WRLFMD

THE Pirbright INSTITUTE

Review of regional FMD situation and vaccine recommendations

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UKRI Biotechnology and Biological Sciences Research Council
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Department for Environment Food & Rural Affairs

eufmd
European Commission for the Control of Foot-and-Mouth disease

World Organisation for Animal Health
Founded as OIE
FMD Reference Laboratory

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FMD epidemiology

- The epidemiology of FMD is dynamic; defined by:
  - Seven virus ecosystems (Pools) that maintain specific FMDV strains requiring tailored diagnostics and vaccines
  - Six circulating FMDV serotypes with an unequal distribution (NB: Serotype C has not been detected globally since 2004)
  - Long-distance “trans-pool” movements of FMDV lineages which are often unpredictable
- **International partnerships are essential to collate, share and analyse data**

WOAH/FAO
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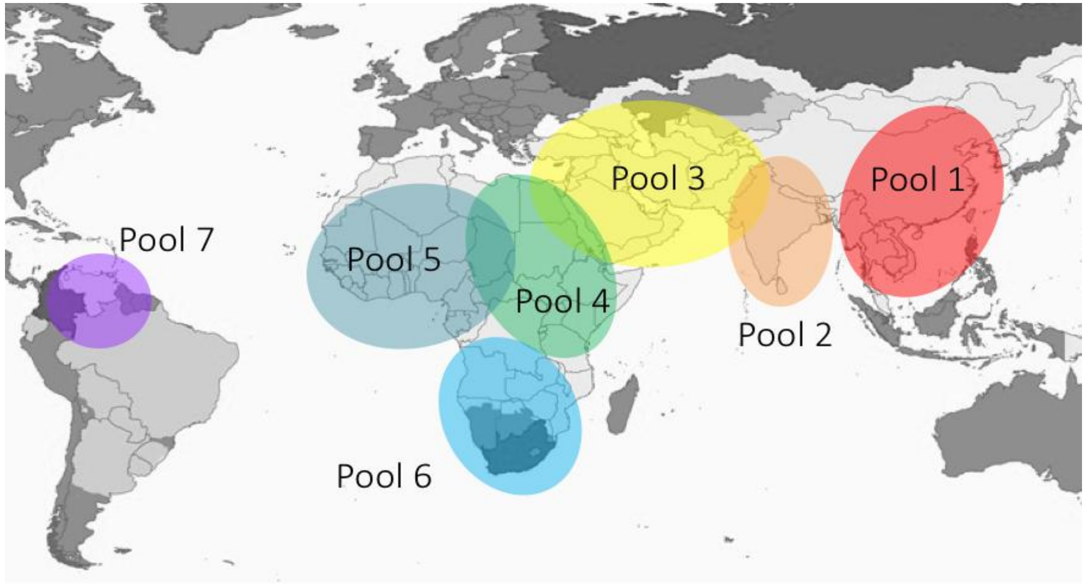
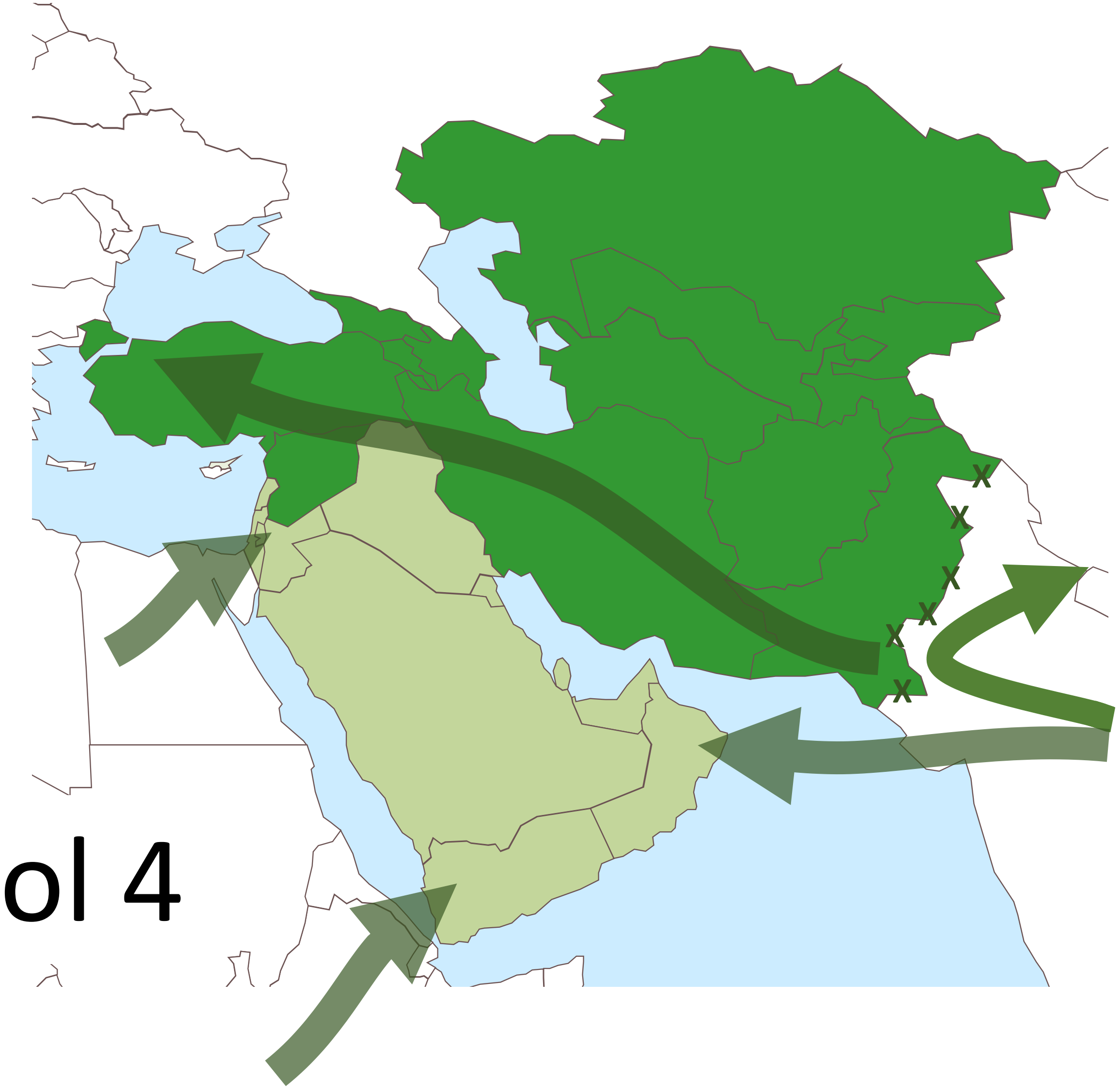
Network



