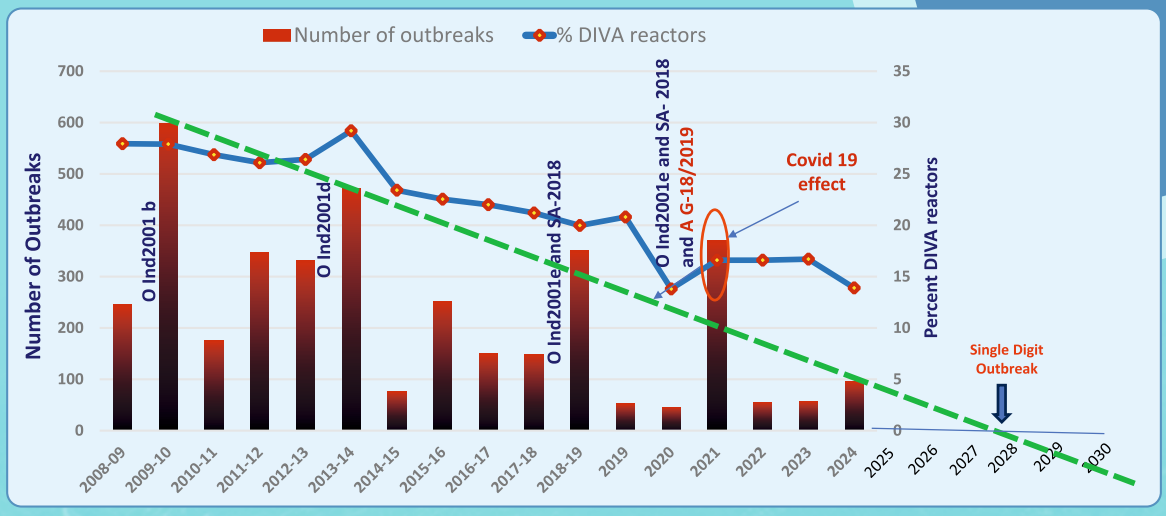
ANNUAL REPORT 2024



ICAR- National Institute on Foot and Mouth Disease
Arugul, Bhubaneswar-752050
Odisha

www.nifmd.res.in

ICAR-NIFMD

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ICAR-National Institute on Foot and Mouth Disease
Arugul, Bhubaneswar-752050, Odisha, India

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Preface

The ICAR-National Institute on Foot and Mouth Disease (NIFMD) stands as India's leading institution dedicated to FMD research. Established in 1968 under the Indian Council of Agricultural Research (ICAR), the institute was officially designated as the National Institute on FMD on February 17, 2023. It also serves as an FAO Reference Centre for FMD. FMD surveillance across India is carried out through a network of 32 regional and collaborating centers located in various states. These centers operate under the guidance of ICAR-NIFMD, Bhubaneswar, with funding support from the Department of Animal Husbandry and Dairying (DAHD), Government of India. The institute's mandate includes conducting research on FMD epidemiology, developing effective control strategies and technologies, and contributing to the long-term goal of disease eradication.

The institute's state-of-the-art BSL-3 laboratory facility at its Bhubaneswar campus has been certified for compliance by the Review Committee on Genetic Manipulation. Furthermore, ICAR-NIFMD is recognized as a member of the National Network of BSL-3/4 laboratories under the National One Health Mission. In alignment with the objectives of the National Animal Disease Control Programme and LHDCP scheme, ICAR-NIFMD offers scientific expertise, technical guidance, and policy support to stakeholders engaged in FMD control efforts across the country.

The institute has built strong scientific capabilities in both traditional and advanced areas of FMD diagnosis, epidemiology, and vaccine research. Beyond the existing diagnostic tools, new assays have been introduced, including a Multi-target RT-PCR assay for pan-serotype detection of the FMDV genome, a monoclonal antibody (MAb)-based competitive ELISA for identifying FMDV NSP antibodies, a species-independent indirect ELISA for FMD serology, and a MAb-based SPCE for detecting serotype O-specific SP antibodies. A comprehensive evaluation was carried out on the effectiveness of commercially available FMD vaccines for pigs. The institute also filed a patent and generated over ₹50 lakhs in revenue through its diagnostic testing services. As FAO Reference C entre for FMD, ICAR-NIFMD actively participated in the 2023 FMD Proficiency Testing Scheme (covering both serology and virology panels), coordinated by the FAO World Reference Laboratory for FMD in the UK, with support from EuFMD and DEFRA. Additionally, the institute organized a proficiency testing program for FMD network laboratories across India.

I would like to convey my sincere gratitude to Dr. Himanshu Pathak, Hon'ble Secretary, DARE & DG, ICAR; Shri Sanjay Garg, Additional Secretary, DARE & Secretary, ICAR; Ms. Alka Nangia Arora, Additional Secretary (DARE) & Financial Advisor (ICAR); Dr. R. Bhatta, DDG (AS), ICAR; and Dr. D. Hemadri, ADG (AH), ICAR, for their invaluable support and guidance in leading the Institute. I also acknowledge the contributions of Dr. Rajneesh Rana, Dr. Harvinder Narula, and Dr. Keshab Barman, Principal Scientists, for their assistance and encouragement. My heartfelt thanks go to the Ms. Alka Upadhyaya, Secretary of DAHD for the generous financial support under NADCP/LHDCP, and to the entire team including, Shri Rama Shankar Sinha, Additional Secretary (LH), Dr. Abhijit Mitra, Animal Husbandry Commissioner, Dr. Sujit Nayak, Joint Commissioner (NADCP), and Dr. Debalina Mitra, Deputy Commissioner (LH), for their unwavering cooperation. It is truly inspiring to see the dedication and perseverance of our scientists as they continue to set new benchmarks and drive the Institute forward. I also extend my heartfelt appreciation to the technical and professional staff, audit and finance teams, administrative personnel, and all support staff whose behind-the-scenes efforts are crucial to the Institute's smooth and efficient operations.

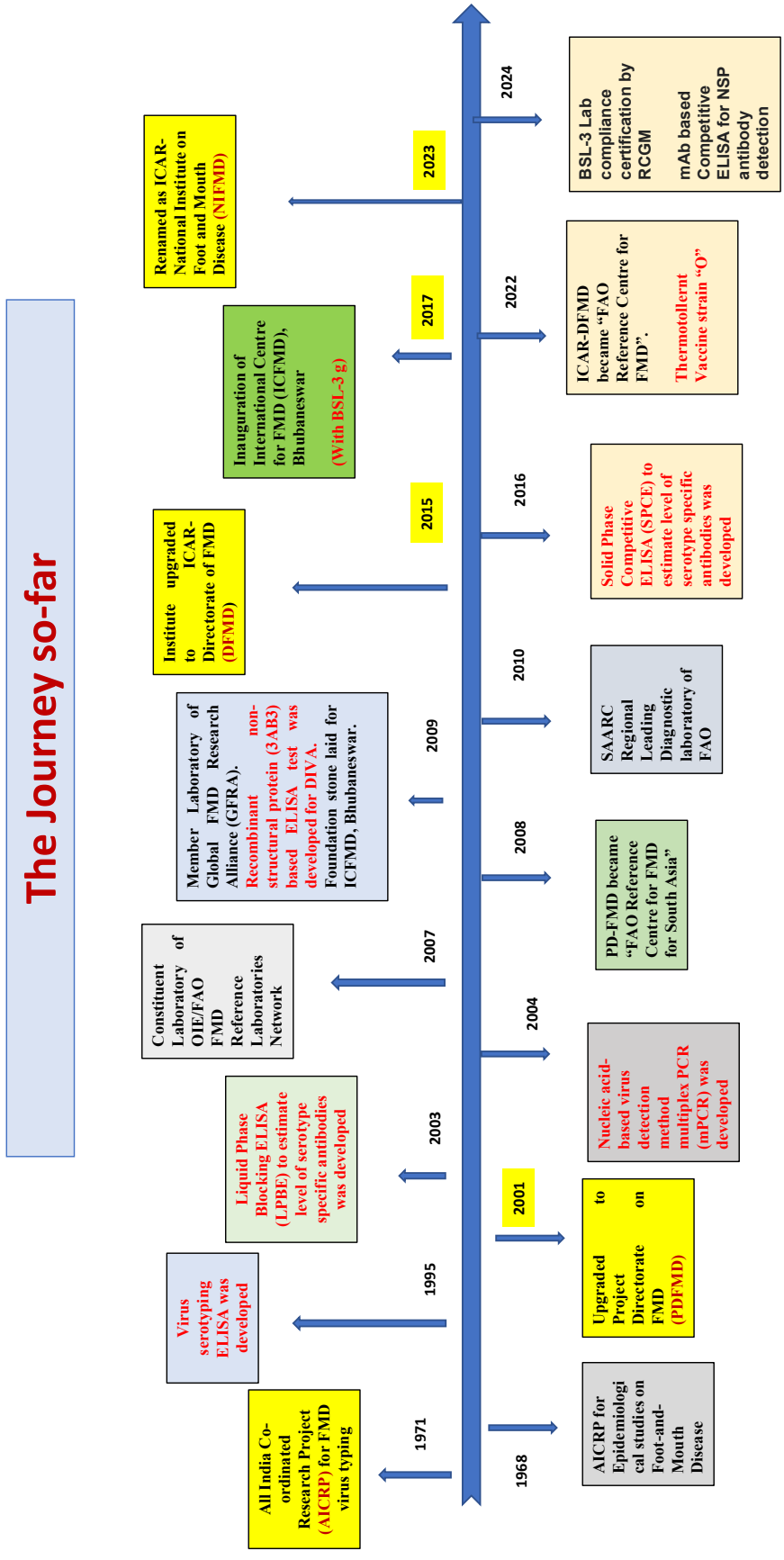
(R. P. Singh)
Director, ICAR-NIFMD

ABOUT ICAR-NIFMD

Introduction

GENESIS

All India Coordinated Research Project (AICRP) for FMD was established in 1968, and has played a pivotal role in FMD research in India. Over the five decades of its existence, the project's scope got expanded, achieving numerous milestones. Initially an AICRP, it evolved into the Project Directorate on FMD in July 2001, upgraded as Directorate of FMD in 2015-16, with 27 regional and collaborative centers covering major regions of the country. On February 17, 2023, it received further recognition as the National Institute on FMD (NIFMD). Presently, there are 32 FMD Centers, technically supported by ICAR-NIFMD, and financially by DAHD. The FMD centers also receive support from ICAR under DAPST, DAPSC, and NEH, from ICAR-NIFMD. The institute has developed scientific expertise in conventional and cutting-edge areas related to diagnosis, epidemiology, and vaccine research. Its mandate includes conducting research on FMD epidemiology, developing technologies to control the disease, and working toward eventual eradication. Additionally, the institute provides technical support, scientific input, and information to planners and strategy-making agencies involved in FMD control in India and the SAARC region. It also has a recognition as FAO reference centre for FMD.


The Journey so-far
1968
AICRP for Epidemiological studies on Foot-and-Mouth Disease
1971
All India Co-ordinated Research Project (AICRP) for FMD virus typing
1995
Virus serotyping ELISA was developed
2001
Upgraded to Project Directorate on FMD (PDFMD)
2003
Liquid Phase Blocking ELISA (LPBE) to estimate level of serotype specific antibodies was developed
2004
Nucleic acid-based virus detection method multiplex PCR (mPCR) was developed
2007
Constituent Laboratory of OIE/FAO FMD Reference Laboratories Network
2008
PD-FMD became "FAO Reference Centre for FMD for South Asia"
2009
Member Laboratory of Global FMD Research Alliance (GFRA). Recombinant non-structural protein (3AB3) based ELISA test was developed for DIVA. Foundation stone laid for ICFMD, Bhubaneswar.
2010
SAARC Regional Leading Diagnostic laboratory of FAO
2015
Institute upgraded to ICAR-Directorate of FMD (DFMD)
2016
Solid Phase Competitive ELISA (SPCE) to estimate level of serotype specific antibodies was developed
2017
Inauguration of International Centre for FMD (ICFMD), Bhubaneswar (With BSL-3 g)
2022
ICAR-DFMD became "FAO Reference Centre for FMD". Thermotollernt Vaccine strain "O"
2023
Renamed as ICAR-National Institute on Foot and Mouth Disease (NIFMD)
2024
BSL-3 Lab compliance certification by RCGM
mAb based Competitive ELISA for NSP antibody detection

VISION

To make India free from Foot and Mouth Disease.

MISSION

Active epidemiological surveillance through regularly monitoring antigenic and genomic make up of Foot and Mouth Disease virus strains responsible for disease incidences, to provide training in diagnosis and epidemiology, and to develop technologies for making country free from FMD.

MANDATE

- Surveillance, epidemiology through systematic monitoring of antigenicity and genomic make of FMD virus strains.
- Repository and capacity development.

OBJECTIVES

- To conduct systematic epidemiological and molecular epidemiological studies on Foot- and- Mouth Disease (FMD), and also to study carrier status of the infection and persistence of the virus.
- Antigenic and molecular characterization and cataloguing of FMD virus strains isolated from incidences, and monitoring suitability of the vaccine strains in use along with maintenance of National Repository of FMD Virus.
- Production, standardization and supply of diagnostic reagents for FMD virus serotyping and post-vaccinal seroconversion, and serosurveillance.
- Maintenance and supply of most appropriate vaccine strains to the FMD vaccine manufacturers.
- Development of newer diagnostic techniques using cutting-edge technologies in molecular biology.
- To act as FAO Reference Centre for FMD.

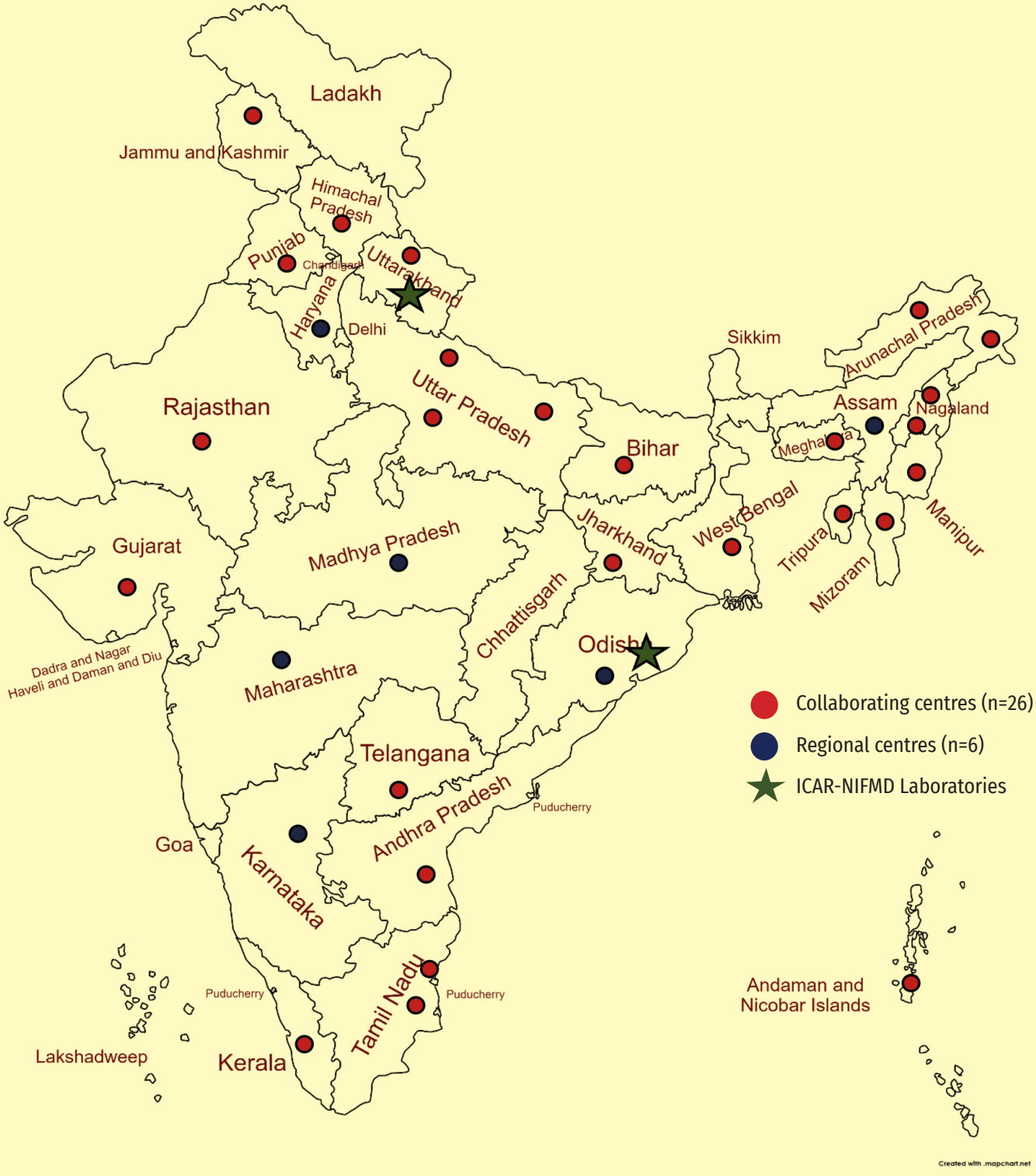
TECHNICAL PROGRAMME

- Active and passive surveillance of FMD in the country in network mode.
- To carry out antigenic and molecular characterization of field isolates.
- To study molecular epidemiology of FMD in India.
- Confirmatory diagnosis and expert advice.
- To carry out vaccine matching exercise for monitoring of appropriateness of in-use vaccine strains.
- Maintenance of National Repository of FMD virus isolates.
- Production, standardization and supply of diagnostic kits for FMD virus diagnosis, sero-monitoring and serosurveillance.
- To develop and standardize advanced laboratory techniques in compliance with the international standards and pass them on to the concerned Centers/Users/Stakeholders with proforma details to facilitate and ensure their uniform application.
- To organize skill orientation programme for the scientific staff of the project for keeping them abreast with the latest knowledge and expertise from time to time through short-term training courses.
- Participation in FMD Control Programme with vital contribution in monitoring pre and post vaccinal antibody response for assessment at individual and herd immunity level.
- National FMD Serosurveillance.
- International collaborations in the areas of interest.

Details of cadre strength as on 31.12.2024

Cadre	Sanctioned	In position	Vacant position with respect to sanction
Research Management Position	01	01	Nil
SCIENTIFIC			
Scientist			
Agriculture Statistics	01	01	Nil
Animal Biochemistry	01	01	Nil
Animal Biotechnology	02	01	01
Animal Genetics & Breeding	01	01	Nil
Animal Physiology	01	01	Nil
Veterinary Microbiology	08	02	06
Veterinary Pathology	02	04	Nil
Total	**16**	**11**	**07**
Sr. Scientist			
Animal Biochemistry	01	Nil	01
Veterinary Microbiology	02	01	01
Veterinary Pathology	01	Nil	01
Total	**04**	**01**	**03**
Pr. Scientist			
Veterinary Microbiology	02	Nil	02
Total	**02**	**Nil**	**02**
OTHER STAFFS			
Administrative	14	06	08
Supporting Staff	02	Nil	02
Technical	05	03	02
Grant Total	**44**	**23**	**24**

India's FMD Laboratories Network



Designation and geographical indicators of regional Centers

Red circle represents collaborating centres (n=26), blue circle represents regional centres (n=6) and green star denotes ICAR-NIFMD Laboratories

Accolades for the institute

The BSL-3 facility at ICAR-NIFMD, Bhubaneswar Campus, has been certified for BSL-3 compliance by the Review Committee on Genetic Manipulation (RCGM), Department of Biotechnology, Ministry of Science and Technology, Government of India since 13.02.24 for a period of three years.

सत्यमेव जयते

Department of Biotechnology
Ministry of Science & Technology, Government of India

Certificate of compliance for BSL-3 Facility

Based on the assessment made by the Inter-ministerial Committee for Certification of BSL-3 facility and recommendations of Review Committee on Genetic Manipulation (RCGM), the following facility is certified for BSL-3 compliance:

ICAR-National Institute of Foot and Mouth Disease
(Formerly, ICAR-Directorate of Foot and Mouth Disease),
International Centre for Foot and Mouth Disease,

Arugul,
Bhubaneswar, -752050, Odisha

Certificate No: BT/IBKP/367/2020-BSL3

Issue Date : 13/02/2024 **Valid up to: 12/02/2027**

N.B. In compliance with IBSC, and other regulatory Biosafety Guidelines of the country applicable from time to time.

Dr. Nitin K Jain,
Scientist- G,
Department of Biotechnology &
Member Secretary,
Review Committee on Genetic Manipulation

Prof. Y. K. Gupta
Chairman,
Review Committee on Genetic Manipulation,
Former Director , IITR, Lucknow and
President, AIIMS, Bhopal

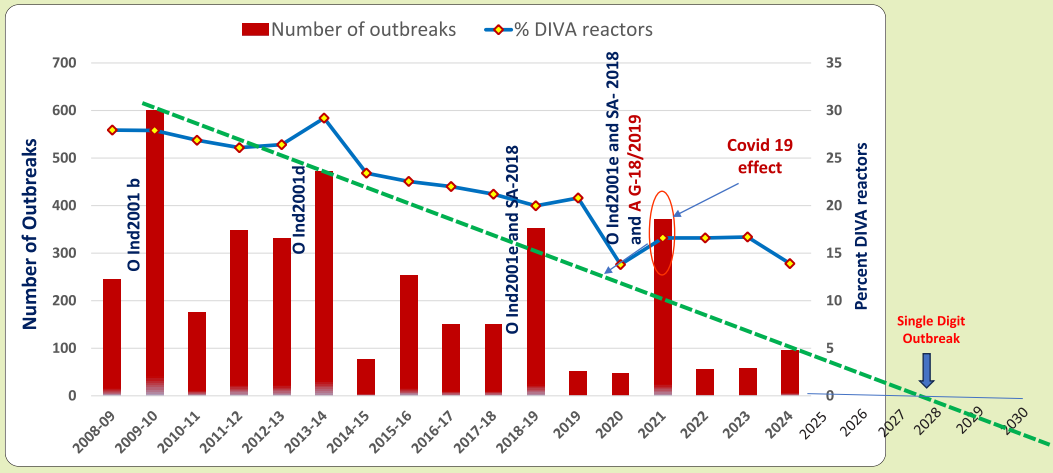
Recognized as Member of National network of BSL-3/4 Labs under NOHM

With reference to Letter No. J/13/2022-PROJ, dated 11th October 2024, from the Office of the Principal Scientific Advisor, GoI, Vigyan Bhawan Annexe, a national network of BSL-3/4 facilities has been established as part of the NATIONAL ONE HEALTH MISSION. This network serves as a common resource for responding to disease outbreaks across the human, livestock, and wildlife sectors. ICAR-NIFMD was inducted as a member of NOHM in 2024. Under this program, ICAR-NIFMD, Bhubaneswar, participated in a capacity-building initiative organized by ICMR to strengthen member laboratories. In this context, three scientists attended capacity-building and hands-on training programs conducted by ICAR-NIHSAD, Bhopal, and ICMR-NIV, Pune

Training attended by scientists of ICAR-NIFMD at ICMR-NIV, Pune, 22-23 October 2024.

"Impact of FMD Control, Knowledge & Technology Input During Recent years"

Foot-and-mouth disease (FMD) affects cloven-hoofed domestic and wild animals, such as cattle, buffalo, pig, goats, sheep, mithun, yak and several wildlife species. The disease is contagious and economically important. FMD is a high-priority transboundary illness that is on the WOAH List A. The government of India supported FMD control programme initiated at pilot scale with 54 districts in the year 2003/04 has reached to a crucial juncture where the entire country is being covered under mass vaccination along with associated measures nowadays. Over the time disease incidence has reduced considerably. Those states vaccinating sincerely twice a year using quality controlled vaccine are making strides towards building high herd immunity. As a result of this for the Ist time, the number of reported FMD outbreaks have reduced in two digits for three consecutive years (2022, 2023 & 2024) from the initial 4 digit outbreaks experienced before beginning of 21st Century. This has motivated the stakeholders towards going for more aggressive & planned approach on disease control & elimination so that the reported disease incidences can be brought down to **"single digit"** at national level in short period of time in a sustainable manner but without any suppressed or under-reporting. The intermittent epidemics previously observed every 2-4 years seem to have disappeared now. To sustain all these achievements and to further reduce outbreak substantially to a "single digit" and to eliminate virus from environment it will require adapting all existing practices along with new innovative approaches for disease prevention & elimination. This will also require extensive and continuous capacity building of all veterinarians and awareness among other stakeholders, most importantly veterinary professionals and livestock farmers of the country. In addition to others, some of these could be synchronized pulse polio mode vaccination by dividing the country into zones (zonal approach), following combing vaccinations, establishing emergency vaccine banks, zero-tolerance towards deployment of poor quality vaccines, testing of vaccines collected during surprise visit from field for antigen quality and integrity, cold chain strengthening and audit, sentinel surveillance, environmental surveillance, regulated animals movements, extensive capacity building and stakeholder's involvement and motivation of vaccination teams for repeat vaccinations and transparent disease reporting etc.



Executive Summary

- A total of 502 clinical samples from 96 FMD outbreaks/incidences were tested for serotype identification. In 2024, with a 97% contribution to all outbreaks, serotype O dominated the scenario in 2024. There was an unexpected rise in the incidence of serotype A in 2023, accounting for 30% of all FMD cases. However, this year, serotype A was detected only in Gujarat and Odisha. Serotype Asia1 was absent during 2024
- A total of 21 FMD virus isolates (20 of serotype O and 1 of serotype A) were successfully revived in the BHK-21 cell culture system and added to the National FMD Virus Repository. The repository now contains a total of 2,485 isolates, categorized as follows: 1,753 of serotype O, 349 of serotype A, 15 of serotype C, and 368 of serotype Asia-1.
- The capsid coding region (P1/VP1) sequences of 69 FMD virus strains were determined, comprising 59 of serotype O and 10 of serotype A. In serotype O, co-circulation of the 'O/ME-SA/Ind2001e' and 'O/ME-SA/SA-2018' lineages were observed. Serotype A exhibited an exclusive prevalence of the 'G-18/2019 non-deletion' lineage.
- Vaccine matching analysis was performed on 18 FMDV isolates, including 17 of serotype O and 1 of serotype A. The vaccine strains for serotype O showed a satisfactory antigenic match. However, the serotype A field isolate exhibited a poor antigenic match with the current vaccine strain A/IND/40/2000. In contrast, the proposed candidate vaccine strain A/IND/27/2011 demonstrated a perfect antigenic match.
- As part of FMD serosurveillance, a total of 77,829 serum samples were collected from various species across the country and tested using the r3AB3 NSP-ELISA. The samples included cattle (48,555), buffalo (21,564), sheep (979), goat (5,946), pig (14), yak (668), and mithun (103). The overall seropositivity in bovine samples was 13.9%, marking a decrease from the previous year's seroprevalence rate of 16.7%.
- Sentinel surveillance was launched in 2024 in collaboration with ICAR-NIVEDI, Bengaluru. As part of this program, serum samples from Karnataka, Andhra Pradesh, and Ladakh were tested, including 1,195 from sheep and 747 from goats. Additionally, surveillance was conducted in slaughterhouses and at the wildlife-livestock interface.
- As part of FMD seromonitoring, a total of 1,29,339 serum samples (1,28,195 from LHDCP and 1,144 from yak and mithun) were analyzed using SPCE to evaluate immunization effectiveness. Protective titers were detected in 42.0%, 36.5%, and 37.8% of animals against serotypes O, A, and Asia-1, respectively, in pre-vaccination samples. In post-vaccination samples, collected at the end of round 4, the protective titers increased to 73.8%, 68.6%, and 71.0% for serotypes O, A, and Asia-1, respectively.
- As part of the follow-up on NSP reactors, 105 serum and oesophageal-pharyngeal fluid (OPF) samples from Haryana and Telangana were tested for the presence of 3AB3 NSP antibodies and viral genome. Among the 17 NSP-positive samples, one sample tested positive for FMD virus serotype O through RT-mPCR.
- A multi-target RT-PCR assay was developed for the pan-serotype detection of the FMDV genome, ensuring high sensitivity and specificity. The one-tube multi-target FMD virus pan-serotype RT-PCR assay demonstrated 100% relative diagnostic sensitivity and specificity compared to the serotype-differentiating mPCR assay currently used in India.
- A monoclonal antibody-based competitive ELISA (cELISA) was developed for marker serology across different species. Using a 45% PI cut-off value, the cELISA demonstrated a DSn of 95.54% (91.71%–97.94%) and a DSp of 98.36% (97.15%–99.15%) at a 95% confidence interval. The test exhibited a relative DSn of 93.52% and DSp of 97.46% compared to the PrioCHECK FMD NS test. Additionally, it showed an overall concordance of 86.13% with r3AB3 NSP-ELISA at the 45% PI cut-off.
- A solid-phase competitive ELISA (SPCE) was developed using recombinant capsid protein (rP1) and a monoclonal antibody (MAb) for the detection of FMDV serotype O-specific antibodies. When tested at a 1:10 serum dilution with a 22% inhibition cut-off, the rP1-MAb-SPCE exhibited a relative diagnostic sensitivity of 93.33% and specificity of 95.23% compared to the gold standard VNT.

- A species-independent indirect ELISA for detecting antibodies against the NSP 2B of the FMD virus was developed. This ELISA enables the detection of anti-NSP antibodies across multiple FMD-susceptible species using a single platform. The assay demonstrated a diagnostic sensitivity of 92.35%, specificity of 98.41%, accuracy of 95.21%, and positive and negative predictive values (PPV and NPV) of 98.58% and 91.67%, respectively, at an optimal cut-off of 44% positivity.
- Efficacy of commercial FMD vaccines available in India was evaluated in pigs. The 2 ml intramuscular FMD vaccine dose induced stronger and longer-lasting antibody response with titers remaining above protective thresholds for 180 days (tested so far). A booster dose significantly enhanced antibody levels, confirming its advantage over a single-dose regimen.
- Role of ILs in the pathogenesis of FMD was studied. FMDV-affected cattle showed significantly elevated Th17 cytokines (IL-17, IL-21, IL-22, IL-23, IL-6) in the naturally infected cattle. Immunohistochemistry confirmed elevated level of IL-17/IL-23 expression in tongue and heart tissues, highlighting Th17 cells' role in FMD pathogenesis and potential for disease monitoring.
- BoLA-DQA typing is important for identifying genes associated with disease resistance. BoLA-Class II-DQA1 typing in cattle was optimized by refining primers, resolving amplification failures (10%) and sequence mismatches (15%). Typing 44 cattle from 8 breeds identified 26 known and 5 novel alleles, highlighting the need for database updates.
- To improve detection, RT-PCR was adapted to a capillary electrophoresis-based system, enhancing throughput and multiplexing. A control gene (GAPDH, ACTB, or HPRT) was added to distinguish true negatives from PCR failures. Optimized fluorescently tagged primers were analyzed using a Genetic Analyzer, enabling faster, high-throughput, and automation-compatible viral detection.
- **SeroMonitor,** an AI-web server was developed and hosted in Indian Council of Agricultural Research (ICAR) Data Centre server located at New Delhi, India, which is compliant to ISO27001:2013 and 20000:2011 standards. Through this computational approach and web-server, it is possible to study the herd immunity at the individual state.
- Web-based prediction server, **NSPPredServ** was developed for determining FMDV NSP-Ab status in test samples using the 2B NSP-ELISA diagnostic assay. Designed with a user-friendly interface, it enables quick and efficient infection status prediction with just a single click.
- The AI-based prediction server, **MolEpidPred** was developed to assist researchers worldwide in the molecular epidemiology of the FMD virus. This user-friendly machine learning interface enables rapid VP1 sequence-based predictions with a single click, enhancing accessibility to computational analysis.
- For the quality control (QC) testing of FMD vaccines to be utilized for the vaccination under LHDCP, ICAR-NIFMD carried out QC testing of six batches of vaccines.
- The institute provided the state FMD centers with three primary test kits (3AB3 indirect DIVA ELISA for 137130 samples, Solid Phase Competitive ELISA (SPCE) for 139003 samples (serotypes O, A and Asia1), and Sandwich ELISA for 2200 samples) for undertaking disease surveillance and seromonitoring.
- A series of capacity building programs on "Foot & Mouth Disease Elimination with Vaccination" were conducted by ICAR-NIFMD, Bhubaneswar between 11.09.2024 to 01.10.2024 through virtual mode. Around 8239 veterinarians participated in the programme from all categories across country including senior level official from DAHD and ICAR.
- Several extension and training programs were organized under LHDCP scheme for stakeholders. In total, 7262 stakeholders, including 6027 farmers, 1235 veterinarians and paraveterinary staff, participated and benefited.
- ICAR-NIFMD organized Serology Proficiency Testing for 32 state FMD regional and collaborating centres, in which a panel of 9 coded samples were distributed for assessing FMD virus infection and vaccination status.
- ICAR-NIFMD, as the 'FAO Reference Centre for FMD,' participated in the FMD Proficiency Testing Scheme, 2023 (Both serology and virology panel), organized by the FAO World Reference Laboratory (WRL) for FMD, UK, with support from EuFMD and DEFRA

कार्यकारी सारांश

- सीरोटाइप पहचान के लिए 96 एफ.एम.डी. प्रकोपों से कुल 502 नैदानिक नमूनों का परीक्षण किया गया। वर्ष 2024 के दौरान, सीरोटाइप 'ओ' का प्रकोप सबसे ज्यादा %97 पाया गया। वर्ष 2023 में सीरोटाइप ए की घटनाओं में अप्रत्याशित वृद्धि हुई थी, जो सभी एफएमडी मामलों का %30 था। हालाँकि, वर्ष 2024 में, सीरोटाइप ए के मामले केवल गुजरात और ओडिशा में देखा गया। वर्ष 2024 के दौरान सीरोटाइप एशिया 1 नहीं पाया गया ।
- बीएचके-21 सेल कल्चर सिस्टम में पुनर्जीवित कुल 21 एफ.एम.डी. वायरस आइसोलेट्स (20 सीरोटाइप 'ओ' और 1 सीरोटाइप 'ए') को एफ.एम.डी. वायरस के राष्ट्रीय भंडार में जोड़ा गया। वर्तमान में, राष्ट्रीय एफएमडी वायरस रिपोजिटरी में कुल 2485 आइसोलेट्स हैं जिसमे ओ-1753, ए-349, सी-15, और एशिया 1-368 के आइसोलेट्स हैं।
- 69 एफ.एम.डी. वायरस उपभेदों के कैप्सिड कोडिंग क्षेत्र (पी1/वीपी1) अनुक्रम निर्धारित किए गए, जिसमें 59 सीरोटाइप 'ओ' और 10 सीरोटाइप 'ए' शामिल हैं। सीरोटाइप ओ में ओ/एम ई-एस ई / इंड2001ई (O/ME-SA/Ind2001e) और ओ/एम ई-एस ए / 2018 (O/ME-SA/2018) वंशावली का सह-परिसंचरण देखा गया। सीरोटाइप A में G-18/2019 गैर-विलोपन वंशावली का विशेष प्रसार था।
- 18 एफ.एम.डी. वायरस आइसोलेट्स (17 सीरोटाइप ओ और 1 सीरोटाइप ए) का वैक्सीन मैचिंग विश्लेषण किया गया। सीरोटाइप ओ के लिए वैक्सीन स्ट्रेन ने संतोषजनक एंटीजेनिक मैच दिखाया। हालांकि, सीरोटाइप ए फील्ड आइसोलेट ने मौजूदा वैक्सीन स्ट्रेन ए/आईएनडी/40/2000 के साथ खराब एंटीजेनिक मैच दिखाया। इसके विपरीत, प्रस्तावित उम्मीदवार वैक्सीन स्ट्रेन ए/आईएनडी/27/2011 ने मौजूदा वैक्सीन के साथ एकदम सही एंटीजेनिक मैच दिखाया।
- एफएमडी सीरोसर्विलांस के हिस्से के रूप में, देश भर में विभिन्न प्रजातियों से कुल 77,829 सीरम नमूने एकत्र किए गए और आर3एबी3 एनएसपी-एलिसा का उपयोग करके उनका परीक्षण किया गया। नमूनों में गोजातीय (48,555), भैंस (21,564), भेड़ (979), बकरी (5,946), सुअर (14), याक (668) और मिथुन (103) शामिल थे। गोजातीय नमूनों में कुल सीरोपॉजिटिविटी 13.9% थी, जो पिछले वर्ष की सीरोप्रिवलेंस दर 16.7% से कम थी।
- आईसीएआर-निवेदी, बेंगलुरु के सहयोग से 2024 में प्रहरी निगरानी (सीरोसर्विलांस) शुरू की गई। इस कार्यक्रम के हिस्से के रूप में, कर्नाटक, आंध्र प्रदेश और लद्दाख से सीरम के नमूनों का परीक्षण किया गया, जिसमें भेड़ों के 1,195 और बकरियों के 747 नमूने शामिल थे। इसके अतिरिक्त, बूचड़खानों और वन्यजीव-पशुधन इंटरफेस में निगरानी की गई।
- एफएमडी सीरोमॉनिटरिंग के हिस्से के रूप में, टीकाकरण प्रभावशीलता का मूल्यांकन करने के लिए एसपीसीई का उपयोग करके कुल 1,29,339 सीरम नमूनों (एलएचडीसीपी से 1,28,195 और याक और मिथुन से 1,144) का विश्लेषण किया गया। टीकाकरण से पहले के नमूनों में, क्रमशः 42.0%, 36.5% और 37.8% जानवरों में सीरोटाइप ओ, ए और एशिया-1 के खिलाफ सुरक्षात्मक टिटर का पता लगाया गया। टीकाकरण के बाद के नमूनों में, जो राउंड 4 के अंत में एकत्र किए गए थे, सुरक्षात्मक टिटर क्रमशः सीरोटाइप ओ, ए और एशिया-1 के लिए 73.8%, 68.6% और 71.0% तक बढ़ गए।
- एनएसपी रिएक्टरों पर अनुवर्ती कार्रवाई के हिस्से के रूप में, हरियाणा और तेलंगाना से 105 सीरम और ओसोफेगल-फेरिंजियल द्रव (ओपीएफ) नमूनों का क्रमशः 3AB3 एनएसपी एंटीबॉडी और वायरल जीनोम की उपस्थिति के लिए परीक्षण किया गया। 17 एनएसपी-पॉजिटिव नमूनों में से, एक नमूना आरटी-एमपीसीआर के माध्यम से एफएमडी वायरस सीरोटाइप ओ के लिए सकारात्मक पाया गया।
- एफएमडीवी जीनोम के पैन-सीरोटाइप का पता लगाने के लिए एक बहु-लक्षीय आरटी-पीसीआर जाँच विकसित की गई, जिससे उच्च संवेदनशीलता और विशिष्टता सुनिश्चित हुई। एक-ट्यूब बहु-लक्ष्य एफएमडी वायरस पैन-सीरोटाइप आरटी-पीसीआर जाँच ने भारत में वर्तमान में उपयोग किए जाने वाले सीरोटाइप-विभेदक एमपीसीआर जाँच की तुलना में 100% सापेक्ष नैदानिक संवेदनशीलता और विशिष्टता का प्रदर्शन किया।
- विभिन्न प्रजातियों में मार्कर सीरोलॉजी के लिए एक मोनोक्लोनल एंटीबॉडी-आधारित प्रतिस्पर्धी एलिसा (cELISA) विकसित किया गया। 45% PI कट-ऑफ मान का उपयोग करते हुए, इस प्रतिस्पर्धी एलिसा ने 95% विश्वास अंतराल पर 95.54% (91.71%–97.94%) का नैदानिक संवेदनशीलता और 98.36% (97.15%–99.15%) का नैदानिक विशिष्टता प्रदर्शित किया। प्रायोचेक एफएमडी एनएस परीक्षण की तुलना में परीक्षण ने 93.52% का सापेक्ष नैदानिक संवेदनशीलता और 97.46% का नैदानिक विशिष्टता प्रदर्शित किया। इसके अतिरिक्त, इसने 45% अवरोध का प्रतिशत (पीआई) कट-ऑफ पर आर3एबी3 एनएसपी-एलिसा के साथ 86.13% की समग्र सहमति दिखाई।
- एफएमडीवी सीरोटाइप ओ-विशिष्ट एंटीबॉडी का पता लगाने के लिए पुनः संयोजक कैप्सिड प्रोटीन (आरपी1) और एक मोनोक्लोनल एंटीबॉडी (एमएबी) का उपयोग करके एक ठोस-चरण प्रतिस्पर्धी एलिसा (एसपीसीई) विकसित किया गया था। 22% अवरोध कट-ऑफ के साथ 1:10 सीरम कमजोर पड़ने पर परीक्षण किए जाने पर, आरपी1-एमएबी-एसपीसीई ने स्वर्ण मानक वीएनटी की तुलना में 93.33% की सापेक्ष नैदानिक संवेदनशीलता और 95.23% की विशिष्टता प्रदर्शित की।
- एफएमडी वायरस के एनएसपी 2बी के खिलाफ एंटीबॉडी

