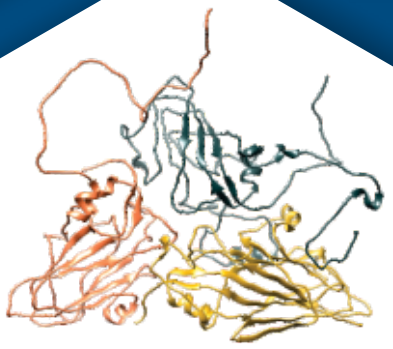
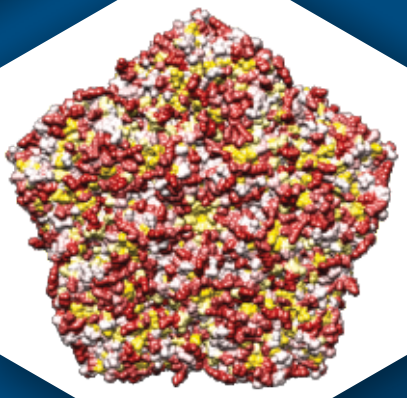
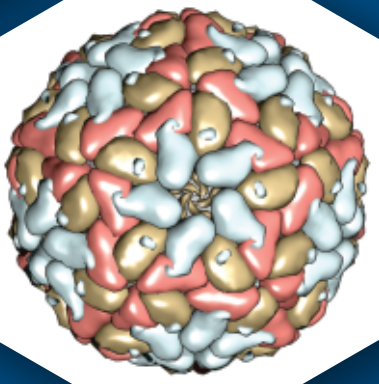
DFMD







भाकृअनुप
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ANNUAL REPORT

2015-16

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ICAR-Directorate on Foot and Mouth Disease

Mukteswar 263 138 (India)

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Mukteswar 263 138
Nainital, Uttarakhand, India

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Comparative homology model of serotype O FMDV vaccine strain R2/75 displayed as;
(A)Protomer: (Ribbons) (B) Pentamer (hydrophobic surface) and (C) Empty virus capsid.
Structures predicted using UCSF Chimera software

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Contents

1 Executive Summary

Foot-and-mouth Disease (FMD) is a highly contagious viral disease of domesticated livestock, primarily cattle, buffalo and pigs. Sheep, goat and different species of wild life are also susceptible to the disease. India has a FMD susceptible livestock population of >500 million (DAHD&F, GoI, 2012). The economic loss to the livestock industry attributed to this dreaded disease is huge. There are direct and indirect losses due to this disease. Direct loss is estimated at >20,000 crore/annum that is due to significant drop in milk yield (up to 80%), loss in drought power, reduction in meat and wool production, abortion in pregnant animals and mortality in calves. Indirect loss could be much more due to trade barrier imposed by the countries free from FMD, and massive expenditure by Government on FMD control and cost of treatment. The causative FMD virus (FMDV) is antigenically diverse having seven distinct serotypes (O, A, C, Asia1 and Southern African Territories (SAT) 1-3 and multiple genetic groups in each serotype. Currently three serotypes (O, A and Asia1) are prevalent in India. Serotype O is the most prevalent one followed by serotypes Asia1 and A.

During the year 2015-16, a total 252 FMD incidences were recorded in India (Table 1). Maximum incidence was reported from the Southern region followed by Eastern and North eastern region. Among the states, Karnataka witnessed maximum numbers of FMD incidences during the period. There was no incidence of the disease in the states of Punjab, Andhra Pradesh, Mizoram and Delhi during 2015-16, and a few sporadic cases were recorded in the states of Haryana and Himachal Pradesh.

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

Year	South	North	Central	West	East	North East	Total
2011-12	97	20	34	60	71	65	347
2012-13	68	16	21	14	104	108	331
2013-14	228	32	35	27	103	40	472
2014-15	10	4	10	3	25	24	76
2015-16	89	18	26	23	44	52	252

Serotype O caused maximum number of outbreaks (97%) and serotype Asia1 was isolated from two isolated incidences recorded in the states of West Bengal and Nagaland. For the last three years, number of incidences owing serotype Asia1 has been very less; mostly observed in the Eastern and North eastern region, which shares international border. This year serotype A, which was absent during last year has been isolated from six incidences (Table 2).

Table 2. Year wise break-up of outbreaks and FMDV serotypes involved during last five years

Year	Total	O	A	Asia1
2011-12	347	246	16	85
2012-13	331	265	16	52
2013-14	472	454	08	10
2014-15	76	75	-	01
2015-16	252	244	06	02

Four seasons viz, winter (December to early April), summer (April to June), monsoon (June to September) and post monsoon (October and November) prevail in the country. It is believed that high relative humidity (RH) and heavy rain during monsoon inhibit aerosol transmission of virus. Usually, incidence of FMD starts occurring from August and peaks in November and maintain until January. Maximum FMD incidences at the end of the monsoon and post monsoon season may be due to comparatively dry weather and moderate RH which is very much conducive for virus transmission. Outbreaks in summer months are less due to very high ambient temperature. This year maximum incidences of FMD were recorded during the months of January and February. A few incidences were observed between the months of March and June (Fig. 1).

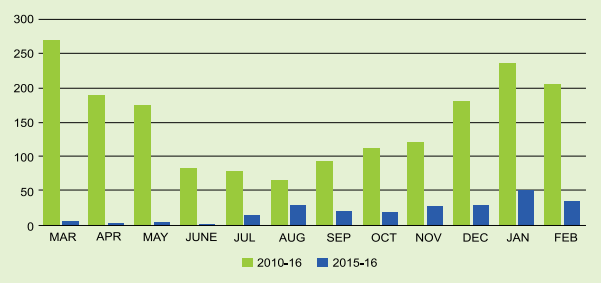


Fig. 1. Month wise occurrence of FMD recorded in the country.

Phylogenetic analysis based on VP1 (1D) coding region was carried out to assess genetic variations, inter-strain relationships and track movement of the virus. During the year, phylogenetic analysis of serotype O virus revealed extended and exclusive dominance of Ind2001 strains.In case of serotype Asia1, the isolates from Nagaland clustered within the lineage C indicating its exclusive prevalence since 2005. All the six isolates of serotype A characterized during the period were found to cluster within the clade18c of VP3[59]-deletion group of genotype 18.

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. Selected virus isolates of all three serotypes were subjected to one-way antigenic relationship analysis (r-value) using Bovine Vaccinate Serum (BVS) against respective vaccine strains. In case of serotype O, the vaccine strain, INDR2/1975 covered 88% of the field isolates. This vaccine strain is able to provide optimal antigenic coverage over the field isolates. In case of serotype A, none of the isolates showed perfect match with the vaccine strain, IND40/2000. Therefore, study has been initiated to evaluate alternate candidate strains for better antigenic coverage with broader match potential.

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 56 to 68 virus isolates (55serotype O, 11 serotype A and 2 serotype Asia1) were added to the repository during the reported period (Table 6). At present the National FMD virus Repository holds a total of 2008 isolates (O-1308, A-319, C-15 and Asia 1-366).

Under National FMD serosurveillance, 62,605 bovine serum samples collected at random from various parts of the country were tested in r3AB3 NSP-ELISA for assessing the prevalence of NSP-antibody (NSP-Ab) positive animals, which is an indicator of FMD virus exposure regardless of vaccination status. The test revealed overall seropositivity in ~ 22.54% samples/animals, which is comparatively lesser than the previous year's average (23.41%). The percentage protective antibody titre in the serum samples collected at random from FMDCP states were found to be higher when compared to the other states.

During 2015-16, a total of pre and post vaccinated serum samples were tested under FMD

Control Programme (FMDCP) and of which, 47,249 serum samples were from first phase (2003-04) FMDCP districts representing XIX and XX phases of vaccinations, and remaining 75,593 serum samples were from expanded FMDCP districts of 2010 representing Phases VIII. Currently, 94.8, 93.6 and 97 percent of animals tested were having protective antibody level (log10 1.8 and above) against serotypes O, A and Asia 1, respectively, in post-vaccination serum samples in the initial FMDCP (2003-04) districts. Similarly in the expanded FMDCP districts (2010), 96.2, 94.6 and 97.1 percent of animals tested had protective antibody level against serotypes O, A and Asia1, respectively in post-vaccination serum samples.

During the year 2015-16, several new research projects for development were undertaken in the cutting-edge areas of FMDV research by the scientists of the institute. 3A protein based DIVA ELISA to detect antibodies induced by FMDV was developed. The r3A I-ELISA could be useful as a screening or confirmatory assay in the sero-surveillance of FMD in India irrespective of extensive bi-annual vaccination. Further an efficient method based on megaprimer-mediated capsid swapping for the construction of chimeric FMDV cDNA clones was optimized, and the technique may be useful for engineering chimeric vaccine strains for use in the control and prevention of FMD in endemic countries.

Four training programmes for the scientific staff of regional and collaborating Centers of AICRP-FMD were conducted on use/application of virus serotyping ELISA, LPB-ELISA and DIVA ELISA. Overall performance of the regional centers and network units were monitored periodically and any technical difficulties faced by them were removed instantly through refresher courses and electronic guidance. Requirement of diagnostics kits in the country was met by the institute. During the period, r3AB3 DIVA Kit for FMD to test 50,380 samples was produced and supplied to the AICRP units. Similarly, virus serotyping Kits for 7500tests and LPB-ELISA Kits for 1,65,520 were supplied to FMD Regional centers/network units for virus diagnosis and post-vaccination sero-monitoring of FMD, respectively.

I am happy to share that ICAR-DFMD is a member of the Global FAO/OIE Network of FMD Reference Laboratories that constitutes of 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). Construction of International Center for FMD has already been started since March 2014. Creation of this international laboratory with state-of-the-art features of bio-safety and bio-containment (BSL 3Ag) will facilitate Global participation and control of the disease in India and SAARC region. I thank all my fellow scientist colleagues, administrative, accounts and laboratory staff of the institute for their sincere efforts and contribution in accomplishing the tasks assigned to the Institute. We are indebted to the scientific and administrative support of Hon'ble Director General, ICAR and Dy Director General (AS), as well as Asst Director General (AH) and Principal Scientist (AH) for their support.

(B. Pattnaik)

2 Vision, Mission, Mandate, objectives and Technical Programme

Vision

To make 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 outbreaks, 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 outbreaks, and also to provide training in diagnosis and epidemiology, and to develop technologies for making country free from FMD.

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 outbreaks, 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. Analysis of economic impact of FMD on livestock industry
6. To act as referral laboratory for FMD in South Asia.

Technical Programme

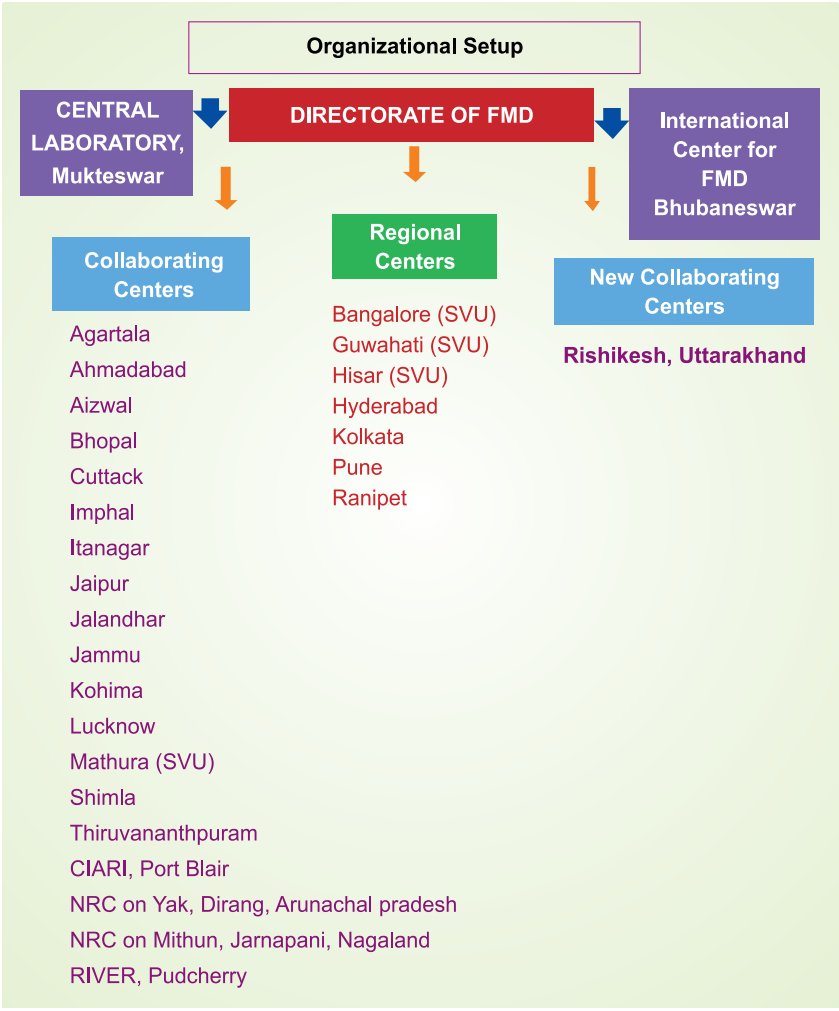
1. Active and passive surveillance of FMD in the country in AICRP mode
2. To carryout antigenic and molecular characterization of field isolates.
3. To study molecular epidemiology of FMD in India.
4. Confirmatory diagnosis and expert advice.
5. To carryout vaccine matching exercise for monitoring of 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 (sandwich ELISA and mPCR kit), sero-monitoring (LPB-ELISA) and serosurveillance (NSP-DIVA ELISA)
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 more than last four decades of its existence the scope of the project has been expanded progressively and several milestones were achieved to reach the current status of a Project Directorate in July, 2001 with 27 regional and collaborative centers 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.



4 Staff Position

S. No.	Name of the Staff	Designation	Discipline	Joining in the Current Post
1	Dr. Bramhadev Pattnaik	Director	Veterinary Microbiology	December 2006
2	Dr. Bana B. Dash	Sr. Scientist	Veterinary Microbiology	August 2009
3	Dr. Jajati K. Mohapatra	Sr. Scientist	Veterinary Microbiology	March 2012
4	Dr. Saravanan Subramaniam	Scientist (SS)	Veterinary Microbiology	January 2007
5	Dr. Manoranjan Rout	Scientist (SS)	Veterinary Pathology	November 2009
6	Dr. Gaurav K. Sharma	Scientist (SS)	Veterinary Microbiology	December 2009
7	Dr. Rajeev Ranjan	Scientist (SS)	Veterinary Pathology	May 2010
8	Dr. Jitendra K. Biswal	Scientist (SS)	Animal Biochemistry	April 2011
9	Dr. Sonalika Mahajan	Scientist	Veterinary Microbiology	April 2013
10	Dr. Khulape Sagar Ashok	Scientist	Animal Biotechnology	April 2015

S. No.	Name of the Staff	Designation	Joining in Current Post
1	Shri Tara Kumar	Assistant	April, 2013
2	Shri Nayan Sanjeev	T-3 (Lab)	October, 2010
3	Shri D. S. Deolia	T-1 (Lab)	January, 2012
4	Shri S.L.Tamta	T-1 (Lab)	April, 2014
5	Shri R.N.Sahoo	UDC	May, 2012
6	Mr. Ravi Chaudhary	Junior Stenographer	August, 2014

5 Epidemiology Report

Table 5.1. FMD cases/outbreaks recorded and diagnosed during 2015-16 and virus serotype(s) involved

States	Reporting AICRP Centre/Unit	No. of. FMD cases/ outbreaks	No. of. Samples tested	Virus Serotypes		
				O	A	Asia1
Southern Region						
Tamil Nadu	Ranipet	01	06	01(01)		
Andhra Pradesh	Hyderabad	No disease				
Karnataka	Bangalore	50	116	47(84)	03(04)	–
Kerala	Thiruvanthapuram	38	103	38(54)	–	–
Total		**89**	**225**	**86(139)**	**03(04)**	–
Northern Region						
Jammu & Kashmir	Jammu	06	22	06(12)	–	–
Haryana	Hisar	01	02	01(02)	–	–
Himachal Pradesh	Shimla	02	08	02(02)	–	–
Punjab	Jalandhar	No disease				
Uttar Pradesh	Mathura/DFMD	06	22	04(12)	02(06)	–
Uttarakhand	DFMD	03	03	02(02)	01(01)	–
Total		**18**	**57**	**15(29)**	**03(07)**	–
Central Region						
Madhya Pradesh	Bhopal	26	58	26(58)	–	–
Total		26	58	26(58)	–	–
Western Region						
Gujarat	Ahmadabad	06	29	06(09)	–	–
Maharashtra	Pune	13	20	13(13)	–	–
Rajasthan	Jaipur	04	17	04(04)	–	–
Total		**23**	**66**	**23(26)**	–	–
Eastern Region						
Odisha	Cuttack	06	13	06(11)	–	–
Bihar	Patna	15	53	15(34)	–	–

States	Reporting AICRP Centre/Unit	No. of. FMD cases/ outbreaks	No. of. Samples tested	Virus Serotypes		
				O	A	Asia1
West Bengal	Kolkata	23	79	22(42)	–	01(01)
Total		**44**	**145**	**43(87)**	–	**01(01)**
North Eastern Region						
Assam	Guwahati	13	39	13(36)	–	–
Meghalaya		01	01	01(01)	–	–
Sikkim		02	02	02(02)	–	–
Nagaland	Kohima	10	11	09(09)	–	01(02)
Mizoram	Aizwal	No disease				
Manipur	Imphal	05	18	05(18)	–	–
Tripura	Agartala	21	50	21(44)	–	–
Total		**52**	**121**	**51(110)**	–	**01(02)**
Grand Total		**252**	**671**	**244(657)**	**06(11)**	**02(03)**

Number of samples collected from FMD suspected outbreaks and diagnosed is given in parenthesis.More than one clinical material was collected from many cases/outbreaks of FMD

Regional Scenario

5.1: Southern Region

Southern region comprises four states (Tamilnadu, Karnataka, Andhra Pradesh and Kerala) and about 21% of the FMD susceptible livestock of the country. The region shares no international border and considered to be hyper endemic area for FMD. The entire southern peninsular region has been covered under FMD-CP since the year 2010-11.

Karnataka: During the year, 50 FMD incidences were reported in the state. The incidences were sporadic in nature that involved only a few animals mostly unvaccinated. While majority of the incidences were caused by serotype O (n=47), serotype A was also isolated in 3 FMD incidences. Except for one incidence that was recorded in pig, all the outbreaks occurred only in cattle.The incidences were widespread and reported from the districts of Bengaluru Urban (10), Bengaluru Rural (08), Kolar (08), Tumkur (05), Belgaum (04), Ramnagara (04), Mandya (03), Hassan (02), and one each in Bidar, Gadag and Dakshin Kannada. The incidences were recorded throughout the year during the months of April (02), May (01), June (01), July (05), August (04), September (01), October (03), November (08), December (05), January (09), February (08) and March (03).

