SEACFMD Laboratory Network Meeting

Research on SAT1 FMD Prevention and Control in China

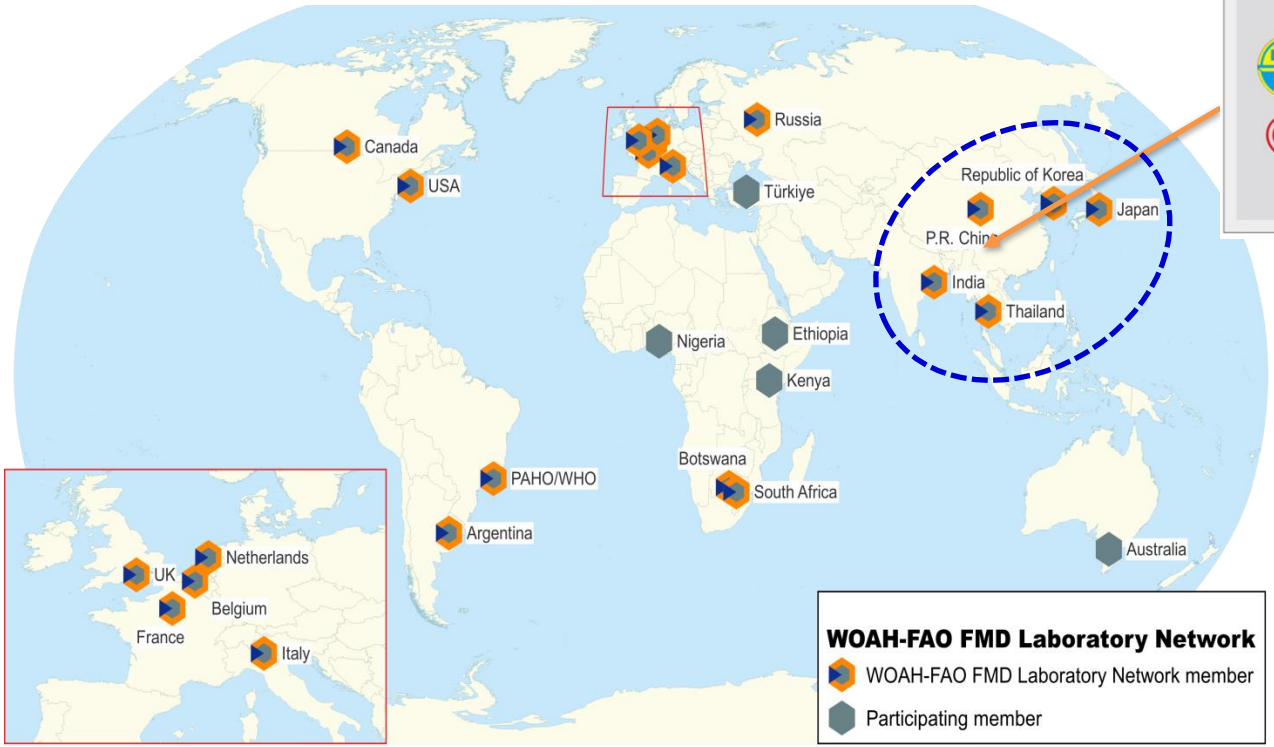
Zixiang Zhu

National/WOAH Reference Laboratory for FMD

Lanzhou Veterinary Research Institute, CAAS

Manila, Philippines 2026-11

WOAH/FAO FMD Reference Laboratory Network



中国农业科学院兰州兽医研究所
Lanzhou Veterinary Research Institute,Chinese Academy of Agricultural Sciences
WOAH口蹄疫参考实验室
World Organisation for Animal Health
Reference Laboratory for Foot and Mouth Disease



Our Ref.: KM/SL 35.921 — 14 June 2011

Dr Zhang Zhongqiu
Deputy Director General
Ministry of Agriculture
Veterinary Bureau
No.11, Nongzhan Nanli Chaoyang District
100125, Beijing
CHINA (PEOPLE'S REP. OF)

Dear Dr Zhongqiu

Application for designation of OIE Reference Laboratories for Foot and mouth disease, Equine infectious anaemia, White spot syndrome, Infectious hypodermal and haematopoietic necrosis and Spring viraemia of carp

I am pleased to advise you that during its recent annual General Session in Paris, the World Assembly of Delegates of the OIE confirmed the designation of the Lanzhou Veterinary Research Institute of the Chinese Academy of Agricultural Sciences as a new OIE Reference Laboratory for Foot and mouth disease, with Dr Xiangtao Liu as the OIE designated Expert, and also of the Harbin Veterinary Research Institute (HVRI) of the Chinese Academy of Agricultural Sciences as a new OIE Reference Laboratory for Equine infectious anaemia, with Dr Jianhua Zhou as the OIE designated Expert.

Regarding applications for aquatic animal diseases, the Assembly confirmed the designation of the Yellow Sea Fisheries Research Institute (YSFRI), Chinese Academy of Fishery Sciences (CAFS), as two new OIE Reference Laboratories for White spot syndrome and Infectious hypodermal and haematopoietic necrosis, with Dr Jie Huang as the OIE designated Expert, and of the Reference Laboratory of Aquatic Animal Diseases, Shenzhen Exit & Entry Inspection and Quarantine Bureau of China as a new OIE Reference Laboratory for Spring viraemia of carp with Dr Hong Liu as the OIE designated Expert.

Thank you for your willingness to co-operate with the OIE and its Members, and I look forward to working with Drs Xiangtao Liu, Zhou, Huang and Hong Liu in the future.

With best regards,

Yours sincerely

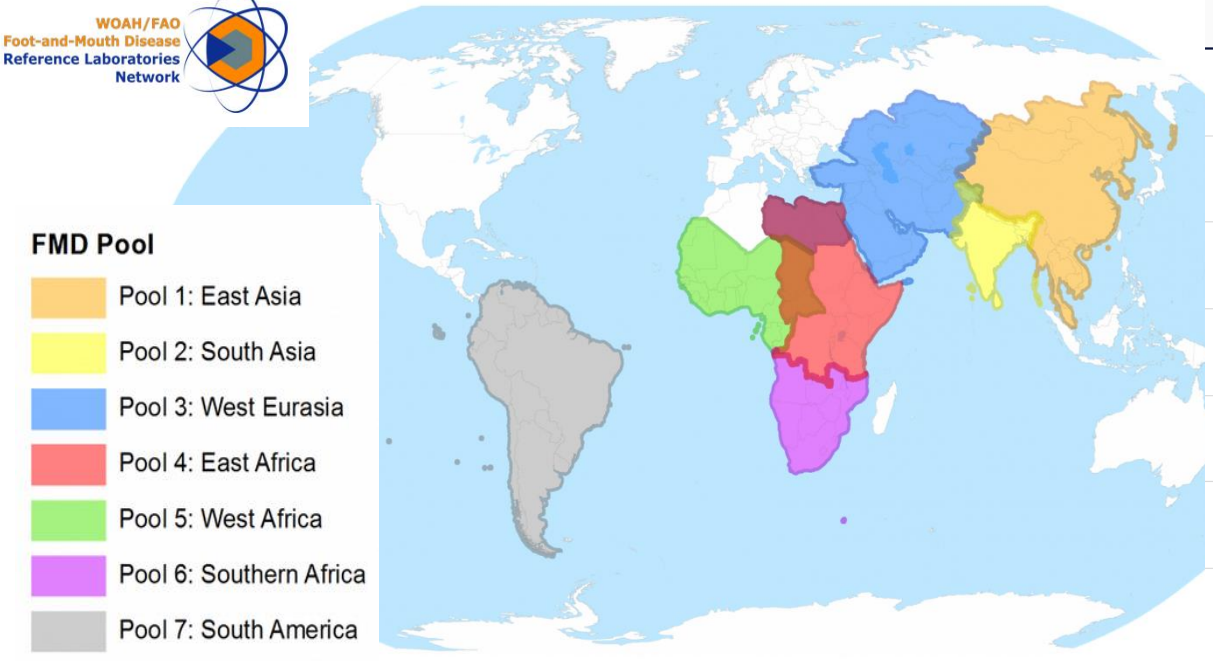
Dr Bernard Vallat
Director General

cc: Dr Xiangtao Liu, Dr Jianhua Zhou, Dr Jie Huang, Dr Hong Liu

- **17 WOAH/FAO FMD Reference Laboratories.**
- **5 FMDRL labs in Asia and Pacific region: China, Thailand, India, Korea and Japan.**
- **LVRI was recognized as OIE FMDRL in 2011.**