का पता लगाने के लिए एक प्रजाति-स्वतंत्र अप्रत्यक्ष एलिसा विकसित किया गया था। यह एलिसा एक ही प्लेटफॉर्म का उपयोग करके कई एफएमडी-संवेदनशील प्रजातियों में एंटी-एनएसपी एंटीबॉडी का पता लगाने में सक्षम बनाता है। परख ने 44% सकारात्मकता के इष्टतम कट-ऑफ पर क्रमशः 92.35% की नैदानिक संवेदनशीलता, 98.41% की विशिष्टता, 95.21% की सटीकता और 98.58% और 91.67% के सकारात्मक और नकारात्मक पूर्वानुमान मूल्य (पीपीवी और एनपीवी) का प्रदर्शन किया।

- भारत में उपलब्ध व्यावसायिक एफएमडी टीकों की प्रभावकारिता का मूल्यांकन सूअरों में किया गया। 2 मिली इंट्रामस्क्युलर एफएमडी वैक्सीन की खुराक ने मजबूत और लंबे समय तक चलने वाली एंटीबॉडी प्रतिक्रिया को प्रेरित किया, जिसमें 180 दिनों तक टाइटर्स सुरक्षात्मक सीमा से ऊपर रहे। बूस्टर खुराक ने एंटीबॉडी के स्तर को काफी हद तक बढ़ाया, जिससे एकल खुराक वाले आहार की तुलना में इसके लाभ की पुष्टि हुई।
- एफएमडी के रोगजनन में आईएल की भूमिका का अध्ययन किया गया। एफएमडीवी से प्रभावित मवेशियों में स्वाभाविक रूप से संक्रमित मवेशियों में टीएच17 साइटोकाइन्स (आईएल-17, आईएल-21, आईएल-22, आईएल-23, आईएल-6) का स्तर काफी बढ़ा हुआ दिखा। इम्यूनोहिस्टोकेमिस्ट्री ने जीभ और हृदय के ऊतकों में आईएल-17/आईएल-23 अभिव्यक्ति के बढ़े हुए स्तर की पुष्टि की, जिससे एफएमडी रोगजनन में टीएच17 कोशिकाओं की भूमिका और रोग निगरानी की क्षमता पर प्रकाश डाला गया है।
- बोला-डीक्यूए (BoLA-DQA) टाइपिंग रोग प्रतिरोधक क्षमता से जुड़े जीन की पहचान करने के लिए महत्वपूर्ण है। मवेशियों में BoLAClass II-DQA1 टाइपिंग को प्राइमर को परिष्कृत करके अनुकूलित किया गया, जिससे एम्पलीफिकेशन विफलताओं (%10) और अनुक्रम बेमेल (%15) का समाधान हुआ। 8 नस्लों के 44 मवेशियों की टाइपिंग से 26 ज्ञात और 5 नए एलील की पहचान हुई, जिससे डेटाबेस अपडेट की आवश्यकता पर प्रकाश डाला गया।
- पहचान में सुधार के लिए, आरटी-पीसीआर को केशिका वैद्तकणसंचलन-आधारित प्रणाली में अनुकूलित किया गया, जिससे थ्रूपुट और मल्टीप्लेक्सिंग में वृद्धि हुई। पीसीआर विफलताओं से सच्चे नकारात्मक को अलग करने के लिए एक नियंत्रण जीन (GAPDH, ACTB, या HPRT) जोड़ा गया। अनुकूलित फ्लोरोसेंटली टैग किए गए प्राइमरों का विश्लेषण जेनेटिक एनालाइज़र का उपयोग करके किया गया, जिससे तेज़, उच्च-थ्रूपुट और ऑटोमेशन-संगत वायरल पहचान संभव हुई।
- सीरोमॉनीटर, एक एआई-वेब सर्वर विकसित किया गया और इसे नई दिल्ली, भारत में स्थित भारतीय कृषि अनुसंधान परिषद (आईसीएआर) डेटा सेंटर सर्वर में होस्ट किया गया, जो आईएसओ 27001: 2013 और 20000: 2011 मानकों के अनुरूप है। इस कम्प्यूटेशनल दृष्टिकोण और वेब-सर्वर के माध्यम से, व्यक्तिगत अवस्था में झुंड प्रतिरक्षा का अध्ययन करना संभव है।
- वेब-आधारित पूर्वानुमान सर्वर, NSPPredServ को 2बी एनएसपी-एलिसा डायग्नोस्टिक परख का उपयोग करके परीक्षण नमूनों में एफएमडी वायरस एनएसपी-एंटीबॉडी स्थिति निर्धारित करने के लिए विकसित किया गया। उपयोगकर्ता के अनुकूल इंटरफ़ेस के साथ डिज़ाइन किया गया, यह केवल एक क्लिक के साथ त्वरित और कुशल संक्रमण स्थिति की भविष्यवाणी करने में सक्षम बनाता है।
- एआई-आधारित भविष्यवाणी सर्वर, मोलएपिडप्रेड (https://nifmd-bbf.icar.gov.in/MolEpidPred), एफएमडी वायरस के आणविक महामारी विज्ञान में दुनिया भर के शोधकर्ताओं की सहायता के लिए विकसित किया गया। यह उपयोगकर्ता के अनुकूल मशीन लर्निंग इंटरफ़ेस एक क्लिक के साथ तेजी से वीपी1 अनुक्रम-आधारित भविष्यवाणियों को सक्षम करता है, जिससे कम्प्यूटेशनल विश्लेषण तक पहुंच बढ़ जाती है।
- एलएचडीसीपी के अंतर्गत टीकाकरण के लिए उपयोग किए जाने वाले एफएमडी टीकों के गुणवत्ता नियंत्रण (क्यूसी) परीक्षण के लिए, आईसीएआर-एनआईएफएमडी ने टीकों के छह बैचों का क्यूसी परीक्षण किया।
- संस्थान ने रोग निगरानी और सीरोमॉनीटरिंग के लिए राज्य एफएमडी केंद्रों को तीन प्राथमिक परीक्षण किट (137130 नमूनों के लिए 3AB3 अप्रत्यक्ष दीवा एलिसा, 139003 नमूनों (सीरोटाइप ओ, ए और एशिया 1) के लिए सॉलिड फेज़ प्रतिस्पर्धी एलिसा (SPCE) और 2200 नमूनों के लिए सैंडविच एलिसा) प्रदान किए।
- भा.कृ.अनु.प.-एनआईएफएमडी, भुवनेश्वर द्वारा 11.09.2024 से 01.10.2024 के बीच आभासी माध्यम से «टीकाकरण के साथ खुरपका और मुँहपका रोग उन्मूलन» पर क्षमता निर्माण कार्यक्रमों की एक श्रृंखला आयोजित की गई। इस कार्यक्रम में डीएएचडी और आईसीएआर के वरिष्ठ स्तर के अधिकारियों सहित देश भर के सभी श्रेणियों के लगभग 8239 पशु चिकित्सकों ने भाग लिया।
- एलएचडीसीपी योजना के अंतर्गत हितधारकों के लिए कई विस्तार और प्रशिक्षण कार्यक्रम आयोजित किए गए। कुल 7262 हितधारकों, जिनमें 6027 किसान, 1235 पशु चिकित्सक और पैरावेटरनरी स्टाफ शामिल थे, ने भाग लिया और लाभ उठाया।
- भा.कृ.अनु.प.-एनआईएफएमडी ने 32 राज्य एफएमडी क्षेत्रीय और सहयोगी केंद्रों के लिए सीरोलॉजी प्रवीणता परीक्षण का आयोजन किया, जिसमें एफएमडी वायरस संक्रमण और टीकाकरण की स्थिति का आकलन करने के लिए 9 कोडित नमूनों का एक पैनल वितरित किया गया।
- यूएफएमडी और डीईएफआरए के सहयोग से एफएओ विश्व संदर्भ प्रयोगशाला (डब्ल्यूआरएल), एफएमडी, यूके द्वारा आयोजित एफएमडी प्रवीणता परीक्षण योजना, 2023 (सीरोलॉजी और वायरोलॉजी दोनों पैनल) में भा.कृ.अनु.प.-एनआईएफएमडी ने 'एफएओ संदर्भ केंद्र फॉर एफएमडी' के रूप में भाग लिया।

2.0 Research Achievements

2.1 Disease Monitoring and Surveillance

In 2024, a total of 96 outbreaks were serotype confirmed, marking a 40% increase compared to 2023 (Table 1). Most outbreaks appeared sporadic and mild, except in Punjab, where the disease was more severe. Kerala recorded the highest number of cases, with all outbreaks attributed to serotype O. The disease spread across 22 states and Union Territories, compared to only 15 in the previous year (Fig. 1). Progressive farming states like Haryana, Punjab, and Andhra Pradesh, reported cases in 2024. The southern region accounted for 46% of all documented FMD outbreaks, while the northern region saw a significant surge compared to the previous year. Majority of the outbreaks were recorded in cattle followed by Cattle & Buffalo (Fig 2). Incidences were also reported in Sheep, Goat, Mithun and Yak-Cattle hybrid. Notably, outbreaks were also recorded in Nehru Zoological Park in Bahadurpura, Hyderabad; Nandanvan Jungle Safari in Nava Raipur, Chhattisgarh; Deer Farm, Patiala Zoo, Patiala and the Sheep Farm at ICAR-CSWRI, Avikanagar.

With a 97% contribution to all outbreaks, serotype O dominated the scenario in 2024. There was an unexpected rise in the incidence of serotype A in 2023, accounting for 30% of all FMD cases (Fig 3). However, this year, serotype A was detected only in Gujarat and Odisha. Serotype Asia1 was absent during 2024. Molecular techniques, such as multiplex PCR and serotype-differentiating sandwich ELISA, were employed to analyse 502 clinical specimens collected from suspected FMD outbreaks. The results identified serotype O in 264 samples, and serotype A in 11 samples (Table 2). The majority of outbreaks were reported in February and July (Fig. 4 and 5). Although FMD cases occur throughout the year in India, there is often a noticeable increase during the monsoon and winter season.

Table 1. FMD incidences recorded and diagnosed during 2024 and virus serotype(s) involved

State/UT	Reporting Centre	Number of FMD outbreaks	FMD Serotypes		
			O	A	Asia1
Southern Region					
Andhra Pradesh	Vijayawada	01	01	-	-
Karnataka	Bengaluru	05	05	-	-
Kerala	Trivendrum	32	32		
Tamilnadu	Ranipet	01	01		
Telangana	Hyderabad	06	06		
Total		**45**	**45**	**-**	**-**
Central Region					
Chhattisgarh	ICAR-NIFMD	01	01	-	-
Total		**01**	**01**	**-**	**-**
Western Region					
Maharashtra	Pune	04	04	-	-
Gujarat	Ahmedabad	09	08	01	-
Rajasthan	Jaipur/ ICAR-NIFMD	04	04	-	-
Total		**17**	**16**	**01**	**-**
Northern Region					
Haryana	Hisar	07	07	-	-
Punjab	Jalandhar	13	13		
Uttarakhand	ICAR-NIFMD	01	01		-
Uttar Pradesh	Meerut	01	01	-	-

Himachal Pradesh	ICAR-NIFMD	01	01		-
Jammu & Kashmir	ICAR-NIFMD	02	02	-	-
Ladakh	ICAR-NIFMD	01	01		
Total		**26**	**26**	**-**	**-**
Eastern Region					
Odisha	Cuttack	02	01	01	--
Jharkhand	Ranchi	01	01	-	-
Total		**03**	**02**	**01**	**-**
North Eastern Region					
Assam	Guwahati	02	02	-	-
Arunachal Pradesh	ICAR-NRC Yak	01	01		
Tripura	Agartala	01	01	-	-
Total		**04**	**04**	**-**	**-**
Grand Total		**96**	**94**	**02**	**-**

Table 2. Number of clinical samples tested during 2024 and virus serotype(s) involved

State/UT	Number of Clinical materials tested	FMD Serotypes		
		O	A	Asia1
Andhra Pradesh	11	2	-	-
Arunachal Pradesh	6	2	-	-
Assam	13	10	-	-
Chhattisgarh	1	1	-	-
Gujarat	38	28	6	-
Haryana	14	13	-	-
Himachal Pradesh	3	3	-	-
Jammu & Kashmir	5	5	-	-
Jharkhand	5	2	-	-
Karnataka	33	21	-	-
Kerala	126	54	-	-
Ladakh	14	10	-	-
Maharashtra	54	9	-	-
Nagaland	3	1	-	-
Odisha	14	6	5	-
Punjab	55	38	-	-
Rajasthan	55	32	-	-
Tamil Nadu	3	1	-	-
Telangana	12	10	-	-
Tripura	22	3	-	-
Uttar Pradesh	6	6	-	-
Uttarakhand	9	8	-	-
Total	**502**	**261**	**11**	**-**

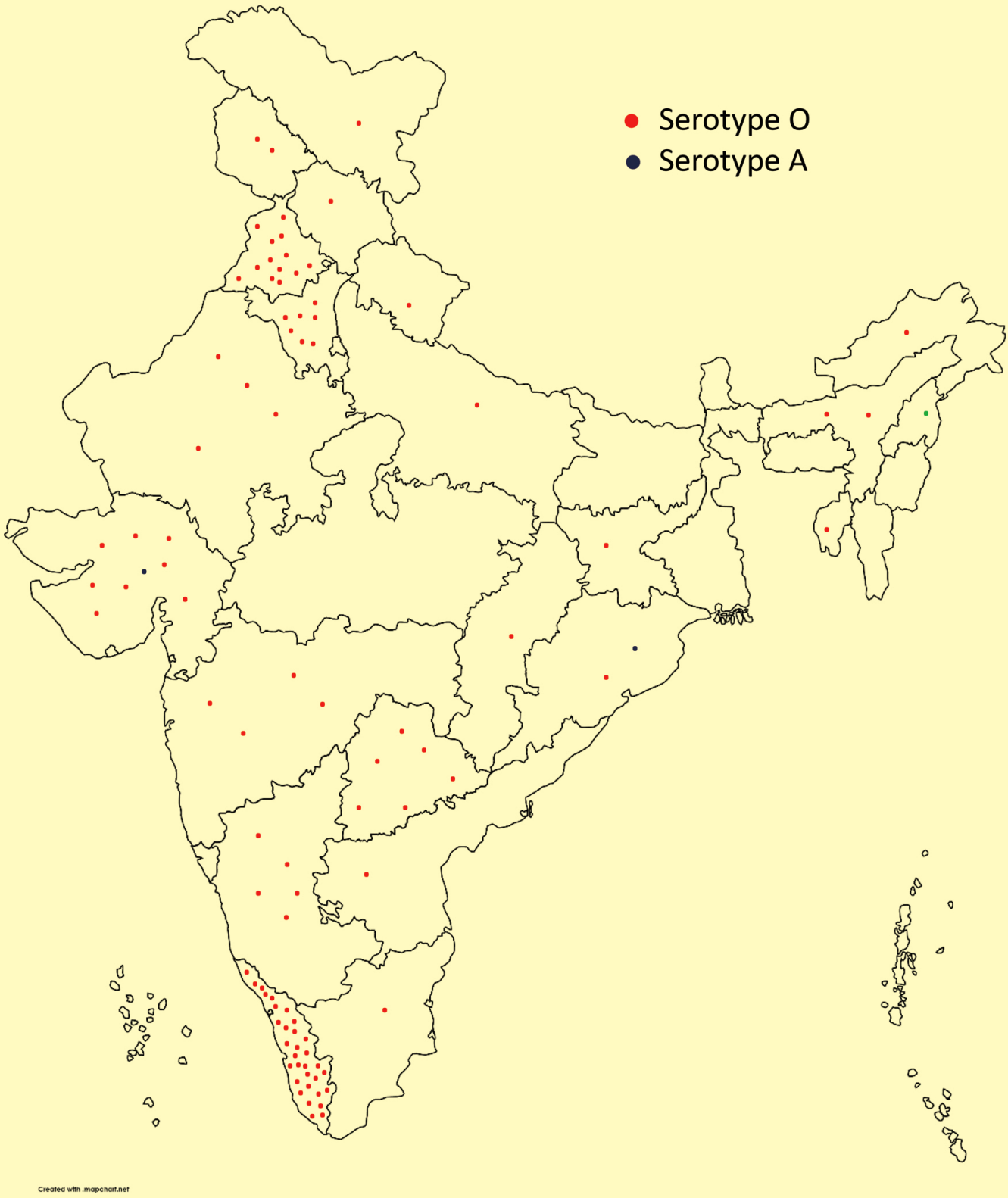


Fig 1. Outbreak-wise FMDV serotype distribution in different states during 2024.

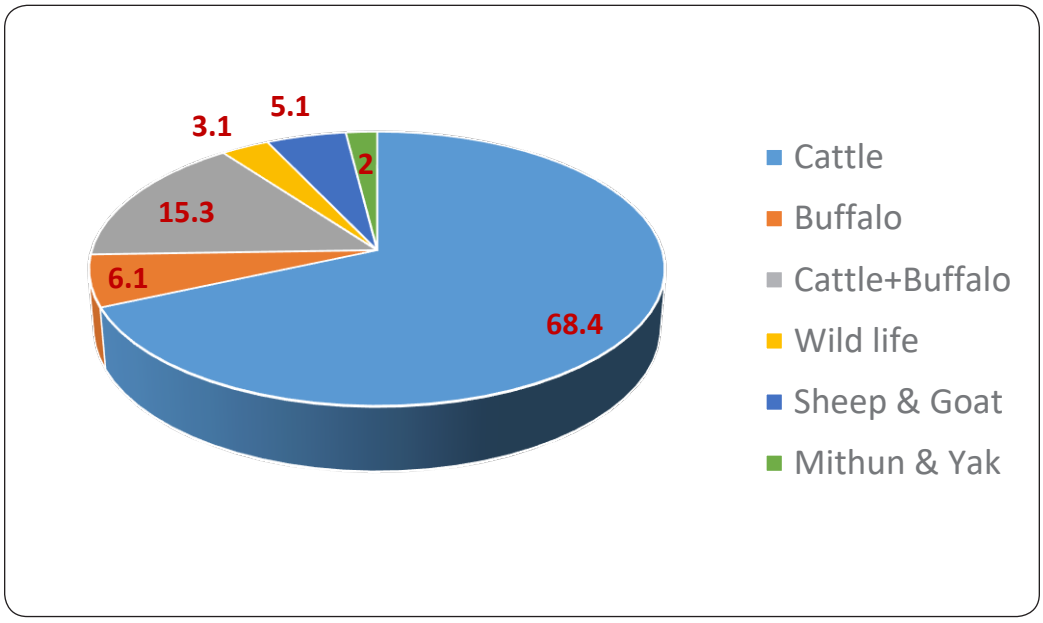


Fig 2. Species involvement in FMD outbreaks recorded during 2024

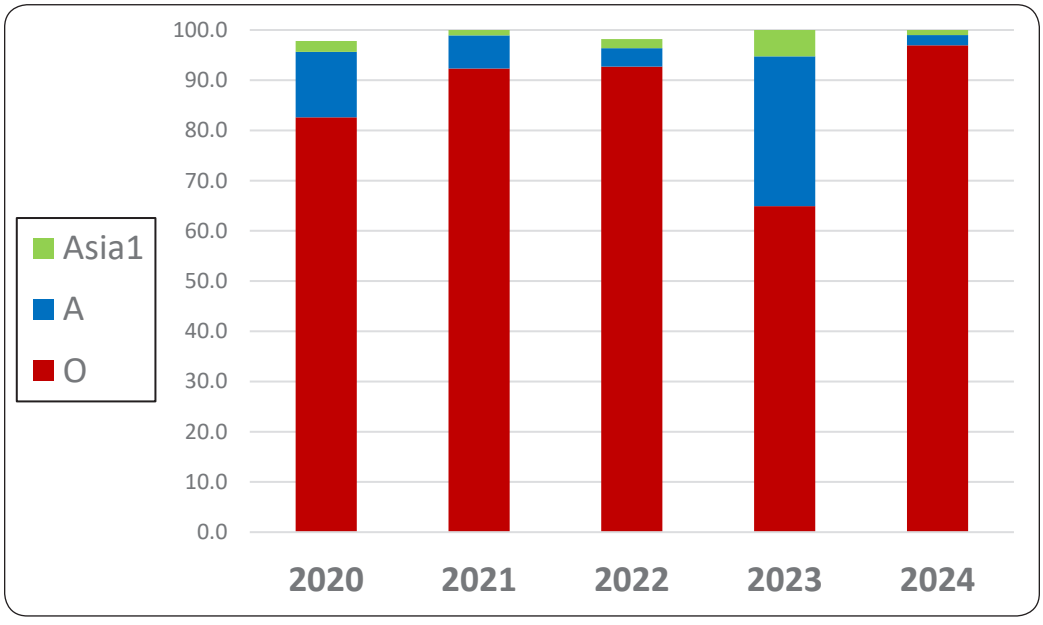


Fig 3. Serotype wise percent FMD outbreaks during last five years

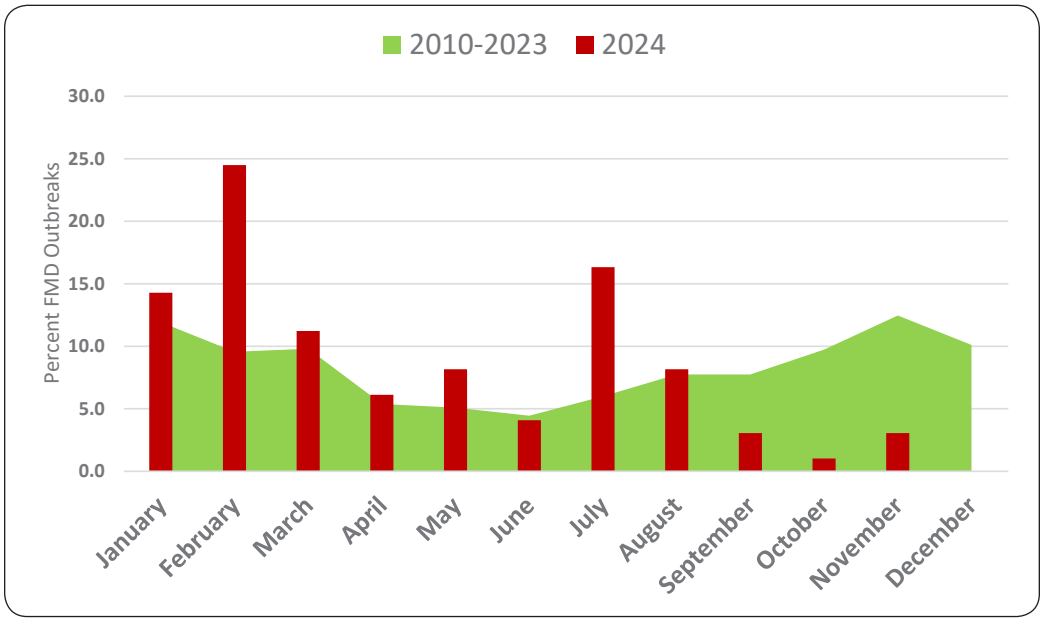


Fig 4. Month-wise percent FMD incidences during the year 2024 compared to last decade (2010-2023)

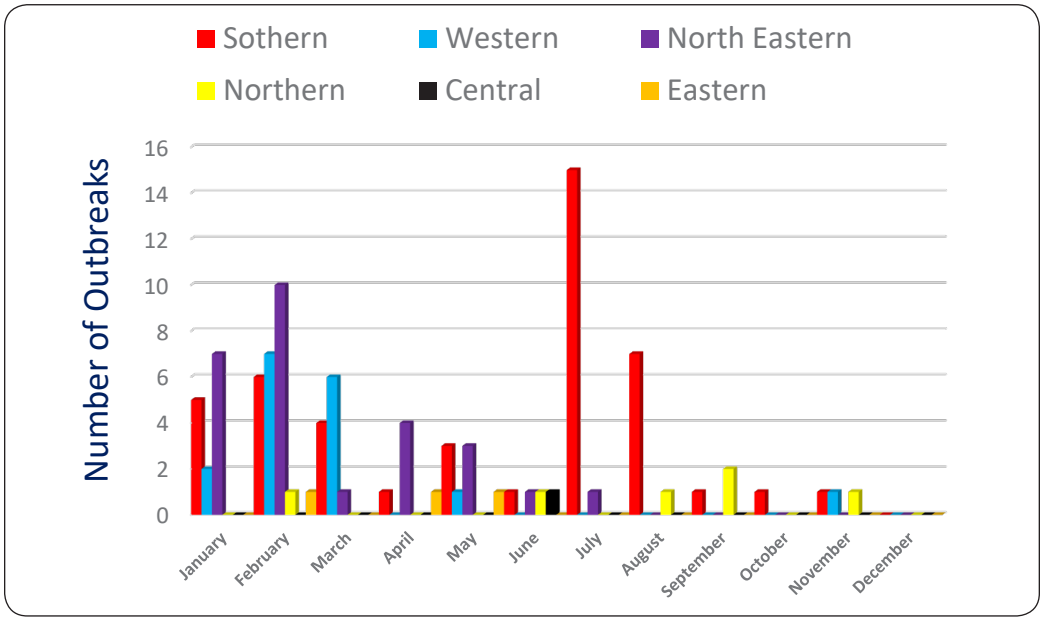


Fig 5. Month-wise percent FMD incidences during the year 2024 in different region

Southern Region

The southern region, comprising five states—Tamil Nadu, Karnataka, Telangana, Andhra Pradesh, and Kerala—along with two union territories, Puducherry and the Andaman and Nicobar Islands, accounts for approximately 21% of India's livestock population susceptible to FMD. This region is geographically isolated, with no international land borders, as it is surrounded by the ocean. FMDCP has been active in the southern peninsular region since 2010-11.

Tamil Nadu: In June, the state reported a single outbreak of FMD, which was attributed to serotype O. This incidence was documented in the Villupuram district. The animals in the affected area had last been vaccinated seven months prior to the outbreak. The morbidity rate was relatively low at 4.5%, and no fatalities were reported.

Kerala: The state reported a total of 32 outbreaks of FMD outbreaks across the year. These outbreaks were recorded in January (1), February (2), March (2), April (1), May (3), July (15), August (7), and November (1). Similar to 2023, the majority of outbreaks occurred during July and August, coinciding with the monsoon season and festivity. The affected districts included Kannur (4), Thiruvananthapuram (6), Kasargode (1), Kottayam (1), Wayanad (2), Thrissur (5), Malappuram (2), Kollam (2), Pathanamthitta (1), Ernakulam (3), and Alappuzha (5). Unlike 2023, when serotype A was associated with several outbreaks, it was entirely absent in 2024, as all 32 outbreaks were caused by serotype O. Implementing effective control measures remains critical to reducing the impact of FMD in the state.

Karnataka: Five outbreaks of FMD were reported in the state, all of which were attributed to serotype O. These outbreaks occurred in the districts of Mandya (2), Shimoga, Bangalore Urban, and Ramanagara. The highest number of outbreaks, totalling three, were reported in January, with one each occurring in February and March

Andhra Pradesh: An outbreak caused by serotype O was reported in the Srikakulam district. This outbreak occurred among sheep and was recorded in the month of September

Telangana: The state reported six outbreaks of FMD, all caused by serotype O. The highest number of outbreaks occurred in February, with three incidents, followed by one each in January, March, and October. Five of these outbreaks were reported from the field, including three in Khammam district, one in Kamareddy district, and one in Mahabubabad district. Additionally, one outbreak was reported at the Nehru Zoological Park in Bahadurpura, Hyderabad, where symptoms were observed in 10 Sambar Deer. Notably, a separate outbreak caused by serotype A had occurred earlier in July 2023 at the same zoo, affecting a horned antelope. Implementing effective measures to control the spread of FMD in both livestock and wildlife populations is crucial for managing the disease in the state.

Central Region

Central region comprises of two states (Madhya Pradesh and Chhattisgarh) and has about 10% of the FMD susceptible livestock of the country. The region shares no international border. The entire central region was covered under FMDCP and now NADCP/ LHDCP.

Chhattisgarh: FDMV serotype O caused an outbreak in the state in the months of June. The incidence was reported in antelope from Nandanvan Jungle Safari, Nava Raipur, Chhattisgarh.

Western Region

Western region comprises of three states (Maharashtra, Rajasthan, Goa and Gujarat) and about 22% of the FMD susceptible livestock of the country. The region shares international border with Pakistan. All the four states in the western region were covered under FMDCP since the year 2010-11.

Maharashtra: The state reported a total of four FMD outbreaks caused by serotype O in the month of March. All the outbreaks were reported in the Ahmednagar district. Notably, in both 2022 and 2023, the district recorded the highest number of FMD outbreaks. Due attention must be given to controlling FMD in Ahmednagar, as it appears to be a hotspot for the disease in the state

Gujarat: The state reported nine FMD outbreaks: two each in January and March, and five in February. The highest number of outbreaks (four) were reported in the Banaskantha district, followed by two in Gandhinagar, and one each in Ahmedabad, Patan, and Rajkot. The outbreak in the Rajkot district was caused by serotype A, while all others were due to serotype O. The suspected sources of the outbreaks were the purchase of new animals and animal movement

Rajasthan: Four FMD outbreaks caused by serotype O were reported in the state. Three outbreaks occurred in cattle and buffalo in the field, and one was reported in a sheep farm at ICAR-CSWRI, Avikanagar. The outbreaks were reported in Jalore (2) in February and May, and in Hanumangarh in February. At the CSWRI farm, the outbreak was recorded in November, which caused high mortality in lambs.

Eastern Region

Eastern region comprises of four states (West Bengal, Odisha, Bihar and Jharkhand) and about 22% of the FMD susceptible livestock of the country. This region shares international border with Bangladesh and Nepal. The entire region is covered under FMDCP since 2017.

Odisha: Two outbreaks were recorded in the state: one in the Puri district caused by serotype O and one in Bhubaneswar caused by serotype A. The outbreaks occurred in the months of April and May. Notably, in 2023, the state also reported an outbreak caused by serotype A.

Jharkhand: During the reported period, a single outbreak was serotype confirmed in the district of Ramgarh, affecting cattle. The causative agent was identified as serotype O, and the outbreak was recorded in the month of February.

Northern Region

Northern region comprises of five states and two UTs (Haryana, Punjab, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Jammu & Kashmir and Ladakh) and about 19% of the FMD susceptible livestock of the country. The region shares international borders with Pakistan, Afghanistan, Nepal and China. The entire Northern region was covered under FMDCP.

Haryana: The state reported seven outbreaks caused by serotype O. The highest number of outbreaks (four) occurred in Hisar, followed by two in the Jind district and one in Bhiwani. The outbreaks were recorded in January (2), February (3), March (1), and April (1). The affected species included cattle, buffalo, and goats.

Punjab: Thirteen outbreaks caused by serotype O were recorded in the state during the months of January (4), February (3), April (3), and May (3). The affected districts included Gurdaspur, Barnala (2), Bhatinda (4), Faridkot, Mansa, Sri Muktsar Sahib, Patiala (2), and Tarn Taran. Twelve outbreaks were reported in cattle and buffalo. One incident occurred at the Deer Farm in Patiala Zoo, District Patiala, in April, where blackbucks were affected, resulting in mortality.

Uttarakhand: The state recorded one confirmed FMD outbreak caused by serotype O, affecting cattle in the Garhwal district. The outbreak occurred in the month of January

Uttar Pradesh: A single outbreak caused by serotype O was reported in the Meerut district in the month of February.

Himachal Pradesh: One outbreak caused by serotype O was recorded in the state's Sirmour district. The outbreak was reported in the month of February

Jammu and Kashmir: Two outbreaks were recorded in the UT. Both the outbreaks were caused by serotype O. The outbreaks were recorded in February and June in Samba and Bandipora districts

Ladakh: One outbreak due to serotype O was recorded in Kargil district in the month of July

North Eastern Region

North eastern region comprises of eight states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura) and about 6% of the FMD susceptible livestock of the country. This region shares international borders with Nepal, China, Myanmar, Bangladesh and Bhutan.

Assam: The state reported two outbreaks, one each in June and August. Both outbreaks were recorded in bovines and were caused by serotype O. The outbreaks occurred in the districts of Darrang and Kamrup.

Arunachal Pradesh: One outbreak was reported in West Kameng district in Yak-Cattle hybrid in the month of November. The outbreak was caused by serotype O

Tripura: One FMD outbreak was type-confirmed and found to be caused by serotype O. The outbreaks were recorded in Gomati District in the month of September.

2.2 Characterization of FMDV and Epidemiology

2.2.1 Molecular Epidemiology

Serotype O

In serotype O, thirteen geographically restricted topotypes have been identified globally, including Europe-South America (EURO-SA), the Middle East-South Asia (ME-SA), South East Asia (SEA), China,

Indonesia (ISA), ISA-2, East Africa (EA)-1, EA-2, EA-3, EA-4, West Africa (WA), CEY-1, and WCSA-1. Among these, only the ME-SA topotype has been reported in India, characterized by the circulation of several genetic groups (lineages and sub-lineages) exhibiting more than 5% nucleotide variation in the 1D region. The Indian vaccine strain (INDR2/1975) belongs to the Branch B lineage. In South Asia, including India, the O/ME-SA/PanAsia and O/ME-SA/Ind2001 strains dominate within the ME-SA topotype. Since its initial detection in 2001, the O/ME-SA/Ind2001 lineage has diversified into at least five sub-lineages: Ind2001a, b, c, d, and e. Phylogenetic analyses revealed the emergence of sub-lineage O/ME-SA/Ind2001e in India in 2015. This sub-lineage caused sporadic cases between 2015 and 2017, leading to epidemic outbreaks in 2018. During that year, a new cluster, designated O/ME-SA/SA-2018, was identified, showing substantial genetic divergence from both the O/ME-SA/Ind2001 and O/ME-SA/PanAsia lineages. By 2021, the O/ME-SA/Ind2001e and O/ME-SA/SA-2018 lineages were implicated in FMD epidemics, with 60% of cases attributed to the former.

In 2024, a total of 59 field isolates of the FMD virus serotype O were sequenced and analyzed phylogenetically. Among these, 23 isolates clustered within the O/ME-SA/SA-2018 lineage, while 36 belonged to the O/ME-SA/Ind2001e lineage (Fig 6a and b). The O/ME-SA/Ind2001e and O/ME-SA/Cluster-2018 lineages accounted for 60% and 40% of the FMD outbreaks recorded in 2024, respectively. This represents a decline in the circulation of the O/ME-SA/Cluster-2018 lineage, which was responsible for 60% of the outbreaks in 2023.The O/ME-SA/SA-2018 isolates collected from Punjab, Gujarat, Maharashtra, and Rajasthan exhibited 100% sequence homology, suggesting a clear epidemiological link. A severe outbreak was reported at the sheep farm of ICAR-CSWRI in Avikanagar, Rajasthan, caused by the O/ME-SA/SA-2018 lineage. Isolates from this outbreak showed a close genetic match to field isolates from Rajasthan, implicating virus transmission due to inadequate biosecurity measures. In Haryana, FMD outbreaks were also attributed to the O/ME-SA/SA-2018 lineage. The O/ME-SA/Ind2001e lineage was isolated from at least ten states, including Kerala, Telangana, Andhra Pradesh, Arunachal Pradesh, Uttarakhand, Gujarat, Maharashtra, Jammu & Kashmir, and Ladakh. This lineage caused an FMD outbreak at the Yak Farm of ICAR-NRC Yak in Arunachal Pradesh, with the isolates showing close sequence homology to a field isolate from Maharashtra. Co-circulation of both lineages, O/ME-SA/SA-2018 and O/ME-SA/Ind2001e, was observed in Gujarat and Maharashtra, highlighting the complexity of the situation and frequent virus transmission.

Serotype A

The serotype A virus population is the most genetically and antigenically diverse among the three serotypes prevailing in the country. Molecular phylogenetic studies have identified the circulation of four genotypes (2, 10, 16, and 18) so far of serotype A, displaying more than 15% nucleotide divergence in the 1D region sequence. Since 2001, genotype 18 has been solely responsible for all field outbreaks and seems to have outcompeted all other circulating genotypes. Within genotype 18, a distinct lineage showing an amino acid deletion at the 59th position in capsid protein VP3 (VP3^{59}-deletion group) emerged in late 2002 and dominated field outbreaks during 2002–03. In 2019, a novel genetic lineage, termed 'G-18/non-deletion/2019' first identified in Maharashtra has established itself in India. In 2024, sequences from ten isolates collected from Kerala, Gujarat, and Odisha were analyzed. Notably, six isolates from Kerala were sampled from field outbreaks during 2023. Phylogenetic analysis confirmed that all the isolates clustered within the 'G-18/non-deletion/2019' lineage (Fig. 7), underscoring its exclusive presence in India since its emergence in 2019.

Full genome characteristics of new lineage of serotype A

The complete genome sequences of G-18/non-deletion/2019 lineage isolates were analysed. The nucleotide identity among A/ASIA/G-18/2019 lineage isolates at the ORF level ranged from 92.6% to 93.8%. These isolates showed the highest nucleotide similarity (92.0%–92.4%) with a G-18 VP3^{59} deletion group isolate collected in India in 2007. Conversely, they exhibited the lowest sequence identity (83.7%–83.9%) with an A/AFRICA/G-IV (G-15) isolate from 2011. Additionally, the 2019 novel lineage isolates displayed nucleotide identities of 90.9%–91.1% with the currently used Indian serotype A vaccine strain IND40/2000 and 89.2%–89.8% with the candidate vaccine strain IND27/2011. All G-18/2019 lineage isolates showed a close antigenic match with IND27/2011 but antigenic divergence from IND40/2000. Compared

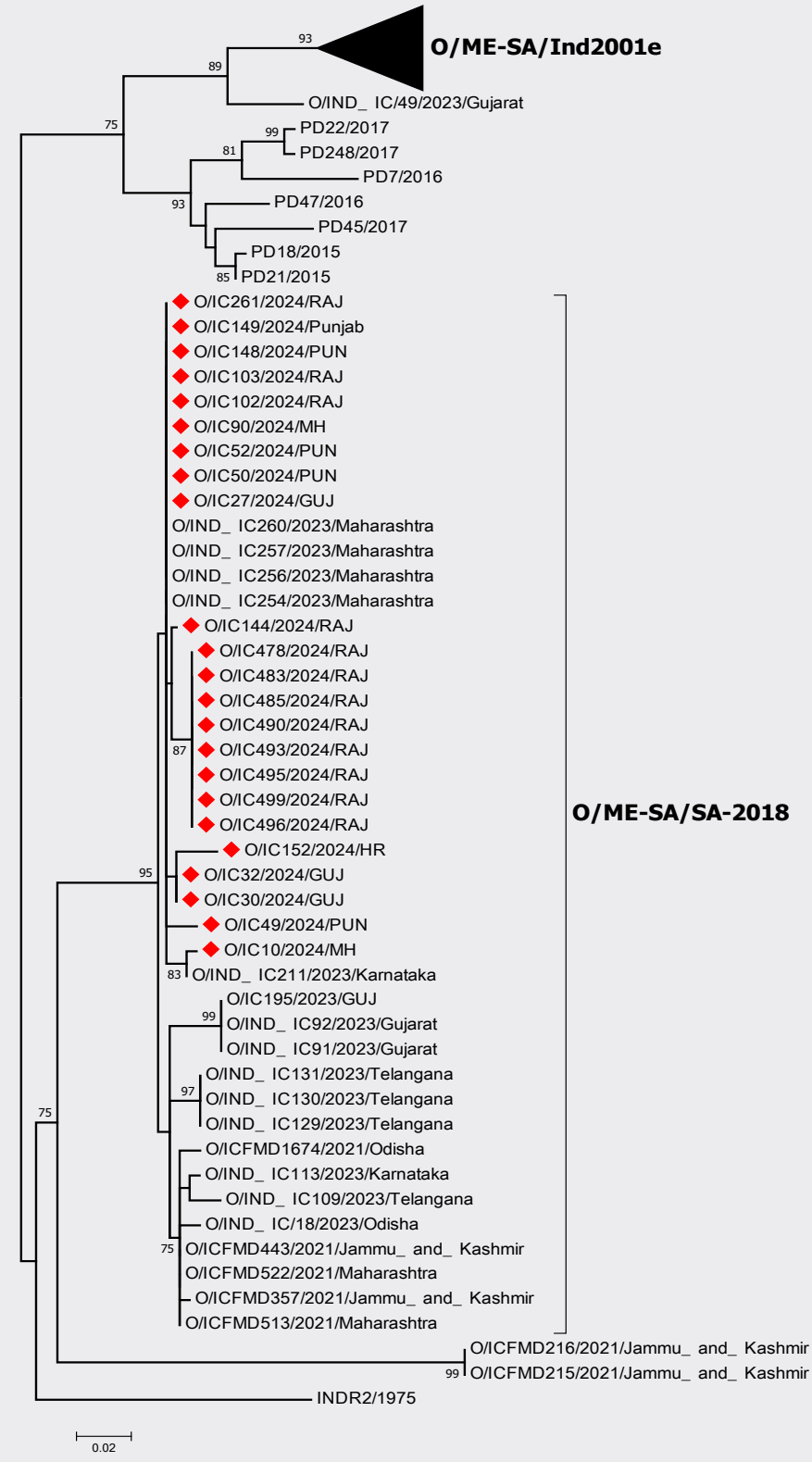


Fig 6a. Maximum Likelihood phylogenetic tree at VP1 coding region of Indian serotype O FMD virus isolates during 2024. Out of 59 Isolates sequenced during 2024, 23 isolates grouped with in O/ME-SA/SA-2018 (indicated by red rhombus).