Kerala: A total of 38 FMD incidences were recorded in the state affecting only cattle and buffalo. The outbreaks were caused by serotype O and were recorded in the districts of Thiruvananthapuram (06), Kollam (02), Alappuzha (08), Pathanamthitta (02), Kottayam (01), Idukki (04), Thrissur (02), Palakkad (02), Malappuram (02), Kozhikkode (03), Wayanad (08) and Kannur (01).The incidences were higher the months of August (13), January (08), October (06), February (05) and limited in the months of July (03), September (02) and November (01). The states did not record any FMD outbreaks during the year 2014-15.

Andhra Pradesh: No FMD was reported during the period.

Tamilnadu: During 2015-16, the state remained relatively free from FMD except for a single incidence due to serotype O in Elephant in the month of January 2016.

Andaman and Nicobar Island: No FMD was reported during the period.

5.2: Central Region

Madhya Pradesh: During 2015-16, twenty six FMD outbreaks were reported. Out of twenty six outbreaks, twenty five involved cattle & buffaloes, while one outbreak was reported in cattle only. Maximum outbreaks were reported from Balaghat (04) and Sager (03) followed by two each in Betul, Chhindwara, Seoni and Shivpuri, and one each in Bhopal, Dewas, Hoshangabad and Jabalpur. Maximum number of typed outbreaks (10 each) were reported in the month of September followed by December (05), January (04), November (03), and two each in July and March.

5.3: Western Region

Western region comprises 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 have been covered under FMD-CP since the year 2010-11.

Maharashtra: Thirteen FMD outbreaks/ incidences were reported from five districts of Maharashtra. The disease was recorded in cattle, buffalo and goat.Maximum outbreaks were reported from Pune (05) followed by Ahmadnagar (03), Sangali (02), Bhandara (02) and Nagpur (01).The outbreaks were reported in the months of October (05), November (04) and December (04).

Gujarat: During the year, six FMD outbreaks/ incidences were type confirmed and all of them were caused by serotype O. The incidences were recorded in the districts of Anand (02), Kheda (02), Navsari (01) and Gandhinagar (01). The outbreaks, which were recorded in cattle and buffalo, occurred in the months of August (02), October (01), November (01), February (01) and March (01).

Rajasthan: During the year, four outbreaks/ incidences of FMD were confirmed in the state due to serotype O in the districts of Sikar (02), Jaipur (01) and Udaipur (01). The outbreaks one each was recorded in the months of April, May, November and December in cattle and buffalo.

5.4: Eastern Region

Eastern region comprises four states (West Bengal, Odisha, Bihar and Jharkhand) and about 22% of the FMD susceptible livestock of the country. The region shares international border with Bangladesh and Nepal. Currently not covered under FMD-CP and vaccination for FMD is mainly carried through ASCAD scheme yearly once.

Odisha: Six outbreaks/cases were recorded in the state. All the outbreaks were caused by Serotype O in bovine.One outbreak was diagnosed in retrospect. Theincidences were recorded in the districts of Puri (02), Khurda (01), Dhenkanal (01), Cuttack (01) and Mayurbhanj (01).Three incidences were recorded in the months of August, and one each in the months of June, September and May.

Bihar: During the period under report, 15 outbreaks/cases of FMD due to serotype O were recorded in the state.Maximum outbreaks/ incidences were observed in the month of February (08) followed by January (05) and August (02). The disease was recorded in the districts of Patna (05), Vaishali (04), Begusarai (02), Rohtas (02), Nalanada (01) and Samastipur(01) in cattle and buffalo.

West Bengal: Twenty three FMD outbreaks/ cases were recorded during the period in the state in which 22 incidences were due to serotype O and one incidence was caused by serotype Asia1.The outbreaks involved cattle, buffalo and goats. Highest number of FMD outbreaks were in the district of Purulia (10), Birbhum (04), two each in Dakshin Dinajpur and Paschim Medinipur, and one each in

Bardwan, North Parganas, Murshidabad, Nadia and South 24 Parganas. The incidences were recorded in the months of April (01), July (01), August (01), September (07), October (02), November (04), December (01), January (05) and February (01).

5.5: Northern Region

Haryana: One incidence of FMD due to serotype O was recorded in the district Yamuna Nagar in the month January 2016.The disease was recorded in cattle and buffalo.

Punjab: No FMD was reported during the period.

Uttar Pradesh: Six FMD incidences/outbreaks were recorded in the state. Serotype O caused four outbreaks and serotype A was identified in two incidences.Four outbreaks were recorded in the month of January and one in May. The outbreaks due to serotype A were occurred in organized herd; one in IVRI, Bareilly and another in Meerut cant during different time. In the month of January 2016, outbreak due to both serotype A (in the IVRI herd) and serotype O (in the neibhouring village) was recorded in Bareilly, a scenario very similar to the one observed in the state of Tamilnadu during 2007. The disease was recorded in both cattle and buffalo.

Jammu and Kashmir: During 2015-16, six sporadic incidences/cases were recorded in the state due to FMDV serotype O. The incidences were recorded in the months of July (01), August (04) and November (01), in the districts of Budgam (02), Srinagar (02), Samba (01) and Anantnag (01), affecting mainly cattle.

Himachal Pradesh: Two sporadic incidences/ cases were recorded in the state due to FMDV serotype O. The incidences were recorded in the months of November 2015 and March 2016 in the districts of Shimla and Kangra, respectively affecting only cattle and buffalo. The state remained FMD free during 2014-15.

Uttarakhand: During 2015-16 there were three incidences/cases were recorded in the state. Incidences were recorded in the districts of Haridwar, Pithoragarh and Udham Singh Nagar. Two outbreaks were recorded in the month of December'15, and one in January'16. The incidence in Haridwarand Pithoragarh were due to serotype O and the one in Udham Singh Nagar was caused by serotype A. No FMD outbreaks were reported during 2014-15 from the state

5.6: North Eastern Region

North eastern region comprises seven states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura)and about5%of the FMD susceptible livestock of the country. The region shares international border with China, Myanmar, Bangladesh and Bhutan. Currently not covered under FMD-CP and vaccination for FMD is mainly carried through ASCAD scheme yearly once.

Assam: Thirteen outbreaks/incidences of FMD were recorded in the state. The disease was widespread and occurred in the districts of Kamrup (05), Nalbari (01), Darrang (01), Barpeta (04), Goalpara (02), Kokrajhar (01)and Lakhimpur (01). During the period, serotype O accounted for all the incidences that were recorded only in cattle and buffalo. One incidence was diagnosed in retrospect. Though cases were recorded throughout the year, it was more in the month of February (05) followed by December (02), and one incidence each was recorded during the months of May, July, August, October, November.

Meghalaya: Once FMD incidence owing to serotype O was recorded in the month of January 2016 in cattle.

Sikkim: This state witnessed tow FMD incidences in cattle during the month of February 2016 and both were caused by serotype O.

Manipur: During the year, 5 outbreaks/cases of FMD due to serotype O were reported in cattle. The outbreaks were recorded in Imphal-West (03), Imphal-East (01) and Senapati (01 in the months of October (01), December (01), January (01) and February (02).

Mizoram: No FMD was reported during the period.

Nagaland: During the year, 10 outbreaks/ incidences of FMD was recorded in which nine incidences were due to serotype O and in one serotype Asia1 was isolated. The disease occurred in the districts of Kohima (06), Peren (02) and Dimapur (02). Six (6) outbreaks were recorded in cattle, three incidences were observed in Mithuns and in one outbreak, and both cattle and Mithuns were affected. The incidences were recorded in the months of July (03), September (01), October (01), November (01), December (02) and January (02).

Tripura: During the period under report, 21 outbreaks/cases of FMD due to serotype O were recorded in the state. Outbreaks were observed in the months of January (09), December (06), November (03) and February (03). Thirteen incidences were recorded in west Tripura and eight in south Tripura. The diseases were recorded only in cattle.

6 Molecular typing of foot-and-mouth disease virus during 2015-16

Processing of field samples and Serotyping

A total of 182 clinical materials were subjected to FMD virus serotype differentiating sandwich ELISA and Multiplex PCR. Preliminary screening of clinical materials using ELISA was carried out at Regional/collaborating laboratories. After initial diagnosis, the tissue samples were forwarded to PDFMD, Mukteswar for confirmation and detailed characterization. FMDV serotypes could be identified in 115 samples. Serotype O virus detected in maximum number of clinical samples (114), and serotype Asia1 virus was detected in 1 sample. Virus isolation was done in BHK-21 cells, and RNA transfection was also used for virus revival from most difficult samples. Details shown in table 5.1

6.1: Serotype O FMD Virus

Genetic grouping of serotype O isolates

During 2015-16, a total of 70 serotype O field isolates were subjected to complete 1D/VP1 region sequence analysis. Maximum likelihood (ML) tree was reconstructed using MEGA 6.06 software package. In the ML tree all the isolates grouped within O/ME-SA/Ind2001 lineage indicating its extended dominance in the field (Fig 6.1). The lineage, which re-emerged in the year 2008, continued its supremacy in the field by displacing the then prevalent O/ME-SA/PanAsia lineage. Since its actual identification in the year 1997, the lineage has diversified globally in to at least four sub-lineages (Ind2001a, b, c and d). The isolates of O/ME-SA/Ind2001 lineagecurrently circulating in the country grouped precisely in sub-lineage Ind2001d. The sub-lineage Ind2001d also prevails in neighbouring countries including Bangladesh, Bhutan and Nepal.

The O/ME-SA/Ind2001d sub-lineage caused several outbreaks during 2013 especially in the states of Karnataka, Kerala and Tamilnadu in the southern region. During the current year, maximum numbers of isolates were sampled in the states of Karnataka (36) followed by Kerala (6) and Tamilnadu (1) in the southern region, which indicates extended circulation Ind2001 lineage in the southern region. Further the isolates were also collected from the states of Uttarakhand (8), Madhya Pradesh (3), Uttar Pradesh (7), Punjab (1), Gujarat (3), West Bengal (1), Odisha (1) and Assam (3). Maximum numbers of isolates were sampled during February'15 (9), August (9) and January'16 (9) followed by November'15 (6), December'15 (4), December'14 (6), October'15 (4), July'15 (4), May'15 (4), September'15 (5), March'15 (2), January'15 (1) and April'15 (1). Most of the outbreaks occurred during the window period that is 4-5 months after vaccination and before the start of next round when protective antibody level is expected to be low.

The isolates were distributed in three distinct clusters; one includes two isolates, one each from the states of Assam and Odisha, which appears to be epidemiologically linked as both the isolates were collected during the month of may and found to be

genetically homogeneous (<2% nucleotide divergence). Twenty seven isolates collected from the states of Karnataka, West Bengal, Gujarat, Assam, Uttarakhand and Uttar Pradesh grouped together in a cluster, which appears to be in circulation predominantly during the later part of 2014 and earlier part of 2015. The other cluster includes isolates from the states of Karnataka, Kerala, Tamilnadu, Madhya Pradesh, Uttar Pradesh, Uttarakhand, Assam and Punjab; this cluster was predominantly circulated during the later part of 2015 and earlier part of 2016. The isolates from Karnataka were found to be distributed in both the major clusters and can be considered as a major hub for virus transmission. The isolates from Uttarakhand were found to be distributed in two distinct clusters, those collected in the month of January shared immediate ancestor with an isolates of Assam collected in the month of December and those collected in the month of December grouped closely with isolates of UP sampled in November. This observation clearly indicated two different incursions in to the state of Uttrakhand over a period of 3 months. The isolates of Assam were distributed in all the three clusters indicating an extensive network of virus transmission.

The isolates collected during 2015-16 differed from currently used vaccine strain INDR2/1975 by 12.7 to 13.9% at nucleotide level at 1D genomic region and 5.7 to 8.1% at amino acid level. The genetic diversity of Ind2001 isolate collected during 2015-16 varied from 0.00 to 8.9% at VP1 region and mean genetic diversity was estimated at 5.1%, which indicate high genetic diversity among Ind2001d isolates.

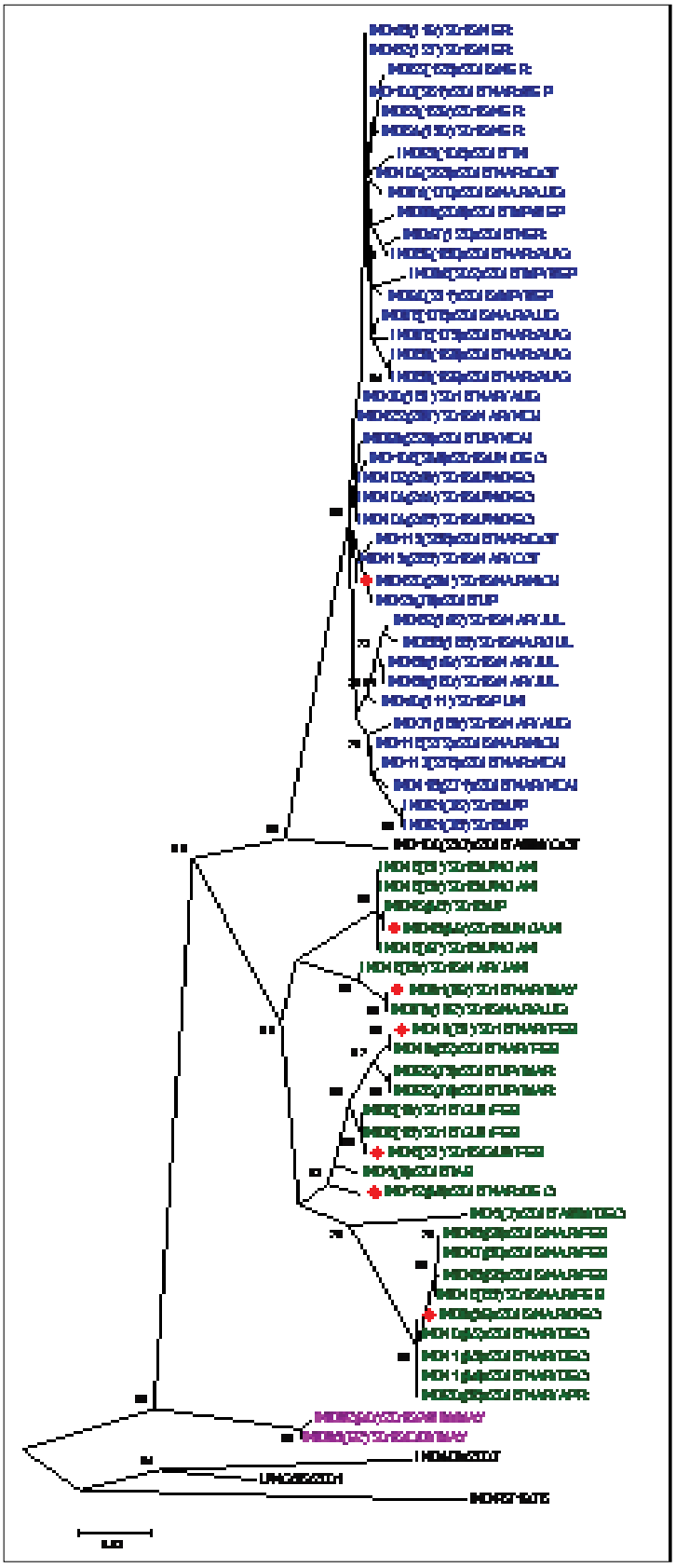


Fig 6.1. Maximum likelihood tree depicting phylogenetic relationship of Ind2001d isolates collected during 2015-16. Isolates circulated predominantly during 2014-15 are marked green and those circulated during 2015-16 are marked blue.

Evolutionary dynamics of foot-and-mouth disease virus O/ME-SA/Ind2001 lineage

Foot-and-mouth disease (FMD) virus serotype O Ind2001 lineage within the Middle East-South Asia topotype is the major cause of recent FMD incidences in India. A sub-lineage of Ind2001 caused severe outbreaks in the southern region of the country during 2013 and also reported for the first time from Libya. In this study, we conducted a detailed evolutionary analysis of Ind2001 lineage. Phylogenetic analysis of Ind2001 lineage based on maximum likelihood method revealed two major splits and three sub-lineages. The mean nucleotide substitution rate for this lineage was calculated to be 6.338×10^{-3}substitutions/site/year (s/s/y), which is similar to those of PanAsian sub-lineages. Evolutionary time scale analysis indicated that the Ind2001 lineage might have originated in 1989. The sub-lineage Ind2001d that caused 2013 outbreaks seems to be relatively more divergent genetically from other Ind2001 sub-lineages. Seven codons in the VP1 region of Ind2001 were found to be under positive selection. Four out of 24 recent Ind2001 strains tested in 2D-MNT had antigenic relationship value of <0.3 with the serotype O vaccine strain indicating intra-epidemic antigenic diversity. Amino acid substitutions found in these minor variants with reference to antigenic diversity have been discussed. The dominance of antigenically homologous strains indicates absence of vaccine immunity in the majority of the affected hosts. Taken together, the evolution of Ind2001 lineage deviates from the strict molecular clock and a typical lineage evolutionary dynamics characterized by periodic emergence and re-emergence of Ind2001 and PanAsia lineage have been observed in respect of serotype O.

6.2: Serotype A FMD Virus

Among all serotypes prevalent in India, serotype A virus population is genetically and antigenically most heterogeneous in nature. VP1(1D) coding region based molecular phylogeny has established circulation of four genotypes {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. This single aa deletion is at an antigenically critical position in structural protein VP3, which is considered to be a major evolutionary jump probably due to immune selection. Recently, it has been observed that the deletion group is on the verge of overthrowing the nondeletion variants and establishing itself as the only prevalent genetic cluster.

During the period under report, structural protein coding region (VP1) sequence for 6field viruses of serotype A recovered from field outbreaks in Karnataka and UP were sequenced for molecular epidemiological analysis. The determined 1D sequences were aligned with other Indian sequences available in the data base of ICAR-DFMD. All the isolates of 2015-16 clustered within genotype 18 in the maximum likelihood tree, and grouped only in the clade 18c of the VP3^{59}-deletion lineage (Fig. 6.2). Clade 18c which was first reported from Southern peninsular India during 2007 seems to have disseminated to Central, Eastern, Western and Northern parts of India after 2009. Interestingly, not a single field outbreak virus without the VP3-59 deletion could be identified during 2015-16 in support of the anticipated exclusive dominance of the VP3^{59}deletion group.

