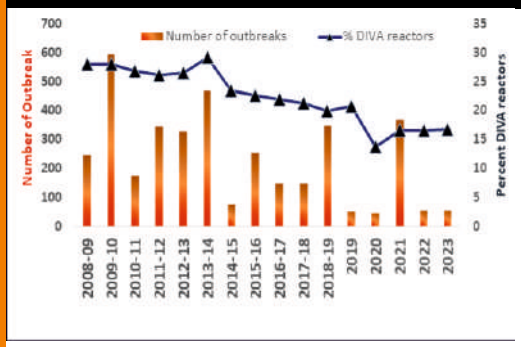
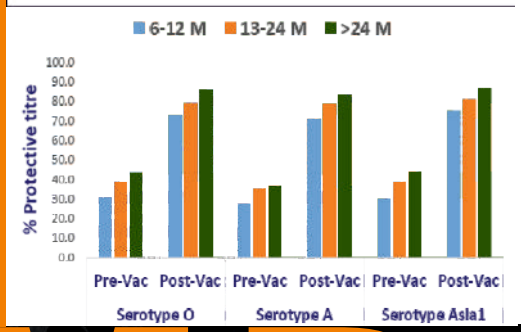
ANNUAL REPORT
2023





NIFMD

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

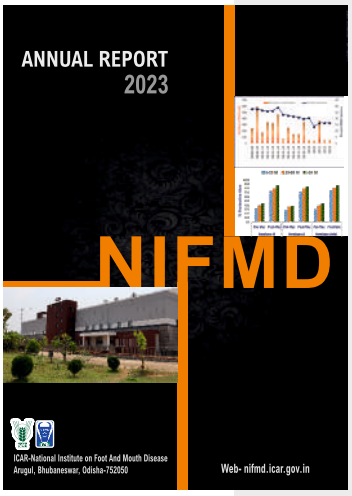
Web- nifmd.icar.gov.in

ICAR-NIFMD

Annual Report

2023

ICAR- National Institute on Foot and Mouth Disease
Arugul, Bhubaneswar-752050, Odisha
Ph. No.: 0674 2601104
Web- www.nifmd.icar.gov.in



Citation: ICAR-NIFMD, Annual Report 2023, ICAR-National Institute on Foot and Mouth Disease, Arugul, Bhubaneswar-752050, Odisha, India

Published by
Director, ICAR-NIFMD
June, 2024

Compiled by
Dr. S. Subramaniam

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PREFACE

The ICAR-National Institute on Foot and Mouth Disease (NIFMD) is the premier institute in India dedicated to FMD research, serving the nation since 1968 under the Indian Council of Agriculture Research (ICAR), New Delhi. Recognized as the National Institute on FMD on February 17, 2023, the institute also functions as an FAO reference center for FMD. FMD surveillance in India is conducted through a network of 32 regional and collaborating centers located in states, supported by the Department of Animal Husbandry and Dairying (DAHD), Government of India, and operated under the auspices of ICAR-NIFMD, Bhubaneswar.

Its mandate includes conducting research on FMD epidemiology, developing technologies to control the disease, and working towards its eventual eradication. Additionally, the institute provides technical support, scientific input, and information to planners and agencies involved in FMD control in India under the National Animal Disease Control Programme (NADCP)/LHDCP Scheme. In 2023, the institute organized ten laboratory training programs and workshops for state FMD regional and collaborating centers. Additionally, two international workshops were conducted, one for BIMSTEC member states and another under the collaborative project 'FMD Vaccine Quality Testing and Enhancing India's Animal Vaccine Testing Capabilities,' involving the World Reference Laboratory for FMD (WRL-FMD), IVRI, and CCS-NIAH. Furthermore, a nationwide capacity-building program for systematic follow-up investigations of NSP reactors for FMD was conducted at six regional centers from June to September, training over 150 veterinarians.

The institute has developed scientific expertise in conventional and cutting-edge areas related to FMD diagnosis, epidemiology, and vaccine research. In addition to our existing diagnostic tests, we have introduced Colorimetric reverse transcription loop-mediated isothermal amplification (RT-LAMP) for sensitive and specific detection of FMD virus, and a Monoclonal antibody-based competitive ELISA for FMDV NSP antibody detection. Candidate vaccine strains for FMDV serotype A (A/IND27/2011) and thermostable FMD virus serotype O, ready for commercialization, have been assigned to Agrinnovate India Limited. As the 'FAO Reference Centre for FMD,' ICAR-NIFMD participated in the FMD Proficiency Testing Scheme, 2022 (both serology and virology panels), organized by the FAO World Reference Laboratory (WRL) for FMD, UK, with support from EuFMD and DEFRA.

I express my deep sense of gratitude to Dr. Himanshu Pathak, Hon'ble Secretary, DARE & DG, ICAR; Shri Sanjay Garg, Addl. Secretary, DARE & Secretary, ICAR; Ms Alka Nangia Arora, Additional Secretary (DARE) & Financial Advisor (ICAR); Dr. B.N. Tripathi, DDG (AS), ICAR; and Dr. Ashok Kumar, ADG (AH), ICAR, for providing all the necessary support and guidance in steering the Institute. Also, the help and support extended by Dr. Jyoti Misri, Principal Scientist (AH), and Dr. Rajneesh Rana, Principal Scientist, are duly acknowledged. The generous funding support from Secretary, DAHD under NADCP/LHDCP, is gratefully acknowledged, along with the entire team, including Dr. Abhijit Mitra, Animal Husbandry Commissioner; Ms. Sarita Chauhan, Joint Secretary (LH); Dr. Sujit Nayak, Joint Commissioner (NADCP); Dr. Deblina Mitra, Assistant Commissioner (LHDCP) and Dr Sushil Kumar (Livestock Officer). The technical support from ICAR-NIVEDI for the formulation of the FMD seromonitoring and surveillance plan and the administrative support from ICAR-IVRI, Mukteswar are duly acknowledged. It is truly admirable to witness the tireless efforts of our scientists as they strive to reach new milestones and contribute to the advancement of our institute. I would also like to extend my gratitude to the technical, professional support personnel, audit and accounting teams, administration staff, and all support staff who work diligently behind the scenes to ensure the smooth functioning of our institute.

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


ICAR - DFMD NEH PROGR
ON
ANIMAL HEALTH
Place
Date

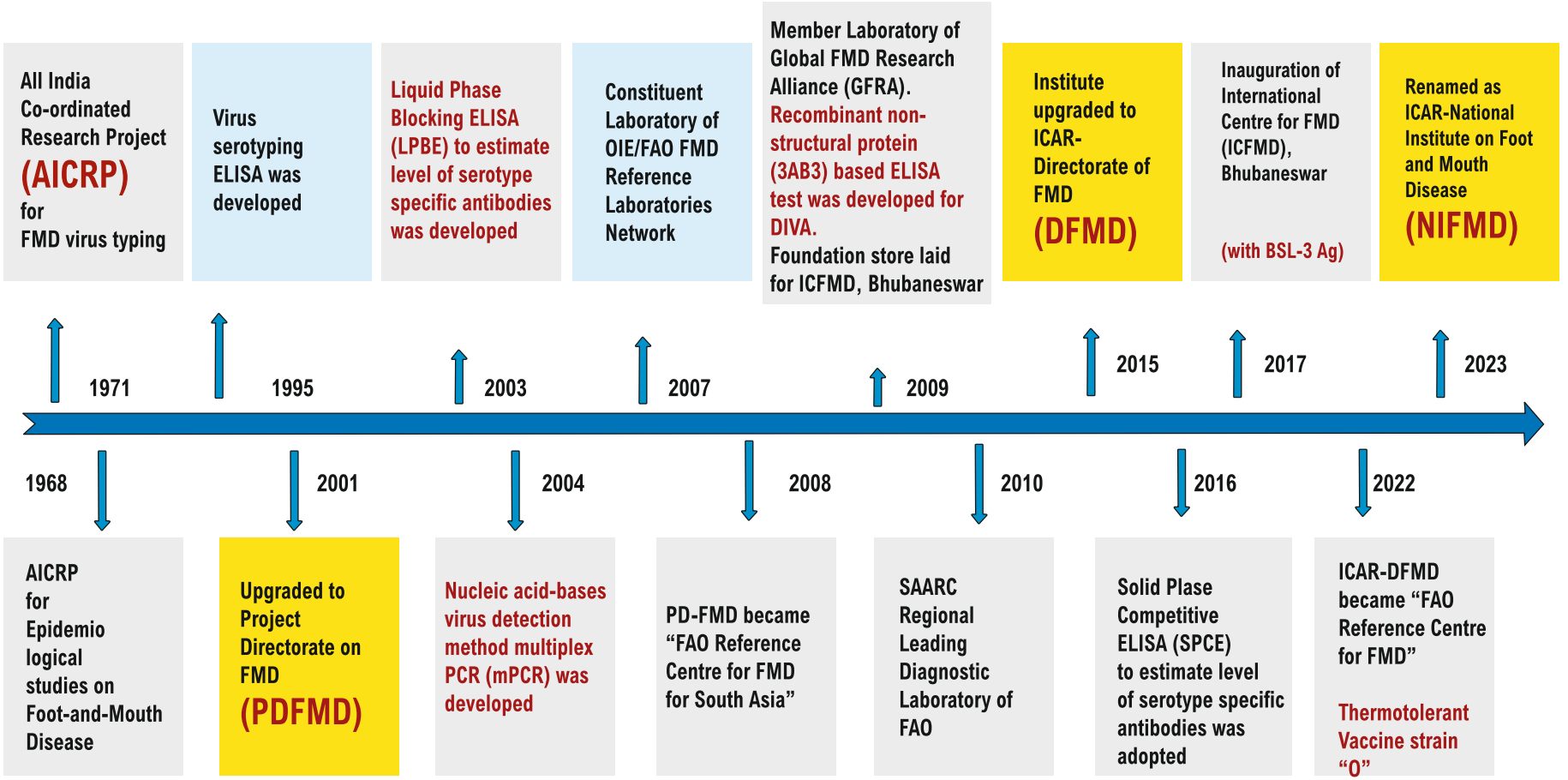
GENESIS

ICAR-National Institute on Foot and Mouth Disease (NIFMD), established as an All India Coordinated Research Project (AICRP) for FMD in 1968, 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 state FMD Centers, technically supported by ICAR-NIFMD, and financially by DAHD. The 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 FMD 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.


Government of Tripura
- DFMD NEH PROGRAMME
DISTRIBUTION PROGRAMME
E : Karnamoni Para VC, Ganganagar
Date :30-03-2023
T :DHALAI,(ASPIRATIONAL DIST)
ED BY - AICRP-FMD AGARTALA CENTRE
n with ICAR -DFMD,Mukteshwar-263138,UK

CONTENTS

Important Millstones



VISION, MISSION, MANDATE, OBJECTIVES AND TECHNICAL PROGRAMME

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:

1. 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.
2. 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.
3. Production, standardization and supply of diagnostic reagents for FMD virus serotyping and post-vaccinal serocon-version, and serosurveillance.
4. Maintenance and supply of most appropriate vaccine strains to the FMD vaccine manufacturers.
5. Development of newer diagnostic techniques using cutting-edge technologies in molecular biology.
6. To act as FAO Reference Centre for FMD.

TECHNICAL PROGRAMME:

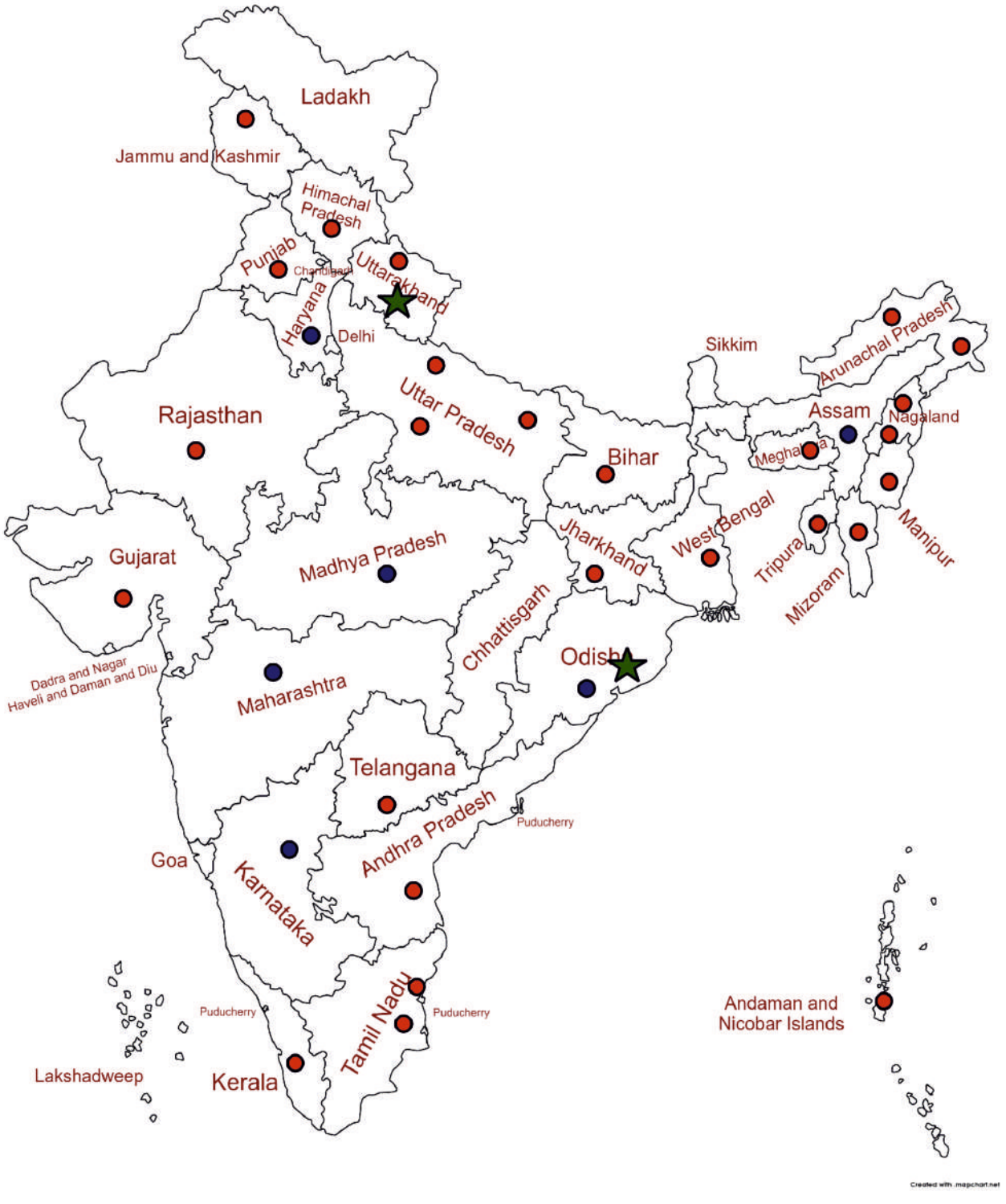
1. Active and passive surveillance of FMD in the country in network mode
2. To carry out antigenic and molecular characterization of field isolates.
3. To study molecular epidemiology of FMD in India.
4. Confirmatory diagnosis and expert advice.
5. To carry out vaccine matching exercise for monitoring of appropriateness of in-use vaccine strains.
6. Maintenance of National Repository of FMD virus isolates.
7. Production, standardization and supply of diagnostic kits for FMD virus diagnosis, sero-monitoring and serosurveillance.
8. 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.
9. 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
10. Participation in FMD Control Programme with vital contribution in monitoring pre and post vaccinal antibody response for assessment at individual and herd immunity level.
11. National FMD Serosurveillance
12. International collaborations in the areas of interest.

DETAILS OF CADRE STRENGTH AS ON 31.12.2023

Cadre	Sanctioned	In position	Vacant position with respect to sanction
Research Management Position	01	01	Nil
SCIENTIFIC			
Scientist			
Agricultural Bioinformatics	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	03	11
Supporting Staff	02	Nil	02
Technical	05	02	03
Grant Total	**38**	**18**	**20**

LOCATION OF STATE FMD LABORATORIES

Red dot (●) represent collaborating Centers (n=26), blue (●) represent regional Centers (n=6) and Green (★) denotes ICAR-NIFMD Laboratories




ICAR-ICFMD
ICFMD
ICAR-ICFMD

1.0 EXECUTIVE SUMMARY

- A total of 426 clinical samples from 57 FMD outbreaks were tested for serotype identification. In 2023, all three FMD virus serotypes were documented, with serotype O leading the outbreak scenario, followed by a notable increase in the prevalence of serotype A. In addition, 149 serum samples from outbreaks were tested for NSP antibodies which revealed seropositivity in 49.3% animals.
- A total of 11 FMD virus isolates (9 serotype O, 1 serotype A, and 1 serotype Asia1) revived in the BHK-21 cell culture system were added to the National Repository of FMD Virus. Currently, the National FMD Virus Repository holds a total of 2464 isolates (O-1733, A-348, C-15, and Asia-1-368).
- The capsid coding region (P1/VP1) sequences of 45 FMD virus strains were determined, which includes 28 serotype O, 16 serotype A, and 1 serotype Asia1. Co-circulation of the O/ME-SA/Ind2001e and O/ME-SA/2018 lineages was observed in serotype O. There was an exclusive prevalence of the G-18/2019 non-deletion lineage in serotype A, and the re-emergence of Group VIII was detected in serotype Asia1.
- The analysis for vaccine matching was conducted on 11 FMDV isolates, comprising 9 serotype O, 1 serotype A, and 1 serotype Asia1. The vaccine strains for serotypes O and Asia1 exhibited a satisfactory antigenic match. However, for serotype A, the field isolate displayed 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.
- Under FMD serosurveillance, a total of 49,481 serum samples were collected from various species across the country and tested using the r3AB3 NSP-ELISA. The samples included cattle (31,916), buffalo (15,450), sheep (913), goat (2,014), pig (51), yak (495), and mithun (89). The overall seropositivity was found to be 16.1% in the bovine samples tested, which is almost consistent with the previous year's seropre-valence of 16.6%.
- Under FMD seromonitoring, a total of 99,715 serum samples (LHDCP-88,825, Farms-10,132, Yak and Mithun-758) were examined using SPCE to assess the efficiency of immunization. Overall, protective titers were found in 35.3%, 31.2%, and 31.0% of animals against serotypes O, A, and Asia1, respectively, in pre-vaccination samples. In post-vaccination samples at the end of round 3, protective titers were observed in 68.9%, 64.0%, and 66.7% of animals against serotypes O, A, and Asia1, respectively.
- Under the follow-up of NSP reactors, a total of 102 serum and oesophageal-pharyngeal fluids (OPF) samples from the states of Haryana, Madhya Pradesh, Karnataka, and Maharashtra were tested to detect the presence of antibodies for 3AB3 NSP and genome. Out of the 102 OPF samples, three were found positive for FMD serotype 'O'.
- TaqMan probe-based one-step RT-qPCR assay in duplex format simultaneously targeting FMDV 2B NSP-coding region and 18S rRNA housekeeping gene was developed and evaluated. The assay demonstrated diagnostic sensitivity and specificity of 100% (95% CI 99–100%) and holds potential for routine FMDV diagnosis in a high-throughput manner.
- Colorimetric reverse transcription loop-mediated isothermal amplification (RT-LAMP) assay was developed for the sensitive and specific detection of FMD virus circulating in India in a pan-serotypic manner. The assay demonstrated a limit of detection of 1000 copies of FMDV viral genome, which is 10 times more sensitive than the agarose-gel-based multiplex RT-PCR assay.
- Monoclonal antibody based competitive ELISA was developed for FMDV NSP antibody detection. The test demonstrated a relative diagnostic sensitivity of 93.52% and specificity of 97.46% compared to the PrioCHECK FMD NS test. It showed an overall concordance of 86.13% at a 45% PI cut-off with r3AB3 NSP-ELISA. The assay is expected to be helpful in FMD sero-surveillance and DIVA in all FMD-susceptible species.

- A heat-resistant FMDV serotype Asia1 vaccine strain was selected through serial passage under heat stress and subsequently isolated by plaque assay. The selected thermostable variant was characterized for its thermal stability by incubating the mutant virus at different temperature-time combinations. In all the tested conditions, the thermally-selected variant performed better than the parental counterpart.
- For the quality control (QC) testing of FMD vaccines to be utilized for the vaccination under LHDCP, ICAR-NIFMD carried out QC testing of seven batches of vaccines.
- The institute provided the state FMD centers with three primary test kits (3AB3 indirect DIVA ELISA for 81,194 samples, Solid Phase Competitive ELISA (SPCE) for 148,500 samples (serotypes O, A and Asia1), and Sandwich ELISA for 2,800 samples) for undertaking disease surveillance and seromonitoring.
- Ten laboratory training programs and workshops were organized as part of capacity building for state FMD regional and collaborating centers. In addition to this, two international workshops were conducted; one for BIMSTEC member states and one under the WRL-FMD, IVRI, CCS-NIAH collaborative project 'FMD Vaccine Quality Testing and Enhancing India's Animal Vaccine Testing Capabilities'. In addition, a country-wide capacity-building program for the systematic follow-up investigation of NSP reactors for FMD was organized at six FMD regional centers from June to September. More than 150 veterinarians were trained to carry out the task.
- Several extension and training programs were organized under LHDCP scheme for stakeholders, including the national FMD control awareness week. In total, 9381 stakeholders, including 4996 farmers, 3687 veterinarians and paraveterinary staff, and 698 students, participated and benefited.
- During the year 2023, a total of 93 programs and activities were conducted under DAPSC, benefiting 2602 farmers and students. Similarly, 79 and 26 programs and activities were conducted under NEH scheme and DAPST, respectively, with 2594 and 2977 farmers and students benefiting from these initiatives.
- ICAR-NIFMD, as the 'FAO Reference Centre for FMD,' participated in the FMD Proficiency Testing Scheme, 2022 (Both serology and virology panel), organized by the FAO World Reference Laboratory (WRL) for FMD, UK, with support from EuFMD and DEFRA.
- FMDV serotype A candidate vaccine strain, A/IND27/2011, and thermostable FMD virus serotype O for inclusion in the Indian vaccine formulation are ready for commercialization, and assigned to Agrinnovate India Limited.

कार्यकारी सारांश

- सीरोटाइप पहचान के लिए 57 एफ.एम.डी. प्रकोपों से कुल 426 नैदानिक नमूनों का परीक्षण किया गया। 2023 के दौरान, सभी तीन एफ.एम.डी. वायरस सीरोटाइप को देखा गया, जिसमें सीरोटाइप 'O' का प्रकोप सबसे ज्यादा था, इसके बाद सीरोटाइप 'A' के प्रसार में उल्लेखनीय वृद्धि हुई। इसके अलावा, एनएसपी एंटीबॉडी के लिए प्रकोप से 149 सीरम नमूनों का परीक्षण किया गया, जिसमें 49.3% जानवरों में सेरोपोसिटिविटी का पता चला।
- बीएचके-21 सेल कल्चर सिस्टम में पुनर्जीवित कुल 11 एफ.एम.डी. वायरस आइसोलेट्स (9 सीरोटाइप 'O', 1 सीरोटाइप 'A', और 1 सीरोटाइप एशिया1) को एफएमडी वायरस को राष्ट्रीय भंडार में जोड़ा गया। वर्तमान में, राष्ट्रीय एफएमडी वायरस रिपोजिटरी में कुल 2464 आइसोलेट्स (O-1733, A-348, C-15, और Asia 1-368) हैं।
- 45 एफ.एम.डी. वायरस उपभेदों के कैप्सिड कोडिंग क्षेत्र (पी1/वीपी1) अनुक्रम निर्धारित किए गए, जिसमें 28 सीरोटाइप 'O', 16 सीरोटाइप 'A' और 1 सीरोटाइप एशिया1 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, और पुनः-समूह VIII का उद्भव सीरोटाइप एशिया1 में पाया गया।
- 11 एफ.एम.डी. विषाणु आइसोलेट्स (9 सीरोटाइप O, 1 सीरोटाइप । और 1 सीरोटाइप Asia 1) का वैक्सीन मैचिंग विश्लेषण किया गया। सेरोटाइप O और Asia 1 के लिए वैक्सीन स्ट्रेन ने बहुत अच्छा एंटीजेनिक मैच दिखाया। सेरोटाइप ए के मामले में, किसी भी फील्ड आइसोलेट्स का वर्तमान में उपयोग किए जा रहे वैक्सीन स्ट्रेन A/IND/40/2000 के साथ एंटीजेनिक मेल नहीं था। इसके विपरीत, प्रस्तावित कैंडिडेट वैक्सीन स्ट्रेन A/IND/27/2011 ने हाल के सेरोटाइप ए फील्ड आइसोलेट्स के साथ एक आदर्श एंटीजेनिक मैच का प्रदर्शन किया।
- एफ.एम.डी. सीरोसर्विलांस के तहत, देश भर में विभिन्न प्रजातियों से कुल 49,481 सीरम नमूने एकत्र किए गए और आर3एबी3 एनएसपी-एलिसा का उपयोग करके परीक्षण किया गया। नमूनों में गोजातीय (31,916), भैंस (15,450), भेड़ (913), बकरी (2,014), सुअर (51), याक (495), और मिथुन (89) शामिल थे। परीक्षण किए गए गोजातीय नमूनों में समग्र सीरोपॉजिटिविटी 16.1% पाई गई, जो लगभग पिछले वर्ष की 16.6% की सीरोप्रवलेंस के अनुरूप है।
- एफ.एम.डी. सेरोमोनिटोरिंग के तहत, टीकाकरण की दक्षता का आकलन करने के लिए सॉलिड फेज कॉम्पिटिटिव एलिसा (एसपीसीई, SPCE) का उपयोग करके कुल 99,715 सीरम नमूनों (एलएचडीसीपी-88,825, फार्म-10,132, याक और मिथुन-758) की जांच की गई। कुल मिलाकर, टीकाकरण पूर्व नमूनों में क्रमशः 35.3%, 31.2% और 31.0% जानवरों में सीरोटाइप 'O', A और Asia 1 के खिलाफ सुरक्षात्मक टाइटर्स पाए गए।
- राउंड 3 के अंत में टीकाकरण के बाद के नमूनों में क्रमशः 68.9%, 64.0% और 66.7% जानवरों में सीरोटाइप ओ, ए और एशिया1 के खिलाफ सुरक्षात्मक टाइटर्स देखे गए।
- एनएसपी रिएक्टरों के अनुवर्ती के तहत, 3AB3 एनएसपी और जीनोम के लिए एंटीबॉडी की उपस्थिति का पता लगाने के लिए हरियाणा, मध्य प्रदेश, कर्नाटक और महाराष्ट्र राज्यों से कुल 102 सीरम और ओसोफेजियल- ग्रसनी तरल पदार्थ (ओपीएफ) नमूनों का परीक्षण किया गया था। 102 ओपीएफ नमूनों में से तीन एफएमडी सीरोटाइप 'O' के लिए सकारात्मक पाए गए।
- टैकमैन प्रोब-आधारित एक-चरण आरटी-क्यूपीसीआर परख डुप्लेक्स प्रारूप में एक साथ एफएमडीवी 2-बी एनएसपी-कोडिंग क्षेत्र और 18-एस आर आरएनए हाउसकीपिंग जीन को लक्षित करके विकसित और मूल्यांकन किया गया। परख ने 100% (95% सीआई 99-100%) की नैदानिक संवेदनशीलता और विशिष्टता का प्रदर्शन किया और उच्च-थ्रूपुट तरीके से नियमित एफएमडीवी निदान की क्षमता रखता है।
- पैन-सीरोटाइपिक तरीके से भारत में प्रसारित होने वाले एफ.एम.डी. वायरस की संवेदनशील और विशिष्ट पहचान के लिए कलरिमेट्रिक रिवर्स ट्रांसक्रिप्शन लूप-मध्यस्थ इजोटेर्मल एम्प्लीफिकेशन (आरटी-

एलएएमपी) परख विकसित की गई। परख ने एफएमडी वायरल जीनोम की 1000 प्रतियों का पता लगाने की सीमा प्रदर्शित की, जो अगरोज-जेल-आधारित मल्टीप्लेक्स आरटी-पीसीआर परख से 10 गुना अधिक संवेदनशील है।

- एफएमडीवी एनएसपी एंटीबॉडी का पता लगाने के लिए मोनोक्लोनल एंटीबॉडी आधारित प्रतिस्पर्धी एलिसा विकसित किया गया। परीक्षण ने प्रायो चेक एफएमडी एनएस (Prio-check FMD-NS) परीक्षण की तुलना में 93.52% की सापेक्ष नैदानिक संवेदनशीलता और 97.46% की विशिष्टता प्रदर्शित की। इसने r3AB3 NSP-ELISA के साथ 45% PI कट-ऑफ पर 86.13% की समग्र अनुरूपता दिखाई। यह परख सभी एफएमडी- अति संवेदनशील प्रजातियों में एफएमडी सीरो-निगरानी और दीवा में सहायक होने की उम्मीद है।
- गर्मी प्रतिरोधी एफएमडीवी सीरोटाइप एशिया1 वैक्सीन स्ट्रेन को गर्मी के तनाव के तहत क्रमिक मार्ग के माध्यम से चुना गया और बाद में प्लाक परख द्वारा अलग किया गया। चयनित थर्मोस्टेबल वैरिएंट को अलग-अलग तापमान-समय संयोजनों में उत्परिवर्ती वायरस को इनक्यूबेट करके इसकी थर्मल स्थिरता के लिए जाना जाता है। सभी परीक्षण की गई स्थितियों में, थर्मली- चयनित संस्करण ने मूल समकक्ष की तुलना में बेहतर प्रदर्शन किया।
- एलएचडीसीपी के तहत टीकाकरण के लिए उपयोग किए जाने वाले एफएमडी टीकों के गुणवत्ता नियंत्रण (क्यूसी) परीक्षण के लिए, आईसीएआर-एनआईएफएमडी ने टीकों के सात बैचों का क्यूसी परीक्षण किया।
- एफ.एम.डी. रोग निगरानी और सेरोमोनिटरिंग के लिए, संस्थान ने राज्य एफएमडी केंद्रों को तीन प्राथमिक परीक्षण किट (81,194 नमूनों के लिए 3AB3 अप्रत्यक्ष DIVA एलिसा, 148,500 नमूनों के लिए सॉलिड चरण प्रतिस्पर्धी एलिसा (एसपीसीई) (सीरोटाइप 'O', ए और एशिया 1), और 2,800 नमूनों के लिए सैंडविच एलिसा) प्रदान किए।
- राज्य एफएमडी क्षेत्रीय और सहयोगी केंद्रों के लिए क्षमता निर्माण के हिस्से के रूप में दस प्रयोगशाला प्रशिक्षण कार्यक्रम और कार्यशालाएं आयोजित की गईं। इसके अतिरिक्त, दो अंतर्राष्ट्रीय कार्यशालाएँ आयोजित की गई एक बिम्सटेक सदस्य देशों के लिए और एक डब्ल्यूआरएल-एफएमडी, आईवीआरआई, सीसीएस- एनआईएएच सहयोगी परियोजना 'एफएमडी वैक्सीन गुणवत्ता परीक्षण और भारत की पशु वैक्सीन परीक्षण क्षमताओं को बढ़ाना' के तहत। इसके अलावा, जून से सितंबर तक छह एफएमडी क्षेत्रीय केंद्रों पर एफएमडी के लिए एनएसपी रिएक्टरों की व्यवस्थित अनुवर्ती जांच के लिए एक देशव्यापी क्षमता निर्माण कार्यक्रम आयोजित किया गया था। इस कार्य को पूरा करने के लिए देश भर के 150 से अधिक पशु चिकित्सकों को प्रशिक्षित किया गया था।
- राष्ट्रीय एफ.एम.डी. नियंत्रण जागरूकता सप्ताह सहित, हितधारकों के लिए एलएचडीसीपी योजना के तहत कई विस्तार और प्रशिक्षण कार्यक्रम आयोजित किए गए। कुल मिलाकर, 4996 किसानों, 3687 पशु चिकित्सकों और पैरावेटरनरी स्टाफ और 698 छात्रों सहित 9381 हितधारकों ने भाग लिया और लाभान्वित हुए।
- वर्ष 2023 के दौरान, DAPSC के तहत कुल 93 कार्यक्रम और गतिविधियाँ आयोजित की गईं, जिससे 2602 किसानों और छात्रों को लाभ हुआ। इसी प्रकार, एनईएच योजना और डीएपीएसटी के तहत क्रमशः 79 और 26 कार्यक्रम और गतिविधियाँ आयोजित की गईं, इन पहलों से 2594 और 2977 किसान और छात्र लाभान्वित हुए।
- आईसीएआर-एनआईएफएमडी ने, 'एफएओ रेफरेंस सेंटर फॉर एफ.एम.डी. के रूप में, एफएमडी, यूके, ईयूएफएमडी और डीईएफआर' के समर्थन से एफएओ वर्ल्ड रेफरेंस लेबोरेटरी (डब्ल्यूआरएल) द्वारा आयोजित एफ.एम.डी. प्रवीणता परीक्षण योजना, 2022 (सीरोलॉजी और वायरोलॉजी पैनल दोनों) में भाग लिया।
- एफएमडीवी सीरोटाइप ए कैंडिडेट वैक्सीन स्ट्रेन, ए/आइएनडी27/2011, और थर्मोस्टेबल एफ.एम.डी. वायरस सीरोटाइप 'O' को भारतीय वैक्सीन फॉर्मूलेशन में शामिल करने के लिए व्यावसायीकरण के लिए तैयार हैं, और एग्रीनोवेट इंडिया लिमिटेड को सौंपा गया है।

2.0 RESEARCH ACHIEVEMENTS

2.1 Disease Monitoring and Surveillance

Epidemiological Status during 2023

There were 57 confirmed outbreaks of FMD in India during the year 2023 (Table 1), a number nearly identical to the outbreaks reported in 2022. The disease was observed in fifteen states and UTs across all geographical regions (Fig. 1). The majority of incidences were reported in the southern region, accounting for 56% of all documented FMD outbreaks. Compared to last year, there was a ten-fold decrease in the northeastern region and a four-fold increase in the southern region in terms of outbreaks (Fig. 2). Kerala reported the highest number of occurrences, with all three serotypes identified. With a 64.9% contribution to all outbreaks, serotype O dominated the scenario in 2023. However, there was an unexpected rise in the incidence of serotype A, accounting for 30% of all FMD incidences (Fig. 3). This necessitates prompt action as the current serotype A Indian vaccine strain, IND40/2000, does not cover the antigenic variations of field isolates. Following antigenic evaluation with recent isolates, a novel serotype A candidate vaccine strain, IND27/2011, has been selected and is ready for incorporation into the Indian vaccine formulation. States such as Kerala, Tamil Nadu, Telangana, Odisha, Maharashtra, and Himachal Pradesh have all reported cases of serotype A outbreaks. Additionally, cases of FMD linked to serotype Asia1 have been documented in Gujarat and Kerala. Molecular techniques, such as multiplex PCR, and serotype-differentiating sandwich ELISA were employed to assess 426 clinical specimens collected from suspected FMD outbreaks. The results revealed serotype "O" in 102 samples, "A" in 42 samples, and "Asia1" in 4 samples (Table 2). The majority of outbreaks were reported from July to November (Fig. 4). While FMD cases occur throughout the year in India, there is often an increase during the winter. Cattle were the primary species affected, constituting over 89% of FMD outbreaks. Cattle and buffalo together were affected in 7% of the outbreaks (Fig. 5). Notably, Telangana experienced an FMD incidence in four-horned antelope linked to serotype A.

