



# WRLFMD Quarterly Report

## April-June 2013

Reference Laboratory Contract Report

7/11/2013  
WRLFMD



This page deliberately blank



**OIE/FAO Reference Laboratory Contract Report<sup>1,2</sup>  
April-June 2013**

**Foot-and-Mouth Disease**

---

<sup>1</sup>N.B. The content of this report is the property of WRLFMD®, The Pirbright Institute. For presentation, publication or any other public use, please contact Dr. Jef Hammond, The Pirbright Institute, [jef.hammond@pirbright.ac.uk](mailto:jef.hammond@pirbright.ac.uk).

<sup>2</sup> Copies of all the individual reports cited herein can be obtained from Dr. Jef Hammond, The Pirbright Institute, [jef.hammond@pirbright.ac.uk](mailto:jef.hammond@pirbright.ac.uk).

**Editor's Note:**

Please note that Dr Jef Hammond is leaving the Pirbright Institute on Monday 15<sup>th</sup> July to take up the position of director of the Elizabeth Macarthur Agricultural Institute in New South Wales Australia

<http://www.dpi.nsw.gov.au/research/centres/emai>

For future FMD reference laboratory enquiries please contact Don King ([donald.king@pirbright.ac.uk](mailto:donald.king@pirbright.ac.uk)) or David Paton ([david.paton@pirbright.ac.uk](mailto:david.paton@pirbright.ac.uk)).

**Summary****ASIA***Bhutan*

A single sample from Bhutan, collected from cattle in Chukha on 06/06/2013 was identified as **FMD type O**. Genotyping showed it to belong to the ME-SA topotype, Ind-2001d lineage and related to viruses from the Indian sub-continent.

*Cambodia*

Two samples from the Kratie province, collected from cattle in September 2012, were identified as **FMD type O**. Genotyping showed them to belong to the ME-SA topotype, PanAsia lineage. This lineage is currently circulating in Southeast Asia and has reached P.R. China and East Kazakhstan.

*PR China*

Both **FMD type O** and **type A** have been reported in China (see table below). No recent genotyping has been reported, so it is not clear how these outbreaks relate to each other.

Type	Date	Location	Host
A	08/04/2013	Hailipaiquke Village, Luopu, Hetian, XINJIANG	Cattle
A	15/05/2013	Xiaoquzi village, Gangou, Urumchi, XINJIANG	Cattle
A	12/04/2013	Kare Village, Rikaze, TIBET	Cattle
A	02/05/2013	Tajie village, Tajie, Lasa, TIBET	Cattle
A	10/05/2013	Jiesha village, Naidong, Shannan, TIBET	Cattle
A	24/05/2013	Yongjiu village, Bayi, Linzhi, TIBET	Cattle
A	30/05/2013	Qudengyangge village, Dangxiong, Lasa, TIBET	Cattle
A	07/05/2013	Chengbei district, Xining, QINGHAI	Cattle
A	09/06/2013	Heping village, Xianggelila, Diqing, YUNNAN	Cattle
O	20/05/2013	Zhonglou district, Zhonglou, Changzhou, JIANGSU	Pigs
O	08/06/2013	Longzhong, Gangba, Rikaze, TIBET	Cattle

*Hong Kong SAR, PRC*

A single sample, collected from pigs on the 02/04/2013 was received and **FMD type O** isolated. Genotyping revealed the virus to belong to the CATHAY topotype.

*Kazakhstan*

Three outbreaks of **FMD type A** were reported in cattle in East Kazakhstan in May and June 2013:  
 11/05/2013, Village Akshoka, Akshokinsky, Urdzharsky;  
 03/06/2013, Akhmetbulak, Djanaulsky, Tarbagatay;  
 07/06/2013, Manyrak, Manyrak, Tarbagatay.  
 No genotyping results have been reported.

*Lao PDR*

Five samples, collected from cattle on 28/12/2012 in Vientiane, were received. **FMD type O** was isolated from all five and genotyping showed these viruses belonged to the ME-SA topotype, PanAsia lineage.

*Palestinian Autonomous Territories*

An outbreak of FMD occurred in calves in the Rafah area of the Gaza Strip in early April 2013. Samples received showed **FMD type A** to be present and genotyping identified the virus as belonging to the ASIA topotype, Iran-05 lineage, BAR-08 sub-lineage and to be very closely related to viruses which are widespread in Egypt (see also the report on Egypt).

*Russian Federation*

Three distinct epizootics of **FMD type A** have been reported. One, consisting of three outbreaks in cattle, in Zabajkal'skij Kray, Eastern Russia (near the Chinese and Mongolian borders) during late March 2013. The second was in cattle near the Black Sea in Karachayev-Cherkesskaya Resp. and Krasnodarskiy Kray in June 2013. The third, again in cattle, was in Eastern Russia in Amurskaya Oblast at the end of June 2013. It is not clear if these three events are linked.

Date	Location
25/03/2013	Village Srednyaya - Borsya, Kalgansky raion, ZABAJKAL`SKIJ KRAY
28/03/2013	Village Duroi, Priargunsky raion, ZABAJKAL`SKIJ KRAY
28/03/2013	Village Priargunsk, Priargunsky raion, ZABAJKAL`SKIJ KRAY
03/06/2013	Mountain region Garnukha, Urupsky raion, KARACHAYEVO-CHERKESSKAYA RESP.
13/06/2013	Cossack village Pregradnaya, Urupsky raion, KARACHAYEVO-CHERKESSKAYA RESP.
15/06/2013	Rural community Solenoye, Mostovskiy raion, KRASNODARSKIY KRAY
26/06/2013	S. Andryuki, Mostovskoy, KRASNODARSKIY KRAY
26/06/2013	Psebay, Mostovskoy, KRASNODARSKIY KRAY
24/06/2013	S. Grodekovo, Blagoveshensk raion, AMURSKAYA OBLAST

*Taiwan POC*

**FMD type O** sub-clinically infected pigs were detected in three areas of Taiwan POC during May 2013 during routine sero-surveys:

17/05/2013, Baozhong Township, YUN-LIN;

27/05/2013, Wuri District, T'AI-CHUNG SHIH;

16/05/2013, Jinhu Township, KINMEN.

As no virus could be isolated no genotyping was performed.

*Thailand*

Cell culture passaged virus isolates received from Thailand revealed the presence of **FMD type O** and **type A** in cattle sampled between August 2012 and February 2013. Seven **type A** viruses belonged to the ASIA topotype, Sea-97 lineage and four **type O** viruses belonged to the SEA topotype, Mya-98 lineage. However, one **type O** virus belonged to the CATHAY topotype and was only three nucleotides different to an old Thai reference/vaccine virus, O/Bangkok/60, suggesting that it may be a laboratory contaminant.

*Turkey*

Samples collected from cattle, sheep and goats between December 2012 and March 2013 were received. **FMD types O, A and Asia 1** were identified. Genotyping showed the **type O** viruses to belong to the ME-SA topotype, PanAsia-2 lineage (with 12 belonging to the FAR-09 sub-lineage and one belonging to the ANT-10 sub-lineage). Genotyping of the **type A** viruses showed that all 17 belonged to the ASIA topotype, Iran-05 lineage, SIS-10 sub-lineage. Genotyping of the **type Asia 1** viruses showed all five to belong to the Sindh-08 lineage.

### *Vietnam*

Two clinical samples and seven virus isolates, collected from cattle or water buffalo in two regions of Vietnam during March and April 2013, were received. **FMD type A** was identified in five of these and genotyping showed them to belong to the ASIA toptype, Sea-97 lineage.

## **AFRICA**

### *Egypt*

Outbreaks of **FMD type A** are widespread in Egypt and samples received all belonged to the ASIA toptype, Iran-05 lineage, BAR-08 sub-lineage (which has been present in the country since at least 2010). An outbreak of **FMD type A** in Rafah, Gaza Strip, Palestinian Autonomous Territories in April 2013 was very closely related to the Egyptian viruses. It is not clear which other FMD types/topotypes are currently circulating in Egypt.

### *Ethiopia*

Outbreaks of **FMD type O** were confirmed following the receipt of samples from the Oromia, Amhara and Southern Nations, Nationalities, and Peoples' (SNNP) Regions. Genotyping showed the EA-3 toptype to be present in Oromia and Amhara, but EA-4 was present in SNNP (Mizan, Bench Maji Zone). The EA-4 toptype has rarely been detected, previously having been found in Uganda in 1998-99, Ethiopia in 2005 (also in Mizan, Bench Maji) and Kenya in 2010.

### *Zimbabwe*

Two epizootics have been reported in April/May. The first consisted of five outbreaks in the southeast of Zimbabwe and were in cattle; the serotype involved has not been reported (diagnosis was by RT-PCR at the National Reference Laboratory):

12/04/2013, Mkwesine, Chiredzi, Masvingo;

31/05/2013, Manzvire 2 Dip Tank, Chisumbanje, Chipinge, Manicaland;

15/05/2013, Levanga, Chiredzi, Masvingo;

15/05/2013, Gudo, Chiredzi, Masvingo;

15/05/2013, Masapasi, Chiredzi, Masvingo.

The second was on 25/04/2013 at Drysdale, Umguza, Matabeleland North (in the west of Zimbabwe) in cattle and was reported as being caused by **FMD type SAT 3**. This appears to have been diagnosed by antibody detection ELISA and therefore remains to be confirmed by virus isolation.

## **SOUTH AMERICA**

No new outbreaks of FMD were reported in the region.

### **Uncharacterised FMD viruses**

A number of outbreaks have occurred where samples have not been sent to the WRLFMD®. It is probable that the countries involved have performed their own genetic characterisation; however, through the OIE/FAO laboratory network we would also like to encourage the submission of samples (or complete VP1 sequences) to the WRLFMD®.

An up-to-date list and reports of FMD viruses characterised by sequencing can be found at the following website: [http://www.wrlfmd.org/fmd\\_genotyping/2013.htm](http://www.wrlfmd.org/fmd_genotyping/2013.htm).

Results from samples received at WRLFMD® (status of samples being tested) are shown in Table 1 and a complete list of clinical sample diagnostics made by the WRLFMD® between April and Jun 2013 is shown in Annex 1 Table A. A record of all samples received to The Pirbright Institute (April to June 2013) is shown in Annex 1 Table B.

