PDFMD

ANNUAL REPORT

2014–15

ICAR-Project Directorate on Foot and Mouth Disease
Mukteswar 263 138 (India)

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

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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, 2007). The economic losses to the livestock industry attributed to this dreaded disease are large. There are direct and indirect losses due to this menace. 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 and due to trade barrier imposed by the countries free from FMD, and massive expenditure by Government on FMD control and cost of treatment lead to further economic loss. 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 subtypes/genotypes 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 2014-15, almost 6-fold reduction in the disease occurrence was observed in the country. There has been reduction in the incidence of FMD in all the regions of the country, lowest in last 9 years (Table 1) possibly due to increased vaccination coverage and infection immunity in other places. A total of 76 outbreaks were recorded during the period, of which more than 60% of the outbreaks were reported from Eastern and North Eastern regions that are not covered under FMD control program (FMD-CP). Outbreaks were not recorded in three of the four southern states. Only in the state of Karnataka a few sporadic incidences were observed. The Southern region had experienced severe outbreaks during 2013-14. There was no incidence of the disease in the states of Punjab, Himachal Pradesh, Maharashtra and Delhi during 2014-15, and a few sporadic cases were recorded in the states of Haryana, Jammu & Kashmir, Gujarat and Rajasthan.

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

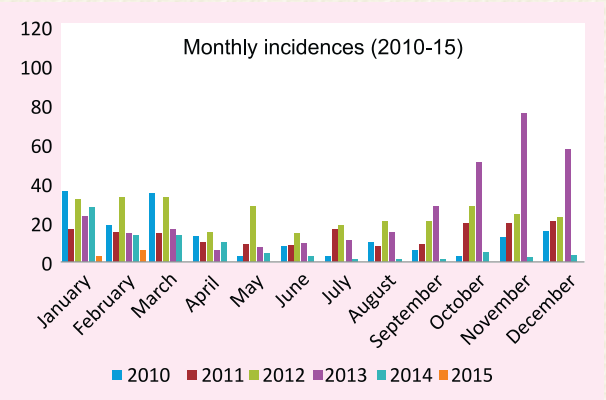
Year	South	North	Central	West	East	North East	Total
2006-07	224	7	23	32	431	64	781
2007-08	445	20	35	33	258	85	876
2008-09	64	18	33	21	66	43	245
2009-10	59	55	20	24	367	74	599
2010-11	51	9	29	17	30	40	176
2011-12	97	20	34	60	71	65	347
2012-13	68	16	21	14	104	108	331
2013-14	228	32	35	27	103	40	472
2014-15	10	4	10	3	25	24	76

Serotype O caused maximum numbers of outbreaks (98.7%) and serotype Asia1 was isolated from a single incidence in the state of West Bengal. This year serotype A has not been recorded in the country (Table 2).

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

Year	Total	O	A	Asia1
2006-07	781	491	84	206
2007-08	879	753	67	56
2008-09	245	200	21	24
2009-10	600	560	24	15
2010-11	176	150	10	16
2011-12	347	246	16	85
2012-13	331	265	16	52
2013-14	472	454	08	10
2014-15	76	75	-	1

Four seasons viz, winter (December to early April), summer (April to June), monsoon (June to September) and post monsoon (October to December) prevail in the country. It is believed that high relative humidity (RH) and heavy rain during monsoon inhibit aerosol transmission of virus. Usually incidences of FMD start occurring from August and peak 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 were less possible due to very high ambient temperature. In contrast to this regular pattern, this year, maximum numbers of outbreaks/incidences were recorded in the months of March, April and January, a few incidences were recorded in the post monsoon season (Fig. 1).



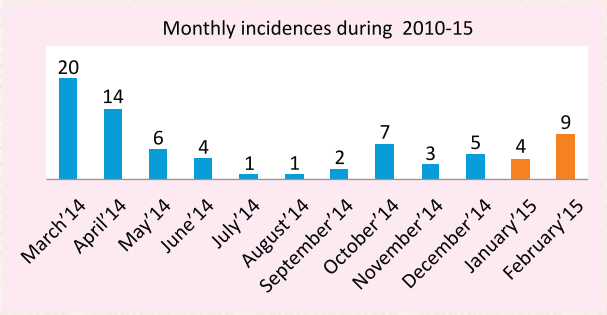


Fig. 1. Month wise occurrence of FMD recorded in the contry.

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 dominance of Ind2001 strains. This lineage was recorded in Assam in the month of May 2014. Two isolates collected from Karnataka in the month of July 2014 grouped within the lineage PanAsia. Previously, the PanAsia lineage did cause many outbreaks in 2007 in the southern peninsular region of India. Re-emergence of this lineage in southern region is an epidemiologically significant event recorded during 2014. In case of serotype Asia1, the isolates from West Bengal clustered within the lineage C indicating its exclusive prevalence since 2005.

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 81% of the field isolates. This vaccine strain is able to provide optimal antigenic coverage over the field isolates. Some isolates were found divergent from the vaccine strain and emergence of such antigenic variants in the field is a regular phenomenon and is not alarming at present. In serotype Asia1, the field isolates analyzed had perfect match with the currently used vaccine strain, IND63/1972.

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 16 virus isolates (12 serotype O and 4 serotype Asia1) were added to the repository during the reported period. At present the National FMD virus Repository holds a total of 1940 isolates (O-1253, A-308, C-15 and Asia 1-364).

Under National FMD Serosurveillance, 68,948 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 ~ 23.41% samples/animals, which is comparatively lesser than the previous year's average (29.2%). 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 2014-15, a total of 1,91,402 pre and post vaccinated serum samples were tested under FMD Control Programme (FMDCP) and of which, 90,244 serum samples were from first phase (2003-04) FMDCP districts representing XVI, XVII and XVIII phases of vaccinations, and remaining 1,01,158 serum samples were from expanded FMDCP districts of 2010 representing Phases VI and VII. Currently, 89, 78.6 and 87.1 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), 93.2, 89.5 and 89.7 percent of animals tested had protective antibody level against serotypes O, A and Asia1, respectively in post-vaccination serum samples.

During the year 2014-15, several new research projects for development were undertaken in the cutting-edge areas of FMDV research by the scientists of the institute. An yeast two-hybrid cDNA library from LFBK cell line was constructed and characterized. The cDNA library was mated with 2C non-structural protein of FMDV in yeast two-hybrid system and several putative interaction partners were identified in the preliminary screening. Through reverse genetics approach, a potential thermo-stable vaccine candidate for FMDV serotype O IND R2/1975 was developed. Furthermore, the reverse genetics approach was also used for mapping of the single amino acid residue responsible for enhanced adaptability of FMDV in BHK-21 cells. In addition, a DIVA compatible negative marker FMDV serotype O virus, containing dual deletions of amino acid residues 93-143 and 10-37 in the non-structural proteins 3A and 3B was also generated from infectious full-length cDNA clone. The negative marker virus and companion diagnostic assay open a promising new avenue for the application of DIVA compatible marker vaccine for the control of FMD in India in coming years; certainly after DFZ are established. An extensive longitudinal study was conducted in India by analyzing the sero-monitoring data. For the purpose of the study, districts of the country were divided into the three groups. The results concluded higher herd immunity in the districts covered under the FMD control program over the other districts. Analysis of the antibody kinetics revealed tentative duration of the protective herd immunity (median antibody titer > log10 1.8) against the three serotypes of 160-180 days post vaccination, leaving an infection window of about 20 days in some population that pose risk of appearance of sporadic incidences/case. Therefore it is essentially required that bi-annual vaccination continues till and after last case of FMD. Through the analysis of bovine Toll-like Receptors (TLR) expression profile in response to FMD vaccine, it has been found that the inclusion of TLR2 and TLR3 agonist in FMD vaccine may enhance the innate immunity and help in clearing of virus and virus persistence after clinical infection. During the year, a collaborative (between ICAR-PDFMD, India and ARS-PIADC, USA) international research project was under taken to understand FMD viral ecology and landscape epidemiology for the control and subsequent eradication of FMD in India. The salient observations are mentioned subsequently in the report.

Twelve training programmes for the scientific

staff of Regional Centers and Collaborating/ network units 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 79,800 samples was produced and supplied to the AICRP units. Similarly, virus serotyping Kits for 3000 tests and LPB-ELISA Kits for 2, 71,960 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-PDFMD 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 now 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

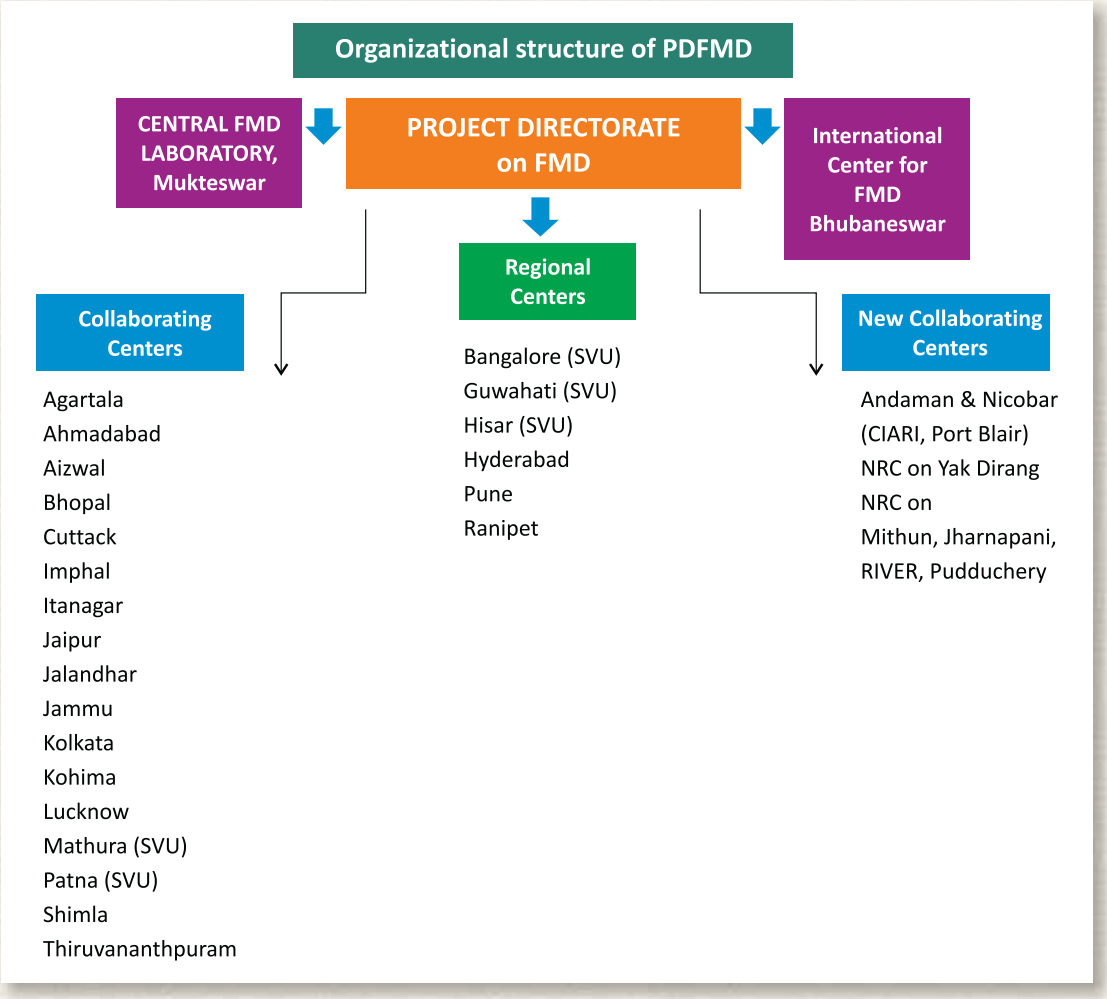
Centres/Users/Stakeholders with proforma details to facilitate and ensure their uniform application.

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 Project Directorate on 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 2001 with 23 Regional Centers and Network Units covering all the major regions of the country. The Project 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	Project 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	Veterinary Pathology	November 2009
6	Dr. Gaurav K Sharma	Scientist	Veterinary Microbiology	December 2009
7	Dr. Rajeev Ranjan	Scientist	Veterinary Pathology	May 2010
8	Dr. Jitendra K Biswal	Scientist	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 P.C.Bhatt	AAO	March, 2013
3	Shri Tara Kumar	Assistant	April, 2013
4	Shri Nayan Sanjeev	T-3 (Lab)	October, 2010
5	Shri D.S.Deolia	T-1 (Lab)	January, 2012
6	Shri S.L.Tamta	T-1 (Lab)	April, 2014
7	Shri J.P.Bhan	S. S. Gr. IV	February, 2008
8	Shri R.N.Sahoo	UDC	May, 2012
9	Mr Ravi Chaudhary	Stenographer	05/09/2014

5

Epidemiology Report

To assess the regional prevalence of FMDV serotypes, country is divided in to five geographical regions namely; Eastern (States of Bihar, Orissa, West Bengal and Jharkhand), Southern (States of Tamilnadu, Kerala, Karnataka, Andhra Pradesh, Telangana and UT of Pudduchery), North Eastern (States of Assam, Manipur, Meghalaya, Mizoram, Arunachal Pradesh, Sikkim and Tripura), Northern (States of Uttar Pradesh, Punjab, Haryana, UT of Delhi, Himachal Pradesh, Jammu & Kashmir and Uttarakhand), Western (States of Rajasthan, Gujarat and Maharashtra) and Central (Madhya Pradesh and Chhattisgarh).

5.1 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 ICAR-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

States	Reporting AICRP Centre/Unit	No. of. FMD cases/ outbreaks	No. of. Samples tested	Virus Serotypes		
				O	A	Asia1
Southern Region						
Tamil Nadu	Ranipet	No disease				
Andhra Pradesh	Hyderabad	No disease				
Karnataka	Bangalore	10	20	10(10)		
Kerala	Thiruvanthapuram	No disease				
Total		**10**	**20**	**10(10)**		
Northern Region						
Jammu & Kashmir	Jammu	01	03	01(02)		
Haryana	Hisar	02	05	02(05)		
Himachal Pradesh	Shimla	No disease				
Punjab	Jalandhar	No disease				
Uttar Pradesh	Mathura	01	02	01(02)		
Total		**04**	**10**	**04(09)**		
Central Region						
Madhya Pradesh	Bhopal	10	28	10(18)		
Total		**10**	**28**	**10(18)**		

States	Reporting AICRP Centre/Unit	No. of. FMD cases/ outbreaks	No. of. Samples tested	Virus Serotypes		
				O	A	Asia1
Western Region						
Gujarat	Ahmadabad	01	08	01(02)		
Maharashtra	Pune	No disease				
Rajasthan	Jaipur	02	08	02(06)		
Total		**03**	**16**	**03(08)**		
Eastern Region						
Odisha	Cuttack	05	05	05(05)*		
Bihar	Patna	09	31	09(20)		
West Bengal	Kolkata	11	27	10(21)		01(01)
Total		**25**	**63**	**24(46)**		**01(01)**
North Eastern Region						
Assam	Guwahati	17	14	17(14)*		
Nagaland	Kohima	02	-	02*		
Mizoram	Aizwal	No disease				
Manipur	Imphal	03	27	03(05)		
Tripura	Agartala	02	04	04(02)		
Total		**24**	**45**	**24(23)**		
Grand Total		**76**	**182**	**75 (114)**	-	**01(01)**

*Outbreaks diagnosed retrospect

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

5.2 Regional Scenario

Southern Region

The states of **Tamilnadu, Andhra Pradesh, Telangana and Kerala** did not record FMD during the period.

Karnataka: During the year, 10 outbreaks/ incidences were reported in the state. The outbreaks were caused by serotype O and were recorded in the districts of Bengaluru Urban (3), Kolar (2) and one each in Shimoga, Mysore, Bengaluru Rural, Hassan and Tumkur. Maximum incidences were recorded in the month of December (4) followed by February (3), January (2) and March (1).

5.3 Central Region

Madhya Pradesh: During this period, ten FMD outbreaks/cases were recorded in the state. Disease was recorded in the districts of Mandsour (01), Balaghat (02), Chhindwara (01), Ujjain (02), Umariya (02), Sidhi (01) and Betul (01). The outbreaks were recorded in the months of March (04), June (02), November (03), and January (01). Serotype O was responsible for all the outbreaks.

5.4 Western Region

Maharashtra: No FMD was reported during the period.

Gujarat: During the year, a single incidence of FMD was recorded in the state in the month of February. The outbreak was caused by serotype O and recorded in Kheda district.

Rajasthan: During the year, two incidences of FMD were recorded in the state in the months of February and April. Both the outbreaks were caused by serotype O and recorded in the districts of Jalore and Udaipur.

5.5 Eastern Region

Odisha: Five outbreaks/cases were recorded in the state. One outbreak was diagnosed in retrospect. All the outbreaks were caused by Serotype O. Maximum outbreaks were recorded in the district Khurda (02) followed by one each in Cuttack,

Jagatsinghpur and Keonjhar. Outbreaks were recorded in the months of March (03) and May (02).

Bihar: During the period under report, 9 outbreaks/cases of FMD due to serotype O were recorded in the state. Outbreaks were observed in the months of April (01), September (02), December (01), February (03) and March (02). The disease was recorded in the districts of Banka (03), Patna (02), Nalanda (01), Aurangabad (01), Sheikhpura (01) and Bhagalput (01).

West Bengal: Eleven FMD outbreaks/cases were recorded during the period in the state. Highest number of FMD outbreaks were in Bankura (03) and Jalpaiguri (03) followed by two outbreaks in Dakshin Dinajpur and one each in Howrah, Darjeeling and South 24 Parganas. Serotypes O caused ten outbreaks and Asia1 was responsible for one incidence. The incidence due to serotype Asia1 was recorded in Bankur in the month of April. Outbreaks occurred in the months of April (07), March (02), October (01) and February (01).

5.6 Northern Region

Haryana: Two sporadic incidences were recorded in the district Hisar in the months of March and April 2014. Both the incidences were caused by serotype O. The virus could not spread further owing to high level of surrounding herd immunity and application of effective biosecurity measures.

