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

Annual Report 2014

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 2014 - 31st December 2014

1.3 Collated input from

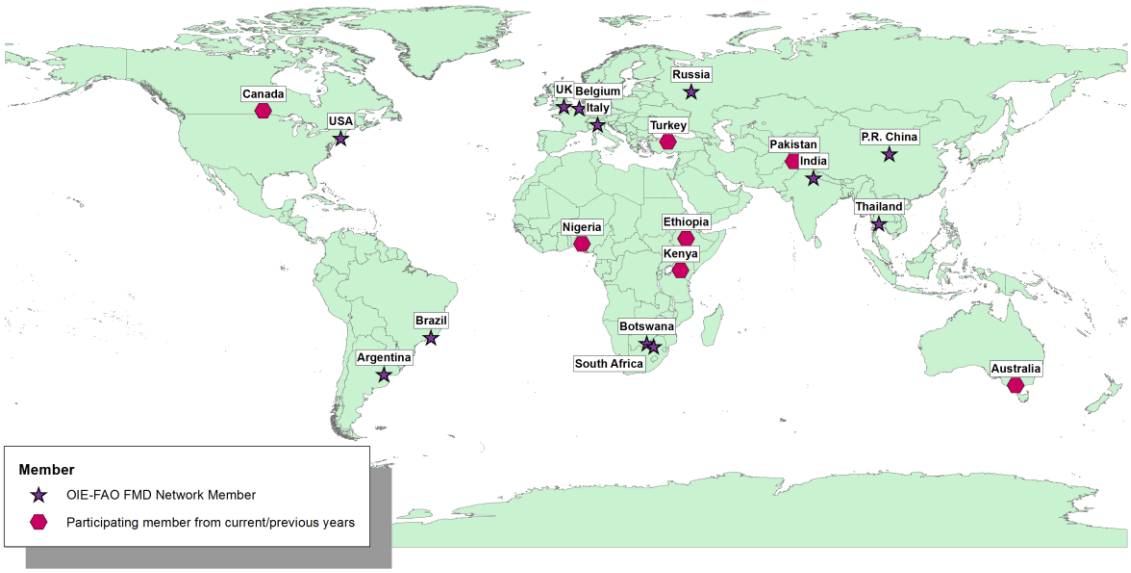


Figure 1-1: Participating laboratories

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

FAO World Reference Laboratory and OIE Reference Laboratory for FMD (WRLFMD)

The Pirbright Institute, Pirbright, 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

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

Winnipeg, Manitoba, Canada

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 2014 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 propensity and opportunities for spread of FMDV into new regions, comparisons of genomic sequences of viruses submitted over many years do show a tendency for similar viruses to recur in the same parts of the world and this presumably reflects 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	Eur-Asia
Pool 4	Eastern Africa
Pool 5	Western Africa
Pool 6	Southern Africa
Pool 7	South America

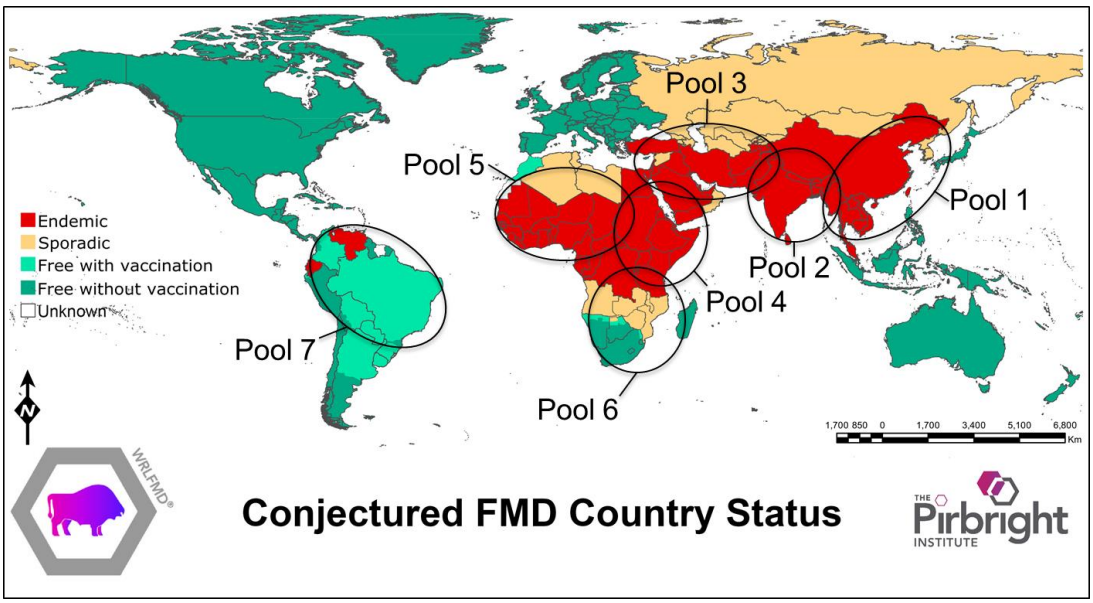


Figure 2.1: Distribution of the seven endemic pools of FMD showing conjectured status of FMD in countries. Virus circulation and evolution within these regional virus pools results in changing priorities for appropriately adapted vaccines. Periodically, viruses spread between pools and to free regions, 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. Note that Paraguay is now FMD-free with vaccination.

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 2014

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 2014, 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 are summarised in Figure 1.2: for reported FMD outbreaks in East and Central Asia (China, DPR Korea, Kyrgyzstan, Mongolia, Russia and Republic of Korea), North Africa (Libya, Tunisia and Algeria) and Southern Africa (Botswana, Namibia, Mozambique, South Africa and Zimbabwe). Additional disease outbreaks in countries in the FMD endemic pools have also been reported to OIE during 2014 (data collated in Table 2-1).

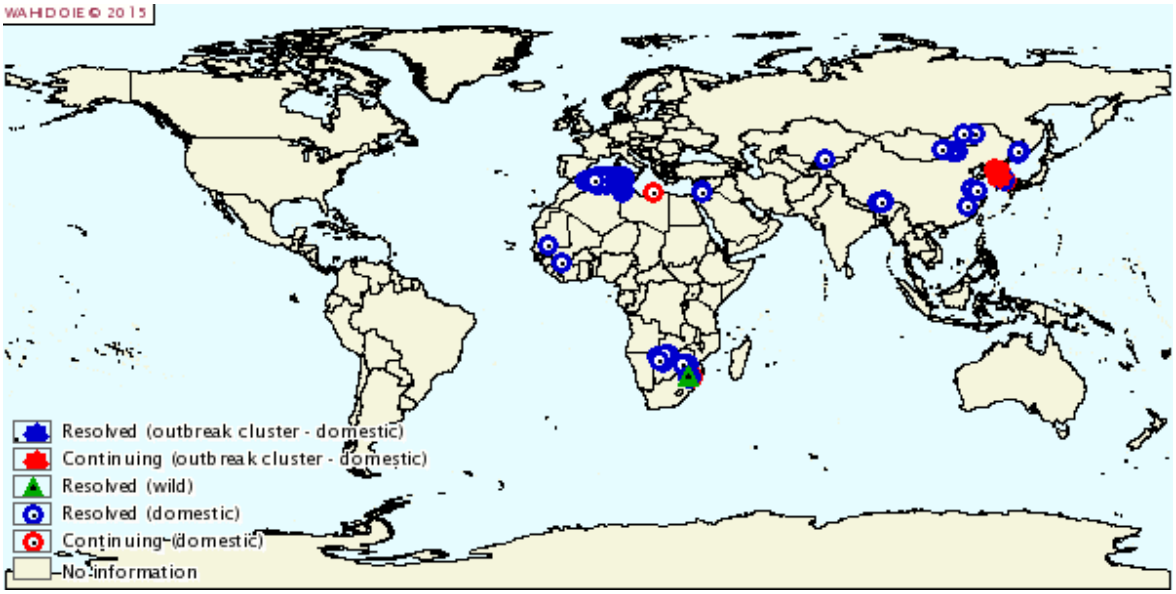


Figure 2-2: Map indicating the location of significant epidemiological events and disease outbreaks reported to OIE in immediate notifications or follow-up reports in 2014 (map generated on WAHID on www.oie.int).

Table 2-1: New FMD outbreaks reported to OIE during 2014 (data retrieved from WAHID on www.oie.int at the end of March 2015). 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			3	154	44	21	9	26	33		4	2	296
Algeria	0						42	375	2				419
Benin	11	7	6			3	3		12	13	9	8	72
Bhutan	19						4						23
Botswana						1		1		1		1	4
Burkina Faso	1	1	2		2	1	42	57	23	34	28	2	193
Cambodia	2	1		3	13	16	9	14		1	1		60
Congo (Dem. Rep. of the)	2						2						4
Cote D'Ivoire	3						2						5
Egypt	13	10	10	9	7	4		3	5	3	10		74
Eritrea			2										2
Ethiopia	7						14						21
Ghana			3								2	1	6
Guinea		2					0						2
Guinea-Bissau	0						1						1
Hong Kong (SAR - PRC)		2	1		1						1	1	6
India	76	57	31	18	7	5	10	5	8	10	4	7	238
Iran	1259						482						1741
Iraq							4	1	1	2	1	1	10
Israel	2												2
Kenya	34	16	9	6	7	13	16	10	19	21	18	4	173
Malaysia		+()	+()		+()	+()							+()
Mali		1		1				2	1		1		6
Mozambique	0						2	4					6
Nepal	8	4	3	2	2	1	4	4	6	5	3	1	43
Niger	18						27						45
Nigeria	1					1		1			1	2	6
Palestinian Auton. Territories	9	11	8	3	4	1			2		2		40
Qatar	3						2						5
Russia	1	2			7				1				11
Senegal	1						2						3
Somalia	23						20						43
South Africa	2					2							4
South Sudan										6			6
Sri Lanka	12	28	35	14	52	54							195
Sudan	2	1				1					1	1	6
Tanzania			1		1	3		1	8	2	2		18
Thailand	26	20	12	12	20	12	10	22	10	21	21	14	200
Togo	3	3			1		2				5		14
Tunisia				15	52	32	15	14	13	1			142
Turkey	44	39	48	48	27	10	11	5	3	12	3	3	253
Uganda	2					2	7	2	1			1	15
United Arab Emirates	1						0						1
Venezuela	?						?						
Vietnam	4	3	1	10			9	1	1	5	9	15	58
Zimbabwe				3		1	4	2	2		49	26	87

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 2014, and it is now more than two 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 2014

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

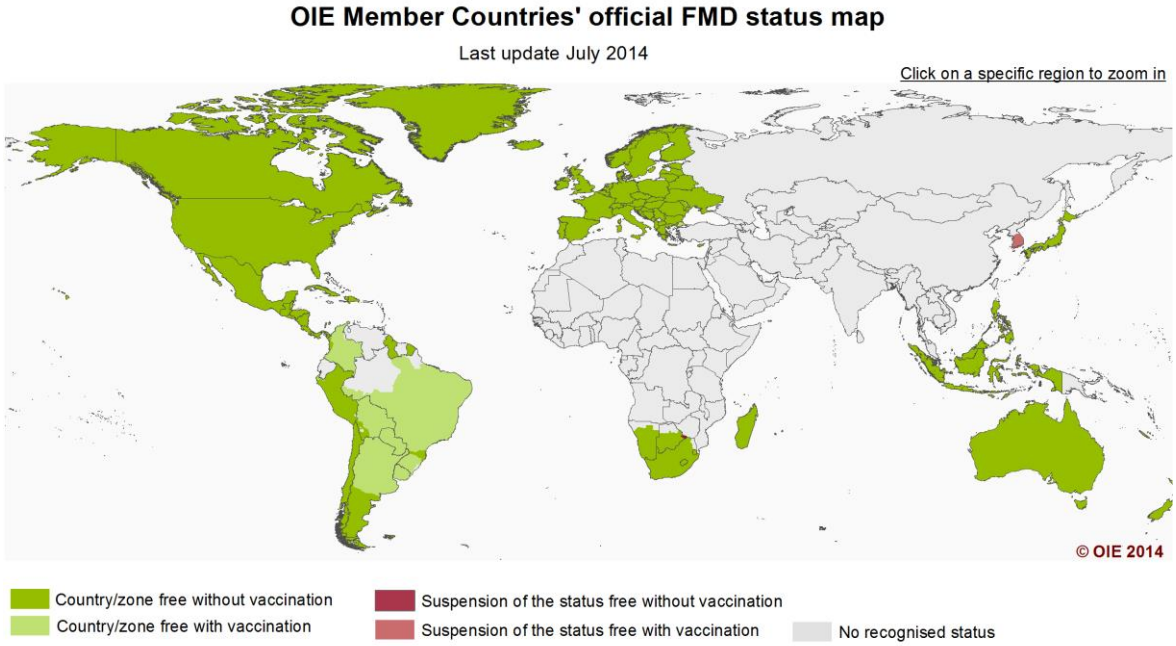


Figure 2-3: Official FMD status for OIE member countries. Data provided from the OIE: http://www.oie.int/en/animal-health-in-the-world/official-disease-status/fmd/en-fmd-carte/

2.3 Overview of the activities of the OIE/FAO FMD Laboratory Network during 2014

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.

3240 clinical samples from suspect cases of FMD were tested by laboratories in the Network (and associated labs) during 2014. These samples were collected from 51 countries in Africa and Asia (Figure 2.7) in 6 out of the 7 FMD endemic pools. 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.

During 2013 only 34% of samples (that were FMD virus positive and characterised using laboratory methods) were of serotype O and in contrast to previous years serotype A was the most frequently detected serotype (51% of characterised samples). This pattern was reversed in 2014 (Figure 2.5), and in common with most of the historical data, serotype O has now regained its status as the predominant global FMDV serotype.

Serotype C has not been detected since 2004 when the last cases due to the serotype were recognised in Kenya and Brazil.

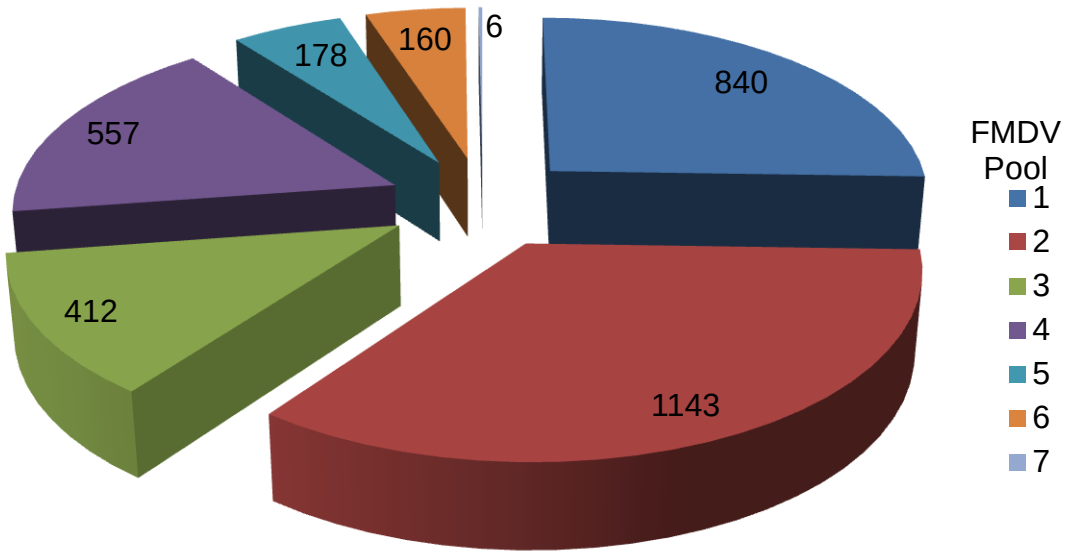


Figure 2-4: Samples (n=3245) tested for FMD investigation (virology) by the OIE/FAO FMD Laboratory Network from FMD endemic countries only during 2014 and their distribution across the seven FMD endemic pools

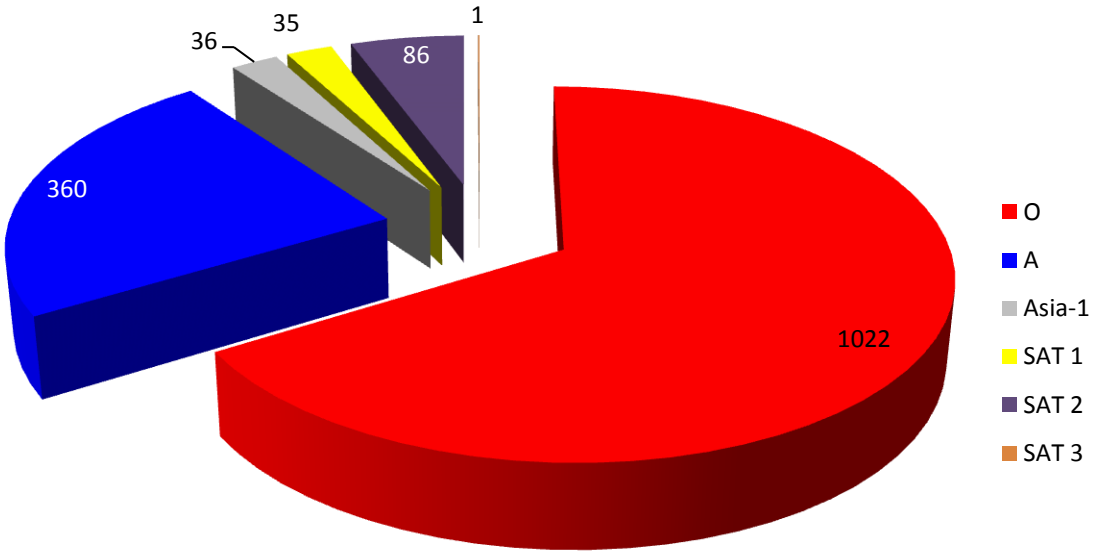


Figure 2-5: Summary of results for characterised isolates from FMD endemic countries were reported by the Network during 2014.