Pathways for virus movements within and into Pool 3



Pool 2

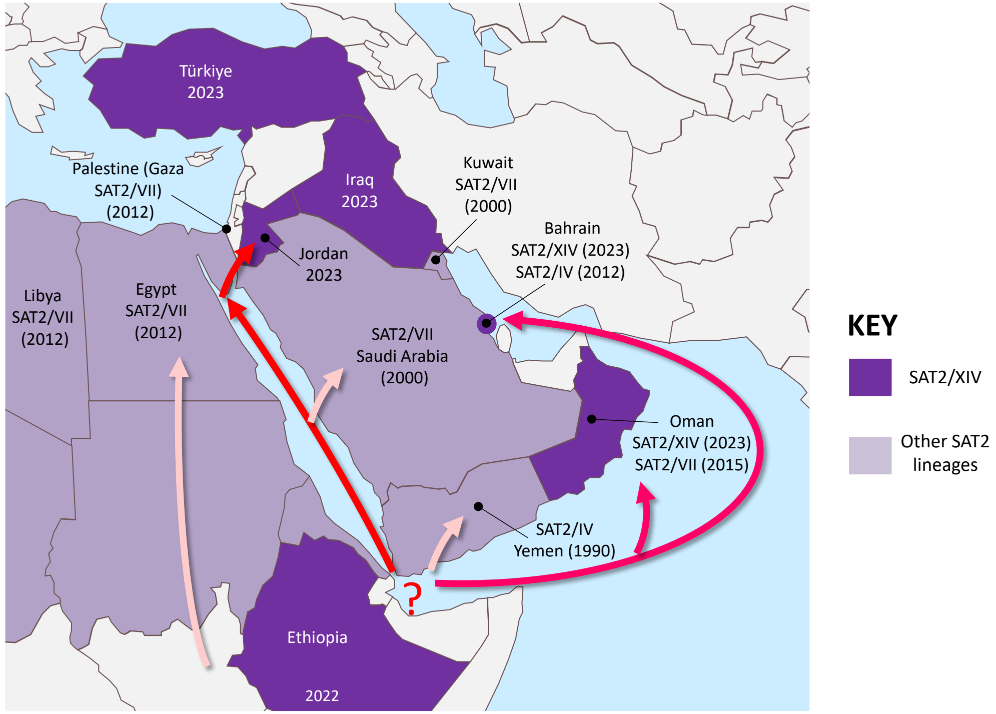
Pool 4

2023: New FMD outbreaks due to the SAT2/XIV topotype

- VP1 sequence data and samples:

kindly shared by colleagues at: Central Veterinary laboratory and Researches Veterinary Dept, Iraq; FMD (ŞAP) Institute, Türkiye; JUST, Jordan, Central Laboratory of Animal Health, Oman; Sultan Qaboos University, Oman; ANSES, France and AHI, Ethiopia

- Most closely related to sequences recovered from samples collected in SW Ethiopia in 2022
- To our knowledge, this is the first time that serotype SAT 2 has been detected in Iraq, Jordan or Türkiye
- Topotype XIV has been detected on only one other previous occasion – in 1991



Arrows represent putative transmission pathways in the region (based on sequence relationships for previous outbreaks)

Recent detection of other East African FMDVs in the Gulf States (since 2020):
A/AFRICA/G-I Bahrain (2021)
O/EA-3 Bahrain (2021)
SAT 1 – Qatar (2023)

Network of Genetic Diversity

evidence for 5 introductions of the SAT2/XIV topotype

Statistical parsimony network (TCS) based on 51 whole-genome sequences (WGS) of SAT2/XIV FMDV isolates:

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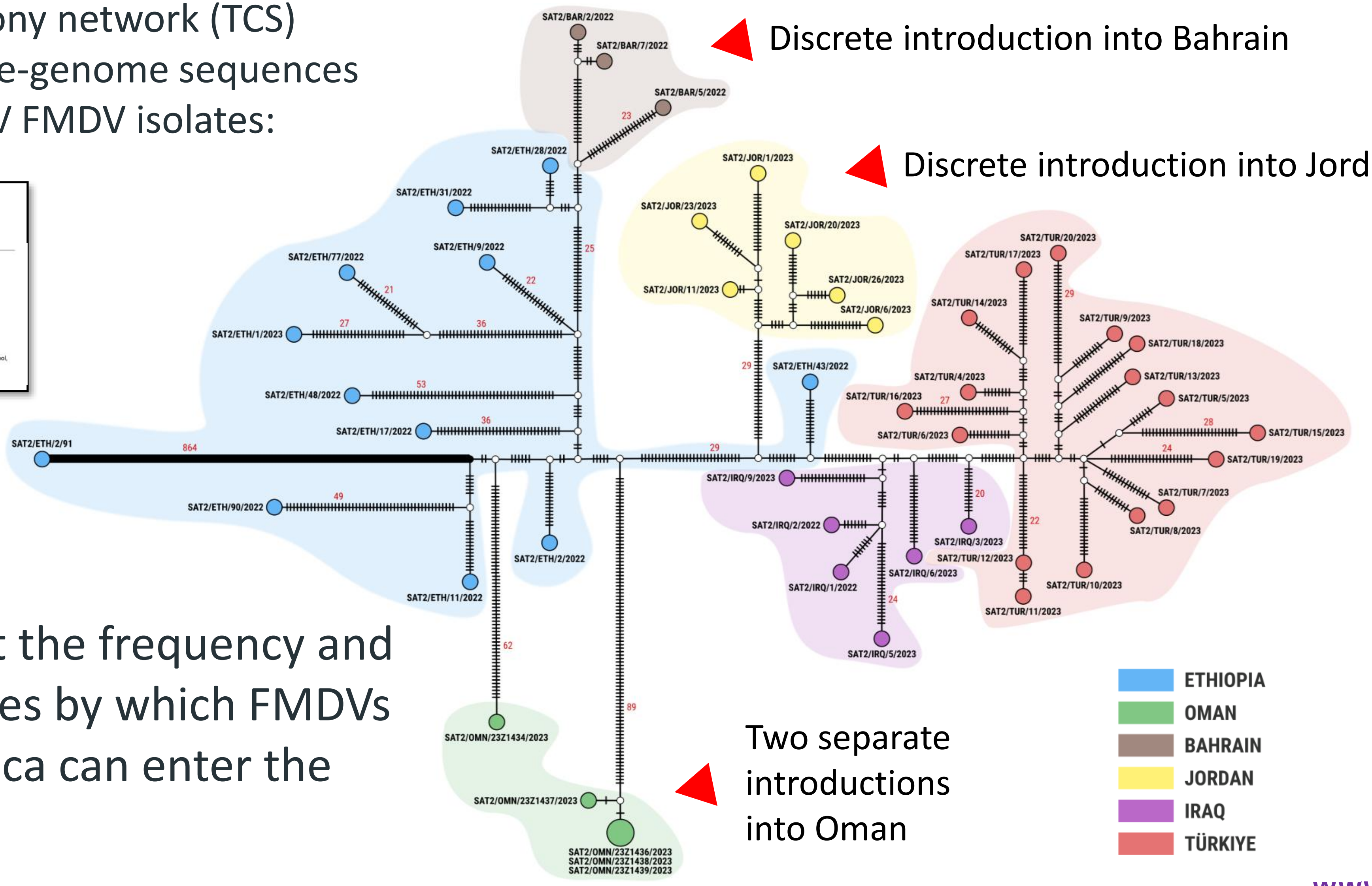
DISPATCHES