The distribution of epidemic strains across the seven serotypes of FMDV has undergone significant changes

WOAH/FAO
Foot-and-Mouth Disease
Reference Laboratories
Network



Pool	Serotypes present
1	O, A, Asia-1
2	O, A, Asia-1
3	O, A, Asia-1 , SAT1
4	O, A, SAT 1, SAT 2, SAT 3
5	O, A, SAT 1, SAT 2
6	SAT 1, SAT 2, SAT 3
7	O, A , SAT1

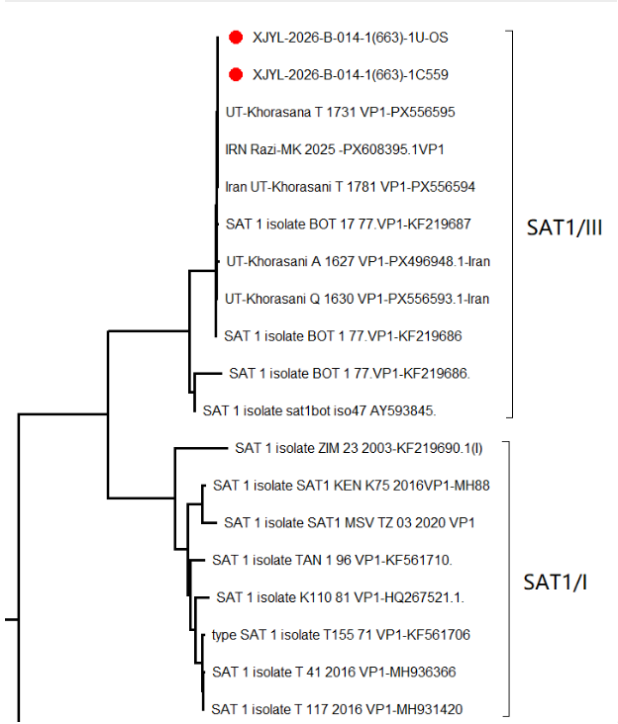
First detection of FMD serotype SAT1 in cattle in March, 2026, China

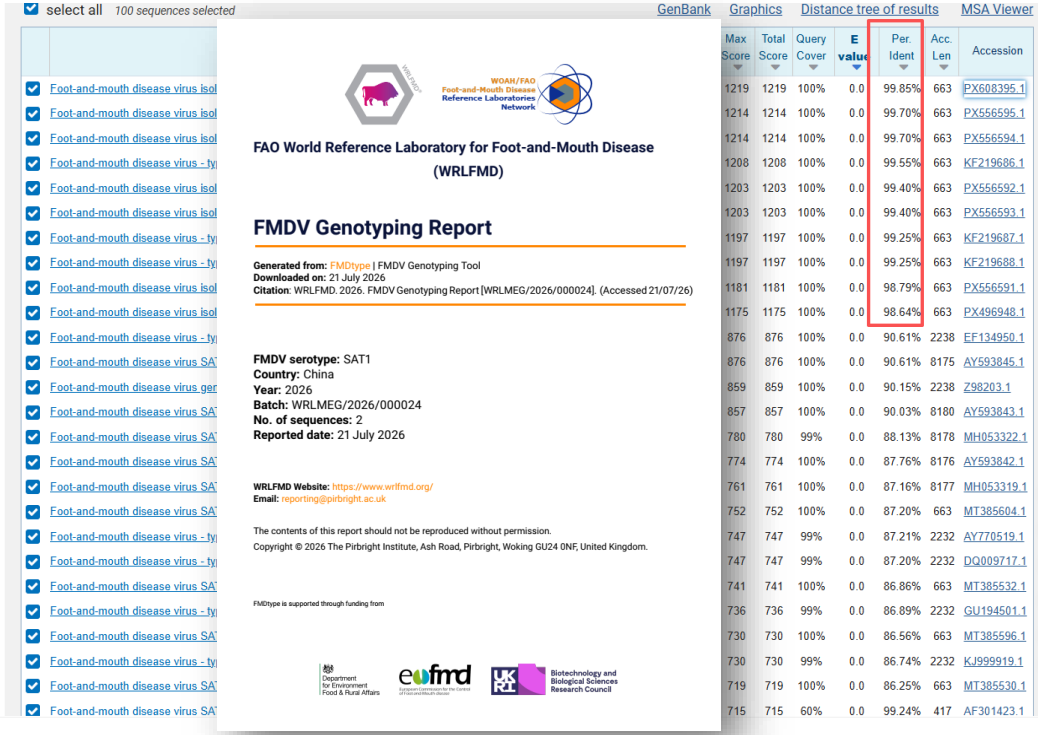






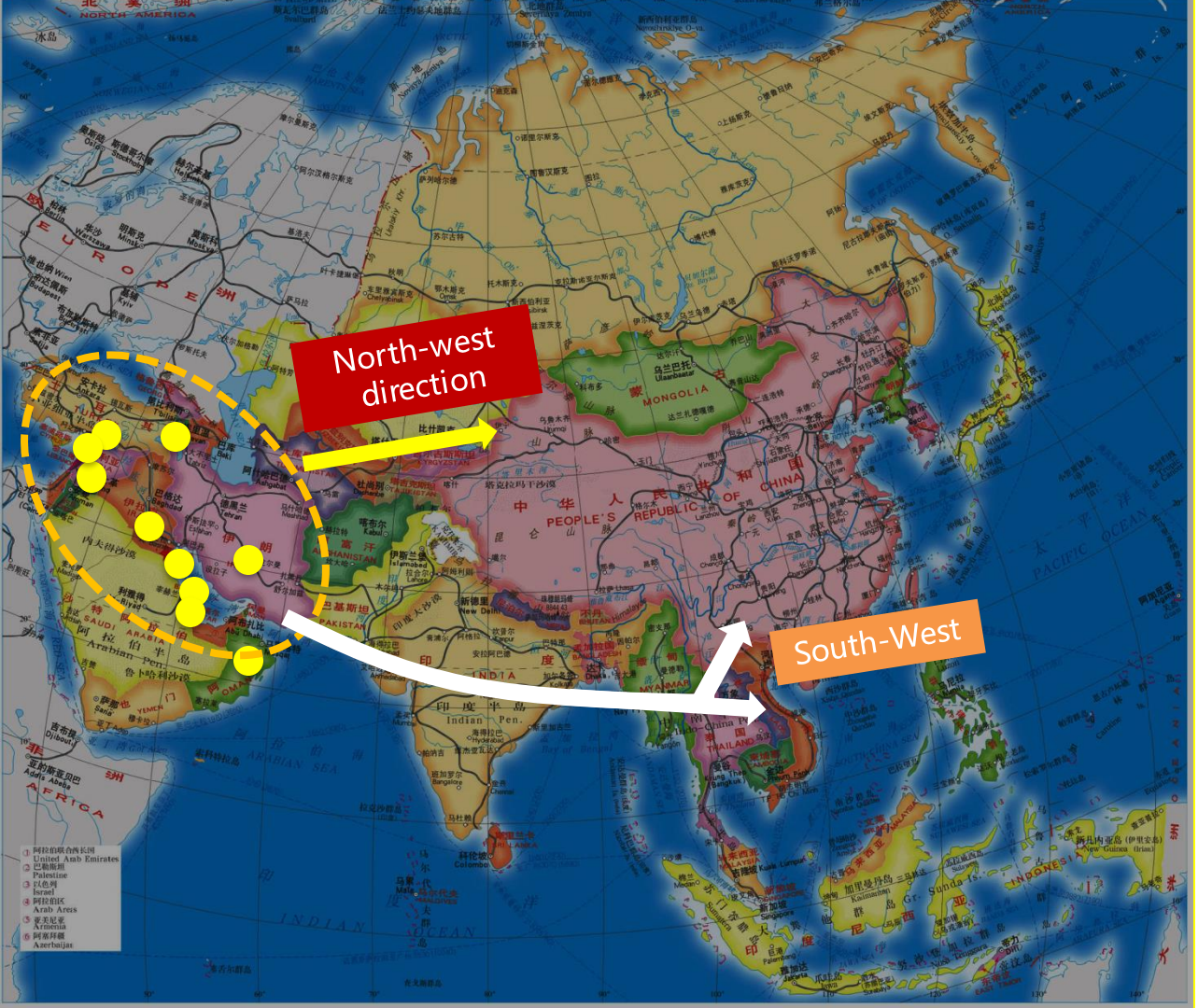
SAT1 FMDV molecular tracing with Pribright laboratory, UK





Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession
1219	1219	100%	0.0	99.85%	663	PX608395.1
1214	1214	100%	0.0	99.70%	663	PX556595.1
1214	1214	100%	0.0	99.70%	663	PX556594.1
1208	1208	100%	0.0	99.55%	663	KF219686.1
1203	1203	100%	0.0	99.40%	663	PX556592.1
1203	1203	100%	0.0	99.40%	663	PX556593.1
1197	1197	100%	0.0	99.25%	663	KF219687.1
1197	1197	100%	0.0	99.25%	663	KF219688.1
1181	1181	100%	0.0	98.79%	663	PX556591.1
1175	1175	100%	0.0	98.64%	663	PX496948.1
876	876	100%	0.0	90.61%	2238	EF134950.1
876	876	100%	0.0	90.61%	8175	AY593845.1
859	859	100%	0.0	90.15%	2238	Z98203.1
857	857	100%	0.0	90.03%	8180	AY593843.1
780	780	99%	0.0	88.13%	8178	MH053322.1
774	774	100%	0.0	87.76%	8176	AY593842.1
761	761	100%	0.0	87.16%	8177	MH053319.1
752	752	100%	0.0	87.20%	663	MT385604.1
747	747	99%	0.0	87.21%	2232	AY770519.1
747	747	99%	0.0	87.20%	2232	DQ009717.1
741	741	100%	0.0	86.86%	663	MT385532.1
736	736	99%	0.0	86.89%	2232	GU194501.1
730	730	100%	0.0	86.56%	663	MT385596.1
730	730	99%	0.0	86.74%	2232	KJ999919.1
719	719	100%	0.0	86.25%	663	MT385530.1
715	715	60%	0.0	99.24%	417	AF301423.1

> 99% identical to the SAT1 lineages circulating in Iran in 2025, and BOT/77



Historic TADs

year	disease	location
2009	FMD A	Hubei
2010	FMD O	Guang dong
2013	FMD A	Guang dong
2013	PPR	Xinjiang
2017	FMD O	Xinjiang
2019	LSD	Xinjiang
2026	SAT1	Xinjiang

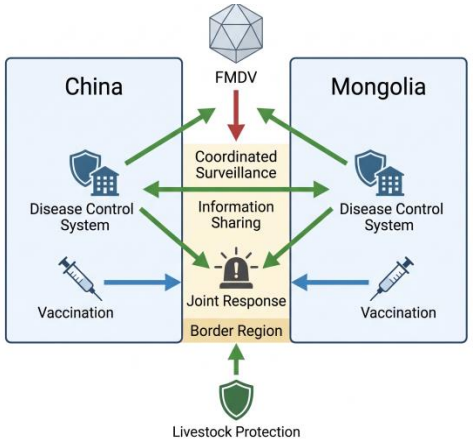
The value of tracing viral origins lies not in reconstructing the past, but in sharpening surveillance targets for the future.

Historically, SAT1 was confined to Africa. Since 2025, Iraq, Kuwait, Türkiye, Egypt and Azerbaijan have reported it for the first time; in 2025–2026, it was detected in Lebanon, Israel, Cyprus and Greece; in March 2026 in China and in May 2026 in Mongolia.

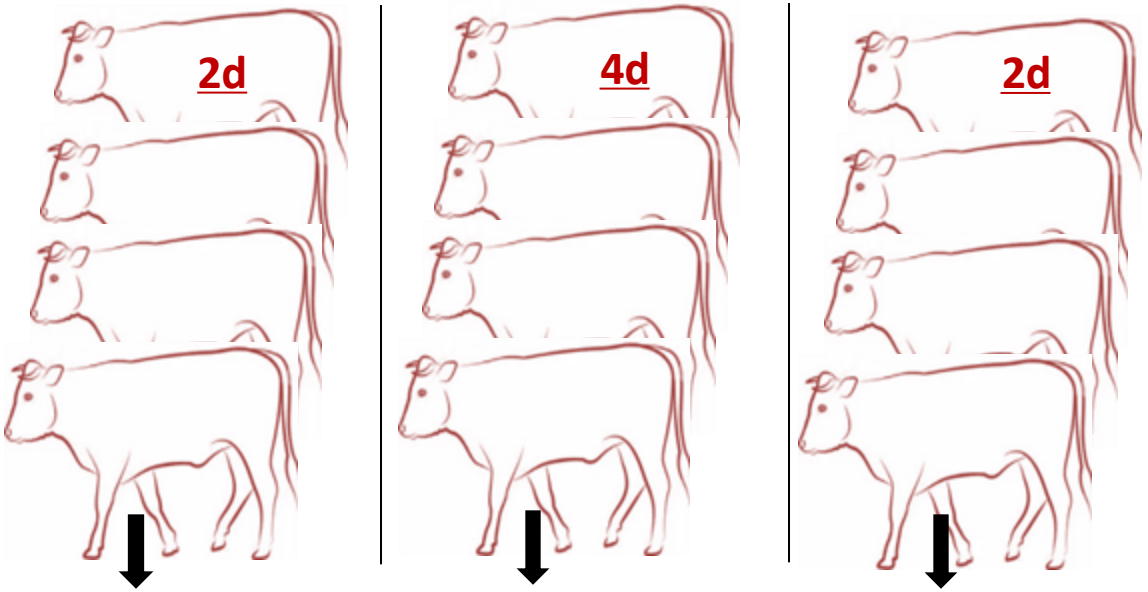
The inferred introduction route, "Middle East → Central Asia → northwestern China," identifies SAT1/III as a priority target for border surveillance.

The May 2026 outbreak in Mongolia may share a transmission chain with outbreaks in China, providing a scientific basis for joint China–Mongolia surveillance.

Local viral strains provide reference materials for validating diagnostic assay specificity.



Study on Pathogenicity of SAT1/III isolate: highly pathogenic



10^{-6}组，4/4+　　10^{-7}组，4/4+　　10^{-8}组，4/4+

year	strain	ID_{50}
2005	Asia1	6.5
2009	A	6.5-7.0
2010	O Mya-98	6.0
2017	O Ind-2001	8.0-8.5
2026	SAT1	> 8.5

