



WRLFMD Quarterly Report

April-June 2011

Reference Laboratory Contract Report

7/20/2011
WRLFMD

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**FAO/OIE Reference Laboratory Contract Report^{1,2}
April-June 2011**

Foot-and-Mouth Disease

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² Copies of all the individual reports cited herein can be obtained from Dr. Jef Hammond, IAH-Pirbright, jef.hammond@bbsrc.ac.uk.

Summary

ASIA

Afghanistan and Pakistan

The O/ME-SA/PanAsia-2^{ANT-10} and A-Iran-05^{AFG-07} lineages continue to dominate in these countries. A new, as yet unnamed, A-Iran-05 lineage was found in Afghanistan.

Kazakhstan

Two outbreaks of FMDV type O were reported on 21/05/2011 (Tinali, Akzholskiy, Akzhaik, Ural'sk) and on 20/06/2011 (Lbishchenskoye, Akzholskiy, Akzhaik, Ural'sk). No sequence data is available.

P.R. China

A new FMDV type O outbreak was reported to have occurred on 29/03/2011 in Jing Xiang Village, Tianzhu, Qian Dongnan, Guizhou. VP1 sequence data provided by the Lanzhou Veterinary Research Institute (and submitted to GenBank – accession number JF837375) showed the virus to belong to the ME-SA/PanAsia lineage and to be closely related to recent viruses from Vietnam.

Taiwan POC

Three new outbreaks were detected by serology on 06/05/2011 (Xinpu Township, Hsin-chu), 16/05/2011 (Yongjing Township, Chang-hua) and 23/05/2011 (Tianwei Township, Chang-hua) all in pigs. No viruses were isolated.

Republic of Korea (South Korea)

Three more outbreaks of FMD type O have been reported: 16/04/2011 (Hwangjeong-ri, Geumho-eup, Yeongcheon-city, Gyeongsangbuk-do), 19/04/2011 (Samho-ri, Geumho-eup, Yeongcheon-city, Gyeongsangbuk-do) and 21/04/2011 (Donam-dong, Yeongcheon-city, Gyeongsangbuk-do). No sequence data has been reported.

The Democratic People's Republic of Korea (North Korea)

Four further outbreaks of FMDV type O were reported during March (on 02/03/2011 in Kangwon-Do province) and on 06/03/2011, 17/03/2011 and 25/03/2011 in Hwanghae-Bukto province). One virus was isolated by the WRLFMD from an earlier outbreak and shown to be O/SEA/Mya-98.

Israel

Between 17/04/2001 and 16/06/2011, 12 outbreaks due to FMDV type O were reported in the Hazafon and Haifa areas in the north of the country and one outbreak in Hadarom in the south, close to the Gaza Strip. Viruses isolated at the WRLFMD all belonged to the ME-SA/PanAsia-2^{ANT-10} sub-lineage.

AFRICA

Botswana

Previously, in February 2011, an outbreak of FMD type SAT 2 was reported in cattle at Kaepe crush, Okavango, Ngamiland, Maun.

A second focus of infection in cattle, also due to SAT 2, was reported on 29/04/2011 at Butale Syndicate Crush, Francistown, North East, close to the border with Zimbabwe. The previous outbreak of FMD in this area was in 2003. Subsequently, two further outbreaks were reported in the region (on 22/05/2011 at Mabethe Crush, Francistown and on 27/05/2011 at Ramokgwebana, Selibe-phikwe, Central, Selibe Phikwe).

Collaboration between the Botswana Vaccine Institute (BVI) and the WRLFMD has shown that the viruses isolated from the two foci belong to two different SAT 2 topotypes. The viruses from the Maun area belong to topotype III and are closely related to viruses present in that area during 2008 and 2009. While the viruses from

the Francistown/ Selibe Phikwe outbreaks belong to topotype I and are closely related to viruses from Mozambique in 2010.

Mozambique

A further outbreak of FMDV type SAT 2 was reported from the Gaza area (20/05/2011 at Lumane, Chicumbane, Xai-xai). No sequence data has been reported.

South Africa

Previously, between 01/02/2011 and 17/03/2011, FMDV non-structural antibodies were discovered in cattle, goats and sheep at 44 locations in KwaZulu-Natal. Although some NSP ELISA tests were positive, most NSP ELISA test results were inconclusive. However, SAT 1 virus has been isolated from cattle samples from the outbreak area and SAT 3 virus was isolated from buffalo samples from a nature reserve in the outbreak area.

Zimbabwe

Collaboration between the Botswana Vaccine Institute (BVI) and the WRLFMD has shown that viruses isolated from Plumtree (close to the border with Botswana) in 2010 belong to SAT 2 topotype I and were most closely related to virus occurring in Zimbabwe in 2002 and 2003. Although belonging to the same topotype as the most recent outbreaks in eastern Botswana, they were not closely related to the Zimbabwe 2010 viruses.

On 22/04/2011, an outbreak of FMD SAT 2 was reported in cattle at Ingwizi Ranch, Mangwe, Matabeleland South. The farm is adjacent to previously infected communal areas. Suspected cases were reported from 6 dip tanks in the area. No sequence data is available.

EUROPE

Bulgaria

On the 3rd April, three new outbreaks (involving cattle, buffalo, sheep, goats and pigs) were reported and confirmed only by serology. Two outbreaks occurred at Bliznak, (Malko Turnovo Municipality, Burgas) and one at Dolno Yabalkovo (Sredets, Burgas).

SOUTH AMERICA

No FMD outbreaks reported.

Uncharacterised FMD viruses

A number of other 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/2010.htm.

WRLFMD vaccine recommendations have not changed from the previous report (Annex 3). However, a recently available PanAsia 2 vaccine is being tested in WRLFMD vaccine matching assays and its ability to match current field strains will be carefully monitored and reported in due course.

Importantly, again recent isolates of serotype Asia 1 from Pakistan and Iran have failed to match with the Asia 1 Shamir vaccine strain in WRLFMD laboratory testing. Further 'in vivo' work is needed to determine the level of protection that may be offered in the field by currently available high potency Asia 1 vaccines. A careful watch will be maintained for further outbreaks of Asia 1 and any isolates obtained will be tested for vaccine matching as rapidly as possible.

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 June 2011 is shown in Annex 1 Table A. A record of all samples received to IAH-Pirbright (April-June 2011) is shown in Annex 1 Table B.

Table 1: Status of sequencing of samples received by the WRLFMD from April to June 2011.

Batch	Date Recd.	Country	Serotype	No. of sequences	Status
WRLFMD/2011/00021*	31/03/2011	Pakistan	O	9	Completed
WRLFMD/2011/00022	20/04/2011	Hong Kong SAR	O	2	Completed
WRLFMD/2011/00023*	31/03/2011	Afghanistan	O	19	Completed
WRLFMD/2011/00023*	31/03/2011	Afghanistan	A	17	Completed
WRLFMD/2011/00023*	31/03/2011	Afghanistan	Asia 1	7	Completed
WRLFMD/2011/00025	21/05/2011	Republic of Korea	O	3	Completed
WRLFMD/2011/00026	01/06/2011	Dem. People's Rep. of Korea	O	1	Completed
WRLFMD/2011/00027	08/06/2011	Israel	O	8	Completed
WRLFMD/2011/00028	10/06/2011	Botswana	SAT 2	5	Completed
WRLFMD/2011/00029	10/06/2011	Zimbabwe	SAT 2	2	Completed
Total				73	

*, carried over from last reporting period.

Detailed Analysis:

ASIA

Afghanistan

WRLFMD/2011/00023

Date received: 31/03/2011

No. of samples: 60

O: 19 (ME-SA/PanAsia-2^{ANT-10})

A: 15 (ASIA/Iran-05^{AFG-07} & unnamed)

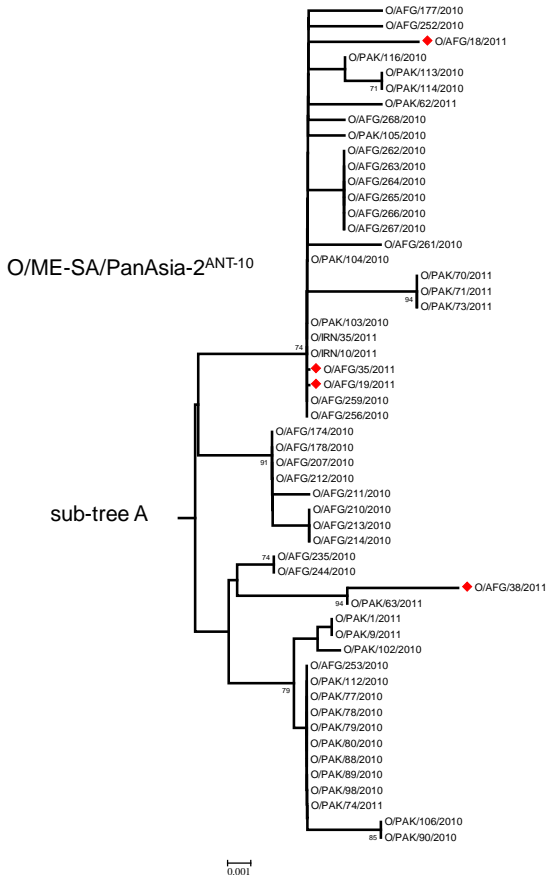
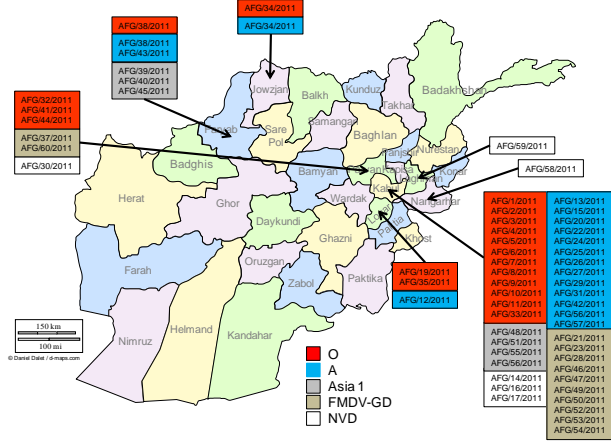
O+A: 1