Evolution of serotype A FMDV on a timescale of three decades: Three decades-long (1977-2013) evolutionary trend of the capsid coding (P1) region of foot-and-mouth disease virus (FMDV) serotype A isolated in India was analysed. The exclusive presence of genotype 18 since 2001 and the dominance of the

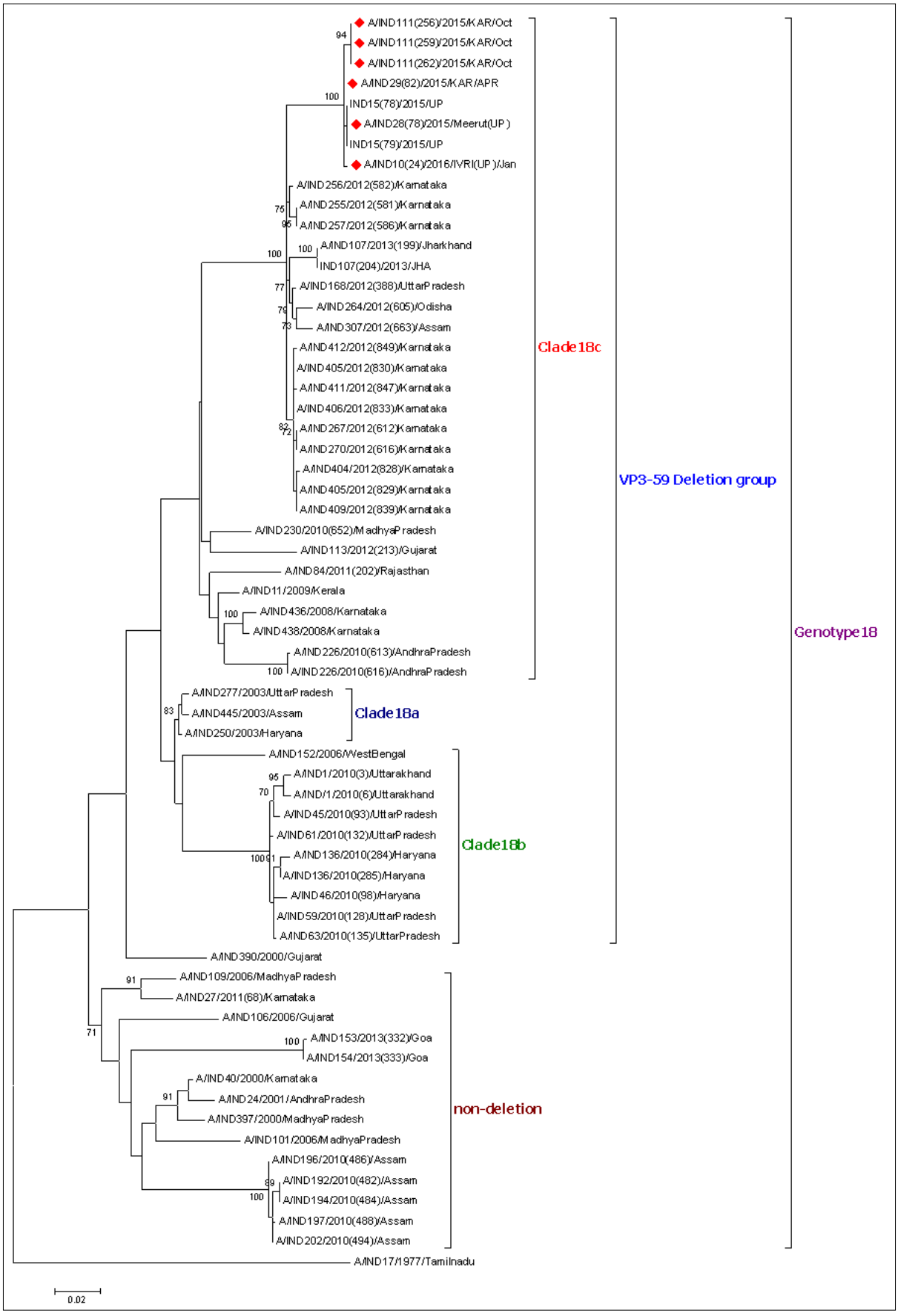


Fig 6.2. Maximum likelihood tree depicting phylogenetic relationship of serotype A isolates collected during 2015-16. All the isolates were found belong to clade 18c of VP359 deletion group.

VP3[59]-deletion group of genotype 18 was evident in the recent years. Clade 18c was found to be currently the only active one among the three clades (18a, 18b and 18c) identified in the deletion group. The rate of evolution of the Indian isolates at the capsid region was found to be 4.96×10^{-3}substitutions/site/year. The timescale analysis predicted the most recent common ancestor to have existed during 1962 for Indian FMDV serotype A and around 1998 for the deletion group. The evolutionary pattern of serotype A in India appears to be homogeneous as no spatial or temporal structure was observed. Bayesian skyline plots indicate a sharp decline in the effective number of infections after 2008, which might be a result of mass vaccination or inherent loss of virus fitness. Analyses of variability at 38 known antigenically critical positions in a countrywide longitudinal data set suggested that the substitutions neither followed any specific trend nor remained fixed for a long period since frequent reversions and convergence was noticed. A maximum of 6 different amino acid residues was seen in the gene pool at any antigenically critical site over the decades, suggesting a limited combination of residues being responsible for the observed antigenic variation. Evidence of positive selection at some of the antigenically critical residues and the structurally proximal positions suggest a possible role of pre-existing immunity in the host population in driving evolution. The VP1 C-terminus neither revealed variability nor positive selection, suggesting the possibility that this stretch does not contribute to the antigenic variation and adaptation under immune selection.

6.3: Serotype Asia1 FMD Virus

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.

Similar to previous year, outbreaks owing to serotype Asia1 were much less during 2015-16.During the period,2 serotype Asia 1 field isolates collected from the state of Nagaland from mithunwere sequenced at 1D/VP1 region and subjected to phylogenetic analysis using Maximum likelihood algorithm. All the isolates were found to cluster within lineage C indicating its supremacy in the field since the year 2005 (**Fig.6.3**). The incidence was recorded during the month of December'15, and the isolates were found to cluster closely with the isolates from Assam.

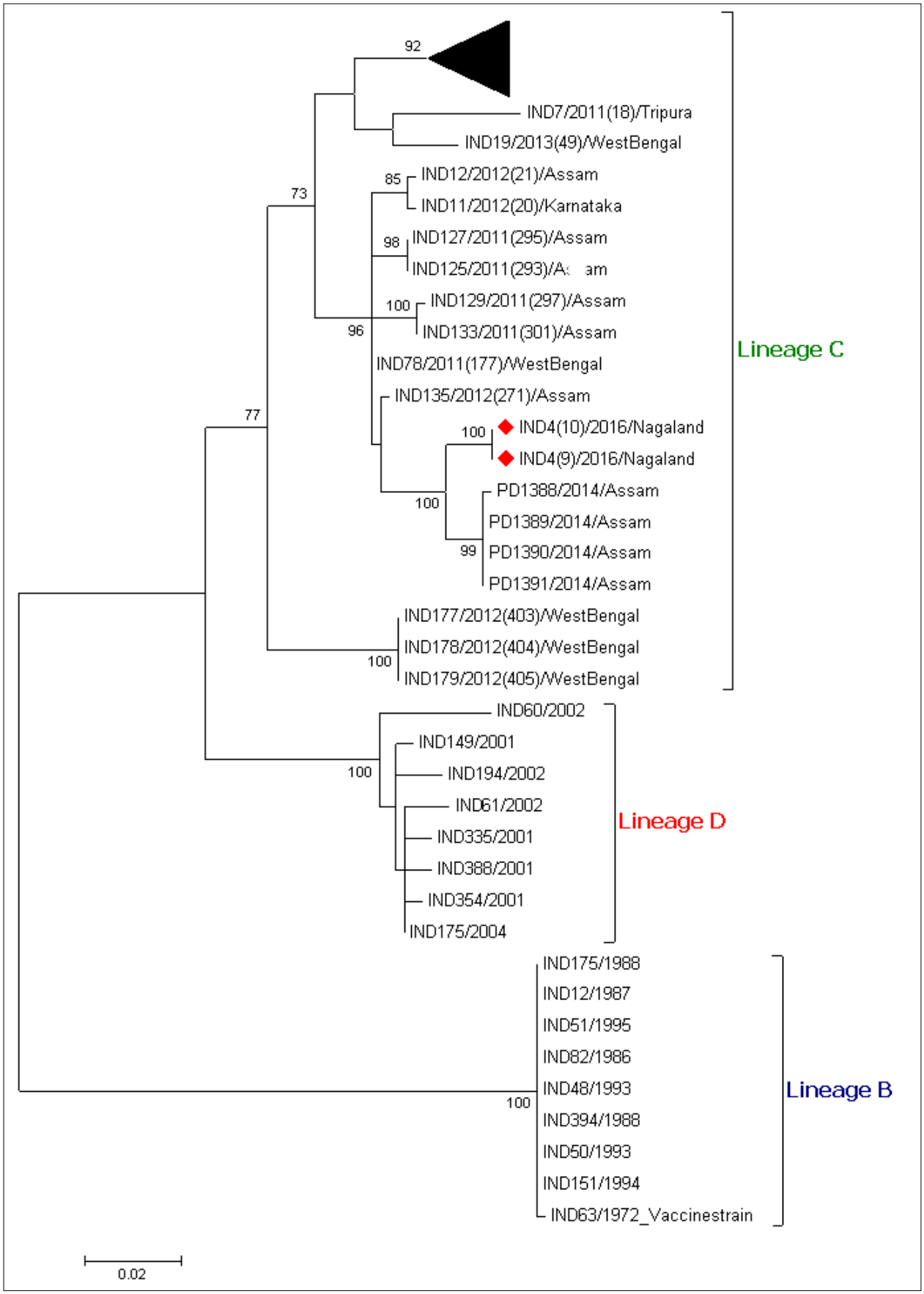


Fig. 6.3. Maximum likelihood phylogenetic tree at VP1 coding region of FMD virus isolates of serotype Asia1 during 2015-16. Lineage C is in circulation in the country since 2005.

Capsid coding region diversity of re-emerging lineage C serotype Asia1

Foot-and-mouth disease virus (FMDV) serotype Asia1 was first reported in India in 1951, where three major genetic lineages (B, C and D) of this serotype have been described until now. In this study, the capsid protein coding region of serotype Asia1 viruses (n = 99) from India were analyzed, giving importance to the viruses circulating since 2007. All of the isolates (n = 50) recovered during 2007-2013 were found to group within the re-emerging cluster of lineage C (designated as sub-lineage C^R). The evolutionary rate of sub-lineage C^R was estimated to be slightly higher than that of the serotype as a whole, and the time of the most recent common ancestor for this cluster was estimated to be approximately 2001. In comparison to the older isolates of lineage C (1993-2001), the re-emerging viruses showed variation at eight amino acid positions, including substitutions at the antigenically critical residues $VP2^{79}$ and $VP2^{131}$. However, no direct correlation was found between sequence variations and antigenic relationships. The number of codons under positive selection and the nature of the selection pressure varied widely among the structural proteins, implying a heterogeneous pattern of evolution in serotype Asia1. While episodic diversifying selection appears to play a major role in shaping the evolution of VP1 and VP3, selection pressure acting on codons of VP2 is largely pervasive. Further, episodic positive selection appears to be responsible for the early diversification of lineage C. Recombination events identified in the structural protein coding region indicates its probable role in adaptive evolution of serotype Asia1 viruses.

7 Vaccine matching of FMD virus field isolates

7.1: FMDV Serotype O

In FMD, vaccine induced protection is serotype specific, frequently genotype/lineage even strain specific. Frequent emergence of genetic variants due to fluctuation in the virus gene pool driven by immunological and non-immunological pressure may leads to the emergence of antigenic variants. Such emergence is considered to be normal phenomenon in an endemic situation where at some point time of the evolutionary path, virus are believed to be under immune selection due to prevalence FMD specific antibody in susceptible animals due to vaccination or infection. Besides, antigenic variants are also observed to arise in the absence of immune pressure. Circulation of larger proportion of antigenic variants in the field may escape vaccine induced protection in animals. Periodic monitoring of FMD virus for their antigenic relationship with the vaccine strain in-use is very essential for successful implementation of FMD control programme through vaccination. During 2015-16, a total of 57 serotype O isolates were tested in 2D-MNT using the bovine vaccinate serum against the currently used Indian vaccine strain INDR2/1975. All the isolates belong to O/ME-SA/Ind2001d lineage, which has been in circulation in the country since 2008, and caused devastating epidemic in the year 2013.

The antigenic relationships of serotype O field isolates to the vaccine strain INDR2/1975 is shown in Fig.7.1. The test results were interpreted as per criteria set by Rweyemamu, (1984) where r1cut-off

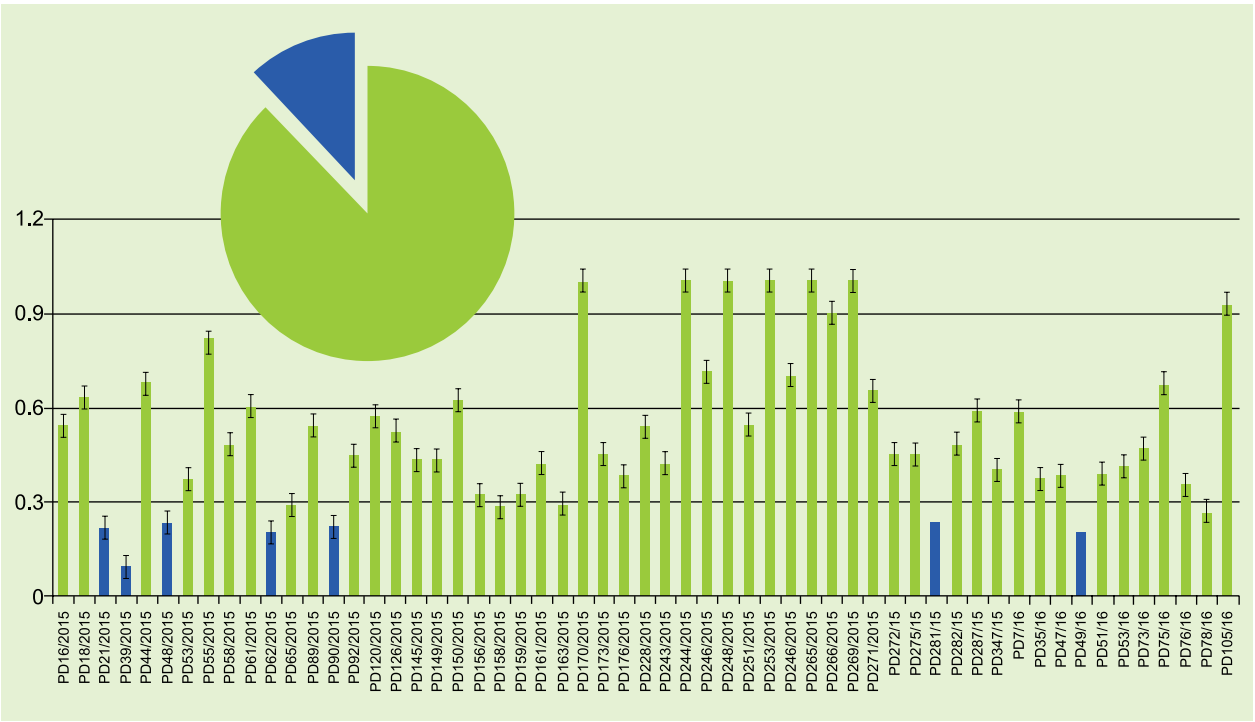


Fig 7.1. Antigenic relationships with vaccine strain INDR2/1975 of serotype O isolates collected during 2015-16

value of >0.3 indicates a good match and value of <0.3 suggest poor antigenic relationship.The r1 value is the ratio of heterologous to homologous serum titre. From the result, it can be seen that 88% (50 of 57) of the isolates showed an r1 value of >0.3 with currently used vaccine strain INDR2/1975. Out of the seven antigenically divergent strains, four were sampled in the state of Karnataka during the months of February, May, November and December, and one collected from Gujarat in the month of February and one from Uttarakhand collected in January'16. Phylogenetically, the isolates were found to group in a cluster along with other antigenically homologous strains. This indicates lack of genetic marker for those variants and continuous emergence and disappearance from field. Surprisingly, six of the seven isolates grouped in cluster that has been observed to be circulated in the early part 2015.

In order to establish a correlation between antigenic value and sequence variation, the aa sequence of antigenically divergent virus (r<0.3) was examined in comparison to homologous virus (r>0.3) and vaccine strain. In one of the divergent strain, exclusive substitutions were found 3 positions in the capsid, but their significance could not be confirmed. Substitutions were found in four positions that define antigenic sites 1, 2 and 3 in the field isolates compared to the vaccine strain INDR2/1975. However, no direct correlation of sequence variations with r-value could be drawn, and it appears that antigenicity of serotype O may neither completely depend on critical residues identified in monoclonal variants. Furthermore isolates having an equal number of aa differences exhibited significantly different serological cross-reactivity as observed for FMDV serotype Asia1.

8 Research for development programs

8.1: 3A based DIVA ELISA to detect antibodies induced by FMDV

Detection of antibodies to the non-structural proteins (NSPs) of FMD virus (FMDV) is the preferred differential diagnostic method for identification of FMD-infected animals in the vaccinated population. Nevertheless, due to the observed variability in the antibody response to NSPs, the likelihood of screening or confirming the FMD infection status in animals is increased if an antibody profile to multiple NSPs is considered for diagnosis. In order to develop and evaluate an additional NSP-based diagnostic assay, in this study, the recombinant 3A protein of FMDV was expressed in Escherichia coli and used as an antigen for detection of FMD infection specific antibodies. At the fixed cut-off value of 45 percentage of positivity, the diagnostic sensitivity and specificity of 3A indirect-ELISA (I-ELISA) were found to be 95.7% and 96.3%, respectively. In FMD naturally infected cattle, about 85% of clinically infected and 75% of asymptomatic in-contact populations were found positive at 13 months post-outbreak. The 3A I-ELISA was further evaluated with the bovine serum samples collected randomly from different parts of the country. Furthermore, the performance of newly developed 3A I-ELISA was compared with the extensively used in-house r3AB3 I-ELISA, and the overall concordance in test results was found to be 93.62%. The r3A I-ELISA could be useful as a screening or confirmatory assay in the sero-surveillance of FMD in India irrespective of extensive bi-annual vaccination.

