavirus
Thailand	Cambodia	17	4	3	2				8		
	Lao PDR	15	6	5					4		
	Myanmar	21	12						9		
	Thailand	449	253	45					151		
	Vietnam	20	1	19							
Turkey	Turkey	205	22	71	28	-	-	-	84		
UK	Afghanistan	21	11		3					9	2 samples dual positive for O & Asia-1
	Bahrain	15	9						5	1	
	Botswana	2				2					
	Cambodia	5	2	2					1		
	Ethiopia	10	3			1	4			3	1 sample dual positive for O & SAT1
	Hong Kong	12	8						2	2	
	Iran	27	7	15	3				2		

Laboratory	Samples from	Total	O	A	Asia 1	Sat 1	Sat 2	Sat 3	NVD	Untyped / FMDVGD	Comments
	Kazakhstan	5							5		
	Laos	5	4	1							
	Mauritania	5					4			1	
	Mongolia	4	4								
	Morocco	3	3								
	Mozambique	2					1		1		
	Myanmar	5	2	3							
	Namibia	6				1	5				
	Niger	4	1						2	1	
	Oman	4					3			1	
	Pakistan	42	17	18	6					5	3 samples dual positive for O & A 1 sample O & Asia-1
	Saudi Arabia	6		6							
	South Korea	5	4							1	10 samples received, only 5 tested
	Taiwan	6							6		
	Tanzania	41	8			29			1	3	
	Thailand	25	8	16						1	
	Turkey	28	4	14	7				2	1	
	Uganda	2							1	1	
	Vietnam	4	1	3							
	Zimbabwe	22				5	14			4	1 sample dual positive for SAT1 & SAT2
Totals		**2079**	**586**	**268**	**53**	**103**	**140**	**2**	**787**	**117**	

Appendix 2 - Vaccine matching studies undertaken by network partners during 2014

Vaccine efficacy is influenced by both vaccine potency and vaccine match and it is possible that a poor match may to some extent be compensated by high potency vaccines and by administering more than one dose at suitable intervals. The use of oil adjuvant is also expected to improve efficacy. Thus, a vaccine with a weak antigenic match to a field isolate, as determined by serology, may nevertheless afford some protection if it is of sufficiently high potency. Therefore, in the absence of a good match, or where the match is unknown, vaccines of high potency should preferably be used. The r_1 values shown below, represent the one way serological match between vaccine strain and field isolate, calculated from the comparative reactivity of an antiserum, raised against the vaccine in question, to the vaccine virus and the field isolate.

Key:

Matched with the vaccine
Borderline
Not matched with the vaccine

For VNT:

$r_1 \geq 0.3$ – suggest that there is a close relationship between field isolate and vaccine strain. A potent vaccine containing the vaccine strain is likely to confer protection

$r_1 \leq 0.3$ - suggest that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect.

For LB-ELISA:

$r_1 \geq 0.4$ – suggest that there is a close relationship between field isolate and vaccine strain. A potent vaccine containing the vaccine strain is likely to confer protection

$r_1 \leq 0.4$ - suggest that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect.

ARC-OVI, South Africa

Vaccine matching results from 2015

	BOT/1/06	KNP/196/91	SAR 9/81
BOT/1/06/1	1.00	0.60	0.26
KNP/196/91/1	0.72	1.00	0.63
ZAM/1/06/1	0.67	0.55	0.23
SAR/9/81/1	0.72	0.50	1.00
TAN/1/10/1	0.42	0.70	0.72
TAN/2/10/1	0.72	0.95	0.29
TAN/3/10/1	0.31	0.47	0.46
TAN/4/10/1	0.20	0.30	0.46
MOZ/1/13/1	1.11	0.43	0.74
MOZ/2/13/1	0.36	0.50	0.46
MOZ/3/13/1	0.31	0.26	0.57
MOZ/4/13/1	0.44	0.32	0.40
MOZ/5/13/1	0.63	0.33	0.32
MOZ/6/13/1	0.67	0.59	0.56
MOZ/7/13/1	0.41	0.35	0.63
MOZ/8/13/1	0.49	0.32	0.22
MOZ/9/13/1	0.01	0.02	0.02
MOZ/12/13/1	0.08	0.11	0.07
ZIM/1/13/1	0.25	0.24	0.23

	ZIM/7/83/2	KNP/19/89/2	SAR/304/2
ZIM 7/83/2	1.00	0.28	0.41
ZIM 14/90/2	0.24	0.33	0.79
KNP 19/89/2	0.22	1.00	0.56
SAR 3/04/2	0.18	0.25	1.00
MOZ/10/13/2	0.52	0.49	1.01
MOZ/11/13/2	0.03	0.02	0.12
ZAM/1/10/2	0.08	0.09	0.27

	SAR/1/06/3	KNP/10/90/3
SAR/1/06/3	1.00	0.87
BOT/6/98/3	0.69	0.30
KNP/10/90/3	0.87	1.00
MOZ/3/10/3	0.29	0.35
MOZ/4/10/3	0.61	0.40
MOZ/5/10/3	0.18	0.11
MOZ/13/13/3	0.12	0.08

FGI ARRIAH, Russia

Vaccine matching results from 2015

[N – Not Matched; M – Matched; Borderline – Borderline]

Name of Field isolate	Vaccine strain					
	A22	*A22 Iraq/64*	*A Iran/97*	*A/Turkey/06*	*A/Zabaikalsky/2013*	*A/Krasnodar/2013*
A/Zabaikalsky/2015	N	borderline	N	N	M	N
Central Asia	N	N	M	N	borderline	M

Name of Field isolate	Vaccine strain			
	O/Russia/2000	*O PanAsia2*	*O Russia/SEA/2010*	*O Russia/PanAsia/2012*
O/Mongolia,Khovd/2015	M	M	M	M

RRLSSA, Botswana

Country	Field virus isolate	Vaccine virus strain	r1- value[2]
Botswana	SAT1/BOT11/2015	SAT109	0.90
	SAT2/BOT15/2015	SAT251	0.49
		SAT2035	0.57
	SAT2/BOT21/2015	SAT251	0.73
Namibia	SAT2/NAM09/2015	SAT251	0.55
	SAT2/NAM20/2015	SAT251	0.48
	SAT1/NAM42/2015	SAT105	0.36
Zimbabwe	SAT2/ZIM17/2015	SAT251	0.82
		SAT2035	0.52

SENASA, Argentina

Assessment of O Ecuador strains from 2010 and 2011 outbreak

- Pooled Sera Tested

- Bovine sera vaccinated with monovalent vaccine O Campos 27 days post vaccination pool number 1-2011
- Bovine sera vaccinated with monovalent vaccine O Campos 27 days post vaccination pool number 3-2011
- Bovine sera vaccinated with monovalent vaccine O Ecuator 27 days post vaccination pool number 9-2013 – experimental vaccine

Homologous Strains	**Field Strains**	
O1/Campos	O/Ecuador/46-2010	O/ECUADOR/23-2010
	O/ECUADOR/03-2006	O/ECUADOR/36-2010
	O/ECUADOR/04-2006 (13)	O/ECUADOR/10-2010
	O/ECUADOR/20-2005 (13)	O/ECUADOR/15-2010

Assessment of O Paraguay strains from last outbreak 2011

- Pooled Sera Tested
  - Bovine sera vaccinated with monovalent vaccine O Campos 27 days post vaccination pool number 1-2011

Homologous Strains	**Field Strains**
O1/Campos	O/San Pedro/Paraguay 11-11

Test No	Strains tested	Tests repetitions	Total number of determinations
01-14	3	3	9
02-14	3	3	9
03-14	5	3	15
04-14	5	3	15
05-14	4	3	12
06-14	5	3	15
07-14	2	2	4
08-14	3	1	3

RRLSEA, Thailand

FMD Vaccine Matching of r-value range by LP ELISA test: 2015 (Antigenic characterizationby LPBE)

Country	Total	FMD Type A					
		A118/87		A/Sakolnakorn/97		A/Lopburi/2012	
		0.2-0.39 Poor/Moderate match	*0.4-1.0* Good match	*0.2-0.39* Poor/Moderate match	*0.4-1.0* Good match	*0.2-0.39* Poor/Moderate match	*0.4-1.0* Good match
Cambodia	1	-	-	-	1	-	1
LAO PDR	5	-	-	-	-	-	5
Thailand	13	-	-	-	10	-	13
Vietnam	20	-	-	-	13	1	10