**Table 1:** Status of sequencing of samples received by the WRLFMD from April to June 2013.

Batch	Date Recd.	Country	Serotype	No. of samples	No. of sequences	Status
WRLFMD/2013/00006	12/04/2013	Turkey	O	13	13	Completed
WRLFMD/2013/00006	12/04/2013	Turkey	A	17	17	Completed
WRLFMD/2013/00006	12/04/2013	Turkey	Asia 1	5	5	Completed
WRLFMD/2013/00007	18/04/2013	Ethiopia	O	5	5	Completed
WRLFMD/2013/00009	02/05/2013	Palestinian AT	A	3	3	Completed
WRLFMD/2013/00010	08/05/2013	Hong Kong SAR, PRC	O	1	1	Completed
WRLFMD/2013/00011	24/04/2013	Vietnam	A	5	5	Completed
WRLFMD/2013/00012	29/05/2013	Egypt	A	10	10	Completed
WRLFMD/2013/00013	17/06/2013	Cambodia	O	2	2	Completed
WRLFMD/2013/00014	17/06/2013	Laos	O	5	5	Completed
WRLFMD/2013/00015	17/06/2013	Thailand	O	5	5	Completed
WRLFMD/2013/00015	17/06/2013	Thailand	A	7	7	Completed
WRLFMD/2013/00016	27/06/2013	Bhutan	O	1	1	Completed
Total				79	79	

Detailed Analysis:

ASIA

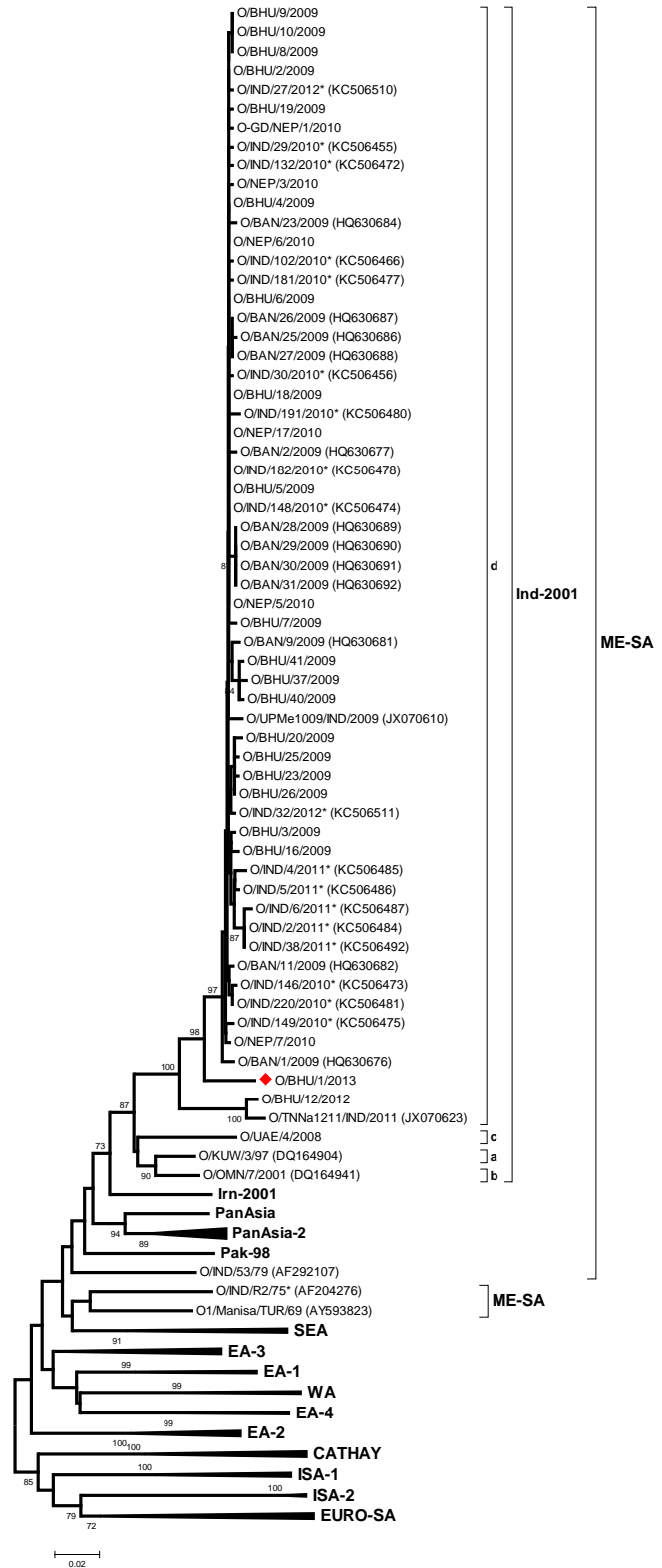
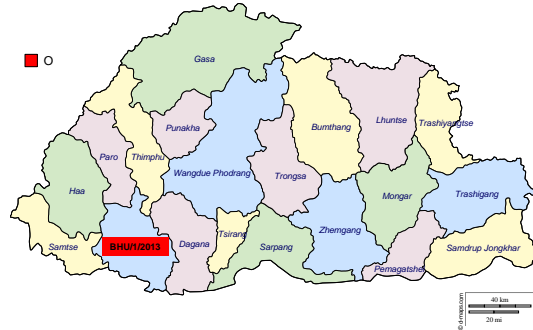
**Bhutan**

WRLFMD/2013/00016

Date received: 27/06/2013

No. of samples: 1

O (ME-SA/Ind-2001d): 1





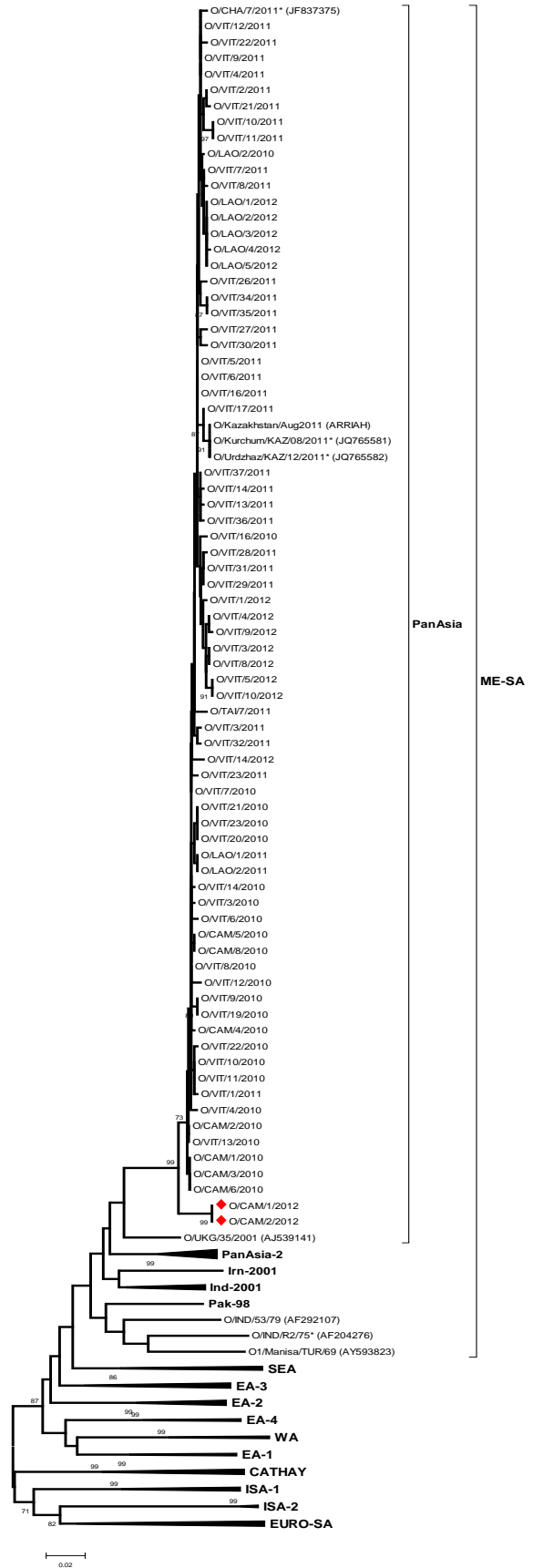
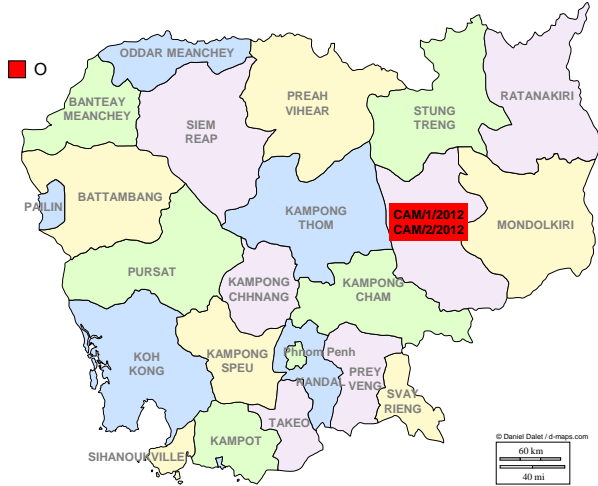
**Cambodia**

WRLFMD/2013/00013

Date received: 17/06/2013

No. of samples: 2

O (ME-SA/PanAsia): 2



**Hong Kong SAR, PRC**

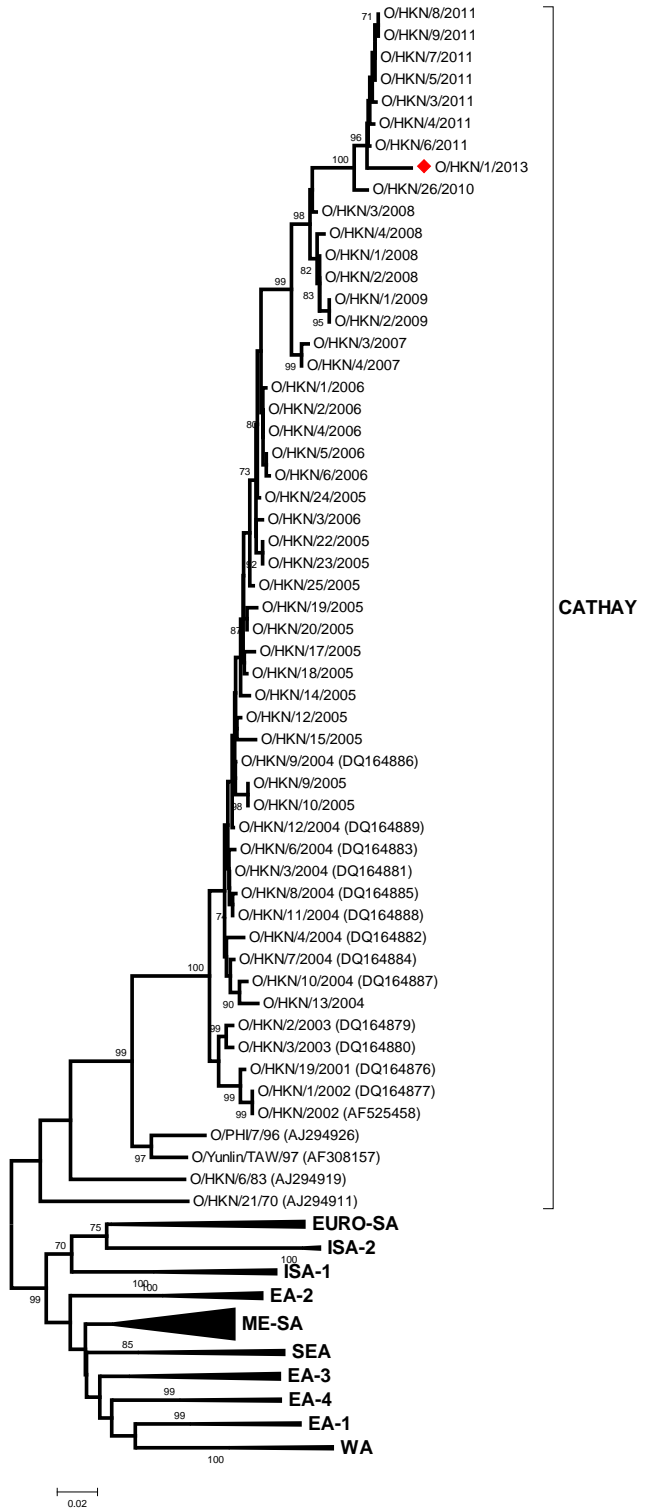
WRLFMD/2013/00010

Date received: 08/05/2013

No. of samples: 1

O (CATHAY): 1

(location not given)