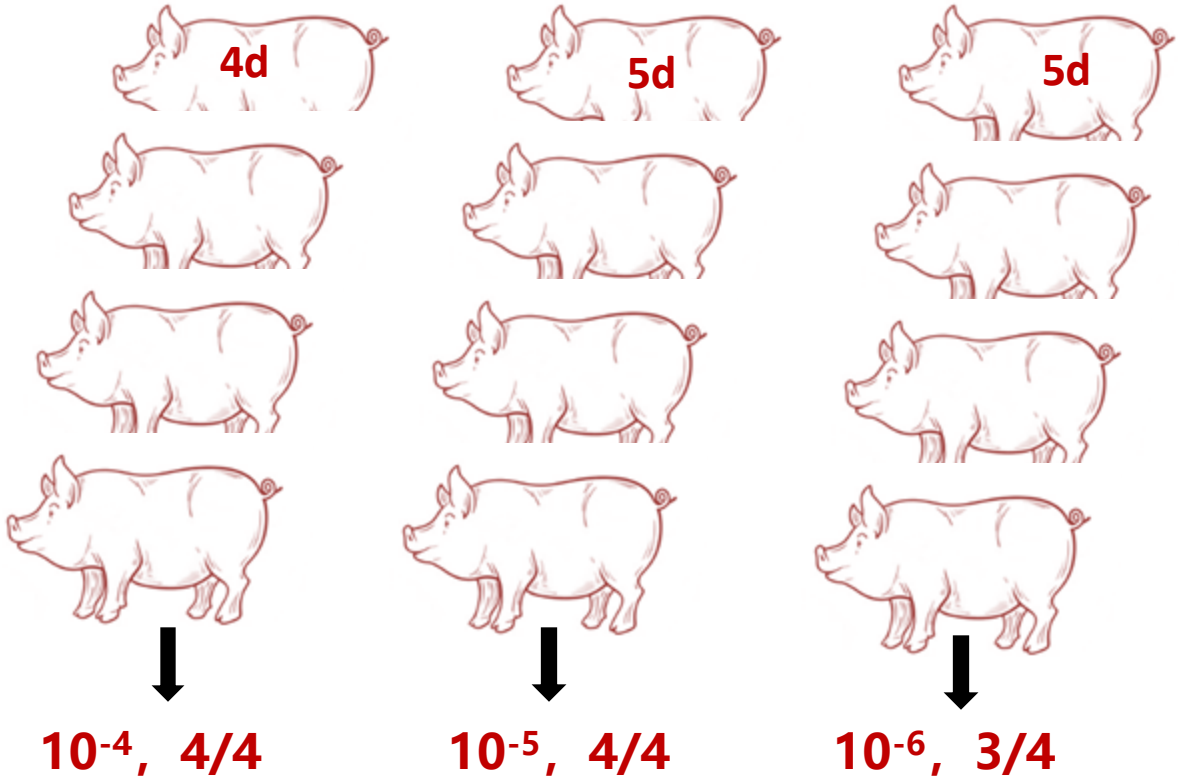
In cattle, the BID_{50} is more than 8.5

In conclusion, SAT1/III is highly pathogenic

Pathogenicity study in cattle

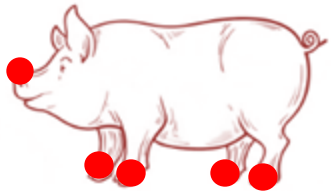
Capable of contact transmission

Pathogenicity study in pigs, SID_{50} =6.5



Capable of contact transmission

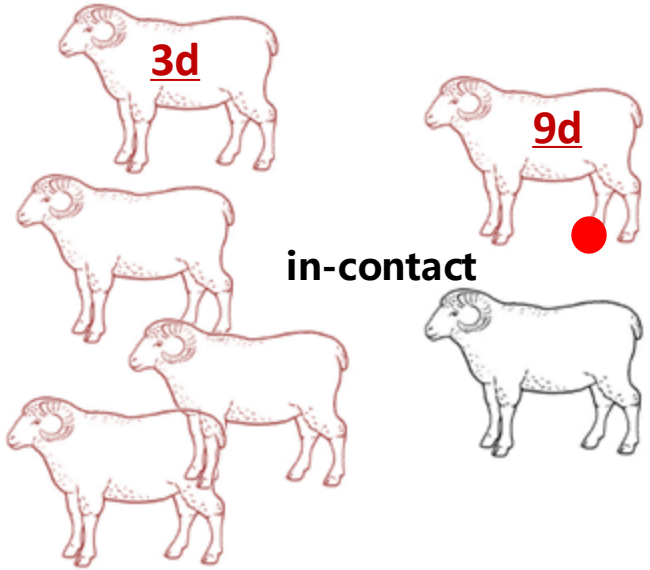
- serious clinical signs
- Heavy injury in feet



SID_{50}:
2005 Type Asia1 3.5
2009 Type A (Wuhan 09) non-pathogenic
2013 Type A 6.0
2010 Type O (Mya-98) 5.0
O/CATHAY strain 4.5-5.0
2017 Ind-2001 strain 4.5

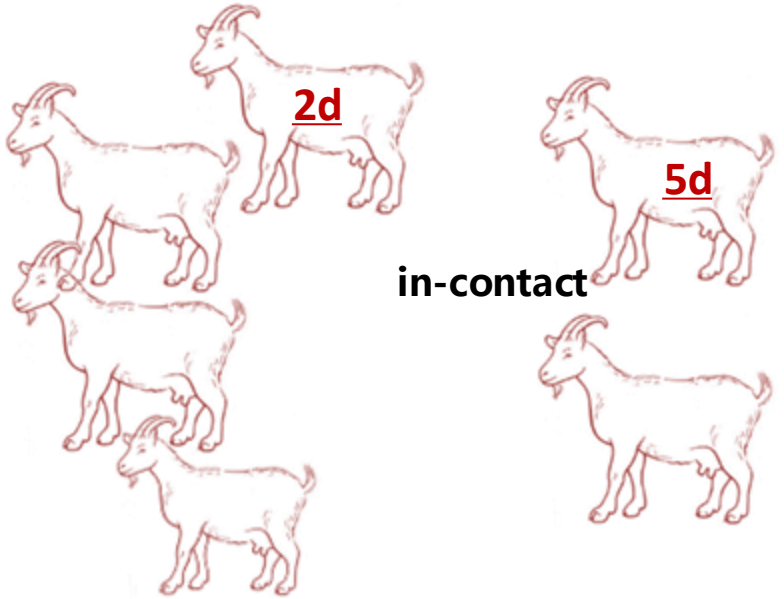
国家口蹄疫参考实验室

Pathogenicity study in sheep/goat



Intradermal injection group: 4/4 developed disease
In-contact group: 1/2 developed disease
(onset began on day 9, 1 hoof affected)

Capable of contact transmission



Goat is more susceptible to SAT1 than sheep.

Intradermal injection group: 4/4 developed disease
(onset began on day 2)
In-contact group: 2/2 developed disease
(onset began on day 5)

国家口蹄疫参考实验室

Pathogenicity test on sows and piglets (7 days old)