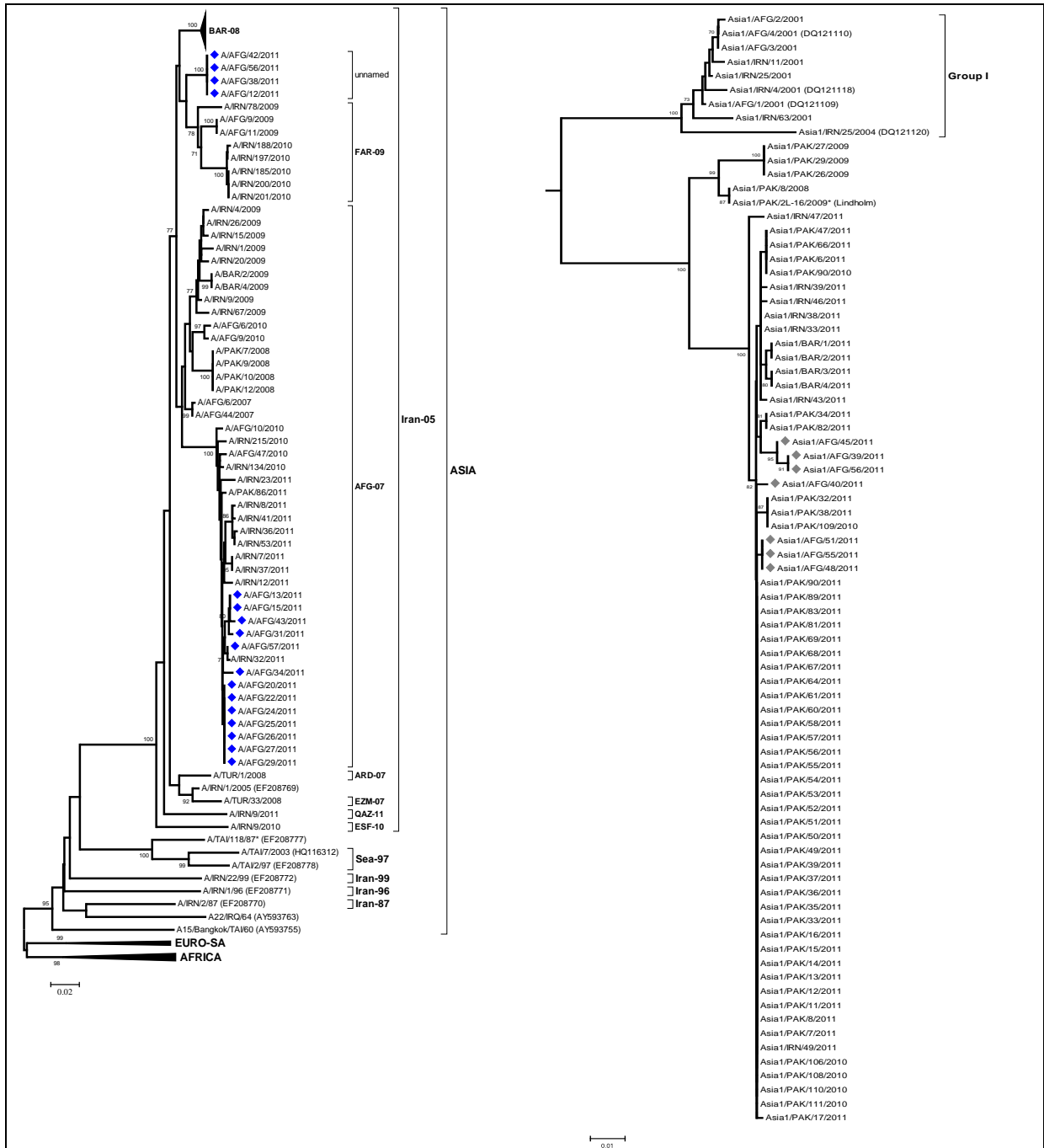
A+Asia1: 1

Asia1: 6

FMDV-GD: 12

NVD: 6





Israel

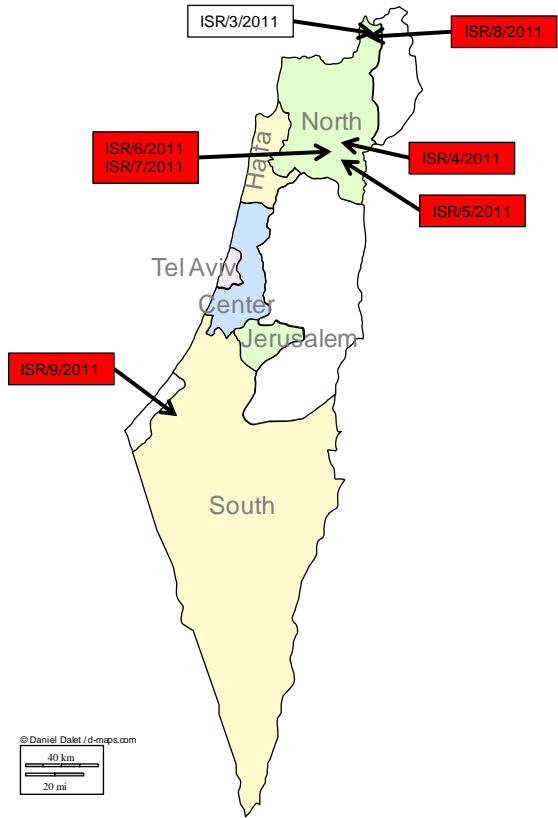
WRLFMD/2011/00027

Date received: 08/06/2011

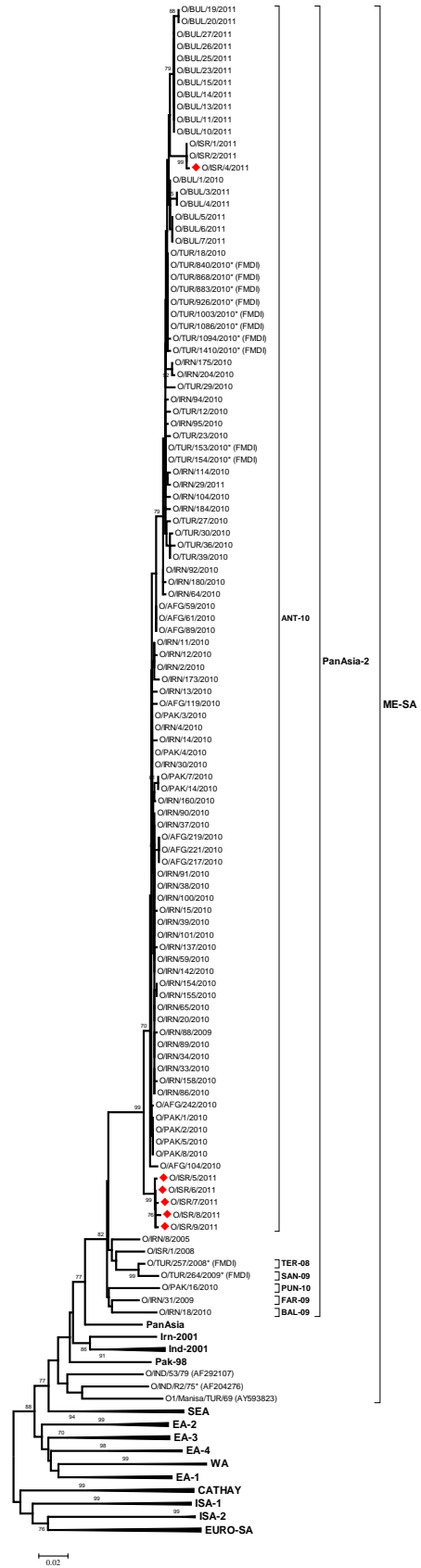
No. of samples: 7

O: 6 (ME-SA/PanAsia-2^{ANT-10})

