ICAR-DFMD

ANNUAL REPORT 2019

ICAR-Directorate of Foot and Mouth Disease
Mukteswar 263 138
Nainital, Uttarakhand, India

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Foreword

Livestock farming - the mainstay of Indian rural economy – is adversely impacted by Foot and Mouth Disease (FMD) which is endemic in India and has been reported throughout the year in almost all parts of the country. The disease remains a serious threat to the livestock population, primarily cattle and buffaloes. Considering the importance of FMD, a bi-annual vaccination-based FMD Control Programme (FMDCP) was initiated by the Government of India since 2004, initially covering 54 districts (Phase I) in the country. Later, the programme has been expanded in a phase-wise manner to cover the entire country. At present; the disease occurrence, severity of the clinical disease, and number of the outbreaks have progressively and substantially declined in areas under regular vaccination campaign. In India, three serotypes (O, A and Asia1) of FMD virus (FMDV) are prevalent. The Serotype "O" is the most prevalent one followed by serotypes "Asia-1" and "A".

Shri Narendra Modi, the Hon'ble Prime Minister of India, launched the National Animal Disease Control Programme (NADCP) on September 11, 2019 with a goal to eradicate FMD and brucellosis in livestock by 2030. The programme aims to vaccinate over 500 million livestock heads, including cattle, buffalo, sheep, goats and pigs, against FMD. The programme is supported by 100% funding from the Centre, amounting to Rs 12,652 crores for five years until 2024. The ICAR-DFMD is the premier research institute in the country involved in FMD research. The institute technically and logistically supports FMD Control programme under NADCP. Several highly sensitive indigenous diagnostic tests/Kits have been developed and are being used for real-time monitoring and surveillance of FMD in animals. Information on genetic and antigenic spectrum of circulating genotypes/lineages of FMD is being generated by molecular epidemiological analyses. The ICAR-DFMD also identifies and supplies appropriate vaccine strains to the Indian Vaccine Manufacturers.

The Serotype "A" FMDV strains circulating in India since 2012-13 have been found to be antigenically divergent from the currently used vaccine strain (A IND40/2000), thereby, warranting selection of a new candidate vaccine strain. The FMDV A/IND27/2011 strain emerged to be the candidate strain of choice out of a panel of 8 strains selected initially based on its widest antigenic relatedness with the circulating field isolates. As there is no outbreak of FMDV serotype A in India since the year 2015, irrespective of antigenic divergence observed in the field, it needs to be debated whether to wait and further check the antigenic relatedness of any field outbreak strain (in case outbreaks occur), with the new candidate vaccine strain A/IND27/2011 since serotype A is historically known for rapid and wide antigenic drift.

ICAR-DFMD organized six-days training programme on "FMD Post Vaccination Sero-monitoring using Solid Phase Competitive ELISA (SPC-ELISA)" in six batches during October-December 2019. A pool of 43 trained personnel from Regional and Collaborating centres of "AICRP on FMD" located in different states was created to undertake the task of FMD sero-monitoring. The SPC-ELISA Kits for testing one round of serum samples were provided to each centre at the end of the training. The ICAR-DFMD monitors the testing activity and produces, standardizes and supplies the SPC-ELISA Kits to all the centres as per their requirement.

In India, for post-vaccination seromonitoring, a sampling strategy comprising 200 each pre- and post-vaccination serum samples collected from each round of vaccination per district was adopted. However, in compliance with the Expert advice of the OIE FMD Mission to India, a new statistically validated post-vaccination sero-monitoring sampling strategy was devised in

collaboration with ICAR-NIVEDI in order to decipher a clear picture of the population immunity. During pre- and post-vaccination serum sample collection, meta-data related to population demography is also being collected.

For 3AB3-NSP-based serosurveillance activity, 200 bovine serum samples (animals 6 - 18 months of age) per district once every year were collected at random from various districts of India. Henceforth a two-stage sampling strategy developed jointly by ICAR-NIVEDI and ICAR-DFMD for FMDV NSP-antibody sero-surveillance would be followed. For NSP serosurveillance, the study design usually focuses on younger animals (less than one year of age) since repeated vaccination even with good quality vaccine can generate false positive signal in FMDV NSP-ELISA. Risk-based sampling strategies may be more effective than simple random sampling.

FMD surveillance in India is being carried out by 27 Regional and Collaborating Centers spanning across the country and International Centre for FMD (ICFMD) at Bhubaneswar. All the activities of these laboratories are coordinated under the All India Coordinated Research Project (AICRP) for FMD. The serotyping of the clinical materials collected from the suspected outbreaks/cases is conducted by the Network Laboratories using sandwich ELISA and clinical samples are referred subsequently to ICFMD for complete characterization of strains. ELISA negative samples are subjected to multiplex PCR for diagnosis. Molecular epidemiological analysis based on P1/1D gene sequence and studies of antigenic relationship of the field outbreak strains with the vaccine strains to monitor antigenic variation, if any, occurring in the field is carried out regularly. The ICAR-DFMD and its AICRP component (AICRP for epidemiological studies on FMD) are involved in gathering real-time epidemiological information since 1968 and developing companion diagnostics for FMD. The institute has been providing all the technical/laboratory and diagnostic support to the FMD Control Programme (FMDCP) being run by DAH&D, Govt. of India since 2003-04.

I am happy to share that ICAR-DFMD is a member of the Global FAO/OIE Network of FMD Reference Laboratories comprising ten other FMD laboratories in the world. The institute also functions as the FAO-FMD Reference Center and SAARC Regional Leading Diagnostic Laboratory for FMD. The institute is also a member of GFRA (Global FMD Research Alliance). The state-of-the-art FMD research centre (ICFMD) with high containment laboratory facility established by ICAR at Bhubaneswar meet the major requirement of FMDCP as stipulated by OIE/FAO, and will cater to the need of researchers and scientists of India and abroad for safe handling of FMD virus as per international norms. This state-of-the-art FMD research centre in South Asia will help analyse exotic FMDV strains in order to develop capacity and be in preparedness in respect of diagnostics and vaccines to prevent any possible future incursion of the disease.

I express deep sense of gratitude to Dr T. Mohapatra, Hon'ble Secretary, DARE & DG, ICAR; Shri B. Pradhan, AS&FA, DARE; Shri C Roul/Shri Sushil Kumar/Shri Sanjay Singh, Addl. Secretary (DARE) & Secretary, ICAR; Dr J. K. Jena/Dr B N Tripathi, DDG (AS), ICAR and Dr Ashok Kumar, ADG (AH), ICAR for providing all the necessary support & guidance in steering the Institute. Also, the help and support extended by Dr. Jyoti Misri, Principal Scientist (AH), Dr Vineet Bhasin, Principal Scientist (AGB) and Dr Ranjan Gupta, Principal Scientist (ANP) is duly acknowledged. Untiring effort of a small group of young scientists in achieving new milestones at the institute is praiseworthy. I place on record my appreciation for Administration, Audit, Accounts, and Technical, and Skilled support staff of the ICAR-DFMD for their excellent assistance in achieving the targets.

R K Singh

Executive Summary

1

During the year 2019, a total 52 outbreaks of FMD were recorded in the country (Table 1). There has been reduction in disease incidences in the entire region of the country. States including Andhra Pradesh, Telangana, Kerala, Uttar Pradesh, Jammu & Kashmir, Himachal Pradesh, Bihar, Odisha, Arunachal Pradesh and Manipur reported nil FMD outbreaks.

Vaccine matching exercise was carried out to evaluate antigenic relationship of field isolates with currently used vaccine strains to monitor antigenic variation, if any, occurring in the field, and to assess appropriateness of in-use vaccine strains. A total of 9 FMD virus serotype O were antigenically characterized during the period. The field situation suggested all of the isolates were

Table 1: Number of confirmed FMD incidences in different geographical regions of the country during the last five years.

Year	South	North	Central	West	East	North East	Total
2015-16	89	18	26	23	44	52	252
2016-17	49	11	05	06	22	57	150
2017-18	101	17	-	10	-	21	149
2018 (Apr-Dec)	207	26	04	15	78	21	351
2019 (Jan-Dec)	16	11	01	13	05	06	52

The serotype O continued to be most predominant one and was responsible for 98% of the outbreaks recorded during 2019. After a period of almost three years, serotype A was recorded in the country in the state of Maharashtra. The serotype Asia1 was not recorded in any of the states (Table 2). Maximum incidences of FMD were recorded in January and February during which a total of 43 of 52 outbreaks were recorded across the country.

Table 2: Year wise outbreaks/incidences of FMD and virus serotypes involved during last 5 years.

Year	No. of outbreaks	O	A	Asia1
2015-16	252	244	06	02
2016-17	150	150	-	-
2017-18	149	146	-	03
2018 (Apr-Dec)	351	347	-	04
2019 (Jan-Dec)	52	51	1	-

antigenically homologous to currently used vaccine strain INDR2/1975. The isolates of serotype Asia1 also antigencially covered by currently used vaccine strain IND63/1972. To circumvent emergence of antigenically divergent VP3[59]-deletion group strains in serotype A, an alternate vaccine candidate strain, A IND 27/2011, (isolated from a bullock in Chikkaballapur district, Karnataka) has been identified for replacement of the existing vaccine strain A IND 40/2000 to maintain the vaccine efficacy and is ready for inclusion in vaccine formulation.

Phylogenetic analysis based on P1/VP1coding region was carried out to assess genetic variations/ mutations/recombination, inter-strain relationships and track movement of the virus. During the period, capsid coding region (P1/VP1) sequences of 31 FMD virus strains were deduced and were added to the sequence database of Indian FMD viruses. Analysis of these data led to many important phylogenetic inferences for understanding molecular epidemiology of FMD. Phylogenetic analysis of

serotype O virus revealed extended dominance of lineage Ind2001 strains. The lineage Ind2001 has been dominating the scenario since the year 2008 with emergence of sub-lineage Ind2001d in 2008 and sub-lineage Ind2001e in 2016. FMD virus serotype A isolates collected from Maharashtra in January clustered within Genotype 18 but distantly from both deletion and non-deletion lineages which indicates the possibility of emergence of new lineage within Genotype 18.

National FMD Virus Repository was upgraded with new virus isolates. The virus repository has served the cause of the country by providing isolates for molecular epidemiological studies, evaluation of antigenic relatedness between the field and vaccine strains and selection of new candidate vaccine strains whenever required. A total of 15 serotype O virus isolates were added to the repository during the reported period. At present the National FMD virus Repository holds a total of 2278 isolates (O-1574, A-323, C-15 and Asia 1-366).

Under FMDCP seromonitoring programme to assess the effectiveness of vaccination, a total of 2,97,900 serum samples were tested using SPCE during 2019 . Till date, 15,32, 320 serum samples collected under FMDCP were tested for estimation protective antibody level against each of the three serotypes (O, A and Asia1). In this process of a total of about 45,96,960 tests were conducted and results were communicated to DAH&D.

Under National FMD Serosurveillance, 30,413 bovine serum samples collected at random from various parts of the country were tested using r3AB3 NSP-ELISA (DIVA) for assessing the prevalence of NSP-antibody (NSP-Ab) positive animals, which is an indicator of FMD virus exposure regardless of vaccination status and virus circulation. The test revealed overall seropositivity in 20.8% samples/ animals, which is slightly higher than the previous year's average of 19.98%.

Vision, Mission, Mandate, Objectives and Technical Programme

2

Vision:

India free from Foot and Mouth Disease.

Mission:

Active epidemiological surveillance through regularly monitoring antigenicity 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:

Active epidemiological surveillance through regularly monitoring antigenicity and genomic make up of the FMD virus strains responsible for disease incidences, and also to provide training in diagnosis and epidemiology.

Objectives:

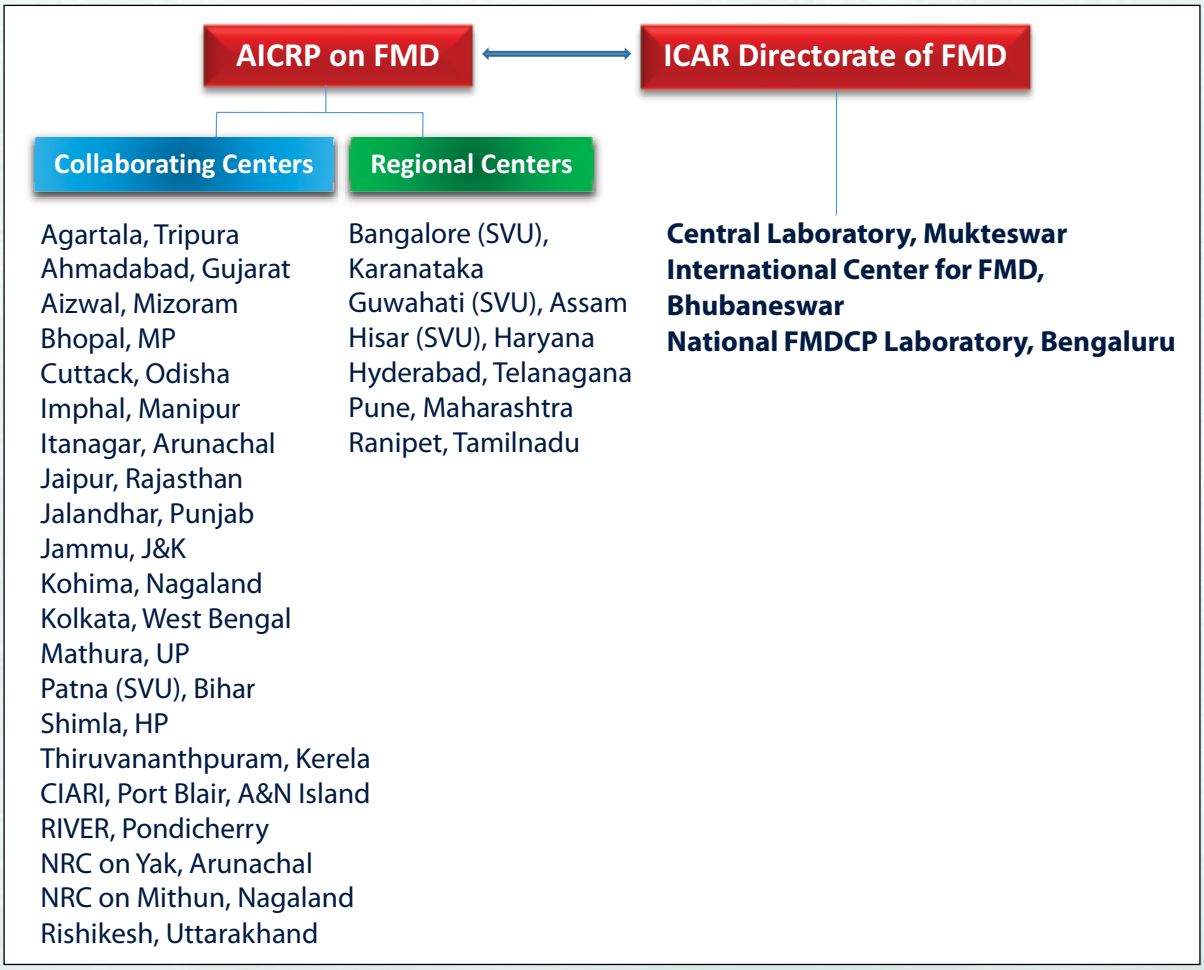
1. To conduct systematic epidemiological and molecular epidemiological studies on Foot-and- Mouth Disease (FMD), and also to study carrier status of the infection and latency of the virus.
2. Antigenic and molecular characterization and cataloguing of FMD virus strains isolated from incidences, and monitoring 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 sero-conversion. Maintenance and supply of most appropriate vaccine strain to the FMD vaccine manufacturers.
4. Development of newer diagnostic techniques using cutting-edge technologies in molecular biology.
5. To act as referral laboratory for FMD in South Asia.

Technical Programme:

1. Active and passive surveillance of FMD in the country in AICRP mode
2. To carryout antigenic and molecular characterization of field isolates.
3. To study molecular epidemiology of FMD in India.
4. Confirmatory diagnosis and expert advice.
5. To carryout vaccine matching exercise for monitoring of appropriateness of in-use vaccine strains.
6. Maintenance of National Repository of FMD virus strains.
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 Centres/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 of individual and herd immunity level.
11. National FMD Serosurveillance
12. International collaborations in areas of interest.

3 Organizational Setup

The ICAR-Directorate of Foot and Mouth Disease (FMD), the premier institute for FMD in the country, was established as an All India Coordinated Research Project (AICRP) for FMD in 1968. During about five decades of its existence the scope of the project has been expanded progressively and several milestones were achieved. The AICRP for epidemiological studies on FMD was upgraded to the Project Directorate on FMD in July 2000 and then renamed as Directorate of FMD since 2015-16 with 27 Regional and Collaborating centres covering all the major regions of the country. The Directorate has developed scientific expertise in conventional as well as in cutting edge areas, in the field of FMD diagnosis, epidemiology and research. The mandate of the institute is to carry out research on the epidemiology of FMD in the country and develop technologies to control the disease with ultimate goal of eradication. It is also entrusted with the duty of providing technical support and scientific input/information to the planners and strategy making agencies in planning control of FMD in the country and the SAARC region. The new addition to the institute is the **International Centre for FMD (ICFMD)** at Bhubaneswar that encompasses both BSL-2 and BSL-3Ag high containment laboratories.