Uttar Pradesh: A single outbreak was confirmed in the state. The incidence was recorded in Aligarh in the month of February 2015. Serotype O was responsible for the disease.

Jammu and Kashmir: One FMD incidence owing to serotype O was recorded in the state. The incidence occurred in the district of Jammu in the month of April.

The states of Punjab and Himachal Pradesh remained free of FMD during the period.

5.7 North Eastern Region

Assam: Seventeen outbreaks of FMD were recorded in the state. The disease was widespread and occurred in the districts of Kamrup (03), Karbi Anglong (01), Nalbari (02), Darrang (01), Barpeta (04), Goalpara (01), Jorhat (01), Dhemaji (02), Dhurbi (01) and Lakhimpur (01). Seven outbreaks were diagnosed in retrospect. Serotype O accounted for all the outbreaks. Outbreaks were recorded during the months of March (05), April (03), May (03), June (01), July (01), October (03) and January (01).

Manipur: During the year, 4 outbreaks/ cases of FMD due to serotype O were recorded. The outbreaks were recorded in Imphal-East (01), Thoubal (01) and Churachandrapur (02) in the months of May, June, August and October 2014.

The state of Mizoram remained free of FMD during the period

Nagaland: During the year, 2 outbreaks of FMD due to serotype O were recorded. The disease occurred in the district of Kohima in October. Both the outbreaks were diagnosed in retrospect.

6

Molecular typing of foot-and-mouth disease virus during 2014-15

6.1 Serotype O FMD Virus

FMDV serotype O is the predominant serotype in India and cause around 80% of the outbreaks in the country. Globally eleven topotypes namely, Cathay, Middle East-South Asia (ME-SA), South-East Asia (SEA), Europe-South America (Euro-SA), Indonesia-1 (ISA-1), Indonesia-2 (ISA-2), East Africa (EA) 1-4 and West Africa have been described. Serotype O isolates from India belong to the Middle East-South Asia (ME-SA) topotype with less than 15% nucleotide divergence among them. Six genetic groups of the virus with more than 5% nucleotide divergence at 1D region designated as Branch A, B, C-I, C-II, C-III (Ind2001), C-IV(PanAsia) have been identified in the country. Last outbreaks due to Branch A and B were recorded during 1994 and 2003, respectively. The Indian vaccine strain (IND R2/1975) belongs to the lineage Branch B. Pan Asia virus which caused worldwide pandemic in the year 2001 has been in circulation in the country since 1982. The 'Ind2001' lineage was first identified in 2001 as the major cause of serotype O outbreaks and since then this lineage has been causing sporadic cases in the country. This lineage has 5-11% nucleotide difference from PanAsia viruses. Later, with in PanAsia, a divergent strain (Pan Asia-2) emerged in the year 2002. During 2006-07 to 2013-14, epidemiological scenario in serotype O has been largely influenced by the PanAsia and Ind2001 strains. A new genetic group in serotype O was identified in the year 2011 with 9.8 to 14.8% and 9.7 to 12.8% nucleotide divergence from contemporary viruses of Ind2001 and PanAsia lineages circulating in India, respectively. This new genetic cluster was named as Ind2011 lineage.

During 2014-15, a total of 25 serotype O field isolates were subjected to complete 1D/VP1 region sequence analysis. Neighbor-joining (NJ) tree was reconstructed using MEGA 6.06 software package. In the NJ tree 23 of 25 isolates grouped within O/ME-SA/Ind2001 lineage indicating its extended dominance in the field. 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) (Fig.1). The isolates of O/ME-SA/Ind2001 lineage currently circulating in the country grouped precisely in sub-lineage Ind2001d. The sub-lineage Ind2001d also prevails in the neighboring countries of Bangladesh, Bhutan and Nepal.

The O/ME-SA/Ind2001d sub-lineage caused several outbreaks during 2013. The lineage was identified widely covering many states including Karnataka, Kerala, Andhra Pradesh and Tamilnadu (Southern region); Uttar Pradesh, Uttarakhand and Jammu & Kashmir (Northern region); Gujarat and Maharashtra (Western region); Odisha, West Bengal and Bihar (Eastern region); Madhya Pradesh (Central region), and Assam and Manipur (North Eastern region). The isolates of the lineage Ind2001 collected during 2014 differed from currently used vaccine strain INDR2/1975 by 14.4 to 15.7% at nucleotide level at 1D genomic region and 6.1 to 8.3% from prototypic Ind2001 lineage isolate collected during 2001. At amino acid level, the cluster showed 4.8 to 9% divergence. The genetic diversity within the Ind2001 isolates collected during 2014 varied from 0.00 to 8.7% at VP1 region and mean genetic diversity was estimated at 3%, which indicate high genetic homology of virus isolate.

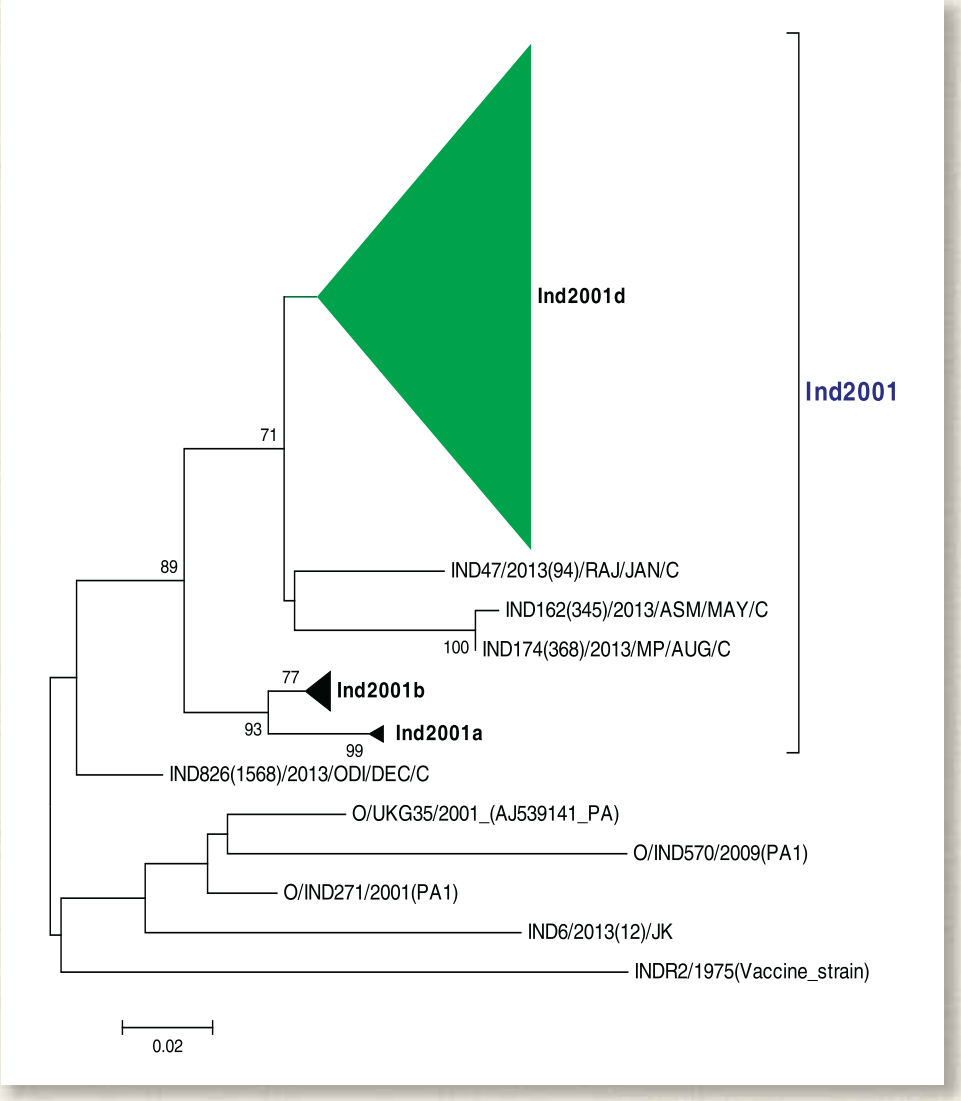


Fig. 1. Neighbor-Joining phylogenetic tree at VP1 coding region of Indian serotype O FMD virus isolates during 2014-15. The tree shows complete dominance O/ME-SA/Ind2001d sub-lineage in India during 2014-15.

The sub-lineage Ind2001d, was responsible for extensive outbreaks in the southern region during 2013, and was detected as early as in December 2012 from the state of Gujarat. This sub-cluster, which caused some sporadic incidence in the first half of 2013, took upper hand since June 2013 to coincide with monsoon and caused many outbreaks. Besides southern peninsula, the lineage was also detected in the states of Uttar Pradesh, Uttarakhand, Maharashtra, Odisha, Madhya Pradesh, Haryana, and Bihar, Assam and Manipur. This cluster was the major cause of serotype O outbreaks during 2013 and is genetically highly homogenous. During 2014, this sub-lineage continued to cause sporadic incidences in the states of Assam, UP, MP, HP, Karnataka, Kerala, Nagaland and Haryana. Of late, this lineage was recorded in Assam in the month of May 2014 (Fig.2).

Two isolates collected from Karnataka in the month of July 2014 grouped within the lineage PanAsia along with another isolate from Jammu during 2013 (Fig.3). These isolates clustered distantly from other PanAsian isolates circulating in the neighboring countries. The PanAsia lineage caused many outbreaks in 2007 in the southern peninsular region of India. Arrival of this lineage in the southern region is an epidemiologically highly significant event recorded during 2014. The emerging Ind2011 lineage could not be detected during the year 2014-15, probably due to infection immunity or natural extinction. However, this remains to be elucidated in coming years.

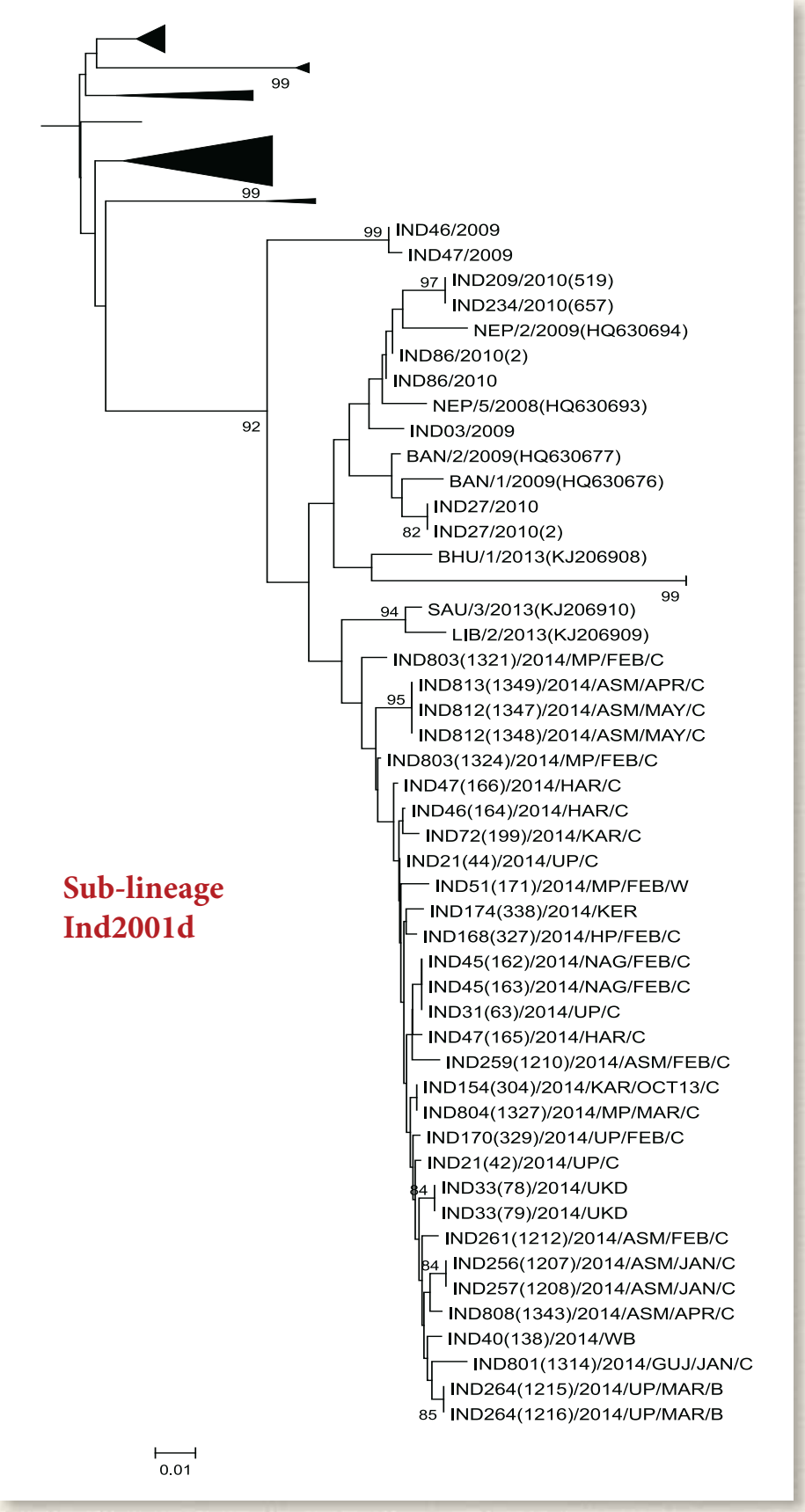


Fig. 2. Neighbor-Joining phylogenetic tree at VP1 coding region of Indian serotype O FMD virus isolates during 2014. The genetic data indicate dominance of Ind2001d lineage in major parts of the country. The lineage first emerged in the year 2001 and dominating serotype O outbreaks since 2009.

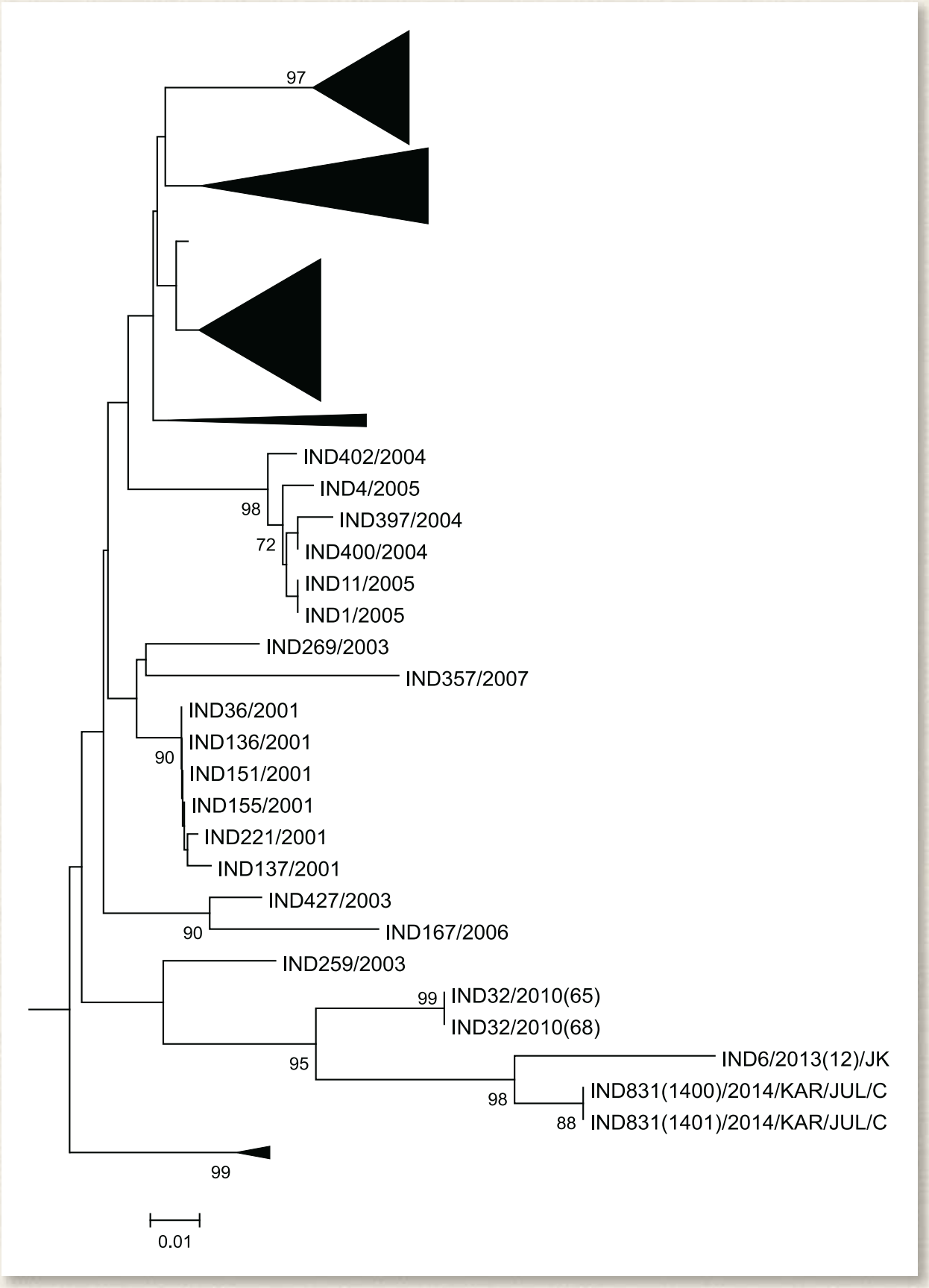


Fig. 3. Neighbor-Joining phylogenetic tree at VP1 coding region of Indian serotype O FMD virus isolates during 2014. The genetic data indicate re-appearance of PanAsia lineage in the state of Karnataka after long time.

6.2 Serotype A FMD Virus

During 2014-15, the serotype A FMDV was not detected in the country

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.

Outbreaks owing to serotype Asia1 were much less during 2014-15. During the period, 4 serotype Asia 1 field isolates collected from the state of Assam were 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).