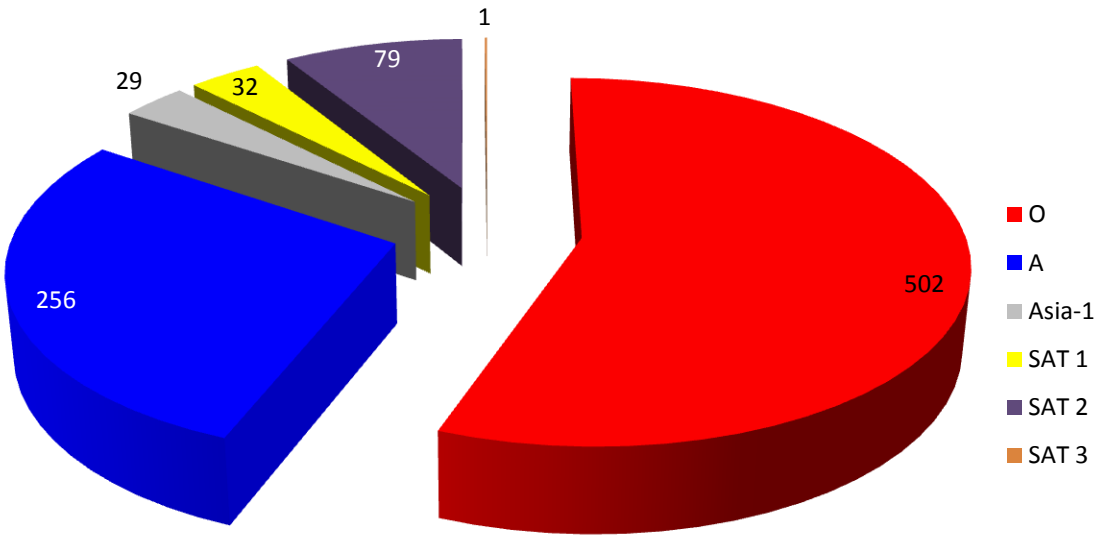


Figure 2-6: Summary of 869 samples (viruses and field isolates) that were sequenced (VP1/capsid/complete genome) during 2014 (see Appendix 3).

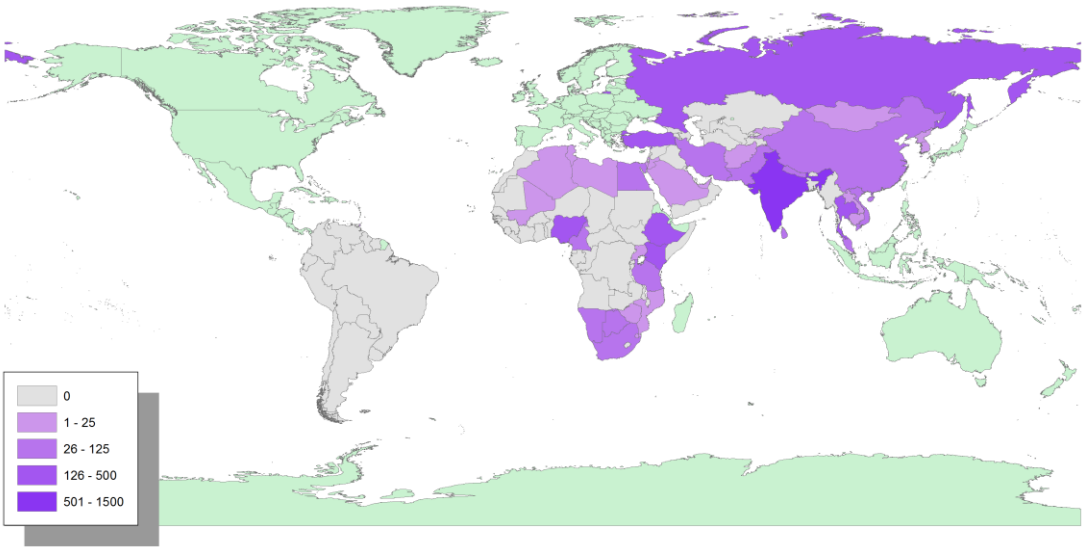


Figure 2-7: Distribution of samples collected from FMD endemic countries (highlighted in purple) and tested by the OIE/FAO FMD Laboratory network during 2014.

The results for the individual samples are reported below. 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.

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	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

2.5 Network activities in each of the regional endemic pools

2.5.1 Pool 1 Regional synopsis

FMD is endemic in Southeast Asia where the SEACFMD Campaign has adopted and is implementing a roadmap to control and eradicate the disease (http://www.rr-asia.oie.int/activities/sub-regional-programme/stanz/seacfmd/).

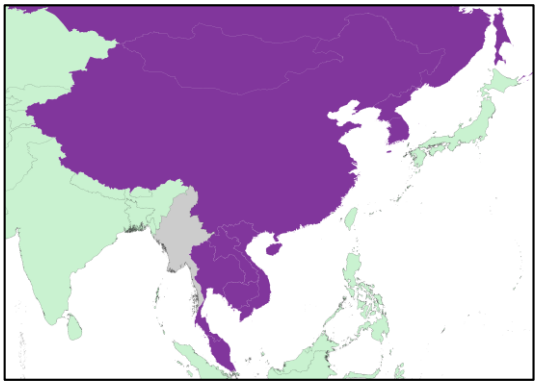


Figure 2-8: Countries within Pool 1 (in grey) that have provided samples to FMD reference centres during 2014 (in purple).

Within mainland Southeast Asia, FMD samples have been received and characterised from Cambodia, Lao PR, Thailand and Vietnam. VP1 sequence data provides evidence for the circulation of a new lineage within serotype A (a sub-lineage of A/ASIA/Sea-97 previously recognised by FMD Reference Laboratories for samples received from the region in 2013 [Appendix 3a-1]), while serotype O sequences are all O/SEA/Mya-98. No field isolates representing serotype Asia-1 have been detected in mainland Southeast Asia since 2006 (Vietnam). However, since 2009 the OIE/FAO FMD Laboratory Network has been monitoring the emergence and circulation of 3 FMD viral lineages (O/SEA/Mya-98, O/ME-SA/PanAsia and A/ASIA/Sea-97) into countries in East Asia. During 2014, new FMD outbreaks have been reported in East Asian countries such as China, DPR Korea, Mongolia, Russia and the Republic of Korea. Field samples from PR China have been characterized as either serotype O [Appendix 3a-2], or serotype A [Appendix 3a-3], while samples from DPR Korea were serotype O (porcine origin) or comprised mixed serotypes O and A (cattle origin). Sequences for serotypes O (O/SEA/Mya-98) and A (A/ASIA/Sea-97) appear to represent new FMD virus sub-lineages in China, and results from an active surveillance programme have identified additional FMD virus and antibody cases indicative of wider circulation in a number of Chinese provinces. FMD outbreaks (serotypes O and A [Appendix 3a-4]) in Russia have occurred at three locations along the southern border with Mongolia and China, and a 30km buffer zone has been established along the southern border where all ruminants (cattle and sheep) are vaccinated. The challenges posed by FMD control in the region are highlighted by outbreaks in the Republic of Korea. During 2014, two series of outbreaks probably due to separate virus introductions (in July and December 2014) have affected the country providing an indication about the extent to which FMDV is circulating in the region [Appendix 3a-5]. Furthermore, these most recent outbreaks (mainly

in pigs) have occurred in spite of vaccination raising concerns about antigenic match of vaccines as well as the deployment of these tools to control FMD.

Conjectured circulating FMD viral lineages in Pool 1 during 2014:

- Serotype O: O/SEA/Mya-98, O/ME-SA/PanAsia, O/CATHAY
- Serotype A: A/ASIA/Sea-97
- Serotype Asia-1 (not detected in the region since 2005 (Myanmar) and 2006 (Vietnam, P.R. China)

Laboratory	Countries of Origin	Number of Samples	
		Clinical Field Cases	Surveillance Activities
OIE RRL Lanzhou	China, North Korea	42	4744
FGBI ARRIAH	Mongolia, Russia	277	
OIE RRL Pakchong	Cambodia, Lao PDR, Thailand	377	15968
WRLFMD	Cambodia, Hong Kong, Lao DPR, Malaysia, Mongolia, South Korea, Thailand, Vietnam	144	

Table 2-3: Overview of samples collected and tested from pool 1 during 2014

Vaccine recommendations:

- 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), and 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

Pool 2 represents the Indian sub-continent where specific lineages of three serotypes (O, A and Asia-1) normally circulate. However, FMDV serotype O is now dominant in the region accounting for 97.5% of the total specimen submissions into the Indian FMD Reference Laboratory (PD-FMD, Mukteswar) over the past two years. Almost all of these samples comprise representatives of the O/ME-SA/Ind-2001 lineage (sub-lineage d [Appendix 3a-6]), which has recently displaced the O/ME-SA/PanAsia lineage that was previously found in this endemic pool. This pattern is mirrored elsewhere in the region (based on reports in Nepal [2008, 2010, 2012-14] and Bhutan [2009, 2013]) and in Sri Lanka where this emerging O/ME-SA/Ind2001 lineage has been detected for the first time in during 2014. This lineage has occasionally spread westwards causing limited outbreaks, e.g. Jordan in 1995, Israel in 1996, Bahrain, Kuwait, Saudi Arabia and the United Arab Emirates (UAE) in 1997, Bahrain, Oman, Saudi Arabia and the UAE in 2001, Palestinian Autonomous Territories and Israel in 2002, the UAE in 2008-2009 and Iran in 2009. The recent trans-regional spread of this lineage is described below in the sections for Pool 3 (Saudi Arabia, UAE) and Pool 4 (North Africa).

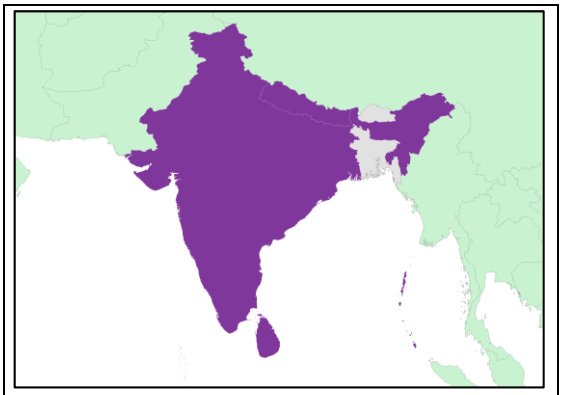


Figure 2-9: Countries within Pool 2 (in grey) that have provided samples to FMD reference centres during 2014 (in purple).

Conjectured circulating FMD viral lineages in Pool 2 during 2014:

- O/ME-SA/Ind-2001 (the O/ME-SA/Ind-2011 lineage that emerged during 2011 has not been recognised during 2012-13)
- O/ME-SA/PanAsia-2 (last detected in 2011 in Sri Lanka)
- A/ASIA/IND (genotype 18)
- Asia-1 (lineage C subdivided into Eastern and Western clusters)

Table 2-4: Overview of samples collected and tested from pool 2 during 2014

Laboratory	Countries of Origin	Number of Samples	
		Clinical Field Cases	Surveillance Activities
PD-FMD	India, Nepal	1035	
WRLFMD	Nepal, Sri Lanka	108	

Vaccine recommendations:

- Locally produced vaccines (by Indian suppliers): O/IND/R2/1975, A/IND/40/2000 and Asia1/IND/63/1972
- 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).

2.5.3 Pool 3 Regional synopsis

A summary of the samples collected from the region is outlined in Table 2-5. The predominant established FMD virus lineages in this region are O/ME-SA/PanAsia-2, A/ASIA/Iran-05 and serotype Asia-1 (currently Sindh-08).

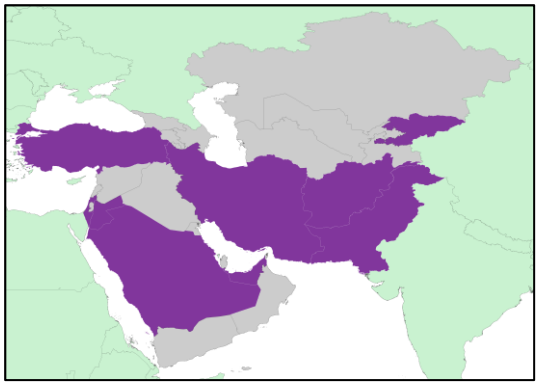


Figure 2-10: Countries within Pool 3 (in grey) that have provided samples to FMD reference centres during 2014 (in purple).

Genomic sequence data can be used to track the prevailing trans-boundary movements of these virus lineages, from countries in the east of the region (such as Pakistan and Afghanistan), through Iran, and into countries in the west of the region (such as Turkey). On occasion, some of these viral lineages have spread beyond West Eurasia to cause FMD outbreaks in North Africa (such in Egypt in 2007, 2011 [O/ME-SA/PanAsia-2] and 2010-11, 2013-14 [A/ASIA/Iran-05], and Libya in 2009 [A/ASIA/Iran-05], and 2010-12 [O/ME-SA/PanAsia-2]), in countries to the north (such as the ex-Soviet states where A/ASIA/Iran-05 strain has caused cases in Kyrgyzstan in 2014), and Europe (O/ME-SA/PanAsia-2 in Bulgaria in 2010-11). During 2013-14, the O/ME-SA/Ind2001 lineage from the Indian sub-continent has been detected in gazelles in Abu Dhabi (United Arab Emirates), as well as being continued to be detected in dairy farms in Saudi Arabia (2013-14) – see further details in Pools 2 and 4.

Across the region, our understanding of the fine-scale epidemiology of FMD is complicated by the presence of multiple sub-lineages (particularly for serotypes O and A) that co-circulate together. In Turkey, O/ME-SA/PanAsia-2 [FAR-09 sub-lineage], A/ASIA/Iran-05 [SIS-10 sub-lineage]) and sporadic cases due to Asia-1 [Sindh-08 lineage] have been reported, although the number of FMD outbreaks has declined sharply since July 2013 (particularly since spring 2014). Of these isolates collected in Turkey, poor neutralisation data for

representative A/ASIA/Iran-05 [SIS-10 sub-lineage] isolates using bovine vaccinal sera (BVS) for available international vaccines may provide an indication of the changing antigenic nature of FMD viruses in the region.

Conjectured circulating FMD viral lineages in Pool 3 during 2014:

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

Table 2-5: Overview of samples collected and tested from pool 3 during 2014

Laboratory	Countries of Origin	Number of Samples	
		Clinical Field Cases	Surveillance Activities
FGBI ARRIAH	Kyrgyzstan	5	
SAP Institute, Ankara	Turkey	270	13230
FADDL, USA	Jordan	6	
WRLFMD	Afghanistan, Bahrain, Iran, Israel, Saudi Arabia, Turkey, Pakistan, UAE	131	

Vaccine recommendations:

- 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
- ARRIAH: O/PanAsia-2, Asia-1 Shamir/89 and a recently produced vaccine for A/ASIA/Iran-05 in Russia: A/Krasnodarsky/RUS/2013 (for vaccine matching data see Appendix 2)
- Other suppliers in the region: SAP FMD Institute, Ankara, Turkey, JOVAC, Jordan, Iran and Egypt

2.5.4 Pool 4 Regional synopsis

Pool 4 represents a major crossroads linking the FMD endemic regions in sub-Saharan Africa, and countries in North Africa and West Eurasia (The Middle East). Within the region, four different FMD serotypes co-circulate and some viral lineages have restricted geographical distributions even within this pool.