Epidemiology and Surveillance

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Table 4.1 FMD incidences recorded and diagnosed during 2019 and virus serotype(s) involved

States	Reporting Centre/Unit	No. of. FMD cases / outbreaks	No. of. Samples tested	Virus Serotypes		
				O	A	Asial
Southern Region						
Tamil Nadu	Ranipet	01	03	01(02)	-	-
Karnataka	Bangalore	15	106	15(29)	-	-
Total		**16**	**109**	**16(31)**	**-**	**-**
Northern Region						
Haryana	Hisar	03	10	03(10)	-	-
Punjab	Jalandhar	08	29	08(20)	-	-
Total		**11**	**39**	**11(30)**	**-**	**-**
Central Region						
Madhya Pradesh	Bhopal	01	05	01(04)		-
Total		**01**	**05**	**01(04)**		**-**
Western Region						
Gujarat	Ahmadabad	02	11	02(05)	-	-
Rajasthan	Jaipur	01	25	01(01)	-	-
Maharashtra	Pune	10	60	09(29)	01(02)	-
Total		**13**	**96**	**12(35)**	**01(02)**	**-**
Eastern Region						
West Bengal	Kolkata	05	25	05(15)	-	-
Total		**05**	**25**	**05(15)**	**-**	**-**
North Eastern Region						
Assam	Guwahati	03	24	03(22)		-
Mizoram	Aizwal	01	06	01(06)	-	
Meghalaya	Guwahati	02	02	02(02)		
Total		**06**	**32**	**06(30)**		
Grand Total		**52**	**306**	**51(145)**	**01(02)**	

Number of samples collected from FMD suspected cases are given in parenthesis. More than one clinical material was collected from a single outbreak.

4.1 Southern Region

Southern region comprises of five states (Tamilnadu, Karnataka, Telanagana, Andhra Pradesh, Kerala) and two UTs (Pondicherry and A&N Island) and about 21% of the FMD susceptible livestock of the country. The region shares no international border and the state of Karnataka is found to be hyperendemic area for FMD. The entire southern peninsular region has been covered under FMDCP since the year 2010-11.

No incidence of FMD was reported form the states of Andhra Pradesh, Telangana, Kerala, Pondicherry and A&N Island

Tamilnadu: During the year, one outbreak due to serotype O was recorded in the state in the month of September. The outbreak was recorded in Ranipet district. There is no mortality and morbidity also very negligible

Karnataka: During the year, fifteen FMD outbreaks were reported in the state. All of them were caused by serotype O. Maximum outbreaks were recorded in the month of January (8) followed by February (4), November (2) and May (1). Six outbreaks each were recorded in the districts of Bengaluru rural and Tumakuru. Remaining outbreaks were reported form the districts of Ramnagara (2) and Bengaluru urban (1). The disease was observed in cattle, buffalo, sheep and goat with a morbidity rate of 1.1%. Mortality rate was found to very negligible (0.06%). Animals were last vaccinated during the month of June 2018 and October 2019.

4.2 Central Region

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

Madhya Pradesh: During the period under report, the state recorded one FMD outbreak in the month of January from district Vidisha. The state was free from FMD during 2017-18. The incidence occurred in cattle and caused by serotype O. The animals in the affected area were last vaccinated in the month of September 2018. No mortality was observed and morbidity of 40% was recorded.

4.3 Western Region

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

Gujarat: The state reported two outbreaks one each in the months of January and February. Both the outbreaks were caused by serotype O and recorded in district Rajkot. The incidences were recorded in cattle and buffalo. Morbidity and mortality rates were found to be low at 2.3 and 0.14 %. The animals in the affected area were last vaccinated in the month of September 2018.

Maharashtra: During the year 2019, ten FMD outbreaks were recorded in the state. FMDV serotype O was responsible for nine outbreaks and serotype A caused one outbreak. Maximum outbreaks were recorded in the month of January (5) followed by February (2), March (2) and July (1). Highest numbers of outbreaks were recorded in the district of Ahmednagar (5) and one each in Satara, Gondia, Beed, Pune and Nashik. The outbreak due to serotype A was recorded in Satara district in January. Low mortality (0.09%) and morbidity (3.8%) was observed

Rajasthan: One outbreak of FMD was serotype confirmed during the period. The incidence occurred in the district Churu and was caused by serotype O. The incidences were recorded in cattle and buffalo.

4.4 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 border with Pakistan, Afghanistan, Nepal and China. The entire states of Haryana, Punjab, Himachal Pradesh, Uttarakhand and Uttar Pradesh are covered under FMDCP. There were no outbreaks in Uttar Pradesh and Himachal Pradesh, Jammu & Kashmir and Ladakh during the period

Haryana: During the year 2019, three outbreaks of FMD were recorded in the state and all of them were caused by serotype O. The outbreaks were recorded in the months of January (1) and February (2). One outbreak each was recorded in Hisar, Bhiwani and Kurukshtra districts. The incidence in Hisar was recorded in an organized farm. The species affected includes cattle and pigs. High mortality (32%) and morbidity (21%) was observed in pig while low mortality and morbidity was reported in cattle. Cattle in the affected area were last vaccinated in September 2018. Pigs were not vaccinated.

Punjab: The state reported eight FMD outbreaks during the period and all of them were caused by serotype O. Three outbreaks were recorded in January and five occurred in February. The outbreaks were recorded in the districts of Rupnagar (n=3), SAS nagar (n=3), Gurdaspur (1) and Tarn Taran (1). The disease occurred in cattle and buffalo. High mortality (36.8%) and moderate morbidity (8.5%) was observed. In the affected areas animals were last vaccinated during December 2018.

4.5 Eastern Region

Eastern region comprises of four states (West Bengal, Odisha, Bihar and Jharkhand) and about 22% of the FMD susceptible livestock of the country. **This region shares international border with Bangladesh and Nepal.** The entire region is covered under FMDCP since 2017. During the period, there are no FMD outbreaks in Bihar and Odisha.

West Bengal: During the period, five outbreaks were recorded in the state in the months of January (02), February (02) and September (01). All the outbreaks were caused by FMD virus serotype O. One outbreak each was reported from the districts of Bankura, Nadia, Howrah, South 24 Pargans and Medinipur. Overall morbidity rate of 7% was observed with no mortality. Cattle and pigs were affected. The animals were last vaccinated during March-June 2018.

4.6 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 border with China, Myanmar, Bangladesh and Bhutan. No FMD was reported during the period in the state of Manipur

Assam: Three outbreaks of FMD were recorded in the state during the period and serotype O accounted for all the outbreaks. The disease was recorded in cattle. The incidences occurred in May, June and July. Two outbreaks were recorded in the districts of Kamrup and one in Borbhag district. Overall morbidity rate of 19% was observed with 0.3% mortality.

Meghalaya: Two outbreaks of FMD caused by serotype O was recorded in cattle during the period in January.

Mizoram: One FMD incidence due to serotype O was recorded in Siaha district in the month of August. The animals in the affected area were last vaccinated in February. High mortality (44.8%) and morbidity (9.6%) was observed.

5 Molecular Epidemiology of FMD

5.1 FMD virus Serotype O

During 2019, a total of 29 serotype O FMDV field isolates were subjected to complete 1D/VP1 region sequence analysis. Phylogentic analysis was carried out using Maximum Likelihood (ML). In the ML tree (Fig 5.1), 24 isolates grouped within sub-lineage O/ME-SA/Ind2001e indicating its extended dominance since its emergence during the year 2016. This sub-lineage gradually displaced O/ME-SA/Ind2001d from field as none of the isolates collected during 2019 clustered within O/ME-SA/Ind2001d sub-lineage. Five isolates clustered distinctly in unnamed group designated here as O/ME-SA/2018 cluster. All the five isolates were collected from the state of Maharashtra. The earliest isolate in this group was from the state of Uttarakhand sampled during February 2018. The 2018 cluster is highly homogenous with a mean distance of 0.01 among them and had a mean distance of 0.046 from Ind2001e sub-lineage. Similar to last year, the isolates of O/ME-SA/Ind2001e collected during 2019 are highly homogeneous with only 0.017 mean nucleotide distance demonstrating an epidemiological link among most of these incidences. Free movement of infected animals/contaminated objects/personnel continued to be the major mode of virus transmission.

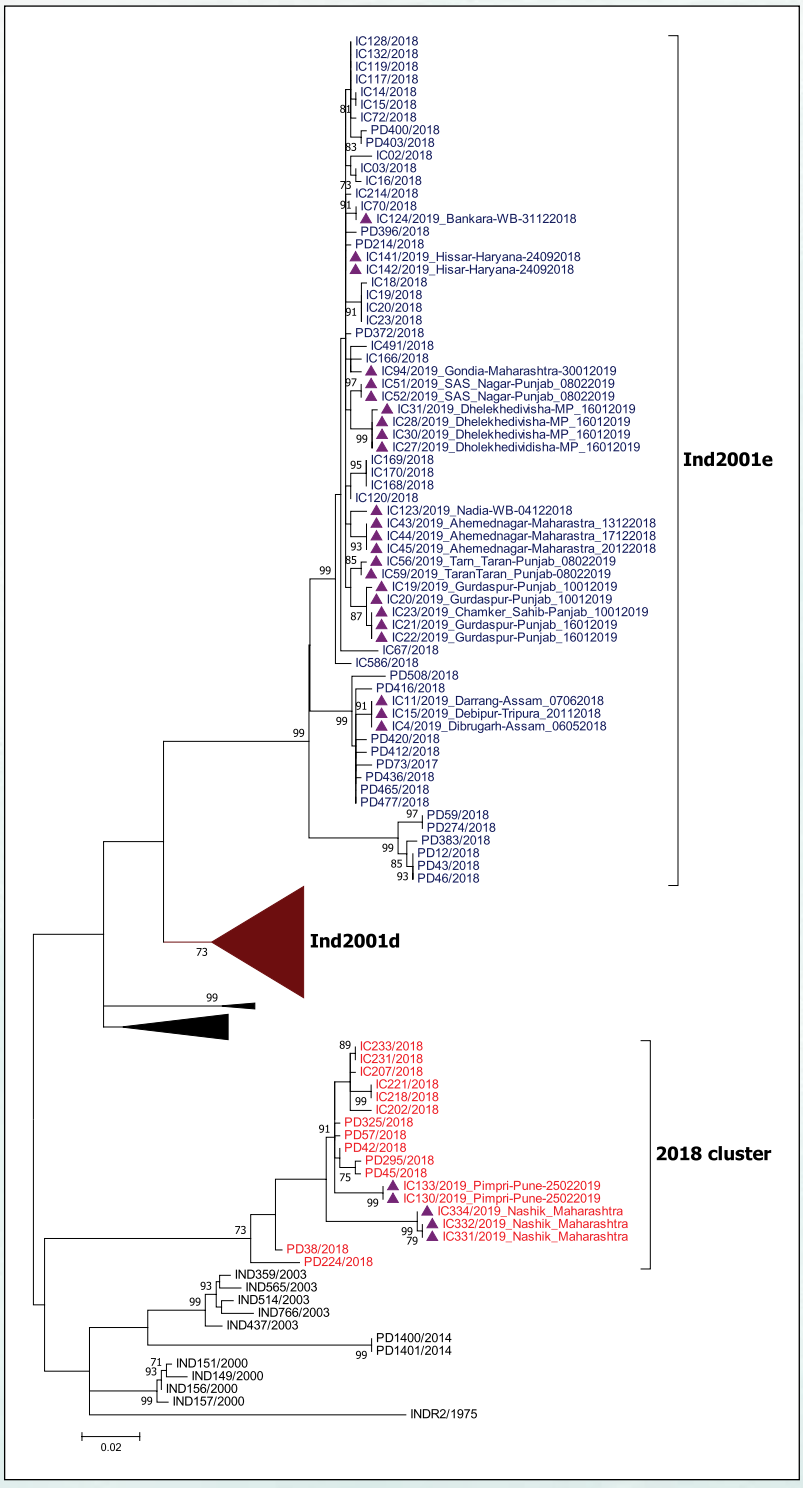


Fig. 5.1: Maximum Likelihood phylogenetic tree at VP1 coding region of Indian serotype O FMD virus isolates during 2019. The analysis shows dominance O/ME-SA/Ind2001e sub-lineage in India during the period.

5.2 FMD virus Serotype A

Serotype A virus population is genetically and antigenically most heterogeneous in nature among the three serotypes prevalent in India. Molecular phylogeny has established circulation of four genotypes (2, 10, 16 and 18) showing more than 15% nucleotide (nt) divergence among them at 1D region of serotype A so far in India. Since 2001, genotype 18 has been exclusively responsible for all the field outbreaks and has outcompeted all other genotypes. Within the currently circulating genotype 18, a divergent and unique lineage emerged in late part of 2002, which showed an amino acid (aa) deletion at 59th position of VP3 ($VP3^{59}$-deletion group) and dominated the field outbreak scenario in 2002-03. Ever since then sporadic outbreaks due to this lineage has been identified. During the year 2019, FMD outbreak due to serotype A was recorded

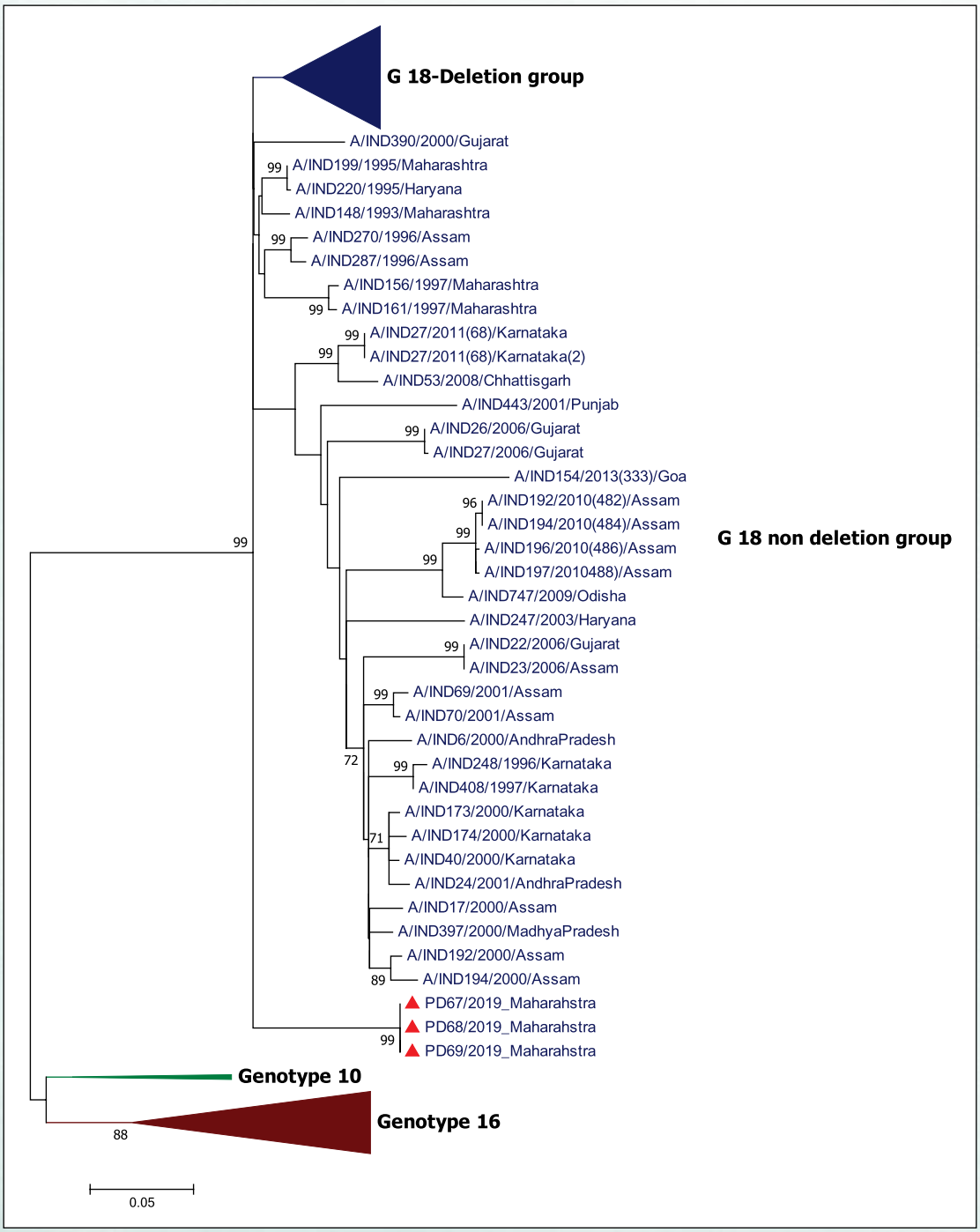


Fig 5.2: Maximum likelihood tree depicting phylogenetic relationship of serotype A isolates collected during 2019.

in Satara district of Maharashtra state in January and three samples were collected. Phyloegenetic analysis ML method revealed clustering of both the isolates within Genotype 18 (Fig. 5.2) but distantly from both deletion and non-deletion lineages. Examination of VP3 region revealed the presence of 59th amino acid. There is a possibility of emergence of new lineage with Genotype 18. However no outbreak due to serotype A was recorded after the single incidence in the month of January. It is to be noted that for the last three years, no incidence of FMDV serotype A is recorded in the country.

5.3 FMD virus serotype Asia1

Previous studies on 1D/VP1 gene based phylogeny demarcated Indian serotype Asia1 field isolates in to three major lineages namely B, C and D. Lineage B which include currently used serotype Asia1 vaccine strain, IND63/1972, was last recorded in the year 2000. The isolates of lineage D emerged late in 2001 and dominated the period between 2002 and 2004. The lineage C dominated the Asia1 field outbreaks between 1998 and 2002, although disappeared between year 2001 and 2004, and re-emerged as the predominating lineage from 2005 onwards.

The serotype Asia1 isolates collected during July 2018 from the state of Assam clustered within sub-lineage CII and the isolates were found to cluster closely with the isolates from Nagaland in December'15 (Fig 5.3). During 2016-17, no incidence of FMDV serotype Asia1 was recorded in the country. Three incidences were recorded during 2017-18 in the states of Kerala and Rajasthan, but the samples were not forwarded to central laboratory, Mukteswar for strain characterization.