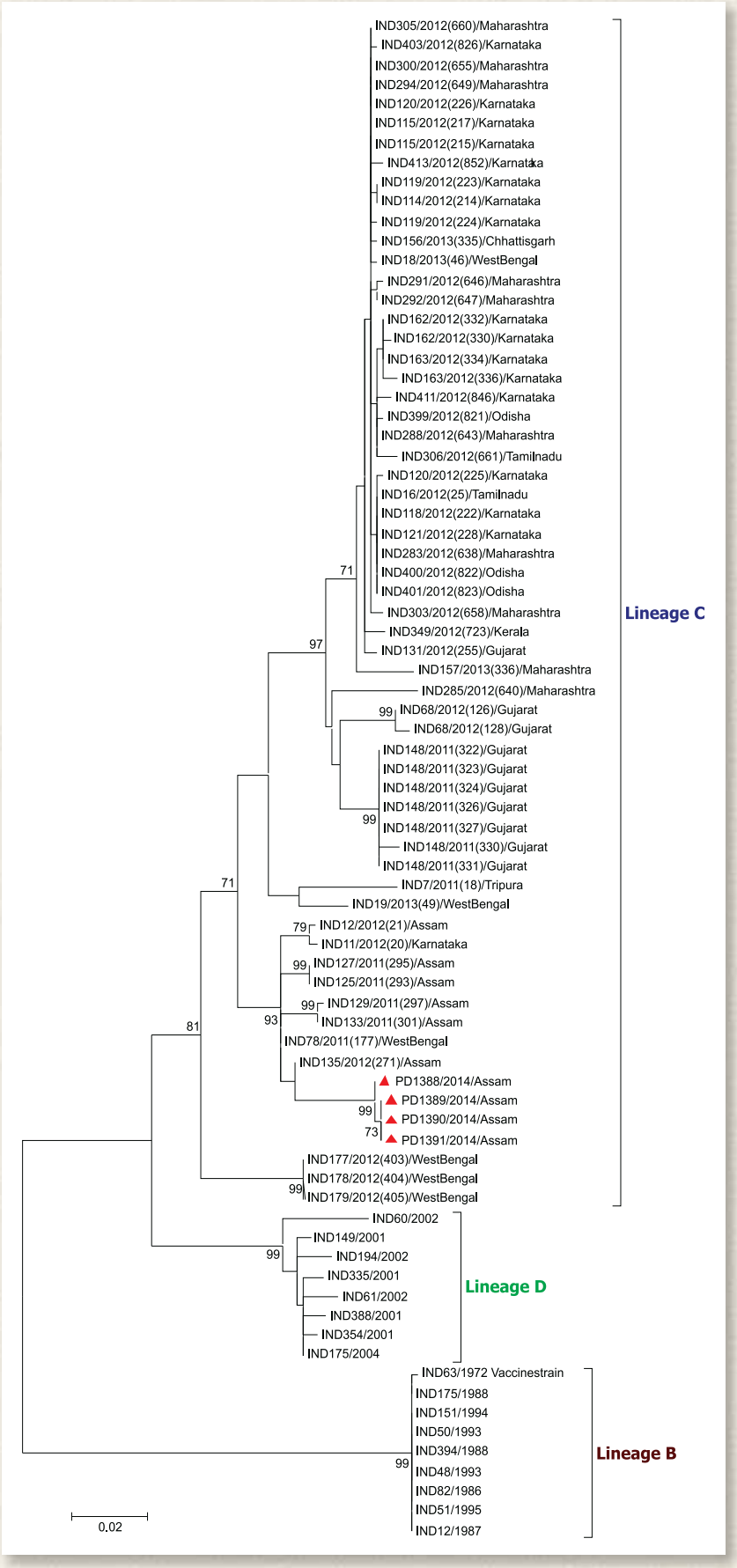


Fig. 4. Maximum likelihood phylogenetic tree at VP1 coding region of FMD virus isolates of serotype Asia1 during 2014-2015. Lineage C is in circulation in the country since 2005.

7

Vaccine matching of FMD virus field isolates

7.1 FMDV Serotype O

Antigenic characterization of FMD virus serotype O field isolates

The antigenic relationships of serotype O field isolates to the currently used vaccine strain INDR2/1975 is shown in Fig.4. The test results were interpreted as per criteria set by Rweyemamu, (1984). A total of 31 isolates were subjected to vaccine matching exercise using bovine vaccinate serum during 2014. From the result, it can be seen that 81% of the isolates showed an r1 value of >0.3 with currently used vaccine strain INDR2/1975 and 19% had an r1 value of <0.3. Emergence of antigenic variant in an endemic country is a normal phenomenon and the currently used vaccine strain INDR2/197 still is able to provide near optimal antigenic coverage to the field isolates. The situation is being monitored carefully to see whether the few variants emerged during 2013-14 epidemic will be able to persist in the future. Further three candidate vaccine strains [(IND408/2007, PanAsia-2), (IND271/2001, PanAsia) and (IND120/2002, Ind2001)] are being evaluated against field isolates to identify an alternate appropriate candidate strain for use in case any emergency.

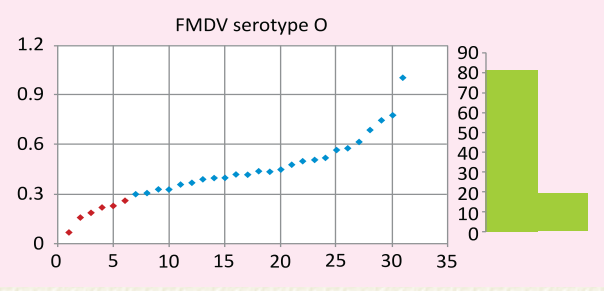


Fig. 1. Relationship values FMD virus serotype O field isolate collected during 2014 in relation to currently used vaccine strain INDR2/1975

7.2 FMDV Serotype A

Considering the emerging antigenic diversity within serotype A virus strains, a panel of 8 candidate vaccine strains representing various lineages that have circulated in India were selected. Anti-146S hyperimmune serum was raised against those strains in rabbits and antigenic matching was conducted against 84 field isolates recovered since 2000 in 2D-VNT. Based on the proportion of isolates showing r1 values > 0.3 and giving emphasis to their antigenic relatedness with the currently existing lineages, three candidate strains were shortlisted viz., A IND 1/2010_Uttarakhand (PD 3/2010) from clade 18b of deletion group, A IND 404/2012_ Karnataka (PD 828/2012) from clade 18c of deletion group and A IND 27/2011_Karnataka (PD 68/2011) from nondeletion group of genotype 18 for raising bovine vaccinal serum (Fig. 8). The post-booster sera collected from both calves for each strain were pooled separately and used for 2D-VNT. For vaccine matching, 84 virus isolates recovered during 2000-2013 were used in VNT. Data raised with rabbit and calf has showed significant differences

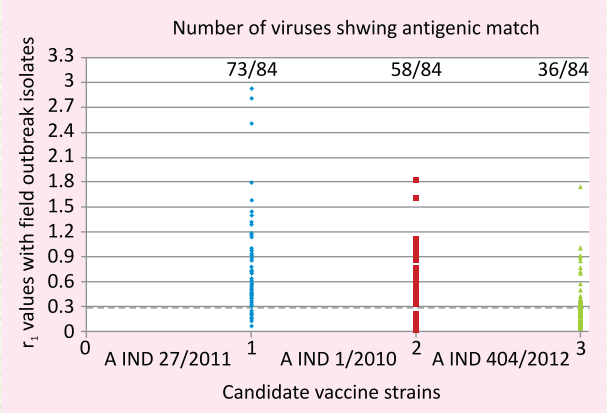


Fig. 2. r1-values of field isolates with the candidate vaccine strains estimated using anti-146S sera raised in calves

in the r1-values suggesting the probable influence of interspecies difference in MHC restriction and recognition of neutralization relevant crucial epitopes on the antibody composition of the vaccinal sera. Although both IND 1/2010 and IND 27/2011 displayed similar extent of antigenic coverage (79 out of 84 isolates covered by each of the strains) when rabbit HIS was used in VNT, A IND 27/2011 (73 matched) behaved in a much superior manner to A IND 1/2010 (58 matched) when calf serum was employed for VNT. With A IND 404/2012, only 36 isolates were antigenically matched. Although IND 27/2011 performed better than the other two strains with respect to their antigenic relationship with the circulating field strains, before finalizing one of the vaccine strains, one more round of VNT need to be run using BVS raised in a pilot experiment following the standard procedure. For this, IVRI, Bangalore has already produced BVS for the 3 strains and the isolates will be retested using those BVS to crossverify the generated data. Furthermore, rest of the vaccine manufacturing parameters such as antigen stability, fermentor growth adaptability, inactivation kinetics and associated loss, growth titers etc. are being tested at IVRI, Bangalore.

7.3 FMDV Serotype Asia1

The antigenic relationship of four serotype Asia1 field isolates (PD1388/2014, PD1389/2014, PD1390/2014 and PD1391/2014) with the currently used vaccine strain IND63/1972 was determined. All the isolates had an antigenic relationships of >0.3 with the vaccine strain. The serotype Asia1 vaccine strain, IND63/1972, has been in use for decades in the country and is still able to provide optimal antigenic coverage to the circulating field isolates.

8

Research for development programs

8.1 Construction and characterization of yeast two-hybrid cDNA library derived from LFBK cell line.

The cDNA libraries are indispensable and critical tools for performing protein-protein interaction studies in virus-host cell interactions. A high quality yeast two-hybrid cDNA library from the LFBK cell line was constructed and characterized. LFBK cell line was originally derived from the swine kidney cells and is highly susceptible to foot-and-mouth disease virus (FMDV) infection. The total RNA was extracted from the LFBK cells and the switching mechanism at the 5' end of RNA template (SMART) technique was employed for the cDNA synthesis. Subsequently, double stranded cDNA was amplified by long-distance PCR, purified and co-transformed with pGADT7-rec vector in yeast strain Y187. The quality parameters of the constructed library were evaluated to qualify the constructed library. Nucleotide sequencing of the randomly selected clones from the library confirmed the swine genotype of LFBK cell line. The LFBK cDNA library was mated with the 2C protein of FMDV in yeast two-hybrid (YTH) system and several putative interaction partners were identified in the preliminary screening (Fig. 8.1). The LFBK library was observed to be of high quality and could potentially be applied to protein interaction studies between FMDV and the host cells using YTH system.

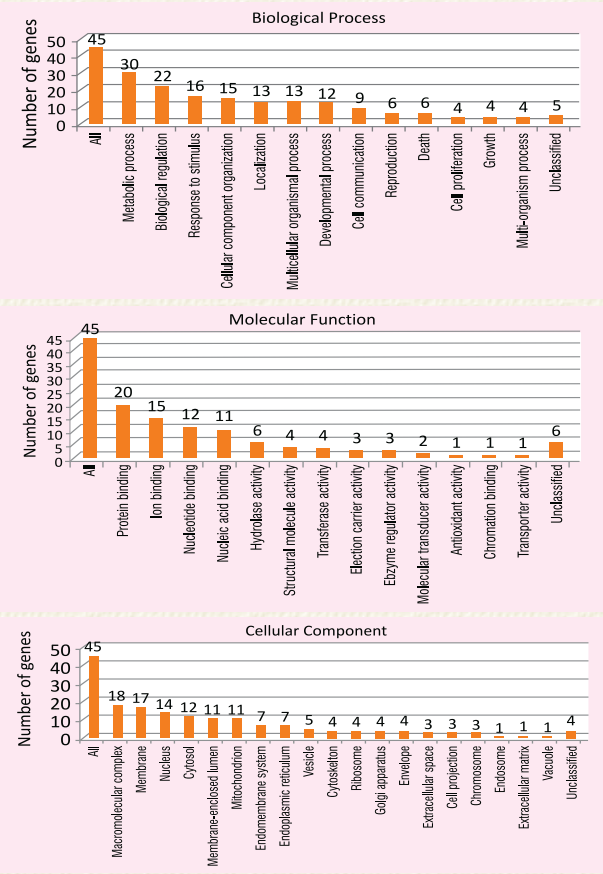


Fig. 8.1. Functional categorization of the Expressed Sequence Tags (ESTs) with Gene Ontology (GO) terms under three categories (a) biological process, (b) molecular function and (c) cellular compartment with respective GO Slim terms

8.2 Improved thermo-stable FMD virus serotype O by reverse genetics technique.

The recently developed FMDV reverse genetics system for FMDV serotype O was used for the generation of FMDV serotype O vaccine strain with enhanced thermo-stability. The crucial amino acid residues located at, or very close to, the inter-subunit interfaces of the FMD virus capsid was altered by site-directed mutagenesis. After confirmation of desired mutations through nucleotide sequencing of whole capsid region, the linearised full-length clone was transcribed to produce in vitro RNA transcripts. Later viable virus was rescued by transfection of in vitro transcripts. Though seven different recombinant full-length cDNA clones were

developed through site-directed mutagenesis, viable genetically defined viruses could be rescued only from the 4 clones. These four genetically defined viruses were tested for enhanced thermostability at different temperature-time conditions. Out of these 4 viruses, one virus (D3069E) was found to be a potential thermo-stable vaccine candidate. The study is in progress.

8.3 Mapping of the amino acid residue responsible for the enhanced adaptability of FMDV serotype A in BHK-21 cells.

Field outbreak strains of foot-and-mouth disease virus (FMDV) infect host cells through certain Arg-Gly-Asp (RGD) dependent integrin family of cellular receptors. In contrast, FMDV adapted in non-host cell cultures are reported to acquire the ability to infect cells via heparan sulphate (HS) or other yet unidentified cell surface molecules. It has been reported that during the serial passage of FMDV serotype A in BHK-21 cell culture, VP2 E131K (E2131K) substitution was fixed within the heparan sulphate binding site. The fixation of positively charged residue at position VP2 131 of serotype A is considered to associate with the ability to utilise alternative receptor. In this study, an infectious full-length cDNA clone for Indian FMDV vaccine strain A IND 40/2000 was constructed. Through site-directed mutagenesis on the cDNA clone, recombinant virus containing positive charged amino acid residue at position VP2 131 was rescued by reverse genetics technology. The recombinant mutated virus was shown to have specific and strong affinity for HS and demonstrated an enhanced infectivity in BHK-21 cell line. The introduction of this positively charged residue may facilitate for rapid cell-culture adaptation of FMDV serotype A by design, which in turn may prove useful for transforming field outbreak viruses to BHK-21 cell culture adaptable vaccine seed strains.

8.4 Recombinant capsid polyprotein (P1) based serodiagnostic strategy for detecting antibodies to FMD virus.

In India, FMD is primarily controlled by prophylactic bi-annual mass vaccination. In this control programme, liquid-phase blocking ELISA (LPBE) using inactivated virus antigen is being widely used for post vaccination seromonitoring. In order to develop an alternative assay to LPBE, the recombinant capsid polyprotein (rP1) of FMD virus (FMDV) serotype O was expressed in E.coli and the recombinant protein antigen was used for the detection of antibodies to FMDV. Capsid polyprotein of FMDV serotype O could be expressed successfully as a recombinant 6xHis-SUMO tagged protein in soluble form. In western blot assay, the rP1 protein reacted strongly with anti-FMDV serotype O guinea pig and bovine serum. Further, an rP1 protein-based solid phase competitive ELISA (rP1-SPCE) was developed and evaluated with a set of serum samples representing various epidemiological situation of the country. The performance of the rP1-SPCE was compared with the in-house LPBE, and the overall concordance in test results was 98.27%. This demonstrates that the recombinant capsid polyprotein-based ELISA has the potential to be an easy-to-perform, safe alternative to the conventional LPBE for the quantitative detection of antibodies to FMDV serotype O. This will dispense with use of whole virus inactivated antigen. The study is in progress on the serotype A and Asia 1.

8.5 Insertion of hexa-histidine tag in the VP1 G-H loop of FMD virus for one-step purification by immobilized metal affinity chromatography.

Immobilized metal affinity chromatography (IMAC) allows for the efficient protein purification via metal affinity tag such as hexa-histidine (His6) sequence. To establish an efficient system for purification and concentration of foot-and-mouth disease virus (FMDV) particles, a novel approach was designed to engineer a His6-tagged virus, allowing for one-step purification by IMAC. We used reverse genetics approach to introduce the His6-tag downstream of the 'RGD' motif in the VP1 G-H loop of the FMD virus serotype O IND R2/1975. Display of the His6-tag on the capsid surface, endowed the virus with an affinity for immobilized nickel ions. We demonstrated that the

His6-tagged FMDV could be produced to high titre and purified from the infected BHK-21 cell lysates by IMAC efficiently. About 48% of the infectious His6-tagged viral particles were recovered in the IMAC purification. Further, a 1,150-fold reduction in protein contaminant level and an 8,400-fold reduction in DNA contaminant level were achieved in the IMAC purification of His6-tagged FMDV. Through various functional assays it was observed that the tagged virus retained its functionality and infectivity similar to the un-tagged virus. The affinity purification of the His6-tagged FMDV may offer a feasible, alternative approach to the current methods of FMDV antigen purification, concentration and process scalability. In addition, the tagged FMDV may be used as a valuable tool to study the various stages of FMDV life cycle.

8.6 Development of 3A and 3B epitope deletion mutant of FMDV

Regular vaccination with chemically inactivated FMD vaccine is the major means of controlling the disease in India. However, the traditional inactivated vaccines may sometime contain traces of FMD viral non-structural protein (NSP), therefore, interfering with the NSP-based serological discrimination between infected and repeatedly-vaccinated animals. The availability of marker vaccine for differentiating FMD infected from vaccinated animals (DIVA) would be crucial for control and subsequent eradication of FMD in India. We constructed a negative marker FMDV serotype O virus (vaccine strain O IND R2/1975), containing dual deletions of amino acid residues 93-143 and 10-37 in the non-structural proteins 3A and 3B through reverse genetics. The negative marker virus exhibited similar growth kinetics and plaque morphology in cell culture as compared to the wild type virus. In addition, an indirect ELISA (I-ELISA) targeted to the deleted 3AB NSP region (truncated 3AB) was developed and evaluated which could be used as a companion differential diagnostic assay. The diagnostic sensitivity and specificity of the truncated 3AB I-ELISA were found to be 95.5 % and 96 %, respectively. The results from this study suggest that the availability negative marker virus and companion diagnostic assay could open a promising new avenue for the application of DIVA compatible marker vaccine for the control of FMD in India in coming years; certainly after DFZs are established.