8.2: Capsid swapping for the construction of custom-engineered chimeric foot-and-mouth disease virus

Foot-and-mouth disease (FMD) is a highly contagious, economically important disease of transboundary importance. Regular vaccination with chemically inactivated FMD vaccine is the major means of controlling the disease in endemic countries like India. However, the selection of appropriate candidate vaccine strain and its adaptation in cell culture to yield high titer of virus is a cumbersome process. An attractive approach to circumvent this tedious process is to replace the capsid coding sequence of an infectious full-genome length cDNA clone of a good vaccine strain with those of appropriate field strain, to produce custom-made chimeric FMD virus (FMDV). Nevertheless, the construction of chimeric virus can be difficult if the necessary endonuclease restriction sites are unavailable or unsuitable for swapping of the capsid sequence. Here we described an efficient method based on megaprimer-mediated capsid swapping for the construction of chimeric FMDV cDNA clones. Using FMDV vaccine strain A IND 40/2000 infectious clone (pA(40/2000)) as a donor plasmid, we exchanged the capsid sequence of pA(40/2000) with that of the viruses belonging to serotypes O (n = 5), A (n = 2), and Asia 1 (n = 2), and subsequently generated infectious FMDV from their respective chimeric cDNA clones. The chimeric viruses exhibited comparable infection kinetics, plaque phenotypes, antigenic profiles, and virion stability to the parental viruses. The results from this study suggest that megaprimer-based reverse genetics technology is useful for engineering chimeric vaccine strains for use in the control and prevention of FMD in endemic countries.

9 National FMD Virus Repository

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 56 to 68 virus isolates (55serotype O, 11 serotype A and 2 serotype Asia1) were added to the repository during the reported period (Table 9.1). At present the National FMD virus Repository holds a total of 2008isolates (O-1308, A-319, C-15 and Asia 1-366).

Table 9.1. Year-wise details of the virus isolates added to National FMD Virus Repositoryduring last five years

Isolates revived	O	A	Asia1	Total
2011-12	46	03	13	62
2012-13	32	19	26	77
2013-14	61	10	2	73
2014-15	12	-	4	16
2015-16	55	11	2	68

State-wise distribution of FMD virus isolates (n=2008) available in National FMD virus repository as on 31st March 2016

State-wise distribution of FMD virus serotype O isolates (n=1308) available in National FMD virus repository as on 31st March 2016

State-wise distribution of FMD virus serotype A isolates (n=319) available in National FMD virus repository as on 31st March 2016

State-wise distribution of FMD virus serotype Asia 1 isolates (n=366) available in National FMD virus repository as on 31st March 2016

State-wise distribution of FMD virus serotype C isolates (n=15) available in National FMD virus repository as on 31st March 2016

10 National FMD Serosurveillance

10.1: DIVA (Antibody against NSPs; Percent Infected)

Seroconversion against NSPs (3AB3) is observed since 10-14 days after FMD virus infection. Whereas, if the animal is not exposed to FMD virus infection but vaccinated with inactivated purified polyvalent FMD vaccine, no anti-NSP immune response is elicited in host's body. This differential induction of anti-NSP antibody is exploited in DIVA ELISA to discriminate between infected and vaccinated animals. In this DIVA test reactivity of anti-3AB3 antibodies present in the serum of an infected animal (bovine species only) was assessed using purified recombinant 3AB3 (~38 kD) NSP in an indirect ELISA. The test is to be considered to be valid provided the mean absorbance of the positive control wells is not less than 0.8. Likewise a plate has to be rejected if the mean absorbance of the supplied negative control serum is > 0.3. The O.D. in back ground control wells should also be less than 0.1. To reduce inter-run variation due to differences in absolute absorbance between runs/tests, final results for each test serum is expressed as the PP value [(test serum sample mean OD/positive control serum mean OD) x 100] i.e., percent positivity value or PP value. The results are interpreted based on the following cut-off zones:

1. 3AB3 NSP reactivity positive: If PP value is more than 40%
2. 3AB3 NSP reactivity negative: If PP value is less than 40%

During the year, a total of 62,605 bovine serum samples collected at random from various parts of the country were tested in 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 in ~ 22.54% samples/animals (Table 10.1).The test also included serum samples from recent suspected outbreak areas

Table 10.1. Result summary of r3AB3 NSP-ELISA on bovine (cattle and buffalo) serum samples (Regional and Collaborating centersand Central FMD labs)

Sl. No.	Place of origin	Host	Total serum samples tested	Total positive	%3AB3 reactors
Southern Region					
1	Telangana	Bovine	1800	608	33.78
2	Karnataka	Bovine	6006	2051	34.15
4	Tamil Nadu	Bovine	6400	1743	27.23
Central Region					
5	Madhya Pradesh	Bovine	7823	1591	20.34

Western Region					
7	Rajasthan	Bovine	2700	1029	38.11
8	Gujarat	Bovine	4180	1657	39.64
9	Maharashtra	Bovine	1389	283	20.37
Eastern Region					
10	West Bengal	Bovine	4023	696	17.30
12	Odisha	Bovine	4103	792	19.3
Northern Region					
13	Haryana	Bovine	2100	189	9.00
14	Uttarakhand	Bovine	956	314	32.85
15	Uttar Pradesh	Bovine	8050	1518	18.86
16	Himachal Pradesh	Bovine	2400	261	10.88
17	Jammu & Kashmir	Bovine	1600	438	27.38
18	Punjab	Bovine	3744	340	9.08
North Eastern Region					
19	Assam	Bovine	2965	495	16.69
22	Mizoram	Bovine	800	55	6.88
24	Tripura	Bovine	1146	43	3.75
Islands					
25	Andaman and Nicobar	Bovine	420	9	2.14
Total		**Bovine**	**62605**	**14112**	**22.54**
	Arunachal Pradesh	Yak	708	334	47.18
		Mithun	6	0	0.00

Table 10.2. Summary of r3AB3 NSP-ELISA During 2008-09 to 2015-16; the prevalence has been around 26%

Year	Total samples tested	Total positive	% DIVA reactors
2008-09	18,326	5,120	27.94
2009-10	29,763	8,303	27.90
2010-11	31,042	8,341	26.87
2011-12	37,467	10,410	26.09
2012-13	40,934	10,811	26.41
2013-14	52,224	15,268	29.20
2014-15	68,948	16,139	23.41
2015-16	62,605	14112	22.54
Total	**3,41,309**	**88,504**	**25.93**

10.2: LPB-ELISA (Percent protected)

During the year under report, a total of 49,325 serum samples were subjected to LPB ELISA for determination of antibody level against structural protein (SPs) of serotypes O,A and Asia1.

Table 10.3. Summary of LPBE result obtained on Random serum samples.

Southern Region					
Andhra Pradesh	Bovine	2600	1831 (70.4)	1739 (66.8)	2008 (77.2)
Telangana	Bovine	1600	1106 (69.1)	1013 (63.3)	1283 (80.1)
Karnataka	Bovine	6006	5290 (88.1)	5078 (84.5)	5522 (91.9)
Kerala	Bovine	1640	1307 (79.7)	1190 (72.6)	1402 (85.5)
Tamil Nadu	Bovine	6400	5537 (86.5)	6084 (95.1)	6141 (96.0)
Central Region					
Madhya Pradesh	Bovine	6242	3885 (62.2)	4060 (65.0)	3520 (56.4)
Western Region					
Maharashtra	Bovine	6242	2357 (37.8)	2182 (35.0)	2722 (43.6)
Gujarat	Bovine	200	151 (75.5)	184 (92.0)	175 (87.5)
Rajasthan	Bovine	256	112 (43.8)	127 (49.6)	159 (62.1)
Northern Region					
Haryana	Bovine	1714	1569 (91.5)	1499 (87.5)	1613 (94.1)
Uttar Prdaesh	Bovine	1450	493 (34.0)	610 (42.1)	1020 (70.3)
Punjab	Bovine	2080	1334 (64.1)	1250 (60.1)	1282 (61.6)
Himachal Pradesh	Bovine	2400	1150 (47.9)	1442 (60.1)	1619 (67.5)
Jammu & Kashmir	Bovine	1144	411 (35.9)	363 (31.7)	381 (33.3)
Eastern Region					
West Bengal	Bovine	3282	2003 (61.0)	1862 (56.7)	2131 (64.9)
North Eastern Region					
Assam	Bovine	2965	566 (19.0)	152 (5.1)	419 (14.1)
Mizoram	Bovine	827	415 (50.2)	366 (44.3)	457 (55.3)
Nagaland	Bovine	1551	961 (62.0)	643 (41.4)	959 (61.8)
Tripura	Bovine	915	570 (62.3)	628 (68.6)	655 (71.6)
Manipur	Bovine	1800	1156 (64.2)	1159 (64.4)	1153 (64.0)
Islantds					
Andaman & Nicobar	Bovine	960	705 (73.4)	727 (75.7)	801 (83.4)
Total		**48992**	**30906 (63.1)**	**30496(62.2)**	**33291 (68.0)**
Arunachal Pradesh	Yak	154	72 (46.8)	0	0
	Mithun	179	166 (92.7)	165(92.2)	167 (93.3)

Percentage serum samples having protective titre against serotypes O, A and Asia 1 is given in parenthesis

11 Sero-monitoring of FMD Control Programme (FMD-CP)

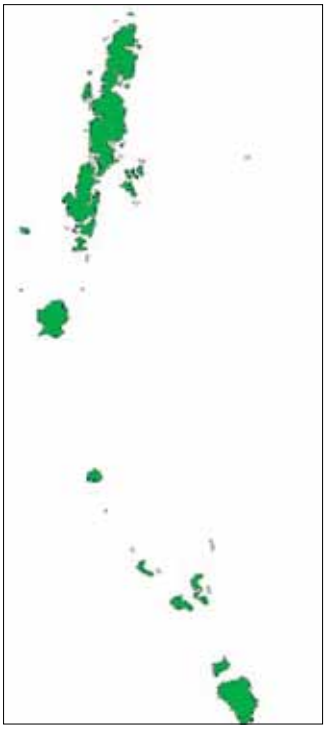
11.1: Sero Monitoring under FMD control Programme of government of India

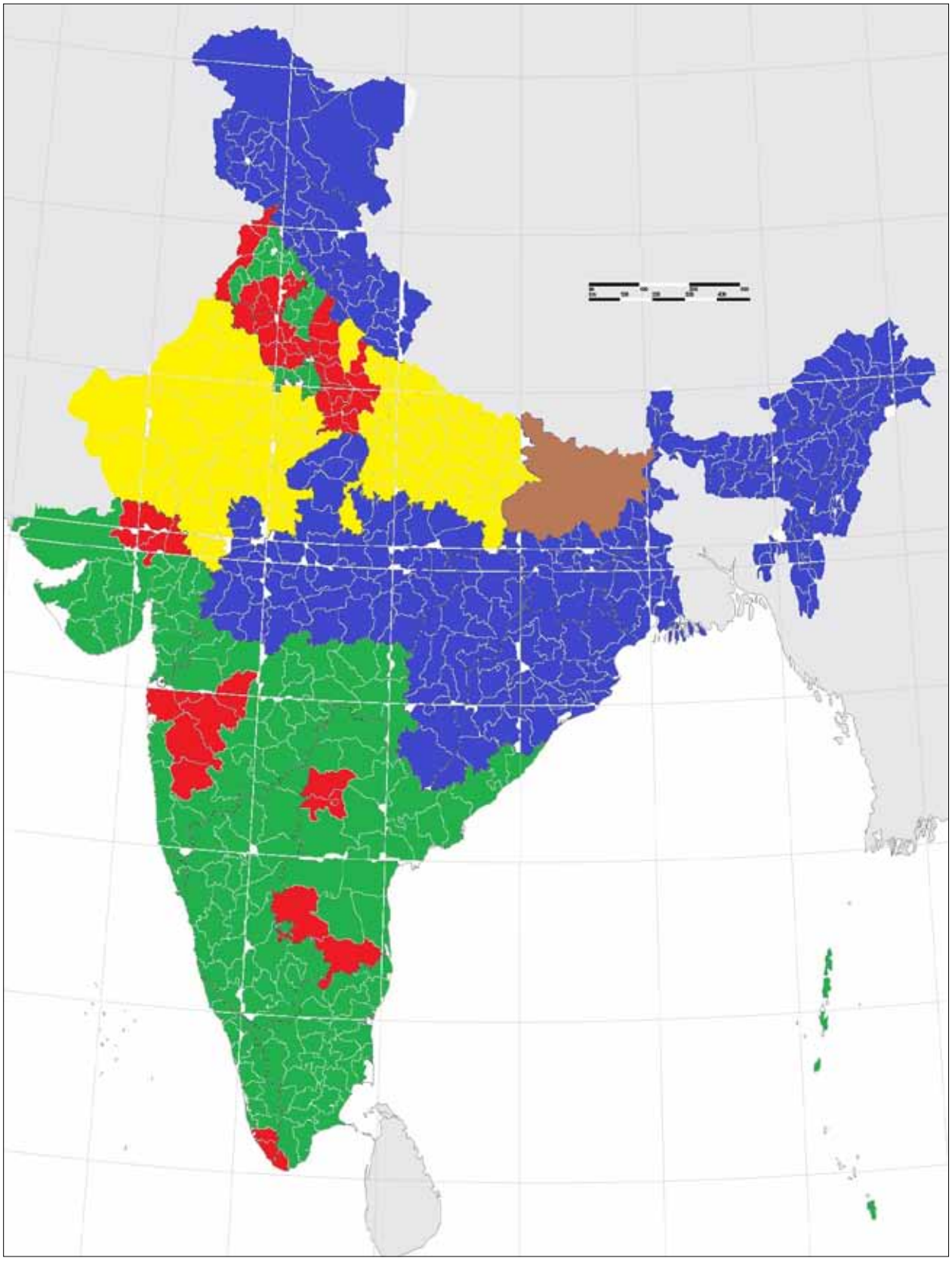
A vaccination based FMD Control Programme (FMD-CP) has been initiated by the Government of India since August 2003-04 covering 54 specified districts in the country. This involves 6 monthly vaccinations with a trivalent O, A and Asia1 vaccine of all cattle and buffaloes against FMD. Serum samples before vaccination and 21 to 30 days post vaccination are collected by the respective state AH department and submitted to testing centers of ICAR-DFMD for estimation of level of serotype specific antibodies by Liquid Phase Blocking ELISA. The Regional and Collaborative Centers, and Central FMD laboratory of the Directorate participate in this post vaccinal sero-conversion under FMD-CP. Since 2011-12, Central Agricultural Research Institute, Port Blair has been included as a testing laboratory for sero-monitoring of FMD in A & N Islands. All reagent and training to conduct LPB ELISA are provided by the institute. Due to initial success, additional 167 districts (another 80-90 million cattle and buffalo) have been included under the programme in 2010-11, and 110 districts have been included since 2013-14, and 38 districts in 2015-16. Currently, this programme includes 369 districts of the country covering all the states of Southern peninsula (Kerala, Tamilnadu, Puducherry, Karnataka and Andhra Pradesh), Maharashtra, Goa, Daman and Diu, Gujarat, Punjab, Haryana, Delhi, Dadra and Nagar Haveli, Andaman & Nicobar Islands, Lakshadweep, Uttar Pradesh, Rajasthan and Bihar (Fig 1).

During 2015-16, a total of 1,22,842 pre and post vaccinated serum samples were tested and of which, 47,249serum samples were from first phase FMDCP districts representing XIX and XX phases of vaccinations and remaining 75,593 serum samples were from expanded FMD CP districts of 2010-11 representing Phases VIII and IX.

Sero-monitoring in Andaman & Nicobar Island

Initially, eight villages of Andaman & Nicobar were covered under FMDCP in 2003-04 and later in 2010-11, entire Andaman & Nicobar Island was included. Central Agricultural Research Institute, Port Blair is undertaking the sero-monitoring of animals covered under the programme in A&N Islands





Regions covered under FMD-CP. Fifty four districts in which control programme started in 2003-04 are marked red. One sixty seven districts in which the control programme started in 2010-11 are marked green. 110 districts covered are marked yellow since 2013-14. 38 districts covered are marked brown in 2015-16.

Table 11.1. Result of Seroconversion in Andaman & Nicobar Islands (FMDCP 2003-04)

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
III	154	162	40(25.9)	97(60)	5(2.8)	37(20.3)	52(34.0)	118(73.6)
IV	149	146	50(33.5)	94(64.6)	50(33.5)	96(65.9)	35(23.4)	101(67.6)
V	126	122	72(57.2)	68(55.8)	62(50.8)	64(52.5)	54(44.3)	62(50.8)
VI	270	270	50 (18.5)	80 (29.6)	66 (24.4)	104 (38.4)	28 (10.2)	36 (13.2)
VII	265	265	112 (42.3)	174 (65.7)	82 (30.9)	110 (41.5)	56 (21.1)	66 (24.9)
VIII	251	251	53(21.11)	102(40.63)	18(7.2)	49(19.52)	47(18.72)	85(33.86)
IX	228	228	73(32.01)	69(30.26)	31(13.5)	35(15.35)	56(24.56)	42(18.42)
XII	180	180	36(20.0)	49(27.22)	19(10.5)	40(22.22)	11(6.11)	30(16.67)
XIII	283	283	26(9.2)	78(27.6)	12(4.2)	52(18.4)	15(5.3)	44(15.5)
XIV	794	593	144(18.1)	279(47)	100(12.6)	214(36.1)	77(10.0)	194(32.7)
XV	1445	1109	308(21.3)	550(49.9)	333(23)	584(52.6)	433(29.9)	674(60.7)
XVI	530	502	220 (41.5)	312 (62.2)	243 (45.8)	398 (79.3)	251(50.0)	394 (74.3)
XVII	521	461	225(42.3)	354(69.2)	302(58.0)	376(82)	286(55.0)	259(78)
XVIII	609	496	383 (62.9)	408 (82.3)	414 (67.9)	426 (85.9)	505 (82.3)	458 (92.3)
XIX	556	480	337 (60.6)	351 (73.1)	355 (63.8)	422 (87.9)	404 (72.7)	416 (86.7)

Overall herd immunity and Seroconversion was good till Phase V and thereafter decline in herd immunity has been observed till phase XV, and build up of herd immunity was observed thereafter.

Sero-monitoring in Tamil Nadu

Only districtKanyakumari, was covered under FMDCP in 2003-04 (filled red) and later in 2010-11, rest of the districts (filled green) was included in the control programme.

