Annual Report

2012-13

Project Directorate on Foot and Mouth Disease
Mukteswar 263 138
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1.0

Project Director's report

India has a FMD susceptible livestock population of 528 million (DAHD&F, GoI, 2007). The overall contribution of Livestock sector to the Agricultural GDP is 28-32% and to national GDP is 4-6%. The economic losses to the livestock industry attributed to FMD are large. There are direct and indirect losses due to this menace. Direct losses to livestock sector are due to significant drop in milk yield (minimum 30%), reduction in meat production, abortion in pregnant animals, and reduction in wool production and mortality in calves. Indirect losses to livestock sector are due to loss of productive function, breeding capacity, reduced draft capacity in working bullocks, loss of milk yields on a permanent basis, loss in flesh in meat animals, flare up of opportunistic infections. Most importantly, loss in cattle trade both national and international, and massive expenditure by Government on FMD control and cost of treatment.

Though it is rarely fatal in adult animals, still is the most feared infectious animal disease owing to nearly 100% percent morbidity, rapid spread, severe decrease in livestock production with calf mortality. There is more than 30% loss in livestock productivity due to reduced growth rate, decreased milk production and crippled agricultural draught power. Milk is the largest contributor to the National GDP among agricultural commodities and contributes to 70% of the livestock output in India, and drop in milk production due to FMD amounts to 80% of the total loss. The direct losses alone due to FMD in India are estimated to be more than USD4.5 billion per year and indirect production losses could be much more that are not yet estimated. Besides, losses due to trade embargo could be many fold more.

Progressive Control Pathway has been developed by FAO for global eradication of FMD. Vaccination based FMD control programme is in operation in India which involves biannual vaccinations of all cattle and buffaloes in selected areas, regular active surveillance and antibody monitoring in vaccinated population with the objective of creating FMD free zones. At present, the disease occurrence, severity of the clinical disease and number of outbreaks have progressively and substantially declined in the control zones as a result of last 13-14 rounds of vaccination with an oil adjuvanted trivalent inactivated vaccine. Short duration of immunity and thermolabile virus structure are major concerns associated with the inactivated vaccine.

Foot-and-mouth Disease (FMD) is a highly contagious viral disease of cattle and buffalo. The disease also affects goats, sheep, pigs, wild ruminant species and elephants. 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 in each serotype. Currently three serotypes (O, A and Asia1) are prevalent in India. Serotype O is the most dominating one followed by serotypes Asia1 and A.

During the year, a total of 331 outbreaks were recorded (Table 1.1). Almost 60% of the total outbreaks were recorded in Eastern and North Eastern states which are not covered under FMD control programme. Maximum numbers of outbreaks were recorded in the states of West Bengal and Assam. There was no incidence of the disease in the states of Punjab and Haryana during 2012-13. There has been reduction in the incidence of FMD in the southern region and western region compared to previous year. All the four states in the southern region and two states (Gujarat and Maharashtra) in western region are covered under FMDCP since 2010-11.

Table 1.1: Number of confirmed FMD outbreaks in different geographical region of the country during the last seven 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

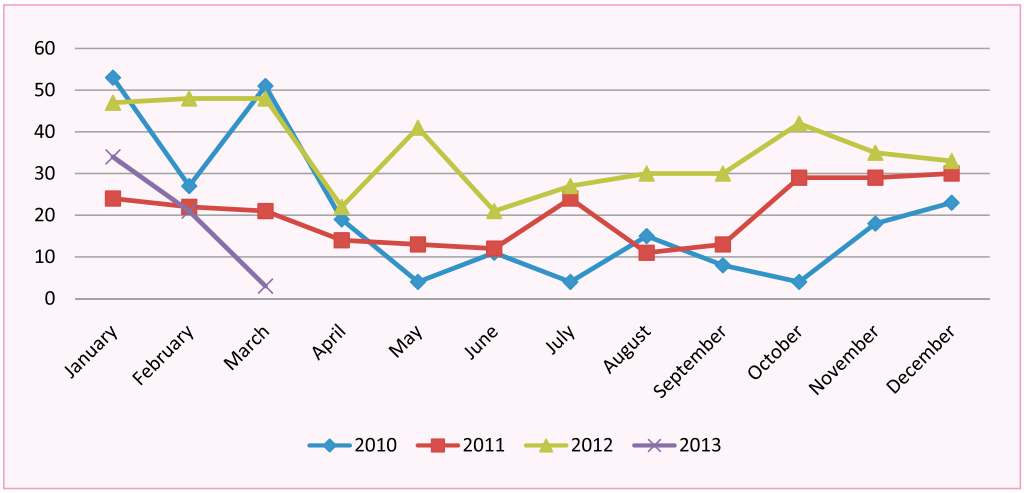
Serotype O caused maximum numbers of outbreaks (79.8%) followed by serotypes Asia1 (15.7%) and A (4.5%). Compared to previous year, number of outbreaks owing to serotype O has considerably increased (Table 1.2). Outbreaks due to serotype Asia1 has decreased by 1.5 fold compared to the last year and occurrence of serotype A remained almost same. Serotype O was most prevalent in all the geographical regions. There was one fold decrease in serotype O outbreaks and 2.5 increase in serotype Asia1 incidences in southern region compared to last year. Serotype Asia1 of 'Western cluster' was introduced in to the southern region during 2010-11 and now wide spread in the states of Karnataka, Tamilnadu and Kerala.

Serotype Asia1 has been occuring regularly in Eastern, North Eastern and Western region of the country. This year, approximately 2 and 5 fold reduction in incidence of serotype Asia1 was observed in Eastern and North Eastern states, and Western region, respectively. All the three serotypes (O, A and Asia1) occurred in North Eastern and Southern regions. Serotype O and Asia1 occurred in Central, Western and Eastern regions. Serotypes O and A occurred in Northern region. In Northern region, serotype Asia 1 could not be detected continuously for last three years since 2010-11 and serotype A appeared after a gap two year (2010-11 and 2011-12). In North Eastern region, serotype A dominated the scenario followed by serotype O. In Eastern region, increase in incidence of serotypes O and Asia1 was observed compared to previous year.

Table 1.2: Year wise break-up of outbreaks and FMDV serotypes involved during last seven 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

The outbreaks occurred round the year with maximum occurrence during October to March, and in May and June **(Fig. 1.1)**



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 shows that 'Ind2001' strains, which reemerged in late part of the year 2008, nearly out-competed PanAsia lineage in causing outbreaks in the county. A distinct genetic cluster of Ind2001 lineage (designated here as Ind2001^{UP-11}) responsible for the outbreaks in UP, Uttarakhand, HP and Odisha last year appears to be major cause serotype O outbreaks during 2012-13 and was detected in many states in different regions of the country. The Ind2011 lineage which appeared during 2011-12 could not be detected in any of the outbreak this year, probably due to infection immunity or natural extinction. In case of serotype A, all the isolates were found to cluster within the genotype 18 in the maximum likelihood tree, and grouped only in the clade 18c of the VP3^{59}-deletion lineage. Clade 18c which was first detected in southern peninsular India during 2007 has disseminated to Central, Eastern, Western and Northern parts of India after 2009. In case of serotype Asia1, the isolates clustered within the lineage C indicating its exclusive prevalence since 2005. Isolates of Western clusters which were introduced to Southern region during 2011-12, now entered in to Eastern region in the states of West Bengal and Odisha. Outbreaks owing to serotype Asia1 in Odisha is very significant as it was not detected for last five years.

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 assessing 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 90% of the field isolates. A few 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 in the present context as more than 90% of the field isolates showed closer antigenic match with in-use vaccine strain. In case of serotype A, about 60% of the isolates did not show perfect match with the vaccine strain, IND40/2000. Therefore, study has been initiated to evaluate alternate candidate strains for better antigenic coverage with broader match potential. In serotype Asia1, about 25% of the isolates collected during 2012-13 had less antigenic match with the currently used vaccine strain, IND63/1972. The isolates collected during 2012-13 differed from the vaccine strain by 15.1 to 18.9% at nucleotide level and 9.6 to 12.1% at amino acid level. A vaccine

candidate panel [IND13/2001, IND78/2011(177) and IND68/2012 (126)] has been identified and being evaluated to have broader antigenic match.

National FMD Virus Repository was upgraded with 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 77 virus isolates (32 type O, 19 type A and 26 Asia 1) were added to the repository during the reported period. At present the National FMD virus Repository holds a total of 1851 isolates (O-1180, A-298, C-15 and Asia 1-358).

Under National FMD Serosurveillance, 40,934 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 indicator of FMD virus exposure regardless of vaccination status. The test revealed overall seropositivity in ~ 26.4% samples/animals. The pattern is similar to previous year. Under FMD control programme, a total of 1,55,611 pre and post vaccinated serum samples were tested and of which, 54,642 serum samples were from first phase FMDCP (54) districts representing XII, XIII and XIV phases of vaccinations and remaining 1,00,969 serum samples were from FMD CP districts (167) of 2010-11, representing Phases I, II and III. After phase XIII vaccination, 53.6, 41.6 and 42.3 percent of animals tested were having protective antibody level (log10 1.8 and above) against serotypes O, A and Asia 1, respectively in post-vac serum samples. After phase II vaccination under expanded FMDCP, 67, 43.4 and 34.5 percent of animals tested were having protective antibody level against serotypes O, A and Asia 1, respectively in post-vac serum samples. There has been substantial reduction in occurrence of the disease in first phase FMDCP districts. The extended FMDCP areas are likely to yield positive result soon.

Seven training programme for the scientific staff of Regional Centers and Network units were conducted on use/application of virus typing 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 electronic guidance. Two regional training were conducted on FMD diagnosis and vaccine matching for scientists from Sri Lanka, Bangladesh, Pakistan, Nepal, Bhutan and Afghanistan as Regional Leading Diagnostic Laboratory (RLDL) for FMD in South Asia. Requirement of diagnostics kits in the Government sector and vaccine industry was met by the institute. During the period, r3AB3 DIVA Kit for FMD to test 85,350 samples was supplied to the AICRP units and vaccine manufacturing companies. Similarly, virus serotyping Kits for 11,500 tests and LPB-ELISA Kits for 1, 77,850 were supplied to FMD Regional centers/ network units for sero-surveillance and monitoring of FMD. Diagnostic kits were also supplied to SAARC Countries.

I am happy to share that PDFMD is now 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). International Center for FMD will be commissioned by 2014-15. 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 the 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 Scientists (AH) for their support.

B. PATTNAIK

2.0

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.

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.

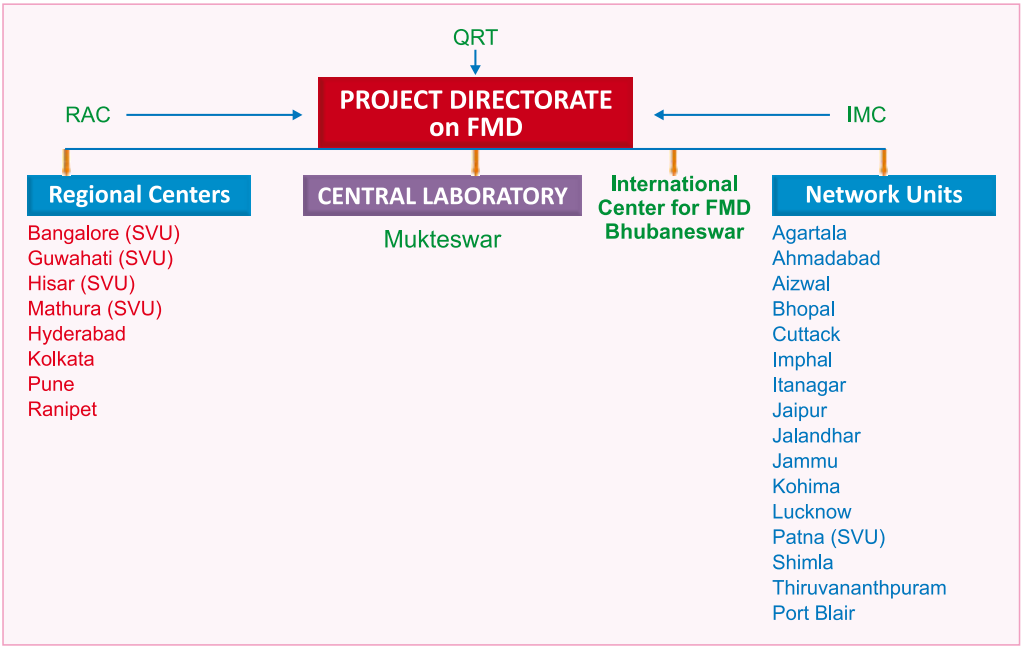
Technical Programme

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.

3.0

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.



Staff Position

Scientific Staff				
S.No.	**Name of the scientist**	**Designation**	**Discipline**	**Joining in the Current Post**
1	Dr. Bramhadev Pattnaik	Project Director	Veterinary Microbiology	December 2006
2	Dr. Aniket Sanyal	Pr. Scientist	Veterinary Microbiology	April 2009 (On deputation eputation)
3	Dr.Bana.B.Dash	Sr. Scientist	Veterinary Microbiology	August 2009
4	Dr. Jajati. K. Mohapatra	Sr. Scientist	Veterinary Microbiology	Joined March 2012
5	Dr. Saravanan Subramaniam	Scientist	Veterinary Microbiology	May 2007
6	Dr. Sachin S Pawar	Scientist	Animal Biotechnology	May 2008
7	Dr.Muniswamy Kankeyan	Scientist	Animal Biotechnology	June 2008
8	Dr.Gaurav.K.Sharma	Scientist	Veterinary Microbiology	December 2009
9	Dr. Manoranjan Rout	Scientist	Veterinary Pathology	March 2010
11	Dr. Rajeev Ranjan	Scientist	Veterinary Pathology	September 2010 (On study leave)
12	Dr. Jitendra .K.Biswal	Scientist	Animal Biotechnology	September 2011

Administrative, Technical and Supporting staff				
S.No.	**Name of the scientist**	**Designation**	**Joining in Current Post**	**Month of Leaving**
1	Shri. A.K.Rai	AO	June, 2012	Continuing
2	Shri. D. N. Joshi	AAO	January 2009	Continuing
3	Shri. Raja Ram	AF & AO	February, 2012	Continuing
4	Shri. A. K. D. Bhatt	T-3 (Stockman)	April 1999	September, 2012
5	Shri Nayan Sanjeev	T-3 (Lab)	October 2010	Continuing
6	Shri D.S.Deolia	T-1 (Lab)	January, 2012	Continuing
7	Shri J.P.Bhan	S. S. Gr. IV	February 2008	Continuing
8	Shri R.N.Sahoo	UDC	May, 2012	Continuing

5.0

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 and Andhra Pradesh), North Eastern (States of Assam, Manipur, Meghalaya, Mizoram, Arunachal Pradesh, Sikkim and Tripura), Northern (States of Uttar Pradesh, Punjab, Haryana, Himachal Pradesh, Jammu& Kashmir and Uttarakhand), Western (States of Rajasthan, Gujarat and Maharashtra) and Central (Madhya Pradesh and Chhattisgarh).

Table 5.1: FMD cases/outbreaks recorded and diagnosed during 2012-13 and virus serotype(s) involved

States	Reporting AICRP Centre/Unit	No. of. FMD cases/ outbreaks	No. of. Samples tested	Virus Serotyping Results		
				O	A	Asia1
Southern Region						
Tamil Nadu	Ranipet	10	15	04(04)	-	06(06)
Andhra Pradesh	Hyderabad	01	02	01(01)	-	-
Karnataka	Bangalore	42	102	28(44)	05(09)	09(15)
Kerala	Thiruvanthapuram	15	42	07(11)	-	08(09)
Total		**68**	**161**	**40(60)**	**05(09)**	**23(30)**
Northern Region						
Jammu & Kashmir	Jammu	07	21	07(13)	-	-
Haryana	Hisar	No disease				
Himachal Pradesh	Shimla	02	10	02(10)	-	-
Punjab	Jalandhar	No disease				
Uttar Pradesh	Mathura	02	07	01(01)	01(01)	-
	CADRAD	02	11	02(03)	-	-
Uttarakhand	-	03	21	03(07)	-	-
Total		**16**	**70**	**15(36)**	**01(01)**	**-**
Central Region						
Madhya Pradesh	Bhopal	21	59	16(32)	-	5(12)
Total		**21**	**59**	**16(32)**	**-**	**5(12)**
Western Region						
Gujarat	Ahmadabad	02	09	02(03)	-	-
Maharashtra	Pune	05	15	-	-	05(15)

States	Reporting AICRP Centre/Unit	No. of. FMD cases/ outbreaks	No. of. Samples tested	Virus Serotyping Results		
				O	A	Asia1
Rajasthan	Jaipur	07	07	05(05)	-	02(02)
Total		**14**	**31**	**07(08)**		**07(17)**
Eastern Region						
Odisha	Cuttack	15	13	10(05)*	01(02)	04(05)
Bihar	Patna	27	74	27(59)	-	-
West Bengal	Kolkata	61	106	50(87)	-	11(19)
Jharkhand	CADRAD	01	10	-	01(10)	-
Total		**104**	**203**	**87(151)**	**02(12)**	**15(24)**
North Eastern Region						
Assam	Guwahati	62	79	54(51)*	8(27)	-
Meghalaya	Guwahati	03	07	03(07)	-	-
Arunachal Pradesh	Itanagar	19	205	19(110)	-	-
Nagaland	Kohima	11	06	09(06)*	-	02*
Mizoram	Aizwal	03	18	03(18)	-	-
Manipur	Imphal	06	13	06(13)	-	-
Tripura	Agartala	04	06	04(06)	-	-
Total		**108**	**334**	**98(211)**	**8(27)**	**02**
Grand Total		**331**	**859**	**263(464)**	**16(49)**	**52(85)**

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
*Outbreaks diagnosed retrospectively

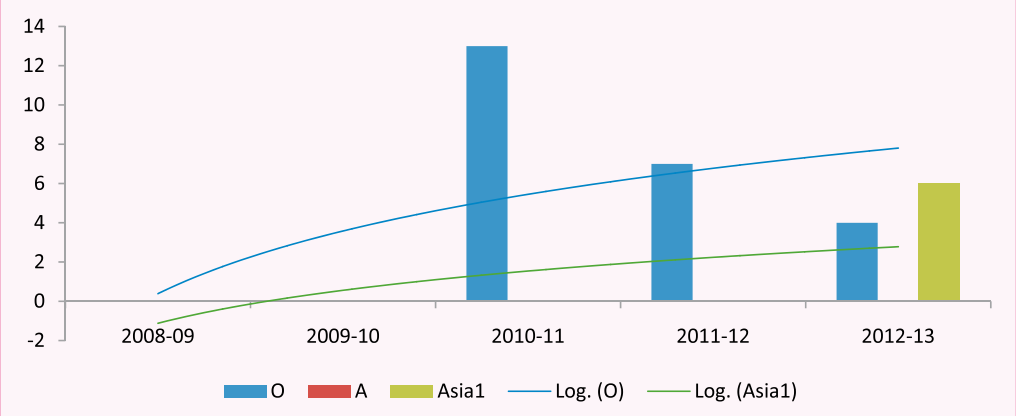


Fig. 5.1: FMD scenario in Tamilnadu during last five years

5.1 Southern Region

Tamilnadu: During the year under report, 10 FMD cases/outbreaks were recorded in the state. FMDV serotype Asia1 was responsible for 06 outbreaks, and remaining 04 outbreaks/cases were caused by serotype O. Outbreaks were recorded in the months of August (03), October (03), September (02) and February (02). Maximum occurrence was in Dindigul (04), followed by Vellore (03), Theni (02) and Villupuram (01). Last occurrence of serotypes A and Asia1 was during 2007-08. There was no incidence of FMD during 2008-10. During 2010-11, only serotype O was recorded.

Karnataka: During the year, 42 outbreaks/ cases were reported in the state. Serotype O caused maximum number of cases (28) followed by serotypes Asia 1(09) and A (05). Highest number of cases were reported from Ramanagara (15) followed by Bangalore urban (06), Bangalore rural (06), Chikkaballapur (05), Gadag (02) and Davanagere (02), and one each in Mandya, Mysore, Shivamoga, Uttarkanada and Kolar districts. The cases were recorded almost throughout the year viz; April (03), May (02), June (08), July (06), August (05), September (03), October (03), November (02), January (05), February (04), and March (01). The disease affected cattle, buffaloes and sheep. Serotype Asia1 was introduced in to the state during 2012-13 after a gap of five years and established itself as the second most prevailing serotype in the state. This has been due to animal movement in to the state.

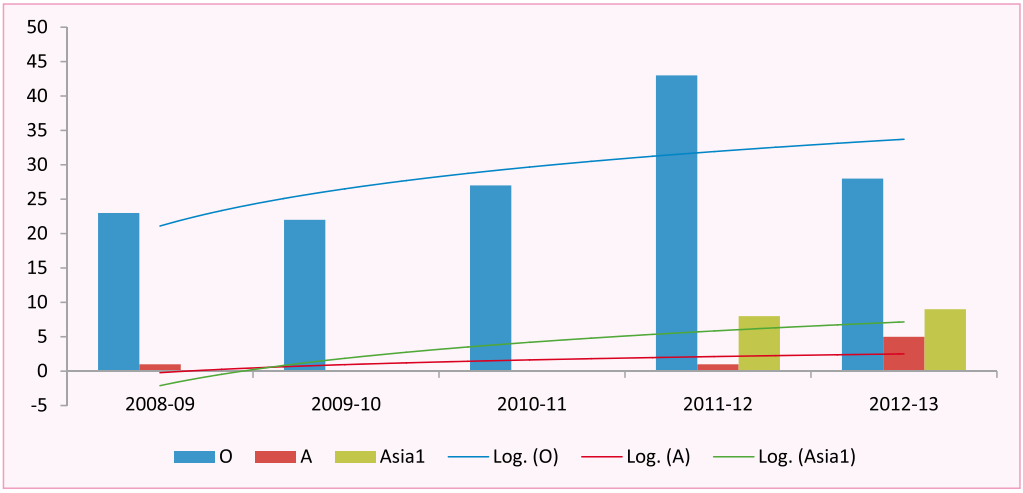


Fig. 5.2: FMD scenario in Karnataka during last five years

Andhra Pradesh: With the launch of FMD CP, the state remained relatively free of FMD. This year, only a single case of FMD was recorded in Khammam districts during the month of September. The disease was recorded in a few animals and caused by serotype O. There was no incidence of serotype Asia1 since 2007-08, and serotype A since 2011-12.

Kerala: A total of 15 outbreaks/cases were recorded in the state. The outbreaks were caused by serotypes O (07) and Asia1 (08), and were recorded in the districts of Thrissur (04), Kollam (04), Kozhikode (02), Pathanamthitta (01), Idukki (01), Wayanad (01), Palakkad (01) and Malappuram (01). Disease was recorded in the months of June (03), September (03), October (03), February (01), April (01), May (01), August (01), December (01) and January (01). Previous incidence of serotypes Asia1 and A was in 2007-08 and 2009-10, respectively.

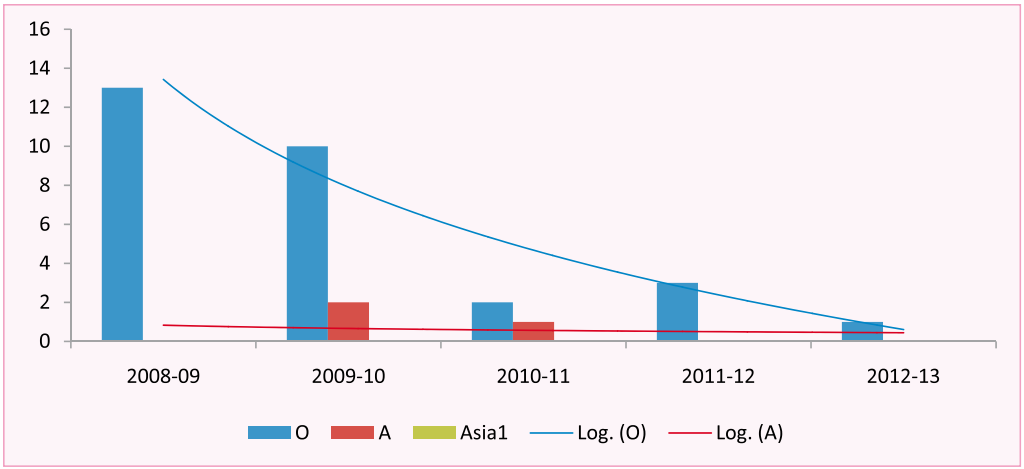


Fig. 5.3: FMD scenario in Andhra Pradesh during last five years

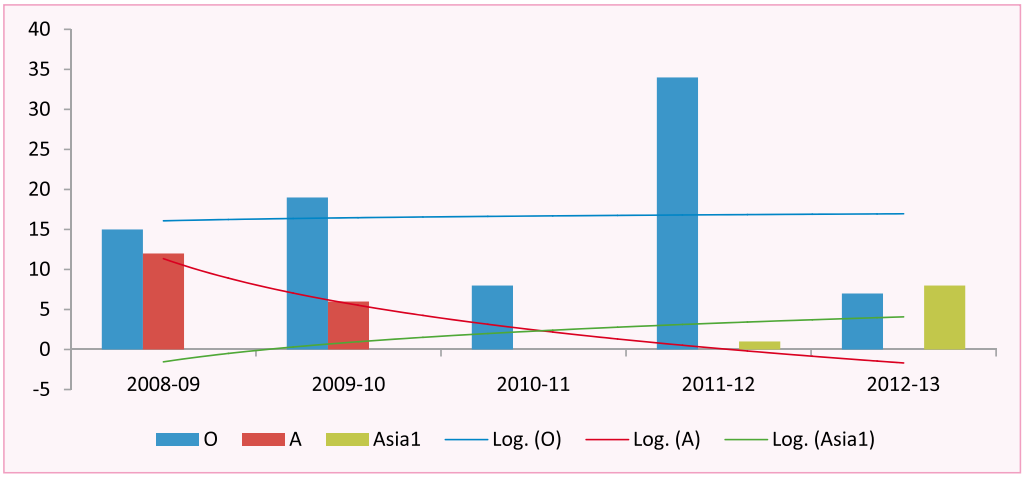


Fig. 5.4: FMD scenario in Kerala during last five years

5.2 Northern Region

Haryana: There was no incidence of FMD in the state during the period. Four FMD cases owing to serotype O were recorded during 2011-12 and were controlled effectively due to biosecurity measures and surrounding herd immunity.

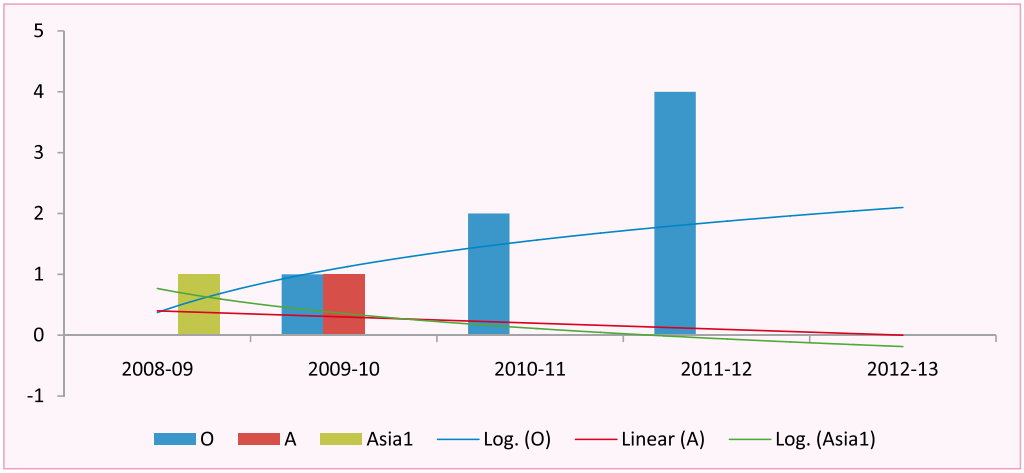


Fig. 5.5: FMD scenario in Haryana during last five years

Punjab: The state remained free of FMD during the period. Previous FMD incidence was recorded in the state during 2010-11.

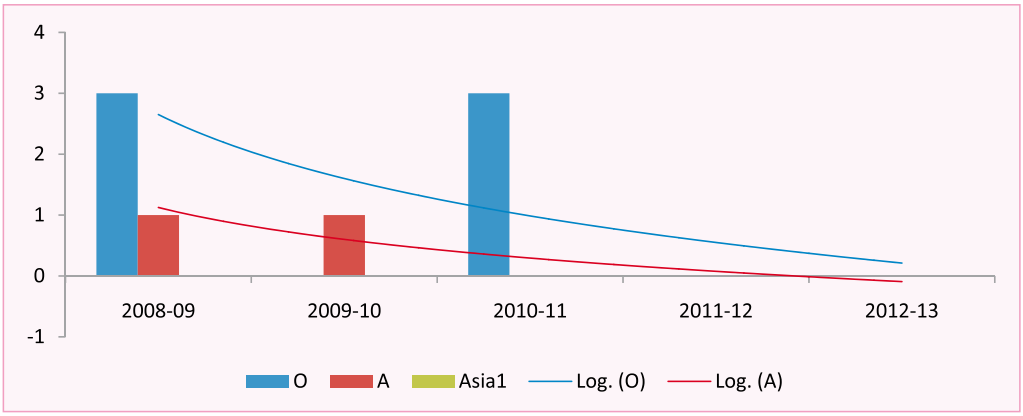


Fig. 5.6: FMD scenario in Punjab during last five years

Himachal Pradesh: Two outbreaks/cases due to serotype O was recorded in the state, one each in the months of August and September. The cases were recorded in Kaza and Mandi districts in cattle and Yak. There was no incidence of FMD in the state during 2007-09. Single case of FMD owing to serotype O each was recorded in the state in 2009-10 and 2010-11, and three cases owing to serotype O was recorded during 2011-12.

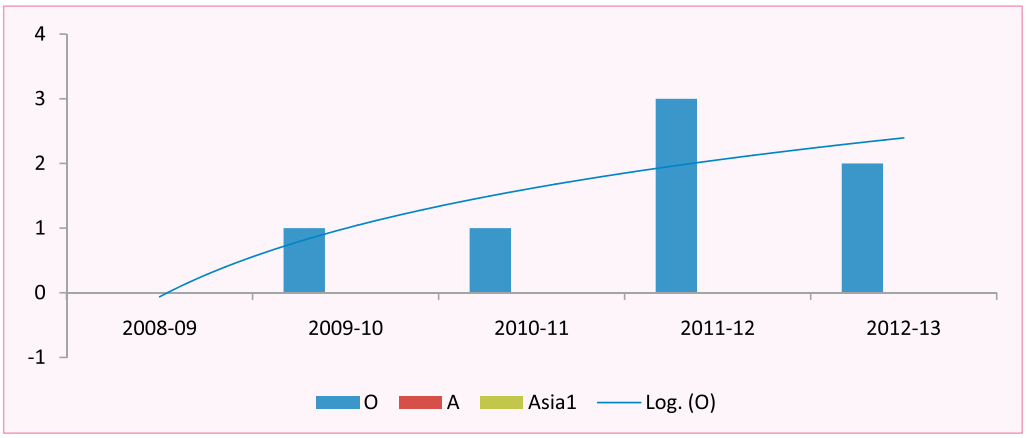


Fig. 5.7: FMD scenario in Himachal Pradesh during last five years

Uttar Pradesh: Four outbreaks/cases were confirmed in the state. The incidences were recorded in Hathras (01), Mathura (01) and Bareilly (02) districts. Outbreak in Hathras was due to serotype A, and in Mathura and Bareilly; serotype O was responsible for the incidence. The incidences were recorded in the month of April (02), March (01) and July (01).

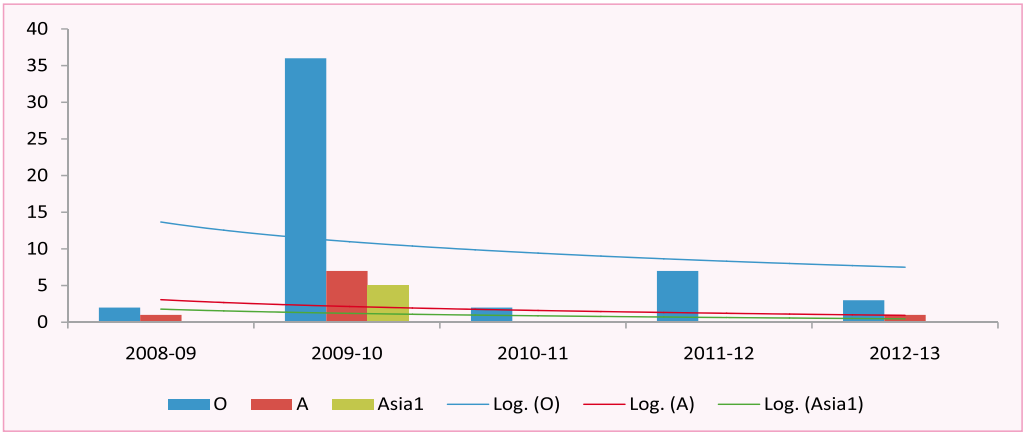


Fig. 5.8: FMD scenario in Uttar Pradesh during last five years

Jammu and Kashmir: Seven outbreaks/cases owing to serotype O was recorded in the state. Outbreaks were recorded in the districts of Jammu (01), Srinagar (02), Bandipore (01), Kupwara (02), Leh (01) and Doda (01). Three outbreaks were recorded in the month of July and one each was recorded in the months of April, May, June, October and November. Serotypes A and Asia1 have not been detected in the state during last five years (2006-2011).

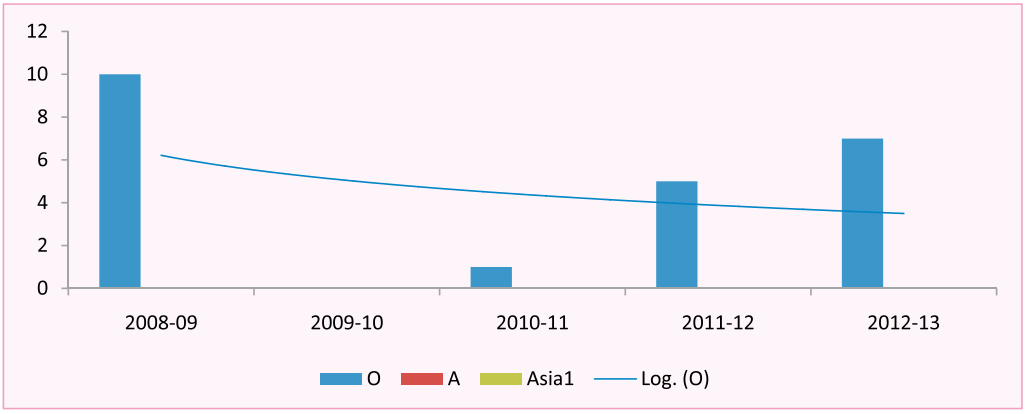


Fig. 5.9: FMD scenario in Jammu and Kashmir during last five years

5.3 Central Region

Madhya Pradesh: During this period, twenty one FMD outbreaks/cases were recorded in the state. Disease was recorded in the districts of Jabalpur (04), Bhopal (05), Khargone (01), Seoni (01), Betul (06), Sehore (01), Raisen (01), Shivpuri (02). Maximum outbreaks (04) were recorded in the months of April and October followed by 03 each in November, December and January, and two each in May and June. Serotype O accounted for 16 outbreaks and serotype Asia1 caused 05 outbreaks. Serotype Asia1 was not detected in the state for last two years in the state. Serotype A which was prevalent during last two years could not be recorded during this year.

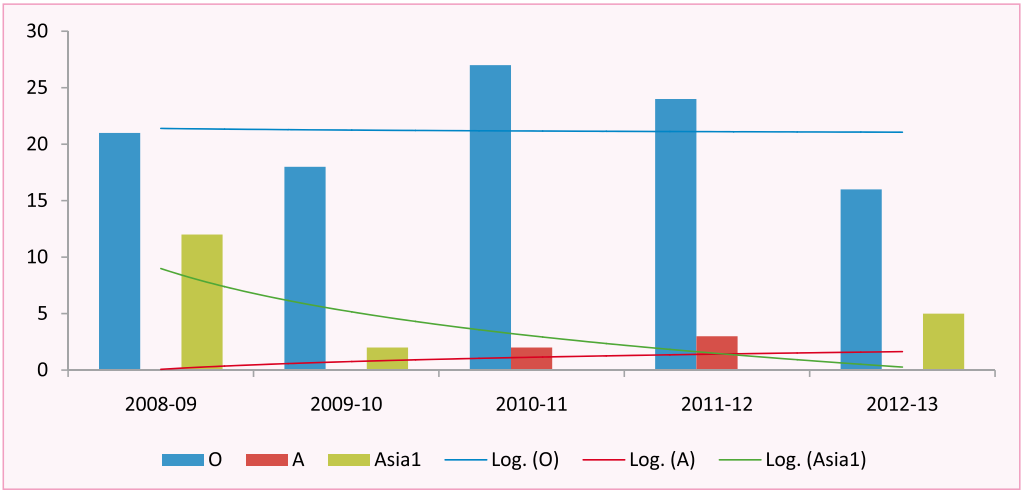


Fig. 5.10: FMD scenario in Madhya Pradesh during last five years

5.4 Western Region

Maharashtra: During the year, 05 outbreaks/ cases of FMD were recorded in the state and all the outbreaks were caused by serotype Asia1. The disease was recorded in the districts of Pune, Nashik, Ponda, Sanguem and Beed. Three outbreaks were recorded in the month of February and one outbreak each was recorded in April and May. Disease was recorded only in cattle. Disease due to serotype Asia1 has been continuously recorded in the state since 2006-07, and the state recorded highest numbers of cases/ outbreaks (35) caused by serotype Asia1 during 2011-12. This year outbreaks owing to serotype O could not be detected in the state.