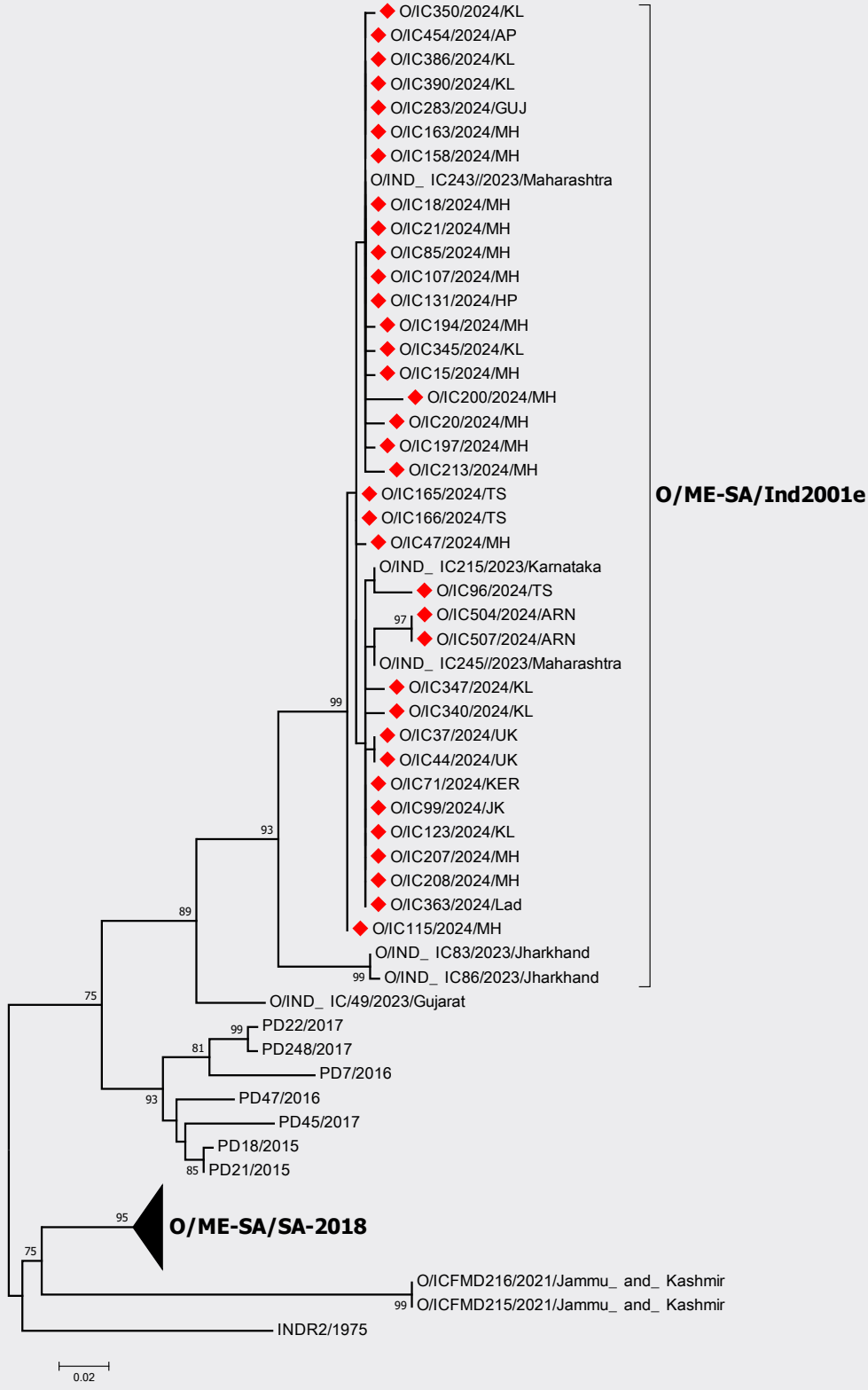


Fig 6b. Maximum Likelihood phylogenetic tree at VP1 coding region of Indian serotype O FMD virus isolates during 2024. Out of 59 Isolates sequenced during 2024, 36 isolates grouped with in O/ME-SA/Ind2001e lineage (indicated by red rhombus).

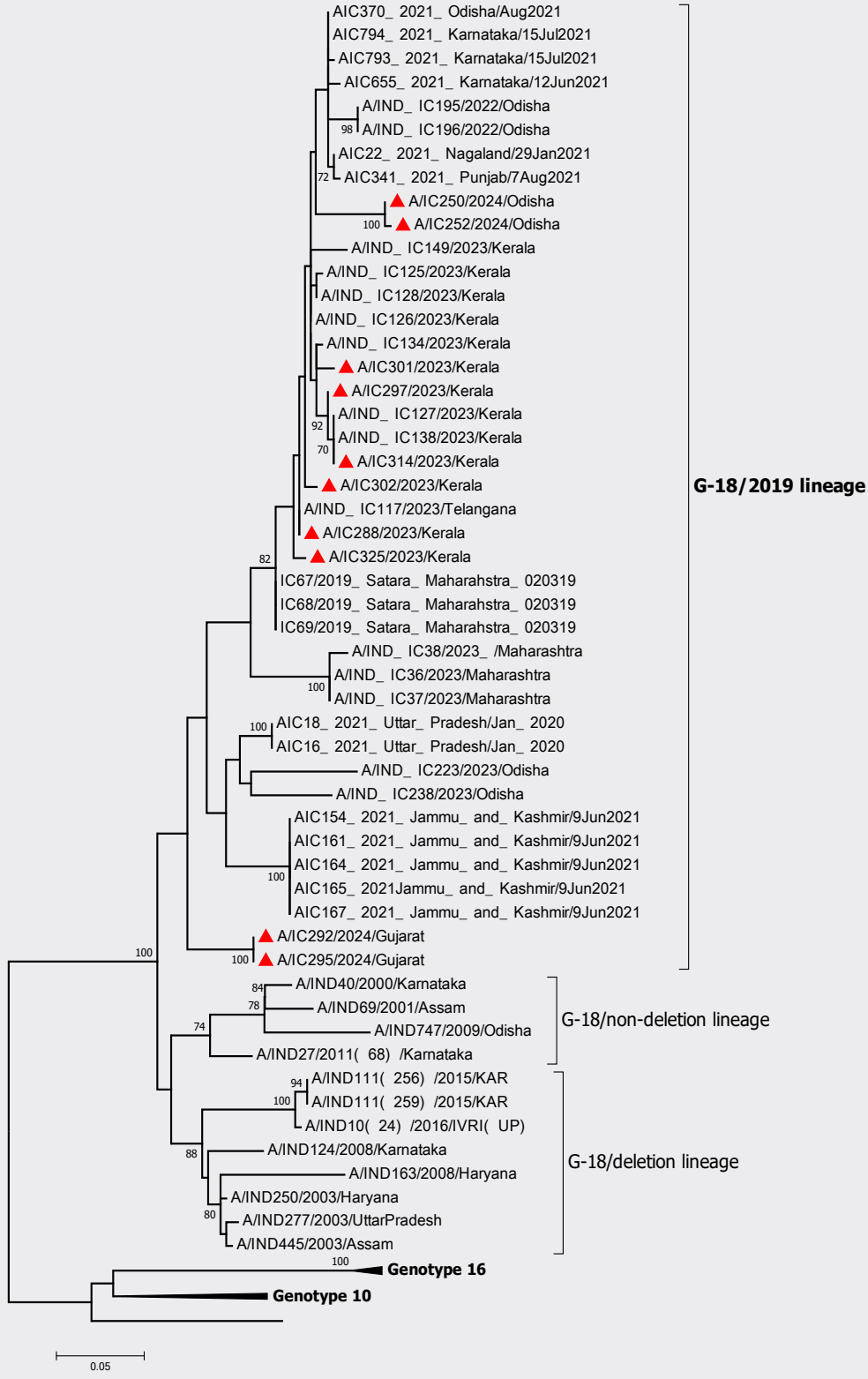


Fig 7. Maximum Likelihood phylogenetic tree at VP1 coding region of Indian serotype A FMD virus isolates during 2024. The analysis showed circulation of G-18/non-deletion/2019 lineage. Isolates (n=10) sequenced during 2024 are indicated by red triangle.

to IND40/2000, the four G-18/2019 lineage viruses exhibited changes at eight, five, and two positions in VP1, VP2, and VP3, respectively. Similarly, relative to IND27/2011, they showed alterations at three, four, and six positions in VP1, VP2, and VP3, respectively. Across both vaccine strains, the new genetic lineage viruses exhibited three, two, and four amino acid (aa) changes in VP1, VP2, and VP3, respectively. Of these, antigenically significant changes were identified at four positions in VP1 (83, 139, 154, and 170), one in VP2 (133), and one in VP3 (59). The G-18/2019 viruses displayed variations at VP1 positions 83, 154, and 170, as well as VP3 position 59 when compared to IND40/2000. Meanwhile, relative to IND27/2011, changes were observed at VP1-139 and VP2-133. In the LF-UTR, a block deletion of nucleotides was found in three FMDV isolates from the novel lineage. Two isolates (AIC169/2019 and AIC195/2022) exhibited a 43-nucleotide deletion, while one isolate (AIC370/2021) had a 16-nucleotide deletion. Despite these variations, critical residues and functional motifs in the non-structural protein coding regions remained fully conserved across all isolates.

Serotype Asia1

Previous studies based on 1D/VP1 gene phylogeny have identified three major lineages (B, C, and D) among Indian serotype Asia1 field isolates. Lineage B, which includes the current serotype Asia1 vaccine strain (IND63/1972), was last recorded in 2000. Lineage D emerged in late 2001 and dominated outbreaks between 2002 and 2004. Lineage C was predominant during 1998–2002 but re-emerged as sub-lineage CII from 2005 onwards. Globally, FMDV serotype Asia1 isolates have been classified into nine genetic groups (G I–IX) since 2004. Indian isolates from 2001–2004 (lineage D) were clustered within Group III, while isolates from 2005 onwards were associated with Group VIII. In 2020, a novel genetic group, G-IX, emerged in India, circulating exclusively during 2021 and 2022. In 2023, an Asia1 isolate from Gujarat was found to cluster within Group VIII, which was last detected in India in 2018 (Fig. 8). This suggests re-emergence of Group IX in the country. The frequent emergence and re-emergence of lineages in serotype Asia1 highlights its unique evolutionary trajectory compared to serotypes O and A.

Full genome characteristics of G-IX isolates

The length of the open reading frame (ORF) of the two G-IX isolates was 6990 nucleotides without any deletion or insertion. The G-IX isolates showed the highest sequence homology with an isolate of G-III at the ORF, L, P2, and P3 regions, and with an isolate of G-VIII at the P1 region. Phylogenetic analysis based on the capsid region (P1) supports the hypothesis that G-VIII and G-IX originated from a common ancestor, as speculated. On the other hand, in the regions of ORF and L, the analyses indicated that G-VIII and G-III radiated from a common ancestor. Further, VP1 region-based phylogenetic analyses revealed the re-emergence of G-VIII after a gap of 3 years. One isolate of G-VIII collected during 2023 revealed a codon insertion in the G-H loop of VP1.

Machine learning in molecular epidemiology

Molecular epidemiology of FMD virus is crucial to implement its control strategy, which primarily relies on VP1 nucleotide sequence data to know the serotype, topotype, and lineage of the virus causing outbreak. The existing approach including serotyping is biological in nature, which are time-consuming and risky. Further, a computational solution is currently unavailable for large-scale molecular epidemiology of FMD virus isolates. Thus, ICAR-NIFMD developed a computational approach for large-scale and comprehensive molecular epidemiology of the FMD virus.

This approach for topotype and lineage prediction, which achieved accuracy ≥96% and precision ≥95% on cross-validated data. The independent validation of the computational approach observed accuracies ≥98%, ≥90%, and ≥80% for serotype, topotype, and lineage prediction, respectively. On wet-lab data, this technique provided results in fewer seconds and achieved accuracies of 100%, 100% and 96% for serotype, topotype, and lineage prediction, respectively, when benchmarked with phylogenetic analysis.

MolEpidPred AI web-server

AI prediction server, *MolEpidPred* was developed for the researchers across the world for molecular epidemiology of the FMD virus, so that the computational approach could be easily accessed. MolEpidPred is a user-friendly ML interface designed to predict molecular epidemiology of the FMD virus using VP1 sequence data with a single click. The user interface of the server was designed using HTML, JavaScript, CSS, and Bootstrap. The backend of the web-server was developed using ASP.NET and R-program

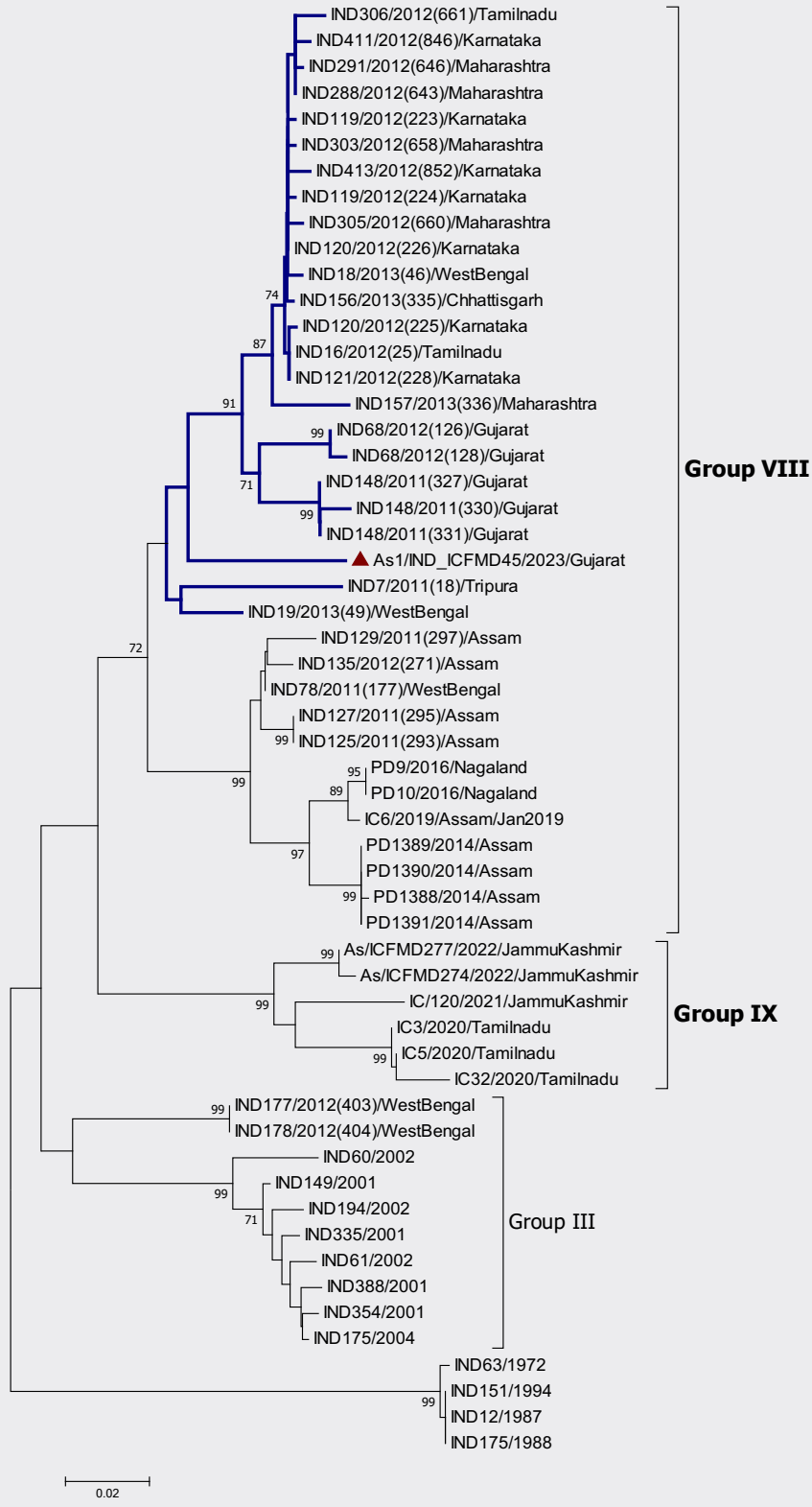


Fig 8. Maximum Likelihood phylogenetic tree at VP1 coding region of Indian serotype Asia1 FMD virus isolates during 2023. Isolates (n=1) sequenced during 2023 are indicated by brown triangle

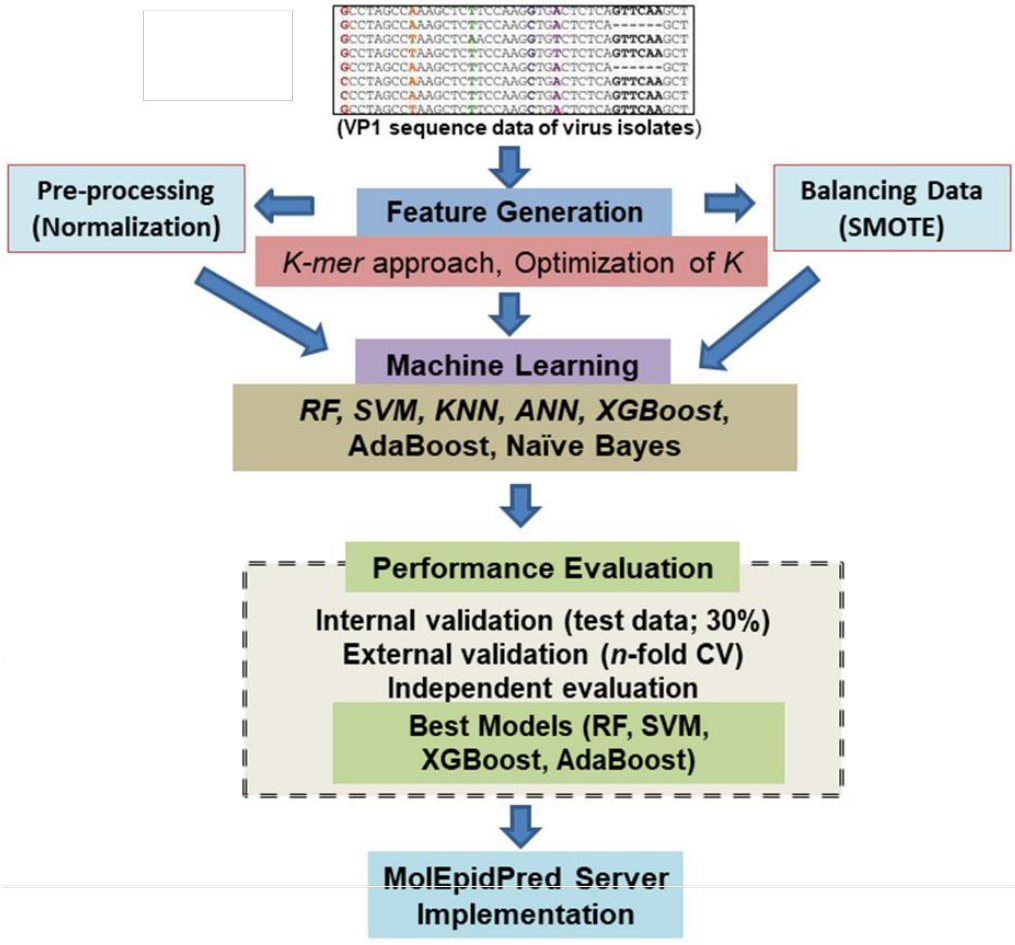


Fig 9. Homepage of AI-based web server, MolEPidPred, developed for molecular epidemiology of the FMD virus

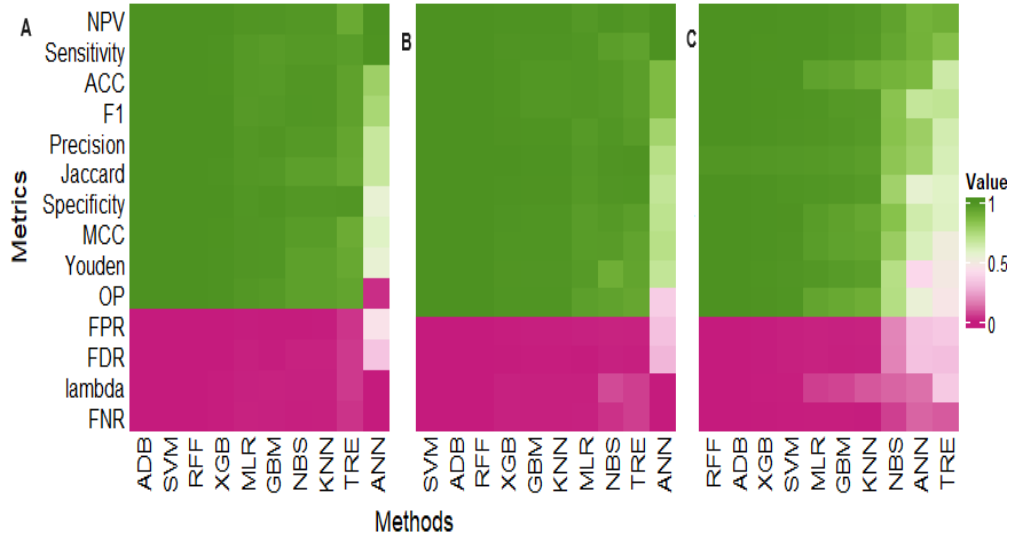


Fig 10. Performance evaluation of the ten machine learning models for molecular epidemiological prediction on independent datasets. support vector machine (SVM), random forest (RFF), adaptive boosting (ADB), extreme gradient boosting (XGB), gradient boosting machine (GBM), artificial neural network (ANN), and decision tree (TRE); *K-th* nearest neighbour (KNN), multiclass logistic regression (MLR and naïve Bayes (NBS).

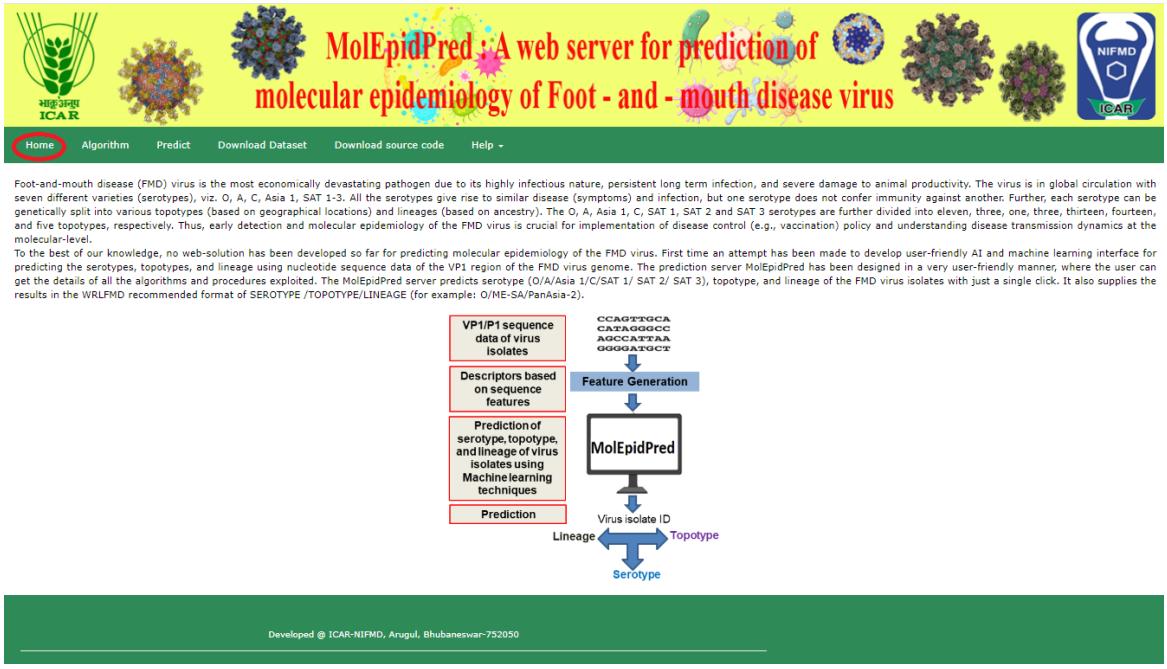


Fig 11. Homepage of AI-based web server, MolEPidPred, developed for molecular epidemiology of the FMD virus

was integrated as statistical engine for execution of the proposed approach. The intuitive interface of the MolEpidPred enables easy sequence upload *via* copy-paste for fewer isolates in FASTA format or by uploading FASTA file for larger datasets. The user can also select the suitable learning options for the prediction. The predicted epidemiological components of the virus are displayed in tabular format. Since, there was little variation in performance of four models (SVM, RF, ADB, and XGB) in terms of serotype prediction, hence these are implemented in the server. Further, an additional option of simultaneously considering all these models was given, where the result from each technique was provided in WRLFMD recommended notation of 'Serotype / Topotype / Lineage'. The researchers can use the common results or results from majority of options for highly confident prediction. For offline use of our computational approach, the user can download and utilize the source code and training dataset. Users can download output files in .txt/.csv format from the predict tab of the server and access interactive visualizations along with comprehensive documentation for effective.

2.2.2 Vaccine matching

Vaccine matching analyses was conducted using bovine vaccinate serum (BVS) against the corresponding vaccine strains and field isolates to evaluate the suitability of the vaccine strain in use. Antibody titers were determined as the reciprocal of the highest serum dilution that neutralized 100 TCID50 in 50% of the wells. The relationship value (r-value) was calculated as the ratio of the antibody titer against field isolates to that against the vaccine strain. An r-value greater than 0.3 indicates sufficient antigenic similarity between field isolates and vaccine strains, while an r-value less than 0.3 suggests antigenic divergence. The test was performed in triplicate, and the log10 titers were averaged to calculate the r-value. In 2024, vaccine matching analyses were carried out on 18 FMDV field strains (**17 Serotype O and 1 Serotype A**) against the respective vaccine strains. No samples for Serotype Asia1 were received.

Serotype O

Seventeen serotype O FMDV field isolates collected in 2024 were analyzed for vaccine matching using BVS against the in-use serotype O vaccine strain, O INDR2/1975. The isolates originated from Maharashtra, Gujarat, Punjab, Himachal Pradesh, Haryana, Telangana, and Kerala. The analysis revealed that all isolates exhibited an r-value >0.3 with the vaccine strain O INDR2/1975, demonstrating an excellent antigenic match with both new lineages circulating in India (Fig 12). These findings confirm that the current serotype O vaccine strain remains highly effective for use in Indian vaccine formulations, providing robust antigenic coverage even 40 years after its isolation.

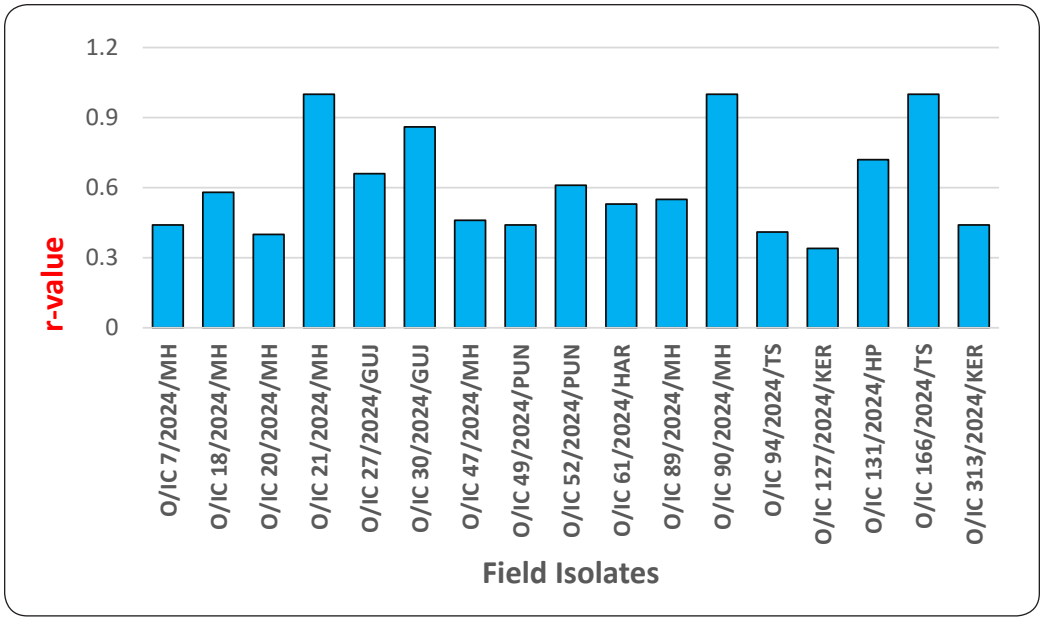


Fig 12. The antigenic relationship value of FMDV serotype O field isolates collected during the year 2024.

Serotype A

Since 2012–13, considerable number of serotype A FMD virus field outbreak strain in India have shown significant antigenic divergence from the current vaccine strain, A/IND40/2000. To address this, ICAR-NIFMD conducted studies to identify a suitable alternative serotype A vaccine strain which can confer adequate coverage to the observed antigenic diversity. Out of eight initially selected strains, A/IND27/2011 was identified as the most promising candidate due to its homology with the broader spectrum of circulating field strains. Further evaluation done at ICAR-IVRI, Bengaluru, confirmed its suitability as a vaccine candidate. In 2024, serotype A isolate from Odisha was subjected to vaccine matching against both the current vaccine strain, A/IND40/2000, and the candidate strain, A/IND27/2011. The isolate exhibited poor antigenic relatedness with A/IND40/2000 while showing higher antigenic homology with A/IND27/2011 (Fig 13). Vaccine matching findings with the recent field isolates

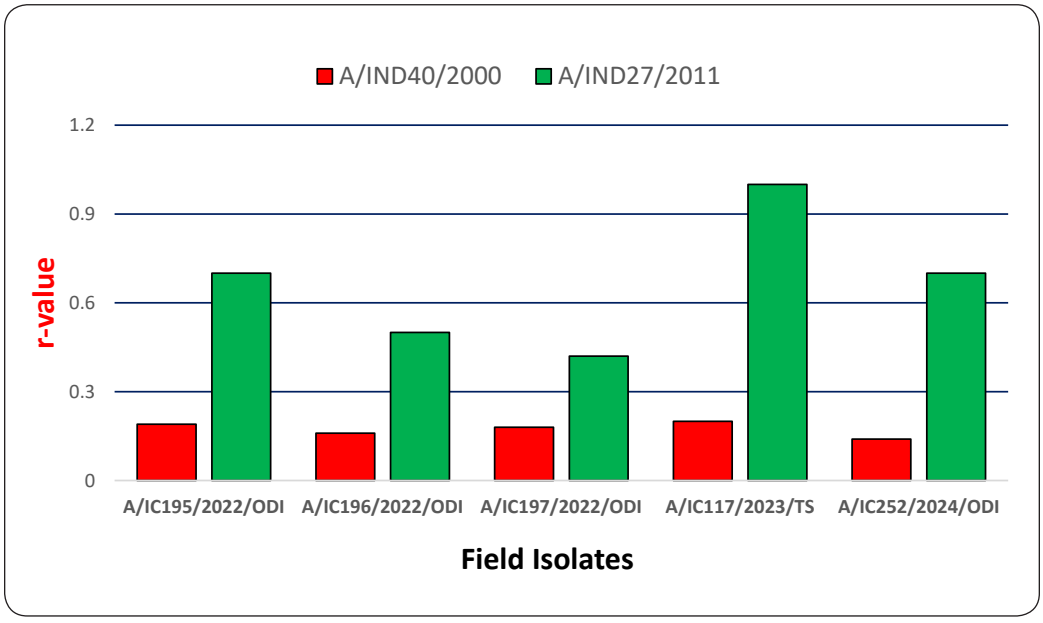


Fig 13. The antigenic relationship value of FMDV serotype A field isolates collected during the years 2022 -2024

suggests in favour of inclusion of the alternate vaccine strain A/IND27/2011 in Indian vaccine formulation. The strain is in process of commercialization and has been assigned to Agrinnovate India Limited.

Serotype Asia1

The relationship value of FMDV serotype Asia1 field isolates sampled during 2020–2023 was assessed using BVS against the in-use vaccine strain IND63/1972. The analysis revealed a strong antigenic match between the field isolates and the vaccine strain, confirming the continued suitability of IND63/1972 for vaccination purposes (Fig 14).

2.3 FMD Serosurveillance

Serosurveillance in Bovine

In India, the primary approach to controlling FMD is vaccination with inactivated vaccine. To effectively implement control programs and evaluate vaccination success, it is crucial to differentiate between infected and vaccinated animals. This distinction plays a key role in serological surveys, particularly after ring vaccination, as well as in import/export serology to detect signs of infection. During active viral replication following FMD virus infection, NSPs are produced, triggering the formation of anti-NSP antibodies. However, animals vaccinated with inactivated virus vaccines without infection do not develop these antibodies. For sero-surveillance using the 3AB3-NSP-based method, a two-stage sampling strategy was implemented, with a minimum design prevalence of 1% at the village level and 5% between villages. The sampling design was developed in collaboration between ICAR-NIFMD and ICAR-NIVEDI. Typically, NSP sero-surveillance targets younger animals aged 6 to 18 months, as repeated vaccinations with even high-quality purified vaccines may lead to false-positive results in NSP ELISA tests.

In 2024, a total of 70,119 bovine serum samples (48,555 from cattle and 21,564 from buffaloes) were randomly collected from different regions of the country as per the sampling plan. These samples were analyzed using the r3AB3 NSP-ELISA to determine the presence of NSP antibodies (NSP-Ab), which indicate FMD virus exposure regardless of vaccination status. The results showed an overall seropositivity rate (DIVA positive) of 13.9% (Table 3). DIVA reactivity, which had remained stable at about 16% between 2021 and 2023, showed a declining trend in 2024. The highest FMD seroprevalence was recorded in West Bengal, Nagaland, and Jammu & Kashmir, while lower seroprevalence was observed in Andaman & Nicobar Islands, Sikkim, and Arunachal Pradesh. Species-wise analysis indicated that cattle exhibited a higher seroprevalence rate (17.6%) compared to buffaloes (6.5%). The percentage of NSP antibody prevalence across different states is illustrated in Figure 15. Although FMD outbreaks have fluctuated over the years, there has been a steady decline in NSP antibody prevalence in the country, except for 2021, 2022 and 2023 (Fig 16).