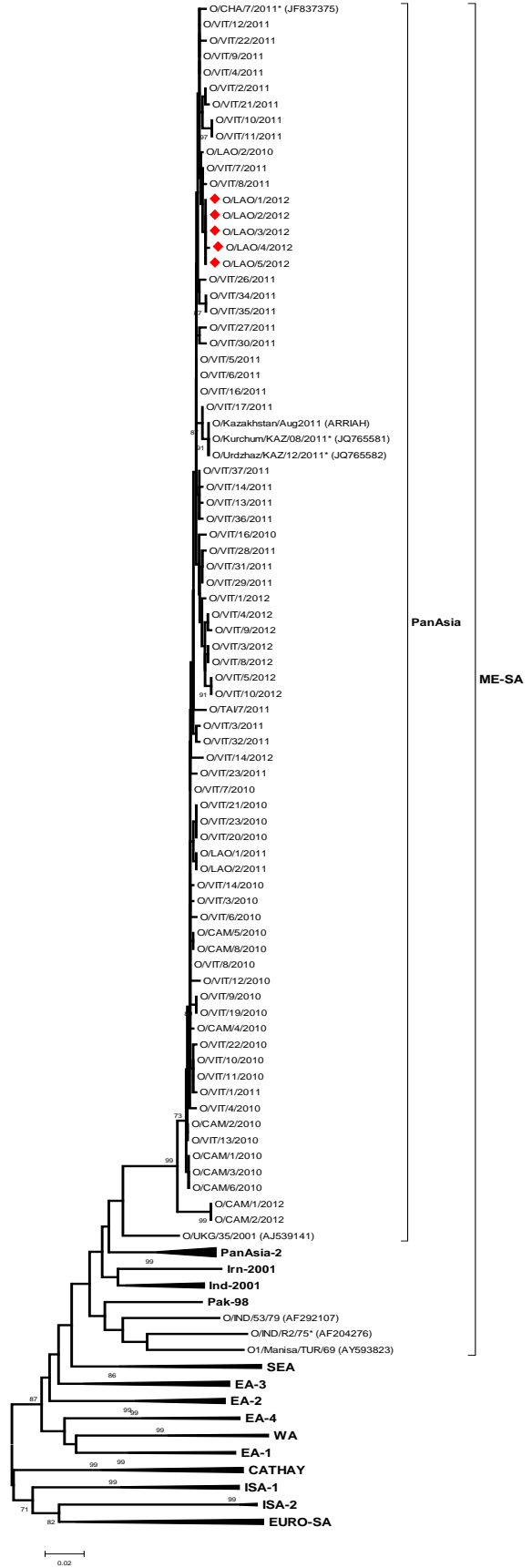
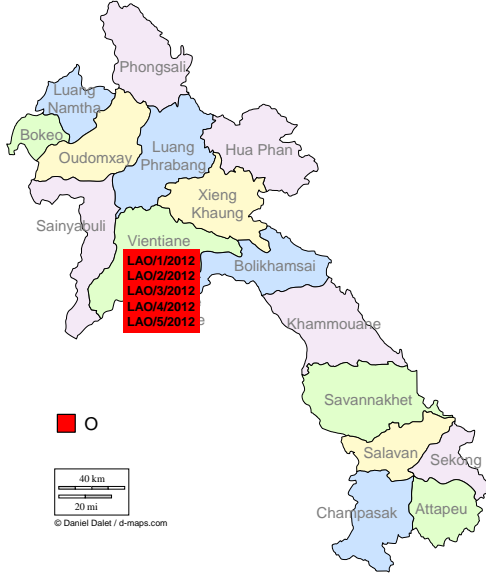
**Laos**

WRLFMD/2013/00014

Date received: 17/06/2013

No. of samples: 5

O (ME-SA/PanAsia): 5



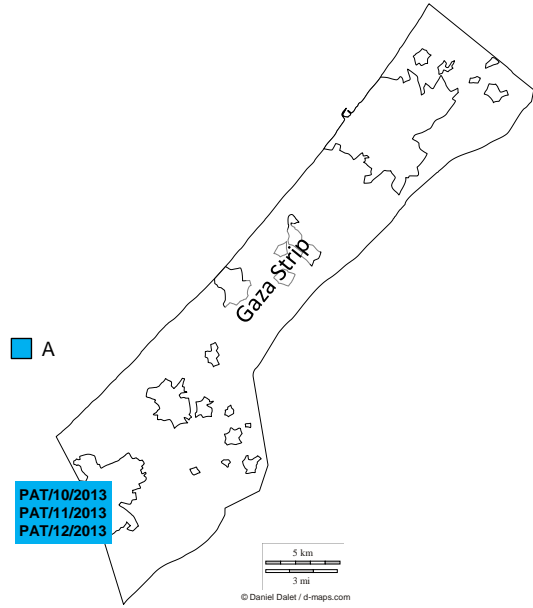
**Palestinian Autonomous Territories**

WRLFMD/2013/00009

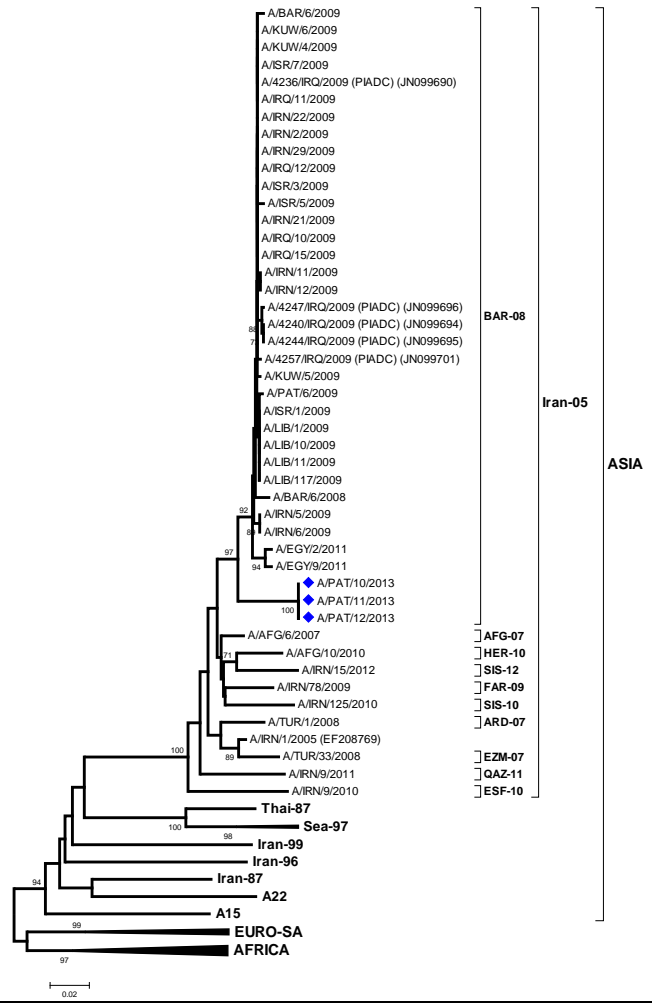
Date received: 02/05/2013

No. of samples: 3

A (ASIA/Iran-05<sup>BAR-08</sup>): 3



PAT/10/2013  
PAT/11/2013  
PAT/12/2013

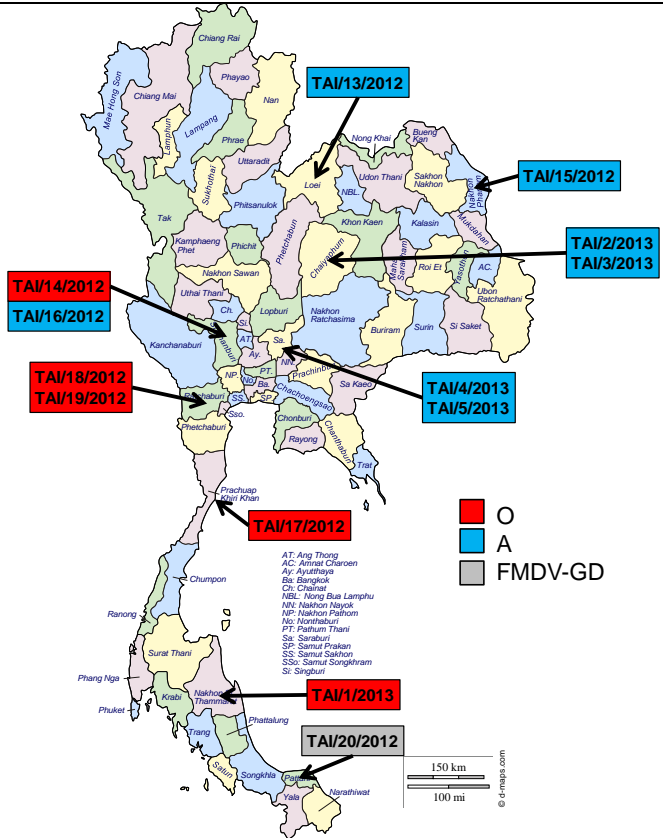


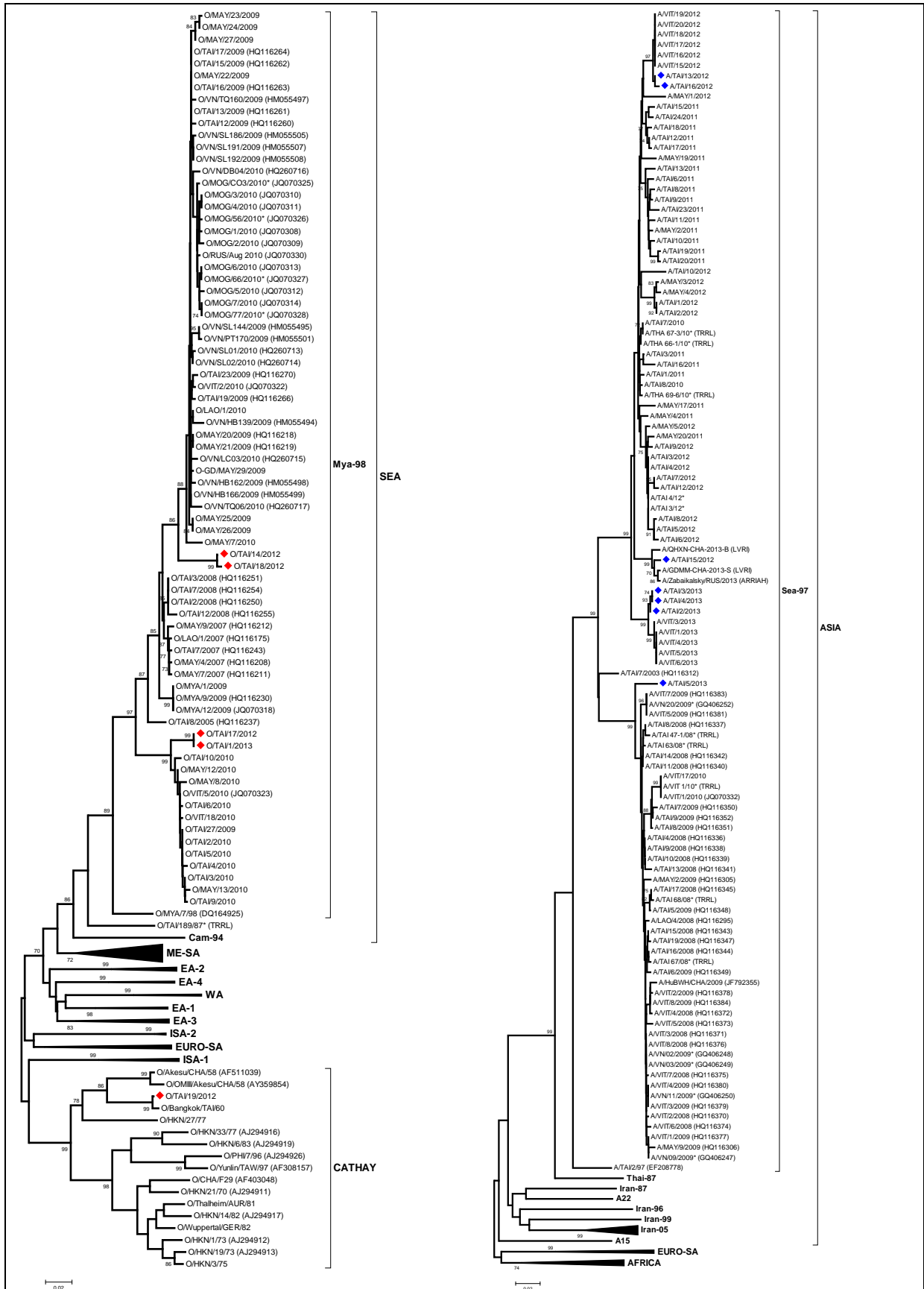
BAR-08  
Iran-05  
ASIA  
AFG-07  
HER-10  
SIS-12  
FAR-09  
SIS-10  
ARD-07  
EZM-07  
QAZ-11  
ESF-10