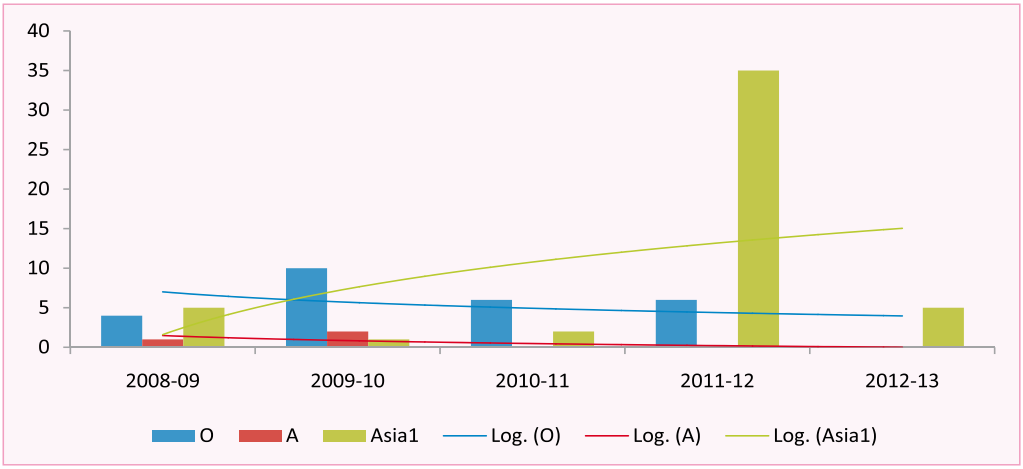


Fig. 5.11: FMD scenario in Maharashtra during last five years

Gujarat: During the year, only 2 outbreaks/cases of FMD were recorded in the state in the month of December. The outbreaks were caused by serotype O and recorded one each in Sabarkanatha and Gandhinagar districts. Last year disease owing to all the three serotypes were recorded in the state.

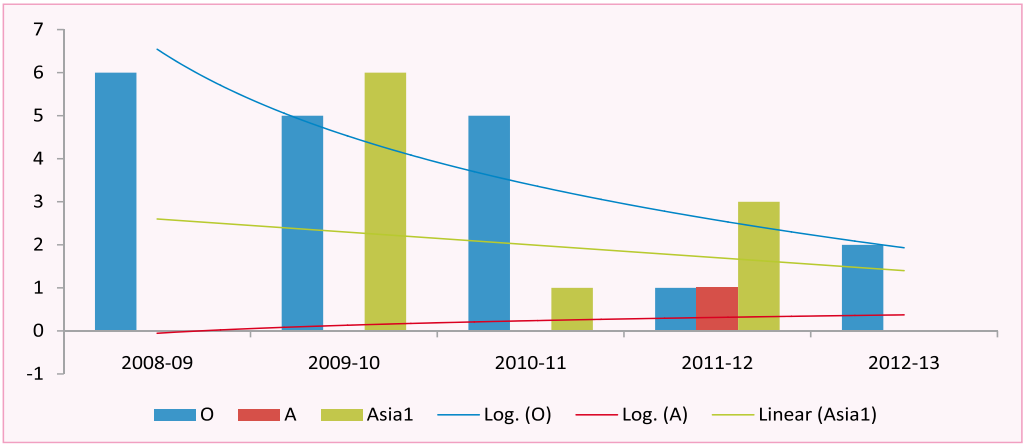


Fig. 5.12: FMD scenario in Gujarat during last five years

Rajasthan: During the year, 7 outbreaks/cases of FMD were recorded. Six outbreaks were recorded in the month of September and one incidence occurred in October. Serotype O was responsible for 5 outbreaks and serotype Asia1 caused 2 outbreaks. The disease was reorded in the districts of Sikar (02), Udaipur (02), Jaipur (01), Churu(01) and Hanumangarh (01).

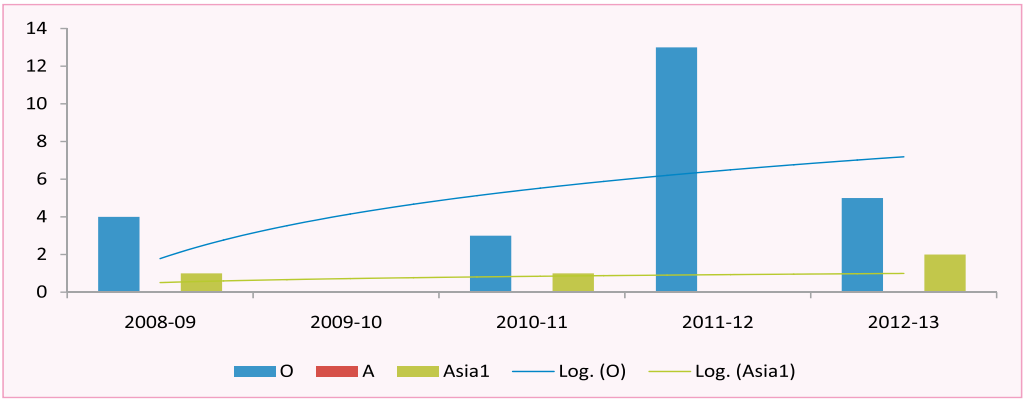


Fig. 5.13: FMD scenario in Rajasthan during last five years

5.5 Eastern Region

Odisha: Fifteen outbreaks/cases were recorded in the state. Serotype O caused 10 outbreaks, 04 outbreaks were due to serotype Asia1, and the remaining one outbreak was caused by serotype A. Maximum outbreaks were recorded in the district Khorda (04) followed by 03 each in Cuttack and Nayagarh, 02 in Ganjam and 01 in Dhenkanal districts. Outbreaks were recorded in the months of April (01), July (03), September (02), October (02), November (02), December (03) and January (02). Disease owing to serotype Asia1 was recorded after a gap of almost five years in the state and the virus might have probably introduced from southern region through animal movement.

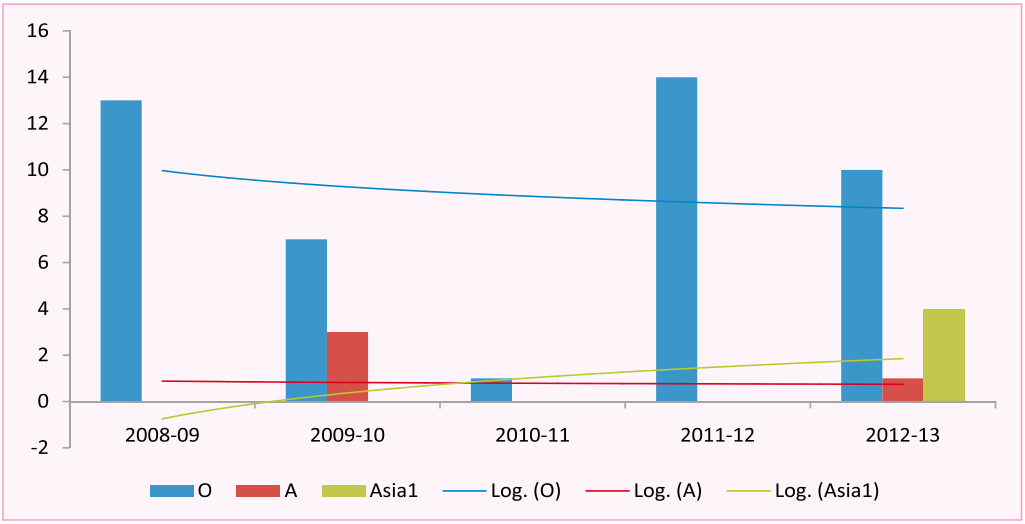


Fig. 5.14: FMD scenario in Odisha during last five years

Bihar: During the period under report, 29 outbreaks/cases of FMD due to serotype O were recorded in the state. Outbreaks were in the months of April (03), August (03), October (07), November (05), December (07) and January (02). Highest number of outbreaks were recorded in Patna (22) followed by Saran (5), Aurangabad (01) and Gaya (01). Serotypes A and Asia1 have not been recorded in the state for last five years.

Fig. 5.15: FMD scenario in Bihar during last five years

West Bengal: Sixty two FMD outbreaks/cases were recorded during the period in the state. Highest number of FMD outbreaks were in Birbhum (16), Purulia (12) followed by nine in Bankura. Rest of the outbreaks were recorded in North 24 Parganas (04), South 24 Parganas (02), Burdwan (02), Dinajpur (02), Nadia (04), Howrah (05), Jalpaiguri(01), Murshidabad (02), Medinapur (01) and Hooghly (02) districts. Serotype O dominated the scenario with 52 outbreaks followed by serotype Asia 1 in 10 outbreaks. Outbreaks occurred almost throughout the year in the months of April (01), May (06), June (01), July (02), August (05), September (06), October (06), November (05), December (11), January (06) and February (01).

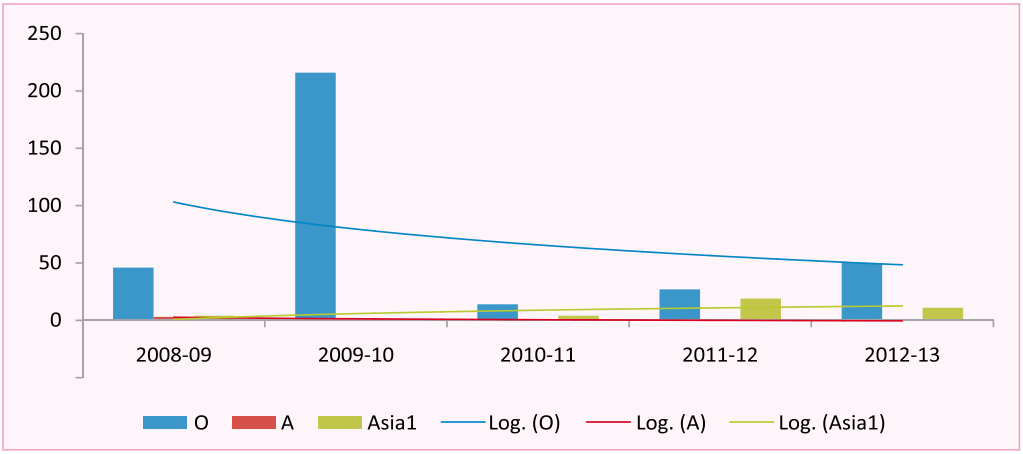


Fig. 5.16: FMD scenario in West Bengal during last five years

5. 6 North Eastern Region

Assam: Sixty-two outbreaks/cases of FMD were recorded in Assam. Outbreaks were widespread and occurred in fourteen districts of the state including Kamrup (16), Sonitpur (11), Jorhat (09), Morigaon (04), Tinsukia (04), Nagaon (04), Dhemaji (03), Udalguri(03), Sivasagar (03), Darrang (02), Dilbrugarh (01), Karmgang(01) and Lakimpur (01). Nine outbreaks were diagnosed in retrospect. Besides cross bred and local cattle, the disease was also recorded in Sambar Deer, Serow and Pigs. Serotype O accounted for maximum numbers of outbreaks (54) followed by serotype A (08). The state recorded highest numbers of outbreaks due to serotype O in last six years. Though the state recorded all the serotypes during 2011-12, outbreak owing to serotype Asia1 could not be recorded during the period. Serotype A appeared in the state in 2010-11, and also continued during the 2011-12 and 2012-13. Outbreaks were recorded during the months of May (20), August (11), November (11), October (06), July (05), April (03), June (02), January (02), February (02).

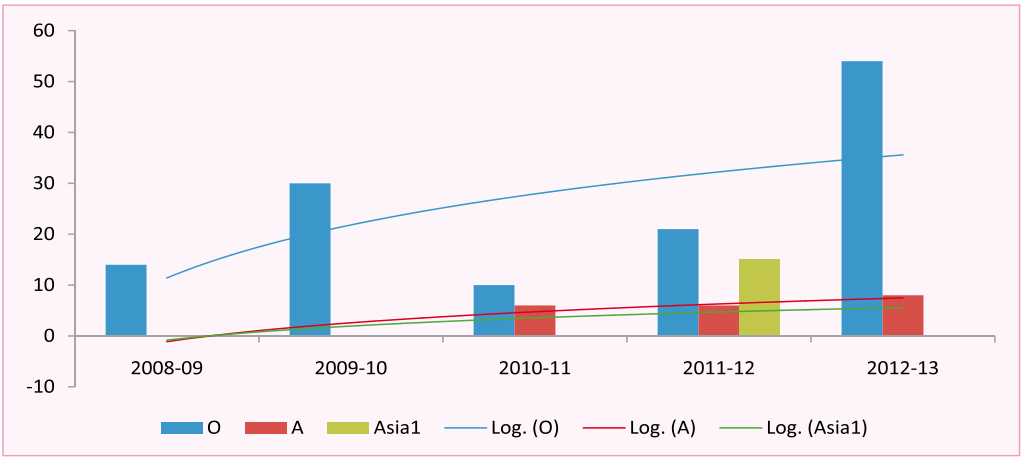


Fig. 5.17: FMD scenario in Assam during last five years

Meghalaya: Three outbreaks were recorded in Rihboi district involving cattle. The outbreaks occurred in the months of May (02) and October (01). All the three outbreaks were caused by serotype O. Last serotype Asia1 outbreak was recorded in 2010-11 and serotype A in 2006-07.

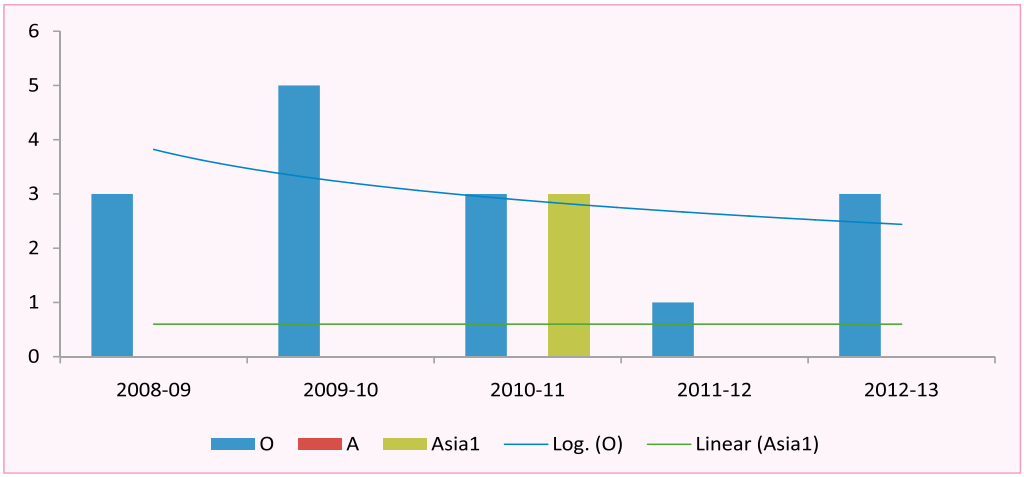


Fig. 5.18: FMD scenario in Meghalaya during last five years

Manipur: During the year, 6 outbreaks/cases of FMD due to serotype O were recorded. Imphal East and Senapati districts recorded two outbreaks each, and Imphal West and Thoubal districts recorded one outbreak each. The outbreaks occurred in the months of June (02), September (01), October (01), January (01) and February (01). Serotypes A and Asia1 are not detected since 2006-07.

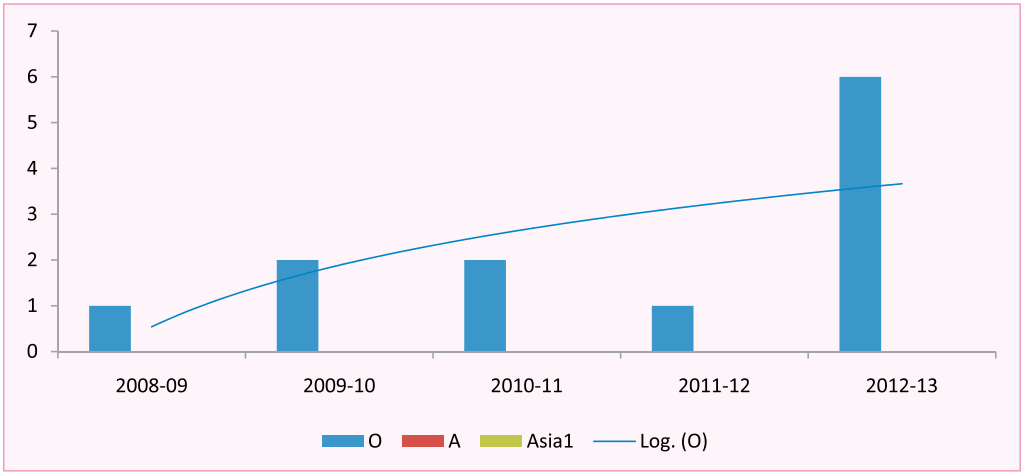


Fig. 5.19: FMD scenario in Manipur during last five years

Nagaland: Eleven outbreaks/cases were recorded in the state and of which 09 outbreaks/cases were due to serotype O, and remaining two were caused by serotype Asia1. Outbreaks were recorded in the districts of Kohima (03), Zunheboto (03), Dimapur (02), Paren (01), Longleng (01), Nerhema (01). The disease occurred during the months of September (02), November (02), February (02), April (01), May (01), August (01), October (01), January (01).

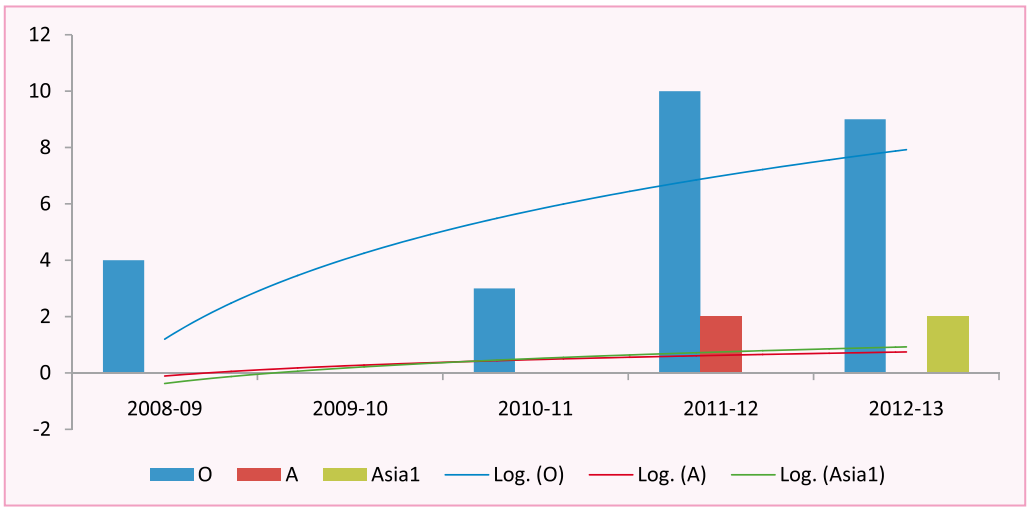


Fig. 5.20: FMD scenario in Nagaland during last five years

Tripura: During the period under report, 04 outbreaks/cases of FMD due to serotype O were recorded in the state. Outbreaks were recorded in the months of January (02), April (01) and July (01). Two outbreaks were recorded in South Tripura and one each was reported from South Tripura and Dhalai districts.

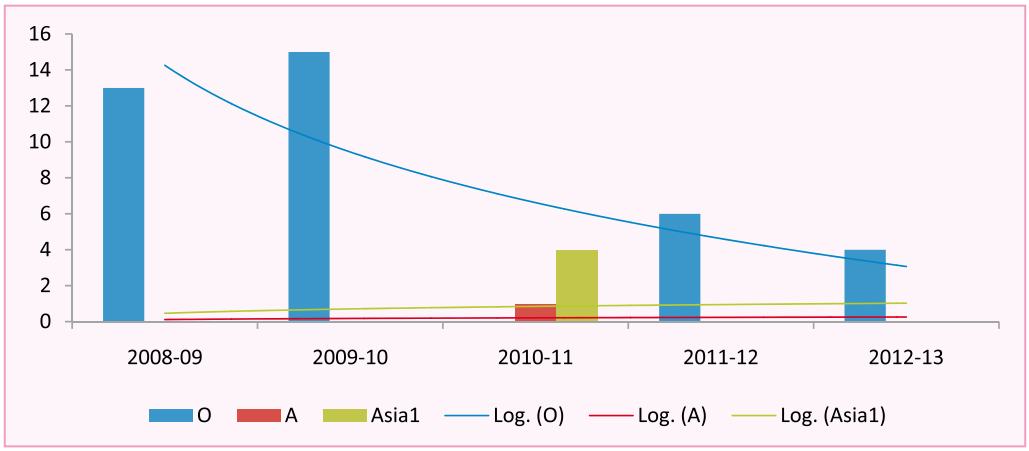


Fig. 5.21: FMD scenario in Tripura during last five years

Arunachal Pradesh: Ninteen outbreaks/cases of FMD were confirmed in the state. The outbreaks were recorded in the districts of East Siang (03), West Siang (03), East Kameng (03), West Kamegn (01), Lower Subansiri (01), Upper Subansiri (01), Papum Pare (03), Rupa (01), Kurung Kumey (01) and Changlang (02). The outbreaks occurred in the months of May (03), June (01), July (01), September (03), October (01), November (03), December (03), January (03) and February (01). All the outbreaks were caused by serotype O. Last outbreak owing to serotype Asia1 and A was recorded in 2010-11 and 2008-09, respectively.

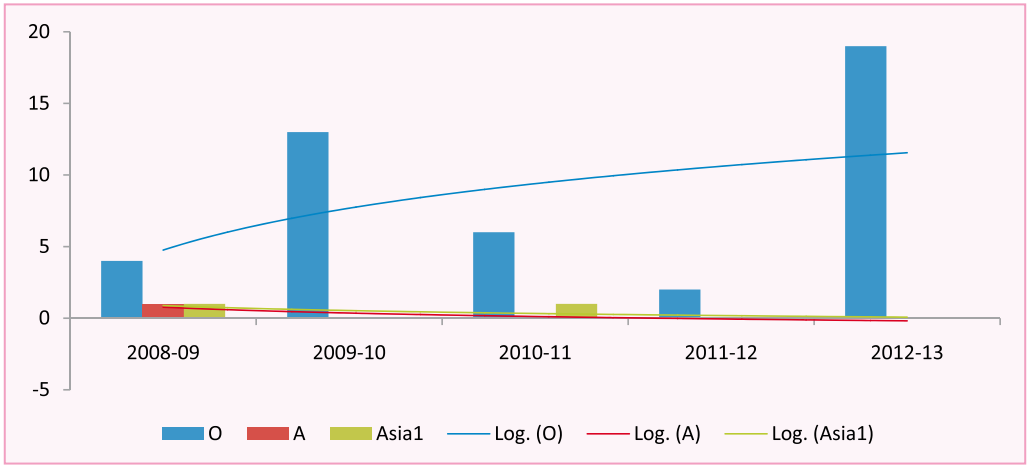


Fig. 5.22: FMD scenario in Arunachal Pradesh during last five years

Mizoram: During the period under report three incidence/outbreaks of FMD was recorded in the state. All the three outbreaks were caused by serotype O. Two outbreaks were recorded in the month of May and one outbreak occurred in June. The outbreaks were recorded in the districts of Aizawl (02) and Kolasib (01).

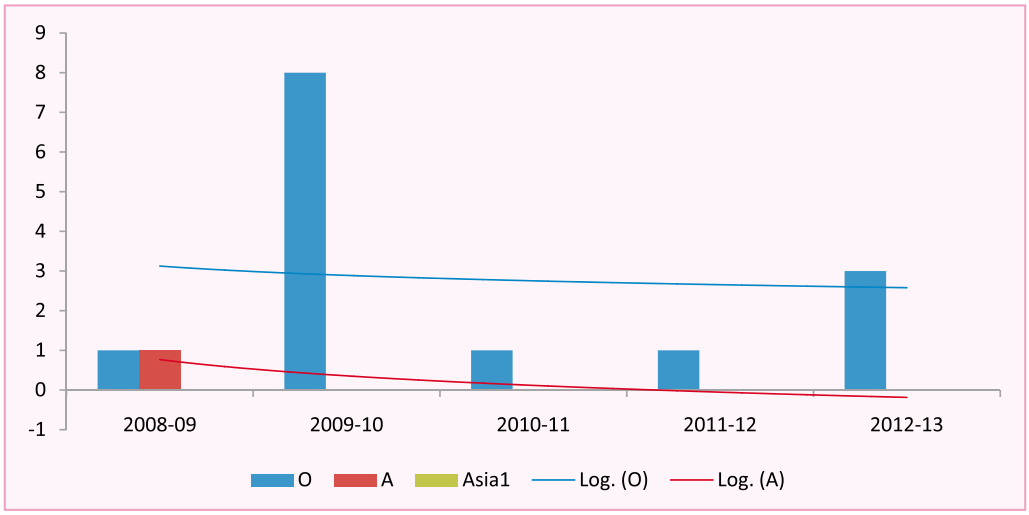


Fig. 5.23: FMD scenario in Mizoram during last five years

6.0

Virology and Molecular Epidemiology

6.1 Processing of field samples and Serotyping

A total of 701 clinical materials were received through Regional Centres and Network Units of the project for confirmatory diagnosis and further characterization at the Central FMD laboratory, Mukteswar. The tissue samples were processed using chloroform and made in to 10% suspension in PBS. The processed materials were subjected to sandwich ELISA, and ELISA negative samples were tested using multiplex PCR for virus diagnosis. Virus isolation was done in BHK-21 cells, and RNA transfection was also used for virus revival from most difficult samples. FMDV serotypes could be identified in 285 samples. FMDV serotype O virus found in maximum number of outbreak samples (218), and serotypes A and Asia1 virus were detected in 15 and 52, respectively.

6.2 Genetic and antigenic characterization of FMD Virus field isolates

Molecular epidemiological analysis based on highly immunogenic capsid protein, VP1(1D) was carried out for understanding and monitoring virus evolution, tracking virus movement and reservoirs. VP1 coding region of FMDV field isolates were amplified either directly from clinical materials or cell culture passaged isolates. Phylogenetic analysis was carried out using MEGA software by applying either maximum likelihood or neighbour joining method. In FMD, periodic emergence of antigenically divergent strains complicates disease control strategies. This warrants regular genetic monitoring and antigenic profiling of the outbreaks strains in relation to the currently used vaccine strain by serological tests such as neutralization test. Two dimensional MNT (2D-MNT) using Bovine Vaccinate Serum (BVS) against vaccine strains was performed regularly to deduce the antigenic relationship of field virus with vaccine strains. BHK-21 cells were used as indicator system. The end point titre of the serum was calculated as the reciprocal of the last dilution of serum that neutralized 100$TCID_{50}$ in 50% of the wells in tissue culture plates. One-way antigenic relationships (r_1-value) of the field isolates relative to the vaccine/reference and other field strains was calculated and expressed as the ratio between heterologous/homologous serum titre. The r_1-values greater than 0.30 indicate that the field isolate is homologous to the vaccine strain and the vaccine is likely to confer protection against challenge with the field isolate. Conversely, values less than 0.30 suggest that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect. The details of the observation presented below.

6.2.1 Serotype O FMD Virus

Genetic characterization:

In case of serotype O, 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 is the predominant serotype and cause around 80% of the outbreaks encountered in the country. 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(Pan Asia I) have been identified in India. Last outbreaks due to Branch A and B were recorded during 1994 and 2003, respectively. The Indian vaccine strain (INDR2/1975) 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 type O outbreaks and since then this lineage has been causing sporadic outbreaks in the country. This lineage showed 5-11% nucleotide difference from Pan Asia viruses. Later, with in Pan Asia, a divergent strain (Pan Asia II) emerged in the year 2002. During 2006-07 to 2010-11, epidemiological scenario in serotype O has been largely influenced by Pan Asia and 'Ind2001' strains

A new genetic group in serotype O appeared 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 is named as Ind2011 lineage with 0.5-1.4% divergence at the nucleotide level among the constituent virus isolates. Divergence at the amino acid level for this group ranged from 0.9-1.9%. The Ind2011 had minimum of 7% nucleotide divergence from global isolates and appeared to share ancestry with PanAsia lineage rather than with Ind2001. Geographically, the Ind2011 lineage is so far restricted to the Southern region in the states of Karnataka, Tamilnadu, Andhra Pradesh and Kerala. Earliest outbreak caused by this lineage as per sample collection date was in September 2011 in Andhra Pradesh. Upto January 2012, this lineage has caused 19 outbreaks involving mostly unvaccinated animals. The virus possibly appeared first (reported and diagnosed late) in the state of Tamilnadu (Erode district) where large cattle markets operate in the month of August every year when movement of thousands of animals occur between the southern states. Extensive spread of the virus was observed in the state of Karnataka where 11 outbreaks due to this lineage were recorded within a short span of time. The lineage had accumulated 12 synonymous and 5 non-synonymous mutations in a span of 5 months in the VP1 region. It corroborate with the established fact that higher mutation rate in earlier phase of emergence is essential for rapid adaptability in viruses. It is uncertain whether the emergence of new genetic lineage was triggered by immune pressure or selected for fitness value or due to a bottleneck in transmission. The level of amino acid divergence is more than nucleotide divergence in both Ind2001 and Ind2011 lineages indicating faster rate of non-synonymous replacements.

During 2012-13, a total of 89 isolates were subjected to 1D/VP1 region sequence analysis. Isolates sequenced during the period are marked with filled triangle in the phylogenetic tree (Figs.6.1, 6.2 and 6.3). Phylogenetic analysis indicated complete dominance Ind2001 in the field (88 out of 89 isolates grouped with Ind2001 lineage). The lineage was distributed widely covering many states including Karnataka, Kerala, Andhra Pradesh and Tamilnadu (Southern region); Uttar Pradesh Himachal 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, Nagaland, Tripura, Manipur, Mizoram, Meghalaya and Arunachal Pradesh (North Eastern region). One isolates from J&K grouped with PanAsia lineage. The emerging Ind2011 lineage could not be detected in any of the outbreak this year, probably due to infection immunity of natural extinction. The isolates collected during 2012-13 differed from vaccine strain by 12.3 to 16.4% at nucleotide level and 4.7 to 7.8% at amino acid level. Mean genetic diversity of 2012-13 isolates were estimated at 6.6% at nucleotide level and 2.8% at amino acid level. Many genetic clusters are evident within the Ind2001 lineage. A genetic cluster of Ind2001 lineage (designated here as Ind2001^{UP-11}) responsible for the outbreaks in UP, Uttarakhand, HP and Odisha during 2011-12, could be detected in many states including Bihar, Assam, J&K, Madhya Pradesh, Manipur, West Bengal, Kerala, Rajasthan, Karnataka, Andhra Pradesh and Arunachal Pradesh. This cluster appears to be major cause serotype O outbreaks during 2012-13 and is highly homogenous.

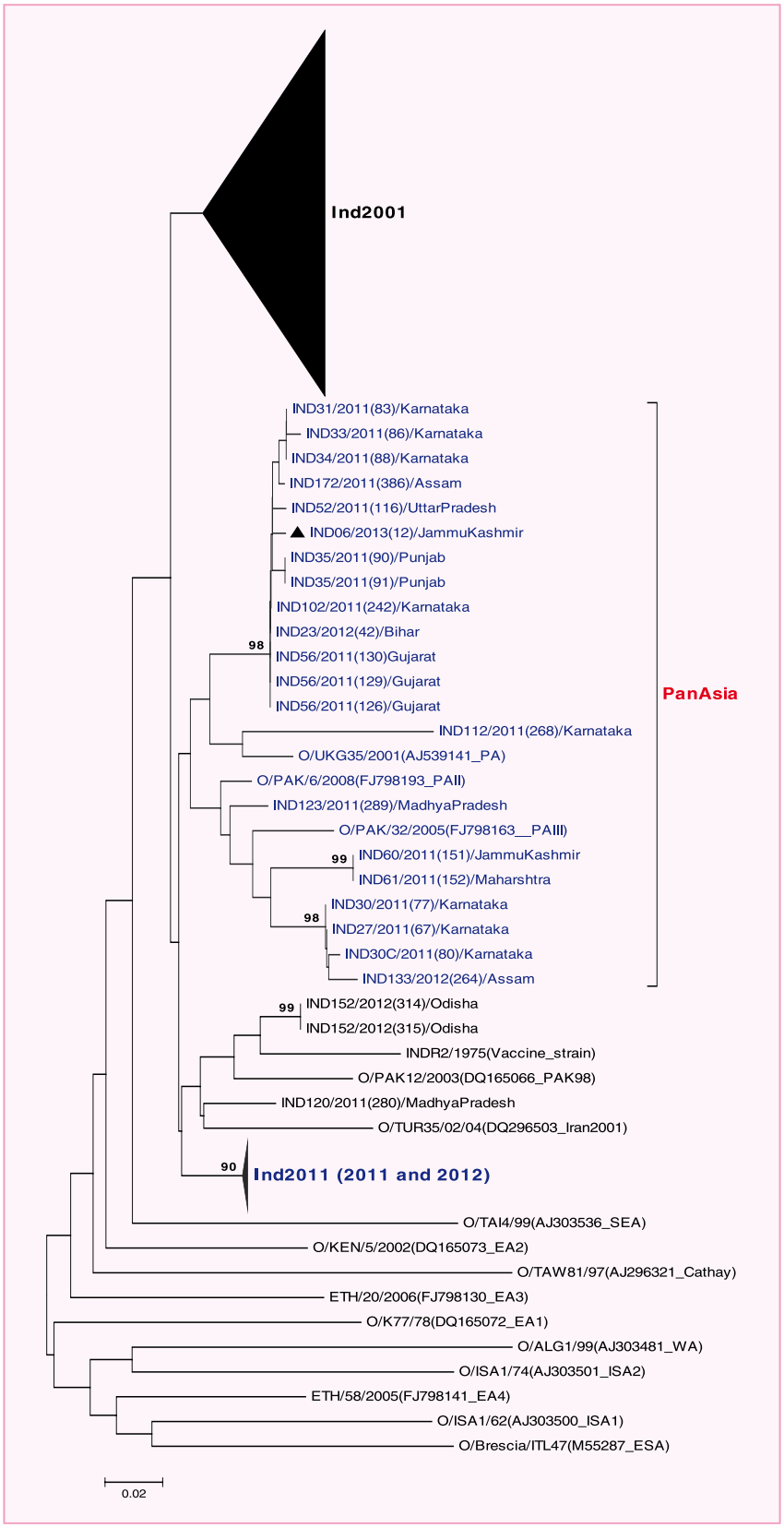


Fig. 6.1: Neighbor-Joining phylogenetic tree at VP1 coding region of Indian serotype O FMD virus isolates during 2012-2013. The tree shows presence of 3 major lineages of FMD virus serotype O co-circulating in India namely Ind2001, PanAsia and New group named Ind2011.

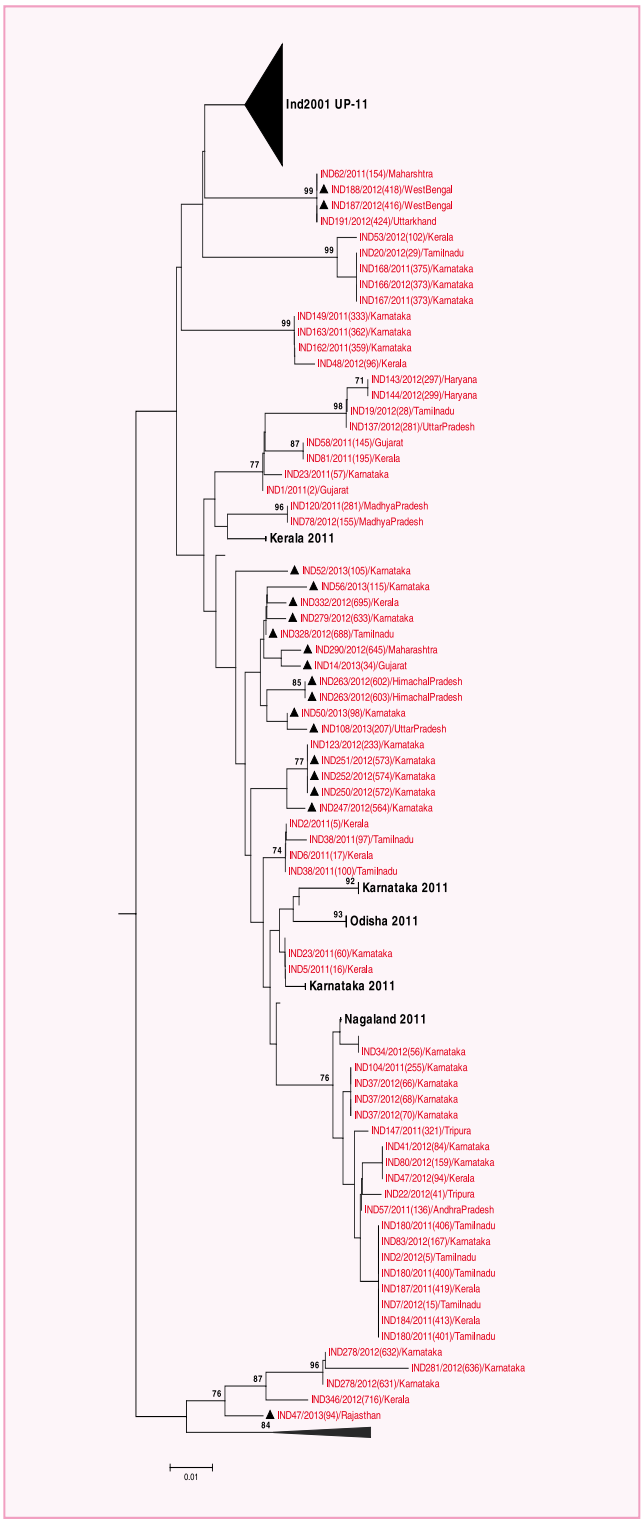


Fig. 6.2: Neighbor-Joining phylogenetic tree at VP1 coding region Ind2001 lineage of Indian serotype O FMD virus isolates during 2012-2013. The genetic data indicate dominance of Ind2001 lineage in major parts of the country. The lineage first emerged in the year 2001 and has been dominating serotype O outbreaks since 2009.