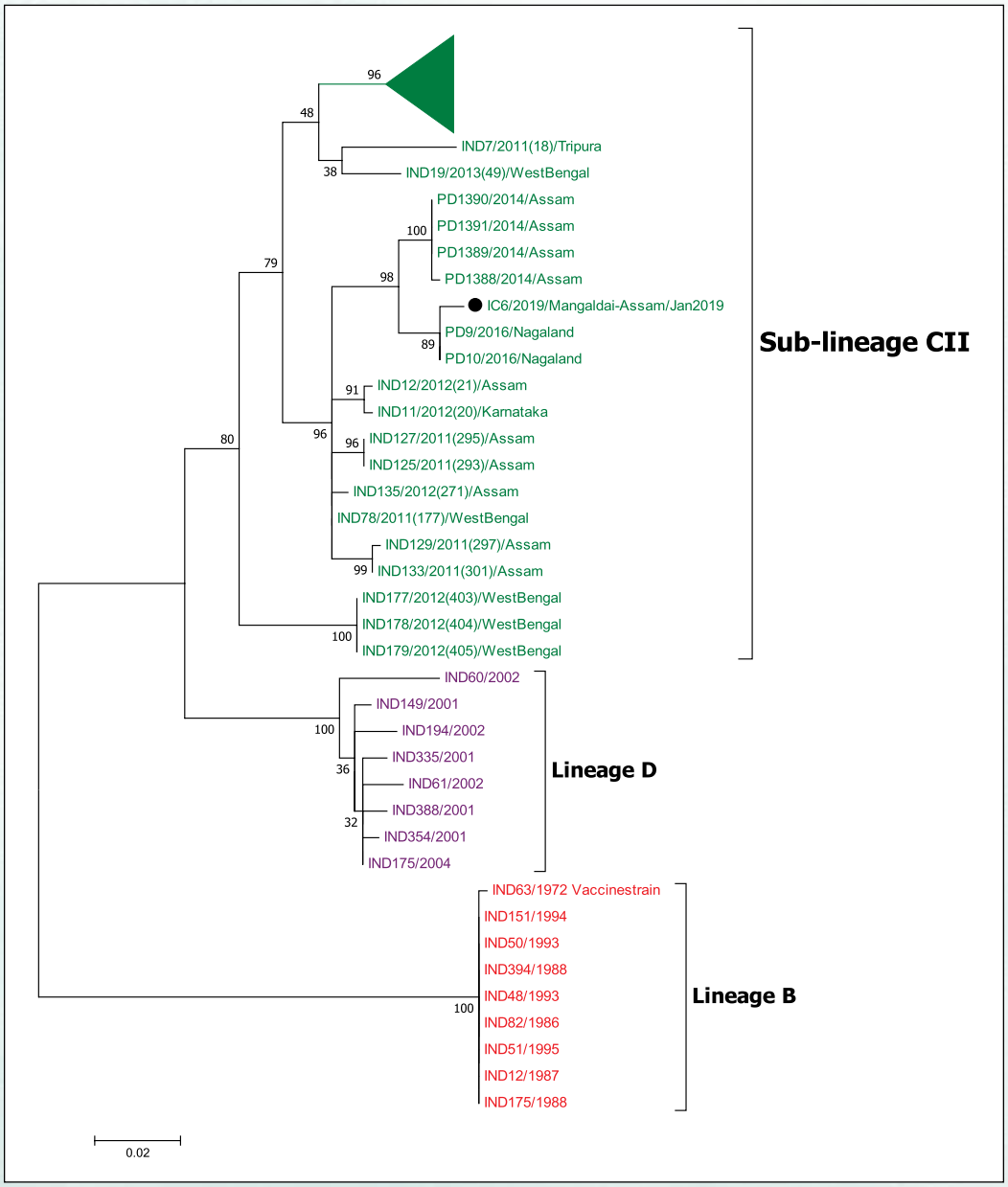


Fig. 5.3: Maximum likelihood phylogenetic tree at VP1 coding region of FMD virus isolates of serotype Asia1 during 2018. Lineage C is in circulation in the country since 2005

6 Vaccine matching of FMD virus field isolates

6.1 FMD virus serotype O

The antigenic relationships of serotype O field isolates to the currently used vaccine strain INDR2/1975 was assessed using bovine vaccinate serum. A total of 9 virus isolates were subjected to vaccine matching exercise using bovine vaccinate serum. The isolates were sampled from different states and different time point. All the 9 isolates had an r1 -value of >0.3with currently used serotype O vaccine strain INDR2/1975, which indicates optimal antigenic coverage by the in-use vaccine strain. The strain INDR2/1975 is suitable for use in vaccine formulation.

6.2 FMD virus serotypes A and Asia1

The field situation suggested emergence of antigenically divergent strains in serotype A, while majority of isolates in Asia 1 were found to be antigenically related to the in-use vaccine strain, IND63/1972. With the recent emergence of antigenically divergent VP3[59]-deletion group in serotype A, a quest for back up candidate vaccine strains was initiated and the best strain showing broader antigenic relatedness (A IND 27/2011) out of the eight shortlisted strains was selected for further studies with respect to the vaccine worth attributes. The new serotype A candidate strain A IND 27/2011 will replace the existing vaccine strain A IND 40/2000. The studies on vaccine attributes of strain A IND 27/2011 have been completed. Besides, attempts were also made to maintain a panel of most suitable candidate vaccine strains for each serotype to meet any exigency or to cater to demand based vaccination if need arises.

National FMD Virus Repository

7

The Central FMD laboratory of the Directorate maintains the National FMD Virus Repository that is upgraded annually with addition of latest/ new virus isolates. The virus repository has served the cause of the country by providing isolates for molecular epidemiological studies, evaluation of antigenic relatedness between the field and vaccine strains and selection of new candidate vaccine strains whenever required. A total of 15 serotype O virus isolates were added to the repository during the reported period (Table 7.1). At present the National FMD virus Repository holds a total of 2278 isolates (O-1574, A-323, C-15 and Asia 1-366).

Table 7.1: Year-wise details of the virus isolates added to National FMD Virus Repository during last five years.

Isolates revived	O	A	Asia1	Total
2015-16	55	11	2	68
2016-17	53	4	-	57
2017-18	121	-	-	121
2018	76	-	-	76
2019	15	-	-	15

8 New Research development

Differential antibody responses to the major antigenic sites of FMD virus serotype O

FMD virus serotype O is the predominant cause of FMD outbreaks in several regions of the world including India. Five independent neutralizing antigenic sites have been identified on the capsid surface of FMD virus serotype O. The relative importance of these neutralizing sites in eliciting antibody responses in the polyclonal sera collected from un-infected vaccinated (both primo and multiply-vaccinated) and naturally infected cattle populations were determined through a combination of reverse genetics and serology. The known critical amino acid residues present on the five antigenic sites of FMD virus serotype O Indian vaccine strain O IND R2/1975 were mutated through site-directed mutagenesis. The mutant viruses were rescued in cell culture and analyzed through virus-neutralization assays along with parent virus using the polyclonal sera collected from three groups of cattle. In the polyclonal sera from primo-vaccinated cattle, significantly higher level of antibodies were directed towards antigenic site 2. In contrast, in polyclonal sera from multiply vaccinated animals, both antigenic sites 1 and 2 were equally important. In case of naturally infected animals, antibody responses were elicited against all the five antigenic sites. Although a drop in neutralization titres was observed for all the mutants, in one instance, increase in titre was noticed for a site 3 mutant. The findings from this study extend our knowledge on the antibody immunodominace following FMDV vaccination and infection, and may improve our strategies for vaccine strain selection and rational vaccine design.

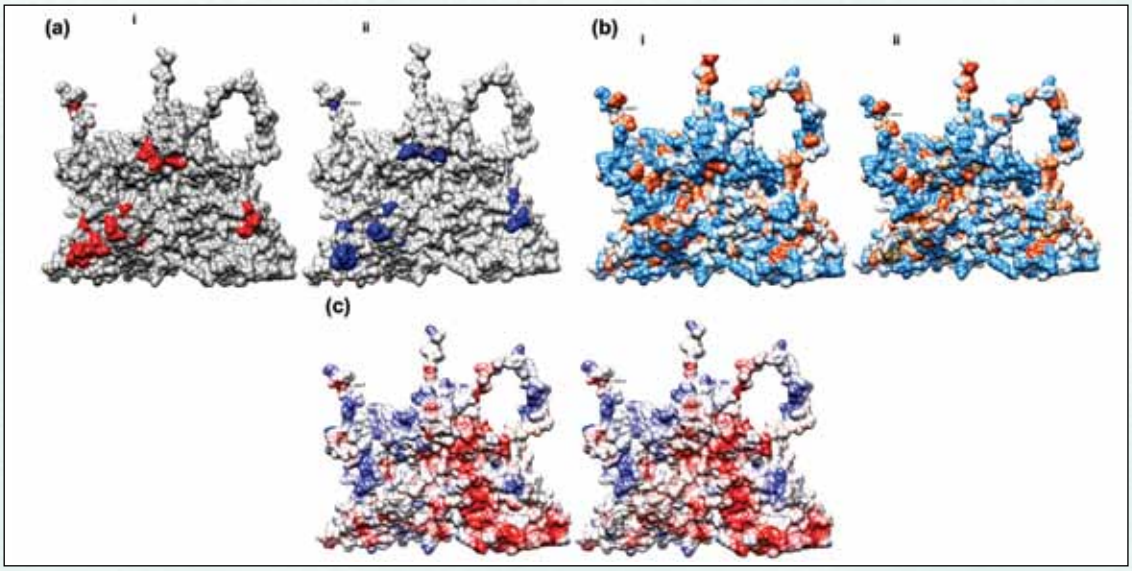


Fig 8.1: 3D structure of FMDV serotype O IND R2/1975 parental (i) and mutant (ii) protomeric unit modelled using the O1 BFS co-ordinates (1FOD) as template. (a) Outside surface view of parental and mutant protomers; the antigenic amino residues are coloured as red and blue in parental and mutant FMDV respectively, (b) the hydrophobicity surface view parental and mutant protomers; the hydrophobic propensity is illustrated as dodger blue for the most hydrophilic to white for neutral, to orange-red for the most hydrophobic amino acid residues, and (c) the electrostatic accessible surface view of parental and mutant O IND R2/1975 modelled biological protomer; the electrostatic potential was coloured with blue for positive charged residues and red for negative charged residues. The scale of colouring was kept constant during the analyses. For convenience, all the antigenic residues have been depicted on a single protomer of either parental or mutant FMDV O IND R2/1975.

National FMD Sero-surveillance

9

During the year 2019, a total of 30,413 bovine serum samples collected at random from various parts of the country were tested using r3AB3 NSP-ELISA for assessing NSP-antibody (NSP-Ab) response, which is an underlying indicator of FMD virus exposure regardless of vaccination status. The test revealed overall seropositivity (DIVA positive) in ~ 20% samples/animals (Table 9.1). Till date, a total of 5,00,075 random serum samples from bovine have been analyzed by DIVA. Higher NSP antibody prevalence was observed in the states of Tamilnadu, Maharashtra, Gujarat, West Bengal and Odisha. Though majority of the states showed reduction in NSP antibody prevalence compared to last year, increase in NSP prevalence was observed in the state of Maharashtra.

Table 9.1. Summary of DIVA reactivity in bovine during 2019

Sl. No.	State	Total serum samples tested	Total positive	%3AB3 reactors (2019)	%3AB3 reactors (2018)
1	Telangana	1800	61	3.4	1.0
2	Tamil Nadu	6400	1420	22.2	29.9
3	Madhya Pradesh	6340	924	14.6	16.2
4	Maharashtra	2988	801	26.8	3.7
5	Gujarat	5150	1935	38.0	42.0
6	West Bengal	1413	447	31.6	51.8
7	Odisha	601	165	27.5	44.9
8	Haryana	2450	179	7.30	8.1
9	Himachal Pradesh	720	96	13.0	19.9
10	Jammu and Kashmir	1620	262	16.2	24.6
11	Assam	503	47	9.34	20.4
12	Andaman & Nicobar	428	2	0.46	11.2
Total		**30413**	**6339**	**20.8**	

10 Post Vaccination Sero-monitoring of FMD Control Programme

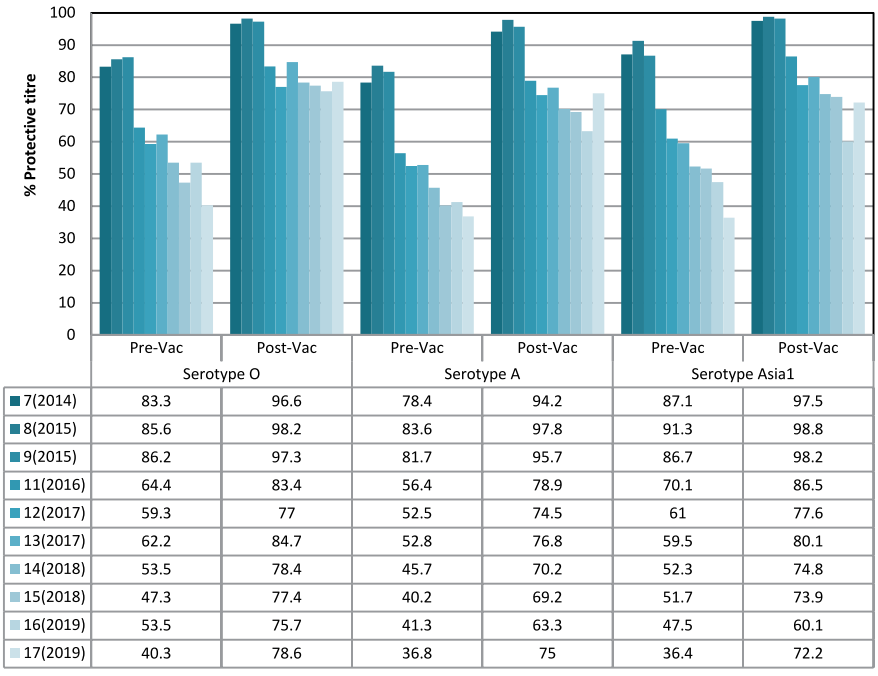
During 2019, a total of 2,97,900 serum samples (pre-vac: 1,51,830 and post vac: 1,46,070) from various states collected under FMDCP were tested to determine the antibody titre against FMD virus serotypes O, A and Asia1 using Solid Phase Competitive ELISA. The testing was carried out at National FMD-CP Seromonitoring Laboratory (ICAR-DFMD), Bengaluru. The details of states wise serum samples tested are presented in Table 10.1. Besides, 4728 serum samples received from various Breeding Bull station and random samples from villages surrounding the Bull station were also tested.

Table 10.1: Number of serum samples tested during 2019 under FMDCP Seromonitoring

State	Pre-vac	Post-vac	Total	Rounds
Tamilnadu	12000	12000	24000	16 and 17
Karnataka	11972	11936	23908	15 and 16
Kerala	5400	5320	10720	14 and 15
Andhra Pradesh	5200	5200	10400	16 and 17
Telangana	3600	3600	7200	15 and 16
Madhya Pradesh	12965	12778	25743	3 and 4
Chhattisgarh	8906	8509	17415	3 and 4
Maharashtra	8363	9631	17994	13 and 14
Gujarat	10000	10000	20000	13 and 14
Rajasthan	13600	13600	27200	7 and 8
Uttar Pradesh	29285	28800	58085	8 and 9
Uttarakhand	4448	3853	8301	4 and 5
Haryana	1997	3183	5180	16 and 17
Jammu & Kashmir	8199	3800	11999	1 and 2
Bihar	7047	4278	11325	4, 5 and 7
Mizoram	1108	1108	2216	1 and 2
Manipur	1900	2694	4594	1 and 2
Assam	5053	4996	10049	1
Goa	400	400	800	15
A & N Island	387	384	771	24
Total	**151830**	**146070**	**297900**	

10.1 Tamil Nadu

- During this period, 12,000 each pre and post vac serum samples from round 16 and 17 were tested
- After round 17, the percent protective titre in pre vac and post vac samples ranged from 36-40% and 72-79% respectively
- There has been increase in post vac titre after round 17 compared to previous round; conversely drop in pre vac titre was observed which requires attention
- Seroconversion was observed in 22.2%, 22% and 12.6% animal against serotype O, A and Asia1, respectively at the end of round 16. Similarly, 38.3%, 38.2% and 35.8% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 17
- There were 23.9%, 27.9% and 26.4% drop in titre against serotype O, A and Asia1, respectively in pre-vac samples of round 16 compared to postvac samples of round 15 and 35.4%, 26.5%, and 23.7% drop was observed at the end of round 17.