Table 11.2. Result of Seroconversion in Tamil Nadu (FMDCP 2003-04).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
		Type O		Type A		Type Asia 1		Post-vac
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	100	100	28(28)	51(51)	29(29)	57(57)	24(24)	54(54)
II	100	100	23(23.0)	63(63.0)	24(24.0)	40(40.0)	18(18.0)	61(61.0)
III & IV	180	330	59(32.7)	246(74.5)	61(33.8)	201(60.9)	45(25.0)	216(65.4)
VI	160	130	30(18.7)	99(76.1)	31(23.8)	109(83.8)	28(21.5)	103(79.2)
VII	300	300	35(11.7)	210(70)	34(11.3)	231(77)	36(12)	226(75.3)
VIII	100	100	34(34)	74(74)	40(40)	60(60)	25(25)	78(78)
IX	100	100	40(40)	58(58)	45(45)	64(64)	33(33)	74(74)
X	100	100	32(32)	62(62)	45(45)	63(63)	41(41)	70(70)
XI	200	200	38(19)	144(72)	31(15.5)	87(43.5)	29(14.5)	83(41.5)
XIV	200	200	71(35.5)	116(58)	93(46.5)	137(68.5)	92(46)	128(64)
XV	200	200	92(46)	199(99.5)	115(57.5)	198(99)	120(60)	194(97)

Increase in herd immunity and Seroconversion has been observed

Table 11.3. Result of Seroconversion in Tamil Nadu (FMDCP 2010-11).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
		Type O		Type A		Type Asia 1		Post-vac
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	5440	5440	1860(34.2)	3417(62.8)	1351(24.8)	2561(47.1)	115(20.5)	2209(40.6)
II	5040	5240	1383(27.4)	3504(66.9)	684(13.6)	2433(46.4)	245(4.9)	979(18.7)
III	4600	4600	789(17.2)	2788(60.6)	396(8.6)	1801(39.2)	1030(22.4)	3361(73.1)
IV	5801	5843	2570(44.3)	4547(77.8)	3296(56.8)	4826(82.6)	3643(62.8)	5066(86.7)
V	7199	6397	4089 (56.8)	5598(87.5)	4434(61.6)	5816(91)	4501(62.5)	5788(90.5)
VI	6400	6400	5041 (79)	6180(96.6)	4230(66.1)	6028(94.2)	5002(78.2)	6240(97.5)
VII	6400	6400	5332 (83.3)	6180 (96.6)	5016 (78.4)	6028 (94.2)	5572 (87.1)	6240 (97.5)
VIII	6400	6400	5480 (85.6)	6287 (98.2)	5348 (83.6)	6259 (97.8)	5845 (91.3)	6322 (98.8)
IX	6400	6400	5517 (86.2)	6224 (97.3)	5230 (81.7)	6126 (95.7)	5547 (86.7)	6282 (98.2)

Increase in herd immunity and Seroconversion has been observed

Table 11.4. Result of Seroconversion in Puducherry (FMDCP 2010-11).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
		Type O		Type A		Type Asia 1		Post-vac
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	30	55	16(44.4)	24(66.66)	9(25)	20(55.55)	5(13.88)	11(30.55)
II	38	38	16(42.1)	20(52.6)	10(26.3)	14(36.8)	0(0)	18(21.1)
III	46	46	21(45.7)	29(63)	7(15.2)	20(43.5)	26(56.5)	30(65.2)
IV			NA					
V			NA					
VI	246	246	214(87)	237(96.3)	182(74)	232(94.3)	213(87)	235(95.5)
VII	243	243	231(95.1)	233(96)	147(60.4)	209(86)	225(93)	231(95.1)
VIII	237	237	173(73.0)	221(93.2)	166(70.0)	222(93.7)	194(81.9)	231(97.5)

Sero-monitoring in Kerala

Three districts of Kerala namely, Trivandrum, Kollam and Pathanamthitta were covered under FMDCP in 2003-04 (filled red) and later in 2010-11; eleven districts (filled green) was included

Table 11.5. Result of Seroconversion in Kerala(FMDCP 2003-04).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
		Type O		Type A		Type Asia 1		Post-vac
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I & II & IV	483	496	158(32.7)	255(51.4)	140(29.0)	236(47.5)	165(34.2)	280(56.4)
V	290	290	67(23.1)	197(67.9)	52(17.9)	171(58.9)	61(21.0)	211(72.7)
VI	70	70	49 (20.4)	185(77.1)	41(17.1)	169(70.4)	38(15.8)	171(71.3)
VII	300	300	48 (16.0)	208(69.3)	43 (14.3)	213 (71	52 (17.3)	210(70.0)
VIII & IX	600	600	226(37.6)	395(65.8)	265(44.2)	341(56.8)	260(43.3)	397(66.2)
X	400	100	160(40)	59(59)	145(36.3)	66(66)	150(37.5)	53(53)
XI	352	315	122(19)	122(19)	122(19)	115(17.2)	96(14.4)	88(13.2)
XII	500	500	59(11.8)	202(40.4)	73(14.6)	197(39.4)	63(12.6)	153(30.6)
XIII	150	150	11(7.3)	42(28)	13(8.7)	39(26)	13(8.7)	41(27.3)
XIV	546	526	73(13.4)	74(14.1)	108(20)	123(23.4)	123(22.5)	200(38)
XV	598	553	129(21.6)	286(51.7)	190(31.8)	327(59.1)	313(52.3)	432(78.1)
XVI	2789	2738	1498(53.7)	2479(90.5)	1425(51.1)	2164(79)	1709(61.3)	2415(88.2)
XVII	2791	2678	2137(76.6)	2173(81.1)	1786(64)	2462(92)	2184(78.3)	2600(97.1)
XVIII	2800	2800	2303 (82.3)	2575 (92.0)	2145 (76.6)	2441(87.2)	2467 (88.1)	2686(95.9)

Overall herd immunity is poor in Kerala till phase XV and afterwards build up of herd immunity was observed.

Table 11.6. Result of Seroconversion in Kerala (FMDCP 2010-11).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
		Type O		Type A		Type Asia 1		Post-vac
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
II	676	180	84(12.4)	65(36.1)	105(15.5)	65(36.1)	65(9.6)	61(34)
III	1631	1474	199(12.2)	525(35.6)	178(10.9)	484(32.8)	135(8.3)	376(25.5)
IV	2378	2109	308(13)	526(25)	362(15.2)	633(30)	404(17)	735(35)
V	2043	1941	400(20)	991(51.1)	505(24.7)	1135(58.5)	922(45.1)	1364(70.3)

Overall herd immunity is poor in Kerala

Table 11.7. Result of Seroconversion in Lakshadweep (FMDCP 2010-11).

Phase	Vaccination	Number & % animals showing titres ≥1.8 $\log_{10}$ against FMDV						
		Type O		Type A		Type Asia 1		Post-vac
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	107	107	45(42.1)	80(74.8)	16(15)	63(58.9)	35(32.7)	50(46.7)

Sero-monitoring in Andhra Pradesh

Four districts of Andhra Pradesh namely, Ananthapur, Chitoor, Medak and Rangareddy are covered under FMDCP in 2003-04 (filled red) and rest of the districts (filled green) were included in 2010-11.

Table 11.8. Result of Seroconversion in Andhra Pradesh (FMDCP 2003-04).

Phase	Vaccination	Number & % animals showing titres ≥1.8 $\log_{10}$ against FMDV						
	Pre	Serotype O		Serotype A		Serotype Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	800	800	83 (10.3)	340 (42.5)	43 (5.3)	244 (30.5)	92 (11.5)	340 (42.5)
II	800	800	N.A.	434 (54.2)	N.A.	498 (62.3)	N.A.	438 (54.7)
III	800	800	210 (26.2)	286 (35.7)	395 (49.3)	532 (66.5)	306 38.2)	422 (52.7)
IV	800	800	281 (35.1)	374 (46.8)	465 (58.1)	617 (77.1)	329 41.1)	518 (64.8)
V	800	800	247 (30.8)	440 (55)	466 (58.2)	574 (71.8)	343(42.8)	450 (56.3)
VI	800	800	275 (34.3)	490 (61.3)	554 (69.2)	690 (86.3)	446 55.7)	634 (79.3)
VII	800	800	274 (34.0)	483 (60.3)	349 (44.0)	540 (67.5)	391(48.8)	518 (64.7)
VIII	800	800	356 (44.5)	594 (74.0)	415 (51.8)	624 (78.0)	333(41.6)	527 (65.8)
IX	800	800	422 (52.8)	673(84.1)	329 (41.1)	534 (66.8)	287(35.9)	534 (66.8)
X	800	800	502(62.7)	635(79.3)	368(46)	575(71.8)	411(51.3)	602(75.2)
XI	800	800	398(49.75)	617(77.1)	356(44.5)	600(75)	333(41.6)	568(71.5)
XII	800	800	387(48.4)	568(71)	266(33.25)	483(60.4)	177(22.1)	367(45.9)
XIII	800	800	537(67.1)	654(81.8)	438(54.8)	602(75.3)	315(39.3)	498(62.3)
XIV	800	800	366(45.7)	634(79.2)	186(23.3)	446(54.7)	100(12.5)	389(48.6)
XV	800	800	464(58)	578(72.2)	605(75.6)	733(91.6)	626(78.2)	726(90.7)
XVI	800	800	503(62.8)	680(85)	675(84.3)	773(96.6)	711(88.8)	796(99.5)
XVII	800	800	593(74.1)	665(83.1)	495(62)	563(70.4)	560(70)	613(76.6)
XVIII	800	800	547(68.4)	749(93.8)	502(62.8)	711(89)	535(67)	743(93.0)
XIX	400	400	297(74.3)	369(89.8)	236(69.0)	365(91.3)	310(77.5)	380(95.0)

Table 11.9. Result of Seroconversion in Andhra Pradesh (FMDCP 2010-11).

Phase	Vaccination		Serotype O		Serotype A		Serotype Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	3600	3600	1043(29)	2396(66.5)	648(18)	2030(56.4)	419(13.1)	1709(47.5)
II	3480	3480	1435(41.2)	2381(68.4)	1026(29.5)	2054(59)	595(17.1)	1499(43.1)
III	3600	3600	1392(38.6)	2498(69.3)	750(20.8)	1661(46.1)	393(10.9)	1162(32.2)
IV	3600	3600	1364(38)	2354(65.4)	1356(37.7)	2821(78.4)	1663(46.2)	2788(77.4)
V	3600	3600	1546(42.9)	2478(68.6)	2292(63.6)	3153(87.5)	2574(71.5)	3239(89.9)
VI	3600	3600	2190(60.8)	2867(79.6)	1997(55.5)	2675(74.3)	2211(61.4)	2752(76.4)
VII	3600	3600	2580(71.7)	3069(85.3)	2186(60.7)	2862(79.5)	2487(69.1)	3102(86.2)
VIII	3200	3200	2546(79.6)	2890(90.3)	2095(65.5)	2731(85.3)	2459(76.8)	2877(89.9)
IX	1800	1800	1430(79.4)	1649(91.6)	1230(68.3)	1589(88.3)	1442(80.1)	1660(92.2)

Overall herd immunity and sero-conversion is very good in Andhra Pradesh

Table 11.10 Result of Seroconversion in Telangana.

Phase	Vaccination		Number & % animals 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
XIX	383	400	339(88.5)	393(98.3)	251(65.5)	356(89.0)	338(88.3)	379(94.8)
XX	400	400	318(79.5)	358(89.5)	300(75.0)	339(84.8)	329(82.3)	375(93.8)

Sero-monitoring in Karnataka

State of Karnataka was included under FMDCP in 2010-11

Table 11.10. Result of Seroconversion in Karnataka (FMDCP 2010-11).

Phase	Vaccination		Number & % animals 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
I	4587	4266	1817(40)	2383(56)	687(15)	1722(40)	426(9)	1049(24.5)
II	5401	4632	2718(50)	3101(67)	1471(27)	2161(47)	1577(39)	2354(51)
III	3864	3075	2118(54.8)	1855(60.3)	1129(29.2)	1289(41.8)	2376(61.5)	2158(70.2)
VI	5053	5225	2439(48.3)	3245(62.1)	3977(78.7)	4493(86)	3834(76)	4294(82.2)
V	5916	5853	1954(33)	3470(59)	3047(52)	3957(68)	3795(64)	4734(81)
VI	5945	5985	3651(61)	5434(86)	3689(62)	5182(87)	4446(75)	5538(92.5)
VII	5930	5930	4934(83)	5741(97)	5211(88)	5567(94)	5543(93)	5813(98)
VIII	5974	5994	5227(87.5)	5723(95.5)	5073(84.9)	5794(96.7)	5447(91.2)	5823(97.1)
IX	NA	1996	NA	1936(97.0)	NA	1895(94.9)	NA	1958(98.1)

Overall herd immunity and sero-conversion is very good in Karnataka

Sero-monitoring in Maharashtra

Six districts of Maharashtra namely, Ahmadnagar, Aurangabad, Pune, Satara, Mumbai and Thanewere covered under FMDCP in 2003-04 (filled red) and later in 2010-11, twenty nine districts (filled green) was included

Table 11.11. Result of Seroconversion in Maharashtra (FMDCP 2003-04).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	844	761	173 (20.5)	456 (59.9)	151(17.9)	437 (57.4)	192 (22.8)	466 (61.2)
II	834	834	N.A.	508 (60.9)	N.A.	490 (58.6)	N.A.	553 (66.2)
III	753	799	184 (24.4)	438 (54.8)	351 (46.8)	580 (72.7)	262 (34.7)	534 (66.9)
IV	789	797	191 (24.2)	417 (52.3)	517 (65.6)	679 (85.3)	278 (35.2)	509 (63.9)
V	802	772	142 (17.7)	271 (35.1)	353 (44.2)	477 (62.3)	121 (15.0)	245 (31.8)
VI	901	928	404 (44.9)	663 (71.4)	622 (69)	853 (91.9)	245 (27.2)	446 (48.1)
VII	1000	1000	446 (44.6)	692 (69.2)	701 (70.1)	893 (89.3)	431 (43.1)	667 (66.7)
VIII	1000	1000	646 (64.6)	904 (90.4)	574 (57.4)	848 (84.8)	198 (19.8)	452 (45.2)
IX	1000	1000	730(73)	951(95.1)	524(52.4)	817(81.7)	324(32.4)	695(69.5)
X	1000	1000	785(78.5)	978(97.8)	686(68.6)	935(93.5)	607(60.7)	846(84.6)
XI	1000	1000	558(55.8)	916(91.6)	534(53.4)	871(87.1)	403(40.3)	837(83.7)
XII	980	980	590(60.2)	894(91.2)	468(47.75)	823(83.97)	341(34.79)	730(74.48)
XIII	950	1050	418(44)	727(69.2)	75(7.9)	332(31.6)	58(6.1)	277(26.4)
XIV	1040	1037	496(48)	881(85)	400(38.5)	839(81)	426(41)	831(81)
XV	1098	1098	382(34.8)	902(82.1)	598(54.5)	999(91)	661(60.2)	1018(92.7)
XVI	1055	1051	702(66.5)	978(93.1)	774(73.4)	991(94.3)	709(67.2)	986(93.8)
XVII	1062	1042	849(79.9)	1003(96.3)	560(52.7)	918(88.1)	406(38.2)	806(77.4)
XVIII	908	888	788(86.8)	876(98.6)	636(70)	835(94)	733(80.7)	835(94)
XIX	1093	1099	930 (85.1)	1066(97.0)	856(78.3)	1021(92.9)	900(82.3)	1048(95.4)
XX	280	300	210(75.0)	276(92.0)	253(90.4)	298(99.3)	254(90.7)	300(100)

Table 11.12. Result of Seroconversion in Maharashtra (FMDCP 2010-11).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	5988	6018	1687(28.2)	4390(72.9)	941(15.7)	3080(51.2)	382(6.4)	2310(38.4)
II	7208	7341	1849(25.7)	4890(66.6)	481(5.8)	2530(34.5)	491(6.8)	2279(31)
III	4721	4723	938(20)	2674(56.6)	1444(30.6)	2933(62.1)	2674(31.6)	3096(65.6)
IV	5250	5305	1673(31)	3746(70.6)	2641(50.3)	4429(83.5)	2809(53.5)	4513(85.1)
V	4891	4891	3027(61.9)	4523(92.5)	3466(70.9)	4619(94.4)	2701(55.2)	4307(88.1)

VI	5362	5362	3285(61.3)	4959(92.5)	2312(43.1)	4438()	1902(35.5)	4112(77)
VII	4181	4181	2973(71.1)	3888(93)	2398(57.4)	3721(89)	2491(60)	2708(65)
VIII	5486	5486	3317(60.5)	4905(89.4)	3726(67.9)	5119(93.3)	3684(67.2)	5149(93.9)

Overall herd immunity and sero-conversion is very good in Maharshtra

Sero-monitoring in Goa

Table 11.13. Result of Seroconversion in Goa (FMDCP 2010-11)

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	391	381	47(12)	244(86.8)	8(2)	92(24.1)	11(2.8)	92(24.1)
II	383	378	159(41.5)	316(84)	59(15.4)	234(62)	175(46)	331(88)
III	384	368	182(47.4)	302(82.1)	241(64.3)	317(86.1)	209(54.4)	316(86)
IV	379	376	171(45.1)	289(77)	222(58.5)	323(86)	215(57)	320(85.1)
V	375	375	322(85.9)	371(98.9)	289(77.1)	361(96.3)	194(51.7)	338(90.1)
VI	371	371	264(71.2)	362(97.6)	211(56.9)	338(91.1)	235(63.3)	343(92.5)
VII	369	369	241(65.3)	343(93.0)	250(67.8)	362(98.1)	282(76.4)	364(98.6)

Sero-monitoring in Gujarat

Four districts of Gujarat namely, Banaskantha, Sabarkantha, Mehsana and Patan were covered under FMDCP in 2003-04 (filled red) and later in 2010-11; rest of the districts (filled green) was included

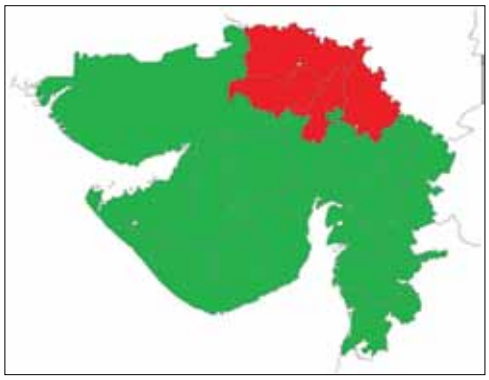


Table 11.14. Result of Seroconversion in Gujarat.