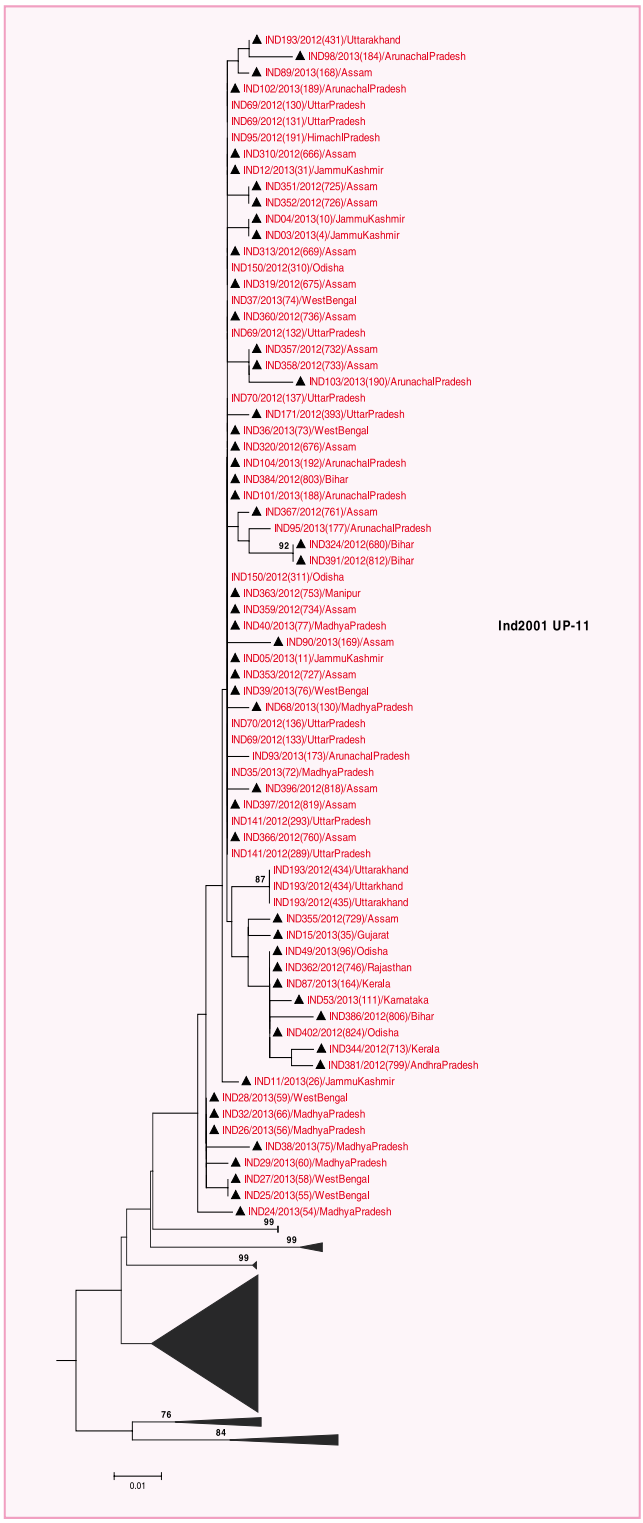


Fig. 6.3: Neighbor-Joining phylogenetic tree at VP1 coding region Ind2001^{UP-11} Sub-lineage of Indian serotype O FMD virus isolates during 2012-2013. The genetic data indicate rapid spread this sub-lineage during 2012-13.

Antigenic characterization:

The antigenic relationships of serotype O field isolates to the currently used vaccine strain INDR2/1975 is shown in Fig. 6.4. The test results were interpreted as per criteria set by Rweyemamu, (1984). A total of 36 isolates were subjected to vaccine matching exercise using bovine vaccinate serum during 2012-13. From the result, it can be seen that 32 isolates showed an r1 value of >0.3 with currently used vaccine strain and four isolates (3 isolates from Karnataka and 1 isolate from Jammu & Kashmir) show an r1 value of <0.3. The r1 value ranged from 0.62-1.0 (excellent match) for 10 isolates, 0.4-0.56 (very good match) for 11 isolates, 0.3-0.39 (good match) for 11 isolates and 0.27-0.28 (poor match) for 4 isolates. Though the four isolates had less antigenic match, the r1 value was close to 0.3 and in such case use of potent vaccine will still be effective. Emergence of antigenic variant in an endemic country is a normal phenomenon and the vaccine strain which is able to antigenically cover >90% of the isolates still considered to be efficient.

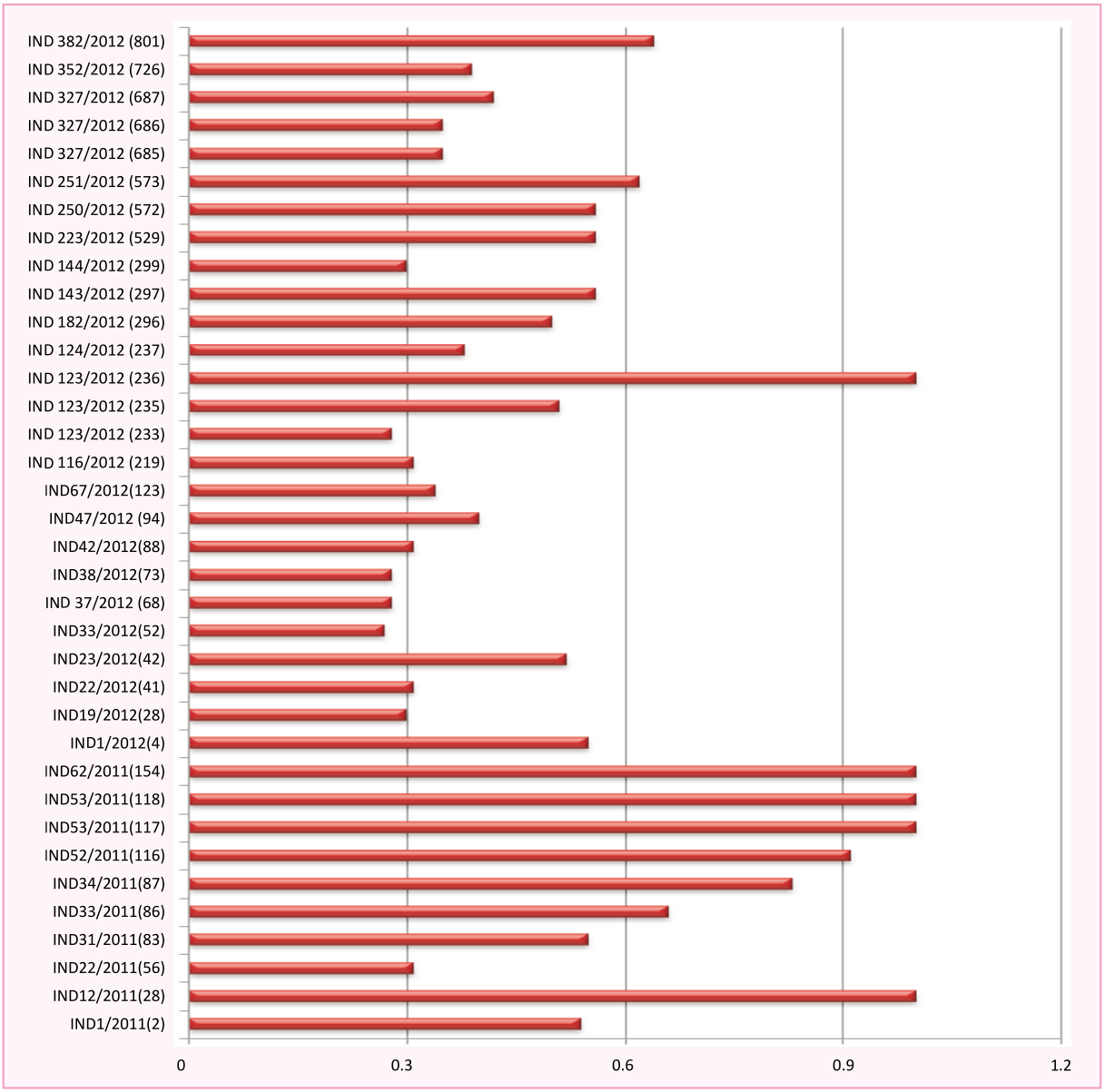


Fig. 6.4: Antigenic relationship (r1) FMD virus serotype O field isolate collected during 2012-2013 in relation to currently used vaccine strain INDR2/1975

Evaluation of serotype O vaccine candidate panel:

Earlier, vaccine candidate panel (IND271/2001, IND120/2002, IND320/2007 and IND408/2007) has been identified to be used as backup in case of emergence of antigenic variants of serotype O in the field. The panel along with currently used vaccine strain INDR2/1975 and older vaccine strainIND489/1997 was evaluated using LPBE and 2D-MNT. For antigenic analysis, all the virus isolates were grown in BHK-21 cells and harvested within 16 to 18 Hrs post infection. An aliquot of each virus after harvest was stored at -80^0 C for titration and virus neutralization purpose and the rest of virus stock was lyophilized and used in LPBE. The relationship value ('r_1' value) was calculated using the homologous and heterologous titres.

In 2D-MNT, the currently used vaccine strain antigenically could cover 92.5% of the isolates examined (Fig.6.5). Three isolates [O/IND333/2005 (PAI), O/IND387/2008 (PAII) and O/IND256/2009 (Branch CII)] showed lower antigenic relation value (r <0.3) with R2/1975 BVS. Emergence of such antigenic variants in the field is a regular phenomenon and is not alarming in the present context as more than 90% of the field isolates showed closer antigenic match with in-use vaccine strain. Maximum number of the isolates showed close antigenic match with the candidate vaccine strains IND320/2007 (95%) and IND408/2007 (97.5%). Both these vaccine candidates belong to Pan Asia II lineage. The vaccine candidate in Pan Asia I lineage (IND271/2001) was antigenically homologous to 90% of the field isolates. In contrast, the vaccine candidate in Ind2001 lineage (IND120/2002) though showed 100% homologous reaction with isolates of the same lineage, shared poor antigenic relationship with isolates of other lineages.

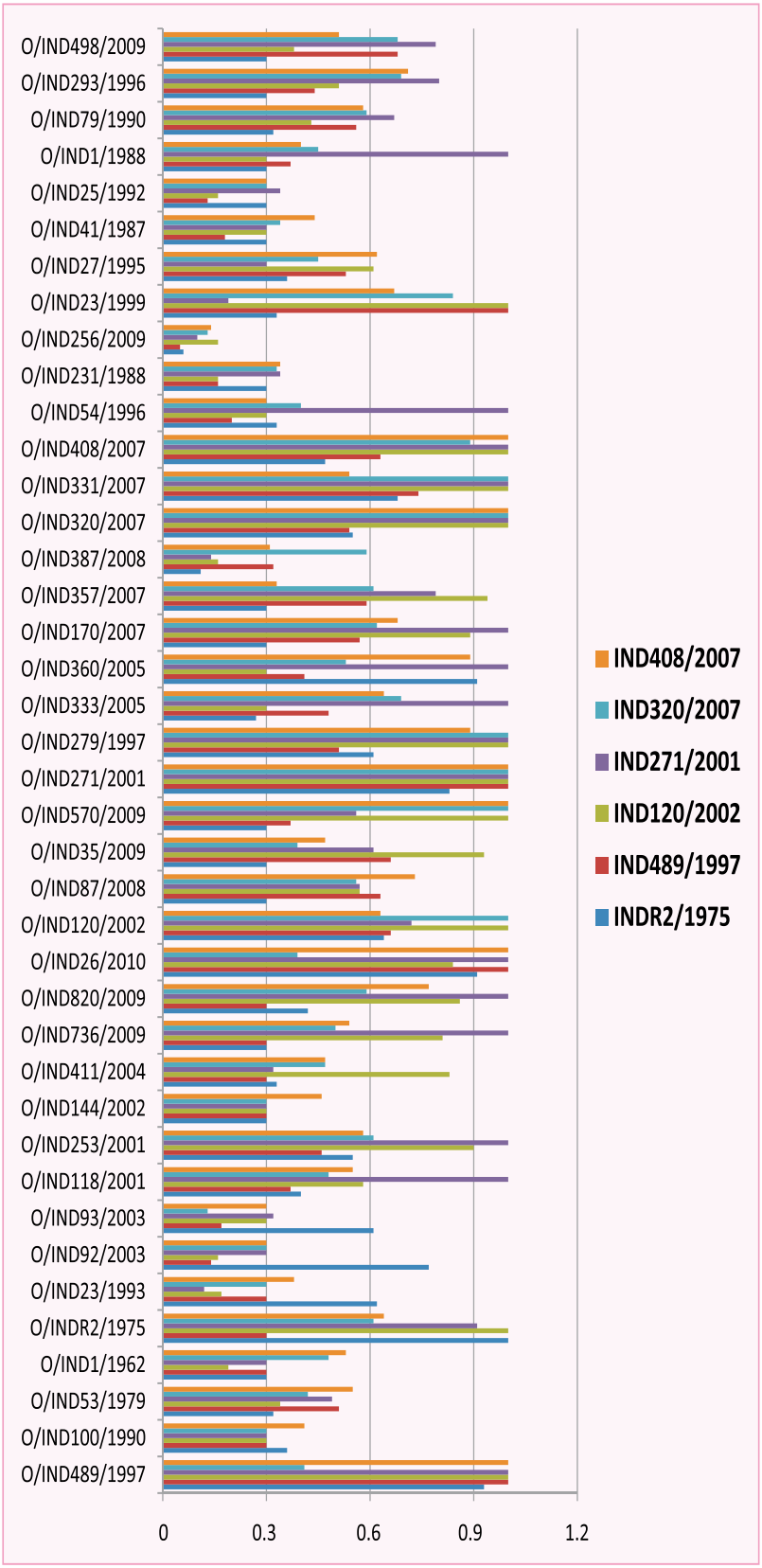


Fig. 6.5: Antigenic relationship (r_1) of FMD virus serotype O field isolates in relation to currently used vaccine strain (INDR2/1975) and vaccine candidates

As 2D-MNT involves handling of live virus, an alternate LPBE using the inactivated virus antigen was employed for candidate strain evaluation. Since LPBE uses inactivated virus antigen and is rapid, currently much emphasis is placed on this ELISA based assay for vaccine matching exercise. The r1 values obtained with LPBE and 2D-MNT were comparable with minor differences. The earlier reported guide lines for LPBE in vaccine matching is that r_1 value of ≥0.4 indicates that the isolate in question is closely related to the reference virus, and a value of <0.2 indicates that isolate is poorly related to the reference virus, where as r1value between 0.2-0.39 indicate that there may not be adequate protection if the reference virus is used in the vaccine at normal dose, but high dose and repeated vaccination can protect.

The sensitivity of the LPBE was assessed considering 2D-MNT as the gold standard assay for vaccine matching in ROC analysis using MedCalc program. The sensitivity of LPBE for different reference serum antibody (BVS) ranged from 89.14% for O/IND489/1997 BVS to 100% for O/IND408/2007 BVS. The sensitivity and percentage of isolates covered is mentioned in the Table.5.1

Table 5.1: Percent coverage of field isolates in 2DMNT and LPBE, and sensitivity of LPBE

BVS	Coverage in 2D-MNT (%)	Coverage in LPBE (%)	Sensitivity of LPBE (%)
INDR2/1975	92.5	97.5	97.36
IND489/1997	85.0	72.5	89.14
IND120/2002	82.5	97.5	97.14
IND271/2001	90.0	95.0	94.73
IND320/2007	95.0	75.0	95.0
IND408/2007	97.5	100	100

6.2.2 Serotype A FMD Virus

Genetic characterization:

Among all serotypes prevalent in India, serotype A virus population is genetically and antigenically most heterogeneous in nature. VP1(1D) coding region based molecular phylogeny has established circulation of four genotypes {showing more than 15% nucleotide (nt) divergence among them at 1D region} of serotype A so far in India. Since 2001, genotype 18 has been exclusively responsible for all the field outbreaks and has out competed all other genotypes. Within the currently circulating genotype 18, a divergent and unique lineage emerged in late part of 2002, which showed an amino acid (aa) deletion at 59th position of VP3 (VP3^{59}-deletion group) and dominated the field outbreak scenario in 2002-03. Ever since then sporadic outbreaks due to this lineage has been identified. This single aa deletion is at an antigenically critical position in structural protein VP3, which is considered to be a major evolutionary jump probably due to immune selection. Recently, it has been observed that the deletion group is on the verge of overthrowing the nondeletion variants and establishing itself as the only prevalent genetic cluster.

During the period under report, structural protein coding region (P1) sequence for 25 field viruses of serotype A recovered from field outbreaks in Karnataka {A IND 27/2011, A IND 106/2011, A IND 255/2012, A IND 256/2012 (PD 582/2012, PD 584/2012, PD 585/2012), A IND 257/2012, A IND 267/2012, A IND 270/2012, A IND 272/2012, A IND 404/2012, A IND 405/2012 (PD 829/2012, PD 830/2012), A IND 406/2012, A IND 409/2012, A IND 410/2012, A IND 411/2012, A IND 412/2012}, Rajasthan (A IND 84/2011), Uttar Pradesh (A IND 168/2012), Assam (A IND 307/2012), Odisha {A IND 264/2012 (PD 604/2012 and PD 605/2012)} and Gujarat {A IND 113/2012 (PD 212/2012 and PD 213/2012)} were sequenced for molecular epidemiological analysis. The determined 1D sequences were aligned with other Indian sequences available in the data base of PDFMD. All the isolates of 2012-13 clustered within genotype 18 in the maximum likelihood tree, and grouped only in the clade 18c of the VP3^{59}-deletion lineage (Fig. 6.6). The 2012 isolates in clade 18c demonstrated an average nucleotide divergence of 7.5% at VP1 coding region from the earlier isolates in that clade suggesting an active phase of evolution and diversification. Clade 18c which was first reported from Southern peninsular India during 2007 seems to have disseminated to Central, Eastern, Western and Northern parts of India after 2009. Interestingly, not a single field outbreak

virus without the VP3-59 deletion could be identified during 2012-13 in support of the anticipated exclusive dominance of the VP3[59] deletion group.

Besides, molecular sequences of large fragment of 5'UTR and L[pro] coding region of 4 serotype A isolates (IND113/2012(PD213 /12) _Gujarat, IND267/2012(PD612/12)_ Karnataka, IND264/2012(PD605/12)_Odisha and IND307/2012(PD663/12)_Assam) was generated. L-based phylogenetic tree did not show congruence in topology to that of the VP1 based tree and monophyletic clustering for genotypes was not seen, which could be attributed to either frequent viable recombinations at the NSP coding region compared to capsid coding region or to independent evolution of NSP and SP-coding regions thereby enforcing distinguishable evolutionary trajectories. The large fragment of 5'UTR did not reveal any chunk deletion at the pseudoknot region in any of the isolates studied (four pseudoknots maintained), which otherwise is a common phenomenon in FMD field viruses.

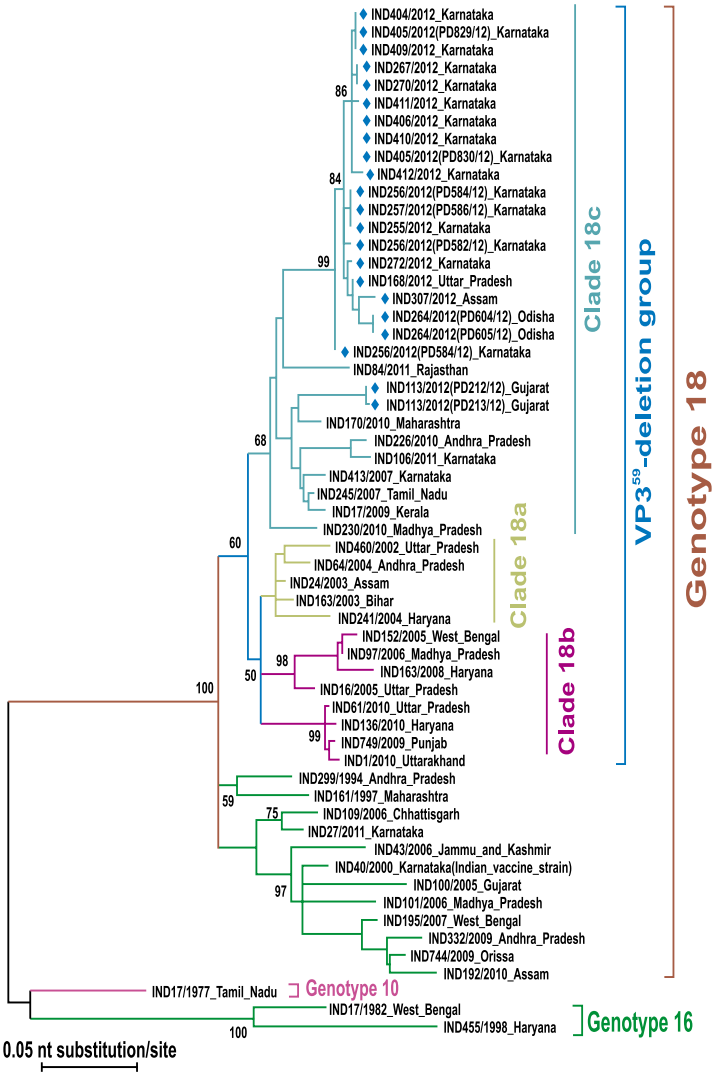


Fig. 6.6: Maximum likelihood phylogeny of serotype A field virus isolates at VP1 coding region. Isolates for which sequence was determined during 2012-13 are marked with blue rhombus

Antigenic characterization:

A total number of 22 serotype A field isolates recovered from 15 outbreaks in five states (Karnataka, Odisha, Gujarat, Assam and Uttar Pradesh) and reposited in the National FMD Virus Repository during 2012-2013 were subjected to 2D-VNT using bovine vaccinate serum against the current vaccine strain, A IND 40/2000 and one way antigenic relationship (r1-value) was investigated. The 'r1'-values which directly correlates with antigenic relationship of isolates with the vaccine strain demonstrated a wide range varying from 0.08 to 1.0 (Fig. 6.7). As an 'r1'-value of more than 0.3 is considered as close antigenic relatedness, it can be inferred that majority of the outbreak strains (13 out of 22) do not show a match with the vaccine strain. All the 22 viruses tested here belong to clade 18c of the VP3[59]-deletion group of genotype 18. This finding suggests recent emergence of an antigenically divergent group of viruses in the field which is of concern. To circumvent this necessary study/investigation has already been initiated.

Three serotype A FMD virus field isolates recovered from outbreaks in Karnataka during 2012 [IND255/2012(PD581/12), IND256/ 2012(PD582/12) and IND257/2012(PD586/12)] were subjected to 2D-VNT using bovine vaccinal serum raised against the current vaccine strain A IND 40/2000 and the two best candidate vaccine strains available at PDFMD (A IND 195/2007 and A 281/2003). From the 'r1- values' it is evident that those field isolates do not show an antigenic match either with the current vaccine strain or with any of the vaccine candidates presently available in the panel (r-1 values < 0.3).

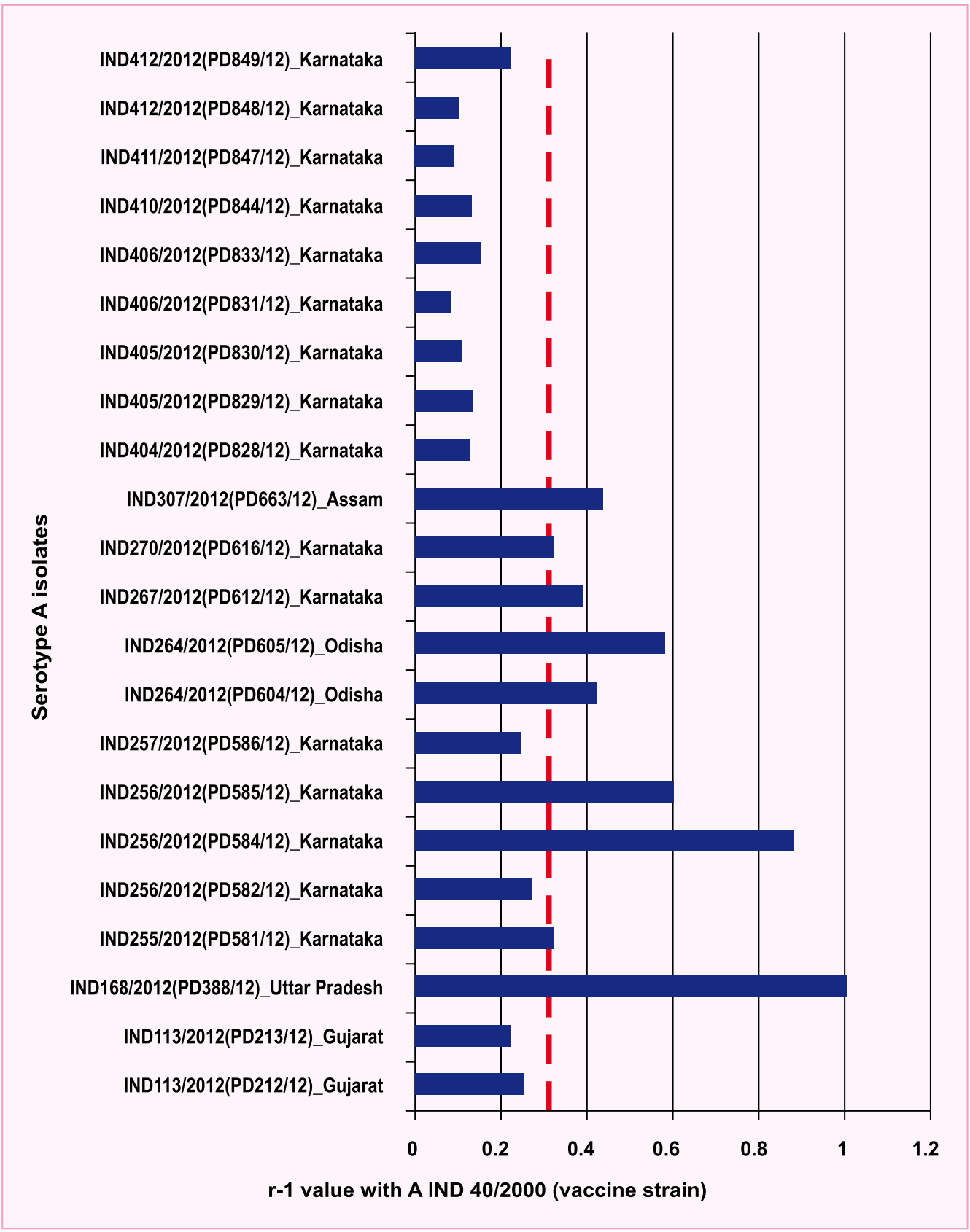


Fig. 6.7: Antigenic relationship of serotype A isolates with the current vaccine strain A IND 40/2000

6.2.3 Serotype Asia1 FMD Virus

Genetic characterization:

Previous studies on 1D/VP1 gene based phylogeny indicated clustering of 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 outbreak between 1998 and 2002, although disappeared between year 2001 and 2004 again emerged as the predominating lineage from 2005 onwards.

During 2012-13, a total of 32 serotype Asia 1 field isolates were sequenced at 1D/VP1 region and subjected to phylogenetic analysis using Neighbor Joining algorithm implemented in MEGA 5.05 software package. All the isolates were found to cluster within lineage C indicating its supremacy in the field since the year 2005 (Fig.6.8). Mean genetic diversity of 2012-13 isolates was estimated at 2.6% at nucleotide level and 0.09 % at amino acid level. Earlier, two spatially distinct groups were identified within the lineage C. The Eastern cluster predominantly comprised isolates from Eastern and North Eastern region, and the Western cluster was constituted by strains from Western region of the country. This year only four isolates sampled from West Bengal and Assam grouped within the Eastern cluster and did not spread beyond its geographical region. Isolates from Western clusters which were introduced to Southern region during 2011-12 established firmly there and caused outbreaks in the three Southern states (Karnataka, Kerala and Tamilnadu) also during 2012-13. Strains of this cluster also entered in to the Eastern region in the states of West Bengal and Odisha. Outbreaks owing to serotype Asia1 in Odisha is very significant as this serotype was not detected for last five years in the state. Further, isolates collected in Odisha had 100% genetic similarity with some isolates from Maharashtra and Karnataka indicating extensive animal movement between these states.

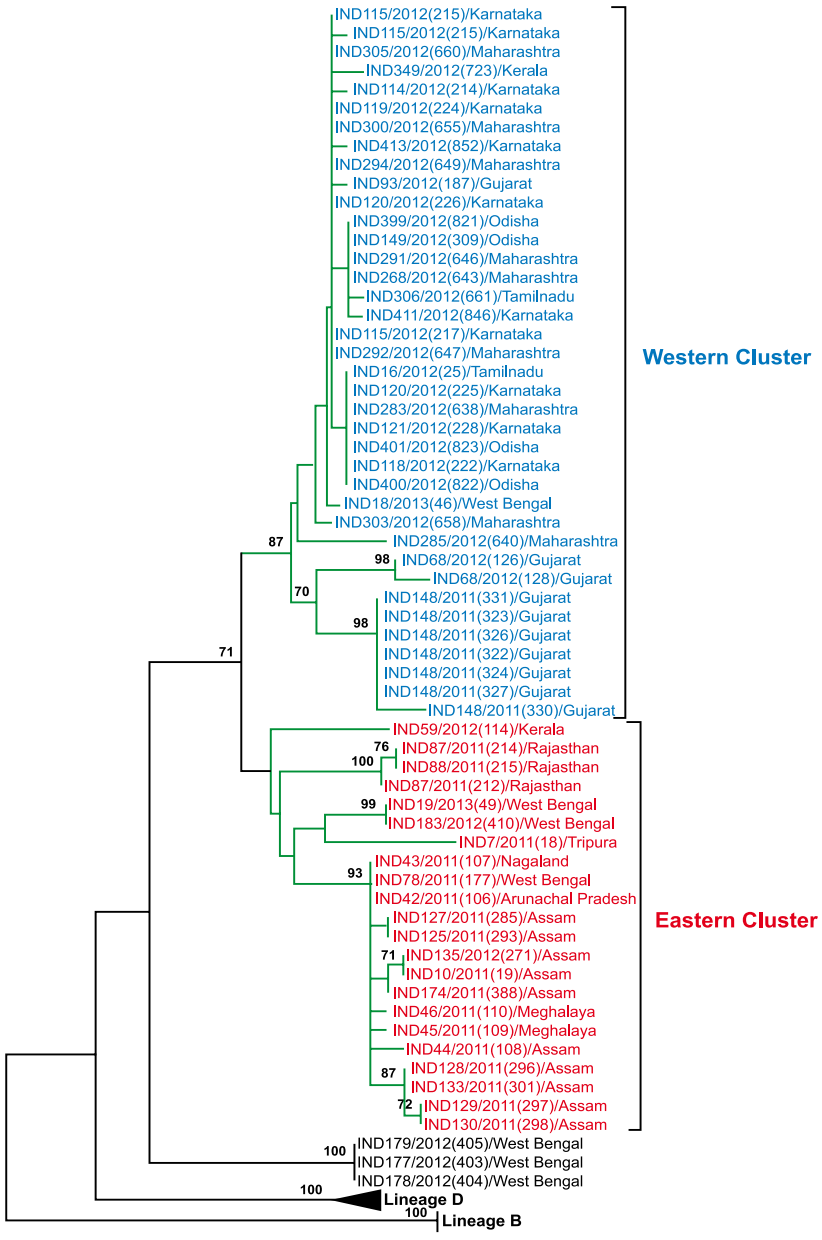


Fig. 6.8: Neigbhour-Joining phylogenetic tree at VP1 coding region of FMD virus isolates of serotype Asia1 during 2012-2013. Lineage C is in circulation in the country since 2005.

Antigenic characterization:

The antigenic relationship of serotype Asia1 field isolates to the vaccine strain is presented in Fig 6.9. The test results were interpreted as per criteria set by Rweyemamu (1984). A total of 32 isolates were subjected to vaccine matching exercise using bovine vaccinate serum during the year. From the result, it can be seen that 24 isolates had an r1 value of >0.3 with the current vaccine strain and 8 isolates had an r1 value of <0.3. The r1 value ranged from 0.65-0.97 (excellent match) for 8 isolates, 0.4-0.59 (very good match) for 7 isolates, 0.31-0.38 (good match) for 9 isolates and 0.15-0.29 (poor match) for 8 isolates. Currently used serotype Asia1 vaccine strain, IND63/1972 has been in use for decades in the country. This vaccine strain belongs to lineage B that was in circulation only until 2000. The isolates collected during 2012-13 differed from vaccine strain by 15.1 to 18.9% at nucleotide level and 9.6 to 12.1% at amino acid level. Almost 25% of the isolates collected during 2012-13 had poor antigenic match with the currently used vaccine strain. A vaccine candidate panel [IND13/2001, IND78/2011(177) and IND68/2012 (126)] has been identified and evaluation is under progress.

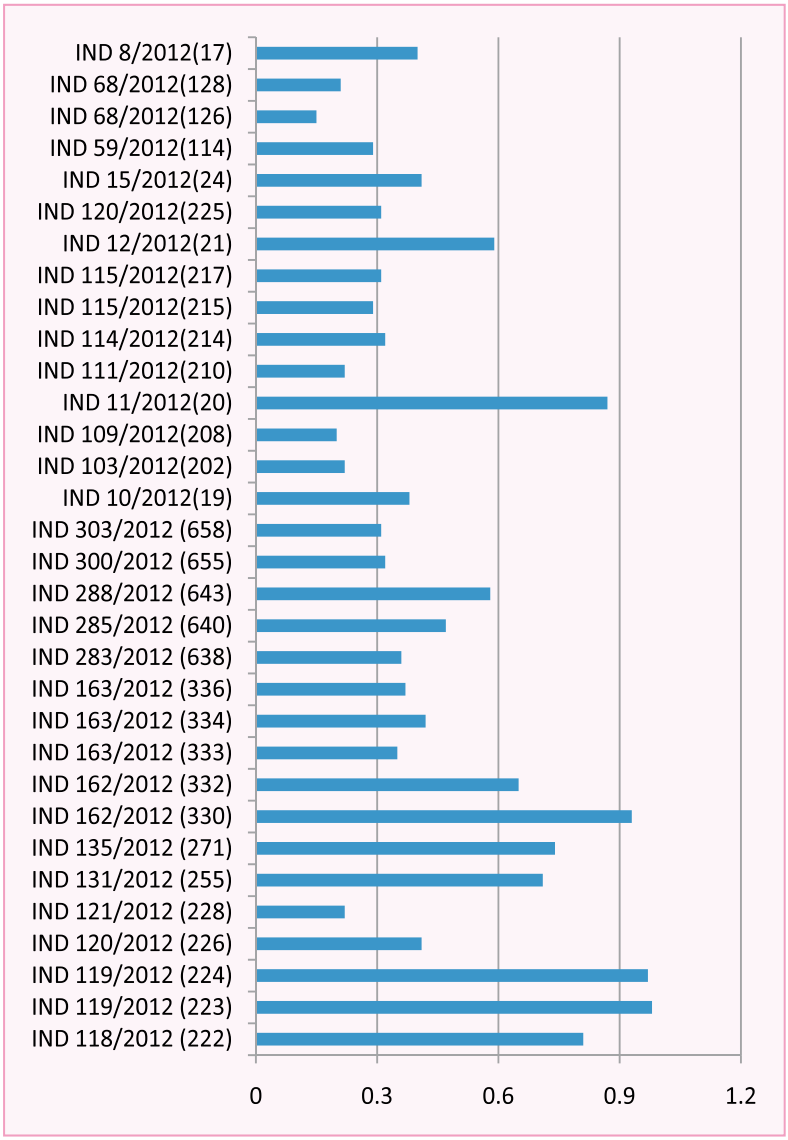


Fig. 6.9: Relationship values FMD virus serotype Asia1 field isolate collected during 2012-2013 in relation to current vaccine strain IND63/1972.

6.3 Construction of infectious cDNA clone for a serotype Asia 1 FMD virus

Full-length genomic cDNA clones provide a valuable platform to modify the virus through reverse genetic techniques for research on functional genomics, for elucidating the molecular mechanisms of pathogenicity and for developing genetically engineered next generation vaccines with desired attributes. The Project Directorate on FMD, Mukteswar, India, the apex institute on FMD research in India has piled up more than 1000 kb of nucleotide sequence data for Indian strains of FMD virus over the decades. This database could help navigate the FMD virus genome and select motifs for creating modified genomes with an objective to provide mechanistic insights into the intricacies of pathogenesis, virulence attenuation and advanced vaccine designs. Here we report the successful construction of a genomic cDNA clone corresponding to a BHK-21 cell culture adapted FMDV strain, Asia 1 IND 491/1997, a historic vaccine strain from India and recovery of viable recombinant infectious virus particles from cells transfected with full-length RNA transcripts generated in vitro under bacteriophage T7 polymerase promoter. The nucleotide sequence, in vitro growth characteristics, plaque morphology, tissue culture infectivity titres and the

antigenic profile of the recombinant virus were found to be indistinguishable from those of the wild-type virus suggesting the authenticity of the virus rescued.

A total of four overlapping fragments (amplicon 1, 2, 3 and 4 of 0.5, 1.4, 2.6 and 4 kb, respectively) covering the complete genome were PCR amplified using Pfu Turbo DNA polymerase (Stratagene) for full-length cDNA clone synthesis. pGEM-T Easy (Promega) vector was used for initial cloning and nucleotide sequencing of the PCR generated amplicons. pBluescript II SK (+) phagemid vector (Stratagene) was used for subcloning of sequence confirmed amplicons from pGEM-T Easy vectors and for full-length cDNA assembly.

Individual amplicons (amplicon 1, 2, 3 and 4) were gel purified, cloned into pGEM-T Easy vector and sequence confirmed. Such clones were designated as pGEMTamplicon1, pGEMTamplicon2, pGEMTamplicon3 and pGEMTamplicon4. Cloning in pBluescript II SK vector was performed by sequential end-to-end ligation of the sequence characterized amplicons cleaved out of the pGEM-T Easy vector (Fig. 6.10). This was accomplished exploiting the unique internal restriction sites found naturally either in the viral genome or in the multiple cloning site (MCS) of the pBluescript vector. Each step of cloning was followed by nucleotide sequencing to confirm the sequence authenticity. Finally, pBluescript II SK vector was digested with BssHII to remove the MCS and the T7 promoter sequence region and the pBlue1234 was digested with AscI to release the viral genomic cDNA. The released viral genomic cDNA fragment was ligated with the digested vector to create pBlueT7Asia1IND491/1997, where the genomic cDNA was assembled directly under the T7 promoter introduced by the AggttgF primer, the forward primer of amplicon 1. This was done to ensure the presence of minimum possible extraneous vector-derived sequence between the promoter and the 5' end of the viral genome. The recombinant plasmid showed presence of two 'G' residues introduced after 'TATA' box and just before the 5'-end of the genome sequence for efficient transcription, 15 Cs in the poly (C) tract and 51 As in the poly (A) tail. Genetic markers in form of MluI restriction sites were engineered into the cDNA clone within the capsid coding region using QuickChange XL site-directed mutagenesis kit (Stratagene) to distinguish recombinant virus from the parent virus.

2 µg of recombinant plasmid pBlueT7Asia1 IND491/1997 carrying the genomic cDNA was linearized with NdeI, whose recognition sequence was put immediately downstream of poly (A) tail in the E2 primer of amplicon 4. After thermal inactivation of the restriction enzyme at 65 °C for 20 mins, 1 µg of linearized plasmid DNA was used for in vitro transcription with the MEGAscript Kit (Ambion). The transcription product was treated with DNase to remove input plasmid. To check the size and quality of the in vitro transcribed RNA, a sample was diluted 1:10 and 1:100 in nuclease free water and was denatured in RNA sample buffer (Fermantas) and electrophoresed on 1% agarose gel in Tris-acetate-EDTA buffer in the presence of ethidium bromide (Fig. 6.11).