animal	no.	lesion	nose	foot	dpi	death
Sow	1	1	1	1	2	0
piglets	13	13	9	13	3-5	5

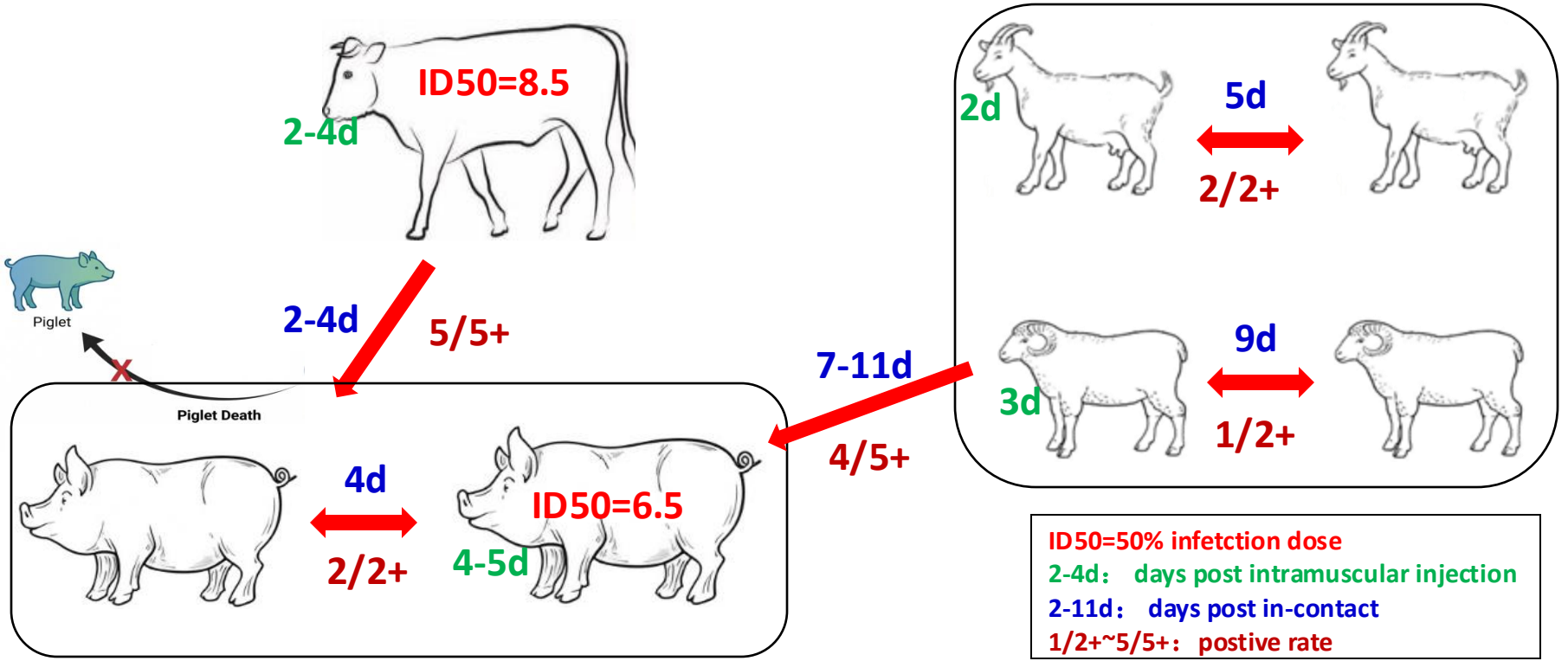






On the second day after the sows became infected and developed disease, the suckling piglets became infected. The morbidity rate in piglets was 13/13, and the mortality rate was 5/13 (38.4%).

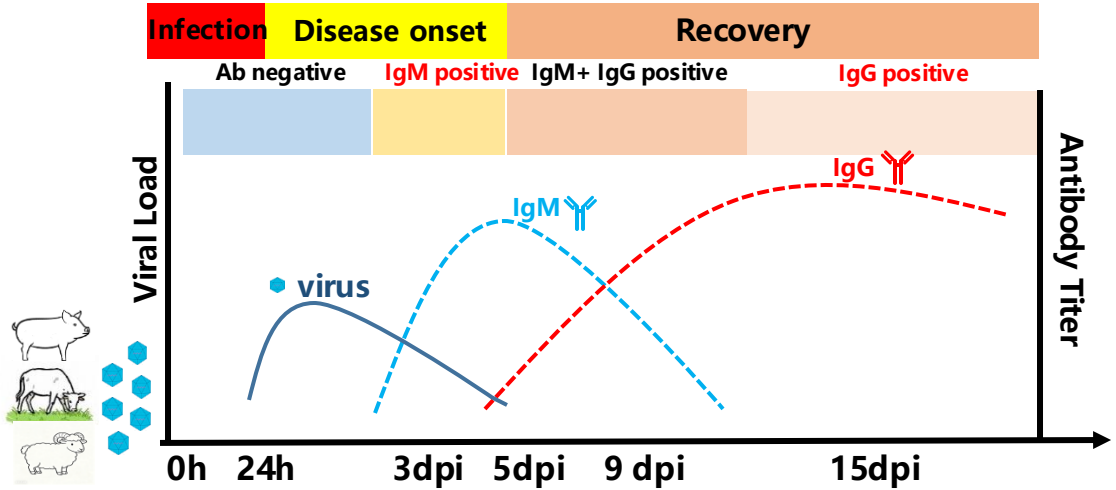
Conclusion on SAT1/III pathogenesis



ID50=50% infetction dose
2-4d： days post intramuscular injection
2-11d： days post in-contact
1/2+~5/5+： postive rate

Culling alone cannot block within-herd transmission; rapid immunity belts and sheep vaccination coverage are essential.

Dynamic cross-curves of viral load and antibody levels under natural infection



Viremia: appeared at 24 hpi and persisted until approximately 5 days.

Structural protein Abs: IgM is an early antibody (~3–15 d), while IgG is a later antibody (~7 d onward).

NSP Abs: Response occurs 5-7 dpi; long-term detectability makes it the **primary diagnostic basis**.

Natural infection involves a dynamic host-virus interplay, with viral load and antibody changes determining the outcome.

(Rodríguez et al. (*Vaccines, 2020*) and data from the National FMD Reference Laboratory)

Rapidly develop and upgrade relevant diagnostic products

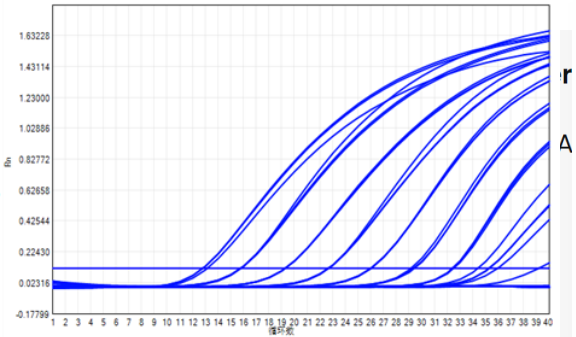
Development of a QPCR detection kit for FMDV SAT1

Lineage specific FMDV Real-time RT-PCR assays

Different real-time RT-PCR assays that have been designed to detect different *Foot-and-mouth disease virus* lineages in different parts of the world.

Each leaflet describes an assay for particular FMDV lineages expected to be circulating in a geographical location. A summary of all these real-time RT-PCR assays, including SAT 1 assays, can be found on this page.

Lineage specific FMDV Real-time RT-PCR assays ›



The lower limit of detection=3 copies/μl



Serotype SAT 1

- SAT1/I (Türkiye (2025), Kenya (2022) and Egypt (2025))
- SAT1/I(NWZ) (Kenya (2020))
- SAT1/III(WZ) (Botswana (2015))
- SAT1/VII (Uganda (2023))

