



WRLFMD Quarterly Report

April-June

World Reference Laboratory Report

7/29/2009

WRLFMD

**OIE/FAO World Reference Laboratory Report¹
April-June 2009**

Foot-and-Mouth Disease

¹ N.B. Copies of all the individual reports cited herein can be obtained from Dr. Jef Hammond, IAH-Pirbright, jef.hammond@bbsrc.ac.uk

Summary

There were no outbreaks officially reported in FMD-free countries that did not practice vaccination between April and June 2009.

FMD type A in the Middle East

In the Middle East the A-Iran-05 strain continues to evolve and spread to previously unaffected countries. During the present reporting period it has appeared for the first time in Israel and the Palestinian Autonomous Territories. During the past two years four distinct sub-lineages have been recognised and named A-Iran-05^{ARD-07}, A-Iran-05^{EZM-07}, A-Iran-05^{AFG-07} and A-Iran-05^{BAR-08}. The first two have evolved within Turkey and have not spread to the rest of the Middle East. A-Iran-05^{AFG-07} has appeared in Afghanistan (2007), Iran (2008-2009), Pakistan (2008-2009) and Bahrain (2009). A-Iran-05^{BAR-08} has become the most widespread sub-lineage appearing in Bahrain (2008), Iran (2009), Pakistan (2009), Lebanon (2009), Iraq (2009), Israel (2009), Kuwait (2009), Libya (2009) and the Palestinian AT (2009).

FMD type O in Egypt

Sequence analysis has shown that outbreaks of FMDV type O appear to be very closely related to the Egyptian vaccine strain, O₁/Sharquia/EGY/72.

FMD type A in China

Since its apparent introduction in January 2009, FMD type A continues to appear sporadically in many parts of the country as does Asia 1 (which was apparently introduced in 2005).

FMD type O in Taiwan

In February 2009, Taiwan reported the first outbreak of type O since 2001. In the last three months further outbreaks have been reported.

FMD type Asia 1 in Bahrain

The appearance of Asia 1 in Bahrain in 2009 has been linked to viruses from India.

FMD types SAT 2 in Botswana

SAT 2 continues to cause problems in the north-east of the country.

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.

WRL vaccine recommendations have changed from the previous report (Annex 3) to take into account the availability of new vaccines against the FMDV serotype A Iran-05 strain.

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/2009.htm.

Results from samples received at WRL (status of samples being tested) are shown in Table 1 and a complete list of clinical sample diagnostics made by the WRL between April and June 2009 is shown in annex 1 Table A. A record of all samples received to IAH-Pirbright (April-June 2009) and their geographical locations are shown in annex 1 Table B and Figure 1.

Table 1: Status of sequencing of samples received by the WRLFMD from April-June 2009.

Batch	Date Recd.	Country	Serotype	No. of isolates	Status
WRLFMD/2009/00018	14/04/2009	Ethiopia	O	5	Complete
WRLFMD/2009/00019	20/04/2009	Myanmar	O	3	Complete
WRLFMD/2009/00020	23/04/2009	Hong Kong	O	11	Complete
WRLFMD/2009/00021	01/05/2009	Bahrain	A	1	Complete
WRLFMD/2009/00021	01/05/2009	Bahrain	Asia 1	2	Complete
WRLFMD/2009/00022	30/04/2009	Kenya	A	2	SFPP
WRLFMD/2009/00022	30/04/2009	Kenya	O	5	SFPP
WRLFMD/2009/00022	30/04/2009	Kenya	O + SAT 1	1	SP
WRLFMD/2009/00022	30/04/2009	Kenya	SAT 1	13	SFPP
WRLFMD/2009/00022	30/04/2009	Kenya	SAT 2	6	SFPP
WRLFMD/2009/00025	01/05/2009	Thailand	O	10	SP
WRLFMD/2009/00025	01/05/2009	Thailand	A	12	SP
WRLFMD/2009/00026	01/05/2009	Cambodia	O	3	SP
WRLFMD/2009/00026	01/05/2009	Cambodia	A	1	SP
WRLFMD/2009/00027	01/05/2009	Myanmar	O	2	SP
WRLFMD/2009/00028	28/05/2009	Egypt	O	16	Complete
WRLFMD/2009/00029	02/06/2009	Israel	O	26	SFPP
WRLFMD/2009/00029	02/06/2009	Israel	A	18	SFPP
WRLFMD/2009/00031	08/06/2009	Botswana	SAT 2	3	Complete
WRLFMD/2009/00032	02/06/2009	Palestinian Autonomous Territories	O	17	SFPP
WRLFMD/2009/00032	02/06/2009	Palestinian Autonomous Territories	A	6	Complete
WRLFMD/2009/00033	22/06/2009	Nepal	O	12	SFPP
WRLFMD/2009/00034	22/06/2009	Iran	O	8	Complete
WRLFMD/2009/00034	22/06/2009	Iran	A	6	Complete
WRLFMD/2009/00035	22/06/2009	Taiwan	O	1	SP
WRLFMD/2009/00036	15/06/2009	Pakistan	A	9	SFPP
				199	

SFPP, sequencing finished, phylogenetics in progress.

SP, sequencing in progress.

Detailed Information: ASIA – Far East & Southeast Asia

Cambodia: Three type O (collected in 2004, 2006 and 2008) and one type A (collected in 2008) FMD viruses were isolated. VP1 sequencing is in progress.



Batch: WRLFMD/2009/00026; received: 01/05/2009 FMD viruses isolated from Cambodia. Red circles are type O and the blue circle is type A.

P.R. China: Ten outbreaks of FMD were reported, six caused by type Asia 1 and four by type A. No samples or sequences were received by the WRLFMD.



Type Asia 1: Shuigui, Lizhou, Guang yang, Sichuan (29/04/2009), cattle.



Type Asia 1: Fuyuan farm, Wusu, Tacheng, Xinjiang (11/04/2009), cattle.



Type Asia 1: Mazong, Tongzi, Zunyi, Guizhou and Dongjiang village, Changning, Hengyang, Hunan, both on 20/04/2009 in cattle.



Type A: Congcong, Wujing, Changzhou, Jiangsu (15/04/2009), cattle.



Type Asia 1: Dengjiayan, Nanzhen, Hanzhong, Shaanxi (21/04/2009), cattle.



Type Asia 1: Huanghualing, Lingchuan, Guilin, Guangxi (28/04/2009), cattle.



Type A: Xi'nian, Lin'gui, Guilin, Guangxi (25/04/2009), cattle.

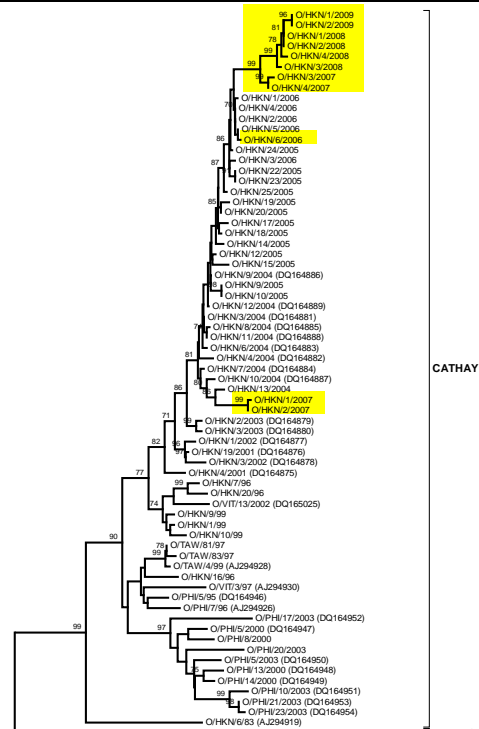


Type A: Haixing chaoyang village, Pan, Liupanshui, Guizhou (14/05/2009), cattle and pigs.



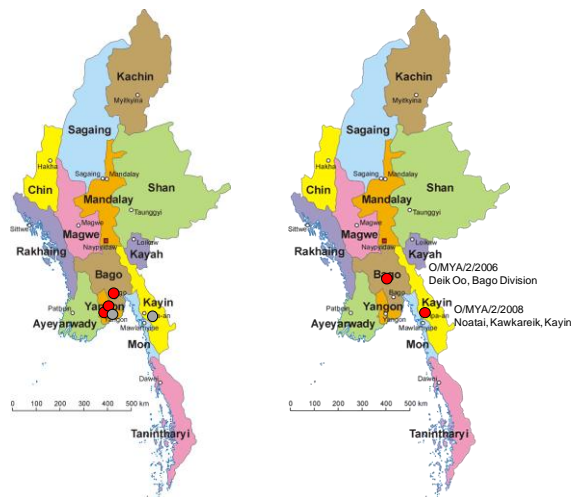
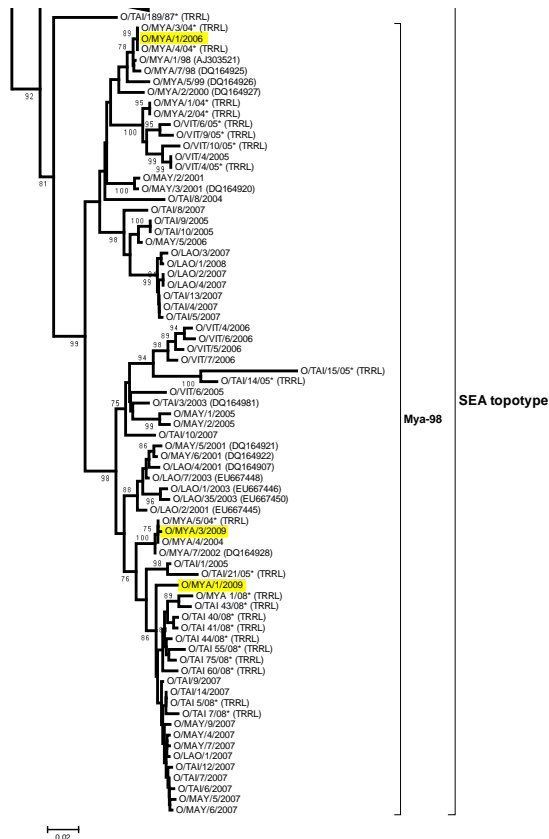
Type A: Bingzhou, Bingcheng district, Bingzhou, Shandong (03/06/2009), cattle.