0.02

**Thailand**

WRLFMD/2013/00015  
 Date received: 17/06/2013  
 No. of samples: 13  
 O (SEA/Mya-98): 4  
 O (CATHAY): 1  
 A (ASIA/Sea-97): 7  
 FMDV-GD: 1





**Turkey**

WRLFMD/2013/00006

Date received: 12/04/2013

No. of samples: 40

O (ME-SA/PanAsia-2<sup>FAR-09</sup>): 12

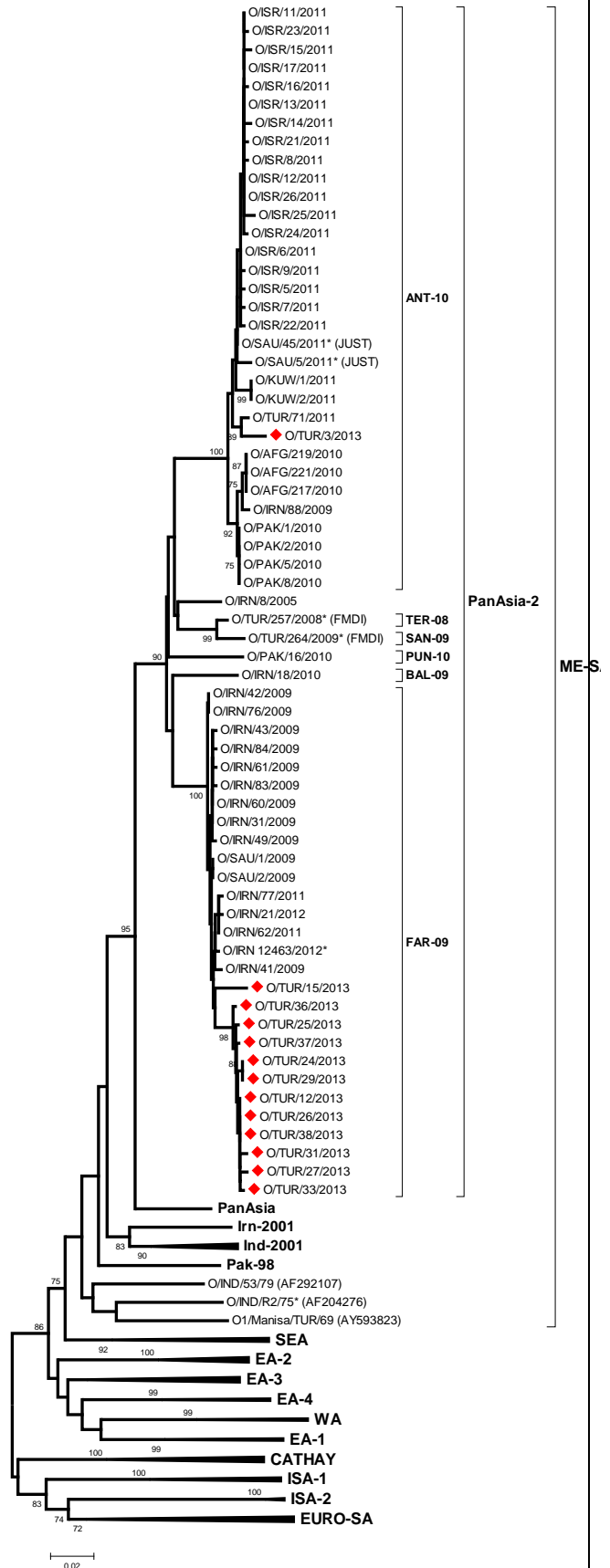
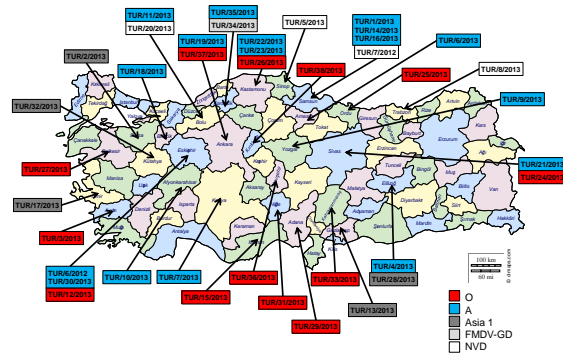
O (ME-SA/PanAsia-2<sup>ANT-10</sup>): 1