Eastern Africa Origin of SAT2 Topotype XIV Foot-and-Mouth Disease Virus Outbreaks, Western Asia, 2023

Antonello Di Nardo, Andrew E. Shaw, Mathilde Gondard, Jemma Wadsworth, Guillaume Girault, Krupali Parekh, Anna Ludi, Valerie Mioulet, Cindy Bernelin-Cottet, Hayley M. Hicks, Noemi Polo, Abdulnaci Bulut, Unal Parlak, Daniel Gizaw, Mustafa Ababneh, Maisa Al Ameer, Layth M.S. Abdulrasool, Fajur S. Al Saloom, Wafa A. Al-Rawahi, Nick J. Knowles, Labib Bakkali-Kassimi, Donald P. King

Published:
Di Nardo et al., (2025) *Emerging Infectious Diseases* **31** (2)



Discrete introduction into Bahrain

Discrete introduction into Jordan

Common pathway for Iraq and Türkiye

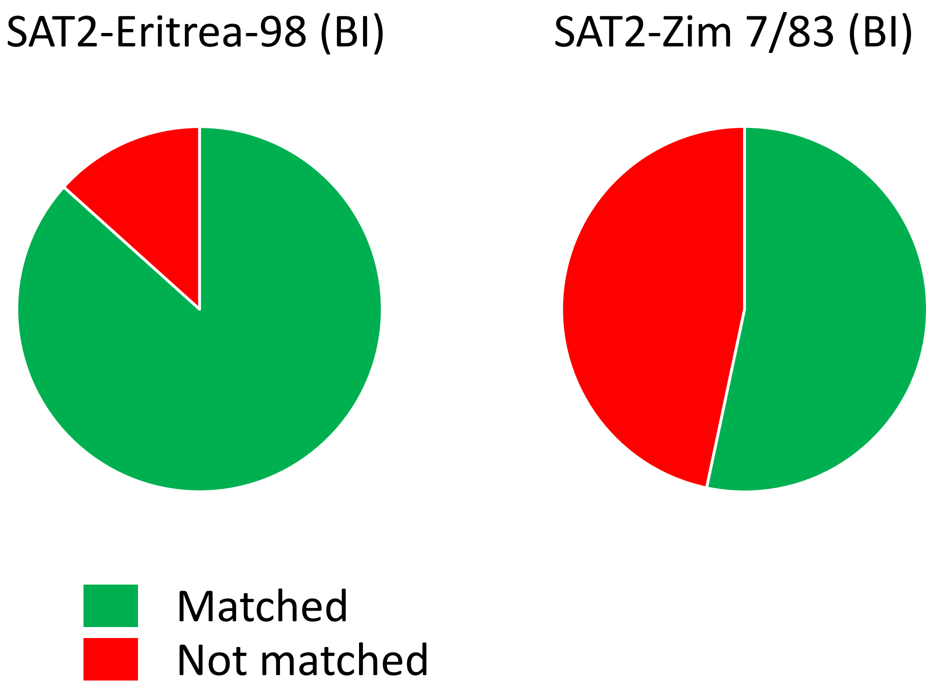
Two separate introductions into Oman

Data highlight the frequency and different routes by which FMDVs from East Africa can enter the Middle East

SAT2/XIV: control via vaccination?

- SAT2 vaccines are not widely used to control FMD outbreaks in the region
- Vaccine matching results from Pirbright (n=15):

	SAT2 Eritrea 98 - BI		SAT2 Zim 83 - BI	
	r1-value	titre	r1-value	titre
ETH/2/2022	0.81	1.62	0.54	2.17
ETH/3/2022	0.49	1.66	0.15	1.7
IRQ/2/2022	0.73	1.75	0.38	2.04
IRQ/5/2023	0.53	1.61	0.74	2.33
IRQ/9/2023	0.42	1.51	0.31	1.95
JOR/11/2023	0.58	1.69	0.2	1.74
JOR/20/2023	0.83	1.85	0.24	1.81
JOR/26/2023	0.86	1.86	0.32	1.94
BAR/2/2022	0.4	1.5	0.39	1.85
BAR/7/2022	0.53	1.62	0.53	1.99
TUR/4/2023	1	1.68	0.31	1.95
TUR/17/2023	0.72	1.52	0.25	1.86
ETH/11/2022	0.33	1.58	0.18	1.88
ETH/105/2022	0.26	1.49	0.17	1.87
ETH/1/2023	0.27	1.49	0.1	1.64