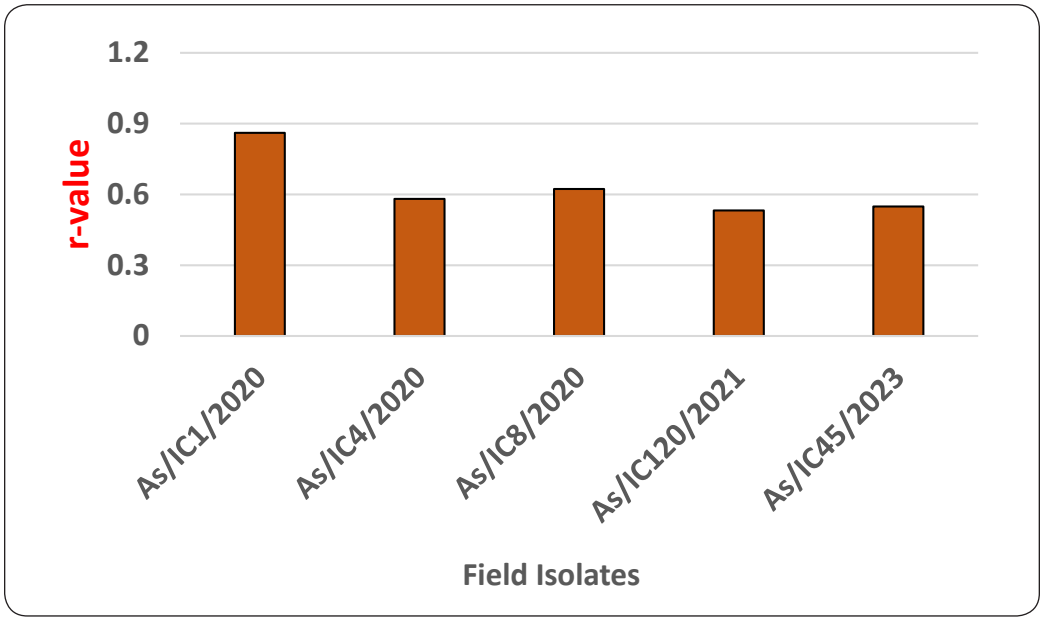


Fig 14. The antigenic relationship value of FMDV serotype Asia1 field isolates collected during the years 2022 and 2023

Table 3. NSP Positivity/ Reactivity during the year 2024 in cattle and buffalo of India

Sl. No.	State/UT	Cattle		Buffalo		No. of samples tested	% NSP Positive
		No. of samples tested	% NSP Positive	No. of samples tested	% NSP Positive		
1	Andhra Pradesh	3022	16.8	3083	2.3	6105	9.5
2	Andaman	818	4.8	-	-	818	4.8
3	Arunachal Pradesh	284	3.9	-	-	284	3.9
4	Assam	1884	17.0	84	11.9	1968	16.8
5	Chhattisgarh	747	17.7	59	10.2	806	17.1
6	Delhi	160	18.8	172	0.6	332	12.3
7	Goa	377	7.7	269	2.6	646	5.6
8	Gujarat	1745	11.0	1887	1.4	3632	6.0
9	Himachal Pradesh	864	6.9	520	3.1	1384	5.5
10	Haryana	222	15.3	983	2.0	1205	4.5
11	Jammu & Kashmir	1808	31.5	-	-	1808	31.5
12	Jharkhand	655	17.6	66	22.7	721	18.0
13	Kerala	465	23.2	11	0.0	476	22.7
14	Karnataka	3732	11.7	759	3.6	4491	10.3
15	Madhya Pradesh	3074	20.0	1618	7.5	4692	15.7
16	Maharashtra	2013	30.5	778	13.0	2791	25.6
17	Manipur	749	13.2	129	10.1	878	12.8
18	Meghalaya	2164	16.8	-	-	2164	16.8
19	Mizoram	1436	17.8	41	0.0	1477	17.3
20	Nagaland	793	47.3	-	-	793	47.3
21	Odisha	3947	20.1	203	13.8	4150	19.8
22	Pondicherry	624	11.5	-	-	624	11.5
23	Punjab	888	13.2	596	21.1	1484	16.4
24	Rajasthan	2062	3.0	1858	18.2	3920	10.2
25	Sikkim	54	3.7	-	-	54	3.7
26	Tamil Nadu	1007	24.7	37	5.4	1044	24.0
27	Telangana	4323	7.0	4452	4.2	8775	5.6
28	Tripura	1280	12.9	-	-	1280	12.9
29	Uttarakhand	2683	18.2	1012	6.4	3695	15.0
30	Uttar Pradesh	2017	16.5	2896	6.9	4913	10.8
31	West Bengal	2658	31.5	51	5.9	2709	31.0
Total		**48555**	**17.1**	**21564**	**6.4**	**70119**	**13.9**

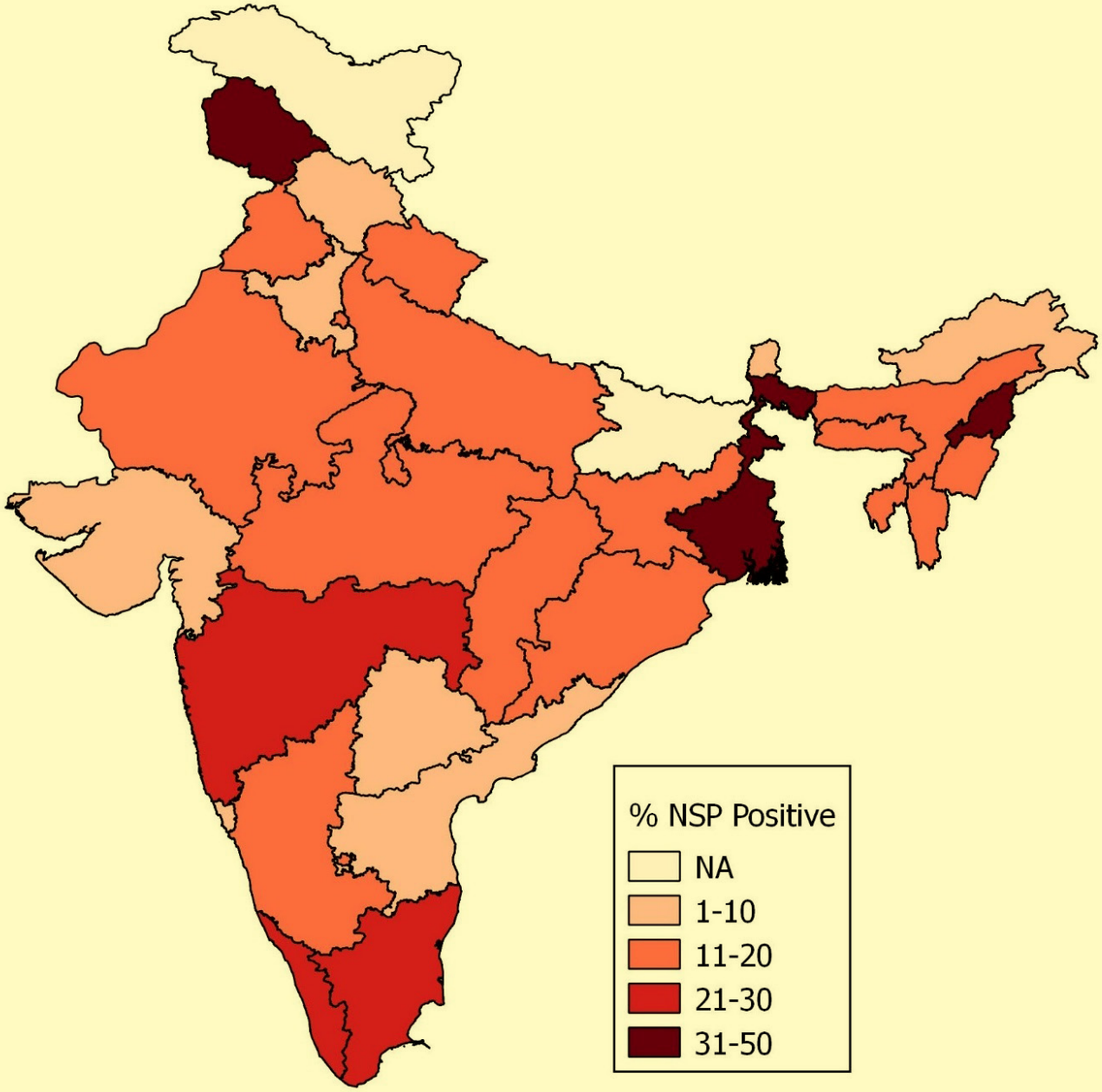


Fig 15. State-wise percent NSP antibody prevalence in bovine during 2024

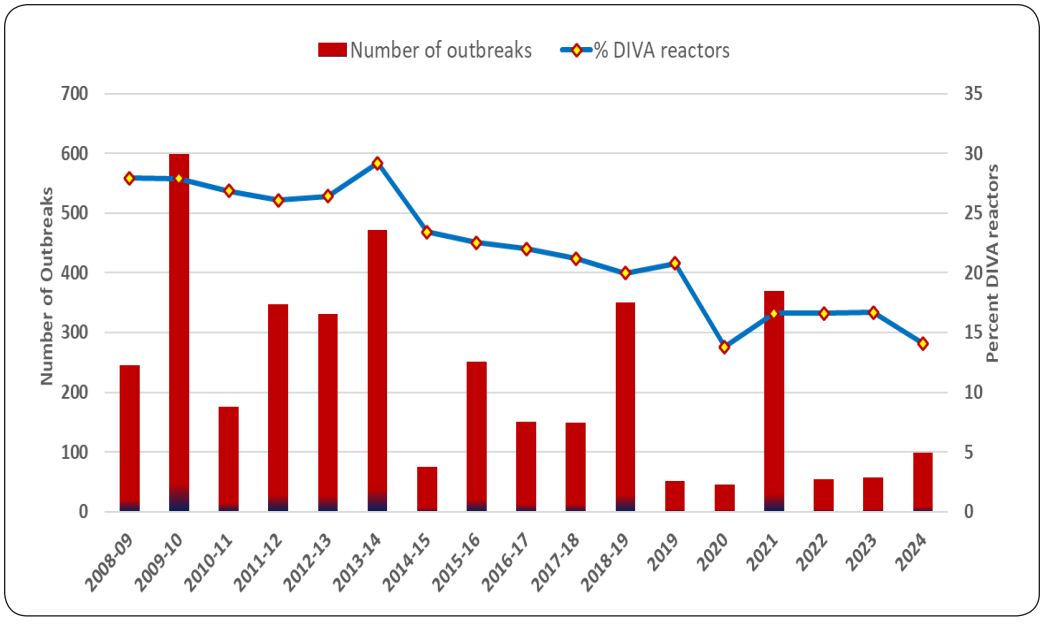


Fig 16. DIVA positivity/reactivity over the years in bovine population of India vis a vis number of FMD outbreaks

Serosurveillance in Caprine, Ovine and Swine

To understand the role of small ruminants and pigs in the epidemiology of FMD and to inform FMD management strategies, particularly vaccination, the surveillance in these species is crucial. Serum samples from randomly selected sheep, goats, and pigs were tested to determine the prevalence of NSP antibodies. The results revealed that the prevalence of NSP antibodies in sheep and goats was lower than the national average of 14.1% observed in cattle and buffalo (Table 4 and Fig 17). In India, routine FMD vaccination under the FMD Control Programme is currently limited to cattle and buffalo, excluding small ruminants and pigs. In this context, goats could serve as sentinel animals or indicators of viral transmission within cattle and buffalo. The elevated levels of NSP antibodies in goats during 2022 may be attributed to the increased number of FMD outbreaks in 2021. Although the samples were collected from specific states, the rise in NSP antibody prevalence in 2024 clearly points to active circulation of the virus.

Sentinel surveillance

Sheep and goats, typically not vaccinated against FMD, serve as ideal populations for NSP antibody surveillance. Detection of NSP antibodies in these animals indicates

Table 4. NSP positivity/reactivity during the year 2024 in small ruminants and pigs

	Sheep		Goat		Total	
State/UT	No. of samples tested	% NSP Positive	No. of samples tested	% NSP Positive	No. of samples tested	% NSP Positive
Jharkhand	-	-	473	15.2	473	15.2
Karnataka	500	3.2	409	8.8	909	5.7
Madhya Pradesh	18	0	2228	10.2	2246	10.1
Manipur	-	-	111	26.1	111	26.1
Odisha	461	6.7	2725	7.8	3186	7.6
Total	**979**	**4.8**	**5946**	**9.7**	**6925**	**9.0**

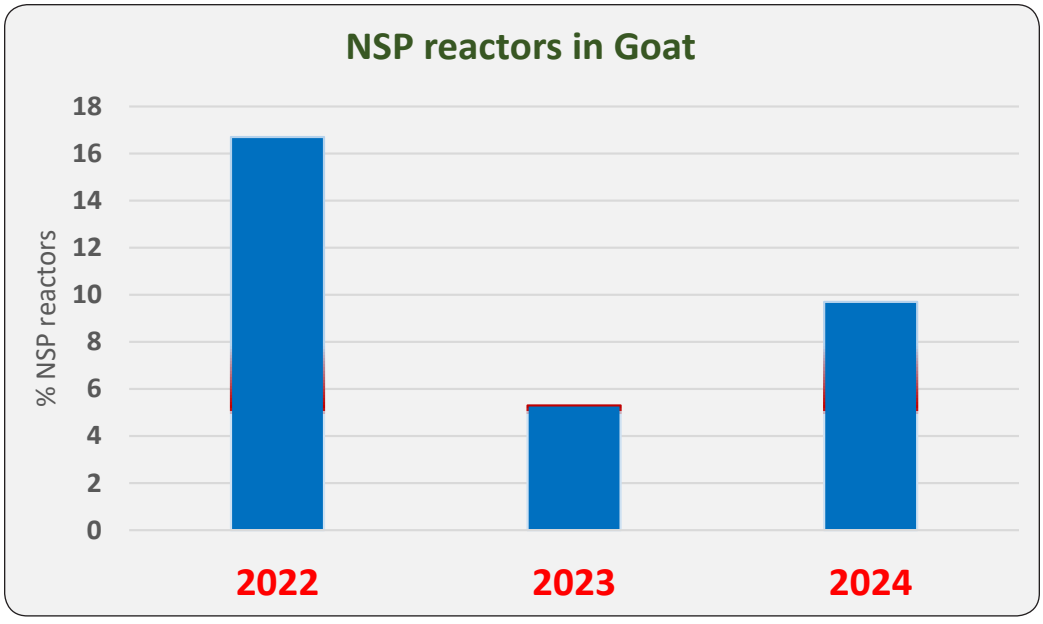


Fig 17. Percent NSP antibody prevalence in goat population during 2022-2024

natural infection, providing unfiltered insights into FMD prevalence. This approach establishes baseline data for infection dynamics and highlights the virus's persistence in the environment. Sentinel surveillance was initiated in 2024 in collaboration with ICAR-NIVEDI, Bengaluru. Under this programme, serum samples from the states of Karnataka, Andhra Pradesh and Ladakh were tested during 2024 (Table 5).

Slaughter house surveillance

In 2024, a total of 270 goat serum samples were collected from local butcher shops in Odisha and tested using the r3 AB3 NSP DIVA ELISA. The results showed an overall positivity rate of 6.7%. Additionally, 23 oral swab samples were collected from goats at local butcher shops and screened for the presence of FMDV RNA using an OIE-approved TaqMan probe-based FMDV pan-serotype RT-qPCR assay targeting the FMDV 5' UTR region. Of these, 4 samples were found positive for FMDV RNA. Further analysis using RT-mPCR confirmed the presence of serotype-O FMDV in the positive samples. This active surveillance offers a reliable overview of disease prevalence, which is crucial for endemic countries like India as they progress through FMD control pathways. The findings are instrumental in developing strategies for the control and prevention of FMDV infections.

Surveillance at wildlife-livestock interface

In collaboration with the Wildlife Conservation Trust (WCT), Mumbai, a serosurveillance study for the FMD virus was conducted at the wildlife-livestock interface (WLI) in the buffer and core zones of six Tiger Reserves in Madhya Pradesh, India (Bandhavgarh, Panna, Pench, Sanjay Dubri, Satpura, and Kanha). The first round of serum sampling (n=1257) was carried out between December 2023 and February 2024, while the second round (n=1203) took place between July and September 2024. In total, 2460 samples were collected from cattle, buffaloes, and goats. The serum samples were tested for the presence of anti-3AB3 non-structural protein (NSP) antibodies against FMDV using the r3AB3 iELISA test.

During the first round of surveillance at WLI, 3AB3 NSP ELISA detected anti-3AB3 NSP antibodies in 13.25% of cattle, 1.50% of buffaloes, and 25.99% of goats. In the second round, the positivity rates were 32.85% in cattle, 7.43% in buffaloes, and 8.13% in goats (Fig 18). The presence of NSP antibodies suggests the circulation of the FMD virus at the WLI. Notably, the detection of anti-NSP antibodies in goats serves as an indicator of FMDV circulation. The increased percentage of NSP-positive reactors in goats may be attributed to active FMDV replication in cattle or the presence of NSP vaccinal impurities. However, since the positivity rate in goats from the same cohort study decreased, the rise in NSP-positive cases is likely due to vaccinal impurities rather than active viral replication.

Table 5. NSP positivity/reactivity in small ruminants during 2024

State/UT	Sheep		Goat		Total (State)	
	No. of samples tested	% NSP Positive	No. of samples tested	% NSP Positive	No. of samples tested	% NSP Positive
Karnataka	342	4.1	227	7.5	569	5.4
Andhra Pradesh	467	3.0	350	6.3	817	4.4
Ladakh	386	3.4	172	3.5	558	3.4
Total (Species)	**1195**	**3.4**	**749**	**6.3**	**1944**	**4.4**

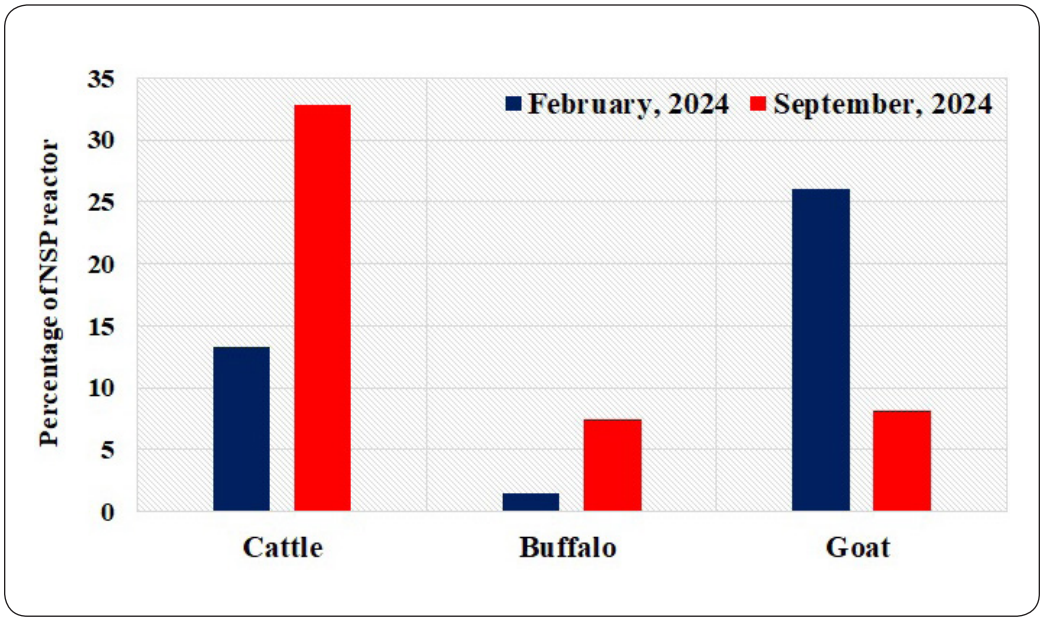


Fig 18. Average percentage of anti-3AB3 Non-structural antibody against FMDV in susceptible species (cattle, buffalo and goat) at six wildlife-livestock interfaces located in the state of Madhya Pradesh, India.

Surveillance in suspected outbreaks

A total of 547 serum samples collected during FMD outbreaks from different species were tested using 3AB3 DIVA ELISA for retrospective diagnosis. NSP antibody seroprevalence was found to be higher (53.4%) in the outbreak scenario in cattle compared to small ruminants and pigs (Table 6).

AI based FMD- NSPPredServ

Non-structural protein (NSP)-ELISA diagnostic assays are extensively used to detect FMD virus infection in a vaccinated population, which are essential in the FMD progressive control pathway. The available NSP assays require different cutoffs for their implementation in FMD control programme. These cutoffs are determined empirically from the data without considering statistical distributions of sample optical density absorbance readings in the ELISA assay. Further, slight change in the cutoff significantly affects performance of the assay, which makes NSP-ELISAs highly dependent on these cutoffs. Therefore, ICAR-NIFMD developed a cutoff independent computational model-based approach for prediction of infection status of animals from test samples using absorbance readings from 2B NSP-ELISA. This approach provides the areas under ROC (and Precision Recall) curves as 92% (99%), 100% (100%), 95% (88%), 92% (78%), and 86% (92%) for cattle, buffalo, goat, sheep, and pig respectively. This indicated that it is suitable for infection status prediction of the test samples across the FMD susceptible species.

Table 6. Serum samples tested in 3AB3 NSP ELISA from outbreaks

Species	No. of samples tested	% NSP Positives
Bovine	462	53.4
Ovine, Caprine and swine	84	17.8

The developed cutoff independent computational model-based approach was implemented in a web-based prediction server NSPPredServ (https://nifmd-bbf.icar.gov.in/NSPPredServ) for predicting the NSP-Ab status in the test samples using 2B NSP-ELISA diagnostic assay. The NSPPredServ is a user-friendly web-interface designed to predict the infection status of samples using the 2B NSP-ELISA test with a single click. The user interface of the NSPPredServ was designed with HTML, JavaScript, CSS, and Bootstrap. The backend of the NSPPredServ was developed using ASP.NET and R-program was integrated as statistical engine for execution of the proposed approach. The intuitive interface of the NSPPredServ tool enables easy input of data via uploading .txt/.csv files especially for large number of samples. For offline use of our approach, the user can download and utilize the source code and training dataset. Besides, the users can download output files in .doc format from the predict tab of the server for further use and reporting (Fig. 19).

2.4 FMD Seromonitoring

FMD Seromonitoring in Bovine

The Government of India initiated the bi-annual vaccination-based FMDCP in 2004, initially covering 54 districts and involving six-monthly vaccinations with an inactivated trivalent FMD vaccine for eligible cattle and buffaloes. The program expanded gradually and achieved nationwide coverage by 2018-19. National Animal Disease Control Programme (NADCP), a flagship scheme targeting 100% of the cattle, buffalo, sheep, goats, and pigs for FMD, and 100% of bovine female calves aged 4-8 months for brucellosis was launched in 2019. Later renamed the Livestock Health and Animal Disease Control Program (LHDCP), the scheme aims to control FMD by 2025 through vaccination and achieve its eventual elimination by 2030. This ambitious program is expected to increase domestic livestock production and boost exports of livestock products. LHDCP is a Central Sector Scheme where 100% of the funds are provided by the Central Government to the States and Union Territories.

ICAR-NIVEDI, in collaboration with ICAR-NIFMD, has developed a post-vaccination sero-monitoring sampling strategy, which is implemented under LHDCP. The new sampling scheme involves generating and distributing a sampling frame for each round of vaccination to the state Animal Husbandry

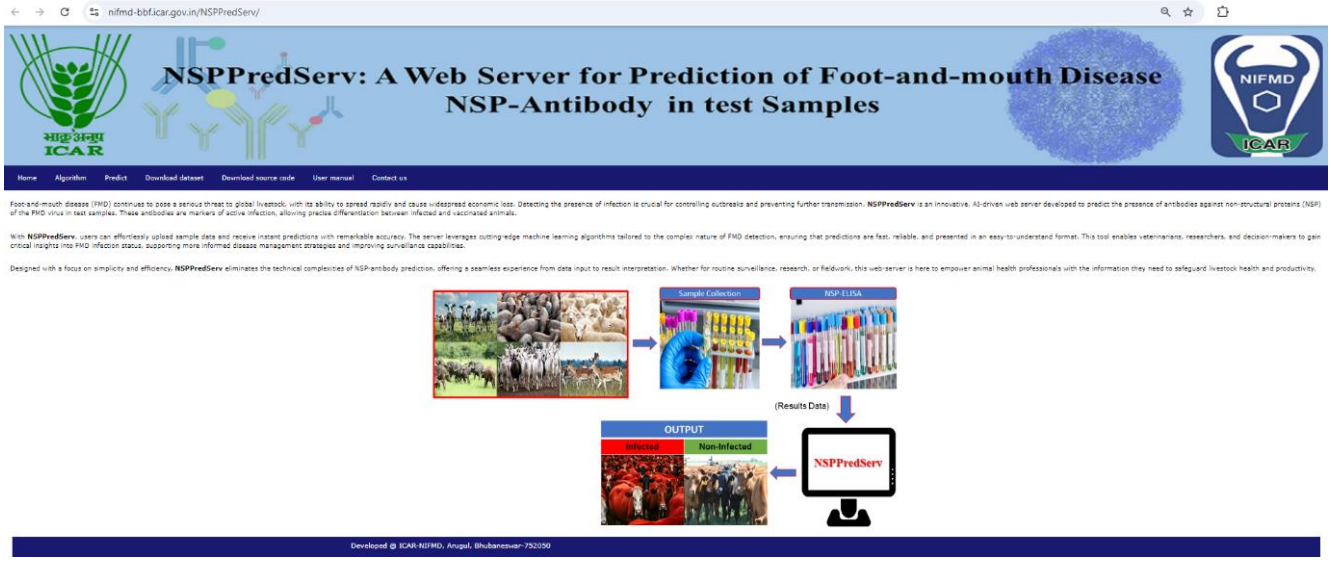


Fig 19. Homepage of AI-based web server, NSPPredServ, developed for prediction of FMD NSP antibodies in test samples

departments. The collected samples include metadata such as the age of the animal, species, sex, and location. Samples are obtained from three age groups (6-12 months, 13-24 months, and >24 months) at a ratio of 5:4:1, following OIE guidelines. The serum samples are collected before vaccination and 21 to 30 days post-vaccination by state Animal Husbandry departments. ICAR-NIFMD and its state FMD laboratories test these samples to estimate the level of serotype-specific seroconversion. Solid Phase Competitive ELISA (SPCE) developed by ICAR-NIFMD has been adopted as a screening method since 2016 to evaluate vaccine response status. In 2021, SPCE was correlated with the gold standard method, Virus Neutralization Test (VNT). Based on the results, the antibody titer cut-off of ≥1.65 log10 (@ 35 PI) was deemed protective at the herd level. This cut-off has been adopted and used for estimating protective titers from NADCP round 2 onwards.

LHDCP Round 3

In total, 1,08,054 serum samples (pre-vac: 54363 and post vac: 53691) were tested. Overall, the protective titer was found in **35.8, 30.6 and 32.0** percent of animals against serotypes O, A and Asia1, respectively in pre vaccination samples, and **65.6, 59.8 and 63.3** percent of animals against serotypes O, A and Asia1, respectively, in post-vaccination samples. The results are presented in the (Table 8).

Table 7. Number of serum samples tested for PVM from different rounds of vaccination

Round/Year	2020	2021	2022	2023	2024	Total
LHDCP-1	90,154	13,108	8690	-	-	1,11,952
LHDCP-2		17,029	69,377	20,787	13,347	1,20,540
LHDCP-3			5900	66,230	35,924	1,08,054
LHDCP-4				5610	62,093	67,703
LHDCP-5					10,436	10,436
LHDCP-6					3434	3434
	90,154	**30,137**	**83967**	**92627**	**128195**	**192588**

Table 8. State/UT wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1 (LHDCP-3)

State/UT	Pre	Post	Serotype O		Serotype A		Serotype Asia1	
			Pre	Post	Pre	Post	Pre	Post
Andaman	476	461	25.4	73.1	19.3	66.8	25.2	74.8
Andhra Pradesh	2131	2132	30.8	74.2	26.2	70.6	29.7	73.0
Assam	78		20.5		16.7		16.7	
Chandigarh	196	196	61.2	84.2	57.7	81.6	58.2	80.1
Chhattisgarh	2210	2220	24.8	65.2	24.3	62.3	25.5	69.0
Daman	172		52.3		51.2		52.9	
Delhi	445	378	43.6	69.8	36.9	64.0	40.2	66.7
Goa	1404	1402	46.0	65.5	39.3	59.7	38.7	62.1
Rajasthan	2280	2214	34.7	63.4	28.9	51.4	28.6	60.3
Gujarat	2145	2145	15.2	28.2	12.2	23.8	17.1	31.6
Himachal Pradesh	1010	1010	18.9	44.5	17.0	34.2	14.5	35.8

Punjab	2158	2091	44.4	68.2	40.9	61.8	42.7	64.3
Jammu & Kashmir	1450	1450	27.0	58.7	19.3	58.8	22.6	60.2
Haryana	2145	2143	32.4	74.3	35.9	77.9	34.6	79.5
Jharkhand	1581	1934	34.5	47.1	23.6	30.6	27.4	45.3
Karnataka	2132	2132	42.6	86.1	39.7	83.7	39.4	87.4
Kerala	2145	2145	44.4	84.7	37.8	83.8	44.5	87.2
Madhya Pradesh	4316	4316	31.7	65.2	24.8	54.1	27.2	60.1
Meghalaya	824	689	85.3	96.5	57.2	83.9	65.8	100.0
Manipur	577	577	31.2	75.6	27.9	72.1	24.3	76.3
Mizoram	697	697	38.0	88.8	42.3	86.9	39.5	89.8
Maharashtra	4377	4377	46.6	84.6	42.5	82.5	42.2	83.2
Nagaland	264		46.6		29.9		31.1	
Odisha	2145	2145	52.0	85.0	46.0	78.0	44.0	76.0
Puducherry	983	953	76.9	85.6	71.6	74.5	74.9	83.6
Sikkim	1070	845	29.7	55.0	21.7	73.7	27.3	53.7
Tamilnadu	2141	2141	53.7	76.9	44.0	67.8	46.7	71.4
Telangana	2145	2145	22.3	71.1	18.7	60.9	21.9	73.7
Tripura	48	48	6.3	27.1	6.3	27.1	6.3	27.1
Uttar Pradesh	5486	5372	22.5	35.1	18.2	27.9	18.7	28.2
Uttarakhand	1196	1117	27.3	53.0	19.6	44.6	22.1	47.9
Arunachal		279		10.8		10.4		4.7
West Bengal	1817	1817	44.1	72.3	36.5	65.1	37.4	70.6
Bihar	2119	2120	21.2	60.8	16.6	53.9	13.0	48.1
Total	**54363**	**53691**	**35.8**	**65.6**	**30.6**	**59.8**	**32.0**	**63.3**

LHDCP Round 4

In total, 67703 serum samples (pre-vac: 35,458 and post vac: 32,245) were tested. Overall, the protective titer was found in **42.0, 36.5 and 37.8** percent of animals against serotypes O, A and Asia1, respectively in pre vaccination samples, and **73.8, 68.6 and 71.0** percent of animals against serotypes O, A and Asia1, respectively, in post-vaccination samples. The results are presented in the (Table 9 and Fig 20).

LHDCP Round 5

In total, 10,436 serum samples (pre-vac: 6325 and post vac: 4111) were tested. Overall, the protective titer was found in **46.4, 44.0 and 46.2** percent of animals against serotypes O, A and Asia1, respectively in pre vaccination samples, and **78.1, 71.7 and 77.6** percent of animals against serotypes O, A and Asia1, respectively, in post-vaccination samples. The results are presented in the (Table 10). This finding indicates slow building of herd immunity from round 4 to round 5. Also this corresponds to reducing trend of outbreaks.

Summary of percent protective titer

There has been an increase in the level of herd immunity and seroconversion rate in every round of the LHDCP. However, maintaining a six-month interval between successive vaccinations has posed certain challenges till 2023. If the timing and density of vaccination are maintained as experienced in 2024, there is a strong likelihood that pre-vaccination titers could reach high levels. A high level of herd immunity is essential to break the chain of FMDV transmission. (Table 12 & Fig 21).

Table 9. State/UT wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1 (LHDCP-4)

State/UT	Pre	Post	Serotype O		Serotype A		Serotype Asia1	
			Pre	Post	Pre	Post	Pre	Post
Andaman & Nicobar	463	443	23.1	21.9	21.4	14.0	27.6	17.6
Andhra Pradesh	2145	2145	35.3	81.8	34.2	81.7	34.2	81.8
Chandigarh	154	154	69.5	92.9	57.8	89.6	54.5	90.3
Chhattisgarh	977	977	29.9	58.5	26.2	52.3	24.5	59.8
Goa	1417	1416	52.1	67.4	42.3	59.5	39.8	61.4
Gujarat	2158	2158	27.0	53.3	23.7	47.6	22.8	49.7
Haryana	2145	2145	44.8	72.0	41.5	70.0	41.1	72.2
Kerala	2145	2145	53.1	85.1	50.1	81.8	54.7	86.5
Karnataka	1754	1780	57.8	86.8	54.0	83.0	56.6	85.8
Maharashtra	2764	2573	45.3	84.5	43.5	82.1	41.9	82.9
Odisha	1066	1066	55.6	86.0	46.2	77.0	38.9	72.0
Sikkim	585	481	24.8	60.1	25.0	50.5	27.4	55.7
Tamil Nadu	1885	1885	53.0	84.7	47.4	78.4	48.1	82.1
Telangana	1716	1716	49.9	78.9	43.3	77.6	46.6	77.9
Madhya Pradesh	2392	2392	39.6	76.6	28.8	60.7	33.6	68.1
Tripura	357	461	42.3	61.8	24.9	50.1	25.5	53.1
Assam	1664	624	27.1	83.5	25.5	81.1	24.6	79.0
Rajasthan	924	792	22.2	47.9	19.3	43.3	19.7	46.0
Punjab	1772	1789	58.9	79.8	51.6	76.5	52.1	75.5
Jammu	418	418	36.6	82.3	44.7	91.6	47.8	93.5
Nagaland	584		46.9		18.8		13.0	
Uttar Pradesh	1880	545	21.3	74.7	16.2	68.4	19.2	72.1
West Bengal	1528	1515	48.6	68.1	37.8	61.4	42.5	64.4
Puducherry	624	598	42.6	77.1	30.1	68.7	45.2	77.8
Jharkhand	186	278	63.4	84.9	37.1	76.3	43.5	73.4
Meghalaya	220	220	59.5	100.0	50.5	92.3	92.7	96.8
Uttarakhand	1535	1529	29.4	49.1	26.8	42.4	27.0	44.4
Total	**35458**	**32245**	**42.0**	**73.8**	**36.5**	**68.6**	**37.8**	**71.0**

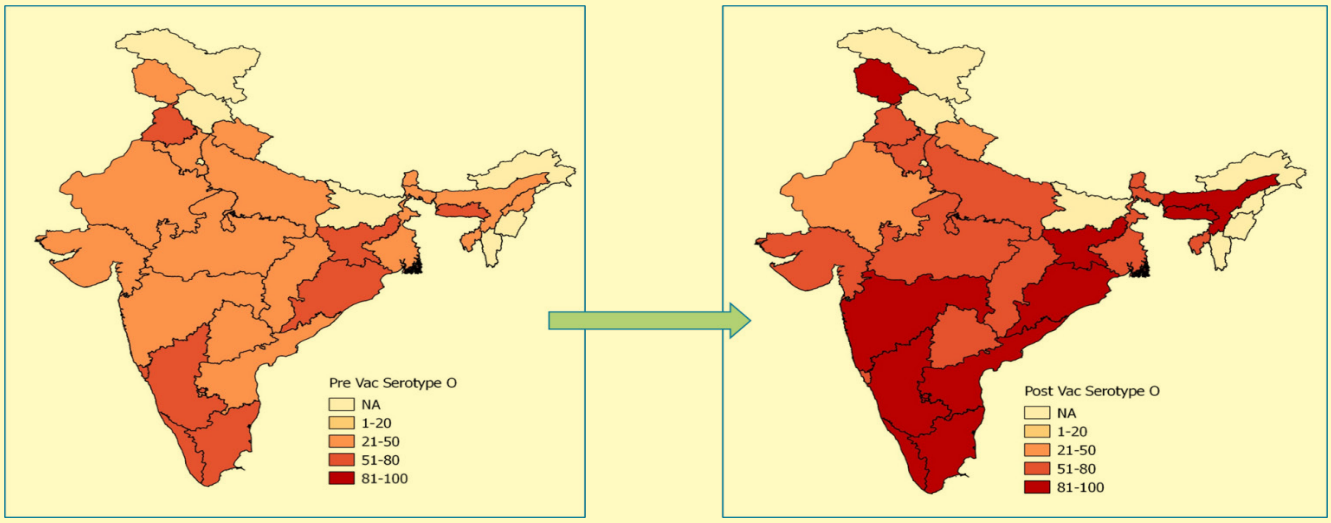


Fig 20a: State-wise percent of animals (Bovine) showing protective antibody level against serotype O after round 4

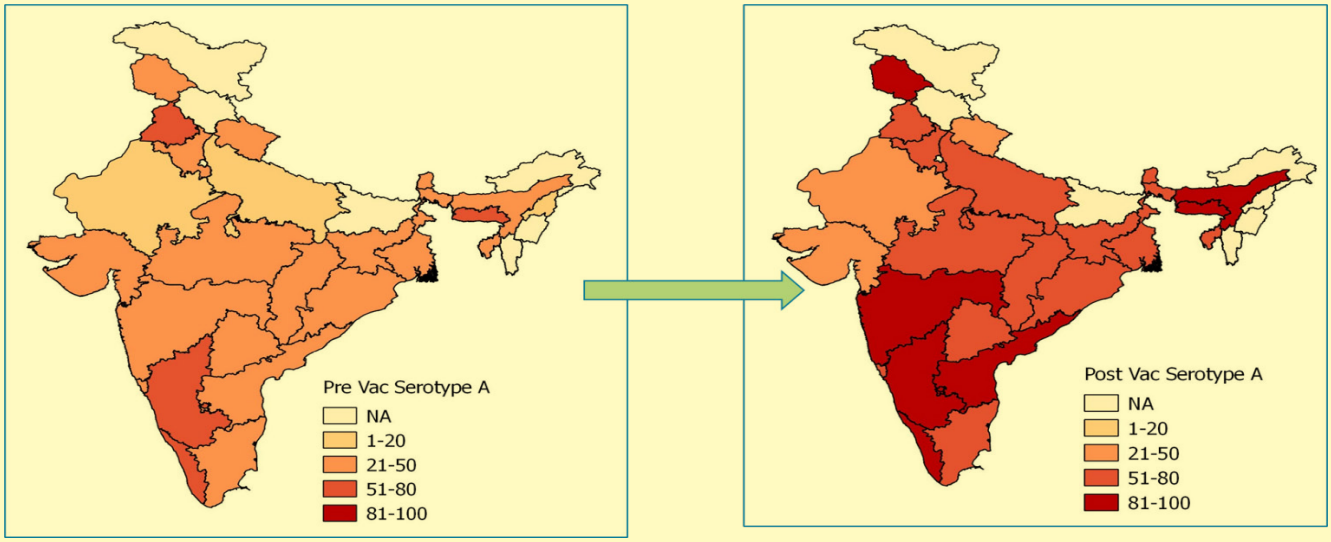


Fig 20b: State-wise percent of animals (Bovine) showing protective antibody level against serotype A after round 4

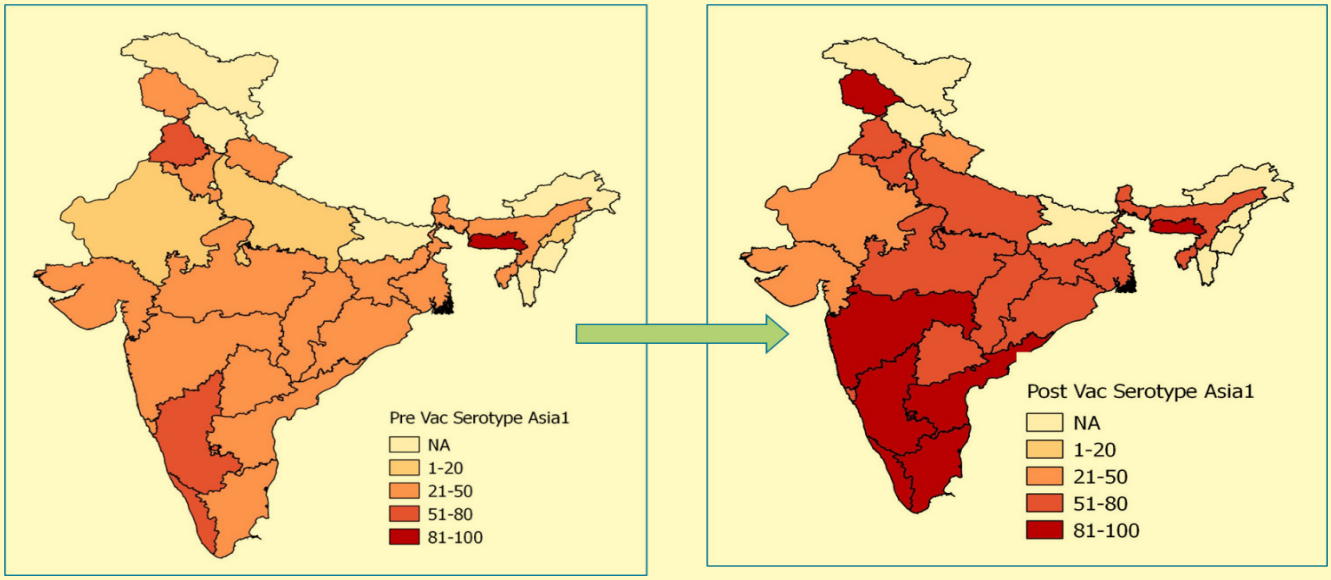


Fig 20c: State-wise percent of animals (Bovine) showing protective antibody level against serotype Asia1 after round 4

Table 10. State/UT wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1 (LHDCP-5)

State/UT	Pre	Post	Serotype O		Serotype A		Serotype Asia1	
			Pre	Post	Pre	Post	Pre	Post
Haryana	1718	1716	36.1	75.6	31.8	64.0	37.7	78.1
Goa	574	573	39.5	76.1	36.9	68.9	31.9	67.9
Karnataka	1461	599	74.2	93.0	70.8	91.7	72.9	92.7
Telangana	1027		52.6		50.8		53.8	
Uttar Pradesh	286	52	31.8	76.9	36.4	67.3	35.3	61.5
Andaman	154	66	16.9	81.8	14.3	68.2	16.2	74.2
Andhra Pradesh	1105	1105	31.2	74.8	31.2	74.8	31.2	74.8
Total	**6325**	**4111**	**46.4**	**78.1**	**44.0**	**71.7**	**46.2**	**77.6**

LHDCP Round 6

Table 11. State/UT wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1 (LHDCP-6)

State/UT			Serotype O		Serotype A		Serotype Asia1	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Haryana	1718	1716	38.7	72.1	40.2	72.8	45.5	77.7

Table 12. Round wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1

Round	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
LHDCP-2	29.5	64.0	25.2	60.4	24.1	60.1
LHDCP-3	35.8	65.6	30.6	59.8	32.0	63.3
LHDCP-4	39.4	69.3	34.0	64.2	35.5	66.6
LHDCP-5	46.4	78.1	44.0	71.7	46.2	77.6

FMD Seromonitoring in Yak and Mithun

FMD seromonitoring studies were conducted in Mithun and Yak species in the North-Eastern states. The seroconversion was found to be better in Yak than in Mithun (Table 13).

Table 13. Percent animals showing protective titer against FMD virus serotypes O, A and Asia1 in organized farms during 2024

Species	Pre	Post	Serotype O		Serotype A		Serotype Asia1	
			Pre	Post	Pre	Post	Pre	Post
Yak	660	369	96.7	98.6	98.6	98.6	99.4	99.7
Mithun	112	103	47.3	66.0	56.3	78.6	45.5	85.4

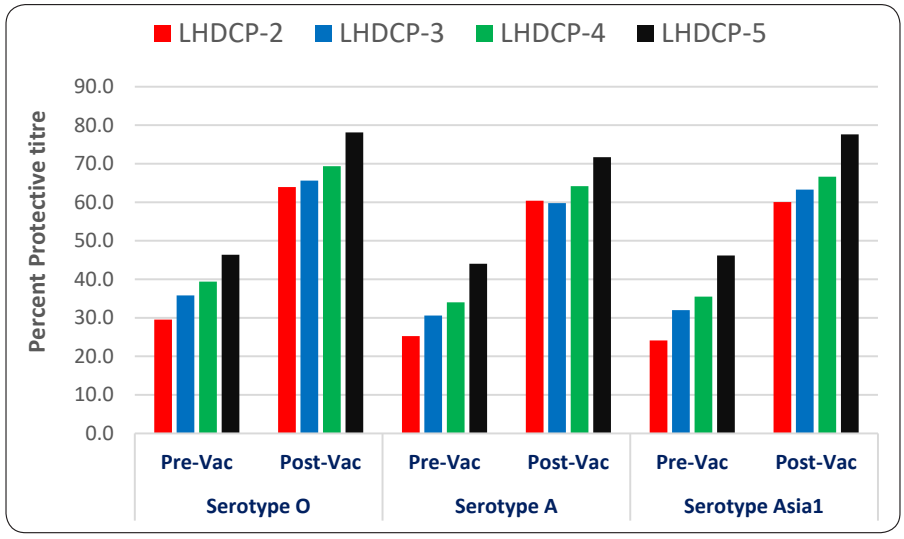


Fig 21. Round wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1

AI based FMDSeroMonitor approach

In India, vaccination-based control program has been adopted for last two decades and a post-vaccination sero-monitoring was designed to evaluate the effectiveness of this program. Through this period, sero-monitoring factors including % inhibition, cut-off, sampling and screening methods, *etc.* were changed as per need, which makes it difficult to have comprehensive and comparative view on distribution of seroconversion responses achieved through FMD vaccination over a period of time. Besides, there is a lack of computational strategy to estimate population-level seroconversion parameters in usual FMD sero-monitoring. Therefore, one computational approach for estimation of population-level seroconversion parameters was developed and demonstrated its utility in India's FMD sero-monitoring studies. The methodology estimated the seroconversion rates of India for pre- and post-vaccination stages as 28% (95%CI: [23.15, 32.88]) with CV=8.86% and 64% (95%CI: [52.43, 81.58]) with CV=11.1% in 2022. Further, it also demonstrated statistically significant effect (*p-value* < 0.001) of FMD vaccination on the change in seroconversion response.

