Boehringer Ingelheim

Q1 2023
Pool 3

WRL FMD Quarterly Report | OUR FOCUS

VPH VETERINARY PUBLIC HEALTH

Consult the latest report

The Foot-and-Mouth Disease Quarterly Report aims to summarize key global epidemiological events relating to Foot-and-Mouth Disease (FMD), as well as collate the laboratory testing work that has been undertaken by the World Reference Laboratory for FMD (WRLFMD) at Pirbright.

First quarter main epidemiological events

FMD outbreaks in:

- Iraq: SAT2/XIV (closely related to Ethiopia 2022 samples)
- Jordan: O/ME-SA/PanAsia-2^{ANT-10} & SAT2/XIV (closely related to Ethiopia 2022 samples)
- Türkiye: SAT2/XIV (closely related to Ethiopia 2022 samples)
- Indonesia: unspecified type
- Malaysia: O/ME-SA/PanAsia, Cattle
- Mongolia: unspecified type
- Iran: O/ME-SA/PanAsia-2^{ANT-10}
- Palestine: O/ME-SA/PanAsia-2^{ANT-10}
- Egypt: unspecified type
- Libya: O
- Comoros: SAT1
- Botswana: SAT1 & SAT2
- South Africa: SAT2 & SAT3

Sequence submissions from:

- Israel: O/ME-SA/PanAsia-2^{ANT-10}
- Palestine: O/ME-SA/PanAsia-2^{ANT-10}

Unexpected events:

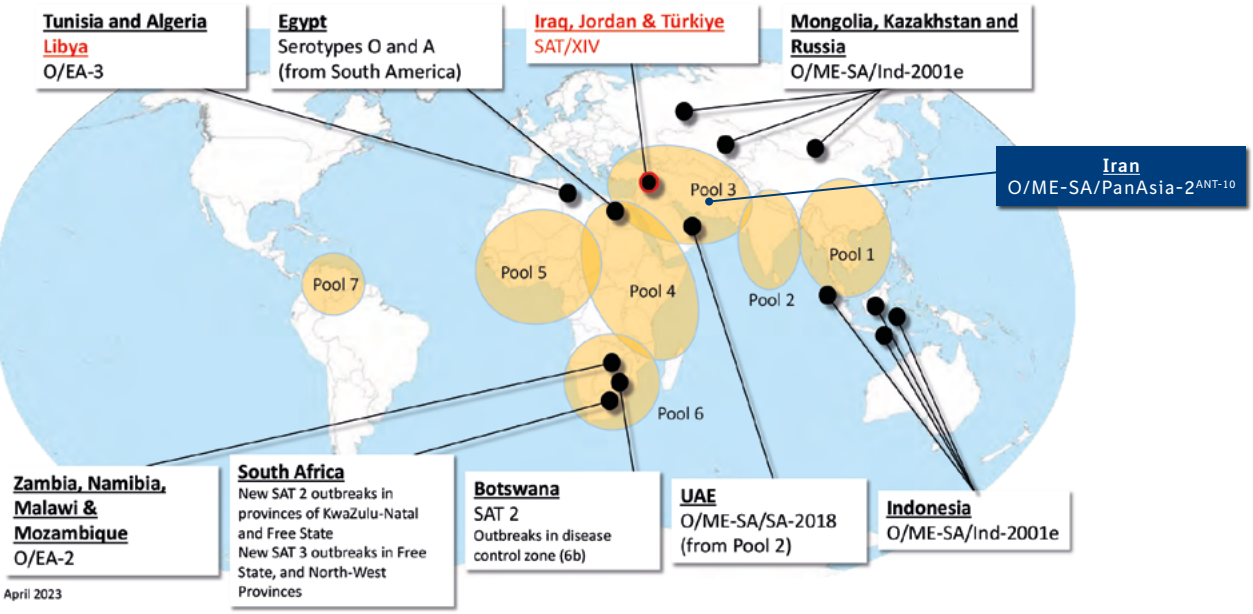
- SAT2/XIV outbreaks: higher-than-expected mortality levels in older animals

Dr Pascal HUDELET

VPH Expert input:

The last Quarterly report shows once again that the new FMD situation is characterized by increased incidence and uncertain epidemiology.
Over the past 12 months, we have witnessed the Indonesian outbreak (after more than 30 years of freedom), the incursion of South American O and A strains into Egypt, and the latest northern incursion of SAT2 viruses into the Middle East and at the European borders.
O/ME-SA/PanAsia is officially reappearing in Pool 1 (Malaysia), after 3 years of silence.
As I write these lines an FMD outbreak is being reported in Korea, after 4 years without any case.
Early detection and reporting remains the key to an efficient response to all these outbreaks, as well as sharing of samples in the reference lab network.