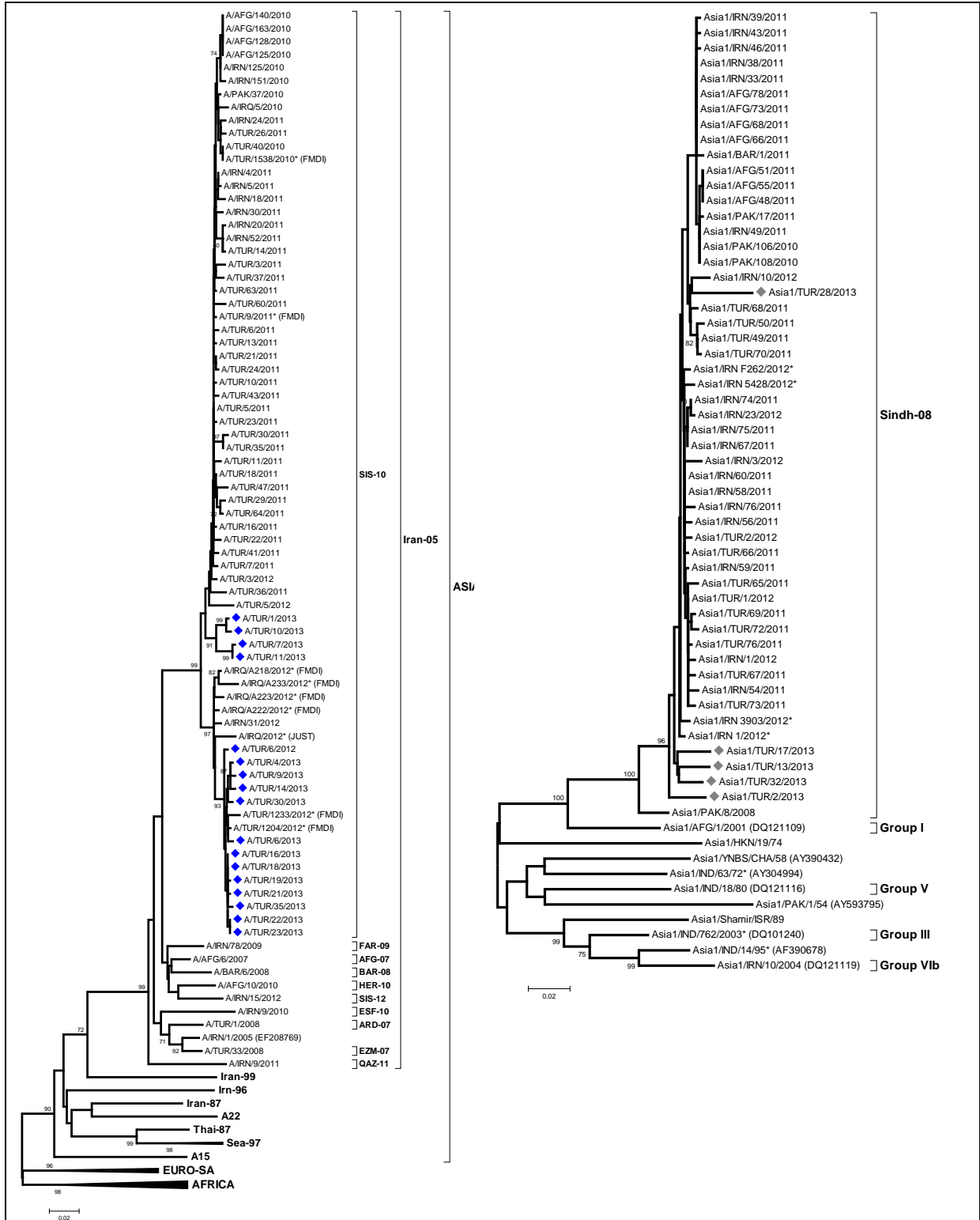
A (ASIA/Iran-05<sup>SIS-10</sup>): 17

Asia1 (Sindh-08): 5

FMDV-GD: 1

NVD: 4







**Vietnam**

WRLFMD/2013/00011

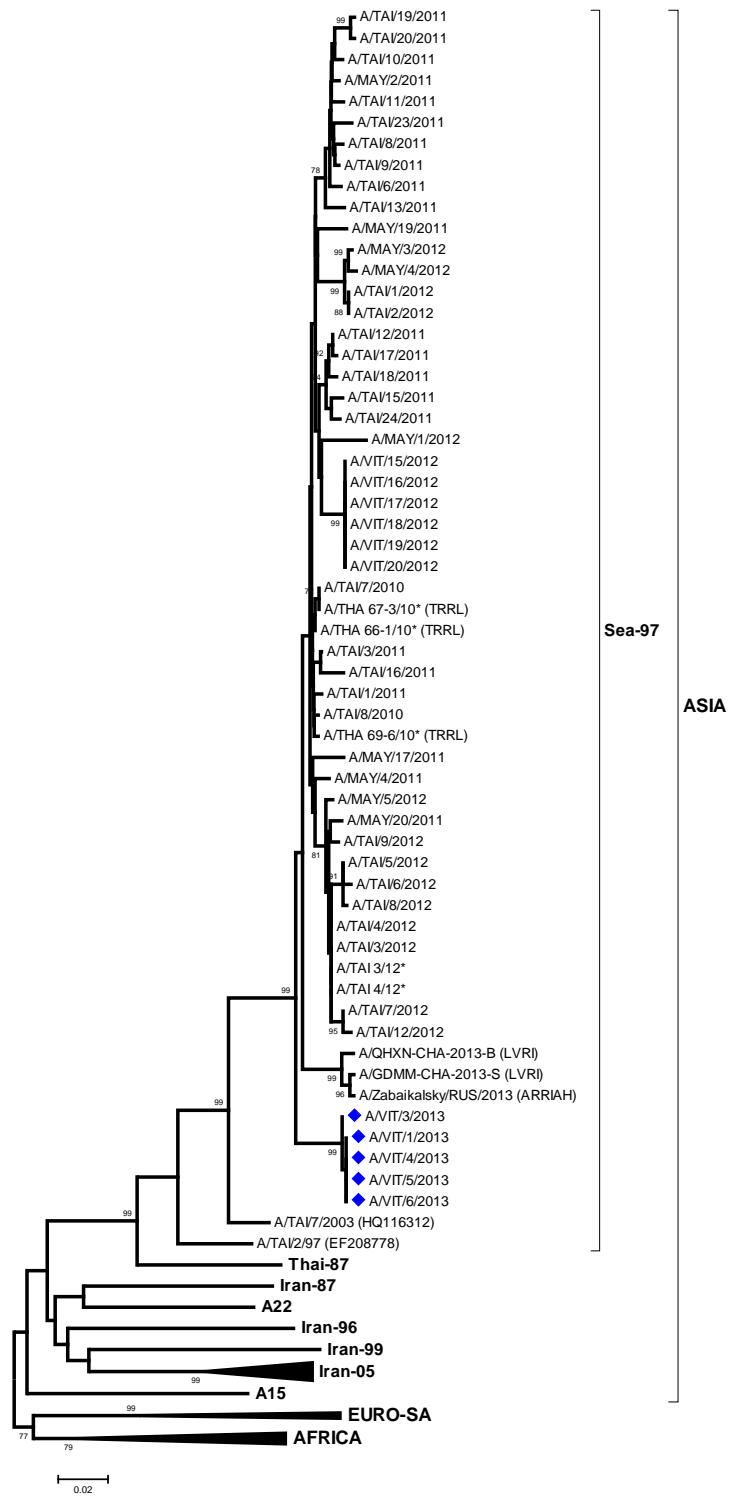
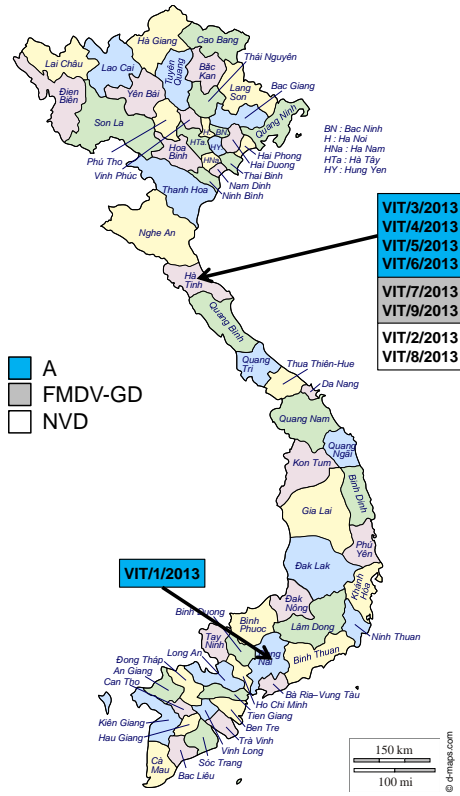
Date received: 24/04/2013

No. of samples: 9

A (ASIA/Sea-97): 5

FMDV-GD: 2

NVD: 2



AFRICA

**Egypt**

WRLFMD/2013/00012

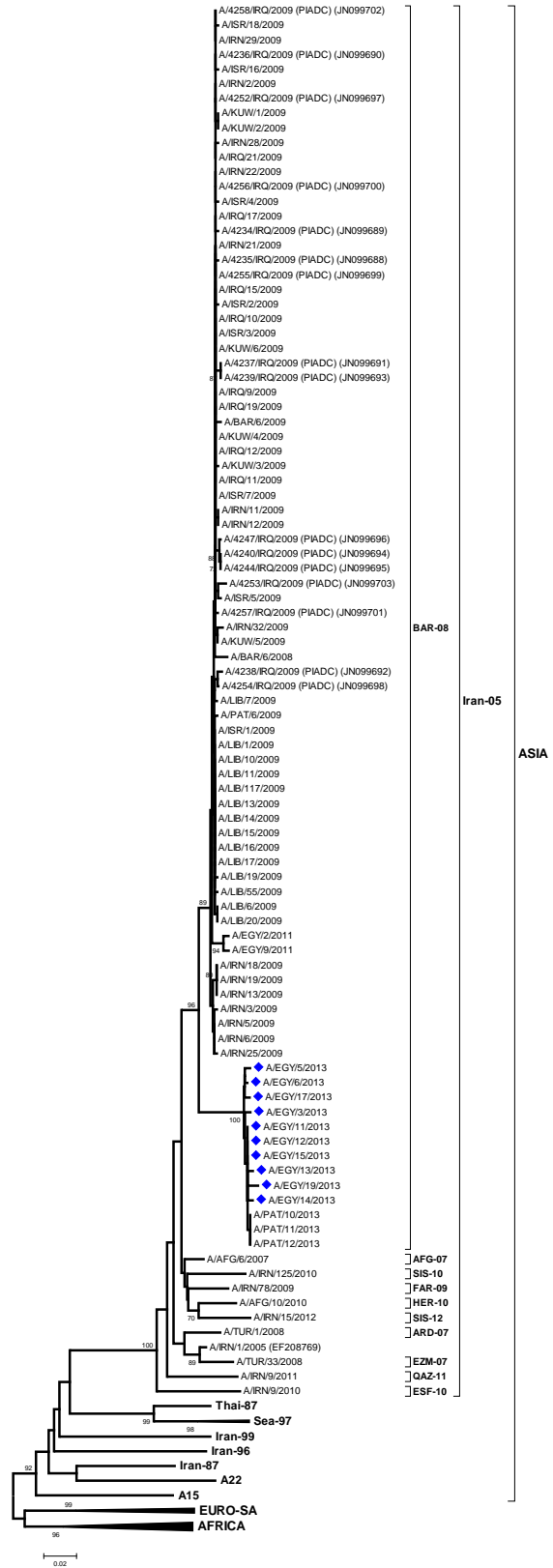
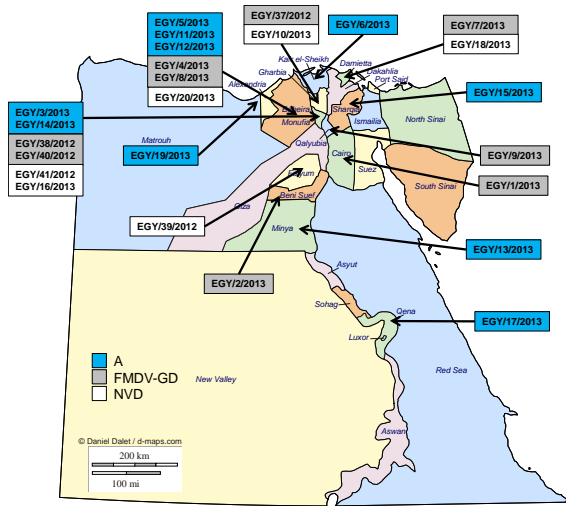
Date received: 29/05/2013

No. of samples: 25

A (ASIA/Iran-05<sup>BAR-08</sup>): 10

FMDV-GD: 9

NVD: 6



**Ethiopia**

WRLFMD/2013/00007

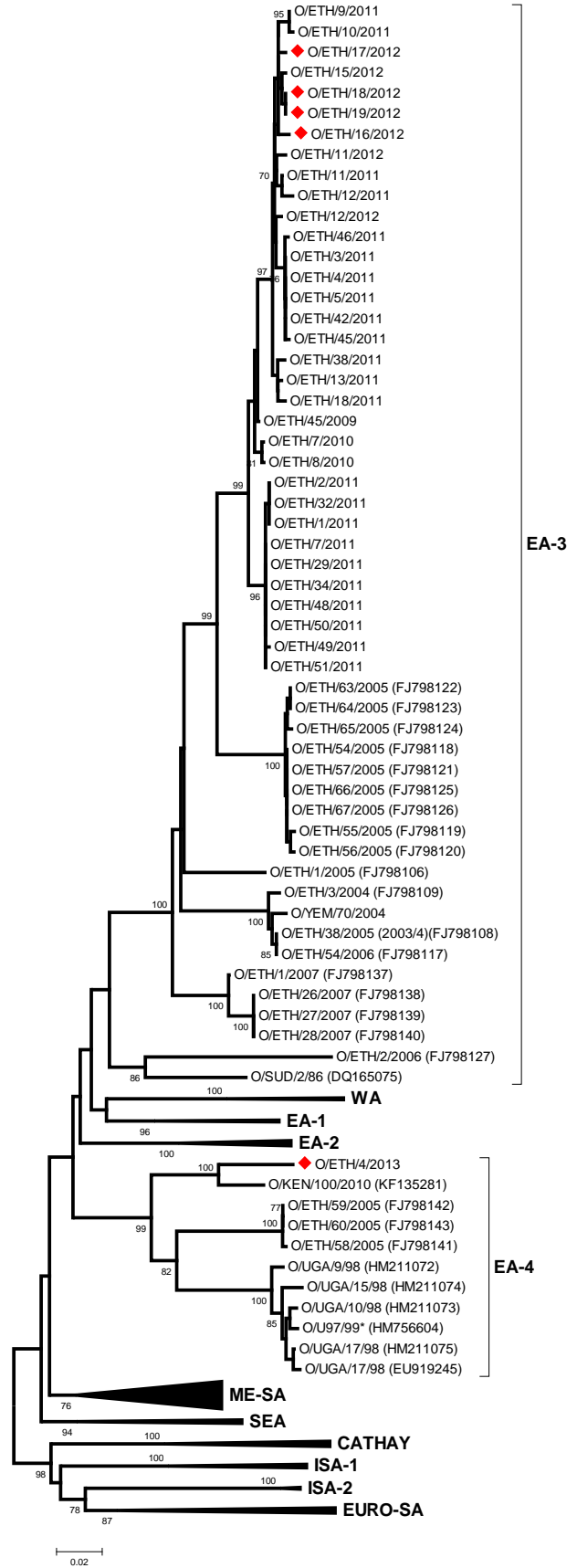
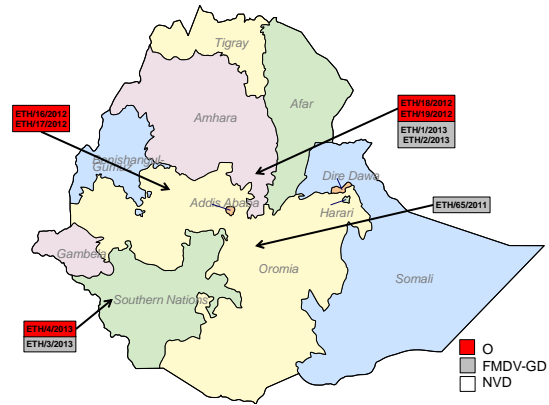
Date received: 18/04/2013

No. of samples: 9

O (EA-3): 4

O (EA-4): 1

FMDV-GD: 4



EA-3

EA-4

## Vaccine matching

Nine FMDV type O isolates (See Table C, Type O for details) from Bhutan, Egypt, Hong Kong (Special Administrative Region of the People's Republic of China), Iran, Pakistan, Taiwan (ROC) and The United Arab Emirates collected in 2012 and 2013 were analysed antigenically by the two dimensional virus neutralisation test (2dmVNT). All isolates matched with O 4625 and most matched with O TUR 5/2009 except the isolates from Hong Kong and Taiwan. Isolates from Egypt, Iran and Pakistan gave a good match with O Manisa (Table C).