Situation in North Africa:

Probably the most globally significant epidemiological event that has occurred during 2014 is the continued spread of the O/ME-SA/Ind2001 lineage in North Africa. This lineage is normally restricted in the Indian sub-continent (India, Nepal, Bhutan and Bangladesh and most recently in Sri Lanka – see details above in Pool 2). Following the first reports of FMD outbreaks due to this lineage in Libya in 2013, a series of outbreaks have occurred in Tunisia (134 outbreaks) and Algeria (418 outbreaks) during 2014 [Appendix 3a-7]. Both of these countries had been previously free of FMD since 2000 when incursions (serotype O [Mahgreb strain]) from West Africa had caused FMD outbreaks in both of these countries, as well as in Morocco. The OIE/FAO FMD Laboratory Network has provided diagnostic and technical training assistance in support of these outbreaks including work by IZSLER in Libya to test SP and NSP antibodies, and in Tunisia to demonstrate the potential of the O-BFS vaccine to generate a booster response in cattle and in sheep (following previous vaccination with O-Manisa/O-TUN/99).

Samples collected from other endemic countries in Pool 4 are reviewed in Table 2-6 and the complexity of the different conjectured FMD virus lineages that are circulating in the region are shown below. Research undertaken by the DANIDA funded project to investigate the epidemiology of FMD in Uganda has highlighted the presence of 5 FMDV serotypes (O, A, SAT 1, SAT 2 and SAT 3) in the last 2-3 years. The SAT 3 virus was detected in a long-horn Ankole calf translocated to the buffalo/cattle interface [Appendix 3a-8]. These studies defining the genetic diversity of FMD viruses from Uganda highlight the impracticalities of the current topotype definitions for some SAT viruses.

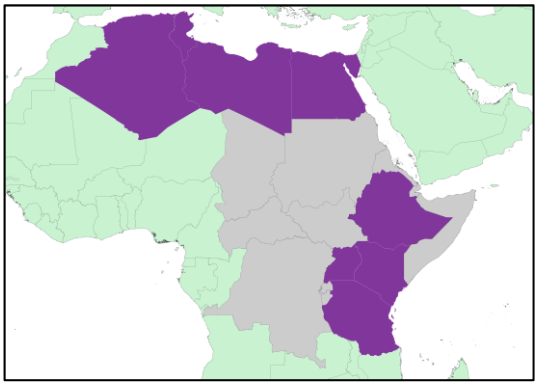


Figure 2-11: Countries within Pool 4 (in grey) that have provided samples to FMD reference centres during 2014 (in purple).

The Eastern Africa FMD Laboratory Network (EALN-FMD) encompasses 12 countries in the region The objectives of the EALN-FMD are (1) to improve the quality of FMD laboratory assays in Eastern Africa, (2) to complement activities of each individual country in fulfilling the objectives of the Progressive Control Pathway for FMD (PCP-FMD), (3) to understand global and regional FMDV circulation, and (4) undertake research and make recommendations on labs, vaccines and FMD control. Based on data from the Network, conjectured epidemiological patterns indicate that cases due to serotype O are increasing

in Kenya, Uganda and South Sudan, while serotypes A, SAT 1 and SAT 2 are more prevalent to the countries in the south of the region (including Tanzania).

Conjectured circulating FMD viral lineages in Pool 4 during 2014:

- O (topotypes EA-2 (Kenya, Tanzania, DR Congo, Uganda), EA-3 (Ethiopia, Eritrea, Sudan, Egypt) and EA-4 (Ethiopia, Kenya, Uganda):
- O/ME-SA/Sharqia-72 (detected in samples collected in Egypt in 2009)
- O/ME-SA/Ind2001 (in Libya, Tunisia and Algeria)
- A/AFRICA (genotypes I (Kenya, Tanzania, D.R. Congo), IV (Sudan, Eritrea, Egypt) and VII (Ethiopia, Egypt))
- A/ASIA/Iran-05 BAR-08 sub-lineage (Egypt)
- SAT 1 (topotypes I (Kenya, Tanzania) and IX (Ethiopia))
- SAT 2 (topotypes IV (Kenya, Tanzania), VII (Sudan, Egypt), XIII (Ethiopia, Sudan))
- SAT 3 (only detected in African buffalo in the south of the QENP, Uganda in 1970 & 1997 and recently in 2014)

Table 2-6: Overview of samples collected and tested from pool 4 during 2014

Laboratory	Countries of Origin	Number of Samples	
		Clinical Field Cases	Surveillance Activities
NAHDIC, Ethiopia	Ethiopia	86	1955
IZSLER	Libya, Tunisia, Algeria	29	3160
Kenya	Kenya, South Sudan, Uganda	274	2782
WRLFMD	Egypt, Ethiopia, Tanzania, Tunisia, Algeria	168	

Vaccine recommendations:

- 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 and SAT2 Kenya 52/84 and NVI (Ethiopia): O Ethiopia O 281, A Ethiopia A110 and BVI (Botswana).

2.5.5 Pool 5 Regional synopsis

FMD is endemic in the whole region covered by pool 5 and epizootic outbreaks are regularly observed, but rarely investigated. Closing this gap in surveillance has been prioritized by the OIE/FAO FMD Laboratory Network, and during 2014 specimens were sent from Nigeria, Cameroon and Mali for strain characterization. FMD virus isolates recovered from these samples were from serotypes O, A and SAT 2, although there is scope to improve local samples collection and transport procedures since poor sample preservation during shipment to the Network Laboratories limited the extend of some of these analyses. An OIE Twinning project which been initiated during 2014 between NVRI, Vom Nigeria and CODA-CERVA will aim to improve laboratory capacity in the region.

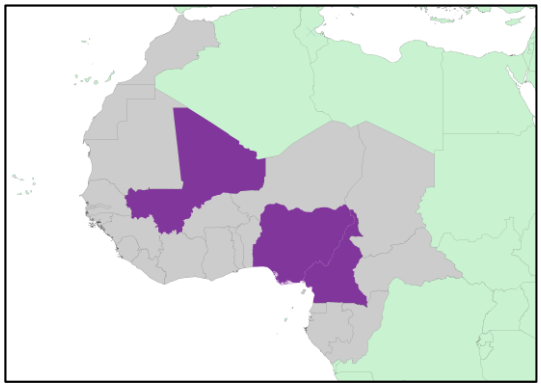


Figure 2-12: Countries within Pool 5 (in grey) that have provided samples to FMD reference centres during 2014 (in purple).

Conjectured circulating FMD viral lineages in Pool 5 during 2014:

- Serotype O (topotypes WA and EA-3 (Nigeria))
- Serotype A (topotype AFRICA, genotypes IV and VI)
- Serotype SAT 1 (?)
- Serotype SAT 2 (topotype VII)

Table 2-7: Overview of samples collected and tested from pool 5 during 2014

Laboratory	Countries of Origin	Number of Samples	
		Clinical Field Cases	Surveillance Activities
NVRI, Nigeria	Nigeria	84	1502
RRLSS, BVI	Mali	6	
WRLFMD	Cameroon, Nigeria	88	

Vaccine recommendations:

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

2.5.6 Pool 6 Regional synopsis

FMD field strains in Pool 6 are normally restricted to FMD virus lineages from the three Southern African Territories serotypes (SAT 1, SAT 2 and SAT 3) and domesticated livestock populations in certain countries (South Africa, Lesotho and Swaziland) and zones (in Botswana and Namibia) are FMD-free (without vaccination), although FMDV is still present in African buffalo with game parks and reserves. Eurasian FMDV serotypes (O and A) have not been detected in Southern African countries since O/ME-SA/PanAsia caused outbreaks in South Africa in 2000, although countries on the northern boundaries of this pool (Tanzania and Zambia) share serotype O and A FMD virus lineages with endemic countries in East Africa. During 2014, new epidemiological events have been reported to OIE. Sequence data collected during 2014 from outbreaks in Bushbuckridge, South Africa (adjacent to the Kruger National Park, in a discrete location from previous outbreaks in 2012) were reported, showing that the causative FMD viruses are from the SAT 2 serotype (topotype I [Appendix 3a-9]). Within Botswana FMD outbreaks due to SAT1 (topotype I –WZ) have been reported in Ngamiland in June and October 2014. Samples collected from Zimbabwe in 2010 and 2014 represented SAT 2 topotypes I and II respectively; and Mozambique SAT 2 topotype I.

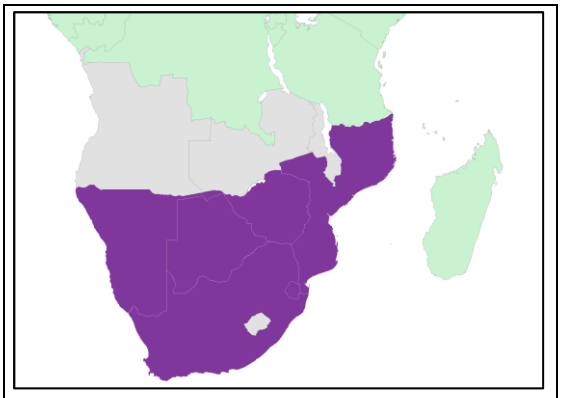


Figure 2-13: Countries within Pool 6 (in grey) that have provided samples to FMD reference centres during 2014 (in purple).

Conjectured circulating FMD viral lineages in pool 5 during 2014:

- 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 2014

Laboratory	Countries of Origin	Number of Samples	
		Clinical Field Cases	Surveillance Activities
RRLSS, BVI	Botswana, Mozambique, Namibia, Zimbabwe	124	
ARC-OVI	Mozambique, South Africa, Swaziland	36	18642

2.5.7 Pool 7 Regional synopsis

Since the 1960s, countries in South America have sought FMD control via vaccination against three FMD serotypes (O, A and C) that were previously present. The tangible success of these systematic vaccination campaigns is now demonstrated by the fact that no clinical cases of FMD have been reported in 2014 across the entire South American continent (since Paraguay in 2012), and it is now >35 months since the last FMD outbreak. Within the continent, complete elimination of FMD is envisaged under the provisions of the Hemispheric Program for the Eradication of FMD by 2020 (PHEFA). At the OIE meeting in May 2014, the FMD free zones (with and without vaccination) were extended in a northerly direction to include a larger part of the South American continent (Figure 2-14).

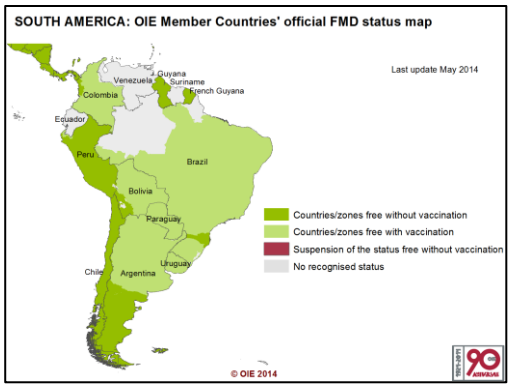


Figure 2-14: FMD status of countries of South America (downloaded from the OIE website: http://www.oie.int/en/animal-health-in-the-world/official-disease-status/fmd/en-fmd-carte/).

Table 2-9: Overview of samples collected and tested from pool 7 during 2014

Laboratory	Countries of Origin	Number of Samples	
		Clinical Field Cases	Surveillance Activities
WRLFMD	Trinidad and Tobago	6	
PANAFTOSA	Ecuador		3649 (PVM) >20,000

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

During 2014, PANAFTOSA organised regional PT schemes for FMDV antigen detection and Ab NCP.

IZSLER, Italy

IZSLER provides PT Samples Panels for FMDV Antigen detection and serotyping ELISA and FMDV serology (supported by EuFMD) to Balkan countries.

PIADDC, FADDL, USA

During 2014, FADDL provided PT materials for inter-laboratory test exercise in the US (National Animal Health Laboratory Network [NAHLN]):

Type of Reagent	Quantity	Recipient of the reagent
FMD rRT-PCR PT Panels	43 panels (43 labs)	NAHLN Laboratories
Serological FMD PT	29 panels (13 labs, 29 participants)	NAHLN Laboratories

RRLSEA, Pakchong, Thailand

The RRLSEA provided the update on the Regional Proficiency testing scheme by Inter-laboratory Comparison testing on FMD Capture ELISA and LP ELISA. The 3rd round was conducted during 2012-2013. Sixteen Laboratories: 7 Regional Veterinary Research and Development centres (RVRDC), the National Institute of Animal Health (NIAH) Thailand and 7 Southeast Asia member countries (Cambodia, LAO PDR, Malaysia, Myanmar, Thailand (RRL), Vietnam (NCVD, RAHO 6) and Singapore) participated the program.

The results were summarized based on the Internal quality control (IQC) of antigen (serotype O, A and Asia-1) and antibody detection by (LP and NSPs) by ELISA. Problems and constraints observed during the activities include lack of systematic equipment calibration, technical errors, budgeting, logistics problem and delayed result submission.

In summary, the laboratory capacities of all participating laboratories had competence in FMD serology by LP ELISA and NSPs test, just 7 laboratories that had competence in FMD Capture ELISA and Serology test.

The 4th round of inter-laboratory comparison testing was scheduled in December 2014.

LVRI, China

In April 2014, China (MoA) organized a PT comprising 5 blind samples (2 of type A, 2 of type O and 1 negative) that was sent to provincial veterinary laboratories in PR China.

WRLFMD, UK

During 2013 and 2014, the WRLFMD has coordinated a PTS for virology and serology diagnostic methods for FMD [and swine vesicular disease (SVD)]. 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.

Table 2: Summary of participating National Reference Laboratories:

	2013	2014
Total invited laboratories[1]	86	91
Total number of shipments[1]	60	66
Participants from European Union (funded by EURL for FMD)	27 (EU member states)	27 (EU member states)
EUFMD funded participants		
Participants from Global Network Labs[2]	BVI, Botswana: ARRIAH, Russia: OVI, South Africa: NAHDIC, Ethiopia: Embakasi, Kenya: Pakchong, Thailand: USDA, USA[3]	BVI, Botswana: OVI, South Africa: NAHDIC, Ethiopia: Embakasi, Kenya: Pakchong, Thailand; Lanzhou, China: Panaftosa, Brazil; NVRI Nigeria; LNERV, Senegal; USDA, USA[3]
% of labs meeting target performance[4]	Cat-1 0% Cat-2 17% Cat-3 50% Cat-4 33%	Analysis of results pending
Participants from EuFMD Member states (non-EU)	Algeria, Bosnia, Georgia, Macedonia, Morocco, Norway, Serbia, Switzerland, Tunisia, Turkey	Albania, Bosnia, Georgia, Macedonia, Norway, Serbia, Switzerland, Turkey
% of labs meeting target performance[4]	Cat-1 0% Cat-2 0% Cat-3 40% Cat-4 60%	Analysis of results pending
Participants from neighbourhood countries	Armenia, Azerbaijan, Belarus, Iran, Libya, Lebanon, Montenegro.	Algeria, Armenia, Azerbaijan, Belarus, Egypt, Iran, Kosovo, Morocoo, Moldova, Tunisia, Montenegro, Lebanon
% of labs meeting target performance[4]	Cat-1 0% Cat-2 0% Cat-3 43% Cat-4 57%	Analysis of results pending
Summary of EUFMD funded participants		
Invited	33	40
Panels shipped	Panel 1: 2 Panel 2: 12 Panel 3: 17 Panel 4: 4	Panel 1: 2 Panel 2: 19 Panel 3: 17 Panel 4: 4
Total number of participants funded by EUFMD	**23**	**29**

([1, 2, 3, 4]: see notes below)

[1] Note: 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 2013 (and was concluded in 2014) was reported at the EuFMD Open Session Meeting in Cavtat, Croatia.

3.2 Supply of reagents

PANAFTOSA, Brazil

Reagents for the following assays are provided by PANAFTOSA: 3ABC ELISA, EITB, ELISA-IS antigen typing, LP-ELISA (for sero-surveillance). Additional reference materials (viruses, cDNAs for FMDV and VSV Reference strains and cell lines) have also been supplied during 2014.

FGI ARRIAH, Russia

Diagnostic kits and reagents supplied by FGBI ARRIAH during 2014

Type of reagent	Quantity	Recipient countries
FMDV antibody kits	988	Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Vietnam
FMDV antigen kits	15	Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Moldova, Russia, South Korea

BVI-RRLSS, Botswana

BVI can produce and provide the following diagnostic reagents: rabbit hyper-immune sera for ELISA, Guinea-pig hyper-immune sera for ELISA, inactivated antigens for ELISA and negative sera. These reagents are supplied to National Veterinary Laboratories on demand.