FMDV-GD: 1



© Daniel Dalet / d-maps.com
40 km
20 km

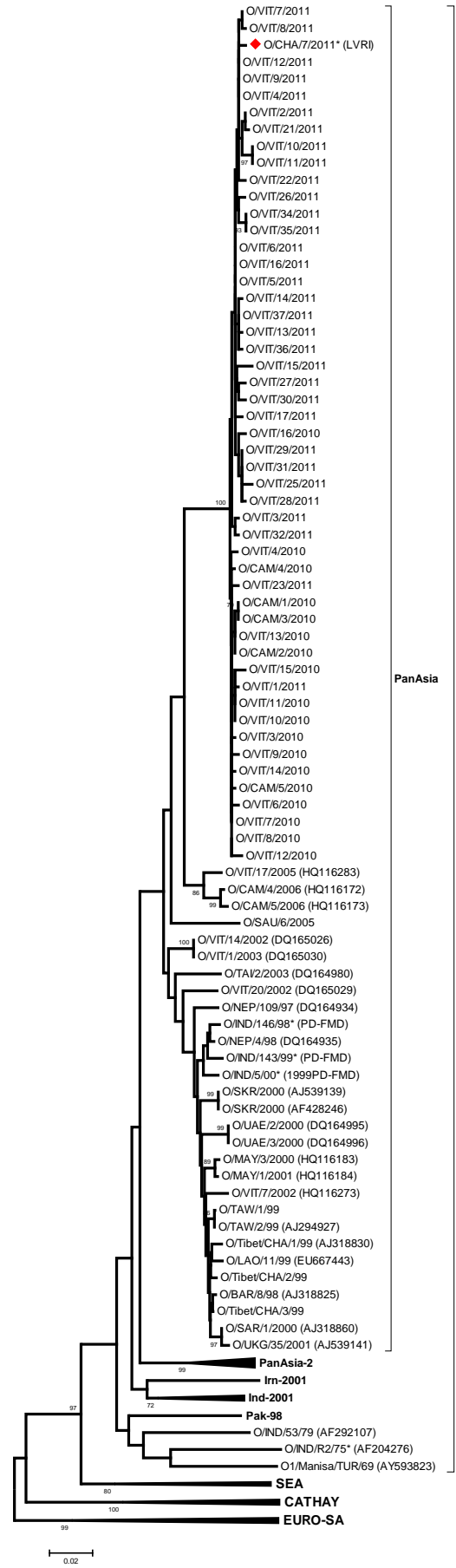


P.R. China

29/03/2011
 Jing Xiang Village, Tianzhu,
 Qian Dongnan, Guizhou.

O/ME-SA/PanAsia

VP1 sequence data provided by the LVRI.



Hong Kong SAR, P.R. China

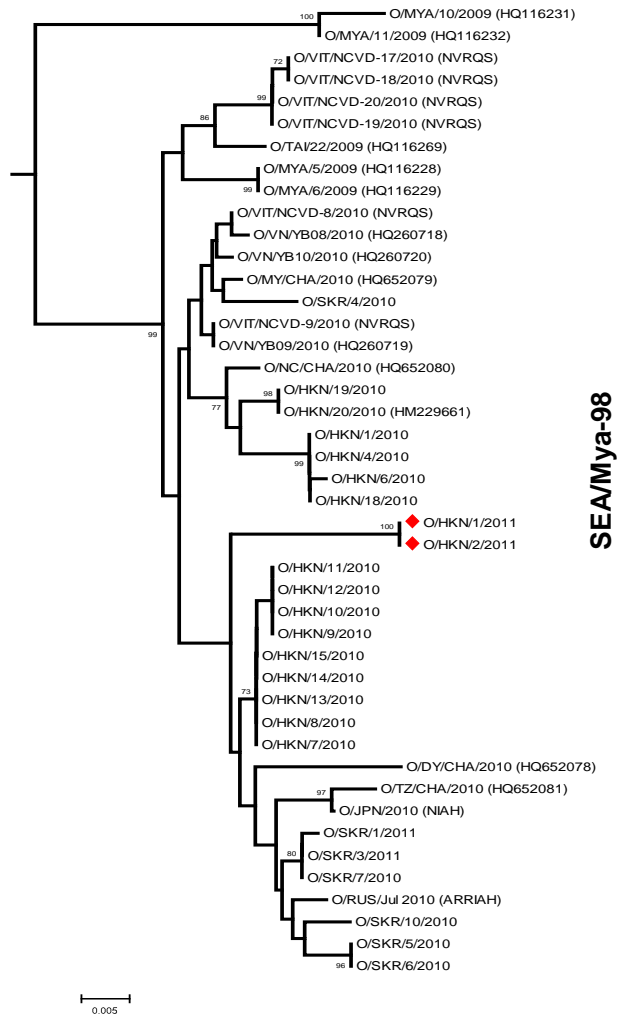
WRLFMD/2011/00022

Date received: 20/04/2011

No. of samples: 2

O: 2 (SEA/Mya-98)

(Locations not given)



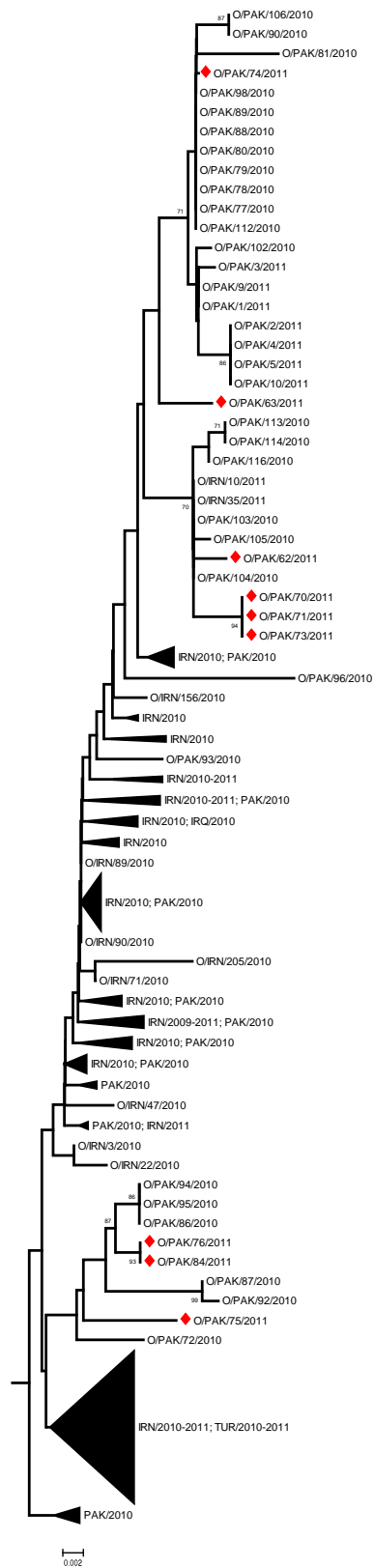
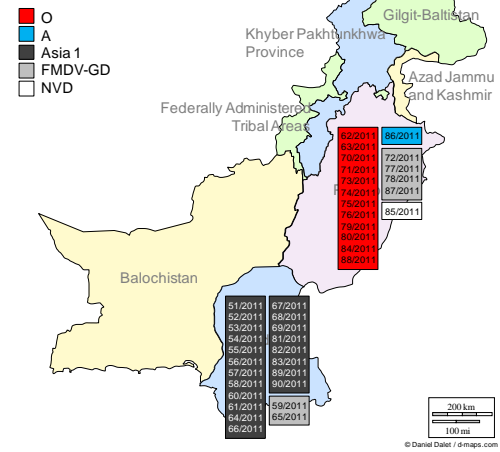
SEA/Mya-98

Pakistan

WRLFMD/2011/00021
 Date received: 31/03/2011
 No. of samples: 40
 O: 9 (ME-SA/PanAsia-2^{ANT-10})
 O (NVI): 3
 A: 1 (ASIA/Iran-05^{AFG-07})
 Asia 1: 20
 GD: 6
 NVD: 1

(NVI, no virus isolated)