Country	Total	FMD Type O/Udonthani 189/87					
		0-0.19 Poor Matching		0.2-0.39 Moderate matching		0.4-1.0 Good matching	
Cambodia	2	-	-	-	-	-	2
LAO PDR	4	-	-	-	-	-	4
Myanmar	7	-	-	-	-	-	7
Thailand	58	-	-	-	-	-	36

LVRI, People's Republic of China

Producer	Vaccine	vaccine strain/Type A	PD_{50}
A	FMD A-O-Asia1 trivalent vaccine	Re-A/WH/09	13.97
B	FMD A-O-Asia1 trivalent vaccine	Re-A/WH/09	11.84
C	FMD A-O-Asia1 trivalent vaccine	AF72	13.59
D	FMD A-O bivalent vaccine	AF72	11.84
E	FMD A-O-Asia1 trivalent vaccine	AKT-III	13.97
challenge with A/GDMM/2013, $BID_{50}=10^{-8.0}$ 10,000 BID50			

Vaccine strain O/Mya98/BY/2010 can protect the type O viruses, collected in China in 2010-2014

PDFMD, India

Vaccine matching results from 2015

	SerotypeO/IND/R2/1975	SeortypeAsia1/IND63/1972
Number of isolates	31	4

WRLFMD, UK

Vaccine matching results from 2015

Serotype O	Topotype	O 3039	O Mansia	O SKR/7/10**	O TAW/98	O TUR/5/09	O IND R2/75 BVS1	O IND R2/75 BVS2	O Russia/00
HKN/1/2015	CATHAY	N	N			N	N	N	M
HKN/2/2015	CATHAY	N	N			N	N	N	M
TAN/4/2014	EA-2	M	N			M			
TAN/6/2014	EA-2	M	N			M			
EGY/23/2014	EA-3	N	N			M			
EGY/36/2014	EA-3	M	N			M			
ETH/3/2015	EA-3	M	N			M			
AFG/2/2014	ME-SA	M	M			M			
AFG/9/2014	ME-SA	B	B			M			
BAR/14/2015	ME-SA	B	N			M			
BAR/8/2015	ME-SA	M	N			M			
PAK/11/2015	ME-SA	M	B			M			
PAK/29/2014	ME-SA	N	N			N			
PAK/40/2014	ME-SA	M	B			M			
PAK/5/2015	ME-SA	B	N			M			
VIT/11/2014	ME-SA	M	N	M		M			
MOR/1/2015	ME-SA/ Ind-2001	M	N			M			
MOR/2/2015	ME-SA/ Ind-2001	M	B			M			
MOG/2/2015	SEA	M	N			M	M	M	
MOG/4/2015	SEA	M	N			M			
SKR/13/2014*		M	N	M	M	M			
SKR/14/2014	SEA	M	N	M	N	M	N	N	
SKR/15/2014*		M	N	M	M	M			
SKR/16/2014	SEA	M	N	M	B	M			
SKR/18/2014	SEA	M	N	M	M	M			
SKR/19/2014*		M	B	M	M	M			
VIT/26/2014	SEA	M	N	M		M			

* These isolates provided by Merial Animal Health from the shipment sent to The Pirbright Institute

** This test used a closely related field strain, not the homologous vaccine strain

Serotype A	Topotype	A Iran 05	A22 IRQ	A TUR/ 20/06	A MAY 97	A SAU 95	A IRN 87	A IRN 96	A IRN 99
IRN/12/2015	ASIA	N	N	N	N	N			
IRN/8/2015	ASIA	N	N	N	N	N			
PAK/10/2015	ASIA	M	N	N					
PAK/12/2015	ASIA	M	M	N					
PAK/13/2015	ASIA	M	N	N					
PAK/16/2015	ASIA	N	M	N					
PAK/21/2015	ASIA	N	M	B					
SAU/1/2015	ASIA	N	N	N	N	N	N	N	N
SAU/2/2015	ASIA	N	N	N	N	N	N	N	N
VIT/14/2014	ASIA	N	M	N	N				
VIT/8/2014	ASIA	N	M	N	N				
PAK/3/2014	ME-SA	N	N	N					

Serotype Asia-1	Topotype	Asia-1 Shamir
AFG/4/2014	ASIA	N
PAK/1/2015	ASIA	N
PAK/35/2014	ASIA	N

Serotype SAT1	Topotype	SAT 105 RHO
TAN/13/2014	I (NWZ)	M
TAN/22/2014	I (NWZ)	M
BOT/1/2015	III (WZ)	M
BOT/2/2015	III (WZ)	M
BOT/4/2014	III (WZ)	M

Serotype SAT2	Topotype	SAT 2 ERI	SAT 2 ZIM
MOZ/2/2014	I	B	M
MOZ/4/2014	I	M	M
ZIM/3/2014	I	M	M
ZIM/1/2014	II	M	M
BOT/1/2013	III	N	N
EGY/24/2014	VII	M	N
EGY/43/2012	VII	M	N
ETH/2/2015	VII	M	M
ETH/22/2014	VII	M	N
OMN/4/2015	VII	M	N

NAHDIC, Ethiopia

Vaccine matching results from 2015

Field Isolate	Vaccine strain				
	O3039	*O Manisa*	*O/Thur/5/ 2009*	*SAT 2 ERI*	*SAT 2 ZIM*
O/ETH/3/20015	0.85	0.25	>1		
SAT2/ETH//2015				0.44	0.23
SAT2/ETH/22/2014				>1	0.51

ŞAP Institute , Turkey

Vaccine matching results from 2015

	Asia1 Shamir	Asia1 TUR11	Asia1 TUR 14
As1/Elaz/10/2015	N	M	M

Appendix 3 - Nucleotide sequence analysis

FMDV nucleotide sequence data for phylogenetic analysis (547 sequences which include some complete viral capsids sequences* and complete genomes†)

Laboratory	Sample source	O	A	Asia-1	SAT1	SAT2	SAT3
Belgium	Nigeria	In progress	In progress		In progress	In progress	
Botswana	Botswana				3	12	
	Mozambique					1	
	Namibia				12	9	
	Niger	10					
	Zambia					5	
	Zimbabwe					13	
China	China	11	23				
	China	2	2				
Italy	Algeria	2					
	Egypt	8	2				
	Tunisia	12		4			
Russia	Central Asia		1				
	Mongolia	10					
	Russia		1				
South Africa	Mozambique					1	
	Namibia					1	
South America	Venezuela‡						
Thailand	Cambodia	3	6				
	LAO PDR	7	3				
	Myanmar	12	3				
	Thailand	92	27				
	Vietnam	1	19				
UK	Afghanistan	12	3	4			
	Bahrain	9					
	Botswana				2		
	Cambodia	2	2				
	Egypt	8	2				
	Ethiopia	4					
	Hong Kong	5					
	Iran		2				
	Laos	4	1				
	Mauritania					4	
	Mongolia	4					
	Morocco	3					
	Mozambique					1	
	Myanmar	2	3				
	Namibia				1	5	
	Niger	1					