Diagnostic kits and reagents supplied by BVI-RLSS, Botswana, during 2014

Type of reagent	Quantity	Recipient of the reagent (Laboratories/Countries)
FMDV antibody kits	200ml	Botswana National Vet Lab. Zimbabwe and Namibia Vet. Labs
FMDV antigen kits	200ml	Botswana National Vet Lab. Zimbabwe and Namibia Vet. Labs

SENASA, Argentina

Diagnostic kits and reagents supplied by SENASA, Argentina, during 2014

Type of Reagent	Quantity	Recipient of the reagent
Hyper-immune guinea pig sera A24 Cruzeiro-Arg 2001-O1 Campos-C3 Indial	104 vials x 1 ml	Argentina, Paraguay
Hemolisin	2 vials x 1 ml	Vietnam
FMD challenge viral suspension for PPG test A24 Cruzeiro -Arg 2001-O1 Campos-C3 Indaial-	8 vials	Argentina
27 DPV Bovine sera (monovalent vaccine O1 Campos)	32 vials x 1ml	Argentina
Standard Bovine sera Pool 27DPV (monovalent vaccine O1 Campos)	5 ml	Vietnam
BHK-21 cells suspension	450ml	Vietnam
LP-ELISA	248 kits x 5 plates	Argentina, Brazil, Colombia and Paraguay
Typing ELISA	25 x 5 plates	Argentina, Paraguay and Uruguay
3 ABC ELISA	6 x 100 plates	Argentina

IZSLER, Italy

IZSLER produces reagents and ELISA kits for FMDV antigen and FMDV-specific antibodies. Antigen detection serotyping assays include combined ELISA kits for serotypes O, A, Asia 1 and C and O, A, SAT1 and SAT2). Solid phase competitive-ELISAs (SP-ELISAs) are also available for serotypes O, A and Asia-1 as well as a NSP (3ABC) ELISA. During 2013, a new SP-ELISA has been developed for the detection of SAT2-specific antibodies. During

2013, ready-to-use kits have been provided to 12 countries (shown in **Error! eference source not found.** below).

Diagnostic kits and reagents provided by IZSLER during 2014

	FMDV antigen detection ELISA KIT		NSP Ab ELISA KIT	SP Ab ELISA KIT			
Country / Organisation	**type O, A, SAT1, SAT2**	**type O, A, C, Asia1**	**3ABC**	**FMDV O**	**FMDV A**	**FMDV Asia1**	**FMDV SAT2**
Iran		100					
Pakistan		251	65	26	26	25	1
Afghanistan		4	2	1	1	1	
Chad	3		3	3	3	3	3
Sudan	1						
Libya	2		1				
Algeria	5						
Tunisia	14			2			
Egypt	20	1	8	10	10		10
Turkey	1	2					
Russia		3		3	3	3	
Greece	1						
Poland	1	1		1	1	1	1
New Zeland	1	1		6	1	1	1
Canada				1	1		
Georgia			1	1	1	1	
Balkan contries		10		10	10	10	
Training courses	15			1	1		1
IAEA	11						
China				3	2	2	
TOTAL KIT DISTRIBUITED	**75**	**373**	**80**	**68**	**60**	**47**	**17**

ARC-OVI, South Africa

Diagnostic kits and reagents supplied by OVI, South Africa, during 2014

Type of reagent	**Quantity**	**Recipient of the reagent (Laboratories/Countries)**
FMDV antibody kits	500 SAT 1 & 2 reactions for LPBE	Uganda (part of training conducted by Dr Francois Maree and USDA)
FMDV antigen kits	none	

PIADDC, FADDL, USA

Type of Reagent	Quantity	Recipient of the reagent (Laboratory /Country)
FMD rRT-PCR PT Panels	43 panels	USA-NAHLN 43 State Laboratories
ELISA 3ABC Kits	16 kits	USA- NAHLN
Serological FMD PT	29 panels	USA-NAHLN
Sera for FMD Ag ELISA surveillance	16 (guinea pig and rabbit anti-FMD sera) 1ml per vial, 6-7 vials per serotype	Panama
FMD Monoclonal Antibodies	1 ml	Jordan
FMD Tissue culture antigen for Ag ELISA	7 FMD antigens (1ml per vial, 6-7 vials per serotype)	Panama

RRLSEA, Thailand

RRLSEA, Pakchong produces the following reagents: rabbit trapping antibody for FMDV type O, A and Asia1, guinea pig detecting antibody for FMDV type O, A and Asia1, concentrated Inactivated FMD antigen type O, A and Asia1, and control serum : strong and weak positive serum, negative serum

During 2014, these have been supplied to the following laboratories:

Type of reagent	Quantity	Recipient of the reagent (Laboratories/Countries)
FMDV antibody kits	25 sets (1 set can be testedfor 500 samples)	NIAH and Veterinary Research and Development Center, Thailand
	1 sets	National Animal Health Center, Department of Livestock and Fisheries, LAO PDR
	1 set	National Veterinary Research Institute, Department of Animal Health and Production, Cambodia
	1 set	FMD Laboratory, Livestock Breeding and Veterinary Department, Myanmar
FMDV antigen kits	2 sets	National Animal Health Center, Department of Livestock and Fisheries, LAO PDR
	1 set	Department of Animal Health (DAH) Hanoi, Vietnam

	1 set	Regional Animal Health Office, Center for Veterinary Diagnostics, Ho Chi Minh City, Vietnam
	1 set	National Veterinary Research Institute, Department of Animal Health and Production, Cambodia
Reagents for PT program	**Quantity**	**Participant**
PT panel	8 sets	NIAH and Veterinary Research and Development Center , Thailand
	1 set	National Animal Health Center, Department of Livestock and Fisheries, LAO PDR
	1 set	Department of Animal Health (DAH) Hanoi, Vietnam
	1 set	Regional Animal Health Office, Center for Veterinary Diagnostics, Ho Chi Minh City, Vietnam
	1 set	National Veterinary Research Institute, Department of Animal Health and Production, Cambodia

LVRI, China

Diagnostic kits and reagents supplied by LVRI, China during 2014:

Type of reagent		Quantity	Recipient Laboratories
FMDV Antibody Kits	LPBE-O	5808	Provincial veterinary laboratories in China and North Korea
	LPBE-Asia1	3858	
	LPBE-A	2950	
	IHA (type O)	9235	
	NSP-3ABC-ELISA	2770	
FMDV Antigen Kits	Mult-RT-PCR	486	
	Real-time PCR	150	

PDFMD, India

Type of reagent	Quantity	Recipient of the reagent (Laboratories/Countries)
FMDV antibody kits-LPBE	3,10,900	FMD regional and collaborating centers, India and SAARC countries
FMDV antibody kits-DIVA	1,19,550	
FMDV antigen kits	18,000	

Embakasi, Kenya

Type of reagent	Quantity	Recipient of the reagent (Laboratories/Countries)
FMDV positive control antisera	20 ml @ O, A, SAT 1 & SAT 2	NADDEC Uganda

WRLFMD, UK

Diagnostic kits and reagents supplied by WRLFMD, UK, during 2014

Quarter	Country	Reagents Supplied
Jan-Mar	Hong Kong SAR	1antigen ELISA for serotype O
	Iraq	2 Antibody kits for serotypes O and Asia 1
	Kazakhstan	1 Antibody kit for serotypes O, A and Asia 1
	Mongolia	1 Antibody kit for serotypes O and A 2 Antibody kits for serotypes O, A, C and Asia 1
	South Korea	1 Antibody kit for serotype O
	Sudan	1 Antigen kit for serotypes O, A, C, SAT 1, SAT 2, SAT3 and Asia 1
	Vietnam	1 Antibody kit for serotype O
Apr-Jun	No Kits Sent	
Jul-Sep	Belarus	1 Antibody kit for serotypes O, A and Asia
	Kenya	1 Antibody kit for serotypes O, A, C, SAT 1, SAT 2 and SAT 3
	Romania	Reagents for Foot and Mouth Disease
	South Korea	1 Antigen ELISA kit for all seven serotypes
	United Arab Emirates	5 Antibody ELISA kits for all seven serotypes
	Vietnam	1 Antibody ELISA kit for serotype A 1 Antibody ELISA kit for serotype O
	Zambia	6 Antibody kits for serotypes SAT 1 and SAT 2
	Brazil	1 Antigen ELISA kit for all seven serotypes
	Kenya	Reagents for Foot and Mouth Disease
	Lao PD	1 Antibody LPBE kit for serotypes O & A
	Malaysia	1 Antigen ELISA kit 11 Antibody LPBE kits for O, A & Asia1
	Mongolia	1 Antibody LPBE kit for serotypes O, A & Asia1
	Pakistan	2 Antibody LPBE kits for serotypes O, A & Asia1
	Russia	Reference sera for Foot and Mouth Disease serotypes O, A & C
	South Korea	4 Antibody LPBE kits for serotypes O, A, Asia1 & SAT3
	Spain	Reference sera for Foot and Mouth Disease
	Taiwan	Reagents for Foot and Mouth Disease
	USA	NSP panel
	Vietnam	4 Antibody LPBE kits for serotypes O & A

3.3 Training courses organised by Network partners

PANAFTOSA, Brazil

During 2014, PANAFTOSA provided training courses in FMD diagnostic methods including cell culture (4 participants), PCR (4 participants), 3ABC ELISA and EITB (4 participants) and biorisk management (30 participants).

FGI-ARRIAH, Russia

Provided training on FMD to 14 veterinarians; from Kazakhstan (2) and Russian Federation (12) in 2014.

SENASA, Argentina

Training organised by under the auspices of a FMD Project: Argentina Fund for Horizontal Cooperation SENASA during 2014 is outlined below:

- March 2014, Training in Vietnam (Health Animal Department, Regional Animal Health, (RAHO) Nº 6 (Ho Chi Minh)), NAVETCO and Institute for Animal Sciences of South Vietnam (IASVN)
- July 2014: Training in Cambodia (Instituto Nacional Veterinario (NaVRI) del Departamento de Sanidad Animal y Producción)
- August 2014 - in Argentina: 2 DVM from RAHO N° 6 and 2 from NAVETCO (Vietnam) to provide training in working in a Laboratory BSL 4 (OIE) bench and large animals, FMD vaccine Quality Control and FMDV antigenic and immunogenic characterization and vaccine matching

IZSLER, Italy

October 2014: Organised training for one veterinary virologist, Veterinary Research Institute (VRI) -Khartoum, Sudan (trainee supported by FAO). Theory and laboratory practice on:

- BHK-38 suspension culture (finalized to vaccine production)
- FMD Virus culture and inactivation
- FMDV antigen detection and serotyping ELISA (virus quality control)

November 2014: Organised training of ten laboratory workers from Balkan countries [Montenegro, Macedonia, Croatia, Serbia, Bosnia-Herzegovina, Albania, Kosovo, Bulgaria, Ukraine, Moldavia] (training supported by EUFMD). Course covered theory and/or laboratory practice on:

- ELISA kits for detection of Antibodies (Ab to NSP and to SP type O, A, Asia1)
- ELISA kit for Antigen detection and serotyping
- Data interpretation
- Biosecurity of labs working with life FMDV
- Concepts and strategies for RT-PCR (conventional and real time)

ARC-OVI, South Africa

November-December 2014: FMD molecular and serological diagnostic methods and other transboundary animal diseases (ASF, CSF, PPR, Rinderpest, Rift valley fever-theoretical).

FADDL, USA

During 2014, FADDL organised the following five courses:

- A Veterinary Laboratory Diagnostic Course for 23 participants.
- A Foreign Animal Disease Diagnostician Course for 55 participants (9 Federal, 20 State, 26 Military)
- A Spanish International Transboundary Animal Disease Course for 23 participants
- A course on International Transboundary Animal Diseases for 24 participants
- An Area Foreign Animal Disease Response Refresher Course for 38 participants from California, 34 from New York and 36 from New Mexico

CODA-CERVA, Belgium

During 2014, CODA-CERVA has initiated a three-year OIE twinning project with the National FMD Reference Laboratory in Nigeria (NVRI, Vom, Nigeria).

RRLSEA, Thailand

Courses organised during 2014:

- Myanmar, workshop on PCR for FMD Diagnosis, 3rd–27th June.
- Australia, vaccine matching study, 21st July–1st August.
- Cambodia, LAO PDR and Vietnam. on “FAO/RRL Laboratory Training on FMD Diagnosis”, 15th-26th December.

LVRI, China

LVRI offered 17 special training courses where ~300 people attended including 2 visitors from Mongolia

PDFMD, India

Title of Training	Participants
Training on FMD diagnosis (Single dilution LPB-ELISA)	AICRP regional and collaborating centres Bengaluru, Jaipur, Imphal, Jammu, Guwahati, Aizawl, Bhopal, Kohima, Port-Blair, Hisar and Palode.
Training on FMD diagnosis (Single dilution LPB-ELISA)	AICRP collaborating centre, Jalandhar
Training on FMD diagnosis (DIVA- ELISA)	AICRP regional centre. Hyderabad
Training on FMD diagnosis (Single dilution LPB-ELISA)	AICRP regional and collaborating centres Mathura, Shimla.
Training on FMD diagnosis (Single dilution LPB-ELISA and DIVA- ELISA)	Arsh Biotech Pvt.Ltd. India
Training on FMD diagnosis (Single dilution LPB-ELISA and DIVA- ELISA)	AICRP collaborating centre Ahmadabad
Training on FMD diagnosis (Single dilution LPB-ELISA)	AICRP collaborating centre Agartala
Training on FMD diagnosis (Single dilution LPB-ELISA and DIVA- ELISA)	AICRP regional centres Hisar, Mathura and Pune

ŞAP Institute, Turkey

The ŞAP Institute ran two training courses during 2014:

- One week training course for Russian speaking countries (under the West EurAsia FMD Road Map-WELNET) for 18 trainees from 8 countries (Armenia, Azerbaijan, Georgia, Kazakhstan, Moldova, Palestine, Turkey, Ukraine)
    - Concept: intensive class-room training for one day followed by 2-3 days of visiting suspect outbreaks, carrying out a full investigation of suspected cases and collection of epi-information, testing of samples onsite or at a laboratory equipped to undertake PCR, ELISA and penside tests for virus and antibody, and analyses to trace the movements of animals and to trace source and spread of infection.

- Outbreak Investigation for local veterinary services for 66 trainees (3 modules of 1 week):
    - Concept: Class-room training on outbreak investigation, clinical diagnosis of FMD, Surveillance And sero-surveillance

NAHDIC, Ethiopia

For 5 regional laboratories, about 75 experts were trained.

In addition a course was provided in Standard Methods and Procedures in Animal Health (SMP-AH) - Supported by USAID and coordinated by AU-IBAR & IGAD

Purpose of the training

- Development of standard methods and procedures for prevention and control of FMD diseases in the region.
- Support implementation of harmonized animal health protocols for prevention and control of other trade related trans-boundary disease in the region.

25 participants from Kenya, Somalia, Djibouti, Ethiopia, Tanzania, South Sudan & Uganda participated

WRLFMD, UK

WRLFMD hosted a scientist from NVRI, Nigeria for 1 month during May 2014. This scientist participated in a 2-week FMD Laboratory Diagnostic Training Course (together with delegates from Argentina, Botswana, Ireland, Israel, New Zealand and South Africa) and received additional instruction in the use of FMD virus sequence data to generate phylogenetic trees. For East Africa, WRLFMD has been actively involved in laboratory and field research projects in Tanzania, and has also recently submitted a Twinning Proposal for a 3 year project with NAHDIC in Ethiopia to build and maintain capacity within the East Africa Laboratory Network for FMD (EALN-FMD).

3.4 Collaborative projects

PANAFTOSA, Brazil

Active projects:

Collaborators	Purpose of collaboration	Outcomes
COSALFA countries	Regional FMD vaccine/antigen bank	Pre proposal approved by 41ª COSALFA Perú April, 2014
MAPA & IBSP - Brazil	Molecular analysis of FMDV in Brazil – Retrospective study	ongoing
INIA - Venezuela	Molecular analysis of FMDV in Venezuela – Retrospective study	ongoing

FGI ARRIAH, Russia

ARRIAH is participating in project to measure cross border trade and TADs Risk Reduction between China, Mongolia and Russia

BVI-RRLSS, Botswana

Collaborators	Purpose of collaboration	Outcomes
CODA-CERVA	FMD Diagnostics and inter-laboratory comparison.	Method validation and staff development
The Pirbright Institute	FMD diagnostics, inter-laboratory comparison and PT schemes	Method validation, and staff development
Botswana National Vet. lab	ISO 17025 GAP analysis and audit observations	Readiness for ISO 17025 accreditation
OVI South Africa	FMD diagnostics and consultations.	Improved FMD diagnostics in the region

SENASA, Argentina

National collaborative research projects (RIIDFA)

- Development, validation and application of methodology for the FMD risk characterization in support of “vaccination for live”
- Development of FMD new generation vaccines based on non-infectious viral capsids

International Agency of Atomic Energy (IAEA):

- “Control of FMD ” (CPR Nº 16050)

SENASA-AAHL-CSIRO (Australian Animal Health Laboratory Commonwealth Scientific and Industrial Research Organization):

- "Testing the early protection of O1Manisa Double Oil Emulsion Emergency Vaccine in Cattle against Heterologous Challenge"

PROCC-FioCruz-Brazil-ICT

- " FMDV proteins modelling studies"

University of San Pablo, Brazil-ICT "Dr. Cesar Milstein":

- "Activity Assessment of FMD antiviral compounds"

IZSLER, Italy

1) Partner: The Pirbright Institute

   Continuous improvement and validation of new-generation ELISAs (ready-to-use kits), substitution of FMDV inactivated antigens with VLP, production of anti-bovine IgA mAbs for assays measuring mucosal antibody.