8.7 Expression profiling of bovine Toll Like Receptors (TLRs) in response to FMD Vaccine

The study was conducted at experimental dairy farm of IVRI, Mukteshwar. Blood samples taken from all three groups viz. control, test group 1 and test group 2, at 0, 14, and 21 days post-vaccination against FMD inactivated vaccine were analyzed for expression of TLR genes in Real Time PCR. FMD inactivated vaccine in bovine provoked differential expression of TLR 2, TLR 3, TLR 7, TLR 8 and TLR10. The mRNA abundance of these target genes was calibrated with that of a housekeeping gene (18 S) and expressed as fold over expression of the TLRs genes in bovine over the 0 days post vaccination control. The data indicated that all of these TLR genes were up-regulated. Overall, all TLRs significantly differed between groups and within groups at $P<0.05$. On 0 day, expression of all TLRs did not varies significantly at $P<0.05$. But The expression of TLR2 and TLR3 genes significantly increased ($P<0.05$) in both test group1 and test group 2 after 14 days and 21 days post vaccination in comparison to the control group on 0 day. Other TLRs like TLR 7, TLR8 and TLR 10 did not vary significantly at $P<0.05$. Expression of TLR2 and TLR3 genes considerably increased ($P<0.05$) in test group 1 and test group 2 and expression of TLR2 and TLR3 genes was higher in test group1 in comparison to test group 2. The preliminary finding, suggests that inclusion of TLR2 and TLR 3 agonist in vaccine may enhance the innate immunity of animals and help in clearing of virus and may prevent establishment of infection. Further studies being undertake on this aspect.

8.8 Impact assessment of bi-annual FMD vaccination

A systematic vaccination campaign is on in India to control and eradicate foot-and-mouth disease (FMD). Since 2010, >120 million bovine population of 221 districts of the country are being

vaccinated at bi-annually with high vaccination coverage. Since then, length and size of FMD outbreaks have reduced progressively since 2006 to occasional sporadic incidences in some parts. Considering the impact of the herd immunity as one of the most important factors for control of the disease, an extensive longitudinal field study was conducted to estimate the herd immunity against the circulating three FMD virus serotypes. In total, 534 districts of the 17 States and one Union-Territory of the country were categorized into three groups for study, depending upon vaccination practice and coverage. A total of 145,966 serum samples (cattle and buffalo) collected during 2013 were analyzed by liquid phase blocking ELISA to estimate antibody titers against serotypes O, A and Asia1. The baseline data for district level herd immunity was generated. It was observed that herd immunity is gradually and progressively building up with regular vaccination in areas under FMD control programme. The median antibody titer of $\log_{10}$1.99 (1.54-2.31), $\log_{10}$2.11 (1.67-2.48), $\log_{10}$2.15(1.65-2.40) was estimated against the serotypes O, A and Asia1, respectively, in the states where systematic six monthly vaccination was followed, while median antibody titer of $\log_{10}$1.76(1.34-2.1), $\log_{10}$1.77(1.42-2.14), and $\log_{10}$1.66(1.41-2.14) against the three serotypes, respectively, was observed in the states where vaccination was performed once in a year. Analysis of the antibody kinetics revealed tentative duration of the protective herd immunity (median antibody titer $\geq \log_{10}$ 1.8) against the three serotypes of 160-180 days post vaccination, leaving an infection window of about 20 days in some population that pose risk of appearance of sporadic incidences/ case. Therefore it is essentially required that bi-annual vaccination continues till and after last case of FMD.

8.9. Understanding FMD viral ecology and landscape epidemiology towards control and eradication

There is a need to improve the understanding of FMD ecology in endemic regions to provide the basis for effective control strategies. The possible role of persistently infected ruminants in initiating new outbreaks remains highly controversial and the inability to quantify the real risk posed by such animals could preclude control of FMD in India. Moreover, the probability of becoming a carrier after infection and the time-dependent probability of clearing persistence need to be determined. The epidemiology of FMDV transmission should be quantified to explore the association between sequence variation with respect to geographical and temporal parameters. This report reflects collaborative research activities between the USDA- ARS Foreign Animal Disease Research Unit (FADRU) at the Plum Island Animal Disease Center and the ICAR-Project Directorate on Foot and Mouth Disease (ICAR-PDFMD) in Mukteswar. The overall objectives of the project entitled "*Understanding Foot and Mouth Disease Viral Ecology and Landscape Epidemiology toward Control and Eradication*" include: 1-Monitoring of FMDV circulating clinically and sub-clinically (including persistence) in cattle, Asian buffalo and small ruminants in selected areas of India; 2-Molecular characterization (genomic sequence) of viruses of interest; 3- Virus isolation and predicted antigenic characteristics, vaccine matching studies with current vaccine strains, to identify potential new emerging viruses and 4- Quantification of the epidemiological dynamics of FMDV transmission and genetic change in India. In order to achieve these objectives, several study sites have been established taking advantage of extensive disease outbreaks occurring in 2013. Three study sites are included in this report; the dairy farm (study site 1) consisting primarily of adult milking cows (HF cross) and the Katula farm (study site 2) in IVRI campus, Mukteswar where replacement heifers (HF cross) and male calves are raised, and a privately owned and managed large commercial dairy operation consisting of cows and buffaloes, the ABIS Dairy (study site 3), located in Chhattisgarh. Serial sampling consisted of serum, probang fluid (oesophageal-pharyngeal fluid;OPF) and lesions when present. Laboratory tests implemented included serotype detecting sandwich ELISA, real-time RT-PCR, multiplex RT-PCR, 3AB indirect ELISA, LPB ELISA, virus neutralization test, virus isolation in LFBKαvβ6 cell line and nucleotide sequencing.

Study sites 1 & 2

These farms located nearly 1 km away from each other had FMD during October 2013 and the outbreak was confirmed to be due to serotype O virus of O/ME-SA/Ind2001d lineage. The animals are being vaccinated at a 4 months interval. Up to a total of 18 clinically affected and 17 asymptomatic cows in the dairy farm (study site 1) and a total of 26 clinically affected and 25 asymptomatic young cattle in Katula (study site 2) were sampled for oesophageal-pharyngeal fluid and serum at monthly intervals since March 2014.

Serum

3AB NSP ELISA

- In comparison with Katula farm, Dairy farm, Mukteswar had a higher overall prevalence of NSP-antibody throughout the observation period (always >68% in Dairy farm, Mukteswar compared to >57% in Katula). The highest % of NSP-Ab positive animals in any collection being 93.75% in Dairy farm compared to 80.4% in Katula. In the clinically infected category[1], both the farms revealed comparable NSP-Ab positive animals (a maximum of 94.44% in Dairy farm and 96% in Katula in any round of collection). On the contrary, considerable difference was noticed in the asymptomatic in-contact category, where a maximum of 100% and 66.6% animals in Dairy farm and Katula, respectively revealed seropositivity despite showing similar proportion of genome PCR positive results between the two farms and between the clinical and asymptomatic categories in each farm. This may be due to older animals in dairy farm, Mukteswar having more mature immune systems and seroconversion with more robust response following infection, particularly in case of low level virus replication and disease without apparent clinical signs. The age group of resident animals in Dairy farm, Mukteswar was between 26 months to 12 years 4 months as compared to between 1-20 months in Katula farm at the time of outbreak. Overall, the high prevalence of NSP-Ab in asymptomatic animals is important because it indicates that many animals that never show disease are actually infected.
- The proportion of NSP-antibody positive cows in Dairy farm were 93.33% in the first 2 collections postoutbreak during Mar and Apr 2014. At 15 months postoutbreak (Feb 2015), 68.57% serum samples still tested positive in 3AB NSP ELISA. Such a percentage in a known infected herd is more than double the apparent 3AB-Ab seroprevalence in the country (~29%) as derived from random sampling.
- Between clinically infected and asymptomatic in-contact categories, neither significant difference in the proportion of 3AB NSP-seroconversion nor in the rate of decline in detectable NSP-Ab (93.75% and 92.85% during Mar 2014 to 66.66% and 70.58% NSP-Ab positive during Feb 2015 collection among clinically infected and asymptomatic population, respectively) was observed in the Dairy farm suggesting a high proportion of infected animals regardless of clinical manifestations.
- The proportion of NSP-Ab positive animals showed a gradual decline postinfection from 93.33% (30 Mar 2014) to 79.31% (30 June 2014) before jumping to the March 2014 level of 93.54% during 1 Aug 2014 collection in Dairy farm. Again the same trend of gradual fall (between 1 Aug 2014 and 17 Oct 2014) and a swift jump to the original level of 93. 75% (11 Nov 2014) was recorded. These spikes in NSP-Ab positive proportion coincided with vaccination 11 to 30 days prior to collection, thereby suggesting an infection-vaccination boost effect in some of the animals possibly due to residual vaccinal NSPs in the repeatedly vaccinated herd. Although it may be argued that during the NSP-Ab spikes, genome detection proportion also demonstrated an increase from 65.38% to 75.86% and 25

[1] Terms "clinically infected" and "asymptomatic" refer to animals that had (or did not have) signs of FMD during the initial outbreak in October 2013.

to 40.62% and therefore the spikes are due to sudden increase in virus load in the persistent phase or an incursion of a new virus strain, the second possibility was rejected in the absence of any clinical symptoms during the said months in the farm and no further virus isolation nor any reported outbreaks in the villages in the vicinity of the farm. This could further be substantiated once the genomic sequence data for different collections are available. The first possibility also could not be substantiated as because during other rounds of collection, despite showing a rise in the genome detection proportion, NSP-Ab displayed a falling trend (for instance between 30 Apr and 30 May 2014 collections and between 1 Aug and 2 Sep 2014 collections). Hence, the spike in genome detection rate coinciding with NSP-Ab spike at those collections could be merely a result of bias imposed by quality of OP fluid sampled rather than being a result of sudden increase in virus load. 4 days after 2 Sep 2014 collection, when 100% samples came positive for genome, 4 cows that showed negative PCR results on 2 rounds of collection before coming positive in Sep 2014 collection were resampled and tested and were found positive, thereby ruling out any possibility of errors (carryover template contamination) while extracting RNA or running RT-PCR.

- One of the clinically infected and one asymptomatic animal in Dairy farm, while six asymptomatic in-contact animals in Katula remained consistently 3AB-Ab seronegative despite being positive for viral genome intermittently. Although no virus isolation could be made from seronegative animals, there were instances when samples tested positive in PCR but remained negative in NSP ELISA and Vis a versa. This indicates NSP-Ab detection alone can not be used as an indicator of FMD virus/genome persistence.

LPB ELISA

- The percentage of animals showing serotype specific structural protein-Ab (SP-Ab) titre of more than log10 1.8 in LPB ELISA (cut-off for vaccinal protective antibody titre) was higher for Mukteswar than Katula in any round of collection despite use of the same batches of vaccine. For Mukteswar farm, the proportion did not drop below 96.5, 73.3 and 100% for serotype O, A and Asia 1, respectively at any round of collection, while the corresponding values for Katula farm was 70, 36.1 and 87.2%, respectively. This difference in the magnitude of postvaccinal Ab response could be a reflection of the difference in the age of animals dictating the maturity of the immune system and the number of vaccinations they have received.
- The fall in the percentage of animals showing more than log10 1.8 SP-Ab titre, although variable between the serotypes, was evident after 3-4 months of vaccination suggesting in favour of a 3-4 monthly vaccination schedule. The fall in serotype A titre was comparatively faster than the other two serotypes suggesting incorporation of more antigenic mass of type A strain in the vaccine may be beneficial.

Oesophageal-Pharyngeal fluid

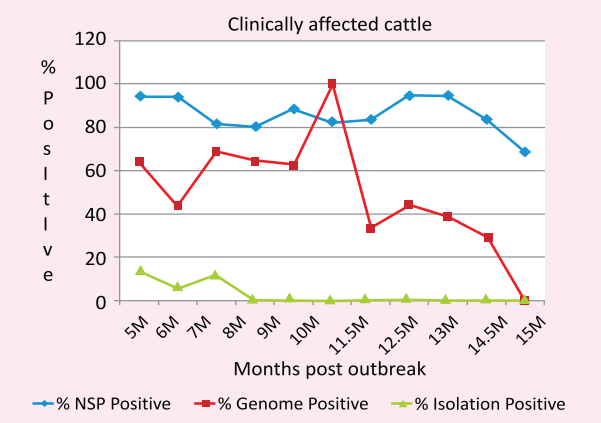
Virus Isolation (VI) in LFBKαvβ6 cells

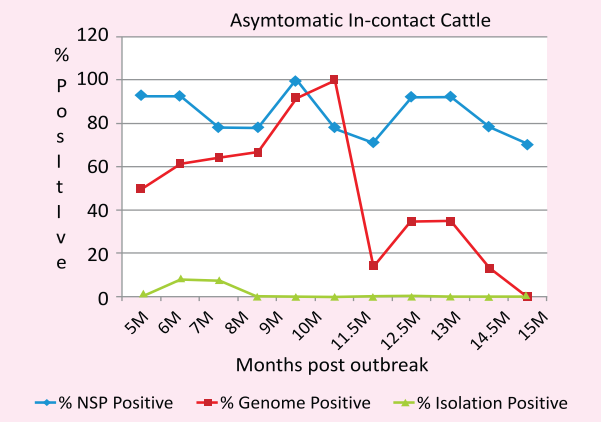
- Only three animals had VI positive results (two of them clinically infected and one was asymptomatic) in dairy farm, while no VI was possible in Katula. The isolates were confirmed to be serotype O in sandwich ELISA, mPCR and VP1 sequencing. Last positive VI result was observed at 7 months postoutbreak.
- All 3 VI positive animals remained 3AB NSP-antibody positive up to last collection during Feb 2015 even after they turned VI negative. On the contrary, genome detection was consistent only up to the point of time when samples tested VI positive, but after that genome detection showed intermittent positive pattern. Since at no collection, the samples that have come positive in VI have tested negative in both genome detection PCRs and NSP ELISA, the chance of isolating virus from cattle that test negative in both PCR and NSP ELISA appears to be a remote possibility. If VI was negative on three consecutive collections at monthly intervals, no further isolation was possible.

Genome detection by mPCR (target VP1)/ SYBR rRT-PCR (target 3D)

- When samples testing positive in one of the two PCRs were considered positive for viral genome, the proportion of genome positive samples varied from 0 in Feb 15 to 100% in Sep 14 collection in Dairy farm. No difference in the trend and proportion of genome positive animals was found between clinical and asymptomatic categories in either dairy or Katula farms. In both populations, the proportion varied from 0 to 100% in the series of collections in dairy farm, while it varied from 4.16 to 100% in clinical and 0 to 95.4% in asymptomatic categories in Katula farm. This supports the hypothesis that the animals which were asymptomatic had similar incidence of infection compared to those which had clinical disease. No animal tested consistently genome negative through the collection, thereby suggesting a very high proportion of persistent infection in all subpopulations.

Dairy Farm (Study site 1)





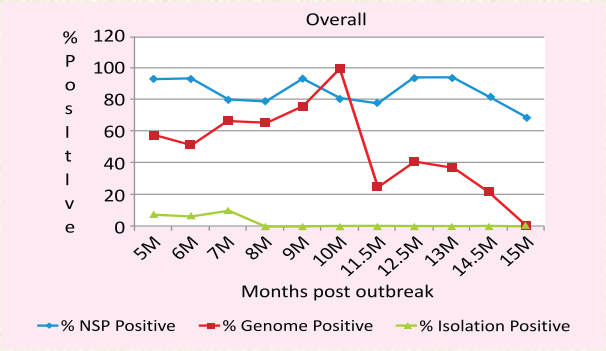
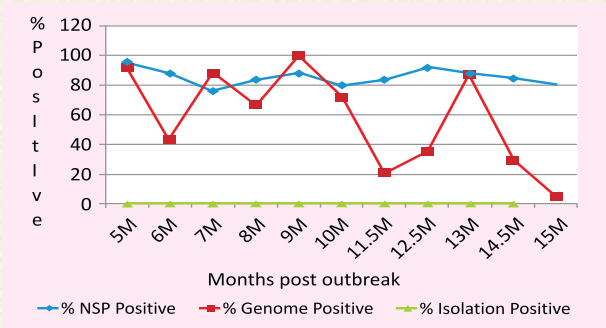
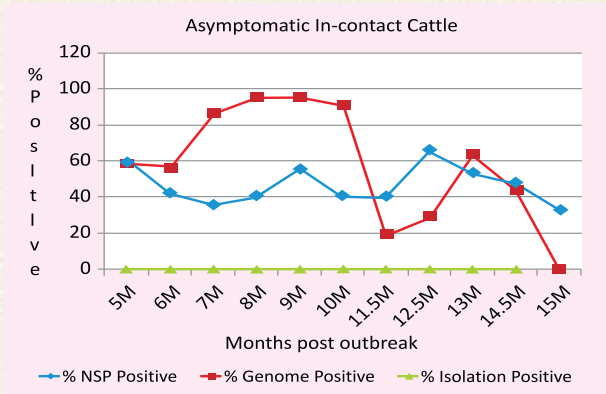


Fig. 8.2. Proportion of clinically affected, asymptomatic in-contact cattle and overall proportion showing positive results for nonstructural protein antibodies, FMD virus genome and FMD virus isolation in dairy farm, IVRI, Mukteswar over time postoutbreak

Young stock farm (Study site 2)





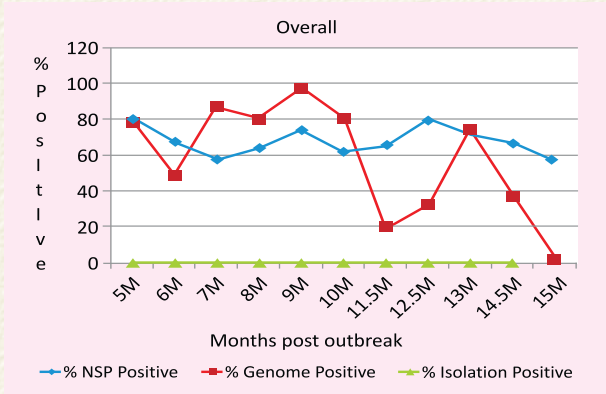


Fig. 8.3. Proportion of clinically affected, asymptomatic in-contact cattle and overall proportion showing positive results for non-structural protein-antibodies, FMD virus genome and FMD virus isolation in Katula farm, IVRI, Mukteswar over time postoutbreak

Study site 3

This privately managed farm had experienced an FMD outbreak during December 2013 and the outbreak was confirmed to be due to serotype O virus of O/ME-SA/Ind2001d lineage. The farm consists of milk cows, buffalo and heifers and therefore provides a unique opportunity to study the comparative persistence dynamics at the species level. The animals are being vaccinated every three months. Up to a total of 21 clinically affected and 16 asymptomatic cattle, and 11 clinically affected and 6 asymptomatic buffalo are being sampled for oesophageal-pharyngeal fluid and serum at 2-3 months interval since Mar 2014. The challenge to collection has been sale out of some of the animals in the mid of sampling (at the discretion of the herd managers).