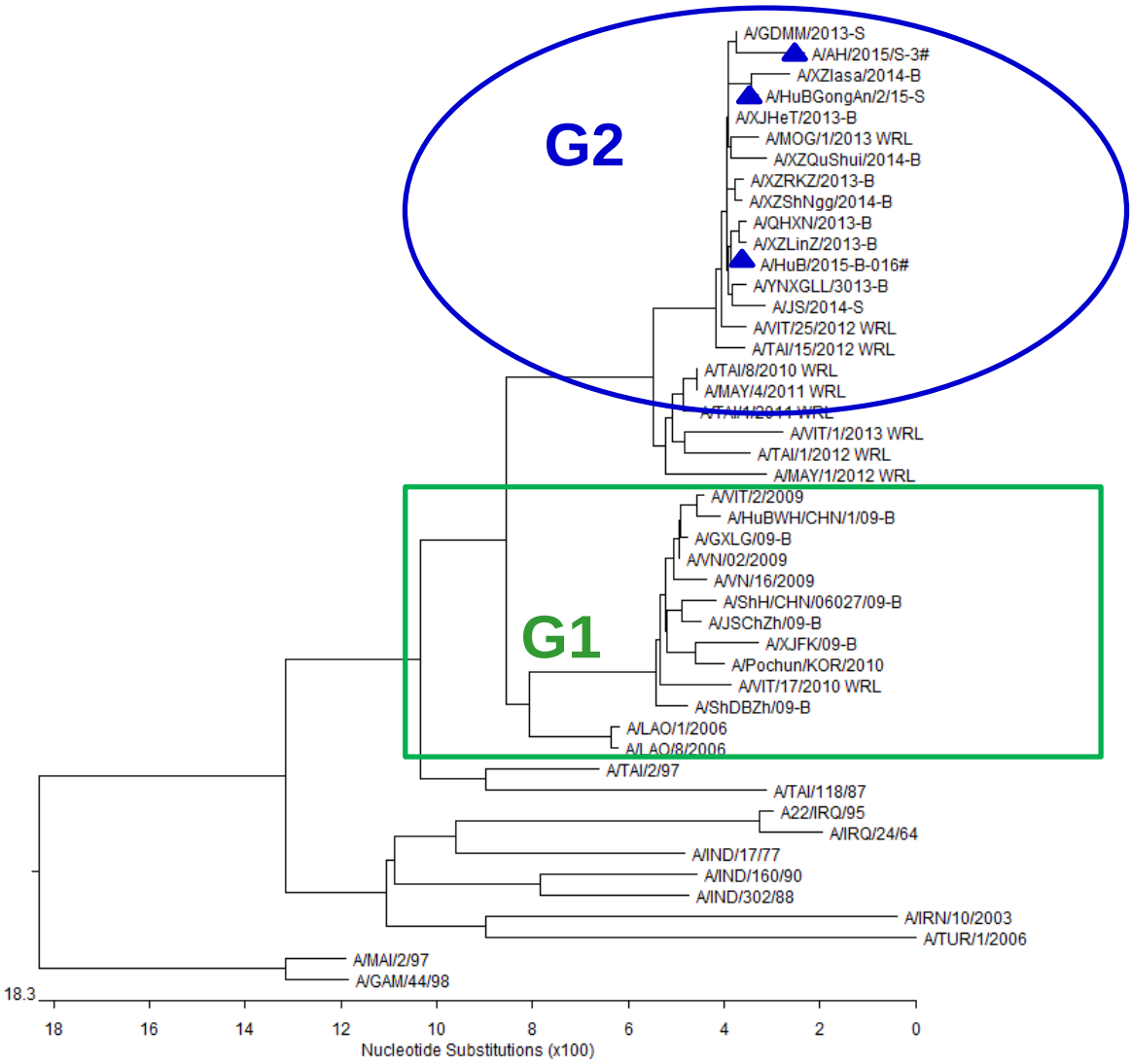
Laboratory	Sample source	O	A	Asia-1	SAT1	SAT2	SAT3
	Oman					3	
	Pakistan	4	18	6			
	Saudi Arabia		4				
	South Korea	4					
	Taiwan		1				
	Tanzania	8			29		
	Thailand	8	16				
	Turkey	4	15	7			
	Vietnam	1	3				
	Zimbabwe				4	12	
TOTAL		**253**	**157**	**21**	**51**	**65**	**0**

†Complete genome sequences were reported from Italy (12 serotype O from Tunisia), China (2 serotype O and 2 serotype A from China).

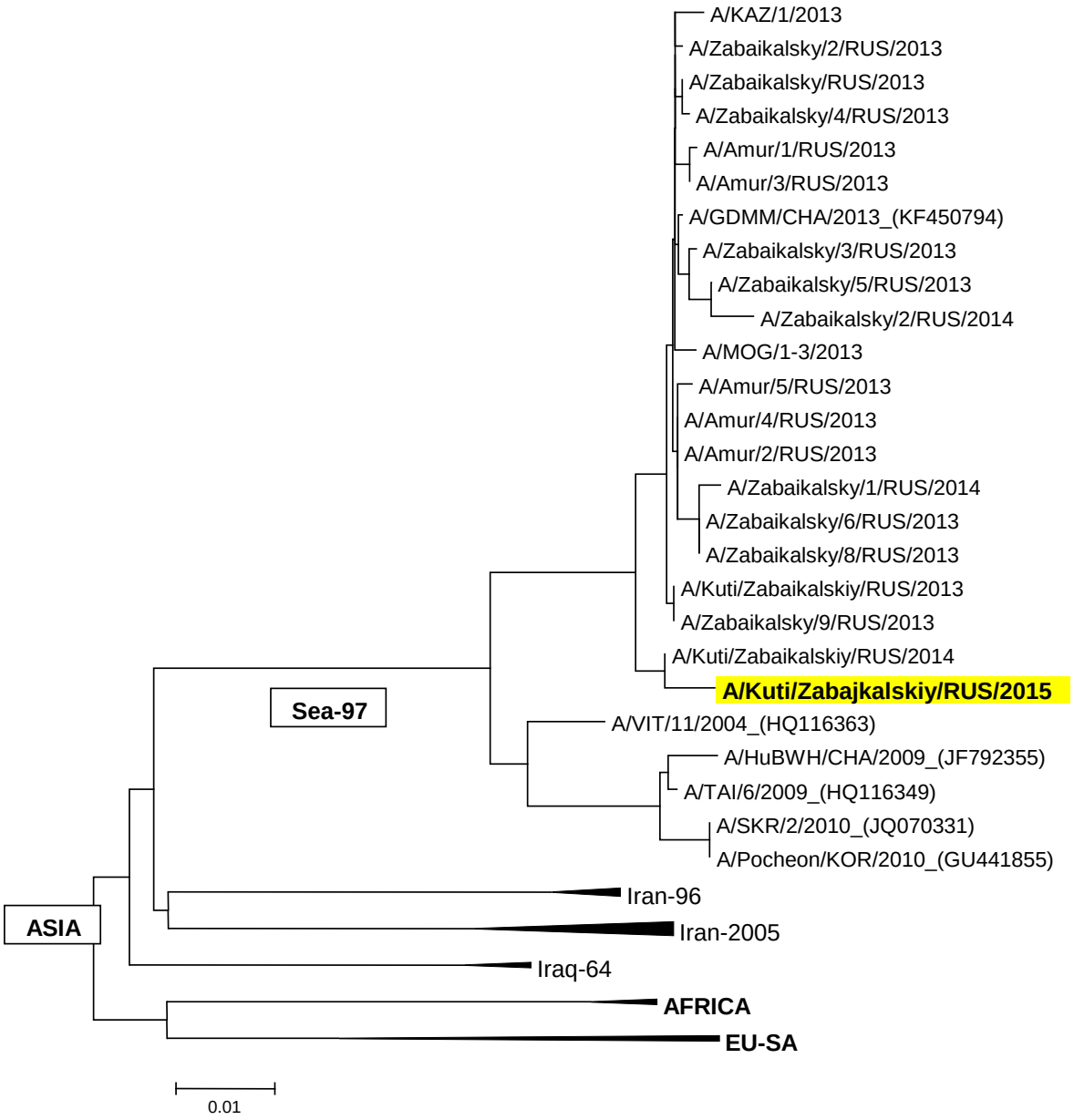
‡The samples from Venezuela were positive for VSV New Jersey and were submitted for Protein P coding region sequencing.