2) Partner: Onderstepoort Veterinary Institute, Agricultural Research Council, South Africa

   Collaborative evaluation and validation of ready-to-use ELISA kits for SAT2 and SAT1 Ab detection developed at IZSLER.

3) Partner: Tunisia

   Field vaccine trial to estimate cross-protection conferred by FMDV vaccine strains with in-vitro poor match with the circulating virus.

ARC-OVI, South Africa

Collaborators	Purpose of collaboration	Outcomes
SADC TADS project	Sampling of buffalo and cattle in Malawi, Mozambique, Tanzania, Zambia, Zimbabwe, Angola	Outstanding samples are in process of being analysed
Namibian Meat Board	Development of export opportunities for beef originating from the FMD endemic zone of the Zambezi region of Namibia	Export opportunities
Plum Island Animal Disease Centre, Makerere University and Uganda Virus Research Institute	FMD surveillance in Uganda	FMDV characterization and vaccine matching
Pirbright Institute, SANPARKS, KNP state vet services	FMD transmission studies in the Kruger National Park.	Understanding FMDV transmission in buffalo
Pirbright Institute and University of Glasgow	Improved vaccine for FMD control by understanding the correlation of vaccine induced protection with humoral and cellular immune responses	Quality of FMDV vaccines and new vaccine matching methodologies
Plum Island Animal Disease Centre	Antigenic structure of FMDV capsid proteins	Improved selection of appropriate candidate vaccine strains in emerging FMD outbreaks
CODA-CERVA and IZSLER	Validation of serological assays	NSP ELISA, SAT 1 and 2 SPCE for SADC region
INTA, Argentina	Investigation of humoral immune responses in vaccinated animals and identification of markers for protection	Novel IgG1 and 2 avidity γ IFN and IgM ELISAs

PIADDC, FADDL, USA

Collaborators	Purpose	Outcomes
Texas A&M, VMRD, FADDL	Development of new FMD 3ABC kit	Transfer of 3B ELISA technology to industry. Currently in last stages of production
Texas A&M, FADDL	Multiplex PCR technology for detection of swine diseases in oral fluids	Multiplex assay for FMD, ASF, and CSF using oral fluids
NAHLN, FADDL	Validation of Prionics 3 ABC ELISA kit	Several NAHLN laboratories validated the 3ABC ELISA kit (irradiated controls)
Texas A&M, FADDL, Micronics Corporation	Pen-side PCR for FMD in oral swab samples	New commercial penside platform (PanNat) for the detection of FMD.
FADDL	Evaluation of FTA cards and MTM as media to inactivate and stabilized TAD agents.	MTM suitable to inactivate and stabilized FMD and CSF in 1 hour.
FADDL	Cross-protection at 7 days post vaccination	Partial cross protection with heterologous challenge at 7DPV despite low r1 values.

RRLSEA, Thailand

Collaborators	Purpose of collaboration	Outcomes
Australian Animal Health Laboratory and Regional Reference Laboratory for FMD in South East Asia	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 in SEA region.
Bureau of Veterinary Biologics, Bureau of Disease Control and Veterinary Services and Regional Reference Laboratory for FMD in South East Asia	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
Regional Reference Laboratory for FMD in South East Asia and Kasetsart University, Thailand	Development of recombinant 3ABC-based ELISA to differentiate vaccinated from FMD infected animals.	To have a new NSP test kit used in Thailand at a lower cost.

CODA-CERVA, Belgium

Collaborators	Purpose of collaboration	Outcomes
CODA-CERVA, Belgium & NVRI Nigeria	OIE Laboratory twinning for capacity building	• Pre-sampling workshop: epidemiology, laboratory biosafety and sample shipment in Nigeria • Laboratory exchange program in Belgium • Key-gaps in the laboratory practices and system will be identified with recommendations to improve current practices and systems • To strengthen and enhance safe and secure diagnostic laboratory practice and skills • To improve laboratory surveillance and disease reporting
CODA-CERVA, Belgium & BVI, Botswana	A collaboration with BVI for quality assurance in diagnostics and sequencing.	• In this respect, training was organized at CODA-CERVA. • In the framework of quality control samples are sequenced in both laboratories and results are compared to increase the confidence in the results.
CODA-CERVA, Belgium; OVI, South Africa & The Pirbright Institute, UK.	Vaccine matching.	• Phylogenic data are exchanged and discussed related to the failure of the actual vaccines used to protect against the current circulating field strains.

LVRI, China

Collaborators	Purpose of collaboration	Outcomes
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
Sino-French cooperation	Optimizing pig FMD vaccination on Efficacy and safety with ISA 201	Animal tests in progress
IAEA (CRP16025)	TDS on diagnosis, vaccination, risk anylis and control	Training/workshop
Roslin Institute and Pirbright Institute	Bioinformatic analysis of FMDV sequence data from a range of species	Sequencing, exchange visitors
FAO, Russia, Mongolia	Cross Border Trade and TADs Risk Reduction between China, Mongolia and Russia	Surveillance
Onderstepoort veterinary research Institute (ARC-OVI)	Cooperation in the development new FMDV diagnostic techniques	Development new FMDV diagnostic techniques

PDFMD, India

1) Understanding FMD viral ecology and landscape epidemiology towards control and eradication (Collaborating organization: The Plum Island Animal Disease Center, US)

2) An effective vaccination programme for the eradication of foot-and-mouth disease from India (Collaborating organization: The Pirbright Institute, UK)

3) Assessment of socio-economic impact of FMD and its control in India (Collaborating Institute: ICAR-PD-ADMAS, India)

4) Influence of genetic and non-genetic factors on FMDV vaccine response

(Collaborating Institute: ICAR-IVRI, India)

Embakasi, Kenya

Collaborators	Purpose of collaboration	Outcomes
FMD Lab Kenya, 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
FMD Lab Kenya, DVS Kenya, EUFMD	FMD Real-Time training	EU and Kenyan Vets capacity for FMD outbreak investigation

NVRI, Nigeria

Collaborators	Purpose of collaboration	Outcomes
CODA-CERVA-Belgium - NVRI Nigeria	OIE Laboratory twinning for capacity building	• Pre-sampling workshop: epidemiology, laboratory biosafety and sample shipment in Nigeria • Laboratory exchange program in Belgium • Key-gaps in the laboratory practices and system will be identified with recommendations to improve current practices and systems • To strengthen and enhance safe and secure diagnostic laboratory practice and skills • To improve laboratory surveillance and disease reporting

WRLFMD, UK

Collaborators	Purpose of collaboration	Outcomes
Tanzanian Veterinary Laboratories Agency; Sokoine University of Agriculture, Tanzania; Makerere University, Uganda and the Danish Technical University	Development of serotype specific molecular assays tailored for FMD virus strains that are circulating in East and Southern Africa	Development of new real-time RT-PCR assays for the East African Region
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
University of Glasgow, UK; Tanzanian Veterinary Laboratories Agency; Tanzania Wildlife Research Institute	Towards the strategic control of endemic foot-and-mouth disease in Africa: new techniques for a neglected problem	Develop tools to better understand the endemic cycle of FMDV infection in sub-Saharan Africa
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

Appendix 1: Details of clinical samples from field cases from FMDV endemic regions tested during 2014

Laboratory	Samples from	Total	O	A	Asia-1	SAT-1	SAT-2	SAT-3	NVD
BVI	Botswana	93				9			84
	Mali	6					2		4
	Mozambique	6					5		1
	Namibia	12							12
	Zimbabwe	13					8		5
LVRI	China	36	6	15	0				15
	North Korea	6	2	1	0				5
PD-FMD	India	1001	360		5				
	Nepal	34	30						
IZSLER	Algeria	4	4						
	Libya	20	13						7
	Tunisia	5	5						
ARRIAH	Kyrgyzstan	5		3					2
	Mongolia	6	6						
	Russia	271	39	14					218
OVI	Mozambique	12					12		0
	South Africa	19							19
	Swaziland	5							5
RRLSEA	Cambodia	17	5						12
	Lao, PDR	5		3					2
	Thailand	355	88	116					151
WRLFMD	Afghanistan	21	4	9					9
	Algeria	3	3						
	Bahrain	3	3						
	Cambodia	3	3						
	Cameroon	46		4			9		33
	Egypt	59	21	3			5		30
	Ethiopia	76	33	2			2		39
	Hong Kong	15	8						7
	Iran	31	7	18	1				5
	Israel	6	6						
	Laos	6	3	3					
	Malaysia	51	10	5					20
	Mongolia	6	5						1
	Nepal	50	23						27
	Nigeria	42	10	9			13		12
	Pakistan	31	23	6	4				
	Saudi Arabia	4	4						

Laboratory	Samples from	Total	O	A	Asia-1	SAT-1	SAT-2	SAT-3	NVD
	South Korea	10	1						9
	Sri Lanka	58	23						17
	Tanzania	28		6		10			12
	Thailand	21	2	19					
	Trinidad & Tobago	6							6
	Tunisia	2	2						
	Turkey	33	10	15	2				6
	United Arab Emirates	2	2						
	Vietnam	32	12	13					7
PIADDC	Jordan	6							6
Kenya	Kenya	198	84	4		16	28		66
	South Sudan	25							
	Uganda	51							
SAP	Turkey	270	100	91	24				50
NAHDIC	Ethiopia	86	62	1			2		21
DTU	Uganda							1	
Nigeria	Nigeria	84							
Totals		**3296**	**1022**	**360**	**36**	**35**	**86**	**1**	**925**

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.

RRLSEA, Thailand

Serotype O (O Udornthani 189/87 Thai vaccine strain)

Country	Number of samples	0-0.19 Poor Matching	0.2-0.39 moderate matching	0.4-1.0 Good Matching
Cambodia	1	-	-	1
Thailand	16	-	1	15

Serotype A (A/Lopburi/2012 vaccine)

Country	Number of samples	0-0.19 Poor Matching	0.2-0.39 moderate matching	0.4-1.0 Good Matching
Laos	3	-	1	2
Thailand	16	-	1	15

NB: these isolates failed to bind in LP ELISA with A118/87 and A/Sakolnakorn/97 reagents

Antigen matching studies (in collaboration with AAHL, Australia): 'r' value estimation of SEA serotype A isolates at RRL in 2014 (LP titres are reported)

Sample IDs	A Lopburi 2012			A22 IRQ 64			A MAY 97		
	Homo	Hetero	'r' value	Homo	Hetero	'r' value	Homo	Hetero	'r' value
VIT/1/13 B3	3.16	3.16	1.00	3.37	2.75	0.24	3.78	3.38	0.40
VIT/2/13 B3	3.16	2.86	0.50	3.59	3.11	0.34	4.08	3.02	0.09
VIT/3/13 B3	3.46	3.16	0.50	3.14	3.18	>1.00	4.38	3.34	0.09
TAI/20/13 R3B3	3.76	3.46	0.50	3.12	2.88	0.58	4.05	2.32	0.02
TAI/26-3/13 R3B2	3.76	3.46	0.50	3.39	4.08	>1.00	4.69	2.33	0.00
TAI/39/13 R1B2	3.16	2.98	0.66	3.22	2.78	0.36	4.20	2.58	0.02
TAI/47-2/13 R1B2	3.16	2.98	0.66	3.78	2.47	0.05	4.00	3.02	0.10
TAI/53/13 R2B2	3.16	2.98	0.66	3.80	2.72	0.08	3.72	3.08	0.23
TAI/58/13 R3B2	3.16	2.98	0.66	3.61	2.45	0.07	3.60	3.15	0.35
TAI/60/13 R1B2	3.46	3.58	>1.00	3.47	2.46	0.10	4.12	3.33	0.16
LAO/2/14 B4	2.56	2.68	>1.00	3.01	2.49	0.30	4.16	3.67	0.33
LAO/5/14 B3	2.56	2.68	>1.00	3.14	2.57	0.27	3.66	3.98	>1.00
TAI/1-2/14 B3	2.56	2.68	>1.00	3.35	2.95	0.39	4.52	2.98	0.03
TAI/2/14 B3	2.56	2.68	>1.00	3.13	2.57	0.27	4.56	3.20	0.04
TAI/5/14 B1	2.56	2.68	>1.00	3.19	2.52	0.21	3.88	3.82	0.88
TAI/10/14 R2B3	2.56	2.68	>1.00	3.57	2.69	0.13	3.83	3.01	0.15
TAI/13-2/14 B4	2.56	2.68	>1.00	3.58	2.38	0.06	4.81	2.74	0.01
TAI /21-2/14 B4	3.46	3.58	>1.00	2.99	2.85	0.73	4.67	3.04	0.02
TAI/44/14 B4	3.16	2.98	0.66	4.00	2.58	0.04	3.60	2.90	0.20
TAI/65-1/14 R1B2	-	-	-	3.35	2.75	0.25	3.95	2.74	0.06

The RRL-Pakchong provides laboratory support and capacity for Southeast Asia which includes countries that are either FMD endemic or FMD-free (without vaccination). During 2014, FMD samples have been received and characterised from Cambodia, LAO PDR and Thailand. Vaccine matching data were summarized from locally produced vaccine strains and international vaccines against representative field viruses.

LVRI, China

Methods used: VNT, VNT (Vivo test –baby mice), Animal challenged tests

	Vaccine strain		
	AF72	Re-A/WH/09	O/Mya98/BY/2010
A/GDMM/2013	M	M	/
A/DPRK/2014	M	nd	/
O/Mya-98	/	/	M
O/PanAsia	/	/	M

FGI ARRIAH, Russia

Isolates	Type A FMDV vaccine strains		
	A_{22} 550	A/Turkey/06 (ARRIAH VS)	A/Iran/05 (Schelkovo VS)
A /Zabaikalsky/14 (Sea-97 lineage)	< 0.3	0.28 - 0.32	0.28 - 0.32

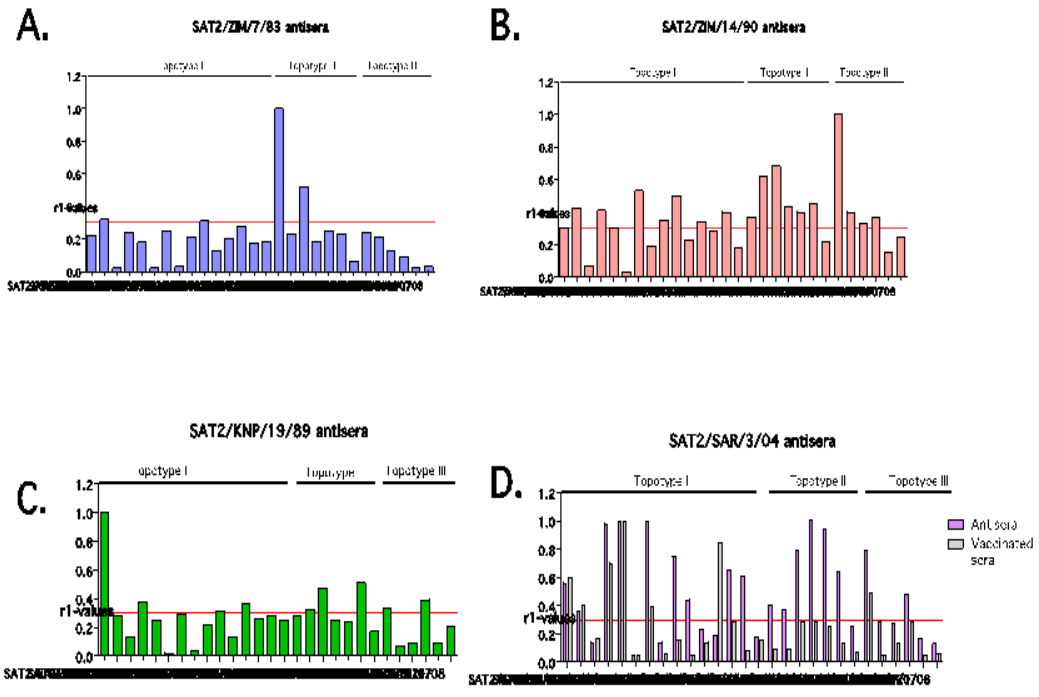
Isolates	FMDV vaccine strains type O			
	O_1 Manisa	O/PanAsia-2	O/RUS/2010 (SEA topotype)	O/PanAsia
O/ Primorsky/14 (O/SEA topotype)	≥ 0.3	< 0.3	≥ 0.3	< 0.3
O/ Zabaikalsky/14 (O/PanAsia lineage)	≥ 0.3	≥ 0.3	≥ 0.3	≥ 0.3

BVI-RRLSS, Botswana

Virus isolate	Vaccine strain / VNT R_1 value			
	SAT251	SAT105	SAT2035	SAT109
SAT2/ZIM3/2014	0.4			
SAT2/ZIM4/2014	0.3			
SAT2/ZIM5/2014	0.3			
SAT2/ZIM7/2014	0.4			
SAT2/ZIM9/2014	0.4			
SAT2/ZIM11/2014	0.02		0.21	
SAT2/MOZ04/2014	0.72		0.43	
SAT1/BOT05/2014		0.58		0.39
SAT1/BOT17/2014		0.65		0.67

ARC-OVI, South Africa

r1-values (heterologous titre / homologous titre) of the 28 SAT2 viruses to the reference sera. The red line indicates an r1-value of 0.3.