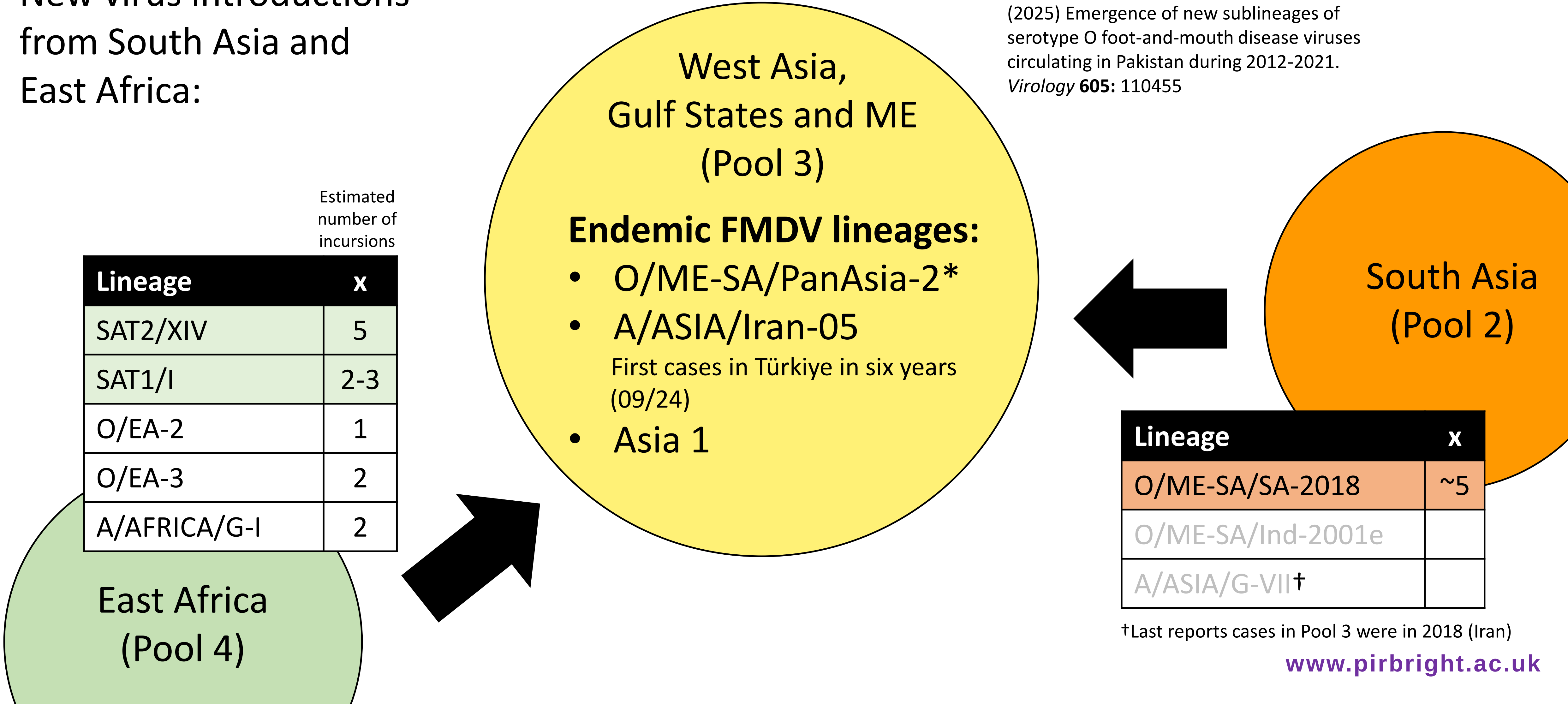


New SAT 2 vaccine from Biogenesis Bago (SAT2 Oman/2015) also tested for six isolates with encouraging results

Updated FMD risks for Pool 3 (since 2020)

New virus introductions from South Asia and East Africa:

*Note: New O/ME-SA/PanAsia-2 designations are proposed by Jamal et al., (2025) Emergence of new sublineages of serotype O foot-and-mouth disease viruses circulating in Pakistan during 2012-2021. *Virology* **605:** 110455



West Asia,
Gulf States and ME
(Pool 3)

Endemic FMDV lineages:
- O/ME-SA/PanAsia-2*
- A/ASIA/Iran-05

  First cases in Türkiye in six years (09/24)
- Asia 1

East Africa
(Pool 4)

Estimated number of incursions

Lineage	x
SAT2/XIV	5
SAT1/I	2-3
O/EA-2	1
O/EA-3	2
A/AFRICA/G-I	2

South Asia
(Pool 2)

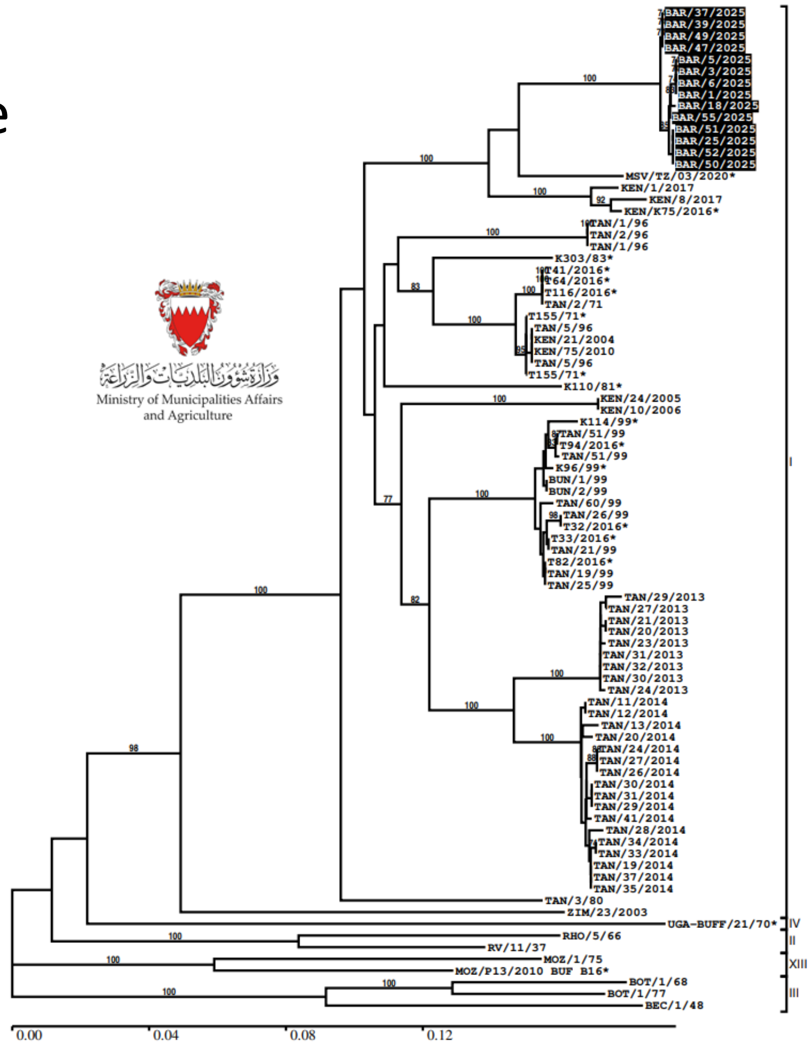
Lineage	x
O/ME-SA/SA-2018	~5
O/ME-SA/Ind-2001e	
A/ASIA/G-VII†	