BHK-21 cells and LF-BK cells were seeded in six-well plates (2 x 105 and 4 x 105 cells/well in 2 ml of antibiotic free GMEM with 10% FBS) 24 hrs before transfection so as to reach 80% confluency during transfection. 5 µg of in vitro transcribed RNA was mixed with 10 µl of lipofectamine 2000 (invitrogen) for complex formation. The mixture was transferred to the cells after washing with opti-MEM I medium and incubation was continued for 4 h. Appropriate negative control in form of lipofectamine 2000 without RNA and positive control in form of parental viral RNA were also included in the experiment. After 4 h of incubation, the cell monolayers were washed and fresh GMEM with 5% FBS was added and incubation continued for 36 h with microscopic observation for characteristic cytopathic effect (Fig. 6.12). CPE similar to that produced by wild-type virus was observed 24 hours post transfection.

To rule out any possibility of within laboratory contamination, supernatant obtained after every passage was checked in serotyping ELISA and mPCR for serotype Asia 1 specificity. To compare the growth characteristics of the rescued virus with the parent virus, BHK-21 cell monolayers were infected separately with wild-type parent and the recombinant viruses obtained after three sequential passage of

supernatant derived posttransfection at a multiplicity of infection of 5 and sampled intermittently. The samples were subjected to two freeze-thaw cycles before titration in BHK-21 cells to determine the virus quantal titre in form of TCID50/ml and plaque assay to determine quantitative titre as pfu/ml. These values were plotted against time points of harvest postinfection to produce the one-step growth curve for both parent and the recombinant virus (Fig. 6.13). Besides, the supernatants were also tested in sandwich ELISA for viral structural antigen detection through measurement of absorbance. Apparently the growth curves were very similar and the highest titre was observed 26-28 h postinfection for either of the viruses (log10 7.6 TCID50/ml). Both parent and the rescued viruses revealed small sized (< 1 mm diameter) clear plaques, probably as an indicator of BHK-21 cell adapted phenotype (Fig. 6.14).

To study the antigenic similarity between the recombinant and the parent virus, both viruses were subjected to two-dimensional virus neutralization test (2D-VNT) using guinea pig hyperimmune serum raised against Asia 1 IND 491/1997 parent virus and also using the bovine vaccinate serum raised against the Indian Asia 1 vaccine strain IND 63/72 virus. From the linear regression analysis, the serum neutralization titers at exactly 100 TCID50 dose of each virus was calculated. The r-1 value for the recombinant with the parent virus was found to be 0.9. The r-1 values with IND 63/72 vaccine strain were determined to be >1 for both parent and the recombinant virus in support of a closely matched antigenic profile.

We engineered an easy-to-differentiate genetic marker in the VP2 region by incorporating 2 silent mutations and thereby also creating a recognition site 'ACG CGT' for restriction enzyme, MluI. We could rescue infectious virus which maintained the marker stably even after 5 passages in cell culture without compromising the infectivity titre of the virus.

The genetically defined cDNA clone constructed in this project would serve as a platform for convenient genetic manipulation within the framework of reverse genetics for studying the role of different motifs in pathogenesis and virulence-attenuation phenotype toward development of genetically engineered marker vaccines with optimized growth and stability, to gain insights into neutralization-relevant antigenic sites and to rapidly produce demand-driven hybrid vaccine candidates by grafting the capsid coding sequence of appropriate field strains with contemporaneous antigenic relevance.

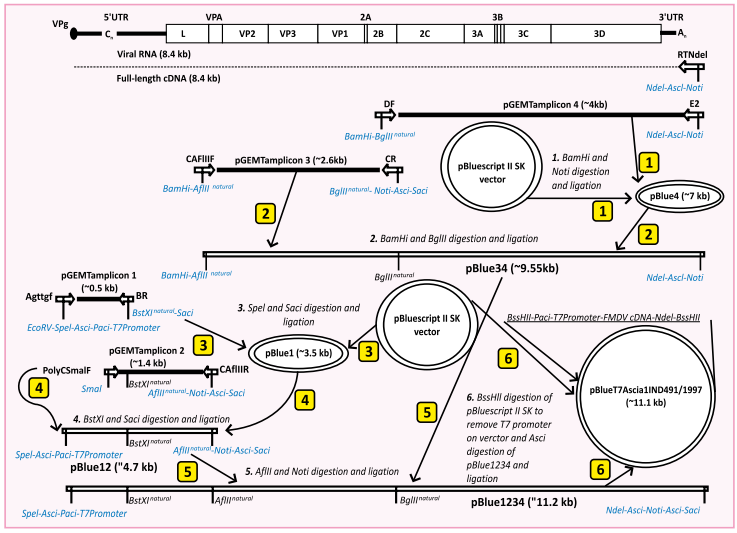
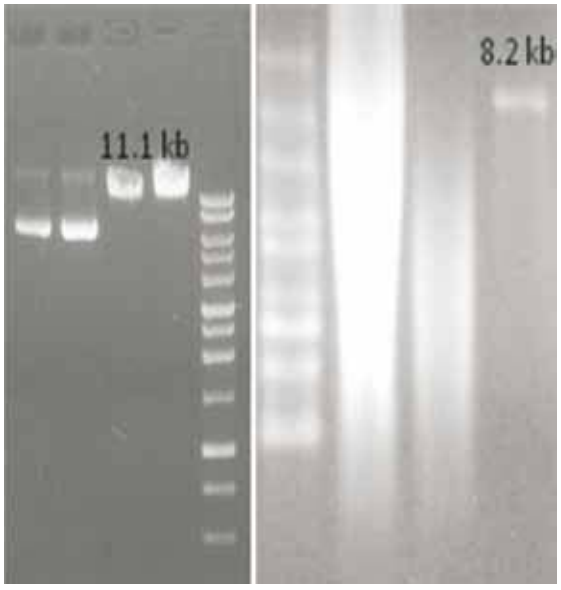


Fig. 6.10: Strategy of cloning and construction of full-length cDNA clone of Asia 1 IND 491/1997 virus. The sequence of cloning steps are shown within boxes adjacent to the arrows. The superscript 'natural' indicates the restriction site is already present on the genome. The prefix pGEMT and pBlue indicates clones in pGEM-T Easy and pBluescript II SK vectors, respectively.



Linearized plasmid In vitro transcripts

Fig. 6.11: Linearization of recombinant plasmid pBlueT7Asia 1 IND491/1997 and in vitro transcription

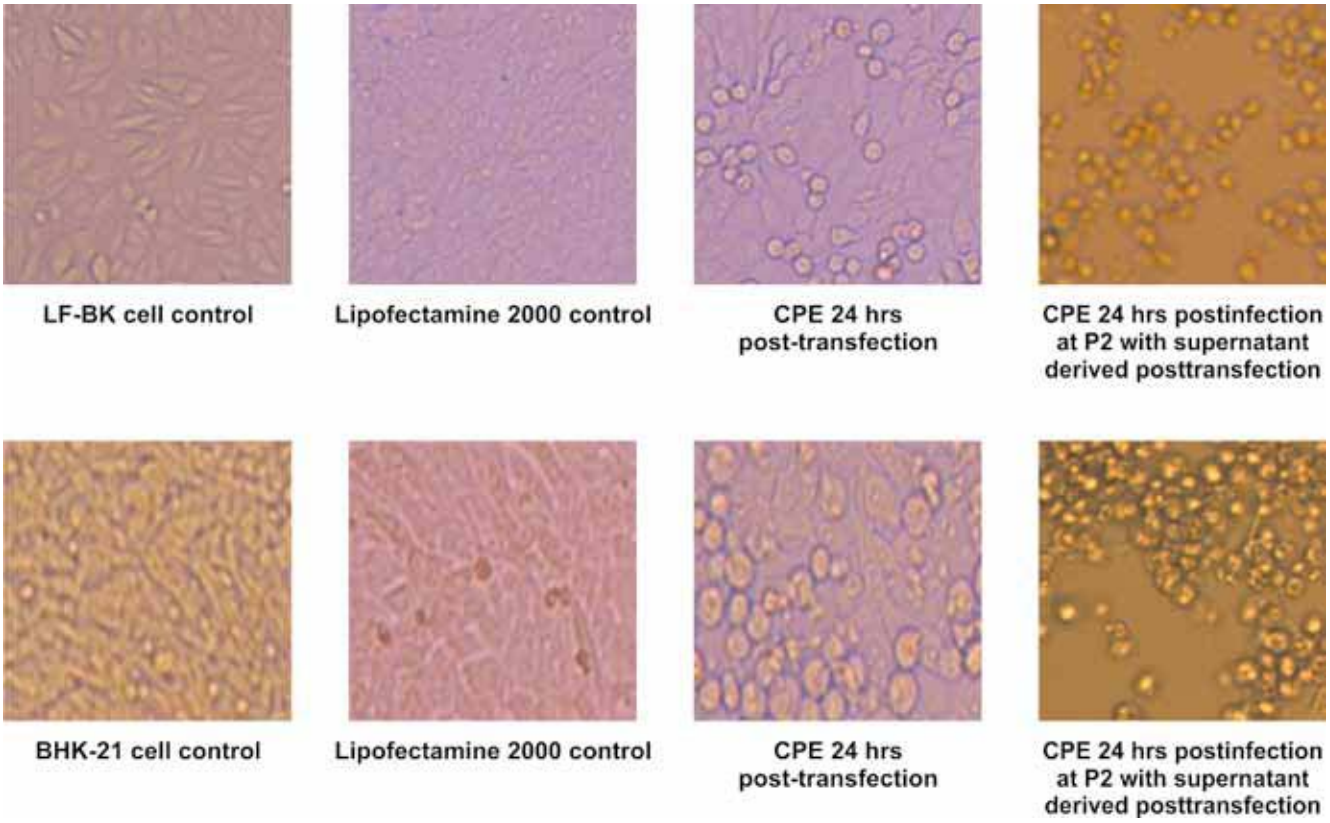


Fig. 6. 12: Characteristic microscopic CPE observed for rescued recombinant virus

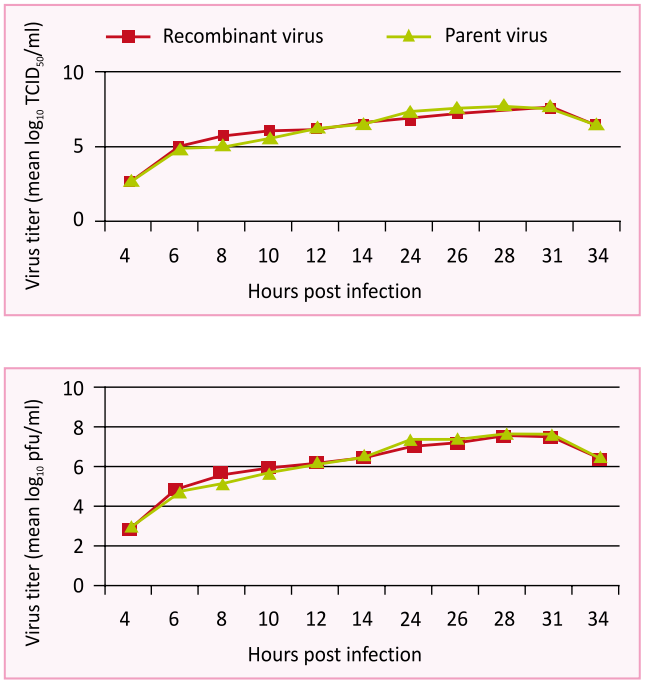


Fig. 6.13: One-step growth curve and absorbance for structural proteins in serotyping ELISA for the parent and the recombinant viruses

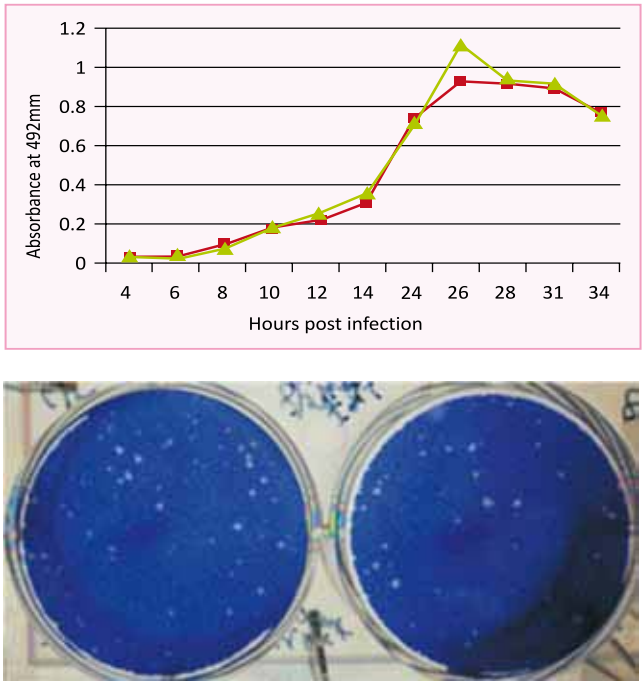


Fig. 6.14: Plaque morphology on BHK-21 monolayer cells at 48 h postinfection: small clear plaques of < 1mm diameter

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 77 virus isolates (32 type O, 19 type A and 26 Asia 1) were added to the repository during the reported period (Table 6). At present the National FMD virus Repository holds a total of 1851 isolates (O-1180, A-298, C-15 and Asia 1-358).

Table 7.1: Details of the virus isolates added to National FMD Virus Repository during 2012-13

S.No.	Isolate Designation	Cell and Passage No.	Place of Origin	Host	Serotype
1.	IND 195/2011 (458)	BHK-21, P-8	Karnataka	Bovine	O
2.	IND 37/2012 (68)	BHK-21, P-8	Karnataka	Pig	O
3.	IND 37/2012 (69)	BHK-21, P-8	Karnataka	Pig	O
4.	IND 116/2012 (219)	BHK-21, P-11	Karnataka	Bovine	O
5.	IND 123/2012 (233)	BHK-21, P-11	Karnataka	Bovine	O
6.	IND 123/2012 (234)	BHK-21, P-12	Karnataka	Bovine	O
7.	IND 123/2012 (235)	BHK-21, P-12	Karnataka	Bovine	O
8.	IND 123/2012 (236)	BHK-21, P-11	Karnataka	Bovine	O
9.	IND 124/2012 (237)	BHK-21, P-12	Karnataka	Bovine	O
10.	IND 141/2012 (292)	BHK-21, P-12	Uttar Pradesh	Bovine	O
11.	IND 182/2012 (296)	BHK-21, P-8	Haryana	Buffalo	O
12.	IND 143/2012 (297)	BHK-21, P-15	Haryana	Cattle	O
13.	IND 144/2012 (299)	BHK-21, P-15	Haryana	Buffalo	O
14.	IND 150/2012 (310)	BHK-21, P-15	Odisha	Bovine	O
15.	IND 223/2012 (529)	LFBK, P-4	Assam	Cattle	O
16.	IND 250/2012 (572)	LFBK, P-4	Karnataka	Cattle	O
17.	IND 251/2012 (573)	LFBK, P-4	Karnataka	Cattle	O
18.	IND 278/2012 (631)	LFBK, P-4	Karnataka	Cow	O
19.	IND 278/2012 (632)	LFBK, P-4	Karnataka	Cow	O
20.	IND 281/2012 (636)	LFBK, P-4	Karnataka	Bull	O
21.	IND 290/2012 (645)	LFBK, P-3	Maharashtra	Cattle	O
22.	IND 319/2012 (675)	LFBK, P-4	Assam	Cattle	O

S.No.	Isolate Designation	Cell and Passage No.	Place of Origin	Host	Serotype
23.	IND 320/2012 (676)	LFBK, P-4	Assam	Cattle	O
24.	IND 327/2012 (685)	LFBK, P-5	Manipur	Cattle	O
25.	IND 327/2012 (686)	LFBK, P-5	Manipur	Cattle	O
26.	IND 327/2012 (687)	LFBK, P-5	Manipur	Cattle	O
27.	IND 352/2012 (726)	LFBK, P-5	Assam	Cattle	O
28.	IND 382/2012 (801)	LFBK, P-4	Andhra Pradesh	Cattle	O
29.	IND 391/2012 (812)	LFBK, P-6	Bihar	Cattle	O
30.	IND 392/2012 (814)	LFBK, P-6	Bihar	Cattle	O
31.	IND 397/2012 (819)	LFBK, P-4	Assam	Cattle	O
32.	IND06/2013(12)	LFBK, P-3	J & K	NA	O
33.	IND 113/2012 (213)	BHK-21, P-8	Gujarat	Cow	A
34.	IND255/2012(581)	LFBK, P-3	Karnataka	Cattle	A
35.	IND255/2012(582)	LFBK, P-3	Karnataka	Cattle	A
36.	IND257/2012(586)	LFBK, P-4	Karnataka	Cow	A
37.	IND 256/2012 (585)	BHK-21, P-4	Karnataka	Cow	A
38.	IND 264/2012 (604)	LFBK, P-3	Odisha	Cattle	A
39.	IND 264/2012 (605)	LFBK, P-3	Odisha	Cattle	A
40.	IND 267/2012 (612)	LFBK, P-5	Karnataka	Cow	A
41.	IND270/2012(616)	LFBK, P-4	Karnataka	Cow	A
42.	IND 307/2012 (663)	LFBK, P-3	Assam	Cattle	A
43.	IND404/2012(828)	LFBK, P-3	Karnataka	Cattle	A
44.	IND405/2012(829)	LFBK, P-3	Karnataka	Cattle	A
45.	IND405/2012(830)	LFBK, P-3	Karnataka	Cattle	A
46.	IND406/2012(831)	LFBK, P-3	Karnataka	Cattle	A
47.	IND406/2012(833)	LFBK, P-3	Karnataka	Cattle	A
48.	IND410/2012(844)	LFBK, P-3	Karnataka	Cattle	A
49.	IND412/2012(849)	LFBK, P-3	Karnataka	Cattle	A
50.	IND411/2012(847)	LFBK, P-3	Karnataka	Cattle	A
51.	IND412/2012(848)	LFBK, P-3	Karnataka	Cattle	A
52.	IND114/2012(214)	BHK21, P9	Karnataka	Cattle	Asia1
53.	IND115/2012(217)	BHK21, P9	Karnataka	Cattle	Asia1
54.	IND 118/2012 (222)	BHK-21, P-8	Karnataka	Bovine	Asia1
55.	IND 119/2012 (223)	BHK-21, P-9	Karnataka	Bovine	Asia1
56.	IND 119/2012 (224)	BHK-21, P-8	Karnataka	Bovine	Asia1
57.	IND 120/2012 (226)	BHK-21, P-8	Karnataka	Bovine	Asia1

S.No.	Isolate Designation	Cell and Passage No.	Place of Origin	Host	Serotype
58.	IND 121/2012 (228)	BHK-21, P-9	Karnataka	Bovine	Asia1
59.	IND 131/2012 (255)	BHK-21, P-13	Gujarat	Bovine	Asia1
60.	IND 135/2012 (271)	BHK-21, P-12	Assam	Bovine	Asia1
61.	IND 162/2012 (330)	BHK-21, P-8	Karnataka	Bovine	Asia1
62.	IND 162/2012 (331)	BHK-21, P-8	Karnataka	Bovine	Asia1
63.	IND 162/2012 (332)	BHK-21, P-8	Karnataka	Bovine	Asia1
64.	IND 163/2012 (333)	BHK-21, P-8	Karnataka	Bovine	Asia1
65.	IND 163/2012 (334)	BHK-21, P-8	Karnataka	Bovine	Asia1
66.	IND 163/2012 (336)	BHK-21, P-8	Karnataka	Bovine	Asia1
67.	IND 283/2012 (638)	LFBK, P-3	Maharashtra	Cattle	Asia1
68.	IND 285/2012 (640)	LFBK, P-4	Maharashtra	Cattle	Asia1
69.	IND 288/2012 (643)	LFBK, P-3	Maharashtra	Cattle	Asia1
70.	IND 300/2012 (655)	LFBK, P-3	Maharashtra	Cattle	Asia1
71.	IND 303/2012 (658)	LFBK, P-3	Maharashtra	Cattle	Asia1
72.	IND 400/2012 (822)	LFBK, P-4	Odisha	Cattle	Asia1
73.	IND 401/2012 (823)	LFBK, P-4	Odisha	Cattle	Asia1
74.	IND 403/2012 (826)	LFBK, P-3	Karnataka	Cow	Asia1
75.	IND 411/2012 (845)	LFBK, P-3	Karnataka	Cow	Asia1
76.	IND 411/2012 (846)	LFBK, P-3	Karnataka	Cow	Asia1
77.	IND 413/2012 (852)	LFBK, P-3	Karnataka	Bull	Asia1

State-wise distribution of serotype A isolates (n = 298) preserved in National FMD virus Repository, PD on FMD, Mukteswar

For two isolates state of origin is not available

State-wise distribution of serotype C isolates (n = 15) preserved in National FMD virus Repository, PD on FMD, Mukteswar

State-wise distribution of serotype Asia 1 isolates (n = 358) preserved in National FMD virus Repository, PD on FMD, Mukteswar

For three isolates state of origin is not available and one isolate is from Bhutan

State-wise distribution of serotype O isolates (n = 1180) preserved in National FMD virus Repository, PD on FMD, Mukteswar

For eleven isolates state of origin is not available and one isolate is from Nepa

State-wise distribution of FMD virus (serotype O, A, C and Asia 1) isolates (*n* = 1851) preserved in National FMD virus Repository, PD on FMD, Mukteswar

For sixteen isolates, state of origin is not available and one isolate each is from Nepal & Bhutar

Research Projects

8.1 Institute Research Projects 2013-14

SNo	Title	PI
1	Cataloging and Maintenance of National FMD virus repository during 2013-14.	B. Pattnaik
2	Production, standardization and supply of diagnostic reagents for FMD diagnosis and surveillance (2013-14).	B. B.Dash
3	Seromonitoring of pre and post vaccinal immunity against FMD during 2013-14.	B. B.Dash
4	Random serosurveillance of FMD in India (2013-14).	B. B.Dash
5	Antigenic and molecular characterization of serotype A FMD viruses during 2013-14.	J.K.Mohapatra
6	Molecular epidemiology and vaccine matching analysis of foot and mouth disease virus serotype O in India during 2013-14.	Saravanan S
7	Genetic and antigenic analysis of foot-and-mouth disease virus serotype Asia1 during 2013-14.	Saravanan S
8	Development of an online Foot and Mouth Disease Decision Support System (FMD-DSS) for control of FMD in India.	G.K.Sharma
9	Development of next generation 3ABC based C-ELISA for differentiation of infected from vaccinated animals.	G.K.Sharma
10	Development of 3B epitope deletion mutant of FMDV serotype O.	J.K.Biswal
11	Development of improved thermo-stable FMD virus serotype O by reverse genetics technique	J.K.Biswal
12	Preparedness for Diagnosis of South African Territories (SAT) Serotypes of Foot and Mouth Disease Virus by Polymerase Chain Reaction.	M. Rout
13	Expression profiling of bovine Toll Like Receptors (TLRs) in response to FMD Vaccine.	S.S.Pawar
14	Validation of LAMP kit for diagnosis of FMD in field samples	
16	Generation of infectious FMD virus serotype O from cloned cDNA using RNA Polymerase 1.	JK Biswal
17	Spatial and temporal distribution of foot and mouth disease in India during 2001-2011	K Muniswamy
18	Surveillance and Monitoring of Foot and Mouth Disease in small ruminants in India	M. Rout

8.2 Collaborative Projects to be undertaken during 2013-14

National

1. PDFMD-PDADMAS collaborative project on 'Assessment of socio-economic impact of FMD and its control in India' (PI: B Ganesh Kumar).
2. PDFMD-TAH, IVRI, Mukteswar collaborative project on 'Influence of genetic and non-genetic factors on FMDV vaccine response' (PI: AK Sharma)
3. PDFMD-NIANP collaborative project on 'Profiling of nutritional requirements for better antibody response to FMD vaccine in cattle'. (PI: C.S Prasad)

International

1. PDFMD-PIADC, USA collaborative project on 'Understanding Foot and Mouth Disease viral ecology and Landscape epidemiology towards control and eradication'. (PI: J K Mohapatra,)
2. PDFMD-BBSRC DBT project with Pirbright Institute on 'An effective vaccination programme for eradication of Foot and Mouth Disease from India'. (PI: B Pattnaik)

National FMD Serosurveillence

9.1 DIVA (Antibody against NSPs; Percent Infected)

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

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

During the year, a total of 40934 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 ~ 26.41% samples/animals (Table 9.1). The test also included serum samples from recent suspected outbreak areas

Table 9.1: Result summary of r3AB3 NSP-ELISA on bovine (cattle and buffalo) serum samples (Regional center, Network Units and Central FMD labs)

Sl. No.	Place of origin	Host	Total serum samples tested	Total positive	%3AB3 reactors
1	Andhra Pradesh	Bovine	1650	382	23.15
2	Rajasthan	Bovine	3171	1269	40.02
3	West Bengal	Bovine	1077	265	24.60
4	Asom	Bovine	1200	294	24.50
5	Arunachal Pradesh	Bovine	787	271	34.4
6	Jharkhand	Bovine	911	322	35.4
7	Bihar	Bovine	2078	662	31.9
8	Gujarat	Bovine	2341	962	41.00
9	Haryana	Bovine	4200	295	07.02
10	Himachal Pradesh	Bovine	380	34	08.94

Sl. No.	Place of origin	Host	Total serum samples tested	Total positive	%3AB3 reactors
11	J & K	Bovine	924	155	16.6
12	Karnataka	Bovine	2744	484	17.60
13	Kerala	Bovine	1260	377	29.92
14	Andaman	Bovine	896	67	7.47
15	Madhya Pradesh	Bovine	2665	761	28.7
16	Maharashtra	Bovine	1430	312	21.82
17	Punjab	Bovine	1700	194	11.4
18	Manipur	Bovine	955	233	24.40
19	Meghalaya	Bovine	100	23	23.00
20	Mizoram	Bovine	800	126	15.75
21	Nagaland	Bovine	1121	454	40.49
22	Odisha	Bovine	2527	863	34.15
23	Tamilnadu	Bovine	3100	1433	46.00
24	Uttar Pradesh	Bovine	2917	573	19.64
	Total		**40934**	**10811**	**26.41**

Table 9.2: Summary of r3AB3 NSP-ELISA During 2008-09 to 2012-2013; the prevalence has been around 27%

Year	Total samples tested	States from which samples were collected	Total positive	% DIVA reactors
2008-09	18,326	Tripura,Gujarat,Mizoram, Himachal Pradesh,Nagaland, Bihar,Madhya Pradesh, West Bengal,Manipur, Maharashtra,Punjab, Kerala,AndhraPradesh, Arunachal Pradesh,Orissa, Haryana,Jammu & Kashmir, Rajasthan,Karnataka, Tamil Nadu	**5120**	27.94
2009-10	29,763	Tripura,Gujarat,Mizoram,Himachal Pradesh,Nagaland,Bihar,Madhya Pradesh, West Bengal,Ma nipur,Maharashtra,Punjab,Kerala,AndhraPradesh,Arunachal Pradesh, Orissa,Haryana,Jammu & Kashmir,Rajasthan,Karnatak a,Tamil Nadu,Assam	**8303**	27.9 %
2010-11	31,042	Assam,Manipur, Mizoram,Nagaland, Tripura,Haryana,Punjab,Orissa, Tamilnadu,Bihar,Andhra Pradesh,West Bengal, Himachal Pradesh, MP,Karnataka, Gujarat,J & K, UP,MP,Manipur,Kerala, Uttarakhand,Rajasthan, Arunachal Pradesh,Maharashtra	**8341**	26.87
2011-12	37,467	Andaman & Nicobar, Andhra Pradesh, Assam, Arunachal Pradesh, Bihar, Gujarat, Haryana, Himachal Pradesh, J & K, Karnataka, Kerala,,Lakshadweep,,Madhaya Pradesh,,Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Pudhucherry, Tamilnadu, UP,West Bengal, Rajasthan, Uttarakhand, Nagaland, Tripura	**10,410**	26.09

Year	Total samples tested	States from which samples were collected	Total positive	% DIVA reactors
2012-13	40934	Andhra Pradesh, Rajasthan, West Bengal, Asom Arunachal Pradesh,Jharkhand,Bihar,Gujarat Haryana,Himachal Pradesh,J & K Karnataka,Kerala,Andaman,Madhya Pradesh Maharashtra,Punjab,Manipur,Meghalaya Mizoram,Nagaland,Odisha, Tamilnadu Uttar Pradesh	**10811**	26.41
Total	**1,57,532**		**42985**	27.29

9.2 LPB-ELISA (Percent protected)

During the year under report, a total of 26,501 serum samples were subjected to LPB ELISA for determination of antibody level against structural protein (SPs) of serotypes O, A and Asia1. The result showed protective antibody titre in 43.2%, 28.9% and 27.4 % samples/animals against serotypes O, A and Asia1, respectively (Table 9.3).

Table 9.3: 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
1.	Andaman & Nicober	Cattle	224	7(3.1)	3(1.3)	2(0.9)
2.	Andhra Pradesh	Cattle+ Buffalo	1650	856(51.8)	577(34.9)	361(21.8)
3.	Arunachal Pradesh	Cattel+ Mithun	681	223(32.7)	185(27.1)	158(23.2)
4.	Asom	Cattle	2450	803(32.8)	440(18)	265(10.8)
5.	Bihar	Cattle+ Buffalo	1109	318(28.7)	155(14)	111(10)
6.	Jharkhand	Cattle+ Buffalo	198	48(24.2)	10(5.1)	11(5.6)
7.	Himachal Pradesh	Cattle+ Buffalo	1164	733(63)	677(58.2)	538(46.2)
8.	Karnataka	Cattle+ Buffalo	2752	1636(59.5)	691(25.1)	1627(59.1)
9.	Nagaland	Cattle+ Buffalo	74	49(66)	20(27)	32(43.2)
10.	Kerala	Cattle	770	125(16.2)	85(11)	168(21.8)
11.	Jammu & Kashmir	Cattle+ Buffalo	916	258(28.2)	145(15.8)	279(30.5)
12.	Madhya Pradesh	Cattle+ Buffalo	2662	684(25.7)	371(13.9)	292(11.0)
13.	Manipur	Cattle+ Buffalo	1625	619(38.1)	552(33.9)	434(26.7)
14.	Mizoram	Cattle	449	212(47.2)	135(29.8)	76(16.3)
15.	Meghalaya	Cattle	141	45(31.9)	39(27.7)	21(14.9)
16.	Odisha	Cattle	2654	1549(58.4)	1053(39.7)	1736(65.4)
17.	Punjab	Cattle+ Buffalo	1800	1176(65.3)	1029(57.2)	0(0)
18.	Rajasthan	Cattle+ Buffalo	619	188 (30.4)	68 (11.0)	96 (15.5)
19.	Tamilnadu	Cattle	3100	1387(44.7)	1047(33.7)	714(23)
20.	Uttar Pradesh	Cattle+ Buffalo	911	214(23.5)	93(10.2)	126(13.8)

Sl. No.	Name of place/State	Species	Total no. of samples	Protective Titre ≥1.8		
				O	A	Asia 1
21.	West Bengal	Bovine	282	104 (36.9)	82 (29.1)	31 (11)
22.	Haryana	Cattle+ Buffalo	270	227(84.1)	223(82.6)	194(71.9)
	Total		**26,501**	**11441(43.2)**	**7660(28.9)**	**7257(27.4)**

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

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

During the mentioned period, a total of serum samples of 3767 animals (sheep = 2047, goat = 1691 and pig = 29) were collected from various states of India.

3AB-NSP-ELISA

Out of 2047 ovine serum samples tested in 3AB-NSP-ELISA, 376 (18.36%) samples were found to be 3AB-NSP reactors. Out of 1691 caprine serum samples tested in 3AB-NSP-ELISA, 312 (18.45%) samples were found to be 3AB-NSP reactors.

LPB-ELISA

Sheep: Out of 2047 ovine serum samples tested in LPB-ELISA, 185 (9.03%) samples showed **$\log_{10}$ titer of 1.5** against serotype O, 82 (4.00%) against serotype A and 80 (3.90%) against serotype Asia 1.Out of 2047 ovine serum samples tested in LPB-ELISA, 81 (3.95%) samples showed **$\log_{10}$ titer of 1.8** against serotype O, 55 (2.68%) against serotype A and 30 (1.46%) against serotype Asia 1.Out of 2047 ovine serum samples tested in LPB-ELISA, 180 (8.79%) samples showed **$\log_{10}$ titer of >2.1** against serotype O, 58 (2.83%) against serotype A and 20 (0.97%) against serotype Asia 1.

Goat: Out of 1691 caprine serum samples tested in LPB-ELISA, 176 (10.40%) samples showed **$\log_{10}$ titer of 1.5** against serotype O, 87 (5.14%) against serotype A and 51 (3.01%) against serotype Asia 1.Out of 1691 caprine serum samples tested in LPB-ELISA, 94 (5.55%) samples showed **$\log_{10}$ titer of 1.8** against serotype O, 36 (2.12%) against serotype A and 22 (1.30%) against serotype Asia 1.Out of 1691 caprine serum samples tested in LPB-ELISA, 135 (7.98%) samples showed **$\log_{10}$ titer of >2.1** against serotype O, 17 (1.00%) against serotype A and 19 (1.12%) against serotype Asia 1.

Pig: Out of 29 porcine serum samples tested in LPB-ELISA, none showed any titer against any of the three serotypes.

The study indicates the evidence of FMD virus circulation and its prevalence estimates among small ruminants and pig population of the country.

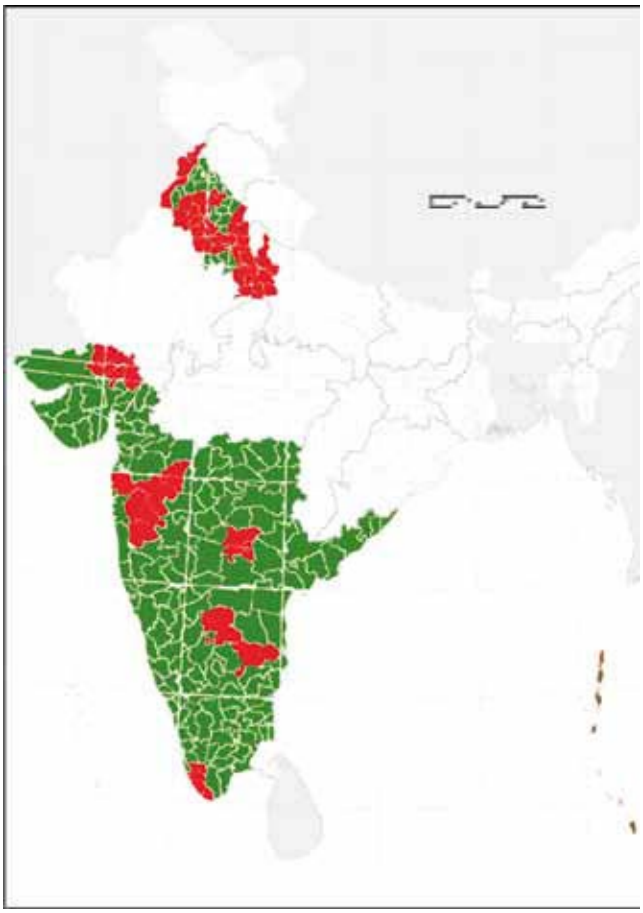
Post Vaccinal Seroconversion Studies

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

A vaccination based FMD Control Programme (FMD-CP) has been initiated by the Government of India since August 2003-04 covering 54 specified districts in the country. This involves 6 monthly vaccinations with a trivalent O, A and Asia1 vaccine of all cattle and buffaloes against FMD. Serum samples before vaccination and 21 to 30 days post vaccination are collected by the respective state AH department and submitted to testing centres of PD-FMD for estimation of level of serotype specific neutralizing antibodies by Liquid Phase Blocking ELISA (LPBE) developed by PD-FMD. The Regional Centers, Network Units and Central FMD laboratory of the Project Directorate participate in this post vaccinal sero-conversion under FMD-CP. Since 2011-12, Central Agricultural Research Institute, Port Blair has been included as a testing laboratory for sero-monitoring of FMD in A & N Islands. All reagent and training to conduct LPB ELISA are provided by the institute. The test was compared with SNT, and it is recommended that LPB ELISA titer (in serum) of ≥ $\log_{10}$ 1.8 indicates protection against FMD. Due to initial success, additional 167 districts (another 80-90 million cattle and buffalo) have been included under the programme in 2010-11. 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 10.1), and targeting ~120 million cattle and buffalo.

During 2012-13, a total of 1,55,611 pre and post vaccinated serum samples were tested and of which, 54,642 serum samples were from first phase FMDCP districts representing XII, XIII and XIV phases of vaccinations and remaining 1,00,969 serum samples were from expanded FMD CP districts of 2010-11 representing Phases I, II and III.

Fig.10.1: 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.



Sero-monitoring in Andaman & Nicobar Island

Initially, eight villages of Andaman & Nicobar were covered under FMDCP in 2003-04 and later in 2010-11, entire Andaman & Nicobar Island was included.