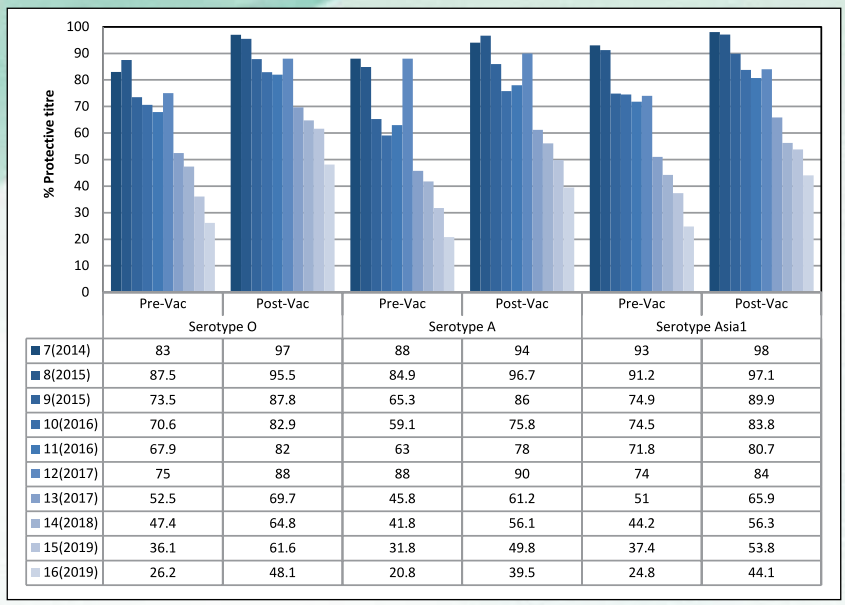


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
7(2014)	83.3	96.6	78.4	94.2	87.1	97.5
8(2015)	85.6	98.2	83.6	97.8	91.3	98.8
9(2015)	86.2	97.3	81.7	95.7	86.7	98.2
11(2016)	64.4	83.4	56.4	78.9	70.1	86.5
12(2017)	59.3	77	52.5	74.5	61	77.6
13(2017)	62.2	84.7	52.8	76.8	59.5	80.1
14(2018)	53.5	78.4	45.7	70.2	52.3	74.8
15(2018)	47.3	77.4	40.2	69.2	51.7	73.9
16(2019)	53.5	75.7	41.3	63.3	47.5	60.1
17(2019)	40.3	78.6	36.8	75	36.4	72.2

Fig 10.1 Protective titre in pre and post vac samples during last 10 rounds in TN

10.2 Karnataka

- During this period 11,972 pre and 11, 936 post vac serum samples from round 15 and 16 were tested
- After the round 16, the percent protective titre in pre vac samples ranged from 21-26% and in post vac samples, it ranged from 40-48%
- There has been decreases in both pre and post vac titre after round 16 compared to previous round which requires great attention
- Seroconversion was observed in 24.5%, 18.0% and 16.4% animal against serotype O, A and Asia1, respectively at the end of round 15. Similarly, 21.9%, 18.7% and 19.3% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 16
- There were 28.7%, 24.3% and 18.9% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 15 compared to post vac samples of round 15 and 35.5%, 29.1%, and 29.0% drop was observed at the end of round 16.

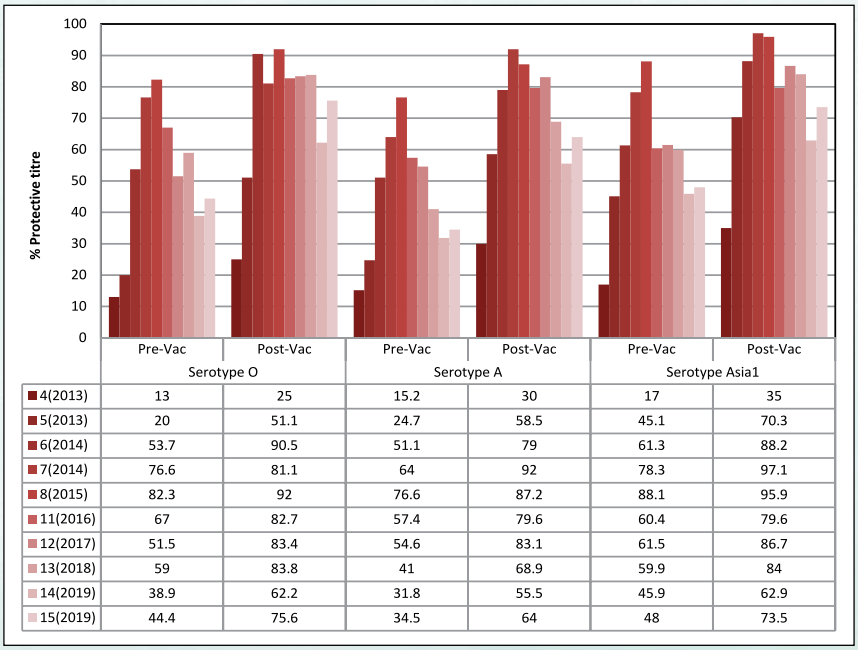


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
7(2014)	83	97	88	94	93	98
8(2015)	87.5	95.5	84.9	96.7	91.2	97.1
9(2015)	73.5	87.8	65.3	86	74.9	89.9
10(2016)	70.6	82.9	59.1	75.8	74.5	83.8
11(2016)	67.9	82	63	78	71.8	80.7
12(2017)	75	88	88	90	74	84
13(2017)	52.5	69.7	45.8	61.2	51	65.9
14(2018)	47.4	64.8	41.8	56.1	44.2	56.3
15(2019)	36.1	61.6	31.8	49.8	37.4	53.8
16(2019)	26.2	48.1	20.8	39.5	24.8	44.1

Fig 10. 2 Protective titre in pre and post vac samples during last 10 rounds in Karnataka

10.3 Kerala

- During this period 5400 pre and 5320 post vac serum samples from round 14 and 15 were tested
- After the round 15, the percent protective titre in pre vac samples ranged from 35-48% and in post vac samples, it ranged from 64-76%
- Increase in both pre and post vac titre after round 15 compared to previous round was observed which is a positive impact of regular vaccination
- Seroconversion was observed in 23.3%, 23.7% and 17.0% animal against serotype O, A and Asia1, respectively at the end of round 14. Similarly, 31.2%, 29.5% and 25.5% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 15
- There were 44.9%, 37.1% and 38.1% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 14 compared to post vac samples of round 13, and 17.8%, 21.0%, and 14.9% drop was observed in round 15.

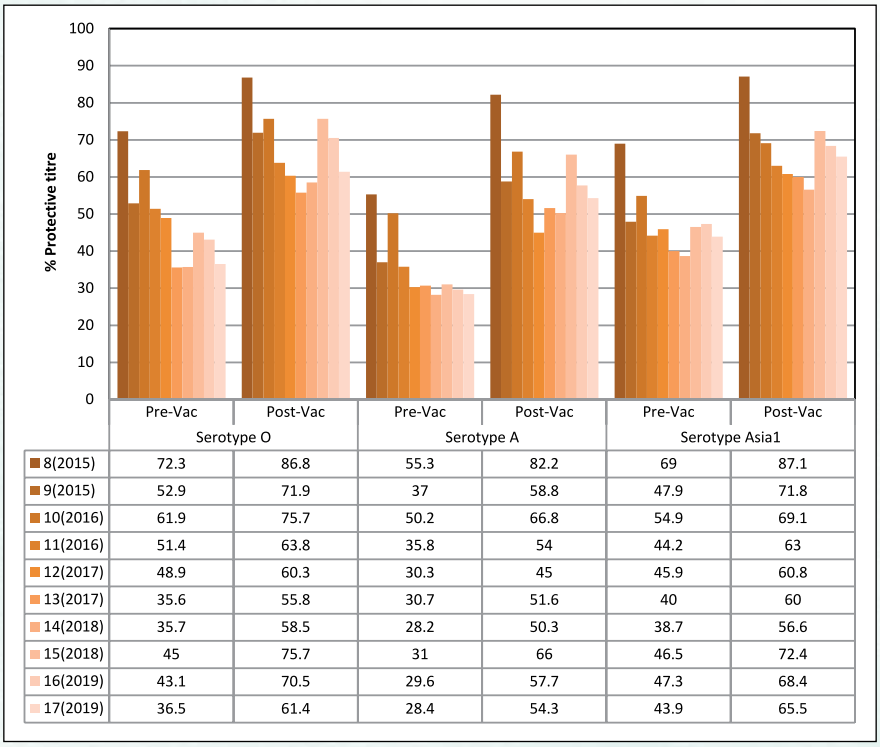


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
4(2013)	13	25	15.2	30	17	35
5(2013)	20	51.1	24.7	58.5	45.1	70.3
6(2014)	53.7	90.5	51.1	79	61.3	88.2
7(2014)	76.6	81.1	64	92	78.3	97.1
8(2015)	82.3	92	76.6	87.2	88.1	95.9
11(2016)	67	82.7	57.4	79.6	60.4	79.6
12(2017)	51.5	83.4	54.6	83.1	61.5	86.7
13(2018)	59	83.8	41	68.9	59.9	84
14(2019)	38.9	62.2	31.8	55.5	45.9	62.9
15(2019)	44.4	75.6	34.5	64	48	73.5

Fig 10. 3 Protective titre in pre and post vac samples during last 10 rounds in Kerala

10.4 Andhra Pradesh

- During this period, 5200 each pre and post vac serum samples from round 16 and 17 were tested
- After the round 17, the percent protective titre in pre vac samples ranged from 28-44% and in post vac samples, it ranged from 54-66%
- Decline in both pre and post vac titre after round 17 compared to previous round requires great attention
- Seroconversion was observed in 27.4%, 28.1% and 21.1% animal against serotype O, A and Asia1, respectively at the end of round 16. Similarly, 24.9%, 25.9% and 21.6% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 17
- There were 32.6%, 36.4% and 25.1% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 16 compared to post vac samples of round 15, and 34.0%, 29.3%, and 24.5% drop was observed in round 17.

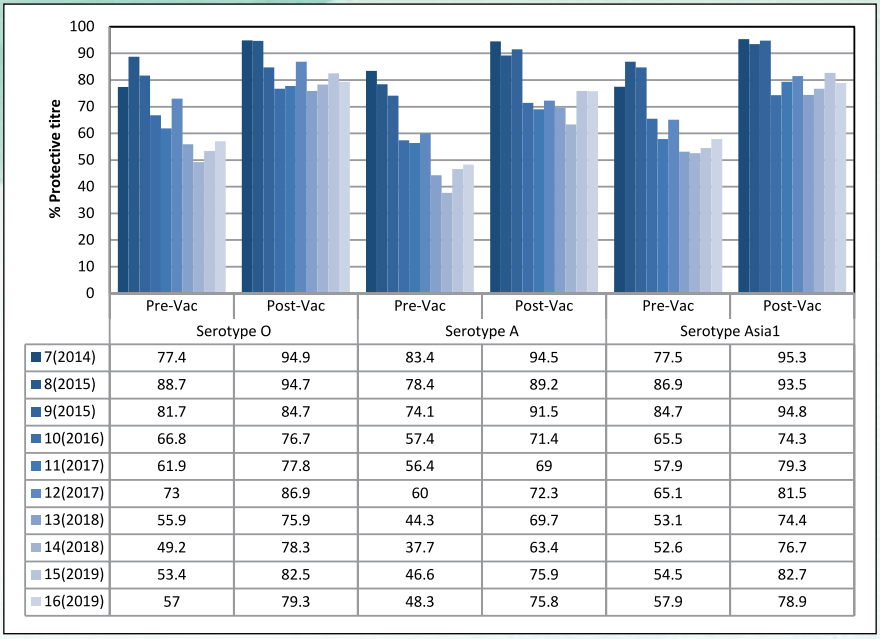


	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
	Serotype O		Serotype A		Serotype Asia1	
8(2015)	72.3	86.8	55.3	82.2	69	87.1
9(2015)	52.9	71.9	37	58.8	47.9	71.8
10(2016)	61.9	75.7	50.2	66.8	54.9	69.1
11(2016)	51.4	63.8	35.8	54	44.2	63
12(2017)	48.9	60.3	30.3	45	45.9	60.8
13(2017)	35.6	55.8	30.7	51.6	40	60
14(2018)	35.7	58.5	28.2	50.3	38.7	56.6
15(2018)	45	75.7	31	66	46.5	72.4
16(2019)	43.1	70.5	29.6	57.7	47.3	68.4
17(2019)	36.5	61.4	28.4	54.3	43.9	65.5

Fig 10.4 Protective titre in pre and post vac samples during last 10 rounds in AP

10.5 Telangana

- During this period, 3600 each pre and post vac serum samples from round 15 and 16 were tested
- After round 16, the percent protective titre in pre vac samples ranged from 48-58% and in post vac samples, it ranged from 76-79%
- Though compared to round 15, a slight rise in titre was observed in pre vac samples, there were decline in post vac titre which requires attention
- Seroconversion was observed in 29.1%, 29.3% and 28.2% animal against serotype O, A and Asia1, respectively at the end of round 15. Similarly, 22.3%, 27.5% and 21.0% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 16
- There were 24.9%, 16.8% and 22.2% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 15 compared to post vac samples of round 14, and 25.5%, 27.6%, and 24.8% drop was observed in round 16.

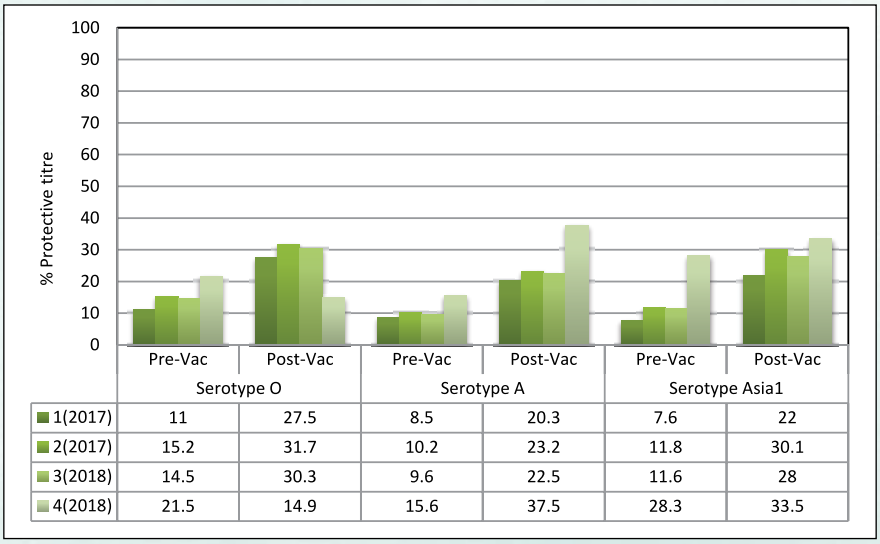


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
7(2014)	77.4	94.9	83.4	94.5	77.5	95.3
8(2015)	88.7	94.7	78.4	89.2	86.9	93.5
9(2015)	81.7	84.7	74.1	91.5	84.7	94.8
10(2016)	66.8	76.7	57.4	71.4	65.5	74.3
11(2017)	61.9	77.8	56.4	69	57.9	79.3
12(2017)	73	86.9	60	72.3	65.1	81.5
13(2018)	55.9	75.9	44.3	69.7	53.1	74.4
14(2018)	49.2	78.3	37.7	63.4	52.6	76.7
15(2019)	53.4	82.5	46.6	75.9	54.5	82.7
16(2019)	57	79.3	48.3	75.8	57.9	78.9

Fig 10.5 Protective titre in pre and post vac samples during last 10 rounds in TS

10.6 Madhya Pradesh

- During this period, 12965 pre and 12778 post vac serum samples from round 3 and 4 were tested
- After round 3 or 4!, the percent protective titre in pre vac samples ranged from 10-15% and in post vac samples, it ranged from 23-30%
- There were drops in pre and post vac titre of round 3 compared to round 2 which is a concern and requires attention
- Seroconversion was observed in 15.8%, 12.9% and 16.4% animal against serotype O, A and Asia1, respectively at the end of round 3.
- There were 12.3%, 10.1% and 10.2% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 3 compared to post vac samples of round 2, and 25.5%, 27.6%, and 24.8% drop was observed in round 4.

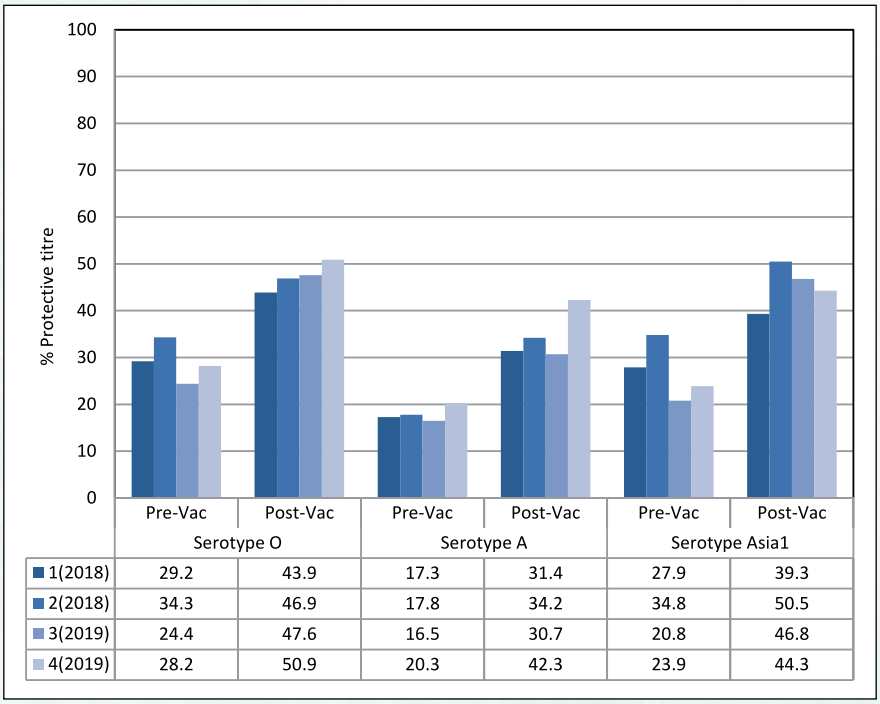


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
1(2017)	11	27.5	8.5	20.3	7.6	22
2(2017)	15.2	31.7	10.2	23.2	11.8	30.1
3(2018)	14.5	30.3	9.6	22.5	11.6	28
4(2018)	21.5	14.9	15.6	37.5	28.3	33.5

Fig 10.6 Protective titre in pre and post vac samples during last 4 rounds in MP

10.7 Chhattisgarh

- During this period, 8906 pre and 8509 post vac serum samples from round 3 and 4 were tested
- After round 4, the percent protective titre in pre vac samples ranged from 20-28% and in post vac samples, it ranged from 42-51%
- There has been increase in protective titre after round 4 compared to previous rounds which are a positive impact of regular vaccination.
- Seroconversion was observed in 23.2%, 14.2% and 26.0% animal against serotype O, A and Asia1, respectively at the end of round 3. Similarly, 22.7%, 22.0% and 20.4% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 4.
- There were 22.5%, 17.7% and 29.7% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 3 compared to post vac samples of round 2, and 19.4%, 10.4%, and 22.9% drop was observed in round 4.