Appendix 4 - Selected Phylogenetic trees

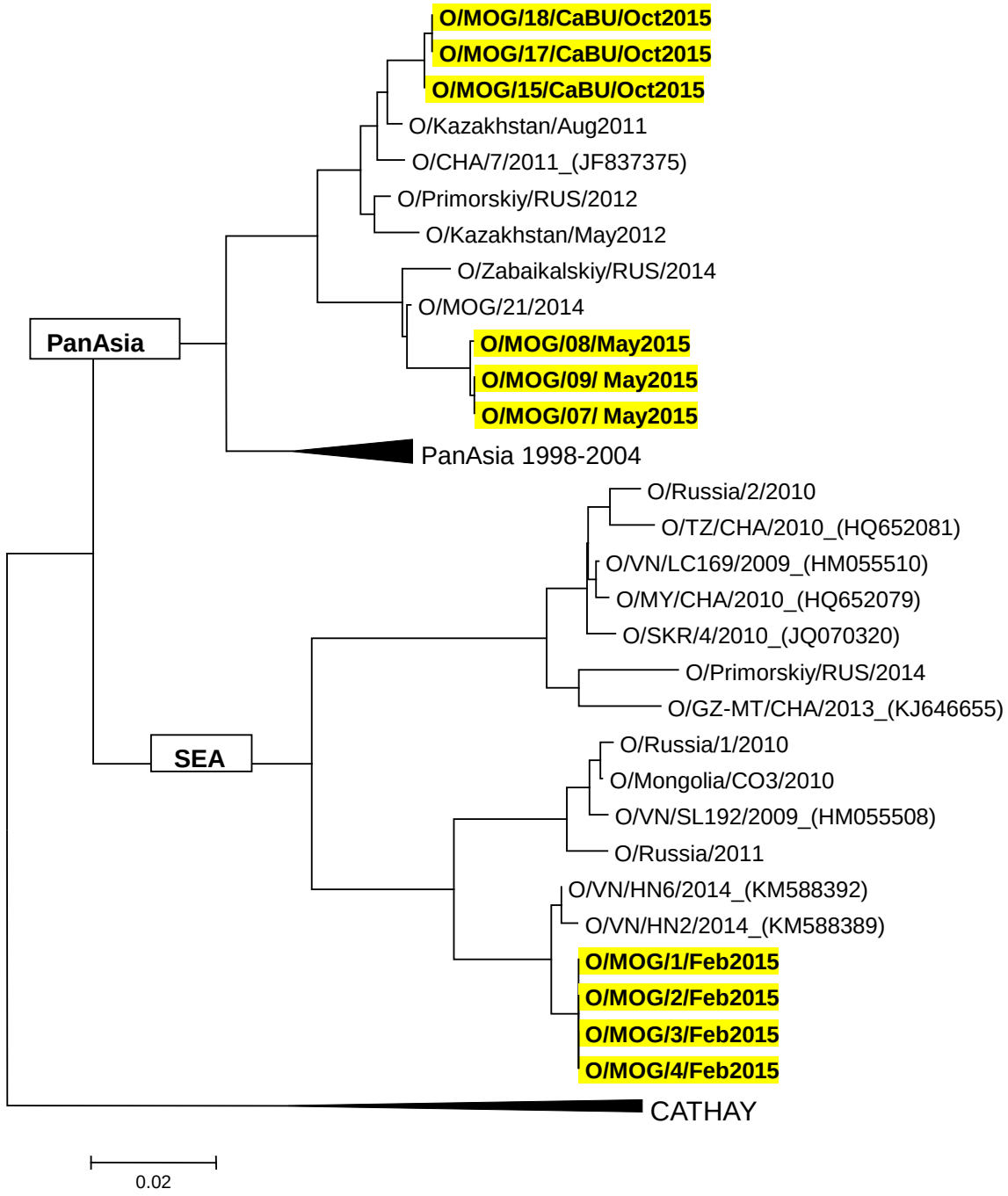
Detailed sequencing reports can be found at :
http://www.wrlfmd.org/fmd_genotyping/index.html



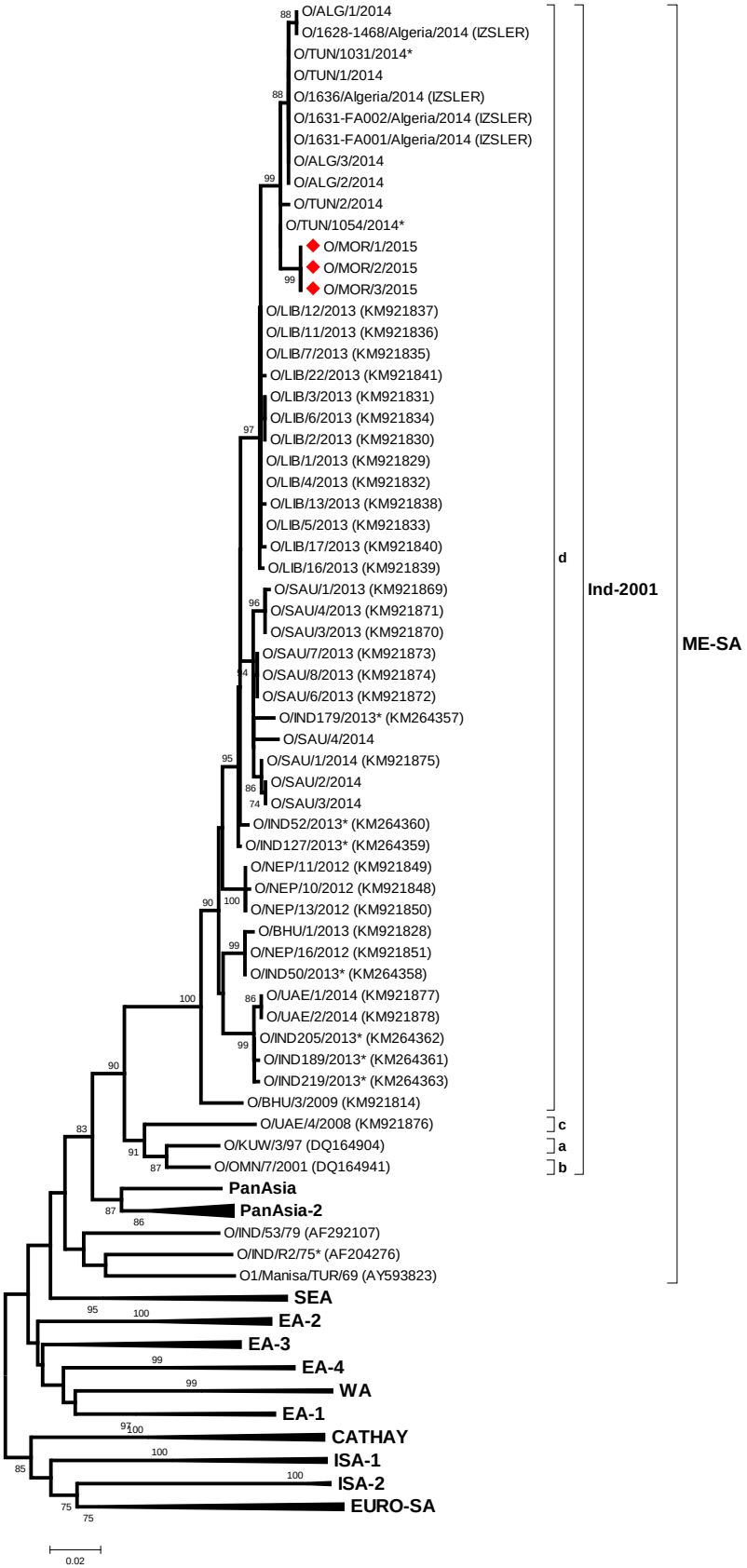
Appendix 4.1: A/ASIA/Sea-97 analysis (LVRI)