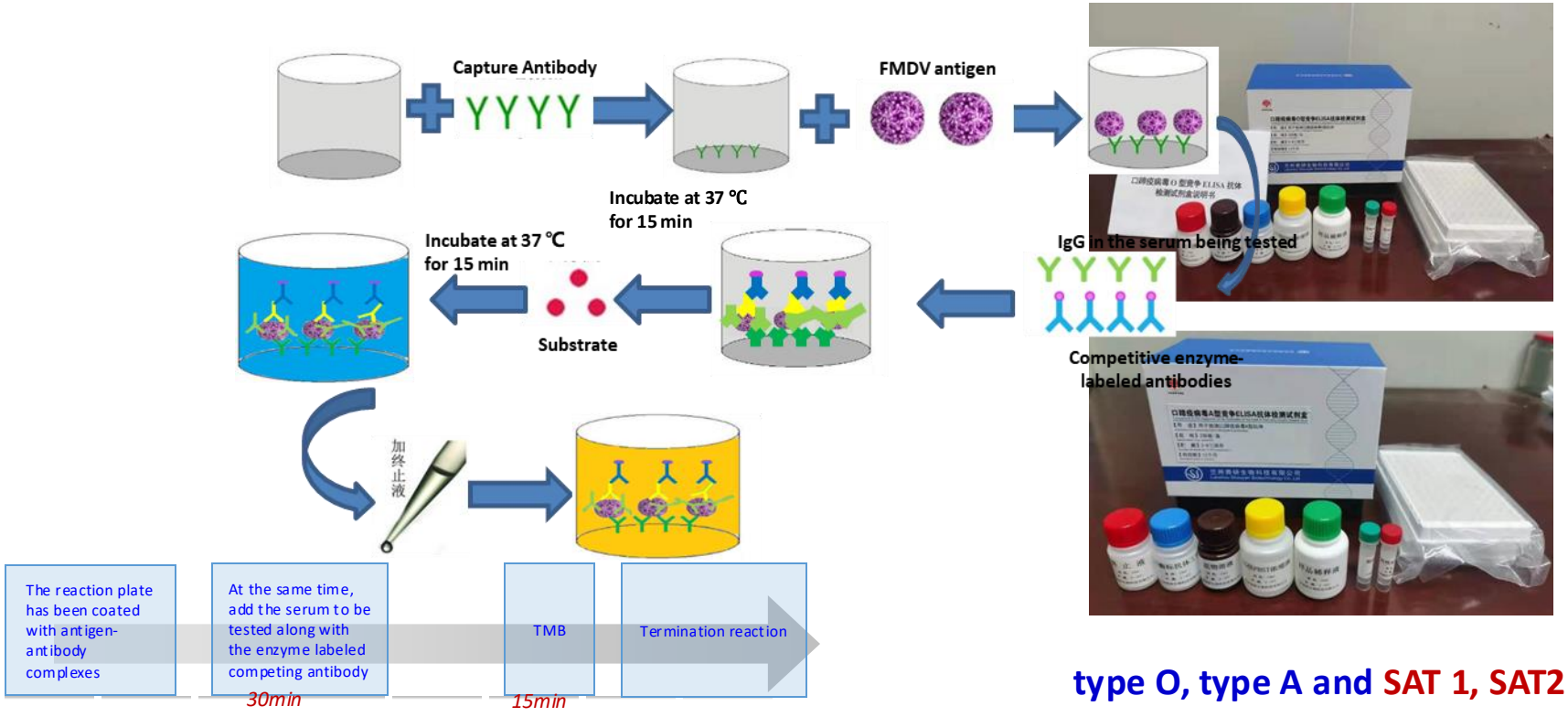
Serotype SAT 2

- SAT2/IV (Kenya (2025))
- SAT2/V (Algeria (2023))
- SAT2/XIV (Türkiye (2025))

WOAH/FAO Foot-and-Mouth Disease Reference Laboratories Network

Network recommended → **Validation and optimization** → **Commercialization and marketing**

Development of bloking and competitive ELISA for FMDV SAT1 antibodies detection

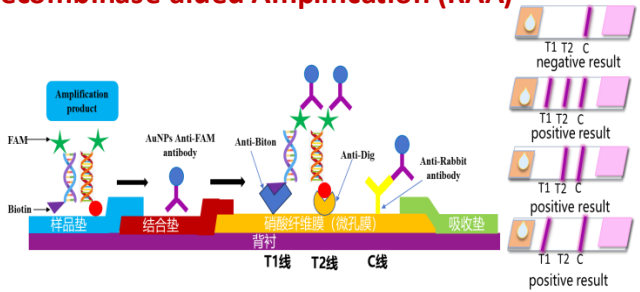


type O, type A and SAT 1, SAT2

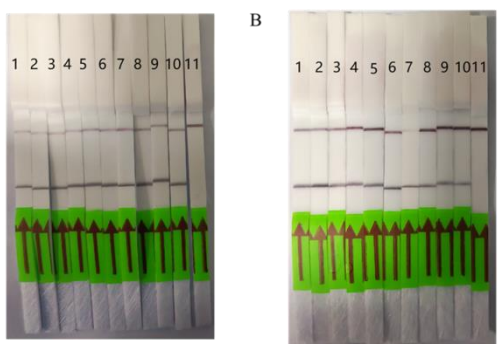
Test completes within 45 minutes

Development of an RAA-Based Rapid Field Detection Kit for SAT1 FMDV

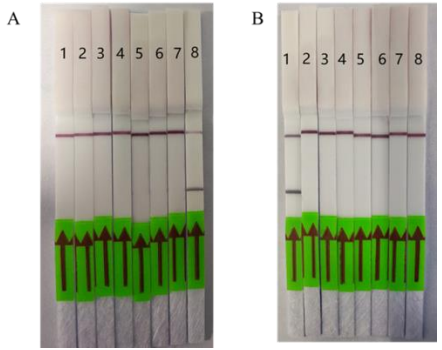
Recombinase-aided Amplification (RAA)



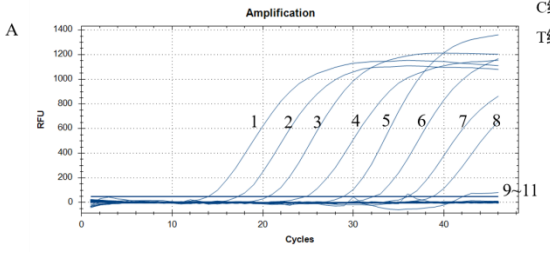
Primer design and labeled group selection
Result readout: lateral flow strip or fluorescent signal



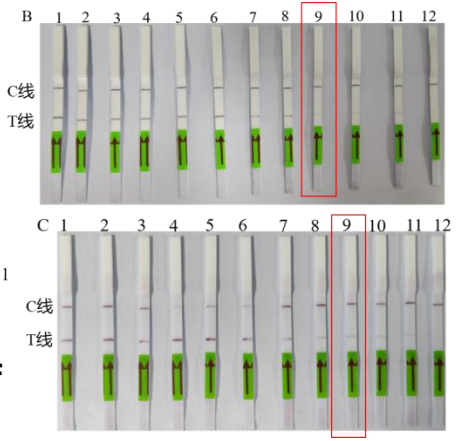
Strip sensitivity analysis



Strip specificity analysis



Fluorescence-based detection of standards

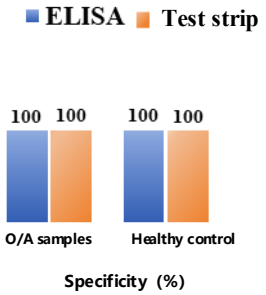


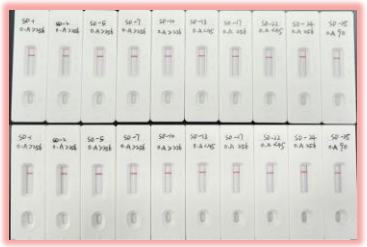
- The sensitivity reached 54.2 copies/μL, with a detectable RNA concentration of 1.2 fg/μL.
- No cross-reactivity with other FMDV serotypes was observed, indicating good specificity.
- Suitable for on-site testing in local settings.

Portable detection method (lateral flow strip)



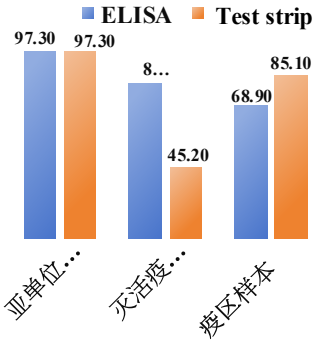
Sample background		Specificity (%)	
		Bloking ELISA	Test strip
SAT1-seronegative serum samples (107)	Sera from cattle immunized with the O/A vaccine (67)	100 (0/67)	100 (0/67)
	Sera from healthy cattle and sheep (40)	100 (0/40)	100 (0/40)
合计		100 (0/107)	100 (0/107)





No cross-reactivity with antibodies against other serotypes

Sample background		Positive rate (%)	
		Bloking ELISA	Test strip
Immunized serum (79)	Subunit vaccine prime + inactivated vaccine boost (37)	97.3 (36/37)	97.3 (36/37)
	7 d post-prime with inactivated vaccine (42)	83.3 (35/42)	45.2 (19/42)
Samples from epidemic areas (74)	Cattle and sheep sera (74)	68.9 (51/74)	85.1 (63/74)