Based on the developed FMDSeroMonitor approach methodology, an AI-web server, *SeroMonitor* was developed and hosted in Indian Council of Agricultural Research (ICAR) Data Centre server located at New Delhi, India, which is compliant to ISO27001:2013 and 20000:2011 standards. Through this computational approach and web-server, it is possible to study the effect of the FMD vaccination at the individual state level (Fig 22).

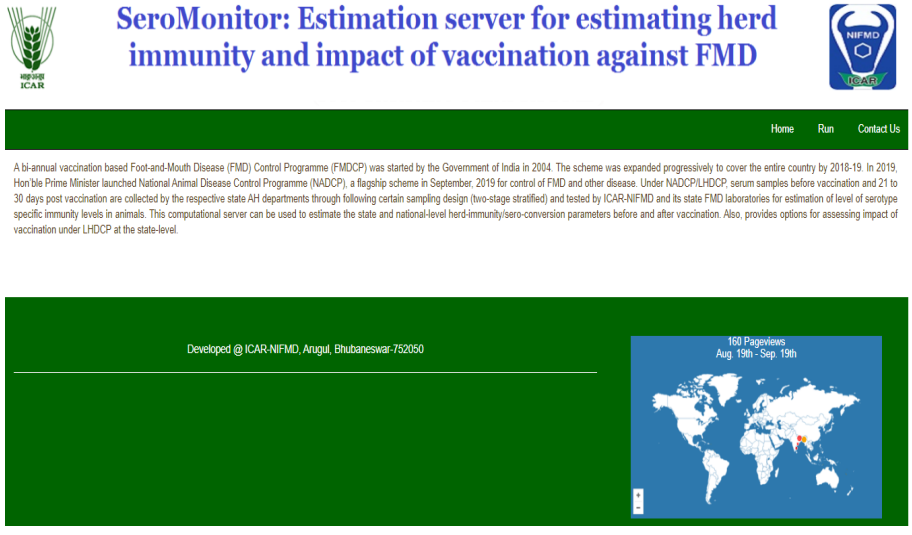


Fig 22. Homepage of AI-based web server, NSPPredServ, developed for prediction of FMD NSP antibodies in test samples

2.5 Investigation of NSP seroreactors

ICAR-NIFMD and state FMD regional and collaborating centres, and state AH departments are working together for systematic follow-up investigation of the FMD NSP seroreactors by collection and testing of oropharyngeal fluid (OPF). During 2024, total 105 serum and oropharyngeal fluids (OPF) were collected and tested for presence of antibody for 3AB3 NSP and genome detection by RT-mPCR for FMD virus from the state of Haryana and Telangana. Out of 105 serum samples 17 were found to have antibodies against NSP. Out of 17 NSP positive samples, 1 sample was found positive for FMD virus serotype O by RT-mPCR.

2.6 FMD Vaccine Quality Control

Under the Livestock Health Disease Control Programme (LHDCP) on FMD, the quality control testing of FMD vaccines to be used for the vaccination was initiated in year 2020 and continued thereafter. For each individual batch, the experimental calves were first screened for sero-negative status with respect to FMD antibody. A group of 12 FMD sero-negative calves were selected for each batch of testing consisting of non-vaccinated control (02), safety testing (02) and potency test (08). The calves were vaccinated 2 times at 28 days interval and pre vaccination (0 day) as well as 28 days post vaccination serum was evaluated for serotype specific FMD antibody titer using VNT for potency. The vaccine batches were also tested for sterility. During the year 2024, six batches of FMD vaccines (Table 14) have been tested at different farms across the country and reports were communicated to DAHD.

Table 14. Various batches of FMD vaccine tested by ICAR-NIFMD with bovine calves of various farms

Sl. No.	Batch	Date of start of test	Place
1.	107-483-B07X-50	13/02/2024	Government cattle breeding farm, Chandkhuri, Raipur
2.	008-523-D18W-75	30/04/2024	Government cattle breeding farm, Garhi, Balaghat
3.	115-538-E15W-75	26/05/2024	Bovine breeding and bull mother farm, Keonjhar
4.	III-548-G11W-20	16/07/2024	State animal farm, Gauriakarma, Hazaribagh
5.	016-578-H16W-50	03/09/2024	Bovine breeding research and bull mother farm, Kuanrmunda, Sundargarh
6.	170-613-J17W-75	29/10/2024	State animal farm, Saraikela, Kharaswan

3.0 Development and Improvement of Diagnostics

Multi-target RT-PCR assay for detection of FMDV genome pan-serotype

Accurate and rapid identification of the FMD virus helps informed decision making on quick implementation of control measures. PCR assays can be useful tools in generating first-hand information on the FMDV prevailing in a region much before viral genome sequence data is generated. The two-step conventional RT-multiplex PCR (RT-mPCR) developed at the ICAR-NIFMD has been in use for serotype differentiation for two decades. Also, some of the reference laboratories prefer to target multiple genetic regions both in generic and serotype specific form by running more than one PCR assay in parallel to enhance the diagnostic efficacy and to add confidence to the test results. Generally, mPCR primers for serotype identification are designed at the hypervariable capsid coding region and tailored to a specific country/region focusing on the sequences of the prevailing lineages. Genetic heterogeneity at the primer binding site of existing mPCR associated with emerging lineages/variants cannot be precluded. In the changing epidemiological scenario, always there is a threat of incursion of exotic lineages or serotypes in the country. In this context, it is imperative that the referred clinical materials be subjected to PCR assays capable of detecting FMDV panserotype. Such assays are also applied to trade certification to augment FMDV genome detection sensitivity and confidence in a serotype independent manner. A pan-serotype PCR employing primers complementary to the almost conserved sites within the non-coding or non-structural protein coding region, if run in parallel, would enhance diagnosis efficacy. FMD virus is known for its quasispecies dynamics, fast evolution and genetic heterogeneity that suggest sequence variability while detecting a single target region in PCR might impact on the diagnostic outcome of the assay. Agarose gel based panserotypic RT-PCR assays available globally detect only a single target in the assay. Therefore, an RT-PCR assay was devised in a way where amplification of three different genetic regions was targeted in a single tube at one go using novel primers designed by incorporating appropriate degenerate bases at variable yet critical positions. The PCR amplicons thus generated could easily be differentiated from their size when visualized on the ethidium bromide-stained agarose gel under UV trans-illumination thereby making it a novel, economical and fail-safe test to detect FMD virus genome pan-serotype (Fig 23). The one tube multi-target FMD virus panserotype RT-PCR assay exhibited a relative diagnostic sensitivity and specificity of 100% in comparison to the serotype differentiating mPCR assay in use in India. This assay is expected to be useful as FMD cases decline and clinical sample availability becomes limited due to intensive vaccination and control efforts. Additionally, it may aid in active and environmental surveillance

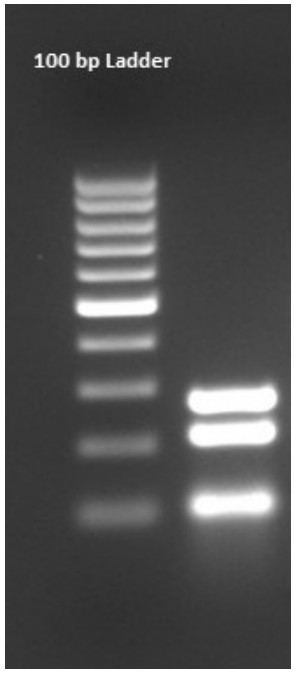


Fig 23. Multi-target panserotype RT-PCR amplified products as visualized on ethidium bromide stained 1.5% agarose gel

Monoclonal antibody based competitive ELISA to detect FMDV NSP antibody

A competitive enzyme linked immunosorbent assay (cELISA) was developed based on recombinant FMDV NSP 3AB3 (r3AB3) and a 3B specific monoclonal antibody (MAb) to detect antibodies induced by virus infection. To determine the cut-off PI, 202 known FMDV-positive and 730 negative sera were tested. Based on the receiver operating characteristics curve analysis and interactive dot diagram analysis by GraphPad Prism statistical software, 45% inhibition was considered as the cut-off. Serum sample showing a PI value of ≥ 45% is considered FMDV-positive and PI < 45% was considered negative. With this cut-off value, the diagnostic sensitivity (DSn) and specificity (DSp) of FMDV 2E4 cELISA was 95.54% (91.71% to 97.94%) and 98.36% (97.15% to 99.15%) respectively at 95% confidence interval (Fig 24 and 25). The FMDV 2E4 cELISA was compared to commercial PrioCHECK FMD NS antibody ELISA test and showed similar DSn and DSp values (93.52% and 97.46%), respectively, for a representative set of 446 serum samples at the prescribed cutoff of 45 PI. Further the newly developed cELISA

was validated with the extensively used in-house r3AB3 based indirect-ELISA which demonstrated an overall concordance of 86.54% for a set of 6859 sera from different host species. The new assay turnover time is under 4 hrs. It does not require sample pre-dilution or any selective blocking agent and has room temperature processing capability. The MAb-based cELISA showed high repeatability and reproducibility when tested at three different laboratories by different operators. The test is species and serotype independent, and can be used in any species without change in testing protocol. The cELISA described is a simple method for sero-surveillance of FMD and detection of virus circulation in the vaccinated population. It can be a very good tool for sentinel surveillance and FMD serosurveillance in wild life population

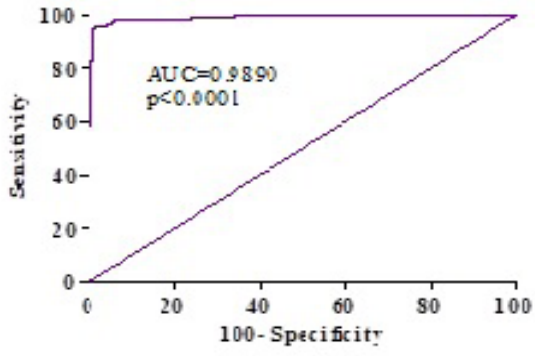


Fig 24. Receiver operating characteristic (ROC) curve analysis of serum samples (n = 932).

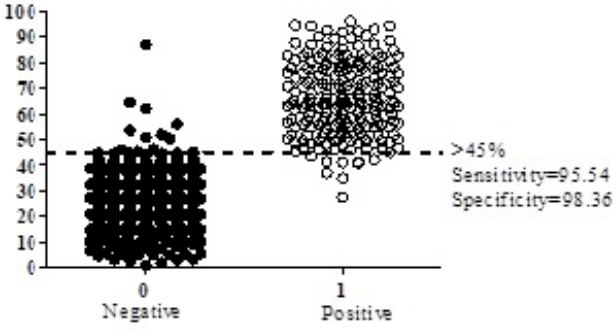


Fig 25. Dot plot analysis of FMDV-negative (0) and positive (1) sera. DSn and DSp were 95.54% and 98.36% respectively.

Species-independent indirect-ELISA for FMD serology

Diagnostic assays that are able to detect FMDV infection in the vaccinated population are essential tools in the progressive control pathway for the FMD. However, testing of serum samples using a single diagnostic assay may not completely substantiate freedom from the virus infection. Therefore, FMDV non-structural proteins (NSPs)-based various serological assays have been developed for the detection of FMD infection. Nevertheless, the NSPs-based ELISAs have been developed in the indirect-ELISA format, thereby necessitating the use of species-specific conjugated secondary-antibodies for the detection of anti-NSP antibodies in various FMD-susceptible species. Therefore, this study presents a novel recombinant 2B-NSP-based indirect ELISA, employing HRP-conjugated protein-A/G detection system which can detect anti-NSPs antibodies from multiple FMD-susceptible species in a single ELISA platform. Recombinant 2B (r2B) protein was expressed as His-SUMO tagged protein in the *E. Coli* cells and purified using NI-NTA affinity column chromatography (Fig. 26). Using the r2B protein and HRP-conjugated protein A/G, an indirect ELISA was developed and validated for the detection of anti-2B antibodies in serum samples collected from multiple FMD-susceptible animal species with known FMD status (Fig. 27). Further, a resampling based statistical technique has been reported for determination of optimal cut-off value for the diagnostic assay (Fig. 28). Through this technique, the optimal cut-off of 44 percentage of positivity value was determined for the assay. At this optimal cut-off value, the developed diagnostic assay provided diagnostic sensitivity, specificity, and accuracy, positive and negative predictive values (PPV and NPV) of 92.35%, 98.41%, 95.21%, 98.58%, and 91.67%, respectively. The assay was validated further by analyzing random serum samples collected across multi-locations in India. The assay can be used as a single platform for testing serum samples from different species of FMDV-susceptible animals and will be useful for NSP-based serosurveillance of FMDV.

MAb based SPCE to detect FMDV serotype O SP antibodies

A solid phase competitive ELISA (SPCE) was developed using recombinant capsid protein (rP1) and monoclonal antibody (MAb) for the detection of FMDV serotype O–specific antibodies. Field sera of different species obtained from naïve, infected and FMDV vaccinated animals were tested. When examining test sera at a dilution of 1:10 with 22% inhibition of reaction as the cut-off, the rP1-MAb-

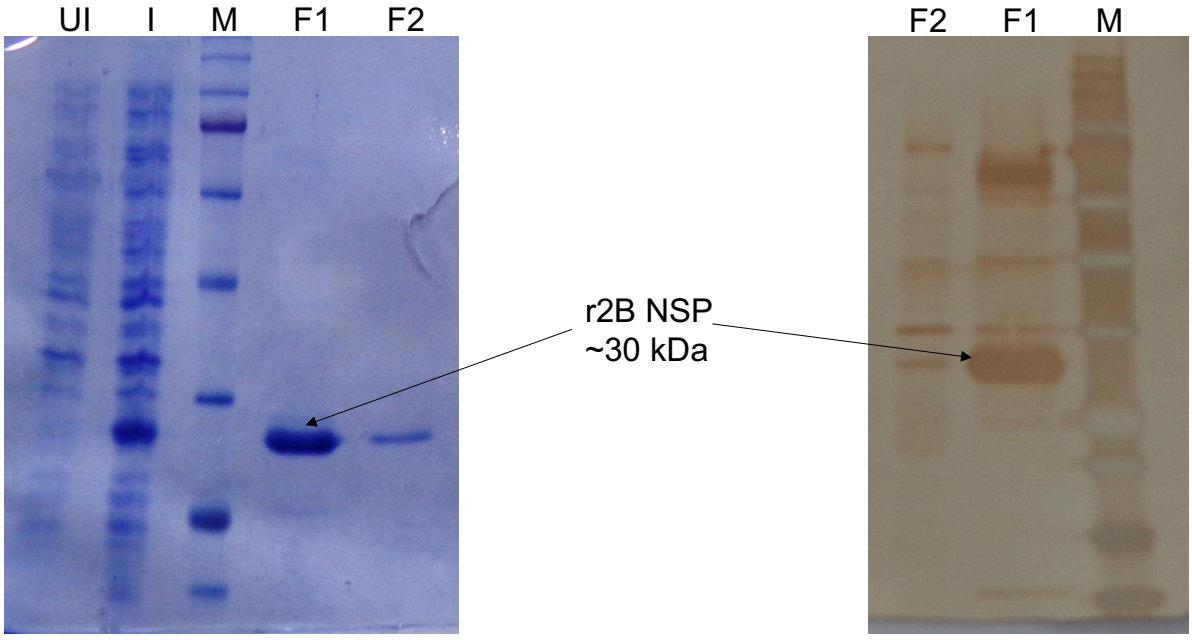


Fig 26. (A) SDS-PAGE profile of recombinant 6xHis-SUMO-2B protein. Lane M, Protein marker (Thermo Scientific); lane UI, un-induced BL21 (DE3) *E.coli* cell lysate; lane I, supernatant fraction of IPTG induced BL21 (DE3) E. coli lysate; lane F1, affinity purified recombinant 2B(r2B) protein fraction-1; lane F2, affinity purified r2B protein fraction-2. (B) Western blot analysis of expressed r2B protein to determine its reactivity with FMDV-infected convalescent cattle serum. Lane M, Protein marker; lane F1, affinity purified r2B protein fraction-1; lane F2, affinity purified r2B protein fraction-2.

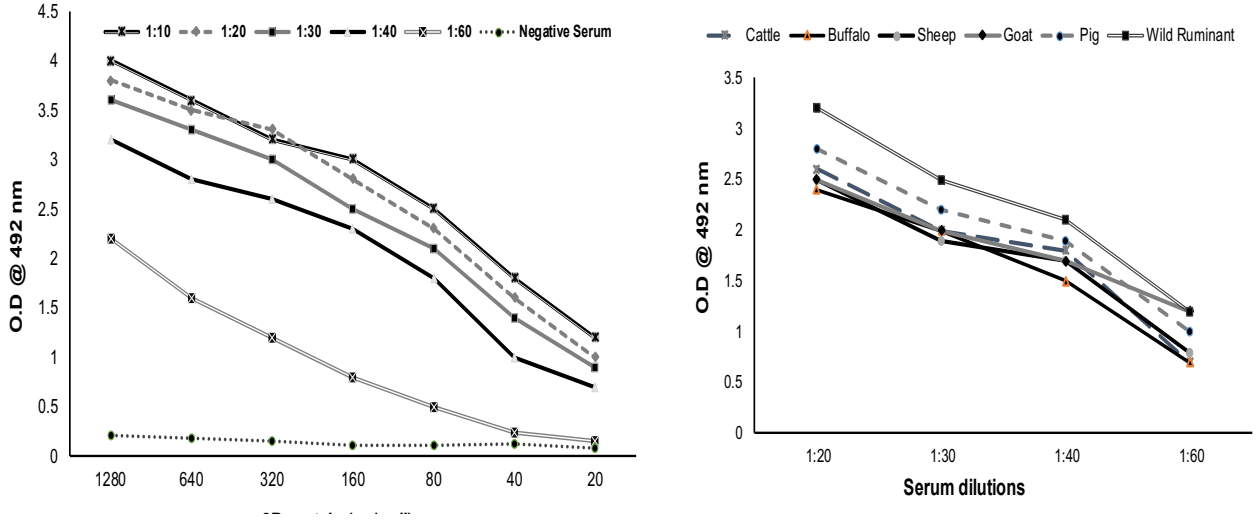
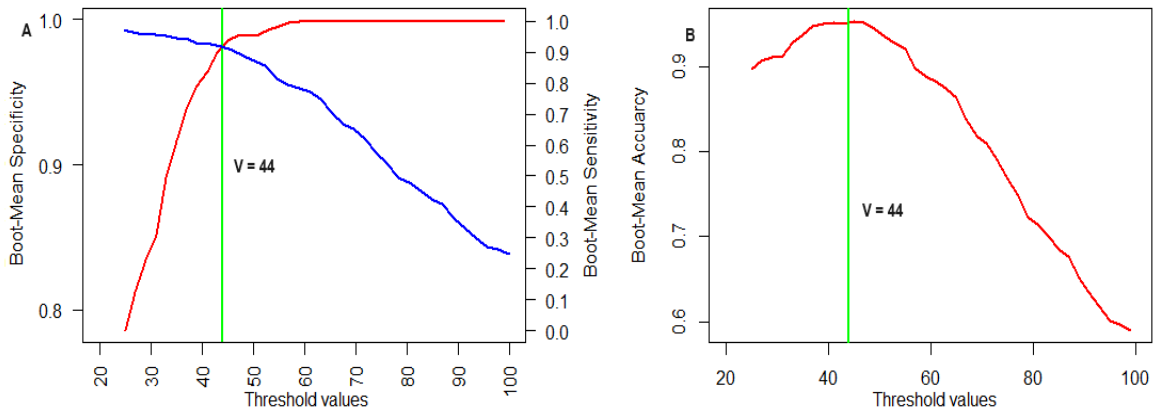


Fig 27. Standardization of protein A/G -based 2B indirect ELISA. (A) Checkerboard titration to optimize recombinant 2B NSP concentration and serum dilution. Various dilutions of positive control bovine-serum indicated by different markers are shown at top-side of the plot. The arrow indicates the optimum concentration of recombinant 2B protein antigen and serum dilution. (B) Graph with optical densities from titrated sera from different FMDV-positive animal-species. Appropriate serum dilution of 1:40 was selected to attain the acceptable signal-noise ratio.



C

Accuracy	Sensitivity	Specificity	PPV	NPV	NIR	p-value
95.21% (94.11, 96.15)	92.53%	98.41%	98.58%	91.67%	0.549	2.2e-16

Fig. 28. Determination of optimal cut-off value for the protein A/G-based 2B indirect ELISA. (A) Cut-off value *vs.* Boot-mean-sensitivity and Boot-mean-specificity plot. x-axis represents the cut-off values, y1 and y2 axes represent the Bootstrap mean sensitivity and specificity values. Vertical line drawn at the point of inflexion. (B) Cut-off value *vs.* Boot-mean-accuracy plot. x-axis represents the cut-off values and y-axis represents the Bootstrap mean accuracy values. The point of inflexion is also highlighted in the graph. (C) Performance metrics based on estimated cut-off value. PPV and NPV represent positive and negative prediction value.

SPCE demonstrated relative diagnostic sensitivity and specificity of 93.33% and 95.23%, respectively as compared to the gold standard virus neutralization test (VNT). The PI values obtained by rP1-MAb-SPCE demonstrated a statistically significant correlation with the VNT titer (R^2 = 0.738; p < 0.0001) for a set of cattle sera (n=51) with known FMDV vaccination status (Fig. 29 and 30). The new rP1-MAb-SPCE ELISA could be used as a first line test to monitor seroconversion against FMDV serotype O. The reagent can be produced in a non-biosecurity environment with GLP. The samples scoring positive could be tested further by VNT for confirmation. Further the test could be used to detect FMDV serotype O infection in unvaccinated animals.

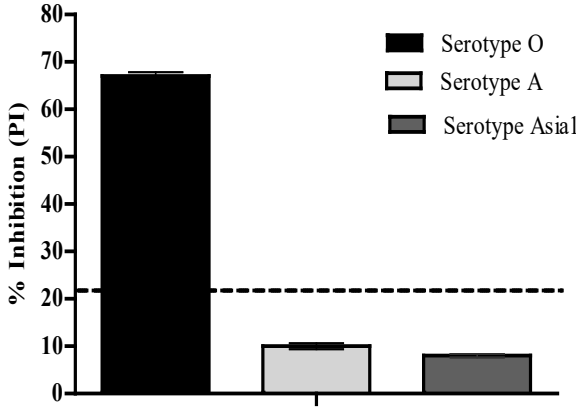


Fig 29. Specificity of rP1-MAb-SPCE for serotype O

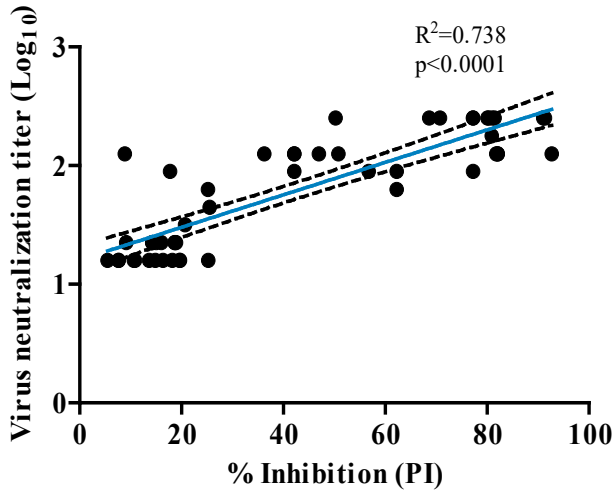


Fig 30. Correlation between rP1-MAb-SPCE and VNT

Capillary electrophoresis-based method for FMD diagnosis

The diagnosis and serotyping of FMDV has always been challenging as because it exists as seven serologically distinct types (O, A, C, Asia 1, SATs 1, 2, 3) with no cross immunity between the serotypes. The existing method of PCR based molecular diagnosis suffer from the limitation of plexing (confined to 3-4 targets) in multiplex PCR based diagnostics. Further, the issue of degraded quality and insufficient sample quantity

is also observed as the vaccination progress and herd immunity increases. In traditional multiplex RT-PCR, the agarose gel electrophoresis used has relatively lower resolution / discriminating power. We converted the existing system of RT-PCR based serotyping to capillary electrophoresis-based system to increase the thorough put and scope of multiplexing. Additionally, an inbuilt control was added in the primer mix which could show the control band to distinguish negative samples from negative amplification (PCR failure). For this a target control gene (having sufficient expression in the epithelial cells) was selected out of 3 prominent housekeeping genes (GAPDH, ACTB and HPRT). A total of 5 sets of primers so chosen were optimized using the host tissues from various susceptible hosts (Cattle, buffalo, sheep, goat and pigs) and target primer set was shortlisted. The short-listed control as well as serotyping primers were tagged with fluorescent dyes (FAM, NED) and florescent primers were optimized for amplification. The amplified fragments were separated by fragment analysis using a Genetic Analyzer with LIZ 600 as size standard which could show peaks at desired length. This method provides workflow to detect the viral genome in less time, more throughput and higher plexing with a scope for automation.

Comparative performance evaluation of SPCE with VNT

Solid Phase Competitive ELISA (SPCE) developed at this institute is being applied in all the testing laboratories involved in FMD post-vaccination seromonitoring activity under NADCP/LHDCP-FMD since 2017. The test provides a semi-quantitative structural antibody titre estimate in the serum sample against Indian vaccine strains for three serotypes such as O, A, and Asia 1 and categorises the serum antibody titres in a dichotomous manner as 'protective' or 'un-protective' titre. Between 2021 and 2023, a set of 696 samples (299 judged protective and 397 un-protective in VNT) were tested both in VNT and SPCE to revise and validate the cut-off of interpretation in SPCE so as to achieve a reasonably high relative diagnostic sensitivity (DSn) and specificity (DSp). VNT, considered to be the gold standard alternative *in vitro* test, was used to categorise the samples as having protective and un-protective levels of antibody titre (log_{10} titre cut-offs of 1.65, 1.5, and 1.5 for serotypes O, A, and Asia 1, respectively). Final interpretation criteria were revised from 50% inhibition of OD_{max} values and a cut-off log_{10} titre of 1.8 to 35% inhibition and log_{10} titre of 1.65. Without losing much of its diagnostic specificity, the diagnostic sensitivity could be significantly improved with the revised interpretation criteria as compared to the earlier criteria of 50% inhibition and log_{10} titre cut-off of 1.8.

To further validate the revised interpretation criteria, a set of 276 serum samples (77 judged protective and 199 un-protective in VNT) were tested during 2024 and analysed including the earlier available data. Revised criteria adopted for SPCELISA (35% inhibition and titre cut-off log_{10} 1.65) exhibited reasonably higher DSn and DSp balance for serotype O and Asia1 (Table 15) and therefore found 'fit-for-purpose' for assessment of protective antibody titre in multiple vaccinated animals under NADCP/LHDCP-FMD at population level. However, for serotype A, 30% inhibition and titre cut-off log_{10}1.65 (DSn 82% and DSp 88%) appears to be a more appropriate choice over 35% inhibition (DSn 75% and DSp 91%). Therefore, as the FMD control programme progress, the data based on dynamic cut-offs may be applicable under different geographies with disease free zones and also over a period of times in the same geography.

Table 15. Diagnostic sensitivity (DSn) and specificity (DSp) of SPCE at different PI compared to gold standard VNT

Serotype O

SPCE log_{10} titre cut off / % Inhibition	Log_{10}1.5		Log_{10}1.65		Log_{10}1.8	
	DSn%	DSp%	DSn%	DSp%	DSn%	DSp%
30%	91	77	90	80	82	83
35%	87	81	84	88	75	88
40%	81	90	80	94	72	94
50%	76	95	72	95	63	96

Serotype A

SPCE log_{10} titre cut off / % Inhibition	Log_{10}1.5		Log_{10}1.65		Log_{10}1.8	
	DSn%	DSp%	DSn%	DSp%	DSn%	DSp%
30%	85	81	82	88	70	89
35%	81	84	75	91	66	93
40%	72	90	71	95	62	95
50%	62	96	60	97	55	97

Serotype Asia1

SPCE log_{10} titre cut off / % Inhibition	Log_{10}1.5		Log_{10}1.65		Log_{10}1.8	
	DSn%	DSp%	DSn%	DSp%	DSn%	DSp%
30%	92	75	90	76	79	82
35%	87	82	82	87	74	90
40%	82	84	80	89	69	95
50%	71	90	62	92	58	95

Production and Characterization of MAbs

Two monoclonal antibodies (MAbs) named (#FMDV3AB-2E4 and #FMDV3AB-4F4) were generated against FMDV NSP r3AB3 by hybridoma method and characterized further. The MAbs were of IgG1 isotype with kappa light chain. The MAbs developed can be used to evaluate purity of FMDV vaccine. MAb #FMDV3AB-2E4 showed two-fold higher reactivity than MAb #FMDV3AB-4F4 against r3AB3 protein in indirect ELISA (Fig. 31). In indirect ELISA, the MAb #FMDV3AB-2E4 showed higher reactivity against r3AB3 protein and peptide 3B while no reactivity was observed against r3A protein (Fig. 32 A) indicating the MAb to be NSP 3B-specific. Further the MAb demonstrated very good reactivity against the three synthetic peptides representing three regions (3B1, 3B2 and 3B3) of NSP 3B showing high ODs (32 B). Western blot analysis confirmed this result as the MAb FMDV3AB-2E4 reacted only against r3AB3 but not r3A antigen compared to FMDV-positive cattle serum which reacted with both r3AB3 and r3A protein (Fig. 33).

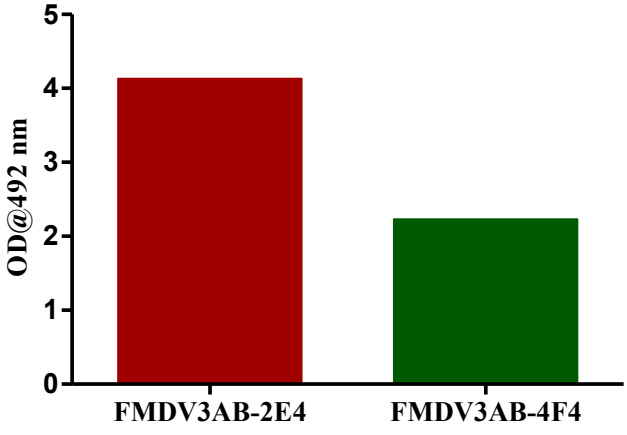


Fig 31. Reactivity of MAbs (#FMDV3AB-2E4 and #FMDV3AB-4F4) against r3AB3 in indirect ELISA

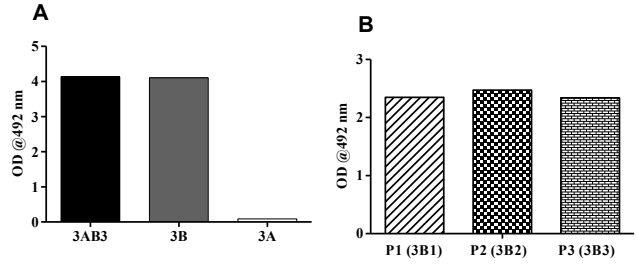
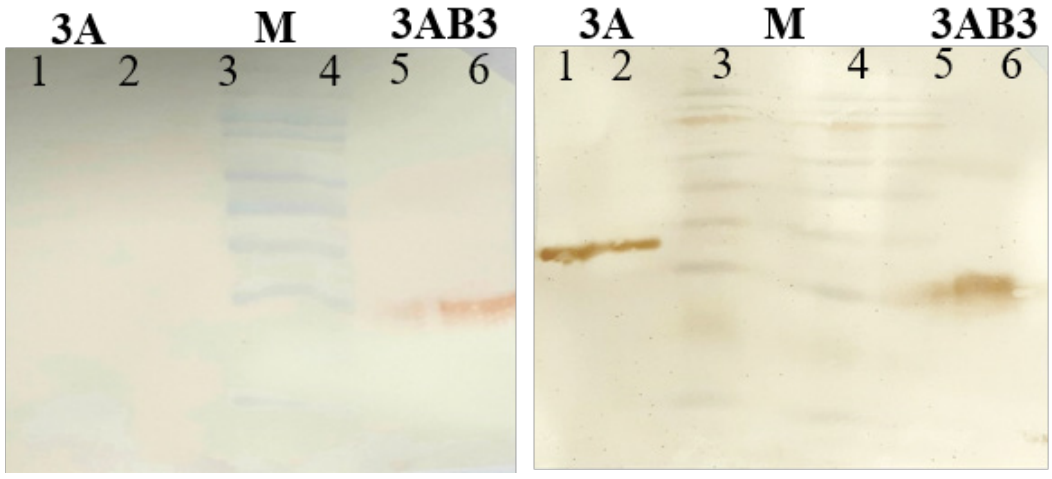


Fig 32. Epitope analysis of MAb using indirect ELISA (A) Specific reactivity of MAb against r3AB3 antigen and 3B peptide but no reactivity against r3A antigen (B) Reactivity of MAb against peptides P1, P2 and P3 representing 3B1, 3B2 and 3B3 NSP regions.



(A) **(B)**

Fig 33. Western blot analysis showing A. Reactivity of MAbFMDV3AB-2E4 against r3A (Lane 1,2) and r3AB3 (Lane 5,6) B. Reactivity of FMDV-positive cattle serum against NSP r3A (Lane 1,2), and r3AB3 Lane 5,6. Protein marker (Lane 3,4).

4.0 Development and Improvement of Vaccines

Efficacy of commercial FMD vaccines available for use in pigs

Pig rearing is one of the most important occupations of rural livelihood particularly in the NE states. According to the20th Livestock census, the pig population stands at 9.06 million. Despite the piggery sector having a high potential for growth in the region, outbreaks of infectious diseases including FMD are the main constraints for pig farming. Cattle are often prioritized concerning FMD prevention and control measures, with less effort invested in pigs. However, studies report acute clinical FMD to be more severe in pigs as compared to ruminants. Additionally, infected pigs are considered to be potent emitters of airborne virus. In this regard, the common practice of vaccinating only cattle, but not pigs against FMD may not be sufficient to prevent the dissemination of a potential outbreak. The continued occurrence of FMD cases in countries that have large pig populations despite extensive vaccination has raised questions about the effectiveness of vaccination in pigs. The effectiveness of FMD vaccines has been widely studied in cattle. However, relatively little information is available on the immune response to these products in swine, especially in field applications with quality assured vaccine intended for use in cattle and buffaloes. Such information is essential for the design of a rational vaccination regimen for the pig population. Furthermore, it is necessary to evaluate the outcomes of pig vaccination using high-quality FMDV vaccines with confirmed efficacy in cattle.

A collaborative research programme to study efficacy of oil adjuvanted trivalent inactivated FMD vaccine commercially available in the country upon immunization in piglets was taken up involving regional FMD network laboratory, Assam Agricultural University, Khanapara, Guwahati. QC test compliant FMD vaccine batches from two different manufacturers (Code A and B) inducing reasonably high virus neutralizing antibody titre in cattle were used to immunize piglets adopting various dose and route regimens. FMD seronegative piglets as tested in virus neutralization test and 3AB3 NSP iELISA of 2-3 months of age were included in the experiment. For immunization, groups of 6 piglets were considered for deep intramuscular route at standard dose of 2 ml as practiced in cattle and 5 piglets were considered for intradermal route at one-tenth standard dose of 0.2 ml. Neck region was selected for both the routes of immunization. An identical booster dose was administered in both the schedules 28 days after inoculation of the primary dose. Additionally in one more group of 10 piglets, only the primary dose was inoculated in a volume of 2 ml following deep intramuscular route without subsequent boosting. For this experiment, a QC test passed vaccine batch different from the other two batches was used. A group of 5 unvaccinated piglets were kept alongside the vaccinated groups as control. Serial blood sampling was done at monthly intervals through 0, 28, 60, 90, 120, 180 days, considering the marketable age of pigs at about 9-10 months. The serum samples after heat inactivation were subjected to virus neutralization test employing serotype O, A and Asia1 vaccine virus strains to determine their SN_{50} antibody titre and duration of antibody persistence.

Out of the two-immunization regimen (Prime-boost Vs prime only and intramuscular Vs intra dermal route of immunization) tried, 2 ml dose following intramuscular route showed a significantly higher antibody titre and more durable antibody response as compared to the intradermal administration of 0.2 ml dose. Considering the threshold of geometric mean SN_{50} antibody titre of 45, 32 and 32 taken as protective in cattle against serotypes O, A and Asia 1, respectively, it was observed that in the intramuscular regimen, the titre persisted even through 180 days post primary immunization. On the contrary, at 90 days post primary immunization in the intradermal schedule, the titre declined to the threshold level. More importantly, some intradermally inoculated pigs did not seroconvert at all. The anamnestic antibody response in terms of magnitude of SN_{50} antibody titre one month post booster administration was quite evident across regimens and vaccine batches tested suggesting a clear advantage of booster dose of vaccine if included in the primary schedule (Table 16). Similarly, comparatively lower titre antibody response was also observed in the single dose regimen (prime only) in agreement with the observation in the prime-boost immunization regimen (Table 17).

Table 16. Geometric mean SN50 antibody titre in the booster regimen (I/M)

Vaccine used	0 day (primary dose)			28 days (booster)			60 days			90 days			120 days			180 days		
	O	A	Asia 1	O	A	Asia 1	O	A	Asia 1	O	A	Asia 1	O	A	Asia 1	O	A	Asia 1
Code A	<8	<8	<8	64	76	40	181	304	128	135	171	90	71	161	68	54	135	121
Code B	<8	<8	<8	64	137	45	256	322	203	228	228	406	114	114	192	68	80	171

Table 17. Geometric mean SN50 antibody titre in the single dose regimen

Vaccine used	0 day			30 days			60 days			90 days		
	O	A	Asia1	O	A	Asia1	O	A	Asia1	O	A	Asia1
Code A (I/M)	<8	<8	<8	35	23	38	31	24	62	82	35	47

Network biology approach to study FMD vaccination response

Network biology techniques are used to understand the FMD vaccination response in cattle using publicly available large gene expression data. Five different gene selection methods are employed to select informative genes from the high-dimensional gene expression data. Then, gene co-expression network analysis is used to construct gene-gene association networks and to identify various gene modules. Next, hub genes, housekeeping hub genes, and unique hub genes are identified in the constructed networks through our earlier developed Differential Hub Gene Analysis (DHGA) approach. Identified 666 unique genes commonly selected by all the gene selection methods that were informative to the vaccination condition. Two gene co-expression networks under vaccination and non-vaccination conditions were constructed, which revealed the association among the selected genes. Further, the selected genes are grouped into 10 and 13 gene modules under vaccinated and non-vaccinated conditions, respectively. In the gene networks, we identified 193 and 94 genes as hubs for vaccinated and non-vaccinated condition, respectively. The detected hub genes are classified into housekeeping hubs (49), unique hubs to vaccinated (144), and unique hubs to non-vaccinated condition (45) based on their connection strengths. The enrichment analysis of gene modules, genes, and various hub genes indicated that functions including protein binding, catalytic, transcription regulator, transporter, *etc.*, activities are majorly activated under vaccination. These identified genes and their key roles can act as potential biomarkers for maximizing FMD vaccination response in cattle. The findings of this study may provide inputs and hypothesis for future immunological studies.