†Last reports cases in Pool 3 were in 2018 (Iran)

Emergence of serotype SAT1/I in the Middle East (Bahrain)

- SAT1/I previously detected in Qatar (in 2023)
- EuFMD supported a SSIS in Bahrain to test the performance of a SAT 2 FMD vaccine - discussion led to samples (collected during 2025) submitted to the WRLFMD
- **SAT1/I detected**
- Closest genetic relative from Tanzania 2020
- Evidence for co-infection with **O/EA-2** in one sample – this topotype also originates from East Africa
- SAT1/I lineage-specific real-time RT-PCRs have been tested (see: Bachanek-Bankowska et al., 2016*)
- Ag-ELISA (from IZSLER) is able to detect and discriminate viruses from this topotype

وزارة شؤون البلديات والزراعة
Ministry of Municipalities Affairs
and Agriculture



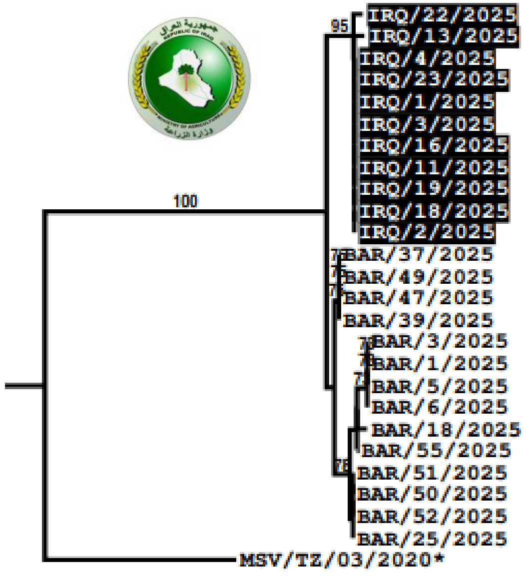
*Bachanek-Bankowska et al., (2016) Development and evaluation of tailored specific real-time RT-PCR assays for detection of foot-and-mouth disease virus serotypes circulating in East Africa. J Virol Methods **237**:114-120.
https://www.foot-and-mouth.org/science/lineage-specific-fmdv-real-time-rt-pcr-assays

Emergence of serotype SAT1/I in the Middle East (Bahrain and Iraq)

- Reports of an upsurge of FMD outbreaks in Iraq where local testing (agELISA) identified serotype SAT1 and O viruses
- **SAT1/I detected in samples sent to WRLFMD**
- Same genetic clade as the sequences from Bahrain (but, not identical!) – do these viruses represent different introductions?
- >15% nt difference to the sequences from the cases in Qatar supporting the idea that these are separate introductions into the region
- SAT1 also reported (WAHIS) for outbreaks in Kuwait – April 2025
- Limited vaccines are available for this serotype (e.g., SAT1/Rho78^{BI})
- <u>Preliminary</u> vaccine matching results:

  Analysis will be repeated using BVS for aqueous-formulated vaccine

and for serotype O…..



Isolate	r1 value	titre
QTR/5/2023	0.39	1.85
QTR/6/2023	0.41	1.86
QTR/7/2023	0.35	1.80
BAR/37/2025	0.17	1.52
BAR/50/2025	0.11	1.33
IRQ/11/2025	0.09	1.21
IRQ/1/2025	0.10	1.25
IRQ/23/2025	0.13	1.37