Nineteen FMDV type A viruses (See Table C, Type A for details) from Iran, Egypt, Palestine, Tanzania, Turkey and Vietnam collected during 2012 and 2013 were analysed antigenically by the two dimensional virus neutralisation test (2dmVNT). Isolates from Tanzania showed a good match with A IRN 2005, A TUR 06 and A22 IRQ; All isolates from Turkey and Vietnam and one virus each from Iran and Palestine showed an antigenic match with A TUR 06, respectively. Isolates from Egypt showed no match with any vaccine strain tested (Table C).

Seven FMDV type Asia 1 isolates (See Table C, Type Asia 1 for details) from Pakistan and Turkey collected in 2012 and 2013 were analysed antigenically by the two dimensional virus neutralisation test (2dmVNT). Two out five isolates from Pakistan showed a good match with Asia 1 emergency vaccine (Table C).

By 2dmVNT, four FMDV type SAT 1 virus (see table C, Type SAT 1 for details) from Zambia and Tanzania collected from 2012 were all antigenically matched with SAT 1 RHO vaccine strain (Table C).

Four FMDV type SAT 2 virus (see table C, Type SAT 2 for details) from Botswana, Zambia and Tanzania collected from 2012 were antigenically analysed by 2dmVNT. All viruses from Botswana and Tanzania matched with both SAT 2 Eritrea and SAT 2 ZIM vaccine strains, however, the SAT 2 virus collected from Zambia showed no match with either of the tested vaccine strains (Table C).

### Annex 1. TABLE A: Clinical sample diagnostics made by the WRLFMD® between April-June 2013

Country	WRL for FMD Sample Identification	Animal	Date of Collection	Results		
				VI/ELISA	RT-PCR	Final report
BHUTAN	BHU 1/2013	BOVINE	06-Jun-13	O	POS	O
CAMBODIA	CAM 1/2012	CATTLE	24-Sep-12	O	POS	O
	CAM 2/2012	CATTLE	24-Sep-12	O	POS	O
EGYPT	EGY 37/2012	CATTLE	28-Aug-12	NOT TESTED	POS	FMDV GD
	EGY 38/2012	CATTLE	03-Dec-12	NOT TESTED	POS	FMDV GD
	EGY 39/2012	CATTLE	19-Dec-12	NOT TESTED	NEG	NVD
	EGY 40/2012	CATTLE	24-Dec-12	NOT TESTED	POS	FMDV GD
	EGY 41/2012	CATTLE	24-Dec-12	NOT TESTED	NEG	NVD
	EGY 1/2013	CATTLE	03-Jan-13	NOT TESTED	POS	FMDV GD
	EGY 2/2013	CATTLE	08-Jan-13	NOT TESTED	POS	FMDV GD
	EGY 3/2013	CATTLE	08-Jan-13	A	POS	A
	EGY 4/2013	CATTLE	30-Jan-13	NOT TESTED	POS	FMDV GD
	EGY 5/2013	CATTLE	31-Mar-13	A	POS	A
	EGY 6/2013	BUFFALO	04-Feb-13	A	POS	A
	EGY 7/2013	CATTLE	06-Feb-13	NOT TESTED	POS	FMDV GD
	EGY 8/2013	BUFFALO	10-Feb-13	NOT TESTED	POS	FMDV GD
EGY 9/2013	BUFFALO	11-Feb-13	NOT TESTED	POS	FMDV GD	
EGY 10/2013	CATTLE	16-Feb-13	NOT TESTED	NEG	NVD	
EGY 11/2013	CATTLE	23-Feb-13	A	POS	A	
EGY 12/2013	BUFFALO	24-Feb-13	A	POS	A	
EGY 13/2013	CATTLE	11-Mar-13	A	POS	A	

	EGY 14/2013	CATTLE	19-Mar-13	A	POS	A
	EGY 15/2013	CATTLE	20-Mar-13	A	POS	A
	EGY 16/2013	CATTLE	25-Mar-13	NOT TESTED	NEG	NVD
	EGY 17/2013	CATTLE	07-Apr-13	A	POS	A
	EGY 18/2013	CATTLE	08-Apr-13	NOT TESTED	NEG	NVD
	EGY 19/2013	CATTLE	09-Apr-13	A	POS	A
	EGY 20/2013	CATTLE	09-Apr-13	NOT TESTED	NEG	NVD
ETHIOPIA	ETH 65/2011	BOVINE	17-Dec-11	NEG	POS	FMDV GD
	ETH 16/2012	BOVINE	14-Aug-12	O	POS	O
	ETH 17/2012	BOVINE	14-Aug-12	O	POS	O
	ETH 18/2012	BOVINE	19-Nov-12	O	POS	O
	ETH 19/2012	BOVINE	19-Nov-12	O	POS	O
	ETH 1/2013	BOVINE	06-Feb-13	NEG	POS	FMDV GD
	ETH 2/2013	BOVINE	06-Feb-13	NEG	POS	FMDV GD
	ETH 3/2013	BOVINE	16-Mar-13	NEG	POS	FMDV GD
	ETH 4/2013	BOVINE	16-Mar-13	O	POS	O
HONG KONG, SAR OF PRC	HKN 1/2013	PIG	02-Apr-13	O	POS	O
LAOS	LAO 1/2012	CATTLE	28-Dec-12	O	POS	O
	LAO 2/2012	CATTLE	28-Dec-12	O	POS	O
	LAO 3/2012	CATTLE	28-Dec-12	O	POS	O
	LAO 4/2012	CATTLE	28-Dec-12	O	POS	O
	LAO 5/2012	CATTLE	28-Dec-12	O	POS	O
PALESTINIAN AUTONOMOUS TERRITORIES	PAT 10/2013	CALVES	02-Apr-13	A	POS	A
	PAT 11/2013	CALVES	02-Apr-13	A	POS	A
	PAT 12/2013	CALVES	02-Apr-13	A	POS	A
THAILAND	TAI 13/2012	CATTLE	15-Aug-12	A	POS	A
	TAI 14/2012	CATTLE	03-Oct-12	O	POS	O
	TAI 15/2012	CATTLE	03-Oct-12	A	POS	A
	TAI 16/2012	CATTLE	12-Oct-12	A	POS	A
	TAI 17/2012	CATTLE	12-Oct-12	O	POS	O
	TAI 18/2012	CATTLE	29-Oct-12	O	POS	O
	TAI 19/2012	CATTLE	23-Nov-12	O	POS	O
	TAI 20/2012	CATTLE	27-Nov-12	NOT TESTED	POS	FMDV GD
	TAI 1/2013	CATTLE	04-Jan-13	O	POS	O
	TAI 2/2013	CATTLE	07-Feb-13	A	POS	A
	TAI 3/2013	CATTLE	13-Feb-13	A	POS	A
	TAI 4/2013	CATTLE	15-Feb-13	A	POS	A
	TAI 5/2013	CATTLE	27-Feb-13	A	NEG	A
TURKEY	TUR 6/2012	CATTLE	28-Dec-12	A	POS	A
	TUR 7/2012	SHEEP	28-Dec-12	NEG	NEG	NVD
	TUR 1/2013	CATTLE	01-Jan-13	A	POS	A
	TUR 2/2013	CATTLE	02-Jan-13	ASIA-1	POS	ASIA-1
	TUR 3/2013	CATTLE	04-Jan-13	O	POS	O
	TUR 4/2013	CATTLE	05-Jan-13	A	POS	A
	TUR 5/2013	SHEEP	05-Jan-13	NEG	NEG	NVD
	TUR 6/2013	CATTLE	08-Jan-13	A	POS	A
	TUR 7/2013	CATTLE	13-Jan-13	A	POS	A

	TUR 8/2013	SHEEP	13-Jan-13	NEG	NEG	NVD
	TUR 9/2013	CATTLE	14-Jan-13	A	POS	A
	TUR 10/2013	CATTLE	17-Jan-13	A	POS	A
	TUR 11/2013	CATTLE	02-Feb-13	A	POS	A
	TUR 12/2013	CATTLE	09-Feb-13	O	POS	O
	TUR 13/2013	CATTLE	09-Feb-13	ASIA-1	POS	ASIA-1
	TUR 14/2013	CATTLE	19-Feb-13	A	POS	A
	TUR 15/2013	CATTLE	21-Feb-13	O	POS	O
	TUR 16/2013	CATTLE	21-Feb-13	A	POS	A
	TUR 17/2013	CATTLE	23-Feb-13	ASIA-1	POS	ASIA-1
	TUR 18/2013	CATTLE	24-Feb-13	A	POS	A
	TUR 19/2013	CATTLE	25-Feb-13	A	POS	A
	TUR 20/2013	GOAT	25-Feb-13	NEG	NEG	NVD
	TUR 21/2013	CATTLE	25-Feb-13	A	POS	A
	TUR 22/2013	CATTLE	25-Feb-13	A	POS	A
	TUR 23/2013	CATTLE	25-Feb-13	A	POS	A
	TUR 24/2013	CATTLE	26-Feb-13	O	POS	O
	TUR 25/2013	CATTLE	02-Mar-13	O	POS	O
	TUR 26/2013	CATTLE	06-Mar-13	O	POS	O
	TUR 27/2013	CATTLE	08-Mar-13	O	POS	O
	TUR 28/2013	CATTLE	09-Mar-13	ASIA-1	POS	ASIA-1
	TUR 29/2013	CATTLE	10-Mar-13	O	POS	O
	TUR 30/2013	CATTLE	11-Mar-13	A	POS	A
	TUR 31/2013	CATTLE	12-Mar-13	O	POS	O
	TUR 32/2013	CATTLE	12-Mar-13	O	POS	O
	TUR 33/2013	CATTLE	12-Mar-13	O	POS	O
	TUR 34/2013	CATTLE	13-Mar-13	NOT TESTED	POS	FMDV GD
	TUR 35/2013	CATTLE	16-Mar-13	A	POS	A
	TUR 36/2013	CATTLE	16-Mar-13	O	POS	O
	TUR 37/2013	CATTLE	17-Mar-13	O	POS	O
	TUR 38/2013	CATTLE	19-Mar-13	O	POS	O
VIETNAM	VIT 1/2013	CATTLE	16-Mar-13	A	POS NOT	A
	VIT 2/2013	CATTLE	16-Mar-13	NVD	TESTED	NVD
	VIT 3/2013	CATTLE	28-Mar-13	A	POS	A
	VIT 4/2013	CATTLE	16-Mar-13	A	POS	A
	VIT 5/2013	BUFFALO	02-Apr-13	A	POS	A
	VIT 6/2013	BUFFALO	02-Apr-13	A	POS	A
	VIT 7/2013	CATTLE	16-Mar-13	NVD	POS	FMDV GD
	VIT 8/2013	BUFFALO	02-Apr-13	NVD	NEG	NVD
	VIT 9/2013	BUFFALO	02-Apr-13	NVD	POS	FMDV GD

**TOTAL: 108**

FMD(V)	Foot-and-mouth disease (virus)
FMDV GD	Genome detected
VI/ELISA	FMDV serotype identified following virus isolation in cell culture and antigen ELISA
RT-PCR	Reverse transcription polymerase chain reaction on epithelial suspension for FMD (or SVD) viral genome
NVD	No foot-and-mouth disease, swine vesicular disease or vesicular stomatitis virus detected
NT	Not tested