Immunoinformatics approach based multi-epitope vaccine for FMDV SAT 2

Among seven distinct serotypes of FMD virus, Southern African Territories (SAT2)-serotype has higher inter-serotype sequence diversity compared to the Eurasian serotypes. Recently, the SAT2 virus has crossed African territory and affected the animals in west Eurasia and Near East regions. Thus, to prevent control the disease, new-age vaccines need to be developed as part of the control strategy. Further, developing a vaccine strain against SAT2 is a challenging task due to its sequence diversity and rapid mutation. Therefore, ICAR-NIFMD developed an immunoinformatic approach for designing a multi-epitope subunit vaccine construct against FMD SAT2 serotype through predicting the immunogenic epitopes in a highly efficient and cost-effective manner (Fig 34). Here, the vaccine construct was obtained by manually linking the predicted epitopes using linkers, such as AAY, GPGPG, and EAAAK. Additionally, Bovine IL-18 molecular adjuvant was selected based on the bovine innate immune response and was further attached to the *N*-terminal of the construct to increase overall immune response. The analytical findings indicated that the designed vaccine was found to be potent, neutral at physiological pH, non-toxic, non-allergenic, stable, and has immunostimulatory capabilities. Molecular dynamic simulations indicated compactness and stability of the vaccine construct. Further, molecular docking exhibited strong binding of the vaccine peptide with MHC-I N*01801 (bovine) alleles. *In-silico* immune simulations indicated that the construct could prompt both cellular and humoral immune response at increased levels.

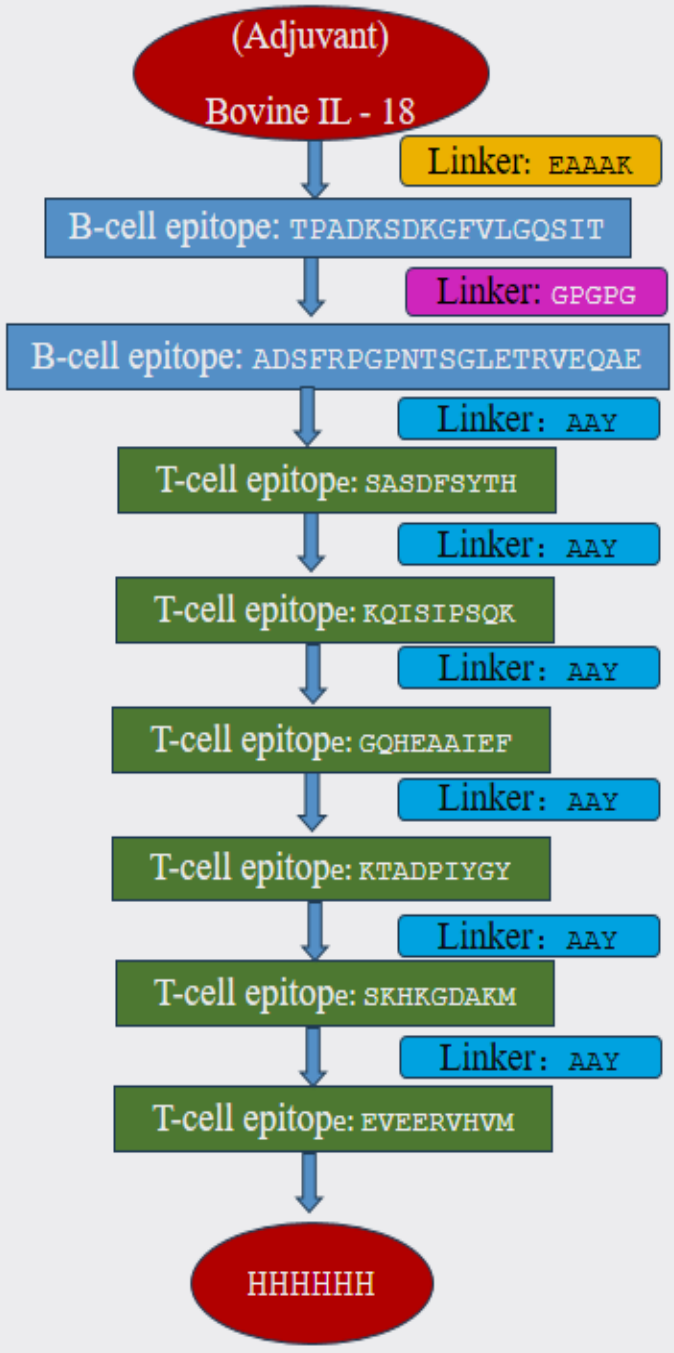


Fig 34. Computer aided multi epitope sub unit vaccine design against FMD SAT-2 serotype

5.0 Host-Pathogen Interaction and Immunopathology

Role of cytokines and chemokines in the pathogenesis of FMD

Cytokines and chemokines play an important role in disease pathogenesis. To explore the role of cytokines and chemokines in the pathogenesis of FMD, the archival intestinal tissues (both small and large intestines) and associated mesenteric lymph node tissues from 41 calves (aged from 2 to 6 months) naturally died of FMD in 2 separate outbreaks recorded in December, 2016 and August 2021 were examined for the presence of the FMD virus antigen and various host cell response molecules using patho-molecular techniques. The affected intestine showed higher apoptosis cell counts, increased levels of proinflammatory cytokine genes (TNF-α, IL-1β), and reduced number of goblet cells containing sulfated mucins. Immunohistochemically, abundant cytoplasmic immunoreactivity was noticed mostly in the crypt epithelium of the affected intestine suggesting the association of the virus with intestinal pathology. The MLNs showed moderate immunoreactivity for viral antigen with higher apoptosis counts in 9 cases, suggesting the association of the virus with lymphocytolysis. The reduced expression of MUC1, MUC2, MUC4 mRNAs, while increased expression of MUC5AC and MUC20 mRNAs was observed in the affected intestine. However, no significant difference in the expression level of MUC15 mRNA was observed. A similar distribution of MUC1, MUC2, and MUC5AC antigens was observed in the paraffin embedded tissue sections of the intestine of FMDV infected calves. The histopathological lesions, immunodetection of viral antigens, increased levels of pro-inflammatory cytokines, reduced goblet cell numbers with altered mucin gene expression likely led to a defective absorptive function of the intestinal epithelium, which contributes to FMDV pathogenesis (Fig 35).

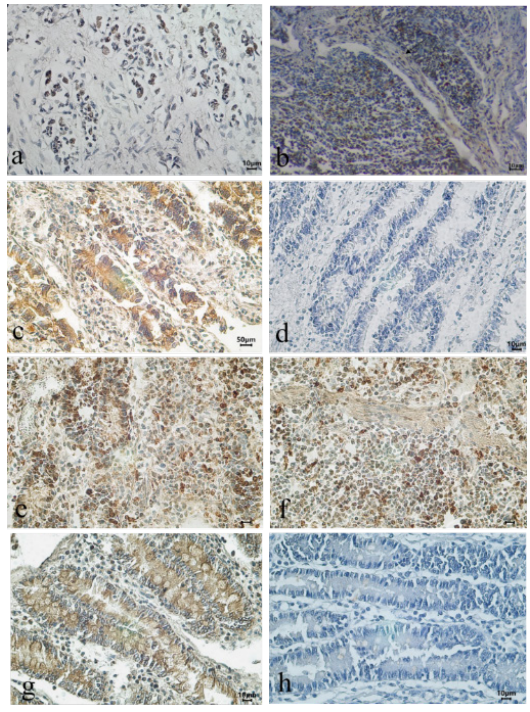


Fig 35. Immunohistochemical detection of pro-inflammatory cytokine genes expression in intestine of FMDV infected calves a) IL-1β in intestinal crypts, small intestine, IHC X400; b) IL-1β in the lymphocytes, payer's patches, ileum, IHC X200, c) IL-1β, large intestine, IHC X400 scale bar 10μm; d) negative control section, IL-1β, IHC X400 ; e) TNF-α, small intestine, IHC X400; f) TNF-α in the payers' patches, ileum, IHC X400; g) TNF-α, large intestine; h) negative control section, TNF-α, IHC X400.

Role of Interleukin (IL)-17 in the pathogenesis of FMD

The role of IL17 in the pathogenesis of FMDV was studied. For this, a total of 88 serum samples of FMDV affected cattle and 8 sera from apparently healthy cattle were tested for Th/17 cytokines [interleukin (IL) 17, IL-21, IL-22, IL-23, and IL-6]. A total of 16 tongue epithelium and heart tissues of 16 naturally infected cattle calves were processed for the molecular detection, and expression of Th/17 associated cytokines. The 10% neutral buffered formalin fixed tissues (tongue and heart) of 16 cases were processed for the *in-situ* demonstration of FMDV and levels of IL-17 and its associated cytokines. The serum samples were analyzed for the detection of antibodies against the non-structural proteins (NSP) of FMD virus using in-house developed indirect 3AB NSP ELISA assay. Tongue epithelium and heart tissues were tested for the serotype detection of FMDV using multiplex PCR. The results indicated that cytokine levels associated with Th/17 associated cytokines (IL-17, Il-23, and Il-6) were highly significantly increased ($P<0.001$) while Il-21, and IL-22 were significantly elevated ($P<0.05$) in naturally infected cattle than the controls. In m-PCR, out of 16 morbid tissues of tongue and heart, 12 and 4 cases were positive for serotype O and A respectively. Microscopically, tongue revealed numerous microvesicles accompanied with marked infiltration of mononuclear cells in the stratum spinosum and

stratum basal layers with formation of bullae in few cases. The heart showed acute interstitial necrotizing myocarditis with severe infiltration of lymphocytes dissecting the myocardial fibers. The affected tongue and heart tissues showed strong cytoplasmic immunoreactivity to caspase-3 showing FMDV induced apoptosis causing histopathological alterations (Fig 36). The tongue and heart tissues showed intense cytoplasmic immunoreactivity for FMDV antigens in the infiltrating mononuclear cells and in the swollen epithelial tissue. The tongue and heart tissues showed high immunoreactivity for IL-17, and IL-23 cytokines whereas moderate immunoreactivity for IL-21, and Il-22 at the lesional site. These results indicated that Th/17 cells play major role in FMD pathogenesis and could have potential value in monitoring disease progression and predicting the prognosis.

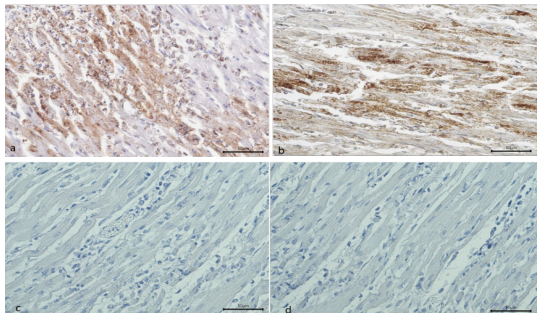


Fig 36. The paraffin embedded tissue sections of heart of naturally FMDV infected calves showing immunoreactivity to Th/17 associated cytokines a) Il-17, heart; b) Il-23, heart; c) negative control, Il-17; d) negative control, Il-23, IHC X200.

FMDV induced endocrinopathies in naturally infected cattle

FMDV induced endocrinopathies in naturally infected cattle was studied. For this, a total of 10% neutral buffered formalin fixed (NBF) archival tissues of endocrine glands such as thymus, thyroid, adrenals and pancreas were used from 10 calves naturally infected with FMD during the past years. Grossly, the calves showed petechial haemorrhages (3 cases), congested (2 cases) and enlarged (4 cases) in thymus, enlarged thyroid glands (n=6), enlarged and congested adrenals (4 cases), and congested pancreas (5 cases). Microscopically, thymus showed congestion, oedema, mild to moderate infiltration of inflammatory cells in the capsular surface with moderate depletion of lymphocytes. The majority of thyroid glands did not show any appreciable microscopic lesions except the presence of scanty colloid in thyroid follicles. However, thyroid glands of 3 calves showed mild to moderate infiltration of inflammatory cells within the thyroid follicles in addition to scanty colloid. Immunohistochemically, endocrine glands showed localization of viral antigen confirming FMDV induced histopathological alterations (Fig 37). The thyroid glands showed high immunoreactivity of viral antigen in the thyroid follicular cells. The pancreas showed moderate immunoreactivity to viral antigen mostly within islets of Langerhans. The thymus showed mild immunoreactivity to viral antigen in Hassall's corpuscles. The adrenal gland showed intense immunoreactivity to FMDV antigens in the zona reticularis. The blood was collected from the 12 calves naturally infected with FMD and serum was separated for the estimation of hormone assay. Peripheral blood nonnuclear cells (PBMCs) were isolated from the blood of FMDV infected (n=10) and recovered calves to determine the kinetics of genes regulating the endocrine glands (Fig 38).

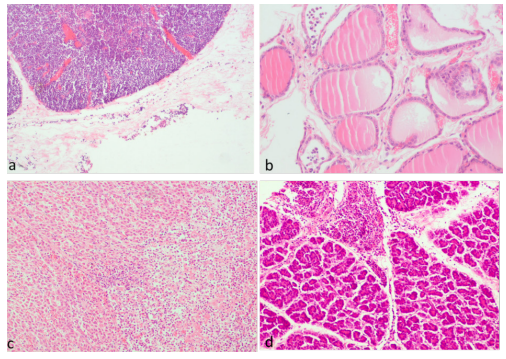


Fig 37. The endocrine glands of calves naturally infected with FMD showing a) infiltration of mononuclear cells in the capsular surface covering the thymic lobule, thymus, b) Thyroid follicles showing scant colloid with infiltration of mononuclear cells in the lumen of thyroid follicles, thyroid, c) infiltration of inflammatory cells in the zona reticularis, adrenal glands, d) Marked infiltration of inflammatory cells surrounding the Islets of Langerhans, pancreas, HE, X200.

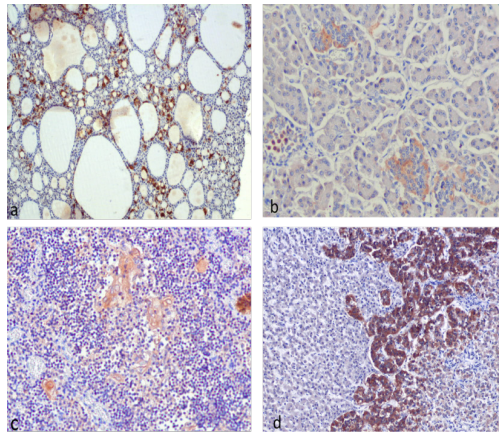


Fig 38. Immunohistochemical localization of FMDV antigen in the endocrine glands of calves naturally infected with FMDV showing a) Intense cytoplasmic immunoreactivity in the thyroid follicular cells, thyroid, IHC X100; b) membranous moderate immunoreactivity in Islets of Langerhans, pancreas, IHC X100; c) Hassall's corpuscles, thymus, IHC, X200; d) Zona reticularis, adrenal gland, IHC X200.

Efficacy of probiotics as mitigation strategy against FMDV

In recent studies, some probiotics have been reported to prevent and alleviate bacterial and viral infections. Here the Efficacy of probiotics as mitigation strategy against FMD virus infection in-vitro was investigated. The Lactobacillus *sporogenes* from the commercial probiotic sachets of human origin (Sporolac sachet) and bovine origin (Ecotas tablet) were revived by inoculating the freeze dried bacterial cultures ($1x10^9$ CFU) in 1 ml of MRS broth followed by plating on nutrient agar plate for the growth of pure bacterial colonies. The cytotoxicity of these 2 probiotics cultures at 10% to 90% levels was checked by MTT assay. The probiotics cultures from 10% to 40% suspensions did not show any cytoxicity effect on BHK21 cell line by MTT assay. Formaldehyde-inactivated *L. sporogenes* was obtained by resuspending the live bacteria pellet in phosphate buffered saline (PBS) containing 4 % v/v formaldehyde overnight. Prior to infection assays, bacteria were washed extensively with PBS to remove traces of MRS broth or formaldehyde, and serially diluted in Dulbecco's Modified Eagle Medium (DMEM) supplemented with 2 % (v/v) heat inactivated fetal bovine serum (FBS). Four experimental set-ups were designed namely, preincubation, pre-treatment, co-treatment and post-treatment. FMD virus infection was carried out at a multiplicity of infection (MOI) of 0.1 for all the set-ups. Cell monolayers were washed with PBS thrice and were maintained in 2 % DMEM supplemented with 50 µg/mL of gentamicin after contact time with bacteria. Culture supernatant was harvested at 12, 24, 48, and 72 hours post-infection for the estimation of virus titre. In the pre-incubation set-up where bacteria and virus are co-incubated prior to incubation with mammalian cells, led to the strongest reduction in virus titer (2.5 log reduction) compared to the positive control which might suggest a direct interaction between bacteria and virus particles that impairs the virus entry. The BHK21 cells with pre-treated probiotics showed reduced the viral load (1.5 to 2 log reduction of virus titre) more effectively as compared to post-treatment and co-treatment. The bovine origin probiotics (*L. sporogenes* at 10^8CFU) showed promising result as compared to human origin suggesting the homologues strain specificity.

Sequence based BoLA-DQA1 typing system for Indian cattle

Research indicates that the FMD virus can downregulate BoLA class II genes (MHC Class II) on antigen-presenting cells (APCs), thereby weakening the immune response and facilitating viral dissemination. There is considerable genetic diversity within BoLA class II genes, resulting in various alleles with different antigen-binding capabilities. These alleles influence an individual's immune response to pathogens, affecting both antibody production and disease resistance. BoLA-DQA, a component of the MHC class II region, is highly polymorphic and plays a critical role in shaping the bovine immune response, which can impact how cattle respond to infections and vaccinations. Studying the distribution of DQA alleles across different cattle populations helps in understanding their genetic structure and disease resilience. We optimized the amplification of the DQA1 gene using previously reported primers through two rounds of internal PCR and a set of internal sequencing primers. However, when genotyping 50 Indian cattle from diverse breeds and geographic locations, 10% of the samples failed to amplify. Additionally, 15% showed mismatches between forward and reverse sequences due to nonspecific amplification. Although no variation was found in the forward primer binding sites, a polymorphism was detected at the reverse primer binding site. To address this, we improved the sequence-based typing method by using a single forward primer instead of two internal sets and designing a new reverse primer. This optimization led to successful amplification and correct alignment of all forward and reverse sequences (19/19), confirmed via NCBI BLAST, with enhanced specificity. Comparing the original and improved methods revealed notable improvements in amplification quality, sequence alignment, and allele identification. A total of 44 cattle from eight different breeds were successfully typed, identifying 26 known alleles and five novel ones. Interestingly, some novel alleles were present in GenBank but missing from the EBI-BoLA database, underscoring the need for ongoing updates to the database. In summary, this optimized PCR-SBT approach provides a robust and efficient method for comprehensive BoLA-DQA1 typing.

6.0 Kits and Biologicals

Production, standardization and supply of diagnostic kits

ICAR-NIFMD optimized, produced and supplied critical regents for 3AB3 indirect DIVA ELISA and Solid Phase Competitive ELISA (SPCE) kits to carry out FMD serosurveillance and seromonitoring, and Sandwich ELISA kit for serotyping of FMD viruses to the state FMD Centers. The details of supplies made are given below. Besides supply, the diagnostic kits were also used at ICAR-NIFMD, Bhubaneswar for seromonitoring and serosurveillance under LHDCP (Table 18).

Table 18. Diagnostic kits supplied and used at NIFMD during 2024 for number of samples

S. No.	Recipient state	3AB3 NSP ELISA	SPC ELISA	Serotyping ELISA
1	Andaman and Nicobar	3500	2000	-
2	Andhra Pradesh	6500	3000	100
3	Arunachal Pradesh	3100	3460	-
4	Jharkhand	4000	1584	-
5	Gujarat	4000	11400	-
6	Mizoram	1900	2774	-
7	Himachal Pradesh	4200	1500	-
8	Jammu & Kashmir	4250	4400	-
9	Karnataka	9000	7000	300
10	Kerala	5400	9461	800
11	Madhya Pradesh	14000	6000	-
12	Maharashtra	6000	-	100
13	Tripura	2000	1350	-
14	Nagaland	6000	11530	-
15	Odisha	5300	4500	-
16	Puducherry	2000	2000	-
17	Assam	2000	1700	500
18	Rajasthan	9500	17500	-
19	Tamil Nadu	3500	11000	-
20	Telangana	19500	13194	-
21	Punjab	1500	4200	100
22	Uttarakhand	6000	5800	-
23	Meghalaya	4550	4550	-
24	Nagaland	3530	1810	-
25	Bihar	-	4290	-
26	Haryana	900	3000	300
27	West Bengal	5000	-	-
Total		**137130**	**139003**	**2200**

7.0 Intellectual property management

Patent applications

IPRs	Application/ Registration No.	Name of Innovation/ Technology/ Product/ Variety	Date of Filing/ Registration	Application Granted/ Registered**
Patent for filing	Indian Patent Application No. –202411102115	One-Tube Multi-Target reverse transcription-PCR Assay for detection of Foot-And-Mouth Disease Virus Genome Pan-Serotype	23/12/2024	Application registered at Indian Patent Office (IPO)

IPRs	Application/ Registration No.	Name of Innovation/ Technology/ Product/ Variety	Date of Filing/ Registration	Application Granted/ Registered**
Complete application for grant of patent	Indian Patent Application No. -202311089799	Monoclonal antibody-based competitive ELISA for the detection of Foot and Mouth Disease Virus (FMDV) non-structural protein antibodies as marker of infection	29/12/2023	Application registered at Indian Patent Office (IPO)

IPRs	Application/ Registration No.	Name of Innovation/ Technology/ Product/ Variety	Date of Filing/ Registration	Application Granted/ Registered**
1st Examination report of patents submitted	Indian Patent Application No.- 202111037282	Thermotolerant Foot-and-Mouth Disease virus (FMDV) serotype O Indian vaccine strain O IND R2/1975 with enhanced immunogenicity in Cattle	17/08/2021	Application registered at Indian Patent Office (IPO)
	Indian Patent Application No. -202211067069	Live-attenuated FMDV serotype O IND R2/1975 Negative-Marker Vaccine Strain	22/11/2022	Application registered at Indian Patent Office (IPO)

IP Awareness Programme Organized

S No	Name of Programme (Training/ workshop/Seminar etc.) Organized	Date of Programme	Participants (No) (Male and Female)	Type of Participants (Scientists/Scholars/ Farmers/Business People etc)
1	Invitation for Webinar-Intellectual Property Rights Filing Process	19/03/2024	100	Scientists and JRFs, SRFs, YPs of ICAR-NIFMD
2	IP Management (IP Day Celebration)	30/04/2024	50	Scientists and JRFs, SRFs, YPs of ICAR-NIFMD

Institute Technology Management Committee Meeting

The **7th ITMC meeting** of ICAR-NIFMD was held on **26.03.2024** in hybrid mode at ICAR-NIFMD, Bhubaneswar. Dr. J.K. Biswal, Member Secretary, briefed the attendees on the agenda items of the meeting, which included:

- **Copyright applications** by Dr. Samarendra Das.
- A **presentation on invention disclosure** for "*Thermostable FMD Virus Serotype A IND 27/2011 Vaccine Strain Selected Through Thermal Shock Method and Application Thereof.*"
- **Discussion on filing the trademark** for the ICAR-NIFMD logo.
- **Discussion on Reliance BioSciences' Expression of Interest** for the transfer of FMDV serotypes O, A, and Asia1 vaccine technologies.

The **8th ITMC meeting** of ICAR-NIFMD was held on **10.07.2024** in hybrid mode. Dr. J.K. Biswal, Member Secretary, briefed the attendees on the agenda items of the meeting, which included:

- A **presentation on invention disclosure** for *"One-Tube Multi-Target Reverse Transcription-PCR Assay for Detection of Foot-and-Mouth Disease Virus Pan-Serotype,"* by Dr. J.K. Mohapatra.
- **Discussion on the commercial viability and assessment** of the monoclonal antibody-based cELISA for FMD sero-surveillance developed at ICAR-NIFMD.

8.0 Professional Services

During 2024, the institute has provided testing services for FMD seromonitoring using SPCE, serosurveillance using DIVA ELISA, and serotype identification using PCR to private bull and dairy farms and exporters, as well as supplied SPCE and DIVA kits. This year, monoclonal antibody based competitive ELISA for FMD serosurveillance was newly added under professional services. The details of revenue generated is depicted in the Table 19 and 20.

Table 19. Details of revenue generation during 2024

Particulars	Total no. of samples	Total Amount (including GST)
Revenue generated through offering diagnostic services		
FMD Seromonitoring using SPCE Testing	4915	₹ 2,852,213.00
FMD Serosurveillance using 3AB3 NSP iELISA	262	₹ 51,444.00
FMD Serosurveillance using 3AB3 NSP MAb cELISA	736	₹ 356,077.00
FMDV Panserotype mPCR Testing	137	₹ 409,798.00
FMDV Panserotype rRT-PCR Testing	124	₹ 378,383.00
MDV Serotyping using mPCR Testing	10	₹ 29,720.00
Revenue generated through supply of diagnostic kit		
SPCE kit without plates	5940	₹ 676,439.00
Serotyping ELISA kit without plates	300	₹ 104,194.00
r3AB3 NSP iELISA kit-2 without plates	1350	₹ 190,915.00
r3AB3 NSP iELISA kit-1 with plates	450	₹ 64,512.00
Total		**₹ 51,13,695.00**

Table 20. Year wise revenue generation

S No	Year	Total Amount (including GST)
1	2019	₹ 6,48,906
2	2020	₹ 24,45,877
3	2021	₹ 22,98,347
4	2022	₹ 32,32,368
5	2023	₹ 19,56,384
6	2024	₹ 51,13,695

9.0 National FMD Virus Repository

The National FMD Virus Repository, managed by ICAR-NIMFD, houses the world's largest collection of FMD viruses. This repository is updated annually with samples of newly identified and well-characterized FMD viruses collected across India. In 2024, a total of 21 FMD virus isolates (20 of serotype O and 1 of serotype A) were revived using the BHK-21 cell system and added to the National Repository of FMD Virus (Table 21). Currently, the repository holds a comprehensive collection of 2,485 isolates, including 1,753 of serotype O, 349 of serotype A, 15 of serotype C, and 368 of serotype Asia-1. The repository supports various functions, such as retrospective analysis, vaccine strain selection, and diagnostic development. Notably, serotype C isolates are exclusively stored in the bio-containment laboratory at ICFMD, Bhubaneswar. To facilitate easy identification, the details of FMDV serotypes in the repository have been digitally catalogued, with individual virus information hyperlinked in an electronic file for quick access.

Table 21. Year-wise details of the virus isolates added to National FMD Virus Repository during last five years.

Year	O	A	Asia1	Total
2020	-	-	-	-
2021	102	10	1	113
2022	48	14	-	62
2023	9	1	1	11
2024	20	1	-	21

10.0 Research Projects

10.1 Institute funded

S. No.	Title	PI and Co-PIs	Duration	IRC Code
1	Host genetic factors affecting FMD vaccine response in calves	NR Sahoo (PI) JK Mohapatra, JK Biswal, M Rout	May 2020-May 2023 (Extended up to March 2024)	ANSC/DFMD/S/I/L/2020/002/00128
2	Elucidating the role of cytokines and chemokines in the pathogenesis of Foot-and-Mouth Disease	M Sahoo (PI), M Rout, JK Biswal, R Ranjan	Sep 2022-Dec 2024	ANSC/DFMD/S/I/L/2022/001/00159
3	Development of a medium throughput NA based diagnostics for FMD	NR Sahoo (PI) M Sahoo, M Rout	Aug 2022-July 2024	ANSC/DFMD/S/I/L/2022/002/00160
4	Development and evaluation of lateral flow immunoassay for Foot-and-Mouth Disease virus detection and serotyping using monoclonal antibodies	S Mallick (PI) JK Mohapatra, JK Biswal, M Rout	Aug 2022-Mar 2025	ANSC/DFMD/S/I/L/2022/002/00162
5	Antigenic and Genetic characterization of Indian foot and mouth disease virus serotype A strains during 2022-27	JK Mohapatra (PI) M Rout, Saravanan S	Aug 2022-March 2027	ANSC/DFMD/S/I/L/2022/001/00163
6	Evolutionary and antigenic analysis of foot and mouth disease virus serotype O strains from India during 2022-27	SS Dahiya (PI) JK Mohapatra, Saravanan S	Aug 2022-March 2027	ANSC/DFMD/S/I/L/2022/001/00164
7	Detection of asymptomatic low-level excretion of foot-and-mouth disease virus (FMDV)/genome in oesophago-pharyngeal fluid and morbid tissue samples associated with oro-laryngo-pharyngeal region of sheep and goats: A field-based study linked to carrier conundrum in FMD epidemiology	M Rout (PI) SS Dahiya, JK Mohapatra, Saravanan S, R Ranjan	Aug 2023-July 2026	ANSC/NIFMD/S/I/L/2023/003/00169
8	Development of a Polymerase Spiral Reaction (PSR) based isothermal nucleic acid amplification assay for rapid identification of Foot-and-Mouth Disease virus	AP Sahoo (PI), JK Biswal, S Das	Aug 2023-July 2024	ANSC/NIFMD/S/I/L/2023/004/00170
9	Exploring the efficacy of Probiotics as mitigation strategy against Foot-and-Mouth Disease	M Sahoo (PI), JK Biswal, T Das, S Mallick and NR Sahoo	Aug 2023-July 2025	ANSC/NIFMD/S/I/L/2023/005/00171
10	Active and passive surveillance of foot and mouth disease virus in livestock and wild herbivores at wildlife livestock interface	R Ranjan (PI) JK Biswal, S Das, M Rout	Oct 2023-Sep 2026	ANSC/NIFMD/C/I/L/2023/006/00172
11	Computational model-based risk factor analysis and NSP sero-prevalence prediction of FMD virus infections using epidemiological survey data: An application to wildlife-livestock interface	S Das (PI), R Ranjan	Aug 2023-July 2026	ANSC/NIFMD/S/I/L/2023/007/00173

12	Use of transition metal ions for the preparation of structurally-stable inactivated FMDV antigen and it's possible adjuvanticity in the FMD vaccine	JK Biswal (PI), R Ranjan	Aug 2023-July 2025	ANSC/NIFMD/S/I/L/2023/008/00174
13	Recombinant Goatpox (GPV) viral-vectored vaccine to control foot-and-mouth disease in livestock	JK Biswal (PI), R P Singh	Aug 2023-July 2025	ANSC/NIFMD/S/I/L/2023/009/00175
14	Comparative studies on host – FMD virus interaction among various species and age groups of animals: An in-vitro approach	T Das (PI), JK Biswal, DM. Sahoo, M. Rout, S. Mallick, S. Das, NR Sahoo and JK Mohapatra	July 2023-Dec 2026	ANSC/NIFMD/S/I/L/2023/010/00176
15	Animal slaughter house-based surveillance of Foot Mouth Disease	T Das (PI), JK Biswal, M. Sahoo, R. Ranjan, M. Rout, SS Dahiya, S. Das	July 2023-Dec 2025	ANSC/NIFMD/S/I/L/2023/011/00177
16	Exploring environmental sampling for FMD diagnosis using indigenously developed diagnostic tools in Indian settings	RP Singh (PI), JK Biswal, R Ranjan, JK Mohapatra	Aug 2023-July 2024	ANSC/NIFMD/S/I/L/2023/012/00178
17	FMD Sentinel surveillance in small ruminants: an indicator for FMD prevalence in India	M. Rout (PI), S. Mallick, Saravanan S, J.K. Mohapatra, R.P. Singh ICAR-NIVEDI: Dr. N. Shivasharanappa, V. Balamurugan, B. Gulati	July 2024-Aug 2025	ANSC/NIFMD/C/I/L/2024/001/00179
18	Epidemiology of Foot and Mouth Disease in Small Ruminants and Pigs in India during 2024-2027	M. Rout (PI), J.K. Mohapatra, Saravanan S	July 2024-Aug 2027	ANSC/NIFMD/S/I/L/2024/002/00180
19	Genetic and Antigenic Characterization of Foot and Mouth Disease Virus Serotype Asia 1 during 2024-2027	M. Rout (PI), S.S. Dahiya, J.K. Mohapatra, Saravanan S	July 2024-Aug 2027	ANSC/NIFMD/S/I/L/2024/003/00181
20	Kinetics of Foot-and-Mouth disease virus (FMDV) induced endocrinopathies in naturally infected cattle	M Sahoo (PI), NR Sahoo, JK Biswal, Tareni Das	July-2024 Aug 2027	ANSC/NIFMD/S/I/L/2024/004/00182
21	Genetic characterization and authentication of cell lines commonly used for FMD research	NR Sahoo (PI), M Sahoo, JK Biswal, J K Mohapatra	July-2024 Aug 2027	ANSC/NIFMD/S/I/L/2024/005/00183

10.2 Externally funded

S. No.	Title	PI	Duration	Funding
1	Generation and analyses of mRNA vaccine against foot-and-mouth disease	JK Biswal (PI) Ranjan R	Feb 2022- Feb 2025	DST-SERB; Budgetary outlay: 47.54 lakhs ANSC/NIFMD/S/ O/L/2022/017/00167
2	Statistical Approaches of Differential Gene Network Analysis for High-throughput Single-cell RNA-sequencing Studies	Das S(PI) NR Sahoo	July 2022- July 2025	DST-SERB, Budgetary outlay: 21.17 lakhs ANSC/NIFMD/S/ O/L/2022/016/00166
3	Understanding FMD viral ecology and landscape epidemiology towards control and eradication	Ranjan R (PI) Mohapatra JK, JK Biswal, Saravanan S, M. Rout, S A. Khulape	Sep 2021- Sep 2024	PIADC, USA Budgetary outlay: 66 lakhs
4	Development of a Gold nanoparticle based enhanced Lateral Flow Assay for rapid infield detection of Foot and Mouth Disease Virus	Mallick S (PI), Biswal JK, Sanatan Majhi (Utkal University)	March 2023- March 2026	Dept. of Science & Technology, Govt. of Odisha Budgetary outlay: 29.628 lakhs ANSC/NIFMD/C/ O/L/2023/001/00165
5	Machine Learning Approaches for Foot and Mouth Disease Virus Serotype and Lineage Prediction using the Virus Next Generation Sequencing Data	Das S (PI), JK Biswal Saravanan S	July 2023- July 2026	Dept. of Science & Technology, Govt. of Odisha Budgetary outlay: 9.96 Lakh ANSC/NIFMD/S/ O/L/2023/002/00168
6	Elucidating the role of Interleukin [lL-17] in the pathogenesis and therapy of foot and mouth Diseases	M Sahoo (PI) JK Biswal Singh RP	Jan 2024- Jan 2027	Dept. of Science & Technology, Govt. of Odisha Budgetary outlay: 9.96 Lakh
7	FMD Vaccine Quality Testing and Enhancing India's Animal Vaccine Testing Capabilities	JK Mohapatra (PI) RP Singh, JK Biswal, SS Dahiya, AP Sahoo, Saravanan S, R Ranjan, M Rout	Dec 2021- March 2024	DAHD Budgetary outlay: 258 lakhs
8	Recombinant Lumpy Skin Disease (LSD) viral-vectored multivalent vaccine to control and combat foot-and-mouth disease in livestock	JK Biswal (PI), RP Singh, J.K. Mohapatra, Saravanan S, Rajeev Ranjan (ICAR-NIFMD) Riyesh, T. BC Bera, TK Bhattacharya (ICAR-NRCE)	Nov 2024- Nov 2026	ICAR NP-GET Budgetary outlay: 40.40 Lakhs

9	Development of new generation vaccine with cross-protective efficacy against FMD virus	JK Biswal (PI), RP Singh, JK Mohapatra, M Rout, S Das, SS Dahiya	Nov 2024-Nov 2026	ICAR NP-GET Budgetary outlay: 48.00 Lakhs
10	Environmental surveillance and early warning system for animal pathogen surveillance	JK Biswal (PI), JK Mohapatra, RP Singh	Dec 2024-Dec 2027	NCBS Budgetary outlay: 28.7 Lakhs sanctioned for the year 2024-25
11	Institute Technology Management Unit	Biswal JK	April 2024-March 25	NAIF ICAR
Projects funded by DAHD to support LHDCP/NADCP				
12	Seromonitoring of pre and post vaccinal immunity against Foot and Mouth Disease under LHDCP/ NADCP during 2024-2027	Saravanan S (PI), Mohapatra JK, SS Dahiya, M Rout, M Sahoo, Tareni Das	July-2024-Aug 2027	DAHD
13	Serosurveillance in bovines under LHDCP/NADCP during 2024-2027	Mohapatra JK (PI) Saravanan S, Rout M, Dahiya SS, AP Sahoo, R Ranjan, Mallick S, S Das	July-2024-Aug 2027	DAHD
14	Investigation of NSP seroreactors for the presence of FMD virus by oropharyngeal fluid testing	R Ranjan (PI) M Rout, JK Biswal, JK Mohapatra, Saravanan S, SS Dahiya, M Sahoo, T Das	April 2021-March 25	DAHD
15	FMD vaccine quality control under LHDCP/NADCP	Sahoo NR (PI) Mohapatra JK Rout M, Dahiya SS, Saravanan S, AP Sahoo, Ranjan R, Biswal JK, Sahoo M, Mallick S, T Das, S Das	April 2021-March 25	DAHD

10.3 Service Projects

S. No.	Title	Nodal Officer	Associates
1	FMD virus isolation and maintenance of virus repository	Dahiya SS	Rout M and Mohapatra JK
2	FMD virus diagnostic service, and serotype identification	Mohapatra JK	Rout M and Biswal JK
3	Production, standardization and supply of diagnostic reagents for FMD virus diagnosis and surveillance	Mohapatra JK	Rout M, Dahiya SS, R Ranjan, Mallick S, Biswal JK and AP Sahoo
4	Laboratory proficiency testing of FMD diagnostics	Mohapatra JK	Rout M, Biswal JK, Mallick S, Dahiya SS, S Das and Saravanan S
5	Paid professional services through samples testing	Saravanan, S	Mohapatra JK, Rout M, Mallick S, Dahiya SS, and Biswal JK

10.4 Flagship programme of Govt of India

S No	Title	Nodal Officer	Associates
1	Implementation of Development Action Plan for Scheduled Caste (DAPSC)	M Rout	All scientists
2	Livelihood support through animal husbandry practice and initiatives to enhance farmers income in North Eastern Hilly Region	NR Sahoo	All scientists
3	Implementation of Development Action Plan for Scheduled Tribe (DAPST)	T Das	All scientists

11.0 Publications

Research Papers

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Popular articles

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- Suresh KP, Patil SS, Gulati BR, Subramaniam S, Mohapatra JK and Singh RP (2024) Sampling Plan for Seromonitoring of FMD in India under National Animal Disease Control Programme Round VI. ICAR-NIVEDI, Bengaluru and ICAR-NIFMD, Bhubaneswar.
- Suresh KP, Heamdri D, Patil SS, Subramaniam S, Mohapatra JK and Singh RP (2024) Sampling Plan for Serosurveillance of FMD in India under National Animal Disease Control Programme: 2024. ICAR-NIVEDI, Bengaluru and ICAR-NIFMD, Bhubaneswar.