Table 1. FMD outbreaks recorded and diagnosed during 2023 and virus serotype(s) involved

State/UT	Reporting Centre	Number of FMD outbreaks	FMD Serotypes		
			O	A	Asia1
Southern Region					
Karnataka	Bengaluru	9	9	-	-
Kerala	Trivendrum	17	5	11	1
Tamilnadu	Ranipet	2	1	1	-
Telangana	Hyderabad	4	3	1	-
Total		**32**	**18**	**13**	**1**
Western Region					
Maharashtra	Pune	5	4	1	-
Gujarat	Ahmedabad	5	3	-	2
Total		**10**	**7**	**1**	**2**
Northern Region					
Uttarakhand	Rishikesh	1	1	-	-
Himachal Pradesh	Shimla	1	-	1	-
Jammu & Kashmir	ICFMD	1	-	1	-
Total		**3**	**1**	**2**	

Eastern Region					
Odisha	Cuttack	3	2	1	-
West Bengal	Kolkata	4	4	-	-
Bihar	Patna	2	2	-	-
Jharkhand	ICFMD	1	1	-	-
Total		**10**	**9**	**1**	-
North Eastern Region					
Assam	Guwahati	1	1	-	-
Mizoram	Aizawl	1	1	-	-
Total		**2**	**2**	-	-
Grand Total		**57**	**37**	**17**	**3**

Table 2. Number of clinical samples tested during 2023 and virus serotype(s) involved

State/UT	Number of Clinical material tested	FMD Serotypes		
		O	A	Asia1
Andhra Pradesh	21	-	-	-
Assam	6	4		
Bihar	5	3		
Chhattisgarh	3	-	-	-
Gujarat	24	8	-	3
Himachal Pradesh	9	-	2	-
Jammu & Kashmir	11	-	1	-
Jharkhand	7	6	-	-
Karnataka	36	14	-	-
Kerala	110	7	27	1
Madhya Pradesh	4	-	-	-
Maharashtra	97	30	7	-
Mizoram	06	02	-	-
Odisha	20	7	2	-
Punjab	8	-	-	-
Tamilnadu	11	2	2	
Telangana	23	12	1	-
Uttar Pradesh				
Uttarakhand	7	1	-	-
West Bengal	18	6	-	-
Total	**426**	**102**	**42**	**4**

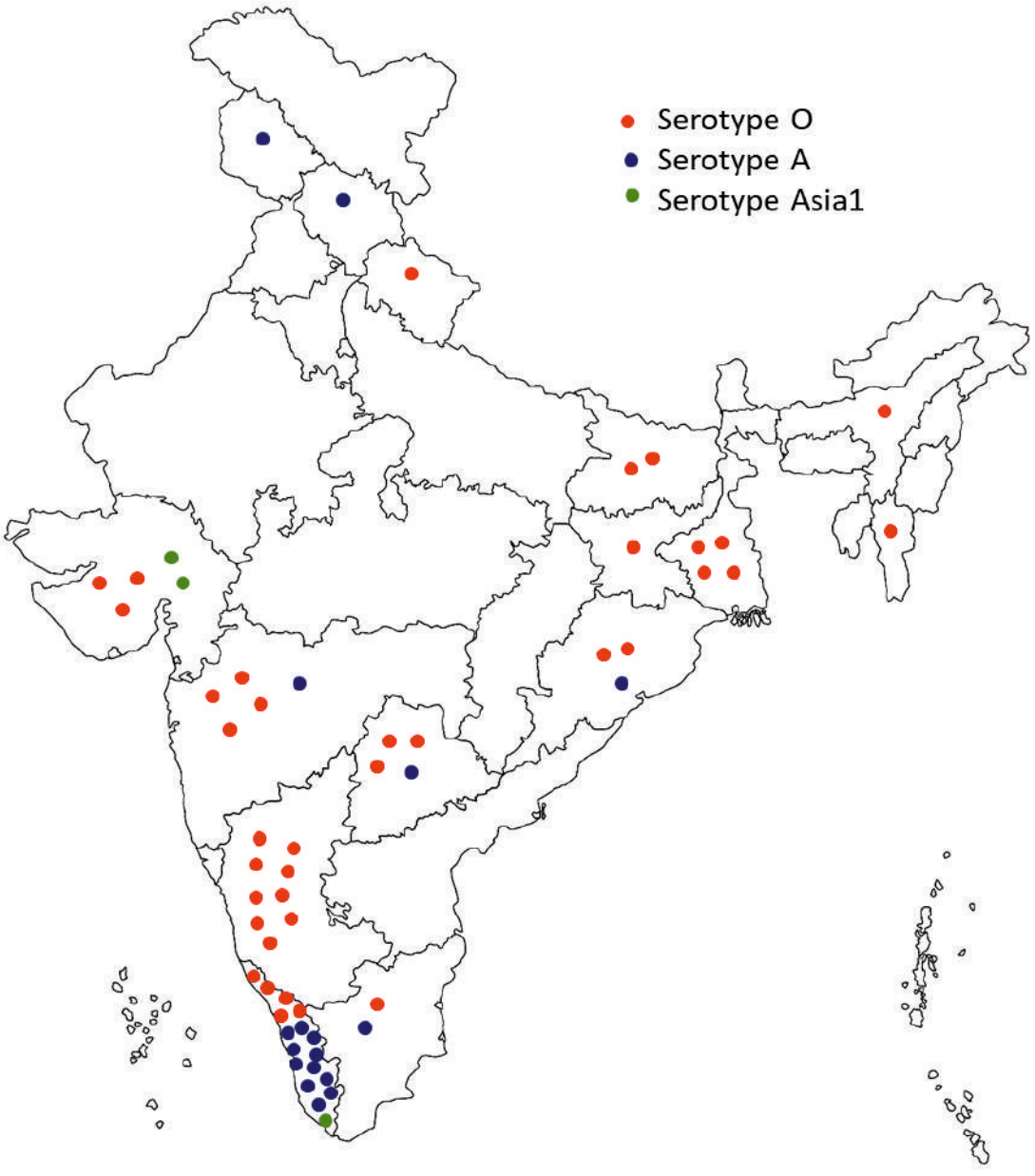


Fig 1: Outbreak-wise FMDV serotype distribution in different states during 2023.

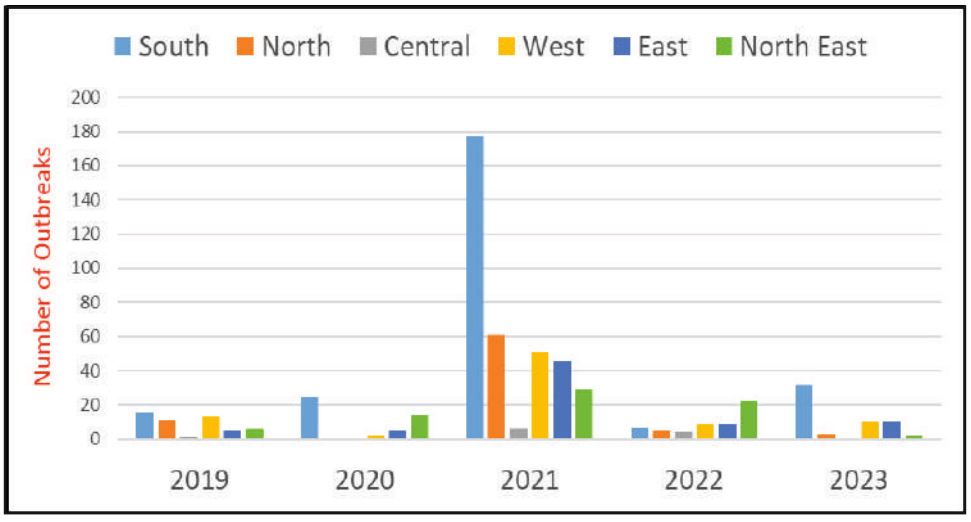


Fig 2: Region wise FMD outbreaks during last five years

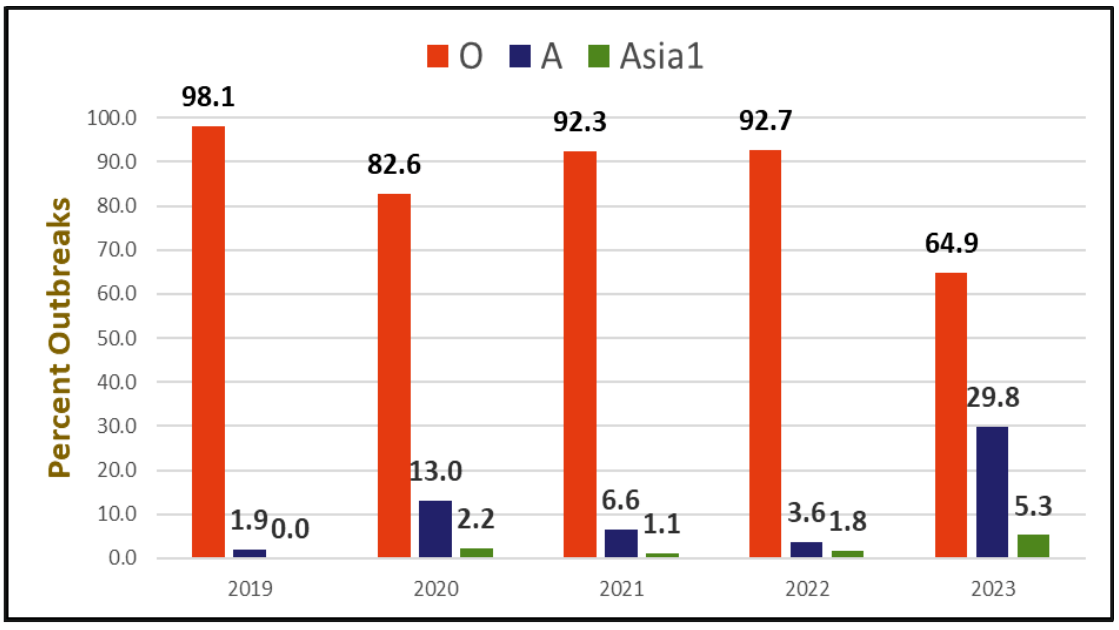


Fig 3. Serotype wise percent FMD outbreaks during last five years

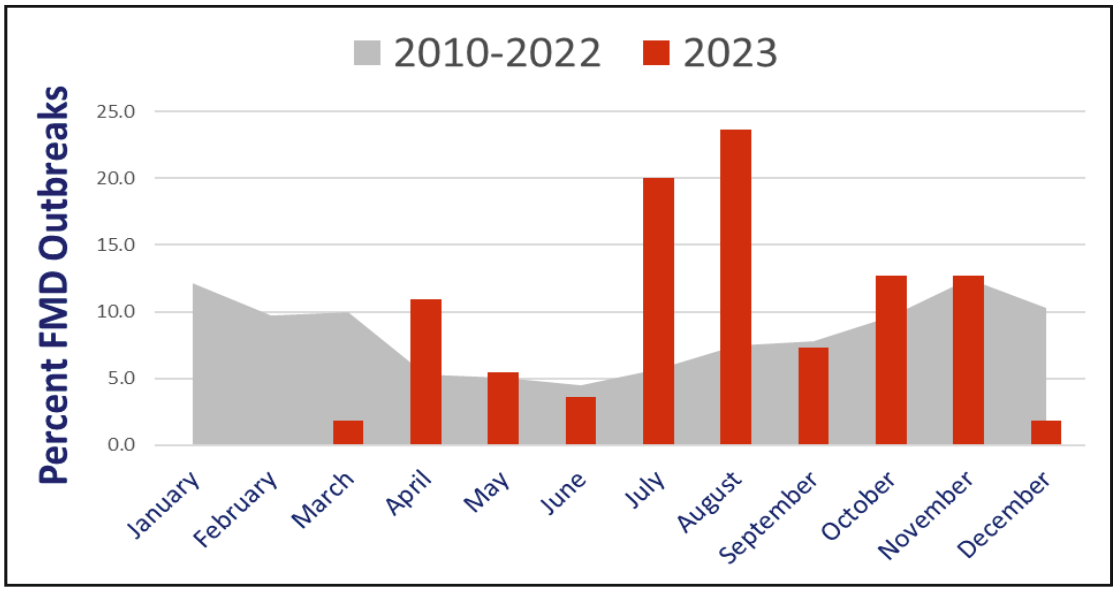


Fig 4. Month-wise percent FMD incidences during the year 2023 compared to last decade (2010-2022)

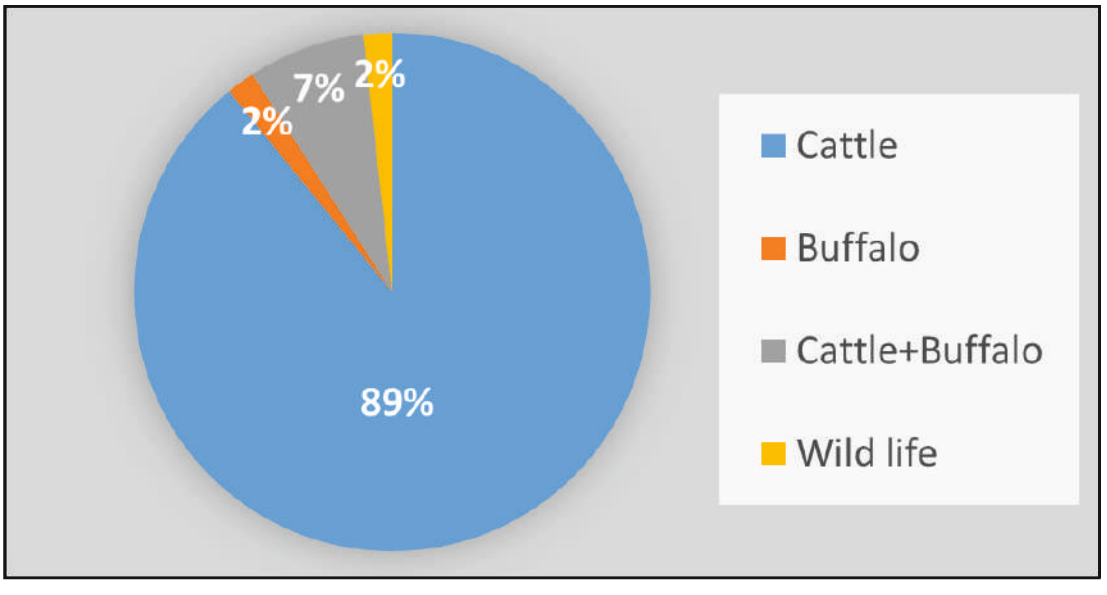


Fig 5. Species involved in FMD outbreaks during 2023

Southern Region

The southern region, which includes five states (Tamil Nadu, Karnataka, Telangana, Andhra Pradesh and Kerala) and two UTs (Puducherry and the Andaman and Nicobar Islands), has roughly 21% of the country's FMD susceptible livestock. The region has no international land borders and is surrounded by ocean. The state of Karnataka has been identified as an FMD hyper-endemic area. FMDCP has been operating in the southern peninsular region since 2010-11.

Tamil Nadu: The state reported two FMD outbreaks in August, one caused by serotype A in Erode district and the other by serotype O in Tiruppur district. The outbreaks affected cattle exclusively.

Telangana: The state reported four FMD outbreaks, with three caused by serotype O and one by serotype A. These outbreaks occurred in the months of June, July (2), and October. The serotype O outbreaks were recorded in the districts of Khammam, Mahabubabad, and Siddipet in cattle and buffalo. The serotype A outbreak occurred in Nehru Zoological Park, Bahadurpura, Hyderabad, in July and affected four horned antelope, resulting in mortality observed in six antelopes. Implementing appropriate measures to control the spread of FMD in susceptible populations, including wildlife, is essential for disease management in the state

Kerala: The state reported seventeen FMD outbreaks, with nine districts affected out of fourteen. The majority of the outbreaks were caused by serotype A, accounting for 11 outbreaks, followed by serotype O in 5 outbreaks and serotype Asia1 in 1 outbreak. The outbreaks were mostly recorded in July (7), August (6), and 2 each in October and November. The affected districts were Thiruvananthapuram, Alappuzha, Pathanamthitta, Ernakulam, Thrissur, Palakkad, Malappuram, Kannur, and Kasaragod. Despite the widespread occurrence, the disease affected only around 114 animals, with mortality observed in 2 calves. Implementing effective control measures is crucial to mitigate the impact of FMD in the state. This is a reflection of prevailing herd immunity due to good quality vaccine and vaccination.

Karnataka: FMDV serotype O caused nine outbreaks in the state during the reporting period. The outbreaks were reported in the months of September (n=4), August (n=3), October (n=1), and May (n=1). The districts of Ramanagara and Bangalore Urban reported two outbreaks each, while the districts of Chikkamagaluru, Bangalore Rural, Chikaballapur, Mandya, and Mysore reported one outbreak each. The morbidity rate was very low at 0.37%, and there were mortalities in 4 animals. This could be a reflection of sincere vaccination effort.

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 five FMD outbreaks, with four caused by serotype

O and one by serotype A. The district of Ahmednagar had the highest number of outbreaks (n = 4), while Kolhapur reported one outbreak. In the year 2022 also, Ahmednagar reported a higher number of outbreaks (5 out of 7), requiring attention. The outbreaks due to serotype A were also reported from Ahmednagar. These outbreaks occurred in the months of October (n = 2) and November (n = 3). The affected animals were limited to cattle and buffalo, with morbidity and mortality rates of 2.4% and 0.07%, respectively.

Gujarat: The state reported five FMD outbreaks, with three caused by serotype O and two by serotype Asia1. The district of Kheda reported the highest number of outbreaks, with four, while one outbreak occurred in Gandhinagar district. The outbreaks were recorded in the months of January (n=2), April (n=1), May (n=1), and August (n=1), with a low morbidity rate (0.2%), and there were no reported mortalities. The source of the outbreak was suspected to be the purchase of new animals and animal movement.

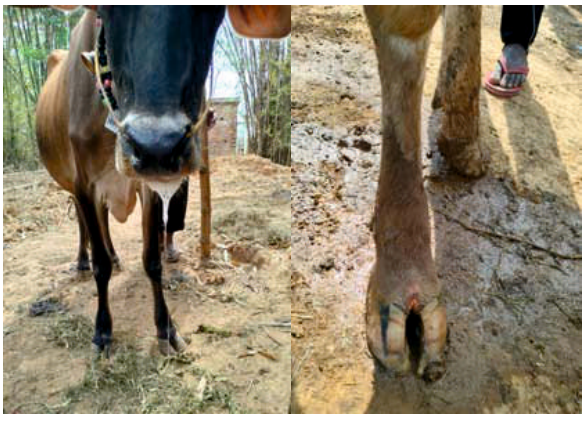
Eastern Region

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, Bhutan and Nepal. The entire region is covered under FMDCP since 2017.

Odisha: During the reported period, the state experienced three FMD outbreaks occurring in the months of April and November (2). Two of these outbreaks were associated with serotype O, while one was caused by serotype A. The affected districts were Khurda and Bhadrak. The morbidity rate was relatively high, reaching 26%, and one animal succumbed to the disease. High morbidity could be due to poor herd immunity.

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

Bihar: During the reporting period, two FMD outbreaks were serotype confirmed, and they were found to be caused by serotype O. These outbreaks occurred in the month of April and were reported in Sasaram district. The affected animals included cattle, with a recorded morbidity rate of 12.5%.



West Bengal: During the reporting period, four FMD outbreaks were recorded in different districts, namely Howrah, Medinipur, Bankura, and South 24 Parganas. These incidents were caused by serotype O and were reported in the months of July (n=2), August (n=1), and October (n=1). The disease affected both cattle and buffalo, with recorded morbidity and mortality rates of 8.4% and 0.5%, respectively.

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.

Himachal Pradesh: The state recorded a single outbreak due to serotype A in April, in the district of Shimla, with a morbidity rate of 14.6%. The introduction of new animals from neighboring states or human movement from infected areas in neighbouring states could be potential causes of introduction of the infection.

Jammu and Kashmir: One outbreak was recorded in Kupwara district in March, caused by serotype A.

Uttarakhand: The state recorded one confirmed FMD outbreak caused by serotype O, affecting cattle in the Dehradun district. The outbreak occurred in the month of December, with a morbidity rate of 25%.

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: One outbreak of FMD, caused by serotype O, was recorded in the state during the reporting period. The outbreak occurred in Kamrup district in the month of June, with a morbidity rate of 5%.

Mizoram: The state reported one FMD outbreak due to serotype O in Kolasib district in May. The disease was observed in only three animals.

2.2 Characterization of Pathogens and Epidemiology

2.2.1 Molecular Epidemiology

Serotype O

In serotype O, thirteen geographically restricted topotypes have been globally identified, 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. Only the ME-SA topotype has been identified in India, characterized by the circulation of several genetic groups (lineages and sub-lineages) with more than a 5% nucleotide difference 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 emerge as the most dominant lineages within the ME-SA topotype. Since its first report in 2001, the O/ME-SA/Ind2001 lineage has diversified into at least five sub-lineages (Ind2001a, b, c, d, and e). Phylogenetic studies identified the appearance of sub-lineage O/ME-SA/Ind2001e in India in 2015. From 2015 to 2017, this sub-lineage caused sporadic cases before triggering epidemic outbreaks in 2018. In that year, a new cluster, designated O/ME-SA/SA-2018, emerged, with significant genetic divergence from both the O/ME-SA/Ind2001 and O/ME-SA/PanAsia lineages. The O/ME-SA/Ind2001e and O/ME-SA/SA-2018 were responsible for FMD epidemics in 2021, with 60% of the incidences attributed to the former.

During the year 2023, a total of 28 FMD virus serotype O field isolates were sequence determined and subjected to phylogenetic analysis. Out of which, 18 were clustered within O/ME-SA/SA-2018, and 10 isolates within lineage O/ME-SA/Ind2001e. It's emphasized that there were no geographical restrictions observed in the circulation of the FMD virus lineages, indicating their co-circulation in Maharashtra, Gujarat, and Karnataka. Furthermore, Jharkhand solely reported O/ME-SA/Ind2001e, whereas the states of Odisha and Telangana recorded only O/ME-SA/SA-2018. The analysis revealed four important epidemiological events (Fig 6).

1. The O/ME-SA/SA-2018 lineage has established itself strongly in India and has also been reported in neighbouring countries.
2. There has been a decline in the circulation of the O/ME-SA/Ind2001e lineage.
3. The O/ME-SA/Ind2001e and O/ME-SA/Cluster-2018 lineages were responsible for 40% and 60% of the FMD outbreaks recorded during 2023.
4. The lineages O/ME-SA/PanAsia-2 ANT^{10} and O/ME-SA/Ind2001d could not be detected anywhere in the country.

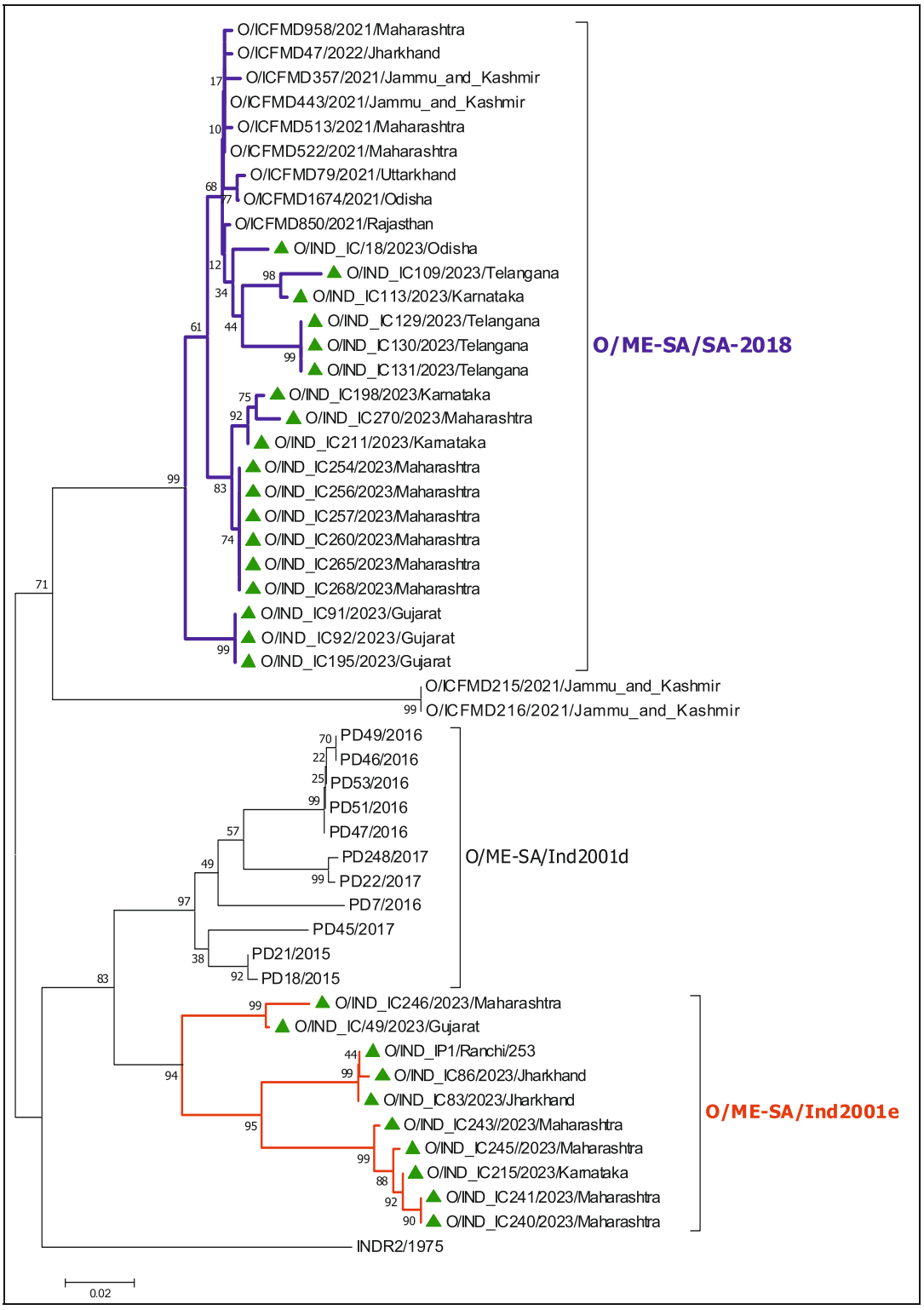


Fig 6: Maximum Likelihood phylogenetic tree at VP1 coding region of Indian serotype O FMD virus isolates during 2023. Isolates (n=28) sequenced during 2023 are indicated by green triangle.

Serotype A

The serotype A virus population in India is the most genetically and antigenically diverse among the three serotypes. Molecular phylogeny has identified the circulation of four genotypes (2, 10, 16, and 18) with more than 15% nucleotide divergence in the 1D region of serotype A. Since 2001, genotype 18 has been exclusively responsible for all field outbreaks, outcompeting other genotypes. Within genotype 18, a unique lineage with a VP3 amino acid deletion at the 59th position

(VP3[59]-deletion group) emerged in late 2002 and dominated field outbreaks in 2002–03. In 2019, a novel genetic lineage, designated as G-18/non-deletion/2019, emerged in Maharashtra and has been established strongly in India. In 2023, the sequences of sixteen isolates from Kerala, Telangana, Madhya Pradesh, Maharashtra, and Odisha were determined, and phylogenetic analysis confirmed their clustering within the G-18/non-deletion/2019 lineage (Fig 7).

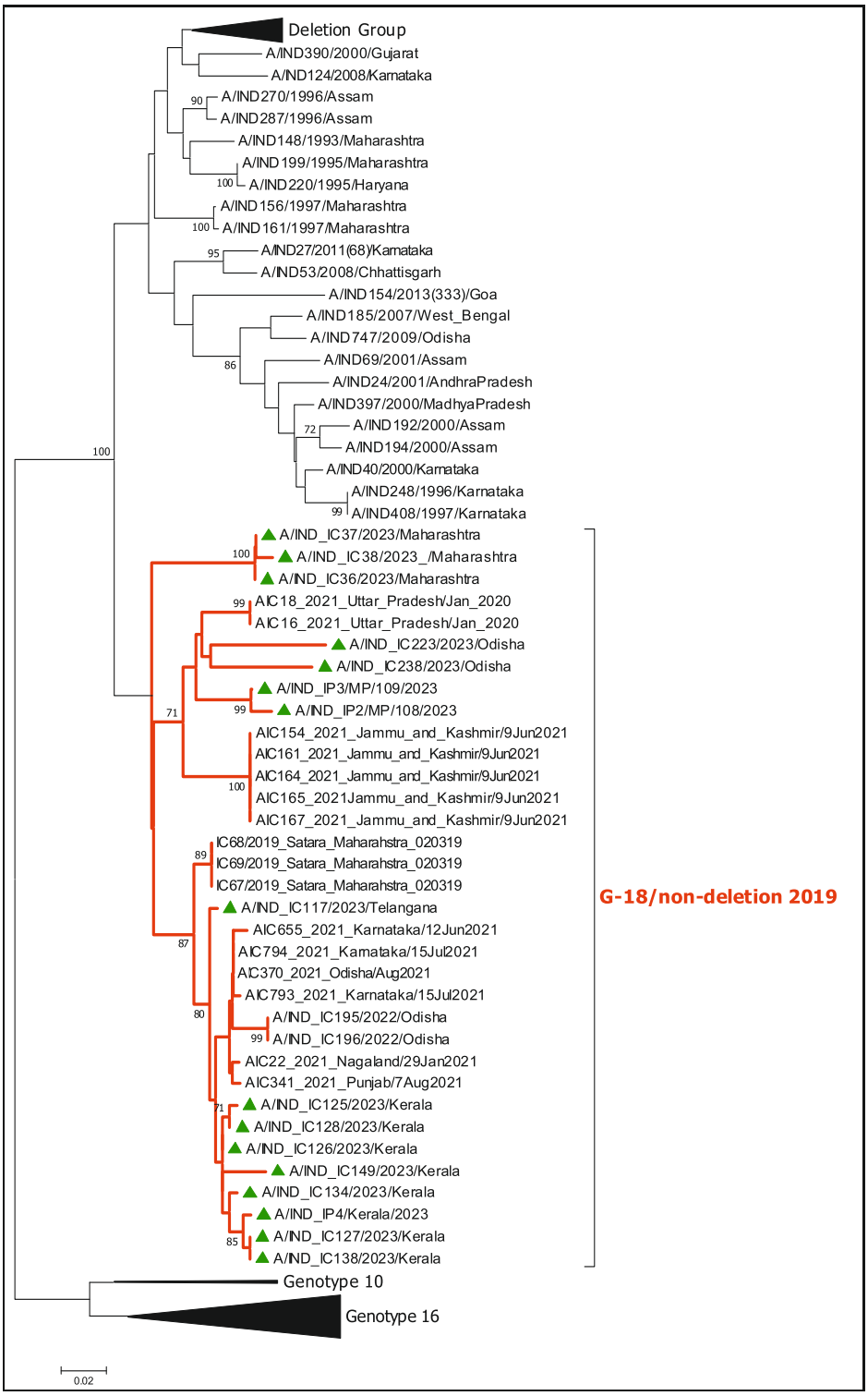


Fig 7: Maximum Likelihood phylogenetic tree at VP1 coding region of Indian serotype A FMD virus isolates during 2023. The analysis showed circulation of G-18/non-deletion/2019 lineage. Isolates (n=16) sequenced during 2023 are indicated by green triangle.

Serotype Asia1

Previous studies based on the 1D/VP1 gene phylogeny identified three major lineages (B, C, and D) for Indian serotype Asia1 field isolates. Lineage B, including the current serotype Asia1 vaccine strain (IND63/1972), was last recorded in 2000. Lineage D emerged in late 2001 and dominated between 2002 and 2004. Lineage C dominated Asia1 field outbreaks from 1998 to 2002, re-emerging as sub-lineage CII from 2005 onwards. Global classification of FMDV serotype Asia1 isolates since 2004 includes nine genetic groups (G I–IX). Isolates from India during 2001–2004 (lineage D) clustered within Group III globally, while post-2005 isolates clustered with Group VIII. In 2020, a new genetic group, G-IX, emerged in India and circulated exclusively in 2021 and 2022. During 2023, an Asia1 isolate from Gujarat clustered within Group VIII, last detected in 2018 in India (Fig 8), indicating extended circulation of Group-VIII in the country. Emergence and re-emergence are frequently observed in serotype Asia1, distinguishing its evolutionary footprint from serotypes O and A.