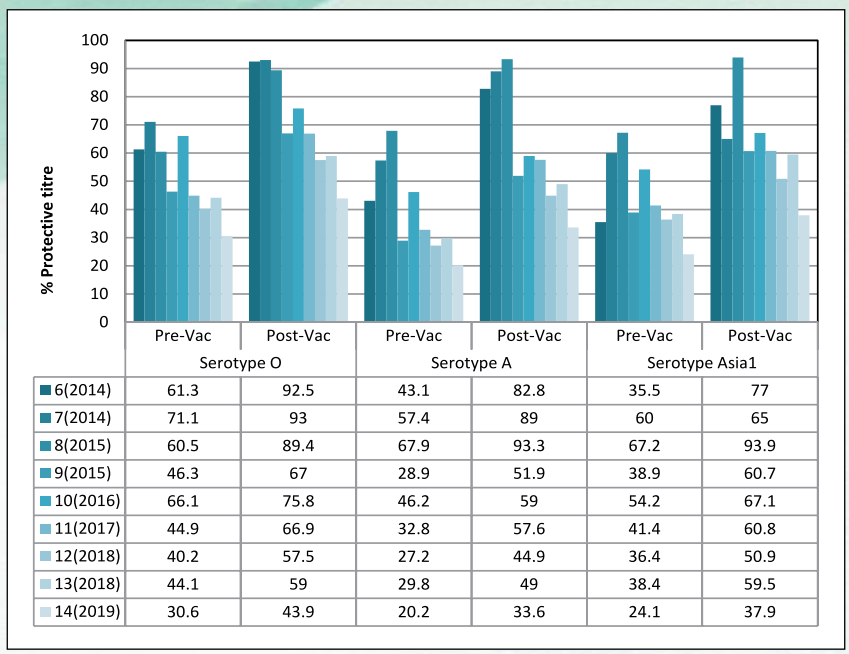


	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
	Serotype O		Serotype A		Serotype Asia1	
1(2018)	29.2	43.9	17.3	31.4	27.9	39.3
2(2018)	34.3	46.9	17.8	34.2	34.8	50.5
3(2019)	24.4	47.6	16.5	30.7	20.8	46.8
4(2019)	28.2	50.9	20.3	42.3	23.9	44.3

Fig 10. 7 Protective titre in pre and post vac samples during last 4 rounds in Chhattisgarh

10.8 Maharashtra

- During this period, 8363 pre and 9631 post vac serum samples from round 13 and 14 were tested
- After round 14, the percent protective titre in pre vac samples ranged from 20-31% and in post vac samples, it ranged from 34-44%
- Decline in titre was observed in pre and post vac samples compared to previous round which requires great attention
- Seroconversion was observed in 14.9%, 19.2% and 21.1% animal against serotype O, A and Asia1, respectively at the end of round 13. Similarly, 13.3%, 13.4% and 13.8% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 14
- There were 13.4%, 15.1% and 12.5% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 13 compared to post vac samples of round 12, and 28.4%, 28.8%, and 35.4% drop was observed in round 14.

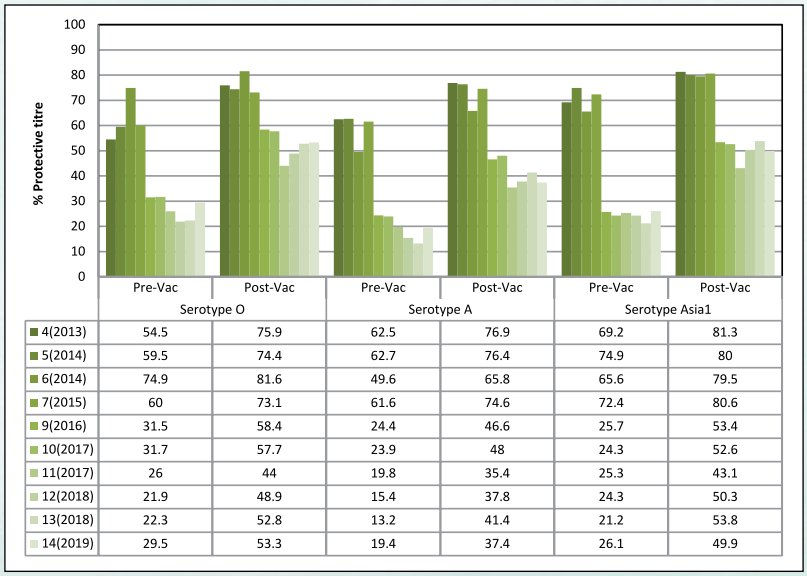


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
6(2014)	61.3	92.5	43.1	82.8	35.5	77
7(2014)	71.1	93	57.4	89	60	65
8(2015)	60.5	89.4	67.9	93.3	67.2	93.9
9(2015)	46.3	67	28.9	51.9	38.9	60.7
10(2016)	66.1	75.8	46.2	59	54.2	67.1
11(2017)	44.9	66.9	32.8	57.6	41.4	60.8
12(2018)	40.2	57.5	27.2	44.9	36.4	50.9
13(2018)	44.1	59	29.8	49	38.4	59.5
14(2019)	30.6	43.9	20.2	33.6	24.1	37.9

Fig 10.8 Protective titre in pre and post vac samples during last 9 rounds in MH

10.9 Gujarat

- During this period 10,000 each pre and post vac serum samples from round 13 and 14 were tested
- After round 14, the percent protective titre in pre vac samples ranged from 19-30% and in post vac samples, it ranged from 37-53%
- Though compared to round 13, a slight rise in pre vac titre was observed, there were decline in post vac titre against serotype A and Asia1 which requires attention
- Seroconversion was observed in 30.5%, 28.2% and 32.6% animal against serotype O, A and Asia1, respectively at the end of round 13. Similarly, 23.8%, 18.0% and 23.8% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 14
- There were 26.6%, 24.6% and 29.1% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 13 compared to post vac samples of round 12, and 23.8%, 18.0%, and 23.8% drop was observed in round 14.

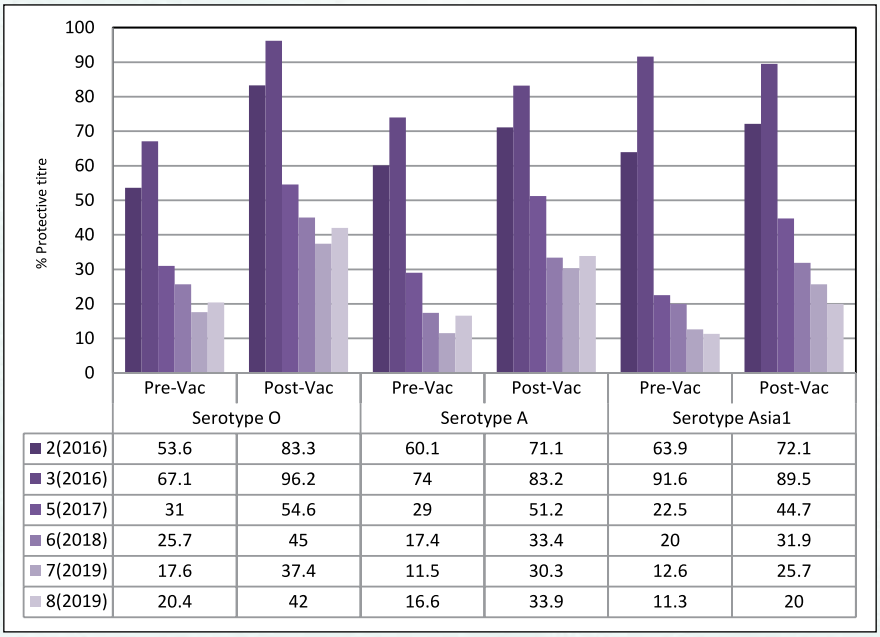


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
4(2013)	54.5	75.9	62.5	76.9	69.2	81.3
5(2014)	59.5	74.4	62.7	76.4	74.9	80
6(2014)	74.9	81.6	49.6	65.8	65.6	79.5
7(2015)	60	73.1	61.6	74.6	72.4	80.6
9(2016)	31.5	58.4	24.4	46.6	25.7	53.4
10(2017)	31.7	57.7	23.9	48	24.3	52.6
11(2017)	26	44	19.8	35.4	25.3	43.1
12(2018)	21.9	48.9	15.4	37.8	24.3	50.3
13(2018)	22.3	52.8	13.2	41.4	21.2	53.8
14(2019)	29.5	53.3	19.4	37.4	26.1	49.9

Fig 10. 9 Protective titre in pre and post vac samples during last 10 rounds in Gujarat

10.10 Rajasthan

- During this period 13,600 each pre and post vac serum samples from round 7 and 8 were tested
- After round 8, the percent protective titre in pre vac samples ranged from 11-20% and in post vac samples, it ranged from 20-42%
- Though compared to round 7, a slight rise in pre and post vac titre was observed for serotype O and A, there were decline in titre against serotype Asia1
- Seroconversion was observed in 19.8%, 18.8% and 13.1% animal against serotype O, A and Asia1, respectively at the end of round 7. Similarly, 21.6%, 17.3% and 8.7% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 8
- There were 27.4%, 21.9% and 19.3% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 7 compared to post vac samples of round 6, and 17.0%, 13.7% and 14.4% drop was observed in round 8.

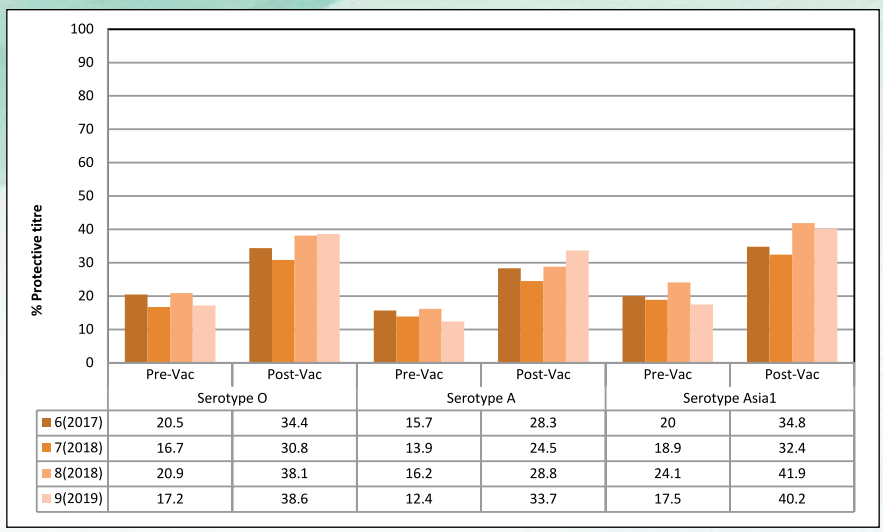


	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
	Serotype O		Serotype A		Serotype Asia1	
2(2016)	53.6	83.3	60.1	71.1	63.9	72.1
3(2016)	67.1	96.2	74	83.2	91.6	89.5
5(2017)	31	54.6	29	51.2	22.5	44.7
6(2018)	25.7	45	17.4	33.4	20	31.9
7(2019)	17.6	37.4	11.5	30.3	12.6	25.7
8(2019)	20.4	42	16.6	33.9	11.3	20

Fig 10.10 Protective titre in pre and post vac samples during last 6 rounds in Rajasthan

10.11 Uttar Pradesh

- During this period 29, 285 pre and 28,800 post vac serum samples from round 8 and 9 were tested
- After round 9, the percent protective titre in pre vac samples ranged from 12-18% and in post vac samples, it ranged from 34-40%
- There has been a decline in protective titre in pre vac samples after round 9 compared to previous rounds which need improvement. Further the post vac titre largely remained same.
- Seroconversion was observed in 17.2%, 12.6% and 17.8% animal against serotype O, A and Asia1, respectively at the end of round 8. Similarly, 21.4%, 21.3% and 22.7% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 9.
- There were 9.9%, 8.3% and 8.3% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 8 compared to post vac samples of round 7, and 20.9%, 16.4%, and 24.9% drop was observed in round 9.

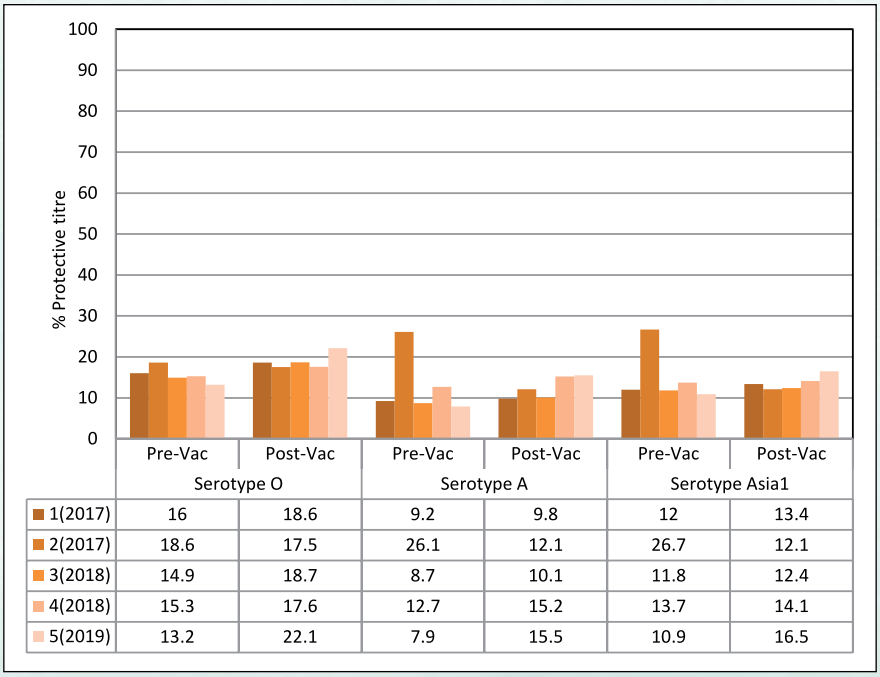


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
6(2017)	20.5	34.4	15.7	28.3	20	34.8
7(2018)	16.7	30.8	13.9	24.5	18.9	32.4
8(2018)	20.9	38.1	16.2	28.8	24.1	41.9
9(2019)	17.2	38.6	12.4	33.7	17.5	40.2

Fig 10.11 Protective titre in pre and post vac samples during last 4 rounds in UP

10.12 Uttarakhand

- During this period 4448 pre and 3853 post vac serum samples from round 4 and 5 were tested
- After round 5, the percent protective titre in pre vac samples ranged from 8-13% and in post vac samples, it ranged from 16-22%
- Seroconversion was observed in 2.3%, 2.5% and 0.4% animal against serotype O, A and Asia1, respectively at the end of round 4. Similarly, 8.9%, 7.6% and 5.6% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 5.
- There were 4.4%, 7.37% and 3.2% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 5 compared to post vac samples of round 4.
- There has been very slight increase in protective titre in post vac samples after round 5 compared to previous round. Conversely decline in pre vac titre was observed. Overall attentions needs to given for proper implementation of the programme

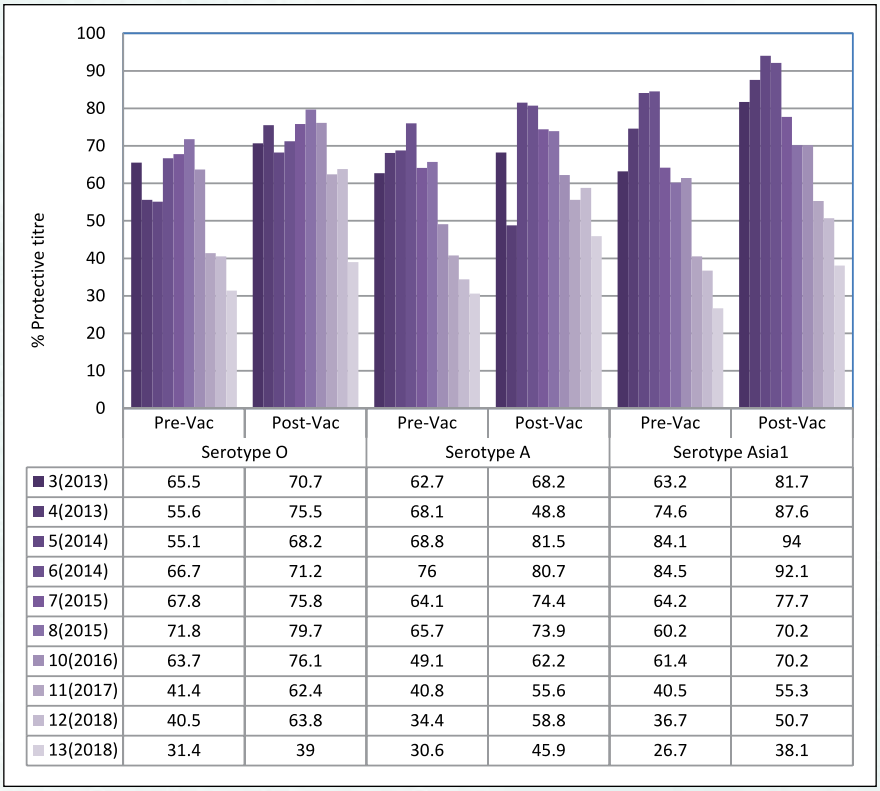


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
1(2017)	16	18.6	9.2	9.8	12	13.4
2(2017)	18.6	17.5	26.1	12.1	26.7	12.1
3(2018)	14.9	18.7	8.7	10.1	11.8	12.4
4(2018)	15.3	17.6	12.7	15.2	13.7	14.1
5(2019)	13.2	22.1	7.9	15.5	10.9	16.5

Fig 10.12 Protective titre in pre and post vac samples during last 5 rounds in UK

10.13 Punjab

- During the year 2019-20 no serum samples were tested
- After round 4, the percent protective titre in pre vac samples ranged from 27-31% and in post vac samples, it ranged from 38-46%
- There has been increase in protective titre after round 13 compared to previous rounds which require attention.
- Seroconversion was observed in 23.3%, 24.4% and 14.0% animal against serotype O, A and Asia1, respectively at the end of round 12. Similarly, 7.6%, 15.3% and 11.4% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 13.
- There were 21.9%, 21.2% and 18.6% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 12 compared to post vac samples of round 11, and 32.4%, 28.2%, and 24.0% drop was observed in round 13.