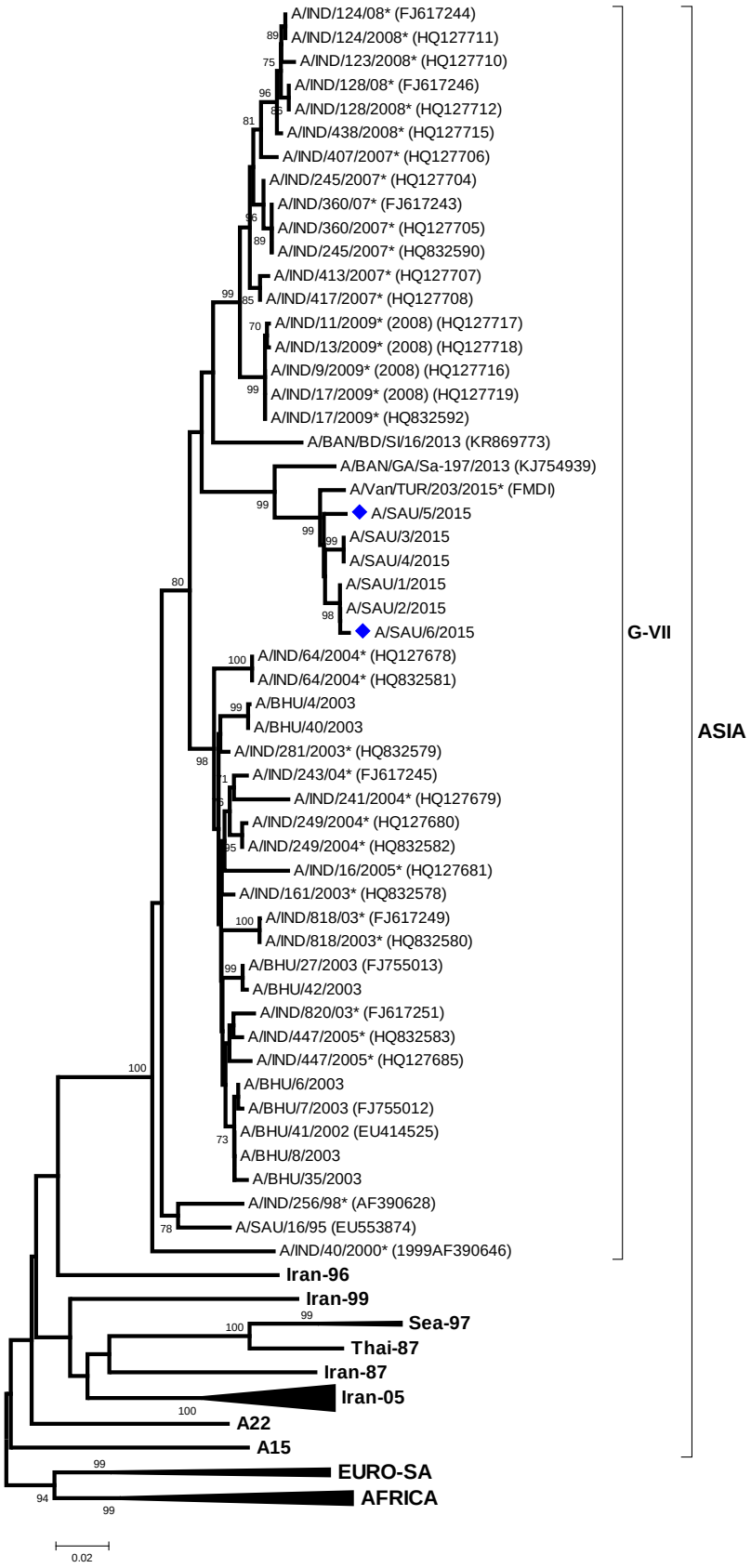
Appendix 4.2: A/ASIA/Sea-97 analysis (ARRIAH)



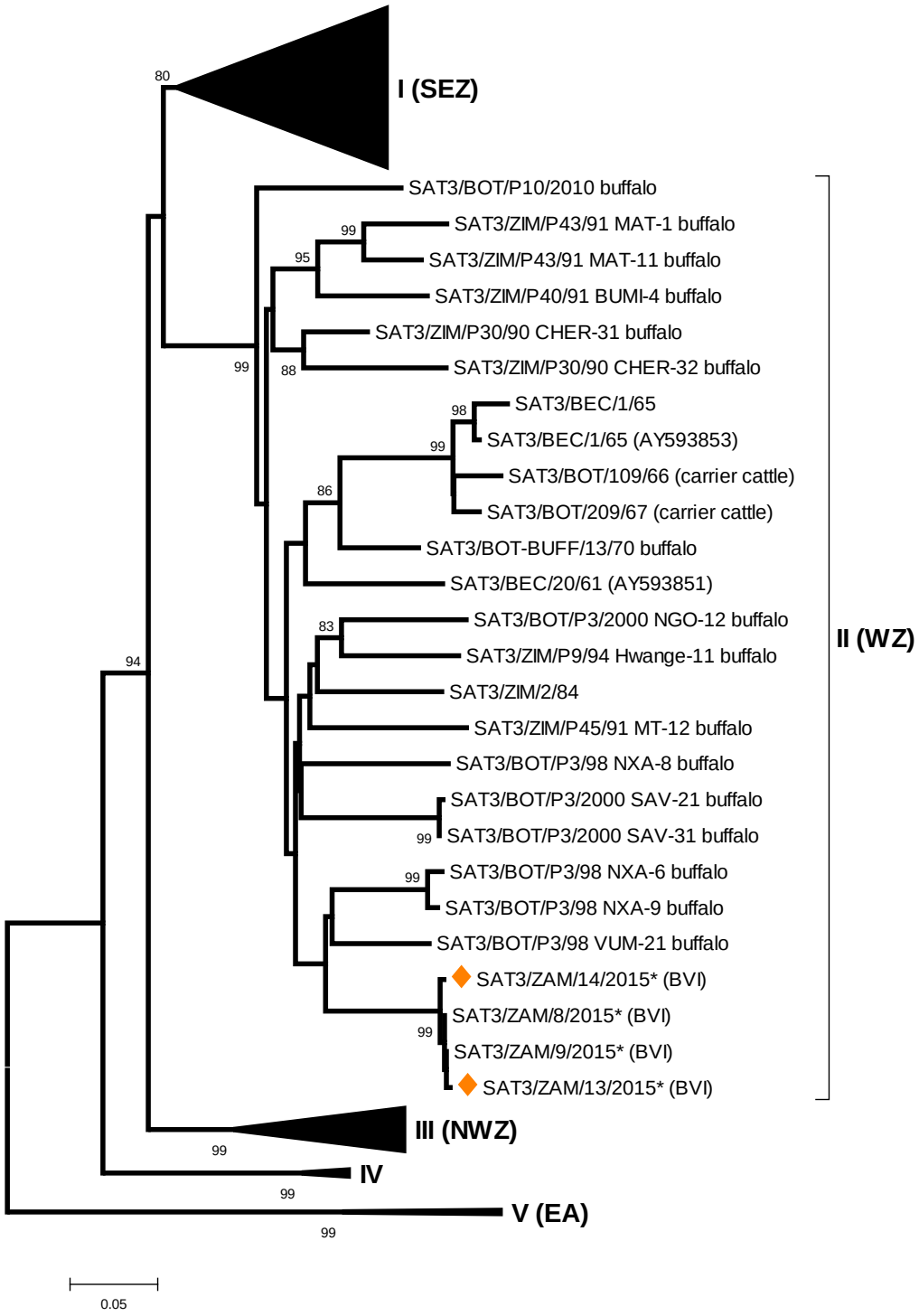
Appendix 4.3: Serotype O analyses for samples from Mongolia (ARRIAH)



Appendix 4.4: Serotype O outbreaks in Morocco (WRLFMD)



Appendix 4.5: Serotype A (A/ASIA/G-VII) outbreaks in the Middle East (WRLFMD and Şap Institute, Turkey)



Appendix 4.6: Serotype SAT 3 outbreaks in Zambia (WRLFMD and BVI)

Appendix 5 - Report from the 10th OIE/FAO FMD Laboratory Network Meeting. Brussels, Belgium: 24th – 26th November 2015

Presentations by delegates:

- An introductory welcome and overview of CODA-CERVA was provided by Dr Thierry van den Berg (Director of Viral Diseases) on the theme *"There is nothing permanent except change" Heraclitus*
- Global situation for FMD (Data from WRLFMD, presented by Dr Don King):

  This presentation reviewed the latest global information for FMD, particularly focussing on the spread of the O/ME-SA/Ind-2001 lineage in North Africa and the Middle East, and the detection by WRLFMD of a new serotype A lineage from the Indian sub-continent in Saudi Arabia. Recent serotype SAT 2 outbreaks in Mauritania and the Gulf States (Oman) were also described which further demonstrate the dynamic situation regarding the current global patterns of FMD distribution. The circulation of these new viral lineages raises obvious questions about suitable vaccines that might be deployed for control, and reinforces the importance of a global FMD Network to share laboratory data that monitor FMD outbreaks in different endemic settings.

Summary of regional and country updates

- Southeast Asia (from RRLSEA Pakchong presented by Dr Pranee Rodtian):

  During 2015, a total of 522 samples have been received by RRLSEA from Thailand and other countries in Southeast Asia. Results from these samples indicate that the prevailing FMDV lineages that are circulating in the region include O/SEA/Mya-98, O/ME-SA/PanAsia and A/ASIA/Sea-97. Initial ag-ELISA data for two samples collected in Cambodia suggests that serotype Asia-1 may also be circulating for the first time in the country since 2000 [this serotype has not been detected anywhere in the region since 2008]; however, sequence data is required to confirm this observation. Vaccine matching data for locally produced vaccines was presented showing a good match for serotype O field strains with O/Udonthani 189/87, and most serotype A viruses with A/Lopburi/2012. An overview of the results from an annual PTS organized by

RRLSEA-Pakchong was also presented with participants from 9 countries in the region. RRLSEA has also provided practical training to a Myanamese and two Australian scientists.