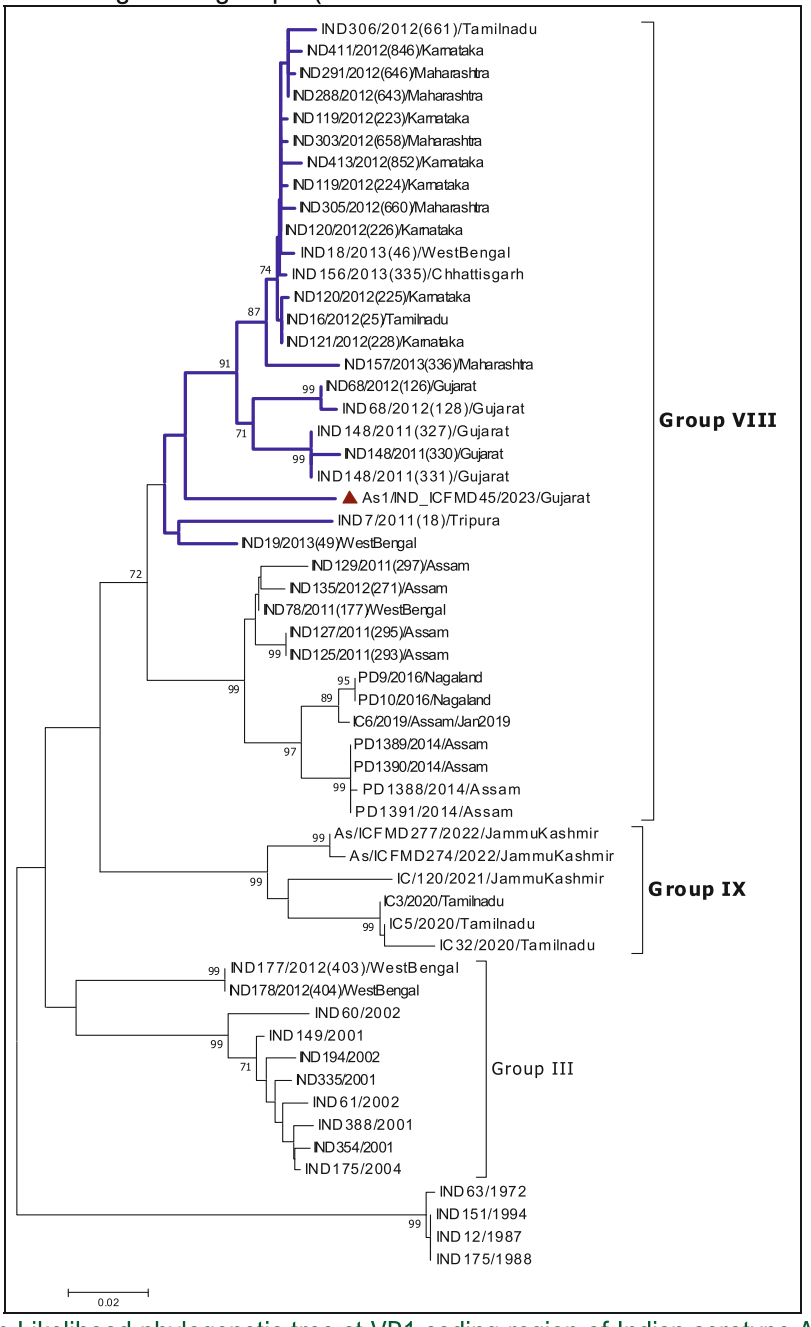


Fig 8: Maximum Likelihood phylogenetic tree at VP1 coding region of Indian serotype Asia1 FMD virus isolates during 2023. Isolates (n=1) sequenced during 2023 are indicated by brown triangle

2.2.2 Vaccine matching

A vaccine matching analysis employing bovine vaccinate serum (BVS) against the respective vaccine strain with field isolates was carried out to assess the appropriateness of the in-use vaccine strain. The antibody titer was determined as the reciprocal of the last dilution of serum that neutralised 100 $TCID_{50}$ in 50% of the wells. The relationship value was calculated as a ratio of antibody titer against field isolates to that against the vaccine strain. The r-value of > 0.3 indicates sufficient antigenic homology between field isolates and vaccine strains. Conversely, an r-value of < 0.3 is suggestive of antigenic deviation. The test was repeated three times, and the log_{10} titers were averaged for the calculation of the r-value.

Serotype O

A total of 9 serotype O FMDV field isolates collected during the year 2023 were subjected to vaccine matching using BVS against in-use serotype O vaccine strain O INDR2/1975. The isolates were collected from the states Telangana, Gujarat, Jharkhand. From the analysis, it was found that all the isolates showed an r-value of >0.3 with the vaccine strain O INDR2/1975, showing an exceptional antigenic match (Fig. 9) with both the new lineages circulating in India. The current serotype O vaccine strain can be used in Indian vaccine formulations since it continues to provide the best antigenic coverage even 40 years after its isolation.

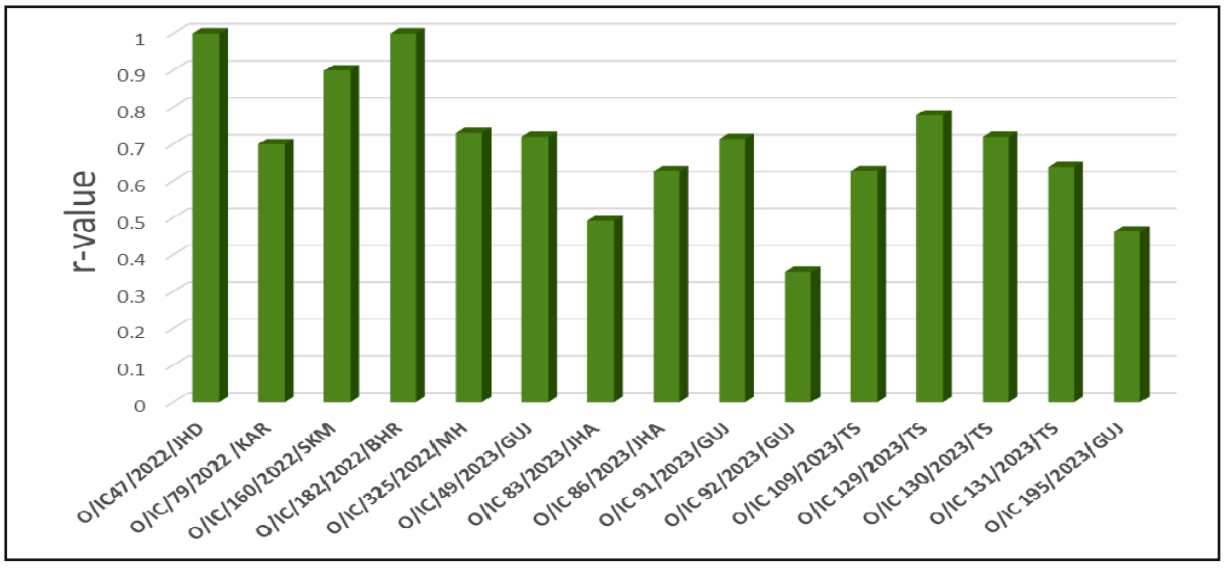


Fig 9: The antigenic relationship value of FMDV serotype O field isolates collected during the years 2022 and 2023.

Serotype A

Since 2012–13, serotype A FMD virus strains in India have been antigenically divergent from the current vaccine strain (IND40/2000). ICAR-NIFMD conducted studies to select a suitable alternate serotype A vaccine strain to cover the antigenic diversity. Among eight initially selected strains, A/IND27/2011 emerged as the candidate strain based on its widest antigenic relatedness with circulating field strains. A/IND27/2011 exhibited all vaccine-worthy attributes as evaluated by IVRI, Bengaluru. In 2023, a serotype A isolate from Telangana was subjected to vaccine matching with A/IND/40/2000 and the new candidate vaccine strain A/IND/27/2011. The isolate showed poor antigenic match with the current vaccine strain A/IND/40/2000. A/IND/27/2011 demonstrated a strong antigenic match (Fig 10) and is considered a preferable alternative for inclusion in the Indian vaccine formulation. A transition plan for incorporating A/IND/27/2011 into the vaccine formulation has already been submitted by ICAR-NIFMD to ICAR and DAHD.

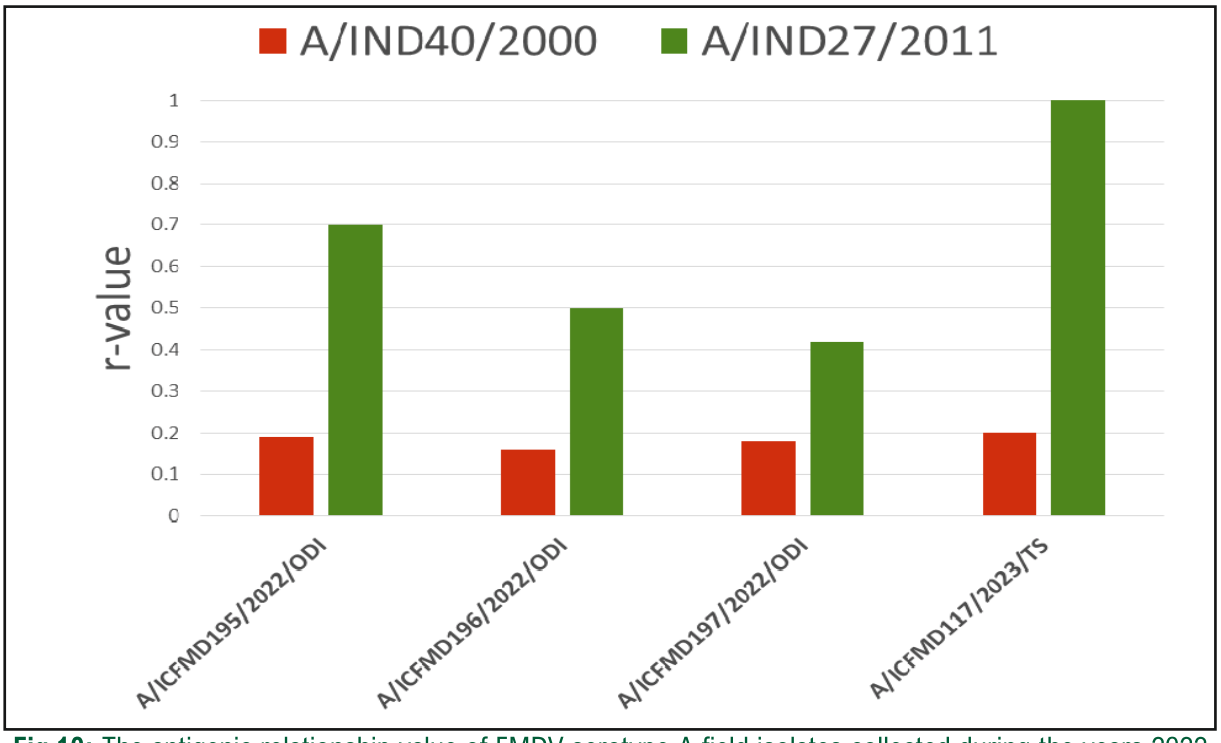


Fig 10: The antigenic relationship value of FMDV serotype A field isolates collected during the years 2022 and 2023

Serotype Asia1

The antigenic relationship value of one FMDV serotype Asia1 field isolate sampled during the year 2023 was determined using BVS against in-use vaccine strain IND63/1972. The isolate showed good antigenic match with the current vaccine strain IND63/1972 indicating its appropriateness (Fig 11).

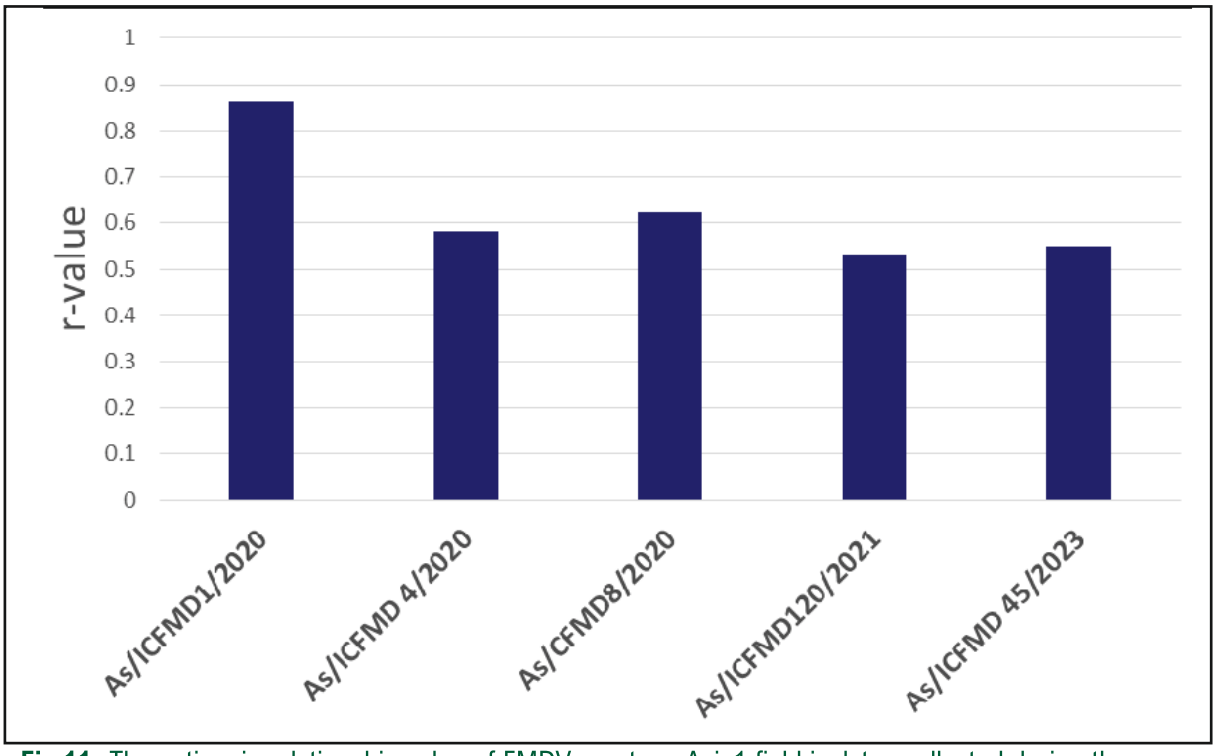


Fig 11: The antigenic relationship value of FMDV serotype Asia1 field isolates collected during the years 2020 to 2023

2.3 FMD Serosurveillance

2.3.1 Serosurveillance in Bovine

In India, vaccination with inactivated vaccines is the primary method for controlling FMD. It is essential to distinguish between infected and vaccinated animals for effective implementation of control programs and to assess the success of vaccination campaigns. Differentiating between these two categories is crucial during serological surveys to detect evidence of infection, especially following ring vaccination, and for import/export serology. During active viral replication after FMD virus infection, various non-structural proteins (NSPs) are produced, eliciting anti-NSP antibodies. This is not the case in uninfected animals vaccinated against FMD with inactivated virus vaccines. Therefore, the use of DIVA (Differentiating Infected from Vaccinated Animals) assays is essential for identifying potential disease-free zones (DFZs), where vaccination has successfully prevented virus circulation in India. For 3AB3-NSP based sero-surveillance activity, a two-stage sampling strategy was employed with a minimum design prevalence of 1% at the first-stage level (village) and 5% between villages. The sampling design was collaboratively developed by ICAR-NIFMD and ICAR-NIVEDI. In NSP sero-surveillance, the study design typically targets younger animals aged between 6 to 18 months. This age group is chosen because repeated vaccination, even with high-quality purified vaccines, is suspected to generate a positive signal in NSP ELISA, leading to false-positive NSP reactors.

During the year 2023, a total of **45,919** bovine serum samples (Cattle-30536 and Buffalo-15383) collected at random as per sampling plan from various parts of the country were tested using r3AB3 NSP-ELISA for assessing NSP-antibody (NSP-Ab) prevalence, which is an underlying indicator of FMD virus exposure regardless of vaccination status. The test revealed overall seropositivity (DIVA positive) in 16.1% samples or animals (Table 3). As compared to DIVA reactivity in 2021 and 2022 (16.6%), the prevalence trend remained the same in 2023. The highest FMD seroprevalence was observed in West Bengal, Karnataka, Jammu & Kashmir, Tamil Nadu and Odisha. The states and UTs of Tripura, Haryana, Uttar Pradesh, Andaman and Telangana recorded lower seroprevalence. Species wise comparison revealed cattle has higher seroprevalence rate (20.1%) than buffalo (8.2%). Percent NSP-Ab prevalence in different states is depicted (Fig 12). Over the years, there has been a fluctuation in the number of outbreaks, but a gradual decline in NSP-Ab prevalence was observed in the country (Fig. 13), except during the last 2-3 years when intensive countrywide vaccination was practiced with an FMD vaccine that was only self-certified by the manufacturer.

Table 3. NSP Positivity/ Reactivity during the year 2023 in cattle and buffalo of India

State/UT	Cattle		Buffalo		Total No of samples tested	Total NSP Positive (%)
	No of samples tested	% NSP Positive	No of samples tested	% NSP Positive		
Andaman	1053	0.7	-	-	1053	0.7
Andhra Pradesh	277	18.1	29	6.9	301	17.3
Arunachal Pradesh	526	0.0	-	-	526	0.0
Assam	1374	22.7	66	7.6	1440	22.0
Bihar	2011	25.2	1048	13.3	3059	21.1
Gujarat	772	25.5	840	6.8	1612	15.8
Haryana	2600	8.8	5208	1.5	7808	3.9

Jammu & Kashmir	923	32.0	-	-	923	32.0
Jharkhand	327	23.9	53	18.9	380	23.2
Karnataka	1970	35.0	489	22.1	2459	32.4
Kerala	1115	15.9	68	7.4	1183	15.5
Madhya Pradesh	901	26.2	451	8.2	1352	20.2
Maharashtra	2926	18.5	1099	5.4	4025	14.9
Manipur	1209	25.1	227	24.7	1436	25.1
Meghalaya	540	18.5	-	-	540	18.5
Mizoram	921	19.5	10	0.0	931	19.3
Odisha	2198	26.3	185	24.3	2383	26.1
Punjab	2721	22.9	1803	28.1	4524	25.0
Rajasthan	473	11.6	337	10.4	810	11.1
Tamil Nadu	1375	23.6	54	2.0	1429	22.7
Telangana	1415	8.8	1458	3.4	2873	6.1
Tripura	477	6.3	180	2.2	657	5.2
Uttar Pradesh	711	5.9	1454	2.1	2165	3.4
Uttarakhand	845	18.9	322	8.2	1167	15.9
West Bengal	876	33.9	2	0.0	878	33.8
Total	**30536**	**20.1**	**15383**	**8.2**	**45914**	**16.1**

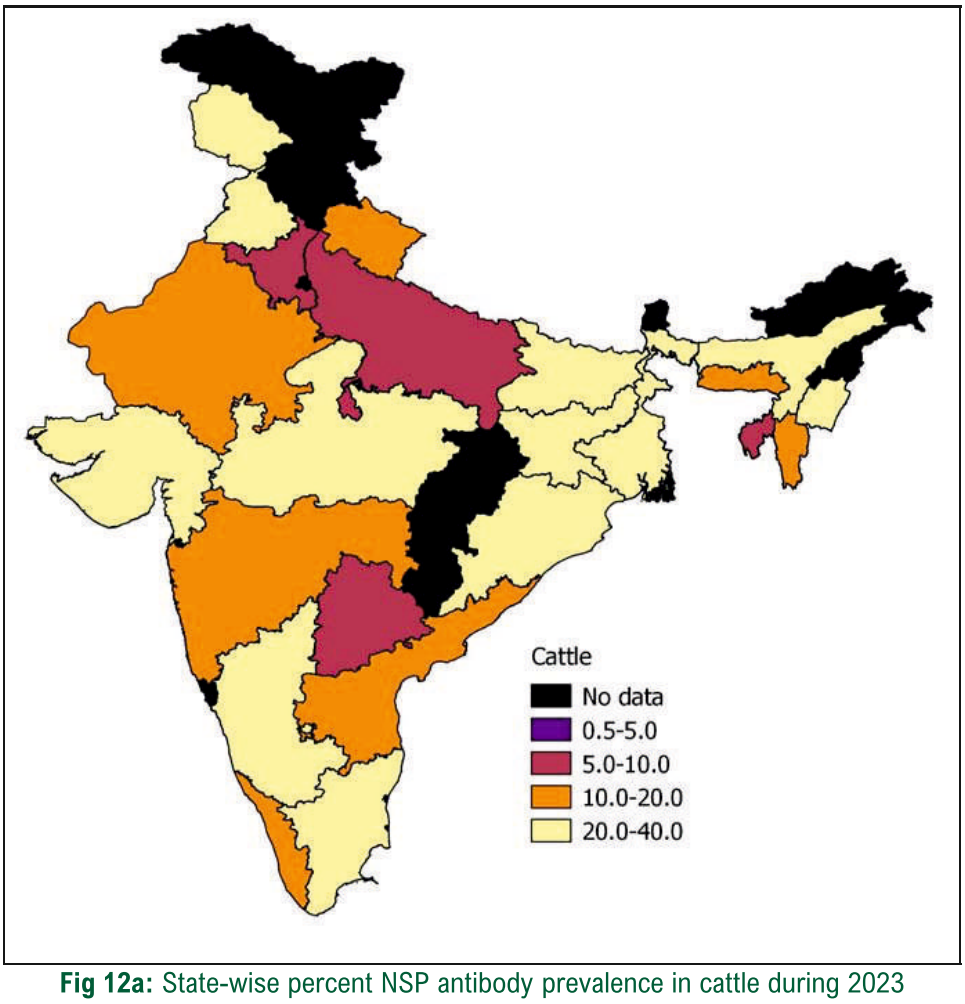


Fig 12a: State-wise percent NSP antibody prevalence in cattle during 2023

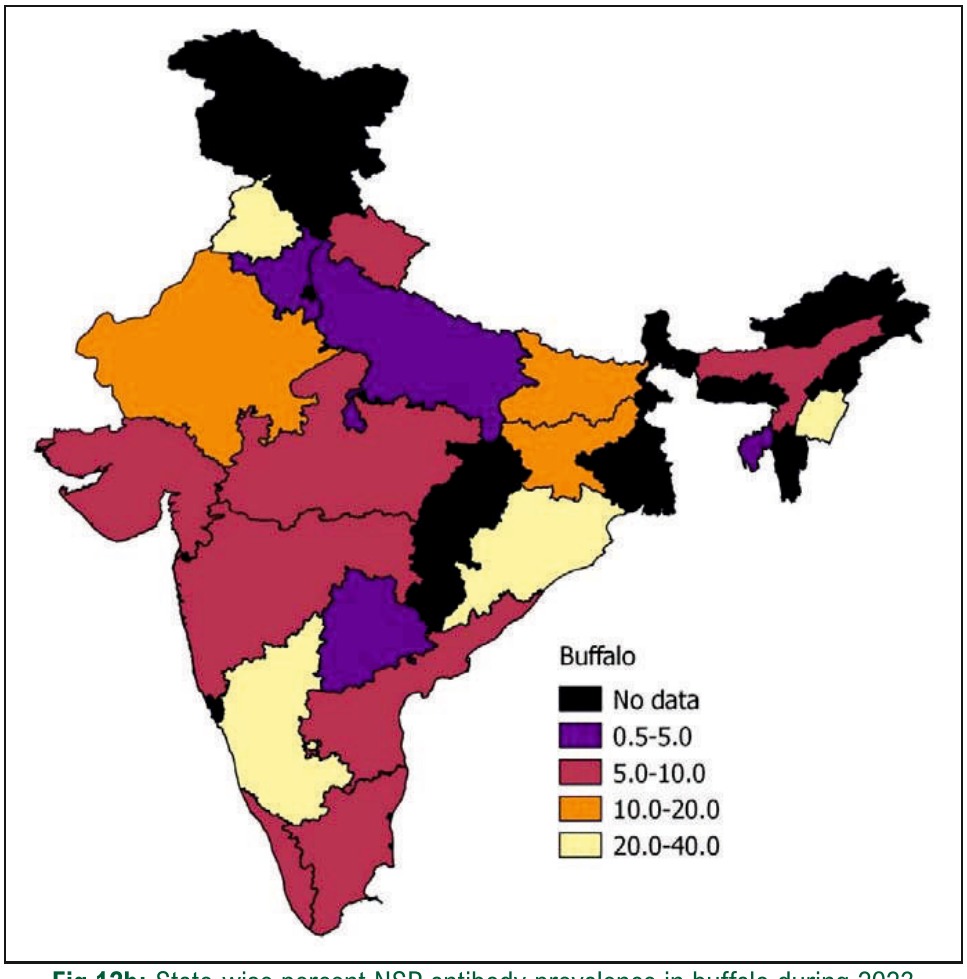


Fig 12b: State-wise percent NSP antibody prevalence in buffalo during 2023

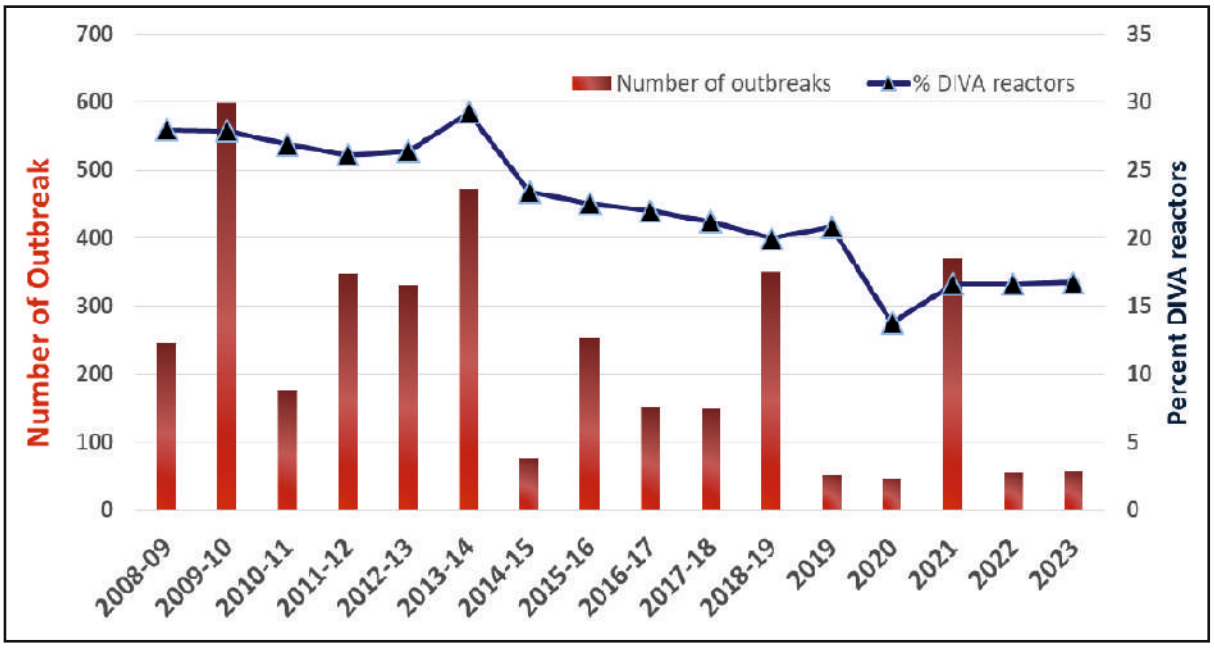


Fig 13. DIVA positivity/reactivity over the years in bovine population of India vis a vis number of FMD outbreaks

2.3.2 Serosurveillance in small ruminants and pigs

In order to comprehend their involvement in FMD epidemiology and to provide inputs for FMD management measures, particularly vaccination, FMD surveillance in small ruminants and pigs is essential. To determine the prevalence of NSP-Abs, serum samples from sheep, goats, and pigs randomly collected were tested (Table 4). The NSP-Ab prevalence in sheep and goats was found to be lower than the national average of 16.6% in bovine. However, the prevalence was found to be high in pig samples, which may be due to spill-over of the virus from the bovine population and covert infection. Goats and sheep may be used as sentinel animals or as markers of viral transmission in buffalo and cattle herds. Under the FMD Control Programme, routine FMD vaccination is carried out in bovine population in India; while small ruminants and pigs are not included in this procedure. It is generally accepted that, under a mixed or integrated animal husbandry system, small ruminants may be less important for FMDV susceptibility than cattle and buffalo.

Table 4. NSP positivity/reactivity during the year 2023 in small ruminants and pigs

State/UT	Sheep		Goat		Pig	
	No of samples tested	% NSP Positive	No of samples tested	% NSP Positive	No of samples tested	% NSP Positive
Madhya Pradesh	9	0.0	694	4.0	4	0
Karnataka	557	3.8	942	4.7		
Odisha	250	7.2	275	3.3		
Manipur	97	26.8	103	25.2	47	25.5
Total	**913**	**7.1**	**2014**	**5.3**	**51**	**25.5**

2.3.3 Serosurveillance in Yak and Mithun

FMD serosurveillance was conducted in mithun and yak species in the north-eastern states. The seroprevalence was found to be lower in yak and higher in mithun (Table 5). The higher prevalence in mithun may be due to recent FMD outbreaks in those species

Table 5. NSP positivity/reactivity during the year 2023 in Yak and Mithun

State/UT	Yak & Hybrid		Mithun	
	No of samples tested	% NSP Positive	No of samples tested	% NSP Positive
Arunachal Pradesh	484	4.3	-	-
Sikkim	11	18.2	-	-
Nagaland	-	-	89	21.4
Total	**495**	**4.7**	**89**	**21.4**

2.3.4 DIVA positivity in outbreak samples

A total of 140 serum samples collected during FMD outbreaks from different species were tested using 3AB3 DIVA ELISA for retrospective diagnosis. NSP-Ab seroprevalence was found to be higher (49.3%) in the outbreak scenario as compared to random samples (Table 6).

Table 6. NSP positivity/ reactivity during the year 2023 in outbreak samples

State	Species	Total No. of Samples	3AB3 NSP Positive results
Maharashtra	Cattle	27	15
	Sheep	6	0
Chhattisgarh	Cattle	7	3
	Buffalo	1	0
Gujarat	Cattle	42	15
	Buffalo	2	0
Himachal Pradesh	Cattle	6	1
Kashmir	Cattle	7	6
Kerala	Cattle	13	8
Odisha	Cattle	23	16
Telangana	Cattle	1	1
	Buffalo	1	0
Uttarakhand	Cattle	4	4
Total		**140**	**69 (49.28%)**

2.3.5 Investigation of NSP seroreactors

During this year, countrywide capacity building programme for systematic follow-up investigation of NSP reactors by oesophageal-pharyngeal fluid (OPF) testing for FMD has been organized and completed at six FMD regional Centers from June to September. In 2023, a total of 102 serum and OPF samples were randomly collected from the states of Haryana, Madhya Pradesh, Karnataka, and Maharashtra for the follow up of NSP reactors. The serum samples were tested for the presence of antibodies against 3AB3 NSP, and the OPF samples were tested for genome detection by RT-mPCR. Out of 102 serum samples, 26 were found to have antibodies against NSP and were classified as FMD NSP reactors. Among the 102 OPF samples, 03 were found positive for FMDV serotype O by RT-mPCR. All three FMDV genome-positive samples were collected from NSP reactors in the state of Haryana (Table 7).

Oropharyngeal fluid (OPF) sample collection steps using probang cup in cattle.

Table 7. Results of follow-up of NSP sero-reactors

Sl. No.	State	NSP reactors (2022)				Samples collected from surrounding animals			
		NSP anti-body positive	Number of OPF sample	FMDV genome positive	Clinical inspection	NSP Reactors	Serum samples (NSP 3AB3 negative)	OPF samples (FMDV genome negative)	Clinical Inspection
1.	Madhya Pradesh	7	7	0	Not observed	Earlier untested	17	17	Not observed
2.	Maharashtra	3	3	0	Not observed	Earlier untested	14	14	Not observed
3.	Karnataka	11	11	0	Not observed	Earlier untested	22	22	Not observed
4.	Haryana	5	5	3	Not observed	Earlier untested	23	23	Not observed
	Total	**26**	**26**	**3**			**76**	**76**	

2.3.6 Status of NSP reactors at livestock-wildlife interface

In collaboration with the Wildlife Conservation Trust (WCT) in Mumbai, FMD serosurveillance was conducted at the livestock-wildlife interface in the buffer/core zone of Sanjay Tiger Reserve and Bandhavgarh Tiger Reserve. A total of 713 serum samples and 52 OPF samples were collected from cattle, buffaloes, and goats, and subjected to detection of 3AB3 NSP antibody and FMDV genome. The results from 3AB3 NSP ELISA showed that 8.8% of cattle and 5.73% of goats were positive for 3AB3 NSP-Ab of FMD virus, while none of the buffaloes showed NSP reactivity. Out of the 52 OPF samples tested for genome detection, 10 were found positive for FMDV serotype A by RT-mPCR. Among these 10 FMDV positive samples, virus could be isolated from 3 samples. Phylogenetic analyses revealed that these viruses clustered with the G-18/non-deletion/2019 lineage and showed close genetic relationships with contemporary serotype A isolates collected from the field during 2023.

2.4 FMD Seromonitoring

The Government of India initiated the bi-annual vaccination-based Foot and Mouth Disease Control Programme (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 to the state Animal Husbandry 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) has been adopted as a screening method since 2016 to evaluate herd immune 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 $\log_{10}$ (@ 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.

2.4.1 NADCP/LHDCP Round 2

Vaccination under round 2 of NADCP was delayed due to several reasons. During later part of 2021, vaccination in selected states/regions was started and continued in 2022 and 2023 as well. For Post Vaccination seromonitoring (PVM), the serum samples were collected as per the sampling frame developed jointly by ICAR-NIFMD and ICAR-NIVEDI. In total, 1,07,193 serum samples (pre-vac: 54,473 and post vac: 52,720) were tested. From round 2, a total of 20784 serum samples were processed during 2023. Rest of the serum samples were tested during the years 2021 and 2022. Overall, the protective titer was found in **29.0, 24.7 and 24.5** percent of animals against serotypes O, A and Asia1, respectively in pre vaccination samples, and **63.8, 60.2 and 61.2** percent of animals against serotypes O, A and Asia1, respectively, in post-vaccination samples. The results are presented in the (Table 8).