Hong Kong SAR, P.R. China: FMDV type O was identified in 12 samples from pigs; however, in one case no virus could be isolated on cell culture. One sample was collected in 2006, five in 2007, four in 2008 and two in 2009. No geographic locations were supplied. Phylogenetic analysis showed all 11 viruses sequenced belonged to the CATHAY topotype. Two viruses from 2007 clustered with earlier isolates from 2004. The isolate from 2006 clustered with previous viruses received from the same year. The remaining two from 2007 clustered with those from 2008 and 2009 and appeared to have evolved from those present in 2006.



Batch: WRLFMD/2009/00020; received: 23/04/2009

Myanmar: Two batches of samples were received from Myanmar consisting of i) O/MYA/1/2006, O/MYA/1/2009, O/MYA/3/2009, FMDV-GD/MYA/1/2008 and FMDV-GD/MYA/2/2009; and ii) O/MYA/2/2006 and O/MYA/2/2008. O/MYA/1/2006, O/MYA/1/2009 and O/MYA/3/2009 belonged to the SEA topotype, Mya-98 strain. Sequencing is in progress on the remaining viruses.



Batch: WRLFMD/2009/00019; received: 20/04/2009

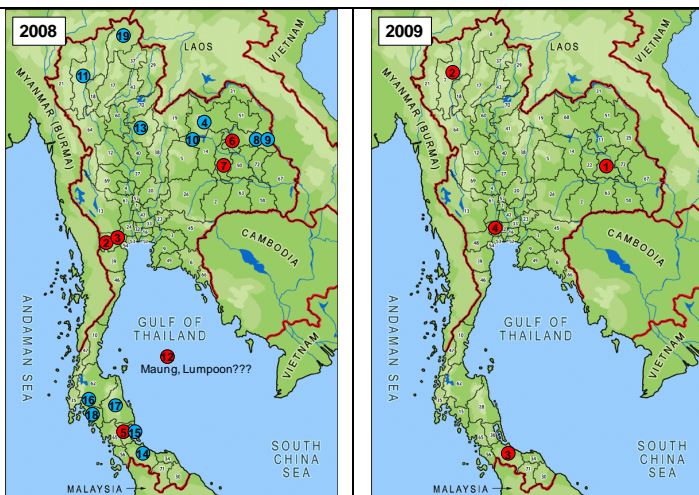
Batch: WRLFMD/2009/00027; received: 01/05/2009

Taiwan POC: A single sample was received from Taiwan and confirmed to be type O. Phylogenetic analysis is progress; however, preliminary findings indicate that it belongs to the CATHAY toptotype . Further outbreaks in pigs in Yanou township, Ping-Tung (18/05/2009) and Dayuan township, T'ao-Yuan (09/06/2009) have recently been reported to the OIE.



Batch: WRLFMD/2009/00035; received: 22/06/2009

Thailand: 22 FMD viruses were received from the Thailand RRL. Ten were type O (six from 2008 and four from 2009) and 12 were type A (all from 2008). VPI sequencing is in progress.



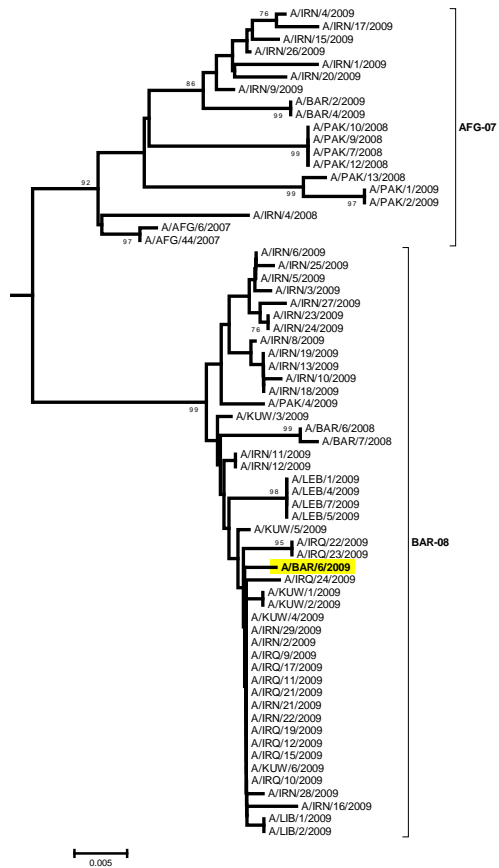
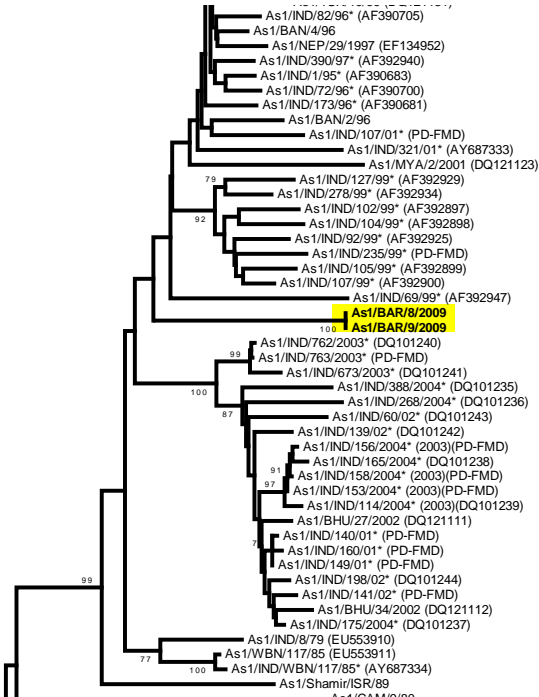
Batch: WRLFMD/2009/00025; received: 01/05/2009

ASIA – Middle East & Southern Asia

Bahrain: Two FMD Asia 1 viruses were isolated from cattle at Al Bahama, Manama (20/04/2009). Phylogenetic analysis revealed that they were distinct from previous viruses found in the region. However, comparison with recently isolated viruses from India revealed a close relationship (B. Patnaik, personal communication, 2009). A single FMD type A virus isolate (from 2009) belonged to the ASIA toptotype, A-Iran-05^{BAR-08} strain.

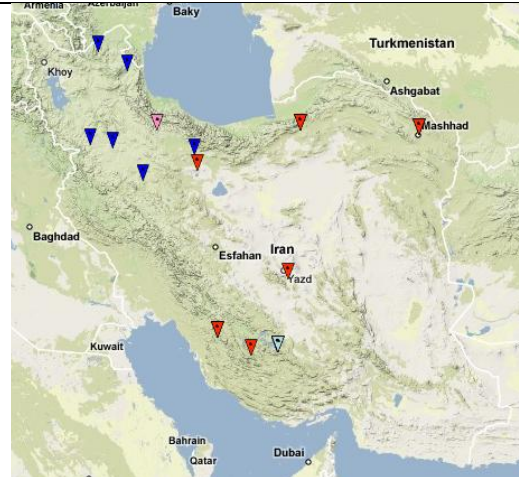


Blue – type A; grey – type Asia 1; pink – NVD.



Batch: WRLFMD/2009/00021; received: 01/05/2009

Iran: Eight FMD type O and eight type A viruses were isolated from samples collected in 2009. Phylogenetic analyses are in progress.



Batch: WRLFMD/2009/00034; received: 22/06/2009

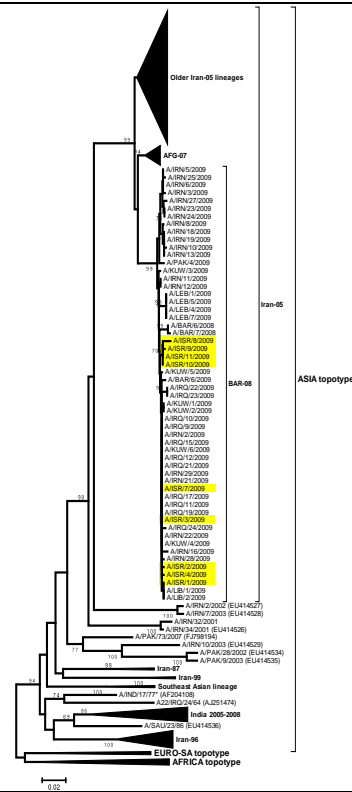
Dark blue – type A; light blue – FMDV-GD; pink – NVD.

Israel: 26 FMD type O viruses were isolated (25 from 2007 and one from 2008); phylogenetic analyses are in progress. 18 FMD type A viruses were isolated from samples collected in 2009. Nine of these have been sequenced and shown to belong to the ASIA topotype, A-Iran-05^{BAR-08} strain.

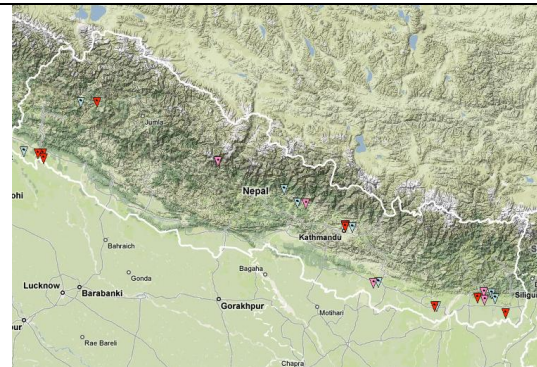


Dark blue – type A; red – type O; light blue – FMDV-GD; pink – NVD.