- China and East Asia (from LVRI, Lanzhou presented by Dr Jijun He)

  The results of samples collected recently in China were presented. Serotype A (A/ASIA/Sea-97) has been detected in clinical specimens collected from 3 outbreaks in the country (Anhui and Hubei (x2) Provinces), in contrast to previous years where both O and A have been found. These serotype A outbreaks have involved pigs which may represent a change in the FMD epidemiology. The source of FMD in China has been attributed to uncontrolled (illegal) animal movements from neighbouring countries. Wider FMD surveillance in the country has tested 3728 oropharyngeal fluid and tissue specimens by RT-PCR and detected serotype A in 11 samples. This work is supported by FMDV serology where >10k sera have been screened using LPB and 3ABC ELISAs to detect SP and NSP antibodies, respectively. Dr He summarized vaccine-matching data for vaccine strains produced in China, in addition to the results of local PTS exercises and international exchanges that have been undertaken by LVRI staff during 2015.
- Asia (from FGBI-ARRIAH presented by Dr Don King on behalf of Dr Alexey Mischenko):

  Colleagues from the FMD Reference Laboratory in Vladimir, Russia were unable to attend the meeting, but provided results for 76 clinical samples that have been tested during 2015. One sample collected from Zabajkalskiy, in eastern Russia was positive for serotype A (A/ASIA/Sea-97), while 6/12 specimens received from three separate areas in Mongolia contained serotype O (O/ME-SA/PanAsia [two separate sub-lineages] and O/SEA/Mya-98). Sequence data for a further FMDV-positive sample received from central Asia (country not defined) was characterised as belonging to the HER-1 sub-lineage of A/ASIA/Iran-05, closely related to sequences previously obtained from Kyrgyzstan in 2014. Vaccine matching data was presented for FMDV vaccines (serotypes O and A) manufactured in Russia. FGBI-ARRIAH has coordinated a PTS exercise for 6 countries (Armenia, Belarus, Moldova, Kazakhstan, Kyrgyzstan and Tajikistan) and has provided practical training to Kazakhstan.
- Asia (from CSIRO, Australia presented by Dr Wilna Vosloo):

  Dr Vosloo provided an overview of recent studies that have evaluated the performance of vaccines included in most vaccine banks to protect against FMD viruses (serotypes O, A and Asia-1) that are circulating in Pool 1 (Southeast Asia). In order to better understand the changing antigenic profiles of field isolates of serotype A collected at RRLSEA, r-values have been determined and analysis of B-cell epitopes has been undertaken to highlight amino acid substitutions in VP1 that are proposed to impact upon viral phenotype driven by vaccine immunity. This presentation also reviewed the findings from a series of in-vivo challenge experiments in cattle and sheep using high-potency A-May-97 and A22-Iraq vaccines. Potency trials undertaken with monovalent O-Manisa vaccine and challenge with O/SEA/Mya-98 (SKR/2010) was also presented indicating that the vaccine will protect at 21 dpv but is not likely to be so effective at earlier times after vaccination. Results for a study in sheep using Asia-1 Shamir

vaccine and challenge (via intranasal-pharyngeal instillation) with a Sindh-08 field virus demonstrated protection at 7 and 21 dpv.

- South Asia (from ICAR PD-FMD presented by Dr Don King on behalf of Dr Pattnaik):

  Colleagues from PD-FMD were unable to attend the meeting but submitted a presentation that summarised test results for India, where serotype O (O/ME-SA/Ind-2001) has dominated the sample submissions in 2014-15. Epidemiological and serosurveillance data was also included in the presentation highlighting where FMD is most frequently occurring in India.
- Turkey (from Şap Institute presented by Dr Fuat Özyöruk):

  During 2015, the FMD Institute in Ankara, Turkey has tested 205 samples collected across the country representing serotypes O, A and Asia-1. Undoubtedly the most significant epidemiological event during 2015 has surrounded the detection of a new serotype A lineage that has emerged from the Indian sub-continent. A new phylogenetic tree with 4 new Turkish isolates (from Van [x3] and Bitlis) was presented showing their relationship to another recent FMDV isolate from Saudi Arabia. Data was also presented to indicate that in-house and IZSLER ag-ELISAs are able to detect viruses from this lineage. For serotype O, sequence data tentatively characterises isolates collected during 2015 within the FAR-09 sub-lineage of the O/ME-SA/PanAsia-2 strain, while Asia-1 isolates collected during 2015 represent two discrete genetic clusters within the Sindh-08 lineage. Unfortunately, the regional WELNET is currently proving not to be an effective forum to share data between countries.
- North Africa (from IZSLER presented by Dr Emi Brocchi):

  IZSLER has established collaboration and cooperation initiatives with countries in North Africa including Algeria, Tunisia, Libya and Egypt. During 2015, samples received from Egypt (n=10) were characterised as serotype O (O/EA-3) and A (A/ASIA/Iran-05^{BAR-08}). Interestingly for three of these samples, both serotype O and A could be isolated depending upon the cell line used (LFBK selected O, while IBRS-2 and BHK-21 selected A). In collaboration with ANSES, full genome data has been generated for 12 FMDVs (O/ME-SA/Ind-2001) collected from Tunisia (see below). Further serological work has been undertaken to support the use of vaccines to protect against O/ME-SA/Ind-2001 including vaccine potency tests, as well as field vaccination studies (in Tunisia) that have attempted to predict the efficacy of O-BFS vaccine. Results indicate that O-BFS is able to elicit a strong and rapid booster/recall response in cattle and sheep previously vaccinated with O-Maghreb/O-Manisa. In naïve animals, single vaccination with O-BFS induced seroconversion, but a proportion of sheep (30%) and cattle (15%) did not achieve antibody levels indicative of heterologous protection. IZSLER has coordinated a PT exercise for 3 Balkan countries (Bulgaria, Macedonia and Serbia) to evaluate serological ELISAs and virological assays.
- North Africa (from ANSES presented by Dr Don King on behalf of Dr Labib Bakkali Kassimi):

  Unfortunately, Dr Bakkali Kassimi Labib was unable to attend the meeting and sent his apologies on behalf of ANSES which has been recently recognised as an OIE Reference Laboratory for FMD. During 2015, samples (n=54) have been received from Tunisia and tested by ANSES. Twenty-one FMD virus isolates

have been generated. Training on FMD diagnostic methods has been provided to Morocco and a delegate from ANSES has participated in a workshop in Tunisia.

- East Africa (from Embakasi presented by Dr Abraham Sangula):

  Serotypes O, A, SAT 1 and SAT 2 have been detected in recent samples (n=101) collected from Kenya, while recent Ugandan samples (n=34) comprised serotype O and SAT 1 [sequence data is pending for all these samples]. Locally produced vaccines (from KEVEVAPI) include K77/78 (for O/EA1), K5/80 (for A/AFRICA/GI), T155/71 (for SAT 1/NWZ) and K52/84 (for SAT 2/IV). A brief overview of collaborative projects was provided.

- Ethiopia (from NAHDIC presented by Dr Daniel Gizaw):

  During 2015, 83 samples have been collected from outbreaks in Ethiopia and characterised at NAHDIC by Ag-ELISA (supported by additional testing and sequencing at OIE/FAO Reference Laboratories). FMDV serotypes O (O/EA-3) and SAT 2 (SAT 2/VII/Alx-12) have been detected (serotype A has not been detected during 2015). Wider surveillance indicates that seroprevalence in small ruminants is 9.2%, while 11.5% of cattle samples (n=6469) were FMDV antibody positive using the 3ABC NSP ELISA. NAHDIC have just started a new 3-year OIE Twinning Project with the Pirbright Institute that aims to improve diagnostic capability.

- Nigeria (from NVRI presented by Dr Wungak Yiltawe):

  A brief overview of work to build a new BSL-3 laboratory at NVRI was presented. This new facility will house the FMD diagnostic and research laboratory as well as work with other highly infectious diseases. In addition to the OIE twinning project with CODA-CERVA (described below), NVRI is undertaking a project to develop improved FMDV vaccines that are tailored for use in Nigeria funded by the West African Agricultural Productivity Project (WAAPP). During 2015, 22 samples from domesticated livestock have been tested and typed using Ag-ELISA [sequence analysis is pending]. Serological analysis of wildlife (eland, wildebeest and waterbuck) was been performed: preliminary analysis reveals the presence of antibodies to serotypes O, A, SAT 1 and SAT2.