Table 8. State/UT wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1 (NADCP-2)

State and UT	Pre	Post	Serotype O		Serotype A		Serotype Asia1	
			Pre	Post	Pre	Post	Pre	Post
A&N Island	472	472	15.3	79.2	6.8	68.0	16.7	85.8
Andhra Pradesh	2722	2716	19.7	41.5	19.5	46.5	22.9	49.2
Arunachal Pradesh	417	342	15.6	82.5	12.0	73.1	0.5	72.5
Assam	1848	1848	24.7	57.1	19.9	54.2	19.9	55.0
Bihar	2246	2117	16.0	45.3	7.4	45.9	11.8	37.2
Chandigarh	200	200	35.5	75.5	32.0	68.0	40.0	79.0
Chhattisgarh	2209	2209	24.4	61.5	16.6	51.6	11.5	58.9
DNH and Daman and Diu	200	191	56.0	69.6	27.5	67.5	32.0	58.6
Delhi	234	230	73.1	88.7	65.0	86.1	65.0	89.6
Goa	1289	1289	48.4	77.8	35.1	79.8	43.2	84.8
Gujarat	2184	2184	15.2	40.6	12.1	27.1	14.0	34.8
Haryana	2289	2285	36.4	68.8	34.7	67.9	43.2	72.9
Himachal Pradesh	619	1432	31.7	61.5	26.8	54.9	20.5	55.1
Jammu & Kashmir	1073	1048	18.5	67.3	13.0	58.2	10.3	57.4

Jharkhand	510	737	24.4	59.5	16.6	49.5	11.5	56.7
Karnataka	2166	2173	50.0	85.5	45.2	84.1	45.5	83.2
Kerala	2182	2182	35.7	72.7	33.7	69.2	37.0	72.5
Madhya Pradesh	4498	4498	26.4	53.4	28.5	53.4	16.9	45.5
Maharashtra	4420	4420	31.4	76.3	33.5	79.7	31.2	77.8
Meghalaya	198	154	34.8	90.9	60.6	92.2	8.1	66.2
Mizoram	1419	1419	21.9	73.8	19.6	76.0	17.8	81.1
Nagaland	1056	-	44.3	-	28.1	-	31.6	-
Odisha	2262	2262	13.4	89.9	12.5	87.9	12.7	87.0
Puducherry	883	883	91.3	95.9	83.1	89.8	85.5	89.1
Punjab	2196	2196	33.2	66.1	29.5	66.7	30.2	68.1
Rajasthan	44	44	22.7	70.5	31.8	72.7	43.2	88.6
Sikkim	1138	1016	12.5	52.4	11.2	48.2	12.6	45.9
Tamilnadu	2327	2327	51.4	78.3	36.5	68.5	40.6	70.3
Telangana	2275	2275	29.8	64.0	22.6	56.0	22.0	57.2
Uttar Pradesh	2433	2240	21.9	42.7	15.9	31.9	18.7	37.7
Uttarakhand	1358	1236	16.7	58.2	13.3	59.7	11.0	45.0
West Bengal	1261	1260	25.0	60.2	20.1	51.3	21.2	59.4
Total	**54473**	**52720**	**29.0**	**63.8**	**24.7**	**60.2**	**24.5**	**61.2**

2.4.2 NADCP/LHDCP Round 3

Vaccination under round 3 of NADCP started in 2022. In total, 62,428 serum samples (pre-vac: 32496 and post vac: 29932) were tested. From round 3, a total of 5,900 serum samples (pre-vac: 3,757 and post-vac: 2,143) were processed in 2022. The rest of the serum samples were tested during the year 2023. Overall, protective titers were found in 35.3%, 31.2%, and 31.0% of animals against serotypes O, A, and Asia1, respectively, in pre-vaccination samples, and 68.9%, 64.0%, and 66.7% of animals against serotypes O, A, and Asia1, respectively, in post-vaccination samples. The pre-vac titer was found to be good (>30% against at least two serotypes) in Puducherry, Chandigarh, Kerala, Maharashtra, Karnataka, Goa, Haryana, Tamil Nadu, and Nagaland. The post-vac titer was found to be good (>70% against at least two serotypes) in Karnataka, Kerala, Maharashtra, Puducherry, Chandigarh, Haryana, Telangana, Meghalaya, Andaman, Odisha, and Andhra Pradesh. In terms of seroconversion, the states of Telangana, Andaman, Karnataka, Haryana, Andhra Pradesh, and Kerala showed very good seroconversion (>40% against at least two serotypes). Serotype O is the most predominant serotype in India, and an immunity level of >80% is desired to prevent virus transmission. The states of Meghalaya, Karnataka, Puducherry, Kerala, Maharashtra, Chandigarh, and Odisha showed a protective antibody titer in >80% of the vaccinated population against serotype O. The states of Meghalaya, Kerala, Karnataka, Maharashtra, and Chandigarh showed a protective antibody titer in >80% of the vaccinated population against serotype A. The states of Karnataka, Kerala, Maharashtra, Puducherry, and Chandigarh showed a protective antibody titer in >80% of the vaccinated population against serotype Asia1. The results are presented in the (Table 9 and Fig 14 a, b &c).

Table 9. State/UT wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1 (NADCP/LHDCP-3)

State	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	-
Bihar	1859	1859	9.4	34.2	3.9	24.9	1.8	21.8
Chandigarh	196	196	61.2	84.2	57.7	81.6	58.2	80.1
Goa	1404	-	46.0	-	39.3	-	38.7	-
Gujarat	2145	2145	15.2	28.2	12.2	23.8	17.1	31.6
Haryana	2145	2143	32.4	74.3	35.9	77.9	34.6	79.5
Jharkhand	824	942	31.9	47.7	21.7	29.0	25.6	36.9
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	2574	2574	31.7	67.3	26.3	55.5	26.9	62.9
Maharashtra	4377	4377	46.6	84.6	42.5	82.5	42.2	83.2
Meghalaya	1298	1298	61.2	92.8	66.6	91.3	28.7	74.9
Manipur	1419	1419	21.9	73.8	19.6	76.0	17.8	81.1
Nagaland	264	-	46.6	-	29.9	-	31.1	-
Odisha	-	1398	-	82.2	-	72.5	-	74.5
Puducherry	983	953	76.9	85.6	71.6	74.5	74.9	83.6
Sikkim	675	286	27.9	46.2	18.5	33.6	26.7	44.8
Tamilnadu	2141	2141	36.3	54.4	29.7	47.5	31.9	50.4
Telangana	1989	260	19.6	73.5	17.2	64.2	20.4	75.8
Tripura	48	48	6.3	27.1	6.3	27.1	6.3	27.1
Uttarakhand	1193	1023	32.8	44.7	25.1	37.0	21.6	40.5
Total	**32496**	**29932**	**35.3**	**68.9**	**31.2**	**64.0**	**31.0**	**66.7**

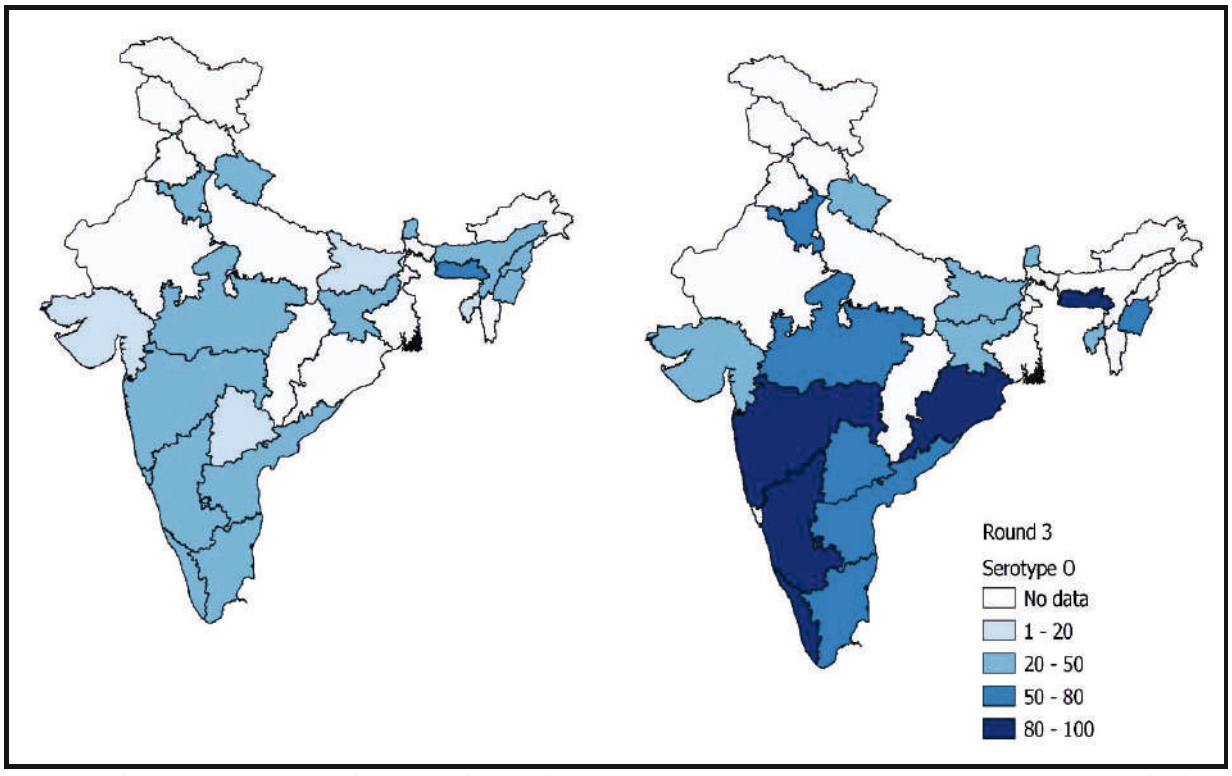


Fig 14a: State-wise percent of animals (Bovine) showing protective antibody level against serotype O after round 3

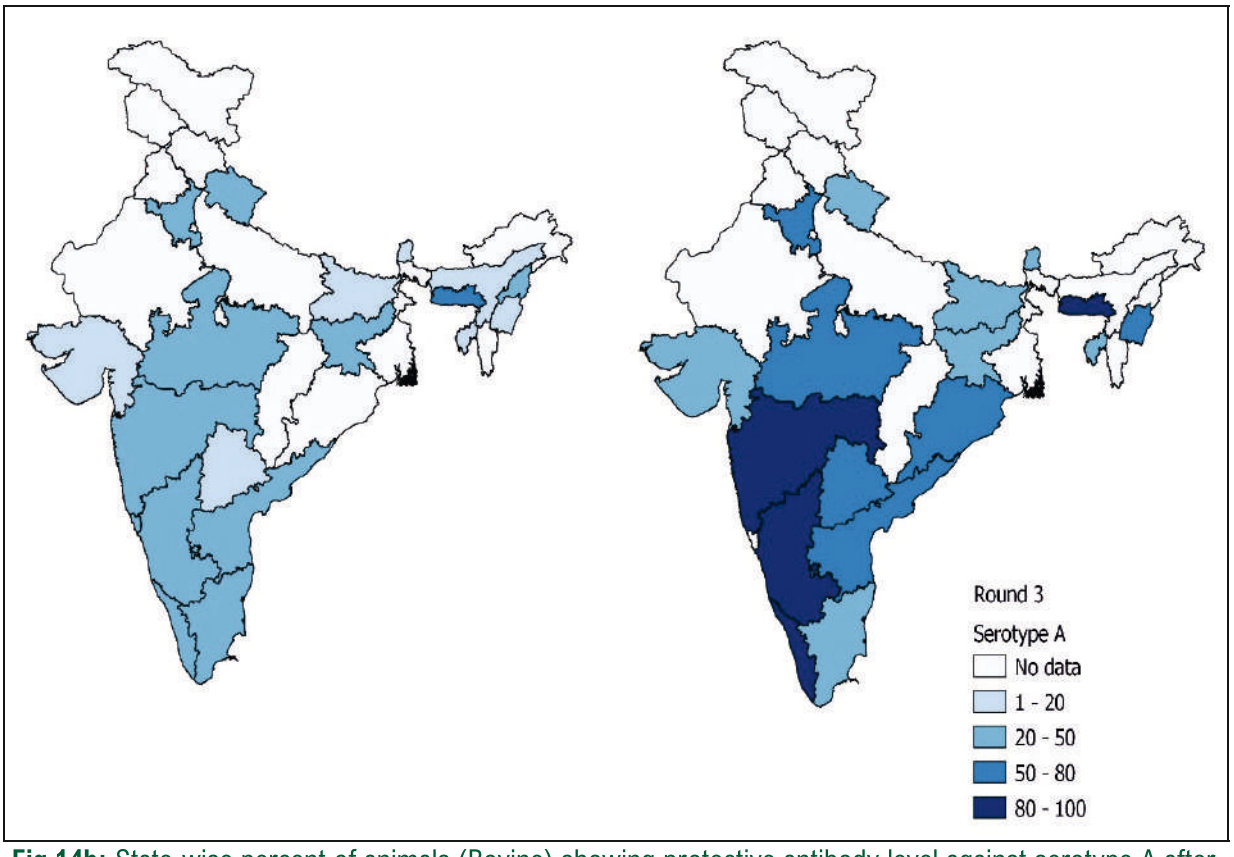


Fig 14b: State-wise percent of animals (Bovine) showing protective antibody level against serotype A after round 3

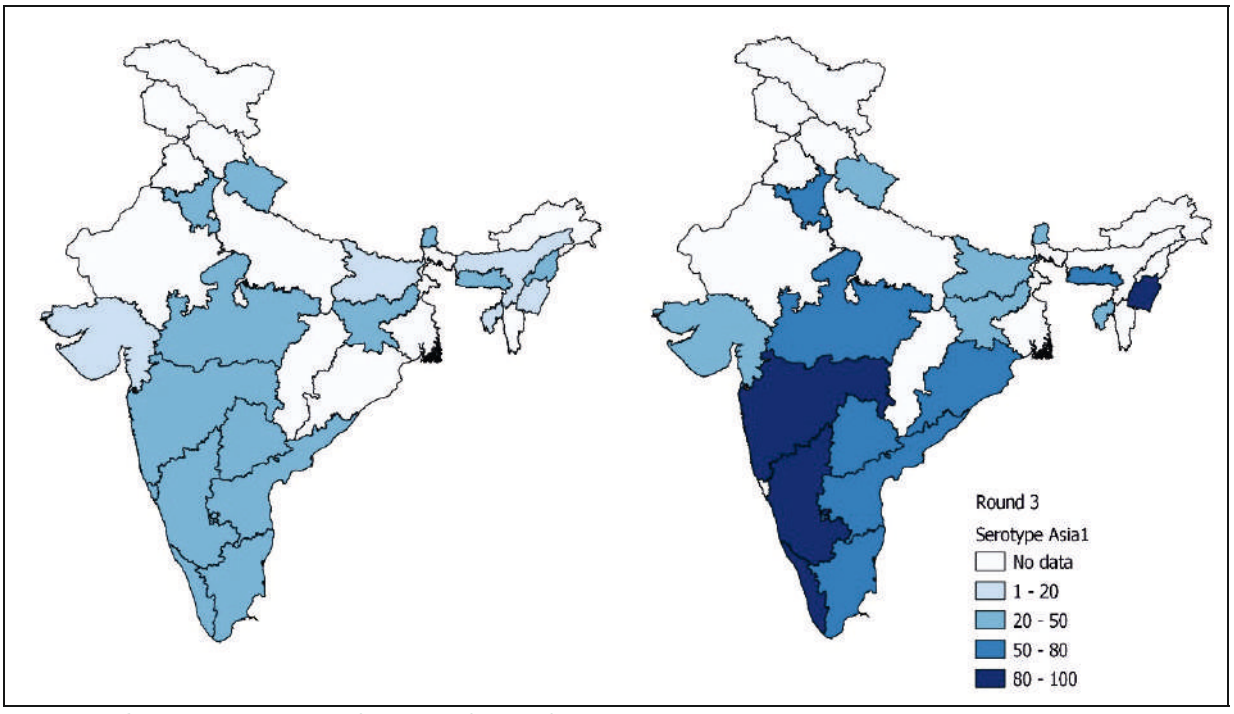


Fig 14c: State-wise percent of animals (Bovine) showing protective antibody level against serotype Asia1 after round 3

Percent antibody response in different age categories of Bovine (Round 3)

- As per new plan, samples were collected from three different age groups viz; 6-12M (Category I), 13-24 M (Category II) and >24 M (Category III) in the ratio of 5:4:1
- Apparently, the adult animals showed better antibody titer in both pre vac and post vac animals (Fig. 15).

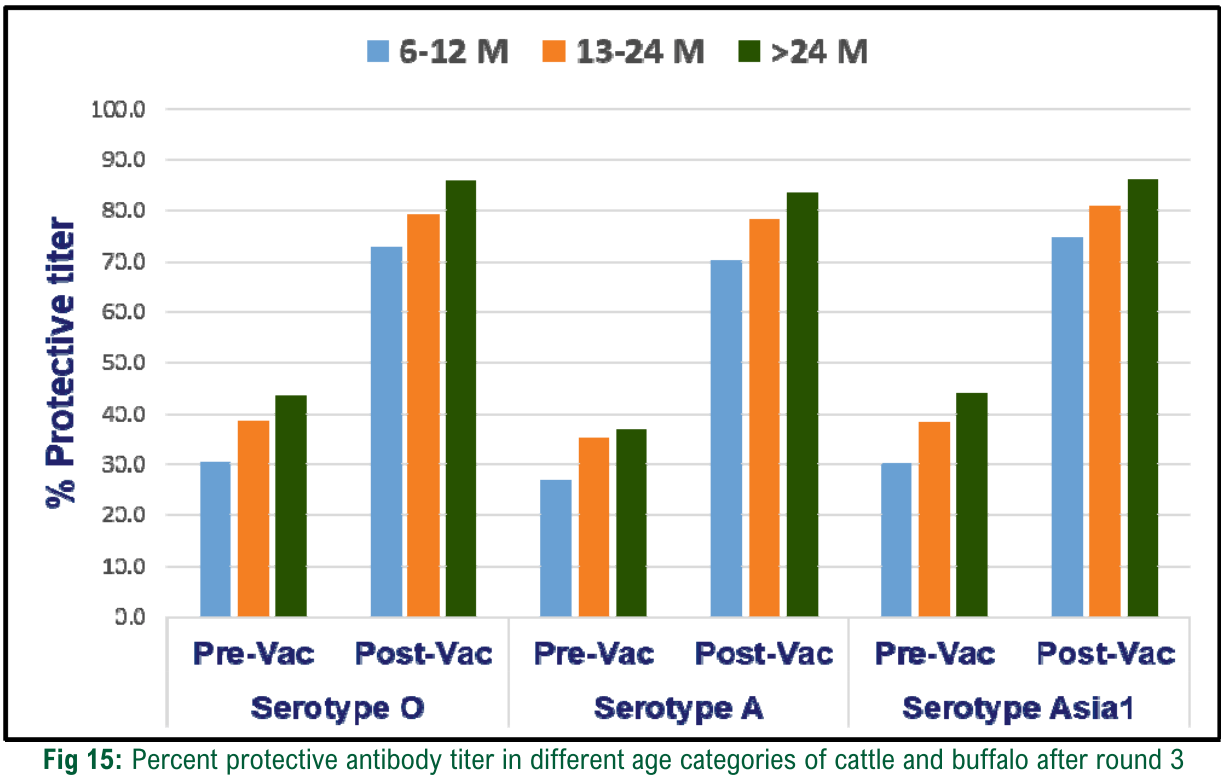


Fig 15: Percent protective antibody titer in different age categories of cattle and buffalo after round 3

Percent antibody response in cattle and buffalo (Round 3)

- ÷ Serum samples were collected from cattle and buffalo
- ÷ Both the species showed good seroconversion and antibody titer in post vac samples
- ÷ Cattle in general showed better response compared to buffalo (Fig 16).

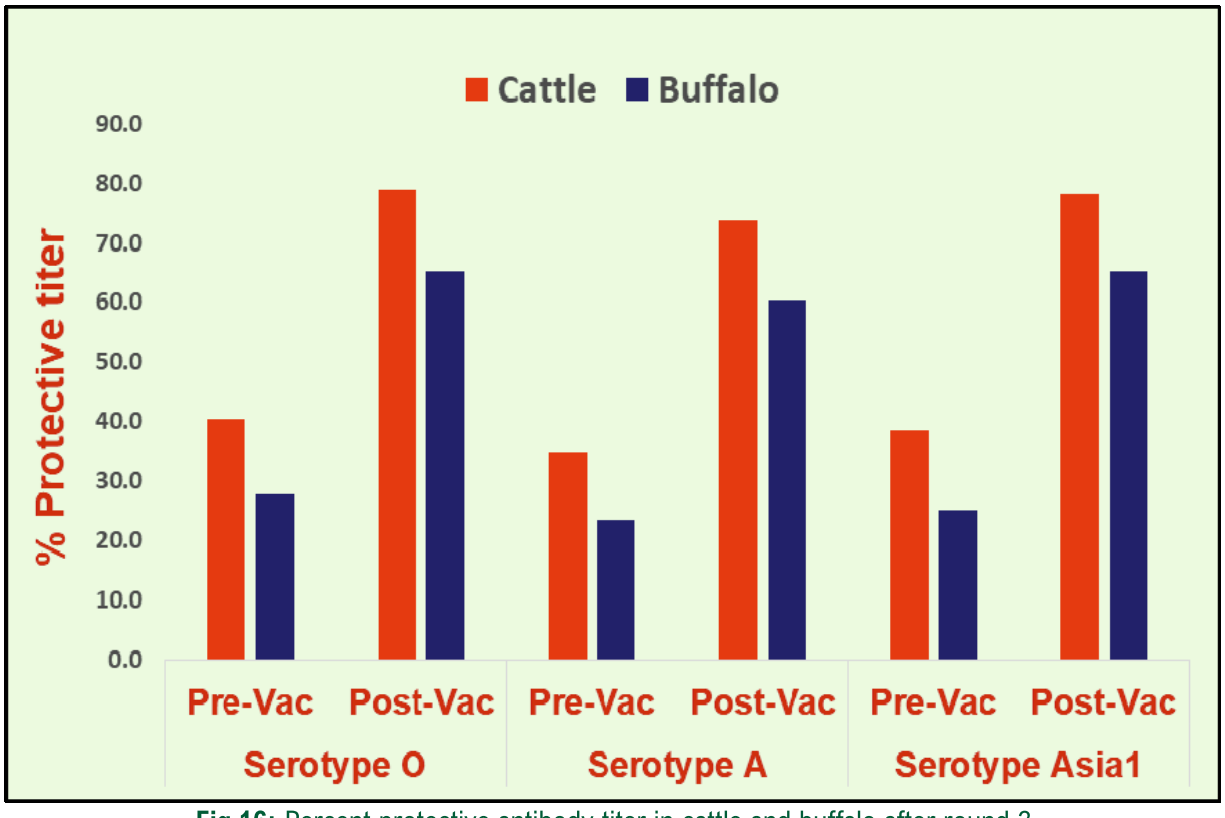


Fig 16: Percent protective antibody titer in cattle and buffalo after round 3

2.4.3 NADCP/LHDCP Round 4

In total, 5610 serum samples (pre-vac: 3465 and post vac: 2145) were tested from round 4. The serum samples were collected from the states of Haryana and Karnataka. Overall, protective titers were found in 48.6%, 46.1%, and 45.8% of animals against serotypes O, A, and Asia1, respectively, in pre-vaccination samples, and 70.5%, 68.4%, and 70.5% of animals against serotypes O, A, and Asia1, respectively, in post-vaccination samples (Table 10).

Table 10. State/UT wise percentage of animals showing protective titer against FMD virus serotypes O, A and Asia1 (NADCP/LHDCP-4)

State/UT	Pre	Post	Serotype O		Serotype A		Serotype Asia1	
			Pre	Post	Pre	Post	Pre	Post
Haryana	2145	2145	44.0	70.5	41.5	68.4	40.3	70.5
Karnataka	1320	-	56.2	-	53.6	-	54.7	-
Total	**3465**	**2145**	**48.6**	**70.5**	**46.1**	**68.4**	**45.8**	**70.5**

Summary of percent protective titer

There has been an increase in the level of herd immunity and seroconversion in every round of LHDCP. However, maintaining a 6-month interval between successive vaccinations has posed certain challenges. If the timing and density of vaccination are maintained, there is a likely chance that pre-vaccination titers might reach high. A high level of herd immunity is required to break the chain of FMDV transmission (Table 11).

Table 11. 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	29.0	63.8	24.7	60.2	24.5	61.2
LHDCP-3	35.3	68.9	31.2	64.0	31.0	66.7

2.4.4 FMD seromonitoring in organized farms

ICAR-NIFMD and its network laboratories undertake the testing of samples from organized government farms. During the year 2023, a total of 10,132 (pre-vac: 4791 and post-vac: 5341) serum samples received from various breeding bull stations and dairy farms were tested to assess the protection level. The antibody titer and post-vaccination seroconversion were found to be excellent (>90%) in most of the farms (Table 12 and Fig 17). In general, regular vaccinations have been practiced without fail on organized farms. In order to bring FMD to a zero level with vaccination, similar efforts need to be adopted across the nation in unorganized bovine population.

Table 12. State wise percent animals showing protective titer against FMD virus serotypes O, A and Asia1 in organized farms during 2023

State/UT	Pre	Post	Serotype O		Serotype A		Serotype Asia1	
			Pre	Post	Pre	Post	Pre	Post
Andhra Pradesh	722	727	65.2	85.0	65.2	85.7	65.9	88.0
Assam	75	63	81.3	95.2	78.7	93.7	78.7	93.7
Chhattisgarh	70	99	100.0	100.0	100.0	100.0	101.4	100.0
Gujarat	35	369	85.7	88.6	85.7	87.3	85.7	88.6
Haryana	888	903	95.5	99.7	94.0	99.7	95.0	99.8
Himachal Pradesh	56	56	96.4	100.0	92.9	100.0	87.5	100.0
Jammu	22	22	100.0	100.0	100.0	100.0	100.0	100.0
Karnataka	216	188	98.1	100.0	97.7	100.0	98.6	100.0
Kerala	826	824	99.9	99.9	100.0	100.0	100.0	100.0
Madhya Pradesh	77	77	88.3	100.0	84.4	100.0	83.1	100.0
Maharashtra	466	457	98.9	99.3	86.9	99.3	97.4	99.6
Manipur	46	46	15.2	84.8	13.0	76.1	13.0	78.3
Odisha		10		100.0		100.0		100.0

Punjab	161	179	85.1	96.1	83.9	96.6	88.8	96.1
Tamilnadu	141	141	96.5	100.0	92.2	100.0	89.4	100.0
Telangana	413	417	97.3	99.5	96.6	99.0	98.1	100.0
Uttar Pradesh	251	479	98.8	97.3	97.6	100.0	100.0	100.0
Uttarakhand	78	36	100.0	100.0	100.0	100.0	100.0	100.0
West Bengal	248	248	98.8	99.6	99.2	100.0	98.0	99.6
Total	**4791**	**5341**	**91.3**	**96.4**	**89.4**	**96.6**	**91.0**	**97.1**

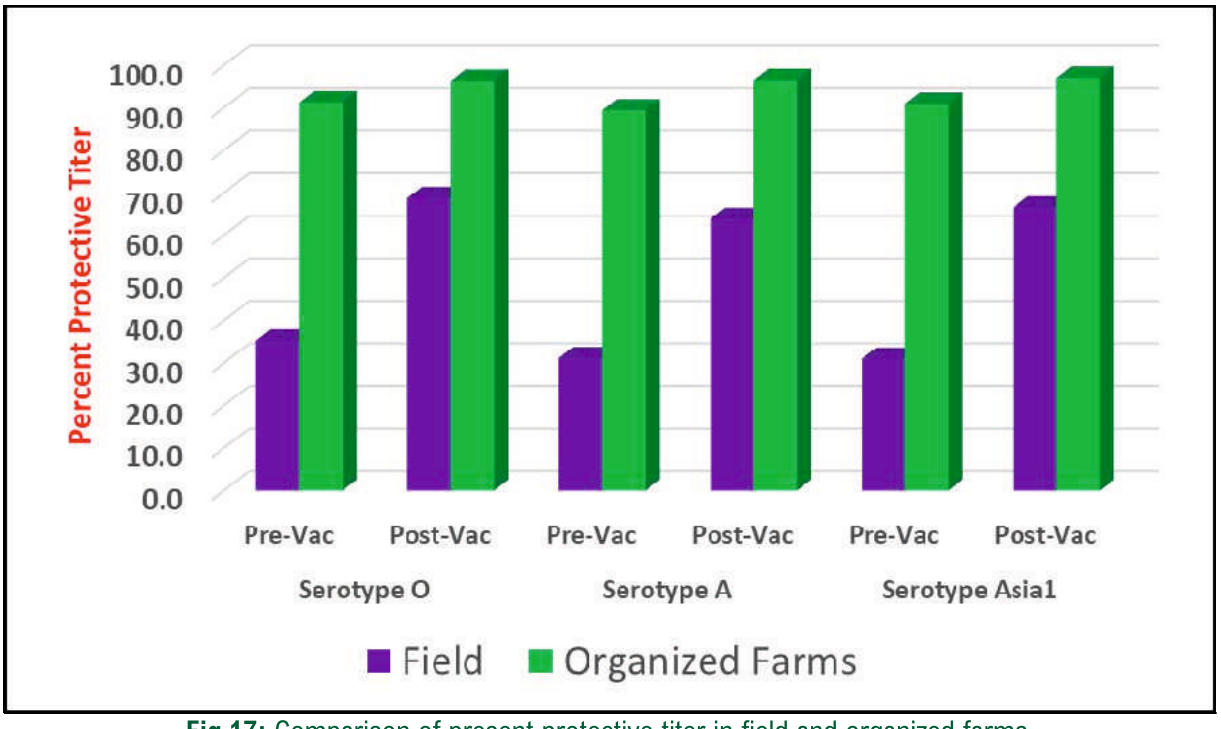


Fig 17: Comparison of present protective titer in field and organized farms

2.4.5 FMD Seroconversion 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 Mithun than in Yak (Table 13).

Table 13. Percent animals showing protective titer against FMD virus serotypes O, A and Asia1 in organized farms during 2023

Species	Pre	Post	Serotype O		Serotype A		Serotype Asia1	
			Pre	Post	Pre	Post	Pre	Post
Yak	267	267	32.6	67.4	22.5	64.0	22.1	65.2
Mithun	112	112	67.9	88.4	60.7	81.3	66.1	87.5

2.5 Development and Improvement of Diagnostics

During the reported period, the institute focused on the development of sensitive diagnostics and the refinement of existing diagnostic tests. Specifically, TaqMan-probe-based one-step multiplex real-time RT-PCR assay and colorimetric RT-LAMP assay, both

based on 2B region was developed for pan-serotype detection of FMDV. In addition to it monoclonal antibody based cELISA for DIVA was also developed. These diagnostic tools contribute to the institute's efforts in effectively detecting and managing FMD in livestock.

2.5.1 TaqMan one-step RT-qPCR assay for pan-serotypic detection

TaqMan probe-based one-step RT-qPCR assay in the duplex format simultaneously targeting FMDV 2B NSP-coding region and 18S rRNA housekeeping gene was developed and evaluated. The duplex RT-qPCR assay specifically detected FMDV genome in both infected cell culture suspensions and a variety of clinical samples such as FMD-affected tongue/feet epithelium, oral/nasal swabs, milk and oro-pharyngeal fluids (Fig 18). The RT-qPCR assay was found to be highly sensitive, since the assay was 10^5-fold more sensitive than the traditional FMDV detecting antigen-ELISA (Ag-ELISA) and 10^2-fold better sensitive than both virus isolation and agarose gel-based RT-multiplex PCR. In addition, the assay could detect up to 100 copies of FMDV genome per reaction. In the epithelial samples (*n*=582) collected from the FMD-affected animals, the diagnostic sensitivity was 100% (95% CI 99–100%). Similarly, all the FMDV-negative samples (n=65) tested were confirmed negative by the new RT-qPCR assay, corresponding to 100% diagnostic specificity (95% CI=94–100%). Further, the duplex RT-qPCR assay proved to be robust, showing an inter-assay co-efficient of variations ranging from 1.4 to 3.56% for FMDV-2B gene target, and from 2 to 4.12% for 18S rRNA gene target. While analysing FMDV-infected cell culture suspension, a fairly strong positive correlation (correlation coefficient=0.85) was observed between 2B-based RT-qPCR and WOAH-approved 5'UTR RT-qPCR assays. Therefore, the one-step RT-qPCR assay developed here with an internal control could be used for rapid, effective, and reliable detection of FMDV in pan-serotypic manner, and has the potential for routine diagnosis of FMDV in high throughput manner.

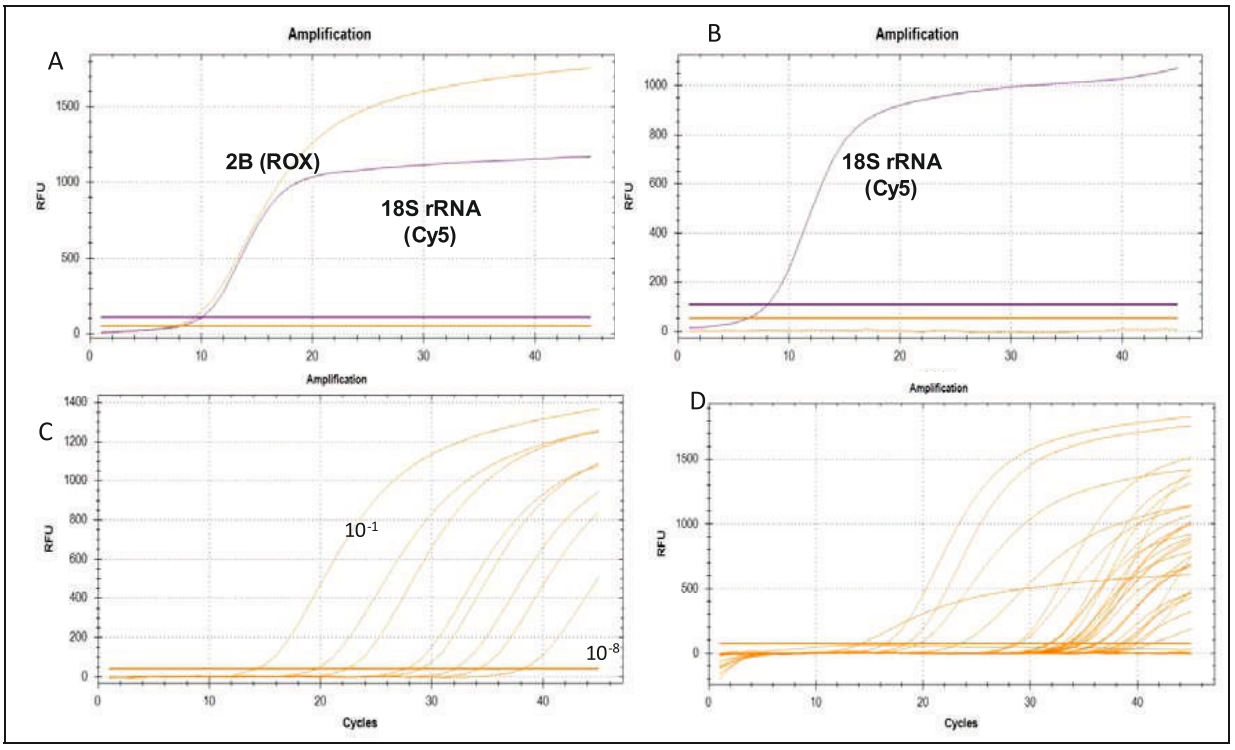


Fig: 18 2B NSP coding region-based RT-qPCR amplification curves in (A) typical FMD positive sample, (B) FMD-negative sample, (C) serially-diluted FMDV RNA samples, and (D) group of tongue epithelial samples from FMD-infected animals.