	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
	Serotype O		Serotype A		Serotype Asia1	
3(2013)	65.5	70.7	62.7	68.2	63.2	81.7
4(2013)	55.6	75.5	68.1	48.8	74.6	87.6
5(2014)	55.1	68.2	68.8	81.5	84.1	94
6(2014)	66.7	71.2	76	80.7	84.5	92.1
7(2015)	67.8	75.8	64.1	74.4	64.2	77.7
8(2015)	71.8	79.7	65.7	73.9	60.2	70.2
10(2016)	63.7	76.1	49.1	62.2	61.4	70.2
11(2017)	41.4	62.4	40.8	55.6	40.5	55.3
12(2018)	40.5	63.8	34.4	58.8	36.7	50.7
13(2018)	31.4	39	30.6	45.9	26.7	38.1

Fig 10.13 Protective titre in pre and post vac samples during last 10 rounds in Punjab

10.14 Haryana

- In the state of Haryana FMD+HS combivac is used under trial mode during 2019
- During this period 1997 pre and 3183 post vac serum samples from round 16 and 17 were tested
- After round 17, the percent protective titre in pre vac samples ranged from 40-45% and in post vac samples, it ranged from 71-76%
- There has been increase in protective titre after round 17 compared to round 16
- Seroconversion was observed in 44.3%, 38.5% and 45.3% animal against serotype O, A and Asia1, respectively at the end of round 16. Similarly, 31.8%, 31.1% and 32.9% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 17.

Round of vaccination	Number of serum samples		Number & % animals (parenthesis) showing titres ≥1.8 log_{10} against FMDV					
			Serotype O		Serotype A		Serotype Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
1(2011)	2587	2573	1105(42.7)	1979(76.9)	838(32.4)	1796(69.8)	769(29.7)	1586(61.6)
2(2011)	2586	2594	1081(41.8)	1876(73.5)	986(38.1)	1876(73.4)	727(28.1)	1537(60.2)
3(2012)	2555	2562	1092(42.5)	1809(71.2)	1113(43.3)	1856(73.1)	650(25.3)	1576(62.1)
4(2012)	2565	2575	1043(40.1)	2049(79.5)	893(34.8)	1811(70.3)	840(32.7)	1700(66)
5(2013)	2600	2600	1210(46.5)	1867(71.8)	1178(45.3)	1638(63)	1010(39.0)	1709(66)
6(2013)	2580	2580	1171(45.4)	2063(80.0)	1455(56.4)	2161(83.8)	1865(72.3)	2341(90.7)
7(2014)	2558	2597	1755(68.0)	2285(88.0)	1895(74.1)	2160(83.2)	2050(80.1)	2483(95.6)
8(2014)	2600	2600	1987(76.4)	2427(93.3)	1907(73.3)	2371(91.2)	2138(82.2)	2506(96.4)
9(2015)	2600	2600	2113(81.3)	2447(94.1)	2112(81.2)	2439(93.8)	2208(84.9)	2542(97.8)
10(2015)	2000	200	1347 (67.4)	192 (96.0)	1343 (67.2)	191 (95.5)	1555 (77.8)	199 (99.5)
16(2019)	797	1383	216(27.1)	988(71.4)	175(21.9)	975(70.4)	229(28.7)	1024(74.0)
17(2019)	1200	1800	474(39.5)	1284(71.3)	535(44.5)	1361(75.6)	503(41.9)	1347(74.8)

10.15 Jammu & Kashmir

- During this period 8199 pre and 3800 post vac serum samples from round 1 and 2 were tested
- After round 1, the percent protective titre in pre vac samples ranged from 15-19% and in post vac samples, it ranged from 19-46%
- Seroconversion was observed in 30%, 14.7% and 5.8% animal against serotype O, A and Asia1, respectively at the end of round 1.

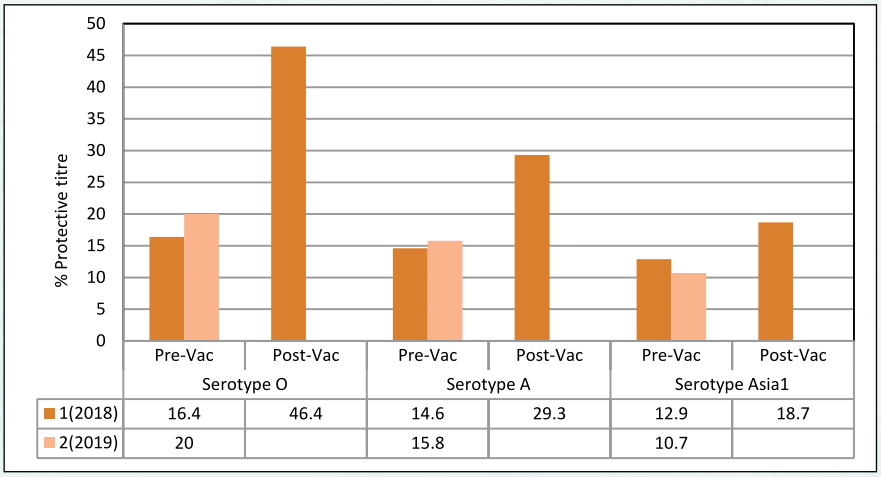


Fig 10.14 Protective titre in pre and post vac samples during last 4 rounds in J&K

10.16 Bihar

- During this period 7047 pre and 4278 post vac serum samples from rounds , 5 and 7 were tested
- After round 5, the percent protective titre in pre vac samples ranged from 2-4% and in post vac samples, it ranged from 6-9%
- Overall seroconversion and herd immunity is found to be very poor
- The strategy of implementation of control programme has to be improved

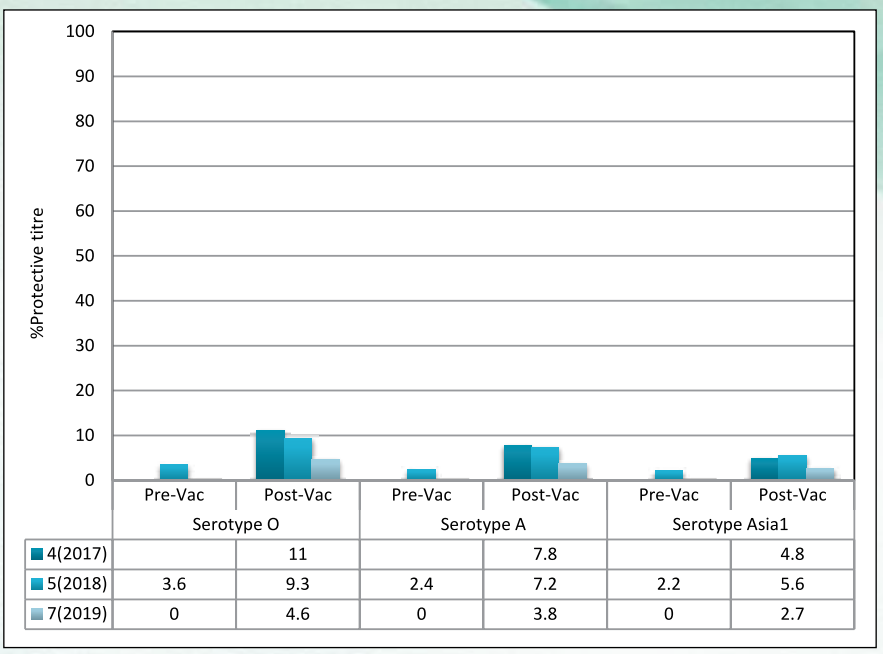


Fig 10.15 Protective titre in pre and post vac samples during last 3 rounds in Bihar

10.17 West Bengal

- During the year 2019-20, no serum samples were tested
- After round 3, the percent protective titre in pre vac samples ranged from 11-23% and in post vac samples, it ranged from 23-43%
- Seroconversion was observed in 21.3%, 12.3% and 11.9% animal against serotype O, A and Asia1, respectively at the end of round 2. Similarly, 19.6%, 11.6% and 13.5% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 3.
- There were 16.6%, 8.9% and 16% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 2 compared to post vac samples of round 1, and 17.6%, 14.1%, and 7.6% drop was observed in round 3.
- There has been very slight increase in protective titre in post vac samples after round 3 compared to previous round against O and Asia1. Overall attentions needs to given for proper execution of the programme

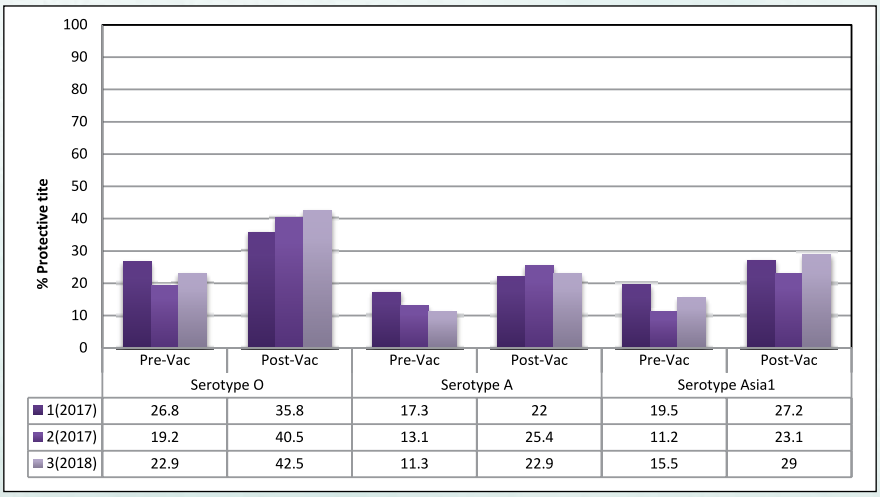
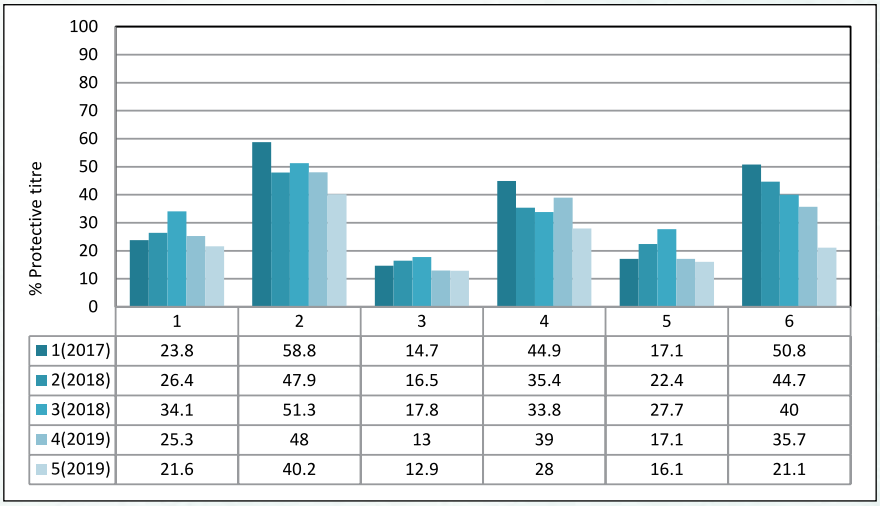


Fig 10.16 Protective titre in pre and post vac samples during last 3 rounds in WB

10.18 Odisha

- During this period 2740 pre and 2720 post vac serum samples from round 4 and 5 were tested
- After round 5, the percent protective titre in pre vac samples ranged from 13-22% and in post vac samples, it ranged from 21-40%
- Though compared to round 4, there were decline in pre and post vac titre against serotypes O, A and Asia1 which requires attention
- Seroconversion was observed in 22.7%, 26.0% and 18.6% animal against serotype O, A and Asia1, respectively at the end of round 4. Similarly, 18.6%, 15.1% and 5.0% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 5
- There were 26.0%, 20.8% and 22.1% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 4 compared to post vac samples of round 3, and 26.4%, 26.1%, and 19.6% drop was observed in round 5.



	1	2	3	4	5	6
1(2017)	23.8	58.8	14.7	44.9	17.1	50.8
2(2018)	26.4	47.9	16.5	35.4	22.4	44.7
3(2018)	34.1	51.3	17.8	33.8	27.7	40
4(2019)	25.3	48	13	39	17.1	35.7
5(2019)	21.6	40.2	12.9	28	16.1	21.1

Fig 10.17 Protective titre in pre and post vac samples during last 5 rounds in Odisha

10.19 Mizoram

- During this period 1108 each pre and post vac serum samples from round 1 and 2 were tested
- After round 2, the percent protective titre in pre vac samples ranged from 38-45% and in post vac samples, it ranged from 64-70%
- There has been a increase in protective titre in both pre vac and post vac samples after round 2 compared to previous round which is a positive impact of proper application of vaccination programme
- Seroconversion was observed in 33.1%, 30.5% and 26.0% animal against serotype O, A and Asia1, respectively at the end of round 1. Similarly, 25.0%, 27.6% and 25.3% percent animals seroconverted against serotype O, A and Asia1, respectively at the end of round 2.
- There were 17.4%, 14.4% and 22.23% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 2 compared to post vac titre of round 1.

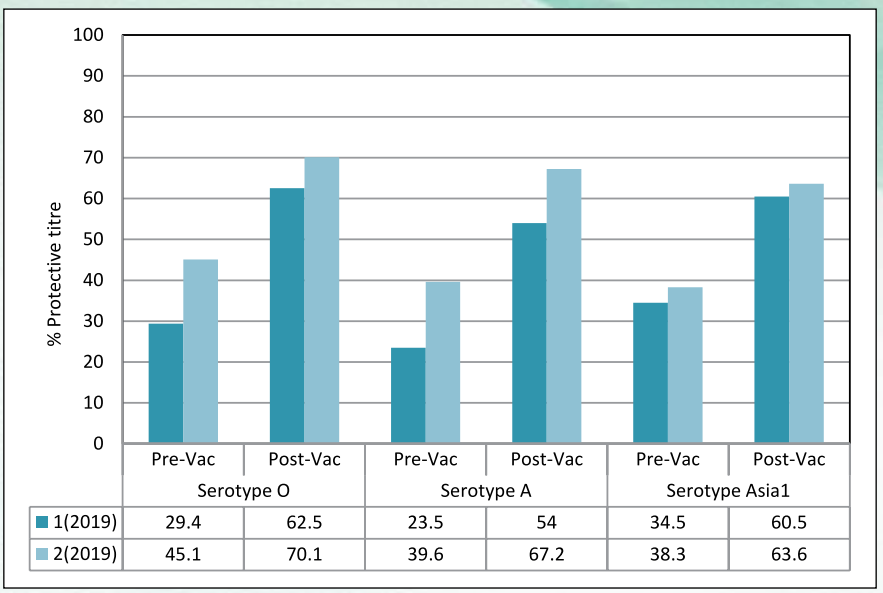


Fig 10.18 Protective titre in pre and post vac samples during last 2 rounds in Mizoram

10.20 Manipur

- During this period 1900 pre and 2694 post vac serum samples from round 1 and 2 were tested
- After round 2, the percent protective titre in pre vac samples ranged from 9-14% and in post vac samples, it ranged from 61-63%
- There has been an increase in protective titre in post vac samples after round 2 compared to previous round which is a positive impact of proper application of vaccination programme. Decrease in pre vac titre is a concern.
- Seroconversion was observed in 28.8%, 23.3% and 29.7% animal against serotype O, A and Asia1, respectively at the end of round 1. Similarly, 49.2%, 52.1% and 49.4% animals seroconverted against serotype O, A and Asia1, respectively at the end of round 2.
- There were 36.9%, 28% and 39% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 2 compared to post vac titre of round 1.