Batch: WRLFMD/2009/00029; received: 02/06/2009



Nepal: 12 FMD type O viruses were isolated from samples collected in 2009; phylogenetic analyses are in progress.



Batch: WRLFMD/2009/00033; received: 22/06/2009

Red – type O; light blue – FMDV-GD; pink – NVD.

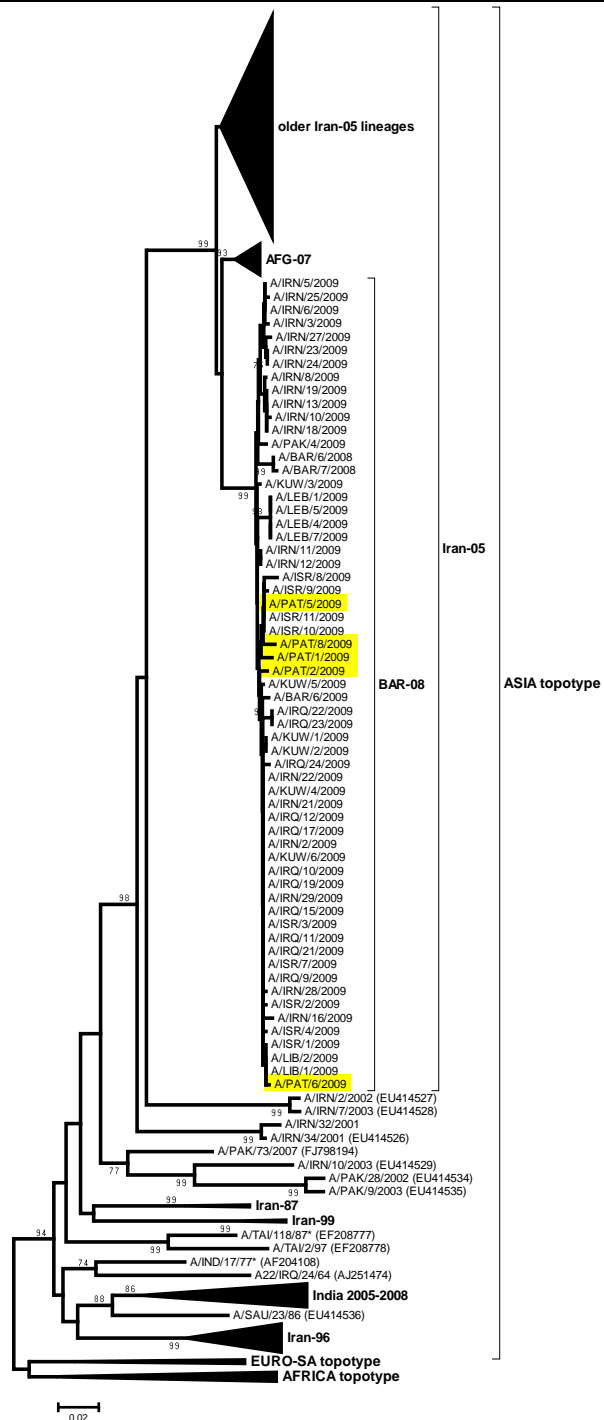
Palestinian Autonomous Territories: 20 FMD type O viruses, collected in 2007, were identified; phylogenetic analyses are in progress.



Five FMD type A viruses, collected in 2009, were identified and shown to belong to the ASIA toptotype, A-Iran-05^{BAR-08} strain.



Blue – type A



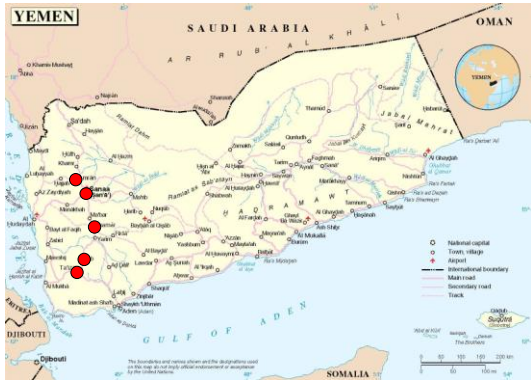
Batch: WRLFMD/2009/00032; received: 02/06/2009

Pakistan: Nine FMD type A viruses were identified, but details of the geographic origin are not clear. Phylogenetic analyses are in progress.

Batch: WRLFMD/2009/00036; received: 15/06/2009

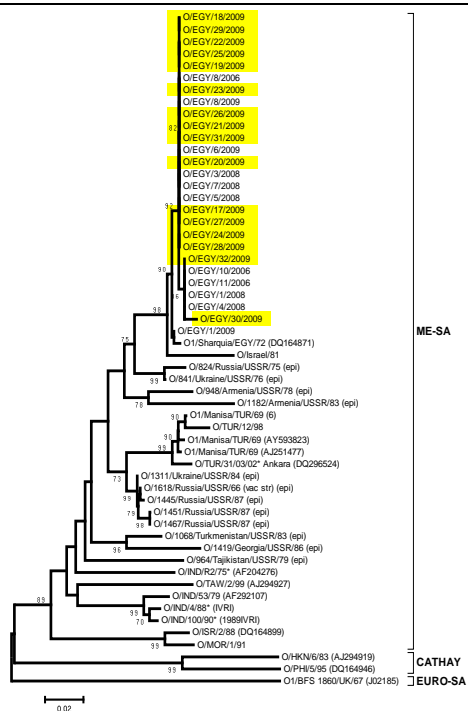
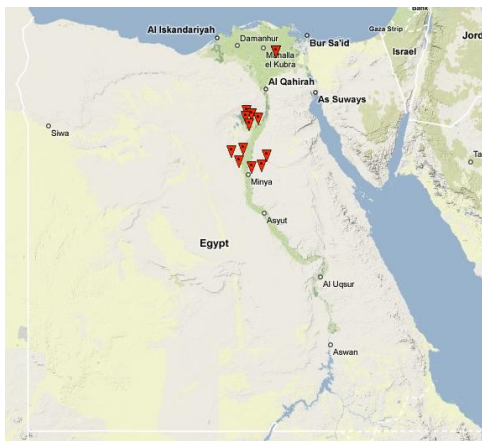
Yemen Arab Republic: 38 type O FMD viruses isolated during the previous reporting period we analysed and shown to belong to the EA-3 topotype. 25 of the viruses, collected in 2009, were closely related to Ethiopian viruses also collected in 2009. Six viruses from 2008 and five from 2009 belonged to a different sub-lineage of EA-3 and were most closely related to viruses from Ethiopia in 2008 and Yemen in 2006.

Batch: WRLFMD/2009/00015; received: 16/03/2009



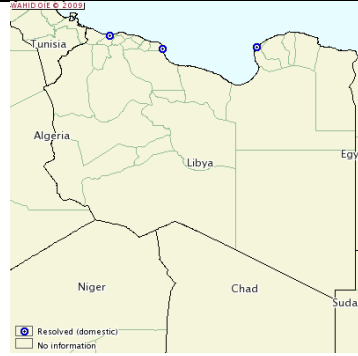
AFRICA - North

Egypt: 16 FMD type O viruses were isolated from samples taken in 2009. All belonged to the ME-SA topotype and were very closely related to the Egyptian vaccine/reference strain O₁/Sharquiah/EGY/72.



Batch: WRLFMD/2009/00028; received: 28/05/2009

Libya: Three outbreaks of FMD type A, which occurred in January and February 2009, were reported to the OIE. They occurred in cattle at Alhwayr, Banghazi (01/01/2009), Tamina, Misratah (20/02/2009) and Bair Trfas, Az Zawiyah (23/02/2009). Sequence analysis was reported in the Jan-Mar FMD Reference Laboratory Network Report showing the viruses to be of the ASIA toptotype, Iran-05^{BAR-08} strain.

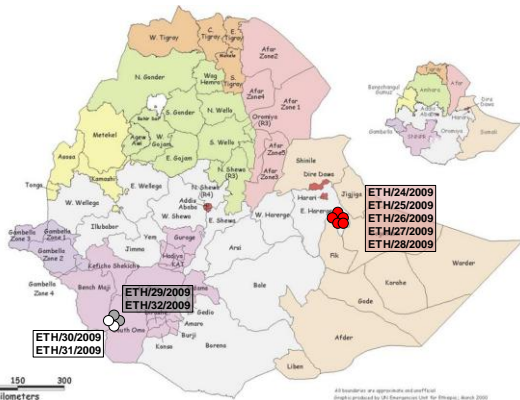


AFRICA - East

Ethiopia: It was not possible to amplify the VP1 genes of three samples (ETH/34/2008, ETH/35/2008 & ETH/22/2009) which were received during the previous reporting period and which typed as O by ELISA but failed to grow on cell cultures.

Five viruses were isolated from samples received on the 14/04/2009. Phylogenetic analysis showed them to belong to toptotype EA-3 and to be closely related to viruses from the Yemen Arab Republic, collected in 2009.

For batch: WRLFMD/2009/00010; received: 06/03/2009 see previous report.



Batch: WRLFMD/2009/00018; received: 14/04/2009



Kenya: 27 FMD viruses were isolated from samples collected in 2008 and 2009. Of the 2008 viruses, one was type A, three were type O, six were type SAT 1, four were type SAT 2 and one was a mixture of O and SAT 1. Of the 2009 viruses, one was type A, two were type O, seven were type SAT 1 and two were type SAT 2. Phylogenetic analyses are in progress and will be presented in the next quarterly report.