2.5.2 RT-LAMP assay for pan-serotypic detection

Rapid, sensitive and accurate diagnosis of FMDV is essential for the prompt control of FMD outbreaks. Agarose gel-based reverse transcription polymerase chain reaction (RT PCR) and real-time quantitative RT-PCR (RT-qPCR) assays are being used for routine FMDV diagnosis as World Organisation for Animal Health (WOAH)-recommended diagnostic assays. However, these PCR-based assays require specialized equipment, trained labour, and long-complicated procedures for the detection of amplified products, therefore, may be unsuitable for under-equipped laboratories in the developing countries. In this study, to overcome these bottlenecks, a simple, rapid, and sensitive reverse transcription loop-mediated isothermal amplification (RT-LAMP) assay was developed for the sensitive and specific detection of FMD virus circulating in India in a pan-serotypic manner. The amplification could be completed in 50 min at 62°C, and the results could be visually detected colorimetric way by the naked eye without any additional detection systems. Owing to the highly conserved nature of 2B-NSP nucleotide coding region amongst the various serotypes of FMD virus, the RT-LAMP assay was designed to amplify the conserved region using a set of six primers and *Bst*3 polymerase enzyme. The limit of detection of the assay is 1000 copies of FMDV viral genome which is 10-times more sensitive than the agarose-gel based multiplex RT-PCR assay. In addition, the new RT-LAMP assay is 10-times less sensitive than the WOAH recommended 5'UTR and 3Dpol-based RT-qPCR assays. Evaluation of the new RT-LAMP assay using different FMDV strain serotypes circulating in India during the last 20-years showed 100% agreement with the results of agarose gel-based RT-multiplex PCR. In addition, evaluation of the new assay with the RNA extracted from FMD-affected tongue epithelial field samples showed complete concordance with the multiplex RT-PCR assay (Table 14). Therefore, by providing rapid naked-eye and sensitive detection of FMDV in the clinical samples, this assay would support the FMD control strategy and quick-response to the FMD outbreaks (Fig 19).

Table 14. Comparative limit-of-detection of colorimetric RT-LAMP assay with the multiplex RT-PCR assay

RNA dilution	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	NTC
RNA conc. (ng/ol)	1.5	$1.5*10^{-1}$	$1.5*10^{-2}$	$1.5*10^{-3}$	$1.5*10^{-4}$	$1.5*10^{-5}$	$1.5*10^{-6}$	0
RNA copies	$1.306*10^{8}$	$1.306*10^{7}$	$1.306*10^{6}$	$1.306*10^{5}$	$1.306*10^{4}$	$1.306*10^{3}$	130	0
RT-LAMP	(+) ve	(+) ve	(+) ve	(+) ve	(+) ve	(+) ve	(–) ve	(–) ve
RT-mPCR	(+) ve	(+) ve	(+) ve	(+) ve	(+) ve	(–) ve	(–) ve	(–) ve

Fig 19: RT-LAMP reactions. In this figure pink and orange colours show negative and positive results respectively

2.5.3 FMD viral genome detection in formalin fixed archived tissues

Formaldehyde, the "gold standard" fixative for tissue preservation, is widely available. Tissues archived in 10% neutral buffered formalin (NBF) can preserve a large amount of nucleic acid that can be used in molecular biological studies and disease diagnosis. The present study's goal was to detect the FMD viral genome in formalin-fixed archived tissue which may avoid cold chain during transportation. This study used FMDV suspected samples such as epithelial tissue (tongue, gum, feet, snout), heart muscle, thigh muscle, liver tissue, intestine, and skin stored in 10% NBF from 0 to 730 days post fixation (dpf). On fresh and archived tissue samples, FMD virus isolation (VI) using chemical transfection methods, as well as genome detection (GD) using RT-mPCR and RT-qPCR, were performed. All archived tissues were positive for FMD viral genome by RT-mPCR and RT-qPCR up to 30 dpf, whereas archived epithelial tissue (tongue, gum, snout, feet) and thigh muscle were positive for FMD vial genome up to 120 dpf. FMD viral genome was detected in sheep cardiac muscle via RT-mPCR and RT-qPCR up to 60 dpf and 120 dpf, respectively. FMD viral genome could be detected in sheep cardiac muscle via RT-qPCR up to 365 dpf on one occasion. The findings suggest that 10% NBF could be used for clinical sample storage and transportation from the field to a diagnostic laboratory for timely and accurate FMD diagnosis using RT-qPCR. The technique may add value in ensuring biosafety measures during disease free zone as well and it can also be applied for other pathogens detection.

2.5.4 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 titer estimate in the serum sample against Indian vaccine strains for three serotypes such as O, A, and Asia 1 and categorises the serum antibody titers in a dichotomous manner as 'protective' titer and 'un-protective' titer. Initially, a set of 440 samples (238 judged protective and 202 un-protective in VNT) were tested both in VNT and SPCE to revise the cut-off of interpretation in SPCE and validate it 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 titer (log_{10} titer 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} titer of 1.8 to 35% inhibition and log_{10} titer 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 log10 titer cut-off of 1.8.

To further validate the revised interpretation criteria, a set of 256 serum samples (61 judged protective and 195 un-protective in VNT) were tested during 2023 and analysed including the earlier available data. At the revised criteria of interpretation, although the relative DSp did not show any significant change, the DSn values dropped to some extent. The revised criteria of interpretation adopted for SPCELISA (35% inhibition and titer cut off log_{10} 1.65) exhibited reasonably higher DSn and DSp balance for serotype O and Asia 1 (Table 15) and therefore are found 'fit-for-purpose' for assessment of protective antibody titer under NADCP/LHDCP-FMD. However, for serotype A, 30% inhibition and titer cut off log_{10} 1.65 (DSn 82% and DSp 86%) appears to be a more appropriate choice over 35% inhibition (DSn 78% and DSp 90%), provided more serum samples are tested to validate the refined cut-off.

Table 15: SPCELISA vs VNT: Relative Diagnostic Sensitivity and Specificity Matrix of SPCELISA over a range of % inhibition and Log10 titer cut-off for estimation of FMD post-vaccination protective antibody titer

FMD Serotype O

SPCE log_{10} titer cut off % Inhibition	Log_{10}1.5		Log_{10}1.65		Log_{10}1.8	
	DSn%	DSp%	DSn%	DSp%	DSn%	DSp%
30%	87	79	86	82	82	84
35%	84	82	84	87	76	89
40%	82	91	81	93	71	95
50%	78	95	77	97	62	98

FMD Serotype A

SPCE log_{10} titer cut off % Inhibition	Log_{10}1.5		Log_{10}1.65		Log_{10}1.8	
	DSn%	DSp%	DSn%	DSp%	DSn%	DSp%
30%	83	81	82	86	76	88
35%	79	87	78	90	72	92
40%	73	91	73	94	63	96
50%	62	95	59	98	53	99

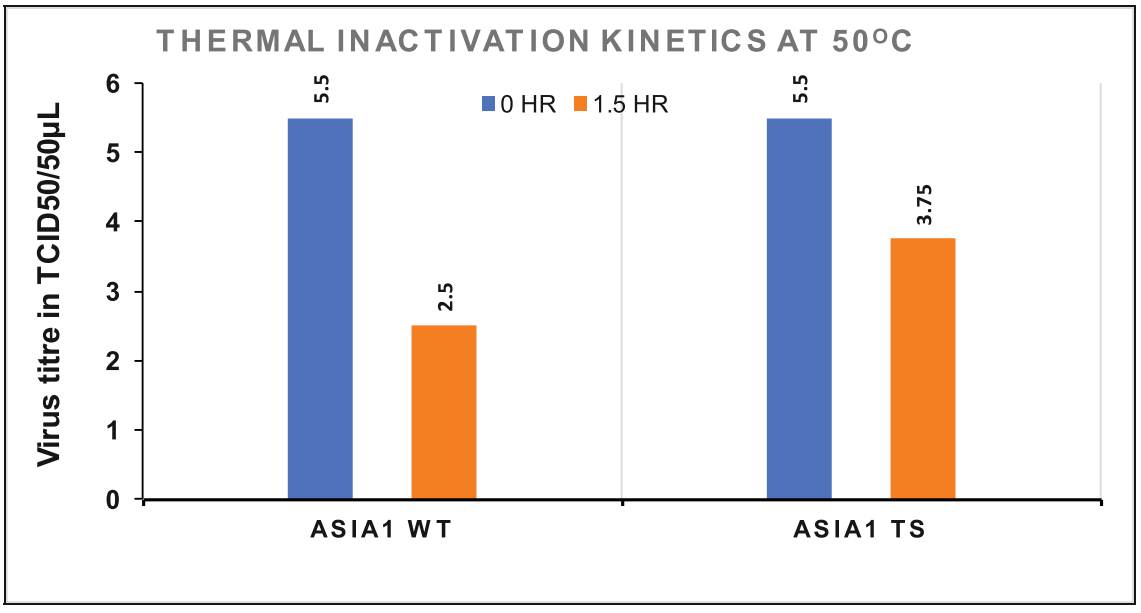
FMD Serotype Asia 1

SPCE log_{10} titer cut off % Inhibition	Log_{10}1.5		Log_{10}1.65		Log_{10}1.8	
	DSn%	DSp%	DSn%	DSp%	DSn%	DSp%
30%	93	76	90	79	77	83
35%	87	80	85	86	75	89
40%	84	86	81	88	69	94
50%	71	92	63	94	56	98

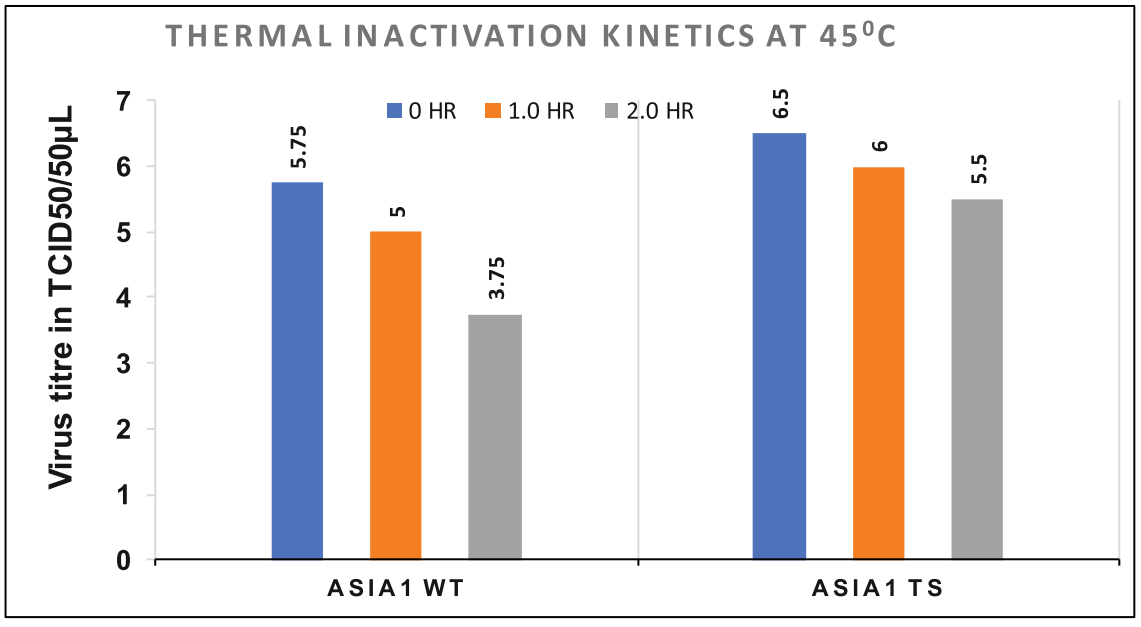
2.6 Development and Improvement of Vaccines

2.6.1 Thermostable mutant of FMDV serotype Asia1 vaccine strain

FMD virus is heat labile in nature and several studies suggested that that protective immunity offered by FMD-vaccine mainly dependent on the intact virion particles (either 146S or 75S), while the dissociated 12S pentameric particles contribute little to vaccine-induced antibody response. Therefore, the dissociation of FMDV antigen in the vaccine-preparation due to high environmental temperature could lead to poor vaccine efficacy and short duration of immunity. Earlier genetically defined thermo-tolerant FMDV serotype O IND R2/1975 vaccine virus was developed at ICAR-NIFMD. In this study, a heat-resistant FMDV serotype Asia1 vaccine strain was selected through serial passage under heat-stress, and subsequently, isolated by plaque assay. The selected thermostable variant was characterised for its thermal stability by incubating the mutant virus at different temperature-time combinations. In all the tested condition the thermally-selected variant performed better than the parental counterpart (Fig. 20).



(A)



(B)

Fig: 20 Thermal inactivation kinetics of parental (Asia1 WT) and thermotolerant (Asia 1Ts) viruses after incubating at 50°C for 1.5 hours (A) and 45°C for 2-hours (B)

2.7 Host-Pathogen Interaction and Immunobiology

2.7.1 FMDV Codon usage patterns

Codon usage patterns an essential information in revealing evolutionary relationships between species as well as host-pathogen coevolution and adaptation of pathogens to specific hosts. The main forces that drive this bias from equal usage are mutational biases due to nucleotide compositional constraints and translational selection. Complete genome sequence of 73 FMDV isolates from India (Serotype O 31, serotype A 17 and Asia1 25) were downloaded from NCBI and analysed for different codon usage indices like base composition, synonymous codon usage (RSCU), effective number of codons (ENC), ENC–GC3 plots, codon adaptation index (CAI) and Relative Codon Deoptimization Index (RCDI) to quantitate codon bias. Nucleotide content distribution and composition of FMDV genome

reveals natural selection in shaping the codon usage patterns in FMDV as C + G at the synonymous codon third position (GC3%) is 1.8 times higher than AT3%. Analysis revealed that A3 (r= 0.83, P<0.01), C3 (r=0.94, P<0.01), T3 (r=0.97, P<0.01), G3 (r=0.87, P<0.01) and GC3 (r=0.78, P<0.01), have significant positive correlations with the set of full-length gene sequences indicate nucleotide content influence FMDV codon usage patterns. These results validate that in addition to natural selection, nucleotide contents can also play a role in synonymous codon usage patterns (Fig 21). FMDV has higher ENC value (51.46±0.32) indicates a lower codon usage preference and lower gene expression. ENC–GC3 plots revealed in addition to the mutation pressure, translation selection also influences the codon usage bias of FMDV. CAI revealed selection pressure from hosts may influence the codon usage pattern of FMDV and the translation resources of cattle are more efficiently utilized by virus than sheep and pig. Correlation analysis between CAI and ENC revealed mutation pressure may be more preferred than translational selection in cattle than goat, sheep and pig. RSCU value indicates preference for G/C nucleotide over A/T nucleotide which impacts the codon usage for translation of viral proteins being enriched with G and C. This information is essential for codon optimization studies which involves replacing rare codons with frequent ones to enhance the translation efficiency of gene. RCDI and eRCDI analysis of all the genes of FMDV serotypes revealed that cattle have highest adaptability for FMDV serotype O and A; yak have highest adaptability for FMDV serotype Asia1; mithun have least adaptability for all the serotypes among Indian livestock and African buffalo have least adaptability for all the three serotypes.

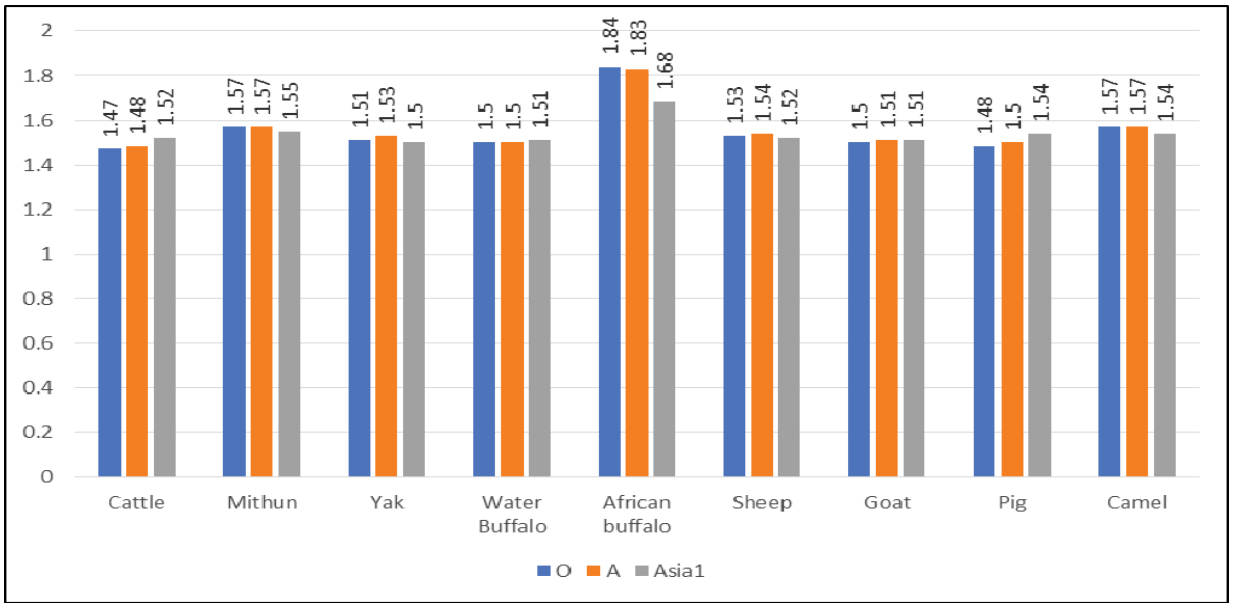


Fig: 21 Host adaptability of all the serotypes of FMDV by RCDI analysis across 9 susceptible hosts (Value closer to 1 being indicative of a greater adaptation to the host)

2.8 FMD Bio-Informatics

2.8.1 FMD Sero Surv methodology and software

In the FMD sero-surveillance, the villages are selected randomly from states and then NSP-antibody prevalence was observed through 3AB3-NSP-ELISA test on the randomly selected samples from the animals (randomly selected from the selected villages). The NSP-ELISA test sample results can be used as input in the FMDSeroSurv methodology to estimate the state and national levels NSP sero-prevalence parameters indicating the history of FMDV circulation and exposure of bovine populations to FMD virus. In this developed methodology, various estimators and their quality measures

were reported. The algorithmic representation of the FMDSeroSurv methodology and its utility to estimate India's NSP sero-prevalence rate is shown (Fig 22, 23 and 24).

To generalize the use of this methodology for any country and other diseases, an R software package was developed and available at https://github.com/sam-dfmd/FMDSeroSurv. The details of its installation, use and interpretation of results is provided at https://www.nature.com/articles/s41598-023-48459-w#MOESM1.

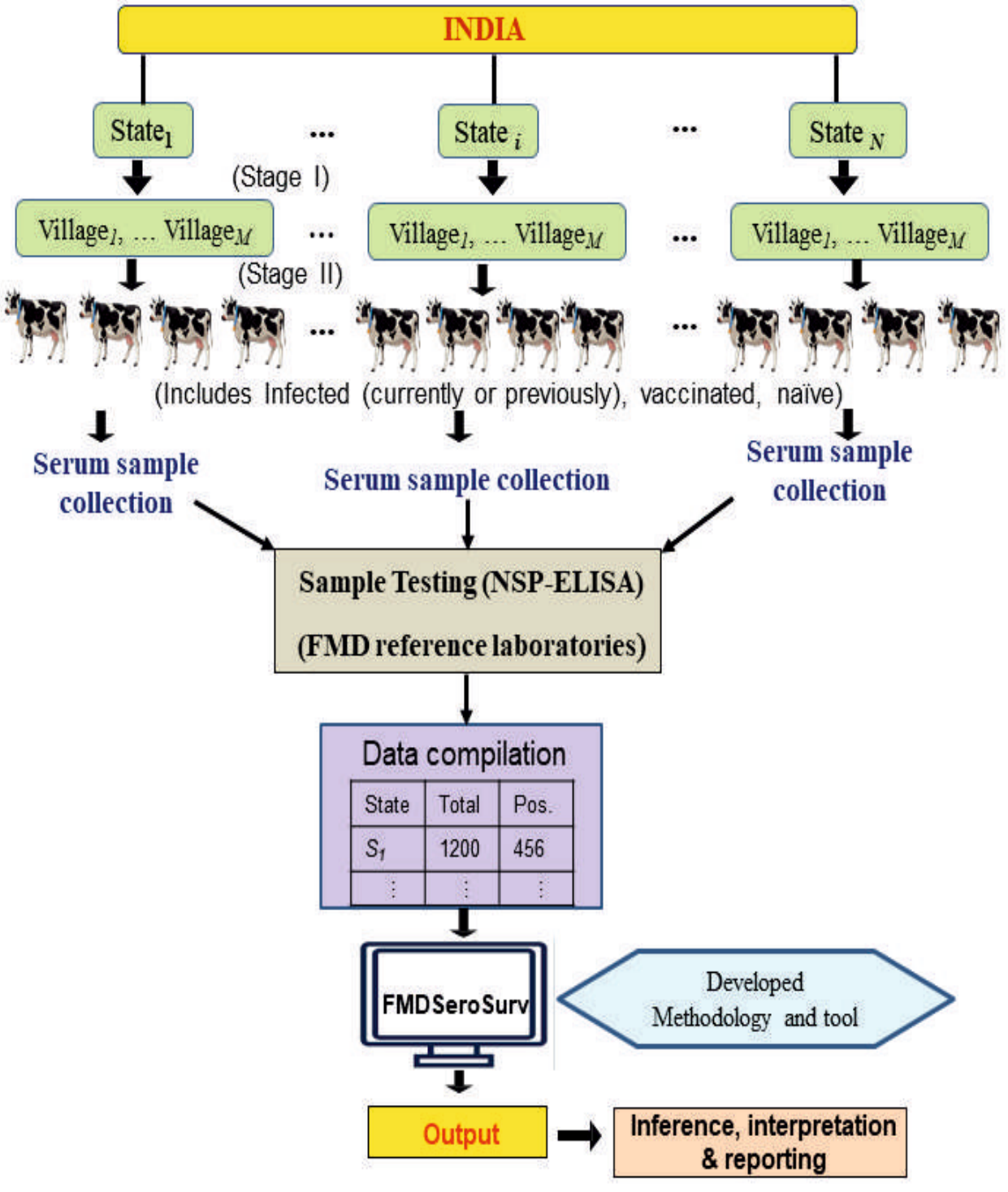


Fig: 22 Schematic diagrams for utility of FMDSeroSurv methodology and software

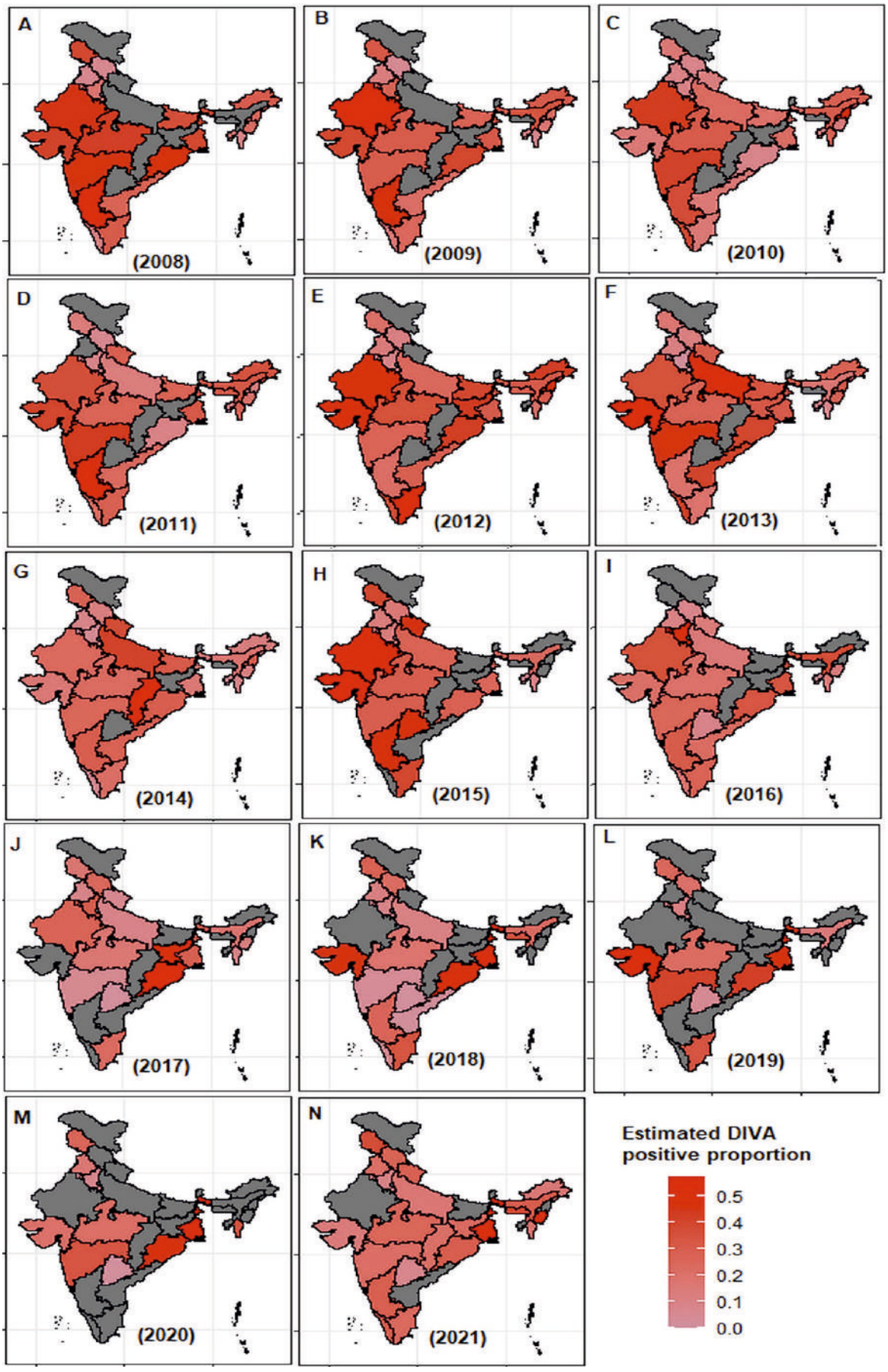


Fig: 23 State-wise distribution of estimated sero-prevalence rates through the FMDSeroSurv software.

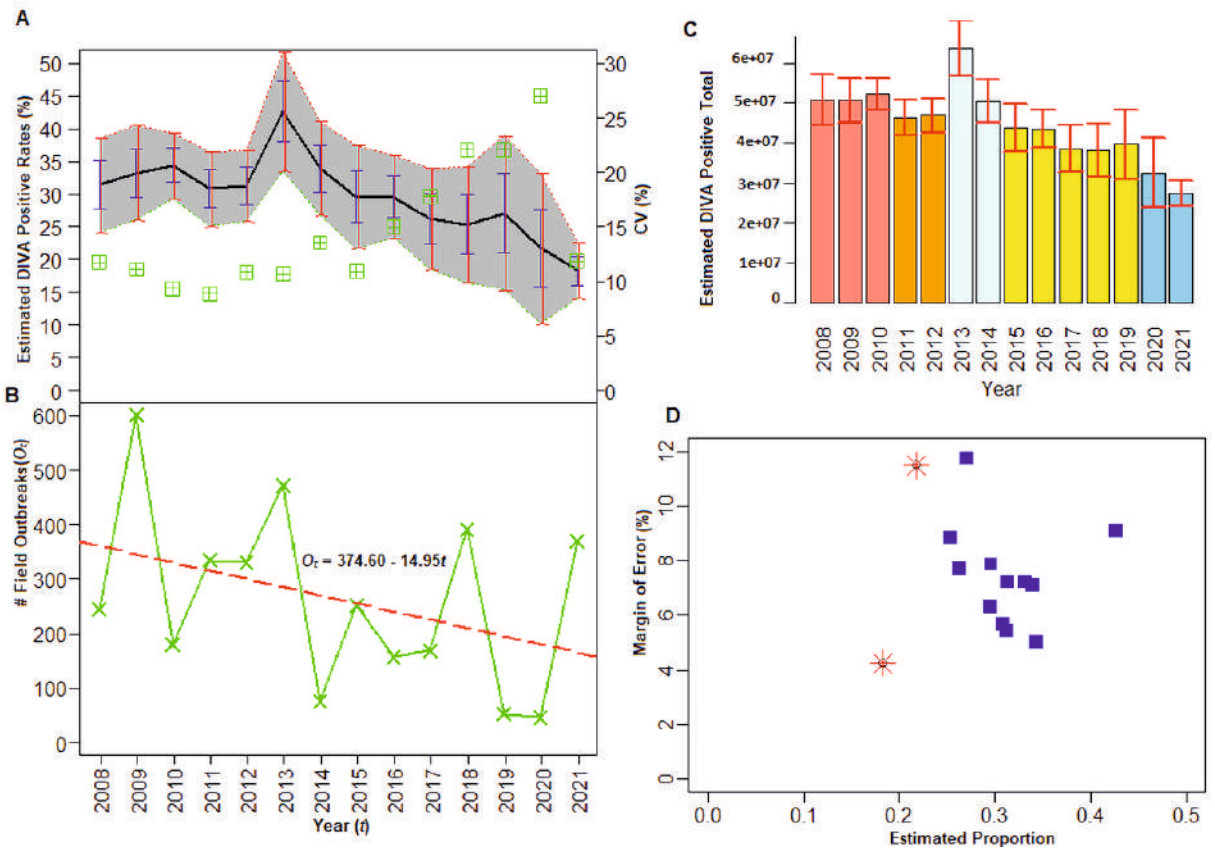


Fig 24. National-level (India) estimation of FMDV NSP sero-prevalence

2.8.2 FMDVSerPred Server for serotype prediction

Every year the FMD causes huge economic loss to the farmers in India. For instance, the total estimated economic loss due to FMD in cattle and buffalo was INR 20,897 crores. In India/Asia, the virus is in circulation with three serotypes (i.e., O, A, and Asia 1). Thus, early detection and accurate serotyping of the FMDV is crucial for implementation of disease control policy including vaccination and molecular epidemiology studies. The FMDVSerPred is a sequence-based computational model for identifying and prediction of serotypes of the FMDV isolates. The computational model uses k-mer technique for feature generation, gain ratio for relevant feature selection, and random forest for model building. The FMDVSerPred model is trained on sequence (VP1) data of FMDV isolates reported from India and tested on independent datasets reported from India and its seven neighbouring countries.

2.8.3 Designing a novel mRNA vaccine against FMDV through immune-informatics approach

The main disadvantages of the currently used whole virus-based inactivated vaccines are the lack of immunological memory and the requirement of strict bio-containment facility for upscaling the virus. In order to lower the burden of FMD, the development of novel and potent vaccines is of paramount importance. Thus, immunoinformatic tools are used to design a multi-epitope- based mRNA vaccine that would protect against the FMD virus serotypes O, A and Asia1. Several bioinformatic tools are utilized to predict T and B-cell epitopes present on the capsid protein of FMD virus. These predicted epitopes are passed through a computational approach comprised of antigenicity, toxicity, allergenicity, and other biochemical properties-based prediction and analyses. Further, molecular docking and simulation among the predicted epitopes and MHC molecules was carried out to identify the key

epitopes and MHC molecules. The structural analysis of antigenic epitopes and MHC alleles revealed their structures and binding sites. The seven predicted epitopes, a highly immunogenic adjuvant, secretion booster, and appropriate linkers were combined for designing the mRNA vaccine. The physico-chemical analysis indicated that the vaccine construct found to be antigenic, almost neutral at physiological pH, non-toxic, non-allergenic, stable, and capable of generating a robust immune response.

2.9 FMD vaccine quality control

2.9.1 Vaccine QC analyses

Under the Livestock Health Disease Control Programme (LHDCP) on FMD, for the quality control testing of FMD vaccines to be used for the vaccination, our institute along with ICAR-IVRI and CCS National Institute of Animal Health Baghpat have participated in the largest ever FMD vaccine quality control programme. The programme 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. A booster was administered to calves in the potency group at 28 days post primo vaccination and animals were sampled at 28 days post booster (56 days post primo-vaccination) and tested in 3AB3-NSP ELISA for NSP antibody purity.

During the year 2023, seven batches of FMD vaccines (Table 16) have been tested at different farms across the country and reports were communicated. Under each batch the safety, sterility, and potency tests were conducted as per the standard operative procedures laid down by DAHD.