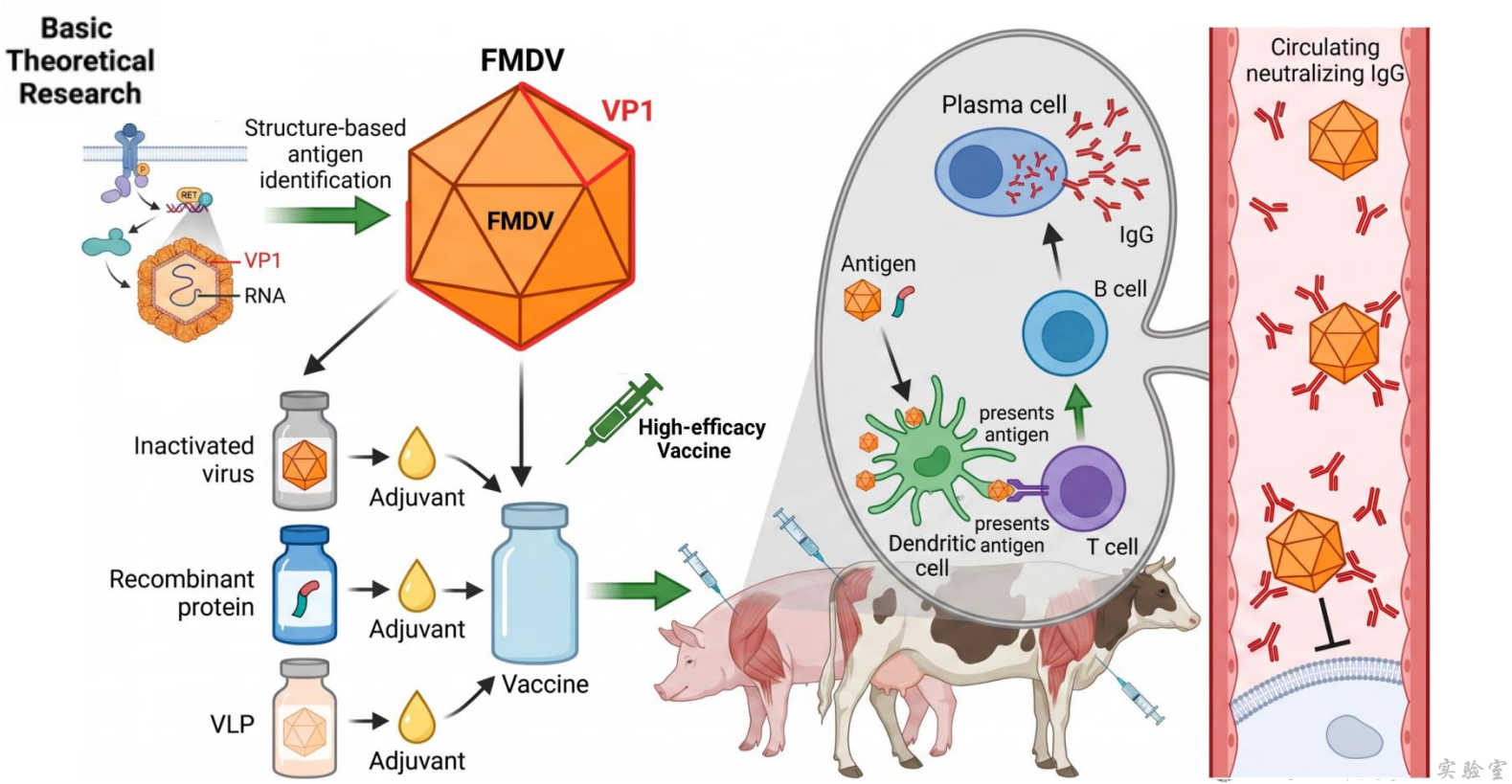




High sensitivity for SAT1 antibody detection

This broadens the applicability of SAT1 antibody detection.

The design and development of highly efficacious FMD vaccines have been guided by the basic theoretical research

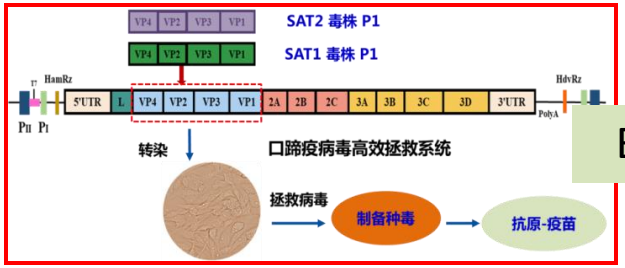


实验室

R&D FMD SAT1 vaccines for emergency vaccination

Reserve strategy on FMD prevention and control under monitoring and early warning

monitoring and early warning



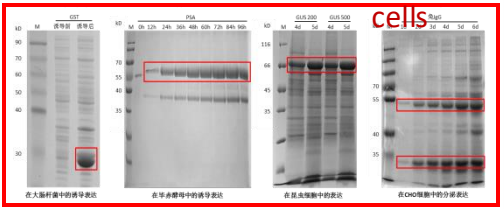
Bench

Basic research (Antigenic epitopes)

Virus Rescue System (Reverse genetics technology)

E. Coli Yeast

Mammalian cells



Insect cell

In vitro antigen expression system with High-efficiency

Purification process

Industrialized production

Purification process





Subunit vaccine

Inactivated vaccine

Market

FMD SAT1 vaccines in China



- Inactivated vaccine（Re-SAT1/2026）
- Subunit vaccine
- Trivalant vaccines
- Inactivated vaccine（field isolates）
- VLPs
- ……

10 producers of FMD Vaccines in China

Inner Mongolia Biwei Antai Biological Technology Co., Ltd

Jinyu Baoling Bio-pharmaceutical Co., Ltd

Xinjiang Tecon Animal Husbandry Bio-technology Co., Ltd

China Agricultural Veterinarian Biology Science and Technology Co. Ltd

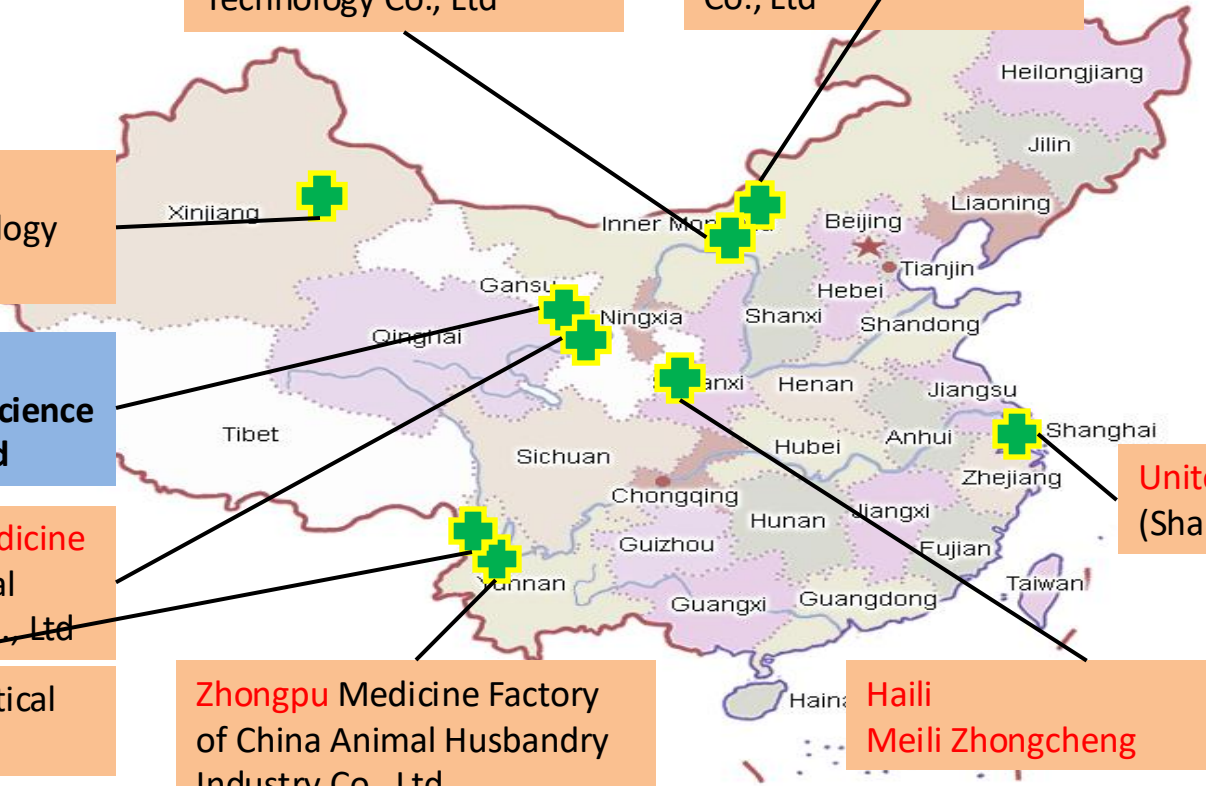
Lanzhou Biological Medicine Factory of China Animal Husbandry Industry Co., Ltd

HuaYu Bio-pharmaceutical Co., Ltd

Zhongpu Medicine Factory of China Animal Husbandry Industry Co., Ltd.