**TABLE B: Summary of samples collected and received to The Pirbright Institute (April-June 2013)**

Country	No. of samples	Virus isolation in cell culture/ELISA								RT-PCR for FMD (or SVD) virus (where appropriate)	
		FMD virus serotypes							NVD	Positive	Negative
		O	A	C	SAT 1	SAT 2	SAT 3	Asia 1			
BHUTAN	1	1	-	-	-	-	-	-	-	1	-
CAMBODIA	2	2	-	-	-	-	-	-	-	2	-
EGYPT	25	-	10	-	-	-	-	-	15	19	6
ETHIOPIA	9	5	-	-	-	-	-	-	4	9	-
HONG KONG, SAR OF PRC	1	1	-	-	-	-	-	-	-	1	-
LAOS	5	5	-	-	-	-	-	-	-	5	-
PALESTINIAN AUTONOMOUS TERRITORIES	3	-	3	-	-	-	-	-	-	3	-
TURKEY	40	14	17	-	-	-	-	4	5	36	4
THAILAND	13	5	7	-	-	-	-	-	1	12	1
VIETNAM	9	-	5	-	-	-	-	-	4	7	1
<b>TOTAL</b>	<b>108</b>	<b>33</b>	<b>42</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>4</b>	<b>29</b>	<b>95</b>	<b>12</b>

VI/ELISA	FMD (or SVD) virus serotype identified following virus isolation in cell culture and antigen detection ELISA
FMD	foot-and-mouth disease
SVD	swine vesicular disease
NVD	no FMD, SVD or vesicular stomatitis virus detected
NT	not tested
RT-PCR	reverse transcription polymerase chain reaction for FMD (or SVD) viral genome

**TABLE C:** Antigenic characterisation of FMD field isolates by matching with vaccine strains by 2dmVNT from 1<sup>st</sup> April to 30<sup>th</sup> June 2012**Type O:**

Vaccine matching studies for serotype O FMDV by VNT-WRLFMD®								
WRL SAMPLE REF	SEROTYPE	O 3039	O 4625	O Campos	O Manisa	O Skr 7/10	O Taw98	O Tur 5/09
BHU 12/2012	O	M	M		N		N	M
EGY 25/2012	O		M		M			M
HKN 1/2013	O	N	M	N	N	N	N	N
IRN 11/2013	O		M		M			M
IRN 36/2012	O		M		M			M
PAK 12/2012	O		M		M			M
PAK 17/2012	O		M		M			M
TAW 01/2012	O	M	M		N	M	M	M
UAE 1/2013	O		M		N			M

**Type A:**

Vaccine matching studies for serotype A FMDV by VNT-WRLFMD®											
WRL SAMPLE REF	SEROTYPE	A Eri 98	A IRN 87	A IRN 96	A Iran 2005	A TUR 06	A22 IRQ	A MAY 97	A MAY 97*	A SAU 95	SAU 41/91
IRN 07/2013	A		N		N	N	N				
IRN 24/2012	A		N		N	N	N				
IRN 33/2012	A		N		N	M	N				
TAN 1/2013	A	N			M	M	M				
TAN 3/2013	A	M			M	M	M				
TAN 56/2012	A	N			M	M	M				
TAN 73/2012	A	N			N	M	N				
VIT 5/2013	A				N	M	M	N	N	N	N
VIT 6/2013	A				N	M	M	N	N	N	N



PAT 10/2013	A				N	M	N				N
PAT 11/2013	A				N	N	N				N
PAT 12/2013	A				N	N	N				N
EGY 3/2013	A	N	N	N	N	N	N			N	N
EGY 13/2013	A	N	N	N	N	N	N			N	N
EGY 17/2013	A	N			N	N	N				
EGY 19/2013	A	N			N	N	N				
TUR 14/2013	A				N	M	N				
TUR 21/2013	A				N	M	N				
TUR 9/2013	A				N	M	N				

**TYPE Asia 1**

Vaccine matching studies for serotype Asia 1 FMDV by VNT-WRLFMD®				
SAMPLE REF	SEROTYPE	Asia1 IND 8/79	Asia1 Shamir	Asia1 Shamir 6pd50
PAK 10/2012	ASIA1	N	N	N
PAK 29/2012	ASIA1	N	N	M
PAK 30/2012	ASIA1	N	N	N
PAK 35/2012	ASIA1	M	N	N
PAK 37/2012	ASIA1	N	N	M
TUR 2/2013	ASIA1	N	N	N
TUR 13/2013	ASIA1	N	N	N

**TYPE SAT 1:**

Vaccine matching studies for serotype SAT 1 FMDV by VNT-WRLFMD®		
SAMPLE REF	SEROTYPE	SAT1 RHO
ZAM 06/2012	SAT1	M
ZAM 08/2012	SAT1	M
TAN 49/2012	SAT1	M

TAN 50/2012	SAT1	M
-------------	------	---

**TYPE SAT 2:**

<b>Vaccine matching studies for serotype SAT 2 FMDV by VNT-WRLFMD®</b>			
SAMPLE REF	SEROTYPE	SAT2 Eritrea	SAT2 ZIM 7/83
BOT 17/2012	SAT2	M	M
BOT 20/2012	SAT2	M	M
ZAM 01/2012	SAT2	N	N
TAN 64/2012	SAT2	M	M

**Results Descriptor:****Results Descriptor:**

M : = Vaccine Match-  $r_1 = \geq 0.3$ . Suggests that there is a close relationship between field isolate and vaccine strain. A potent vaccine containing the vaccine strain is likely to confer protection.

N : = No Vaccine Match -  $r_1 = < 0.3$ . Suggests that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect

  = Not tested against this vaccine

**Annex 2. Recent FMD Publications cited by PubMed**

1. Zhou JH, Zhang J, Sun DJ, Ma Q, Ma B, Pejsak Z, Chen HT, Ma LN, Ding YZ, Liu YS. Potential roles of synonymous codon usage and tRNA concentration in hosts on the two initiation regions of foot-and-mouth disease virus RNA. *Virus Res.* 2013 Jun 25. doi:pii: S0168-1702(13)00209-8. 10.1016/j.virusres.2013.06.006. [Epub ahead of print] PubMed PMID: 23806792.
2. Su C, Duan X, Zheng J, Liang L, Wang F, Guo L. IFN- $\alpha$  as an Adjuvant for Adenovirus-Vectored FMDV Subunit Vaccine through Improving the Generation of T Follicular Helper Cells. *PLoS One.* 2013 Jun 18;8(6):e66134. Print 2013. PubMed PMID: 23823532; PubMed Central PMCID: PMC3688841.
3. Gullberg M, Muszynski B, Organtini LJ, Ashley RE, Hafenstein SL, Belsham GJ, Polacek C. Assembly and characterization of foot-and-mouth disease virus empty capsid particles expressed within mammalian cells. *J Gen Virol.* 2013 Jun 5. [Epub ahead of print] PubMed PMID: 23740480.
4. Nandi SP, Rahman MZ, Momtaz S, Sultana M, Hossain MA. Emergence and Distribution of Foot-and-Mouth Disease Virus Serotype A and O in Bangladesh. *Transbound Emerg Dis.* 2013 Jun 4. doi: 10.1111/tbed.12113. [Epub ahead of print] PubMed PMID: 23734722.
5. Pedersen LE, Harndahl M, Nielsen M, Patch JR, Jungersen G, Buus S, Golde WT. Identification of peptides from foot-and-mouth disease virus structural proteins bound by class I swine leukocyte antigen (SLA) alleles, SLA-1\*0401 and SLA-2\*0401. *Anim Genet.* 2013 Jun;44(3):251-8. doi: 10.1111/j.1365-2052.2012.02400.x. Epub 2012 Sep 18. PubMed PMID: 22984928.
6. Rai DK, Schafer EA, Singh K, McIntosh MA, Sarafianos SG, Rieder E. Repeated exposure to 5D9, an inhibitor of 3D polymerase, effectively limits the replication of foot-and-mouth disease virus in host cells. *Antiviral Res.* 2013 Jun;98(3):380-5. doi: 10.1016/j.antiviral.2013.03.022. Epub 2013 Apr 8. PubMed PMID: 23578728.
7. Zhou JH, You YN, Chen HT, Zhang J, Ma LN, Ding YZ, Pejsak Z, Liu YS. The effects of the synonymous codon usage and tRNA abundance on protein folding of the 3C protease of foot-and-mouth disease virus. *Infect Genet Evol.* 2013 Jun;16:270-4. doi: 10.1016/j.meegid.2013.02.017. Epub 2013 Mar 14. PubMed PMID:23499709.
8. LaRocco M, Krug PW, Kramer E, Ahmed Z, Pacheco JM, Duque H, Baxt B, Rodriguez LL. A continuous bovine kidney cell line constitutively expressing bovine  $\alpha\beta 6$  integrin has increased susceptibility to foot-and-mouth disease virus. *J Clin Microbiol.* 2013 Jun;51(6):1714-20. doi: 10.1128/JCM.03370-12. Epub 2013 Mar 20. PubMed PMID: 23515553.
9. Polacek C, Gullberg M, Li J, Belsham GJ. Low levels of foot-and-mouth disease virus 3C protease expression are required to achieve optimal capsid protein expression and processing in mammalian cells. *J Gen Virol.* 2013 Jun;94(Pt 6):1249-58. doi: 10.1099/vir.0.050492-0. Epub 2013 Jan 30. PubMed PMID: 23364188.
10. Gladue DP, O'Donnell V, Baker-Branstetter R, Holinka LG, Pacheco JM, Fernández Sainz I, Lu Z, Ambroggio X, Rodriguez L, Borca MV. Foot-and-Mouth Disease Virus Modulates Cellular Vimentin for Virus Survival. *J Virol.* 2013 Jun;87(12):6794-803. doi: 10.1128/JVI.00448-13. Epub 2013 Apr 10. PubMed PMID:23576498; PubMed Central PMCID: PMC3676138.
11. Zhou G, Wang H, Wang F, Yu L. Recombinant adenovirus expressing type Asia1 foot-and-mouth disease virus capsid proteins induces protective immunity against homologous virus challenge in mice. *Res Vet Sci.* 2013 Jun;94(3):796-802. doi:10.1016/j.rvsc.2012.12.004. Epub 2012 Dec 23. PubMed PMID: 23267820.
12. Legesse Y, Asfaw Y, Sahle M, Ayelet G, Jenberie S, Negussie H. First confirmation of foot and mouth disease virus serotype SAT-1 in cattle and small ruminants in Ethiopia in 2007/08. *Trop Anim Health Prod.* 2013 Jun;45(5):1265-7. doi: 10.1007/s11250-012-0339-2. Epub 2012 Dec 19. PubMed PMID: 23250672.
13. Quattrocchi V, Molinari P, Langellotti C, Gnazzo V, Taboga O, Zamorano P. Co-inoculation of baculovirus and FMDV vaccine in mice, elicits very early protection against foot and mouth disease virus without interfering with long lasting immunity. *Vaccine.* 2013 May 31;31(24):2713-8. doi: 10.1016/j.vaccine.2013.03.067. Epub 2013 Apr 12. PubMed PMID: 23588086.