Serum

3AB NSP ELISA

- The NSP-Ab positive proportion varied from 68.75 to 100% for asymptomatic category compared to 83.33 to 100% in clinical category in case of cattle. The overall NSP-Ab prevalence among cattle dropped from 100% at 3 months postoutbreak to 75% at 13 months postoutbreak. In buffalo, in both categories, the proportion of NSP-Ab positive animals were significantly less (varying from 0 to 37.5%) than cattle despite having higher proportion of genome positive animals. This could again be related to comparatively less severe clinical disease in buffalo than cattle with low clinical attack rate (6.8% in buffalo herd compared to 12% in cattle herd) and the age group of buffalo (buffalo heifers of less than 3 years age compared to mostly adult milch cows) sampled leading to lower rate of seroconversion and faster decline of weak titred NSP-Ab response in buffalo as compared to cattle. This also corroborates with earlier findings where NSP-ELISA have performed unsatisfactorily in detecting persistently infected animals particularly in subclinically infected vaccinated herds. The seronegative status of infected buffaloes needs to be further confirmed by a commercial NSP cELISA before reaching any definitive conclusion since an anti-cowHRP conjugate is used in the in house 3AB3 NSP indirect ELISA.

LPB ELISA

- The percentage of animals showing serotype specific structural protein-Ab (SP-Ab) titre of more than log10 1.8 in LPB ELISA was found to be considerably less against serotype A compared to the other 2 serotype components in the vaccine as observed for Mukteswar farms. Serotype A–titre did not show much improvement even after a month of vaccination suggesting a requirement for more type A antigenic mass in the vaccine.

Oesophageal-Pharyngeal fluid

Virus Isolation (VI) in LFBKαvβ6 cells

- Between cattle and buffalo considerable difference both in VI positive proportion (0 to 59.25 % in cattle, while 16.66 to 87.5% in buffalo at different collections) and duration of VI positive animals postoutbreak was noticed. In cattle, only up to 7 months after outbreak, while in buffalo, up to 13 months VI positive animals were found. Whether the buffaloes as a species better support persistent infection with FMD virus than cattle needs to be ascertained with more sampling in buffalo.
- The VI positive proportion was higher for the clinical (75%) than the asymptomatic (36.36%) cattle on the first collection 3 months after outbreak. But subsequently, the isolation rate was similar for both with a significant drop in the isolation rate in the very next collection at 5 months postoutbreak (dropped to 7.69% in clinical and 12.5% in asymptomatic categories). But in case of buffalo the VI positive proportion was comparable between clinical and asymptomatic categories.
- Virus could be isolated consistently from a clinically affected buffalo up to 10 months postoutbreak.
- There was only one clinically affected buffalo which tested negative for viral genome in both PCRs during Feb 2015 collection despite

being positive for VI suggesting in a particular collection, no single test can conclusively establish absence of virus in the persistent phase.

Genome detection by mPCR/ SYBR rRT-PCR

- In cattle, the genome positive proportion varied from 7.4 to 100% and not much difference was observed between the clinical (varied from 9 to 100%) and the asymptomatic (varied from 6.25 to 100%) categories. Similarly, in buffalo, no difference was observed between clinical and asymptomatic categories. Again, this herd revealed high prevalence of persistently infected animals.

Dairy Farm (Study site 3), Chhattisgarh

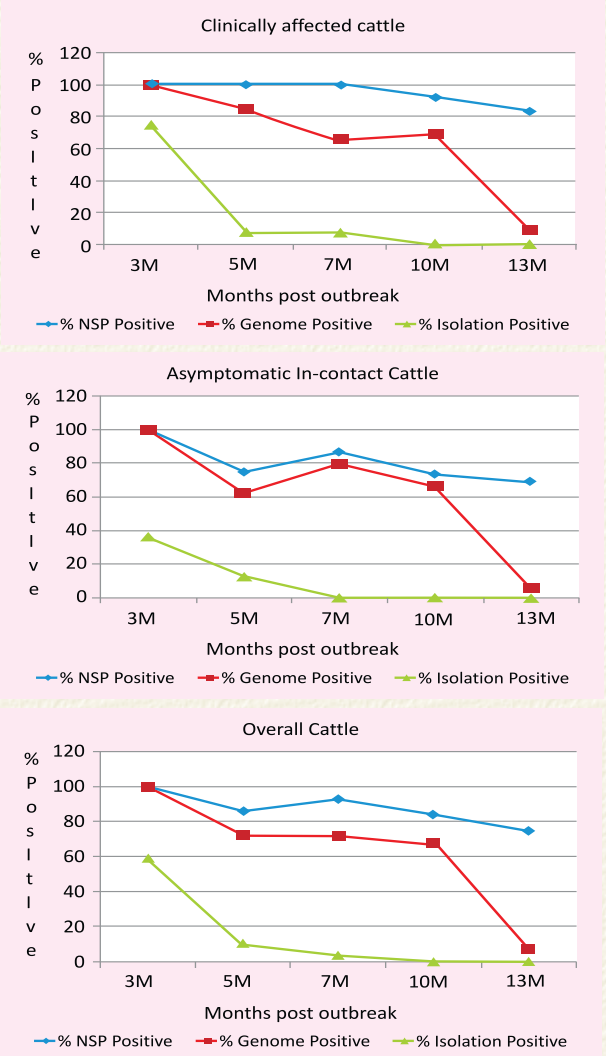


Fig. 8.4. Proportion of clinically affected, asymptomatic in-contact cattle and overall proportion showing positive results for nonstructural protein antibodies, FMD virus genome and FMD virus isolation in ABIS dairy farm, Chhattisgarh over time postoutbreak

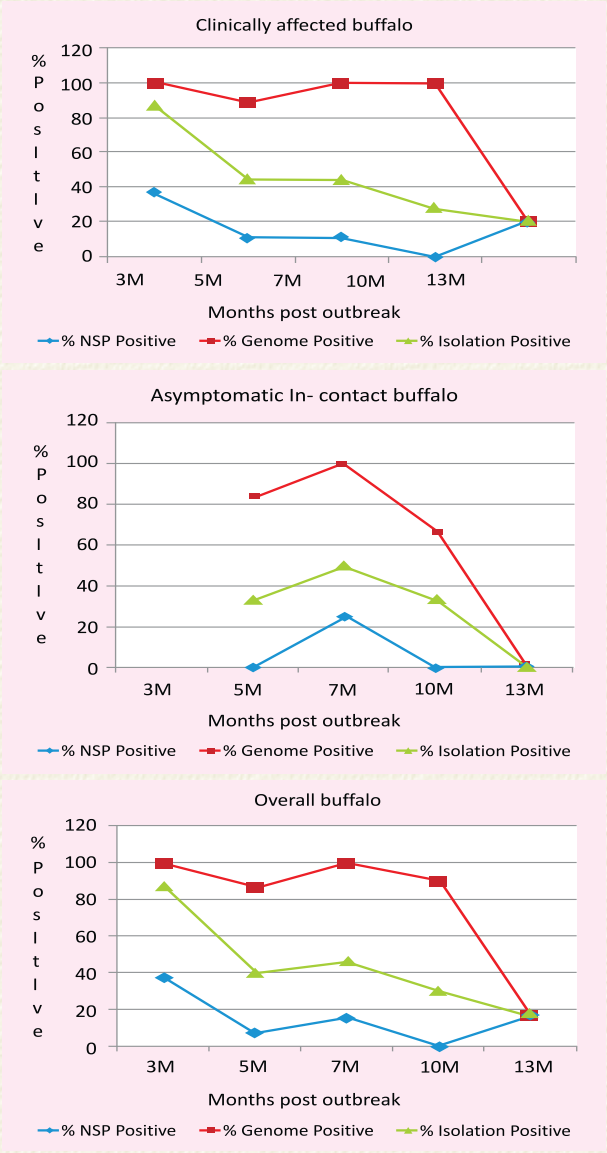


Fig. 8.5. Proportion of clinically affected, asymptomatic in-contact buffalo and overall proportion showing positive results for nonstructural protein antibodies, FMD virus genome and FMD virus isolation in ABIS dairy farm, Chhattisgarh over time postoutbreak

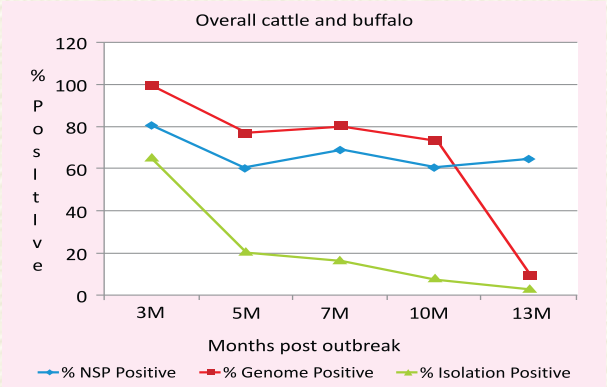


Fig. 8.6. Overall proportion of cattle and buffalo showing positive results for nonstructural protein antibodies, FMD virus genome and FMD virus isolation in ABIS dairy farm, Chhattisgarh over time postoutbreak

Virus clearing with time in all the three sampled farms was evident from the gradual decline in the proportion of viral genome positive samples and virus isolation. Genetic and antigenic characterization of the isolates obtained from OP fluid of persistently infected animals is under progress.

9

National FMD Virus Repository

The Central FMD laboratory of the Project 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 16 virus isolates (12 serotype O and 4 serotype Asia1) were added to the repository during the reported period (Table 6). At present the National FMD virus Repository holds a total of 1940 isolates (O-1253, A-308, C-15 and Asia 1-364).

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

Isolates revived	O	A	Asia1	Total
2010-11	06	17	02	25
2011-12	46	03	13	62
2012-13	32	19	26	77
2013-14	61	10	2	73
2014-15	12	0	4	16

State-wise distribution of FMD virus isolates (n=1940) available in National FMD virus repository as on 31st April 2015

State-wise distribution of FMD virus serotype O isolates (n=1253) available in National FMD virus repository as on 31st April 2015

State-wise distribution of FMD virus serotype A isolates (n=308) available in National FMD virus repository as on 31st April 2015

State-wise distribution of FMD virus serotype Asia 1 isolates (n=364) available in National FMD virus repository as on 31st April 2015

State-wise distribution of FMD virus serotype C isolates (n=15) available in National FMD virus repository as on 31st April 2015

10

National FMD Serosurveillence

10.1 DIVA (Antibody against NSPs):

Seroconversion against NSPs (3AB3) was observed since 10-14 days after FMD virus infection. 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 the animals. 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 68,948 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 ~ 23.41% samples/animals (Table 1). While an overall seropositivity of 29.2% was observed during the year 2013-14.

Table 1. Result summary of r3AB3 NSP-ELISA on bovine (cattle and buffalo) serum samples (Regional center, Network Units and Central FMD Laboratory)

Sl. No.	Place of origin	Host	Total serum samples tested	Total positive	%3AB3 reactors
Southern Region					
1	Andhra Pradesh	Bovine	4400	1342	30.50
2	Karnataka	Bovine	6002	1994	33.22
3	Kerala	Bovine	1981	136	06.87
4	Tamil Nadu	Bovine	6400	1553	24.26
Central Region					
5	Madhya Pradesh	Bovine	8430	2164	25.67
6	Chattisgarh	Bovine	248	158	63.71
Western Region					
7	Rajasthan	Bovine	6147	1634	26.58
8	Gujarat	Bovine	5000	878	17.56

Sl. No.	Place of origin	Host	Total serum samples tested	Total positive	%3AB3 reactors
9	Maharashtra	Bovine	4217	1192	28.26
Eastern Region					
10	West Bengal	Bovine	1038	184	17.73
11	Bihar	Bovine	540	188	34.81
12	Odisha	Bovine	3191	1058	33.15
Northern Region					
13	Haryana	Bovine	3810	210	05.51
14	Uttarakhand	Bovine	990	408	41.21
15	Uttar Pradesh	Bovine	1959	899	45.89
16	Himachal Pradesh	Bovine	2400	322	13.42
17	Jammu & Kashmir	Bovine	1260	383	30.39
18	Punjab	Bovine	1900	185	09.73
North Eastern Region					
19	Assam	Bovine	2258	437	19.35
20	Arunachal Pradesh	Bovine	85	12	14.12
21	Manipur	Bovine	1800	234	13.00
22	Mizoram	Bovine	1710	167	09.76
23	Nagaland	Bovine	887	299	33.70
24	Tripura	Bovine	1755	75	04.27
Islands					
25	Andaman and Nicobar	Bovine	540	27	5.0
	Total	**Bovine**	**68948**	**16139**	**23.41**

Table 2. Summary of r3AB3 DIVA positivity during 2008-09 to 2014-15

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
Total	**2,78,704**	**74392**	**26.69**

10.2. LPB-ELISA (Percent protected)

During the year under report, a total of 46,893 random serum samples were subjected to LPB ELISA for determination of antibody level against structural protein (SPs) of serotypes O, A and Asia1.

Table 3. Summary of LPBE result obtained on Random serum samples.

Sl. No.	Name of place/State	Species	Total no. of samples	Protective Titre ≥1.8		
				O	A	Asia 1
Southern Region						
1	Andhra Pradesh	Bovine	4400	2753 (62.6)	1868 (42.5)	2292 (52.1)
2	Karnataka	Bovine	6002	5039 (84.0)	5160 (86.0)	5557 (93.0)
3	Kerala	Bovine	1960	1759 (89.7)	1665 (84.9)	1801(92.0)
4	Tamil Nadu	Bovine	6400	4364 (68.2)	4691 (73.3)	5242 (81.9)
Central Region						
5	Madhya Pradesh	Bovine	7275	2321 (31.9)	1776 (24.4)	1953 (26.9)
Western Region						
6	Maharashtra	Bovine	4046	3089 (76.4)	2808 (69.4)	2717 (67.2)
7	Rajasthan	Bovine	2313	798 (34.5)	1046 (45.2)	1530 (66.1)
Northern Region						
8	Haryana	Bovine	270	204 (75.5)	218 (80.7)	239 (88.5)
9	Uttarakhand	Bovine	1168	1022 (87.5)	868 (74.3)	1006 (86.1)
10	Punjab	Bovine	1800	1057 (58.7)	1133 (62.9)	1351 (75.1)
11	Himachal Pradesh	Bovine	2200	1286 (58.5)	1598 (72.6)	1553 (70.6)
12	Jammu & Kashmir	Bovine	1495	501 (33.5)	440 (29.4)	640 (42.8)
Eastern Region						
13	West Bengal	Bovine	1319	361 (37.4)	335 (25.4)	378 (28.7)
14	Bihar	Bovine	287	74 (25.8)	45 (15.7)	35 (12.2)
15	Odisha	Bovine	755	340 (45.03)	433 (57.4)	573 (76.0)
North Eastern Region						
16	Assam	Bovine	2258	490 (21.7)	139 (06.5)	319 (14.1)
17	Mizoram	Bovine	1344	245 (18.4)	383 (28.5)	441 (32.8)
18	Tripura	Bovine	1309	664 (50.7)	749 (57.2)	787 (60.1)
Islands						
19	Andaman & Nicobar	Bovine	292	160 (54.8)	188 (64.4)	167 (57.1)
Total			**46893**	**26527 (56.6)**	**25543 (54.5)**	**28581 (61.0)**

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

10.3 Surveillance and Monitoring of FMD in ovine, caprine and porcine species in India

During the period, a total of 1542 serum samples from goats and 838 from sheep were collected. Out of 838 ovine serum samples tested in 3AB NSP ELISA, 343 (40.93%) samples were found to be 3AB-NSP reactors. Out of 1623 caprine serum samples tested in 3AB NSP ELISA, 266 (16.38%) samples were found to be 3AB-NSP reactors. Similarly out of 2056 porcine serum samples tested in optimized 3AB NSP ELISA, 268 (13.03%) samples were found positive. Overall this study revealed high NSP reactivity in ovine serum samples. Out of 50 ovine serum samples tested in LPB ELISA, 29 (58%) samples showed log10 titer of 1.8 against serotype O, 25 (50%) against serotype A and 32 (64%) against serotype Asia 1. Out of 393 porcine serum samples tested in LPB ELISA, 9 samples showed log10 titer of 1.8 against all three serotypes. Role of Sheep in epidemiology of FMD is under investigation.