Epidemiology update - global view of the outbreaks reported from January to March 2023 in the endemic pools:



Recent FMD global outbreaks

Recent FMD outbreak added, based on WRL report narrative description

Source: WRL Foot-and-Mouth Disease Quarterly Report January to March 2023, page 4 to 10

EPIDEMIOLOGICAL UPDATES IN POOL 3

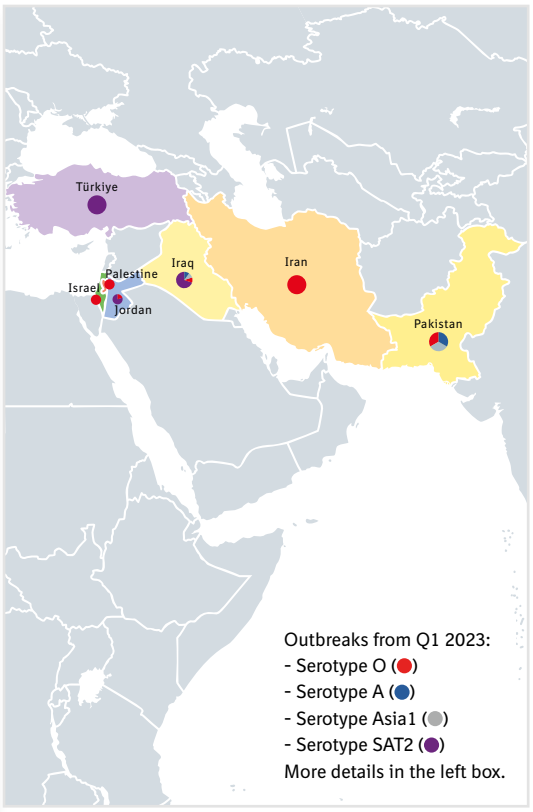
Latest updates in Pool 3

- Islamic Republic of Iran: 118 outbreaks O/ME-SA/PanAsia-2^{ANT-10}. No SAT2 have been identified.
- Republic of Iraq: 271 outbreaks were reported. 66 of them have been due to SAT2/XIV and remainder being caused by O, A and Asia1 serotype.
- Hashemite Kingdom of Jordan: SAT2/XIV FMD outbreaks were reported in January, February, and March from Mafraq and Zarqa governorates. 1st apparition of SAT2 in the country (sequenced by the Jordan University of Science and Technology – JUST). 10963 cases were identified, causing 379 deaths. O/ME-SA/PanAsia-2^{ANT-10} outbreaks was reported in February causing 2 deaths.
- Islamic Republic of Pakistan: 893 outbreaks were reported due to serotypes O, A and Asia1.
- Republic of Türkiye: 6 SAT2/XIV outbreaks (1st time in the country) in Agri, Erzurum, Iğdır, Kars, Van, Asagimahalle, Tuzluca provinces. Preventive SAT2 Eri 98 (BI) vaccination (from EU Bank) is occurring in Thrace region local SAP vaccine was made by SAP in 35 days (18 Million dose) for use since 9th March.

Received samples:

- Republic of Iraq: 5 SAT2 XIV VP1 sequences were submitted by the Ankara FMD Institute (FMDI – Türkiye) from Baghdad and Nineveh governorates. 10 SAT2 XIV samples were received from Babil, Baghdad, Erbil, Kirkuk, Najaf and Ninevah governorates.
- State of Israel: 1 VP1 received by Kimron Veterinary Institute (KVI) from Golan Heights, belonging to O/ME-SA/PanAsia-2^{ANT-10}.
- State of Palestine: 2 O VP1 sequences were received from West Bank: Bani Naim (Hebron) and Bethlehem. They belonged to O/ME-SA/PanAsia-2^{ANT-10}.

FMD outbreaks reported in Q1 2023, in Pool 3
Source: WRL Foot-and-Mouth Disease Quarterly Report Jan. - Mar. 2023, pages 7 - 10



Epidemiological risk evolution during Q1 2023:

Lineage	Southeast / Central / East Asia [Pool 1]	South Asia [Pool 2]	West Eurasia & Middle East [Pool 3]	North Africa	Eastern Africa [Pool 4]	West / Central Africa [Pool 5]	Southern Africa [Pool 6]	South America [Pool 7]
O ME-SA PanAsia-2			28					
O ME-SA PanAsia	10							
O SEA Mya-98	21.5							
O ME-SA Ind2001	40	86[1]	5.5	2				
O EA or O WA			2.5	55	55.5	65	16	
O EURO-SA								90
O CATHAY	10.5							
A ASIA Sea-97	18							
A ASIA Iran-05	0		25					
A ASIA G-VII		10	8					
A AFRICA				33	22	17		
A EURO-SA								10
Asia-1	0	4	11					
SAT 1				0	8	3	16	
SAT 2			20	10	14	15	52	
SAT 3					0.5		16	
C								