14. Yin S, Yang S, Shang Y, Sun S, Zhou G, Jin Y, Tian H, Wu J, Liu X. Characterization of Asia 1 sdAb from Camels Bactrianus (*C. bactrianus*) and Conjugation with Quantum Dots for Imaging FMDV in BHK-21 Cells. *PLoS One*. 2013 May 30;8(5):e63500. doi: 10.1371/journal.pone.0063500. Print 2013. PubMed PMID: 23737944; PubMed Central PMCID: PMC3667858.
15. Zhu JJ, Arzt J, Puckette MC, Smoliga GR, Pacheco JM, Rodriguez LL. Mechanisms of Foot-and-Mouth Disease Virus Tropism Inferred from Differential Tissue Gene Expression. *PLoS One*. 2013 May 28;8(5):e64119. doi: 10.1371/journal.pone.0064119. Print 2013. PubMed PMID: 23724025; PubMed Central PMCID: PMC3665847.
16. Guo C, Zhang C, Zheng H, Huang Y. Recombinant adenovirus expression of FMDV P1-2A and 3C protein and its immune response in mice. *Res Vet Sci*. 2013 May 27. doi:pii: S0034-5288(13)00180-X. 10.1016/j.rvsc.2013.05.001. [Epub ahead of print] PubMed PMID: 23722010.
17. Chen HT, Liu YS. Immunity of Foot-and-Mouth Disease Serotype Asia 1 by Sublingual Vaccination. *PLoS One*. 2013 May 22;8(5):e63839. doi: 10.1371/journal.pone.0063839. Print 2013. PubMed PMID: 23717497; PubMed Central PMCID: PMC3661678.
18. Maree FF, Blignaut B, de Beer TA, Rieder E. Analysis of SAT Type Foot-And-Mouth Disease Virus Capsid Proteins and the Identification of Putative Amino Acid Residues Affecting Virus Stability. *PLoS One*. 2013 May 22;8(5):e61612. doi: 10.1371/journal.pone.0061612. Print 2013. PubMed PMID: 23717387; PubMed Central PMCID: PMC3661562.
19. Li X, Wang J, Liu J, Li Z, Wang Y, Xue Y, Li X, Cao H, Zheng SJ. Engagement of soluble resistance-related calcium binding protein (sorcina) with foot-and-mouth disease virus (FMDV) VP1 inhibits type I interferon response in cells. *Vet Microbiol*. 2013 May 21. doi:pii: S0378-1135(13)00245-9. 10.1016/j.vetmic.2013.04.028. [Epub ahead of print] PubMed PMID: 23764275.
20. Wang H, Liu X, Wu J, Wu G, Yu L, He C, Yang H, Xie W, Xia X, He H. Bovine fetal epithelium cells expressing shRNA targeting viral VP1 gene resisted against foot-and-mouth disease virus. *Virology*. 2013 May 10;439(2):115-21. doi: 10.1016/j.virol.2013.02.003. Epub 2013 Mar 6. PubMed PMID: 23481248.
21. Borley DW, Mahapatra M, Paton DJ, Esnouf RM, Stuart DI, Fry EE. Evaluation and use of in-silico structure-based epitope prediction with foot-and-mouth disease virus. *PLoS One*. 2013 May 7;8(5):e61122. doi: 10.1371/journal.pone.0061122. Print 2013. PubMed PMID: 23667434; PubMed Central PMCID: PMC3646828.
22. Subramaniam S, Sanyal A, Mohapatra JK, Sharma GK, Biswal JK, Ranjan R, Rout M, Das B, Bisht P, Mathapati BS, Dash BB, Pattnaik B. Emergence of a novel lineage genetically divergent from the predominant Ind2001 lineage of serotype O foot-and-mouth disease virus in India. *Infect Genet Evol*. 2013 May 3;13C:1-7. doi: 10.1016/j.meegid.2013.04.027. [Epub ahead of print] PubMed PMID: 23643555.
23. Fernández N, Buddrus L, Piñeiro D, Martínez-Salas E. Evolutionary conserved motifs constrain the RNA structure organization of picornavirus IRES. *FEBS Lett*. 2013 May 2;587(9):1353-8. doi: 10.1016/j.febslet.2013.03.005. Epub 2013 Mar 15. PubMed PMID: 23507141.
24. Basagoudanavar SH, Hosamani M, Tamil Selvan RP, Sreenivasa BP, Saravanan P, Chandrasekhar Sagar BK, Venkataramanan R. Development of a liquid-phase blocking ELISA based on foot-and-mouth disease virus empty capsid antigen for seromonitoring vaccinated animals. *Arch Virol*. 2013 May;158(5):993-1001. doi:10.1007/s00705-012-1567-5. Epub 2012 Dec 16. PubMed PMID: 23242775.
25. Toka FN, Golde WT. Cell mediated innate responses of cattle and swine are diverse during foot-and-mouth disease virus (FMDV) infection: A unique landscape of innate immunity. *Immunol Lett*. 2013 May;152(2):135-43. doi: 10.1016/j.imlet.2013.05.007. Epub 2013 May 30. PubMed PMID: 23727070.
26. Diaz-San Segundo F, Dias CC, Moraes MP, Weiss M, Perez-Martin E, Owens G, Custer M, Kamrud K, de los Santos T, Grubman MJ. Venezuelan equine encephalitis replicon particles can induce rapid protection against foot-and-mouth disease virus. *J Virol*. 2013 May;87(10):5447-60. doi: 10.1128/JVI.03462-12. Epub 2013 Mar 6. PubMed PMID: 23468490; PubMed Central PMCID: PMC3648198.

27. Wang G, Shang Y, Wang Y, Tian H, Liu X. Comparison of a loop-mediated isothermal amplification for orf virus with quantitative real-time PCR. *Viol J.* 2013 May 1;10:138. doi: 10.1186/1743-422X-10-138. PubMed PMID: 23634981; PubMed Central PMCID: PMC3651318.
28. Du P, Shang Y, Yin S, Zhang K, Wang G, Lv Z, Yang S, Wu J, Jin Y, Chen Y, Liu Y, Tian H, Liu X. Comparative analysis of cloned cDNAs encoding Chinese yellow cattle and Gansu black swine integrin receptors for foot-and-mouth disease virus. *Arch Virol.* 2013 Apr 26. [Epub ahead of print] PubMed PMID: 23620003.
29. Alejo DM, Moraes MP, Liao X, Dias CC, Tulman ER, Diaz-San Segundo F, Rood D, Grubman MJ, Silbart LK. An adenovirus vectored mucosal adjuvant augments protection of mice immunized intranasally with an adenovirus-vectored foot-and-mouth disease virus subunit vaccine. *Vaccine.* 2013 Apr 26;31(18):2302-9. doi: 10.1016/j.vaccine.2013.02.060. Epub 2013 Mar 13. PubMed PMID: 23499593.
30. Yang M, Goolia M, Xu W, Bittner H, Clavijo A. Development of a quick and simple detection methodology for foot-and-mouth disease virus serotypes O, A and Asia 1 using a generic RapidAssay Device. *Viol J.* 2013 Apr 22;10:125. doi: 10.1186/1743-422X-10-125. PubMed PMID: 23607273; PubMed Central PMCID:PMC3646701.
31. Zhang Y, Sun Y, Yang F, Guo J, He J, Wu Q, Cao W, Lv L, Zheng H, Zhang Z. Induction of partial protection against foot and mouth disease virus in guinea pigs by neutralization with the integrin  $\beta$ -1 subunit. *Viruses.* 2013 Apr 19;5(4):1114-30. doi: 10.3390/v5041114. PubMed PMID: 23604096.
32. Tajdini F, Amini MA, Mokarram AR, Taghizadeh M, Azimi SM. Foot and Mouth Disease virus-loaded fungal chitosan nanoparticles for intranasal administration: impact of formulation on physicochemical and immunological characteristics. *Pharm Dev Technol.* 2013 Apr 16. [Epub ahead of print] PubMed PMID: 23590209.
33. Dar PA, Suryanaryana VS, Nagarajan G, Reddy GR, Dechamma HJ, Kondabattula G. DNA prime-protein boost strategy with replicase-based DNA vaccine against foot-and-mouth disease in bovine calves. *Vet Microbiol.* 2013 Apr 12;163(1-2):62-70. doi: 10.1016/j.vetmic.2012.12.017. Epub 2012 Dec 25. PubMed PMID: 23305616.
34. Ma YB, Hao CX, Chang HY. Nucleotide mismatches of foot-and-mouth disease virus during replication. *Genet Mol Res.* 2013 Apr 2;12(2):1022-7. doi: 10.4238/2013.April.2.18. PubMed PMID: 23613248.
35. Park JH, Lee KN, Ko YJ, Kim SM, Lee HS, Shin YK, Sohn HJ, Park JY, Yeh JY, Lee YH, Kim MJ, Joo YS, Yoon H, Yoon SS, Cho IS, Kim B. Control of foot-and-mouth disease during 2010-2011 epidemic, South Korea. *Emerg Infect Dis.* 2013 Apr;19(4):655-9. doi: 10.3201/eid1904.121320. PubMed PMID: 23632094; PubMed Central PMCID: PMC3647416.
36. Chu JQ, Lee YJ, Park JN, Kim SM, Lee KN, Ko YJ, Lee HS, Cho IS, Kim B, Park JH. Construction of a bovine enterovirus-based vector expressing a foot-and-mouth disease virus epitope. *J Virol Methods.* 2013 Apr;189(1):101-4. doi: 10.1016/j.jviromet.2013.01.010. Epub 2013 Feb 4. PubMed PMID: 23391822.
37. Xu L, Hurtle W, Rowland JM, Casteran KA, Bucko SM, Grau FR, Valdazo-González B, Knowles NJ, King DP, Beckham TR, McIntosh MT. Development of a universal RT-PCR for amplifying and sequencing the leader and capsid-coding region of foot-and-mouth disease virus. *J Virol Methods.* 2013 Apr;189(1):70-6. doi:10.1016/j.jviromet.2013.01.009. Epub 2013 Feb 1. PubMed PMID: 23380590.
38. Park JH, Lee KN, Ko YJ, Kim SM, Lee HS, Park JY, Yeh JY, Kim MJ, Lee YH, Sohn HJ, Cho IS, Kim B. Diagnosis and control measures of the 2010 outbreak of foot-and-mouth disease A type in the Republic of Korea. *Transbound Emerg Dis.* 2013 Apr;60(2):188-92. doi: 10.1111/j.1865-1682.2012.01333.x. Epub 2012 May 27. PubMed PMID: 22630568.

## Annex 3. RECOMMENDATIONS FROM WRLFMD® ON FMD VIRUS STRAINS TO BE INCLUDED IN FMDV ANTIGEN BANKS – June 2013

### High Priority

O Manisa \*  
 O PanAsia-2  
 O BFS or Campos  
 A24 Cruzeiro  
 Asia 1 Shamir  
 A Iran-05  
 A22 Iraq  
 SAT 2 Saudi Arabia (*or equivalent i.e. SAT 2 Eritrea*)

\*can be supplemented with O 4625 or O 3039

### Medium Priority

A Eritrea  
 A Iran '96  
 SAT 2 Zimbabwe  
 A Iran 87 or A Saudi Arabia 23/86 (*or equivalent*)  
 SAT 1 South Africa  
 A Malaysia 97 (*or Thai equivalent such as A/NPT/TAI/86*)  
 A Argentina 2001  
 O Taiwan 97 (*pig-adapted strain or Philippine equivalent*)  
 A Iran '99

### Low Priority

A15 Bangkok related strain  
 A87 Argentina related strain  
 C Noville  
 SAT 2 Kenya  
 SAT 1 Kenya  
 SAT 3 Zimbabwe  
 A Kenya (not in order of importance)