11

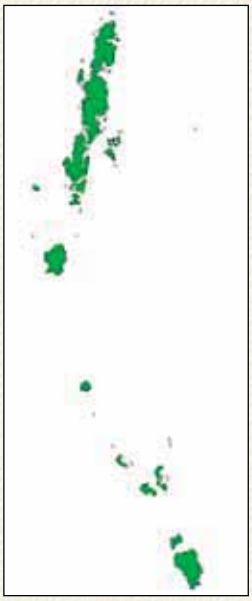
Sero-monitoring of FMD Control Programme (FMD-CP)

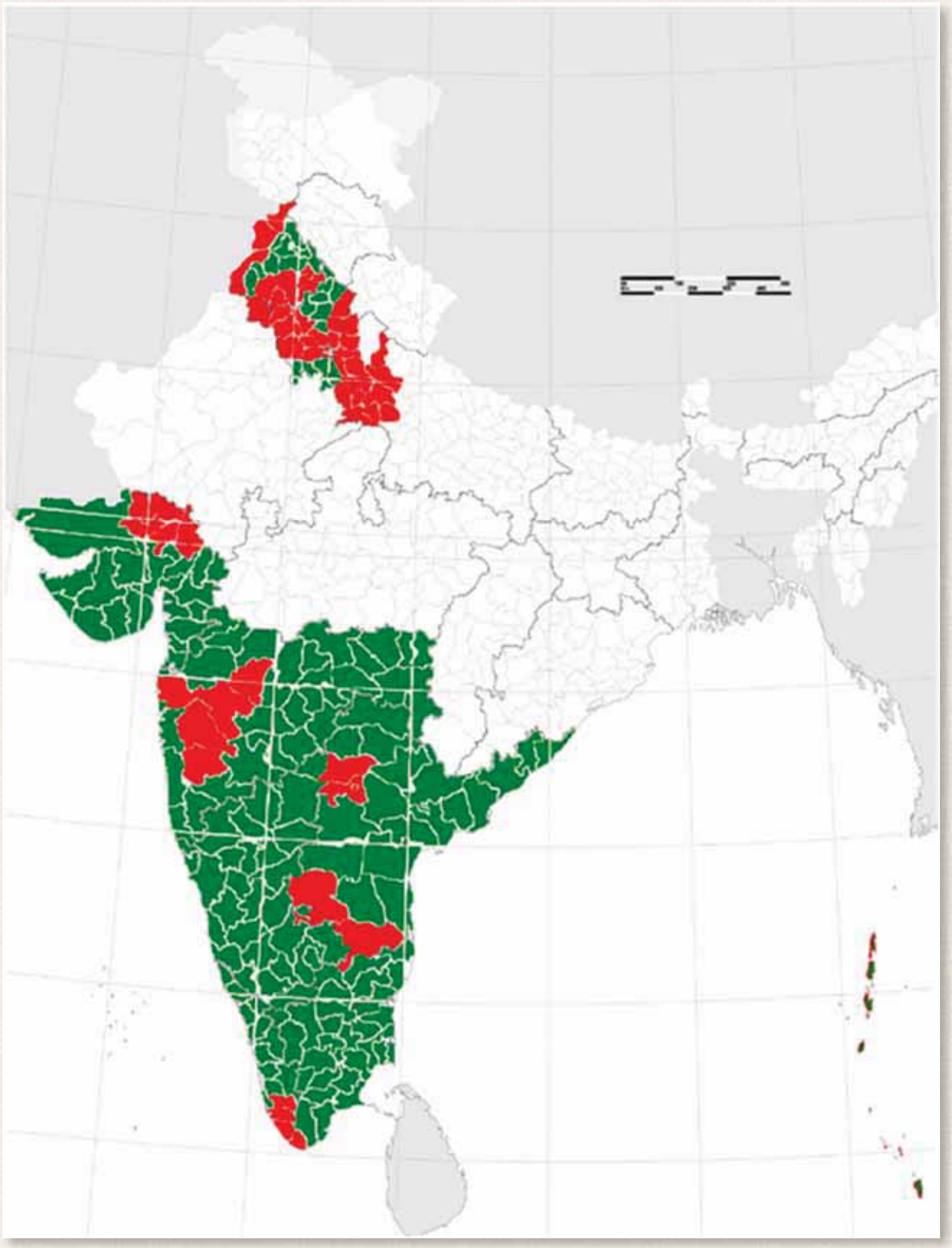
A vaccination based FMD Control Programme (FMD-CP) was initiated by the Department of Animal Husbandry, Dairying and Fisheries (DAHD &F) Government of India since August 2003-04 covering 54 specified districts in the country. This involves 6 monthly vaccinations with a trivalent (O, A and Asia1) vaccine 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 centres of PD-FMD for estimation of level of serotype specific neutralizing antibodies by Single dilution Liquid Phase Blocking ELISA (Sd-LPBE). The Regional Centers, Network Units and Central FMD laboratory of the Project Directorate participate in this post vaccinal sero-monitoring under FMDCP. Since 2011-12, Central Island Agriculture 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. The test was compared with SNT, and it is recommended that LPB ELISA titer (in serum) of ≥ log10 1.8 indicates protection against FMD. Due to initial success, additional 167 districts (another 80-90 million cattle and buffalo) were included under the programme in 2010. Currently, this programme includes 221 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 and 16 districts in Uttar Pradesh (Fig 1), and targeting ~120 million cattle and buffalo.

During 2014-15, a total of 1,91,402 pre and post vaccinated serum samples were tested and of which, 90,244 serum samples were from first phase FMDCP districts (2004) representing XVI, XVII and XVIII phases of vaccinations and remaining 1,01,158 serum samples were from expanded FMD CP districts of 2010 representing Phases VI and VII.

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 Island Agriculture 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.

Table: 1. Result of Seroconversion in Andaman & Nicobar Islands (2003-04)

Phase	Vaccination*		Number & % animals showing titres ≥1.8 log10 against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)	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)

*Number of serum samples collected before (pre) and after (post) vaccination.

Sero-monitoring in Tamil Nadu

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

Table: 2. Result of Seroconversion in Tamil Nadu under FMDCP(2003-04).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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 in the districts over the years

Table: 3. Result of Seroconversion in Tamil Nadu under FMDCP (2010-11).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Increase in herd immunity and Seroconversion has been observed

Table: 4. Result of Seroconversion in Puducherry under FMDCP (2010-11).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Increase in herd immunity and seroconversion has been observed

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: 5. Result of Seroconversion in Kerala under FMDCP(2003-04).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Overall herd immunity is good in Kerala

Table: 6. Result of Seroconversion in Kerala under FMDCP (2010-11).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)
XVII	2791	2678	2137(76.6)	2173(81.1)	1786(64)	2462(92)	2184(78.3)	2600(97.1)

Overall herd immunity is poor in Kerala

Table: 7. Result of Seroconversion in Lakshadweep under FMDCP (2010-11).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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: 8. Result of Seroconversion in Andhra Pradesh under FMDCP (2003-04).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Table: 9. Result of Seroconversion in Andhra Pradesh under FMDCP (2010-11).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type 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)

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

Sero-monitoring in Karnataka

State of Karnataka was included under FMDCP in 2010-11

Table: 10. Result of Seroconversion in Karnataka under FMDCP (2010-11).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type 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)

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 Thane were covered under FMDCP in 2003-04 (filled red) and later in 2010-11, twenty nine districts (filled green) was included

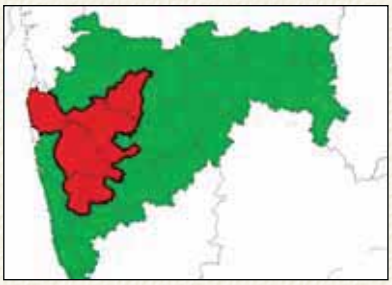


Table: 11. Result of Seroconversion in Maharashtra under FMDCP (2003-04).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Table : 12. Result of Seroconversion in Maharashtra (2010-11).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Overall herd immunity and sero-conversion is good in Maharshtra

Sero-monitoring in Goa

Table: 13. Result of Seroconversion in Goa under FMDCP (2010-11)

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

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 .

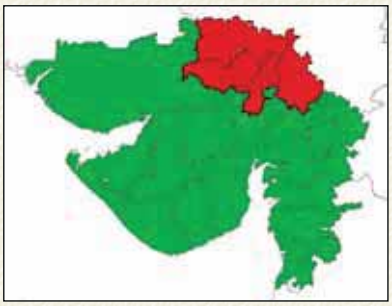


Table: 14. Result of Seroconversion in Gujarat (FMDCP 2003-04).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
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)

Table: 15. Result of Seroconversion in Gujarat (FMDCP 2010-11).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Overall herd immunity and sero-conversion is good in Gujarat

Sero-monitoring 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

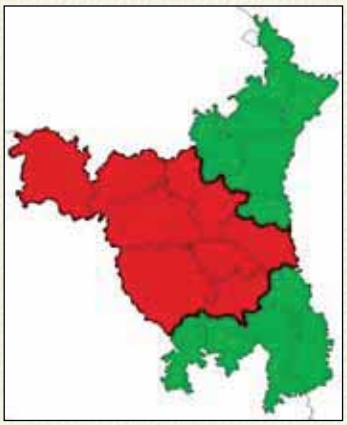


Table: 16. Result of Seroconversion in Haryana under FMDCP (2003-04).

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
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)

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Serotype O		Serotype A		Serotype Asia 1	
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)

Overall post-vac response is good against all the three serotypes, and this has been well reflected as drastic reduction in occurrence of the disease in the state.

Table: 17. Result of Seroconversion in Haryana under 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	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: 18. Result of Seroconversion in Delhi under FMDCP (2003-04).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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								
XVII								
XVIII	200	200	154(77)	196(98)	107(53.5)	177(88.5)	161(80.5)	193(96.5)

Herd immunity is 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: 19. Result of Seroconversion in Punjab under FMDCP (2003-04).

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
	Pre	Post	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-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)

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Type O		Type A		Type Asia 1	
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	NA	2538(71)	NA	2423(67.5)	NA	2338(65.1)	NA

Overall Seroconversion and herd immunity is good.

Table: 20. Result of Seroconversion in Punjab under 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	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, Gautam Bhuddha 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.

Table: 21. Result of Seroconversion in Uttar Pradesh (2003-04).

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
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)

Phase	Vaccination		Number & % animals showing titres ≥1.8 log_{10} against FMDV					
			Serotype O		Serotype A		Serotype Asia 1	
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	NA	4114(38.2)	NA	4527(42.1)	NA	4570(42.5)	NA

Seroconversion requires improvement.

Summary of overall sero conversion against each serotype and impact of vaccine (54 districts; FMDCP 2003-04)

The herd immunity has progressively increased with minor aberrations that speak for positive impact of vaccination for last 10-11 years. Incidence/ occurrence of the disease has also progressively declined in the Northern region and also down to near zero in the states of Haryana and Punjab. There have been cases of FMD in FMDCP 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. There have been certain problems in 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 22. Percent animals showing post vaccinal antibody titers of ≥1.8 log10 against FMD virus (FMDCP 2003-04, 54 districts)

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	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

Table 23. Percent animals showing post vaccinal antibody titers of ≥1.8 log10 against FMD virus (FMDCP 2010-11, 167 districts)

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	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

Table: 24a. Summary of total number of serum samples tested under FMDCP (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: 24b

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

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
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: 24c

State/UT	Phase XV		Phase XVI		Phase XVII		Phase XVIII	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andaman & Nicobar	1445	1109	530	502	521	461		
Andhra Pradesh	800	800	800	800	800	800	800	800
Delhi	200	200	-	-	-	-	200	200
Gujarat	800	800	4600	4538	5200	5200	3600	3600
Haryana	1600	1600	1600	1600	1597	1600	1600	1600
Kerala	598	553	2789	2738	2791	2678		
Maharashtra	1098	1098	1055	1051	1062	1042	908	888
Punjab	3299	3015	3182	3522	3590	-		
Tamilnadu	200	200						
Uttar Pradesh	3870	3968	10763	-				
Sub Total	13910	13343	25319	14751	15561	11781	7108	7088
Total	**27253**		**40070**		**27342**		**14196**	
Grand total	**314878**							

* excluding the samples of Phases I, II, IV, VIII and IX from Kerala; Phases 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: 25. Summary of total number of serum samples tested under extended FMDCP (2010-11)

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
Andhra Pradesh	3600	3600	3480	3480	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
Haryana	3086	2354	2586	2594	2555	2362	2565	2575	2600	2600	2580	2580	2558	2597
Karnataka	4587	4266	5401	4632	3864	3075	5053	5225	5916	5853	5945	5985	5930	5930
Maharashtra	5988	6018	9435	9698	4721	4723	5250	5305	4891	4891	5362	5362	4181	4181
Goa	381	391	383	378	384	368	379	376	375	375	371	371		
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	6400	6400	6400	6400
Puducherry	30	55	38	38	46	46	-	-	-	-	246	246	243	243
Lakshadweep	107	107	-	-										
Sub total	**25019**	**24031**	**32033**	**31622**	**28173**	**26546**	**26943**	**26690**	**25524**	**24957**	**24504**	**24544**	**22912**	**22951**
Total	**49050**		**63655**		**54719**		**53633**		**50481**		**49048**		**45863**	
Grand total	**366449**													

11.2 Sero-monitoring of post vaccinal immunity in animals vaccinated under ASCAD/RKVY programmes and sampled at random

State	Number of sample tested	Species	Number & % animals showing titres ≥1.8 log10 against FMDV					
			Type O		Type A		Type Asia 1	
			Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
Madhya P.	7513+5037	Bovine	2023(26.9)	2024(40.2)	1584(21.1)	1562(31)	1947(25.9)	1872(37.2)
Bihar	47+26	Bovine	16(34.0)	16(61.5)	07(15.0)	12(46.2)	07(15.0)	11(42.3)
Tripura	2411+2411	Bovine	1100(45.6)	1598(66.3)	1162(48.2)	1694(70.3)	1194(49.5)	1768(73.3)
Assam	900+900	Bovine	166(18.4)	553(61.4)	57(6.3)	238(26.4)	114(12.7)	398(44.2)
Himachal P.	1800+1800	Bovine	820(45.6)	1293(71.8)	984(54.7)	1420(79.0)	921(51.2)	1369(76.1)
Odisha	21+12	Bovine	08(38.1)	09(75.0)	09(42.9)	08(66.7)	08(38.1)	08(66.7)
J&K	284+291	Bovine	145(51.1)	191(65.6)	119(41.9)	191(65.6)	145(51.1)	193(68.0)
Mizoram	183+178	Bovine	130(71.0)	162(91.0)	78(42.6)	141(79.2)	103(56.3)	160(90.0)
Manipur	792+792	Bovine	170(21.5)	736(92.9)	138(17.4)	709(89.5)	71(9.0)	635(80.2)
Nagaland	440+438	Bovine	177(40.2)	373(85.2)	138(31.4)	354(80.8)	123(28.0)	356(81.3)
	14391+11885		4755(33.0)	6955(58.5)	4276(29.7)	6329(53.3)	4633(32.2)	6770(57.0)

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.

During the period, r3AB3 DIVA Kit for FMD to test a total number of 79,800 serum samples was produced and sampled. Similarly, virus serotyping Kits for 3000 tests and LPB-ELISA Kits for 2,71,960 were supplied. 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	3000	79,800

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Research Projects

S. No.	Title	PI	Year	Institute code
	Institute Plan Projects			
1	Cataloging and Maintenance of National FMD virus repository during 2015-16	B. Pattnaik	2015-16	PDFMD/1/2015-16
2	Production, standardization and supply of diagnostic reagents for FMD diagnosis and surveillance during 2015-16.	B. B. Dash	2015-16	PDFMD/2/2015-16
3	Seromonitoring of pre and post vaccinal immunity against FMD during 2015-16.	B. B. Dash	2015-16	PDFMD/3/2015-16
4	Random serosurveillance of FMD in India during 2015-16.	B. B. Dash	2015-16	PDFMD/4/2015-16
5	Genetic and antigenic characterizations of FMD virus serotype A during 2015-16.	J.K. Mohapatra	2015-16	PDFMD/5/2015-16
6	Evolutionary and antigenic analysis of foot and mouth disease virus serotype O from India during 2015-16	Saravanan S.	2015-16	PDFMD/6/2015-16
7	Epidemiology of Foot and Mouth Disease in small ruminants and pigs in India during 2015-16.	M. Rout	2015-16	PDFMD/7/2015-16
8	Development of single chain variable fragment antibodies against structural proteins of FMD virus through phage display.	G. K. Sharma	2014-16	PDFMD/9/2014-16
9	Genetic and antigenic analysis of Foot and Mouth Disease virus serotype Asia1 during 2015-16.	G. K. Sharma	2015-16	PDFMD/9/2015-16
10	A comprehensive study to understand the serotype O dominance in India.	G. K. Sharma	2015-16	PDFMD/10/2015-16
11	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	2015-17	PDFMD/8/2015-17
12	Application of Recombinant Capsid Polyprotein of FMDV serotype Asa1 for Immunodiagnosis.	J. K. Biswal	2015-16	PDFMD/11/2015-16
13	Further Development and Characterization of Improved thermostable FMDV serotype O vaccine candidates generated by reverse genetics technologies.	J. K. Biswal	2015-17	PDFMD/12/2015-17
14	Exploring the function of Foot and Mouth Disease virus protein 2B in virus replication with special emphasis on immune evasion mechanism.	S. Mahajan	2015-16	PDFMD/13/2015-16
15	Transcriptome and miRNA profiling of host responses to Foot and Mouth Disease virus in LFBK cell line. Component I: Differential gene expression in LFBK cells infected with FMD virus at different time points.	S. Mahajan	2015-16	PDFMD/14/2015-16

S. No.	Title	PI	Year	Institute code
Collaborative Projects				
16	Influence of genetic and non-genetic factors on FMDV vaccine response	B.B. Dash	Sep 2014-2015	PDFMD/14/2014-15 **PDFMD-IVRI**
17	Assessment of Economic impact of FMD and its control in India	G. Govindraj	2014-16	PDFMD/15/2014-16 **PDFMD-NIVEDI**
18	Understanding FMD viral ecology and landscape epidemiology towards control and eradication.	J K Mohapatra	2014-16	ICAR-PDFMD & PIADC, USA collaborative project

14

Transfer of Technology

An MoA was signed between Agrinnovate India Ltd (AgIn) and M/s Arsh Biotech Pvt Ltd on 22 December 2014 for licensing the technology of **'3AB3 and 3ABC Non-structural protein based diagnostic assay (ELISA) that can differentiate infected from vaccinated animals (DIVA)'.** The technology has been developed at Project Directorate on Foot and Mouth Disease (PDFMD), Mukteswar.