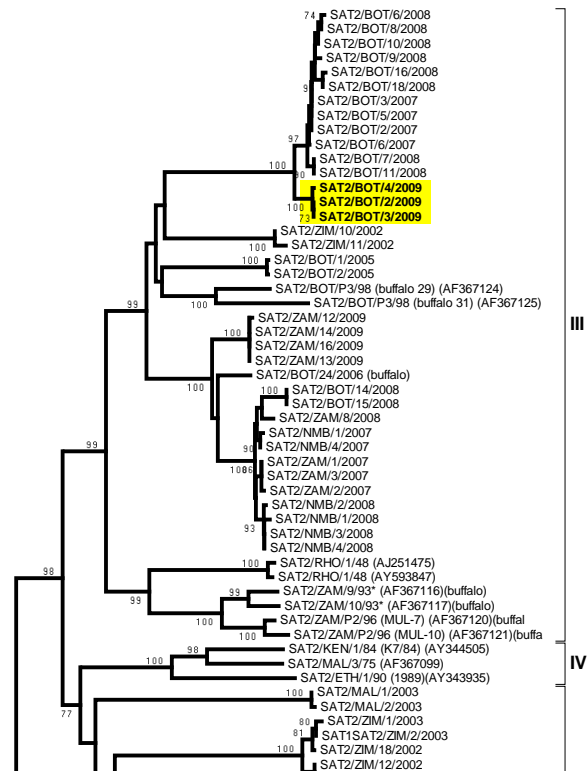
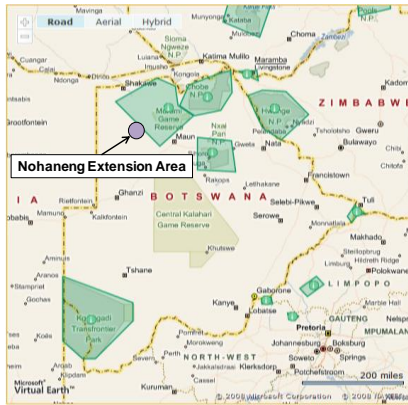
Batch: WRLFMD/2009/00022; received: 30/04/2009

AFRICA – Southern

Angola: An outbreak of FMD was reported in cattle at Luiana, Rivungo, Cunado Cubango (27/02/2009), close to the borders with Namibia and Zambia. The serotype was identified as SAT 2 by the Onderstepoort Veterinary Institute. The last known occurrence of this serotype was in 1974. No phylogenetic analyses have been reported.



Botswana: An outbreak of FMD occurred in cattle in the Nohaneng Extension Area about 15 km north of Habu (Maun Veterinary District). FMDV type SAT 2 was identified by ELISA in four samples collected on 11/05/2009, but virus was only isolated on cell cultures in three cases. Phylogenetic analysis showed the virus to belong to toptotype III and to be most closely related to virus from the same area in 2007 and 2008.



Batch: WRLFMD/2009/00031; received: 08/06/2009

Vaccine matching

Four FMDV type O isolates (O IRN 7 and 14/2009; and O TUR 3 and 35/2009) from Iran and Turkey collected in 2009 were further characterised by two dimensional virus neutralisation test (2dmVNT) and/or LPBE. The results showed that two isolates from Iran were antigenically matched with O Manisa if a high potency vaccine was used but there was not a close match to O BFS or O IND R2/75. O TUR 35/2009 was antigenically relatively close to O 4174 if a high potency vaccine was used. O TUR 3/2009 showed no match with O Manisa, O BFS and O 4174 (Table C).

Six FMDV type A viruses (A TUR 7, 14 and 40/2009; A ETH 12 and 13/2009; and A LIB 14 and 117/2009) from Turkey, Ethiopia and Libya collected in 2009, were analysed for antigenic relationship with various vaccine strains by 2dmVNT and/or LPBE. All isolates tested showed close match to the A TUR 06 vaccine strain but failed to match with A₂₂ IRQ except A LIB 14/2009 which showed a relative match with A₂₂. Two viruses isolated from Ethiopia were antigenically close to A Eritrea 98 vaccine but not to A SAU 41/91, A IRN 99 and A IRN 87. Two viruses from Turkey showed no antigenic match with A SAU 41/91, A IRN 99 and A IRN 87 while A TUR 40/2009 showed a low match to A Eritrea 98 by LPBE. A LIB 14/2009 gave a match with A SAU 41/91 but not with A Eritrea 98 while A LIB 117/2009 showed no antigenic relationship with either A Eritrea 98 or A SAU 41/91 (Table C).

Annex 1.

Table A: Clinical sample diagnostics made by the WRL between April and June 2009

Country	WRL for FMD Sample Identification	Animal	Date of Collection	Results		Final report
				VI/ELISA	RT-PCR	
BAHRAIN	BAR 5/2009	Cattle	23.04.09	NVD	Negative	NVD
	BAR 6/2009	Cattle	23.04.09	A	Positive	A
	BAR 7/2009	Cattle	23.04.09	NVD	Negative	NVD
	BAR 8/2009	Cattle	25.04.09	Asia 1	Positive	Asia 1
	BAR 9/2009	Cattle	25.04.09	Asia 1	Positive	Asia 1
BOTSWANA	BOT 1/2009	Cattle	11.05.09	SAT 2	Positive	SAT 2
	BOT 2/2009	Cattle	11.05.09	SAT 2	Positive	SAT 2
	BOT 3/2009	Cattle	11.05.09	SAT 2	Positive	SAT 2
	BOT 4/2009	Cattle	11.05.09	SAT 2	Positive	SAT 2
CAMBODIA	CAM 1/2004	Cattle	23.06.04	O	Positive	O
	CAM 5/2006	Cattle	28.06.06	O	Positive	O
	CAM 1/2008	Cattle	28.02.08	O	Positive	O
	CAM 2/2008	Cattle	26.06.08	A	Positive	A
EGYPT	EGY 17/2009	Cattle	13.04.09	O	Positive	O
	EGY 18/2009	Cattle	13.04.09	O	Positive	O
	EGY 19/2009	Cattle	13.04.09	O	Positive	O
	EGY 20/2009	Cattle	13.04.09	O	Positive	O
	EGY 21/2009	Cattle	13.04.09	O	Positive	O
	EGY 22/2009	Cattle	13.04.09	O	Positive	O
	EGY 23/2009	Cattle	19.04.09	O	Positive	O
	EGY 24/2009	Cattle	19.04.09	O	Positive	O
	EGY 25/2009	Cattle	19.04.09	O	Positive	O
	EGY 26/2009	Cattle	19.04.09	O	Positive	O
	EGY 27/2009	Cattle	19.04.09	O	Positive	O
	EGY 28/2009	Cattle	19.04.09	O	Positive	O
	EGY 29/2009	Sheep	04.05.09	O	Positive	O
	EGY 30/2009	Sheep	04.05.09	O	Positive	O
	EGY 31/2009	Sheep	04.05.09	O	Positive	O
	EGY 32/2009	Sheep	04.05.09	O	Positive	O
ETHIOPIA	ETH 24/2009	Cattle	11.03.09	O	Positive	O
	ETH 25/2009	Cattle	11.03.09	O	Positive	O
	ETH 26/2009	Cattle	11.03.09	O	Positive	O
	ETH 27/2009	Cattle	11.03.09	O	Positive	O
	ETH 28/2009	Cattle	11.03.09	O	Positive	O
	ETH 29/2009	Cattle	17.03.09	NVD	Positive	FMDV GD
	ETH 30/2009	Cattle	17.03.09	NVD	Negative	NVD
	ETH 31/2009	Cattle	17.03.09	NVD	Negative	NVD
	ETH 32/2009	Cattle	17.03.09	NVD	Positive	FMDV GD
	ETH 33/2009	Cattle	03.06.09	NVD	Negative	NVD
	ETH 34/2009	Cattle	03.06.09	NVD	Negative	NVD

	ETH 35/2009	Cattle	03.06.09	NVD	Negative	NVD
	ETH 36/2009	Cattle	03.06.09	NVD	Negative	NVD
	ETH 37/2009	Cattle	03.06.09	NVD	Negative	NVD
	ETH 38/2009	Cattle	03.06.09	NVD	Negative	NVD
HONG KONG	HKN 6/2006	Pig	26.01.06	O	Positive	O
	HKN 1/2007	Pig	10.01.07	O	Positive	O
	HKN 2/2007	Pig	23.03.07	O	Positive	O
	HKN 3/2007	Pig	25.10.07	O	Positive	O
	HKN 4/2007	Pig	25.10.07	O	Positive	O
	HKN 5/2007	Pig	25.10.07	O	Positive	O
	HKN 1/2008	Pig	10.11.08	O	Positive	O
	HKN 2/2008	Pig	10.11.08	O	Positive	O
	HKN 3/2008	Pig	10.11.08	O	Positive	O
	HKN 4/2008	Pig	10.11.08	O	Positive	O
	HKN 1/2009	Pig	04.02.09	O	Positive	O
	HKN 2/2009	Pig	04.02.09	O	Positive	O
	HKN 3/2009	Pig	25.02.09	NVD	Negative	NVD
IRAN	IRN 30/2009	Cattle	10.04.09	A	Positive	A
	IRN 31/2009	Cattle	12.04.09	O	Positive	O
	IRN 32/2009	Cattle	20.04.09	A	Positive	A
	IRN 33/2009	Sheep/Goat	24.04.09	NVD	Negative	NVD
	IRN 34/2009	Cattle	24.04.09	O	Positive	O
	IRN 35/2009	Sheep/Goat	28.04.09	O	Positive	O
	IRN 36/2009	Cattle	03.05.09	A	Positive	A
	IRN 37/2009	Cattle	06.05.09	A	Positive	A
	IRN 38/2009	Cattle	12.05.09	O	Positive	O
	IRN 39/2009	Cattle	14.05.09	A	Positive	A
	IRN 40/2009	Cattle	16.05.09	O	Positive	O
	IRN 41/2009	Cattle	18.05.09	O	Positive	O
	IRN 42/2009	Sheep/Goat	30.05.09	O	Positive	O
	IRN 43/2009	NK	NK	O	Positive	O
	IRN 44/2009	NK	NK	A	Positive	A
	IRN 45/2009	Cattle	NK	NVD	Positive	FMDV GD
ISRAEL	ISR 11/2007	Cattle	25.01.07	O	Positive	O FMDV
	ISR 12/2007	Cattle	25.01.07	NVD	Positive	GD
	ISR 13/2007	Cattle	27.01.07	O	Positive	O
	ISR 14/2007	Cattle	28.01.07	O	Positive	O
	ISR 15/2007	Cattle	31.01.07	O	Positive	O FMDV
	ISR 16/2007	Cattle	07.02.07	NVD	Positive	GD
	ISR 17/2007	Cattle	08.02.07	O	Positive	O
	ISR 18/2007	Goat	08.02.07	NVD	Negative	NVD
	ISR 19/2007	Cattle	17.02.07	O	Positive	O
	ISR 20/2007	Cattle	19.02.07	O	Positive	O
	ISR 21/2007	Cattle	21.02.07	O	Positive	O
	ISR 22/2007	Cattle	22.02.07	NVD	Negative	NVD
	ISR 23/2007	Goat	22.02.07	NVD	Negative	NVD
	ISR 24/2007	Cattle	26.02.07	O	Not tested	O
	ISR 25/2007	Cattle	10.03.07	O	Not tested	O
	ISR 26/2007	Cattle	19.03.07	NVD	Not tested	NVD
	ISR 27/2007	Gazelle	21.03.07	NVD	Not tested	NVD