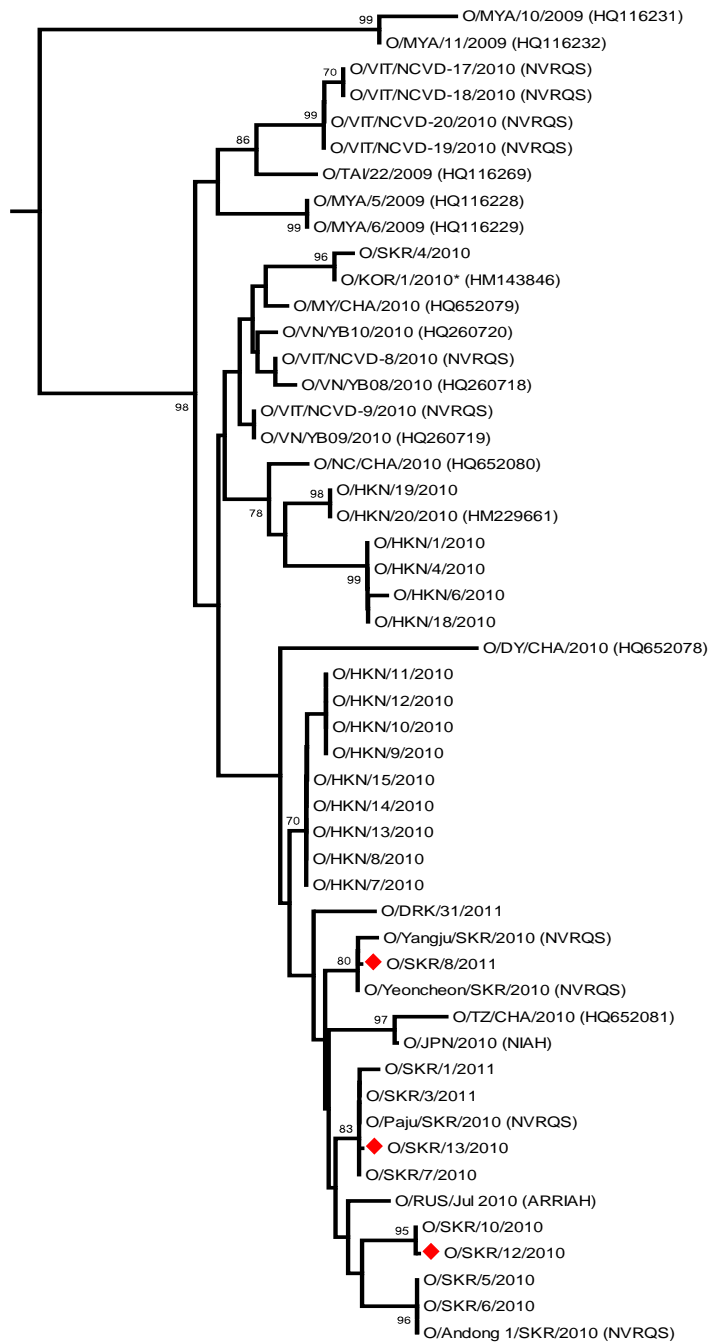
WRLFMD/2011/00021



Republic of Korea (South Korea)

WRLFMD/2011/00025
 Date received: 21/05/2011
 No. of samples: 3
 O: 3 (SEA/Mya-98)

(Locations not given)



0.005

Dem. People's Rep. of Korea (North Korea)

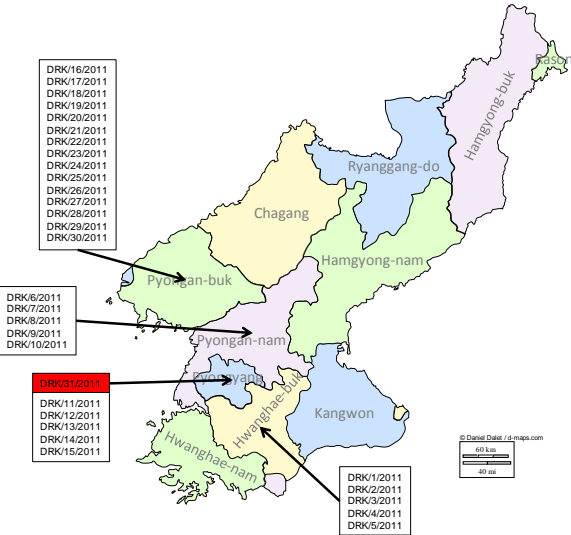
WRLFMD/2011/00026

Date received: 01/06/2011

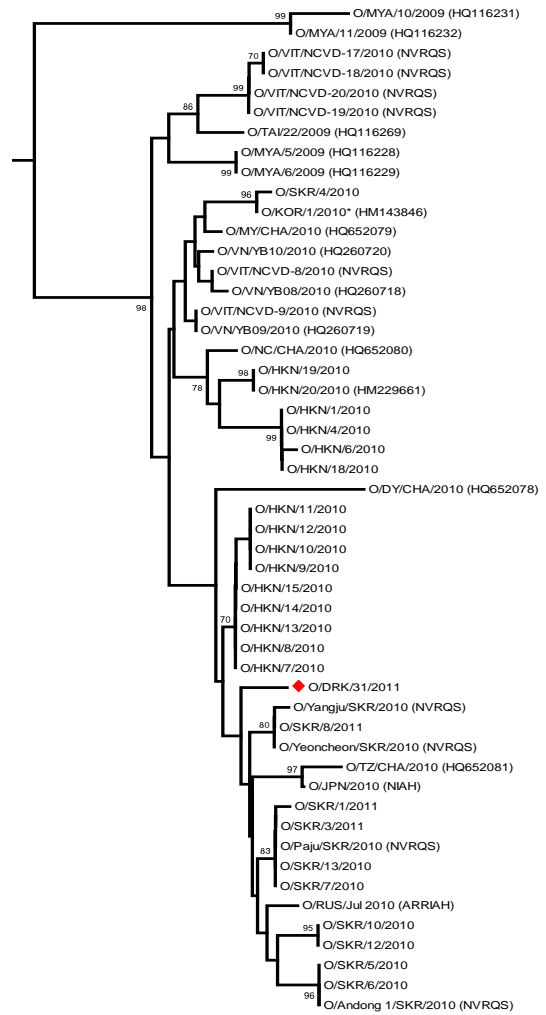
No. of samples: 31

O: 1 (SEA/Mya-98)

NVD: 30



O/SEA/Mya-98



0.005

AFRICA

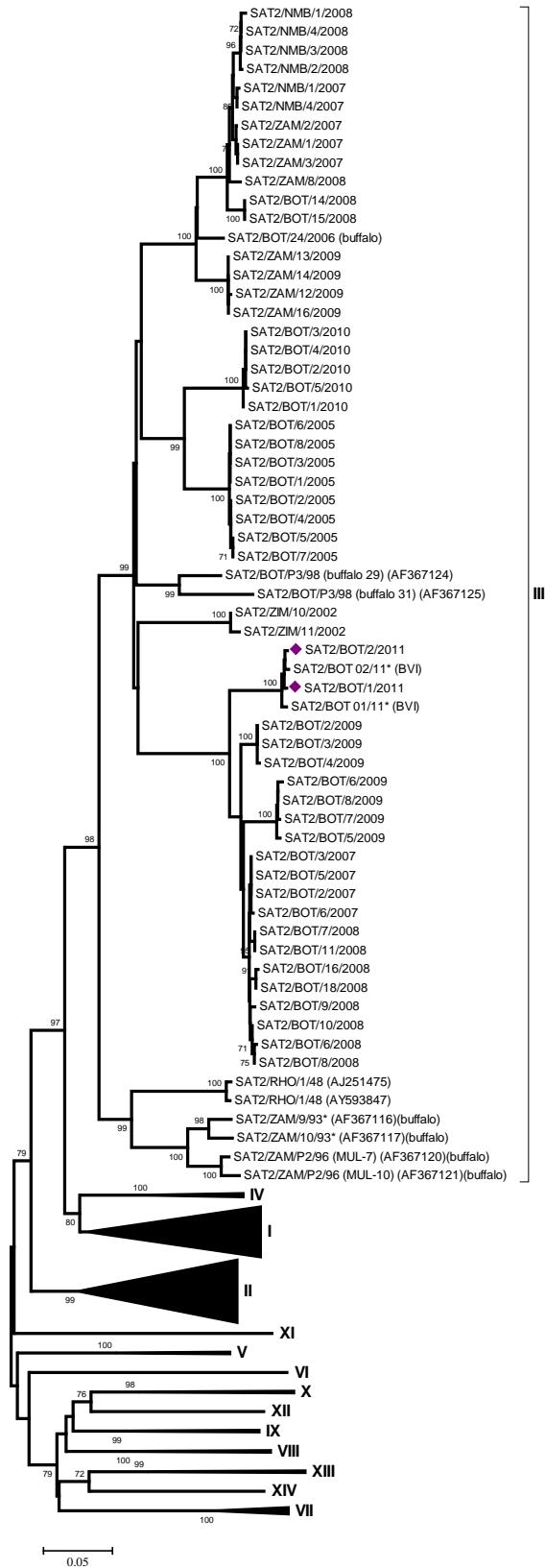
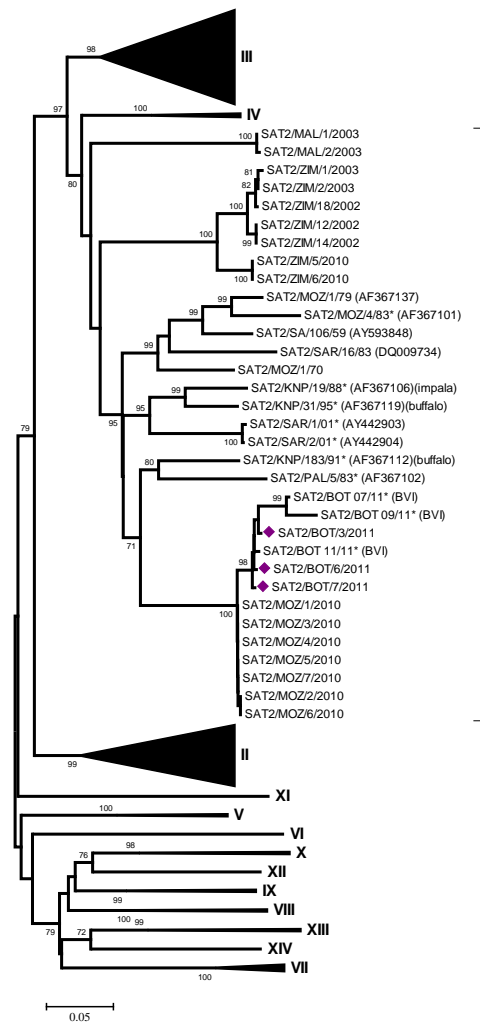
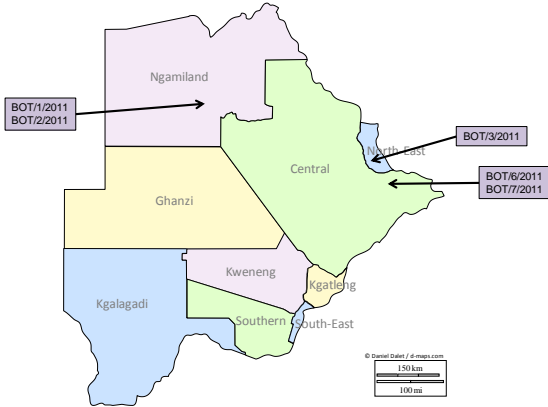
Botswana