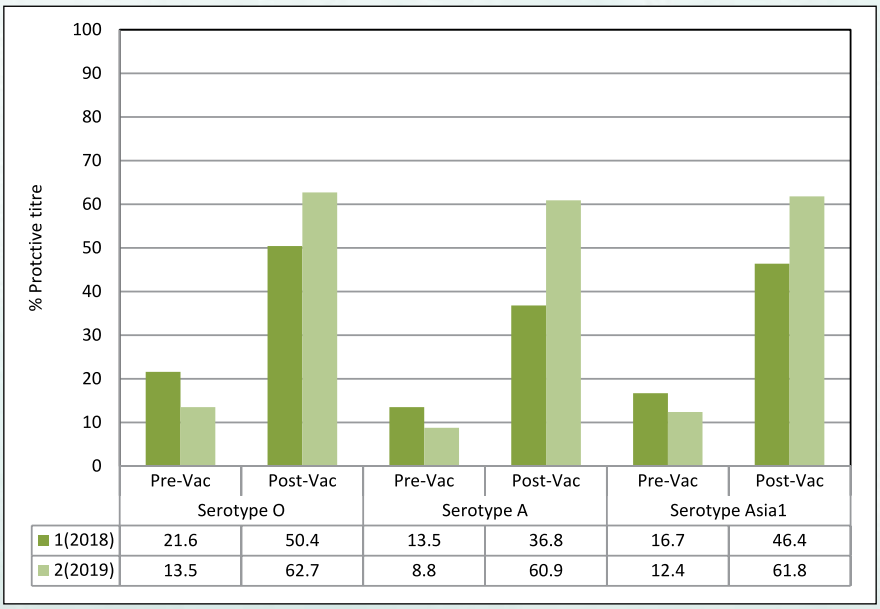
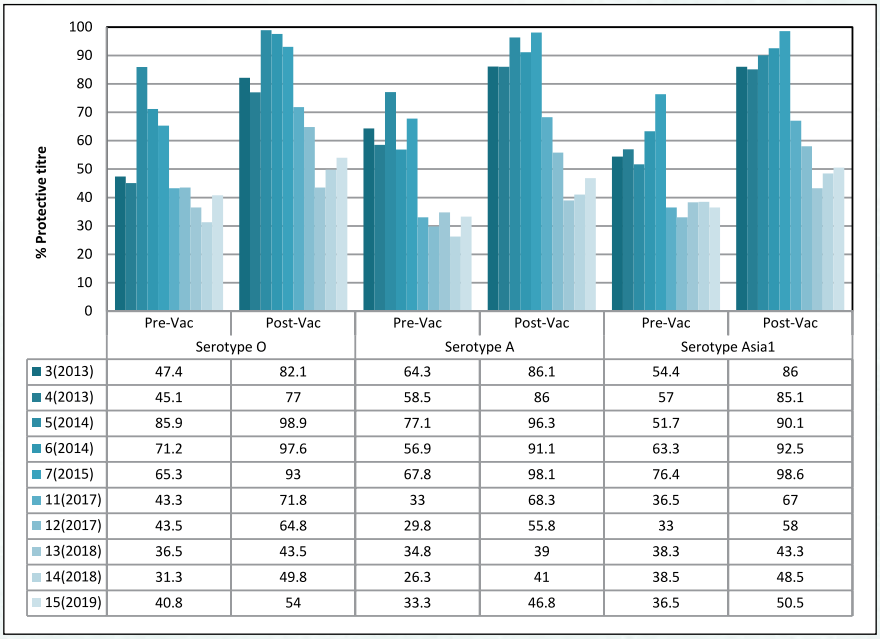


Fig 10.19 Protective titre in pre and post vac samples during last 2 rounds in Manipur

10.21 Goa

- During this period 400 each pre and post vac serum samples from round 15 were tested
- After round 15, the percent protective titre in pre vac samples ranged from 33-41% and in post vac samples, it ranged from 47-54%
- Seroconversion was observed in 13.2%, 13.5% and 14.0% percent animal against serotype O, A and Asia1, respectively at the end of round 15.
- There were 12.2%, 12.7% and 4.8% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 14 compared to post vac samples of round 13, and 9.0%, 7.7%, and 12.09% percent drop was observed in round 15.
- There has been increase in protective titre after round 15 compared to previous round.

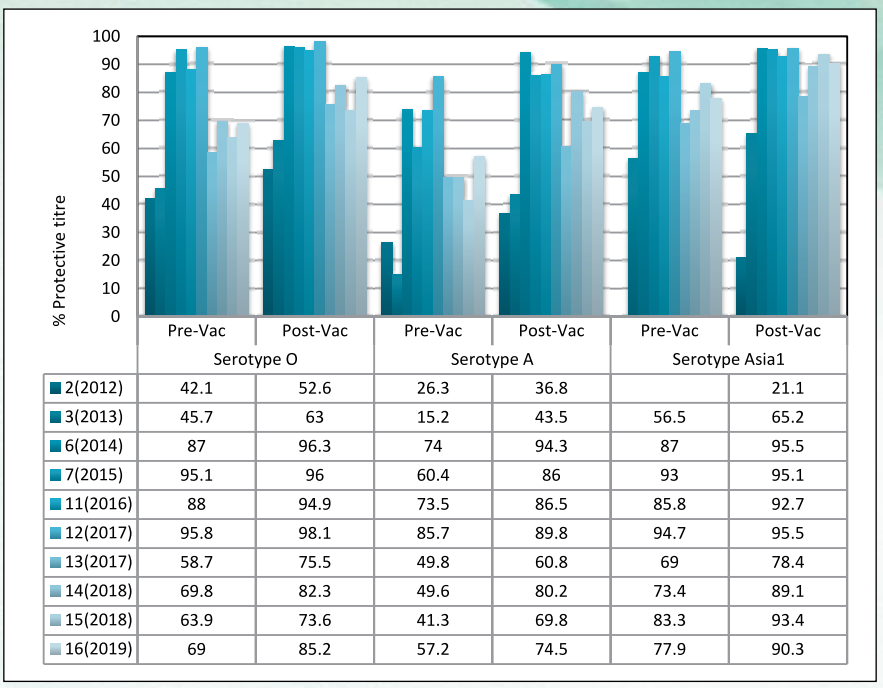


	Serotype O		Serotype A		Serotype Asia1	
	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
3(2013)	47.4	82.1	64.3	86.1	54.4	86
4(2013)	45.1	77	58.5	86	57	85.1
5(2014)	85.9	98.9	77.1	96.3	51.7	90.1
6(2014)	71.2	97.6	56.9	91.1	63.3	92.5
7(2015)	65.3	93	67.8	98.1	76.4	98.6
11(2017)	43.3	71.8	33	68.3	36.5	67
12(2017)	43.5	64.8	29.8	55.8	33	58
13(2018)	36.5	43.5	34.8	39	38.3	43.3
14(2018)	31.3	49.8	26.3	41	38.5	48.5
15(2019)	40.8	54	33.3	46.8	36.5	50.5

Fig 10.20 Protective titre in pre and post vac samples during last 10 rounds in Goa

10.22 Pondicherry

- During this period 290 pre and 290 post vac serum samples from round 16 were tested
- After round 16, the percent protective titre in pre vac samples ranged from 57-78% and in post vac samples, it ranged from 75-90%
- Seroconversion was observed in 16.2%, 17.3% and 12.4% animal against serotype O, A and Asia1, respectively at the end of round 16.
- There were 4.6%, 12.6% and 15.9% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 16 compared to post vac samples of round 15.
- Overall seroconevrsion and herd immunity is found to be good

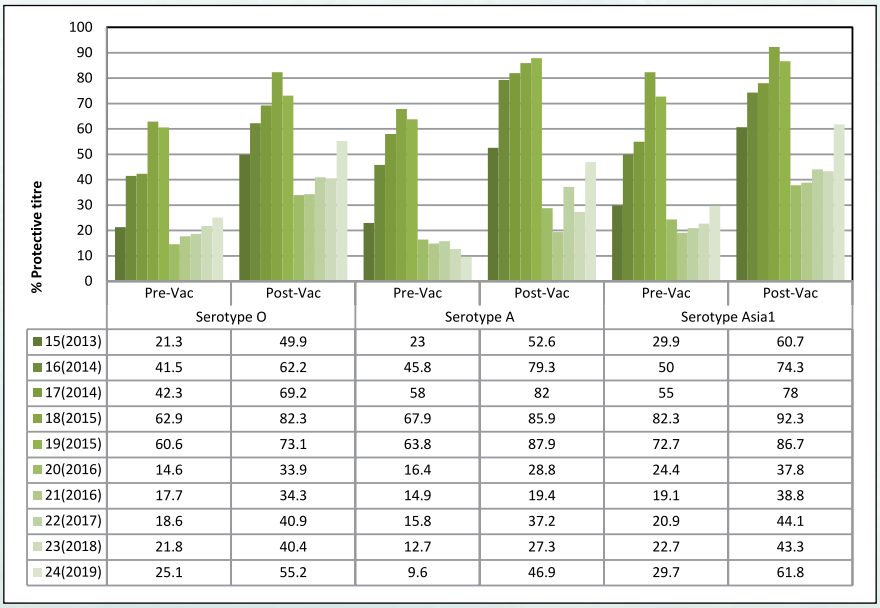


	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
	Serotype O		Serotype A		Serotype Asia1	
2(2012)	42.1	52.6	26.3	36.8		21.1
3(2013)	45.7	63	15.2	43.5	56.5	65.2
6(2014)	87	96.3	74	94.3	87	95.5
7(2015)	95.1	96	60.4	86	93	95.1
11(2016)	88	94.9	73.5	86.5	85.8	92.7
12(2017)	95.8	98.1	85.7	89.8	94.7	95.5
13(2017)	58.7	75.5	49.8	60.8	69	78.4
14(2018)	69.8	82.3	49.6	80.2	73.4	89.1
15(2018)	63.9	73.6	41.3	69.8	83.3	93.4
16(2019)	69	85.2	57.2	74.5	77.9	90.3

Fig 10.21 Protective titre in pre and post vac samples during last 10 rounds in Pondicherry

10.23 Andaman & Nicobar Islands

- During this period 387 pre and 384 post vac serum samples from round 24 were tested
- After round 24, the percent protective titre in pre vac samples ranged from 10-30% and in post vac samples, it ranged from 47-62%
- Seroconversion was observed in 30.1%, 37.3% and 32.1% animal against serotype O, A and Asia1, respectively at the end of round 24.
- There was 19.1%, 24.5% and 21.4% drop in titre against serotype O, A and Asia1, respectively in pre vac samples of round 23 compared to post vac samples of round 22, and 15.3%, 17.7%, and 13.6% percent drop was observed in round 24.
- There has been increase in protective titre after round 24 compared to previous rounds



	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac	Pre-Vac	Post-Vac
	Serotype O		Serotype A		Serotype Asia1	
15(2013)	21.3	49.9	23	52.6	29.9	60.7
16(2014)	41.5	62.2	45.8	79.3	50	74.3
17(2014)	42.3	69.2	58	82	55	78
18(2015)	62.9	82.3	67.9	85.9	82.3	92.3
19(2015)	60.6	73.1	63.8	87.9	72.7	86.7
20(2016)	14.6	33.9	16.4	28.8	24.4	37.8
21(2016)	17.7	34.3	14.9	19.4	19.1	38.8
22(2017)	18.6	40.9	15.8	37.2	20.9	44.1
23(2018)	21.8	40.4	12.7	27.3	22.7	43.3
24(2019)	25.1	55.2	9.6	46.9	29.7	61.8

Fig 10.22 Protective titre in pre and post vac samples during last 10 rounds in A&N Islands

10.24 Assam

- During the year 2019, 5053 pre and 4996 post vac serum samples from round 1 was tested
- After round 1, the percent protective titre in pre vac samples ranged from 7.2-9.9% and in post vac samples, it ranged from 21.4-24.7%

Publications

11

a. Peer reviewed Journals

- Biswal JK, Subramaniam S, Ranjan R, VanderWaal K, Sanyal A, Pattnaik B, Singh RK (2019). Differential antibody responses to the major antigenic sites of FMD virus serotype O after primo-vaccination, multiply-vaccination and after natural exposure. Infect Genet Evol. 6; 78:104105 **(Impact factor: 2.773)**
- Biswal JK, Ranjan R, Subramaniam S, Mohapatra JK, Patidar S, Sharma, MK, Bertram MR, Brito B, Rodriguez LL, Pattnaik B, Arzt, J (2019). Genetic and antigenic variation of foot-and-mouth disease virus during persistent infection in naturally infected cattle and Asian buffalo in India. Plos One. https://doi.org/10.1371/journal.pone.0214832 **(Impact factor: 2.74)**
- Bertram MR, Palinski RM, Ranjan R, Biswal JK, Pauszek SJ, Hartwig EJ, Smoliga GR, Fish IH, Vierra D, Subramaniam S, Mohapatra JK, Das B, Pattnaik B, Arzt J5 (2019). Genome Sequences of 18 Foot-and-Mouth Disease Virus Outbreak Strains of Serotype O Sublineage Ind2001d from India, 2013 to 2014. **Microbiol Resour Announc. 15;8(33). pii: e00776-19.**
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- Khulape SA, Maity HK, Pathak DC, Ramamurthy N, Ramakrishnan S, Chellappa MM, Dey S (2019). Evaluations of a fusion gene-based DNA prime-protein boost vaccination strategy against Newcastle disease virus. Trop Anim Health Prod. 51(8):2529-2538 **(Impact factor: 1.333)**
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- Jai Sunder, Arun Kumar De, Debasis Bhattacharya, Tamilvanan Sujatha, Sagar Ashok Khulape and Anandamoy Kundu (2019). Re-emergence of Foot and Mouth Disease in Andaman and Nicobar Islands, India. Indian Journal of Animal Research. 9:.2 363-367 **(Impact factor: 0.395)**
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- Kiran, M. Naveena, B.M. Smrutirekha, M. Baswa Reddy, P. Rituparna, Banerjee Praveen Kumar, Y. Venkatesh, Ch. Rapole, Srikanth (2019). Traditional halal slaughter without stunning versus slaughter with electrical stunning of sheep (Ovis aries). Meat Science. 148: 127-136 **(Impact factor: 3.644)**

b. Presentations in Conferences/ Symposia/ Seminars/ Other fora

- Santhosh A, Sahoo NR, Gaur GK, Maurya R, Kumar P, Darji MK, Panigrahi M , Sonwane A and Srivastava N (2019) Factors affecting qPCR based gametic sex ratio in boar semen. 18th Annual convocation of NAVS (I) and scientific convention on "Futuristic Technologies in Animal Health and Production" at Gandhinagar on 26-28th December 2019.

c.Training manuals/Technical bulletin/Books

- Suresh KP, Patil SS, Roy P, Mohapatra JK, Subramaniam S and Singh RK (2019). Sampling Plan for Serosurveillance and Seromonitoring of FMD in India under National FMD Control Programme (Volume I: serosurveillance), ICAR-NIVEDI. Bengaluru
- Suresh KP, Patil SS, Roy P, Mohapatra JK, Subramaniam S and Singh RK (2019). Sampling Plan for Serosurveillance and Seromonitoring of FMD in India under National FMD Control Programme (Volume II: Seromonitoring), ICAR-NIVEDI. Bengaluru
- Biswal JK, Subramaniam S, Mohapatra JK (2019). Training manual on Solid Phase Competitive ELISA (SPCE) for anti-FMDV structural antibody estimation. ICAR-DFMD, Mukteswar-263138, Nainital, India.

d. Hindi book chapter

- पशु–फार्म के लिए जैवसुरक्षा के उपायपद training manual under SCSP scheme 2019-20 for demonstration cum workshop organized for farmers entitled पहाड़ी क्षेत्र में पशुधनस्वास्थ्य प्रबंधन।

Award / Fellowship / Recognition

12

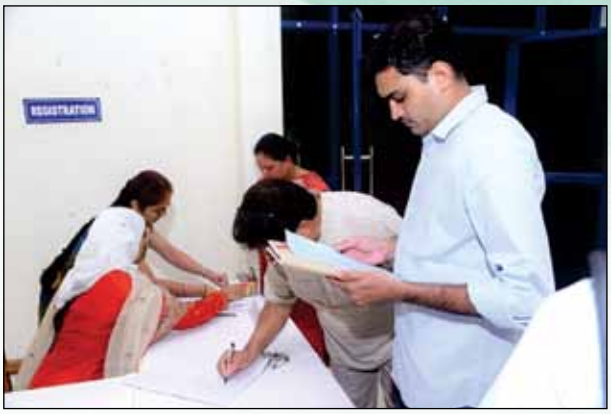
- NAVS Associate to Dr Nihar Ranjan Sahoo for 2018-19 conferred on December 26th 2019.
- Dr. Rajeev Ranjan awarded with "IFBA Certified Professional"- Professional Certification in Biorisk Management (IFBA Certified Professional, ID Number: NBU344843) provided by "International Federation of Biosafety Associations (IFBA), 102-2460 Lancaster Road Ottawa, Ontario, Canada, K1B 4S5" on June 24, 2019.
- Dr. Rajeev Ranjan awarded with "IFBA Certified Professional"- Professional Certification in Biosafety Cabinets (IFBA Certified Professional, ID Number: NBU344843) provided by "International Federation of Biosafety Associations (IFBA), 102-2460 Lancaster Road Ottawa, Ontario, Canada, K1B 4S5" on July 11, 2019.
- Dr. Rajeev Ranjan awarded with "ICVP Certified Diplomate"- ICVP Board Certification Examination organized by Indian College of Veterinary Pathologist in the month of September, 2019.
- Dr. Rajeev Ranjan awarded with "IFBA Certified Professional"- Professional Certification in Biological Waste Management (IFBA Certified Professional, ID Number: NBU344843) provided by "International Federation of Biosafety Associations (IFBA), 102-2460 Lancaster Road Ottawa, Ontario, Canada, K1B 4S5" on October 23, 2019.

13 Training and Capacity Building

a. Participation in Training, Seminars, Workshops, Symposia, Conferences and Meetings

Title	Date and Venue	Participants
Biocontainment Facility Design, Operation, and Maintenance program (online)	June 11, 2019 Frontline Foundation, USA	Dr Rajeev Ranjan
MDP on Priority setting, Monitoring and Evaluation (PME) of Agricultural Research Projects	18-23 July 2019, ICAR-NAARM, Hyderabad	Dr Saravanan S
E-Samiksha meeting conducted by DAHD, GoI regarding FMD vaccination and testing	06, August 2019 Krishi Bhavan, New Delhi	Dr Saravanan S
27th Annual Review Meeting of AICRP on FMD	30-31 August, 2019 IAHVB, Bengaluru	Dr JK Mohapatra Dr Saravanan S Dr A P Sahoo Dr R Ranjan Dr JK Biswal
Winter school on "Climate change Impacts and Innovative Adaptation option for smart Animal-Agriculture"	6-26 September 2019 OUAT, Bhubaneswar	Dr JK Biswal
Expert meeting for finalization of sampling plan for seromonitoring and serosurveillance	11 October, 2019 ICAR-NIVEDI, Bengaluru	Dr JK Mohapatra Dr Saravanan S
Hands on training on high throughput sequence data analysis	23-30 November 2019 at ICAR-CIFA, Bhubaneswar	Dr JK Mohapatra
Advances in diagnosis and control of endemic and emerging infectious diseases of livestock and poultry in North Eastern Region of India	03-23 December 2019, AAU, Guwahati.	Dr Shyam S Dahiya
Annual convocation of NAVS (I) and scientific convention on "Futuristic Technologies in Animal Health and Production"	26-28th December 2019 Gandhinagar	Dr Nihar R Sahoo
ICAR Sponsored Winter School on "advanced molecular techniques in fish diagnosis and management in freshwater aquaculture".	26 Nov-16 Dec. 2019 ICAR-CIFA, Bhubaneswar	Dr Rajeev Ranjan

XXVII Annual Review meeting of AICRP on FMD under ICAR-DFMD held at IAHVB, Bengaluru, Karnataka



b. Extension activities

Dr Sagar A Khulape participated and represented institute at Farmer First program on occasion of World Apple day on 23rd Oct 2019 in demonstration and workshop organized by CITH, Mukteshwar Campus.