Central Agricultural Research Institute, Port Blair is undertaking the sero-monitoring of animals covered under the programme in A&N Islands

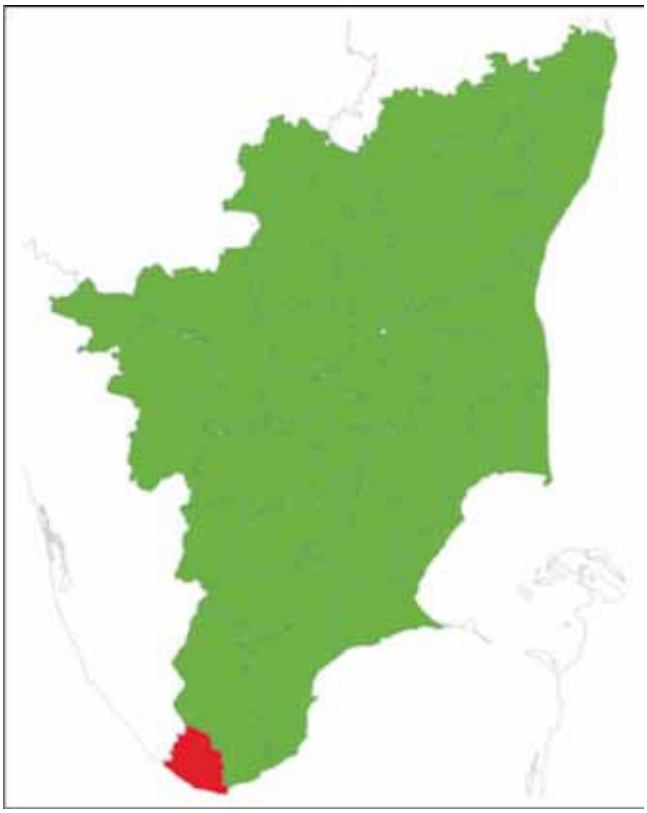
- In phase III, 154 pre and 162 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 25.9 for type 'O', 2.8 for type 'A' and 34.0 for type 'Asia 1'. The same for post-vac samples was 60.0 for type 'O', 20.3 for type 'A' and 73.6 for type 'Asia 1'.
- In phase IV, 149 pre and 146 post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples were 33.5 for type 'O', 33.5 for type 'A' and 23.4 for type 'Asia 1'. The same for post-vac samples were 64.6 for type 'O', 65.9 for type 'A' and 67.6 for type 'Asia 1'.
- In phase V, 126 pre and 122 post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples were 57.2 for type 'O', 50.8 for type 'A' and 44.3 for type 'Asia 1'. The same for post-vac samples were 55.8 for type 'O', 52.5 for type 'A' and 50.8 for type 'Asia 1'.
- In phase VI, 270 pre and 270 post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples were 18.5 for type 'O', 24.4 for type 'A' and 10.2 for type 'Asia 1'. The same for post-vac samples were 29.6 for type 'O', 38.4 for type 'A' and 13.2 for type 'Asia 1'.
- In phase VII, 265 pre and 265 post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples were 42.3 for type 'O', 30.9 for type 'A' and 21.1 for type 'Asia 1'. The same for post-vac samples were 65.7 for type 'O', 41.5 for type 'A' and 24.9 for type 'Asia 1'.
- In phase VIII, 251 pre and post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples were 21.11 for type 'O', 7.17 for type 'A' and 18.72 for type 'Asia 1'. The same for post-vac samples were 40.63 for type 'O', 19.52 for type 'A' and 33.86 for type 'Asia 1'.
- In phase IX, 228 pre and post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples were 32.01 for type 'O', 13.59 for type 'A' and 24.56 for type 'Asia 1'. The same for post-vac samples were 30.26 for type 'O', 15.35 for type 'A' and 18.82 for type 'Asia 1'.
- In phase XII, 180 each of pre and post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples were 20 for type 'O', 10.56 for type 'A' and 6.11 for type 'Asia 1'. The same for post-vac samples were 27.22 for type 'O', 22.22 for type 'A' and 16.67 for type 'Asia 1'.
- In phase XIII, 283 each pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 9.2 for serotype O, 4.2 for serotype A and 5.3 for serotype Asia 1. The same for post-vac samples was 27.6 for serotype O, 18.4 for serotype A and 15.5 for serotype Asia 1.
- Overall herd immunity and seroconversion was very poor

Table 10.1: Result of seroconversion in Andaman & Nicobar Islands (2003-04)

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
III	40(25.9)	97(60.0)	5(2.8)	37(20.3)	52(34.0)	118(73.6)
IV	50(33.5)	94(64.6)	50(33.5)	96(65.9)	35(23.4)	101(67.6)
V	72(57.2)	68(55.8)	62(50.8)	64(52.5)	54(44.3)	62(50.8)
VI	50 (18.5)	80 (29.6)	66 (24.4)	104 (38.4)	28 (10.2)	36 (13.2)
VII	112 (42.3)	174 (65.7)	82 (30.9)	110 (41.5)	56 (21.1)	66 (24.9)
VIII	53(21.11)	102(40.63)	18(7.17)	49(19.52)	47(18.72)	85(33.86)
IX	73(32.01)	69(30.26)	31(13.59)	35(15.35)	56(24.56)	42(18.42)
XII	36(20.0)	49(27.22)	19(10.56)	40(22.22)	11(6.11)	30(16.67)
XIII	26(9.2)	78(27.6)	12(4.2)	52(18.4)	15(5.3)	44(15.5)

Sero-monitoring in Tamil Nadu

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



District included in 2003-04(Red)

- In phase I, each of 100 pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 28 for type 'O', 29 for type 'A' and 24 for type 'Asia 1'. The same for post-vac samples was 51 for type 'O', 57 for type 'A' and 54 for type 'Asia 1'.
- In phase II, each of 100 pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 23 for type 'O', 24 for type 'A' and 18 for type 'Asia 1'. The same for post-vac samples was 63 for type 'O', 40 for type 'A' and 61 for type 'Asia 1'.
- In phase III & IV, 180 pre and 330 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 32.7 for type 'O', 33.8 for type 'A' and 25 for type 'Asia 1'. The same for post-vac samples was 74.5 for type 'O', 60.9 for type 'A' and 65.4 for type 'Asia 1'.
- For phase V, serum samples were not available.
- In phase VI, 160 pre and 130 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 18.7 for type 'O', 23.8 for type 'A' and 21.5 for type 'Asia 1'. The same for

post-vac samples was 76.1 for type 'O', 83.8 for type 'A' and 79.2 for type 'Asia 1'.

- In phase VII, 300 pre and 300 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 11.7 for type 'O', 11.3 for type 'A' and 12.0 for type 'Asia 1'. The same for post-vac samples was 70.0 for type 'O', 77.0 for type 'A' and 75.3 for type 'Asia 1'.
- In phase VIII, 100 pre and 100 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 34 for type 'O', 40 for type 'A' and 25 for type 'Asia 1'. The same for post-vac samples was 74 for type 'O', 60 for type 'A' and 78 for type 'Asia 1'.
- In phase IX, 100 pre and 100 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 40 for type 'O', 45 for type 'A' and 33 for type 'Asia 1'. The same for post-vac samples was 58 for type 'O', 64 for type 'A' and 74 for type 'Asia 1'.
- In phase X, 100 pre and 100 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 32 for type 'O', 45 for type 'A' and 41 for type 'Asia 1'. The same for post-vac samples was 62 for type 'O', 63 for type 'A' and 70 for type 'Asia 1'.
- In phase XI, 200 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 19 for serotype O, 15.5 for serotype A and 14.5 for serotype Asia 1. The same for post-vac samples was 72 for type O, 43.5 for type A and 41.5 for serotype Asia 1.
- Though seroconversion was good, overall herd immunity was poor

Table 10.2: Result of seroconversion in Tamil Nadu (2003-04).

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	28(28)	51(51)	29(29)	57(57)	24(24)	54(54)
II	23(23.0)	63(63.0)	24(24.0)	40(40.0)	18(18.0)	61(61.0)
III & IV	59(32.7)	246(74.5)	61(33.8)	201(60.9)	45(25.0)	216(65.4)
VI	30(18.7)	99(76.1)	31(23.8)	109(83.8)	28(21.5)	103(79.2)
VII	35(11.7)	210(70)	34(11.3)	231(77)	36(12)	226(75.3)
VIII	34(34)	74(74)	40(40)	60(60)	25(25)	78(78)
IX	40(40)	58(58)	45(45)	64(64)	33(33)	74(74)
X	32(32)	62(62)	45(45)	63(63)	41(41)	70(70)
XI	38(19)	144(72)	31(15.5)	87(43.5)	29(14.5)	83(41.5)

Districts included in 2010-11 (Green)

- In phase I, 5440 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 34.2 for serotype O, 24.8 for serotype A and 20.5 for serotype Asia 1. The same for post-vac samples was 62.8 for type O, 47.1 for type A and 40.6 for serotype Asia 1.
- In phase II, 5040 pre and 5240 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 27.4 for serotype O, 13.6 for serotype A and 4.9 for serotype Asia 1. The same for post-vac samples was 66.9 for type O, 46.4 for type A and 18.7 for serotype Asia 1.
- In phase III, 1550 each of pre and post-vac serum

samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 24.5 for serotype O, 13.5 for serotype A and 30.5 for serotype Asia 1. The same for post-vac samples was 62.3 for type O, 50.1 for type A and 73.3 for serotype Asia 1.

- There is a good boosting effect after first vaccination

Table 10.3: Result of seroconversion in in Tamil Nadu (2010-11).

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	1860(34.2)	3417(62.8)	1351(24.8)	2561(47.1)	115(20.5)	2209(40.6)
II	1383(27.4)	3504(66.9)	684(13.6)	2433(46.4)	245(4.9)	979(18.7)
III	380(24.5)	965(62.3)	210(13.5)	777(50.1)	473(30.5)	1136(73.3)

Sero-monitoring in Puducherry

Districts included in 2010-11

- In phase I, 30 pre and 55 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 44.4 for serotype O, 25 for serotype A and 13.88 for serotype Asia 1. The same for post-vac samples was 66.66 for type O, 55.55 for type A and 30.55 for serotype Asia 1.
- In phase II, 38 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 42.1 for serotype O, 26.3 for serotype A and 0 for serotype Asia 1. The same for post-vac samples was 52.6 for type O, 36.8 for type A and 21.1 for serotype Asia 1.
- In phase III, 46 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 45.7 for serotype O, 15.2 for serotype A and 56.5 for serotype Asia 1. The same for post-vac samples was 63 for type O, 43.5 for type A and 65.2 for serotype Asia 1.

Table 10.4: Result of seroconversion in Puducherry.

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	16(44.4)	24(66.66)	9(25)	20(55.55)	5(13.88)	11(30.55)
II	16(42.1)	20(52.6)	10(26.3)	14(36.8)	0(0)	18(21.1)
III	21(45.7)	29(63)	7(15.2)	20(43.5)	26(56.5)	30(65.2)

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; rest of the districts (filled green) was included

- In phase I, II & IV, 483 pre and 496 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 32.7 for type 'O', 29 for type 'A' and 34.2 for type 'Asia 1'. The same for post-vac samples was 51.4 for type 'O', 47.5 for type 'A' and 56.4 for type 'Asia 1'.
- For phase III, serum samples were not available.
- In phase V, each of 290 pre and post-vac serum samples were tested. Percent serum sample

having protective antibody titer of 1.8 and above for pre-vac samples were 23.1 for type 'O', 17.9 for type 'A' and 21 for type 'Asia 1'. The same for post-vac samples was 67.9 for type 'O', 58.9 for type 'A' and 72.7 for type 'Asia 1'.

- In phase VI, each of 70 pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 20.4 for type 'O', 17.1 for type 'A' and 15.8 for type 'Asia 1'. The same for post-vac samples was 77.1 for type 'O', 70.4 for type 'A' and 71.3 for type 'Asia 1'.
- In phase VII, each of 300 pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 16.0 for type 'O', 14.3 for type 'A' and 17.3 for type 'Asia 1'. The same for post-vac samples was 69.3 for type 'O', 71.0 for type 'A' and 70.0 for type 'Asia 1'.
- In phase VIII & IX 600 pre and 600 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 37.6 for type 'O', 44.16 for type 'A' and 43.3 for type 'Asia 1'. The same for post-vac samples was 65.8 for type 'O', 56.8 for type 'A' and 66.2 for type 'Asia 1'
- In phase X, each of 400 pre and 100 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 40.0 for type 'O', 36.25 for type 'A' and 37.5 for type 'Asia 1'. The same for post-vac samples was 59 for type 'O', 66 for type 'A' and 53 for type 'Asia 1'.
- In phase XI, 352 pre and 315 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 18.29 for serotype O, 18.29 for serotype A and 14.39 for serotype Asia 1. The same for post-vac samples was 18.29 for type O, 17.24 for type A and 13.19 for serotype Asia 1.
- In phase XII, 500 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 11.8 for serotype O, 14.6 for serotype A and 12.6 for serotype Asia 1. The same for post-vac samples was 40.4 for type O, 39.4 for type A and 30.6 for serotype Asia 1.
- In phase XIII, 150 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 7.3 for serotype O, 8.7 for serotype A and 8.7 for serotype Asia 1. The same for post-vac samples was 28 for type O, 26 for type A and 27.3 for serotype Asia 1.
- Herd immunity is very poor against all the three serotypes

Table 10.5: Result of seroconversion in Kerala (2003-04).

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 & II& IV	158(32.7)	255(51.4)	140(29.0)	236(47.5)	165(34.2)	280(56.4)
V	67(23.1)	197(67.9)	52(17.9)	171(58.9)	61(21.0)	211(72.7)
VI	49 (20.4)	185(77.1)	41(17.1)	169(70.4)	38(15.8)	171(71.3)
VII	48 (16.0)	208(69.3)	43 (14.3)	213 (71.0)	52 (17.3)	210(70.0)
VIII & IX	226(37.6)	395(65.8)	265(44.16)	341(56.8)	260(43.3)	397(66.2)
X	160(40)	59(59)	145(36.25)	66(66)	150(37.5)	53(53)
XI	122(18.29)	122(18.29)	122(18.29)	115(17.24)	96(14.39)	88(13.19)

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
XII	59(11.8)	202(40.4)	73(14.6)	197(39.4)	63(12.6)	153(30.6)
XIII	11(7.3)	42(28)	13(8.7)	39(26)	13(8.7)	41(27.3)

District included in 2010-11(Green)

- In phase I, serum sample was not made available for testing.
- In phase II, 676 pre and 180 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 12.4 for serotype O, 15.5 for serotype A and 9.6 for serotype Asia 1. The same for post-vac samples was 36.1 for type O, 36.1 for type A and 34 for serotype Asia 1.
- In phase III, 1631 pre and 1474 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 12.2 for serotype O, 10.9 for serotype A and 8.3 for serotype Asia 1. The same for post-vac samples was 35.6 for type O, 32.8 for type A and 25.5 for serotype Asia 1.
- In phase IV, 810 pre and 770 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 6.7 for serotype O, 7.4 for serotype A and 4 for serotype Asia 1. The same for post-vac samples was 18.8 for type O, 17.5 for type A and 11 for serotype Asia 1.
- Overall herd immunity and seroconversion was poor, and likely to improve over further rounds of vaccination.

Table 10.6: Result of seroconversion in Kerala (2010-11).

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	Not available					
II	84(12.4)	65(36.1)	105(15.5)	65(36.1)	65(9.6)	61(34)
III	199(12.2)	525(35.6)	178(10.9)	484(32.8)	135(8.3)	376(25.5)
IV	54(6.7)	145(18.8)	60(7.4)	135(17.5)	32(4)	85(11)

Sero-surveillance in Lakshadweep under FMDCP (2010-11)

- In phase I, 107 each of pre and post-vac serum samples of Lakshadweep were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 42.1 for serotype O, 15 for serotype A and 32.7 for serotype Asia 1. The same for post-vac samples was 74.8 for type O, 58.9 for type A and 46.7 for serotype Asia 1. Seroconversion is good

Table 10.7: Result of seroconversion in Lakshadweep (2010-11).

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	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.

Districts included in 2003-04 (Red)

- In phase I, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 10.3 for serotype 'O', 5.3 for serotype 'A' and 11.5 for serotype 'Asia 1'. The same for post-vac samples was 42.5 for serotype 'O', 30.5 for serotype 'A' and 42.5 for serotype 'Asia 1'. It shows boosting of antibody level following vaccination.
- In phase II, 800 post-vac serum samples were tested. Pre-vac serum samples were not available. Percent serum sample having protective antibody titer of 1.8 and above was 54.2 for serotype 'O', 62.3 for serotype 'A' and 54.7 for serotype 'Asia 1'.
- In phase III, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 26.2 for serotype 'O', 49.3 for serotype 'A' and 38.2 for serotype 'Asia 1'. The same for post-vac samples was 35.7 for serotype 'O', 66.5 for serotype 'A' and 52.7 for serotype 'Asia 1'.
- In phase IV, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 35.1 for serotype 'O', 58.1 for serotype 'A' and 41.1 for serotype 'Asia 1'. The same for post-vac samples was 46.8 for serotype 'O', 77.1 for serotype 'A' and 64.8 for serotype 'Asia 1'.
- In phase V, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 30.8 for serotype 'O', 58.2 for serotype 'A' and 42.8 for serotype 'Asia 1'. The same for post-vac samples was 55.0 for serotype 'O', 71.8 for serotype 'A' and 56.3 for serotype 'Asia 1'.
- In phase VI, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 34.3 for serotype 'O', 69.2 for serotype 'A' and 55.7 for serotype 'Asia 1'. The same for post-vac samples was 61.3 for serotype 'O', 86.3 for serotype 'A' and 79.3 for serotype 'Asia 1'.
- In phase VII, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 34.0 for serotype 'O', 44.0 for serotype 'A' and 48.8 for serotype 'Asia 1'. The same for post-vac samples was 60.3 for serotype O, 67.5 for serotype 'A' and 64.7 for serotype 'Asia 1'.
- In phase VIII, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 44.5 for serotype 'O', 51.8 for serotype 'A' and 41.6 for serotype 'Asia 1'. The same for post-vac samples was 74.0 for serotype 'O', 78.0 for serotype 'A' and 65.8 for serotype 'Asia 1'.
- In phase IX, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 52.8 for serotype 'O', 41.1 for serotype 'A' and 35.9 for serotype 'Asia 1'. The same for post-vac samples was 84.1 for serotype 'O', 66.8 for serotype 'A' and 66.8 for serotype 'Asia 1'.
- In phase X, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 62.7 for serotype 'O', 46 for serotype 'A' and 51.3 for serotype 'Asia 1'. The same for post-vac samples was 79.3 for serotype 'O', 71.8 for serotype 'A' and 75.2 for serotype 'Asia 1'.
- In phase XI, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 49.75 for serotype O, 44.5

for serotype A and 41.62 for serotype Asia 1. The same for post-vac samples was 77.12 for serotype O, 75 for serotype A and 71.5 for serotype Asia 1.

- In phase XII, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 48.37 for serotype O, 33.25 for serotype A and 22.12 for serotype Asia 1. The same for post-vac samples was 71 for serotype O, 60.37 for serotype A and 45.87 for serotype Asia 1.
- In phase XIII, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 67.1 for serotype O, 54.8 for serotype A and 39.3 for serotype Asia 1. The same for post-vac samples was 81.8 for serotype O, 75.3 for serotype A and 62.3 for serotype Asia 1.
- In phase XIV, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 45.7 for serotype O, 23.3 for serotype A and 12.5 for serotype Asia 1. The same for post-vac samples was 79.2 for serotype O, 55.7 for serotype A and 48.6 for serotype Asia 1.
- Overall seroconversion and herd immunity is good, and this corroborates with significant drop in occurrence of the disease in the regularly vaccinated districts.

Table 10.8: Result of seroconversion in Andhra Pradesh (2003-04).

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	Serotype O		Serotype A		Serotype Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	83 (10.3)	340 (42.5)	43 (5.3)	244 (30.5)	92 (11.5)	340 (42.5)
II	N.A.	434 (54.2)	N.A.	498 (62.3)	N.A.	438 (54.7)
III	210 (26.2)	286 (35.7)	395 (49.3)	532 (66.5)	306 (38.2)	422 (52.7)
IV	281 (35.1)	374 (46.8)	465 (58.1)	617 (77.1)	329 (41.1)	518 (64.8)
V	247 (30.8)	440 (55)	466 (58.2)	574 (71.8)	343 (42.8)	450 (56.3)
VI	275 (34.3)	490 (61.3)	554 (69.2)	690 (86.3)	446 (55.7)	634 (79.3)
VII	274 (34.0)	483 (60.3)	349 (44.0)	540 (67.5)	391 (48.8)	518 (64.7)
VIII	356 (44.5)	594 (74.0)	415 (51.8)	624 (78.0)	333 (41.6)	527 (65.8)
IX	422 (52.8)	673 (84.1)	329 (41.1)	534 (66.8)	287 (35.9)	534 (66.8)
X	502(62.7)	635(79.3)	368(46)	575(71.8)	411(51.3)	602(75.2)
XI	398(49.75)	617(77.1)	356(44.5)	600(75)	333(41.6)	568(71.5)
XII	387(48.4)	568(71)	266(33.25)	483(60.4)	177(22.1)	367(45.9)
XIII	537(67.1)	654(81.8)	438(54.8)	602(75.3)	315(39.3)	498(62.3)
XIV	366(45.7)	634(79.2)	186(23.3)	446(54.7)	100(12.5)	389(48.6)

Districts included in 2010-11 (Green)

- In phase I, 3600 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 29 for serotype O, 18 for serotype A and 13.1 for serotype Asia 1. The same for post-vac samples was 66.6 for serotype O, 56.4 for serotype A and 47.5 for serotype Asia 1.
- In phase II, 3480 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above

for pre-vac samples were 41.2 for serotype O, 29.5 for serotype A and 17.1 for serotype Asia 1. The same for post-vac samples was 68.4 for serotype O, 59 for serotype A and 43.1 for serotype Asia 1.

- In phase III, 3600 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 38.6 for serotype O, 20.8 for serotype A and 10.9 for serotype Asia 1. The same for post-vac samples was 69.3 for serotype O, 46.1 for serotype A and 32.2 for serotype Asia 1. It shows boosting of antibody level following vaccination.
- In phase IV, 400 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 23.5 for serotype O, 23.7 for serotype A and 6.7 for serotype Asia 1. The same for post-vac samples was 77 for serotype O, 43.8 for serotype A and 35.8 for serotype Asia 1. It shows boosting of antibody level following vaccination.
- There is a very good response to serotype O compared to the other two serotypes.

Table 10.9: Result of seroconversion in Andhra Pradesh (2010-11).

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	Serotype O		Serotype A		Serotype Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	1043(29)	2396(66.5)	648(18)	2030(56.4)	419(13.1)	1709(47.5)
II	1435(41.2)	2381(68.4)	1026(29.5)	2054(59)	595(17.1)	1499(43.1)
III	1392(38.6)	2498(69.3)	750(20.8)	1661(46.1)	393(10.9)	1162(32.2)
IV	94(23.5)	308(77)	95(23.7)	175(43.8)	27(6.7)	143(35.8)

Sero-monitoring in Karnataka

State of Karnataka was included under FMDCP in 2010-11

Districts included in 2010-11 (Green)

- In phase I, 4587 pre and 4266 post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples was 40 for serotype O, 15 for serotype A and 9 for serotype Asia 1. The same for post-vac samples was 56 for serotype O, 40 for serotype A and 24.5 for serotype Asia 1.
- In phase II, 5401 pre and 4632 post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples was 50 for serotype O, 27 for serotype A and 39 for serotype Asia 1. The same for post-vac samples was 67 for serotype O, 47 for serotype A and 51 for serotype Asia 1.
- In phase III, 1459 pre and 690 post-vac serum samples were tested. Percent serum samples having protective antibody titer of 1.8 and above for pre-vac samples was 52 for serotype O, 30 for serotype A and 59 for serotype Asia 1. The same for post-vac samples was 65 for serotype O, 49 for serotype A and 70.5 for serotype Asia 1.
- There is clear boosting effect after first vaccination and resulting herd immunity of >55% is a good indicator.
- Overall herd immunity and seroconversion is good

Table 10.10: Result of seroconversion in Karnataka (2010-11).

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	Serotype O		Serotype A		Serotype Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	1817(40)	2383(56)	687(15)	1722(40)	426(9)	1049(24.5)
II	2718(50)	3101(67)	1471(27)	2161(47)	1577(39)	2354(51)
III	753(52)	451(65)	444(30)	336(49)	861(59)	487(70.5)

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, rest of the districts (filled green) was included

Districts included in 2003-04 (Red)

- In phase I, 844 pre and 761 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 20.5 for type 'O', 17.9 for type 'A' and 22.8 for type 'Asia 1'. The same for post-vac samples was 59.9 for type 'O', 57.4 for type 'A' and 61.2 for type 'Asia 1'.
- In phase II, 834 post-vac serum samples were tested. Pre-vac serum samples were not available. Percent serum sample having protective antibody titer of 1.8 and above was 60.9 for type 'O', 58.6 for type 'A' and 66.2 for type 'Asia 1'.
- In phase III, 753 pre and 799 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 34.4 for type 'O', 46.8 for type 'A' and 34.7 for type 'Asia 1'. The same for post-vac samples was 54.8 for type 'O', 72.7 for type 'A' and 66.9 for type 'Asia 1'.
- In phase IV, 789 and 797 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 24.2 for type 'O', 65.6 for type 'A' and 35.2 for type 'Asia 1'. The same for post-vac samples was 52.3 for type 'O', 85.3 for type 'A' and 63.9 for type 'Asia 1'.
- In phase V, 802 pre and 772 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 17.7 for type 'O', 44.2 for type 'A' and 15 for type 'Asia 1'. The same for post-vac samples was 35.1 for type 'O', 62.3 for type 'A' and 31.8 for type 'Asia 1'.
- In phase VI, 901 pre and 928 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 44.9 for type 'O', 69 for type 'A' and 27.2 for type 'Asia 1'. The same for post-vac samples was 71.4 for type 'O', 91.9 for type 'A' and 48.1 for type 'Asia 1'.
- In phase VII, 1000 pre and 1000 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 44.6 for type 'O', 70.1 for type 'A' and 43.1 for type 'Asia 1'. The same for post-vac samples was 69.2 for type 'O', 89.3 for type 'A' and 66.7 for type 'Asia 1'.
- In phase VIII, 1000 pre and 1000 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 64.6 for type 'O', 57.4

for type 'A' and 19.8 for type 'Asia 1'. The same for post-vac samples was 90.4 for type 'O', 84.8 for type 'A' and 45.2 for type 'Asia 1'.

- In phase IX, 1000 pre and 1000 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 73 for type 'O', 52.4 for type 'A' and 32.4 for type 'Asia 1'. The same for post-vac samples was 95.1 for type 'O', 51.7 for type 'A' and 69.5 for type 'Asia 1'.
- In phase X, 1000 pre and 1000 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 78.5 for type 'O', 68.6 for type 'A' and 60.7 for type 'Asia 1'. The same for post-vac samples was 97.8 for type 'O', 93.5 for type 'A' and 84.6 for type 'Asia 1'.
- In phase XI, 1000 pre and 1000 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 55.8 for serotype O, 53.4 for serotype A and 40.3 for serotype Asia 1. The same for post-vac samples was 91.6 for type O, 87.1 for type A and 83.7 for serotype Asia 1.
- In phase XII, 980 pre and 980 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 60.2 for serotype O, 47.75 for serotype A and 34.79 for serotype Asia 1. The same for post-vac samples was 91.2 for type O, 83.97 for type A and 74.48 for serotype Asia 1.
- In phase XIII, 950 pre and 1050 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 44 for serotype O, 7.9 for serotype A and 6.1 for serotype Asia 1. The same for post-vac samples was 69.2 for type O, 31.6 for type A and 26.4 for serotype Asia 1.
- In phase XIV, 100 each pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 57 for serotype O, 6 for serotype A and 3 for serotype Asia 1. The same for post-vac samples was 93 for type O, 47 for type A and 41 for serotype Asia 1.
- Seroconversion and herd immunity against serotype O is good, and that against serotypes A and Asia1 is poor. The drop in herd immunity after phase XIII of vaccination is possible due to delay in vaccination.

Table 10.11: Result of seroconversion in Maharashtra (2003-04).

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	173 (20.5)	456 (59.9)	151(17.9)	437 (57.4)	192 (22.8)	466 (61.2)
II	N.A.	508 (60.9)	N.A.	490 (58.6)	N.A.	553 (66.2)
III	184 (24.4)	438 (54.8)	351 (46.8)	580 (72.7)	262 (34.7)	534 (66.9)
IV	191 (24.2)	417 (52.3)	517 (65.6)	679 (85.3)	278 (35.2)	509 (63.9)
V	142 (17.7)	271 (35.1)	353 (44.2)	477 (62.3)	121 (15.0)	245 (31.8)
VI	404 (44.9)	663 (71.4)	622 (69)	853 (91.9)	245 (27.2)	446 (48.1)
VII	446 (44.6)	692 (69.2)	701 (70.1)	893 (89.3)	431 (43.1)	667 (66.7)
VIII	646 (64.6)	904 (90.4)	574 (57.4)	848 (84.8)	198 (19.8)	452 (45.2)
IX	730(73)	951(95.1)	524(52.4)	817(81.7)	324(32.4)	695(69.5)
X	785(78.5)	978(97.8)	686(68.6)	935(93.5)	607(60.7)	846(84.6)
XI	558(55.8)	916(91.6)	534(53.4)	871(87.1)	403(40.3)	837(83.7)
XII	590(60.2)	894(91.2)	468(47.75)	823(83.97)	341(34.79)	730(74.48)
XIII	418(44)	727(69.2)	75(7.9)	332(31.6)	58(6.1)	277(26.4)

Districts included in 2010-11 (Green)

- In phase I, 5988 pre and 6018 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 28.2 for serotype O, 15.7 for serotype A and 6.4 for serotype Asia 1. The same for post-vac samples was 72.9 for type O, 51.2 for type A and 38.4 for serotype Asia 1.
- In phase II, 7208 pre and 7341 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 25.7 for serotype O, 5.8 for serotype A and 6.8 for serotype Asia 1. The same for post-vac samples was 66.6 for type O, 34.5 for type A and 31 for serotype Asia 1. Overall seroconversion is good.

Table 10.12: Result of seroconversion in Maharashtra (2010-11).

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	Serotype O		Serotype A		Serotype Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	1687(28.2)	4390(72.9)	941(15.7)	3080(51.2)	382(6.4)	2310(38.4)
II	1849(25.7)	4890(66.6)	481(5.8)	2530(34.5)	491(6.8)	2279(31)

Seromonitoring in Goa

Districts included in 2010-11 (Green)

- In phase I, 391 pre and 381 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 12 for serotype O, 2 for serotype A and 2.8 for serotype Asia 1. The same for post-vac samples was 86.8 for type O, 24.1 for type A and 24.1 for serotype Asia 1.
- Seroconversion was very good against serotypes O, but poor against type A and Asia1

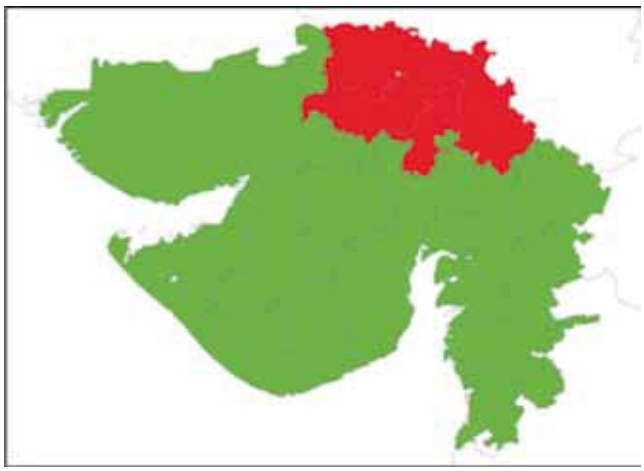
Table 10.13: Result of seroconversion in Goa (2010-11).

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	Serotype O		Serotype A		Serotype Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	47(12)	244(86.8)	8(2)	92(24.1)	11(2.8)	92(24.1)

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

- In phase I, 382 pre and 259 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 19.1 for type 'O', 24.5 for type 'A' and 16.1 for type 'Asia 1'. The same for post-vac samples was 44.7 for type 'O', 48.7 for type 'A' and 43.5 for type 'Asia 1'.



- Serum samples were not available for Phase II.
- In phase III, 442 pre and 357 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 27.8 for type 'O', 39.2 for type 'A' and 12.4 for type 'Asia 1'. The same for post-vac samples was 47.9 for type 'O', 58.3 for type 'A' and 35.4 for type 'Asia 1'.
- In phase IV, 497 and 456 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 22.7 for type 'O', 40.7 for type 'A' and 14.6 for type 'Asia 1'. The same for post-vac samples was 60.7 for type 'O', 81.2 for type 'A' and 46.8 for type 'Asia 1'.
- In phase V, 195 pre and 202 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 23.6 for type 'O', 66.1 for type 'A' and 26.5 for type 'Asia 1'. The same for post-vac samples was 49 for type 'O', 91.6 for type 'A' and 51.3 for type 'Asia 1'.
- In phase VI, 395 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 30.1 for type 'O', 63.0 for type 'A' and 49.3 for type 'Asia 1'. The same for post-vac samples was 56.4 for type 'O', 80.2 for type 'A' and 60.7 for type 'Asia 1'.
- In phase VII, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 54.3 for type 'O', 48.1 for type 'A' and 43 for type 'Asia 1'. The same for post-vac samples was 78.8 for type 'O', 69.9 for type 'A' and 69.5 for type 'Asia 1'.
- In phase VIII, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 23.9 for type 'O', 24.6 for type 'A' and 33 for type 'Asia 1'. The same for post-vac samples was 49.3 for type 'O', 44.6 for type 'A' and 50.4 for type 'Asia 1'.
- In phase IX, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 28.7 for type 'O', 35.5 for type 'A' and 40.7 for type 'Asia 1'. The same for post-vac samples was 77.2 for type 'O', 71.5 for type 'A' and 74.4 for type 'Asia 1'.
- In phase X, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 44.5 for type 'O', 35.7 for type 'A' and 34.5 for type 'Asia 1'. The same for post-vac samples was 77.5 for type 'O', 65.6 for type 'A' and 66.9 for type 'Asia 1'.
- In phase XI, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 27.5 for serotype O, 22 for serotype A and 14.5 for serotype Asia 1. The same for post-vac samples was 38 for type O, 35.5 for type A and 24.5 for serotype Asia 1.
- In phase XII, 800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 52 for serotype O, 40 for serotype A and 28 for serotype Asia 1. The same for post-vac samples was 52.5 for type O, 33.5 for type A and 12.5 for serotype Asia 1.
- In phase XIII, 2007 pre and 2029 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 29.4 for serotype O, 20.3 for serotype A and 33.4 for serotype Asia 1. The same for post-vac samples was 49.7 for type O, 38.6 for type A and 49.8 for serotype Asia 1.
- In phase XIV, 775 pre and 511 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 40.9 for serotype O, 28.9 for serotype A and 45.8 for serotype Asia 1. The same for post-vac samples was 44.6 for type O, 33.9 for type A and 44.8 for serotype Asia 1.
- Seroconversion was poor

Table 10.14: Result of seroconversion in Gujarat.

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	50 (19.1)	116 (44.7)	59 (24.5)	128 (48.7)	42 (16.1)	114 (43.5)
II	Serum samples not available					
III	123 (27.8)	171 (47.9)	171 (39.2)	268 (58.3)	51 (12.4)	149 (35.4)
IV	113 (22.7)	277 (60.7)	184 (40.7)	355 (81.2)	73 (14.6)	218 (46.8)
V	46 (23.6)	99 (49.0)	126 (66.1)	179 (91.6)	44 (26.5)	92 (51.3)
VI	119 (30.1)	223 (56.4)	249 (63.0)	317(80.2)	195 (49.3)	240 (60.7)
VII	434 (54.3)	630 (78.8)	385 (48.1)	559 (69.9)	344 (43.0)	556 (69.5)
VIII	191 (23.9)	394 (49.3)	197 (24.6)	357 (44.6)	264 (33.0)	403 (50.4)
IX	230(28.7)	618(77.2)	284(35.5)	572(71.5)	326(40.7)	595(74.4)
X	356(44.5)	620(77.5)	286(35.7)	525(65.6)	276(34.5)	535(66.9)
XI	55(27.5)	76(38)	44(22)	71(35.5)	29(14.5)	49(24.5)
XII	104(52)	105(52.5)	80(40)	67(33.5)	56(28)	25(12.5)
XIII	589(29.4)	1009(49.7)	407(20.3)	784(38.6)	670(33.4)	1011(49.8)
XIV	317(40.9)	228(44.6)	224(28.9)	173(33.9)	355(45.8)	229(44.8)

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

- Serum samples were not made available for Phase I.
- In phase II, 1558 post-vac serum samples were tested. Pre-vac serum samples were not available. Percent serum sample having protective antibody titer of 1.8 and above was 68.3 for serotype O, 55.1 for serotype A and 53.3 for serotype Asia 1.
- In phase III, 1585 post-vac serum samples were tested. Pre-vac serum samples were not available. Percent serum sample having protective antibody titer of 1.8 and above was 72.3 for serotype O, 63.6 for serotype A and 63.4 for serotype Asia 1.
- In phase IV, 1589 pre and 1552 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above

for pre-vac samples were 60.1 for serotype O, 42.1 for serotype A and 53.2 for serotype Asia 1. The same for post-vac samples was 78.7 for serotype 'O', 57.1 for serotype A and 75.3 for serotype Asia 1.

- In phase V, 1600 pre and 1599 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 59.7 for serotype O, 50.8 for serotype A and 58.8 for serotype Asia 1. The same for post-vac samples was 84.5 for serotype O, 79.6 for serotype A and 84.5 for serotype Asia 1.
- In phase VI, 1496 pre and 1499 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 66.5 for serotype O, 59.8 for serotype 'A' and 56.4 for serotype Asia 1. The same for post-vac samples was 87.1 for serotype O, 82 for serotype A and 74.6 for serotype Asia 1.
- In phase VII, 1562 pre and 1574 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 54.8 for serotype 'O', 65.3 for serotype 'A' and 56.8 for serotype 'Asia 1'. The same for post-vac samples was 82.3 for serotype 'O', 87.6 for serotype 'A' and 83.6 for serotype 'Asia 1.
- In phase VIII, 1547 pre and 1540 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 61.3 for serotype 'O', 56.6 for serotype 'A' and 49.4 for serotype 'Asia 1'. The same for post-vac samples was 83.7 for serotype 'O', 64.4 for serotype 'A' and 71.4 for serotype 'Asia 1'.
- In phase IX, 1497 pre and 1476 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 43.2 for serotype 'O', 39.4 for serotype 'A' and 27.4 for serotype 'Asia 1'. The same for post-vac samples was 77.2 for serotype 'O', 69.2 for serotype 'A' and 59.6 for serotype 'Asia 1'.
- In phase X, 1420 pre and 1439 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 59.9 for serotype 'O', 43.3 for serotype 'A' and 41.3 for serotype 'Asia 1'. The same for post-vac samples was 93.8 for serotype 'O', 69.7 for serotype 'A' and 79.5 for serotype 'Asia 1'.
- In phase XI, 1500 pre and 1464 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 48.9 for serotype O, 36.4 for serotype A and 30.3 for serotype Asia 1. The same for post-vac samples was 88.9 for serotype O, 80.6 for serotype A and 75.8 for serotype Asia 1.
- In phase XII, 1360 pre and1210 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 43.6 for serotype O, 38.2 for serotype A and 34.9 for serotype Asia 1. The same for post-vac samples was 80.6 for serotype O, 81.7 for serotype A and 74.1 for serotype Asia 1.
- In phase XIII, 1590 pre and 1600 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 58.2 for serotype O, 59.6 for serotype A and 41.7 for serotype Asia 1. The same for post-vac samples was 83.3 for serotype O, 83.1 for serotype A and 70.8 for serotype Asia 1.
- In phase XIV, 1580 each pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 39.7 for serotype O, 37.6 for serotype A and 33.9 for serotype Asia 1. The same for post-vac samples was 84 for serotype O, 81 for serotype A and 80.5 for serotype Asia 1.
- Overall post-vac response is very good at 80% against all the three serotypes, and this has been well reflected as drastic reduction in occurrence of the disease in the state.