Emergence of O/ME-SA/SA-2018 in Pool 3

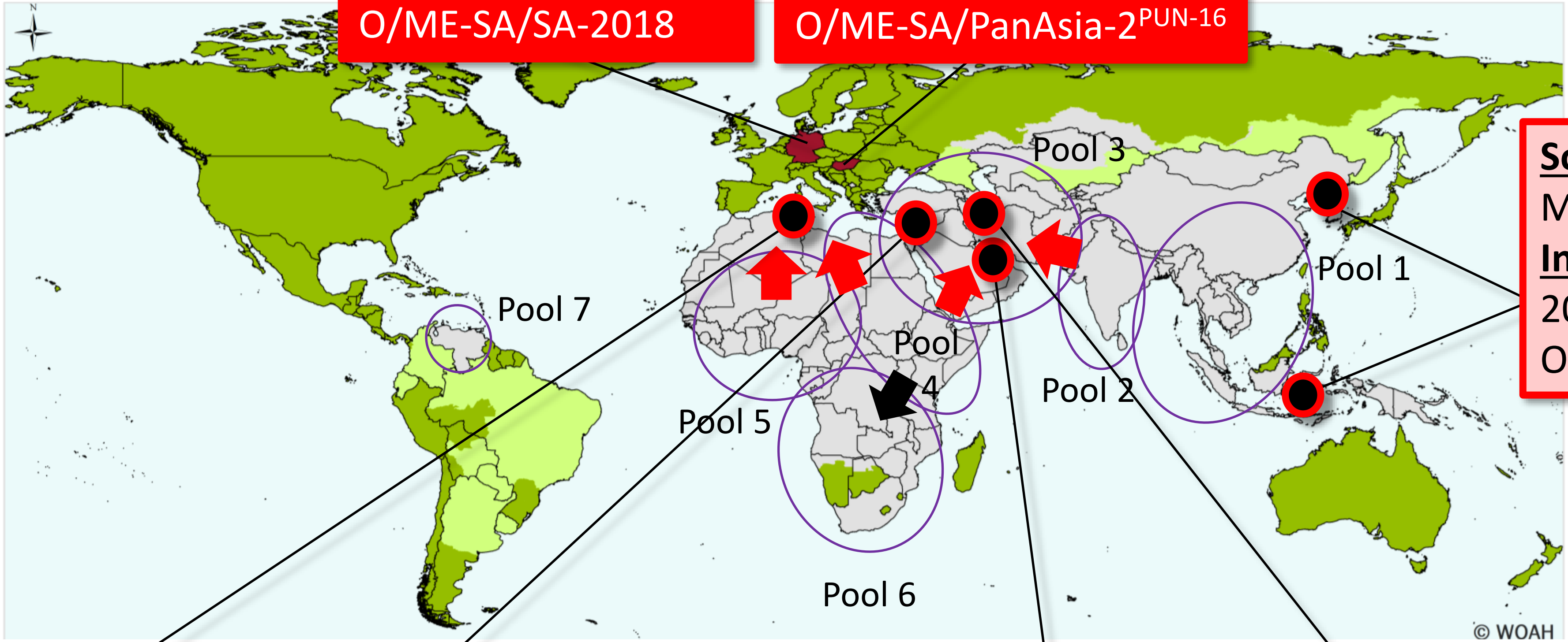
- History tells us that pandemic serotype O lineages emerge from Pool 2
- O/ME-SA/SA-2018 lineage originates in Pool 2 (India, Nepal, Bangladesh and Sri Lanka)
- Lineage estimated to represent ~ 40% of serotype O cases in India
- Previous incursions into Pool 3 (UAE and Oman) in 2021 in small ruminants
- 2023/4: further evidence for infection in Iran, Palestinian AT and Türkiye
- **2025: cases due to this lineage detected in Iraq and Israel**
- Sequences from Palestine/Israel are distinct to those from Türkiye, Iraq and Iran (~4% nt dif.)
- **Data support multiple recent introductions of this lineage from Pool 2**

State of Palestine
Ministry of Agriculture

Vaccine Matching data is available for 7 field isolates from the O/ME-SA/SA-2018 lineage

Isolate	O-Manisa ^{BI}		O-TUR/5/09 ^{MSD}		O-3039 ^{BI}		O-Campos ^{BI}		O-PanAsia-2 ^{BI}		O-Campos ^{BB}	
	r_1 value	titre	r_1 value	titre	r_1 value	titre	r_1 value	titre	r_1 value	titre	r_1 value	titre
UAE/15/2021	0.56	2.15	0.69	2.32	0.75	1.94	0.28	2.19	0.47	2.3	0.51	2.63
UAE/9/2021	0.44	2.04	0.68	2.32	0.59	1.83	0.23	2.10	0.32	2.13	0.60	2.70
NEP/13/2022	0.63	2.33	1.00	2.32	1.00	2.02	0.40	2.28	0.57	2.35	0.51	2.65
NEP/26/2022	0.32	2.04	0.68	2.15	0.66	1.82	0.23	2.03	0.32	2.10	0.20	2.29
NEP/38/2022	0.98	2.45	0.89	2.29	0.84	2.00	0.45	2.17	0.50	2.31	0.66	2.71
NEP/13/2024	0.88	2.40	0.78	2.23	0.82	1.99	0.74	2.27	0.99	2.49	0.68	2.72
► GER/1/2025	1.00	2.41	0.97	2.37	0.84	1.96	0.48	2.06	0.56	2.15	0.58	2.44

Headline global status for FMD (new events: March 25)



Germany
Jan 2025
O/ME-SA/SA-2018

Hungary, Slovakia
Mar 2025
O/ME-SA/PanAsia-2$^{\text{PUN-16}}$

South Korea
March 2025
Indonesia
2024-25
O/ME-SA/Ind-2001e

Algeria (2023/4)
SAT2/V
Tunisia (2024)
O/EA-3

Middle East (2023)
SAT2/XIV
(SAT1/I Qatar)

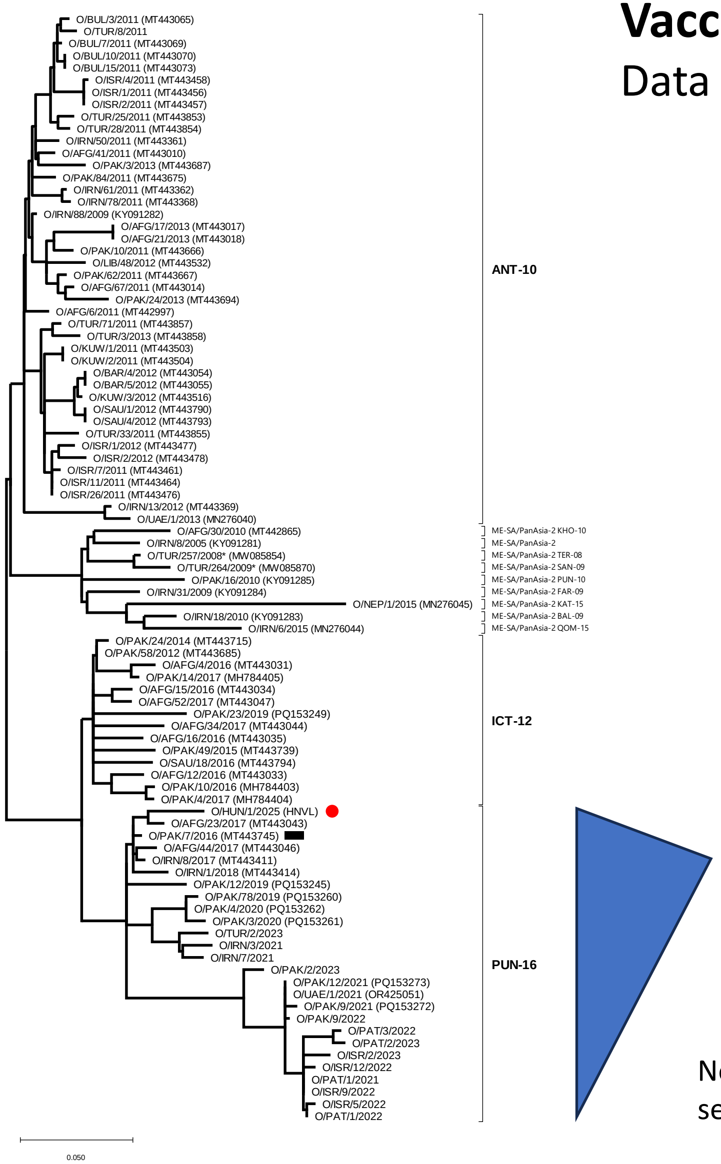
Bahrain, Iraq
January 2025
SAT1/I
(O/EA-2)