Table. 16 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.	33TVC23002	08/05/2023	SCBF, Saraikela Kharsuan
2.	111-351-E11W-50	29/05/ 2023	CLF/ Chinthaladevi/ Nellore
3.	010-345-E10W-75	29/05/ 2023	CLF/ Chinthaladevi/ Nellore
4.	012-375-H22W-75	05/09/2023	Government Cattle Breeding Farm Chandkhuri, Raipur
5.	001-381-1122W-20	09/09/2023	Pashu Prajanan Prachetra, Gadi, Balaghat
6.	021-371-H22W-50	01/11/2023	Pashu Prajanan Prachetra, Gadi, Balaghat
7.	003-443- K23W-20	06/12/2023	SCBF, Saraikela, Jharkhand

2.9.2 *In vitro* antigen-quantification test for FMD virus vaccines

Under the projects 'FMD Vaccine Quality Testing and Enhancing India's Animal Vaccine Testing Capabilities' (Collaborative Programme between ICAR (ICAR-NIFMD, ICAR-IVRI), CCS-NIAH and the WRL on FMD supported by DAH&D, GoI), WP2 aimed at developing *in vitro* assay for estimation of the antigenic mass (irrespective of serotype) for in-process quality control and to apply the assay for QC of formulated vaccines. The VP4 and VP2 mAbs received from the WRL on FMD were applied as per the provided SOP of WRL for quantification of intact virus particles (146S) vis a vis total antigen including degraded

particles in serotype independent manner in ELISA. The antigen from the oil-adjuvanted vaccine (8 batches of oil adjuvanted vaccine that was tested in cattle for antibody titer in VNT) was extracted using n-butanol. The extracted antigens were tested in both VP2-ELISA and VP4-ELISA separately before and after acid treatment. While for four batches reasonably high absorbance was observed in both VP2 and VP4 MAb based ELISA suggesting better quality and quantity of vaccine antigen. In the rest four batches, no or marginal reactivity in VP4 ELISA was seen despite showing high absorbance in VP2 ELISA in three of those four batches, indicating possible dissociation of protective 146S virion particles upon storage. The absorbance in the *in vitro* antigen quantification assays correlated well with the induced protective antibody titer in cattle with respect to the threshold titer of protection. For more specific assessment of antigenic mass in the vaccines, a set of reference antigen preparation of known antigenic mass is required to be included in the assay.

2.9.2 Guinea pig as an alternative model for biological release assays

Under the projects 'FMD Vaccine Quality Testing and Enhancing India's Animal Vaccine Testing Capabilities' (Collaborative Programme between ICAR (ICAR-NIFMD, ICAR-IVRI), CCS-NIAH and the WRL on FMD supported by DAH&D, GoI), Guinea pigs are being explored as an alternative model to cattle serology batch release testing. The objective of WP5 was to establish a serological cut off in guinea pigs that predicts whether a full dose of the same FMD vaccine given to cattle will elicit a protective response that corresponds to 75% protection. A total of 6 commercial vaccine batches received for QC testing at ICAR-NIFMD were inoculated almost simultaneously into cattle and guinea pigs. A group of 8 guinea pigs of Dunkin Hartley strain with body weight of about 400-500g were inoculated intramuscular in the thigh region at a dose of 200 or 400 µl each and bled 28 days post-inoculation. At the same time, a group of 8 cattle of 6-12 months age were vaccinated with the standard dose of 2 ml vaccine and were bled 28 days postvaccination. The 28 days serum samples collected from cattle and guinea pig were subjected to virus neutralization test using 56-133 $TCID_{50}$ dose of virus in the same run to determine correlation between the geometric mean antibody titer in these two species. For two of the six batches, significant correlation could be observed for serotype O, A and Asia 1 specific SN_{50} titers inferred between cattle and guinea pigs, while for the rest of the batches correlation could be drawn for titers against two out of the three serotypes only. Testing of more batches of vaccine and data analysis is under progress.

3.0 KITS AND BIOLOGICALS

3.1 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 laboratories at Bhubaneswar and Mukteswar for seromonitoring and serosurveillance under LHDCP (Table 17).

Table 17. Diagnostic kits supplied and used at NIFMD during 2023 for number of samples

Recipient State	3AB3 NSP ELISA	SPC ELISA	Serotyping ELISA
Andaman	1500	2500	-
Andhra Pradesh	7000	11500	200
Arunachal Pradesh	1200	3160	-
Assam	2000	5000	-
Bihar	3069	2780	-
Gujarat	7000	11000	-
Haryana	9000	12500	-
J&K	3300	2800	-
Jharkhand	1000	-	-
Karnataka	4350	2000	100
Kerala	1183	5800	500
Madhya Pradesh	2700	15000	200
Maharashtra	4250	18500	300
Manipur	949	2860	-
Meghalaya	900	2200	-
Mizoram	1073	-	-
Nagaland	1300	2000	-
Odisha	3800	4500	-
Puducherry	1500	2500	-
Punjab	5000	5000	100
Tamil Nadu	2360	10300	200
Telangana	3500	5000	400
Tripura	1400	500	-
Uttar Pradesh	3700	13800	100
Uttarakhand	2160	2800	-
West Bengal	2000	1000	200
ICAR-NIFMD	4000	3500	500
Grand Total	**81,194**	**1,48,500**	**2,800**

4. PUBLICATIONS

4.1 Research Papers

1. Biswal JK, Mohapatra JK, Ranjan R, Rout M, Dahiya SS, Singh RP (2023). TaqMan probe-based one-step multiplex real-time RT-PCR assay for the diagnosis of foot-and-mouth disease. **Acta Virol**. https://doi.org/10.3389/av.2023.12075 (**Impact Factor: 1.83**)
2. Biswal JK, Ranjan R, Mohapatra JK, Rout M, Joshi HR, Singh RP (2023). Development of TaqMan Probe-Based One-Step RT-qPCR Assay Targeting 2B-NSP Coding Region for Diagnosis of Foot-and-Mouth Disease in India. **Current Microbiology**. 16; 80(8):245. doi: 10.1007/s00284-023-03369-y. (**Impact Factor: 2.343**)
3. Dahiya SS, Subramaniam S, Mohapatra JK, Rout M, Biswal JK, Giri P, Nayak V, Singh RP (2023). Foot-and-Mouth Disease Virus Serotype O Exhibits Phenomenal Genetic Lineage Diversity in India during 2018–2022. **Viruses** 15(7):1529. https://doi.org/10.3390/v15071529 (**Impact Factor: 5.818**)
4. Das, S., Pal, S., Rautaray, S.S., Subramaniam S., Mohapatra JK., Rout M., Rai SN and Singh RP (2023). Estimation of foot-and-mouth disease virus sero-prevalence rates using novel computational approach for the susceptible bovine population in India during the period 2008–2021. **Scientific Reports** 13, 22583 (**Impact Factor: 4.6**)
5. Jana C, Khulape SA, Mohapatra JK, Dubey P, Sharma D and Singh RP (2023). Clinical investigation and risk factor analysis for Foot and Mouth Disease outbreak in farm ruminants at Uttarakhand. **Indian Journal of Veterinary Pathology**., 47(2): 111-116, 2023: DOI: 10.5958/0973-970X.2023.00019.6
6. Khulape SA, Biswal JK, Jana C, Subramaniam S, Singh RP (2023). Novel pan-lineage VP1 specific degenerate primers for precise genetic characterization of serotype O foot and mouth disease virus circulating in India. **Journal of Veterinary Science** 24(3):e40. doi: 10.4142/jvs.22292. (**Impact Factor: 1.8**)
7. Mallick S, Singh RP, Biswal JK, Mohapatra JK, Rout M, Samanta R, Khulape SA, Ranjan R (2023). Production and characterization of monoclonal antibodies against foot-and-mouth disease virus serotype O and development of a sandwich ELISA for virus antigen detection. **Veterinary Research Communications**. 24:1–10. doi: 10.1007/s11259-023-10143-9. (**Impact Factor: 2.2**)
8. Mohapatra JK, Dahiya SS, Subramaniam S, Rout M, Biswal JK, Giri P, Nayak V, Singh RP (2023). Emergence of a novel genetic lineage 'A/ASIA/G-18/2019' of foot and mouth disease virus serotype A in India: A challenge to reckon with. **Virus Research.** 333:199140. doi: 10.1016/j.virusres.2023. 199140. (**Impact Factor: 6.286**)
9. Mohapatra JK, Rout M, Subramaniam S, Giri P, Dahiya SS, Rautaray SS, Biswal JK, Sahoo NR, Singh RP (2023). A reverse transcription-multiplex PCR strategy devised for concomitant detection and differentiation of foot and mouth disease virus serotypes O, A and Asia 1 in India. **Journal of Virological Methods**. doi: 10.1016/j.jviromet.2023.114829. (**Impact Factor: 3.1**)
10. Ranjan R, Biswal JK and Singh RP (2023). Optimization and Development of Protocol for Detection of Foot-And-Mouth Disease Virus by Negative Staining Using Transmission Electron Microscopy. **Acta Scientific Veterinary Sciences** 5.2 (2023): 18-23. (**Impact Factor: 1.008**)
11. Ranjan R, Biswal JK, Sahoo PK, Tripathy JP, Singh RP (2023). Diagnostic application of formalin fixed archived tissues for detection of foot-and-mouth

disease. **Journal of Virological Methods,** 318:114754. doi: 10.1016/j.jviromet.2023. 114754. (**Impact Factor: 3.1**)

12. Sahoo M, Singh R, Kumar P, Kumar Mariappan A, Munnuswamy P, Singh K, Mani S, Dhama K, Kondabattula G, Das T, Thakor JC, Kashyap G, Sahoo NR (2023). Novel pathologic findings and viral antigen distribution in cattle and buffalo calves naturally infected with Foot-and-Mouth disease virus. **Vet Quarterly** 43(1):1-13. doi: 10.1080/01652176.2023.2260435 (**Impact Factor: 8.07**).

4.2 Technical papers / review articles / invited papers

1. M Sahoo (2023) "***Unravelling the sequential development of neuropatho-genesis of important bacterial pathogens of pigs***" in Veterinary Pathology Congress 2023 held at ICAR-IVRI.
2. Ranjan R, Biswal JK and Singh RP (2023). ***Subclinical and Persistent infection: A challenge to FMD Control***. Veterinary Pathology Congress-2023 on "Advances in Veterinary Pathology for Diagnosis and Control of Emerging Disease of Livestock and Poultry" held on 20-22 December 2023. Indian Association of Veterinary Pathologists, ICVP and IVRI, Izatnagar, Bareilly-243122, UP. Pp.294-297.
3. Sahoo NR, Sahoo M and Qureshi S (2023). ***Differential host response to bacterial pathogen with special reference to diarrhoeagenic E. coli in pigs***. In Training Manual on "Advances in Molecular and Serological Techniques for Research in Microbiology" held at ICAR-IVRI on 17/07/2023 to 26/07/2023 Pp-122-126
4. Das, S. (2023). **Biological Data Analysis using R/ RStudio**. DBT funded Training manual on "Application of Biotechnology and Bioinformatics in Fisheries and Life Science". Edited by Parhi, J., Mandal, S.C., Dhar, B., Choudhury, T.G., Saha, B. Published by College of Fisheries, CAU, Lembucherra, Tripua-799210.
5. Das, S. (2023). **Introduction to Basics of R and R Studio**. DBT funded Training manual on "Application of Biotechnology and Bioinformatics in Fisheries and Life Science". Edited by Parhi, J., Mandal, S.C., Dhar, B., Choudhury, T.G., Saha, B. Published by College of Fisheries, CAU, Lembucherra, Tripua-799210.
6. Das, S. (2023). **Network Biology Approaches in Molecular Biology**. Training manual on "Application of Biotechnology and Bioinformatics in Fisheries and Life Science". Edited by Parhi, J., Mandal, S.C., Dhar, B., Choudhury, T.G., Saha, B. Published by College of Fisheries, CAU (Imphal), Lembucherra, Tripua-799210.
7. Das, S. (2023). **Statistical Modeling in Gene Expression Genomics**. DBT funded Training manual on "Application of Biotechnology and Bioinformatics in Fisheries and Life Science". Edited by Parhi, J., Mandal, S.C., Dhar, B., Choudhury, T.G., Saha, B. Published by College of Fisheries, CAU, Lembucherra, Tripua-799210.

4.3 Abstracts / papers presented in conferences / symposia

1. Biswal JK., Ranjan R., Mohapatra JK., Subramaniam S and Singh,R.P (2023). ***Potential live attenuated FMDV serotype O INDR2/1975 vaccine candidate strain generated through genome re-coding approach***. The 2023 Scientific Meeting of the Global Foot and Mouth Disease Research Alliance (GFRA), 8th – 10th November 2023, Kampala, Uganda.
2. Pannu A, Dahiya S, Lather A, Kaur A, Sangwan P, Rani N, Ranjan R, Mohapatra JK (2023). ***Systematic follow-up investigation of NSP seroreactors by testing oesophageal-pharyngeal fluid of cattle and buffaloes for foot-and-mouth disease virus in Haryana during 2022***. 35th Annual Convention and National Conference of IAVMIS on 'Novel Approaches in Animal Health for Realizing One Health Mission'. Department of Veterinary Microbiology, CSKHPKV, Palampur (HP)-176062, India. 7-8th April, 2023, Pp:11-12.

3. Rout M., Dahiya SS., Biswal JK., Subramaniam S., Mohapatra JK and Singh,R.P (2023). ***Antigenic and genetic analyses of foot and mouth disease virus serotype Asia1 from field outbreaks during 2020 and 2021***. VIROCON 2023 "Advancements in Global Virus Research towards One Health", 1st - 3rd December 2023, ICAR-NRC Banana, Tiruchirappalli, Tamil Nadu.

4. Rout M., Dahiya SS., Subramaniam S., Mohapatra JK and Singh,R.P (2023). ***Co-circulation of multiple serotypes of foot and mouth disease amonh susceptible animal population in India during 2021-2022***. XVI Agricultural Science Congress 2023. Transformation of Agri-Food Systems for Achieving Sustainable Development Goals. 10-13 October 2023, Kochi, Kerala, India

5. Rout M., Garam GB., Rinchin Lama, Deka P., Tripathy JP., Giri P., Acharya R., Subramaniam S., Mohapatra J K and Singh, R. P (2023). ***Foot and Mouth Disease in mithun, yak, cattle-yak hybrids and cattle in the north-eastern states of India during 2021-2022.*** XVI Agricultural Science Congress 2023. Transformation of Agri-Food Systems for Achieving Sustainable Development Goals. 10-13 October 2023, Kochi, Kerala, India

6. Sahoo AP., Subramaniam S., Sahoo NR., Das S., Sajjanar B and Khulape AS (2023). ***Analyses of nucleotide and codon usage pattern of Foot-and-mouth disease virus (FMDV) genome to elucidate information about molecular evolution of FMDV and adaptation to the host***. VII Annual Convention of SVBBI and International Symposium on Multiomics to One Health: Challenges and Way Forward in Biomedical Research. 14th-15th Dec 2023. ICAR-IVRI, Izatnagar, Bareilly.

7. Sahoo M, Patel S, Thakor J, Dinesh M, Singh R, Kumar P, Singh KP, Das T, Patel SK, Pathak M, and Sahoo NR (2023). ***Pathological, serological and molecular investigation of leptospirosis in naturally affected dogs***.Pp-186, under Session-5, Pet/companion animals and Avian Pathology. In Veterinary Pathology Congress-2023 on "Advances in Veterinary Pathology for diagnosis and control of emerging diseases of livestock and poultry"

8. Sahoo M, Biswal JK, Ranjan R, Das T and Sahoo NR (2023). ***Cytokine and chemokine profiling in cattle naturally infected with Foot and Mouth Disease***. Pp-354, under Session-7, Farm animal, lab animal, wild animal pathology and Veterinary Forensic Pathology. In Veterinary Pathology Congress-2023 on "Advances in Veterinary Pathology for diagnosis and control of emerging diseases of livestock and poultry"

9. Sahoo M, Patel S, Thakor J, Dinesh M, Singh R, Kumar P, Singh KP, Das T, Patel SK, Pathak M, and Sahoo NR (2023). ***Pathological, molecular detection and phylogenetic characterization of OCV2 from slaughterd pigs of India***.Pp-71, under Session-7, Farm animal. In Veterinary Pathology Congress-2023 on "Advances in Veterinary Pathology for diagnosis and control of emerging diseases of livestock and poultry"

10. Kaur A, Lather A, Dahiya S, Rout M, and Pannu A (2023). **Seromonitoring and serosurveillance studies of foot-and-mouth disease virus in goats of rural cohorts of Haryana during 2021**. XXXV Annual Convention and National Conference of IAVMICON-23, Indian Association of Veterinary Microbiologists, Immunologists and Specialists in Infectious Diseases on Novel Approaches in Animal Health for Realizing One Health Mission Organized By Department of Veterinary Microbiology Dr G.C. Negi College of Veterinary and Animal Sciences, CSKHPKV, Palampur, (HP)-176062, India on April 7th-8th, 2023. Pp. 12.

11. Dahiya S, Lather A, Dalal A, Sangwan P, Kaur A, Rani N, Anshul, Kakker NK, Rout M and Singh RP. (2023). **Serosurveillance of foot-and-mouth disease in small and large ruminants in**

rural cohorts of Haryana, India (2019-2022). International Symposium on "Promotion of One Health: Opportunities, Challenges and Solutions" and XIX Annual Conference of Indian Association of Veterinary Public Health Specialists (IAVPHS) organized 7th and 8th December 2023 by Department of Veterinary Public Health & Epidemiology, Lala Lajpat Rai University of Veterinary and Animal Sciences Hisar-125004 (Haryana) Pp. 93.

4.4 Training manual / compendium

1. Ranjan R, T Lokhande, B D Kadam, R Hegde, S Dahiya, P Deka, and R P Singh. (2023). **Report on Capacity building programme on systematic follow-up investigation of FMD NSP Reactors**. June- September, 2023. Pp. 1-15.

4.5 Book chapters

1. Das, S., Raman, R.K. and Yadav, A. (2023). **Machine learning applications for Aluminum stress responsive genes selection in Soybean**. *In: Technological Advancement and Use of Artificial Intelligence in Climate Smart Agriculture*. (Eds. Mukherjee, A., Raman, R.K., Singh, D.K., Kumar, R., Shubha, K., Kumar, U., and Kumar, A. International Books & Periodical Supply Service, New Delhi-110034, pp. 201-215; 1st ed. ISBN: 978-93-94023-44-4
2. Sahoo, A.P and Khulape, S.A. (2023). **Application of systems biology approach in virological research**. In Advanced Virological Techniques for Research in Life Science (2023).): ICAR-Indian Veterinary Research, Institute, Izatnagar (UP) India. ISBN No: 978-93-6039-346-5. Editors K. K. Rajak, A. K. Yadav, M. Bhatt, V. Upmanyu B. Kumar, R. K. Agrawal.
3. Singh, R.P., Mallick, S. and Rajak, K.K (2023). **Monoclonal antibody production and its applications in viral disease diagnosis**. Advanced virological techniques for research in life science (2023): ICAR-Indian Veterinary Research, Institute, Izatnagar (UP) India. ISBN No: 978-93-6039-346-5. Editors K. K. Rajak, A. K. Yadav, M. Bhatt, V. Upmanyu B. Kumar, R. K. Agrawal.Pp 75-84.

4.6 Popular articles

1. Das, T., Das, N.K. and Mallick, S. (2023). Inclusion body hepatitis and hydropericardium syndrome or hydropericardium hepatitis syndrome-an emerging poultry disease. E Pasudhan Praharee
2. Das, T., Sahoo, M., Vidya Rani H.B., Chauhan, A. and Das, N.K. (2023). Contagious pustular dermatitis: Etiopathology, diagnosis, clinical management and control. E Pasudhan Praharee
3. Rout, M., Mohapatra, J.K. and Singh, R.P. (2023). A Brief Review on Vesicular Stomatitis. Biotica Research Today, 5(7): 473-475.
4. Rout, M., Mohapatra, J.K. and Singh, R.P. (2023). Field observations of suspected clinical cases of contagious ecthyma in goats. Biotica Research Today, 5(10): 720-723.
5. Sahoo, M., Rana, J., Patel, S.K. and Singh, S. (2023). Foot and Mouth Disease in Pigs: An overview Indian Foot and Mouth Disease in Pigs: An overview in Indian perspective. The Science World. 3(06), 1056-1057.
6. Singh, R.P. and Tripathi, B.N. (2023). Management of Transboundary Animal Diseases. Agriculture Today: 26 (8), pp 16-17.

4.7 Extension bulletins

1. Ranjan, R., Subramaniam, S. and Singh, R.P. (2023). **Report on National FMD Control Awareness Week Observation (11th-17th September, 2023**). ICAR-National Institute on FMD, Bhuaneswar in collaboration with state FMD regional and collaborating Centers. Pp. 1-57
2. एस.एस. दहिया, राजीव रंजन, एन आर साहू, एम राऊत, जे के महापात्र, जे के बिसवाल, एस आर मल्लिक्क, एम साहू,

एस दास, टी दास एवं आर पी सिंह (2023). खुरपका मुँहपका रोग (एफ एम डी), राष्ट्रीय पशु रोग नियंत्रण कार्यक्रम (एनेडीसीपी)।

4.8 Sampling Plan

1. Suresh, K.P., Heamdri, D., Patil, S.S., Subramaniam, S., Mohapatra, J.K. and Singh, R.P. (2023) **Sampling Plan for Seromonitoring of FMD in India under National Animal Disease Control Programme Round IV**. ICAR-NIVEDI, Bengaluru and ICAR-NIFMD, Bhubaneswar.
2. Suresh, K.P., Heamdri, D., Patil, S.S., Subramaniam, S., Mohapatra, J.K. and Singh, R.P. (2023) **Sampling Plan for Serosurveillance of FMD in India under National Animal Disease Control Programme: 2023**. ICAR-NIVEDI, Bengaluru and ICAR-NIFMD, Bhubaneswar.

4.9 Expert Talks

S No	Presenter	Title	Venue
1.	Dr R. P. Singh	Strength and weakness of FMD control programme with special reference to North East India	College of Veterinary Science, Khanapara on 21-09-2023
2.	Dr JK. Mohapatra	Strengthening Veterinary Service Delivery for Enhanced Production & Productivity in Livestock sector	Convention Centre, Lokaseva Bhawan, Bhubaneswar on 29th April 2023.
3.	Dr JK.Mohapatra	Issue & challenges in Disease Surveillance with special emphasis on FMD	National level workshop on Animal Disease Surveillance under ASCAD at Hotel New Marrion, Bhubaneswar on 13th Feb 2023
4.	Dr R Ranjan	Animal Biosafety Levels and Best Practices to be followed	NCARE, SBS, NISER, Bhubaneswar, Odisha on 25.05.2023
5.	Dr R Ranjan	Management of Foot and Mouth Disease Outbreak and sample collection, packaging and its dispatch	Directorate of Animal Husbandry, Hesag, Ranchi, Jharkhand during 1-2nd November, 2023
6.	Dr R Ranjan	Overview of biosafety and biosecurity practices at Biosafety Laboratory	DBT-Institute of Life Sciences, Bhubaneswar, Odisha on 30th November, 2023
7.	Dr S Das	Big Data Analysis and Single-cell RNA-sequencing Data Analysis	High Performance Computing Facility Centre, OUAT, Bhubaneswar, OD, India during March 13 – 19, 2023
8.	Dr S Das	High-throughput and High-dimensional data analysis Statistical methods and bioinformatics tools for big genomic data analysis	Department of Agricultural Statistics, College of Agriculture, OUAT, Bhubaneswar, OD, India on December 07-08, 2023
9.	Dr S Das	Statistical Modeling in Gene Expression Genomics Network Biology Approaches in Molecular Biology	College of Fisheries, CAU (Imphal), Lembucherra, Tripua during December 05 -26, 2023
10.	Dr S Das	Bioinformatics Tools and their Application in Aquaculture	College of Fisheries, Central Agricultural University, Lembucherra, Tripura during December 11-15, 2023

4.10 GenBank/NCBI

1. Biswal, J.K. and Subramaniam, S. (2023). Foot-and-Mouth Disease Virus Serotype O Exhibits Phenomenal Genetic Lineage Diversity in India during 2018-2022. OQ732575-OQ732605; **31 VP1 Sequences (19.81 kb)**
2. Dahiya, S.S., Biswal, J.K. and Subramaniam, S. (2023). Foot-and-Mouth Disease Virus Serotype O Exhibits Phenomenal Genetic Lineage Diversity in India during 2018-2022. OQ806933-OQ806938; **6 VP1 Sequences (3.83 kb)**
3. Dahiya, S.S., Mohapatra, J.K., Rout,M. and Subramaniam,S (2023). Foot-and-Mouth Disease Virus Serotype O Exhibits Phenomenal Genetic Lineage Diversity in India during 2018-2022. OQ846953-OQ847053; **101 VP1 Sequences (645.39 kb)**
4. Mohapatra, J.K., Dahiya, S.S., Biswal, J.K., Rout, M., Subramaniam, S. and Singh, R.P (2023). Emergence of a novel genetic lineage 'A/ASIA/G-18/2019' of foot and mouth disease virus serotype A in India: A challenge to reckon with. OQ378364-OQ378389; **26 VP1 Sequences (16.61 kb)**
5. Rout, M. Dahiya, S.S. Subramaniam, S. Biswal, J.K. Mohapatra J.K and Singh R.P. (2023). Full genome sequence analyses and antigenic characterization of emerging lineage G-IX of foot and mouth disease virus serotype Asia1. **OR916275-OR916276; 2 ORF (13.99kb)**

5.0 INTELLECTUAL PROPERTY MANAGEMENT

5.1 Patent applications filed

1. Mallick S, Singh RP, Mohapatra JK, Biswal JK, Rout M and Ranjan R. Monoclonal antibody - based competitive ELISA for the detection of antibodies to Foot and Mouth Disease Virus (FMDV) non-structural protein as a marker of infection. Patent Application No: **202311089799.** Date of filing: **29th December 2023**

5.2 Technologies assigned for commercial transfer

1. **FMDV serotype A candidate vaccine strain, A/IND27/2011**: To cover antigenic diversity within serotype A virus, FMDV serotype A vaccine strain, A/IND27/2011 was selected. The candidate strain A/IND 27/2011 showed all the vaccine worth attributes and is ready for inclusion in the vaccine formulation.
2. **Thermo-stable FMD virus serotype O.** Thermo-tolerant FMD virus serotype O candidate vaccine strain was developed and evaluated for potency in cattle. In the long term immunity study, without booster, protective levels of antibody titer were observed even after 6 months post-vaccination.

5.3 Revenue generated

During 2023, the institute has provided testing services for FMD seromonitoring using SPCE, serosurveillance using DIVA ELISA, and serotype identification using mRT-PCR to private bull and dairy farms and exporters, as well as supplied SPCE and DIVA kits. The details of revenue generated is depicted in the Table 18.

Table 18. Details of revenue generation during last five years

Year	Testing of serum sample using SPCE	Testing Service using DIVA	Testing Service using m PCR	Supply of DIVA Kit	Supply of SPCE Kit	Total (In Rupees)
2019	6,48,906	-	-	-		6,48,906
2020	23,65,438	-		80,439		24,45,877
2021	21,99,633	8294	8024	-	82,396	22,98,347
2022	30,99,944	38,906	79,441	14,077	-	32,32,368
2023	15,91,838	53,425	1,14,079	96,550	1,00,492	19,56,384

5.4 National FMD virus repository

The National FMD Virus Repository, maintained by ICAR-NIMFD, has the world's largest collection of FMD viruses. The repository is updated yearly with samples of novel, well-characterised FMD viruses collected in India. During 2023, a total of **11** FMD virus isolates (**serotype O-9, serotype A-1, and serotype Asia1-1)** revived in the BHK-21 cell system were added to the National Repository of FMD Virus maintained at the International Centre for FMD, Bhubaneswar (Table 19). At present, the National FMD Virus Repository holds a total of **2464** isolates (**O-1733, A-348, C-15, and Asia-1-368**). The repository serves purposes such as retrospective analysis, the selection of vaccine strains, diagnostic development, etc. FMDV serotype C isolates are being kept only at the bio-containment laboratory of the ICFMD,

Bhubaneswar. Box-wise digitalization of details of FMDV serotypes available in the repository was done for easy identification. Individual details of the viruses have been hyperlinked in the electronic file

Table 19. Year-wise details of the virus isolates added to National FMD Virus Repository during last five years.

Year	O	A	Asia1	Total
2019	15	-	-	15
2020	-	-	-	-
2021	102	10	1	113
2022	48	14	-	62
2023	9	1	1	11

FMD lession

6.0 AWARDS AND RECOGNITIONS

1. Dr R.P. Singh was awarded National Academy of Veterinary Sciences (India) Fellowship, during year 2023
2. Dr M. Sahoo won Best Farm Animals Pathologist Award-2023 by Indian association of Veterinary Pathologist
3. Dr M. Sahoo won Best Oral presentation award for paper entitled “Tearfilm is an easily accessible biofluid of significance for biomarker detection in ocular surface diseases in dogs” in International Conference organized by SVBBI during Dec 14-15, 2023
4. Dr S. Das acted as the guest editor of the Entropy journal (IF: 2.573) and edited a special issue on “Biostatistics, Bioinformatics, and Data Analysis” for this journal
5. The team of Rout, M., Dahiya, S.S., Biswal J.K., Subramaniam, S., Mohapatra, J.K. and Singh, R.P. was awarded with the second best oral presentation award in VIROCON 2023 on “Advancements in Global Virus Research towards One Health”, 1st - 3rd December 2023, ICAR-NRC Banana, Tiruchirappalli, Tamil Nadu presenting the work entitled “Antigenic and genetic analyses of foot and mouth disease virus serotype Asia1 from field outbreaks during 2020 and 2021”.

7.0 RESEARCH PROJECTS

7.1 Institute funded

S. No.	Title	PI and Co-PIs	Duration	IRC Code
1.	Generation of monoclonal antibodies against recombinant FMDV polyprotein 3AB and their application in immunodiagnosis	SR Mallick (PI) JK Mohapatra, JK Biswal, SS Dahiya	Mar 2019-July 2023 (Extended for 3 months)	ANSC/DFMD/S/I/L/2019/013/00126
2.	Production and characterization of monoclonal antibodies against recombinant capsid polyprotein (rP1) of FMD virus serotype O	SR Mallick (PI), JK Biswal	Aug 2021-July 2023 (Extended up to March 2024)	ANSC/DFMD/S/I/L/2021/003/00146
3.	Development and evaluation of lateral flow immunoassay for Foot-and-Mouth Disease virus detection and serotyping using monoclonal antibodies	SR Mallick (PI) JK Mohapatra, JK Biswal, M Rout	Aug 2022-Mar 2025	ANSC/DFMD/S/I/L/2022/002/00162
4.	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
5.	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
6.	Development of combination reverse transcription-PCR (RT-PCR) strategy to enhance sensitivity and confidence of FMD virus serotype diagnosis	JK Mohapatra (PI) NR Sahoo, M Rout, Saravanan S, SS Dahiya JK Biswal	Aug 2022-Mar 2024	ANSC/DFMD/S/I/L/2022/002/00161
7.	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
8.	Epidemiology of Foot and Mouth Disease in Small Ruminants and Pigs in India	M Rout (PI) JK Mohapatra, Saravanan S	July 2021-July 2024	ANSC/DFMD/S/I/L/2021/007/00150
9.	Detection of asymptomatic low-level excretion of foot-and-mouth disease virus (FMDV)/genome in oesophago-pharyngeal fluid and morbid tissue samples	M Rout (PI) SS Dahiya, JK Mohapatra, Saravanan S, R Ranjan	Aug 2023-July 2026	ANSC/NIFMD/S/I/L/2023/003/00169

	associated with oro-laryngo-pharyngeal region of sheep and goats: A field-based study linked to carrier conundrum in FMD epidemiology			
10.	Genetic and antigenic characterization of Foot and Mouth Disease virus serotype Asia1	M Rout (PI), SS Dahiya, JK Mohapatra, Saravanan S	July 2021-July 2024	ANSC/DFMD/S/I/L/2021/013/00156
11.	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
12.	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
13.	Exploring the efficacy of Probiotics as mitigation strategy against Foot-and-Mouth Disease	M Sahoo (PI), JK Biswal, T Das, SR Mallick and NR Sahoo	Aug 2023- July 2025	ANSC/NIFMD/S/I/L/2023/005/00171
14.	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
15.	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
16.	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
17.	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
18.	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

19.	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
20.	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
21.	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

7.2 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 2023	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 SR (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	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 [ILJ-17 in the	M Sahoo (PI) JK Biswal		Dept. of Science & Technology, Govt. of

	pathogenesis and therapy of foot and mouth Diseases	Singh RP		Odisha Budgetary outlay: 9.96 Lakh
7.	FMD Vaccine Quality Testing and Enhancing India's Animal Vaccine Testing Capabilities	R P Singh (Project coordinator-Indian partner) JK Mohapatra (PI) RP Singh, JK Biswal, SS Dahiya, AP Sahoo, Saravanan S, R Ranjan, M Rout	Dec 2021-Dec 2023	LHDCP-DAHD Budgetary outlay: 258 lakhs
8.	Institute Technology Management Unit	Biswal JK	April 2023-March 24	NAIF ICAR
Projects funded by DAHD to support LHDCP/NADCP				
Programme co-ordinator: R P Singh				
9.	Seromonitoring of pre and post vaccinal immunity against Foot and Mouth Disease under LHDCP/NADCP during 2021-2024	Saravanan S (PI), Mohapatra JK, SS Dahiya, M Rout, AP Sahoo, S Das	April 2021-March 24	LHDCP-DAHD
10.	Serosurveillance in bovines under LHDCP/NADCP during 2021-2024	Mohapatra JK (PI) Saravanan S, Rout M, Dahiya SS, AP Sahoo, R Ranjan, Mallick SR, S Das	April 2021-March 24	LHDCP-DAHD
11.	Investigation of NSP seroreactors for the presence of FMD virus by oesophageal-pharyngeal fluid testing	R Ranjan (PI) M Rout, JK Biswal, JK Mohapatra, Saravanan S, SS Dahiya, M Sahoo, T Das	April 2021-March 25	LHDCP-DAHD
12.	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 SR, T Das, S Das	April 2021-March 25	LHDCP-DAHD

7.3 Service Projects

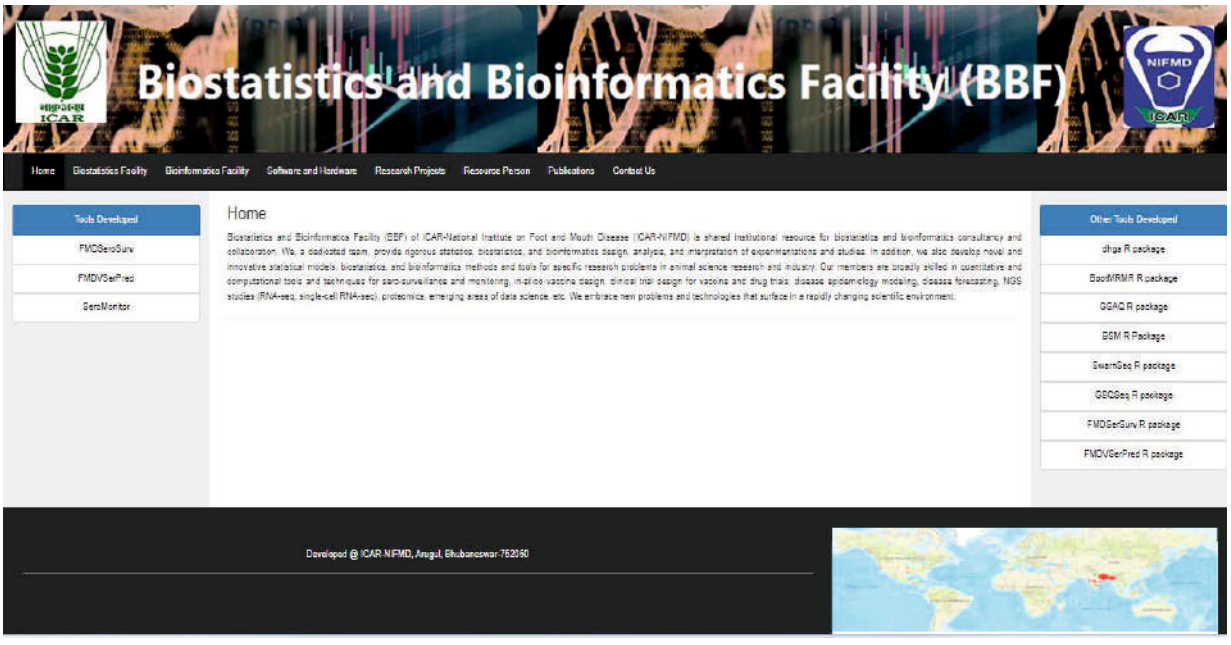
S. No.	Title	Nodal Officer/PI	Associates
1.	FMD virus isolation and maintenance of virus repository	Dahiya SS	Rout M, Mohapatra JK
2.	FMD virus diagnostic service, and serotype identification	Mohapatra JK	Biswal JK, Dahiya SS, Rout M, T Das
3.	Production, standardization and supply of diagnostic reagents for FMD virus diagnosis and surveillance	Mohapatra JK	All scientists
4.	Laboratory proficiency testing of FMD diagnostics	Mohapatra JK	All scientists
5.	Paid professional services through samples testing	Saravanan, S	All scientists
6.	Surveillance of FMD and vaccine effectiveness study within 5 km radius of ICFMD, Arugul, Bhubaneswar	Rout M	Mohapatra JK, Sahoo NR Saravanan S
7.	Transmission Electron Microscopy as a tool in diagnostic pathology and research for Foot-and-mouth disease virus	Ranjan R	M Sahoo, M Rout

7.4 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

8.0 INFRASTRUCTURE DEVELOPMENT

Biostatistics and Bioinformatics Facility (BBF) at the ICAR-NIFMD, Bhubaneswar was developed and have dedicated space for server and computer installation. The BBF has its own website (https://nifmd-bbf.icar.gov.in/), where the offered services are listed. The website is hosted at the ICAR data center server located at New Delhi. This website also lists all the computational solutions and web-applications developed by the institute. The BBF of the ICAR-NIFMD has Linux and Windows based workstation servers equipped with all the required software(s) for next generation sequencing and other statistical, and bioinformatics data analysis. Also, this facility has a computer lab, where the students, research fellows and scientists can work for their data analysis. The web page of this shared institutional facility is given below.