Table 10.15: Result of seroconversion in Haryana (2003-04).

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	Serotype O		Serotype A		Serotype Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	Serum samples not available					
II	NA	1065(68.3)	NA	859 (55.1)	NA	831 (53.3)
III	NA	1146(72.3)	NA	1007(63.6)	NA	1005(63.4)
IV	953 (60.1)	1222(78.7)	668 (42.1)	887 (57.1)	844(53.2)	1170(75.3)
V	955 (59.7)	1352(84.5)	813 (50.8)	1274(79.6)	941(58.8)	1353(84.5)
VI	995 (66.5)	1306(87.1)	895 (59.8)	1229(82.0)	844(56.4)	1118(74.6)
VII	856(54.8)	1296 (82.3)	1021 (65.3)	1380 (87.6)	888 (56.8)	1317 (83.6)
VIII	949(61.3)	1289 (83.7)	877 (56.6)	992 (64.4)	765 (49.4)	1101 (71.4)
IX	647(43.2)	1140(77.2)	590(39.4)	1022(69.2)	410(27.4)	879(59.6)
X	851(59.9)	1350(93.8)	615(43.3)	1003(69.7)	587(41.3)	1145(79.5)
XI	734(48.9)	1302(88.9)	546(36.4)	1180(80.6)	455(30.3)	1109(75.8)
XII	593(43.6)	975(80.6)	520(38.2)	989(81.7)	474(34.9)	896(74.1)
XIII	925(58.2)	654 (82.8)	218(27.6)	630(79.8)	185(23.4)	616(78.0)
XIV	627(39.7)	1327(84.0)	594(37.6)	1279(81.0)	536(33.9)	1272(80.5)

Districts included in 2010-11 (Green)

- In phase I, 3086 pre and 2354 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 43.9 for serotype O, 41.4 for serotype A and 30 for serotype Asia 1. The same for post-vac samples was 76.1 for serotype O, 76 for serotype A and 62.4 for serotype Asia 1.
- In phase II, 2586 pre and 2594 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 41.8 for serotype O, 38.1 for serotype A and 38.1 for serotype Asia 1. The same for post-vac samples was 73.5 for serotype O, 28.1 for serotype A and 60.2 for serotype Asia 1.
- In phase III, 2555 pre and 2562 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 42.5 for serotype O, 43.3 for serotype A and 25.3 for serotype Asia 1. The same for post-vac samples was 71.2 for serotype O, 73.1 for serotype A and 62.1 for serotype Asia 1.
- Seroconversion is likely to improve after subsequent vaccinations.

Table 10.16: Result of seroconversion in Haryana (2010-11).

Phase	Number & % animals showing titres ≥1.8 log_{10} against FMDV					
	Serotype O		Serotype A		Serotype Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	1049(43.9)	1790(76.1)	988(41.4)	1789(76.0)	715(30.0)	1469(62.4)
II	1081(41.8)	1876(73.5)	986(38.1)	727(28.1)	986(38.1)	1537(60.2)
III	1092(42.5)	1809(71.2)	1113(43.3)	1856(73.1)	650(25.3)	1576(62.1)

Sero-monitoring in Delhi

Delhi was included under FMDCP in 2003-04

Districts included in 2003-04 (Red)

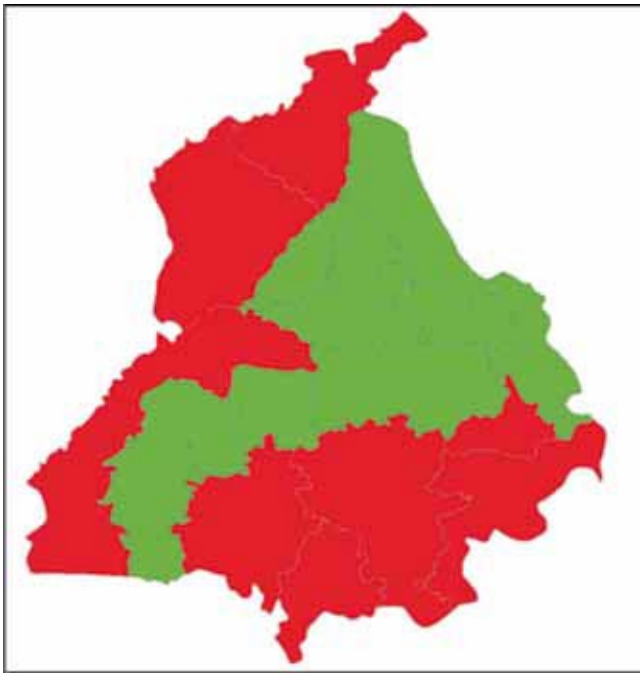
- In phase I, 50 each of pre and post-vac serum samples from buffaloes were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 53 for type 'O', 26 for type 'A' and 34 for type 'Asia 1'. The same for post-vac samples was 100 for type 'O', 94 for type 'A' and 96 for type 'Asia 1'.
- In phase II, 24 each of pre-vac and post-vac serum samples from buffaloes were tested. Pre-vac serum samples were not available. Percent serum sample having protective antibody titer of 1.8 and above was 91 for type 'O', 40 for type 'A' and 95 for type 'Asia 1'. The same for post-vac samples was 96 for type 'O', 62 for type 'A' and 86 for type 'Asia 1'.
- In phase III, 50 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 94 for type 'O', 60 for type 'A' and 86 for type 'Asia 1'. The same for post-vac samples was 98 for type 'O', 80 for type 'A' and 92 for type 'Asia 1'.
- In phase IV, 50 pre and 46 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 76 for type 'O', 28 for type 'A' and 54 for type 'Asia 1'. The same for post-vac samples was 82.6 for type 'O', 86.9 for type 'A' and 89.1 for type 'Asia 1'.
- In phase V, 44 pre and 53 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 59 for type 'O', 52.2 for type 'A' and 72.7 for type 'Asia 1'. The same for post-vac samples was 88.6 for type 'O', 69.8 for type 'A' and 77.3 for type 'Asia 1'.
- In phase VI, 98 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 77.5 for type 'O', 61.2 for type 'A' and 72.4 for type 'Asia 1'. The same for post-vac samples was 98.9 for type 'O', 94.9 for type 'A' and 98.9 for type 'Asia 1'.
- In phase VII, 50 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 78 for type 'O', 66 for type 'A' and 50 for type 'Asia 1'. The same for post-vac samples was 88 for type 'O', 86 for type 'A' and 82 for type 'Asia 1'.
- In phase VIII, 100 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 92 for type 'O', 66 for type 'A' and 83 for type 'Asia 1'. The same for post-vac samples was 100 for type 'O', 86 for type 'A' and 98 for type 'Asia 1'.
- In phase IX, 100 pre-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 57 for type 'O', 65 for type 'A' and 33 for type 'Asia 1'. Post-vac serum samples were not available.
- In phase X, serum samples were not made available for testing.
- In phase XI, 200 pre-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 86 for type 'O', 50 for type 'A' and 45.5 for type 'Asia 1'.
- In phase IV, 100 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 98 for serotype O, 95 for serotype A and 87 for serotype Asia 1. The same for post-vac samples was 98 for serotype O, 100 for serotype A and 100 for serotype Asia 1.
- Herd immunity is very good at >80%.

Table 10.17: Result of seroconversion in Delhi (2003-04).

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	26 (53)	50 (100)	13 (26)	47 (94)	17 (34)	48 (96)
II	22 (91)	23 (96)	12 (40)	15 (62)	23 (95)	22 (86)
III	47 (94)	49 (98)	30 (60)	40 (80)	43 (86)	46 (92)
IV	38 (76)	38 (82.6)	14 (28)	40 (86.9)	27 (54)	41 (89.1)
V	26 (59)	47 (88.6)	23 (52.2)	37 (69.8)	32 (72.7)	41 (77.3)
VI	76 (77.5)	97 (98.9)	60 (61.2)	93 (94.9)	71 (72.4)	97 (98.9)
VII	39(78)	44(88)	33(66)	43(86)	25(50)	41(82)
VIII	92 (92)	100 (100)	66 (66)	86 (86)	83 (83)	98 (98)
IX	57(57)	NA	65(65)	NA	33(33)	NA
XI	172(86)	NA	100(50)	NA	91(45.5)	NA
XIII	98(98)	98(98)	95(95)	100(100)	87(87)	100(100)

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



- In phase I, 742 post-vac serum samples were tested. Pre-vac serum samples were not available. Percent serum sample having protective antibody titer of 1.8 and above was 25.2 for type 'O', 11.5 for type 'A' and 49.5 for type 'Asia 1'.
- In phase II, 500 post-vac serum samples were tested. Pre-vac serum samples were not available. Percent serum sample having protective antibody titer of 1.8 and above was 43.8 for type 'O', 20.9 for type 'A' and 58.1 for type 'Asia 1'.
- In Phase III, 1084 pre and 1365 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 84.4 for type 'O', 75.3 for type 'A' and 40.2 for type 'Asia 1'. The same for post-vac samples was 86.1 for type 'O', 73.8 for type 'A' and 42.0 for type 'Asia 1'.
- In phase IV, 1291 pre and 978 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 76.5 for type 'O', 61.5 for type 'A' and 53.8 for type 'Asia 1'. The same for post-vac samples was 81.0 for type 'O', 64.1 for type 'A' and 36.4 for type 'Asia 1'.
- In phase V, 1370 pre and 1139 post-vac serum samples were tested. Percent serum sample

having protective antibody titer of 1.8 and above for pre-vac samples were 34.8 for type 'O', 32.8 for type 'A' and 38.5 for type 'Asia 1'. The same for post-vac samples was 54.5 for type 'O', 53.7 for type 'A' and 60.1 for type 'Asia 1'.

- In phase VI, 1509 pre and 1568 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 43.3 for type 'O', 43.3 for type 'A' and 32.9 for type 'Asia 1'. The same for post-vac samples was 60.2 for type 'O', 58.7 for type 'A' and 47.4 for type 'Asia 1'.
- In phase VII, 1265 pre and 1432 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 36.3 for type 'O', 22.8 for type 'A' and 33.0 for type 'Asia 1'. The same for post-vac samples was 57.8 for type 'O', 42.0 for type 'A' and 46.4 for type 'Asia 1'.
- In phase VIII, 984 pre and 1125 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 58.94 for type 'O', 41.66 for type 'A' and 45.93 for type 'Asia 1'. The same for post-vac samples was 73.33 for type 'O', 57.15 for type 'A' and 65.86 for type 'Asia 1'.
- In phase IX, 1558 pre and 1546 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 66.43 for type 'O', 53.33 for type 'A' and 59.43 for type 'Asia 1'. The same for post-vac samples was 77.16 for type 'O', 63.26 for type 'A' and 73.22 for type 'Asia 1'.
- In phase X, 1592 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 64.73 for serotype O, 56.81 for serotype A and 60.96 for serotype Asia 1. The same for post-vac samples was 77.32 for type O, 68.96 for type A and 72.61 for serotype Asia 1.
- In phase XI, 1600 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 61.9 for serotype O, 55.1 for serotype A and 60.3 for serotype Asia 1. The same for post-vac samples was 74.1 for type O, 67.2 for type A and 71.4 for serotype Asia 1.
- In phase XII, 1600 pre and 1556 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 64.5 for serotype O, 57.1 for serotype A and 56.1 for serotype Asia 1. The same for post-vac samples was 71.6 for type O, 65.9 for type A and 0 for serotype Asia 1.
- Overall seroconversion and herd immunity is good.

Table 10.18: Result of seroconversion in Punjab (2003-04).

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	N.A.	187(25.2)	N.A.	90(11.5)	N.A.	273(49.5)
II	N.A.	219(43.8)	N.A.	113(20.9)	N.A.	279(58.1)
III	915(84.4)	1175(86.1)	816(75.3)	1007(73.8)	437(40.2)	573(42.0)
IV	988(76.5)	792 (81.0)	794(61.5)	627 (64.1)	694 (53.8)	356(36.4)
V	477(34.8)	621(54.5)	445(32.8)	630(53.7)	513(38.5)	690(60.1)
VI	653 (43.3)	944 (60.2)	654 (43.3)	921 (58.7)	496 (32.9)	743 (47.4)
VII	520 (41.1)	898 (62.7)	356 (28.1)	639 (44.6)	448 (35.4)	696 (48.6)
VIII	580(58.9)	825(73.33)	410(41.7)	643(57.2)	452(45.9)	741(65.9)
IX	1035(66.4)	1193(77.1)	831(53.3)	978(63.4)	926(59.4)	1132(73.2)
X	1030(64.7)	1231(77.3)	904(56.8)	1098(67.0)	970(61.0)	1156(72.6)

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
XI	991(61.9)	1186(74.1)	881(55.1)	1075(67.2)	965(60.3)	1142(71.4)
XII	1033(64.5)	1115(71.6)	914(57.1)	1026(65.9)	897(56.1)	NT

NT: Not tested

Districts included in 2010-11(Green)

- In phase I, 1800 each of pre and post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 44.3 for serotype O, 39.1 for serotype A and 34.2 for serotype Asia 1. The same for post-vac samples was 54.3 for type O, 45.8 for type A and 48.6 for serotype Asia 1.
- In phase II, 1800 pre and 1782 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 55.6 for serotype O, 50.1 for serotype A and 50.2 for serotype Asia 1. The same for post-vac samples was 61.5 for type O, 54.8 for type A and 0 for serotype Asia 1.
- Overall seroconversion and herd immunity is good.

Table 10.19: Result of seroconversion in Punjab (2010-11).

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	797(44.3)	978(54.3)	704(39.1)	825(45.8)	615(34.2)	874(48.6)
II	1002(55.6)	1096(61.5)	902(50.1)	978(54.8)	904(50.2)	NT

NT: Not tested

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.

- No serum samples were received for phase I.
- In phase II, 139 and 407 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was nil for serotype 'O', 'A' and 'Asia 1'. The same for post-vac samples was 44.2 for serotype 'O', 38.1 for serotype 'A' and 72.0 for serotype 'Asia 1'.
- In phase III, 1155 and 1584 post-vac serum samples were tested. Percent serum sample

having protective antibody titer of 1.8 and above for pre-vac samples were 34.5 for serotype 'O', 42.7 for serotype 'A' and 42.4 for serotype 'Asia 1'. The same for post-vac samples was 49.2 for serotype 'O', 57.4 for serotype 'A' and 71.8 for serotype 'Asia 1'.

- In phase IV, 1910 and 1770 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 18 for serotype 'O', 31.9 for serotype 'A' and 27.2 for serotype 'Asia 1'. The same for post-vac samples was 30.3 for serotype 'O', 48.9 for serotype 'A' and 45.6 for serotype 'Asia 1'.
- In phase V, 1440 pre and 1591 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 35.8 for serotype 'O', 43.4 for serotype 'A' and 47.5 for serotype 'Asia 1'. The same for post-vac samples was 44.9 for serotype 'O', 50.4 for serotype 'A' and 49.4 for serotype 'Asia 1'.
- In phase VI, 1488 pre and 1579 post vac serum samples out of total 2182 pre and 1986 post vac serum samples collected were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples were 34.5 for serotype 'O', 34.9 for serotype 'A' and 26.9 for serotype 'Asia 1'. The same for post-vac samples was 61.3 for serotype 'O', 52.3 for serotype 'A' and 53.1 for serotype 'Asia 1'.
- In phase VII, 2833 pre and 2075 post vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for a pre-vac sample was 23.4 for serotype 'O', 18.6 for serotype 'A' and 19.3 for serotype 'Asia 1'. The same for post-vac samples was 43.9 for serotype 'O', 38.9 for serotype 'A' and 44.8 for serotype 'Asia1'.
- In phase VIII at present 1904 pre and 2744 post vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for a pre-vac sample was 37.1 for serotype 'O', 26.4 for serotype 'A' and 32.41 for serotype 'Asia 1'. The same for post-vac samples was 56.5 for serotype 'O', 47.7 for serotype 'A' and 46.9 for serotype 'Asia1'.
- In phase IX, 2762 pre and 3002 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 33.56 for serotype O, 22.34 for serotype A and 21.6 for serotype Asia 1. The same for post-vac samples was 39.9 for serotype O, 36.48 for serotype A and 35.7 for serotype Asia 1.
- In phase X, 88 pre-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 28.4 for serotype O, 14.8 for serotype A and 14.8 for serotype Asia 1.
- In phase XI, 643 pre and 2206 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 7.3 for serotype O, 10.6 for serotype A and 59.9 for serotype Asia 1. The same for post-vac samples was 21.8 for serotype O, 14.6 for serotype A and 50 for serotype Asia 1.
- In phase XII, 1934 pre and 1535 post-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 9.5 for serotype O, 13 for serotype A and 21.9 for serotype Asia 1. The same for post-vac samples was 17.6 for serotype O, 34.1 for serotype A and 50.6 for serotype Asia 1.
- In phase XIII, 87 pre-vac serum samples were tested. Percent serum sample having protective antibody titer of 1.8 and above for pre-vac samples was 14.9 for serotype O, 10.3 for serotype A and 3.4 for serotype Asia 1.
- Seroconversion is very poor.

Table 10.20: Result of seroconversion in Uttar Pradesh (2003-04).

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
II	0(0)	180(44.2)	0(0)	155(38.1)	0(0)	293(72.0)
III	399(34.5)	780(49.2)	494(42.7)	910(57.4)	490(42.4)	1138(71.8)
IV	344(18.0)	537(30.3)	610(31.9)	866(48.9)	519(27.2)	808(45.6)
V	516(35.8)	715(44.9)	625(43.4)	802(50.4)	684(47.5)	786(49.4)
VI	514(34.5)	968 (61.3)	520 (34.9)	826 (52.3)	400 (26.9)	838 (53.1)
VII	706 (24.9)	911 (43.9)	597 (21.1)	808 (38.9)	740 (26.1)	930 (44.8)
VIII	707(37.1)	1550(56.5)	502(26.4)	1310(47.7)	617(32.41)	1288(46.9)
IX	927(33.5)	1198(39.9)	617(22.34)	1095(36.48)	597(21.6)	1072(35.7)
XI	47(7.3)	481(21.8)	68(10.6)	321(14.6)	385(59.9)	1103(50)
XII	184(9.5)	270(17.6)	252(13)	524(34.1)	424(21.9)	773(50.6)

10.2 Phase wise number and percent of animals showing antibody titer ≥1.8 log_{10} against FMD virus (54 districts)

Phase I

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
Andhra Pradesh	83 (10.3)	340 (42.5)	43 (5.3)	244 (30.5)	92 (11.5)	340 (42.5)
Delhi	26 (53)	50 (100)	13 (26)	47 (94)	17 (34)	48 (96)
Gujarat	50 (19.1)	116 (44.7)	59 (24.5)	128 (48.7)	42 (16.1)	114 (43.5)
Kerala*	158(32.7)	255(51.4)	140(29.0)	236(47.5)	165(34.2)	280(56.4)
Maharashtra	173 (20.5)	456 (59.9)	151(17.9)	437 (57.4)	192 (22.8)	466 (61.2)
Punjab	N.A.	187(25.2)	N.A.	90(11.5)	N.A.	273(49.5)
Tamil Nadu	28(28)	51(51)	29(29)	57(57)	24(24)	54(54)

* Kerala Phase I, II & IV data is combined.

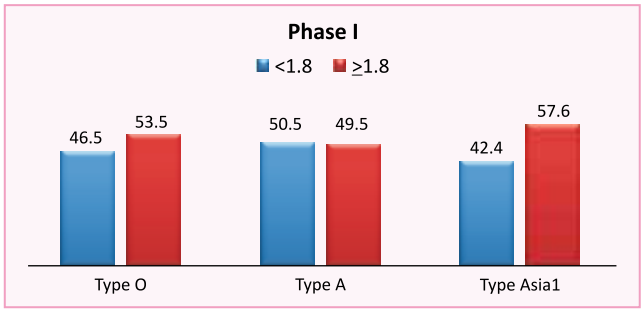


Fig. 2: Average post vaccinal seroconversion in Phase I.

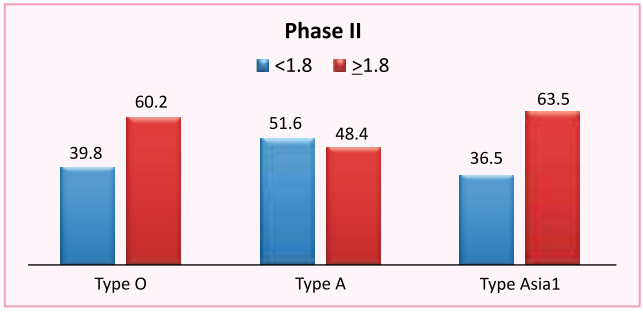


Fig. 3: Average post vaccinal seroconversion in Phase II.

Phase II

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
Andhra Pradesh	N.A.	434 (54.2)	N.A.	498 (62.3)	N.A.	438 (54.7)
Delhi	22 (91)	23 (96)	12 (40)	15 (62)	23 (95)	22 (86)
Haryana	NA	1065(68.3)	NA	859 (55.1)	NA	831 (53.3)
Kerala*	158(32.7)	255(51.4)	140(29.0)	236(47.5)	165(34.2)	280(56.4)
Maharashtra	N.A.	508 (60.9)	N.A.	490 (58.6)	N.A.	553 (66.2)
Punjab	N.A.	219(43.8)	N.A.	113(20.9)	N.A.	279(58.1)
Tamil Nadu	23(23.0)	63(63.0)	24(24.0)	40(40.0)	18(18.0)	61(61.0)
Uttar Pradesh	0(0)	180(44.2)	0(0)	155(38.1)	0(0)	293(72.0)

* Kerala Phase I, II & IV data is combined.

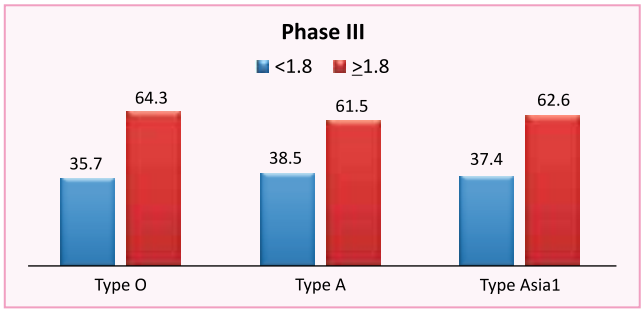


Fig. 10.2: Average post vaccinal seroconversion in Phase II.

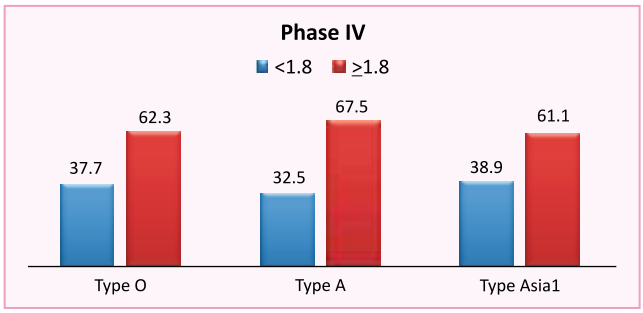


Fig. 10.3: Average post vaccinal seroconversion in Phase III.

Phase III

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
Andaman& Nicobar	40(25.9)	97(60.0)	5(2.8)	37(20.3)	52(34.0)	118(73.6)
Andhra Pradesh	210 (26.2)	286 (35.7)	395 (49.3)	532 (66.5)	306 (38.2)	422 (52.7)
Delhi	47 (94)	49 (98)	30 (60)	40 (80)	43 (86)	46 (92)
Gujarat	123 (27.8)	171 (47.9)	171 (39.2)	268 (58.3)	51 (12.4)	149 (35.4)
Haryana	NA	1146(72.3)	NA	1007(63.6)	NA	1005(63.4)
Kerala	Serum samples not available					
Maharashtra	184 (24.4)	438 (54.8)	351 (46.8)	580 (72.7)	262 (34.7)	534 (66.9)
Punjab	915(84.4)	1175(86.1)	816(75.3)	1007(73.8)	437(40.2)	573(42.0)
Tamil Nadu**	59(32.7)	246(74.5)	61(33.8)	201(60.9)	45(25.0)	216(65.4)
Uttar Pradesh	399(34.5)	780(49.2)	494(42.7)	910(57.4)	490(42.4)	1138(71.8)

** Tamil Nadu Phase III & IV data is combined.

Phase IV

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
Andaman & Nicobar	50(33.5)	94(64.6)	50(33.5)	96(65.9)	35(23.4)	101(67.6)
Andhra Pradesh	281 (35.1)	374 (46.8)	465 (58.1)	617 (77.1)	329 (41.1)	518 (64.8)
Delhi	38 (76)	38 (82.6)	14 (28)	40 (86.9)	27 (54)	41 (89.1)
Gujarat	113 (22.7)	277 (60.7)	184 (40.7)	355 (81.2)	73 (14.6)	218 (46.8)
Haryana	953 (60.1)	1222(78.7)	668 (42.1)	887 (57.1)	844 (53.2)	1170(75.3)
Kerala*	158(32.7)	255(51.4)	140(29.0)	236(47.5)	165(34.2)	280(56.4)
Maharashtra	191 (24.2)	417 (52.3)	517 (65.6)	679 (85.3)	278 (35.2)	509 (63.9)
Punjab	988(76.5)	792 (81.0)	794(61.5)	627 (64.1)	694 (53.8)	356(36.4)
Tamil Nadu**	59(32.7)	246(74.5)	61(33.8)	201(60.9)	45(25.0)	216(65.4)
Uttar Pradesh	344(18.0)	537(30.3)	610(31.9)	866(48.9)	519(27.2)	808(45.6)

* Kerala Phase I, II & IV data is combined;
* *Tamil Nadu Phase III & IV data is combined.

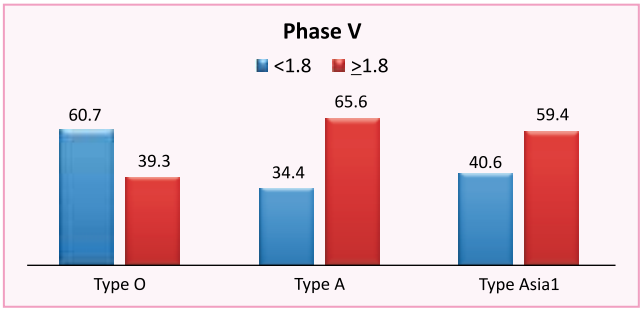


Fig. 10.4: Average post vaccinal seroconversion in Phase V.

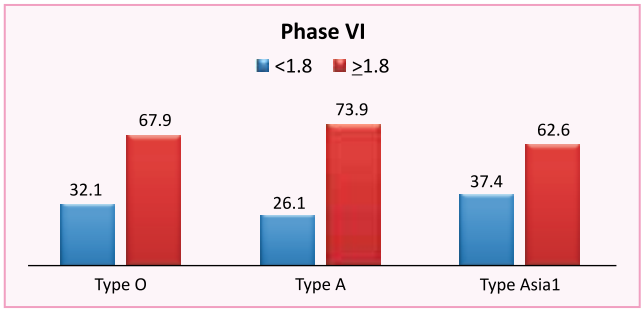


Fig. 10.5: Average post vaccinal seroconversion in Phase VI.

Phase V

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
Andaman& Nicobar	72(57.2)	68(55.8)	62(50.8)	64(52.5)	54(44.3)	62(50.8)
Andhra Pradesh	247 (30.8)	440 (55)	466 (58.2)	574 (71.8)	343 (42.8)	450 (56.3)
Delhi	26 (59)	47 (88.6)	23 (52.2)	37 (69.8)	32 (72.7)	41 (77.3)
Gujarat	46 (23.6)	99 (49.0)	126 (66.1)	179 (91.6)	44 (26.5)	92 (51.3)
Haryana	955 (59.7)	1352(84.5)	813 (50.8)	1274(79.6)	941 (58.8)	1353(84.5)
Kerala	67(23.1)	197(67.9)	52(17.9)	171(58.9)	61(21.0)	211(72.7)
Maharashtra	142 (17.7)	271 (35.1)	353 (44.2)	477 (62.3)	121 (15.0)	245 (31.8)

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
Punjab	477(34.8)	621(54.5)	445(32.8)	630(53.7)	513(38.5)	690(60.1)
Tamil Nadu	Serum samples not available					
Uttar Pradesh	516(35.8)	715(44.9)	625(43.4)	802(50.4)	684(47.5)	786(49.4)

Phase VI

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
Andaman& Nicobar	50 (18.5)	80 (29.6)	66 (24.4)	104 (38.4)	28 (10.2)	36 (13.2)
Andhra Pradesh	275 (34.3)	490 (61.3)	554 (69.2)	690 (86.3)	446 (55.7)	634 (79.3)
Delhi	76 (77.5)	97 (98.9)	60 (61.2)	93 (94.9)	71 (72.4)	97 (98.9)
Gujarat	119 (30.1)	223 (56.4)	249 (63.0)	317(80.2)	195 (49.3)	240 (60.7)
Haryana	995 (66.5)	1306(87.1)	895 (59.8)	1229(82.0)	844 (56.4)	1118(74.6)
Kerala	49 (20.4)	185(77.1)	41(17.1)	169(70.4)	38(15.8)	171(71.3)
Maharashtra	404 (44.9)	663 (71.4)	622 (69)	853 (91.9)	245 (27.2)	446 (48.1)
Punjab	653 (43.3)	944 (60.2)	654 (43.3)	921 (58.7)	496 (32.9)	743 (47.4)
Tamil Nadu	30(18.7)	99(76.1)	31(23.8)	109(83.8)	28(21.5)	103(79.2)
Uttar Pradesh	514 (34.5)	968 (61.3)	520 (34.9)	826 (52.3)	400 (26.9)	838 (53.1)

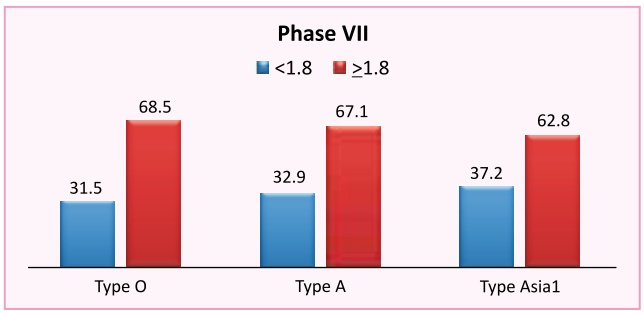


Fig. 10.6: Average post vaccinal seroconversion in Phase VII.

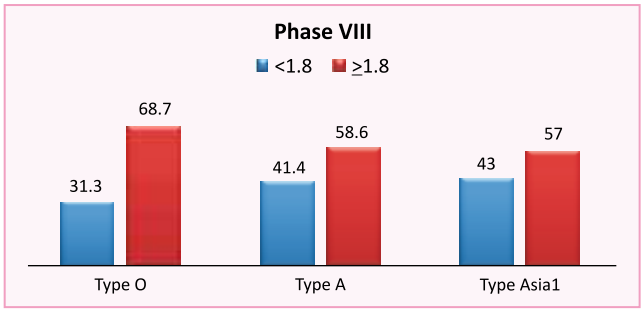


Fig. 10.7: Average post vaccinal seroconversion in Phase VIII.

Phase VII

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
Andaman & Nicobar	112 (42.3)	174 (65.7)	82 (30.9)	110 (41.5)	56 (21.1)	66 (24.9)
Andhra Pradesh	274 (34.0)	483 (60.3)	349 (44.0)	540 (67.5)	391 (48.8)	518 (64.7)
Delhi	39(78)	44(88)	33(66)	43(86)	25(50)	41(82)
Gujarat	434 (54.3)	630 (78.8)	385 (48.1)	559 (69.9)	344 (43.0)	556 (69.5)
Haryana	856(54.8)	1296 (82.3)	1021 (65.3)	1380 (87.6)	888 (56.8)	1317 (83.6)
Kerala	48 (16.0)	208 (69.3)	43 (14.3)	213 (71.0)	52 (17.3)	210 (70.0)
Maharashtra	446 (44.6)	692 (69.2)	701 (70.1)	893 (89.3)	431 (43.1)	667 (66.7)
Punjab	413 (36.3)	650 (57.8)	260 (22.8)	472 (42.0)	376 (33.0)	521 (46.4)
Tamil Nadu	35(11.7)	210(70)	34(11.3)	231(77)	36(12)	226(75.3)
Uttar Pradesh	706 (24.9)	911 (43.9)	597 (21.1)	808 (38.9)	740 (26.1)	930 (44.8)

Phase VIII

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
Andaman& Nicobar	53(21.1)	102(40.6)	18(7.2)	49(19.5)	47(18.7)	85(33.86)
Andhra Pradesh	356 (44.5)	594 (74.0)	415 (51.8)	624 (78.0)	333 (41.6)	527 (65.8)
Delhi	92 (92)	100 (100)	66 (66)	86 (86)	83 (83)	98 (98)
Gujarat	191 (23.9)	394 (49.3)	197 (24.6)	357 (44.6)	264 (33.0)	403 (50.4)
Haryana	949(61.3)	1289 (83.7)	877 (56.6)	992 (64.4)	765 (49.4)	1101 (71.4)
Kerala*	226(37.6)	395(65.8)	265(44.16)	341(56.8)	260(43.3)	397(66.2)
Maharashtra	646 (64.6)	904 (90.4)	574 (57.4)	848 (84.8)	198 (19.8)	452 (45.2)
Punjab	580(58.94)	825(73.3)	410(41.66)	643(57.15)	452(45.93)	741(65.86)
Tamil Nadu	34(34)	74(74)	40(40)	60(60)	25(25)	78(78)
Uttar Pradesh	707(37.1)	1550(56.5)	502(26.4)	1310(47.7)	617(32.4)	1288(46.9)

* Kerala Phase VIII & IX data is combined.

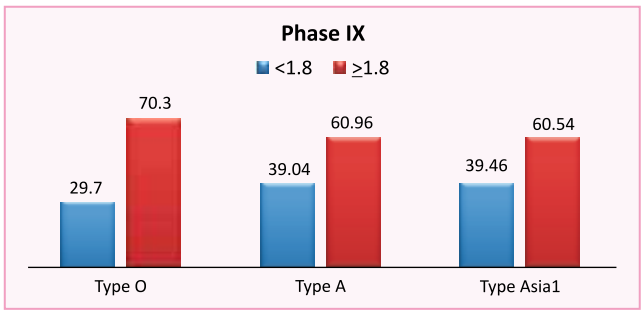


Fig. 10.8: Average post vaccinal seroconversion in Phase IX.

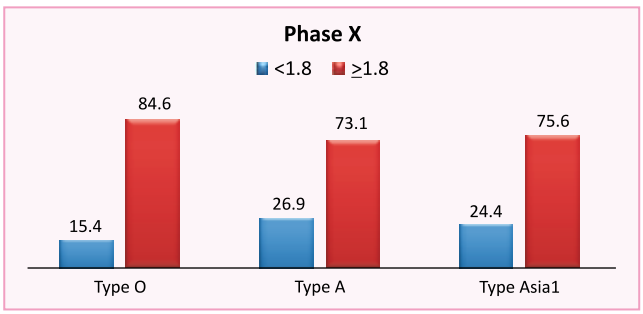


Fig. 10.9: Average post vaccinal seroconversion in Phase X.

Phase IX

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
Andaman& Nicobar	73(32)	69(30.26)	31(13.59)	35(15.35)	56(24.56)	42(18.42)
Andhra Pradesh	422(52.8)	673(84.1)	329(41.1)	534(66.8)	287(35.9)	534(66.8)
Delhi	57(57)	NA	65(65)	NA	33(33)	NA
Gujarat	230(28.7)	618(77.2)	284(35.5)	572(71.5)	326(40.7)	595(66.9)
Haryana	647(43.2)	1140(77.2)	590(39.4)	1022(69.2)	410(27.4)	879(59.6)
Kerala*	226(37.6)	395(65.8)	265(44.16)	341(56.8)	260(43.3)	397(66.2)
Maharashtra	730(73)	951(95.1)	524(52.4)	817(81.7)	324(32.4)	695(69.5)
Punjab	1035(66.4)	1193(77.2)	831(53.3)	978(63.3)	926(59.4)	1132(73.2)
Tamil Nadu	40(40)	58(58)	45(45)	64(64)	33(33)	74(74)
Uttar Pradesh	927(33.56)	1198(39.9)	617(22.34)	1095(36.48)	597(21.6)	1072(35.7)

* Kerala Phase VIII & IX data is combined.

Phase X

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
Andhra Pradesh	502(62.7)	635(79.3)	368(46)	575(71.8)	411(51.3)	602(75.2)
Gujarat	356(44.5)	620(77.5)	286(35.7)	525(65.6)	276(34.5)	535(66.9)
Haryana	851(59.9)	1350(93.8)	615(43.3)	1003(69.7)	587(41.3)	1145(79.5)
Kerala	160(40)	59(59)	145(36.25)	66(66)	150(37.5)	53(53)
Maharashtra	785(78.5)	978(97.8)	686(68.6)	935(93.5)	607(60.7)	846(84.6)
Punjab	1030(64.73)	1231(77.32)	904(56.8)	1098(68.96)	970(60.96)	1156(72.6)
Tamil Nadu	32(32)	62(62)	45(45)	63(63)	41(41)	70(70)

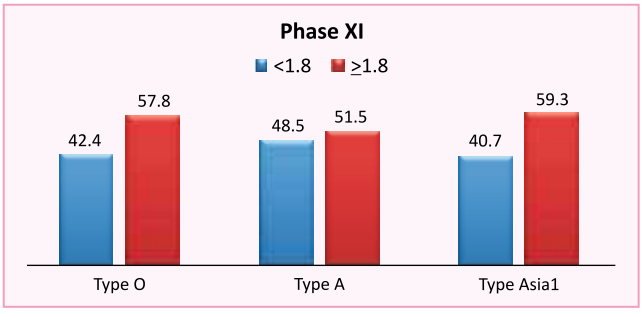


Fig. 10.10: Average post vaccinal seroconversion in Phase XI.

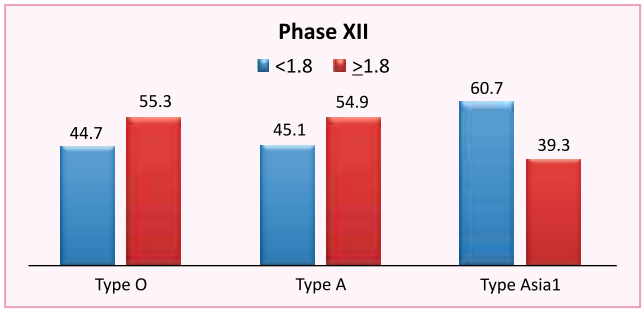


Fig. 10.11: Average post vaccinal seroconversion in Phase XII.