From this in-vitro cross-reactivity data, it is clear that the SAT2/ZIM/7/83 antisera does not provide adequate cross-reaction to the majority of field

strains in southern Africa, whereas SAT2/ZIM/14/90 and SAT2/SAR/3/04 antisera cross-reacted more broadly to the 28 SAT2 field isolates.

FADDL, USA

Serum	r1 values for A 22 Iraq virus
A22 Iraq	1
A Argentina 2001	0.058
A Malaysia 97	0.144

PDFMD, India

Summary of results:

serotype	Vaccine Strain	Number of isolates tested	Number of isolates showing an r-value of >0.3
Type O	IND R2/1975	39	34
Type A	IND 40/2000	-	-
Type Asia1	IND 63/1972	-	-

AAHL, Australia

Sample IDs	A Lop Buri 2012	A22 IRQ 64	A MAY 97
TAI/16-1/12	>1.00	>1.00	0.09
TAI/17-1/12	0.66	0.23	0.04
VIT/1/13	1.00	0.24	0.40
VIT/2/13	0.50	0.34	0.09
VIT/3/13	0.50	>1.00	0.09
TAI/20/13	0.50	0.58	0.02
TAI/26-3/13	0.50	>1.00	0.00
TAI/39/13	0.66	0.36	0.02
TAI/47-2/13	0.66	0.05	0.10
TAI/53/13	0.66	0.08	0.23
TAI/58/13	0.66	0.07	0.35
TAI/60/13	>1.00	0.10	0.16
LAO/2/14	>1.00	0.30	0.33
LAO/5/14	>1.00	0.27	>1.00
TAI/1-2/14	>1.00	0.39	0.03
TAI/2/14	>1.00	0.27	0.04
TAI/5/14	>1.00	0.21	0.88
TAI/10/14	>1.00	0.13	0.15
TAI/13-2/14	>1.00	0.06	0.01
TAI/21-2/14	>1.00	0.73	0.02
TAI/44/14	0.66	0.04	0.20
TAI/65-1/14	-	0.25	0.06

Collaboration with RRL:

Sample IDs	A Sakhon Nakhon 97	A22 IRQ 64	A MAY 97
TAI/89-2/11	0.66	0.61	>1.0
TAI/94-3/11	0.66	0.39	0.49
TAI/99-2/11	0.66	>1.00	>1.00

Kenya

VNT	Vaccine strain
Name of Field isolate	**T155/71**
K150/2012	0.40

Turkey

Number of r value by VNT at ŞAP INSTITUTE	Vaccine strain		
	O TUR07 O PanasiaII	A TUR11 A Iran 05	Asia1TUR11 Asia1/Sindh08
O PanasiaII/FAR09/AGR13	1		
O PanasiaII/FAR09/GUM12	2		
O PanasiaII/FAR09/NIG14	4 (2^{c})		
A Iran05/SIS10/CAN14		7(2*)	
A Iran05/BAB-12		1	
A Iran05/BIN-13		1	
Asia1/Sindh08/BAL13			0
Asia1/Sindh08/ADA14			1 (2^{c})

Note:

Numbers of r value results indicated here are matched with their own strains

*: not matched with old vaccine strain, A TUR06; matched with ATUR11

c: continued

ARC-OVI

Vaccine matching is undertaken using VNT to establish r-values against the following strains: SAT 1 (Topotype I: KNP/196/91, SAR/9/81, Topotype II: BOT/1/06 and topotype III: ZAM/1/06), SAT 2 (Topotype I: KNP 19/89 and topotype II: ZIM/7/83) and SAT 3 (topotype I: KNP 10/90). Capacity to determine vaccine matching using ELISA approaches is also being established in the laboratory.

SENASA and PANAFTOSA

Within pool 7, well established vaccine matching capabilities are available at the region reference centers for the vaccine antigens that are widely used in South America. These antigens are: O1 Campos, A24 Cruzeiro, A/Arg/2001 and C3 Indial. In South America, the in-vivo Protection against Podal Generalisation (PGP) test is used to establish vaccine potency. This test involves 16 vaccinated + 2 control animals which are subsequently challenged with a viral dose of 10,000 BID50%.

WRLFMD

Pools 1, 2, 3, 4, 6: Vaccine matching data from WRLFMD: serotype O, A, Asia-1, SAT 1 and SAT 2: 73 field isolates (further details of these reports can be found at: http://www.wrlfmd.org/ref_labs/fmd_ref_lab_reports.htm.

Serotype A vaccine matching results from WRLFMD (n=22 isolates):

Sample Reference	A/ERI/98	A/Iran/05	A22 Iraq	TUR/20/06	A/TUR/06	A MAY 97
TAN/07/2013	N	M	M		M	
TAN/14/2013	M	N	N		Borderline	
TAN/26/2013	M	N	N		Borderline	
AFG/5/2013		N	N		M	
AFG/19/2013		N	N		M	
EGY/21/2013	N	N	N		N	
IRN/2/2014		N	N	N	N	
IRN/3/2014		N	N	N	M	
IRN/4/2014		N	N	N	M	
TUR/41/2013		N	N		N	
TUR/2/2014		N	M		N	
TUR/16/2014		N	N		N	
NIG/3/2013	M	N	N		M	M
NIG/7/2013	M	N	N		Borderline	Borderline
PAK/10/2014		M	M		M	M
PAK/22/2014		N	N		M	M
TAI/4/2014		N	M		N	N
MAY/12/2013		N	M		M	M
MAY/20/2013		N	M		M	M
MAY/23/2013		N	M		N	M
CAR/4/2013		N	N		M	
CAR/10/2013		N	N		M	

Serotype O vaccine matching results from WRLFMD (n=36 isolates):

Sample Reference	O 3039	O1 Manisa	O TAW/98	O TUR/5/09	O BFS
LIB/17/2013	M	N	N	M	
LIB/22/2013	M	M	M	M	
SAU/1/2014	Borderline	N	M	M	
UAE/1/2014	M	Borderline	M	M	
UAE/2/2014	M	Borderline	M	M	
ISR/1/2014	M	N	M	M	
ISR/5/2014	M	M	M	M	
NEP/13/2012	M	Borderline	M	M	
NEP/21/2012	N	N	M	M	
NEP/18/2013	M	N	M	M	
NEP/1/2014	M	N	M	M	
IRN/17/2013	M	N		M	
IRN/1/2014	M	N		M	
TUR/3/2014	M	M	M	M	
TUR/9/2014	M	M	M	M	
EGY/10/2014	M	N		M	
EGY/18/2014	M	N		M	
ETH/12/2013	Borderline	N		M	
ETH/22/2013	M	N		M	
ALG/1/2014	Borderline	N	Borderline	M	N
CAM/2/2013	Borderline	N	M	M	
HKN/13/2014	N	N	N		
LAO/1/2013	N	N	M	N	
NIG/3/2014	M	N			
NIG/4/2014	M	N			
PAK/17/2014	N	N	N		
PAK/24/2014	M	M	M		
SKR/6/2014	M	N	M		
SRL/1/2013	M	N	M	M	N
SRL/1/2014	M	Borderline	M	M	
TAI/10/2013	N	N	M	M	
TUN/1/2014	Borderline	N	Borderline	M	N
SRL/28/2014	M	N	M	M	N
SRL/30/2014	M	N	M	Borderline	N
MAY/2/2014	M	Borderline	Borderline	N	
MAY/3/2014	M	M	M	M	

Serotype Asia-1 vaccine matching results from WRLFMD (n=5 isolates):

Sample Reference	IND/8/79	Asia1 Shamir
IRN/15/2013	N	N
TUR/6/2014	N	N
TUR/23/2014	N	N
PAK/19/2014	N	N
PAK/20/2014	N	N

Serotype SAT 1 vaccine matching results from WRLFMD (n=3 isolates):

Sample Reference	SAT1/RHO
TAN/22/2013	N
TAN/27/2013	N
TAN/30/2013	Borderline

Serotype SAT 2 vaccine matching results from WRLFMD (n=7 isolates):

Sample Reference	ERI 3218	ZIM/7/83
EGY/20/2014	M	N
EGY/22/2014	M	M
ETH/23/2010	M	N
ETH/24/2010	M	N
NIG/17/2011	N	N
NIG/3/2012	N	M
CAR/16/2013	M	M

Appendix 3: Nucleotide sequence analysis

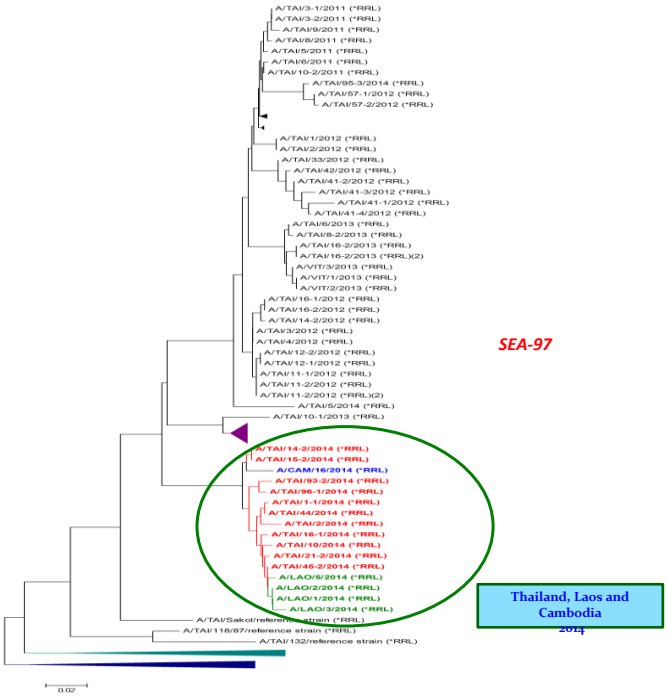
FMDV nucleotide sequence data for phylogenetic analysis (869 sequences which include some complete viral capsids sequences* and complete genomes†)

Lab	Sample source	O	A	Asia-1	SAT-1	SAT-2	SAT-3
ARRIAH	Russia	26	19†				
	Mongolia	6	1†				
	Kyrgyzstan		3				
LVRI	China	8	29				
	North Korea	2*	5*				
	South Korea	1					
OVI	South Africa					7*	
	Mozambique					2*	
BVI	Zimbabwe					8	
	Botswana				7	2	
	Mozambique					5	
	Mali					2	
RRLSEA	Cambodia	6	1				
	Lao PDR		4				
	Thailand	19	25				
PD-FMD	India	147*†		8*			
	Nepal	8*					
IZSLER	Algeria	4					
	Tunisia	2					
WRLFMD	Afghanistan	4	9				
	Algeria	3					
	Bahrain	3					
	Botswana				3	2	
	Cambodia	3					
	Cameroon		4			9	
	Egypt	20	6			5	
	Ethiopia	35	2			2	
	Hong Kong	8					
	Iran	7	18	1			
	Israel	6					
	Laos	3	3				
	Malaysia	10	5				
	Mongolia	5					
	Mozambique					4	
	Nepal	23					
	Nigeria	10	9			13	
	Pakistan	23	7	4			

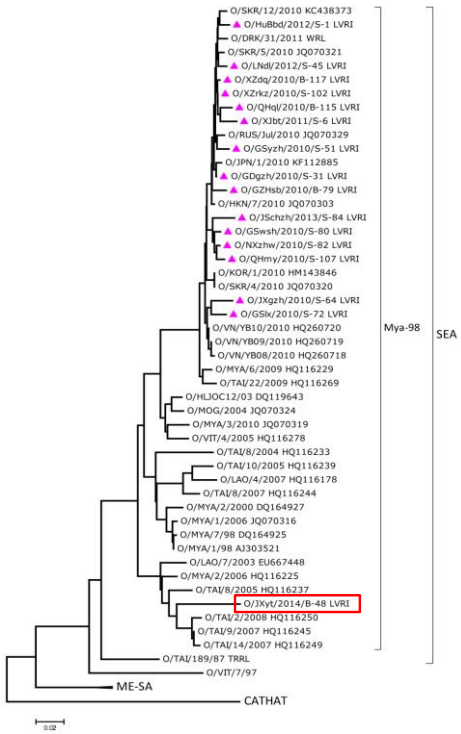
Lab	Sample source	O	A	Asia-1	SAT-1	SAT-2	SAT-3
	Saudi Arabia	5†					
	South Korea	1					
	Sri Lanka	23					
	Tanzania		6		11		
	Thailand	2	19				
	Tunisia	2					
	Turkey	10	17†	2			
	UAE	2					
	Vietnam	12	13				
	Zimbabwe					6	
SAP	Turkey	53	51	14			
Kenya	Kenya				11	12	
DTU	Uganda						1†
TOTAL		**502**	**256**	**29**	**32**	**79**	**1**

†Complete genome sequences were reported from ARRIAH (6 total – 5 serotype A from Russia, and 1 serotype A from Mongolia), PD-FMD (12 serotype O from India), WRLFMD (10 total, from Turkey, Mozambique, Libya, Bhutan and Saudi Arabia)

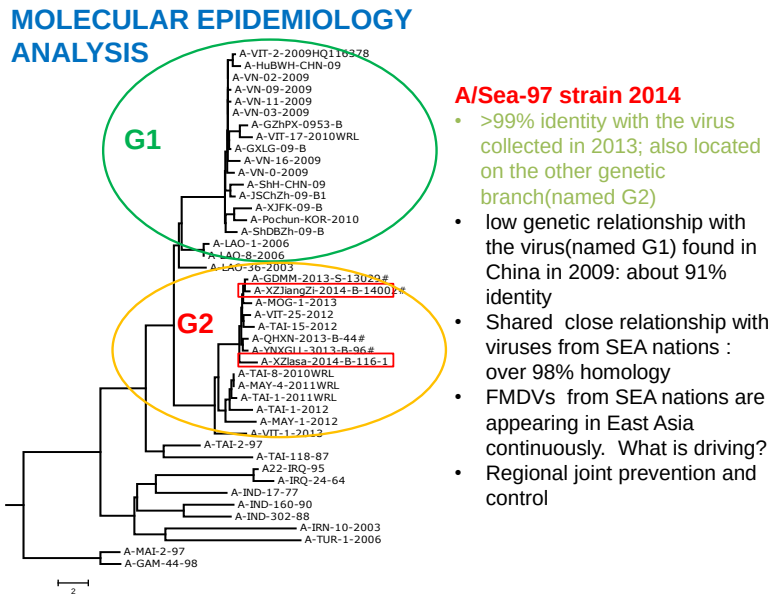
Appendix 3a: Selected Phylogenetic trees



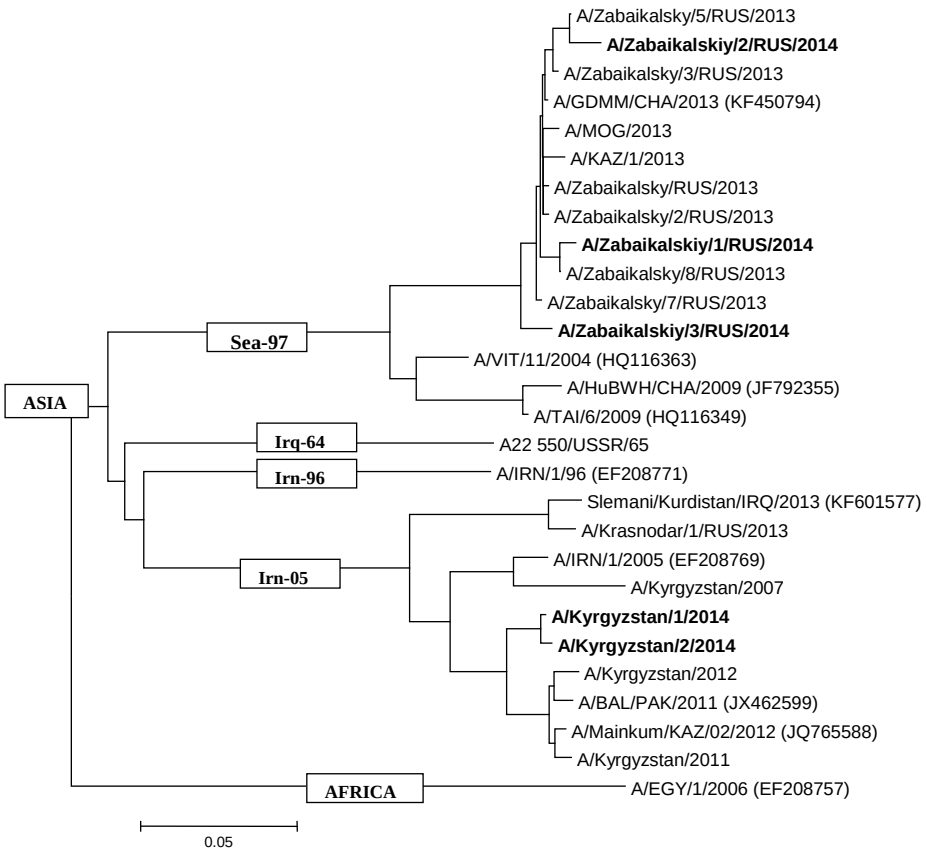
Appendix 3a-1: Serotype A sequence analysis from RRLSEA, Pakchong