- Nigeria (OIE Twinning Project):

  A study to investigate the epidemiology of FMD in Nigeria has been carried out by investigating the ~30% of NSP-positive cases in non-vaccinated cattle and sheep (in the Kachia grazing reserve). These positive samples were tested by SPCE, which showed that the dominant serotype was O followed by A. Many sera generated antibody positive results for multiple serotypes and rRT-PCR analysis of probang samples was able to detect FMDV, although no viruses were isolated.

- Senegal (from LISRA-LNERV presented by Dr Mariame Diop):

  There is currently no virus isolation facility or capacity to carry out sequencing at the FMD Reference Laboratory in Senegal and only a small number (n=2, serotype A) of sample submissions have been received during 2015. Retrospective analysis indicates that serotypes O and A are responsible for 37% and 51% of FMD outbreaks, respectively [~12% are currently untyped]. A

collaborative project with ANSES is on-going which aims to deploy and evaluate molecular detection systems in Senegal.

- Sub-Saharan Africa (from BVI-SSARRL presented by Dr George Matlho):

  This presentation summarised the results for 159 samples sent to BVI during 2015 from 7 countries (Botswana, Mozambique, Namibia, Niger, Uganda, Zambia and Zimbabwe). Recent FMD outbreaks in north-west Botswana have been due to SAT 1, which is a change from previous years where SAT 2 has dominated. Elsewhere, both SAT 1 and SAT 2 have been implicated in recent FMD outbreaks in Namibia. In October 2015, new outbreaks in western Zambia were due to serotype SAT3 which poses new risks to the region. Vaccine matching results were presented for BVI vaccines, which included data for a vaccine strain (SAT2035), which is used in combination with SAT251.

- Sub-Saharan Africa (from ARC-OVI presented by Dr Francois Maree):

  During 2015, samples (n=13) have been received from Mozambique (SAT 2), Namibia (SAT 2) and Swaziland (NVD). OVI also undertakes serological testing for export, suspected outbreaks, trials and wider surveillance in the region, and during 2015 has tested 2126 sera from Mozambique (n=47), Namibia (n=1857) and Swaziland (n=222), in addition to 13,545 sera tested from South Africa. An overview of work to improve the antigenic characterisation and vaccine matching of FMD viruses (serotypes SAT 1, SAT 2 and SAT 3) was presented and has highlighted gaps in the coverage of existing vaccines.

- South America (from PANAFTOSA presented by Dr Rossana Allende):

  Since no FMD has been reported in the continent, no samples have been received during 2015 for outbreak investigation. Ecuador has been recently recognised by the OIE as a country FMD-free with vaccination and the FMD control program in Venezuela has now been recognized by the OIE. A PT exercise has been coordinated during 2015 for FMDV and VSV typing by RT-PCR involving 13 participants.

- South America (from SENASA presented by Dr Andrea Pedemonte):

  Further to the presentation from PANAFTOSA, Dr Pedemonte described the situation in Argentina where five zones have been established: two that are FMD-free with vaccination, and three that are FMD-free without vaccination (including Valles de Calingasta and Patagonia Norte A which were granted the new FMD-free status in 2015). An overview of on-going research projects was also provided which include the development of a new generation of non-infectious capsid-based vaccines.

- USA (From NVSL-VS-STAS-APHIS FADDL presented by Dr Consuelo Carillo):

  Dr Carillo provided an update on the situation in the US regarding the recent emergence of Seneca Virus A/Seneca Valley Virus as a virus that can cause vesicular-like clinical signs in pigs. A similar pattern in pigs has also been seen in South America and Canada (reported by Dr Allende and Dr Nfon). Cases of vesicular disease due to VSV have also been reported in the US during 2015. A range of training courses for FMD have been offered including two International Transboundary Animal Disease (ITAD) courses to 56 participants.

Reports from the Network Working Groups

In response to discussions at last year's OIE/FAO FMD Laboratory Network meeting (Brescia), two working groups have been established to focus the expertise of the Network members specific issues relating to the control of FMD and laboratory analysis of field strains of FMDV. A summary of the progress made by these working groups was provided by the respective coordinating secretaries:

- Virus Nomenclature (presented by Dr Kasia Bankowska from WRLFMD)

  The aim of this working group is to address isolate, lineage and topotype nomenclature and to provide recommendations about coherent naming of FMD viruses. Members of this working group are: Francois Maree (OVI), Fuat Özyöruk (Şap), Wilna Vosloo (CSIRO), Nick Knowles (WRLFMD), Jitendra Biswal (PD-FMD), Jijun He (LVRI) and Alexei Scherbakov (ARRIAH – when he is able to attend). Four teleconferences have been arranged since July 2015, although it is recognised that there have been some technical and logistical difficulties to arrange the meetings so that all members are able to attend. The terms of reference and priorities of the group are to [1] To propose common nomenclature to be used to describe samples and sequences, [2] To define topotype nomenclature for all serotypes (including nucleotide sequence cut-offs for different serotypes), and [3] To explore formal approaches (such as establishing a standing Network sub-group committee) to oversee the naming of new FMD viral lineages. Progress on work to redefine a common topotype nomenclature for SAT viruses was presented, which has considered the degree of nucleotide identity between representative viruses. Two peer-reviewed publications are planned to outline this new proposed SAT nomenclature, as well as to publicise the role of this working group to oversee the naming of new FMD viral lineages.

- Vaccine recommendations for endemic countries (presented by Dr Anna Ludi from WRLFMD)

  This working group was also established in July 2015 and has 9 members: Alexey Mischenko (ARRIAH), David Paton (WRLFMD), Emiliana Brocchi (IZSLER), Gaurav Sharma (PD-FMD), George Matlho (BVI), Jijun He/Yanmin Li (LVRI), Kees Van Mannen (EuFMD), Kris De Clercq (CODA-CERVA) and Rossana Allende (PANAFTOSA). The group has held three meetings and will also explore alternative communication methods to improve participation from all the delegates. The goal of the working group is to prepare harmonized guidance for approaches that can be used to select FMDV vaccines (in endemic and FMD-free with vaccination settings). Broadly, this work can be broken-down into 4 activities: [1] Developing approaches and generation of new reagents to explore whether or not alternative serological approaches are more appropriate for vaccine matching recommendations in endemic settings where multivalent vaccines provided by local or international suppliers are employed. If so, the group should consider developing standardized laboratory methods and reagents for this purpose that can be rolled-out to members within the Network, [2] Inter-laboratory robustness of serological data: review data from previous PT

exercise with a view to publishing this data, [3] Calibration of different test approaches: plan a further practical study that can be used to harmonise in-vitro vaccine matching methods (VNT and LPBE) used in different laboratories within the Network, [4] Validation of methods: ensure this advice is supported by appropriate data from field and epidemiological studies. During 2015, new BVS (against Asia1 Shamir, A_{22} IRQ, A MAY/97, O Manisa, O 3039, SAT 2 Eritrea) has been prepared by WRLFMD for use by FMD Reference Laboratories. Further discussion will ensure coordination of reagent product with other Network partners (FADDL and IZSLER).

Acknowledgements:

The OIE and FAO were thanked for providing financial support for delegates to travel to the meeting, and the European Commission were acknowledged for providing support (via EuFMD) to WRLFMD. This meeting was kindly hosted by CODA-CERVA, Brussels, Belgium and the hospitality of Drs Kris De Clercq, David Lefebvre and colleagues in the face of the prevailing “difficulties in the city” was very much appreciated by the delegates. The OIE/FAO FMD Laboratory Network warmly thanked Dr Thomas Struckmeyer and Thermo Fisher Scientific for kindly hosting the evening meal. Thanks also go to Sarah Belgrave who provided assistance to organize this meeting at WRLFMD.

Special topic for discussion: <u>Serotype C</u>

A special session of the Network meeting considered the current status of FMDV serotype C. As reported previously by Network partners, this serotype has not been detected anywhere in the world since the last clinical samples representing this serotype were collected in 2004 (in Kenya and Brazil). Three invited presentations provided an overview the historical distribution of FMDV serotype C and recent serological data:

- Dr Aldo Dekker from CVI: *FMD serology for freedom of infection: absence of proof is not proof of absence*
- Dr Abraham Sangula from Embakasi (with Dr Graham Belsham - DTU): *FMDV serotype C in Kenya (1967-2004)*
- Dr Rossana Allende from PANAFTOSA: *FMDV serotype C history in South America*.