ISR 28/2007	Cattle	22.03.07	NVD	Not tested	NVD
ISR 29/2007	Gazelle	22.03.07	O	Not tested	O
ISR 30/3007	Cattle	25.03.07	O	Not tested	O
ISR 31/2007	Goat	30.03.07	O	Not tested	O
ISR 32/2007	Cattle	31.03.07	O	Not tested	O
ISR 33/2007	Cattle	01.04.07	NVD	Not tested	NVD
ISR 34/3007	Sheep	01.04.07	O	Not tested	O
ISR 35/2007	NK	01.04.07	NVD	Not tested	NVD
ISR 36/2007	Cattle	07.04.07	O	Positive	O
ISR 37/2007	Cattle	12.04.07	O	Positive	O
ISR 38/2007	Cattle	12.04.07	O	Positive	O
ISR 39/2007	Cattle	22.04.07	O	Positive	O
ISR 40/2007	Gazelle	26.04.07	O	Positive	O
					FMDV
ISR 41/2007	Sheep	01.05.07	NVD	Positive	GD
ISR 42/2007	Cattle	01.05.07	O	Positive	O
ISR 43/2007	Cattle	03.05.07	O	Positive	O
ISR 44/2007	Sheep	03.05.07	O	Positive	O
ISR 45/2007	Boar	03.06.07	NVD	Negative	NVD
ISR 46/2007	Cattle	04.06.07	O	Positive	O
ISR 47/2007	Boar	05.06.07	NVD	Negative	NVD
ISR 48/2007	Gazelle	06.06.07	NVD	Negative	NVD
ISR 49/2007	Cattle	08.06.07	NVD	Negative	NVD
ISR 50/2007	Cattle	08.06.07	O	Positive	O
					FMDV
ISR 51/2007	Cattle	18.06.07	NVD	Positive	GD
ISR 1/2008	Cattle	31.01.08	O	Positive	O
ISR 1/2009	Cattle	02.02.09	A	Positive	A
ISR 2/2009	Sheep	12.02.09	A	Positive	A
ISR 3/2009	Cattle	24.02.09	A	Positive	A
ISR 4/2009	Cattle	26.02.09	A	Positive	A
ISR 5/2009	Sheep	28.02.09	A	Positive	A
ISR 6/2009	Cattle	08.03.09	A	Positive	A
ISR 7/2009	Cattle	09.03.09	A	Positive	A
ISR 8/2009	Goat	15.03.09	A	Positive	A
ISR 9/2009	Cattle	17.03.09	A	Positive	A
ISR 10/2009	Sheep	19.03.09	A	Positive	A
ISR 11/2009	Cattle	19.03.09	A	Positive	A
ISR 12/2009	Cattle	19.03.09	A	Positive	A
ISR 13/2009	Sheep	26.03.09	A	Positive	A
ISR 14/2009	Sheep	28.03.09	A	Positive	A
ISR 15/2009	Cattle	28.03.09	A	Positive	A
ISR 16/2009	Sheep	11.04.09	A	Positive	A
ISR 17/2009	Goat	12.04.09	A	Positive	A
ISR 18/2009	Cattle	16.04.09	A	Positive	A
					FMDV
KENYA**	KEN 17/2008	Cattle	00.05.08	NVD	GD
	KEN 18/2008	Cattle	00.06.08	SAT 2	SAT 2
	KEN 19/2008	Cattle	00.06.08	SAT 2	SAT 2
					FMDV
	KEN 20/2008	Cattle	00.06.08	NVD	GD
	KEN 21/2008	Cattle	00.06.08	SAT 2	SAT 2
	KEN 22/2008	Cattle	00.06.08	O/SAT 1	O/SAT 1
	KEN 23/2008	Cattle	00.07.08	SAT 1	SAT 1
	KEN 24/2008	Cattle	00.07.08	O	O

	KEN 25/2008	Cattle	00.08.08	SAT 1	Positive	SAT 1
	KEN 26/2008	Cattle	00.08.08	SAT 1	Positive	SAT 1 FMDV
	KEN 27/2008	Cattle	14.08.08	NVD	Positive	GD
	KEN 28/2008	Cattle	00.08.08	A	Positive	A FMDV
	KEN 29/2008	Cattle	00.09.08	NVD	Positive	GD FMDV
	KEN 30/2008	Cattle	00.09.08	NVD	Positive	GD
	KEN 31/2008	Cattle	00.09.08	SAT 2	Positive	SAT 2
	KEN 32/2008	Cattle	00.10.08	SAT 1	Positive	SAT 1 FMDV
	KEN 33/2008	Cattle	00.10.08	NVD	Positive	GD
	KEN 34/2008	Cattle	00.11.08	SAT 1	Positive	SAT 1
	KEN 35/2008	Cattle	00.11.08	SAT 1	Positive	SAT 1
	KEN 36/2008	Cattle	00.12.08	O	Positive	O
	KEN 37/2008	Cattle	00.12.08	O	Positive	O FMDV
	KEN 1/2009	Cattle	00.01.09	NVD	Positive	GD
	KEN 2/2009	Cattle	00.01.09	SAT 1	Positive	SAT 1 FMDV
	KEN 3/2009	Cattle	00.01.09	NVD	Positive	GD FMDV
	KEN 4/2009	Cattle	00.01.09	NVD	Positive	GD FMDV
	KEN 5/2009	Cattle	00.02.09	NVD	Positive	GD
	KEN 6/2009	Cattle	00.02.09	O	Positive	O
	KEN 7/2009	Cattle	00.02.09	NVD	Negative	NVD
	KEN 8/2009	Cattle	00.02.09	SAT 1	Positive	SAT 1
	KEN 9/2009	Cattle	00.02.09	SAT 1	Positive	SAT 1
	KEN 10/2009	Cattle	00.02.09	O	Positive	O
	KEN 11/2009	Cattle	00.02.09	SAT 2	Positive	SAT 2
	KEN 12/2009	Cattle	00.02.09	SAT 1	Positive	SAT 1
	KEN 13/2009	Cattle	00.02.09	SAT 2	Positive	SAT 2
	KEN 14/2009	Cattle	00.02.09	SAT 1	Positive	SAT 1
	KEN 15/2009	Cattle	00.03.09	SAT 1	Positive	SAT 1
	KEN 16/2009	Cattle	00.03.09	SAT 1	Positive	SAT 1
	KEN 17/2009	Cattle	00.03.09	NVD	Negative	NVD FMDV
	KEN 18/2009	Cattle	00.03.09	NVD	Positive	GD
	KEN 19/2009	Cattle	00.03.09	NVD	Negative	NVD
	KEN 20/2009	Cattle	00.03.09	NVD	Negative	NVD FMDV
	KEN 21/2009	Cattle	00.03.09	NVD	Positive	GD
	KEN 22/2009	Cattle	00.03.09	A	Positive	A
	KEN 23/2009	Cattle	00.04.09	NVD	Negative	NVD
MYANMAR	MYA 1/2006	Pig	25.10.06	O	Positive	O FMDV
	MYA 1/2008	Cattle	11.06.08	NVD	Positive	GD
	MYA 1/2009	Cattle	26.01.09	O	Positive	O FMDV
	MYA 2/2009	Cattle	26.01.09	NVD	Positive	GD
	MYA 3/2009	Cattle	25.03.09	O	Positive	O
	MYA 2/2006	Cattle	25.10.06	O	Positive	O
	MYA 2/2008	Cattle	16.06.08	O	Positive	O
NEPAL	NEP 1/2007	Cattle	25.03.07	NVD	Positive	FMDV