Phase XI

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
Andhra Pradesh	398(49.75)	617(77.12)	356(44.5)	600(75)	333(41.62)	568(71.5)
Delhi	172(86)	NA	100(50)	NA	91(45.5)	NA
Gujarat	55(27.5)	76(38)	44(22)	71(35.5)	29(14.5)	49(24.5)
Haryana	734(48.9)	1302(88.9)	546(36.4)	1180(80.6)	455(30.3)	1109(75.8)
Kerala	122(18.29)	122(18.29)	122(18.29)	115(17.24)	96(14.39)	88(13.19)
Maharashtra	558(55.8)	916(91.6)	534(53.4)	871(87.1)	403(40.3)	837(83.7)
Punjab	991(61.9)	1186(74.1)	881(55.1)	1075(67.2)	965(60.3)	1142(71.4)
Tamil Nadu	38(19)	144(72)	31(15.5)	87(43.5)	29(14.5)	83(41.5)
Uttar Pradesh	47(7.3)	481(21.8)	68(10.6)	321(14.6)	385(59.9)	1103(50)

Phase XII

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
Andaman & Nicobar	36(20.0)	49(27.22)	19(10.56)	40(22.22)	11(6.11)	30(16.67)
Andhra Pradesh	387(48.37)	568(71)	266(33.25)	483(60.37)	177(22.12)	367(45.87)
Gujarat	104(52)	105(52.5)	80(40)	67(33.5)	56(28)	25(12.5)
Haryana	593(43.6)	975(80.6)	520(38.2)	989(81.7)	474(34.9)	896(74.1)
Kerala	59(11.8)	202(40.4)	73(14.6)	197(39.4)	63(12.6)	153(30.6)
Maharashtra	590(60.2)	894(91.2)	468(47.75)	823(83.97)	341(34.79)	730(74.48)
Punjab	1033(64.5)	1115(71.6)	914(57.1)	1026(65.9)	897(56.1)	0(0)
Uttar Pradesh	184(9.5)	270(17.6)	252(13)	524(34.1)	424(21.9)	773(50.6)

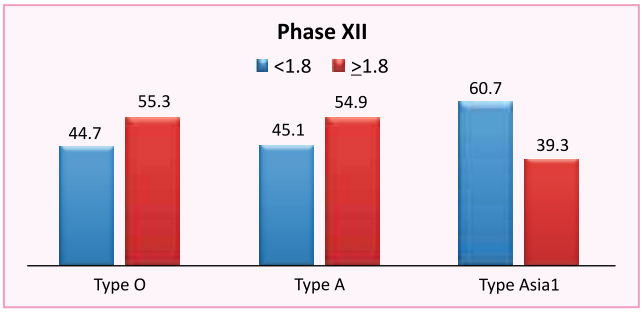


Fig. 10.12: Average post vaccinal seroconversion in Phase XII.

Phase XIII

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
Andaman & Nicobar	26(9.2)	78(27.6)	12(4.2)	52(18.4)	15(5.3)	44(15.5)
Andhra Pradesh	537(67.1)	654(81.8)	438(54.8)	602(75.3)	315(39.3)	498(62.3)
Delhi	98(98)	98(98)	95(95)	100(100)	87(87)	100(100)
Gujarat	589(29.4)	1009(49.7)	407(20.3)	784(38.6)	670(33.4)	1011(49.8)
Haryana	925(58.2)	654 (82.8)	218(27.6)	630(79.8)	185(23.4)	616(78.0)
Maharashtra	418(44)	727(69.2)	75(7.9)	332(31.6)	58(6.1)	277(26.4)

Phase XIV

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
Andhra Pradesh	366(45.7)	634(79.2)	186(23.3)	446(54.7)	100(12.5)	389(48.6)
Gujarat	317(40.9)	228(44.6)	224(28.9)	173(33.9)	355(45.8)	229(44.8)
Haryana	627(39.7)	1327(84.0)	594(37.6)	1279(81.0)	536(33.9)	1272(80.5)

10.3 Phase wise number and percent of animals showing antibody titer ≥1.8 log10 against FMD virus (167 districts)

Phase I

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
Andhra Pradesh	1043(29)	2396(66.5)	648(18)	2030(56.4)	419(13.1)	1709(47.5)
Goa	47(12)	244(86.8)	8(2)	92(24.1)	11(2.8)	92(24.1)
Lakshadweep	45(42.1)	80(74.8)	16(15)	63(58.9)	35(32.7)	50(46.7)

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
Haryana	1049(43.9)	1790(76.1)	988(41.4)	1789(76.0)	715(30.0)	1469(62.4)
Maharashtra	1687(28.2)	4390(72.9)	941(15.7)	3080(51.2)	382(6.4)	2310(38.4)
Punjab	797(44.3)	978(54.3)	704(39.1)	825(45.8)	615(34.2)	874(48.6)
Tamil Nadu	1860(34.2)	3417(62.8)	1351(24.8)	2561(47.1)	115(20.5)	2209(40.6)
Karnataka	1817(40)	2383(56)	687(15)	1722(40)	426(9)	1049(24.5)
Puducherry	16(44.4)	24(66.66)	9(25)	20(55.55)	5(13.88)	11(30.55)

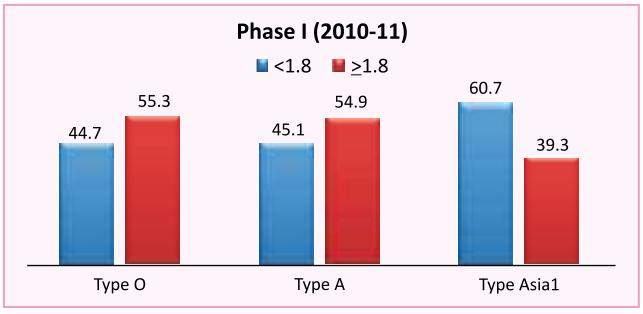


Fig 10.13: Average post vaccinal seroconversion in Phase I.

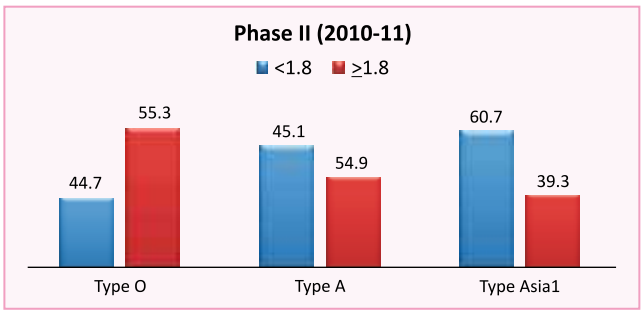


Fig. 10.14: Average post vaccinal seroconversion in Phase II.

Phase II

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
Andhra Pradesh	1435(41.2)	2381(68.4)	1026(29.5)	2054(59)	595(17.1)	1499(43.1)
Haryana	1081(41.8)	1876(73.5)	986(38.1)	727(28.1)	986(38.1)	1537(60.2)
Kerala	84(12.4)	65(36.1)	105(15.5)	65(36.1)	65(9.6)	61(34)
Maharashtra	1849(25.7)	4890(66.6)	481(5.8)	2530(34.5)	491(6.8)	2279(31)
Punjab	1002(55.6)	1096(61.5)	902(50.1)	978(54.8)	904(50.2)	0(0)
Tamil Nadu	1383(27.4)	3504(66.9)	684(13.6)	2433(46.4)	245(4.9)	979(18.7)
Karnataka	2718(50)	3101(67)	1471(27)	2161(47)	1577(39)	2354(51)
Puducherry	16(42.1)	20(52.6)	10(26.3)	14(36.8)	0(0)	18(21.1)

Phase III

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
Andhra Pradesh	1392(38.6)	2498(69.3)	750(20.8)	1661(46.1)	393(10.9)	1162(32.2)
Haryana	1092(42.5)	1809(71.2)	1113(43.3)	1856(73.1)	650(25.3)	1576(62.1)
Kerala	199(12.2)	525(35.6)	178(10.9)	484(32.8)	135(8.3)	376(25.5)
Tamil Nadu	380(24.5)	965(62.3)	210(13.5)	777(50.1)	473(30.5)	1136(73.3)
Karnataka	753(52)	451(65)	444(30)	336(49)	861(59)	487(70.5)
Puducherry	21(45.7)	29(63)	7(15.2)	20(43.5)	26(56.5)	30(65.2)

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

The herd immunity has progressively increased with minor aberrations that speak for positive impact of vaccination for last 6-7 years. Incidence/occurrence of the disease has also progressively declined in the southern region and also down to near zero in the states of Haryana and Punjab. There has been case of FMD in FMD-CP districts affecting very limited number of animals and did not spread due to surrounding herd immunity. Further, there has been reduction in severity of clinical sickness. Of late, due to delay in vaccination there have been a few sporadic incidences in vaccinated areas. There have been certain 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 21: Percent animals showing post vaccinal antibody titers of ≥1.8 log10 against FMD virus (2003-04, 54 districts)

Phase	Type O		Type A		Type Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	27.3	53.5	22.0	49.5	23.8	57.6
II	36.7	60.2	23.3	48.4	36.8	63.5
III	43.7	64.3	43.7	61.5	39.1	62.6
IV	41.2	62.3	42.4	67.5	36.2	61.1
V	38.0	39.3	46.3	65.6	40.8	59.4
VI	38.9	67.9	46.6	73.9	36.8	62.6
VII	39.7	68.5	39.4	67.1	35.1	62.8
VIII	42.3	68.7	37	58.6	33.5	57
IX	63.7	85.6	52	73.3	52.6	73
X	63.4	87.4	50.6	74.7	48.9	76.7
XI	44.1	57.8	37.8	51.5	39.3	59.3
XII	36.6	55.3	31.8	54.9	30	39.3
XIII	43.5	53.6	20.9	41.6	22.3	42.3

Table 22: Percent animals showing post vaccinal antibody titers of ≥1.8 log10 against FMD virus (2010-11, 167 districts)

Phase	Type O		Type A		Type Asia 1	
	Pre-vac	Post-vac	Pre-vac	Post-vac	Pre-vac	Post-vac
I	33.4	65.3	21.4	50.7	10.9	40.7
II	36.5	67	21.6	43.4	18.5	34.5

Table 23a: Summary of total number of serum samples tested under FMD CP (2003-04)

State/UT	Phase I		Phase II		Phase III		Phase IV		Phase V		Phase VI		Phase VII	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andaman & Nicobar	-	-	-	-	154	162	149	146	126	122	270	270	265	265
Andhra Pradesh	800	800	-	800	800	800	800	800	800	800	800	800	800	800
Delhi	50	50	24	24	50	50	50	46	44	53	98	98	50	50
Gujarat	382	259	-	-	442	357	497	456	195	202	395	395	800	800
Haryana	-	-	-	1558	-	1585	1589	1552	1600	1599	1496	1499	1562	1574
Kerala	483 (pre) and 496(post) of Phase I, II and IV								290	290	70	70	300	300
Maharashtra	844	761	-	834	753	799	789	797	802	772	901	928	1000	1000
Punjab	-	742	-	500	1084	1365	1291	978	1370	1139	1509	1568	1265	1432
Tamilnadu	100	100	100	100	180(pre)		330(post)		-	-	160	130	300	300
Uttar Pradesh	-	-	139	407	1155	1584	1910	1770	1440	1591	1488	1579	2833	2075
subTotal	2176	2712	263	4223	4438	6707	7075	6545	6667	6568	7187	7337	9175	8596
Total	**4888***		**4486***		**11145***		**13620***		**13235**		**14524**		**17771**	

Table 23b: Summary of total number of serum samples tested under FMD CP (2003-04)

State/UT	Phase VIII		Phase IX		Phase X		Phase XI		Phase XII		Phase XIII		Phase XIV	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andaman &Nicobar	251	251	228	228	-	-	-	-	180	180	283	283		
Andhra Pradesh	800	800	800	800	800	800	800	800	800	800	800	800	800	800
Delhi	100	100	100	-	-	-	200	-	-	-	100	100		
Gujarat	800	800	800	800	800	800	800	800	800	800	2007	2029	775	511
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		
Maharashtra	1000	1000	1000	1000	1000	1000	1000	1000	980	980	950	1050	100	100

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
Punjab	984	1125	1558	1546	1592	1592	1600	1600	1600	1556				
Tamilnadu	100	100	100	100	100	100	200	200	-	-				
Uttar Pradesh	1904	2744	2762	3002	88	-	643	2206	1934	1535	87			
subTotal	8086	8460	8845	8952	6200	5831	7095	8385	8154	7561	5967	6012	3255	2991
Total	**16546***		**17797***		**12031**		**15480**		**15715**		**11972**		**6246**	
Grant total	**174556**													

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

**this includes all the samples tested

Table 25: Summary of total number of serum samples tested under extended FMD CP (2010-11)

State/UT	Phase I		Phase II		Phase III		Phase IV	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andhra Pradesh	3600	3600	3480	3480	3600	3600	400	400
Haryana	3086	2354	2586	2594	2555	2362		
Karnataka	4587	4266	5401	4632	1459	690		
Maharashtra	5988	6018	7208	7341				
Goa	381	391						
Punjab	1800	1800	1800	1782				
Kerala			676	180	1631	1474	810	770
Tamilnadu	5440	5440	5040	5240	1550	1550		
Puducherry	30	55	38	38	46	46		
Lakshadweep	107	107	-	-				
Sub total	25,019	24031	26229	25287	10841	9722	1210	1170
Total	**49050**		**51516**		**20563**		**2380**	
Granttotal	**123509**							

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

State	Number of sample tested	Species	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
Madhya P	3598+1240	C+B	870(24.2)	545(44)	412(11.5)	384(31)	359(10)	285(23)
Arunachal P	269+269	C+M	79(29.3)	228(84.7)	62(23)	206(76.5)	51(18.9)	184(68.4)
Asom	500+500	C	135(27)	340(68)	96(19.2)	301(60)	77(15.4)	258(51.6)

State	Number of sample tested	Species	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
Himachal P	40+40	C	25(62.5)	30(75)	15(37.5)	22(55)	16(40)	17(42.5)
Odisha	655+600		252(38.5)	481(80.2)	174(26.6)	349(58.2)	253(38.6)	483(80.5)
Mizoram	160+160	C	22(13.8)	77(48.1)	7(4.3)	49(30.1)	0(0)	16(10)
Manipur	2915+2915	C+B	681(23.4)	2249(77.2)	540(18.5)	2177(74.7)	340(11.7)	2019(69.3)
Nagaland	110+110	C	42(38.2)	101(91.2)	51(46.4)	96(87.3)	63(57.7)	106(96.4)
West Bengal	32+32	C	22(68.8)	31(96.9)	17(53.1)	29(90.6)	10(31.3)	31(96.9)
Bihar	120+220	C+B	30(25)	102(46.4)	10(8.3)	61(27.7)	16(13.3)	72(32.7)

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

11.0

Production, Standardization and Supply of Diagnostic Reagents

For production of reagents, the vaccine virus strains {O (IND R2/75), Asia1 (IND 63/72),) and A (IND 40/00)} were bulk produced in roller culture vessels and purified by density gradient centrifugation. Inactivated virus antigen was also outsourced from a FMD vaccine production house (Indian Immunological Ltd) in the country to meet demand for diagnostic kits in the region. 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 under report, r3AB3 DIVA Kit for FMD to test a total number of 93,500 serum samples was produced and reagents to test 85,350 samples have been supplied to the AICRP units and vaccine manufacturing companies. Similarly, virus serotyping Kits for 16,500 tests and LPB-ELISA Kits for 1,90,500 were produced, and virus serotyping Kits for 11,500 tests and LPB-ELISA Kits for 1, 77,850 were supplied to FMD Regional centers/network units for sero-surveillance and monitoring of FMD. Diagnostic kits were also supplied to SAARC Countries.

FMD Outbreak Investigation

12.1 Haridwar and Dehradun, Uttarakhand

A team of three scientists from PDFMD, Mukteswar, visited the Haridwar and Dehradun districts of Uttarakhand during 1-2May 2012 for the investigation of FMD outbreaks in and around Haridwar. The scientists visited Kuan Kheda, Munda Kheda, Ghateki, Luxor, Kheda, Khanpur, Tugalpur, Idrispur, Mundavilla, Sherpurvilla, Haridwar, Dallaballa and Chandipur villages in the District of Haridwar and Kheri Khurd Syampur, Bhattaballa, Rusha Farm, Balla Farm villages in the district of Dehradun, Uttarakhand. In the course of the investigation 19 serum samples of cattle and buffaloes and 8 oral swabs and one tongue epithelium from affected cattle and buffaloes were collected for laboratory investigation. The team came back to Mukteswar on 3rd May 2012.

The following observations were made during the investigation of the FMD outbreak in the livestock of Haridwar and Dehradun, districts of Uttarakhand.

- The FMD vaccination in livestock of Haridwar and Dehradun districts are covered under ASCAD programme.
- Only cattle and buffaloes in the area are vaccinated once in a year against FMD. There was only about 60 % vaccination coverage as some farmers refuse to vaccinate their animals various reasons including reluctance to pay Rs 2.00 per each animal vaccinated as charged by the State Animal Husbandry Department of Uttarakhand. Small ruminants and pigs are not vaccinated against FMD.
- Last routine vaccination was done during October 2011 in the Haridwar district. Once FMD outbreak occurred in the last week of February 2012, animals were vaccinated against FMD immediately which was completed in the affected areas by second week of March 2012.
- The agro climatic zone of Haridwar and surrounding areas comes under the dry zone and the atmospheric temperature at the time of outbreak was 37^0C.
- The farmers rear mixed species of livestock viz. cattle (HF Cross Bred and a few indigenous) and buffaloes (Murrha).
- It was informed by the farmers and local Veterinary Officers that local livestock traders purchase and procure animals from the hills of Uttarakhand and from other states like Rajasthan, Punjab, Haryana and Uttar Pradesh and sale them in villages. It was also observed during investigation that nomadic livestock farmers move with their unvaccinated animals from hills of Uttarakhand to the villages of Haridwar and Dehradun for grazing and trade. Nomadic livestock farmers from Uttar Pradesh (Muzaffar Nagar, Meerut, Moradabad, Nazimabad etc) with both large and small ruminants also visit the villages of Haridwar District.
- The practice of using the services of common milkers by the livestock owners of a cluster of villages also might have helped in the spread of the infection.
- It was observed that the clinical lesions were severe in buffaloes as compared to cattle and mostly oral lesions were observed in buffaloes. In a few cases, teats were affected in buffaloes. The affected animals showed symptoms of anorexia, limping, loss of milk production (up to 40 - 50%) with pyrexia, salivation, masking sounds and formation of vesicles on the surface of tongue, dental pads and inter digital space. There were hemorrhagic wounds on the surface of tongue, dental pad, teats and hoof (Photo).
- One organized dairy farm, Shanti Kunj Goushala, with about 242 dairy cattle (Sahiwal, Tharparker and Hariyana) was also affected with FMD. All these animals were never vaccinated against

FMD. FMD was observed on 12th April 2012 in the farm leading to the death of 3 calves. The farm authorities then vaccinated the animals against FMD on 14th April 2012. During the visit, the animals were found in the recovery stage with one animal having foot lesion with secondary bacterial infection with maggot infestation. Though the animals of the goushala are stall fed, there are/ were frequent visitors to the ashram and the goushala for different purposes.

- In Kuankheda village of Luxor in Haridwar district, cases of FMD in cattle and buffaloes were recorded in the last week of February 2012. One bullock purchased from Haryana and introduced in to the village, first showed the symptoms of FMD and the disease gradually spread to other animals and to the surrounding villages in the district, and also affected the villages of Dehradun district bordering Haridwar, where fresh incidence of FMD was observed at the time of investigation. The animals in the affected and surrounding villages were vaccinated by the state department against FMD immediately.
- The outbreak of FMD continued for one month in Haridwar district, and the affected herds were in recovery stage at the time of investigation.

Interaction with the Farmers

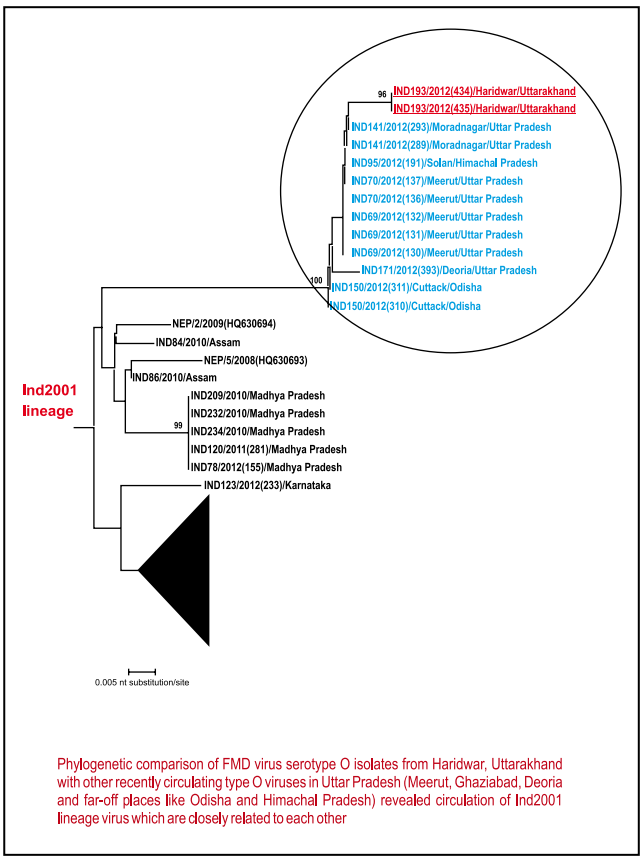
- The farmers were apprised of the importance of FMD in livestock including small ruminants and pigs.
- They were advised to vaccinate their animals above three months of age at six monthly intervals. The calves need to be vaccinated at 4 months of age followed with a booster dose after 4 weeks and subsequent regular vaccination at 6 months interval.
- The farmers were distributed with leaflets and bulletins, prepared By PDFMD in Hindi on importance of FMD and its control and prevention programme.
- The farmers expressed the desire that the small ruminants should be vaccinated along with cattle and buffaloes under FMD vaccination programme, twice in ayear which need to be free of charge.
- The farmers desired some incentives for their animals in the form of medicines, mineral mixture, anthelmintics, vitamin supplements, farm disinfectants etc. during investigation of outbreaks / collection of biological materials from their herds.
- The local veterinary officers expressed the help of PDFMD to organize FMD awareness programme in the district of Haridwar involving the local progreesive farmers and veterinarians.

Virus diagnosis:

1. Clinical materials collected from cattle and buffalo during investigation were confirmed to be serotype O FMD virus in sandwich ELISA and multiplex PCR.
2. Phylogenetic analysis revealed involvement of 'Ind2001' lineage of serotype O virus in the outbreak.
3. Interestingly viruses isolated from Meerut, Solan, Muradnagar and Haridwar were genetically closely related to each other. Although, the clinical material collected on 25-01-2012 from outbreak in Military Farm, Meerut; investigation revealed that the disease was continuing in this farm, and in and around Meerut since last one month. Outbreak in Solan was also observed at the same time. Based on time of isolation it is possible that the virus might have moved from Meerut to Muradnagar and subsequently to Haridwar. This is possible because the places are separated by a distance of 30-100 Km only. Interaction with farmers revealed frequent movement of animals by the livestock traders from this region.
4. Clinical material from Haridwar for cell culture isolation is in progress to determine antigenic relationship with in-use vaccine virus. **Similar viruses isolated from Meerut showed close antigenic relationship (r value of 0.50-1.00) with the in-use vaccine strain O/IND/R2/1975.**

Conclusion:

The investigation of the FMD outbreaks in the livestock revealed that the introduction of new animals by the local livestock traders most possibly has introduced the disease. The involvement of serotype 'O' FMD virus was detected in the clinical samples collected during the investigation of outbreak. The detail laboratory investigation is in process to draw further information.



Phylogenetic comparison of FMD virus serotype O isolates from Haridwar, Uttarakhand with other recently circulating type O viruses in Uttar Pradesh (Meerut, Ghaziabad, Deoria and far-off places like Odisha and Himachal Pradesh) revealed circulation of Ind2001 lineage virus which are closely related to each other

12.2 Chikkaballapur, Karnataka

The Epidemiological team constituted by Dr. B.B. Dash, Senior Scientist, Dr. M. Rout, Scientist and Dr. J.K. Biswal, Scientist attended FMD outbreak in Bangalore, Karnataka during 7th - 12th April' 2012. During the investigation, a total of 357 serum samples (from 327 sheep, 23 goats, 7 cattle), 51 oral swabs from affected and recovered sheep, goats and cattle, 1 tongue epithelium sample from affected cattle were collected. Suitable photographs of FMD affected animals were also taken.

All serum samples were subjected to LPB-ELISA and 3AB-NSP-ELISA. Oral swabs were subjected to Sandwich/Typing ELISA for serotype detection and cell culture isolation of virus. RNA was extracted from the swab samples, reverse transcribed and multiplex PCR was done. However, no virus could be recovered in BHK-21 cell culture from any of the oral swabs/clinical materials collected nor any of those could be serotyped in Sandwich ELISA. Multiplex PCR results also came negative. This might be due to degradation of RNA of clinical samples collected. All serum samples proved to be very useful to give the retrospective diagnosis. In 3AB-NSP-ELISA, out of 3 of 7 (42.8%) cattle, 195 of 327 (59.63%) sheep, and 17 of 23 (73.91%) goats were found positive.

12.3 University Pig and Livestock farm, COVAS, Mannuthy, Thrissur, Kerala

The Epidemiological team constituted by Dr. M. Rout, Scientist and Dr. S. Pawar, Scientist visited University Pig and Livestock farm, Kerala Veterinary and Animal Sciences University, Mannuthy, Thrissur, Kerala during 02nd to 07th March 2013 for investigation of Foot and Mouth Disease outbreak.

One outbreak of FMD occurred in the University Pig farm, Kerala Veterinary and Animal Sciences University, Mannuthy, Thrissur, Kerala on 14.01.2013. The pig farm had total population of 1463 pigs housed in the same farm under semi-intensive conditions. A total of 112 pigs were affected with FMD. Vesicular fluids were collected by District ADCP Unit on 14.01.2013. Detailed investigation was done by the Project Co-ordinator, ADCP and Veterinary Assistant Surgeon, FMD Network Unit, Palode on 31.01.2013. Three samples each from University Pig farm and University Livestock farm (suspected outbreak near to UPF) were collected for serotyping and were confirmed to be serotype 'O'. Representative samples were also sent to Central FMD Laboratory at PD on FMD, Mukteswar. A total of 13 serum samples (12 from pigs and 1 from convalescent cattle) were also sent to PD on FMD. A total of 7 clinical samples from oral epithelium of pigs were also collected and sent to PD on FMD.

A total of 6 nasal swabs from affected and recovered pigs were collected for virus isolation. A total of 18 serum samples from healthy and affected cattle, and 13 serum samples from healthy and affected pigs were collected for estimation of antibody titre against three FMDV serotypes. The FMD lesions have been subsided in cattle, but the healed hoof lesions (with typical removal of claws) were still there evident in affected and recovered pigs, which were clearly photographed. There was mild loss of milk yield in the affected dairy cattle.

Characteristics of the farm: The pig farm had total population of 1463 pigs (Boars = 81, Sows = 517, Gilts = 183, Piglings >4 months = 188, Piglings <4 months = 494) housed in the same farm under semi-intensive conditions. The breeds maintained were Landrace, Duroc, Angamally Desi, Large White Yorkshire etc. The University Livestock farm was located near to the Pig farm. It has the total strength of 283 (young = 45, Growing = 110, Adults = 126) dairy cattle of Jersey and Holstein breeds.

FMD History: As per the history, the outbreak of FMD occurred in the University Pig farm as well as in University Livestock farm on 14.01.2013.

FMD Vaccination History: Normally the vaccination was being done twice a year. Last FMD vaccination before the outbreak was done in September 2012 and re-vaccination done during the outbreak in the month of January in cattle and pigs.

Biosecurity Management in Livestock farm area

- People working in the pig farm also work in the cattle farm.
- Frequent entry of visitors into the farm.
- The farm does not have any practice of procurement of animals from outside.

Collection of Serum Samples: A total of 14 bovine and 30 porcine serum samples from University Livestock farm and University Pig Farm, respectively were collected by PDFMD/AICRP-FMD Network Unit, Palode during 4-6 March 2013.

Result of Serum Samples

3AB-NSP-ELISA (DIVA) Results

In 3AB-NSP-ELISA, 13 of 14 (92.85%) cattle and in C-ELISA, 13 of 30 (43.33%) pigs were positive indicating high virus circulation in the cattle herd. This also suggests that there is high probability of virus transmission from cattle farm to pig farm.

LPB-ELISA Results (Protective antibody assay)

All serum samples were subjected to liquid phase blocking ELISA (LPB-ELISA) to assess the level of protective antibody (antibodies against structural proteins) against FMD virus serotypes O, A and Asia 1. LPBE results showing $\log_{10}$ titer of ≥1.8 or more against individual and all the three serotypes for all animals are shown in tables 1 and 2.

In LPB-ELISA, 9 out of 14 (64.28%) cattle and 7 out of 30 (23.33%) pigs were found to have protective $\log_{10}$ Ab titre of ≥1.8 against all threes serotypes. This indicates poor herd immunity in pigs against FMD virus and moderate in case of cattle.

FMD Virus diagnosis

Out of 7 oral epithelium samples from pigs collected by AICRP-FMD Network Unit, Palode, 3 samples (KER-276, KER-277 and KER-281) were found to be of serotype O in multiplex PCR. No virus could be isolated from the nasal swabs collected from pigs till 5th passage in cell culture.

- Herd immunity was found to be moderate (64.28%) in cattle and low (23.33%) in pigs.
- From the serological analysis, it is evident that that the disease spread from cattle farm to the pig farm.
- High FMD virus circulation in cattle herd with >92% DIVA positivity.

Recommendations

- All animals need to be vaccinated with trivalent FMD vaccine every 6 months to boost and maintain the herd immunity at least at 75-80% level. Animals may be tested for antibody level before and 28-30 days after vaccination.
- Any new animal should not be introduced without testing for serum antibody for DIVA.
- Necessary precautionary measures should be followed during the visit of outsiders entering the farm premises.
- Strict biosecurity measures in terms of men and materials should be followed.

Pathological Lesions of FMD in Pigs in the UPF, Mannuthy, Thrissur, Kerala

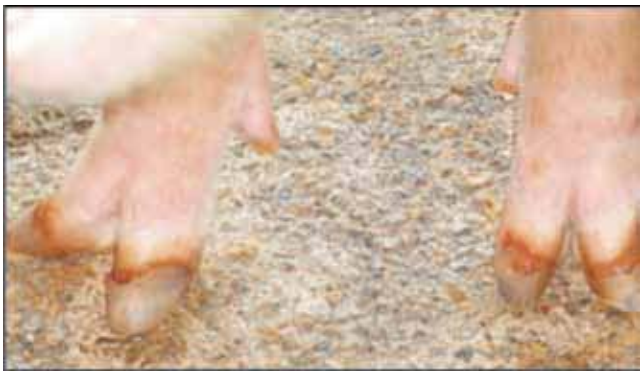


Fig 1. Erosive Lesions in the digits

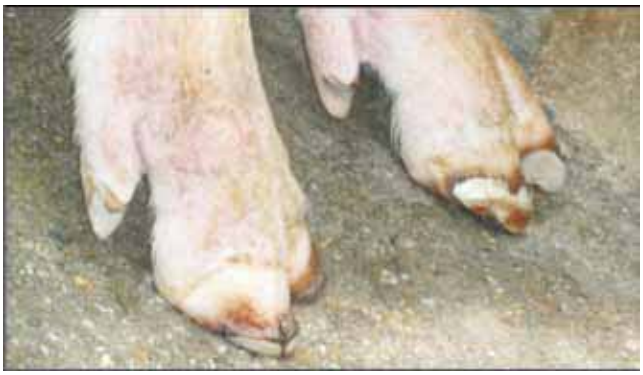


Fig 2. Partially sloughed hoof

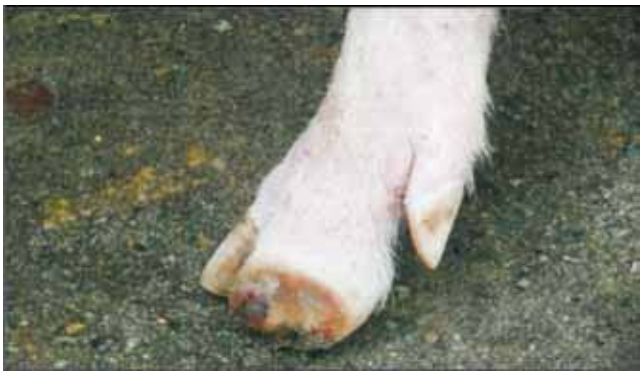


Fig 3. Completely sloughed hoof

Fig 4. Worst blistering in the feet

Fig 5. Worst blistering and erosive lesions in the feet

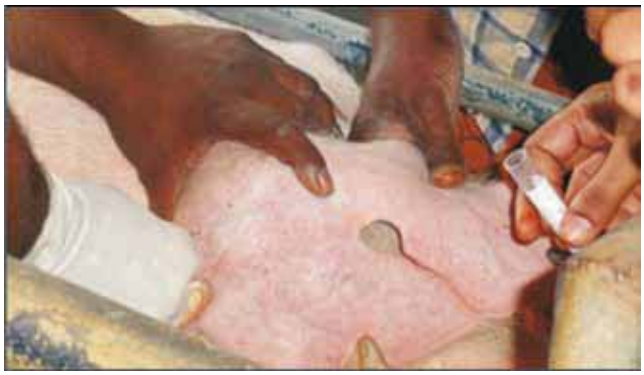


Fig 6. Collection of blood from ear vein of Pig

Fig 7. Collection of Nasal swab from Pig

Fig 8. Visit for serum collection in the Dairy Farm

13.0

Reports and Recommendations

13.1 Proceedings/Recommendations of the 9th Meeting of the IMC held at PDFMD, Mukteswar on 04.07.2012

The 9th meeting of the Institute Management Committee (IMC) was held on 04.07.2012 in the Committee Room of PDFMD at Mukteswar.

The following members were present and participated in the meeting.

1. Dr. B.Pattnaik, Project Director, PDFMD
2. Dr. Gaya Prasad, ADG (AH), ICAR (could not attend due to last minute engagements)
3. Dr. R. N. Sreenivas Gowda, Former Vice Chancellor, KVU, Bangalore
4. Dr (Ms) Chanda Nimbkar, Director, NARI, Phaltan, Maharashtra
5. Dr. G. K. Singh, Dean, Veterinary College, GBPUAT, Pantnagar.
6. Director, AH, UP (did not attend)
7. Dr. D. Hemadri, Principal Scientist, PD-ADMAS, Bangalore
8. Dr. Sandeep Bhatia, ICAR National Fellow, HSADL, Bhopal
9. Dr. D. Bhattacharya, Senior Scientist, NRC on Yak, Arunachal Pradesh
10. Dr. Bharat Chand, Addl. Director, AH, Nainital, UK
11. Dr. R. Chandra, Joint Director, AH, Nainital, UK
12. Finance & Accounts Officer, IVRI, Izatnagar (did not attend)
13. Mr. A. K. Rai, AO (acted as member secretary), Special Invitees
    1. Dr. A. Sanyal, Principal Scientist, PD-FMD (now on deputation to FAO)
    2. Dr . B.B. Dash, Sr. Scientist, I/C PME, PDFMD
    3. Dr . J. K. Mohapatra, Sr. Scientist, PDFMD
    4. Shri Raja Ram, AF&AO, PDFMD

Dr. B. Pattnaik, Project Director, PDFMD welcomed the hon'ble members to the meeting of the IMC.

ITEM NO	AGENDA/RECOMMENDATION OF THE IMC	COMMENTS OF THE MEMBERS	COMMENTS OF THE DIRECTOR
1	**Approval of the proceedings of the 8th Meeting of the Institute Management Committee of the Project Directorate on FMD** Proceedings of 8th IMC were discussed at length and ATR was presented by the Project Director. It was observed that appropriate action is being taken / initiated on all the recommendations of 8th IMC.	It was noted by all the members and they were satisfied with the action taken, and it was observed by the members that the matter of an additional post of Principal Scientist (Vet Microbiology) to function as Biosafety Officer for the IC-FMD may be taken up again in the EFC of XII Plan. The members agreed that under the circumstances, suitable rented accommodation for the camp office of the IC-FMD at Bhubaneswar may be selected through local newspaper advertisement, and necessary administrative approval may be obtained from the Council.	The matter of PS (Vet Microbiology) and T-6 (MA/ MBBS) will be taken up at the EFC stage. As the PS post was already approved in the XI Plan, the Council is requested to provide a vacant post of PS to be filled up by ASRB.
2	**Presentations on research accomplishments of the Institute** Dr. Saravanan Subramaniam, scientist presented about the serotype O FMD virus scenario in the country, and informed that a new genetic lineage with >8% divergence in the nucleotide sequence has appeared in some states of south India since Septemeber 2011. Dr. Gaurav K Sharma presented before the hon'ble members about the new user friendly software developed for ELISA interpretations and diagnosis with specific use in seromonitoring of FMD control programme. Dr. Sharma also presented about the new lyophilized mPCR ready to use kit for virus diagnosis that has been validated for thermostability during transport by post, intended for use in field diagnostic laboratories. The kit contains lyophilized master mix, and only template and water to be added before PCR amplification. This kit has increased the rate of diagnosis to > 90%. Dr. Rajeev Ranjan, Scientist presented about the new LAMP kit for FMD diagnosis on difficult clinical materials and bovine semen. The LAMP-FMD kit is developed to meet future requirement in monitoring DFZs. This kit is being converted to lyophilized form to improve thermostability. Dr. Jitendra K Biswal, Scientist apprised the members about the progress made towards designing an infectious cDNA clone of serotype O vaccine strain. This replicating/ infectious clone is being made for use as alternate source of virus population with sequence homogeneity, and also to modify/ replace certain amino acid residues in the virus structure with the aim/ hope to circumvent thermolability of the virus.	Hon'ble members appreciated the sincerity and devotion of very young scientists for preparedness to meet future requirements and demands in the field of FMD surveillance and diagnosis. The members expressed their satisfaction on the progress made by the institute in real-time monitoring of the disease and the virus in the country that is required to implement and assess the control programme. The members agreed that 'new generation sequencing chemistry' (third generation nucleic acid sequencer) is required to resolve sequence diversity to understand and monitor micro-evolution of FMDV genome, as continuing mutation of the virus/ viral genome is a major challenge to control strategies.	Cutting edge laboratory equipments will enhance the output of the young scientists in FMD virology and epidemiology, and will help in unraveling virus evolution and ecology of FMD in the country.