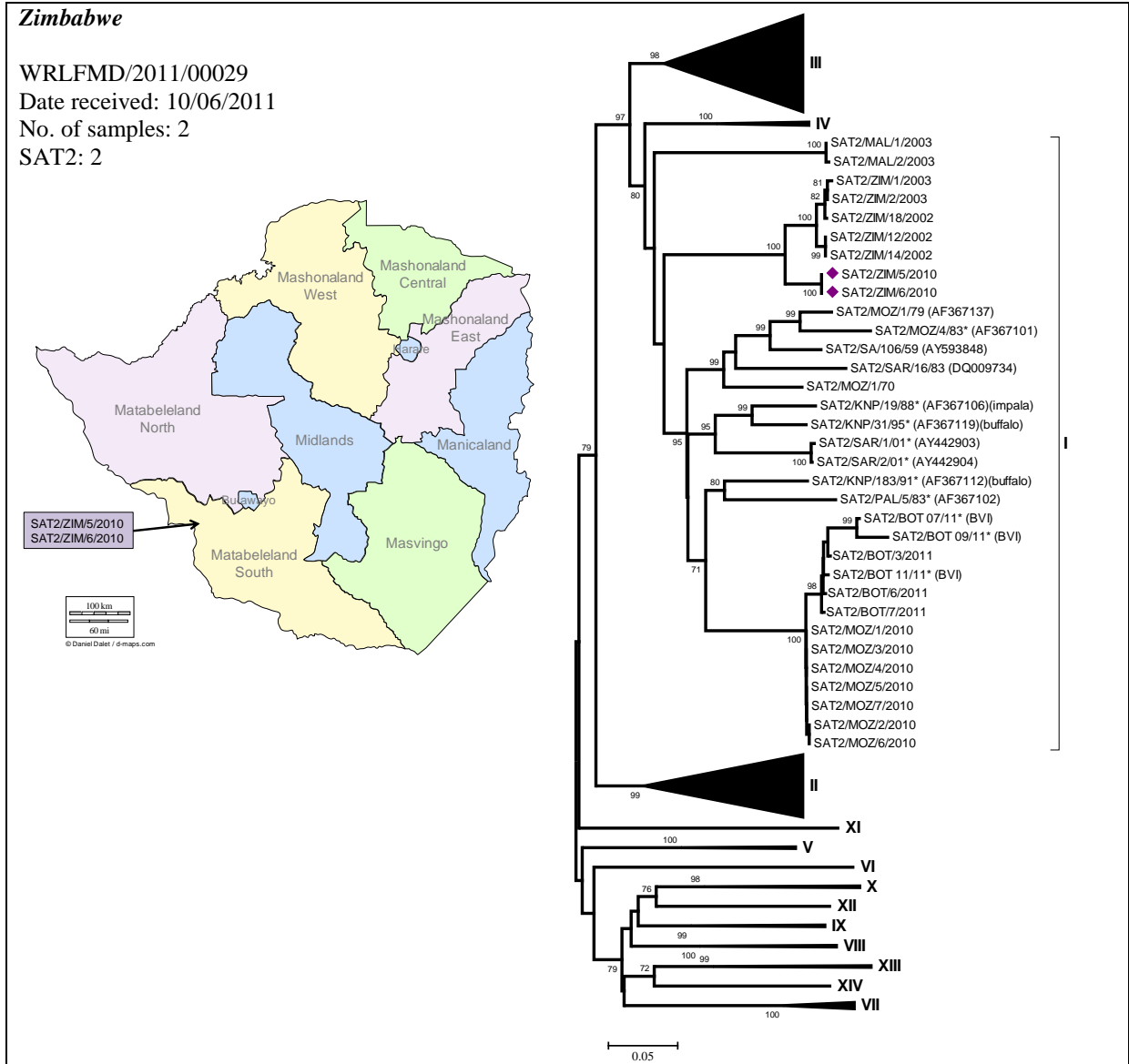
WRLFMD/2011/00028

Date received: 10/06/2011

No. of samples: 7

SAT2: 5





Vaccine matching

Seven FMDV type O isolates (See Table C, Type O for details) from Afghanistan, Vietnam and Hong Kong collected in 2010 and 2011 were analysed antigenically by the two dimensional virus neutralisation test (2dmVNT). Isolates from Afghanistan and Vietnam showed antigenic matching with vaccines of O 4625, O Campos, O TAW 98 and O TUR except one virus from Vietnam which did not match with O Campos. Viruses from Hong Kong showed no match with any of the test vaccine strains; O Campos, O Manisa, O TAW 98 and O TUR 09 apart from one virus which was antigenically close to O 4625 (Table C).

Six FMDV type Asia 1 viruses (see table C, Type Asia 1 for details) from Pakistan and Iran collected in 2011 showed no antigenic matching with vaccines Asia 1 IND 8/79, Asia 1 Shamir and Asia 1 WBN, apart from one virus from Pakistan which was antigenically close to Asia 1 Shamir (Table C).

Annex 1.

TABLE A: Clinical sample diagnostics made by the WRL between April-June 2011

Country	WRL for FMD Sample Identification	Animal	Date of Collection	Results		
				VI/ELISA	RT-PCR	Final report
BOTSWANA	BOT 1/2011	Cattle	12.02.11	SAT 2	Positive	SAT 2
	BOT 2/2011	Cattle	12.02.11	SAT 2	Positive	SAT 2
	BOT 3/2011	Cattle	29.04.11	SAT 2	Positive	SAT 2
	BOT 6/2011	Cattle	27.05.11	SAT 2	Positive	SAT 2
	BOT 7/2011	Cattle	27.05.11	SAT 2	Positive	SAT 2
BULGARIA	BUL 16/2011	Cattle	28.03.11	NVD	Positive	FMDV GD
	BUL 17/2011	Cattle	28.03.11	NVD	Positive	FMDV GD
	BUL 18/2011	Cattle	28.03.11	NVD	Positive	FMDV GD
	BUL 19/2011	Cattle	28.03.11	O	Negative	O
	BUL 20/2011	Cattle	28.03.11	O	Positive	O
	BUL 21/2011	Cattle	28.03.11	NVD	Positive	FMDV GD
	BUL 22/2011	Cattle	28.03.11	NVD	Positive	FMDV GD
	BUL 23/2011	Cattle	28.03.11	O	Positive	O
	BUL 24/2011	Cattle	28.03.11	NVD	Positive	FMDV GD
	BUL 25/2011	Cattle	28.03.11	O	Positive	O
	BUL 26/2011	Cattle	28.03.11	O	Positive	O
	BUL 27/2011	Cattle	28.03.11	O	Positive	O
	BUL 28/2011	Cattle	01.04.11	NVD	Positive	FMDV GD
	BUL 29/2011	Cattle	01.04.11	NVD	Positive	FMDV GD
	BUL 30/2011	Cattle	01.04.11	NVD	Positive	FMDV GD
	BUL 31/2011	Cattle	01.04.11	NVD	Negative	NVD
	BUL 32/2011	Cattle	01.04.11	NVD	Positive	FMDV GD
	BUL 33/2011	Cattle	01.04.11	NVD	Negative	NVD
	BUL 34/2011	Cattle	16.04.11	NVD	Negative	NVD
HONG KONG	HKN 1/2011	Pig	01.03.11	O	Positive	O
	HKN 2/2011	Pig	01.03.11	O	Positive	O
IRAQ	IRQ 1/2010	Cattle	12.01.10	NVD	Positive	FMDV GD
	IRQ 2/2010	Sheep	11.04.10	NVD	Negative	NVD
	IRQ 3/2010	Cattle	11.09.10	NVD	Positive	FMDV GD
	IRQ 4/2010	Cattle	12.09.10	O	Positive	O
	IRQ 5/2010	Cattle	12.09.10	A	Positive	A
	IRQ 6/2010	Sheep	12.09.10	O	Positive	O
	IRQ 7/2010	Cattle	11.10.10	O	Positive	O
	IRQ 8/2010	Cattle	11.10.10	O	Positive	O
	IRQ 9/2010	Cattle	11.10.10	NVD	Positive	FMDV GD
	IRQ 10/2010	Cattle	11.10.10	NVD	Positive	FMDV GD
	IRQ 11/2010	Cattle	10.11.10	NVD	Positive	FMDV GD
	IRQ 12/2010	Sheep	14.11.10	O	Positive	O
	IRQ 13/2010	Sheep	14.11.10	O	Positive	O
	IRQ 14/2010	Sheep	21.11.10	NVD	Positive	FMDV GD
	IRQ 15/2010	Cattle	23.11.10	NVD	Positive	FMDV GD
	IRQ 16/2010	Cattle	23.11.10	NVD	Negative	NVD