						GD
	NEP 2/2007	Cattle	22.04.07	O	Positive	O
	NEP 3/2007	Cattle	19.06.07	NVD	Negative	NVD
	NEP 4/2007	Cattle	10.07.07	NVD	Negative	NVD
						FMDV
	NEP 5/2007	Cattle	10.07.07	NVD	Positive	GD
	NEP 1/2008	Cattle	04.01.08	NVD	Negative	NVD
						FMDV
	NEP 2/2008	Cattle	08.01.08	NVD	Positive	GD
						FMDV
	NEP 3/2008	Cattle	08.01.08	NVD	Positive	GD
	NEP 4/2008	Cattle	21.04.08	O	Positive	O
	NEP 5/2008	Cattle	17.07.08	O	Positive	O
						FMDV
	NEP 6/2008	Cattle	19.07.08	NVD	Positive	GD
	NEP 7/2008	Cattle	09.12.08	O	Positive	O
						FMDV
	NEP 1/2009	Buffalo	02.01.09	NVD	Positive	GD
	NEP 2/2009	Cattle	05.01.09	O	Positive	O
	NEP 3/2009	Cattle	05.01.09	O	Positive	O
						FMDV
	NEP 4/2009	Buffalo	31.01.09	NVD	Positive	GD
	NEP 5/2009	Cattle	11.02.09	NVD	Negative	NVD
	NEP 6/2009	Cattle	11.02.09	O	Positive	O
						FMDV
	NEP 7/2009	Cattle	11.02.09	NVD	Positive	GD
	NEP 8/2009	Cattle	26.02.09	NVD	Negative	NVD
						FMDV
	NEP 9/2009	Cattle	26.02.09	NVD	Positive	GD
	NEP 10/2009	Cattle	28.02.09	O	Positive	O
	NEP 11/2009	Cattle	03.03.09	O	Positive	O
						FMDV
	NEP 12/2009	Cattle	03.03.09	NVD	Positive	GD
	NEP 13/2009	Buffalo	14.03.09	O	Positive	O
	NEP 14/2009	Buffalo	14.03.09	O	Positive	O
	NEP 15/2009	Cattle	14.03.09	O	Positive	O
						FMDV
PAKISTAN	PAK 5/2009	Buffalo	02.04.09	NVD	Positive	GD
	PAK 6/2009	Buffalo	04.04.09	A	Positive	A
	PAK 7/2009	Cattle	04.04.09	A	Positive	A
	PAK 8/2009	Buffalo	04.04.09	A	Positive	A
	PAK 9/2009	Cattle	08.04.09	A	Positive	A
	PAK 10/2009	Buffalo	08.04.09	A	Positive	A
						FMDV
	PAK 11/2009	Buffalo	08.04.09	NVD	Positive	GD
	PAK 12/2009	Cattle	08.04.09	NVD	Negative	NVD
	PAK 13/2009	Cattle	08.04.09	A	Positive	A
	PAK 14/2009	Buffalo	02.05.09	NVD	Negative	NVD
	PAK 15/2009	Buffalo	02.05.09	A	Positive	A
						FMDV
	PAK 16/2009	Buffalo	07.05.09	NVD	Positive	GD
	PAK 17/2009	Buffalo	07.05.09	A	Positive	A
	PAK 18/2009	Buffalo	07.05.09	A	Positive	A
	PAK 19/2009	Buffalo	10.05.09	NVD	Negative	NVD
						FMDV
	PAK 20/2009	Buffalo	10.05.09	NVD	Positive	GD
	PAK 21/2009	Buffalo	10.05.09	NVD	Positive	FMDV

						GD
PALESTINIAN AUTONOMOUS TERRITORIES	PAT 1/2007	Sheep	07.02.07	O	Positive	O
	PAT 2/2007	Cattle	07.02.07	O	Positive	O
	PAT 3/2007	Cattle	14.02.07	O	Positive	O
	PAT 4/2007	Cattle	14.02.07	O	Positive	O
	PAT 5/2007	Cattle	14.02.07	O	Positive	O
	PAT 6/2007	Cattle	15.02.07	O	Positive	O
	PAT 7/2007	Cattle	15.02.07	O	Positive	O
	PAT 8/2007	Cattle	15.02.07	O	Positive	O
	PAT 9/2007	Cattle	21.02.07	NVD	Positive	FMDV GD
	PAT 10/2007	Goat	21.02.07	NVD	Positive	FMDV GD
	PAT 11/2007	Goat	27.02.07	O	Positive	O
	PAT 12/2007	Goat	06.03.07	O	Positive	O
	PAT 13/2007	Goat	06.03.07	O	Positive	O
	PAT 14/2007	Sheep	06.03.07	NVD	Negative	NVD
	PAT 15/2007	Sheep	14.03.07	O	Positive	O
	PAT 16/2007	NK	14.03.07	O	Positive	O
	PAT 17/2007	NK	14.03.07	O	Positive	O
	PAT 18/2007	NK	21.03.07	O	Positive	O
	PAT 19/2007	Sheep	21.03.07	O	Positive	O
	PAT 20/2007	Sheep	29.03.07	NVD	Positive	FMDV GD
PAT 21/2007	Sheep	12.04.07	O	Positive	O	
PAT 22/2007	Sheep	12.04.07	O	Positive	O	
PAT 23/2007	Sheep	12.04.07	O	Positive	O	
PAT 24/2007	Sheep	12.04.07	O	Positive	O	
PAT 25/2007	Sheep	01.05.07	NVD	Negative	NVD	
PAT 1/2009	Cattle	24.02.09	A	Positive	A	
PAT 2/2009	Sheep	17.03.09	A	Positive	A	
PAT 3/2009	Sheep	17.03.09	NVD	Negative	NVD	
PAT 4/2009	Sheep	25.03.09	NVD	Negative	NVD	
PAT 5/2009	Goat	02.04.09	A	Positive	A	
PAT 6/2009	Cattle	02.04.09	A	Positive	A	
PAT 7/2009	Sheep	06.04.09	NVD	Positive	FMDV GD	
PAT 8/2009	Sheep	08.04.09	A	Positive	A	
PAT 9/2009	Sheep	08.04.09	NVD	Positive	FMDV GD	
SOMALIA	SOM 1/2009	Cattle	00.03.09	NVD	Negative	NVD
	SOM 2/2009	Cattle	00.03.09	NVD	Negative	NVD
	SOM 3/2009	Cattle	00.03.09	NVD	Negative	NVD
	SOM 4/2009	Cattle	00.03.09	NVD	Negative	NVD
TAIWAN	TAW 1/2009	Pig	04.02.09	O	Positive	O
THAILAND	TAI 2/2008	Cattle	27.04.08	O	Positive	O
	TAI 3/2008	Cattle	10.05.08	O	Positive	O
	TAI 4/2008	Cattle	29.07.08	A	Positive	A
	TAI 5/2008	Cattle	11.08.08	O	Positive	O
	TAI 6/2008	Cattle	00.08.08	O	Positive	O
	TAI 7/2008	Buffalo	00.08.08	O	Positive	O
	TAI 8/2008	Cattle	00.08.08	A	Positive	A

	TAI 9/2008	Buffalo	00.08.08	A	Positive	A
	TAI 10/2008	Cattle	00.08.08	A	Positive	A
	TAI 11/2008	Cattle	00.08.08	A	Positive	A
	TAI 12/2008	Cattle	00.11.08	O	Positive	O
	TAI 13/2008	Cattle	11.11.08	A	Positive	A
	TAI 14/2008	Cattle	00.11.08	A	Positive	A
	TAI 15/2008	Cattle	28.11.08	A	Positive	A
	TAI 16/2008	Cattle	00.12.08	A	Positive	A
	TAI 17/2008	Cattle	00.12.08	A	Positive	A
	TAI 18/2008	Cattle	00.12.08	A	Positive	A
	TAI 19/2008	Cattle	00.12.08	A	Positive	A
	TAI 1/2009	Cattle	00.01.09	O	Positive	O
	TAI 2/2009	Cattle	06.01.09	O	Positive	O
	TAI 3/2009	Cattle	19.01.09	O	Positive	O
	TAI 4/2009	Pig	00.01.09	O	Positive	O
UGANDA	UGA 1/2009	Cattle	00.02.09	NVD	Negative	NVD FMDV
	UGA 2/2009	Cattle	00.02.09	NVD	Positive	GD FMDV
	UGA 3/2009	Cattle	00.02.09	NVD	Positive	GD
	TOTAL : 292					

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

GD genome detected

VI/ELISA FMDV serotype identified following virus isolation in cell culture and antigen ELISA reverse transcription polymerase chain reaction on epithelial suspension for FMD viral genome

RT-PCR

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

** one sample from Kenya contained a mixture of type O and SAT 1 FMDVs

TABLE B: Summary of samples collected and received to IAH-Pirbright (April-June 2009)

Country	No. of samples	Virus isolation in cell culture/ELISA								RT-PCR for FMD (or SVD)			
		FMD virus serotypes				SVD virus	NVD	virus (where appropriate)		Not tested			
		O	A	C	SAT 1	SAT 2	SAT 3	Asia 1	Positive		Negative		
BAHRAIN	5	-	1	-	-	-	-	2	-	2	3	2	-
BOTSWANA	4	-	-	-	-	4	-	-	-	-	4	-	-
CAMBODIA	4	3	1	-	-	-	-	-	-	-	4	-	-
EGYPT	16	16	-	-	-	-	-	-	-	-	16	-	-
ETHIOPIA	15	5	-	-	-	-	-	-	-	10	7	8	-
HONG KONG	13	12	-	-	-	-	-	-	-	1	12	1	-
IRAN	16	8	6	-	-	-	-	-	-	2	15	1	-
ISRAEL	60	26	18	-	-	-	-	-	-	16	41	7	12
KENYA**	44	6	2	-	14	6	-	-	-	17	39	5	-
MYANMAR	7	5	-	-	-	-	-	-	-	2	7	-	-
NEPAL	27	12	-	-	-	-	-	-	-	15	22	5	-
PAKISTAN	17	-	9	-	-	-	-	-	-	8	14	3	-
PALESTINIAN AUTONOMOUS TERRITORIES	34	20	5	-	-	-	-	-	-	9	30	4	-
SOMALIA	4	-	-	-	-	-	-	-	-	4	-	4	-
TAIWAN	1	1	-	-	-	-	-	-	-	-	1	-	-
THAILAND	22	10	12	-	-	-	-	-	-	-	22	-	-
UGANDA	3	-	-	-	-	-	-	-	-	3	2	1	-
TOTAL	292	124	54	-	14	10	-	2	0	89	239	41	12