Fig. 14. Dignitaries described the FMD 3AB3 DIVA Kit from Arsh Biotech as the "best demonstration of MAKE IN INDIA initiative" whereby an ICAR PDFMD Technology has been commercialized into an user-friendly, safe and highly sensitive diagnostic kit. Dr S Ayyappan, Director General (ICAR) chaired the MoA meeting, which among others was attended by Dr S.S Honnappagol (AHC, AH&D), Dr KML Pathak, (DDG, Animal Sciences), Dr G Prasad (ADG, Animal Health), Dr. S Mauria (ADG, IP & TM) and Dr. B Pattnaik (Project Director, PDFMD).

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Publications/ Abstracts/Presentations in Conferences

Research Publications

1. Mohapatra J.K., Laxmi K. Pandey, Devendra K. Rai, Biswajit Das, Luis L. Rodriguez, Manoranjan Rout, Saravanan Subramaniam, Aniket Sanyal, Elizabeth Rieder, and Bramhadev Pattnaik (2014). Cell culture adaptation mutations in foot-and-mouth disease virus serotype A capsid proteins: implications for receptor interactions. **J Gen Virol** vir.0.071597-0; doi: 10.1099/vir.0.071597-0

2. Subramaniam S., Mohapatra J.K., Das B., Sanyal A., Pattnaik B. (2015). Genetic and antigenic analysis of foot-and-mouth disease virus serotype O responsible for outbreaks in India during 2013. **Infect Genet Evol**. doi: 10.1016/j.meegid.2014.12.009.

3. Sharma G. K., Mahajan S., Matura R., Subramaniam S., Mohapatra J. K., Pattnaik B (2014). Production and characterization of single-chain antibody (scFv) against 3ABC non-structural protein in Escherichia coli for sero-diagnosis of Foot and Mouth Disease virus. **Biologicals** 42(6):339-45

4. Sharma G. K., Mohapatra J.K., Mahajan S., Matura R., Subramaniam S., Pattnaik B (2014). Comparative evaluation of non-structural protein-antibody detecting ELISAs for foot-and-mouth disease sero-surveillance under intensive vaccination. **J Virol Methods.** doi: 10.1016/j.jviromet.2014.06.022.

5. Sharma G. K., Mahajan S., Das B. B., Ranjan R., Kanani A., Sanyal A., Pattnaik B (2014). Comparison of stabilisers for development of a lyophilised multiplex reverse-transcription PCR mixture for rapid detection of foot and mouth disease virus serotypes **OIE Scientific and Technical Review** 33 (3)

6. Biswal J. K., Mohapatra J. K., Bisht P., Subramaniam S. , Sanyal A., Pattnaik B (2015). A positively charged lysine residue at VP2 131 position allows for the enhanced adaptability of foot-and-mouth disease virus serotype A in BHK-21 cells. **Biologicals**. http://dx.doi.org/10.1016/j.

7. Biswal J.K., Bisht,P., Mohapatra,J.K., Ranjan,R., Sanyal, A., Pattnaik,B (2015). Application of a recombinant capsid polyprotein (P1) expressed in a prokaryotic system to detect antibodies against foot-and-mouth disease virus serotype O. **Journal of Virological Methods.** doi:10.1016/j.jviromet.2015.02.008

8. Mahajan S, Gaurav Kumar Sharma, Rakesh Matura, Saravanan Subramaniam, Jajati Keshari Mohapatra, Bramhadev Pattnaik (2015). Construction and characterization of yeast two-hybrid cDNA library derived from LFBK cell line. **Biologicals.** 2015.01.003

9. Mahajan S., Mohapatra J.K., Pandey L.K., Sharma G.K., Pattnaik B (2014). Indirect ELISA using recombinant nonstructural protein 3D to detect foot and mouth disease virus infection associated antibodies. **Biologicals.** 43(1):47-54.

10. Ranjan R., Kangayan M., Subramaniam S., Mohapatra J. K., Biswal J. K., Sharma G. K., Sanyal A. , Pattnaik B (2014) Development and evaluation of a one step reverse transcription-loop mediated isothermal amplification assay (RT-LAMP) for rapid detection of foot and mouth disease virus in India. **Virus Disease.** 25 (3) 358-364.

11. Rout M., Senapati M.R., Kanani A., and Mohapatra J.K (2014). Serological Evidence for Active Foot-and-Mouth Disease Virus Circulation in Organized Dairy Herds of Gujarat. **Indian Veterinary Journal.** 91: 18-20.

12. Rout, M., Senapati, M., R. Mohapatra, J. K., Ayub, M., Narula, H. K., Sawal, R. K., Sanyal, A (2014). Prevalence of foot and mouth disease virus antibodies in an organized sheep farm of Rajasthan. **Indian Journal of Small Ruminants** 20 (1) 126-127

13. Rout M., Sunder J., Pandey L.K., Mohapatra J.K. and Pattnaik B. (2014). Serological Survey of Foot-and-Mouth Disease in Traditionally Managed Goats of

Andaman & Nicobar Islands. **Indian Res. J. Ext. Edu.** 14 (4), 82

14. Mohapatra A. K., Mohapatra J. K., Pandey L. K., Sanyal A., Pattnaik B. Diagnostic potential of recombinant nonstructural protein 3B to detect antibodies induced by foot-and-mouth disease virus infection in bovines. **Arch Virol.** 2014 159(9):2359-69.

15. Audarya S. D., Sanyal A., Pandey L.K., Mohapatra J. K. and Pattnaik B. (2014). Molecular Cloning and Sequencing of Bovine TNF-Á Cytokine Gene from Peripheral Blood Mononuclear Cells **Indian Res. J. Ext. Edu.** 14 (4), 65

16. J.K. Mohapatra, M. Rout, **Rajeev Ranjan** and B. Pattnaik (2014). Foot-and-Mouth Disease: Epidemiology and Control. Indian Farming, Dec,2014: 44- 46.

Publications with inter-institutional collaborations

1. Mahapatra M., Yuvaraj S., Madhanmohan M., Subramaniam S., Pattnaik B., Paton D.J., Srinivasan V.A., Parida S. (2015). Antigenic and genetic comparison of foot-and-mouth disease virus serotype O Indian vaccine strain, O/IND/R2/75 against currently circulating viruses. **Vaccine.** doi: 10.1016/j.vaccine.2014.11.058.

2. Knowles NJ, Bachanek-Bankowska K, Wadsworth J, Mioulet V, Valdazo-González B, Eldaghayes IM, Dayhum AS, Kammon AM, Sharif MA, Waight S, Shamia AM, Tenzin S, Wernery U, Grazioli S, Brocchi E, Subramaniam S, Pattnaik B, King DP (2014). Outbreaks of Foot-and-Mouth Disease in Libya and Saudi Arabia during 2013 Due to an Exotic O/ME-SA/Ind-2001 Lineage Virus. **Transbound Emerg Dis.** doi: 10.1111/tbed.12299.

3. Vandre R.K., Sharma A.K., Gowane G.R., Sankar M., Sanyal A, Bisht P., Pattnaik B. (2014). Trend of association ofBoLA-DQA1 alleles with FMDV vaccine elicited immune response in crossbred cattle. **Indian Journal of Animal Sciences** 84 (6): 619–623.

4. Gowane G. R., Sharma A. K. , Sankar M. , Narayanan K., Bisht P., Subramaniam S. and Pattnaik B. (2014). The expression of IL6 and 21 in crossbred calves upregulated by inactivated trivalent FMD vaccine. **Animal Biotechnology.** 25: 108–118.

Lead Papers

1 Bramhadev Pattnaik (2014) Evolution of Foot and mouth disease virus in India in the XXVIII-IAVMI & International Conference on Challenges Opportunities in Animal Health at the Face of Globalization and Climate Change at DUVASU, Mathura during 30 Oct to 1 Nov 2014

2 Bramhadev Pattnaik, Saravanan Subramaniam and Jyoti Misri (2014). Trends, Current Scenario and Future perspectives for the prevention and control of FMD in the XXVIII-IAVMI & International Conference on Challenges Opportunities in Animal Health at the Face of Globalization and Climate Change at DUVASU, Mathura during 30 Oct to 1 Nov 2014

Abstract presented/published in conferences

1. S. Subramaniam and B. Pattnaik (2014). Characterization of 2013 outbreak strains of foot and mouth disease in southern peninsular India. Recent trends in Virology Research in the Omics Era. VIROCON-2014, 18-20 December, 2014, TANU, Coimbatore (TN)

2. M. Rout, B.Das, S. Subramaniam, J.K. Mohapatra and B. Pattnaik (2014). Preparedness of foot and mouth disease virus by polymerase chain reaction. International Conference on challenges and opportunities in animal health at the face of Globalization and Climate change. IAVMI-2014, 30th October-1st November 2014, Mathura (UP)

3. M. Rout, S. Subramaniam, J.K. Mohapatra, B.B.Dash and B. Pattnaik (2014). Foot and mouth disease in a pig farm at Kollam district of Kerala. National Conference on Opportunities and Strategies for Sustainable Pig Production, 20-21 December, 2014, NRC-Pig, Guwahati, Assam.

4. M. Rout,N.S.Nair, B.Das, S. Subramaniam, J.K. Mohapatra and B. Pattnaik (2014). Foot and mouth disease in Elephants in Kerala during 2013. Recent trends in Virology Research in the Omics Era. VIROCON-2014, 18-20 December, 2014, TANU, Coimbatore (TN)

5. L.K.Sarangi, J.K. Mohapatra, S. Subramaniam, L.K.Pandey, B.Das, A.Sanyal and B. Pattnaik (2014). Spectrum of VP1 region genetic variants in the foot and mouth disease virus serotype O

population derived from infected cattle tongue epithelium. International Conference on challenges and opportunities in animal health at the face of Globalization and Climate change. IAVMI-2014, 30th October-1st November 2014, Mathura (UP)

6. Jitendra K. Biswal, **Rajeev Ranjan** and Bramhadev Pattnaik (2014). Recombinant capsid polyprotein (P1)-based serodiagnostic strategy for detecting antibodies to foot-and-mouth disease virus serotype O. XXVIII annual convention of Indian Association of Veterinary Microbiologist, Immunologists and Specialists in Infectious Disease (IAVMI) and International conference on "Challenges and Opportunities in animal health at the face of globalization and climate change" DUVASU, Mathura- 281001, UP, India, 30th Oct- 1st – Nov.- 2014. Pp- 14.

7. Jitendra K. Biswal, **Rajeev Ranjan** and Bramhadev Pattnaik (2014). Mapping of the amino acid residue responsible for the enhanced adaptability of foot-and-mouth disease virus serotype A in BHK-21 cells by reverse genetics technology. XXVIII annual convention of Indian Association of Veterinary Microbiologist, Immunologists and Specialists in Infectious Disease (IAVMI) and International conference on "Challenges and Opportunities in animal health at the face of globalization and climate change" DUVASU, Mathura- 281001, UP, India, 30th Oct- 1st – Nov.- 2014. Pp- 21.

8. **Rajeev Ranjan,** Jitendra Kumar Biswal and B. Pattnaik (2014). Transplacental transmission of Foot and Mouth Disease virus in dairy cattle. Veterinary Pathology Congress- 2014. National symposium on "Impact of Climate change on Pathobiology of Diseases of animals, poultry and fish" at college of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand- 388001, Gujarat, India, 13- 15 November 2014, pp 80-81.

16

Training and Capacity Building

Training Organized

Twelve training Programmes on sandwich ELISA, SdLPBE , LPBELISA and DIVA were organized, in which for scientists from network units/regional centres of AICRP on FMD and FMD vaccine manufacturing companies.

S.No	Name of Training	Duration	AICRP Center(s)/ Industry
1	Training on FMD diagnosis (Sd-ELISA)	19.05.14 to 23.05.14	AICRP center Jalandhar
2	Training on FMD diagnosis (DIVA ELISA)	03.06.14 to 07.06.14	IIL-Hyderabad
3	Training on FMD diagnosis (Sd-ELISA)	14.07.14 to 17.07.14	AICRP centers Mathura and Shimla
4	Training on FMD diagnosis (DIVA & Sd-ELISA)	06.08.14 to 16.08.14	Arsh Biotech Pvt. Ltd
5	Training on FMD diagnosis (DIVA & Sd-ELISA)	01.09.14 to 07.09.14	AICRP center Ahmedabad
6	Training on FMD diagnosis (Sd-ELISA)	24.11.14 to 27.11.14	AICRP center Agartala
7	Training on FMD diagnosis (DIVA & Sd-ELISA)	25.11.14 to 28.11.14	AICRP centers Hisar, Mathura and Pune
8	Training on FMD diagnosis (Typing, LPB, DIVA, Sd-ELISA & mPCR)	13.01.15 to 23.01.15	NRC on Yak, Dirang
9	Training on FMD diagnosis (Typing, LPB, DIVA, Sd-ELISA & mPCR)	05.03.15 to 13.03.15	AICRP center Kolkata
10	Training on FMD diagnosis (Typing, LPB, DIVA, Sd-ELISA & mPCR)	09.03.15 to 13.03.15	AICRP center Puducherry
11	Training on FMD diagnosis (DIVA ELISA)	12.03.15 to 22.03.15	Arsh Biotech Pvt. Ltd
12	Training on FMD diagnosis (Typing, LPB, DIVA, Sd-ELISA & mPCR)	16.03.15 to 24.03.15	NRC on Yak, Dirang

Participation in the trainings/ meetings/ conferences

1. All the scientist participated in the 25th Annual Review Meeting of AICRP on FMD held at Guwahati during 10-11, October, 2014
2. Dr. B Pattnaik, Dr. J.K.Biswal and Dr.R.Ranjan attended XXVIII-IAVMI & International Conference on Challenges Opportunities in Animal Health at the Face of Globalization and Climate Change at DUVASU, Mathura during 30 Oct to 1 Nov 2014
3. Dr. B.B. Dash and Dr. Saravanan S attended training programme on consultancy projects management during 22-27, August, 2014 at NAARM, Hyderabad
4. Dr. J. K. Mohapatra and Dr. Saravanan S participated in the SBS-ASM-ICAR Biosafety Awareness Programme including workshop on "Culture of Responsibility" "Pathogen Inventory Management" and "Safety is the Rule: Fundamentals of working with Biosafety Cabinets" at ICAR-NIHSAD, Bhopal during 13 -14 March, 2015
5. Dr. Saravanan S attended VIROCON-2014 on Recent trends in Virology Research in the

Omics Era, 18-20 December, 2014, TANU, Coimbatore (TN)

6. Dr. M. Rout a ttended Kisan Gosthi on "Disaster Management along with Animal Health Camp" at village 'Dol' in collaboration with scientists of CITH and IVRI, Mukteswar, dated 16.09.2014.
7. Dr. M. Rout attended 'Kisan Mela' with a stall of PD on FMD at village Reetha-Pokhra, dated 28.10.2014.
8. Dr. B.B.Dash and Dr. M.Rout participated as registered delegate in the "XII Agricultural Science Congress on Sustainable Livelihood Security for Smallholder Farmers" held at ICAR-National Dairy Research Institute, Karnal, Haryana on 3rd – 6th February 2015.
9. Dr. Rajeev Ranjan attended regional training & awareness program on J-Gate@CeRA on 29th September 2014 at NASC Conference Facility, New Delhi.
10. Dr. Rajeev Ranjan attended Veterinary Pathology Congress- 2014. National symposium on "Impact of Climate change on Pathobiology of Diseases of animals, poultry and fish" at college of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand- 388001, Gujarat, India, 13- 15 November 2014.
11. Dr. Rajeev Ranjan participated in Kisan goshthi, organized by IVRI and ICAR-PDFMD, Mukteshwar at different places in Uttarakhand and transferred knowledge of FMD: Prevention, management and control.

17

Reports and Recommendations

17.1. Action Taken Report on the recommendation of the 25th Annual Review Meeting

S. No.	Recommendations	Action	Action Taken
1	The report on the status of FMD and its epidemiology with suitable recommendation as evaluated by each AICRP on FMD centers need to be shared and presented before the respective State AH Directors, for their appraisal ad further necessary action to be taken for the control of FMD in the respective states along with an information to ICAR-PDFMD, Mukteswar and DADF, GoI starting the with report of 2014-15.	All Regional centers and Collaborating Units of AICRP, State AH Dept. and DAHD & F, GOI	The AICRP centers have initiated the exercise
2	All the Directors of the State AH Departments to be invited to the next ARM for their views in the implementation of FMDCP and strengthening in their states disease reporting system, keeping in view of the enormous role of state AH department machinery, FMD National Control Programme.	ASD, ICAR and ICAR-PDFMD	Noted
3	Detail studies on economic impact of FMD in the country, taking into consideration of direct and indirect losses to be estimate.	ICAR-PDFMD and NIVEDI	The economic impact studies is in progress under a project in collaboration with NIVEDI
4	The role of small ruminants in the epidemiology of FMD (sheep and goats) needs to be investigated.	ICAR-PDFMD and State AH Depts.	A total of 2380 randomly collected serum samples of small ruminants were tested and found carrying antibodies against non structural protein in 40.9% of sheep and 17.18 % goats. Four clinical samples collected from pigs were tested and serotype O FMD virus was detected by mPCR.
5	FMD epidemiological studies in Kargil & Ladakh to be initiated as FMD outbreaks are reported every 2-3 years interval in the region.	ICAR-PDFMD, DAHD & F, GOI and AICRP center Jammu	The epidemiological studies in the Ladakh region is undertaken by the AICRP collaborating center of Jammu.
6	The construction of ICFMD at Bhubaneswar need to be speeded up for its completion in scheduled time	ICAR-PDFMD and NDDB	The construction work of ICFMD has been speeded up.
7	FMDCP should be implemented in all states of the country for proper vaccination and control of FMD in India.	DAHD & F, GOI	The DAHD & F, GOI has covered all the districts of Rajasthan and Uttar Pradesh under FMDCP, and it has been proposed to cover all the states under FMDCP during XII plan period.