Dr Sagar A Khulape carried out field investigation (Pro-bang sampling) of FMD in large ruminant population of district Pithoragarh and Almora (Uttarakhand) during 23rd -29th June 2019.

NADCP launch and FMD awareness camp




Tribal Sub Plan (TSP)

Under this plan, piglets, improved variety of chicks, feed, milk cans, mineral mixtures and pig feed were supplied in TSP areas. Further, awareness camps were conducted


c. Training Imparted

ICAR-DFMD at its National FMDCP Sero-monitoring Laboratory, Bengaluru campus organized six-days training programme on 'FMD Post Vaccination Sero-monitoring using Solid Phase Competitive ELISA (SPC-ELISA)' in six batches during October-December 2019. A pool of 43 trained personnel from regional and collaborating centres located in different states was created to undertake the task of sero-monitoring. The SPCE kit for testing one round of serum samples were provided to each centre at the end of the training. ICAR-DFMD will continue to monitor the testing activity and will be involved in trouble shooting of any issue arising from time to time.

Table: Training programme on SPCE

SNo	Name	Centre
	First Batch October 14-19	
1	Dr Jai Sunder	Port Blair
2	Dr A K De	Port Blair
3	Dr. B.M Veeregowda	Bengaluru
4	Dr Gowthaman	Bengaluru
5	Dr. Sulekha Kamdi	Pune
6	Dr. SS Sobha	Trivendrum
7	Dr. Aparna S	Trivendrum
8	Dr T Lokhande	Bhopal
9	Dr Seema Bhindwale	Bhopal
10	Dr S Tanju	Hyderabad
11	Dr. Neelam Bishnoi	Hisar
12	Dr Anshul Bhateja	Hisar
13	Dr Swati Dahiya	Hisar
14	Dr. Anshul Lather	Hisar
	Second Batch October 21-26	
1	Dr D Patro	Cuttack
2	Dr M Behura	Cuttack

SNo	Name	Centre
3	Dr Esther Lalzoliani	Aizawl
4	Dr C Neihthanpuii	Aizawl
5	Dr. Sabitri Maibam	Imphal
6	Dr. Usharani Devi	Imphal
7	Dr Pankaj Deka	Guwahati
8	Dr Pranab Das	Guwahati
9	Dr H Lalzhampu	NRC Mithun
	Third Batch November 4-9	
1	Dr Alok Khanduri	Risikesh
2	Dr Prasoon Dubey	Risikesh
3	Dr. Ritesh Biswas	Kolkata
4	Dr Sumit Chowdhury	Kolkata
5	Dr Gyamnya Baki Garam	Itanagar
	Fourth Batch November 11-16	
1	Dr Gaurav Sharma	Jalandhar
2	Dr Charanjeet Sarangal	Jalandhar
3	Dr.D.Raja Sekaran	Ranipet
4	Dr. Selva Maheswari	Ranipet
5	Dr. Khrisamhazo Rhetso	Kohima
6	Dr. Ketholelie Mere	Kohima
7	Dr Lenin Bhatt	Jaipur
8	Dr Amit Sharma	Jaipur
9	Dr Nilay Kumar Das	Tripura
	Fifth Batch November 18-23	
1	Dr Manoj Kumar	Patna
2	Dr V. M. Vivek Srinivas	Pondicherry
3	Dr Mohit Kaul	Jammu
4	Dr Vikram Singh Slathia	Jammu
5	Dr Hatinder Singh	Shimla
	Sixth Batch November 18-23	
1	Dr Vartika Chandra	Ahmedabad

Training on FMD Seromonitoring

14 Revenue generation

The institute offered testing service for FMD seromonitoring to private dairy farm and through which revenue of Rs. 6,48,906 was generated and also supplied DIVA ELISA kit to vaccine manufacturers by which revenue of Rs 80,439 was generated. Overall, revenue generated was Rs. 7,29,345 during the year 2019.

Various Committees

15

Research Advisory Committee

S. No.	Name	Position
1	Dr. R.N.S. Gowda, Former Vice Chancellor, KVAFSU, Bengaluru	Chairman
2	Dr. M.V. Subbarao, Former Dean, SVU, Hyderabad	Member
3	Dr. Nem Singh, Former Joint Director (Research), IVRI	Member
4	Dr. B.C. Kar, Former Professor, Orissa Veterinary College	Member
5	Shri Sumit Lakhotia, Farmer, Kashipur, Uttarakhand	Member
6	Shri Khirod Satapathy, Farmer, Khordha, Odisha	Member
7	Dr. Ashok Kumar, ADG (AH), ICAR, Krishi Bhavan	Member
8	Dr Saravanan S, Sr Scientist, DFMD	Member secretary

Institute Bio safety Committee

S. No.	Name	Position
1	Dr R K Singh, Director, DFMD	Chairman
2	Dr Biswajit Mishra, Medical consultant, Khurda	Biosafety officer
3	Dr Sandeep Bhatia, Pr Scientist, NIHSAD, Bhopla	Outside Expert
4	Dr B P Mishra, JD (Research), IVRI, Bareilly	DBT nominee
5	Dr Biswal JK, Scientist, DFMD	Internal Member
6	Dr Sahoo AP, Scientist, DFMD	Internal Member
7	Dr Khulape SA, Scientist, DFMD	Internal Member
8	Dr Saravanan S, Sr Scientist, DFMD	Internal Member
9	Dr Rajeev Ranjan, Scientist, DFMD	Member secretary

Institute Animal Ethics Committee

S. No.	Name	Position
1	Director, DFMD	Chairman
2	Dr. Prakash Kumar Sahoo Scientist, ICMR – Regional Medical Research Centre, Chandrasekharpur, Bhubaneswar	CPCSEA Nominee
3	Shri. Narendra Kumar Parida, The College of Pharmaceutical Sciences,Tamando, Bhubaneswar	Link Nominee
4	Dr. S. Parthasarathy Fisheries & Animal Resources Development Dept, Govt of Odisha	Scientist from outside of the Institute
5	Shri Amulya Nayak PFA, Jagosinghpur, Animal Welfare Activist	Socially aware Nominee
6	Dr Sahoo AP, Scientist, DFMD	Scientist from different biological discipline
7	Dr Biswal JK, Scientist, DFMD	Scientist from different biological discipline
8	Dr Smrutirekha Mallick, Scientist, DFMD	Veterinarian
9	Dr Rajeev Ranjan, Scientist, DFMD	Member Secretary

Meeting proceedings

16

A. Proceedings of cost fixation committee meeting for Solid Phase Competitive (SPC) ELISA:

The meeting of committee for fixation of cost of Solid Phase Competitive (SPC) ELISA with reference to office order no 3-19/SPCE Kit cost/DFMD/2019-20/1804-1810 dated 17-10-2019 was held at National FMDCP Seromonitoring Laboratory (ICAR-DFMD) at Bengaluru on 18 November 2019 under the Chairmanship of Dr M Hosamani, Pr. Scientist, ICAR-IVRI, Bengaluru Campus. The following members were present.

1. Dr. D.Hemadri, Pr. Scientist, ICAR-NIVEDI
2. Dr. G.Govindaraj, Sr. Scientist, ICAR-NIVEDI
3. Dr. J.K.Mohapatra, Sr. Scientist, ICAR-DFMD
4. Dr. Saravanan S, Sr. Scientist, ICAR-DFMD
5. Shri. Vijay Kumar, AF&AO, ICAR-NIVEDI
6. Shri. Tara Kumar, AAO, ICAR-DFMD & Member secretary

The committee deliberated on fixation of price for the following categories (prices to be effective till 31-03-2021)

- Cost of complete SPC-ELISA kit
- Cost of SPC-ELISA kit without plasticware
- Cost of serum sample testing service using SPC-ELISA
- Cost of SPC-ELISA training

The committee took in to account the detailed cost calculation of each component and associated services for arriving at the proposed cost.

B. Proceedings of the meeting for fixation of cost for 3AB3 NSP ELISA (DIVA) Kit, Testing Service and Training fees:

The meeting of committee for fixation of cost of 3AB3 NSP ELISA (DIVA) Kit, Testing Service and Training, with reference to office order no 3-19/SPCE Kit cost/DFMD/2019-20/1910-1916 dated 20 December 2019 was held at National FMDCP Seromonitoring Laboratory (ICAR-DFMD) at Bengaluru on 6 January 2020; 10.30 a.m. under the Chairmanship of Dr D. Hemadri, Pr. Scientist, ICAR-NIVEDI, Bengaluru. The following members were present.

1. Dr P. K. Dixit, Pr. Scientist, ICAR-NDRI, Bengaluru
2. Dr M. Hosamani, Pr. Scientist, ICAR-IVRI, Bengaluru
3. Dr J.K.Mohapatra, Sr. Scientist, ICAR-DFMD, Bengaluru
4. Shri Vijay Kumar, AF&AO, ICAR-NIVEDI, Bengaluru
5. Shri Tara Kumar, AAO, ICAR-DFMD, Mukteswar & Member Secretary

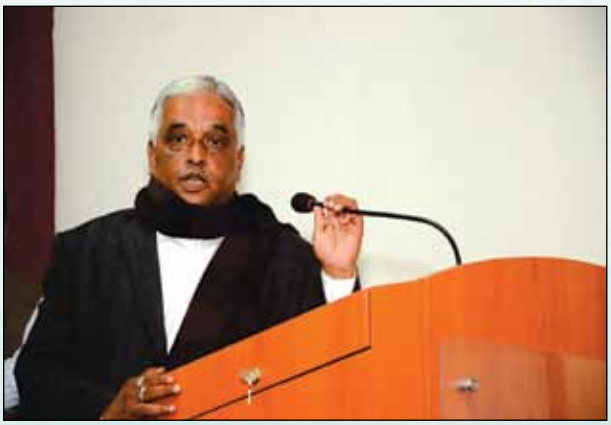
Dr Saravanan S, Sr. Scientist & member, ICAR-DFMD, Bengaluru could not attend the meeting due to some other urgent assignment with kind approval of Director, DFMD.

The committee deliberated on fixation of price for the following categories (prices to be valid till 31-03-2021)

- Cost of complete 3AB3 NSP ELISA (DIVA) kit
- Cost of 3AB3 NSP ELISA (DIVA) kit without plasticware
- Cost of serum sample testing service using 3AB3 NSP ELISA (DIVA)
- Cost of 3AB3 NSP ELISA (DIVA) on campus hands-on training

The committee looked into the detailed calculation presented by Dr J. K. Mohapatra and agreed to the proposed cost upon detailed deliberation.

Farewell Ceremony of Dr. Bramhadev Pattnaik, Director, ICAR-DFMD, Mukteswar



ICAR-DFMD Staff involved in Swachh Bharath Abhiyan




Swachhta Pledge taken by ICAR-DFMD

Hindi Pakhwada celebrated during 19-29 September 2019

Research Projects

17

S. No.	Title	PI and Co-PIs	Duration	Institute Code
1	Foot-and-mouth disease virus surveillance at the wildlife-livestock interface	Ranjan R (PI) Biswal JK	2019-21	ANSC/DFMD/S/ I/L/2019/001/00114
2	Development, standardization and quality control of biosecurity procedures at BSL3+Ag laboratory of International Centre for Foot-and-mouth disease virus	Ranjan R (PI) Biswal JK	2019-22	ANSC/DFMD/S/ I/L/2019/002/00115
3	Development of DIVA-compatible live-attenuated vaccine candidate strain for FMDV serotype O	Biswal JK(PI) Saravanan S Ranjan R	2019-21	ANSC/DFMD/S/ I/L/2019/003/00116
4	Development and in vitro characterization of thermostable vaccine candidates for FMDV serotypes Asia1 and A	Biswal JK(PI) Saravanan S Khulape SA	2019-21	ANSC/DFMD/S/ I/L/2019/004/00117
5	Heterologous expression of FMDV genome regions and proteins	Khulape SA(PI) Jana C Biswal JK Ranjan R	2019-21	ANSC/DFMD/S/ I/L/2019/007/00120
6	Study of vaccine induced antibody response in livestock in organized herd	Rout M(PI) Mohapatra JK	2019-21	ANSC/DFMD/S/ I/L/2019/009/00122
7	Generation of monoclonal antibodies against recombinant FMDV polyprotein 3AB and their application in immunodiagnosis	Mallick SR(PI) Sahoo AP Biswal JK Ranjan R	2019-21	ANSC/DFMD/S/ I/L/2019/013/00126
8	Use of calcium phosphate nanoparticles for the generation of thermostable vaccine candidate against FMDV serotype O	Biswal JK(PI)	2020-22	ANSC/DFMD/S/ I/L/2020/001/00127
9	Host genetic factors affecting FMD vaccine response in calves	Sahoo NR(PI) Mohapatra JK Biswal JK Rout M	2020-22	ANSC/DFMD/S/ I/L/2020/002/00128
10	Association of Foot and Mouth disease virus vaccine induced immune response with reproductive status and production performance of bovines in organized herd.	Mallick SR(PI) Mohapatra JK	2020-22	ANSC/DFMD/S/ I/L/2020/003/00129
11	Antigenic and Genetic characterization of foot and mouth disease virus serotype O from India during 2020-21.	Dahiya SS(PI) Saravanan S Mohapatra JK	2020-21	ANSC/DFMD/S/ I/L/2020/004/00130
12	Antigenic and Genetic characterization of foot and mouth disease virus serotype A from India during 2020-21.	Mohapatra JK(PI) Rout M	2020-21	ANSC/DFMD/S/ I/L/2020/005/00131

S. No.	Title	PI and Co-PIs	Duration	Institute Code
13	Genetic and antigenic characterization of Foot and Mouth Disease virus serotype Asia1 during 2020-21	Biswal JK(PI) Khulape SA	2020-21	ANSC/DFMD/S/ I/L/2020/006/00132
14	FMD virus isolation and maintenance of virus repository	Dahiya SS(PI) Rout M Mohapatra JK Khulape SA	2020-21	ANSC/DFMD/S/ I/L/2020/007/00133
15	Epidemiology of Foot and Mouth Disease in small ruminants and pigs in India during 2020-21.	Rout M(PI) Mohapatra JK Saravanan S	2020-21	ANSC/DFMD/S/ I/L/2020/008/00134
16	Production, standardization and supply of diagnostic reagents for FMD virus diagnosis and surveillance during 2020-21.	Mohapatra JK(PI) Sahoo AP Khulape SA Dahiya SS Biswal JK Jana C Saravanan S	2020-21	ANSC/DFMD/S/ I/L/2020/009/00135
17	Seromonitoring of pre and post vaccinal immunity against Foot and Mouth Disease under NADCP (2020-21).	Saravanan S(PI) Sahoo AP Mohapatra JK	2020-21	ANSC/DFMD/S/ O/L/2020/010/00136
18	Serosurveillance in bovines under NADCP (2020-21).	Mohapatra JK(PI) Saravanan S Rout M Sahoo AP Ranjan R Mallick SR	2020-21	ANSC/DFMD/S/ O/L/2020/011/00137
19	FMD virus diagnostic service and serotype identification	Mohapatra JK(PI) Biswal JK Dahiya SS Rout M	2020-21	ANSC/DFMD/S/ I/L/2020/012/00138
20	FMD vaccine quality control under NADCP	Sahoo NR(PI) Mohapatra JK Saravanan S Sahoo AP Rout M Dahiya SS	2020-21	ANSC/DFMD/S/ O/L/2020/013/00139
21	Surveillance of FMD and vaccine effectiveness study within 20 km radius of ICFMD, Arugul, Bhubaneswar	Rout M(PI) Mohapatra JK Sahoo NR Saravanan S	2020-22	ANSC/DFMD/S/ I/L/2020/014/00140

S. No.	Title	PI and Co-PIs	Duration	Institute Code
22	Production of anti-FMDV Hyper-immune sera in rabbits and guinea pigs for FMD virus diagnosis and seromonitoring	Sahoo AP(PI) Sreenivasa B P Saravanan S Mohapatra JK Khulape SA	2020-21	ANSC/DFMD/C/I/L/2020/015/00141
23	Transmission Electron Microscopy as a tool in diagnostic pathology and research for Foot-and-mouth disease virus	Ranjan R(PI)	2020-22	ANSC/DFMD/S/I/L/2020/016/00142

18 Staff Position (2019)

S No	Name	Designation
1	Dr. Raj Kumar Singh	Director (RPM)
	Scientific staff	
	Veterinary Microbiology	
2	Dr. Jajati K Mohapatra	Senior Scientist
3	Dr. Saravanan Subramaniam	Senior Scientist
4	Dr. Shyam S Dahiya	Scientist (Sr Scale)
	Veterinary Pathology	
5	Dr. Chandrakanta Jana	Senior Scientist
6	Dr. Manoranjan Rout	Scientist (Sr Scale)
7	Dr. Rajeev Ranjan	Scientist (Sr Scale)
	Animal Physiology & Biochemistry	
8	Dr. Jitendra K Biswal	Scientist (Sr Scale)
9	Dr. Smrutirekha Mallick	Scientist
	Animal Genetic & Biotechnology	
10	Dr. Nihar R Sahoo	Senior Scientist
11	Dr. Aditya P Sahoo	Scientist (Sr Scale)
12	Dr. Khulape S Ashok	Scientist
	Technical staff	
13	Sh. Nayan Sanjeev	T-3 (Lab)
14	Sh. S.L.Tamta	T-1 (Lab)
	Administrative staff	
15	Sh. Tara Kumar	AAO
16	Sh. R.N.Sahoo	UDC
17	Sh. Ravi Chaudhary	Junior Stenographer

NOTE

NOTE

ICAR-Directorate of Foot and Mouth Disease
Mukteswar 263 138
Nainital, Uttarakhand, India