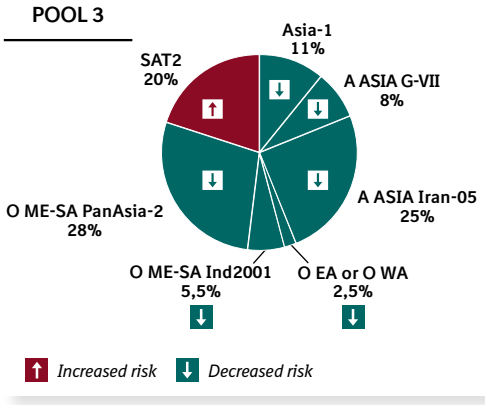
[1] Includes cases due to the emerging O/ME-SA/SA-18 lineage that has been recently detected in Pool 2.

Source: WRL Foot-and-Mouth Disease Quarterly Report Jan. - Mar. 2023, page 13

This table summarises expert discussions and assesses the risk of having certain types of viruses circulating in a given area.

Data:

- are reviewed every year at the annual meeting of the FMD Lab Network
- include latest information from partner labs + a wider perspective to consider missing information from these surveillance activities.



Dr Nicolas DENORMANDIE

During this quarter the main concerns for Pool 3 are for the incursion of SAT2/XIV:

For SAT2/XIV occurring for the first time in Iraq, Jordan and Türkiye, clinical disease in large ruminants appears to be severe, with higher than expected mortality levels in older animals being reported.

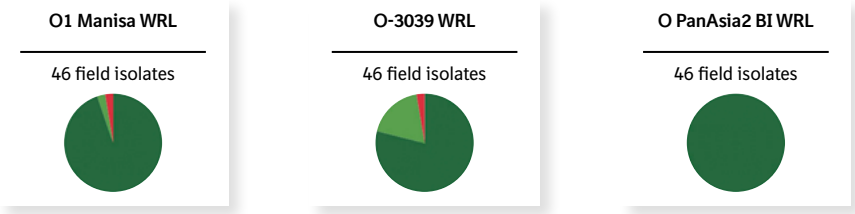
There is a risk for rapid onward spread to other countries in the region and to the FMD-free buffer zone in Thrace via East-to-West virus conveyers, as per what have been described for other lineages (e.g. A/ASIA/G-VII in 2015 but also O/ME-SA/PanAsia2, A/ASIA/Iran-05, and Asia1).

VACCINE MATCHING : OUR VACCINES ARE EFFICIENT IN THIS EPIDEMIOLOGICAL SITUATION

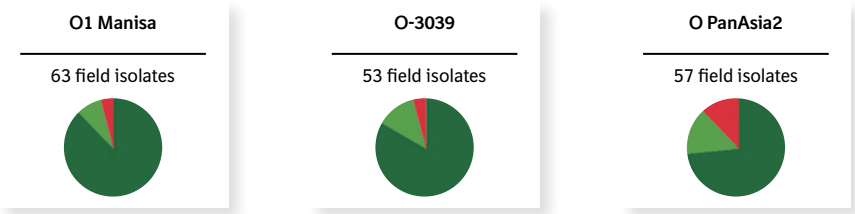
1 Boehringer Ingelheim FMD vaccines are efficient against Serotype O circulating strains.

Field isolates since 2020 in Pools 2, 3 and 4 are covered by O Manisa , O-3039 and O PanAsia2
(Based on Heterologous Titers from WRL and BI Laboratories)

DATA FROM



DATA FROM Boehringer Ingelheim



High heterologous titre *Good heterologous titre* *Poor heterologous titre*

Source: WRL FMD Quarterly Reports & Boehringer Ingelheim's laboratory data since 2020

After analysis of all the WRL FMD Quarterly Reports and Boehringer Ingelheim's laboratory data since January 2020, Boehringer Ingelheim vaccine strains are mostly eliciting **high and good heterologous titres** (dark & light green) against recently circulating field isolates.

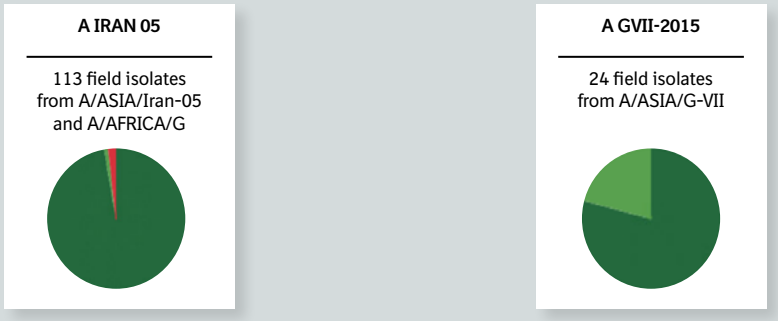
NB: Heterologous titres are indicators of cross-protection.