	IRQ 17/2010	Cattle	25.11.10	NVD	Negative	NVD
ISRAEL	ISR 3/2011	Cattle	26.04.11	NVD	Poaitive	FMDV GD
	ISR 4/2011	Cattle	30.04.11	O	Poaitive	O
	ISR 5/2011	Cattle	09.05.11	O	Poaitive	O
	ISR 6/2011	Sheep	16.05.11	O	Poaitive	O
	ISR 7/2011	Cattle	21.05.11	O	Poaitive	O
	ISR 8/2011	Cattle	21.05.11	O	Poaitive	O
	ISR 9/2011	Sheep	30.05.11	O	Poaitive	O
DEMOCRATIC PEOPLES' REPUBLIC OF KOREA	DRK 1/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 2/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 3/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 4/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 5/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 6/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 7/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 8/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 9/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 10/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 11/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 12/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 13/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 14/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 15/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 16/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 17/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 18/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 19/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 20/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 21/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 22/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 23/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 24/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 25/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 26/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 27/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 28/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 29/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 30/2011	Cattle	00.00.11	NVD	Negative	NVD
	DRK 31/2011	Cattle	00.00.11	O	Positive	O
SOUTH KOREA	SKR 12/2010	Cattle	27.12.10	O	Positive	O
	SKR 13/2010	Cattle	27.12.10	O	Positive	O
	SKR 8/2011	Cattle	02.01.11	O	Positive	O
VIETNAM	VIT 14/2010	Cattle	11.11.10	O	Positive	O
	VIT 15/2010	Cattle	18.11.10	O	Positive	O
	VIT 16/2010	Pig	16.12.10	O	Positive	O
	VIT 1/2011	Buffalo	01.01.11	O	Positive	O
	VIT 2/2011	Buffalo	02.01.11	O	Positive	O
	VIT 3/2011	Pig	05.01.11	O	Positive	O
	VIT 4/2011	Pig	05.01.11	O	Positive	O
	VIT 5/2011	Cattle	05.01.11	O	Positive	O
VIT 6/2011	Buffalo	06.01.11	O	Positive	O	

	VIT 7/2011	Cattle	11.01.11	O	Positive	O
	VIT 8/2011	Buffalo	11.01.11	O	Positive	O
	VIT 9/2011	Cattle	14.01.11	O	Positive	O
	VIT 10/2011	Cattle	14.01.11	O	Positive	O
	VIT 11/2011	Cattle	14.01.11	O	Positive	O
	VIT 12/2011	Buffalo	17.01.11	O	Positive	O
	VIT 13/2011	Pig	19.01.11	O	Positive	O
	VIT 14/2011	Pig	20.01.11	O	Positive	O
	VIT 15/2011	Pig	21.01.11	O	Positive	O
	VIT 16/2011	Buffalo	21.01.11	O	Positive	O
	VIT 17/2011	Pig	24.01.11	O	Positive	O
	VIT 18/2011	Cattle	25.01.11	NVD	Positive	FMDV GD
	VIT 19/2011	Cattle	25.01.11	NVD	Positive	FMDV GD
	VIT 20/2011	Pig	25.01.11	NVD	Positive	FMDV GD
	VIT 21/2011	Buffalo	25.01.11	O	Positive	O
	VIT 22/2011	Pig	26.01.11	O	Positive	O
	VIT 23/2011	Pig	27.01.11	O	Positive	O
	VIT 24/2011	Pig	30.01.11	NVD	Positive	FMDV GD
	VIT 25/2011	Pig	17.02.11	O	Positive	O
	VIT 26/2011	Pig	20.02.11	O	Not tested	O
	VIT 27/2011	Pig	22.02.11	O	Positive	O
	VIT 28/2011	Pig	22.02.11	O	Positive	O
	VIT 29/2011	Pig	22.02.11	O	Positive	O
	VIT 30/2011	Pig	23.02.11	O	Positive	O
	VIT 31/2011	Pig	23.02.11	O	Positive	O
	VIT 32/2011	Pig	10.03.11	O	Positive	O
	VIT 33/2011	Buffalo	21.03.11	NVD	Positive	FMDV GD
	VIT 34/2011	Cattle	21.03.11	O	Positive	O
	VIT 35/2011	Cattle	21.03.11	O	Positive	O
	VIT 36/2011	Pig	28.03.11	O	Positive	O
	VIT 37/2011	Buffalo	29.03.11	O	Positive	O
ZIMBABWE	ZIM 5/2010	Cattle	10.06.10	SAT 2	Positive	SAT 2
	ZIM 6/2010	Cattle	10.06.10	SAT 2	Positive	SAT 2

TOTAL : 126

* Institute for Animal Health, Pirbright Laboratory, Woking, Surrey GU24 0NF

FMD(V) foot-and-mouth disease (virus)

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 viral genome

NVD no foot-and-mouth disease, swine vesicular disease or vesicular stomatitis virus detected

TABLE B: Summary of samples collected and received to IAH-Pirbright (April-June 2011)

Country	No. of samples	Virus isolation in cell culture/ELISA							NVD	RT-PCR for FMD (or SVD) virus (where appropriate)		
		FMD virus serotypes								Pos	Neg	NT
		O	A	C	SAT 1	SAT 2	SAT 3	Asia 1				
BOTSWANA	5	-	-	-	-	5	-	-	-	5	-	-
BULGARIA	19	6	-	-	-	-	-	-	13	15	4	-
DEMOCRATIC PEOPLES' REPUBLIC OF KOREA	31	1	-	-	-	-	-	-	30	1	30	-
HONG KONG	2	2	-	-	-	-	-	-	-	2	-	-
IRAQ	17	6	1	-	-	-	-	-	10	14	3	-
ISRAEL	7	6	-	-	-	-	-	-	1	7	-	-
SOUTH KOREA	3	3	-	-	-	-	-	-	-	3	-	-
VIETNAM	40	35	-	-	-	-	-	-	5	39	-	1
ZIMBABWE	2	-	-	-	-	2	-	-	-	2	-	-
TOTAL	126	59	1	-	-	7	-	-	59	88	37	1

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 VNT from 1st April to 30th June 2011**Type O:**

Vaccine matching studies for type O FMDV by VNT-WRL FMD						
SAMPLE WRL REF	SEROTYPE	O 4625	O Campos	O Manisa	O Taw 98	O Tur 09
AFG 110/2010	O	M	M	N	M	M
AFG 268/2010	O	M	M	N	M	M
VIT 16/2010	O	M	N	N	M	M
VIT 3/2011	O	M	M	N	M	M
VIT 32/2011	O	M	M	N	M	M
HKN 1/2011	O	M	N	N	N	N
HKN 2/2011	O	N	N	N	N	N

Type Asia 1:

Vaccine matching studies for type Asia 1 FMDV by VNT-WRL FMD				
SAMPLE WRL REF	SEROTYPE	Asia1 IND 8/79	Asia1 Shamir	Asia1 WBN 117/85
PAK 51/2011	ASIA1	N	N	N
PAK 89/2011	ASIA1	N	M	N
IRN 33/2011	ASIA1	N	N	N
IRN 38/2011	ASIA1	N	N	N
IRN 43/2011	ASIA1	N	N	N
IRN 46/2011	ASIA1	N	N	N

M: the isolate was antigenically matched with the vaccine strain

N: the isolate showed no antigenic match with the vaccine strain

Annex 2. Recent FMD Publications cited by PubMed

1: Li J, Zhong Y, Li H, Zhang N, Ma W, Cheng G, Liu F, Liu F, Xu J. Enhancement of Astragalus polysaccharide on the immune responses in pigs inoculated with foot-and-mouth disease virus vaccine. *Int J Biol Macromol.* 2011 Oct 1;49(3):362-8. Epub 2011 May 27. PubMed PMID: 21640133.

2: Wieringa-Jelsma T, Wijnker JJ, Zijlstra-Willems EM, Dekker A, Stockhofe-Zurwieden N, Maas R, Wisselink HJ. Virus inactivation by salt (NaCl) and phosphate supplemented salt in a 3D collagen matrix model for natural sausage casings. *Int J Food Microbiol.* 2011 Aug 2;148(2):128-34. Epub 2011 May 18. PubMed PMID: 21632134.

3: Jamal SM, Ferrari G, Ahmed S, Normann P, Belsham GJ. Genetic diversity of foot-and-mouth disease virus serotype O in Pakistan and Afghanistan, 1997-2009. *Infect Genet Evol.* 2011 Aug;11(6):1229-38. Epub 2011 Mar 17. PubMed PMID: 21419880.