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	382	259	50 (19.1)	116 (44.7)	59 (24.5)	128 (48.7)	42 (16.1)	114 (43.5)
III	442	357	123 (27.8)	171 (47.9)	171 (39.2)	268 (58.3)	51 (12.4)	149 (35.4)
IV	497	456	113 (22.7)	277 (60.7)	184 (40.7)	355 (81.2)	73 (14.6)	218 (46.8)
V	195	202	46 (23.6)	99 (49.0)	126 (66.1)	179 (91.6)	44 (26.5)	92 (51.3)
VI	395	395	119 (30.1)	223 (56.4)	249 (63.0)	317(80.2)	195 (49.3)	240 (60.7)
VII	800	800	434 (54.3)	630 (78.8)	385 (48.1)	559 (69.9)	344 (43.0)	556 (69.5)
VIII	800	800	191 (23.9)	394 (49.3)	197 (24.6)	357 (44.6)	264 (33.0)	403 (50.4)
IX	800	800	230(28.7)	618(77.2)	284(35.5)	572(71.5)	326(40.7)	595(74.4)
X	800	800	356(44.5)	620(77.5)	286(35.7)	525(65.6)	276(34.5)	535(66.9)
XI	800	800	55(27.5)	76(38)	44(22)	71(35.5)	29(14.5)	49(24.5)
XII	800	800	104(52)	105(52.5)	80(40)	67(33.5)	56(28)	25(12.5)
XIII	2007	2029	589(29.4)	1009(49.7)	407(20.3)	784(38.6)	670(33.4)	1011(49.8)

XIV	1555	1201	742(47.7)	641(53.4)	513(33)	491(41)	557(35.8)	384(32)
XV	800	800	641(80.1)	582(77.1)	559(70)	626(78)	647(81)	612(76.5)
XVI	4600	4538	2506(54.5)	3444(75.9)	2874(62.5)	3491(76.9)	3183(69.2)	3688(81.3)
XVII	5200	5200	3093(59.5)	3869(74.4)	3260(62.7)	3971(76.4)	3376(74.9)	4160(80)
XVIII	3600	3600	2695(74.9)	2937(81.6)	1786(49.6)	2369(65.8)	2722(65.6)	2861(79.5)
XIX	600	600	491(81.8)	443(73.8)	482(80.3)	470(78.1)	456(76.0)	454(75.7)

Phase	Vaccination	Number & % animals showing titres ≥1.8 $\log_{10}$ against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
II	3194	3600	1323(41.4)	2132(59.2)	1065(33.3)	1906(60)	1191(37.3)	1940(54)
III	3900	3908	2011(51.6)	2582(66.1)	1678(43)	2320(59.4)	1598(41)	2142(54.8)
IV	4400	4400	2509(57.0)	3213(73.0)	2599(59.1)	3258(74.0)	3164(71.9)	3577(81.3)

Overall herd immunity and sero-conversion is very good in Gujarat

Sero-monitoring in Haryana

Eight districts of Haryana namely, Bhiwani, Fatehabad, Hisar, Jhajjar, Jind, Rohtak, Sirsa and Sonipat were covered under FMDCP in 2003-04 (filled red) and later in 2010-11; rest of the districts (filled green) were included

Overall post-vaccination response is very good at above 80% against all the three serotypes, and this has been well reflected as drastic reduction in occurrence of the disease in the state.

Table 11.15. Result of Seroconversion in Haryana (FMDCP 2003-04).

Phase	Vaccination	Number & % animals showing titres ≥1.8 $\log_{10}$ against FMDV						
	Pre	Serotype O		Serotype A		Serotype Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
II	1558	1558	NA	1065(68.3)	NA	859 (55.1)	NA	831 (53.3)
III	1585	1585	NA	1146(72.3)	NA	1007(63.6)	NA	1005(63.4)
IV	1589	1552	953 (60.1)	1222(78.7)	668 (42.1)	887 (57.1)	844(53.2)	1170(75.3)
V	1600	1599	955 (59.7)	1352(84.5)	813 (50.8)	1274(79.6)	941(58.8)	1353(84.5)
VI	1496	1499	995 (66.5)	1306(87.1)	895 (59.8)	1229(82.0)	844(56.4)	1118(74.6)
VII	1562	1574	856(54.8)	1296 (82.3)	1021(65.3)	1380(87.6)	888 (56.8)	1317 (83.6)
VIII	1547	1540	949(61.3)	1289 (83.7)	877 (56.6)	992 (64.4)	765 (49.4)	1101 (71.4)
IX	1497	1476	647(43.2)	1140(77.2)	590(39.4)	1022(69.2)	410(27.4)	879(59.6)
X	1420	1439	851(59.9)	1350(93.8)	615(43.3)	1003(69.7)	587(41.3)	1145(79.5)
XI	1500	1464	734(48.9)	1302(88.9)	546(36.4)	1180(80.6)	455(30.3)	1109(75.8)
XII	1360	1210	593(43.6)	975(80.6)	520(38.2)	989(81.7)	474(34.9)	896(74.1)
XIII	1590	1600	925(58.2)	654 (82.8)	218(27.6)	630(79.8)	185(23.4)	616(78.0)
XIV	1580	1580	627(39.7)	1327(84.0)	594(37.6)	1279(81.0)	536(33.9)	1272(80.5)
XV	1600	1600	963(60.2)	1286(80.4)	856(53.5)	1207(75.4)	724(45.3)	1182(73.9)
XVI	1600	1600	913(57.1)	1335(83.4)	813(50.8)	1351(84.4)	983(61.4)	1409(88.1)
XVII	1597	1600	935(58.5)	1434(89.6)	1044(65.4)	1460(91.3)	1323(82.8)	1556(97.3)

XVIII	1600	1600	1153(72.1)	1547(63.8)	1020(69.1)	1476(96.7)	1106(92.3)	1541(96.3)
XIX	1600	1600	1332(83.3)	1569(98.1)	1305(81.6)	1546(96.6)	1327(82.9)	1590(99.4)
XX	900	900	667(74.1)	875(97.2)	621(69.0)	835(92.8)	805(89.4)	884(98.2)

Table 11.16. Result of Seroconversion in Haryana (FMDCP 2010-11).

Phase	Vaccination	Number & % animals showing titres ≥1.8 $\log_{10}$ against FMDV						
	Pre	Serotype O		Serotype A		Serotype Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	3086	2354	1049(43.9)	1790(76.1)	988(41.4)	1789(76.0)	715(30.0)	1469(62.4)
II	2586	2594	1081(41.8)	1876(73.5)	986(38.1)	727(28.1)	986(38.1)	1537(60.2)
III	2555	2562	1092(42.5)	1809(71.2)	1113(43.3)	1856(73.1)	650(25.3)	1576(62.1)
IV	2565	2575	1043(40.1)	2049(79.5)	893(34.8)	1811(70.3)	840(32.7)	1700(66)
V	2600	2600	1210(46.5)	1867(71.8)	1178(45.3)	1638(63)	1010(39)	1709(66)
VI	2580	2580	1171(45.4)	2063(80)	1455(56.4)	2161(83.8)	1865(72.3)	2341(90.7)
VII	2558	2597	1755(68)	2285(88)	1895(74.1)	2160(83.2)	2050(80.1)	2483(95.6)

Sero-monitoring in Delhi

Delhi was included under FMDCP in 2003-04

Districts included in 2003-04 (Red)

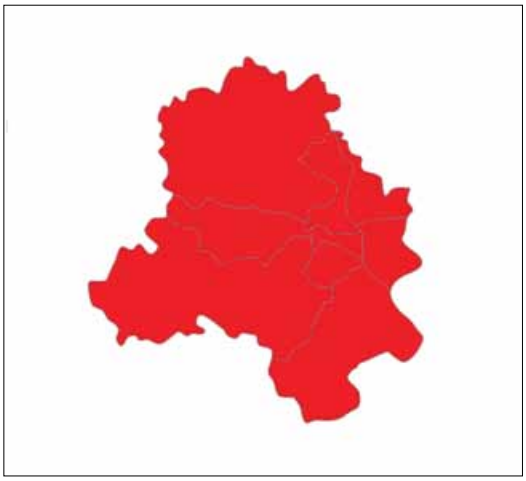


Table 11.17. Result of Seroconversion in Delhi (FMDCP 2003-04).

Phase	Vaccination	Number & % animals showing titres ≥1.8 $\log_{10}$ against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	50	50	26 (53)	50 (100)	13 (26)	47 (94)	17 (34)	48 (96)
II	24	24	22 (91)	23 (96)	12 (40)	15 (62)	23 (95)	22 (86)
III	50	50	47 (94)	49 (98)	30 (60)	40 (80)	43 (86)	46 (92)
IV	50	46	38 (76)	38 (82.6)	14 (28)	40 (86.9)	27 (54)	41 (89.1)
V	44	53	26 (59)	47 (88.6)	23 (52.2)	37 (69.8)	32 (72.7)	41 (77.3)
VI	98	98	76 (77.5)	97 (98.9)	60 (61.2)	93 (94.9)	71(72.4)	97 (98.9)
VII	50	50	39(78)	44(88)	33(66)	43(86)	25(50)	41(82)
VIII	100	100	92 (92)	100 (100)	66 (66)	86 (86)	83 (83)	98 (98)
IX	100	NA	57(57)	NA	65(65)	NA	33(33)	NA
XI	200	NA	172(86)	NA	100(50)	NA	91(45.5)	NA

XIII	100	100	98(98)	98(98)	95(95)	100(100)	87(87)	100(100)
XIV	NA	200	NA	170(85)	NA	179(89.5)	NA	153(76.5)
XV	200	200	157(78.5)	171(85.5)	124(62)	158(79)	143(71.5)	156(78)
XVI	NA							
XVII	NA							
XVIII	200	200	154(77)	196(98)	107(53.5)	177(88.5)	161(80.5)	193(96.5)
XIX	200	200	137 (68.5)	184 (92)	140 (70)	184 (92)	162 (81)	183 (91.5)

Herd immunity is very good at >80%.

Sero-monitoring in Punjab

Eight districts of Punjab namely, Amritsar, Bhatinda, Fatehgarh Sahib, Ferozpur, Mansa, Sangrur, Patiala and Gurdaspur were covered under FMDCP in 2003-04 (filled red) and later in 2010-11, Rest of the districts (filled green) was included

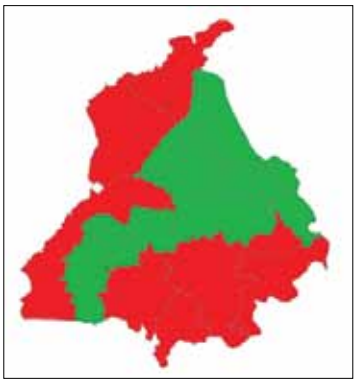


Table 11.18. Result of Seroconversion in Punjab (FMDCP, 2003-04).

Phase	Vaccination	Number & % animals showing titres ≥1.8 $\log_{10}$ against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	-	742	N.A.	187(25.2)	N.A.	90(11.5)	N.A.	273(49.5)
II	-	500	N.A.	219(43.8)	N.A.	113(20.9)	N.A.	279(58.1)
III	1084	1365	915(84.4)	1175(86.1)	816(75.3)	1007(73.8)	437(40.2)	573(42.0)
IV	1291	978	988(76.5)	792 (81.0)	794(61.5)	627 (64.1)	694 (53.8)	356(36.4)
V	1370	1139	477(34.8)	621(54.5)	445(32.8)	630(53.7)	513(38.5)	690(60.1)
VI	1509	1568	653 (43.3)	944 (60.2)	654 (43.3)	921 (58.7)	496 (32.9)	743 (47.4)
VII	1265	1432	520 (41.1)	898 (62.7)	356 (28.1)	639 (44.6)	448 (35.4)	696 (48.6)
VIII	984	1125	580(58.9)	825(73.33)	410(41.7)	643(57.2)	452(45.9)	741(65.9)
IX	1558	1546	1035(66.4)	1193(77.1)	831(53.3)	978(63.4)	926(59.4)	1132(73.2)
X	1592	1592	1030(64.7)	1231(77.3)	904(56.8)	1098(67.0)	970(61.0)	1156(72.6)
XI	1600	1600	991(61.9)	1186(74.1)	881(55.1)	1075(67.2)	965(60.3)	1142(71.4)
XII	1600	1556	1033(64.5)	1115(71.6)	914(57.1)	1026(65.9)	897(56.1)	NT
XIII	3320	3210	2002(60.3)	1920(59.8)	2048(61.7)	1868(58.2)	2114(63.7)	2494(77.7)
XIV	1998	1853	1061(53.1)	1333(72)	1214(61)	1099(59.3)	1520(76.1)	1553(83.8)
XV	3299	3015	1906(57.8)	2080(69)	2282(69.2)	2407(80)	2831(85.8)	2772(92)
XVI	3182	3522	2107(66.2)	2470(70.1)	2408(75.7)	2808(79.7)	2662(83.7)	3211(91.2)
XVII	3590	3605	2538(71)	2728(75.7)	2423(67.5)	2637(731)	2338(65.1)	2803(77.8)
XVIII	3978	3829	2815(70.8)	3030(79.1)	2619(65.8)	2811(73.4)	2739(61.3)	2748(71.8)
XIX	1272	NA	918(72.2)	NA	836(65.7)	NA	831(65.3)	NA

Districts included in 2010-11(Green)

Overall Seroconversion and herd immunity is good.

Table 11.19. Result of Seroconversion in Punjab (FMDCP, 2010-11).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
	Pre	Type O		Type A		Type Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
I	1800	1800	797(44.3)	978(54.3)	704(39.1)	825(45.8)	615(34.2)	874(48.6)
II	1800	1782	1002(55.6)	1096(61.5)	902(50.1)	978(54.8)	904(50.2)	NT
III	2872	2390	1880(65.5)	1690(70.7)	1880(65.5)	1690(70.7)	1806(62.9)	1979(82.8)
IV	1917	1657	1094(57.1)	1125(68.7)	1317(69.3)	659(40)	1329(69.3)	1363(82.3)

Overall Seroconversion and herd immunity is good, and this has been well reflected as drastic reduction in occurrence of the disease in the state.

Sero-monitoring in Uttar Pradesh

Sixteen districts of UP (Agra, Aligarh, Budaun, Bulandsahar, Etah, Ferozabad, GautamBhuddha Nagar, Gaziabad, Hatras, J.P.Nagar, Mathura, Meerut, Baghpat, Saharanpur, Muzaffarnagar and Muradabad) are covered under FMDCP in 2003-04 (Red). No new districts included during the expansion in 2010-11.

Seroconversion is very poor.

Table 11.20. Result of Seroconversion in Uttar Pradesh (FMDCP, 2003-04).

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
	Pre	Serotype O		Serotype A		Serotype Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
II	139	407	0(0)	180(44.2)	0(0)	155(38.1)	0(0)	293(72.0)
III	1155	1584	399(34.5)	780(49.2)	494(42.7)	910(57.4)	490(42.4)	1138(71.8)
IV	1910	1770	344(18.0)	537(30.3)	610(31.9)	866(48.9)	519(27.2)	808(45.6)
V	1440	1591	516(35.8)	715(44.9)	625(43.4)	802(50.4)	684(47.5)	786(49.4)
VI	1488	1579	514(34.5)	968 (61.3)	520 (34.9)	826 (52.3)	400 (26.9)	838 (53.1)
VII	2833	2075	706 (24.9)	911 (43.9)	597 (21.1)	808 (38.9)	740 (26.1)	930 (44.8)
VIII	1904	2744	707(37.1)	1550(56.5)	502(26.4)	1310(47.7)	617(32.41)	1288(46.9)
IX	2762	3002	927(33.5)	1198(39.9)	617(22.34)	1095(36.5)	597(21.6)	1072(35.7)
XI	643	2206	47(7.3)	481(21.8)	68(10.6)	321(14.6)	385(59.9)	1103(50)
XII	1934	1535	184(9.5)	270(17.6)	252(13)	524(34.1)	424(21.9)	773(50.6)
XIII	983	2946	146(15)	955(32.4)	69(7.7)	780(26.5)	220(22.4)	1054(35.8)
XIV	4041	3800	2473(61.2)	2522(66.4)	2501(62)	2139(56.3)	2501(62)	1107(29)
XV	3870	3968	1641(42.4)	2260(57)	1312(33.9)	2256(56.9)	1507(38.9)	2626(66.2)
XVI	10763	3648	4114(38.2)	1375 (37.7)	4527(42.1)	1584 (43.4)	4570(42.5)	1834 (50.3)
XVII	8840	NA	2721 (30.8)	NA	4343(49.1)	NA	5595(63.3)	NA

Sero-monitoring in Rajasthan

All districts of Rajasthan are covered under FMDCP.

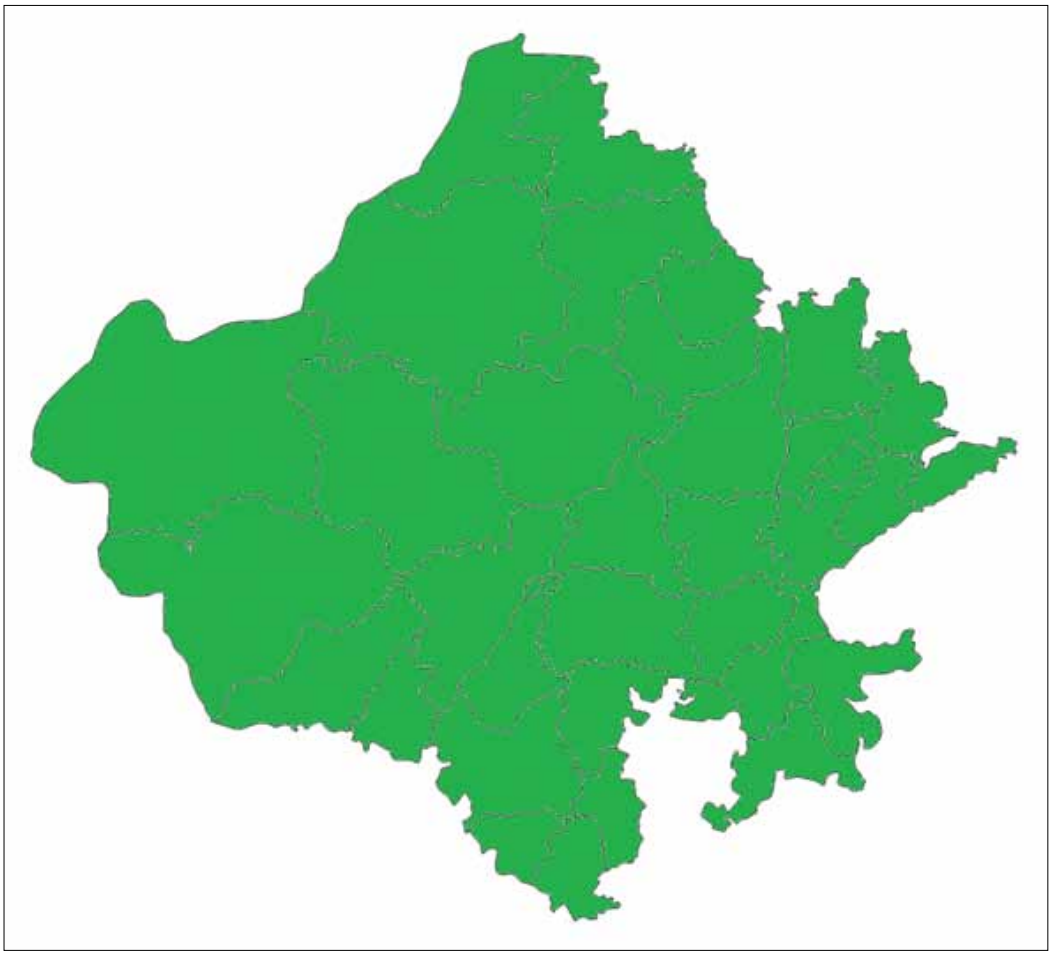


Table 11.21. Result of Seroconversion in Rajasthan

Phase	Vaccination	Number & % animals showing titres ≥1.8 log_{10} against FMDV						
	Pre	Serotype O		Serotype A		Serotype Asia 1		Post-vac
		Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	
II	1996	2298	1069(53.6)	1915(83.3)	1199(60.1)	1634(71.1)	1276(63.9)	1657(72.1)

Summary of overall sero conversion against each serotype and impact of vaccination (54 districts)

The herd immunity has progressively increased with minor aberrations that speak for positive impact of vaccination for last 6-7 years. Incidence/ occurrence of the disease has also progressively declined in the southern region and also down to near zero in the states of Haryana and Punjab. There has been case of FMD in FMD-CP districts affecting very limited number of animals and did not spread due to surrounding herd immunity. Further, there has been reduction in severity of clinical sickness. Of late, due to delay in vaccination there have been a few sporadic incidences in vaccinated areas. There have been certain problemsin maintaining 6 month interval between successive vaccinations. This problem can be circumvented/compensated by using a vaccine having at least 6-8 PD50/dose. The results have been encouraging and should be further strengthened by constituting a National FMD Control Commission.