2 Boehringer Ingelheim FMD vaccines are efficient against Serotype A circulating strains.

Cumulative data since 2012:
Heterologous VNT titres from field isolates from Pools 3 & 4

Cumulative data since 2015:
Heterologous VNT titres from field isolates from Pool 3

DATA FROM Boehringer Ingelheim



High heterologous titre *Good heterologous titre* *Poor heterologous titre*

Source: Boehringer Ingelheim's laboratory data since 2012 and 2015 respectively

Boehringer Ingelheim A Iran 05, A/AFRICA/G and A GVII-2015 vaccines are eliciting high and good Heterologous titres (dark and light green) against recently circulating field isolates, respectively A/ASIA/Iran-05 and A/ASIA/G-VII lineages in more than 95% in both cases.

3 Boehringer Ingelheim SAT2 Eri 98 vaccine strain is efficient against SAT2 recent circulating strains

Heterologous VNT titres from field isolates from Pools 3,4,5 and 6

DATA FROM

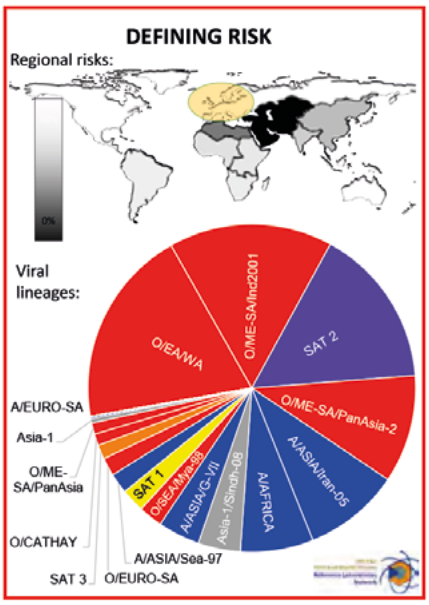
DATA FROM Boehringer Ingelheim

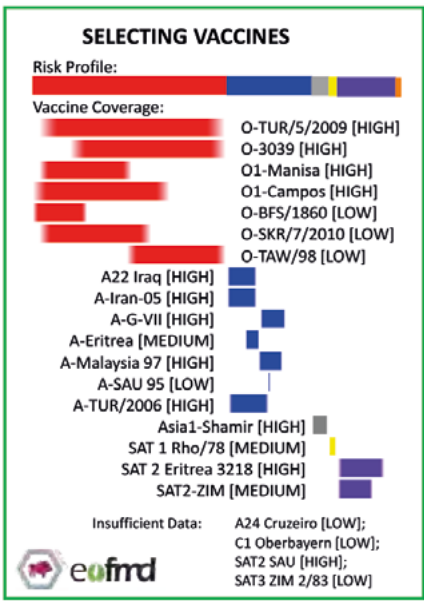
High heterologous titre *Good heterologous titre* *Poor heterologous titre*

Source: WRL FMD Quarterly Reports & Boehringer Ingelheim's laboratory data since 2012

Boehringer Ingelheim SAT2 ERI 98 vaccines are eliciting mostly high and good Heterologous titres (dark and light green) against recently circulating field isolates.

ALL BOEHRINGER INGELHEIM FMD VACCINES ARE PRODUCED WITH ANTIGENS WHICH ARE LISTED AS HIGH PRIORITY BY WRL.





NB: Analyses uses best available data, however there are gaps in surveillance and vaccine coverage data

Source: WRL Foot-and-Mouth Disease Quarterly Report Jan. - Mar. 2023, page 32

The diagram on the left shows the risk mapping for Europe based on WRL expert discussions.
The diagram on the right shows the level of coverage of the different vaccine strains with the theoretical spectrum of protection.

All Boehringer Ingelheim FMD vaccines are produced with antigens which are listed as high priority by WRL.

THE WINNING COMPLEMENTARY ATTRIBUTES OF A GOOD FMD VACCINE

STRONG EFFICACY + **HIGH SAFETY**

Appropriate strains
WRL high priority antigens
Able to protect against circulating strains

Synergistic effect of 2 O strains
For the best protection against circulating strains

High potency
Broad and durable protection

Purity of the antigen
Unique purification technology by chromatography

Aqueous formulation adjuvanted with Aluminium Hydroxide and Purified Saponin
Less local and general reactions
No drop of milk production

Vaccines produced under European Union Good Manufacturing Practices (EU-GMP)

Technical support
Post Vaccination Monitoring
Field trials
Good Vaccination Practices Guidelines

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