4: Ferris NP, Grazioli S, Hutchings GH, Brocchi E. Validation of a recombinant integrin $\alpha\beta 6$ /monoclonal antibody based antigen ELISA for the diagnosis of foot-and-mouth disease. *J Virol Methods.* 2011 Aug;175(2):253-60. Epub 2011 May 27. PubMed PMID: 21635921.

5: Lung O, Fisher M, Beeston A, Hughes KB, Clavijo A, Goolia M, Pasick J, Mauro W, Deregt D. Multiplex RT-PCR detection and microarray typing of vesicular disease viruses. *J Virol Methods.* 2011 Aug;175(2):236-45. Epub 2011 May 19. PubMed PMID: 21620898.

6: Zhang K, Huang J, Wang Q, He Y, Xu Z, Xiang M, Wu B, Chen H. Recombinant pseudorabies virus expressing P12A and 3C of FMDV can partially protect piglets against FMDV challenge. *Res Vet Sci.* 2011 Aug;91(1):90-4. Epub 2010 Oct 13. PubMed PMID: 20947111.

7: Jadav SK, Reddy KS, Rashmi BR, Dechamma HJ, Ganesh K, Suryanarayana VV, Reddy GR. Improved immune response by ID-pVAC: A secretory DNA vaccine construct delivered by PLG micro particles against foot and mouth disease in guinea pigs. *Res Vet Sci.* 2011 Aug;91(1):86-9. Epub 2010 Sep 29. PubMed PMID: 20884037.

8: Mohamed F, Swafford S, Petrowski H, Bracht A, Schmit B, Fabian A, Pacheco JM, Hartwig E, Berninger M, Carrillo C, Mayr G, Moran K, Kavanaugh D, Leibrecht H, White W, Metwally S. Foot-and-Mouth Disease in Feral Swine: Susceptibility and Transmission. *Transbound Emerg Dis.* 2011 Aug;58(4):358-71. doi: 10.1111/j.1865-1682.2011.01213.x. Epub 2011 Mar 21. PubMed PMID: 21418546.

9: Abdul-Hamid NF, Firat-Saraç M, Radford AD, Knowles NJ, King DP. Comparative sequence analysis of representative foot-and-mouth disease virus genomes from Southeast Asia. *Virus Genes.* 2011 Aug;43(1):41-5. Epub 2011 Apr 9. PubMed PMID:21479678.

- 10: Reeve R, Cox S, Smitsaart E, Beascoechea CP, Haas B, Maradei E, Haydon DT, Barnett P. Reducing animal experimentation in foot-and-mouth disease vaccine potency tests. *Vaccine*. 2011 Jul 26;29(33):5467-73. Epub 2011 Jun 2. PubMed PMID:21640777.
- 11: Cubillos-Zapata C, Guzman E, Turner A, Gilbert SC, Prentice H, Hope JC, Charleston B. Differential effects of viral vectors on migratory afferent lymph dendritic cells in vitro predicts enhanced immunogenicity in vivo. *J Virol*. 2011 Jul 13. [Epub ahead of print] PubMed PMID: 21752909.
- 12: Dong Y, Xu Y, Liu Z, Fu Y, Ohashi T, Tanaka Y, Mawatari K, Kitamori T. Rapid screening swine foot-and-mouth disease virus using micro-ELISA system. *Lab Chip*. 2011 Jul 7;11(13):2153-5. Epub 2011 May 26. PubMed PMID: 21617821.
- 13: Schley D, Ward J, Zhang Z. Modelling foot-and-mouth disease virus dynamics in oral epithelium to help identify the determinants of lysis. *Bull Math Biol*. 2011 Jul;73(7):1503-28. Epub 2010 Aug 20. PubMed PMID: 20725794.
- 14: Rodríguez-Pulido M, Borrego B, Sobrino F, Sáiz M. RNA Structural Domains in Noncoding Regions of the Foot-and-Mouth Disease Virus Genome Trigger Innate Immunity in Porcine Cells and Mice. *J Virol*. 2011 Jul;85(13):6492-501. Epub 2011 Apr 27. PubMed PMID: 21525336; PubMed Central PMCID: PMC3126542.
- 15: Le VP, Lee KN, Nguyen T, Kim SM, Cho IS, Van Quyen D, Khang DD, Park JH. Development of one-step multiplex RT-PCR method for simultaneous detection and differentiation of foot-and-mouth disease virus serotypes O, A, and Asia 1 circulating in Vietnam. *J Virol Methods*. 2011 Jul;175(1):101-8. Epub 2011 Apr 29. PubMed PMID: 21550367.
- 16: Hüsser L, Alves MP, Ruggli N, Summerfield A. Identification of the role of RIG-I, MDA-5 and TLR3 in sensing RNA viruses in porcine epithelial cells using lentivirus-driven RNA interference. *Virus Res*. 2011 Jul;159(1):9-16. Epub 2011 Apr 22. PubMed PMID: 21539869.
- 17: Li P, Lu Z, Bao H, Li D, King DP, Sun P, Bai X, Cao W, Gubbins S, Chen Y, Xie B, Guo J, Yin H, Liu Z. In-vitro and in-vivo phenotype of type Asia 1 foot-and-mouth disease viruses utilizing two non-RGD receptor recognition sites. *BMC Microbiol*. 2011 Jun 29;11(1):154. [Epub ahead of print] PubMed PMID: 21711567.
- 18: Christensen LS, Brehm KE, Skov J, Harlow KW, Christensen J, Haas B. Detection of foot-and-mouth disease virus in the breath of infected cattle using a hand-held device to collect aerosols. *J Virol Methods*. 2011 Jun 23. [Epub ahead of print] PubMed PMID: 21723882.
- 19: Maree FF, Blignaut B, Esterhuysen JJ, de Beer TA, Theron J, O'Neill HG, Rieder E. Predicting antigenic sites on the foot-and-mouth disease virus capsid of the South African Territories (SAT) types using virus neutralization data. *J Gen Virol*. 2011 Jun 22. [Epub ahead of print] PubMed PMID: 21697350.
- 20: Dillon MB. Skin as a potential source of infectious foot and mouth disease aerosols. *Proc Biol Sci*. 2011 Jun 22;278(1713):1761-9. Epub 2011 Mar 30. PubMed PMID: 21450741; PubMed Central PMCID: PMC3097839.
- 21: Burks JM, Zwieb C, Müller F, Wower IK, Wower J. In silico analysis of IRES RNAs of foot-and-mouth disease virus and related picornaviruses. *Arch Virol*. 2011 Jun 17. [Epub ahead of print] PubMed PMID: 21681504.
- 22: Du J, Gao S, Luo J, Zhang G, Cong G, Shao J, Lin T, Cai X, Chang H. Effective inhibition of foot-and-mouth disease virus (FMDV) replication in vitro by vector-delivered microRNAs targeting the 3D gene. *Virol J*. 2011 Jun 10;8:292. PubMed PMID: 21663611.
- 23: Spitteler MA, Fernández I, Schabes E, Krimer A, Régulier EG, Guinzburg M, Smitsaart E, Levy MS. Foot and mouth disease (FMD) virus: Quantification of whole virus particles during the vaccine manufacturing process by size exclusion chromatography. *Vaccine*. 2011 Jun 7. [Epub ahead of print] PubMed PMID: 21651939.
- 24: McKillen J, McMenemy M, Reid SM, Duffy C, Hjertner B, King DP, Bélak S, Welsh M, Allan G. Pan-serotypic detection of foot-and-mouth disease virus using a minor groove binder probe reverse transcription polymerase chain reaction assay. *J Virol Methods*. 2011 Jun;174(1-2):117-9. Epub 2011 Mar 16. PubMed PMID: 21419170.