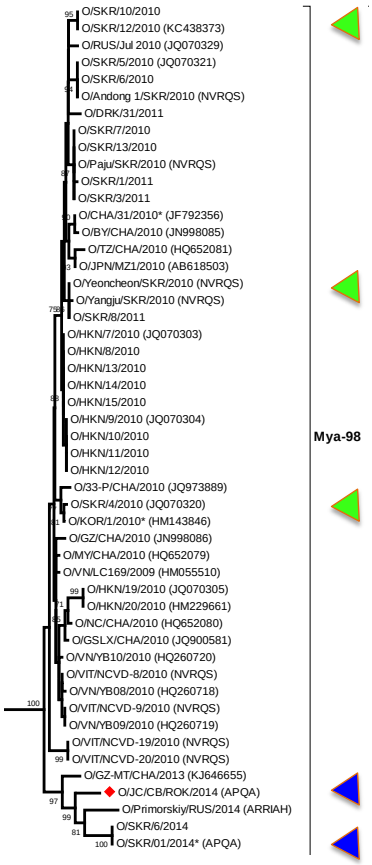
Appendix 3a-2: Serotype O sequence analysis from China (LVRI, China)



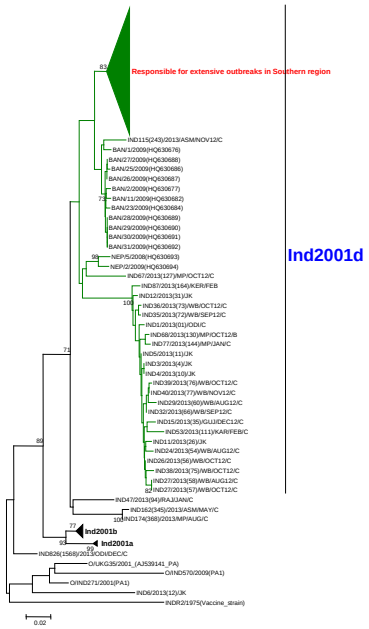
Appendix 3a-3: Serotype A sequence analysis from China (LVRI, China)



Appendix 3a-4: Serotype A sequence analysis from Russia and Kyrgyzstan (ARRIAH, Russia)



Appendix 3a-5: Serotype O sequence analysis from the Republic of Korea (WRLFMD)

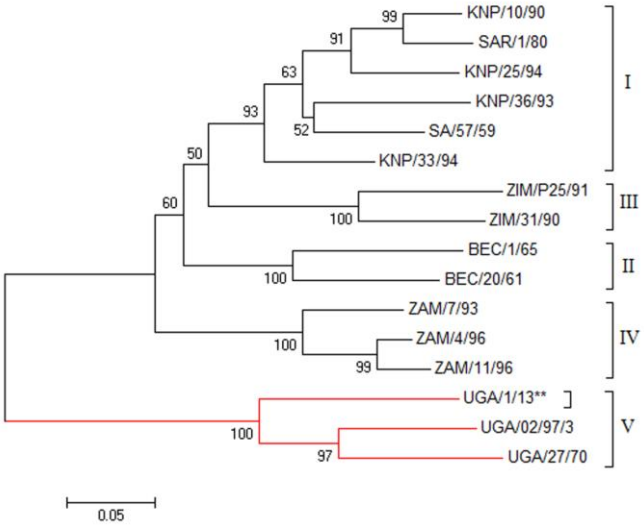


Serotype O

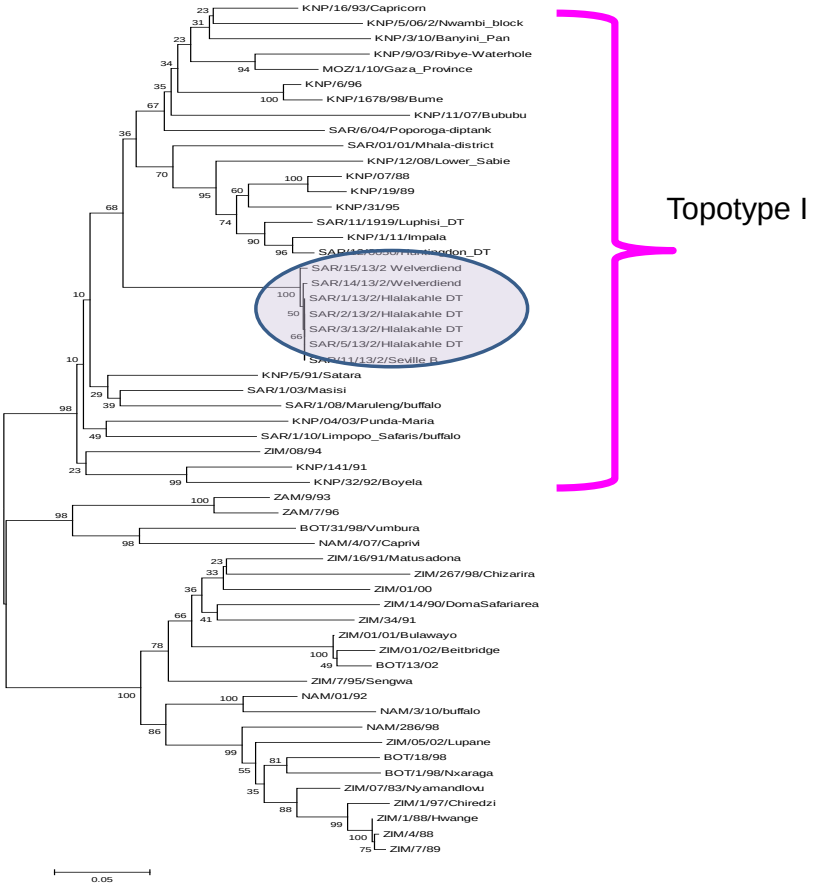
- A total of 146 field isolates were subjected to complete 1D/VP1 region sequence analysis.
- In the NJ tree, 145 of 146 isolates grouped within O/ME-SA/Ind2001 lineage indicating its complete dominance in the field.
- The lineage, which re-emerged in the year 2008, continued its supremacy in the field by displacing the then prevalent O/ME-SA/PanAsia lineage.
- Since its initial identification in the year 1997, the lineage has diversified globally in to at least four sub-lineages (Ind2001a, b, c and d).
- The isolates of O/ME-SA/Ind2001 lineage currently circulating in the country groped precisely in sub-lineage Ind2001d.
- The sub-lineage Ind2001d also prevails in neighboring countries including Bangladesh, Bhutan and Nepal.

Appendix 3a-6: Serotype O sequence analysis from India (PD-FMD)

Appendix 3a-6: Serotype O sequence analysis of emerging the O/ME-SA/Ind2001 lineage (WRLFMD, IZSLER, PD-FMD)



Appendix 3a-8: Serotype SAT 3 sequence analysis from Uganda (DTU, Denmark)



Appendix 3a-9: Serotype SAT 2 sequence analysis from South Africa (OVI)

Appendix 4: Report from the 9th OIE/FAO FMD Laboratory Network Meeting Brescia, Italy: 26th – 27th November 2014

Day 1:

- An introductory welcome and overview of IZSLER was provided by Dr Giorgio Varisco (Technical Director of IZSLER)
- Global situation for FMD (Data from WRLFMD, presented by Dr Don King)

  During 2014 (to date), 554 sample submissions have been received from 24 countries. Isolates generated from these samples are mainly serotype O and represent 5/7 FMDV serotypes (serotype C has not been detected since 2004 and serotype SAT 3 has not been detected at WRLFMD during 2014). Together with data provided from laboratories in the OIE/FAO FMD Network, this information is used to monitor the global distribution of FMDV, and to provide early intelligence about emerging lineages that may pose new threats. The recent spread of the O/ME-SA/Ind-2001 lineage is a tangible example of the important role played by laboratory data, and these FMD outbreaks in two countries in North Africa (Tunisia and Algeria) that were previous FMD-free (with vaccination) highlight the contribution of the Network to detect the spread of FMD. Opportunities to further increase the scope and impact of the Network activities were introduced (specific topics to be discussed later in the breakout sessions).

Summary of regional and country updates

- Southeast Asia (from RRL-Pakchong presented by Dr Somjai Kamolsiripichaiporn).

  The RRL-Pakchong provides laboratory support and capacity for pool 1 which includes countries that are either FMD endemic or FMD-free (without vaccination). During 2014, FMD samples have been received and characterised from Cambodia, Lao PR and Thailand. VP1 sequence data provides evidence for the circulation of a new lineage within serotype A (sub-lineage of A/ASIA/Sea-97), while serotype O sequences are all O/SEA/Mya-98. Dr Kamolsiripichaiporn summarized vaccine matching data for locally produced vaccine strains and international vaccines (data via WRLFMD) against representative field viruses. An overview of the results from an annual PTS organized by RRL-Pakchong was also presented.

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

  Recent results for clinical samples received from PR China (n=27, from 5 outbreaks) and DPR Korea (n=6) were presented. Samples from China have been characterized as either serotype O or serotype A, while samples from DPR Korea were serotype O (porcine origin) or comprised mixed serotypes O and A (cattle origin). No serotype Asia-1 viruses have been detected in China since 2009. Sequences for serotypes O (O/SEA/Mya-98) and A (A/ASIA/Sea-97) appear to represent new FMD virus lineages in China. As part of on-going active surveillance in China, additional samples (3045 OPF from cattle, sheep and goats, and 1120 LB from pigs) have been screened by real-time RT-PCR, and ~9,000 sera have been tested by LPBE and 3ABC ELISA for SP and NSP antibodies. Results from this active surveillance programme have identified additional FMD virus and antibody cases indicative of wider circulation in a number of Chinese provinces.

- Southern Africa (from ARC-OVI, South Africa presented by Dr Rahana Dwarka)

  In addition to specimens from South Africa, ARC-OVI has recently received samples from 5 other countries in Southern Africa (Botswana, Mozambique, Namibia, Swaziland and Zimbabwe). Sequence data collected during 2014 from outbreaks in Bushbuckridge (adjacent to the Kruger National Park, in a discrete location from previous outbreaks in 2012) were reported, showing that the causative FMD viruses are from the SAT 2 serotype (topotype I). There is evidence that some of these outbreaks have occurred in cattle receiving vaccine (at 3 PD50). Other SAT 2 outbreaks have occurred in Maputo, Mozambique. *In-vitro* cross-reactivity data has indicated that SAT2/ZIM/7/83 does not provide adequate cross-reaction to the majority of field strains in southern Africa, whereas SAT2/ZIM/14/90 and SAT2/SAR/3/04 cross-react more broadly to a panel of 28 SAT2 field isolates.

- Southern Africa (from BVI, Botswana presented by Dr George Matlho)

  Results for samples collected from 5 countries (Botswana, Mozambique, Namibia, Zimbabwe and Mali) were presented. Within Botswana FMD outbreaks due to SAT1 (topotype I –WZ) have been reported in Ngamiland in June and October 2014. Samples collected from Zimbabwe in 2010 and 2014 represented SAT 2 topotypes I and II respectively; and Mozambique SAT 2 topotype I. All isolates for SAT 1 virus showed good match to currently used local vaccine strains (SAT 105 and SAT 109) and SAT 2 viruses against SAT251 as determined by 2D-VNT method. A new SAT 2035 vaccine strain has been adopted specifically for Ngamiland region of Botswana and has been used since 2013. FMDV-specific SAT 2 sequences were detected in samples from Mali by PCR, although no isolation was made due to poor preservation of samples during shipment to BVI. Results from BVI were confirmed by WRLFMD and CODA-CERVA. In conclusion, SAT1 and SAT 2 virus are predominant in both cattle and buffalo, while SAT 3 had the lowest significance in the region. All countries which submitted samples for vaccine matching were able to control outbreaks in cattle with the use of the locally produced vaccine.

- Nigeria (from NVRI, Vom presented by Dr David Ehizibolo with Dr Kris De Clercq from CODA-CERVA)

  A brief summary of the laboratory diagnostic capacity at NVRI was presented. During 2014, a panel of 37 representative samples from 8 Nigerian states has been sent to the WRLFMD for analysis (work funded by EuFMD). Results were presented showing FMD virus isolates recovered from these samples were from serotypes O, A and SAT 2. Additional tissue and probang samples have been tested by real-time RT-PCR at CODA-CERVA (as part of an OIE Twinning project), while NSP serosurveys conducted in Nigeria during 2014 have shown that only 11% (n=360) of camel sera and 1.5% (n=800) of pig sera were positive for FMDV.

- Ethiopia (from NAHDIC presented by Dr Hagos Asgedom)
  A recent study has shown that approximately one-third of the districts in Ethiopia are affected by FMD outbreaks on an annual basis with the highest incidence occurring in central Ethiopia.Tissue, swab, probang and sera samples (n=2040) have been tested this year for the presence of FMDV and FMD virus-specific antibodies. Out of the total samples, only 18.18% (n=371) were positive for FMDV and FMDV antibodies. Of the FMD virus and antibody positive samples, serotype O was most frequently detected: the remainder of samples collected during 2014 being serotype A followed by SAT2. Locally produced vaccine (from the National Veterinary Institute: NVI) for serotypes O, A and SAT 2 is available, although the numbers of doses are insufficient (and too expensive) for wide-scale use.Kenya (from FMD Laboratory, Embakasi presented by Dr Abraham Sangula)

  Results for specimens (n=175) received to the laboratory during 2014 from Kenya were presented. FMD virus positive samples comprised serotypes O (n=81), A (n=3), SAT 1 (n=15) and SAT 2 (n=21) and sequence analysis of these isolates was assisted by DTU, Denmark. Dr Sangula also provided an overview of the Eastern Africa FMD Laboratory Network (EALN-FMD) that encompasses 12 countries in the region. The objectives of the EALN-FMD are (1) to improve the quality of FMD laboratory assays in Eastern Africa, (2) to complement activities of each individual country in fulfilling the objectives of the Progressive Control Pathway for FMD (PCP-FMD), (3) to understand global and regional FMDV circulation, and (4) undertake research and make recommendations on labs, vaccines and FMD control. Based on data from the Network, conjectured epidemiological patterns indicate that cases due to serotype O are increasing in Kenya, Uganda and South Sudan, while serotypes A, SAT 1 and SAT 2 are more prevalent to the countries in the south of the region (including Tanzania).

- Asia (from FGBI-ARRIAH presented by Dr Alexsei Scherbakov)

During 2014, FGBI-ARRIAH has tested samples (n=282) collected from FMD outbreaks in the Russian Federation, Mongolia and Kyrgyzstan. VP1 (and selected complete genome) sequence data highlight putative epidemiological links with other countries in East Asia and Southeast Asia for the O/SEA/Mya-98, O/ME-SA/PanAsia and A/ASIA/Sea-97 lineages. Outbreaks (serotypes O and A) in Russia have occurred at three locations along the southern border with Mongolia and China. A 30km buffer zone has been established along the southern border where all ruminants (cattle and sheep) are vaccinated. A representative field isolate for the O/ME-SA/PanAsia lineage generated positive antigenic matching data against 4 vaccines (O-Manisa, O/PanAsia-2, O/RUS/2010 and O/PanAsia), while an O/SEA/Mya-98 isolate was only positively matched against O-Manisa and O/RUS/2010. A recent serotype A isolate (A/Zabaikalsky/14) did not match with A22 550 and only generated borderline data for two other vaccines (A/Turkey/06 and A/Iran/05) indicating that a new vaccine may be required.

- South Asia (presentation provided by Drs Saravanan Subramaniam and Bramhadev Pattnaik from PD-FMD)

  Unfortunately no-one from PD-FMD could attend the meeting. However, Drs Pattnaik and Subramaniam kindly provided a presentation that summarized the recent activities of PD-FMD. In India and Nepal, FMDV serotype O continues to dominate and has accounted for 97.5% of the total specimen submissions during the past two years; of these 145/146 samples sequenced were from the O/ME-SA/Ind-2001 lineage (sub-lineage d) which has displaced the O/ME-SA/PanAsia lineage across the Indian sub-continent. A summary data for Indian vaccine strains shows that they continue to be matched against field strains from India (% of matched strains (2012-2014): 86.0%, 28.1% and 73.5% for O/INDR2/1975, A/IND40/2000 and Asia1/IND63/1972, respectively).