S. No.	Recommendations	Action	Action Taken
8	Animal quarantine, surveillance and vaccination of animals against FMD at interstate borders need to be implemented	DAHD & F, GOI and State AH Depts.	Noted
9	Pilot study on effect of monovalent Serotype 'O' FMD vaccine with higher payload to be carried out in selected areas.	ICAR-PDFMD, DAHD & F, GOI and FMD vaccine industry	The focal areas for monovalent vaccination will be identified after observing the epidemiology status of FMD in the country during 2014-15
10	The AICRP on FMD collaborative center of Lucknow to be closed immediately and the FMD epidemiological study in Up will be taken up by the collaborative centre of Mathura with assistance from ICAR-PDFMD	ICAR-PDFMD and Dept. of AH, Govt. of UP	Noted
11	There will be rotation of 10 villages in each district annually covered under FMDCP for Post vaccination seromonitoring to avoid resistance from farmers to collect blood samples from their animals repeatedly.	DAHD & F, GOI and State AH Depts.	Noted
12	Keeping in view the work load due to inclusion of Rajasthan under FMDCP, the AICRP collaborating center of Jaipur may be strengthened with one scientific man power (Preferably in Veterinary Microbiology/Pathology)	Dept of AH Govt. of Rajasthan	Noted
13	The activities of the collaborating center of Patna need to be improved and disease reporting system of the State AH Department to be strengthened	ICAR-PDFMD, State AH Dept. of Bihar and AICRP collaborating center, Patna	Noted
14	Each State AH Departments is legally bound to report each incidence of FMD.	DAHD & F, GOI, State AH Depts. and ICAR-PDFMD	Noted
15	All the AICRP on FMD centers will collect 200 random serum samples from each district for testing by LPB and DIVA ELISA under National Serosurveillance Programme	ICAR-PDFMD and State AH Departments	The programme has been implemented
16	Alternate Serotype 'A' FMD virus vaccine candidate strain to be identified to cover the mismatched serotype 'A' variants.	ICAR-PDFMD	The work is under progress to identify a suitable vaccine candidate.
17	The performance of AICRP on FMD collaborating centers of Itanagar, Patna, Jammu and Cuttack need to be improved substantially	ICAR-PDFMD and concerned State AH Departments	Noted
18	Studies on the virulence of FMD virus isolate causing recent outbreaks in 2013 in Southern India need to be initiated.	ICAR-PDFMD	The work will be initiated with the availability of animal experimentation facilities
19	The disease investigating agencies at the time of outbreak investigation need to follow biosecurity and bio-safety measures to check the spread of the disease in the process	AICRP Regional Centers and Collaborating Centers and State AH Departments	Noted
20	Serum samples of DIVA to be collected from animals of 1-2 years old and for seromonitoring of vaccinal immunity above 1.5 years of age	All AICRP Regional Centers and State AH Departments	Noted
21	The supply of the diagnostics kits from the central laboratory, ICAR-PDFMD, Mukteswar, to the AICRP centers may be made through the courier to save time, manpower and expense on travel	ICAR-PDFMD	Implemented

S. No.	Recommendations	Action	Action Taken
22	ICAR-PDFMD should conduct proficiency testing for the AICRP scientists.	ICAR-PDFMD	Continuing
23	FMD vaccination should come under the right to service for farmers for which necessary legislation need to be framed	DAHD & F, GOI and State AH Depts.	Noted
24	Vaccination for FMD may continue in Andaman & Nicobar Islands till there are DIVA positive animals, and transport of DIVA negative animals from mainland need to be ensured to prevent re-entry of FMD virus	DAHD & F, GOI and Dept. of AH, Govt. of A&N Islands	Noted
25	Budget for 100% biannual FMD vaccination may be used from ASCAD/RKVY fund in the stats where FMDCP is not implemented for the control of FMD	DAHD & F, GOI and State AH Depts.	Noted

17.2. Action Taken Report on the recommendation of 11th IMC meeting held on 7-11-2014

S No.	Agenda/Recommendation of IMC	Comments of the Members	Comments of the Director	Action Taken
1	**Approval of the proceedings of the 10th meeting of the Institute Management Committee of the Project Directorate on FMD** Proceedings of 10th IMC were discussed at length and ATR was presented by I/C PME Cell. It was observed that appropriate action is being taken/initiated on all the recommendations of 10th IMC	The members expressed their satisfaction over the action taken/initiated of 10th meeting recommendations. However the members insisted to put scientists at the site to monitor the day to day activities in the site of IC-FMD and ensure that biosafety standards are maintained during construction. The biosafety officer should be aquatinted with the penetration inlets and outlets in the BSL3 facility. The construction work need to be escalated for timely completion without further delay.	Scientists will be put at the site of ICFMD as per the necessity at the earliest. The progress of the work is being monitored every fifteen day by the local monitoring committee constituted by ICAR	One Senior Scientist (Vet Microbiology) has been posted at ICFMD to see, learn, and record the bio-safety features being incorporated during construction of the BSL3+ Laboratory, so that the operation becomes handy after commissioning.
2	**Presentation of the 5th QRT Report for the period 2009-14** The Chairman of 5th QRT presented the report with recommendation which was discussed in the house in detail.	The Chairman and members of 5th QRT applauded the research achievements made by the scientists of ICAR-PDFMD. They expressed satisfaction with the research projects being pursued at ICAR-PDFMD and the quality diagnostic kits produced that is being used in the country for FMD diagnosis and surveillance with uniform SOP. The members of IMC agreed with the assessment and recommendation of 5th QRT in respect of ICAR-PDFMD	The 5th QRT report was submitted after thorough discussion and the provision of BSL 2 facility in the AICRP centers will be initiated.	The 5th QRT report has been submitted to the Council.

S No.	Agenda/Recommendation of IMC	Comments of the Members	Comments of the Director	Action Taken
3	**Presentation on research accomplishments of the institute (2013-14)** I/C PME Cell presented the project wise research accomplishments undertaken during 2013-14	Hon'ble members appreciated the sincerity and devotion of scientists for the preparedness to meet the real time surveillance of FMD in the field condition with rapid action. The members were of the opinion to strengthen the FMD awareness programme to sensitize the livestock owners to vaccinate their animals regularly.	ICAR-PDFMD remains alert and takes prompt action on the FMD incidences once it is brought to its notice and also regularly monitors the disease occurrence and FMD vaccine response with reporting to all the stake holders. However, disease reporting and the FMD vaccination programme are in the domain of DADF and ICAR-PDFMD only provides technical/scientific back stopping. It was informed that the southern states were affected extensively with FMD during 2013-14 caused by serotype "O" virus of genomic lineage IND2001d having similar antigenic matching with the in-use vaccine strain indR2/75. All the concerned state AH departments were advised to vaccinate the animals against HS before onset of monsoon to restrict the major secondary infection with FMD to check mortality	Regular surveillance and monitoring of FMD has been undertaken on regular basis with strengthening of FMD awareness programme.
4	**Discussion on RFD for 2013-14** The RFD of the institute for 2013-14 was presented by the RFD nodal officer with the objectives, actions taken, success indicators and achievements and the score cards. it was stated that ICAR-PDFMD's performance was adjudged as excellent for the year 2013-14 with the score of 98.47.	Hon'ble members expressed their satisfaction and congratulate the scientists for their contribution. They also encouraged the scientists to keep it up in the future.	Noted	All the targets fixed under RFD were achieved.
5	Budget allocation for the financial year 2013-14 It was presented by I/C PME cell which was reviewed by the IMC	The IMC expressed the satisfaction of the optimum utilization of the allocated budget.	Budget utilization was as per the annual allocation.	The allocated budget was fully utilized

S No.	Agenda/Recommendation of IMC	Comments of the Members	Comments of the Director	Action Taken
6	**Purchase of essential laboratory equipments during 2014-15** **It was proposed to purchase the following essential laboratory equipments being approved under XII plan EFC.** New Generation Nucleic acid Sequencer (One) Thermalcycler (two) and Luminometer (one)	The members agreed to the purchase of equipments i.e. new Generation Nucleic acid Sequencer (one), Thermalcycler (two) and Luminometer (one) keeping in view of the researchable issues of priority and to facilitate research activities.	The required fund is already available under the head, equipment in the XII plan, and procurements tenders have been finalized and orders issued.	The suggested equipments were purchased following the codal formalities.

17.3. Action Taken Report on the recommendation of 6th Meeting of the RAC Held on 29-03-2014

S.No.	Recommendation	Comment of the Director, ICAR-PDFMD	Action Taken
1	All the new research projects enlisted for 2014-15 including one outside funded and one inter institutional collaborative research projects were approved by RAC.	All the Projects have already been initiated	Seventeen institutional projects out of eighteen were completed with one project is under progress. One inter institutional project is under progress and another project is to be extended for second year. The outside funded international project is under progress.
2	Studies on molecular epidemiology of FMD need to be continued with studies on the field isolates of each outbreak of FMD.	Studies on molecular epidemiology of FMD virus isolates retrieved from clinical samples are under taken routinely and further emphasis will be given to cover all the outbreaks of FMD.	Molecular epidemiology of 121 field isolates with nucleotide sequencing of 155.81 Kb was done and all the outbreaks were thoroughly investigated.
3	In order to assess the trend of FMD virus isolates causing large scale incidences of FMD as experienced in the southern States of the country, studies on virus ecology and area specific epidemiology need to be under taken.	Project on 'understanding virus ecology and landscape epidemiology for control and eradication of FMD' has been initiated in collaboration with USDA.	The project work is under progress and to be continued for the second year.
4	The vaccine matching exercise to ascertain the antigenic relationship of the field isolates with the in-use vaccine strains to be continued with further characterization of the unmatched isolates with low antigenic relationship and identification of a suitable vaccine candidate to cover these isolates.	One project has been initiated to evaluate FMD serotype O virus vaccine candidate panel using the recent field virus isolate causing major incidences of FMD.	Two suitable vaccine candidate strains have been identified against serotype O virus.

S.No.	Recommendation	Comment of the Director, ICAR-PDFMD	Action Taken
5	The disease reporting system need to be strengthened for instant reporting of the outbreaks of FMD and each outbreak should be thoroughly investigated particularly in FMD-CP areas.	Disease reporting in the country is in the domain of State AH departments. However, necessary facilities are available in all the AICRP-FMD centers for quick reporting of FMD outbreaks and proper investigation of the outbreaks are conducted from time to time. It will be further emphasized to attain the outbreaks at shortest possible intervals.	Disease reporting system have been further strengthened with the availability of free SMS system and through e-mail by all the stake holders including livestock owners / farmers.
6	Study on epidemiology of FMD in small ruminants and pigs is required to establish the status of FMD in these species of animals and their role in transmission of FMD virus to cattle and buffalo.	Research projects are under progress to study in details the epidemiology of FMD in small ruminants and pigs for their role in FMD incidences in large ruminants.	A total of 2380 randomly collected serum samples of small ruminants were tested and found carrying antibodies against non structural protein in 40.9% of sheep and 17.18 % goats. Four clinical samples collected from pigs were tested and serotype O FMD virus was detected by mPCR.
7	Studies on the host genetics factors for vaccine response to FMD may be carried out in indigenous and crossbred cattle in collaboration with the Division of TAH, IVRI, Mukteshwar, and host genetic markers providing resistance to FMD in animals may be identified	A Pilot study on the role of host genetic factors in vaccine response against FMD has been formulated and initiated in collaboration with the Division of TAH, IVRI, Mukteshwar	One research project in collaboration with the Division of TAH, IVRI has been initiated since October 2014.
8	One day workshop on FMD and its impact on export of livestock products may be convened at ICAR-PDFMD, Mukteswar involving the meat industry, NRC on meat and DADF, Govt. of India	The workshop will be organized in due course of time in collaboration with the NRC on meat an Dept. of DAJDF, Govt. of India involving all the stake holders.	The workshop has been deferred due to FMD incidences in nearby areas of ICAR-PDFMD and will be held in due course of time.
9	ICAR-PDFMD has to enhance its FMD awareness programmes in the country by participating with IVRI and other ICAR institutes.	Noted and to be followed	ICAR-PDFMD is participating with the extension activities of IVRI and other ICAR institutions to enhance the FMD awareness programme.
10	The construction work for BSL3 Ag laboratory of international Center on FMD (ICFMD) needs to be hastened for early functioning of the containment laboratory to carry out the R&D activities on FMD involving live FMD virus	The construction of the BSL3 Ag laboratory of International Center on FMD (ICFMD) has already started w.e.f. March 2014 and its progress is monitored from time to time	The construction of the BSL 3 Ag laboratory of ICFMD is continuing.
11	Necessary human resources need to be developed at ICAR-PDFMD in the areas of Bio-informatics, Bio-safety, GIS etc to address the requirements of FMD epidemiology and research in the country	Scientists will be deputed for training in India and abroad in the field of cutting edge technologies to manage the future research programmes of the institute.	Two scientists have been trained for Bio-Safety and Bio-Security measures.

S.No.	Recommendation	Comment of the Director, ICAR-PDFMD	Action Taken
12	The name of ICAR-PDFMD may be replaced as Directorate of FMD or a National institute to address the existing problem of FMD in the livestock leading to its control and eradication from the country	In the XII plan EFC meeting, the name has been changed to Directorate of Foot and Mouth Disease.	The new name of ICAR-PDFMD is under consideration of the Council.

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Acknowledgements

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Scientists of ICAR-PDFMD participated in XII Agricultural Science Congress, NDRI, Karnal during 3/2/15 to 6/2/15

25th Annual Review Meet on All India Co-ordinated Research Project for epidemiolocal studies on Foot-and-mouth Disease at AAU, Khanapara, Guwahati.

Dr S. Ayyappan, Secretary (DARE) and DG, ICAR visited the site of IC-FMD, Argul, Odisha.

OIE visited ICAR-PDFMD

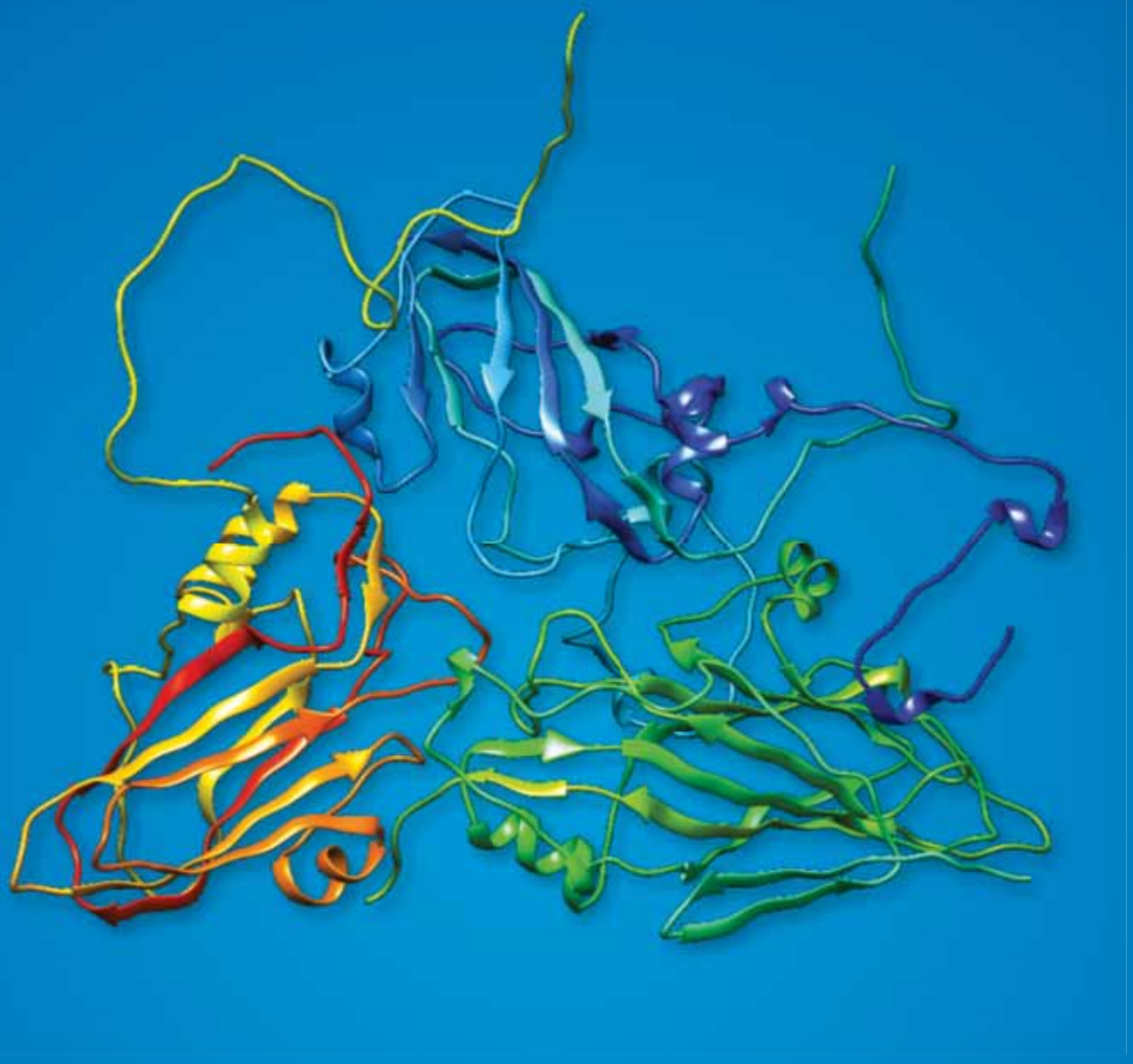
PTC members at IC-FMD site

QRT Meeting

Secretary DADF visited ICAR-PDFMD

Special secretary, DARE, visited IC-FMD site

Visit of Secretary ICAR, DDG (AS) and MD of NDDB to the ICFMD site



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