- 25: Yu Y, Abaeva IS, Marintchev A, Pestova TV, Hellen CU. Common conformational changes induced in type 2 picornavirus IRESs by cognate trans-acting factors. *Nucleic Acids Res.* 2011 Jun 1;39(11):4851-65. Epub 2011 Feb 8. PubMed PMID: 21306989; PubMed Central PMCID: PMC3113573.
- 26: Maddur MS, Rao S, Chockalingam AK, Kishore S, Gopalakrishna S, Singh N, Suryanarayana VV, Gajendragad MR. Absence of heat intolerance (panting) syndrome in foot-and-mouth disease-affected Indian cattle (*Bos indicus*) is associated with intact thyroid gland function. *Transbound Emerg Dis.* 2011 Jun; 58(3):274-9. PubMed PMID: 21388520.
- 27: Loth L, Osmani MG, Kalam MA, Chakraborty RK, Wadsworth J, Knowles NJ, Hammond JM, Benigno C. Molecular characterization of foot-and-mouth disease virus: implications for disease control in Bangladesh. *Transbound Emerg Dis.* 2011 Jun;58(3):240-6. doi: 10.1111/j.1865-1682.2011.01206.x. Epub 2011 Feb 14. PubMed PMID: 21320294.
- 28: Shao JJ, Wang JF, Chang HY, Liu JX. Immune potential of a novel multiple-epitope vaccine to FMDV type Asia 1 in guinea pigs and sheep. *Virol Sin.* 2011 Jun;26(3):190-7. Epub 2011 Jun 12. PubMed PMID: 21667339.
- 29: Wang D, Fang L, Bi J, Chen Q, Cao L, Luo R, Chen H, Xiao S. Foot-and-mouth disease virus leader proteinase inhibits dsRNA-induced RANTES transcription in PK-15 cells. *Virus Genes.* 2011 Jun;42(3):388-93. Epub 2011 Mar 12. PubMed PMID:21399922.
- 30: Sanchez-Juan P, Bishop MT, Croes EA, Knight RS, Will RG, van Duijn CM, Manson JC. A polymorphism in the regulatory region of PRNP is associated with increased risk of sporadic Creutzfeldt-Jakob disease. *BMC Med Genet.* 2011 May 22;12(1):73. PubMed PMID: 21600043; PubMed Central PMCID: PMC3114709.
- 31: Stenfeldt C, Heegaard PM, Stockmarr A, Tjørnehøj K, Belsham GJ. Analysis of the acute phase responses of Serum Amyloid A, Haptoglobin and Type 1 Interferon in cattle experimentally infected with foot-and-mouth disease virus serotype O. *Vet Res.* 2011 May 18;42(1):66. PubMed PMID: 21592356; PubMed Central PMCID: PMC3123197.
- 32: He DS, Li KN, Lin XM, Lin SR, Su DP, Liao M. Genomic comparison of foot-and-mouth disease virus R strain and its chick-passaged attenuated strain. *Vet Microbiol.* 2011 May 12;150(1-2):185-90. Epub 2011 Jan 15. PubMed PMID:21330068.
- 33: Díaz-San Segundo F, Weiss M, Perez-Martín E, Koster MJ, Zhu J, Grubman MJ, de los Santos T. Antiviral activity of bovine type III interferon against foot-and-mouth disease virus. *Virology.* 2011 May 10;413(2):283-92. Epub 2011 Mar 24. PubMed PMID: 21435672.
- 34: Glass EJ, Baxter R, Leach RJ, Jann OC. Genes controlling vaccine responses and disease resistance to respiratory viral pathogens in cattle. *Vet Immunol Immunopathol.* 2011 May 7. [Epub ahead of print] PubMed PMID: 21621277.
- 35: Juleff ND, Maree FF, Waters R, Bengis RG, Charleston B. The importance of FMDV localisation in lymphoid tissue. *Vet Immunol Immunopathol.* 2011 May 7. [Epub ahead of print] PubMed PMID: 21616546.
- 36: Yoon SH, Lee KN, Park JH, Kim H. Molecular epidemiology of foot-and-mouth disease virus serotypes A and O with emphasis on Korean isolates: temporal and spatial dynamics. *Arch Virol.* 2011 May;156(5):817-26. Epub 2011 Jan 29. PubMed PMID: 21279395.
- 37: Bøtner A, Kakker NK, Barbezange C, Berryman S, Jackson T, Belsham GJ. Capsid proteins from field strains of foot-and-mouth disease virus confer a pathogenic phenotype in cattle on an attenuated, cell-culture-adapted virus. *J Gen Virol.* 2011 May;92(Pt 5):1141-51. Epub 2011 Jan 26. PubMed PMID: 21270284.
- 38: Reid E, Juleff N, Gubbins S, Prentice H, Seago J, Charleston B. Bovine plasmacytoid dendritic cells are the major source of type I interferon in response to foot-and-mouth disease virus in vitro and in vivo. *J Virol.* 2011 May;85(9):4297-308. Epub 2011 Feb 9. PubMed PMID: 21307187; PubMed Central PMCID:PMC3126242.
- 39: Ramos-Vivas J, Pilares-Ortega L, Remuzgo-Martínez S, Padilla D, Gutiérrez-Díaz JL, Navas-Méndez J. *Rhodococcus equi* human clinical isolates enter and survive within human alveolar epithelial cells. *Microbes Infect.* 2011 May;13(5):438-46. Epub 2011 Jan 22. PubMed PMID: 21262372.

- 40: Yoon SH, Park W, King DP, Kim H. Phylogenomics and molecular evolution of foot-and-mouth disease virus. *Mol Cells*. 2011 May;31(5):413-21. Epub 2011 Mar 24. PubMed PMID: 21448588.
- 41: Malirat V, Bergmann IE, de Mendonça Campos R, Salgado G, Sánchez C, Conde F, Quiroga JL, Ortiz S. Phylogenetic analysis of Foot-and-Mouth Disease Virus type O circulating in the Andean region of South America during 2002-2008. *Vet Microbiol*. 2011 Apr 29. [Epub ahead of print] PubMed PMID: 21601999.
- 42: Wu L, Jiang T, Lu ZJ, Yang YM, Sun P, Liang Z, Li D, Fu YF, Cao YM, Liu XT, Liu ZX. Development and validation of a prokaryotically expressed foot-and-mouth disease virus non-structural protein 2C'3AB-based immunochromatographic strip to differentiate between infected and vaccinated animals. *Virology*. 2011 Apr 23;8:186. PubMed PMID: 21513550; PubMed Central PMCID: PMC3094302.
- 43: Mahapatra M, Seki C, Upadhyaya S, Barnett PV, La Torre J, Paton DJ. Characterisation and epitope mapping of neutralising monoclonal antibodies to A24 Cruzeiro strain of FMDV. *Vet Microbiol*. 2011 Apr 21;149(1-2):242-7. Epub 2010 Nov 9. PubMed PMID: 21144677.
- 44: Li Z, Yin X, Yi Y, Li X, Li B, Lan X, Zhang Z, Liu J. FMD subunit vaccine produced using a silkworm-baculovirus expression system: protective efficacy against two type Asia1 isolates in cattle. *Vet Microbiol*. 2011 Apr 21;149(1-2):99-103. Epub 2010 Nov 4. PubMed PMID: 21109368.
- 45: Yang X, Zhou YS, Wang HN, Zhang Y, Wei K, Wang T. Isolation, identification and complete genome sequence analysis of a strain of foot-and-mouth disease virus serotype Asia1 from pigs in southwest of China. *Virology*. 2011 Apr 16;8:175. PubMed PMID: 21496298; PubMed Central PMCID: PMC3094298.
- 46: King DP, Burman A, Gold S, Shaw AE, Jackson T, Ferris NP. Integrin sub-unit expression in cell cultures used for the diagnosis of foot-and-mouth disease. *Vet Immunol Immunopathol*. 2011 Apr 15;140(3-4):259-65. Epub 2011 Jan 25. PubMed PMID:21329991.
- 47: Huang X, Li Y, Fang H, Zheng C. Establishment of persistent infection with foot-and-mouth disease virus in BHK-21 cells. *Virology*. 2011 Apr 14;8:169. PubMed PMID: 21492421; PubMed Central PMCID: PMC3097150.
- 48: Chen TH, Lee F, Lin YL, Dekker A, Chung WB, Pan CH, Jong MH, Huang CC, Lee MC, Tsai HJ. Differentiation of Foot-and-Mouth Disease-Infected Pigs from Vaccinated Pigs Using Antibody-Detecting Sandwich ELISA. *J Vet Med Sci*. 2011 Apr 4. [Epub ahead of print] PubMed PMID: 21467761.
- 49: Blignaut B, Visser N, Theron J, Rieder E, Maree FF. Custom-engineered chimeric foot-and-mouth disease vaccine elicits protective immune responses in pigs. *J Gen Virol*. 2011 Apr;92(Pt 4):849-59. Epub 2010 Dec 22. PubMed PMID: 21177923.
- 50: Wang D, Fang L, Li P, Sun L, Fan J, Zhang Q, Luo R, Liu X, Li K, Chen H, Chen Z, Xiao S. The leader proteinase of foot-and-mouth disease virus negatively regulates the type I interferon pathway by acting as a viral deubiquitinase. *J Virol*. 2011 Apr;85(8):3758-66. Epub 2011 Feb 9. PubMed PMID: 21307201; PubMed Central PMCID: PMC3126127.
- 51: Willems T, Lefebvre DJ, Neyts J, De Clercq K. Diagnostic performance and application of two commercial cell viability assays in foot-and-mouth disease research. *J Virol Methods*. 2011 Apr;173(1):108-14. Epub 2011 Feb 3. PubMed PMID: 21295609.
- 52: Ganges L, Borrego B, Fernández-Pacheco P, Revilla C, Fernández-Borges N, Domínguez J, Sobrino F, Rodríguez F. DNA immunization of pigs with foot-and-mouth disease virus minigenes: from partial protection to disease exacerbation. *Virus Res*. 2011 Apr;157(1):121-5. Epub 2011 Feb 17. PubMed PMID: 21315115.

Annex 3. RECOMMENDATIONS FROM WRLFMD ON FMD VIRUS STRAINS TO BE INCLUDED IN FMDV ANTIGEN BANKS – June 2011

High Priority

O Manisa (*covers panasian topotype*)
 O BFS or Campos
 A24 Cruzeiro
 Asia 1 Shamir
 A Iran-05
 A22 Iraq
 SAT 2 Saudi Arabia (*or equivalent*)

(not in order of importance)

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

(not in order of importance)

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)