- North Africa (from IZSLER presented by Dr Emi Brocchi)

  Dr Brocchi provided an overview of the important contribution made by IZSLER to provide diagnostic and technical training assistance during the recent FMD O/ME-SA/Ind-2001 outbreaks in North African countries (Libya, Tunisia and Algeria). In addition to testing of clinical samples, IZSLER has also undertaken serological studies: in Libya (>3000 tests) to detect SP and NSP antibodies; and in Tunisia to demonstrate the potential of the O-BFS vaccine to generate a booster response in cattle and in sheep (following previous vaccination with O-Manisa/O-TUN/99). ISZLER (in partnership with WRLFMD) has supplied a range of ELISA test kits for the detection and characterization of FMD virus antigen and FMD virus-specific antibodies to ~20 countries (in Asia, Africa and FMD-free countries) during 2014.

- South America (from PANAFTOSA presented by Dr Rossana Allende, and from SENASA presented by Dr Eduardo Maradei)

  No clinical cases of FMD have been reported in 2014 across the entire South American continent, and it is now >35 months since the last FMD outbreak. At the OIE meeting in May 2014, the FMD free zones (with and without vaccination) were extended in a northerly direction to include a larger part of the South American continent. A focus at PANAFTOSA has been to provide laboratory support to the serological surveys that are underway in Ecuador where 3,649 samples have been tested for PVM purposes and > 20,000 sera have been screened using the 3ABC (I-ELISA)/EITB to attempt to detect circulating FMDV. During 2014 training courses have been offered by PANAFTOSA in laboratory diagnostics (cell culture, PCR, ELISA/EITB) and biorisk management, while SENASA has provided training to AU-PANVAC, Ethiopia and to laboratories in Vietnam and Cambodia. Dr Maradei highlighted two recent publications describing the antigenic characterization of FMD viruses from South America and the results from cross-protection studies.

- Turkey (from SAP-Ankara presented by Dr Naci Bulut)

  FMD continues to circulate in Turkey, although the number of outbreaks has declined sharply since July 2013, particularly since spring 2014. During this year, SAP has tested 270 samples from clinical cases in the country. This material generated isolates from 3 FMD serotypes O (n= 100), A (n=91) and Asia-1 (n=24). The predominant lineages currently circulating in Turkey are O/ME-SA/PanAsia-2 (FAR-09), A/ASIA/Iran-05 (SIS-10) with sporadic cases due to Asia-1 (Sindh-08 lineage). In addition, >100,000 sera from Turkey have been tested for a variety of purposes including post-outbreak sero-monitoring, active surveillance surrounding the Kurban festival, and assessment of vaccine performance in the field. Dr Bulut also briefly outlined the activities of the West Eurasia Laboratory Network (WELNET FMD), including FMD surveillance activities in other countries such as Pakistan, Iran and Kyrgyzstan.

- European laboratory activities (from ANSES, presented by Dr Labib Bakkali Kassimi)

  This presentation summarized recent work undertaken by ANSES to characterise FMD field viruses from West Africa (Benin, Ghana, Nigeria and Cameroon) and Pakistan. In addition, ANSES are actively involved in the facilitation of training and technology transfer to a number of West African countries (particularly those that are French-speaking) and in 2015 will lead a new project to genetically and antigenically characterise FMDV strains collected from Tunisia. Research projects at ANSES have recently developed a new real-time RT-PCR (which includes an internal control) to detect FMDV RNA, novel RT-PCR assays to type FMD viruses in West Africa, and have evaluated simple ways to transport FMD virus positive samples to reference laboratories.

- European laboratory activities (from DTU-Lindholm, presented by Dr Graham Belsham)

  DTU have recently participated in a DANIDA funded project to investigate the epidemiology of FMD in Uganda that has highlighted the presence of 5 FMDV serotypes (O, A, SAT 1, SAT 2 and SAT 3) in the last 2-3 years. The SAT 3 virus was detected in a long-horn Ankole calf translocated to the buffalo/cattle interface. These studies defining the genetic diversity of FMD viruses from Uganda highlight the impracticalities of the current topotype definitions for some SAT viruses (specific point covered later in the meeting and by the proposed working group).

- North American laboratory activities (from FADDL, USDA presented by Dr Hernando Duque)

  In addition to domestic submissions from suspect FMD cases in the USA, during 2014 FADDL has received samples from Jordan (n=6) that were all FMD negative. Dr Duque provided a brief overview of the North American Foot-and-Mouth Disease Vaccine Bank (NAFMDVB) that tests and stores commercial FMDV vaccines for use in the USA, Canada and Mexico. Results from recent in-vivo cross-protection studies using three monovalent FMD emergency vaccines (A22 Iraq, A/Arg/2001 and A/May/97) and subsequent challenge by contact at 7 days post vaccination (dpv) with A22 Iraq virus were presented. Protection achieved with these vaccines was 80%, 0% and 40% respectively. In a follow up study 37.5% of the bovines vaccinated with the A Malaysia vaccine were protected against a needle challenge with A22 Iraq virus at 7 dpv.

- North American laboratory activities (from NCFAD, Canada presented by Dr Charles Nfon)

  Seventy domestic submissions from suspect FMD cases in Canada were received at the NCFAD in 2014 and all tested negative. The NCFAD also provided material and coordinated proficiency testing for the Canadian Animal Health Surveillance Network laboratoriesAn overview was provided of two collaborative FMDV projects involving NCFAD and (i) Ministry of Primary Industries, New Zealand (diagnostic test methods in red deer), and (ii) CSIRO, Australia (early vaccine protection in sheep).

- Australian laboratory activities (from AAHL, presented by Dr Wilna Vosloo)

  AAHL coordinates a national PT exercise for laboratories in the Australian LEADDR network. A research project has focused on the antigenic properties of serotype A viruses from Southeast Asia (undertaken in collaboration with RRL-Pakchong) using the LPBE test.

  Topics for breakout groups:

- Enhancing the global OIE/FAO FMD Laboratory Network
- A new framework for European/African FMDV surveillance
- Priorities for laboratory capacity and training

Day 2:

Summary of points and recommendations from the breakout sessions:

Opportunities to **Enhance the Network** were discussed including whether we should learn from (i) best practice, (ii) network organization and (iii) mechanisms used for communication employed by other OIE/FAO Networks such as OFFLU. The opinion of the delegates was that the specific governance of OFFLU was not appropriate for the OIE/FAO FMD Laboratory Network, particularly since GFRA already exists as a successful research network for FMD. However, the organization of OFFLU into specific thematic working groups is an idea that could be explored, and it was suggested that the core OIE/FAO FMD Network Partners could consider the constitution of the Network as a topic for discussion at next year's meeting (in a closed session). For example, the Network currently focuses on laboratory outputs which would benefit from formal interaction with epidemiologists and research on the socio/economic impacts of FMD. Another example of a possible gap in the current Network could be addressed by establishing a **new framework for European/African FMD surveillance**. This type of collaborative group could seek OIE support, and would provide a formal recognition to legitimize sample collection, testing and reporting in under-sampled endemic pools in Africa for those laboratories within Europe that do not have an official OIE or FAO status. However, the constitution of such a group should endeavor to be inclusive and (where necessary) should aim to engage with other members of the Network (such as those laboratories outside of Europe and Africa). Together, these activities should aim to provide strength to the regional lab networks to address gaps and priorities for **laboratory capacity and training** and to facilitate the recognition of "Leading Regional Laboratories".

Opinion from the core members (OIE and FAO Reference Laboratories) indicated that it might be possible to invite "associate" members to the Network, although an agreement (LoU or MTA) may be required to properly document the roles and responsibilities of these new laboratories. Furthermore, the Network should ensure that the meeting does not get too large since this might be a detriment to the exchange of real-time data between the core participants which currently works very well.

Actions:

- Individual core members were invited to consider proposals regarding the composition of the Network and the format of the meeting - provide feedback to the secretariat (see workplan for 2015 – below).
- ANSES will prepare a document to outline a collaborative network for FMD in Africa (interested parties should contact Dr Labib Bakkali Kassimi or Dr Stéphan Zientara at ANSES.

Antigenic Characterisation of FMD virus field isolates

This session was guided by three presentations from Drs Kris De Clercq (CODA-CERVA), Anna Ludi (WRLFMD) and Aldo Dekker (CVI-Lelystad) who introduced the approaches currently used to define the antigenic properties of FMD virus isolates, and the limitations of using these methods for vaccine selection. The goal of achieving equivalence of results between different methods (such as VNT and LBPE) and different laboratories is constrained by the inherent variability of the tests used. Furthermore, there is sometimes confusion in endemic settings regarding how to interpret vaccine matching reports provided by Network laboratories (such as WRLFMD) that focus on the emergency use of vaccines in FMD-free settings.

In the short term, it was agreed:

[1] that the following standardized method should be employed to generate BVS for vaccine matching studies (particularly those that are used to recommend vaccine antigens for FMD-free without vaccination regions):

- Monovalent single vaccine
- Adjuvant (use commercial formulated product)
- > 3PD50 or >6PD_{50} (nature of product should be defined) or >=80% PGP
- 21-28 days post vaccination
- No Boost
- Pool of five cattle with individual titres mid-range (i.e. no low responders (may need to define criteria for exclusion)

[2] Where possible, vaccine matching reports should include details of the individual titres

[3] To establish a Network working group to recommend practical approaches that can be used for vaccine selection in endemic and FMD-free with vaccination settings (see Workplan 2015 – below).

Virus isolate and lineage nomenclature (presentation by Dr Don King – WRLFMD)

In view of the increasing amount of data that is shared between laboratories, this presentation outlined the motivation to establish a standardized nomenclature for FMD samples (covering viral isolates and sequences), FMD viral topotypes and lineages, that might also include vaccines and antisera. It was agreed that that these issues would be addressed by a working group to be established during 2015 (see Work Plan below).

Sequence databases (update provided by Dr Don King – WRLFMD)

The concept of the "Open-FMD" system was introduced last year by Dr Filip Claes from FAO and was briefly summarized in this year's presentation from FAO by Dr Metwally. At the recent 3rd Global Conference of OIE Reference laboratories (Incheon, South Korea), the OIE made a recommendation that OIE Reference centres "*contribute to the design of the future OIE Platform for the collection and management of genomic sequences in animal health, in particular when notifying positive diagnostic results to the OIE, to be used within the WAHIS mechanism*". In the context of FMD, WRLFMD have discussed these two approaches with OIE and FAO in an attempt to harmonize the efforts as well as reduce redundancy between the two possible systems. As these systems develop it will be critical to ensure that real-time links are maintained between the different data sources, and that tools are provided to the different Network laboratories to allow them to analyse data and generate reports.

Update from OIE (presented by Dr Joseph Domenech)

Dr Domenech's talk covered the OIE's activities to support FMD control and eradication, and an update on FMD GF TADs Working Group activities. The talk included a brief summary of the OIE Reference Laboratories, regional activities, and OIE standards (horizontal generic approaches, and vertical disease specific chapters) relating to the control of livestock diseases. The GF TADs working group is collecting country data regarding PCP status, and is assisting countries to prepare national FMD control programmes (in partnership with the activities of the FAO – see below).

Update from FAO (presented by Dr Samia Metwally)

In addition to describing the FAO's activities during 2014 (including an update about "Open FMD"), this presentation also reviewed the implementation of the PCP-FMD since 2012. Within the endemic pools gaps still remain in West Africa where many countries are still at PCP stage 0, and in East Africa where the majority of countries are still at PCP stage 1. However, it is encouraging that the PCP-FMD approach and reinforcement of veterinary services within countries are gradually gaining acceptance, and now ~60 countries are engaged in in this programme in several of the FMD endemic pools. This presentation also briefly reviewed FAO missions to DPR Korea, Uganda, Tunisia (an OIE mission in collaboration with EuFMD and with FAO's participation), Algeria and Egypt.

Update from EuFMD (presented by Dr Kees van Maanen)

An overview of the activities of EuFMD was provided by Dr van Maanen including the top-level objectives to (1) improve readiness for FMD crisis management by Members, (2) reduce the risk to Members of an FMD incursion from the neighborhood, and (3) promote the global FMD control strategy. EuFMD will fund small applied research projects and current have a call for proposals.

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 Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna "Bruno Ubertini" (IZSLER), Brescia, Italy. The OIE/FAO FMD Laboratory Network warmly thanks Giorgio Varisco (Technical Director of IZSLER) for hosting the evening meal, and Drs Emi Brocchi and Santina Grazioli and colleagues for all their help and hospitality during our stay in Italy. Thanks also go to Sarah Belgrave and Trish Ryder who provided assistance to organize this meeting at WRLFMD.

Draft Work Plan for 2015

1: Scope 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
- 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, and by OIE and FAO
- 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
- Core Network partners to review MoU documentation outlining the establishment and coordination of the network

2: Virus nomenclature:

- Establish a **Network Working Group** to address isolate, strain and topotype nomenclature and to provide recommendations about coherent naming of FMD viruses.
  Initial priorities for working group:
  [1] To propose common nomenclature to be used to describe samples and sequences (FMDV positive [and FMDV negative?] specimens)
  [2] To define topotype nomenclature for SAT serotypes (including nucleotide sequence cut-offs for different serotypes)
  [3] To explore formal approaches (such as establishing a standing Network sub-group committee) to oversee the naming of new FMD viral lineages
  Proposed Members: *Nick Knowles, Wilna Vosloo, Fuat Ozyoruk, Alexi Scherbakov, Rahana Dwarka, representative from PDFMD (tbc).*

3: FMD vaccines and recommendations for vaccine matching:

- Network partners will provide feedback and support for the OIE/FAO PVM guidelines
- Establish a **Network Working Group** to explore vaccine recommendations for endemic and FMD-free (with vaccination) settings
  Initial priorities for working group:
  [1] Review data from previous PT exercise with a view to publishing this data
  [2] 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.
  [3] Explore whether 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 for this purpose that can be rolled-out to members within the Network.
  Proposed Members: *Kris De Clercq, Emi Brocchi, Anna Ludi, Rosanna Allende, George Matlho, China (tbc), PDFMD (tbc), Kees van Maanen (observer, tbc).*

4: Communication:

- WRLFMD to coordinate the preparation of an Annual Report
  Agreed timelines for preparation of 2014 report: - Network partners to provide feedback on pools they work closely with. Network members to provide an update to WRLFMD for report (include data for November and December 2014)
  - Final summaries: January 2015
  - Draft Report: February 2015
  - Report Published: March 2015
- 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
- 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.

Meeting Delegates:

Name	Email address
Abdulnaci Bulut	nacib@sap.gov.tr
Abraham Sangula	aksangula@gmail.com
Aldo Dekker	aldo.dekker@wur.nl
Alexey Mishchenko	mischenko@arriah.ru
Alexsei Scherbakov	ascherbakov@arriah.ru
Anna Ludi	anna.ludi@pirbright.ac.uk
Bernd Haas	bernd.haas@fli.bund.de
Charles Nfon	Charles.nfon@inspection.gc.ca
David Ehizibolo	kingdavid_e@yahoo.com
David Lefebvre	David.Lefebvre@coda-cerva.be
Donald King	donald.king@pirbright.ac.uk
Eduardo Maradei	emaradei@yahoo.com
Emi Brocchi	emiliana.brocchi@izsler.it
Giorgio Varisco	giorgio.varisco@Izsler.it
Graham Belsham	grbe@vet.dtu.dk
Hagos Asgedom Weldeabzgi	haghad2012@yahoo.com
Hernando Duque	Hernando.Duque@aphis.usda.gov
Jijun He	hejijun1979@163.com
Joseph Domenech	j.domenech@oie.int
Kees VanMaanen	Cornelius.VanMaanen@fao.org
Kris De Clercq	krdec@coda-cerva.be
Labib Bakkali Kassimi	labib.bakkali-kassimi@anses.fr
Maria Teresa Scicluna	maria.scicluna@fao.org
Min Kyung Park	m.park@oie.int
Mpolokang Elliot Fana	efana@bvi.co.bw
Onkabetse George Matlho	gmatlho@bvi.co.bw
Qiang Zhang	qzhang1616@sohu.com
Rahana Dwarka	DwarkaR@arc.agric.za
Romphruke Udon	romphrukeudon@yahoo.com
Rossana Allende	rallende@paho.org
Samia Metwally	Samia.Metwally@fao.org
Santina Grazioli	santina.grazioli@izsler.it
Somjai Kamolsiripichaiporn	somjaik@dld.go.th
Wilna Wosloo	Wilna.Vosloo@csiro.au