Table 11.22. Percent animals showing post vaccinal antibody titers of ≥1.8 log_{10} against FMD virus (FMDCP, 2003-04, 54 districts)

Phase	Type O		Type A		Type Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	27.3	53.5	22.0	49.5	23.8	57.6
II	36.7	60.2	23.3	48.4	36.8	63.5
III	43.7	64.3	43.7	61.5	39.1	62.6
IV	41.2	62.3	42.4	67.5	36.2	61.1
V	38.0	39.3	46.3	65.6	40.8	59.4
VI	38.9	67.9	46.6	73.9	36.8	62.6
VII	39.7	68.5	39.4	67.1	35.1	62.8
VIII	42.3	68.7	37	58.6	33.5	57
IX	63.7	85.6	52	73.3	52.6	73
X	63.4	87.4	50.6	74.7	48.9	76.7
XI	44.1	57.8	37.8	51.5	39.3	59.3
XII	36.6	55.3	31.8	54.9	30	39.3
XIII	44.0	48.8	26.8	41.4	30.4	46.3
XIV	48.2	67.7	45.5	58.9	47.3	52.7
XV	46.5	71.6	50.1	76.0	54.4	78.5
XVI	47.8	77.0	52.5	78.4	57.0	85.9
XVII	66.6	80.6	63.4	82.8	67.3	84.8
XVIII	75.1	89.0	57.0	78.6	74.0	87.1
XIX	75.5	92.8	69.7	93.4	73.4	96.0
XX	75.8	94.8	71.0	93.6	87.2	97.0

Table 11.23. Percent animals showing post vaccinal antibody titers of ≥1.8 log_{10} against FMD virus (FMDCP, 2010-11, 167districts)

Phase	Type O		Type A		Type Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	33.4	65.3	21.4	50.7	10.9	40.7
II	37.5	66.5	23.5	46.3	20.5	38.2
III	36.5	63.1	28.3	52.1	34.2	56.1
IV	39.4	66.8	50.5	75.3	53.7	77.8
V	45.9	74.1	57.3	81.1	60.4	84.4
VI	64.5	90.0	57.4	86.0	65.0	87.8
VII	77.7	93.2	73.6	89.5	80.2	89.7
VII	84.2	95.1	76.8	94.5	88.1	96.2
VIII	84.7	96.2	78.8	94.6	85.2	97.1

Table 11.24A. Summary of total number of serum samples tested under FMD CP (2003-04)

State/UT	Phase I		Phase II		Phase III		Phase IV		Phase V		Phase VI		Phase VII	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andaman & Nicobar	-	-	-	-	154	162	149	146	126	122	270	270	265	265
Andhra Pradesh	800	800	-	800	800	800	800	800	800	800	800	800	800	800
Delhi	50	50	24	24	50	50	50	46	44	53	98	98	50	50
Gujarat	382	259	-	-	442	357	497	456	195	202	395	395	800	800
Haryana	-	-	-	1558	-	1585	1589	1552	1600	1599	1496	1499	1562	1574
Kerala	483 (pre) and 496(post) of Phase I, II and IV								290	290	70	70	300	300
Maharashtra	844	761	-	834	753	799	789	797	802	772	901	928	1000	1000
Punjab	-	742	-	500	1084	1365	1291	978	1370	1139	1509	1568	1265	1432
Tamilnadu	100	100	100	100	180(pre)		330(post)		-	-	160	130	300	300
Uttar Pradesh	-	-	139	407	1155	1584	1910	1770	1440	1591	1488	1579	2833	2075
SubTotal	**2659**	**2712**	**759**	**4223**	**4618**	**6702**	**7405**	**6545**	**6667**	**6568**	**7187**	**7337**	**9175**	**8596**
Total	**5371***		**4982***		**11320***		**13950***		**13235**		**14524**		**17771**	

Table 11. 24B. Summary of total number of serum samples tested under FMD CP (2003-04)

State/UT	Phase VIII		Phase IX		Phase X		Phase XI		Phase XII		Phase XIII		Phase XIV	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andaman & Nicobar	251	251	228	228	-	-	-	-	180	180	283	283	794	593
Andhra Pradesh	800	800	800	800	800	800	800	800	800	800	800	800	800	800
Delhi	100	100	100	-	-	-	200	-	-	-	100	100	-	200
Gujarat	800	800	800	800	800	800	800	800	800	800	2007	2029	1555	1201
Haryana	1547	1540	1497	1476	1420	1439	1500	1464	1360	1210	1590	1600	1580	1580
Kerala	600 (pre)		600(post)		400	100	352	315	500	500	150	150	546	526
Maharashtra	1000	1000	1000	1000	1000	1000	1000	1000	980	980	950	1050	1040	1037
Punjab	984	1125	1558	1546	1592	1592	1600	1600	1600	1556	3320	3210	1998	1853
Tamilnadu	100	100	100	100	100	100	200	200	-	-	-	-	200	200
Uttar Pradesh	1904	2744	2762	3002	88	-	643	2206	1934	1535	983	2946	4041	3800
Sub Total	**8086**	**8460**	**9445**	**8952**	**6200**	**5831**	**7095**	**8385**	**8154**	**7561**	**10183**	**12168**	**12554**	**11790**
Total	**16546***		**18397***		**12031**		**15480**		**15715**		**22351**		**24344**	

Table 11. 24C. Summary of total number of serum samples tested under FMD CP (2003-04)

State/UT	Phase XV		Phase XVI		Phase XVII		Phase XVIII		Phase XIX		Phase XX	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andaman & Nicobar	1445	1109	530	502	521	461	609	496	556	480	-	-
Andhra Pradesh	800	800	800	800	800	800	800	800	400	400	-	-
Delhi	200	200	-	-	-	-	200	200	-	-	-	-
Gujarat	800	800	4600	4538	5200	5200	3600	3600	600	600	-	-
Haryana	1600	1600	1600	1600	1597	1600	1600	1600	1600	1600	900	900
Kerala	598	553	2789	2738	2791	2678	2800	2800	-	-	-	-
Maharashtra	4079	1098	1055	1051	1062	1042	908	888	1093	1099	280	300
Punjab	3299	3015	3182	3522	3590	3605	3978	3829	1272	-	-	-
Tamilnadu	200	200	-	-	-	-	-	-	-	-	-	-
Telangana	-	-	-	-	-	-	-	-	383	400	400	400
Uttar Pradesh	3870	3968	10763	3648	8840	-	-	-	-	-	-	-
Sub Total	16891	13343	25319	18399	24401	15386	14495	14213	5904	4579	1580	1600
Total	**30234**		**43718**		**39787**		**28708**		**10483**		**3180**	
Grand total	**3,62,127**											

* excluding the samples of Phase I, II, IV, VIII and IX from Kerala; Phase III and IV from Tamilnadu as samples of this phases were mixed up at the level of collection and labeling
**this includes all the samples tested

Table 11.25. Summary of total number of serum samples tested under extended FMD CP (2010-11)

State/UT	Phase I		Phase II		Phase III		Phase IV		Phase V	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andhra Pradesh	3600	3600	3480	3480	3600	3600	3600	3600	3600	3600
Haryana	3086	2354	2586	2594	2555	2362	2565	2575	2600	2600
Karnataka	4587	4266	5401	4632	3864	3075	5053	5225	5916	5853
Maharashtra	5988	6018	9435	9698	4721	4723	5250	5305	4891	4891
Goa	381	391	383	378	384	368	379	376	375	375
Punjab	1800	1800	1800	1782	2872	2390	1917	1657	-	-
Gujarat	-	-	3194	3600	3900	3908	-	-	-	-
Kerala	-	-	676	180	1631	1474	2378	2109	2043	1941
Tamilnadu	5440	5440	5040	5240	4600	4600	5801	5843	6099	5697
Puducherry	30	55	38	38	46	46	-	-	-	-
Lakshadweep	107	107	-	-	-	-	-	-	-	-
Rajasthan	-	-	1996	2298	-	-	-	-	-	-
Sub total	**25019**	**24031**	**34029**	**33920**	**28173**	**26546**	**26943**	**26690**	**25524**	**24957**
Total	**49050**		**67949**		**54719**		**53633**		**50481**	

State/UT	Phase VI		Phase VII		Phase VIII		Phase IX	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andhra Pradesh	3600	3600	3600	3600	3200	3200	1800	1800
Haryana	2580	2580	2558	2597	-	-	-	-
Karnataka	6696	5985	5930	5930	5974	5994	-	1996
Maharashtra	5362	5362	4181	4181	5486	5486	-	-
Goa	371	371	369	369	-	-	-	-
Punjab	-	-	-	-	-	-	-	-
Gujarat	-	-	-	-	4400	4400	-	-
Kerala	-	-	-	-	-	-	-	-
Tamilnadu	6400	6400	6400	6400	6400	6400	6400	6400
Puducherry	246	246	243	243	237	237	-	-
Sub total	25255	24544	23281	23320	25697	25717	8200	10196
Total	**49799**		**46601**		**51414**		**18396**	
Grand total	**4,42,042**							

Serum testing under FMD Control Programme

State	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Andaman & Nicobar	-	-	Phase III, IV & V	Phase VI	Phase VII	Phase VIII & IX	Phase XII	Phase XIII	Phase XIV & XV	Phase XVI & XVII	Phase XIX & VIII Ext Phase
Andhra Pradesh	Phase I	Phase I	Phase II, III, IV, V & VI	Phase VI	Phase VII, VIII & IX	Phase IX	Phase XI & XII Ext Phase I &II	Phase XIII & XIV Ext Phase I, II, III & IV	Phase XV & XVI Ext Phase IV, V & VI	Phase XVII & XVIII Ext Phase VI & VII	Phase XIX Ext Phase VIII, IX
Karnataka								Ext Phase I, II & III	Ext Phase III, IV & V	Ext Phase VI & VII	Ext Phase VII&IX
Delhi	Phase I	Phase I	Phase II, III, IV, V & VI	Phase VI	Phase VII & VIII	Phase IX & XI	-	Phase XIII	Phase XIV & XV	Phase XVIII	Phase XIX
Gujarat	Phase I	Phase I	Phase III, IV, V & VI	Phase VI	Phase VII & VIII	Phase IX & X	Phase XI & XII	Phase XIII & XIV	Phase XIV & XV Ext Phase II & III	Phase XVI, XVII & XVIII	Phase XIX Ext Phase VI
Haryana	Phase II	-	Phase III, IV, V & VI	-	Phase VII & VIII	Phase IX & X	Phase XI & XII	Phase XIII & XIV Ext Phase I, II & III	Phase XV & XVI Ext Phase IV & V	Phase XVII & XVIII Ext Phase VI & VII	Phase XIX & XX
Kerala	Phase I	Phase I	Phase II, IV, V & VI	Phase VI	Phase VII	Phase VIII, IX & X	Phase XI Ext Phase I	Phase XII & XIII Ext Phase I, II, III & IV	Phase XIV & XV Ext Phase IV & V	Phase XVI & XVII	Phase XVIII
Maharashtra	Phase I	Phase I & II	Phase III, IV, V & VI	Phase VIII	Phase VI & VII	Phase IX & X	Phase XI & XII Ext Phase I	Phase XIII Ext Phase I & II	Phase XIV, XV & XVI Ext Phase III, IV & V	Phase XVII & XVIII Ext Phase VI & VII	Phase XIX& XX Ext Phase VII& VIII
Goa								Ext Phase I	Ext Phase I, II, III & IV	Ext Phase V & VI	Ext VII

Punjab	Phase I	Phase I & II	Phase III, IV, V & VI	Phase VI & VII	Phase VII	Phase VII, VIII & IX	Phase X & XI Ext Phase I	Phase XI & XII Ext Phase I & II	Phase XIII & XIV Ext Phase III & IV	Phase XV, XVI & XVII	Phase XVII, XVIII , XIX
Tamil Nadu	Phase I	Phase I	Phase II, III, IV & VI	Phase VII	Phase IX	Phase VIII & X	Phase XI Ext Phase I	Ext Phase II & III	Phase XIV & XV Ext Phase III, IV & V	Ext Phase VI & VII	Ext Phase VIII&IX
Telangana	-	-	-	-	-	-	-	-	-	-	Phase XIX & XX
Puducherry								Ext Phase I, II & III		Ext Phase VI & VII	Ext Phase VII
Lakshadweep								Ext Phase I			
Uttar Pradesh	Phase II	Phase II	Phase II, III, IV & VI	Phase VII	Phase VI & VII	Phase VIII & IX	Phase IX	Phase XI & XII	Phase XIII & XIV	Phase XV& XVI	Phase XVI& XVII
Rajasthan	-	-	-	-	-	-	-	-	-	-	Ext Phase II

11.2: Sero-monitoring of post vaccinal immunity in animals vaccinated under ASCAD/RKVY programmes: sampling was done at random, and not as per FMD-CP format

State	T	T	O	%	A	%	Asia1	%	O	%	A	%	Asia1	%
Himachal P.	2000	2000	900	45.00	1122	56.10	1193	59.65	1287	64.35	1516	75.80	1521	76.05
Manipur	900	900	151	16.78	153	17.00	146	16.22	794	88.22	799	88.78	813	90.33
Madhya P.	5245	2949	1676	31.95	1546	29.48	2034	38.78	1470	49.85	1299	44.05	1562	52.97
Tripura	1366	1366	694	50.81	737	53.95	784	57.39	964	70.57	1011	74.01	1039	76.06
J & K	216	200	26	12.04	38	17.59	18	8.33	52	26.00	81	40.50	46	23.00
Nagaland	393	360	179	45.55	110	27.99	201	51.15	336	93.33	291	80.83	314	87.22
Mizoram	517	558	328	63.44	312	60.35	354	68.47	521	93.37	496	88.89	534	95.70
Total	10637	8333	3954	37.17	4018	37.77	4730	44.47	5424	65.09	5493	65.92	5829	69.95

Percentage serum samples having protective titre against serotypes O, A and Asia 1 is given in parenthesis

12 Production, Standardization and Supply of Diagnostic Reagents/kits

For production of reagents, the vaccine virus strains {O (INDR2/75), Asia1 (IND 63/72),) and A (IND40/00)} were bulk produced in roller culture vessels and purified by density gradient centrifugation. Antibodies against purified virus was raised and titrated against homologous as well as heterologous virus. Freeze dried and standardized serum antibodies (rabbit and guinea pig) and known positive antigen (killed) of all three serotypes were supplied to all the centres and network units for use in virus serotyping ELISA and LPB-ELISA. Recombinant 3AB3 NSP was produced as per requirement. The kits have been supplied to the AICRP units FMD Regional centers/network units for sero-surveillance and monitoring of FMD and also to the SAARC Countries.