- * Institute for Animal Health, Pirbright Laboratory, Woking, Surrey GU24 0NF
- 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
- RT-PCR reverse transcription polymerase chain reaction for FMD (or SVD) viral genome
- ** one sample from Kenya contained a mixture of type O and SAT 1 FMDVs

Figure 1. Geographical locations of clinical sample diagnostics made by the WRL between April and June 2009



TABLE C: Antigenic characterisation of FMD field isolates by matching with vaccine strains by VNT and/or LPBE – r₁ value data from 1st April to 30th June 2009

Field Isolate	r ₁ ' values by 2dmVNT				r ₁ ' values by LPBE			
	A22 Irq	A Tur06	A Eritrea	A Sau 41/91	A22 Irq	A Irn 99	A Irn 87	A Eritrea
A Tur 7/09	0.13	0.44	0.05	0.03	0.11	0.13		0.15
A Tur 40/09	0.06	0.79	0.10	0.01	DNT*	DNT		0.25
A Lib 14/09	0.37	0.83	0.04	0.36	0.11	DNT		DNT
A Lib 117/09	0.18	0.61	0.03	0.23	0.07			0.05
A Eth 12/09	0.16	0.46	0.35	0.06	DNT	0.00	0.13	≥0.75
A Eth 13/09	0.20	0.34	0.37	0.09	0.03	0.00	0.14	0.50

Field Isolate	"r ₁ " values by 2dmVNT			"r ₁ " values by LPBE		
	O Manisa	O BFS	O Ind R2/75	O Manisa	O BFS	O 4174
O Irn 7/09	0.17	0.06	0.18	0.75	DNT	DNT
O Irn 14/09	0.26	0.16		0.84	0.15	0.21
O Tur 3/09				0.15	0.03	0.05
O Tur 35/09				DNT	DNT	0.28

*DNT: didn't trap.

Interpretation of r₁ values

In the case of VNT:

r₁ = ≥ 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.

r₁ = < 0.3. Suggests that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect

In the case of LPB ELISA:

r₁ = 0.4-1.0. 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.

r₁ = 0.2-0.39, Suggests that the field isolate is antigenically related to the vaccine strain. The vaccine strain might be suitable for use if no closer match can be found provided that a potent vaccine is used and animals are preferably immunised more than once.

r₁ = < 0.2. Suggests that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect

Annex 2. Recent FMD Publications cited by PubMed

- 1: Goris N, Vandebussche F, Herr C, Villers J, Van der Stede Y, De Clercq K. Validation of two real-time RT-PCR methods for foot-and-mouth disease diagnosis: RNA-extraction, matrix effect, uncertainty of measurement and precision. *J Virol Methods*. 2009 Sep;160(1-2):157-62. Epub 2009 May 15. PubMed PMID: 19447138.
- 2: Ren XG, Xue F, Zhu YM, Tong GZ, Wang YH, Feng JK, Shi HF, Gao YR. Construction of a recombinant BHV-1 expressing the VP1 gene of foot and mouth disease virus and its immunogenicity in a rabbit model. *Biotechnol Lett*. 2009 Aug;31(8):1159-65. Epub 2009 Apr 3. PubMed PMID: 19343503.
- 3: O'Donnell V, Pacheco JM, Gregg D, Baxt B. Analysis of foot-and-mouth disease virus integrin receptor expression in tissues from naïve and infected cattle. *J Comp Pathol*. 2009 Aug-Oct;141(2-3):98-112. Epub 2009 Jun 9. PubMed PMID: 19515380.
- 4: Xiong Y, Lin M, Yuan B, Yuan T, Zheng C. Expression of Exogenous IFN-alpha by Bypassing the Translation Block Protects Cells against FMDV Infection. *Antiviral Res*. 2009 Jul 13. [Epub ahead of print] PubMed PMID: 19607862.
- 5: Jenik M, Schirhagl R, Schirk C, Hayden O, Lieberzeit P, Blaas D, Paul G, Dickert FL. Sensing picornaviruses using molecular imprinting techniques on a quartz crystal microbalance. *Anal Chem*. 2009 Jul 1;81(13):5320-6. PubMed PMID: 19469532.
- 6: Dory D, Rémond M, Béven V, Cariolet R, Zientara S, Jestin A. Foot-and-Mouth Disease Virus neutralizing antibodies production induced by pcDNA3 and Sindbis virus based plasmid encoding FMDV P1-2A3C3D in swine. *Antiviral Res*. 2009 Jul;83(1):45-52. Epub 2009 Mar 27. PubMed PMID: 19501256.
- 7: Morioka K, Fukai K, Yoshida K, Yamazoe R, Onozato H, Ohashi S, Tsuda T, Sakamoto K. Neutralizing monoclonal antibody sandwich liquid-phase blocking enzyme-linked immunosorbent assay for detection of Foot-and-mouth disease virus type O antibodies. *J Vet Diagn Invest*. 2009 Jul;21(4):499-503. PubMed PMID: 19564498.
- 8: Escarmís C, Perales C, Domingo E. Biological effect of Muller's Ratchet: distant capsid site can affect picornavirus protein processing. *J Virol*. 2009 Jul;83(13):6748-56. Epub 2009 Apr 29. PubMed PMID: 19403672; PubMed Central PMCID: PMC2698577.
- 9: Piccone ME, Feng Y, Chang AC, Mosseri R, Lu Q, Kutish GF, Lu Z, Burrage TG, Gooch C, Rock DL, Cohen SN. Identification of cellular genes affecting the infectivity of foot-and-mouth disease virus. *J Virol*. 2009 Jul;83(13):6681-8. Epub 2009 Apr 15. PubMed PMID: 19369337; PubMed Central PMCID: PMC2698527.
- 10: Ko YJ, Jeoung HY, Lee HS, Chang BS, Hong SM, Heo EJ, Lee KN, Joo HD, Kim SM, Park JH, Kweon CH. A recombinant protein-based ELISA for detecting antibodies to foot-and-mouth disease virus serotype Asia 1. *J Virol Methods*. 2009 Jul;159(1):112-8. Epub 2009 Mar 20. PubMed PMID: 19442854.
- 11: Alves MP, Guzylack-Piriou L, Juillard V, Audonnet JC, Doel T, Dawson H, Golde WT, Gerber H, Peduto N, McCullough KC, Summerfield A. Innate immune defences induced by CpG do not promote vaccine-induced protection against foot and mouth disease virus in pigs. *Clin Vaccine Immunol*. 2009 Jun 24. [Epub ahead of print] PubMed PMID: 19553550.
- 12: Sánchez-Aparicio MT, Rosas MF, Ferraz RM, Delgui L, Veloso JJ, Blanco E, Villaverde A, Sobrino F. Discriminating foot-and-mouth disease virus-infected and vaccinated animals through beta-galactosidase allosteric biosensors. *Clin Vaccine*

Immunol. 2009 Jun 24. [Epub ahead of print] PubMed PMID: 19553549.

13: Du J, Chang H, Gao S, Cong G, Shao J, Lin T, Liu Z, Liu X, Cai X. Sheep (*Ovis aries*) integrins alphavbeta1 and alphavbeta6 related to foot-and-mouth disease virus infection: Molecular cloning, sequence analysis and comparison with homologues. *Mol Cell Probes*. 2009 Jun 23. [Epub ahead of print] PubMed PMID: 19555755.

14: Furuta Y, Takahashi K, Shiraki K, Sakamoto K, Smee DF, Barnard DL, Gowen BB, Julander JG, Morrey JD. T-705 (favipiravir) and related compounds: Novel broad-spectrum inhibitors of RNA viral infections. *Antiviral Res*. 2009 Jun;82(3):95-102. Epub 2009 Mar 6. Review. PubMed PMID: 19428599.

15: Toka FN, Nfon CK, Dawson H, Golde WT. Accessory-cell-mediated activation of porcine NK cells by toll-like receptor 7 (TLR7) and TLR8 agonists. *Clin Vaccine Immunol*. 2009 Jun;16(6):866-78. Epub 2009 Apr 15. PubMed PMID: 19369481; PubMed Central PMCID: PMC2691044.

16: Chen TH, Pan CH, Jong MH, Lin HM, Huang YL, Hsiung KP, Chao PH, Lee F. Development of a chromatographic strip assay for detection of porcine antibodies to 3ABC non-structural protein of foot-and-mouth disease virus serotype O. *J Vet Med Sci*. 2009 Jun;71(6):703-8. PubMed PMID: 19578276.

17: Johns HL, Berryman S, Monaghan P, Belsham GJ, Jackson T. A dominant-negative mutant of rab5 inhibits infection of cells by foot-and-mouth disease virus: implications for virus entry. *J Virol*. 2009 Jun;83(12):6247-56. Epub 2009 Apr 8. PubMed PMID: 19357169; PubMed Central PMCID: PMC2687373.

18: Dunbar MR, Johnson SR, Rhyan JC, McCollum M. Use of infrared thermography to detect thermographic changes in mule deer (*Odocoileus hemionus*) experimentally infected with foot-and-mouth disease. *J Zoo Wildl Med*. 2009 Jun;40(2):296-301. PubMed PMID: 19569476.

19: Lv K, Guo Y, Zhang Y, Wang K, Li K, Zhu Y, Sun S. Transient inhibition of foot-and-mouth disease virus replication by siRNAs silencing VP1 protein coding region. *Res Vet Sci*. 2009 Jun;86(3):443-52. Epub 2008 Dec 4. PubMed PMID: 19062053.