12.0 Awards and Recognitions

- **R P Singh:** Member Joint Advisory Committee (JAC) of Rinderpest of GF-TADS by FAO-WOAH.
- **R P Singh:** Member of Advisory & Review Committee on R&D on Medical Counter Measures, One Health Mission, Govt. of India.
- **Nihar R Sahoo:** recognized as NAVS (I) Associate Fellow
- **Mohapatra JK:** Outside Expert, Institute Bio Safety Committee, ICMR-RMRC
- **Mohapatra JK:** Chairman, Technical Purchase Committee, ICMR-RMRC, Bhubaneswar
- **S. Subramaniam:** Member, Institute Management Committee, ICAR-NIHSAD, Bhopal
- **R Ranjan**: Biosecurity Expert in BSL3 construction committee for ICMR-RMRC, Bhubaneswar
- **R Ranjan**: DBT Nominee for Institute Bio Safety Committee of RMRC, Bhubaneswar, Odisha
- **R Ranjan:** IAVP-**Best Farm Animal Pathologist Award**, 2024. Veterinary Pathology Congress-2024, Jammu 28-30 November 2024

Conference Awards

- **M Sahoo: Best oral presentation award (first)** at the 3rd International Conference on "Climate-Smart Nutri Sensitive Integrated Farming System for Gender-equitable Sustainable Agriculture: Prospects and Challenges (ICNSFS-2024) during Nov 06-08, 2024 at ICAR-CIWA, Bhubaneswar, Odisha. (Sahoo M, Biswal JK, Ranjan R, Sahoo NR, and Singh RP (2024). Role of T regulatory cells in the pathogenesis of Foot-and-Mouth Disease in naturally infected cattle)
- **S Mallick**: **Best oral presentation award (second)** at the 3rd International Conference on "Climate-Smart Nutri Sensitive Integrated Farming System for Gender-equitable Sustainable Agriculture: Prospects and Challenges (ICNSFS-2024) during Nov 06-08, 2024 at ICAR-CIWA, Bhubaneswar, Odisha. (Mallick SR, Singh RP, Biswal JK, Rout M and Mohapatra JK (2024) Recombinant antigen and monoclonal antibody-based solid phase competitive ELISA to detect FMDV serotype O-specific antibodies)
- **M Rout**: **Best oral presentation award (third)** at the 3rd International Conference on "Climate-Smart Nutri Sensitive Integrated Farming System for Gender-equitable Sustainable Agriculture: Prospects and Challenges (ICNSFS-2024) during Nov 06-08, 2024 at ICAR-CIWA, Bhubaneswar, Odisha. (Rout M**,** Behera P, Padhy P, Samanta R, Mohapatra JK and Singh RP (2024) Estimating antibodies against nonstructural protein of foot-and-mouth disease virus in randomly sampled small ruminants of Odisha state during 2024)
- **R Ranjan**: **Best oral presentation award (third)** at International Conference on 'Emerging Viruses: Pandemic & Biosecurity Perspectives' on 11-13, November, 2024 organized by Defence Research & Development Establishment, Gwalior. (Ranjan R, Biswal JK, Mohapatra JK, Rout M, Subramaniam S, Rodriguez L, Arzt J, Mallick S, Pattnaik B and Singh RP (2024). Understanding Foot-and-Mouth Disease Viral Ecology by Systematic Follow-up Investigation Towards Control and Elimination of FMD in India)

13.0 Human Resource Development

13.1 Capacity Building and Training Programmes

Training programmes

ICAR-NIFMD organized two training/capacity building programs on FMD diagnosis, serosurveillance and seromonitoring in which a total of 5 staff from state FMD Centres, Andhra Pradesh, Himachal Pradesh, Kerala &Telangana were trained. Training on monoclonal antibody-based competitive ELISA for detection of FMDV NSP antibody in goat sera; one physical and one online was (Table 22)

Table 22. Details of training provided during 2024 by ICAR-NIFMD, Bhubaneswar

Name of Centre	No. of Trainees	Period	Days	Type of Training
Odisha	2	30th April 2024	1	Hands on training on Monoclonal antibody-based competitive ELISA for detection of FMDV NSP antibody in goat sera
Bengaluru, Hisar, Guwahati, Pune, Bhopal	10 (online)	4th July 2024	1	Monoclonal antibody-based competitive ELISA for detection of FMDV NSP antibody in goat sera
Andhra Pradesh & Himachal Pradesh	3	23-27, Sep, 2024	5	Hands on training on SPC ELISA, Serotyping & 3AB3 NSP ELISA
Kerala &Telangana	2	21-26, Oct, 2024	6	Hands on training on SPC ELISA, Serotyping & 3AB3 NSP ELISA

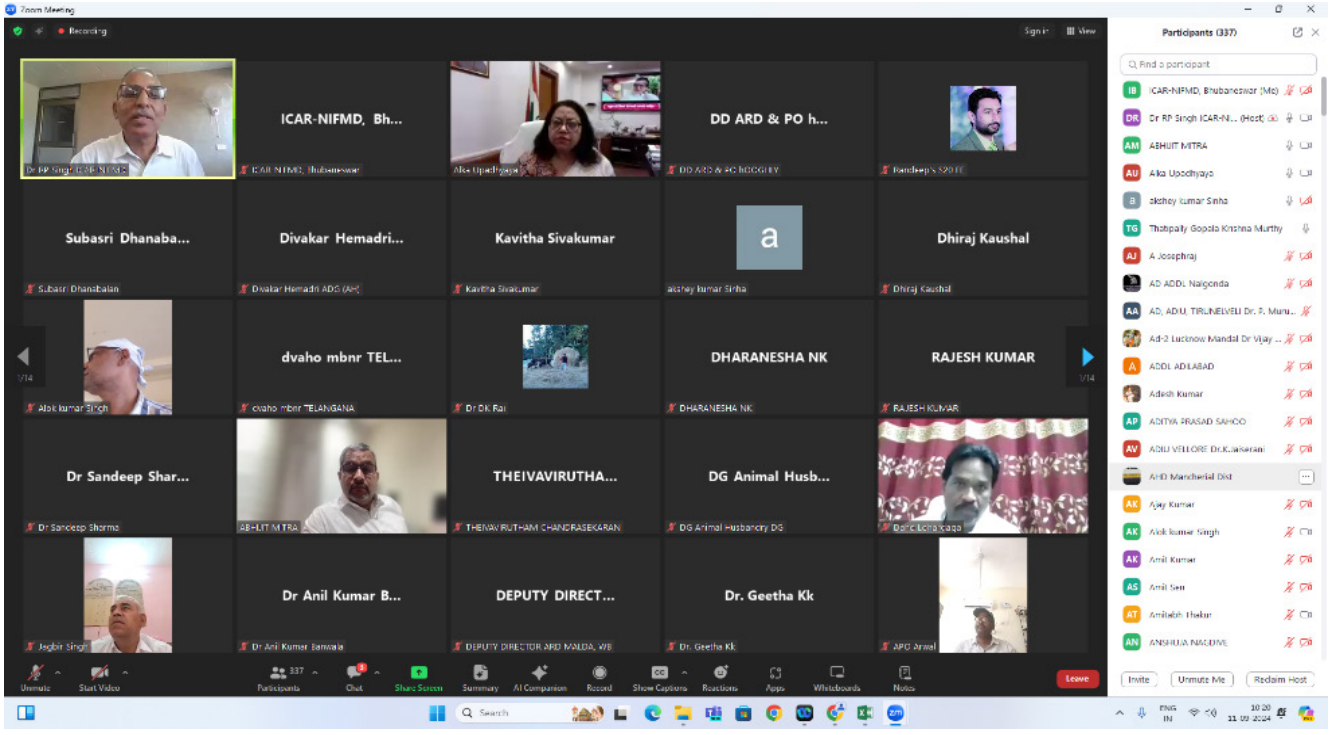
Capacity Building Series On "FMD Elimination with Vaccination"

A series of capacity building programs on **"Foot & Mouth Disease Elimination with Vaccination"** were conducted by ICAR-National Institute on Foot and Mouth Disease (ICAR-NIFMD), Bhubaneswar between 11.09.2024 to 01.10.2024. This program was initiated on 11th September, 2024, simulating with the date of launch of NADCP on FMD & Brucellosis by our honorable Prime Minister, in the year 2019.This was conducted as a two-stage program on 14 days for capacity building of veterinarians across the country. The topics in capacity building program included **i)** how to build high herd immunity against FMD to break virus transmission cycle, **ii)** disease prevention, control and other contingency measures, **iii)** sero-monitoring/post vaccinal monitoring, **iv)** sero-surveillance, **v)** good practices on vaccine cold chain management **vi)** motivation of vaccination teams **vii)** stakeholders' involvement, **viii)** high vaccination coverage and animal movement control etc. Around **8239 veterinarians** (both at senior management level and field level) participated in the program from across the country including senior level officials from DAHD and ICAR (Table 23).

Table 23. Date wise participations along with observations from ICAR-NIFMD as feedback are depicted below in the table for necessary action to various stakeholders.

Sl. No.	Date of Program	Name of State/UTs	No. of Registrations/ Participants/ Beneficiaries	Feed-back from ICAR-NIFMD on different states
1.	11.09.2024	Countrywide-National Programme **(For District level and above officers)**	**1198**	
	State/UT wise program for Veterinary Officers and Senior Veterinary Officers (12.09.2024 to 01.10.2024)			There should be a provision of compensation in case of accidental death due to vaccination (which is very minimum)

2.	12.09.2024	Uttar Pradesh	370	Realistic disease reporting and more vaccination coverage
3.	13.09.2024	Bihar	690	Strengthening of veterinary services
4.	17.09.2024	West Bengal & Tripura	421	More commitments required for quality vaccination
5.	18.09.2024	Gujarat	255	Commitment for quality vaccination required
6.	19.09.2024	Rajasthan	168	More commitments required for vaccination
7.	20.09.2024	Madhya Pradesh & Chhattisgarh	114	Commitment for quality vaccination required
8.	23.09.2024	J & K, Ladakh, Himachal Pradesh & Uttarakhand	364	Commitment for quality vaccination required
9.	24.09.2024	Odisha & Jharkhand	219	More commitment for quality vaccination required
10.	25.09.2024	Manipur, Mizoram, Arunachal Pradesh, Meghalaya, Nagaland, Sikkim & Assam	286	More commitment for quality vaccination required
11.	26.09.2024	Maharashtra & Goa	1647	Good possibility of disease-free zone
12.	27.09.2024	Punjab, Haryana & Delhi	1119	Good possibility of disease-free zone. There is need for more potent FMD vaccine for Haryana.
13.	30.09.2024	Telangana, Andhra Pradesh & Karnataka	947	Good possibility of disease-free zone
14.	01.10.2024	Kerala, Tamil Nadu, A&N & Puducherry	441	Good possibility of disease-free zone. Strict livestock movement in Kerala required.
	Total Participants		**8239**	There is a strategy with ICAR-NIFMD to reach out to all 81000 veterinarians in the country within 12 months for similar and repeated capacity building.



Participation in FMD Proficiency Testing Scheme, 2023 organized by the WRL- FMD

ICAR-NIFMD, as the 'FAO Reference Centre for FMD' and part of the WOAH/FAO FMD reference laboratory network, actively participated in the FMD Proficiency Testing Scheme, 2023. Both serology and virology panels were included. As per the feedback report received, the Institute's performance was categorized as 'Category 3.' The range of tests performed by the Institute indicated its capability consistent with a laboratory located in a 'Progressive Control Pathway (PCP) 5' country. It is noteworthy that all the diagnostic tests applied to PT coded samples are indigenously developed by the scientists at the Institute. These tests are widely used across the country through national FMD network laboratories.

THE Pirbright INSTITUTE

Wednesday, 28 February 2024

ICAR – National Institute on Foot and Mouth Disease,
Mukteswar 263138,
Nainital, Bhubaneswar,
752050,
India

Dear Dr Rabindra Prasad Singh

Feedback on the Foot-and-Mouth Disease Proficiency Test Scheme 2023

Thank you for your participation in the 2023 Foot-and-Mouth Disease Proficiency Testing Scheme (Phase XXXV), organised by the FAO World Reference Laboratory for Foot-and-Mouth Disease (with support from the European Commission for the Control of FMD, EuFMD) and the UK Government's Department of Environment, Food & Rural Affairs (DEFRA).

For the results that you have submitted, we define your performance as category 3 (see Appendix 1). Based on the range of test you have performed this capability is consistent with a laboratory located in a PCP 5 country. See Table 1 for further guidance on what additional test you may want to include in the future.

Performance	Capability
3	5

Please contact us if you have any queries or corrections to the way in which we have interpreted the data we have received from you. If we do not hear from you within three weeks, we will consider this the final report.

As always please feel free to contact us if you require any further assistance regarding recommended follow-up and corrective actions arising from this proficiency testing scheme.

Yours sincerely,

Dr Donald King
Head of the Vesicular Reference Laboratory
Head of the WRLFMD

Dr Anna Ludi
Head of Serology
Organiser of the PTS

The Pirbright Institute Ash Road, Pirbright, Woking, GU24 0NF UK
t +44 (0)1483 232441 f +44 (0)1483 232448 e enquiries@pirbright.ac.uk

ICAR-NIFMD

ICAR-NIFMD, Bhubaneswar organized Serology Proficiency Testing for 32 state FMD regional and collaborating centres, in which a panel of 9 coded samples were distributed for assessing FMD virus infection and vaccination status. Samples showing infection induced antibodies were not to be tested for protective antibodies coming from vaccination. A total of 23 operators from state FMD Regional and Collaborating Network Laboratories participated. For determining FMD virus infection status, the in-house developed 3AB3 NSP iELISA (DIVA) was applied by the laboratories. Except a few operators (1-3 out of 23), the overall interpretation with respect to sero-positive status for each sample showed concordance with the NIFMD result and the infection status was judged accurately. However, one seronegative sample having a running mean PP value of about 30 PP was misinterpreted as positive by 7 operators (Fig 39). A total of 23 operators from state FMD Regional and Collaborating Network Laboratories participated and performed the in-house developed SPC ELISA on NSP Ab-negative samples. When a total of 7 NSP-antibody negative samples were analyzed for protective antibody titre detection, except one operator for certain samples out of the 6 samples having protective antibody titre, the overall interpretation of all operators with respect to protective status showed concordance with the NIFMD result. For the only sample in the panel having no protective level antibody, up to 4 operators misinterpreted as having protective antibodies (Fig 40).

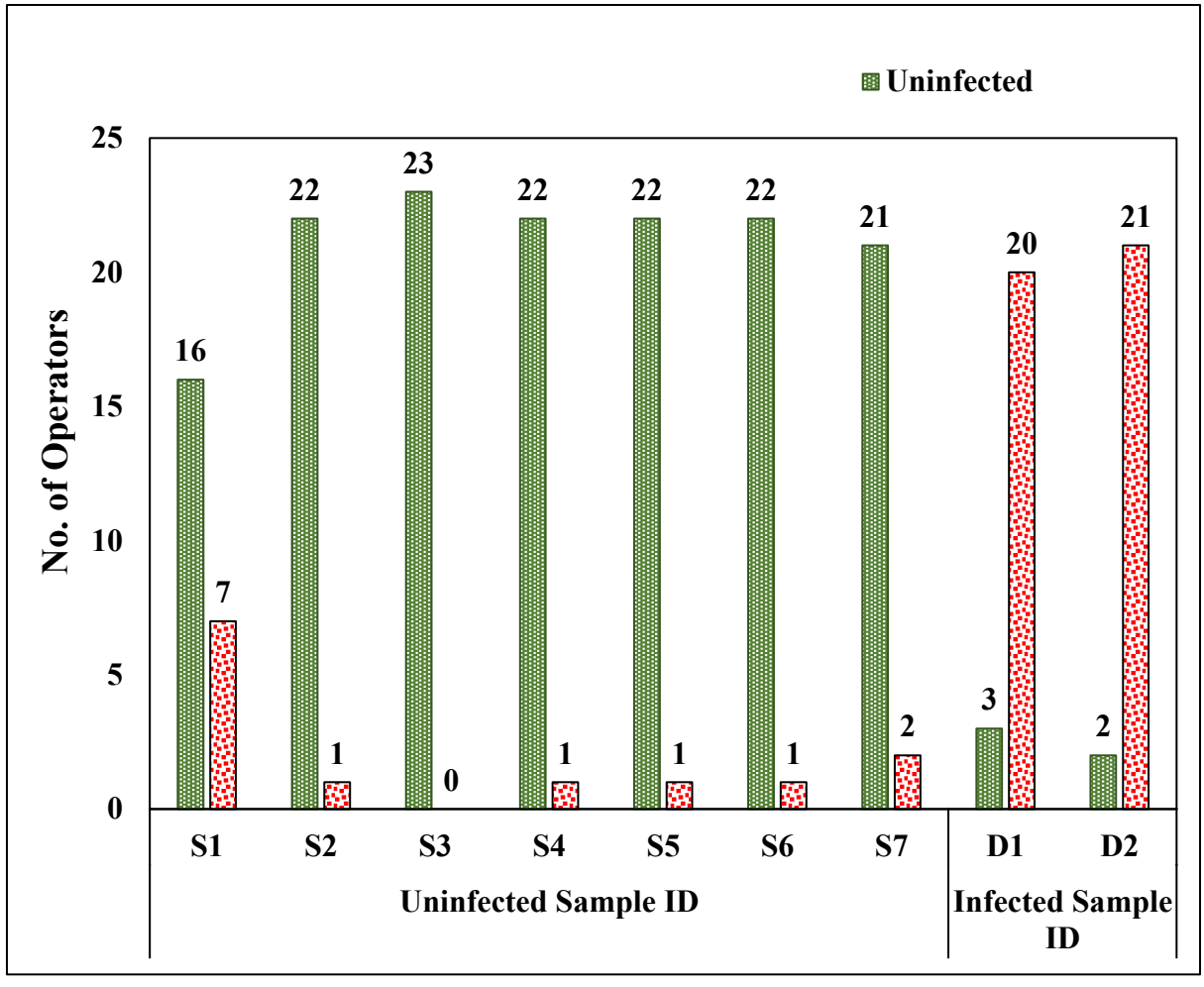


Fig 39. Interpretation of infection Status (DIVA) of Each Coded Sample by Various Operators

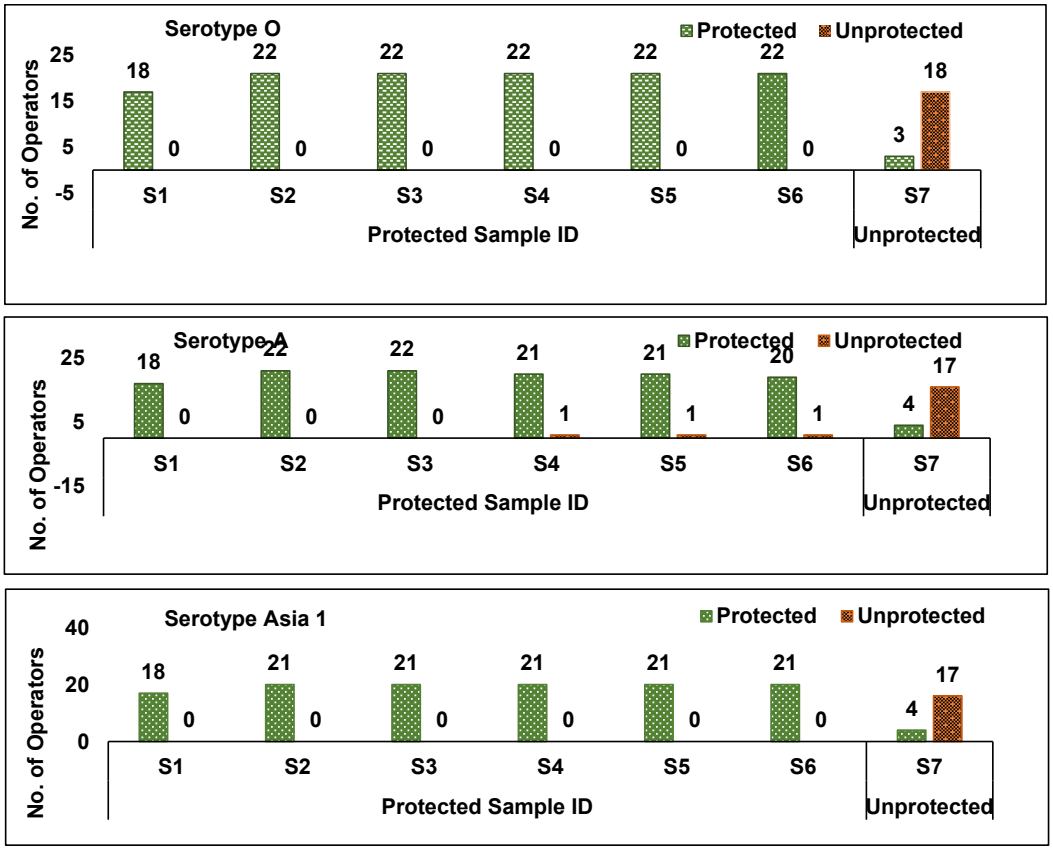


Fig 40. Interpretation of Protective Status (Protected and Unprotected) of Each Coded Sample by Various Operators

13.2 Conferences, Seminars, Symposia, Worksop, and Trainings

Participation of scientists in Conferences, Seminars and Symposium

S No	Name of conferences and Symposium	Date	Venue	Participating Scientists
		International		
1	Animal Virus, Vaccines and Immunity (AVVI)-2024	February 9-11, 2024	IVS&AH, SOA, Bhubaneswar,	R Ranjan J K Biswal
2	Artificial Intelligence	February 29 – March 02, 2024	XIM University, Bhubaneswar	S Das
3	Emerging Technologies in Agriculture and Allied Sciences (ETAAS-2024)	August 10-11, 2024	Online	M Rout
4	Climate-Smart Nutri-Sensitive Integrated Farming System for Gender-equitable Sustainable Agriculture: Prospects and Challenges	November 06-08, 2024	ICAR-CIWA, Bhubaneswar	R P Singh M Rout M Sahoo SS Dahiya S Das S Mallick T Das
5	Emerging Viruses: Pandemic & Biosecurity Perspective	November 11-13, 2024	DRDE, Gwalior	R P Singh N R Sahoo R Ranjan

National				
1	Data-driven predictive analytics (Dept. of Statistics, Sambalpur University)	March 19-20, 2024	Online	S Das
2	96th ICAR Foundation and Technology Day Ceremony	July 15-16, 2024	NASC, New Delhi	R P Singh S Subramaniam
3	Challenges in Animal Health and Production amidst Climate Change: Innovative Sustainable Solutions and their Translation	September 26-28, 2024	MVC, Chennai	S Subramaniam SS Dahiya
4	Exploring Veterinary Pathology and Diagnostic Innovations in Animal and Poultry Diseases Amidst Climatic Challenges	28-30 November 2024	SKUAST-Jammu	R Ranjan
5	Digital Agriculture: Empowering Indian Farming	December 16-18,2024	NAAS, New Delhi	S Das

Participation of scientists in Training and Workshop

S No	Name of Training/Workshop	Date	Venue	Participating Scientists
International				
1	The Development of Standard In Vitro Models for Studying Metabolic Diseases (ATCC)	11 January, 2024	Online	T Das
2	Get to the Heart of Your Toxicological Studies with Immortalized Primary Cells (ATCC)	11 March, 2024	Online	T Das
3	Multi-Sectoral Experts Workshop on Animal Health with One Health (AH-OH) by FAO of United Nations, India	14 March, 2024.	New Delhi, India	R P Singh
4	19th Joint Advisory Committee (JAC) meeting on Rinderpest by GF-TADs	26th April, 2024 23rd Sept, 2024	Online	R P Singh
5	WOAH Workshop on Lumpy Skin Disease Control in South Asia: Building Epidemiology and Laboratory Networks to Support TADs Control in the Sub-Region	6-8 August 2024	Kathmandu, Nepal	R P Singh
6	Animal Infectious Disease Prioritization Workshop by FAO & DAHD	28-30 August, 2024	New Delhi, India	R P Singh
7	19th OIE/FAO FMD Reference Laboratories Network Annual Meeting by WRL, FMD, The Pirbright Institute	25-27, September, 2024	Online	R P Singh
National				
1	AgrIP 2024 organized by IP&TM Unit, ICAR, and ZTM-AIC, ICAR-CIFT, Kochi	January 15 to February 15, 2024	Online	R Ranjan T Das

2	Development of AI based Android Applications in Agriculture organized by ICAR-IASRI, New Delhi	March 05-25, 2024	Online	Samarendra Das
3	Training-cum-workshop on Biosafety for handling and diagnosis of high-risk animal pathogens in ABSL-3 AND BSL-3 laboratories under National One Health Mission	August 26-30, 2024	ICAR-NIHSAD, Bhopal	SS Dahiya
4	Introduction and Hands-on Training on seasonal and non-seasonal influenza diagnosis using Real Time PCR	October 22-23, 2024	ICMR-NIV, Pune	R Ranjan J K Biswal

Invited Talks

Sl. No.	Presenter	Title	Date	Venue
1	Mohapatra JK	FMD vaccines and their quality control	31 January, 2024	Online, ICAR-IVRI, Bareilly
2	R Ranjan	Advances in diagnosis of animal diseases	3 February, 2025	ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar-7510023, Odisha (training program on 'Molecular Techniques for Fish Disease Diagnosis' from 29.01.2024 to 09.02.2024)
3	R P Singh	Foot and Mouth Disease Prevention & Control: Challenges & the Way Forward	19 February, 2024	Brain Storming Session on "Transboundary animal diseases: way forward for prevention and control". DUVASU, Mathura
4	S Das	Artificial Intelligence and Machine Learning Application in Animal Disease Diagnostics	29 Feb – 2 March, 2024	XIM University, Bhubaneswar (Xavier International Conference on AI)
5	R P Singh	Perspectives on Disease Management: Livestock and Wildlife Health	11 March, 2024	Wildlife Conservation Trust & Forest Department, Madhya Pradesh
6	R P Singh	Animal Disease Surveillance in India –Futuristic Implementation Insights.	14 March, 2024	Multi-Sectoral Experts Workshop on Animal Health with One Health, FAO of United Nations, India
7	S Das	MolEpidPred: A novel machine learning strategy for molecular epidemiology of FMD virus in cloven-hoofed animals	19 -20 March, 2024	Sambalpur University (National seminar on Data-driven predictive analytics)
8	M Sahoo	Special staining Techniques in fish disease diagnosis	15-19 April, 2024	ICAR-DCFR, Bhimtal (Online)
9	M Sahoo	Application of immunohistochemistry for the detection of infectious pathogens in tissue samples	15-19 April, 2024	ICAR-DCFR, Bhimtal (Online)
10	Mohapatra JK	Control & eradiation of FMD, PPR & Goat pox	29 May, 2024	VOTI, BBSR

11	R P Singh	Prevention, Management and Control of Foot and Mouth Disease	11 June, 2024	National Webinar on "FMD Awareness: Control and Management of Outbreak", IVRI, Pune (Online)
12	R P Singh	SAARC Laboratory Directors forum, revitalization efforts (2024).	6-8 August 2024	WOAH Workshop on Lumpy Skin Disease Control in South Asia: Building Epidemiology and Laboratory Networks to Support TADs Control in the Sub-Region, Kathmandu, Nepal
13	Mohapatra JK	Interactive lecture; Role model interaction with Vigyan Jyoti girls	21 August, 2024	Jawahar Navodaya Vidyalaya, Khordha
14	R P Singh	Status of Pool -2 FMD viruses circulating in India	25-27 September, 2024	19th WOAH/FAO FMD Reference Laboratories Network Annual Meeting, FAO , Rome (Online)
14	S Das	Application of R software in Next Generation Sequence data analysis	21-25 October, 2024	ICAR-CIFA, Bhubaneswar (training program on "Biological Data Analysis Using Computational Methods")

13.3 Academic activities and collaborations

Student Guidance

Sl. No.	Name of students	Degree and Discipline	Thesis research guide	Year of degree awarded	Title of thesis
1	Ms. Mimansa Sahoo Admin No. 222122314	M. Sc. and Bioinformatics	Samarendra Das	2024	Computational approach for gene regulation network modelling in single-cell RNA-sequencing studies
2	Ms. Bhagyashree Roul Admin No. 222122311	M. Sc. and Bioinformatics	Samarendra Das	2024	Molecular Characterisation of FMD Virus Serotype O using Machine Learning Approach
3	Ms. Sujata Parida Admin No. 222122318	M. Sc. and Bioinformatics	Samarendra Das	2024	Machine Learning Approach for FMD Virus Vaccine Matching Score Prediction using VP1 nucleotide Sequence Data
4	Ms. Diptimavee Padhan Admin No. 222122313	M. Sc. and Bioinformatics	Samarendra Das	2024	In-silico Design of multi-epitope recombinant vaccine against foot-and-mouth disease and lumpy skin disease

- ✓ Mohapatra J.K. and Rout M served as Co-Chairman Member, respectively of the Advisory Committee, RIVER, Puducherry, for an MVSc student in Veterinary Microbiology.
- ✓ Rout M served as Member of the Advisory Committee. Odisha Veterinary College, OUAT, Bhubaneswar for two MVSc students in Veterinary Pathology
- ✓ S. Das acted as an external question setter for the course STAT-502 (Statistical Methods for Applied Sciences) at the Centre for Postgraduate Studies, OUAT, Bhubaneswar, and for BI-502 (Statistical Genomics) at the College of Agriculture, OUAT, Bhubaneswar (2024).
- ✓ S. Das also served as a guest faculty member for the ICAR-funded training program on "Biological Data Analysis Using Computational Methods" at ICAR-CIFA, Bhubaneswar, from October 21–25, 2024.
- ✓ Ranjan R served as Member of the Advisory Committee for Dr Gopakrishna Mohanty, MVSc, Admission No.: 211922304, College of Veterinary Science & Animal Husbandry, OUAT, Bhubaneswar, Odisha.

14.0 Extension activities and Outreach Programs

Extension activities under LHDCP

Under LHDCP, state collaborating units carried out a variety of extension activities for stakeholders across different states in the country. FMD Centers organized 52 training sessions for veterinary officers and students, addressing various aspects of FMD prevention and control, samples collection, surveillance and monitoring with a total of 2276 professionals participating. Additionally, 118 awareness programs and animal health camps focused on FMD control were conducted, benefiting 7918 farmers (Table 23).

Table 23. Details of FMD Awareness camps for Farmers, training programme for vets and paravets

Centre / State	FMD awareness program for Farmers		Training program for vets and paravets	
	No. of Programs	Beneficiaries	No. of Programs	No. of Trained Personnel
Andaman	3	98	-	-
Assam	10	291	-	-
Agartala	17	2581	-	-
Ahmedabad	4	122	-	-
Madhya Pradesh	6	300	4	162
Haryana	6	391	4	115
Ranchi	1	1700	1	88
Rajasthan	-	-	7	198
Telangana	-	-	6	122
Arunachal	3	181	-	-
Mizoram	2	157	-	-
Manipur	7	512	-	-
Nagaland	9	473	-	-
Arunachal Pradesh	16	191	-	-
Jammu & Kashmir	3	169	-	-
Meghalaya	6	346	-	-
Maharashtra	-	-	5	126
	-	-	2 (online)	900
NRC Yak	16	191		
Kerala	7	145	13	216
Tamilnadu	2	70	1	90
Karnataka	-	-	9	259
Total	**118**	**7918**	**52**	**2276**

Participation in Agricultural Exhibition (MPSO-2024)

Drs. N.R. Sahoo, M. Rout, and R. Ranjan participated in "Matsya-Pranee Samavesh Odisha (MPSO)-2024" at Janta Maidan, Bhubaneswar, from February 16–18, 2024. They showcased the institute's work through posters, bulletins, and informational materials. Visitors, including dignitaries, farmers, and students, engaged with the scientists on FMD-related topics such as diseases, immunization, and biosecurity. The team also distributed technical resources for further reference.

Participation in Agricultural Exhibition cum Fair at ICAR-IIWM

Drs. N.R. Sahoo, M. Rout, and R. Ranjan showcased an institute stall at ICAR-Indian Institute of Water Management, Bhubaneswar, during its 37th Foundation Day on May 12, 2023. The event featured Chief Guest Dr. S K Chaudhary, DDG (NRM), ICAR, along with other distinguished dignitaries. Visitors, including the Chief Guest and officials, explored the stall, where scientists presented posters, bulletins, and technical information on Foot-and-Mouth Disease (FMD). They also shared insights on disease prevention, immunization, and biosecurity, distributed extension leaflet to attendees.

Participation in Agricultural Exhibition at ICAR-CIWA

Drs. M. Rout, M. Sahoo, S. Mallick, and T. Das participated in a three-day workshop at ICAR-Central Institute for Women in Agriculture from November 6–8, 2024. They showcased an institute stall featuring information on FMD prevention, immunization, biosecurity, and management strategies. Dignitaries, farmers, students, and NGO representatives explored the stall, engaging with scientists on disease control measures.

Participation in Aspiring Odisha Exhibition

Drs NR Sahoo and M Rout participated "Aspiring Odisha" exhibition held on 12-14th Dec 2024 at Narmada Garden, Baripada, Mayurbhanj representing ICAR along with the team from ICAR-NRRI. The ICAR stall (ICAR-NIFMD and ICAR-NRRI) bagged the outstanding stall award in the event.

ICAR-NIFMD Foundation Day Exhibition

An "Animal Science/Agriculture Exhibition" was organized to expose the farmers/ visitors to the newly developed technologies in the field of agriculture and allied sectors on the occasion of 23rd foundation day of IACR-NIFMD on 5th July-2024.

Activities under Flagship Programmes

Development and Action Plan for Schedule Caste (DAPSC)

During the year 2024, a total of 6 animal health camps, 55 input distribution programmes, 15 Input distribution programme for vulnerable SC family, 23 FMD awareness programmes, 7 goat distribution programme, 6 poultry chick distribution programmes, 12 PPR vaccination camps, 1 capacity building programme and 3 Layer bird distribution programmes were conducted under DAPSC. A total of 3249 families were benefited (Table 24).

Table 24. Types of interventions executed in the year 2024 under DAPSC

S No.	Programme	No. of Activities	Venue	No. of Beneficiary families
01	Animal Health Camp	6	Different GPs of Khordha & Puri district, Odisha	130
02	Input Distribution	55	Different GPs of Khordha & Puri district, Odisha	1501
03	Input Distribution Programme for Vulnerable SC family	15	Different GPs of Khordha & Puri districts and NIFMD Campus, Odisha	134
04	FMD Awareness	23	Different GPs of Khordha & Puri district, Odisha	570
05	Goat Distribution	7	Different GPs of Khordha & Puri district, Odisha	163

06	Poultry Chicks Distribution	6	Different GPs of Khordha & Puri districts, Odisha	411
07	PPR Vaccination	12	Different GPs of Khordha & Puri districts, Odisha	207
08	Capacity Building	1	Different GPs of Khordha & Puri districts at NIFMD Campus, Odisha	72
09	Layer bird distribution	3	Different GPs of Khordha district, Odisha	61

Success Story of DAPSC Activities

The activities and interventions conducted under Development Action Plan on Scheduled Caste (DAPSC) by ICAR-NIFMD, Bhubaneswar could create a significant visible impact on the livelihood and economic status of the SC community around the Institute. These include a drastic shift in the mindset and attitude of the beneficiaries towards such flagship programme of the Government of India (GoI). They started believing that such an initiative by the GoI is intended with focused objectives to produce immense benefits for the people in improving their livelihood earnings and financial security. As per the guidelines of activities under DAPSC, the share of resources spent for the benefit of SC community was ensured and an annual technical report generated for each financial year by ICAR-NIFMD was published.

Our interventions could create income generating opportunities where the unemployed or low-income group of people could make themselves engaged in poultry (chick and layer) and goat rearing and tried to improve their financial status. As productive assets, the SC farmers were distributed with goats and poultry that supported their livelihood. The capacity building/development programmes could improve their knowledge and understanding as well as awareness on animal husbandry practices as a source of income including the disease preventive measures for their animals. The ICAR-NIFMD team also followed up such interventions afterwards with farmers. The PPR vaccination drives conducted by the institute at the door steps of the SC farmers could save the lives of their goats against a dreaded disease called PPR/goat plague.

Between, April 2021 to March 2024, a total of 254 activities were conducted, which included 105 input distribution programmes. Of these 8 goat distribution programmes, 8 poultry chick distribution programmes, 10 study inputs distribution programmes in school, mango spling distribution programme, 38 FMD awareness camps, 31 animal health camps, 33 PPR/goat plague vaccination campaigns, 15 capacity building programmes were conducted. The input distribution programmes could provide benefits to 4359 beneficiaries. The benefits with such programmes they developed more interest towards livestock keeping with a belief that it could be a source of income for their family. Odisha being goat rearing state, the related community is involved in goat rearing extensively. PPR/goat plague has been regarded as one of the most important and dreadful diseases of the small ruminants with very high mortality. As a preventive measure, PPR vaccination campaigns were conducted at the door steps of the farmers of different village for 397 beneficiaries

covering 3710 animals. This intervention was tremendously impactful in drastically reducing the rate of mortality of small ruminants in comparison to the earlier years and has boosted the financial security in many families. Some of the farmers were reluctant to keep goats as they did not have the confidence to rear. After the interventions, when they were given goats with proper guidance, they turned out to be very successful in goat rearing and have now a good number of goats. The backyard poultry chicks along with poultry feed packets, feeders and drinkers benefitted 461 SC beneficiaries of 7-gram panchayats. This programme could be able to give the farmers a tangible profit along with eggs as good source of protein enhancing their nutritional security as well as income. Effort is now being made to develop Farmer Producer Organizations (FPOs) in the field of Goat and Poultry farming and to strengthen entire goat and poultry value chain in the area.

Socio-economic impact of DAPSC Scheme

Sl No.	Name of village	Name of the successful farmer	Impact on livelihood security
1	Barakuda village of Jamukoli GP, Jatni block, Khordha district	Smt. Narmada Bhoi	She has gained ₹9000-12000 from goats which helped her in repaying loan. She has made profit of ₹5000-6000 from the poultry. She has motivated several other lady farmers of the same community under SHG and they have also shown interest towards goat husbandry and poultry rearing. She has been awarded from our institute for her excellent work in the farming.
		Mr. Pradeep Bhoi	He has presently 60 goats. He has gained an amount of ₹40,000 from goats. He was also provided with poultry chicks and he gained ₹4000 selling poultry in the market.
		Smt. Sasmita Bhoi	He has presently 9 goats which helped her to meet the expenses for operation for kidney stone problem in a private hospital. She sold one male goat costing around ₹9000 for the purpose.
		Mr. Abinash Behera	He has presently kept 7 goats
		Mr. Ramakant Behera	He has 3 goats. He has sold the male goat and saved ₹10000 in bank. He could sell 22 poultry birds at the rate of INR 400, 450 and 500. He has also purchased feed packet from the local market. He has intimated that he would purchase 20-30 poultry birds from his own pocket and rear for the better livelihood earning.
		Mr. Debraj Behera	He has 6 goats, 5 female calves and 01 cow producing 1 litre milk per day. He is successfully rearing poultry birds
		Mr. Bijay Behera	He has 17 goats. Selling 2 male goats in 2 phases at ₹9000 each and total ₹18000 he saved in bank that has helped him during exigency.
		Mr. Hrudananda Behera	He has 15 goats with him and is depending on goatery as a source of income. He has received 25 poultry birds. Earlier, he has kept 3 cows. Now he purchased a jersey cow costing INR 32000. The cattle feed received from our office through DAPSC have been very useful for him.
		Mr. Aparti Behera	He owns 36 goats. He got ₹15000 from selling 2 male goats and utilized the amount for the marriage of his daughter. He has dairy farming with 5 cows getting 2 litres milk per day.
		Mr. Bidyadhar Behera	He owns total 13 goats. He is rearing cow and poultry. He has sold the 11 poultry birds at ₹500 each and the total amount he has saved in his bank account. He earns 3-4 litres of milk from cows. He consumes 1-2 litres milk and selling 2 litres milk at ₹ 30 per litre.
		Mr. Parikhita Nayak	He has kept 7 goats. He rears poultry birds and has sold 2 birds at ₹700 each and saved ₹ 1400 in bank.
		Mr. Dama Bhoi	He maintains the total strength of goat at 25. Recently, he has sold 5 goats at the cost of INR 3000, 8000 and 9000. The money thus generated was used for agriculture works in his field and for his own household requirements.
		Smt. Sula Bhoi	He earns her livelihood through livestock rearing. She has now 15 goats, 2 cows. She gets more than 3 litres milk per day from cow and sells at the cost of INR 35 per litre.

		Mr. Abinash Behera	He was given 11 poultry chicks and he has received a benefit of few thousand rupees selling those birds. The money he has used for buying feed for goats and remaining amount he has saved in his bank account.
2	Kansapada village of Haripur GP, Jatni block, Khordha district	Mr. Kanhucharan Nayak	He earns his livelihood through goat, poultry farming. He has 3 goats. He could get INR 3000 after selling one male goat. Subsequently, he sold 2 male goats at INR 14,000. Out of the poultry received, he sold 8-10 poultry birds at the cost of INR 300-4000 each. The money earned was used for his household emergencies.
		Smt. Banita Pahanda	She has kept cows and poultry. She has sold 16 poultry birds at the cost of INR 400 and 500. The money earned was utilized for her children's education. She has received 50kg cattle feed packets along with mineral mixture packets from our office. She was getting 2 litres of milk per day; out of which 1 litre was consumed by her family, while 1 litre milk was sold to get some money.
		Smt. Labanga Nayak	She has sold 22 poultry birds at the cost of INR 500 each and earned INR 10000 in total. She has used some amount for household purchases while the rest amount for agriculture works.
3	Aragul village of Haripur GP	Mr. Kedar Nayak	He has 9 goats. He has sold 3 goats at the cost of INR 4000 to 5000.
		Mr. Kedar Nayak	He has received poultry chicks, poultry feed packets along with feeder and drinker from office. He has sold out 8 poultry birds at the cost of INR 500. The money earned out of this was used for his agriculture works and rest amount he has saved in the savings bank account of his daughter.
		Smt. Tunamani Sethi	She has sold 14 birds at INR 500 to 600. The amount he has saved in his savings bank account. Some of the birds were laying eggs that were further beneficial for him. He has requested to receive goats as well as poultry wire-mesh from our office through DAPSC.
4	Garh-Beguniapada, Ghanipur GP, Delang Block, Puri district	Smt. Mamina Behera	She has kept 5 goats. She has sold 13 poultry birds at INR 400 and kept the amount in the saving account of her daughter in post office. She has kept one cow and has received cattle feed packet and mineral mixture packets from office.
5	Ghanipur village, Ghanipur GP	Mr. Mithun Malik	He has 4 goats and 2 cows. He has received poultry feed, feeder and drinker from office before receiving the birds. He has sold 10 poultry birds at the cost of INR 300 each. Out of the money generated, he used some money to purchase 2 layer birds for egg, while used rest amount for his household purpose.
		Mr. Kusa Behera	He received one female goat. He has kept one cow. He has sold 15 poultry birds at the cost of INR 400 each.
		Mr. Litu Behera	He has sold 18 birds at the cost of INR 250 to 300 each and has saved the money in the savings bank account.
6	Ichhapur, Rengal GP, Delang Block, Puri district	Smt. Puspalata Behera	He received 1 female goat. She has sold 15 poultry birds at the cost of INR 200 to 250. The money gained was saved in the account and she uses the money for study and tuition fees of her children at intervals.