Supply of Diagnostic kits

	LPBE	S-ELISA	DIVA
2009-10	80,000	7,000	54,485
2010-11	82,800	9,000	71,940
2011-12	1,54,600	10,000	61,670
2012-13	1,77,850	16,500	85,350
2013-14	2,36,640	21,500	87,850
2014-15	2,71,960	3,000	79,800
2015-16	1,65,520	7,500	50,380

13 Research Projects

S.No.	Title	PI	Co-PI	Duration	Institute code
1.	Cataloguing and Maintenance of National FMD virus repository during 2016-17	B. Pattnaik	Saravanan S Sagar A. Khulape	2016-17	DFMD/1/2016-17
2.	Production, standardization and supply of diagnostic reagents for FMD diagnosis and surveillance during 2016-17.	R. Ranjan	M. Rout Sagar A. Khulape	2016-17	DFMD/2/2016-17
3.	Seromonitoring of pre and post vaccinal immunity against FMD during 2016-17.	B. B. Dash	Saravanan S. J. K. Biswal	2016-17	DFMD/3/2016-17
4.	Random serosurveillance of FMD in India during 2016-17.	B. B. fDash	M Rout J. K. Biswal	2016-17	DFMD/4/2016-17
5.	Genetic and antigenic characterizations of FMD virus serotype A during 2016-17.	J. K. Biswal	M. Rout R. Ranjan	2016-17	DFMD/5/2016-17
6.	Evolutionary and antigenic analysis of foot and mouth disease virus serotype O from India during 2016-17.	Saravanan S.	B. B. Dash M. Rout	2016-17	DFMD/6/2016-17
7.	Epidemiology of Foot and Mouth Disease in small ruminants and pigs in India during 2016-17.	M. Rout	B.B. Dash	2016-17	DFMD/7/2016-17
8.	Genetic and antigenic analysis of Foot and Mouth Disease virus serotype Asia1 during 2016-17.	Sagar A. Khulape	Saravanan S	2016-17	DFMD/9/2016-17
9.	Deep sequencing of FMD virus genome.	Sagar A. Khulape	Saravanan S. J.K. Biswal	2016-17	DFMD/10/2016-17
10.	Expression profile of TLRs, chemokines and cytokines in tissues and OP fluid of FMD virus carrier and non-carrier bovine under natural condition.	R. Ranjan	J.K. Biswal	2015-17	DFMD/8/2015-17
11.	Further Development and Characterization of Improved thermostable FMDV serotype O vaccine candidates generated by reverse genetics technologies.	J. K. Biswal	Saravanan S. R. Ranjan	2015-17	DFMD/12/2015-17
12.	Surveillance and monitoring of Foot and Mouth Disease in susceptible captive/wildlife species of India	M Rout	B. B. Dash Sagar A. Khulape Anil K. Sharma (IVRI) Devendra Kumar (CZA)	2015-2016 (Oct)	DFMD/16/2015-16
13.	Understanding FMD viral ecology and landscape epidemiology towards control and eradication.	R. Ranjan	Saravanan S. M. Rout J.K. Biswal Sagar A. Khulape	2016-17	ICAR-DFMD & PIADC, USA collaborative project

14 Publications/ Abstracts/Presentations/ Awards in Conferences

Research Publications

1. Gaurav Kumar Sharma, Sonalika Mahajan, Rakesh Matura, Saravanan Subramaniam, Jajati K. Mohapatra, Bramhadev Pattnaik (2015). Quantitative single dilution liquid phase blocking ELISA for sero-monitoring of foot-and-mouth disease in India. **Biologicals.**http://dx.doi.org/10.1016/j.biologicals.2015.03.003
2. Gaurav Kumar Sharma, Mahajan S, Matura R, Biswal JK, Ranjan R, Subramaniam S, Misri J, Bambal RG, Pattnaik B(2016). Herd Immunity against Foot-and-Mouth Disease under different vaccination practices in India. **TransboundEmerg** Dis. doi: 10.1111/tbed.12478.
3. Jitendra K. Biswal, Das B, Sharma GK, Khulape SA, Pattnaik B (2016). Role of a single amino acid substitution of VP3 H142D for increased acid resistance of foot-and-mouth disease virus serotype A. **Virus Genes**. 2016 Feb 12.
4. Jitendra K. Biswal, PunamBisht, SaravananSubramaniam, Rajeev Ranjan, Gaurav K. Sharma, Bramhadev Pattnaik (2015). Engineering foot-and-mouth disease virus serotype O IND R2/1975 for one-step purification by immobilized metal affinity chromatography. **Biologicals**. http://dx.doi.org/10.1016/j.biologicals.2015.06.001
5. Jitendra K. Biswal, Rajeev Ranjan and Bramhadev Pattnaik (2016) Diagnostic application of recombinant non-structural protein 3A to detect antibodies induced by foot-and-mouth disease virus infection. **Biologicals**. DOI: 10.1016/j.biologicals.2016.02.004
6. Jitendra K. Biswal, Subramaniam S, Sharma GK, Mahajan S, Ranjan R, Misri J, Pattnaik B. (2015). Mega primer-mediated capsid swapping for the construction of custom-engineered chimeric foot-and-mouth disease virus. **Virus Genes**. 51(2):225-33.
7. Jitendra K. Biswal, Saravanan Subramaniam , Rajeev Ranjan , Gaurav K. Sharma, Jyoti Misri , Bramhadev Pattnaik (2015). Marker vaccine potential of foot-and-mouth disease virus with large deletion in the non-structural proteins 3A and 3B. **Biologicals**. 43(6):504-11
8. Jitendra K. Biswal, S. Subramaniam, R. Ranjan, G.K. Sharma and B. Pattnaik. (2015). Isolation and characterisation of foot-and-mouth disease virus from a captive Indian elephant (Elephasmaximus). **Indian J. Vet. Pathol.** 39(4) : 376-379
9. ManoranjanRout, S.S. Pawar, N.S. Nair, E.D. Benjamin, A.P. Usha, K.S. Anil, J.K. Mohapatra, S. Subramaniam, B. Pattnaik (2016). Detection of foot-and-mouth disease virus infection in cattle and pigs at Mannuthy, Kerala. **Indian Journal of Veterinary Pathology;** 40(1):55.
10. Rajeev Ranjan, Jitendra Kumar Biswal, Ajay Kumar Sharma, Manoj Kumar, Bramhadev Pattnaik (2016). Management of foot and mouth disease in a dairy farm: by ethnoveterinary practice . **The Indian Journal of Animal Sciences** 86 (3)

11. Saravanan Subramaniam, Jajati K Mohapatra, Biswajit Das, Gaurav K Sharma, Jitendra K Biswal, Sonalika Mahajan, Jyoti Misri, Bana B Dash and Bramhadev Pattnaik (2015). Capsid coding region diversity of re-emerging lineage C foot-and-mouth disease virus serotype Asia1 from India. **Archives of Virology**. DOI 10.1007/s00705-015-2459-2

12. Saravanan Subramaniam, Jajati K. Mohapatra, Gaurav K. Sharma, Jitendra K. Biswal, Rajeev Ranjan, Manoranjan Rout, Biswajit Das, Bana B. Dash, Aniket Sanyal, Bramhadev Pattnaik (2015). Evolutionary dynamics of foot-and-mouth disease virus O/ME-SA/ Ind2001 lineage. **Veterinary Microbiology**. http://dx.doi.org/10.1016/j.vetmic.2015.05.015

13. Kumar N, Singh R, Kurade NP, Saminathan M, Ranjan R and Kumar Pawan (2015). Immunohistochemical evaluation of chemopreventive effect of hydro-alcoholic extract of garlic (*Alium sativum*) in N-mehtyl-nitrosourea (NMU) induced rat mammary tumours. ***Indian J.Vet. Pathol.***, 39(3): 201- 216, 2015: DOI: 10.5958/0973-970X.2015.00051.6

14. SaravananSubramaniam, PunamBisht, Jajati K Mohapatra, Aniket Sanyal & Bramhadev Pattnaik (2015). A new genetic lineage of foot-and-mouth disease virus serotype O in India. **Veterinary Italiana**. doi: 10.12834/VetIt.106.296.2

15. Behura M, Mohapatra JK, Pandey LK, Das B, Bhatt M, Subramaniam S, Pattnaik B.(2016). The carboxy-terminal half of nonstructural protein 3A is not essential for foot-and-mouth disease virus replication in cultured cell lines. **Arch Virol.** DOI 10.1007/s00705-016-2836-5.

16. Das B, Mohapatra JK, Pande V, Subramaniam S, Sanyal A (2016). Evolution of foot-and-mouth disease virus serotype A capsid coding (P1) region on a timescale of three decades in an endemic context. **Infect Genet Evol**. doi: 10.1016/j.meegid.2016.03.024.

17. Nihar Nalini Mohanty, SaravananSubramaniam, Manoranjan Rout, Laxmi Narayan Sarangi, PunamBist ,Laxmi Kant Pandey , JajatiKeshariMohapatra ,Hemant Kumar Panda (2015). Serosurveillance of foot-and-mouth disease in ruminant population of Coastal Odisha, India. Beni-SuefUniversity **Journal of Basic and Applied Sciences.** doi: 10.1016/j.bjbas.2015.11.002

18. Sarangi LN, Mohapatra JK, Subramaniam S, Pandey LK, DAS B, Sanyal A, Misri J, Pattnaik B.(2015). Spectrum of VP1 region genetic variants in the foot-and-mouth disease virus serotype O populations derived from infected cattle tongue epithelium. **Acta.Virol.** 59(3):305-10.

19. Audarya S. D., Sanyal A., Mohapatra J. K. and Pattnaik B. (2015). Polymerase chain reaction for amplification of IL-1β gene from peripheral blood mononuclear cells of cattle. **Indian Journal of Comparative Microbiology, Immunology and Infectious Diseases**. 14 (4), 65

Publications with inter-institutional collaborations

1. Govindaraj G, Ganeshkumar B, Nethrayini KR, Shalini R, Balamurugan V, Pattnaik B, Rahman H (2015). Farm Community Impacts of Foot-and-Mouth Disease Outbreaks in Cattle and Buffaloes in Karnataka State, India. **Transbound Emerg Dis**. doi: 10.1111/tbed.12450.

2. Jai Sunder, Satya K Balasundaram, Gaurav Sharma, Brahmadev Pattnaik (2015). Serological Status of Foot and Mouth Disease in Cattle and Buffalo of Andaman and Nicobar Islands of India. **Advances in Animal and Veterinary Sciences.** http://dx.doi.org/10.14737/journal.aavs/2015/3.8.461.465

3. R K Vandre, A K Sharma, G R Gowane, M Sankar, A Sanyal, B Pattnaik (2016). Sequence based typing for BoLA-DQA1 alleles in Indian

zebu and its crossbred populations. The Indian **Journal of Animal Sciences** 86 (3)

Review/Popular articles/Folder/ Leaflets

1. Gaurav Kumar Sharma, SonalikaMahajan, Rakesh Matura, SaravananSubramaniam, Rajeev Ranjan, Jitendra Biswal, Manoranjan Rout, JajatiKeshariMohapatra, BanaBihari Dash, Aniket Sanyal, Bramhadev Pattnaik (2015). Diagnostic assays developed for the control of foot-and-mouth disease in India. **World Journal of Virology**.4(3): 295–302.
2. Rajeev Ranjan, Jitendra K Biswal and B. Pattnaik (2015). Khurpaka - muhpaka rog: prabandhan evam niyantran. **Kheti,** September, 38- 40.
3. Manoranjan Rout (2015). Small Ruminants: The Silent Players of Foot and Mouth Disease. **Indian Farming**. 65-2.
4. Rajeev Ranjan (2015). Folder in hindi- on Khurpaka muhpaka rog mein pashupalak ki mahatavpurn bhumika.
5. Rajeev Ranjan (2015). Folder in english- Farmers plays an important role in control of FMD.
6. Rajeev Ranjan (2015). Leaflet in english- Farmers play an important role in control of FMD.

Abstract published/presented in conferences

1. Ranjan R, Biswal JK, Mohapatra JK, Sharma GK, Rout M, Subramaniam S, Dash BB, Sharma AK, Rodriguez L, Artz, J and Pattnaik B (2015). Understanding FMD Viral Ecology and Landscape epidemiology towards control and eradication of FMD in India. GFRA-2015, 20-22 October 2015, Hanoi, Vietnam.
2. Rajeev Ranjan, Jitendra Kumar Biswal, Gaurav Kumar Sharma, Bana Bihar Dash and Brahmadev Pattnaik. 2015. Foot-and-mouth disease in captive elephant in India. International Symposium on "Ecology and Health Management of Asiatic Elephant (Elephas maximus)", 19-20 November 2015, New Delhi, India.
3. Biswal JK, Ranjan R, Subramaniam S, Sharma GK, Misri J and Pattnaik B (2015). Determining the epitope dominance of FMDV serotype O circulating in India by site directed mutagenesis. GFRA-2015, 20-22 October 2015, Hanoi, Vietnam.
4. Biswal Jitendra Kumar, Rajeev Ranjan, Mahajan Sonalika, Misri Jyoti & Pattnaik, Bramhadev.2015. Construction of custom-engineered chimeric foot-and-mouth disease virus through mega-primer mediated capsid swapping. GFRA 2015 scientific meeting. Book of abstracts. 20- 22, October, 2015, Hanoi, Vietnam. Pp- 102.
5. Ranjan Rajeev, Biswal J K, Singh K P, Arzt J and Pattnaik B. Naturally occurring, subclinical Foot-and-mouth Disease virus infection in young calves. Veterinary Pathology Congress-2015. National symposium on "Challenges and Advances in Disease diagnosis of Livestock, Poultry and Fish: Redefining the role of Veterinary Pathologist" at Department of Veterinary Pathology, NTR College of Veterinary Science, Gannavaram- 521 102, Andhra Pradesh, India, 03- 05 December 2015, pp 48.
6. Ranjan Rajeev, Biswal J K, Singh K P, Arzt J and Pattnaik B. Evidence of vertical transmission of foot-and-mouth disease virus from cow to the foetus. Veterinary Pathology Congress-2015. National symposium on "Challenges and Advances in Disease diagnosis of Livestock, Poultry and Fish: Redefining the role of Veterinary Pathologist" at Department of Veterinary Pathology, NTR College of Veterinary Science, Gannavaram- 521 102, Andhra Pradesh, India, 03- 05 December 2015, pp 325- 326.
7. Sankar M, Sharma AK, Bhatt M, Kumar, R, Dash BB, Saravanan, S and Pattnaik B (2016) Expression kinetics of Interferon gamma and Interleukine-21 during foot and mouth disease infection in cattle. Global symposium on

Animal Health; Newer technologies and their Applications. IAVMI-2015, 12-14 February, 2016, Guwahati, Asom.

8. L. Dash, S. Subramaniam, GK. Sharma, S. Khulape, SD, Narnaware, NV. Patil and B. Pattnaik (2015). Characterization of single domain heavy chain libraries against foot and mouth disease virus structural proteins from camelusdromederius. Transboundary viral diseases under one health: Perspectives and challenges. VIROCON-2014, 8-10 October, 2015. Meghalaya.

Award in conferences

1. "Savithree Jibachch Sinha" awarded to Ranjan Rajeev, Biswal J K, Singh K P, Arzt J and Pattnaik B for the Best Poster Presentation Award -2015 on the topic entitled "Evidence of vertical transmission of foot-and-mouth disease virus from cow to the foetus" during Veterinary Pathology Congress- 2015 at Department of Veterinary Pathology, NTR College of Veterinary Science, Gannavaram- 521 102, Andhra Pradesh, India, 03- 05 December 2015.

15 Training and Capacity building

Participation in Training/workshop

1. Dr. Rajeev Ranjan, Scientist, attended training entitled "Foreign Animal Disease Diagnostician Course and immunomicroscopy" at Foreign Animal Disease Research Unit, USDA/ARS Plum Island Animal Disease Center, P.O. Box 848, Greenport New York, ZIP: 11944, USA under the ICAR- USDA-ARS collaborative research programme on "understanding Foot and Mouth Disease Viral Ecology in India and Landscape Epidemiology toward Control and Eradication" from 1st June to 19th June, 2015.
2. Dr. Rajeev Ranjan, Scientist attended ILRI-ICAR workshop on communication and knowledge management in animal science research and development at NASC Lecture Hall (Ground Floor), New Delhi, on 4th March 2016.
3. Dr. Sagar A Khulape, Scientist undergone Orientation training (one month) and professional attachment training (three months) as FOCARS-101 module, organized at ICAR-DFMD, Mukteshwar.
4. Mr. Ravi Chaudhary, Stenographer underwent MIS-FMS training for seven days organized at ICAR-IASRI, New Delhi

Trainings organized for various categories of employees

Three training Programmes on DIVA-ELISA and FMD-DSS were organized, in which scientists from regional and collaborative centres of AICRP on FMD and FMD vaccine manufacturing companies.

S.No	Name of Training	Duration	No. of Person
1	Training on FMD diagnosis (DIVA ELISA)	9-13 March 2015	2
2	Training on FMD diagnosis (DIVA ELISA)	16-24 March 2015	1
3	Training on FMD diagnosis (DIVA ELISA)	1-3 June 2015	2
4	Training on FMD Decision Support System	15-16 June 2015	8

16 Acknowledgements

We express our deep sense of gratitude to Deputy Director General (Animal Science), ICAR, and ADG (Animal Health), ICAR for providing all the necessary financial and infra-structural facilities and providing the guidance. We are thankful for untiring help and support of Dr. Jyoti Misri, Principal Scientist (AH) on various matters. We are also thankful to Director, IVRI for necessary support provided at Mukteswar. Untiring effort of a small group of young scientists in achieving new milestones at the institute is praise worthy. We also wish to express our appreciation to the administration, audit, account and technical supporting staffs of the Directorate for their excellent assistance in achieving targets.

Secretary, ICAR, Mr. Chhabilendra Roul (IAS) visited ICAR-Directorate of FMD, Mukteshwar, May 2016








Secretary (DARE) and DG (ICAR), Dr. Trilochan Mohapatra; DDG (AS), Dr. H. Rahman; ADG (AH), Dr. Ashok Kumar Tyagi visited International Centre for FMD, Aragul, Bhubaneswar, May 2016



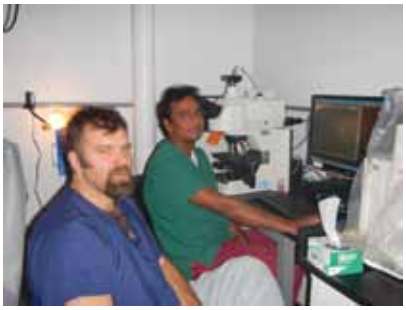
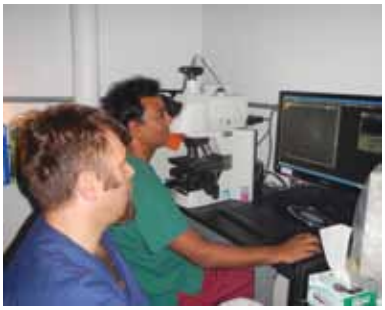
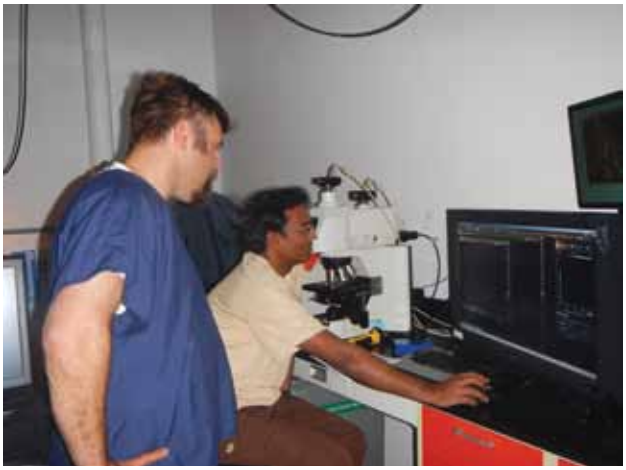



Project Management & Monitoring and Project Technical Committee visited
International Centre for FMD, Aragul, Bhubaneswar, May 2016



Dr. Rajeev Ranjan and Dr Jitendra K Biswal, Scientist attended
Annual Scientific Meeting of Global Foot-and-Mouth Disease Research Alliance (GFRA) 2015 held at the Pullman Hanoi, Vietnam, October 2015


Dr. Rajeev Ranjan and Dr Jitendra K Biswal, Scientist attended
ILRI-ICAR workshop on communication and knowledge management in animal science research and development at, New Delhi, March 2016.


Dr. Rajeev Ranjan, Scientist, attended
Foreign Animal Disease Diagnostician Course and immunomicroascopy training
at Foreign Animal Disease Research Unit, USDA/ARS Plum Island Animal Disease Center, USA June, 2015.





Hindi Saptah-2015 organized at DFMD, Mukteshwar

Chinese Delegation visited DFMD, October 2015

FMD-DSS training at DFMD, Mukteswar, June 2015

Unity Day & Vigilance Oath taking Ceremony, October 2015

Swachh Bharat Mission celebrated at in and around DFMD, Mukteshwar, June 2015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