Iran, Iraq, Türkiye, Palestine
2023 and Q4 2024
O/ME-SA/SA-2018

Talk summary

- Epidemiology of FMD is very dynamic in Pool 3
- New patterns due to virus incursions from East Africa and southern Asia
- Circulation of different FMD virus lineages impact the selection of appropriate vaccines to control outbreaks
- **Sampling of field outbreaks is critical………**
- **WRLFMD and the WOAH/FAO Lab Network welcome sample submissions**
  - **Testing is free of charge**
  - **Contact: donald.king@pirbright.ac.uk**
- Testing/evaluation of FMD vaccines is important
  - Vaccine matching
  - Heterologous testing
  - Small scale immunogenicity studies and evaluation of FMD vaccines in the field

Proposed reclassification of O/ME-SA/PanAsia-2^{ANT-10} viruses



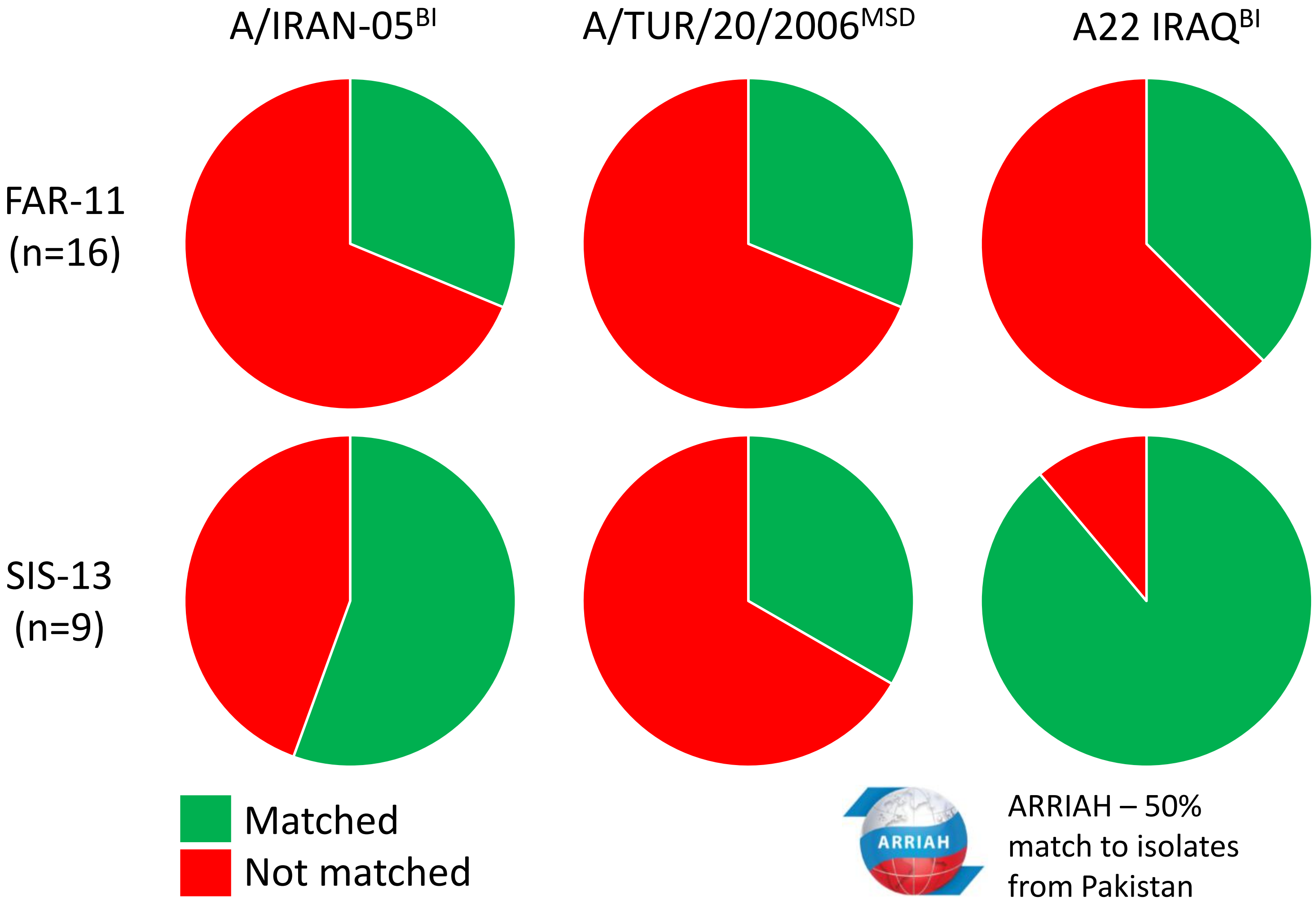
Vaccine Matching data is available for 78 isolates from the ANT-10 lineage

Data in table is for clade most closely related to HUN/1/2025 (O/ME-SA/PanAsia-2^{PUN-16})