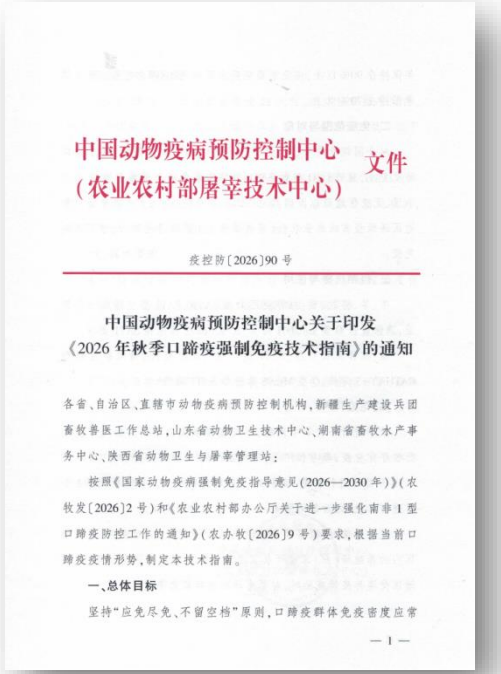
United Biomedical (Shanghai) Co.,Ltd.

Haili Meili Zhongcheng



FMD vaccines developed by LVRI supporting national vaccination programme

- Subunit vaccine of FMD type SAT1
- Inactivated vaccine for FMD type SAT1 (Re-SAT1/2026 strain)
- Trivalent inactivated vaccines for FMD types O, A and SAT1 (Re-O/Ind-2001/2023 + Re-A/WH/09 + Re-SAT1/2026)
- Bivalent inactivated vaccine for swine FMD types O and SAT1 (Re-O/CATHAY/2024 + Re-O/MYA98/2023 + Re-SAT1/2026)
- FMD VLPs vaccines



中国动物疫病预防控制中心
（农业农村部屠宰技术中心） 文件

疫控防〔2026〕90 号

中国动物疫病预防控制中心关于印发
《2026 年秋季口蹄疫强制免疫技术指南》的通知

各省、自治区、直辖市动物疫病预防控制机构，新疆生产建设兵团畜牧兽医工作总站，山东省动物卫生技术中心、湖南省畜牧水产事务中心、陕西省动物卫生与屠宰管理站：

按照《国家动物疫病强制免疫指导意见（2026—2030 年）》（农牧发〔2026〕2 号）和《农业农村部办公厅关于进一步强化南非 1 型口蹄疫防控工作的通知》（农办牧〔2026〕9 号）要求，根据当前口蹄疫疫情形势，制定本技术指南。

一、总体目标

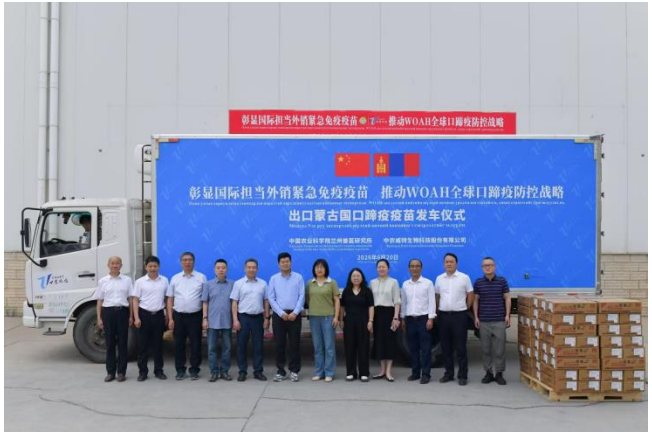
坚持“应免尽免、不留空档”原则，口蹄疫群体免疫密度应常

— 1 —

Reverse genetics technology is used to construct vaccine strais, which have superior performance and reduced pathogenicity

Emergency supply of 1.65 million doses of SAT1 vaccine from China to Mongolia, with cross-border joint prevention and control to block epidemic spread

- Late May: SAT1 FMD outbreak in western Mongolia. Request for vaccine assistance from the General Authority for Veterinary Services of Mongolia.
- June 7: Lanzhou VRI-Mongolia specialized consultation confirming antigenic match and emergency readiness.
- June 15: Sample delivery.
- June 20: Border transport.
- 17-day timeline from notification to vaccination completion.





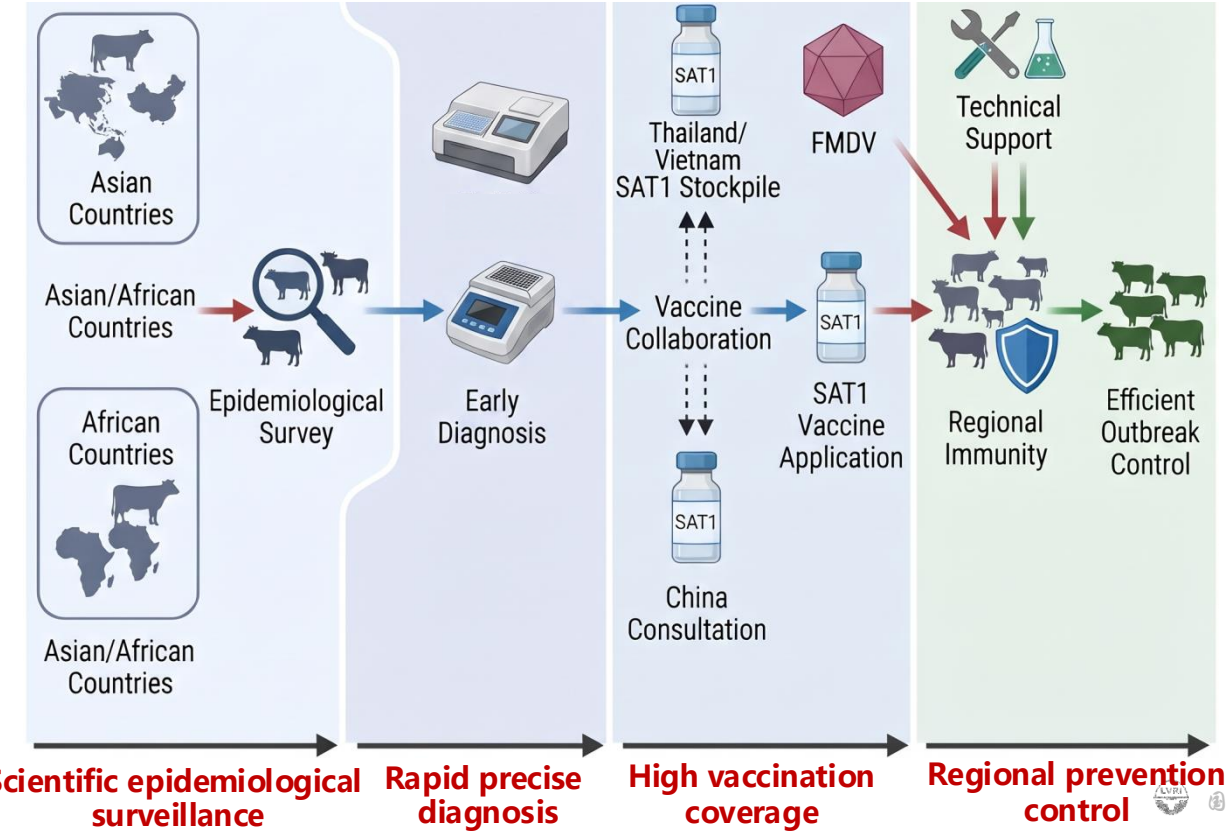


Chinese Ambassador to Mongolia posted the news on the social media

中国农业科学院兰州兽医研究所 LVRI CAAS

Join hands to fight FMD

Promoting the Action for the Prevention, Control and Eradication of FMD in Asia and Africa



国家口蹄疫参考实验室

谢谢！ Thank you for your attention