7	Rengal village, Rengal GP	Mr. Sanjay Behera and Mr. Sujit Behera	They have received 50 poultry birds from office. He has received poultry feed packets along with feeder and drinker from office before receiving the birds. They have been very successful in poultry rearing. The 50 birds received were kept in one set up. He has told that all the poultry birds were in good health condition and he has earned INR 15000 through selling these birds. After consumption of the feed packets received from office, he has purchased further feed packets for the poultry. Out of INR 15000, he has given INR 5000 to his son-in-law, INR 5000 to his son, while INR 5000 he has kept with him. He has planned to keep more number of birds. After being successful in poultry rearing with the intervention of our office, he has made up his mind to continue poultry rearing in future times too. He has kept 02 cows and has also received cattle feed packets from our office.
		Mr. Manoj Das	He has sold out 21 poultry birds at the cost of INR 400-450 each and earned more than INR 8000. After consumption of poultry feeds, he has purchased 02 feed packets from local market. He has used the money for household purchases and some amount he has kept with him.
		Mr. Raghunatha Behera	He sold out 16 birds at the cost of INR 400 to 500 and the money he used for his household activities. He has developed interest in poultry rearing.
		Mr. Amar Rout	He has received poultry, feed packets along with feeder and drinker. He has sold 20 birds at the cost of INR 300-400. The money earned out of selling poultry birds were used for purchasing 2 female goats by the person. He has expressed his interest in generating money through goat husbandry in future times.
8	Barasahi GP, Khordha Block, Khordha district	Smt. Jhilimani Behera	She is a successful mushroom farmer doing poultry rearing, as well as dairying. She is earning 4-5 kg mushroom per day and sells at INR 200 per kg. She has received 25 poultry birds, poultry feed packets, feeder and drinker. She has sold 14 birds at the cost of INR 350 each. The money generated from the poultry rearing was used for purchase of medicines during her ill health as well as for household purchases. She has kept 3 jersey cows. She gets 3-4 litre milk everyday and sells at the cost of INR 40 per litre. She has received cattle feed packets and mineral mixture packets.
		Mr. Chinmaya Behera and Mr. Pradipta Behera	Mr. Chinmaya Behera and his uncle Mr. Pradipta have kept 50 poultry birds received in one place. He has kept 32 adult poultry birds weighing 2kg each. He has kept 2 cows.
		Smt. Kanchan Behera	Out of the poultry birds kept, she has sold 5 birds at the cost of INR 400-500 each. She has also kept 2 cows and has also received cattle feed packets from office.
		Mr. Bharat Sethi	He has sold 16 birds at the cost of INR 150 and has earned more than INR 5000. He has 2 bullocks for ploughing his land. He has also received cattle feed for the animals.
9	Chhanaghara GP, Khordha District	Mr. Sushanta Behera	He has sold out 18 birds at the cost of INR 400-500. The money earned through this was used to purchase 5 desi poultry birds. Some amount he has used in constructing house for poultry birds, while remaining amount he has kept with him. He has kept 01 cow and 02 calves.

Development Action Plan for Schedule Tribes (DAPST)

During this year, ICAR-NIFMD carried out different activities under DAPST in different tribal dominated villages (Haripur GP, Barasahi GP, Kuradhamalla GP and Mallipur GP) of Khordha district, Odisha and village Jhankat, Mukteswar with a long-term vision for upliftment of scheduled tribe community. Different activities conducted under DAPST were trainings (4), input distributions (9) and awareness/ sensitization programmes (9). Tribal families were distributed with need-based critical inputs like cattle feed (5 tonnes), mineral mixture (0.228 tonne) and veterinary medicines for improving livestock health and productivity; 25 sets of small agricultural tools as an aid in their kitchen gardening or farming; phenyl, KMnO4, bleaching powder and hand wash for improving hygiene and sanitation; study materials for tribal school children as aid to education etc. A total 590 tribal farmers and families got benefit through these activities under DAPST (Table 25).

Table 25. Types of interventions executed in the year 2024 under DAPST

Sl. No.	Description of activity	Venue	Date	Beneficiaries	Inputs
1	Study material distribution cum hygiene awareness programme	Govt. Primary School, Kumarabasta, Adibasi Sahi, Khordha, Odisha	5 January, 2024	38	Study materials, water bottle, hand wash
2	Input Distribution cum FMD awareness Programme. Training on "important diseases of goat and its control measures"	Haripur GP of Khordha district, Odisha	30 April, 2024	35	Mineral mixture, black phenyl, detergent, bleaching powder, tub, hand wash, bucket, Leaflet

3	Study Materials Distribution cum Hygiene awareness Programme	Aragul UP School, Aragul, Khordha	22 August, 2024	20	Study materials, water bottle, hand wash
4	Input Distribution cum FMD awareness Programme	Mallipur GP of Khordha district, Odisha	30 October, 2024	16	Cattle feed (13 bags, 50 kg each) and mineral mixture (32 Packets, 1.2 kg each), leaflets
5	Input Distribution cum FMD awareness Programme. Training on "important diseases of cattle and their management"	Barasahi GP of Khordha district, Odisha	21 November, 2024	34	Cattle feed (34 bags, 50 kg packet each) white phenyl, mineral mixture (1.2 kg/ Pkt), leaflets
6	Input Distribution cum FMD awareness Programme. Training on "vaccination of cattle against important diseases"	Kuradhamalla GP of Khordha district, Odisha	6 December, 2024	24	Study material set (7), cattle feed (50 kg packet, 19 bags), mineral mixture (1 kg/ Pkt, 34 packets)
7	Input Distribution cum FMD awareness Programme	Adibasi Sahi, Thakurpada Village, Barasahi GP of Khordha district, Odisha	13 December, 2024	20	Black phenyl, mineral mixture (1 kg/ Pkt, 41 packets), cattle feed (20 Bags, 50 kg packet each)
8	Input Distribution cum FMD awareness Programme and Swachh Bharat Programme	Adibasi Sahi, Thakurpada Village, Barasahi GP of Khordha district, Odisha	26 December, 2024	25	White phenyl, mineral mixture (1 kg/ Pkt, 50 packets), cattle feed (50 kg packet each, 14 packets). 25 sets of small hand farm tools (axe, pick axe, Khurpi and rake
9	Input distribution Programme. Training on "Benefits of Vaccination, and timely booster shots." Awareness on importance of providing adequate Shelter, nutrition, and veterinary care during the colder months to ensure the health and well-being of the animals.	Village Jhankat, Mukteswar	20 November, 2024	29 families	Veterinary medicines, Mineral mixture, KMnO4 powder

Livelihood support through animal husbandry practices in NEH region

NEH programme of ICAR-National Institute on Foot and Mouth Disease is implemented with the aim to support surveillance & epidemiology of FMD as well as other need-based interventions (disease diagnostic, screening and prevention) to support the livelihood of the stakeholders using animal husbandry activities focusing piggery, poultry husbandry. In the year 2024, several activities have been carried out across the NE states as per the guidelines focusing the aspirational districts as well as focusing the activities to a single theme attached with the Key Performance Indicators associated with. Therefore, to strengthen the pig production system on the north-eastern states to rejuvenate the loss due to pandemic of African swine fever reported since 2020, where a huge number of pigs died, and piggery development programme was taken up in different parts of NEH region which are under different stages of progress. This scheme was operated in the different villages of the aspirational districts of different North Eastern States.

Table 26. Selected villages from the Aspirational districts

Sl No.	State	District	Block	Village
1	Assam	West Karbi, Anglong	Chinthong	Sumer Pathar
2	Manipur	Chandel	Chakpikarong	Thorcham, Charong, Kanakhangbung
3	Nagaland	Kohima	Sanis	Lotsu, Mengujuma
4	Tripura	Dhalai	Dumburnagar	Gandachara
5	Mizoram	Lunglei & Lawngtlai	Chawngte, Bungtlang	Kamalanagar 11 & Bungtlang South
6	Arunachal Pradesh	Upper Subansiri & Papum Pare	Payeng, Changlang	Leya, Vijoynagar, Loth
7	Meghalaya	Ri-Bhoi	Umling C&RD Block	Umdohkha, Umjari,

During the year 2024, there were 7 participating centres such as Regional Research Centre at C.V.Sc., A.A.U., Khanapara, Guwahati (SAU) as well as State FMD collaborating Centres at Imphal, Aizawl, Kohima, Itanagar, Shillong and Agartala under Animal Husbandry Departments of respective state governments. The collaborating centres conducted various activities such as FMD awareness camps, training & workshops, capacity building, animal health camps & FMD vaccination in collaboration with ICAR-NIFMD as a part of the programme.

Table 27. List of activities conducted during 2024.

Sl. No.	Name of the Activities	Number	No. of Beneficiaries	State/ District
1	Trainings / Capacity building / Skill Development etc.	11	332	Assam (West Karbi Anglong and Darrang district) Manipur (Chandel district), Mizoram (Lawngtlai District), Nagaland (Longleng district), Tripura (Dhalai District), Meghalaya (Ri-Bhoi).
2	Awareness camps, Workshops, exposure visits, Mela etc.	29	946	Assam (West Karbi Anglong and Darrang district) Manipur (Chandel district), Mizoram (Lawngtlai District), Nagaland (Peren district), Tripura (Dhalai District), Arunachal Pradesh (Chander, Lubrang village) Meghalaya (Ri-Bhoi).
3	Front Line Demonstrations (FLDs) and other demonstrations	7	133 Families	Assam (West Karbi Anglong and Darrang district) Manipur (Chandel district,Chakpikarong)
4	Animal Health Camp	8	374	Assam (West Karbi Anglong and Darrang district) Manipur (Chandel district), Mizoram (Lawngtlai District), Nagaland (Longleng district), Tripura (Dhalai District), Arunachal Pradesh (Upper Subansiri) Meghalaya (Ri-Bhoi)
5	Vaccination/Medicine	14	1094	Assam (West Karbi Anglong and Darrang district) Manipur (Chandel district), Mizoram (Lawngtlai District), Nagaland (Peren district)
6	Input Distribution			
i	Distribution of Chicks, Feeding tray, drinker and egg tray	1510	60 Families	Assam (West Karbi Anglong district), Arunachal Pradesh (Chander, Lubrang village)

ii	Distribution of Goat	10	05	Nagaland (Longleng District)
iii	Distribution of poultry	1500	50 Families	Assam (West Karbi Anglong and Darrang district)
iv	Distribution of poultry Feed	25 Quintal	50 Families	Assam (West Karbi Anglong and Darrang district)
v	Distribution of pig feed	18 Quintal	18 Families	Assam (West Karbi Anglong district) Mizoram (Lawngtlai District), Arunachal Pradesh (Chander, Lubrang village)
vi	Distribution of Mineral Mixture	365 Kg	327 Families	Assam (West Karbi Anglong district), Arunachal Pradesh (Chander, Lubrang village)
vii	Distribution of Pig	30 no	3-4 months old HDK-75 piglets: to 45 Families	West Karbi Anglong, Assam, Mizoram (Lawngtlai District)
viii	Livestock covered under health monitoring, disease status, control and eradication	08 no	480	8 District of Manipur
ix	Human resource trained	53 no	37	Jorhat, Assam; Darrang, Assam; Baksa, Assam and West Garo Hill District Meghalaya, Tripura (Dhalai District)
7	Vaccination	Doses	NDV-6000 doses, 1500 doses (R2B), Fowl pox-1500 doses to 50 Families	Assam (West Karbi Anglong and Darrang district)

Table 28. Number of activities done in collaboration with individual Centres

Sl. No.	Name of the Collaborating Centre	State	No. of events	Number of beneficiaries		
				Male	Female	Total
1	RRC, Guwahati	Assam	9	170	158	328
2	Imphal FMD CC	Manipur	9	145	162	307
3	Aizawl FMD CC	Mizoram	8	156	87	243
4	Kohima FMD CC	Nagaland	3	30	35	65
5	Agartala FMD CC	Tripura	12	224	316	540
6	Dept.of AHV& DD, Itanagar	Arunachal Pradesh	7	280	145	425
7	Shillong FMD CC	Meghalaya	3	65	66	131
Total			**51**	**1070**	**969**	**2039**

15.0 Meetings and Visits

Research Advisory Committee

The 12th RAC meeting of ICAR-NIFMD, chaired by Dr. H. Rahman, was held in hybrid mode on June 28, 2024, at ICAR-NIFMD, Bhubaneswar. Attendees included distinguished experts from ICAR, FAO, and academic institutions. Dr. R.P. Singh presented the institute's overall activities, and Dr. Saravanan S. presented the Action Taken Report from the 11th RAC meeting. Additionally, Dr. J.K. Mohapatra and Dr. A.P. Sahoo highlighted the achievements of ICAR-NIFMD Bhubaneswar and the NIFMD Laboratory, Mukteswar.

Institutional Animals Ethics Committee

The 9th IAEC meeting of ICAR-NIFMD was held on 30.10.2024. During the meeting, the progress of ongoing approved projects and newly submitted proposals for IAEC approval were discussed by Dr Rajeev Ranjan, Member Secretary. To meet the institute's current requirements, the Animal House facility of ICAR-NIFMD has been upgraded this year. The annual inspection of the animal house was conducted by Dr. Ajit K. Naik, Main Nominee of CCSEA, on 13.12.2024, and the necessary compliance report has been submitted.

Institute Research Committee (IRC) meeting

The Institute Research Council (IRC) meeting of ICAR-NIFMD was held on 16th, 17th May, and 29th July 2024 under the chairmanship of Dr. R. P. Singh, Director, ICAR-NIFMD. The primary agenda of the meeting was to review the status and progress of research and service projects conducted during 2023-24.

Annual Review Meeting

The 31st Annual Review Meeting (ARM) of State FMD network laboratories and ICAR-NIFMD was held on June 18-19, 2024, at the ICFMD Campus, ICAR-NIFMD, Bhubaneswar. The meeting was chaired by Dr. Raghavendra Bhatta, DDG (AS), ICAR. The primary agenda was to review the activities and progress made by the FMD network laboratories during 2022 and 2023. The meeting was attended by 56 participants, including representatives from state FMD centers, dignitaries from ICAR headquarters, and representatives from DAHD. Dr. R.P. Singh, Director, ICAR-NIFMD, in his opening remarks, briefed the audience on the objectives of the annual review meeting. Dr. Raghavendra Bhatta, DDG (AS), ICAR, in his remarks, expressed that achieving an FMD-free India by 2030 is an ambitious goal, but the country has the capability to reach it. During the first technical session, the Director of ICAR-NIFMD presented the Action Taken Report of the 30th ARM and elaborated on the research activities and achievements of ICAR-NIFMD during 2022 and 2023. This was followed by presentations from the state FMD centers.

16.0 Celebration and Events

ICAR-NIFMD Celebrates 23rd Foundation Day

ICAR-NIFMD celebrated its 23rd Foundation Day on **5th July 2024** at the NIFMD Campus, Bhubaneswar. The program was conducted in a hybrid mode. Dr. Raghavendra Bhatta, DDG (AS), ICAR, New Delhi, graced the occasion as the Chief Guest. He inaugurated the Foundation Day Exhibition in the presence of Prof. P.K. Roul, VC of OUAT, Dr. B. Pattnaik, Former Director of ICAR-NIFMD and Dean of IVS&AH, SOA University, Dr. R. Venkataramanan, Former Joint Director of ICAR-IVRI, Bengaluru, Dr. A.K. Nayak, Director of ICAR-NRRI, and other dignitaries from various ICAR institutes in Cuttack and Bhubaneswar, OUAT, and state government officials. The exhibition attracted many farmers from nearby villages and around 300 school students. Following this, a plantation program was held, where distinguished guests planted trees on the campus. Dr. R.P. Singh, Director of ICAR-NIFMD, welcomed the guests and briefly presented the institute's achievements. This was followed by addresses from the Guests of Honour, Dr. B. Pattnaik and Dr. R. Venkataramanan. The contributions of retired directors and staff were highlighted, and the felicitation of staff and successful farmers was carried out by the dignitaries. The Chief Guest of the program, Dr. Bhatta, congratulated all the staff of the institute on the occasion for their commendable work. He also appreciated the contributions of former directors and staff and discussed a roadmap for addressing future challenges in the interest of the country, with a vision of **FMD-Mukt Bharat**. Dr. R. Venkataramanan, Former Joint Director of ICAR-IVRI, Bengaluru, graced the occasion as the Distinguished Speaker & Guest of Honour. He delivered the Foundation Day Lecture on **"Foot and Mouth Disease Control in India – Lessons from Experience in South America."** The meeting concluded with a vote of thanks by Dr. J.K. Mohapatra.

Swachh Bharat activities

ICAR-NIFMD organized Swachh Bharat activities from 2nd October to 31st October, 2024 and during 16-31 December 2024. Several indoor and outdoor swachhata awareness programs were conducted during this period. Hygiene awareness program was conducted at Govt. High school, Arugul on 20.09.2024 to inculcate the habit of personal and environmental hygiene among the school children. ICAR-NIFMD celebrated KISAN DIWAS on 23rd December 2024 to mark the Birth Anniversary of the 5th Prime Minister of India, Honorable Shri Choudhary Charan Singh Ji. On 24.12.2024 and 26.12.2024 swachhata drives were organized at Kansapada village and Barasahi Gram Panchayat respectively. The farmers and farm women were made aware about the importance of cleanliness and distributed with inputs related to hygiene and other livelihood support essentials under DAPSC and DAPST.

Women's Day Celebration

The women cell of ICAR-NIFMD organized one scientific talk on "Cell-matrix interaction and immune cell migration during inflammation" by Dr. P P Sarangi (Associate professor, IIT Roorkee) on 02.01.2024 at ICAR-NIFMD on the eve of New Year celebration. A total of 14 scientists, and 15 senior Research fellows attended the meeting and gained the knowledge regarding the role of various immune cells during the progressive development of sepsis. For the celebration of International Women's' Day (IWD) on 08.03.2024, 2 lecture series were organized on behalf of Women cell, ICAR-NIFMD. The 1st talk was given by Dr. P P Sarangi (Assoc. Professor, IIT Roorkee) on "**How mind matters?**" and 2nd talk was given by Dr Priyadarshini Mishra (Associate professor, AIIMS Bhubaneswar) on "**Awareness of common ocular diseases**". A total of 14 scientists, 16 research fellows, and 8 administrative staffs of NIFMD attended the programme. Both the presentations were informative and motivated the participants to learn the various techniques to maintain the mental calmness during the stress as well as to update their knowledge about the various ocular diseases of human along with their management.

Vigilance Awareness Week

Vigilance Awareness Week-2024 was observed from 28th October to 3rd November with a theme of 'Culture of Integrity for Nation's Prosperity'. Activities undertaken were: administering pledge, publicity through social media like Whatsapp group of FMD Lab network, and E-integrity pledge.

हिन्दी अनुभाग

हिन्दी अनुभाग द्वारा सरकारी कामकाज में हिंदी के प्रयोग को बढ़ावा देने के लिए संस्थान में कई उपाय किए गए हैं जो कि इस प्रकार है:

1. हिन्दी राजभाषा कार्यान्वयन समिति: आईसीएआर-एनआईएफएमडी में संस्थान के निदेशक की अध्यक्षता में एक राजभाषा कार्यान्वयन समिति (ओएलआईसी) का गठन किया गया है और इसकी बैठक प्रत्येक तिमाही में नियमित रूप से आयोजित की जाती है। यह समिति राजभाषा विभाग, गृह मंत्रालय द्वारा जारी वार्षिक कार्यक्रम में निर्धारित लक्ष्यों को प्राप्त करने की दृष्टि से राजभाषा नीति के संवैधानिक प्रावधानों को लागू करने की रणनीति तैयार करती है। समिति समय-समय पर राजभाषा (हिंदी) के प्रयोग में हुई प्रगति की समीक्षा करती है और राजभाषा नीति के प्रभावी कार्यान्वयन के लिए सुझाव और उपाय सुझाती है।

2. राजभाषा नीति का कार्यान्वयन: भारत सरकार की राजभाषा नीति के अनुसरण में, यह संस्थान राजभाषा अधिनियम, 1963 की धारा 3)3) के तहत आने वाले सभी दस्तावेज अंग्रेजी और हिंदी में जारी करने का हर सक्षम प्रयास कर रहा है।

3. हिन्दी पखवाड़ा2024-: भा.कृ.अनु.प.-राष्ट्रीय खुरपका मुँहपका रोग संस्थान, अंतर्राष्ट्रीय खुरपका मुँहपका रोग केंद्र, अरुगुल, भुवनेश्वर- 752050, ओड़ीशा में "हिन्दी पखवाड़ा28-14 "2024- सितम्बर 2024 तक मनाया गया। इस हिन्दी पखवाड़ा में विविन्न प्रतियोगिताएँ जैसे कि हिन्दी शब्दावली एवं प्रश्नावली प्रतियोगिता, हिन्दी एक्स्टेंपोर प्रतियोगिता, हिन्दी वाद-विवाद प्रतियोगिता, हिन्दी काव्य पाठ (स्वरचित/सस्वर बाल कविता) प्रतियोगिता (बाल सदस्य) का आयोजन हिन्दी अधिकारी, डा. राजीव रंजन एवं संस्थान के निदेशक महोदय की देख रेख में प्रत्यक्ष एवं आभासी माध्यम द्वारा किया गया। हिन्दी पखवाड़ा- 2024 का शुभारंभ 14.09.2024 को मुख्य अतिथि हरिराम पंसारी जी, पूर्व वरिष्ठ प्रबंधक (राजभाषा), नालको, भुबनेश्वर एवं संस्थान के निदेशक डा रबीन्द्र प्रसाद सिंह की उपस्थिति में की गयी एवं इस पखवाड़े में संस्थान के वैज्ञानिक, अधिकारी, कर्मचारी, एसआरएफ़ & वाई पी 1- & II, एवं उनके परिवार के सदस्यों (पत्नी एवं बच्चें) ने भाग लिया। इस प्रतियोगिता में प्रतिभागियों का चयन निर्णायक मंडल के सदस्यों द्वारा किया गया। हिन्दी पखवाड़ा- 2024 का पुरस्कार वितरण एवं समापन समारोह आयोजन दिनांक 03.102024 को मुख्य आतिथि श्री फकीर चरण नायक जी के उपस्थिती में हुआ। प्रतियोगिता में उपस्थित प्रतिभागियों को मुख्य आतिथि एवं निदेशक महोदय द्वारा विभिन्न पुरस्कारों (प्रथम, द्वितीय, तृतीय एवं सांत्वना पुरस्कार) से पुरस्कृत किया गया।

4. Hindi website: वेबसाइट को नियमित रूप से अपडेट भी किया जा रहा है।

5. आज का शब्द (Aaj ka Shabd): संस्थान में कार्यरत सभी कर्मचारी का हिन्दी अच्छी हो इसके लिए हिन्दी अधिकार द्वारा प्रत्येक दिन हिंद का एक नया शब्द 'आज का शब्द' के रूप में लिखा जा रहा है, जिसे हिंदी अधिकारी इस साल भी जारी रखेंगे। इस योजना के तहत अंग्रेजी का एक शब्द और उसका हिंदी पर्याय बोर्ड पर प्रदर्शित किया जा रहा था। ये शब्द प्राय: प्रशासनिक और तकनीकी प्रकृति के होते हैं, जिनका उपयोग दिन-प्रतिदिन के आधिकारिक कार्यों में किया जाता है।

अंग्रेजी में शब्द	हिन्दी में अर्थ
Sealed	मोहरबंद
Response	अनुक्रिया
Despatch	रवानगी, प्रेषण
Diary	दैनिकी, दैनंदिनी
Committee	समिति
Competent	सक्षम
Recommended	अनुशंसित
Harmonisation	समानीकरण

कार्यशाला का आयोजन: सनातन में हिन्दी को अधिकाधिक प्रचार प्रसार हो इसके किए संस्थान में समय समय पर हिन्दी अधिकारी, डा. राजीव रंजन जी के द्वारा संस्थान में कार्यरत कर्मचारियों एवं अधिकारियों के लिए कार्यशाला किया जाता है। वर्ष 2024 के दौरान, कुल दो कार्यशाला का आयोजन किया गया। प्रथम कार्यशाला का विषय "कार्यालय में यूनिकोड का प्रयोग" था। इस कार्यशाला में कुल 13 प्रतिभागियों ने भाग लिया एवं इस कार्यशाला से लाभान्वित हुये। इस कार्यशाला में मुख्य प्रशिक्षक डा. राजीव रंजन, वरिष्ठ वैज्ञानिक एवं प्रभारी हिन्दी अधिकारी, भा.कृ. अनु.प.- खुरपका मुँहपका रोग निदेशालय थे। दूसरी कार्यशाला का विषय "हिन्दी का आर्थिक महत्व एवं कृत्रिम मेधा आधारित नई तकनीकी सुविधाएँ" था। इस कार्यशाला में कुल 28 प्रतिभागियों ने भाग लिया एवं इस कार्यशाला से लाभान्वित हुये। इस कार्यशाला में मुख्य प्रशिक्षक श्री मान, श्री हरिराम पंसारी जी, पुर्व वरिष्ठ प्रबंधक (राजभाषा), नालको, भुबनेश्वर थे। श्री हरिराम पंसारी जी ने हिन्दी का आर्थिक महत्व एवं कृत्रिम मेधा आधारित नई तकनीकी सुविधाएँ के बारे में बहुत ही विस्तृत रूप में बताया एवं सभी प्रतिभागियाओं ने कृत्रिम मेधा के बारे सीखे। सभी प्रतिभागी इस कार्यशाला से लाभान्वित हुये एवं उन्होनें यह भी कहा कि वे सभी अपने दैनिक जीवन में इसका प्रयोग करके संस्थान में हिन्दी के प्रयोग को आगे बढ़ाने में हर संभव प्रयास करेंगे।

हिन्दी अनुभाग

हिन्दी पखवाड़ा – 2024- प्रतियोगिता

क्र. सं.	प्रतियोगिता का नाम	विजेता का नाम
१	हिन्दी शब्दावली एवं प्रश्नावली प्रतियोगिता	1. श्री नयन संजीव सिंह- **प्रथम** 2. डा जजाति केशरी महापात्र- **द्वितीय** 3. श्री रॉकी कुमार- **तृतीय** 4. डा आदित्य प्रसाद साहू- **सांत्वना** 5. डा समरेन्द्र दास- **सांत्वना** 6. डा स्मृतिरेखा मल्लिक- **सांत्वना**
२	हिन्दी एक्स्टेंपोर प्रतियोगिता	1. श्री उत्तम पुष्प निराला- **प्रथम** 2. डा आदित्य प्रसाद साहू- **द्वितीय** 3. डा श्याम सिंह दहिया- **तृतीय** 4. डा मनोरंजन राऊत- **सांत्वना** 5. श्री मनोरंजन स्वाइ- **सांत्वना** 6. डा मोनालिसा साहू- **सांत्वना**
३	हिन्दी वाद-विवाद प्रतियोगिता	1. डा. जजाति केशरी महापात्र- **प्रथम** 2. डा. मोनालिसा साहू- **द्वितीय** 3. श्री नयन संजीव सिंह- **तृतीय** 4. डा आदित्य प्रसाद साहू- **सांत्वना** 5. श्री उत्तम पुष्प निराला- **सांत्वना** 6. श्री बिप्र प्रसाद कर- **सांत्वना**
४	हिन्दी काव्य / रस्वस / तचरिस्व) ठाप- (तवकिलाब प्रतियोगिता (युवा वर्ग)	1. डा जजाति केशरी महापात्र- **प्रथम** 2. डा निहार रंजन साहू- **द्वितीय** 3. श्री बिप्र प्रसाद कर- **तृतीय** 4. डा मोनालिसा साहू- **सांत्वना** 5. श्री नयन संजीव सिंह- **सांत्वना** 6. श्रीमती शीतल नयन सिंह- **सांत्वना**
	हिन्दी काव्य-पाठ (स्वरचित/ सस्वर/ बालकविता) (प्रतियोगिता (बाल-सदस्य	1. सुश्री शाश्वति महापात्र- **प्रथम** 2. सुश्री मस्विनी कर- **द्वितीय** 3. सुश्री श्रेया रंजन- **तृतीय** 4. सुश्री संजीवनी कर- **सांत्वना** 5. सुश्री श्रेया बिस्वाल- **सांत्वना** 6. सुश्री प्रयुशी महापात्र- **सांत्वना**

17.0 Committees

Quinquennial Review Team

Name	Designation	Role
Dr. K. M. L Pathak	Former DDG (AS), ICAR and Ex-VC, DUVASU, Mathura	Chairman
Dr. M. S. Oberoi	Former Dean GADVASU and Former FAO Expert	Member
Dr. D. K. Sarma	Former National Fellow AAU and Director, ICAR-NRC Pig, Guwahati	Member
Dr. N. Pazhanivel	Professor, Veterinary Pathology, TANUVAS, Chennai	Member
Dr. P.S. Birthal	Director, ICAR-NIAP, New Delhi	Member
Dr. S Killari	M/S Biovet	Member
Dr. J. K. Mohapatra	Principal Scientist, ICAR-NIFMD, Bhubaneswar	Member Secretary

Research Advisory Committee

Name	Designation	Role
Dr. H Rahman	ILRI Regional Representative and Former DDG (AS), ICAR, New Delhi	Chairman
Dr. B Pattnaik	Dean, Faculty of Veterinary Science and Animal Husbandry, SOA University and Former Director, ICAR-NIFMD	Member
Dr. A Chakrabarty	Former Director of Research, Assam Agricultural University, Assam	Member
Dr. Satya Parida	FAO Expert and Former Professor, The Pirbright Institute, United Kingdom	Member
Dr. B Ganesh Kumar	Head, Human Resource Management, ICAR-NAARM, Hyderabad	Member
Dr. R P Singh	Director, ICAR-NIFMD	Member
Dr. D Hemadri	ADG (AH), ICAR, Krishi Bhavan, New Delhi-110 001	Member
Dr. S P Biswal	S/o Basanta Kumar Biswal, Bhubaneswar	Member
Dr. J Mondal	S/o Late Janaki Mondal, Bankura, West Bengal	Member
Dr. Saravanan S	Principal Scientist, ICAR-NIFMD	Member Secretary

Institute Technology Management Committee

Name	Designation	Role
Dr. Rabindra Prasad Singh	Director, ICAR-NIFMD	Chairman
Dr. S K Singh	Joint Director (R), IVRI, Izatnagar	External Member
Dr. Jajati K Mohapatra	Pr. Scientist, ICAR-NIFMD	Member
Dr. Saravanan S	Pr. Scientist, ICAR-NIFMD	Member

Dr. Shyam Singh Dahiya	Sr. Scientist, ICAR-NIFMD	Member
Dr. J K Biswal	Sr. Scientist, ICAR-NIFMD	Member Secretary

Institutional Animals Ethics Committee

Name	Designation	Role
Dr. J K Mohapatra	Pr. Scientist, ICAR-NIFMD	Biological Scientist (Chairperson)
Dr. Ajit K Naik	Department of Veterinary Pharmacology & Toxicology, Odisha University of Agriculture & Technology, Bhubaneswar – 751023, Odisha, India	CCSEA Main Nominee
Dr. Durga Madhab Kar	School of Pharmaceutical Sciences, Siksha 'O' Anusandhan, Kalinga Nagar, Ghatikia, Bhubaneswar–751003, Odisha	Link Nominee
Dr. Shantibhushan Senapati	Institute of Life Sciences, Nalco Square, Bhubaneswar, Odisha–751023	Scientist from outside of the Institute
Shri Nihar Ranjan Mansingh	Gundicha Vihar, (3rd Lane) Left side, Sarvodaya Nagar, Post & Dist.- Puri-752002	Socially aware Nominee
Dr. Saravanan S	Pr. Scientist, ICAR-NIFMD	Scientist from different biological discipline
Dr. Nihar R Sahoo	Sr. Scientist, ICAR-NIFMD	
Dr. Tareni Das	Scientist, ICAR-NIFMD	Veterinarian
Dr. Rajeev Ranjan	Sr. Scientist, ICAR-NIFMD	Member Secretary

Institutional Biosafety Committee

Name	Designation	Position
Dr Rabindra Prasad Singh	Director, ICAR-NIFMD	Chairman
Dr Biswajit Mishra	Medical consultant, Khurda	Biosafety officer
Dr Sandeep Bhatia	Pr. Scientist, NIHSAD, Bhopal	Outside Expert
Dr Sidhartha Giri	Scientific E, ICMR-RMRC, Bhubaneswar	DBT nominee
Dr Rajeev Ranjan	Sr. Scientist, ICAR-NIFMD	Internal Member
Dr Shyam Singh Dahiya	Sr. Scientist, ICAR-NIFMD	Internal Member
Dr Jitendra K Biswal	Sr. Scientist, ICAR-NIFMD	Internal Member
Dr Jajati K Mohapatra	Pr. Scientist, ICAR-ICFMD	Internal Member & Member Secretary

Institute Management Committee

Name	Designation	Position
Dr R P Singh	Director, ICAR-NIFMD, Bhubaneswar	Chairman
Dr B Sahoo	Principal Scientist, ICAR-CIWA, Bhubaneswar	Member
Dr C Tosh	Principal Scientist, ICAR-NIHSAH, Bhopal	Member
Dr B P Srinivas	Principal Scientist, ICAR-IVRI, Bengaluru	Member
Dr M Samanta	Head, Fish Health Management, ICAR-CIFA, Bhubaneswar	Member
Dr. D Hemadri	ADG (AH), ICAR, New Delhi-110 001	Member
Dr Shiba Prasad Biswal	S/o Basanta Kumar Biswal, Bhubaneswar	Member
Dr Jayanta Mondal	S/o Late Janaki Mondal, Bankura, West Bengal	Member
Director	Directorate of Animal Husbandry & Veterinary Services, Cuttack, Odisha	Member
Dean	College of Veterinary Science and Animal Husbandry, Anjora, Durg, Chhattisgarh	Member
Dean	College of Veterinary Science & Animal Husbandry, OUAT, Bhubaneswar, Odisha	Member
Sh Ankush K Mishra	AO, ICAR-NIFMD, Bhubaneswar	Member Secretary

हिन्दी राजभाषा कार्यान्वयन समिति (01.01.2024 से 31.12.2024 तक)

- डा रबीन्द्र प्रसाद सिंह, निदेशक : अध्यक्ष
- डा जजाति केशरी महापात्र, प्र. वैज्ञानिक : सदस्य
- डा सर्वनान सुबरमानियम, प्र. वैज्ञानिक : सदस्य
- डा स्मृतिरेखा मल्लिक्क, वैज्ञानिक : सदस्य
- श्री तारा कुमार, स. प्र.अ. : सदस्य (31.07.2024 तक)
- श्री अंकुश कुमार मिश्रा, प्रसाशनिक अधिकारी : सदस्य (21.11.2024 से)
- श्री नयन संजीव सिंह, तकनीकी अधिकारी : सदस्य
- श्री रौकी कुमार, तकनीशिसियन 1- : सदस्य (21.11.2024 से)
- डा राजीव रंजन, वरिष्ठ वैज्ञानिक : हिन्दी अधिकारी एवं सदस्य सचिव।

18.0 Personnel

Scientific

Sl. No.	Name	Designation	Discipline
1	Dr. Rabindra Prasad Singh	Director	Veterinary Microbiology
2	Dr. Jajati K Mohapatra	Principal Scientist	Veterinary Microbiology
3	Dr. Saravanan Subramaniam	Principal Scientist	Veterinary Microbiology
4	Dr. Nihar R Sahoo	Principal Scientist	Animal Genetics & Breeding
5	Dr. Aditya P Sahoo	Senior Scientist	Animal Biotechnology
6	Dr. Manoranjan Rout	Senior Scientist	Veterinary Pathology
7	Dr. Shyam S Dahiya	Senior Scientist	Veterinary Microbiology
8	Dr. Monalisa Sahoo	Senior Scientist	Veterinary Pathology
9	Dr. Jitendra K Biswal	Senior Scientist	Animal Biochemistry
10	Dr. Rajeev Ranjan	Senior Scientist	Veterinary Pathology
11	Dr Samarendra Das	Senior Scientist	Agricultural Statistics
12	Dr. Smrutirekha Mallick	Scientist (Sr. Scale)	Animal Physiology
13	Dr. Tareni Das	Scientist	Veterinary Pathology

Technical

Sl. No.	Name	Designation
1	Sh. Nayan Sanjeev	T-5 (Lab)
2	Sh. S.L.Tamta	T-1 (Lab) (Upto 31.10.2024)
3	Sh. Rocky Kumar	T-1 (Lab)
4	Sh. Uttam P Nirala	T-1 (Lab)

Administration

Sl. No.	Name	Designation
1	Dr. Rabindra Prasad Singh	Director
2	Sh. Ankush K Mishra	Administrative Officer
3	Sh. Tushar Singh	Finance and Account Officer
4	Sh. Tara Kumar	AAO (till July 2024)
5	Sh. R.N.Sahoo	Assistant

6	Sh. Ravi Chaudhary	Junior Stenographer
7	Sh. Manoranjan Swain	Personal Assistant
8	Sh. Tathagata Mukherjee	Assistant (From 23.09.2024)

Joining/ Transfer/Promotions/Superannuation

Sl. No.	Name	Date	Details
Promotion			
1	Dr. Nihar R Sahoo	12.06.2022	Promoted to Principal Scientist (level 14)
2	Dr. Shyam S Dahiya	15.12.2021	Promoted to Senior Scientist (level 13A)
3	Dr Rajeev Ranjan	11.05.2023	Promoted to Senior Scientist (level 13A)
4	Dr. Jitendra K Biswal	27.04.2023	Promoted to Senior Scientist (level 13A)
5	Dr Samarendra Das	01.01.2023	Promoted to Senior Scientist (level 12)
6	Dr. Smrutirekha Mallick	01.07.2021	Promoted to Scientist (Sr Scale) (level 11)
Joining			
1	Sh. Ankush K Mishra	22.04.2024	Joined as Administrative Officer
2	Sh. Tushar Singh	22.04.2024	Joined as Finance & Account Officer
3	Sh. Tathagata Mukherjee	23.09.2024	Joined as Assistant
4	Sh. Rocky Kumar	06.05.2024	Joined as T-1 (Lab)
5	Sh. Uttam P Nirala	29.04.2024	Joined as T-1 (Lab)
Superannuation			
1	Sh. Tara Kumar	31.07.2024	Retired as AAO
2	Sh. S.L.Tamta	31.10.2024	Retired as T-1 (Lab)

"Farewell Taraji!"

In Charges of Section/Unit/Cell

S. No.	In Charge	Section/unit/cell/others
1	Dr. Mohapatra JK	Bio Safety Officer and Public Relation
2	Dr. Saravanan S	PME cell
3	Dr. Biswal JK	ITMU and Vigilance cell
4	Dr. Ranjan R	Animal House Facility, HRD, Hindi Cell, Krishi Portal
5	Dr. Rout M	DAPSC
6	Dr. Sahoo NR	NEH Scheme
7	Dr. Dahiya SS	Engineering Section
8	Dr. Das S	Library & Journal Club, Website Management
9	Dr. Tareni Das	DAPST
10	Dr. M Sahoo	Women Cell, Public Information Officer, Scientific RTI, CPGRAMS
11	Dr. Mallick S	Horticulture and civil management, Swachh Bharat Abhiyan, In-Charge- Store (General items)