Isolate	O-Manisa ^{BI}		O-TUR/5/09 ^{MSD}		O-3039 ^{BI}		O-Campos ^{BI}		O-PanAsia-2 ^{BI}		O-Campos ^{BB}	
	r_1 value	titre	r_1 value	titre	r_1 value	titre	r_1 value	titre	r_1 value	titre	r_1 value	titre
AFG/23/2017	0.72		0.74		0.46							
AFG/44/2017	0.36		0.65		0.44							
IRN/8/2017	0.29	1.87	0.52	1.71	0.43	1.57						
IRN/1/2018	0.37	1.95	0.34	1.83	0.58	1.66						
PAK/12/2019	0.50	2.20	0.76	2.11	0.66	1.79			0.32	2.00		
PAK/78/2019	0.32	2.03	0.49	1.99	0.33	1.56	0.36	1.97	0.41	2.14	0.40	2.42
PAK/3/2020	0.40	1.94	0.98	2.1	0.55	1.71			0.36	2.05	0.56	2.19
PAK/4/2020	0.07	1.41	0.59	2.07	0.11	1.10	0.26	1.83	0.34	2.03	0.39	2.41
TUR/2/2023	0.34	1.86	0.67	2.05	0.33	1.60	0.25	1.88	0.34	2.06	0.56	2.56
IRN/3/2021	0.22	1.95	0.63	2.12	0.58	1.84			0.26	2.02	0.59	
IRN/7/2021	0.31	1.94			0.50	1.78			0.22	1.95	0.48	2.46
PAK/2/2023	0.35	1.98	0.90	2.22	0.41	1.80	0.36	2.00	0.36	2.01	0.35	2.48
PAK/12/2021	0.25	2.06	0.78	2.34	0.81	1.87	0.25	1.95	0.32	2.19	0.42	2.53
UAE/1/2021	0.48	2.08	0.44	2.13	0.38	1.64	0.19	2.02	0.32	2.14	0.43	2.56
PAK/9/2021	0.19	1.94	0.30	1.92	0.45	1.61	0.15	1.72	0.32	2.19	0.47	2.58
PAK/9/2022	0.28	1.91	0.26	1.88	0.41	1.79	0.16	1.66	0.27	1.88	0.13	2.04
PAT/3/2022	0.52	1.90	0.59	2.02	0.65	1.82	0.29	1.79	0.27	1.93	0.51	2.43
PAT/2/2023	0.37	1.76	0.58	2.01	0.52	1.62	0.30	1.76	0.15	1.68	0.34	2.26
ISR/2/2023	0.32	1.85	0.47	1.84	0.38	1.74	0.26	1.75	0.28	1.80	0.45	2.40
ISR/12/2022	0.38	1.89	0.43	1.81	0.32	1.66	0.24	1.72	0.34	1.90	0.59	2.52
PAT/1/2021	0.40	2.01	0.72	2.31	0.53	1.78	0.29	2.01	0.53	2.15	0.36	2.46
ISR/9/2022	0.33	1.97	0.54	2.16	0.57	1.76	0.25	1.92	0.39	2.18	0.58	2.51
ISR/5/2022	0.33	1.97	0.57	2.18	0.48	1.69	0.18	1.78	0.32	2.09	0.42	2.37
PAT/1/2022	0.50	2.10	0.60	2.23	0.56	1.79	0.26	1.95	0.64	2.23	0.51	2.61

Note: New O/ME-SA/PanAsia-2 designations are shown proposed by Jamal et al., (2025) Emergence of new sublineages of serotype O foot-and-mouth disease viruses circulating in Pakistan during 2012-2021. *Virology* **605:** 110455

A/ASIA/Iran-05: vaccine matching



Poor match of Turkish vaccines for FAR-11 viruses from Iran

ARRIAH – 50% match to isolates from Pakistan

- Reinforces the importance of good quality vaccines, booster regime with good coverage in target host populations

Further information……

- FMD reports and lab testing (https://www.wrlfmd.org/ref-lab-reports)
    - *Genotyping reports*, *Vaccine matching* and *Serotyping reports*
- Other data sources:
    - Quarterly WRLFMD/EuFMD report (https://www.wrlfmd.org/ref-lab-reports)
    - Annual report of the WOAH/FAO FMD Laboratory Network (http://foot-and-mouth.org/)
    - OpenFMD (www.openfmd.org) – sequences, genotyping, vaccine selection and surveillance

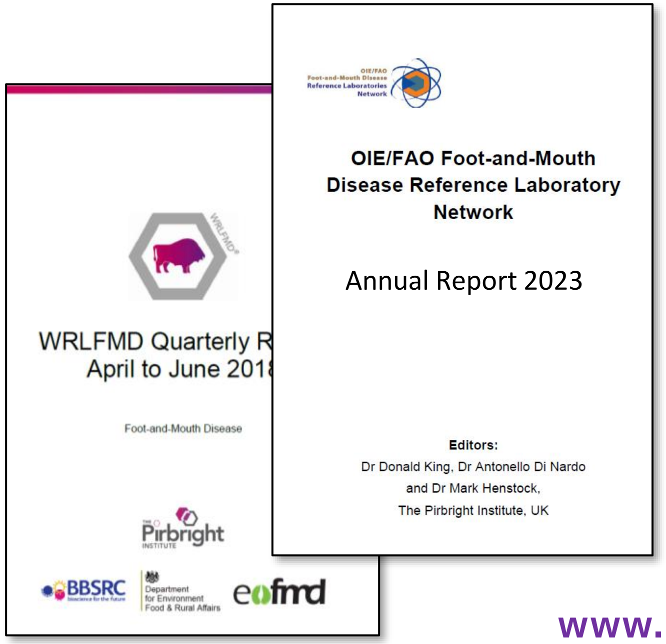
Welcome

The Pirbright Institute is designated as the *World Reference Laboratory for Foot-and-Mouth Disease* by the Food and Agriculture Organization (FAO) of the United Nations and as a reference laboratory for FMD by the Office International des Epizooties (OIE).

Country FMD Reports

Details of samples tested for FMD at WRLFMD from around the world.

Country Reports ›



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April to June 201

Foot-and-Mouth Disease

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

Annual Report 2023

Editors:
Dr Donald King, Dr Antonello Di Nardo
and Dr Mark Henstock,
The Pirbright Institute, UK

Thanks:

FAO FIAT PANIS

eufmd European Commission for the control of FMD

Department
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Food & Rural Affairs

- Collaborating FMD Reference Laboratories and field teams
- Partners within the WOAH/FAO FMD Lab Network
- Support for the WRLFMD and research projects


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