Discussion among the delegates considered the difficulties of interpreting serotype-specific serological data, and other epidemiological approaches that might be adopted to substantiate the “extinction” of this serotype.

<u>Draft recommendations arising from discussion between the Network partners:</u>

Research priorities to provide evidence that serotype C is no longer circulating

- Follow up investigation of serotype C serologically positive samples:
  - Investigate whether heterologous cross-reactivity (for other serotypes) can account for the signal detected in these positive samples
  - Consider whether or not the positive/negative cut-off adopted in serological tests (often based on “negative” sera from FMD-free settings) is appropriate for use to screen sera (collected in Africa)
  - Evaluate whether or not there is significant spatial or temporal clustering of serotype C positive samples which would indicate active circulation of FMDV
  - Where possible, undertake resampling and testing of animals (and other individuals within the epidemiological units) where serotype C-specific responses have been detected
- Develop serotype C-specific molecular tests for use to pro-actively screen samples collected from the field (particularly those where virus recovery might be challenging)

On the use of serotype C in vaccines

- In-vitro “live” virus work with serotype C should only be performed in facilities that conform to (EU or equivalent) minimum standards (BSL3+)
- In-vivo challenge (and potency tests) studies using serotype C should no longer continue
- Consideration be given to halting the production of serotype C vaccines
  Risk-based approaches should consider the continued use of serotype C in vaccines (in South America) and inclusion in vaccine antigen banks (FMD-free countries).

Formal meeting of OIE and FAO Reference Laboratories to discuss organisation and management of the Network:

Apologies from PD-FMD, ARRIAH and ANSES

10 year review of Network History and Membership: (presentation from Don King, WRLFMD)

Network goals

- Understanding global FMD virus distribution and patterns in order to identify threats and make vaccine recommendations
- Improving the quality of laboratory tests from international and national reference laboratories
- Building up local capability in support of regional control programmes

This Network arose from a meeting of the OIE Ad Hoc group of Antigen and Vaccine Banks (in Paris 2004) where it was decided to generate two forums to coordinate international activities: a vaccine bank network (now the IVSRN), and this FMD Reference Laboratory Network. Currently there are 14 core members, with two new members joining the network in 2015: ANSES (OIE) and Winnipeg (FAO). Attendance at the meeting by delegates from affiliate FMD laboratories is an essential component of the Network and provides an approach to ensure that the most relevant data is collected regarding FMD outbreaks and surveillance. A history of meetings held by the Network is outlined below:

2004: Paris
2005: Pirbright
2006: 1st Meeting in Florianopolis, Brazil
2007: 2nd Meeting in Gaborone, Botswana
2008: 3rd Meeting in Lanzhou, China
2009: 4th Meeting in Delhi, India
2010: 5th Meeting in Pirbright, UK
2011: 6th Meeting in Pirbright, UK
2012: 7th Meeting in Jerez, Spain
2013: 8th Meeting Bangkok, Thailand
2014: 9th Meeting Brescia, Italy
2015: 10th Meeting in Brussels, Belgium

Memorandum of Understanding (MoU)

It was agreed that this document is central to the philosophy of the Network: however, in the past only a few laboratories have formally signed this agreement. In some respects, the current lack of a formal agreement limits the open exchange of unpublished data between partners. The previously drafted document was reviewed by all of the partners that attended the meeting and there was broad agreement that the text appeared to be still relevant and fit-for-purpose.

ACTION (by April 2016): All partners agreed to send a draft version of this document to their Institutional Administrators, with the view to get an opinion of whether are any obstacles that might prevent signing of this document. If any changes are required these will be provide back to the partners. The goal is to prepare a final draft by July 2016, for circulation to all partners by October 2016. This document has been circulated by email – please contact Don King (donald.king@pirbright.ac.uk) if you need a copy.

Draft Work Plan for 2016

1: Continued activities of the OIE/FAO FMD Laboratory Network:

- With assistance from OIE and FAO, the network will obtain and analyse samples from under-sampled endemic pools (particularly West and Central Africa and central Asia)
- Network partners will provide a central resource of expertise and advice regarding FMD control, vaccines and diagnostics
- The network will continue to explore (and support) tools for real-time sharing of Laboratory data generated within the Network
    - Continue to engage with OIE and FAO regarding the design and implementation of tools to exchange sequence data
    - Local tools being developed at WRLFMD (VibaSys) will be circulated to partners when completed
- Core OIE and FAO Network partners to consider the organization of the network and opportunities to make it a more inclusive network to maximize data collected from the field

2: Continue the work of the Network Working Groups

- Virus nomenclature
- FMD vaccines and recommendations for vaccine matching

Anyone interested in joining these groups should contact Dr Anna Ludi or Dr Kasia Bankowska.

3: Communication:

- WRLFMD to coordinate the preparation of an Annual Report

  Agreed timelines for preparation of 2015 report: - Network partners to provide feedback on pools they work closely with. Network members to provide an update to WRLFMD for report (include final data for November and December 2015)
    - Final summaries: January 2016
    - Draft Report: February 2016
    - Report Published: March 2016
- WRLFMD to organise an Annual meeting (location to be agreed after discussion with OIE and FAO) – will be at the end of the year. Agreed that (where possible) this should be hosted by a member lab of the network
- WRLFMD to host new website outlining Network activities:
    - Feedback and suggestions from partners are welcome
    - Website will contain “Public” and “Private” areas
    - Links to institutional websites and GFRA
- Proposal to enhance real-time exchange of data between partners, possibly in each of the pools – communicate new virus strains in real-time or other information; or quarterly conference call; link with EUFMD update monthly report (calendar to have specific times to write/edit for each lab). However, this will not require another report. [Dr Rossana Allende agreed to look at ways that this might be accomplished]

4: Formal agreement

- OIE/FAO Reference laboratories agreed to review the formal MoU that covers work of the Network and data exchange between partners
    - March 2016 – comments on draft and suggested revisions
    - July 2016 – prepare final draft
    - October 2016 – circulate document or signatures

Meeting Delegates:

Name	Email address
Abraham Sangula	aksangula@gmail.com
Aldo Dekker	aldo.dekker@wur.nl
Andrea Raquel Pedemonte	apedemon@senasa.gov.ar
Andy Haegeman	Andy.Haegeman@coda-cerva.be
Anna Ludi	anna.ludi@pirbright.ac.uk
Annebel De Vleeschauwer	Annebel.DeVleeschauwer@coda-cerva.be
Charles Nfon	Charles.nfon@inspection.gc.ca
Consuelo Carillo	consuelo.carrillo@aphis.usda.gov
Daniel Gizaw Demississie	nebiyudan@gmail.com
David Ehizibolo	kingdavid_e@yahoo.com
David Lefebvre	David.Lefebvre@coda-cerva.be
Donald King	donald.king@pirbright.ac.uk
Emi Brocchi	emiliana.brocchi@izsler.it
Ewa Camara	Ewa.CAMARA@ec.europa.eu
Francois Maree	mareef@arc.agric.za
Fuat Özyöruk	fuato@sap.gov.tr; fuat2004@gmail.com
Guo Jianhong	guojianhong@caas.cn
Jijun He	hejijun1979@163.com
Kasia Bankowska	kasia.bankowska@pirbright.ac.uk
Kees Van Maanen	Cornelius.VanMaanen@fao.org
Kris De Clercq	krdec@coda-cerva.be
Maria Teresa Scicluna	maria.scicluna@fao.org
Mariame Diop	madiopsoda@gmail.com
Min Kyung Park	m.park@oie.int
Mpolokang Elliot Fana	efana@bvi.co.bw
Onkabetse George Matlho	gmatlho@bvi.co.bw
Pranee Rodtian	pranee.rodtian@gmail.com
Romphruke Udon	romphrukeudon@yahoo.com
Rossana Allende	rallende@paho.org
Santina Grazioli	santina.grazioli@izsler.it
Somjai Kamolsiripichaiporn	somjaik@dld.go.th
Ularamu Husseini	ularamuhussaini@yahoo.co.uk
Wilna Wosloo	Wilna.Vosloo@csiro.au
Wungak Yiltawe	yiltex2@yahoo.com