9.0 CAPACITY BUILDING AND TRAINING PROGRAMMES

9.1 Regular programmmes

ICAR-NIFMD organized eight routine training / capacity building programs on FMD diagnosis, serosurveillnace and seromonitoring in which a total of 9 staff were trained (Table 20)

Table 20. Details of routine training provided during 2023 by ICAR-NIFMD, Bhubaneswar

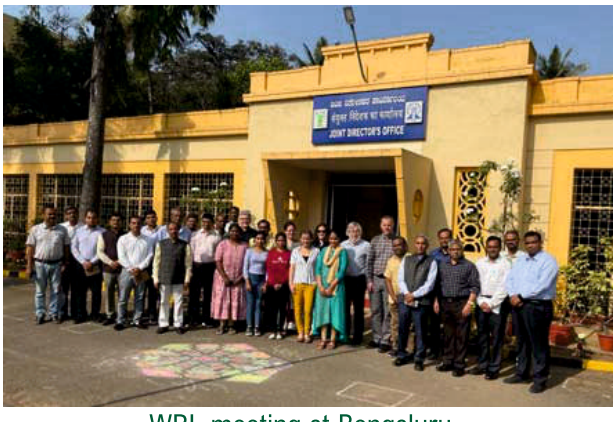
Details of participants	No. of Trainee	Period	Type of Training
State Disease Diagnosis Laboratory Rishikesh, Uttarakhand	1	23-25, January	FMD serosurveillance and hands on training on DIVA ELISA
FMD Collaborating Centre, TalabTillo, Jammu	1	6-10, February	FMD serosurveillance, seromonitoring, serotyping and hands on training on DIVA ELISA, SPC ELISA, and by sandwich ELISA
Veterinary Biologicals & Research Institute, Labbipeta, Vijayawada	2	13-17, February	FMD serosurveillance, seromonitoring, serotyping and hands on training on DIVA ELISA, SPC ELISA, and by sandwich ELISA
VBRI, Vijayawada	1	10-13, April	FMD seromonitoring and hands on training on SPC-ELISA
ICAR-CIARI, Port Blair	1	10-14, April	FMD serosurveillance, seromonitoring and hands on training on DIVA ELISA and SPC ELISA
FMD Network Unit, C.V.Sci. & A.H., Ranchi, Jharkhand	1	7-11, August	FMD serosurveillance, seromonitoring and hands on training on DIVA ELISA and SPC ELISA
Veterinary Officer,State DI Laboratory, Abhoynagar, Agartala,West Tripura	1	4-9, September	FMD serosurveillance, seromonitoring and hands on training on DIVA ELISA and SPC ELISA
College of Biotechnology, SardarVallabh Bhai Patel University of Agriculture & Technology (SVPUAT), Modipurum, Meerut	1	25-27, October	FMD serosurveillance, seromonitoring, serotyping and hands on training on DIVA ELISA, SPC ELISA, and by sandwich ELISA

9.2 Other training/workshop

1. International Collaborative Workshop on FMD Vaccine Quality Testing and Enhancing the India's Animal Vaccine Testing Capabilities. February 6-7, 2023. ICAR-IVRI, Bengaluru campus In collaboration with ICAR-NIFMD, Bhubaneswar. Experst from WRL-FMD, UK, ICAR-NIFMD and ICAR-IVRI participated.

2. Training programme on the "Application of multiplex PCR for sensitive and rapid detection of FMDV serotypes" was conducted during February 21–24, 2023, in which 9 staff from Bengaluru, Ahmedabad, Hisar, Cuttack, Bhopal and Pune centre participated.
3. One day (online) workshop on “Annual J-Gate@CeRA Training & Awareness” at ICAR-NIFMD, Bhubaneswar Co-ordinator: Dr Samarendra Das 23-03-2023 42 participants
4. The vaccine QC harmonization workshop was held from 22nd to 25th August 2023 at ICAR-NIFMD, Bhubaneswar. 25 staff from all three vaccine manufacturers such as M/s Brilliant Biopharma, M/s IIL and M/s Biovet and three testing laboratories participated.
5. Workshop on Epidemiological Approaches to Prevent and Control Transboundary Animal Diseases with Special Focus on Zoonotic Diseases and Foot and Mouth Diseases. 3-12, October 2023 for BIMSTEC member states.

Training on m-PCR at ICAR-NIFMD (ICFMD), Bhubaneswar on 24/02/2023



WRL meeting at Bengaluru

9.3 Capacity building programme on follow-up of FMD NSP reactors

ICAR-NIFMD has organized a *“Country wide Capacity Building Programme on Probang/ Oesophageal-pharyngeal fluid (OPF) collection, dispatch and follow-up of FMD NSP reactors”* to support the India’s FMD control programme under LHDCP endorsed by the World Organisation for Animal Health (WOAH). Programmes were conducted in online (for sensitization and preliminary knowledge) and offline mode as per the details shown (Fig. 25 & 26, and Table 21). More than 150 veterinarians were trained to carry out the task

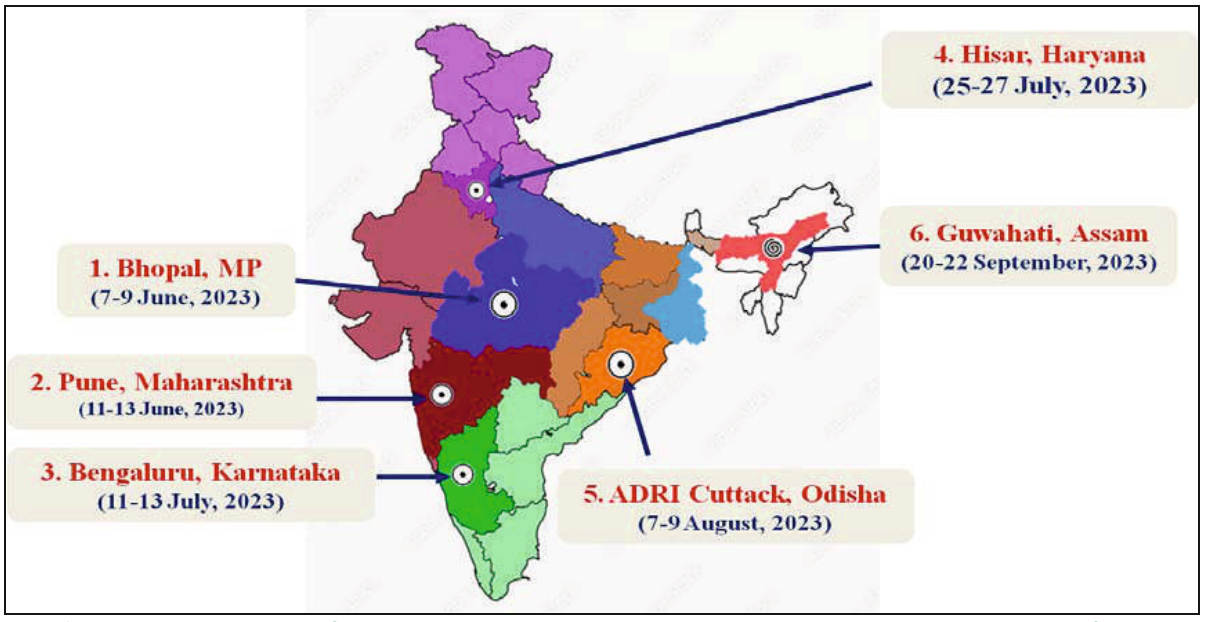


Fig: 25. Pictorial depiction of country wide capacity building training programme on systematic follow-up investigation on FMD NSP reactor by OPF were delivered during 2023.

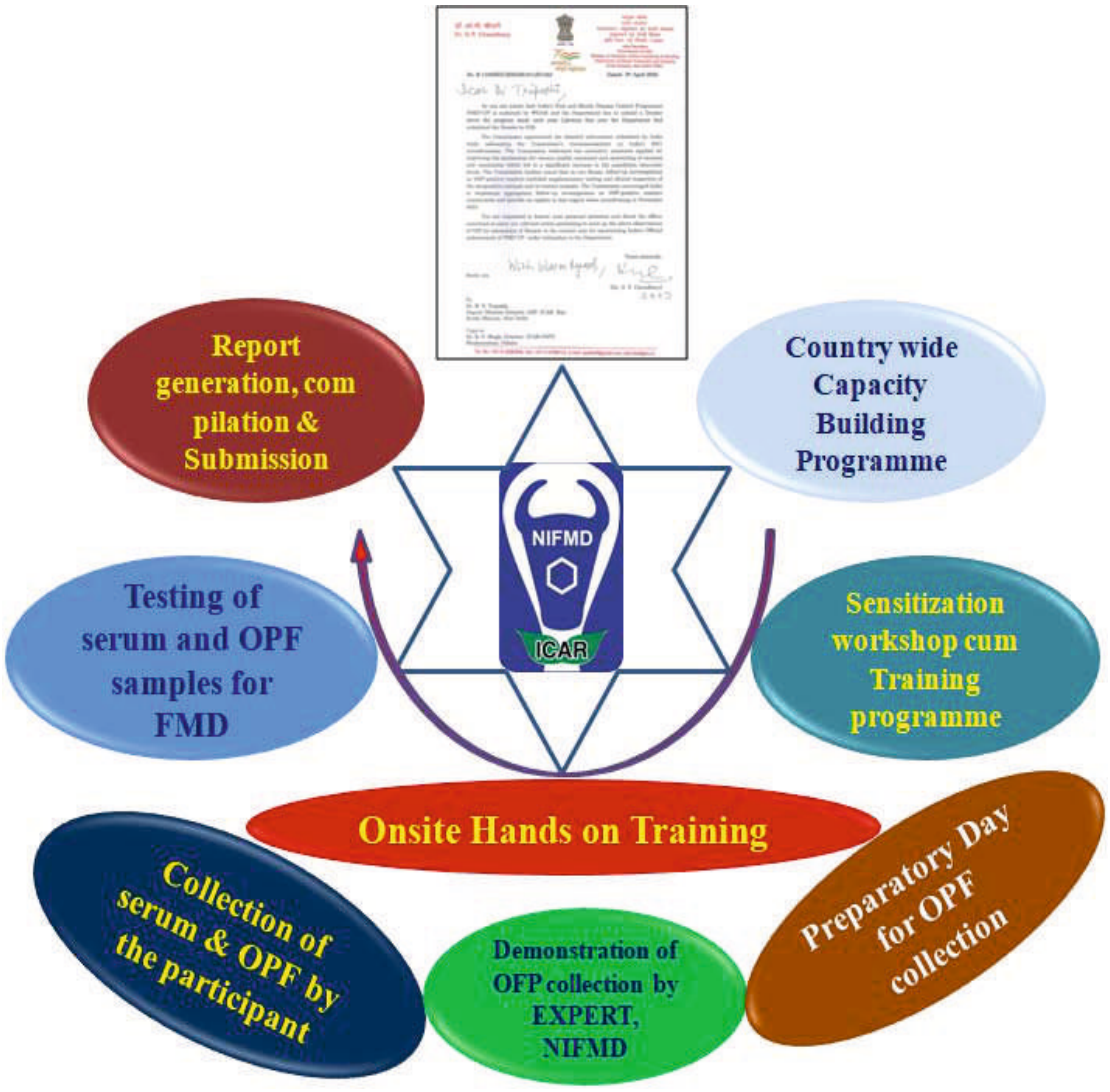


Fig 26: Mode of operation

Table 21. Details of training/workshops conducted on DIVA reactor follow up

Sl. No.	Training/ Workshop	Expert (ICAR-NIFMD)	Mode of Training	Place	Participating States/ UN	No. of Participants
1.	Sensitization workshop cum Training programme on 'Systematic follow-up investigation of NSP reactor by testing of oesophageal-pharyngeal fluid'	Scientist of ICAR-NIFMD	Online	Online Platform	All	>100 from 100 points
2.	Follow up investigation of FMD virus non-structural protein (NSP)-seroreactors by oesophageal-pharyngeal fluid (OPF) sampling and testing	Scientist of ICAR-NIFMD	Online	Online Platform	All	>142 from 142 points
3.	Follow up investigation of FMD virus non-structural protein (NSP)-seroreactors by oesophageal-pharyngeal fluid (OPF) sampling and testing	Scientist of ICAR-NIFMD	Online	Online Platform	All	>92 from 92 points
4.	Capacity building programme on probang/ oesophageal-pharyngeal fluid (OPF) collection, dispatch and follow-up of FMD NSP reactors for Central Region	÷ Dr Rajeev Ranjan ÷ Dr Manoranjan ÷ Dr R.P. Singh	Offline	FMD Regional Centre, Bhopal	Madhya Pradesh, Uttar Pradesh	18
5.	Capacity building programme on probang/ oesophageal-pharyngeal fluid (OPF) collection, dispatch and follow-up of FMD NSP reactors for Western Region	÷ Dr Rajeev Ranjan ÷ Dr J.K. Mohapatra ÷ Dr R.P. Singh	Offline	FMD Regional Centre, Pune	Maharashtra, Rajashtan, Gujarat, Goa, Diu Goa	28

6.	Capacity building programme on probang/ oesophageal-pharyngeal fluid (OPF) collection, dispatch and follow-up of FMD NSP reactors for Southern Region	÷ Dr Rajeev Ranjan ÷ Dr Saravanan S.	Offline	FMD Regional Centre, Bengaluru	Karnataka,Tamilnadu,Kerala, Andhara Pradesh, Puducherry, Telangana, Andaman & Nocobar	28
7.	Capacity building programme on probang/ oesophageal-pharyngeal fluid (OPF) collection, dispatch and follow-up of FMD NSP reactors for Northern Region	÷ Dr Rajeev Ranjan ÷ Dr A.P. Sahoo	Offline	FMD Regional Centre, Hisar	Haryana, Himachal Pradesh, Punjab, Delhi, Uttarakhand, Jammu (UT)	22
8.	Capacity building programme on probang/ oesophageal-pharyngeal fluid (OPF) collection, dispatch and follow-up of FMD NSP reactors for Eastern region	÷ Dr Rajeev Ranjan ÷ Dr Monalisa Sahoo ÷ Dr Tareni Das ÷ Dr R.P. Singh	Offline	FMD Regional Centre, Cuttack	Odisha, Bihar, Jharkhand, Chhatishgarh	20
9.	Capacity building programme on probang/ oesophageal-pharyngeal fluid (OPF) collection, dispatch and follow-up of FMD NSP reactors for North Easter region	÷ Dr Rajeev Ranjan ÷ Dr N.R. Sahoo ÷ Dr R.P. Singh	Offline	FMD Regional Centre, Guwahati	Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya	24

Glimpses of hands on training

10. HUMAN RESOURCE DEVELOPMENT

10.1 Participation of scientists in conferences, trainings etc.

10.1.1 Symposium/Seminar attended

S. No.	Name of Symposium/Seminar	Name of Scientists Attended
	International	
1.	First South Asia Transboundary Animal Diseases (TADs) coordination meeting, 8-12 May 2023, Paro, Bhutan	Dr R.P. Singh
2.	Webinar on 'The Dermal Microbiome: Identifying Biases at Different Stages of Your NGS Workflow' conducted by ATCC on September 21, 2023	Dr T. Das
3.	Eighteenth OIE/FAO FMD Reference Laboratory Network Annual Meeting. National Centre for Foreign Animal Disease (NCFAD), Winnipeg, Canada and online by video conferencing on 10th - 12th Ocotber 2023 (Online)	Dr R.P. Singh
4.	Webinar on 'the Need for Speed: Learn How Immune Checkpoint Reporter Cell Lines Can Accelerate Immunotherapeutic Development' conducted by ATCC on October 20, 2023(Online)	Dr T. Das
5.	Global FMD Research Alliance (GFRA) Scientific Meeting 2023 in Kampala, Uganda during 8th-10th November 2023	Dr J.K. Biswal
6.	Sixth meeting of the Peste des Petits Ruminants Global Research and Expertise Network (PPR-GREN) and 6th Peste des Petits Ruminants Advisory Committee (PPR AC), 28 November- 2 December 2023, Bengaluru India.	Dr R.P. Singh
7.	South Asia FMD Regional Advisory Group - virtual meeting - 8 Dec 2023 (Online)	Dr R.P. Singh
	National	
1.	XXXVth Annual Conference of IAVMI on the theme "Novel Approaches in Animal Health for Realizing One Health Mission" on April 7-8, 2023. DGCN College of Veterinary and Animal Sciences, CSK Himachal Pradesh Agricultural University, Palampur,	Dr R.P. Singh
2.	13 National Conference on One Health (hybrid mode) on 6th July, 2023 organized by Millenium India Education Foundation, New Delhi and Dept. of community medicine, VMMC and Safder Jung Hospital, New Delhi.	Dr T. Das
3.	XVI Agricultural Science Congress from October 10–13, 2023, at ICAR-CMFRI, Kochi, with a 3x3 m area exhibition stall.	Dr M. Rout Dr S.S. Dahiya
4.	VIROCON 2023 "Advancements in Global Virus Research towards One Health", 1st - 3rd December 2023, ICAR-NRC Banana, Tiruchirappalli, Tamil Nadu.	Dr M. Rout
5.	Veterinary Pathology Congress-2023 on "Advances in Veterinary Pathology for Diagnosis and Control of Emerging Disease of Livestock and Poultry" held on 20-22 December 2023 Organised by Indian Association of Veterinary Pathologists, ICVP and IVRI, Izatnagar, Bareilly-243122, UP	Dr M. Sahoo Dr R. Ranjan

First South Asia Transboundary Animal Diseases (TADs)

10.1.2 Training/Workshop attended

S. No.	Name of Training/Workshop	Name of Scientists Attended
	International	
1.	Two days (Hybrid) hands-on workshop on "The University of California Santa Cruz (UCSC) Genome Browser" organized by Genomics Training and Education Core, KY INBRE, USA during January 23-24, 2023	Dr S Das
2.	International workshop on "Genetic improvement of performance traits: A Genome wide selection prospective" organized by ICAR-CIFA in collaboration with AoA (Association of Aquaculturists), Kaushalyaganga, BBSR on 28th Oct 2023.	Dr NR Sahoo
	National	
1.	NABL Assessors' Training Course on ISO/IEC 17025:2017 held at ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI), Barrackpore during 17th January to 21st January 2023	Dr AP Sahoo Dr M Rout Dr JK Biswal Dr SS Dahiya
2.	IP Awareness/Training program under National Intellectual Property Awarness Mission on January 12,2023	All scientists
3.	Introduction to emerging technologies by Karmayogi, CBC on 22nd March, 2023	Dr T Das
4.	Online training program on "Introduction to emerging technologies" organized during March 28-30, 2023 by DoPT and Karmayogi Bharat, Govt. of India	Dr S Das
5.	Awareness programme on use of J-Gate@ ceRA on 23rd March, 2023	All scientists
6.	Training programme on "Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Officers of ICAR" organized by ICAR-NAARM, Hyderabad as HRD Nodal Officer between 27th February to 1st March 6, 2023	Dr R Ranjan
7.	National Training Conclave-2023 on 11th June 2023 at 9.00 am organized by Capacity Building Commission, GoI at Pragati Maidan, ITPO, New Delhi.	Dr R Ranjan

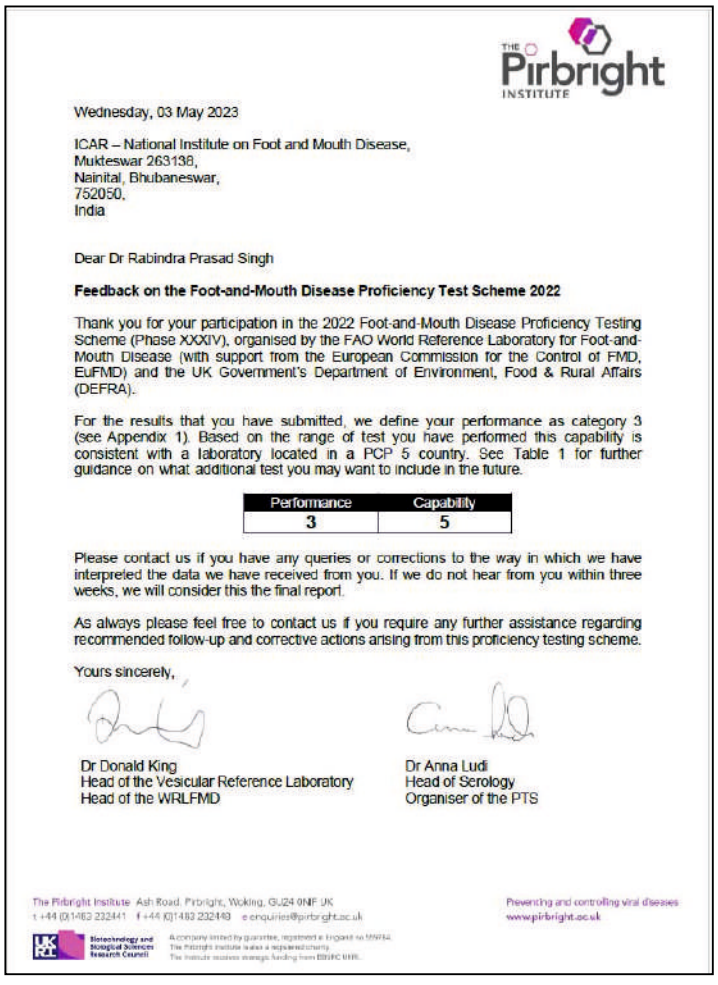
8.	Data Analysis with 'R' organised by Centre for e-Learning in collaboration with Dept. of Agricultural Statistics, College of Agriculture, Vellanikkara, Kerala Agricultural University, Thrissur during 07th to 11th August, 2023	Dr Saravanan S
9.	Training programme on Applied statistical concepts and tools for research data analysis organized by Department of Animal Genetics and Breeding, College of Veterinary Science and Animal Husbandry, Rewa (M.P.), India from 25th to 29th September 2023 (Online)	Dr T Das
10.	Three days Training/workshop on Right to Information Officers from 27-27th September, 2023 organized by Institute of Secretary Training and Management (ISTM), New Delhi.	Dr M Sahoo
11.	One Day Regional Training-cum-Awareness Workshop on J-Gate@CeRA for Eastern Region organized by Informatics pvt. Ltd. in collaboration with ICAR at OUAT, Bhubaneswar on November 10, 2023	Dr S Das
12.	Training programme on Geo-Spatial Analysis using QGIS & R organized by ICAR-National Academy of Agricultural Research Management (NAARM) Rajendra Nagar, Hyderabad 500030 during 20-24, November, 2023.	Dr Saravanan S
13.	ICVP workshop on "Morphological description of pathological lesions and Hands on training on Evaluation and interpretation of histopathological slides" by ICAR-IVRI on 23.12.23	Dr M Sahoo Dr R Ranjan

10.2 Student Guidance

Name of students and University	Degree and Discipline	Thesis research guide	Year of degree awarded	Title of thesis
Dr Shrinivas J Wattamwar (roll no M6084) ***(IVRI)***	M.V.Sc. Veterinary Pathology	Dr C. Jana	2023	Characterization of Foot and Mouth Disease virus isolated from outbreaks in farm ruminants and localization of viral antigen in goat tissues
Mr. Utkal Nayak (Admin no.: 212121318) ***(OUAT)***	M.Sc. Bioinformatics	Dr Samarendra Das	2023	Machine learning approaches for Foot and mouth disease virus molecular epidemiology prediction using nucleotide sequence data
Mr. Tanmay Parida (Admin no.: 212121310) ***(OUAT)***	M.Sc. Bioinformatics	Dr Samarendra Das	2023	Immuno-informatics approach for designing multi-epitope peptide based vaccine against Foot-and-Mouth disease SAT2 serotype

7.3 Participation in FMD PT Scheme, 2022 organized by the FAO-WRL for 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, 2022. This scheme was organized by the FAO World Reference Laboratory (WRL) for FMD in the UK, with support from EuFMD and DEFRA. In 2021, the institute participated only in the proficiency testing (PT) on the serology panel. However, in 2022, 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 (Fig 32). 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, 03 May 2023

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 2022

Thank you for your participation in the 2022 Foot-and-Mouth Disease Proficiency Testing Scheme (Phase XXXIV), 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

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11.0 EXTENSION ACTIVITIES AND OUTREACH PROGRAM

11.1 National FMD Control Awareness Week Observation

ICAR-NIFMD, Bhubaneswar, has enhanced its FMD awareness programmes in the country through different modes, like the celebration of second 'NATIONAL FMD CONTROL AWARNESS WEEK' in the week during September 11 (date of launch of NADCP on FMD) every year in collaboration with the 32 regional and collaborating FMD Centers spread across the country and all other stakeholders. Efforts are also being made to develop regular communication and stakeholders' involvement so that awareness, learning, and cross-learning can be encouraged during the entire process till we achieve the goal of "FMD Mukt Bharat". The present awareness campaign was therefore planned with the objective of strengthening stakeholder involvement (farming community, policymakers, technical experts, viz., scientists, field veterinarians, vaccine producers, communication experts, NGOs, and meat exporters) in order to achieve the goal of "FMD Mukt Bharat". In this context, ICAR-NIFMD, along with all the FMD regional and collaborating Centers, organised FMD control awareness programmes from the week that commenced from September 11 to September 17, 2023, followed by a feedback session on September 18, 2023. Similarly, National FMD Control Awareness Week was celebrated on September 11–17, 2023, at 32 state FMD regional and collaborating Centers, where several awareness programmes, vaccination camps, health camps, thematic lectures, role-playing, poster competitions, TV and radio talks, etc. were organised throughout the country by 32 state FMD regional and collaborating Centers and ICAR-NIFMD, Bhubaneswar. Beneficiaries of this FMD control awareness programme were farmers, livestock inspectors, livestock assistants, Gopal mitras, local public representatives, students, private dairy cooperatives, Zoological Park administrators, scientists, veterinarians, etc. In total, 9381 stakeholders, including 6231 farmers, 1845 veterinarians, 607 paraveterinary staff, and 698 students, participated directly in the programme. In addition, this awareness programme covered many more stakeholders through radio talk and newspaper coverage, live Facebook programmes, and other social media programmes conducted throughout the country..

Glimpse of National FMD control awareness week celebrated during September 11-17, 2023 by ICAR-NIFMD along with State FMD Centers.















11.2 Extension activities under LHDCP

Under LHDCP, state collaborating units conducted various extension activities for stakeholders across different states in the country. FMD Centers organized 35 training sessions for veterinary officers and students, covering various aspects of FMD prevention and control, with a total participation of 1235 professionals. Additionally, 118 awareness programs and animal health camps focused on the thematic area of FMD control were organized, benefiting a total of 6953 farmers (Table 22). Furthermore, 6 digital outreach programs were conducted in different languages to facilitate the prompt popularization of the NADCP/LHDCP project (Table 23).

Table 22. Details of FMD Awareness camp for Farmers, training programme for vets and paravets

Centre	FMD awareness program for Farmers Venue and date/ Month		Training program on FMD field work for vets and paravets	
	No of programs	Beneficiaries	No of programs	No Trained
Pune	2	200	8	285
Agartala	20	1024	–	–
Ahmedabad	1	457	–	–
Bhopal	–	–	5	231
Imphal	4	255	–	–
Ranchi	1	1500	5	265
Shimla	1	300	–	–
NRC M	2	114	–	–
Telangana	–	–	13	244
Andaman	1	25	–	–
Jammu & Kashmir	9	567	–	–
Andhra Pradesh	39	992	–	–
NRC Yak	11	95	–	–
Kerala	5	94	2	40
Tamil Nadu	2	70	–	–
Uttar Pradesh	1	25	–	–
Haryana	3	600	2	170
Punjab	3	86	–	–
Assam	10	404	–	–
Karnataka	1	60	–	–
Rajasthan	2	85	–	–

Table 23. Details of FMD Awareness through TV and radio talk

Programme	Date	Center	Media
पशुओं में खुरहा रोग एवं इससे बचाव **(TV programme recorded for the purpose of telecast on Krishi Darshan channel)**	13/04/ 2023	FMD collaborating centre, Bihar	Krishi Darshan programme on DD Bihar Channel
बाद में खुरहा रोग से बचाव **(TV programme recorded for the purpose of telecast on Krishi Darshan)**	26/08/2023	FMD collaborating centre, Bihar	Krishi Darshan programme on DD Bihar Channel
वर्षा ऋतु में खुरहा रोग का खतरा एवं बचाच **(TV programme recorded for the purpose of telecast on Krishi Darshan)**	27/08/2023	FMD collaborating centre, Bihar	Krishi Darshan programme on DD Bihar Channel
खुरहा रोग से बचाव हेतु टीकाकरण अभियान एवं कृषकों की भागदारी **(TV programme recorded for the purpose of telecast on Krishi Darshan)**	03/11/2023	FMD collaborating centre, Bihar	Krishi Darshan programme on DD Bihar Channel
FMD awareness	11/07/2023	FMD collaborating centre, Ranchi	Doordarshan
FMD awareness	20/04/2023	FMD collaborating centre, Ranchi	Red FM Radio jingle on FMD
Importance of FMD+HS combined vaccination for livestock owners	29/09/ 2023	FMD Regional Centre, Haryana	FM, Hisar

11.3 Participation in Agricultural Exhibition

÷ Dr M. Rout and Dr S.S. Dahiya participated and displayed an institute stall at the 16th Agricultural Science Congress (ASC) and ASC Expo from 10 to 13 October 2023 in Kochi, organized by the ICAR-Central Marine Fisheries Research Institute (CMFRI) and National Academy of Agricultural Sciences (NAAS), New Delhi. The theme of the expo was 'Transformation of agri-food systems for achieving sustainable development goals (SDGs)'.

÷ A team of scientists (Dr Rajeev Ranjan, Dr Nihar Ranjan Sahoo and Dr Manornajan Rout) from ICAR-NIFMD, Arugul, Bhubaneswar displayed an institute stall at ICAR- Central Institute for Women in Agriculture on the occasion of the organization's 28th Foundation Day on February 17, 2023. Following the exhibition's opening, numerous dignitaries, farmers, students, NGOs employees, etc. visited the stall. At the agricultural exhibition, scientists disseminated information on illness, immunisation, biosecurity, and other management strategies for FMD prevention and control to the visitors.

Glimpses of Agricultural exhibition at ICAR-Central Institute for Women in Agriculture, Bhubaneswar on 11th May, 2023

÷ A team of scientists (Dr Rajeev Ranjan and Dr Nihar Ranjan Sahoo) from ICAR-NIFMD-ICFMD, Arugul, Bhubaneswar displayed an institute stall at ICAR- Indian Institute of Water Management on the occasion of the organization's 36th Foundation Day on May 11, 2023. Following the exhibition's opening, dignitaries, farmers, students, NGOs employees, etc. visited the stall. At the agricultural exhibition, scientists diseminated information on illness, immunisation, biosecurity, and other management strategies for FMD prevention and control to the visitors. Visitors also received leaflets, folders, and other technical information about FMD.