20: Lee SH, Jong MH, Huang TS, Lin YL, Wong ML, Liu CI, Chang TJ. Pathology and viral distributions of the porcineophilic foot-and-mouth disease virus strain (O/Taiwan/97) in experimentally infected pigs. *Transbound Emerg Dis*. 2009 Jun;56(5):189-201. PubMed PMID: 19432640.

21: Knowles NJ, Nazem Shirazi MH, Wadsworth J, Swabey KG, Stirling JM, Statham RJ, Li Y, Hutchings GH, Ferris NP, Parlak U, Ozyörük F, Sumption KJ, King DP, Paton DJ. Recent spread of a new strain (A-Iran-05) of foot-and-mouth disease virus type A in the Middle East. *Transbound Emerg Dis*. 2009 Jun;56(5):157-69. PubMed PMID: 19432637.

22: Rainwater-Lovett K, Pacheco JM, Packer C, Rodriguez LL. Detection of foot-and-mouth disease virus infected cattle using infrared thermography. *Vet J*. 2009 Jun;180(3):317-24. Epub 2008 Mar 4. PubMed PMID: 18308596.

23: Cao Y, Lu Z, Sun J, Bai X, Sun P, Bao H, Chen Y, Guo J, Li D, Liu X, Liu Z. Synthesis of empty capsid-like particles of Asia I foot-and-mouth disease virus in insect cells and their immunogenicity in guinea pigs. *Vet Microbiol*. 2009 May 28;137(1-2):10-7. Epub 2008 Dec 11. PubMed PMID: 19167843.

24: Serrano P, Ramajo J, Martínez-Salas E. Rescue of internal initiation of translation by RNA complementation provides evidence for a distribution of functions between individual IRES domains. *Virology*. 2009 May 25;388(1):221-9. Epub 2009 Apr 21. PubMed PMID: 19383564.

- 25: Díaz-San Segundo F, Rodríguez-Calvo T, de Avila A, Sevilla N. Immunosuppression during acute infection with foot-and-mouth disease virus in swine is mediated by IL-10. *PLoS One*. 2009 May 21;4(5):e5659. PubMed PMID: 19478852; PubMed Central PMCID: PMC2682558.
- 26: Joyappa DH, Ashok Kumar C, Banumathi N, Reddy GR, Suryanarayana VV. Calcium phosphate nanoparticle prepared with foot and mouth disease virus P1-3CD gene construct protects mice and guinea pigs against the challenge virus. *Vet Microbiol*. 2009 May 19. [Epub ahead of print] PubMed PMID: 19505774.
- 27: Tam S, Clavijo A, Engelhard EK, Thurmond MC. Fluorescence-based multiplex real-time RT-PCR arrays for the detection and serotype determination of foot-and-mouth disease virus. *J Virol Methods*. 2009 May 7. [Epub ahead of print] PubMed PMID: 19427333.
- 28: Quan M, Murphy CM, Zhang Z, Durand S, Esteves I, Doel C, Alexandersen S. Influence of exposure intensity on the efficiency and speed of transmission of Foot-and-mouth disease. *J Comp Pathol*. 2009 May;140(4):225-37. Epub 2009 Feb 11. PubMed PMID: 19215941.
- 29: Reid SM, Ebert K, Bachanek-Bankowska K, Batten C, Sanders A, Wright C, Shaw AE, Ryan ED, Hutchings GH, Ferris NP, Paton DJ, King DP. Performance of real-time reverse transcription polymerase chain reaction for the detection of foot-and-mouth disease virus during field outbreaks in the United Kingdom in 2007. *J Vet Diagn Invest*. 2009 May;21(3):321-30. PubMed PMID: 19407083.
- 30: Martín-Acebes MA, González-Magaldi M, Vázquez-Calvo A, Armas-Portela R, Sobrino F. Internalization of swine vesicular disease virus into cultured cells: a comparative study with foot-and-mouth disease virus. *J Virol*. 2009 May;83(9):4216-26. Epub 2009 Feb 18. PubMed PMID: 19225001; PubMed Central PMCID: PMC2668442.
- 31: Gerner W, Hammer SE, Wiesmüller KH, Saalmüller A. Identification of major histocompatibility complex restriction and anchor residues of foot-and-mouth disease virus-derived bovine T-cell epitopes. *J Virol*. 2009 May;83(9):4039-50. Epub 2009 Feb 11. PubMed PMID: 19211750; PubMed Central PMCID: PMC2668444.
- 32: Garabed RB, Johnson WO, Thurmond MC. Analytical epidemiology of genomic variation among Pan Asia strains of foot-and-mouth disease virus. *Transbound Emerg Dis*. 2009 May;56(4):142-56. PubMed PMID: 19341389.
- 33: Du J, Gao S, Chang H, Cong G, Lin T, Shao J, Liu Z, Liu X, Cai X. Bactrian camel (*Camelus bactrianus*) integrins alphavbeta3 and alphavbeta6 as FMDV receptors: Molecular cloning, sequence analysis and comparison with other species. *Vet Immunol Immunopathol*. 2009 Apr 19. [Epub ahead of print] PubMed PMID: 19443046.
- 34: Xin A, Li H, Li L, Liao D, Yang Y, Zhang N, Chen B. Genome analysis and development of infectious cDNA clone of a virulence-attenuated strain of foot-and-mouth disease virus type Asia 1 from China. *Vet Microbiol*. 2009 Apr 10. [Epub ahead of print] PubMed PMID: 19410387.
- 35: Joensuu JJ, Brown KD, Conley AJ, Clavijo A, Menassa R, Brandle JE. Expression and purification of an anti-Foot-and-mouth disease virus single chain variable antibody fragment in tobacco plants. *Transgenic Res*. 2009 Apr 3. [Epub ahead of print] PubMed PMID: 19343526.
- 36: Larska M, Wernery U, Kinne J, Schuster R, Alexandersen G, Alexandersen S. Differences in the susceptibility of dromedary and Bactrian camels to foot-and-mouth disease virus. *Epidemiol Infect*. 2009 Apr;137(4):549-54. Epub 2008 Aug 8. PubMed PMID: 18687160.

- 37: Rodríguez Pulido M, Sobrino F, Borrego B, Sáiz M. Attenuated foot-and-mouth disease virus RNA carrying a deletion in the 3' noncoding region can elicit immunity in swine. *J Virol.* 2009 Apr;83(8):3475-85. Epub 2009 Feb 11. PubMed PMID: 19211755; PubMed Central PMCID: PMC2663259.
- 38: Zhang Z, Bashiruddin JB. Quantitative analysis of foot-and-mouth disease virus RNA duration in tissues of experimentally infected pigs. *Vet J.* 2009 Apr;180(1):130-2. Epub 2008 Feb 21. PubMed PMID: 18294878.
- 39: Li R, Sakwivatkul K, Yutao L, Hu S. Enhancement of the immune responses to vaccination against foot-and-mouth disease in mice by oral administration of an extract made from *Rhizoma Atractylodis Macrocephalae* (RAM). *Vaccine.* 2009 Mar 26;27(15):2094-8. Epub 2009 Feb 12. PubMed PMID: 19356611.
- 40: Harmsen MM, Fijten HP, Engel B, Dekker A, Eblé PL. Passive immunization with llama single-domain antibody fragments reduces foot-and-mouth disease transmission between pigs. *Vaccine.* 2009 Mar 18;27(13):1904-11. Epub 2009 Jan 31. PubMed PMID: 19368770.
- 41: Summerfield A, Guzylack-Piriou L, Harwood L, McCullough KC. Innate immune responses against foot-and-mouth disease virus: current understanding and future directions. *Vet Immunol Immunopathol.* 2009 Mar 15;128(1-3):205-10. Epub 2008 Oct 17. PubMed PMID: 19026453.
- 42: Dory D, Rémond M, Béven V, Cariolet R, Backovic M, Zientara S, Jestin A. Pseudorabies virus glycoprotein B can be used to carry foot and mouth disease antigens in DNA vaccination of pigs. *Antiviral Res.* 2009 Mar;81(3):217-25. Epub 2008 Dec 25. PubMed PMID: 19103226.
- 43: Klein J. Understanding the molecular epidemiology of foot-and-mouth-disease virus. *Infect Genet Evol.* 2009 Mar;9(2):153-61. Epub 2008 Nov 28. Review. PubMed PMID: 19100342.
- 44: Nagendrakumar SB, Madhanmohan M, Rangarajan PN, Srinivasan VA. Genetic analysis of foot-and-mouth disease virus serotype A of Indian origin and detection of positive selection and recombination in leader protease-and capsid-coding regions. *J Biosci.* 2009 Mar;34(1):85-101. PubMed PMID: 19430121.
- 45: Hema M, Chandran D, Nagendrakumar SB, Madhanmohan M, Srinivasan VA. Construction of an infectious cDNA clone of foot-and-mouth disease virus type O 1 BFS 1860 and its use in the preparation of candidate vaccine. *J Biosci.* 2009 Mar;34(1):45-58. PubMed PMID: 19430118.
- 46: Zheng H, Tian H, Jin Y, Wu J, Shang Y, Yin S, Liu X, Xie Q. Development of a hamster kidney cell line expressing stably T7 RNA polymerase using retroviral gene transfer technology for efficient rescue of infectious foot-and-mouth disease virus. *J Virol Methods.* 2009 Mar;156(1-2):129-37. Epub 2008 Dec 31. PubMed PMID: 19095010.
- 47: Ryan E, Wright C, Gloster J. Measurement of airborne foot-and-mouth disease virus: preliminary evaluation of two portable air sampling devices. *Vet J.* 2009 Mar;179(3):458-61. Epub 2007 Nov 26. PubMed PMID: 18023217.

Annex 3. RECOMMENDATIONS FROM WRLFMD ON FMD VIRUS STRAINS TO BE INCLUDED IN FMDV ANTIGEN BANKS – June 2009

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)

*= newly available