Glimpse of Agricultural exhibition at ICAR- Indian Institute of Water Management, Bhubaneswar on 11th May, 2023

÷ Dr N.R. Sahoo, Dr R. Ranjan and Dr T. Das participated in OUAT Farmers' Fair-2023 Organized at OUAT main campus, Bhubaneswar on 27th-28th February 2023.

11.4 Development Action Plan for Scheduled Caste (DAPSC)

÷ During the year 2023, a total of 10 animal health camps, 32 input distribution programmes, 20 FMD awareness programmes, 1 goat distribution programme, 4 poultry chick distribution programmes, 13 PPR vaccination camps, 2 capacity building programmes and 10 study material distribution programmes were conducted under DAPSC. A total of 2582 people were benefited (Table 24).

Table 24. Details of FMD Awareness camp for Farmers, input distribution under DAPSC

S.No.	Programme	No of Activities	Venue	No of Beneficiary
1.	Animal Health Camp	10	Different GP of Khordha district and NIFMD Campus, Odisha	166
2.	Input Distribution	32	Different GP of Khordha district and NIFMD Campus, Odisha	938
3.	FMD Awareness	20	Different GP of Khordha district and NIFMD Campus, Odisha	641
4.	Goat Distribution	1	Different GP of Khordha district and NIFMD Campus, Odisha	30
5.	Poultry Chicks Distribution	4	Different GP of Khordha district, Odisha	52
6.	PPR Vaccination	13	Different GP of Khordha district, Odisha	192
7.	Capacity Building	2	Different GP of Khordha district and NIFMD Campus, Odisha	63
8.	Study Material Distribution	10	Different GP of Khordha district, Odisha	500
9.	Input Distribution	1	Nainital, Uttarakahnd	20

Glimpses of FMD Awareness & Input Distribution Programme in Odisha

Glimpses of Health Camp in Odisha

Glimpses of PPR vaccination Camp in Odisha

Glimpses of study material distribution in Odisha

11.4.1 Creation of goat value chain-A successful model under DAPSC

The activities carried out by ICAR-NIFMD under the DAPSC initiative in the years 2021, 2022, and 2023 have had a significant impact on the livelihood security of the Scheduled Caste (SC) community in the villages surrounding the institute. An exemplary case is that of Mr. Pradeep Bhoi from Barakuda village, an enthusiastic goat farmer who actively participated in the institute's initiatives. Before the intervention, Mr. Pradeep Bhoi had 40 goats. Through the institute's activities, he was provided with 8 additional goats in three phases, and his goat population has now increased to 60. As a result, he has gained an income of ₹40,000 from selling goats. In addition to goats, he was also provided with poultry chicks, and by selling poultry in the market, he earned ₹4000. Some of the poultry are now producing eggs, serving as a source of protein for his family. Due to his guidance, several people in the village have developed an interest and started keeping goats and birds under the supervision of ICAR-NIFMD's activities.

11.5 North Eastern Hill Region scheme

NEH programme of ICAR-NIFMD was initiated with the aim to support surveillance activities & epidemiology of FMD in terms of FMD awareness as per the institute mandate as well as to support NADCP on FMD activities. Under this activity, during the year 2023, there were 5 participating Centers such as Regional Research Centre at C.V.Sc., A.A.U., Khanapara, Guwahati (SAU) as well as State FMD collaborating Centers at Imphal, Aizawl, Kohima, and Agartala under Animal Husbandry Departments of respective Governments (Table 25).

Table 25. Type of activities conducted under NEH scheme

Sr. No	Activity	Units	States (Districts)
1.	Stakeholders trained	179 (M) + 261 (F) = 440	Manipur (Imphal East, Thoubal), Nagaland (Peren, Longleng), Tripura, Assam (West Karbi, Anglong)
2.	Testing of samples for disease/ Serosurvillance/ seromonitoring	7493	Manipur, Nagaland, Tripura, Assam, Mizoram
3.	Awareness / Vaccination / Health camp conducted	Camps - 87 Beneficiaries -2443	Manipur (Thoubal, Bishnupur, Tamenglong, Chandel), Nagaland (Peren, Longleng), Tripura, Assam (West Karbi, Anglong Kamrup), Mizoram (Kolasib and Aizawl).
4.	Distribution of critical inputs	Piglets-44 Chicks-927 Goat-02 Total - 973	Manipur (Chandel), Nagaland (Peren,Longleng), Assam (West Karbi, Anglong)

Piggery/ Poultry development programme organized RRC, Khanapara, Guwahati

Awareness/Health camp conducted Imphal Collaborating Centre, Manipur

Inputs distribution and Awareness/ Health camp conducted by Collaborating Center, Aizawl, Mizoram



11.7 Development Action Plan for Scheduled Tribe (DAPST)

The Developmental Action Plan for schedule Tribes was implemented in in 05 state 01 union territory for the year 2023. The operational areas included the tribal dominated villages from Odisha, Assam, Gujarat, Jammu & Kashmir, Jharkhand and Uttarakhand state/union territories were selected on operational area for DAPST 2022-23 schemes (Table 26). The various capacity building activities like demonstration, awareness camp, kisan goshti, animal health camp, input distribution for upkeep of animal health and production and improvement of livilihood was conducted.

Table 26. Activities under developmental action plan for schedule tribes by ICAR-NIFMD, Bhubaneswar

S.No.	Programme	No of Activities	Venue	Beneficiaries
1.	Baseline survey among ST stake holders	3	Different GPs of Khordha district, Odisha	57
2.	Input distribution to Farmers	9	Different GPs of Khordha district, Odisha	1821
3.	Study material distribution	4	Different GPs of Khordha district, Odisha	133
4.	FMD Awareness camps and kisan gosthi	2	Uttarakhand and Jammu	443
5.	Input distribution	2	Uttarakhand and Jammu	54
6.	Training programmes for Farmers	4	Uttarakhand, Assam and Jammu	391
7.	Demonstrations	2	Uttarakahnd and Jharkhand	78


Glimpses of activities under DAPST

12.0 EVENTS AND ACTIVITIES

12.1 Jan Bhagidari events

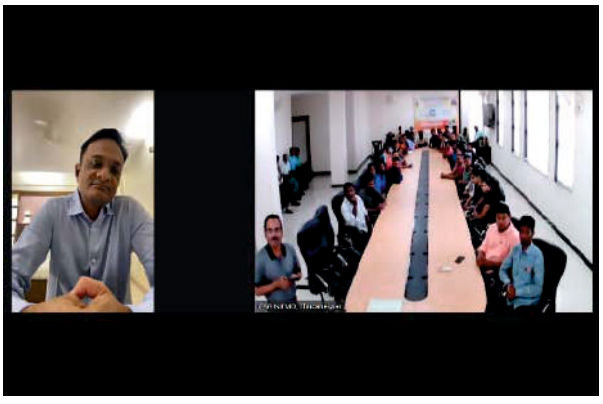
ICAR-NIFMD has been identified as a standalone institution for organizing and coordinating Jan Bhagidari events to raise awareness and imbibe the spirit of participation and ownership with India's G20 presidency in Odisha state that has been successfully commenced from 1st April 2023 (Utkal Dibasa / Odisha Day). ICAR-NIFMD has organized series of lectures, Input distribution, Vaccination and Swachhta campaign. Details are provided in the Table 27.

Table 27. Activities performed by NIFMD under G20

Sl. No.	Activity/program	Date	Place	No. of participants/ beneficiaries
1.	Observance of Utkal Divas and Inaugural function of G20	01.04.2023	ICFMD Campus	105
2.	Seminar and Webinar on different scientific topics (14 number)	07.04.2023 to 24.04.2023	ICFMD Campus, Different GP in Khordha and Puri districts	524
3.	Distribution of Inputs (14 number)	05.04.2023 to 21.04.2023	Different GP in Khordha	346
4.	Animal Health camp (2 number)	04.04.2023 to 13.04.2023	Different GP in Khordha	44
5.	Swachhta campaign	03.04.2023 to 12.04.2023	ICFMD Campus	74

Glimpses of Input Distribution


Glimpses of Lecture series

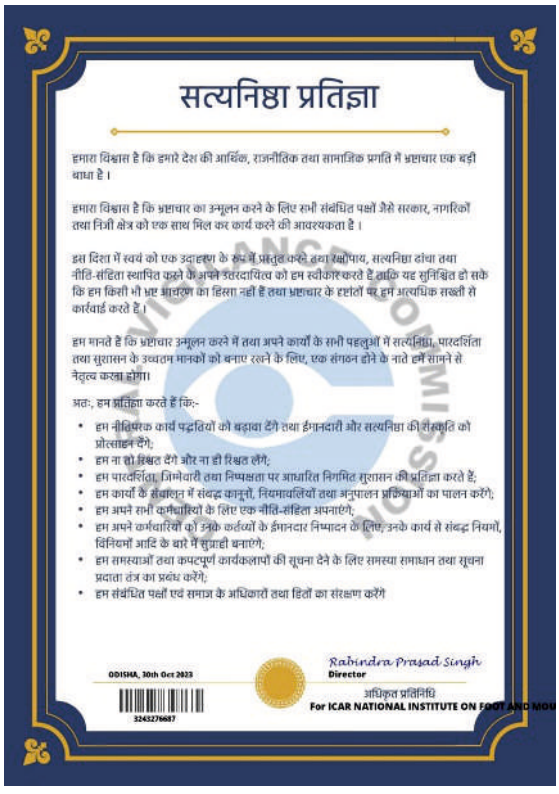



Glimpses of Health Camp


Observance of Utkal Divas

12.2 Vigilance Awareness Week

Vigilance Awareness Week-2023 was observed from 30th October to 5th November 2023 with a theme of 'Say no to corruption; commit to the Nation'. Activities undertaken were: administering pledge, publicity through social media like Whatsapp group of FMD Lab network. E-integrity pledge. Lecture on aspect of administration by CAO, and Lecture on GFR by F&AO was organized through online mode for the staff of ICAR-NIFMD.



सत्यनिष्ठा प्रतिज्ञा

हमारा विश्वास है कि हमारे देश की आर्थिक, राजनीतिक तथा सामाजिक प्रगति में भ्रष्टाचार एक बड़ी बाधा है।

हमारा विश्वास है कि भ्रष्टाचार का उन्मूलन करने के लिए सभी संबंधित पक्षों जैसे सरकार, नागरिकों तथा निजी क्षेत्र को एक साथ मिल कर कार्य करने की आवश्यकता है।

इस दिशा में स्वयं को एक उदाहरण के रूप में प्रस्तुत करने तथा स्वोपाय, सत्यनिष्ठा दांधा तथा नीति-संहिता स्थापित करने के अपने उत्तरदायित्व को हम स्वीकार करते हैं ताकि यह सुनिश्चित हो सके कि हम किसी भी भ्रष्ट आचरण का हिस्सा नहीं हैं तथा भ्रष्टाचार के दृष्टांतों पर हम अत्यधिक सख्ती से कार्रवाई करते हैं।

हम मानते हैं कि भ्रष्टाचार उन्मूलन करने में तथा अपने कार्यों के सभी पहलुओं में सत्यनिष्ठा, पारदर्शिता तथा सुशासन के उच्चतम मानकों को बनाए रखने के लिए, एक संगठन होने के नाते हमें सामने से नेतृत्व करना होगा।

अतः, हम प्रतिज्ञा करते हैं कि:-

- हम नीतिपरक कार्य पद्धतियों को बढ़ावा देंगे तथा ईमानदारी और सत्यनिष्ठा की संस्कृति को प्रोत्साहन देंगे;
- हम ना तो रिश्वत देंगे और ना ही रिश्वत लेंगे;
- हम पारदर्शिता, जिम्मेवारी तथा निष्पक्षता पर आधारित निगमित सुशासन की प्रतिज्ञा करते हैं;
- हम कार्यों के संचालन में संबद्ध कानूनों, नियमावलियों तथा अनुपालन प्रक्रियाओं का पालन करेंगे;
- हम अपने सभी कार्यवाहियों के लिए एक नीति-संहिता अपनाएंगे;
- हम अपने कर्मचारियों को उनके कर्तव्यों के ईमानदार निष्पादन के लिए उनके कार्य से संबद्ध नियमों, विनियमों आदि के बारे में सुग्राही बनाएंगे;
- हम समस्याओं तथा कपटपूर्ण कार्यकलापों की सूचना देने के लिए समस्या समाधान तथा सूचना प्रदाता तंत्र का प्रबंध करेंगे;
- हम संबंधित पक्षों एवं समाज के अधिकारों तथा हितों का संरक्षण करेंगे

ODISHA, 30th Oct 2023

Rabindra Prasad Singh
Director
अधिकृत प्रतिनिधि
For ICAR NATIONAL INSTITUTE ON FOOT AND MOU

12.3 Swachha Bharat activities

ICAR-NIFMD organized Swachha Bharat activity under Special Campaign 3.0 from 2nd October to 31st October, 2023 and during 16-31 December 2023. Several indoor and outdoor swachhata awareness programs were conducted during this period by Dr S. Mallick. Hygiene awareness programs were conducted at Govt. High school, Podapada and Haladipada on 6.10.2023 and 13.10.2023 respectively to inculcate the habit of personal and environmental hygiene among the school children. On 18.12.2023 a swachhata drive was organized at Kuradamalla Gram Panchayat of Khurdha block. Dr S. Mallick, Dr T. Das and Dr M. Sahoo attended the programme. The farmers and farm women were made aware about the importance of cleanliness and Swachha Bharat Abhiyan. A total of 30 farmers were distributed with a set of essential items such as plastic tub, handwash, towel and phenyl for the betterment of their livelihood practices under DAPST. Several in-campus cleanliness programmes were also organized during the swachhata pakhwada.

Green Campus

Ms. Alka Upadhyaya, Secretary (DAHD), New Delhi plantation at ICAR-NIFMD (ICFMD), Bhubaneswar on 25/08/2023

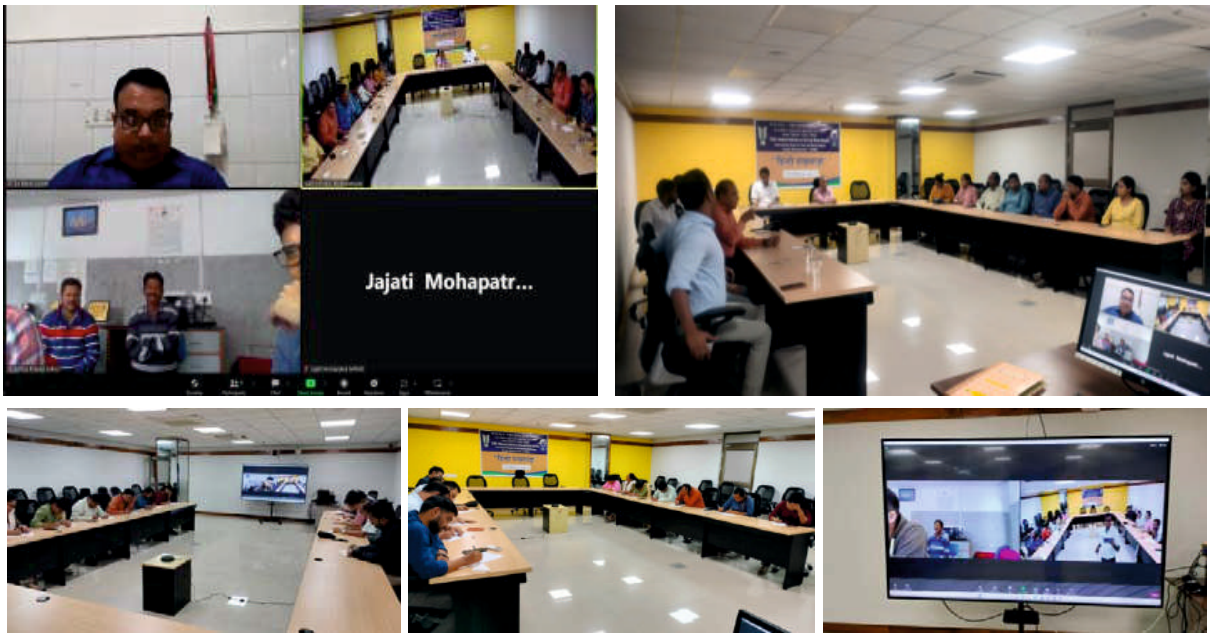
Dr. J.K. Jena, DDA(AS), ICAR, New Delhi plantation at ICAR-NIFMD (ICFMD), Bhubaneswar on 25/08/2023

Dr. Abhijit Mitra, AHC (DAHD), New Delhi plantation at ICAR-NIFMD (ICFMD), Bhubaseswar on 25/08/2023

13.0 हिंदी पखवाड़ा

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 हैः–

1. **हिन्दी राजभाषा कार्यान्वयन समितिः** आईसीएआर–डीएफएमडी 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 कार्यान्वयनः** भारत सरकार की राजभाषा नीति के अनुसरण में, राजभाषा अधिनियम, 1963 की धारा 3(3) के तहत आने वाले सभी दस्तावेज अंग्रेजी और हिंदी में जारी किए जा रहे हैं।
3. **हिन्दी पखवाड़ा–2023:** भाकृअनुप– राष्ट्रीय खुरपका मुँहपका रोग संस्थान, अंतर्राष्ट्रीय केंद्र खुरपका मुँहपका रोग, अरुगुल, भुवनेश्वर– 752050, ओड़ीशा में "हिन्दी पखवाड़ा–2023" 14–28 सितम्बर 2023 के बीच मनाया गया। इस हिन्दी पखवाड़ा में विविन्न प्रतियोगिताएँ जैसे कि हिन्दी शब्दावली एवं प्रश्नावली प्रतियोगिता, कम्प्युटर पर यूनिकोड में हिन्दी अनुवाद टाइपिंग, हिन्दी वाद–विवाद प्रतियोगिता– विषयः नई शिक्षा नीति, हिन्दी काव्य–पाठ (स्वरचित /सस्वर/बालकविता) प्रतियोगिता (बाल–सदस्य) का आयोजन हिन्दी अधिकारी, डा. राजीव रंजन एवं संस्थान के निदेशक महोदय की देख रेख में आभासी एवं प्रत्यक्ष माध्यम द्वारा किया गया।



चित्रः हिन्दी पखवाड़ा–2023, 14–28 सितम्बर, 2023 के अंतर्गत आयोजित विभिन्न कार्यक्रम।

हिन्दी पखवाड़ा–2023 का शुभारंभ 14.09.2023 को मुख्य अतिथि डा बबलू कुमार एवं संस्थान के निदेशक डा रबीन्द्र प्रसाद सिंह की उपस्थिति में की गयी एवं इस पखवाड़े में संस्थान के वैज्ञानिक, कर्मचारी, अधिकारी, एसआरएफ–वाई पी –I/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 पखवाड़े–2023 का पुरस्कार वितरण एवं समापन समारोह आयोजन दिनांक 29.09.2023 को मुख्य आतिथि श्री हरिराम पंसारी जी, पुर्व वरिष्ठ प्रबंधक (राजभाषा), नालको, भुबनेश्वर की उपस्थिति में हुआ। प्रतियोगिता में उपस्थित प्रतिभागियों को मुख्य अतिथि 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. **Aaj ka Shabd:** संस्थान में कार्यरत सभी कर्मचारी की हिन्दी अच्छी हो इसके लिए हिन्दी अधिकार द्वारा प्रत्येक दिन हिन्दी 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। यह शब्द प्रायः प्रशासनिक और तकनीकी प्रकृति के होते हैं, जिनका उपयोग दिन–प्रतिदिन के आधिकारिक कार्यों में किया जाता है।

अंग्रेजी में शब्द	हिन्दी में अर्थ
Livelihood	आजीविका
Overdue	पुराना, अतिदेय
Kindly	कृप्या, अनुकूल
Aid	मदद, सहायता
Potential	संभावित
Notable	महत्वपूर्ण, विशेष
Abolition	समाप्ति, उन्मूलन
Oversight	चूक, भूल

6. **Inspection regarding progressive use of Hindi:** परिषद मुख्यालय के अधिकारियों द्वारा भुवनेश्वर स्थित सभी आईसीएआर संस्थानों का वार्षिक राजभाषायी निरीक्षण दिनांक 17.08.2023 आईसीएआर–आईआईडबल्यूएम में किया गया। इस बैठक में डा अर्जमादत्त षड़ंगी (निदेशक, आईसीएआर–आईआईडबल्यूएम) श्री संजय बोकोलिया (निदेशक, राजभाषा विभाग, आईसीएआर, नई दिल्ली), श्री आर डी शर्मा (उप निदेशक, राजभाषा, आईसीएआर, नई दिल्ली) एवं श्री जी भट्ट (आईसीएआर, नई दिल्ली) एवं भुवनेश्वर स्थित सभी आईसीएआर संस्थानों उपस्थित रहे। सभी संस्थानों की वार्षिक रिपोर्ट की समीक्षा निदेशक एवं उप निदेशक महोदया द्वारा किया गया एवं निरीक्षण के तत्पश्चात भुवनेश्वर स्थित सभी आईसीएआर संस्थानों को यह सुझाव दिया गया की सभी संस्थान राजभाषा विभाग भारत सरकार द्वारा दिये गए दिशा निर्देश के अनुसार संस्थानों में हिन्दी का अधिक से अधिक उपयोग करें। इस वार्षिक राजभाषायी निरीक्षण बैठम में संस्थान कि तरफ से प्रभारी हिन्दी अधिकारी, डा राजीव रंजन, वरिष्ठ वैज्ञानिक ने भाग लिए थे।

14.0 DISTINGUISHED VISITORS

Ms. Alka Upadhyaya, Secretary (DAHD), Dr Abhijit Mitra, AHC, Dr J.K. Jena, DDG (AS), ICAR, New Delhi and Shri S.K. Bashith, Principal Secretary (FARD Govt. of Orissa), visited the ICAR-NIFMD (ICFMD), Bhubaneswar on 25/08/2023

Smt. Aparajita Sarangi, Hon'ble Member of Parliament, Bhubaneswar, visited the ICAR-NIFMD (ICFMD), Bhubaneswar on 22/11/2023

Sh. G.P. Sharma, Joint Secretary (Finance), ICAR visited the ICAR-NIFMD (ICFMD), Bhubaneswar on 02/12/2023

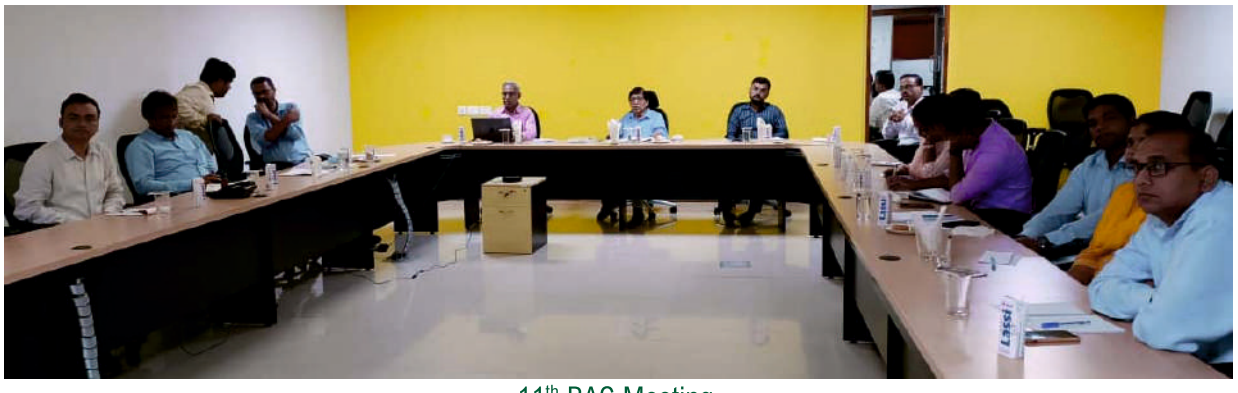
Dr. A. Sahoo, Director, NRC on Camel, visited the ICAR-NIFMD (ICFMD), Bhubaneswar on 24/02/2023

15.0 COMMITTEES

15.1 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, Siksha O Anusandhan 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 Ashok Kumar	ADG (AH), ICAR, KrishiBhavan, New Delhi-110 001	Member
Dr S P Biswal	Bhubaneswar, Odisha	Member
Dr J Mondal	Bankura, West Bengal	Member
Dr Saravanan S	Principal Scientist, ICAR-NIFMD	Member Secretary

1. The eleventh meeting of the RAC of ICAR-NIFMD presided over by Dr C. Renukaprasad, Former Vice-Chancellor, KVAFSU was held on 24th, May 2023 in hybrid mode at ICAR-NIFMD, ICFMD, Bhubaneswar
2. The pre-RAC meeting of ICAR-NIFMD, Bhubaneswar, was held on September 8, 2023, at 11.30 AM through an online platform under the chairmanship of Dr H. Rahman
3. The Institute Research Committee (IRC) meeting of ICAR- NIFMD, Bhubaneswar, was held on July 20 and 21, 2023, under the chairmanship of Dr R.P. Singh, Director, ICAR-NIFMD, at the ICFMD campus, Bhubaneswar.
4. The Mid-term Institute Research Committee (IRC) meeting of ICAR-NIFMD, Bhubaneswar, took place on December 4 and 5, 2023, under the chairmanship of Dr R.P. Singh, Director, ICAR-NIFMD, at the ICFMD campus in Bhubaneswar.



11th RAC Meeting

15.2 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	Scientist (SS), ICAR-NIFMD	Member
Dr J K Biswal	Sr.Scientist, ICAR-NIFMD	Member Secretary

1. 5th ITMC meeting was held on 1st June 2023 at committee hall of ICFMD, Bhubaneswar on the subject "identification and certification of the products / technologies / concept / methodology etc., developed by scientists for recognition and wider dissemination.

2. 6th ITMC meeting was held on 12th December 2023 at committee hall of ICFMD, Bhubaneswar on the subject "identification and certification of the products / technologies / concept / methodology etc., developed by scientists for recognition and wider dissemination, and technology commercialization.

6th ITMC meeting

13.3 Institutional Animals Ethics Committee

Name	Designation	Role
Dr Jajati 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	Scientist In-charge of Animal House Facility (Member Secretary)

7th and 8th IAEC meeting of ICAR-NIFMD were held on 26.05.2023 and 05.10.2023, respectively. During this meeting, progress of ongoing approved project and new submitted proposal for approval from IAEC have been discussed. During 2023, total 03 new projects have been approved by IAEC. IAEC of the institute has been renewed and it will be constitute for next five years. Annual inspection of animal house has also been carried out by the Dr Ajit K Naik, Main Nominee CCSEA on 29.12.2023 presence of Dr JK Mohapatra, Chairman and Dr R Ranjan, Member Secretary, IAEC.

Fig.: 7th and 8th IAEC meeting of ICAR-NIFMD held on 26.05.2023 and 05.10.2023 at ICAR-NIFMD, Bhubaneswar, Odisha

13.4 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	Scientist, ICAR-NIFMD	Internal Member
Dr Jitedra K Biswal	Sr. Scientist, ICAR-NIFMD	Internal Member
DrJajati K Mohapatra	Pr. Scientist, ICAR-ICFMD	Internal Member & Member Secretary

13.5 Institute Management Committee

Name	Designation	Position
Dr Rabindra Prasad Singh	Director, ICAR-NIFMD, Bhubaneswar	Chairman
Dr D Hemadri	Principal Scientist, NIVEDI, Bengaluru	Member
Dr C Tosh	Principal Scientist, NIHSAH, Bhopal	Member
Dr B P Srinivas	Principal Scientist, IVRI, Bengaluru	Member
Dr Sanjay Barua	Principal Scientist, VTCC, NRCE, Hisar	Member
Dr Ashok Kumar	ADG (AH), ICAR, New Delhi	Member
Dr Shiba Prasad Biswal	S/o Basanta Kumar Biswal, Bhubaneswar	Member
Dr Jayanta Mondal	S/o Late Janaki Mondal, Bankura, West Bengal	Member
Mr Tarakumar	AAO, ICAR-NIFMD, Bhubaneswar	Member Secretary

13.6 हिन्दी राजभाषा कार्यान्वयन समिति

÷	**डा. रवीन्द्र प्रसाद सिंह**, निदेशक	अध्यक्ष
÷	**डा. जजाति केशरी महापात्र**, प्रधान वैज्ञानिक	सदस्य
÷	**डा. सरवनन सुबरमणियम**, प्रधान वैज्ञानिक	सदस्य
÷	**डा. सागर अशोक खुलापे**, वैज्ञानिक	सदस्य
÷	**श्री तारा कुमार**, स.प्र.अ.	सदस्य
÷	**श्री नयन संजीव सिंह**, तकनीकी अधिकारी	सदस्य
÷	**डा. राजीव रंजन**, वरिष्ठ वैज्ञानिक	हिन्दी अधिकारी एवं सदस्य सचिव

14.0 PERSONNEL

14.1 Details of the staff as on 31-12-2023

	Name	Designation	Discipline
1.	Dr Rabindra Prasad Singh	Director	RMP
2.	Dr Jajati K Mohapatra	Principal Scientist	Veterinary Microbiology
3.	Dr Saravanan Subramaniam	Principal Scientist	Veterinary Microbiology
4.	Dr Nihar R Sahoo	Senior Scientist	Animal Genetics
5.	Dr Aditya P Sahoo	Senior Scientist	Animal Biotechnology
6.	Dr Manoranjan Rout	Senior Scientist	Veterinary Pathology
7.	Dr Monalisa Sahoo	Senior Scientist	Veterinary Pathology
8.	Dr Rajeev Ranjan	Senior Scientist	Veterinary Pathology
9.	Dr Jitendra K Biswal	Senior Scientist	Animal Biochemistry
10.	Dr Shyam S Dahiya	Scientist (Sr. Scale)	Veterinary Microbiology
11.	Dr Samarendra Das	Scientist (Sr. Scale)	Bioinformatics
12.	Dr Smrutirekha Mallick	Scientist	Animal Physiology
13.	Dr Tareni Das	Scientist	Veterinary Pathology
14.	Sh H L Meena	Adnl Charge of HoA, Regular service in CIFA	
15.	Sh Prabhat Kumar Nayak	Adnl Charge of F&AO, Regular service in CIWA	
16.	Sh. Tara Kumar	AAO	-
17.	Sh. R.N.Sahoo	Assistant	-
18.	Sh. Ravi Chaudhary	Junior Stenographer	-
19.	Sh. Nayan Sanjeev	T-5 (Lab)	-
20.	Sh. S.L.Tamta	T-1 (Lab)	-

14.2 Joining/ Transfer/Promotions/Superannuation

	Name	Designation	Date	Details
1.	Dr Saravanan S	Sr. Scientist	08.01.2022	Promoted to Principal Scientist (level 14)
2.	Dr A P Sahoo	Sr. Scientist	21.04.2021	Promoted to Senior Scientist (level 13A)
3.	Dr M Rout	Sr. Scientist	04.11.2021	Promoted to Senior Scientist (level 13A)
4.	Dr M Sahoo	Sr. Scientist	21.04.2022	Promoted to Senior Scientist (level 13A)
5.	Dr S A Khulape	Sr. Scientist	13.07.2023	Relieved to join NRC-Camel
6.	Dr Saravanan S	Sr. Scientist	10.03.2023	Transferred to NIFMD, Bhubaneswar
7.	Dr A P Sahoo	Sr. Scientist	10.03.2023	Transferred to FMD lab, Mukteswar

14.3 In Charges of Section / Unit / Cell

	In Charge/Nodal Officer	Section/unit/cell/others
1.	Dr Mohapatra JK	Bio Safety Officer and Public Relation
2.	Dr Saravanan S	PME and Vigilance cell
3.	Dr Biswal JK	ITMU
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

30 th Annual Review Meeting of State FMD Centres

Date: 01-11-2022 & 02-11-22

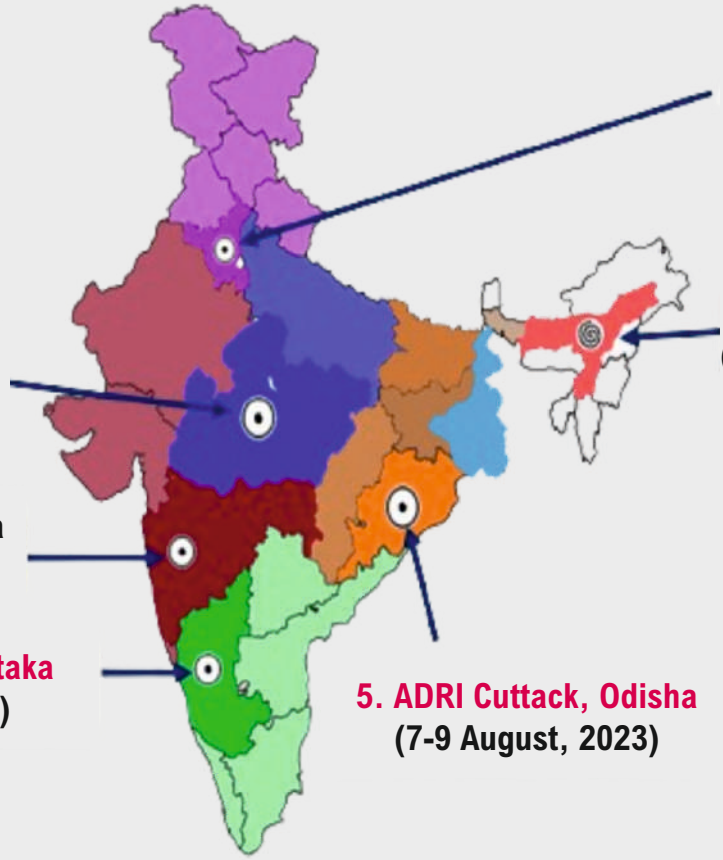
Division of Animal Biotechnology College of Biotechnology

at

College of Biotechnology

Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut

Country-wide Capacity building programme on follow-up of FMD NSP reactors



4. Hisar, Haryana
(25-27 July, 2023)

6. Guwahati, Assam
(20-22 September, 2023)

1. Bhopal, MP
(07-09 June, 2023)

2. Pune, Maharashtra
(11-13 June, 2023)

3. Bengaluru, Karnataka
(11-13 July, 2023)

5. ADRI Cuttack, Odisha
(7-9 August, 2023)

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