ITEM NO	AGENDA/RECOMMENDATION OF THE IMC	COMMENTS OF THE MEMBERS	COMMENTS OF THE DIRECTOR
	Dr. J. K. Mohapatra, Senior Scientist presented the progress and achievements of the institute during the period 2011-12. He presented a comprehensive view of epidemiology of FMD in the country during the year. Continuous evolution in FMD viral genome was highlighted, and effectiveness of in-use vaccine (virus) strains was presented. He emphasized that 'new generation sequencing chemistry' (third generation nucleic acid sequencer) is required to resolve sequence diversity to understand and monitor micro-evolution of FMDV genome, as continuing mutation of the virus/ viral genome is a major challenge to control strategies. He also presented the latest sero-monitoring results of districts under FMD control programme. He also presented the diagnostics and diagnostic capabilities that are being provided to the SAARC countries. Dr. Mohapatra also appraised the members about the recombinant human adenovirus constructs carrying FMD virus genome that has been developed under collaboration with PIADC-USDA that will be evaluated at IVRI Bangalore as an alternate vaccine. He further informed that such vaccine is essential for emergency vaccination in DFZs, if required, and is DIVA compliant. Dr. Pattnaik observed that increase in number of outbreaks during 2011-12, compared to the previous year, is due to delay in vaccination in FMDCP areas causing decay in herd immunity, and infection immunity in some other areas in the country.		
3	**Discussion on the ATR of the 4th QRT recommendations** Action taken report on all the recommendations was presented by the Project Director.	Hon'ble members expressed their satisfaction on the actions taken.	Noted
4	**Review of Budget and expenditure of XI Plan** The IMC reviewed the budget utilization in the 11th Plan period till 2011-12 and found it optimum.	Budget utilization is appropriate.	Budget utilization is as per annual allocation(s).
5	**Budget allocation for the financial year 2012-13** It was presented by the Project Director.	The IMC emphasized timely utilization of budget allocation, and early establishment of IC-FMD.	Progress on establishment of IC-FMD is good.
6	**Establish ment of International Center for FMD (IC-FMD)** Progress made on this front was presented by the Project Director.	The members expressed their satisfaction, but emphasized on early completion of the IC-FMD project.	Noted and agreed. The project is being pursued so that it is completed by December 2014, and commissioned and internationally validated/ accreditated by June 2015.

ITEM NO	AGENDA/RECOMMENDATION OF THE IMC	COMMENTS OF THE MEMBERS	COMMENTS OF THE DIRECTOR
7	**Hiring of accommodation for camp office for International Center for FMD (IC-FMD) at Bhubaneswar** Revised EFC of XI Plan has been approved for establishment of International Centre for FMD at Bhubaneswar, Odisha. MOU has been signed with NDDB to establish the BSL 3+ laboratory at Bhubaneswar. Necessary funds have been deposited with the NDDB. The boundary wall has been constructed at the site of the IC-FMD, Bhubaneswar by CPWD. NDDB has completed the land survey and contour mapping of the site. NDDB has to start the construction work very soon. In view of this certain essential services are required to be provided by the PDFMD. It was proposed in earlier meetings of the IMC to hire a suitable camp office at Bhubaneswar for pursuing laboratory construction and related work. It was suggested to look for space in the sister institutes at Bhubaneswar. As there is requirement of about 8-12 rooms for office, both for NDDB engineers and PDFMD, no sister institute has space to accommodate the requirement. Therefore, a suitable accommodation has to be selected by advertisement in local news paper(s) at Bhubaneswar.	Hon'ble members agreed to the requirement.	The Council is requested to accord approval to select and rent accommodation of requirement at Bhubaneswar for the camp office of IC-FMD. It will be shared by both NDDB and PDFMD.
8	**Requirement of additional post of Principal Scientist in the discipline of Veterinary Microbiology** An additional post of Principal scientist in the discipline of veterinary microbiology is required to look after the Bio-safety and Bio- security aspect of International centre of FMD at Bhubneswar. Construction of Boundary wall around the site is to be completed soon. Revised EFC to facilitate early initiation of construction of BSL3+ laboratory has been approved and the construction is to start soon. As it is a specialized containment laboratory facility, a Principal scientist in discipline of veterinary microbiology is required to look after bio safety and bio security (a full time work) aspect of the facility since beginning of construction.	The hon'ble members agreed to the requirement	The post is already approved by XI Plan EFC to be filled on re-deployment basis. Till now a suitable redeployment has not been possible due to shortage in the number of such scientist in the system. It is requested that a post of Principal Scientist is provided and filled up through direct selection by ASRB.
9	**Purchase of essential laboratory equipments during 2012-13** The following laboratory equipments were proposed (along with justifications) to be procured during the financial year 2012-13. All these equipments are included in the EFC for XII Plan. 1. New generation nucleic acid sequencer (complete work flow): 120=00 Lac 2. Off-gel iso-electric focusing apparatus with fractionators: 20=00 lac 3. Nano-sight : 35=00 lac 4. Automated microplate washer (2): 20=00 lac	The hon'ble members agreed to the requirement of cutting edge laboratory equipments like 'new generation' nucleic acid sequencer etc.	An amount of Rs.222.00 lakh is available during 2012-13 for procurement of essential laboratory equipments. Additional amount of Rs. 54 .00 Lakh will be required during the current financial year at RE stage. It is

ITEM NO	AGENDA/RECOMMENDATION OF THE IMC	COMMENTS OF THE MEMBERS	COMMENTS OF THE DIRECTOR
	5. In-situ thermal cycler: 8=00 lac 6. Refrigerated circulating water bath: 12=00 lac 7. Micro-spectrophotometer: 7=00 lac 8. Ice flaking machine: 4=00 lac 9. Interactive web site for AICRP-FMD : 50=00 lac		requested that approval may be accorded so that tender procedure can be initiated for timely procurement. For the first 2 items (New generation nucleic acid sequencer and Off-gel iso-electric focusing apparatus with fractionators), Expression of Interest has been completed and specifications have been drawn for tendering. Urgent requirement of a New Gen Sequencer (3rd Gen) has been explained earlier in the proceeding. The last item, interactive web site, was processed during the XI Plan (approved item under equipments) and the job was placed with ERNET, and 42 lac is already remitted against demand from ERNET.
10	*Works during 2012-13* An amount of Rs.10223.00 Lakh is available during 2012-13 under the head Works for IC-FMD at Bhubaneshwar, International Guest House of ICAR at Mukteswar and Repair and maintenance of AICRP Centers at **NEH** Region.	The members emphasized for timely utilization of the budget under the head works.	Noted and action is being taken.
11	**Opening of 09 new FMD network units –Meghalaya, Sikkim, Chhattisgarh, Jharkhand, Goa, A&N Islands, Lakshadweep, Uttarakhand and Srinagar** It is proposed to include the entire country in AICRP on FMD for comprehensive epidemiology.	The members agreed to the proposed expansion of the FMD epidemiology network of AICRP-FMD.	Necessary provision is being included in the XII Plan EFC.
12	**New FMD Network Units in related sister institutes of ICAR** The following sister institutes are proposed to be included for strengthening surveillance of FMD in small ruminants including migratory ones. • CADRAD, IVRI, Izatnagar • CSWRI, Garsa, Himachal Pradesh • CIRG, Makdoom	The members emphasized that FMD surveillance in sheep and goat is essential for comprehensive control of the disease. The members suggested to include also NRC on Yak to undertake FMD surveillance in migratory Yak.	Necessary provision is being included in the XII Plan EFC.

ITEM NO	AGENDA/RECOMMENDATION OF THE IMC	COMMENTS OF THE MEMBERS	COMMENTS OF THE DIRECTOR
13	**Establishment of ICAR International Guest House at Mukteswar** It is required to have a state-of-the-art guest house during XII Plan at Mukteswar to meet the demand of the Campus that has three ICAR institutes. Current guest house facility at Mukteswar is very limited. Sometimes it is very difficult to accommodate many delegates at a particular point of time during meetings/seminar/training etc. In addition PDFMD, being the SAARC Regional Leading Diagnostic laboratory (RLDL) is organizing training for international participants at regular intervals. Having a guest house of such kind will help in smooth conducting of such meetings/seminar/training etc. Further, it would add to the infrastructure of ICAR at Mukteswar. Necessary ground work has been completed by CPWD and design lay out has been drawn. The building will be maintenance free for 20 years both outside and inside. Design specifications were presented before the IMC.	The Hon'ble members approved the requirement with certain modifications in design and classification.	Necessary action is being taken to incorporate the suggestions of hon'ble members, and necessary provision is being reflected in the XII Plan EFC.
14	**Provision of Multi-utility Vehicle (MUV) at existing Regional centers/ Network units and new network units** Due to absence of vehicle at the network units, it becomes difficult for the scientists to attend outbreaks in time, and also for FMD surveillance in different districts. One vehicle (MUV) each for all the 32 (23 existing regional centers/network units and 09 new network units) centers of AICRP on FMD and 01 for central FMD laboratory is required to be provided during XII Plan. **Replacement:** Regional Centers Hisar, Hyderabad, Bangalore, Mathura, Ranipet and Kolkata (06) **New Vehicle:** 25 (15 existing network units and 09 new network units) and 01 for Central FMD laboratory of AICRP on FMD. Necessary provision is being reflected in the EFC of XII Plan.	The Hon'ble members approved the requirement.	Necessary provision is being reflected in the EFC of XII Plan.
15	**Renovation of laboratory building to include minimum biosafety requirements at 08 Regional Centers, 15 network units and Central FMD laboratory** As Incidence of FMD is gradually decreasing in the country, it has become essential to have minimum biosafety provisions for safe manipulation of FMD virus during the XII Plan period, as per international requirement. The amount will be required as below: • For 08 Regional Centers @ Rs. 200 lakh = Rs. 1600.00 lakh • For 15 Network Unit @ Rs. 50 lakh = Rs. 1500.00 Lakh	The Hon'ble members approved the requirement.	Necessary provision is being reflected in the EFC of XII Plan.

ITEM NO	AGENDA/RECOMMENDATION OF THE IMC	COMMENTS OF THE MEMBERS	COMMENTS OF THE DIRECTOR
	• The Central FMD laboratory at Mukteswar is housed in a 50 years old building. Repair/renovation including the roof is required to meet GLP requirement. An amount of Rs. 200 lakh will be required for this purpose, Necessary provision is being reflected in the EFC of XII Plan.		
16	**Any other item deemed fit to discuss** 1. Upgradation of Network unit, Ahmedabad to Regional Center. As FMD control programme has been expanded to cover entire Gujarat, and is a major state in milk production, and competent scientific manpower is available there, it is required to upgrade the network unit to Regional Center during XII Plan period.	The Hon'ble members approved the requirement.	It is required to strengthen the Ahmedabad Network Unit to function as Regional Center. Further, the state has international boundary and is an important milk producing state in the West. Necessary provision is being included in the XII Plan EFC.

13.2 Proceedings of the 4th meeting of the Research Advisory Committee (RAC) of PDFMD held at Mukteshwar on 6-9- 2012

The fourth meeting of the RAC of PDFMD was held at PDFMD, Mukteshwar on 6th September, 2012. In this RAC the following members were present.

1. Dr. S.K. Garg, Chairman RAC & former Vice Chancellor, DUVASU, Mathura.
2. Dr. Lal Krishna, Member RAC & former AHC, Govt. of India & ADG (AH), ICAR.
3. Dr. V.A. Srinivasan, Member RAC & Advisory, NDDB, Hyderabad.
4. Dr. Nem Singh, Member RAC & Former Director, IVRI Izatnagar.
5. Dr. Arvind Kumar, Member RAC & Professor, Dept of Microbiology, LLRVASU, Hisar.
6. Dr. B. Pattnaik, Project Directorate on PDFMD, Mukteshwar
7. Dr. A Sanyal, Member Secretary RAC, PDFMD, Mukteswar
8. Dr. B.B. Dash, Senior Scientist, PDFMD, Mukteswar
9. Dr. J.K. Mohapatra, Senior Scientist, PDFMD, Mukteswar
10. Dr. Saravanan S., Scientist, PDFMD, Mukteswar
11. Dr. G.K. Sharma, Scientist, PDFMD, Mukteswar
12. Dr. M. Rout, Scientist, PDFMD, Mukteswar
13. Dr. J.K. Biswal, Scientist, PDFMD, Mukteswar
14. Dr. K. Muniswamy, Scientist, PDFMD, Mukteswar
15. Dr A.K. Sharma, Invitee, Head, Division of TAH, IVRI, Mukteshwar

Dr. B. Pattnaik welcomed all the dignitaries, followed by the condolence for the sad demise of Late Prof. KCP Singh, member, RAC of PDFMD, The ICAR Sangeet was played before the onset of the deliberations.

The scientist of PDFMD presented the ongoing research activities before the committee as follows:

1. "Development and application of LAMP (Loop mediated Isothermal Amplification)", was presented by Dr. R. Ranjan. Dr. Srinivasan suggested to conduct a spiking experiment based on qPCR. He also suggested to explore use of battery operated water bath in consultation with industry for field use. Dr. Lal Krishna suggested

for intensification of internal validation with all the AICRP centres. The members appreciated the work as a tool for Penside diagnosis. Dr. Lal Krishna suggested for further work on FMD virus serotyping using LAMP assay.

2. Dr, J.K Mohapatra presented the progress on ICAR-USDA collaborative project on non-replicating Human adeno virus 5-vectored FMDV Chimera vaccine. He opined to use vaccine delivery through intranasal route so that the vaccine can be used as an emergency vaccine. Further work need to be done for quantification of the recombinant virus in HEK-293 cells to determine the optimum PD_{50} of the vaccine antigen as suggested by Dr. Srinivasan.
3. Dr. Saravanan S. presented the findings of the emergence of new genetic lineage of serotype O FMD virus in India. He demonstrated the emergence of a new genetic lineage of Serotype 'O' virus with more than 11% divergence from all other prevalent lineage (Ind2001, Pan Asia etc.), named as 'Ind 2011', first appeared in Tamilnadu during September 2011, which had travelled to other southern states of Andhra Pradesh, Karnataka and Kerala by January 2012. However 'Ind 2011' lineage of serotype O virus was found to have optimum antigenic relationship with the in-use vaccine strain of serotype O, Dr. Srinivasan suggested to monitor the prevalence of 'Ind 2011' lineage serotype O virus in small ruminants in these states.
4. Dr. G.K. Sharma presented the standardization of ready-to-use multiplex PCR (mPCR) for FMD diagnosis. He emphasised that with this reagent, diagnosis of serotype of FMD virus in difficult sample will be possible at the level of AICRP on FMD laboratories across the country.

   B. Pattnaik supplemented that in the state / region, where there is reduction of FMD outbreaks, more sensitive tests are required and this technique will be useful at AICRP laboratories to screen the Typing ELISA negative samples, to avoid false negative results.

   Dr. Srinivasan suggested for collaboration with the industry and to use a portable battery operated PCR machine with digital camera, to make this test a useful pen side diagnostic tool.
5. Use of a software for analysis and interpretation of ELISA data for the diagnosis of FMD was presented by Dr. G.K. Sharma. The use of software will save time and will avoid manual errors and the result can be transferred from the ELISA readers of the AICRP centres to the central lab of PDFMD Mukteshwar, instantly.

   All the members of RAC appreciated the approach and Dr. Arvind Kumar suggested for the application of copyrights of this work.
6. Dr. G.K. Sharma also presented the technique of high throughput assay for quantitative estimation of protective antibody titre against FMD virus in serum. This technique, where single dilution of serum samples is used for testing in LPB ELISA for estimation of antibody titre against three serotypes of FMD virus, will save time and reagents to make this test more cost effective.

   In respect to this study, Dr. Srinivasan suggested for collaboration with vaccine manufactures, which perform the challenge study, serum neutralization test and determines the PD_{50} of each batch of vaccine to correlate the serum antibody titre and protection in animals, in relation to PD50 of the vaccine. The members of RAC complimented the work.
7. Dr. J.K. Biswal presented the findings of the ongoing project on "Generation of infectious FMD virus serotype 'O' from cloned cDNA using RNA polymerase I". This study, based on reverse genetics aimed to develop FMD virus serotype 'O' vaccine strain INDR2/75, for possible use as candidate thermostable vaccine in future. The members of RAC suggested that PDFMD should undertake research on improvement of the FMD vaccine in terms of thermostablity and longer duration of immunity.
8. Dr. A.K. Sharma of IVRI, Mukteshwar presented the findings of a collaborative study on the influence of genetic and non genetic factors on immune response to FMD vaccine in cross bred cattle, in an organised herd. He demonstrated low heritability of immune response to FMD vaccine but significant influence was observed for the non-genetic factors like stress, milking, repeat breeding etc. on the immune response against FMD vaccine.

Dr. Lal Krishna suggested to undertake studies in the face of FMD outbreak (where some animals exhibit clinical symptoms and some remains apparently healthy) to find out the involvement of specific alleles so that allele mining can be used in animals under FMD-Control Programme. It was also suggested by the members of RAC for further expansion and continuation of the study.

9. Dr. J.K. Mohapatra presented the scenario of FMD in India during 2010-12. Dr. Srinivasan suggested to undertake detail epidemiological studies on Asia1 FMD virus and to find out the focal points and ecology so that vaccination against Asia1 serotype could be intensified to check further spread of the serotype.
10. Dr. A.Sanyal presented the FAO, RLDL activities and production of Bovine Vaccinate Serum (BVS) at IC-FMD site, Bhubaneswar using as activated antigen for vaccine matching exercise and preparation of diagnostic kits.
11. Dr. B.B. Dash presented the observations of National FMD sero-surveillance and seromonitoring and FMD-CP and the function and performance of AICRP on FMD constituents during 2010-12. All the members of RAC suggested for their participation in the annual review meeting of AICRP on FMD to know the achievements and difficulties of each AICRP component.
12. Dr. B. Pattnaik presented the ATR on the recommendation of the third RAC meeting, research priorities for XII Plan, and the progress on the establishment of International centre for FMD at Bhubaneswar.

Agenda Items	Recommendation of RAC	Comments of the Director
1	All the 19 research projects enlisted for 2012-13 were approved by RAC	All projects have been initiated.
2	The LAMP assay to be used for diagnosis of FMD in all the AICRP Centres and Network Units, for internal validation	Internal validation has already been initiated.
3	PDFMD should undertake new generation vaccine research for the development of FMD vaccine with thermostablity and longer duration of immunity.	One research program through reverse genetics has already been initiated.
4	The PDFMD-IVRI collaborative research project on influence of genetic and non-genetic factors for FMD vaccine immune response needs to be continued with further expansion.	A collaborative research program with the Division of TAH, IVRI, Mukteswar is being formulated for continuance and expansion of the investigation.
5	Facility has to be created immediately at International Center for FMD, Bhubaneswar for production of Bovine Vaccinated Serum (BVS) for use in vaccine matching exercise and production of diagnostic kits.	This will be initiated after a temporary cattle shed for 20-30 cattle is constructed.
6	New AICRP on FMD network units need to be opened at Goa, Sikkim, Uttarakhand, Jharkhand, Chhattisgarh, Meghalaya, NRC on Yak in Arunachal Pradesh and CARI Port-Blair for better FMD surveillance in their States and Union Territories.	The expansion of the FMD network is being included in the EFC of 12th Plan.
7	New Generation DNA sequencing technology has to be applied for better understanding of virus evolution.	A third generation sequencing platform will be procured during 12th Plan for deep sequencing. Till that time, we will outsource new generation sequencing data for understanding of virus evolution currently occurring in the field.
8	Liquid handling system should be used for high throughput in all the AICRP Network centres.	Necessary systems will be provided during 12th Plan period; after EFC is approved.

Agenda Items	Recommendation of RAC	Comments of the Director
9	Research on pre-clinical diagnosis FMD need to be initiated.	A study using mice model is undergoing.
10	The program on establishment of International Center for FMD at Bhubaneswar has to be further accelerated to make it operational in the scheduled time period.	The project is being pursued continuously. International bio-safety consultant and primary engineering consultant have already been appointed by NDDB. It is expected that the master plan will be finalized soon for initiation of construction work.

13.3 Recommendations of the 23rd Annual Review Meeting

Proceedings of Review of FMD Control Programme

The review of FMD control Programme was conducted on 14th Sep. 2012 at DUVASU, Mathura under the chairmanship of Sri G.C. Pati, Secretary, DADF, Govt of India and the followings were present.

Prof. K.M.L Pathak, DDG (AS), ICAR,

Dr. AS Nanda, Animal Husbandry Commissioner, DADF, Govt of India,

Sri RS Rana, Joint secretary, DADF, Govt. of India,

Dr. B. Pattnaik, Project Director, PDFMD, Mukteshwar,

DR. R. venkataramanan, Joint Director, IVRI, Bengaluru,

Mr. Yadav, Animal Husbandry Commissioner, Govt of Tamilnadu,

Dr. R.G. Bambal, Assist Commissioner (LH) DADF, Govt of India,

Directors of State Animal Husbandry departments of Kerala, Karnataka, Rajasthan, Puducherry, Uttar Pradesh and

The Project Director, PDFMD, Mukteswar presented a comprehensive report on sero-monitoring under FMD Control Programme in the country. The salient features were as follows:

1. During the first round of FMD control programme launched during 2003-04 by Govt. of India, 54 districts were covered which has been extended to 221 districts during 2011-12, covering the entire Southern region, Maharashtra, Gujarat, Haryana and Punjab, targeting a population of around 120 million cattle and buffaloes.
2. Till Dec. 2011, 12th phases of vaccination against FMD have been carried out in 54 districts and these districts have attained the stage III and expended 167 districts are on stage II of Progressive Control Pathway (PCP), for control of FMD.
3. The sero-monitoring indicated the overall increased trend in percentage of protected animals during pre and post vaccination period over the phases of vaccination.
4. The number of outbreaks in FMD-CP districts (54) has been reduced from 247 during first phase of vaccination to 50 by 12th phase of vaccination.
5. A total of 145105 serum samples (Pre-70625 and Post-74480) were tested from 54 districts from phase I to XII. A total of 24540 serum samples (Pre-13383 and Post-11157) have been tested for phase I and II under FMDCP extended programme (167 districts).
6. The overall effect of vaccination has resulted in the decline of disease occurrence in the vaccinated areas along with decrease in number of DIVA positive animals due to progressive increase in herd immunity.
7. Delay in vaccination, sometimes, has resulted in the decline of herd immunity leading to the recurrence of the disease at places, so uniformity in timing and density of vaccination is required for better results.
8. At the current antigen payload of 3PD50 / animal, the protective antibody level tends to decline after 4th month of vaccination. The use of higher antigen payload per dose of vaccine (6 to 8 PD_{50} / animal) is required to maintain the required antibody level up to 6 month post vaccination.

9. The collection of serum samples by the State AH departments does not comply the sampling frame which needs monitoring.
10. Change or transfer of trained scientist(s) by some state AH departments has affected the output of AICRP regional centres and Network units which will be taken care of with the signature of Umbrella MoU between ICAR and host institutions.
11. It is necessary for the formation of FMD Control Authority/ Commission on the line of EU-FMD and PANAFTOSA for monitoring of the control programme in entirety including FMD vaccine quality assurance, timely delivery of adequate doses of vaccine, serum sampling and testing.
12. Strengthening of serum testing centres in terms of cold storage place, laboratory equipments / instruments/ liquid handling system and contractual men power to handle about 1.8 lackhs serum samples/ annum is necessary.
13. Appropriate funding is required for undertaking investigations on FMD virus ecology in FMD-CP vaccinated areas to understand the dynamics of virus circulation and reservoirs and to estimate the economic impact of vaccination from time to time.

Proceedings Annual Review Meeting of AICRP and PD on FMD

The 23rd Annual review Meeting (ARM) of AICRP on FMD was held on 14-15 Sep 2012 at DUVASU, Mathura under the chairmanship of Prof. (Dr.) KML Pathak, DDG (Animal Science) ICAR participated by the followings.

Dr. Gaya Prasad ADG (AH) ICAR,

Dr. A.P Singh VC, DUVASU,

Sri R.S Rana Joint Secretary, DADF Govt. of India,

Dr. B. Pattnaik Project Director, PDFMD Mukteshwar,

Dr. Garg, Dean, Veterinary College, DUVASU Mathura,

Dr. R. Venkataramanan, Joint Director (IVRI), Bengaluru,

Dr. R.G. Bambal, Assist Commissioner (LH) DADF, Govt. of India,

Mr. Yadav, Animal Husbandry Commissioner Govt of Tamilnadu,

Directors of State Animal Husbandry departments of Kerala, Karnataka, Rajasthan, Puducherry and Uttar Pradesh

Principle Investigators and Co- PIs of AICRP on FMD Regional centres and Network Units of Hisar, Bengaluru, Mathura, Pune, Lucknow, Ranipet, Kolkata, Guwahati, Ahmedabad Jalandhar, Imphal, Cuttack, Bhopal, Jaipur, Jammu, Aizwal, Itanagar, Thiruvananthapuram, Patna and Shimla, Scientist of PDFMD, Mukteshwar and CARI Port-Blair .

The PIs and Co-PIs of AICRP regional centre of Hyderabad and AICRP network units of Agartala and Kohima did not participate in the review Meeting.

Prof. Gaya Prasad, ADG (AH), ICAR, in his welcome address stated that the meeting is aimed to review the progress and achievements made by the AICRP regional centres and network units, as well as of PDFMD Mukteshwar during 2011-12 and to develop road map to further strengthen epidemiological investigation for control of FMD in the country. The difficulties and gaps in this process have to be identified and discussed to find out solution to address them. He invited suggestions from the stake holders and participants for further strengthening of the process. He also emphasised importance of quality vaccine for success of the FMD Control Programme. He suggested to investigate the source and movement of serotypes A and Asia 1 FMD Virus in certain ecological areas of the country.

Prof. KML Pathak DDG (AS) ICAR, in his presidential address emphasised the economic importance of FMD and its threat to global and regional food security. He emphasised the role small ruminants, pigs and wild animals in the spread of FMD and suggested that these animals/ species be included in the FMD control program during 12th Plan. He emphasised that availability of adequate quantity of vaccine of optimum quality is important for the success of the control program. Research need to be initiated on development of FMD vaccine with better thermostablity and duration of immunity. Diagnosis of FMD before onset of clinical symptoms in animals is another researchable issue so that the affected animals can be segregated to check the

spread of infection. He suggested the extension of the FMD epidemiological network of the AICRP to cover the entire country. He emphasised the role of India in control of FMD in the SAARC countries in relation to supply of quality diagnostics, vaccines, and development of human resources specialised in FMD. He suggested for strengthening of the disease reporting system in the country, and studies on FMD virus ecology to understand the persistence of certain serotypes of the virus in certain pockets.

The Action Taken Report (ATR) of the recommendations drawn during 22nd ARM held at Thiruvananthapuram was presented by the Project Director and discussed in detail. During the deliberations following suggestions were made.

- Vaccination of all the cattle and buffalo population against FMD using trivalent vaccine, twice a year preferably during March- April and Aug-Sep keeping in view of the occurrence of the disease. (Action: DADF, ICAR)
- Since the prevalence of serotype O virus is maximum in the country causing >80% of outbreaks, suitability of serotype O monovelant vaccine can be tested/ experimented in selected pockets/ areas to reduce circulation of serotype O virus. Data generated will be valuable for taking further decisions. (Action: DADF, PDFMD)
- Surveillance of FMD in Zoo animals is important to control and eradicate FMD in the country. Work should be initiated to survey the status of FMD in captive and domesticated elephants, and other captive animals in Tamilnadu and Kerala. (Director, AH of the states of Tamilnadu and Kerala, AICRP-FMD Regional Centre, Ranipet and FMD Network Unit, Thiruvananthapuram)
- All the PIs/ Co PIs were advised to attend the FMD outbreaks in person in their respective states for active surveillance of the disease. (Action: All AICRP-FMD Regional Centres and Network Units)
- It was felt necessary to continue the study on economic loss being incurred from time to time due to FMD outbreaks. (Action: PDFMD, PDADMAS)
- The formation of National FMD Control Commission is needed to comprehensively monitor of the control program including quality assurance of the vaccine, its proper transport and administration. (Action: DADF, ICAR)
- In order to expand the FMD epidemiological network in the entire country it was suggested to open new AICRP on FMD network units in the states of Goa, Sikkim, Uttarakhand, Jharkhand, Chhattisgarh, Andaman and Nicobar Islands, Meghalaya and Lakshadweep. FMD network unit(s) may be opened in NRC on Yak, Dirrang, in Arunachal Pradesh, CSWRI Regional Centre, Garsa, HP and CARI, Port-Blair. as these places are important in epidemiology of the disease. (Action: PDFMD/Directors, CSWRI/NRC Yak/ CARI)
- The functioning of AICRP on FMD network unit at Lucknow need to be strengthened with permanent posting of PI by the state AH department, and regular meeting need to be conducted between the Director, Dept. of AH, Govt. of Uttar Pradesh, ADG(AH), ICAR and Project Director, PDFMD at six months interval in order to monitor its functioning. (Action: Director, AH, UP/ADG(AH)/ PDFMD)

Presentations were made by the scientists of PDFMD, In-charges of 7 regional centres, 13 network units and the scientist of CARI Port-Blair on the status of FMD and progress made on sero-surveillance and monitoring of FMD in their respective states. The session was chaired by Prof. Gaya Prasad, ADG (AH), and co-chaired by Dr. R. Venkataramanan JD, IVRI, Bangalore.

There was a detailed discussion to finalise the requirements during the XII plan period for the AICRP centres and network units under the chairmanship of Dr. C. Renuka Prasad, Director IAH&VB, KVAFSU, Bangaluru and Dr. R. Sharma, PI, Hisar Centre, co-chaired.

The regional centres and network units of AICRP on FMD were evaluated for their performance under the chairmanship of Prof. Gaya Prasad ADG (AH) ICAR, amongst them the regional centres of Hisar, Bengaluru and the network unit of Ahmedabad where adjudged as 1st, 2nd and 3rd, respectively.

The chairman complimented the performance of the AICRP and PD on FMD in investigating and understanding detailed studies on epidemiology of FMD in the country from time to time and in assessing the impact of FMD vaccination in control

of the disease. After detailed discussions under the chairmanship of Prof Gaya Prasad, ADG (AH), and co-chaired by Dr. R. Venkataramanan JD, IVRI, Bangalore in the presence of Dr. B Pattnaik and other special invitees the following recommendations were made.

Recommendations of the 23rd Annual Review Meeting

1. Disease reporting system need to be strengthened for prompt reporting occurrence of FMD in the country. (Action: DADF/ State AH Depts./ AICRP Centres and Network Units)
2. A pilot study has to be initiated to assess the effect of monovelant vaccine with higher payload (6-8 PD_{50} / animal) against serotype O virus in certain areas / pockets, where in serotype O is pre-dominant. (Action: DADF/ State AH / PDFMD/ FMD vaccine industry)
3. Research project to assess the economic losses due to FMD outbreaks in the country has to be continued with collaboration with AD-ADMAS. (Action: PDFMD/ PDADMAS)
4. Investigations on FMD virus ecology in FMD-CP areas to understand the extent of virus circulation and reservoirs to be initiated. (Action: PDFMD)
5. Research on new generation FMD vaccine to be initiated to improve the vaccine quality in terms of thermo- stability and long term immunity. (Action: PDFMD/ IVRI)
6. Newer technologies like deep sequencing technology to be adopted for understanding and monitoring FMD virus evolution. (Action: PDFMD, AICRP regional centres)
7. Studies on the role of genetic and non-genetic factors that influence FMD immune response in cross bred and indigenous cattle and buffaloes to be taken up to understand the factors and genetic markers that augment better immune response. (Action: TAH, IVRI, Mukteshwar / PDFMD)
8. Logistics support for FMD diagnosis, surveillance and control need to be extended to the SARRC member countries, to make the country least vulnerable to FMD virus infection across the trans-boundary areas. (Action: PDFMD/ ECTAD, FAO, Kathmandu)
9. Emphases may be put to create FMD free zones with vaccination in Andhra Pradesh, Haryana, Punjab, Himachal Pradesh and Delhi as the incidence of FMD in these states has become sporadic due to impact of regular vaccination under FMDCP/ASCAD. (Action: DADF/ State AH Depts. / PDFMD)
10. Rajasthan, Himachal Pradesh and Madhya Pradesh may be covered under FMD-CP for effective control of FMD in Central, western and Northern regions of the country. (Action: DADF)
11. FMD surveillance programme in Chandigarh has to be taken up by the Jalandhar network unit of the AICRP. (Action: Director, AH, Punjab/ PDFMD/ AICRP Network Unit, Jalandhar)
12. The results of testing 400 of serum samples (cattle and buffalo) per district per phase of vaccination in FMD-CP/ ASCAD areas, and 100 serum samples (cattle and buffalo) per year per district under National FMD sero surveillance programme to be complied by each of the AICRP regional centre(s) and network unit(s) in their respective states. (Action: PDFMD/ Regional Centres and Network units of AICRP on FMD)
13. It will be mandatory for each AICRP regional centre(s) and network unit(s) to present their annual progress/ activities and achievements for review in the annual review meeting(s), for further continuation of the project and release of necessary funds. (Action: PDFMD/ Director, State AH Departments/ Regional Centres and Network units of AICRP on FMD)
14. The FMD vaccinated animals to be identified with ear tags and to be issued with a health card for proper monitoring of FMD vaccination and surveillance. (Action: DADF/ State AH Depts.)
15. Cattle and buffalo population need to be vaccinated against FMD using trivalent vaccine twice every year, preferably during March-April and Aug-Sep keeping in view occurrence of the disease. (Action: DADF/ State AH Depts.)
16. Formation of FMD Control Authority/ Commission to be initiated for monitoring of the FMD control programme in entirety including FMD vaccine quality assurance, timely supply of adequate doses of vaccine and its administration, serum sampling and testing etc. (Action: DADF/ ICAR)
17. Timely collection of serum samples to be ensured by the State Animal Husbandry departments for monitoring of vaccinal immunity in FMD-CP/ ASCAD Program areas and for National FMD sero-

surveillance Programme. (Action: DADF/ Director, State AH Depts.)

18. Regular training on FMD diagnosis and surveillance for the scientific personnel of AICRP on FMD regional centres and network units has to be conducted by PDFMD to keep them abreast with new knowledge. (Action: PDFMD)
19. The functioning of Lucknow network unit need to be improved with placement of a permanent PI with supporting manpower. Functioning of the network unit has to be reviewed at 6 month intervals by the Director, AH, Govt. of Uttar Pradesh, ADG (AH), ICAR and Project Director, PDFMD. The new officers posted will undergo training at PDFMD. (Action: Director AH, UP/ ADG (AH)/ PDFMD)
20. New AICRP on FMD network units to be opened during XII Plan in the states of Goa, Sikkim, Uttarakhand, Jharkhand, Chhattisgarh, Andaman and Nicobar Islands, Meghalaya and Lakshadweep to cover the entire country under FMD surveillance. Additional network unit(s) at NRC on Yak, Dirang, Arunachal Pradesh, CSWRI Regional Station, Garsa, and CARI Port-Blair is required as these areas have significant importance in epidemiology of FMD. (Action: PDFMD/ Director, State AH departments/ Directors CSWRI, NRC Yak, CARI)
21. It is mandatory for all PIs/ Co PIs of AICRP on FMD regional centres and network units to attend and monitor the FMD outbreaks in person in their respective states. (Action: PDFMD/ Regional centres and Network units of AICRP on FMD)
22. Necessary contractual manpower in the form of Research Associates (RA) and Senior Research fellows (SRF) to be provided to the regional centres and network units under FMD-CP and FMD surveillance. (Action: PDFMD)
23. Infrastructure of all the regional centres and network units to be strengthened during 12th Plan period in terms of cold storage facilities to store serum samples, instruments/ equipments for laboratory diagnosis, provision of BSL-2 facilities and multi utility vehicles for prompt monitoring and timely investigation of FMD outbreaks. (Action: PDFMD)
24. The work on establishment of International Centre on FMD at Bhubaneswar has to be accelerated for early operation. (Action: PDFMD).
25. Disease reporting system need to be strengthened for prompt reporting occurrence of FMD in the country. (Action: DADF/ State AH Depts./ AICRP Centres and Network Units)
26. A pilot study has to be initiated to assess the effect of monovelant vaccine with higher payload (6-8 PD_{50} / animal) against serotype O virus in certain areas / pockets, where in serotype O is pre-dominant. (Action: DADF/ State AH / PDFMD/ FMD vaccine industry)
27. Research project to assess the economic losses due to FMD outbreaks in the country has to be continued with collaboration with AD-ADMAS. (Action: PDFMD/ PDADMAS)
28. Investigations on FMD virus ecology in FMD-CP areas to understand the extent of virus circulation and reservoirs to be initiated. (Action: PDFMD)
29. Research on new generation FMD vaccine to be initiated to improve the vaccine quality in terms of thermo- stability and long term immunity. (Action: PDFMD/ IVRI)
30. Newer technologies like deep sequencing technology to be adopted for understanding and monitoring FMD virus evolution. (Action: PDFMD, AICRP regional centres)
31. Studies on the role of genetic and non-genetic factors that influence FMD immune response in cross bred and indigenous cattle and buffaloes to be taken up to understand the factors and genetic markers that augment better immune response. (Action: TAH, IVRI, Mukteshwar / PDFMD)
32. Logistics support for FMD diagnosis, surveillance and control need to be extended to the SARRC member countries, to make the country least vulnerable to FMD virus infection across the trans-boundary areas. (Action: PDFMD/ ECTAD, FAO, Kathmandu)
33. Emphases may be put to create FMD free zones with vaccination in Andhra Pradesh, Haryana, Punjab, Himachal Pradesh and Delhi as the incidence of FMD in these states has become sporadic due to impact of regular vaccination under FMDCP/ASCAD. (Action: DADF/ State AH Depts. / PDFMD)
34. Rajasthan, Himachal Pradesh and Madhya Pradesh may be covered under FMD-CP for effective control of FMD in Central, western and Northern regions of the country. (Action: DADF)

14.0

Publications/ Abstracts/Presentations in Conferences

Publication in Research Journals

1. Saravanan Subramaniam, Bramhadev Pattnaik, Aniket Sanyal, Jajati K. Mohapatra, Sachin S.Pawar, Gaurav K.Sharma, Biswajit Das and Bana B.Dash (2012). Status of Foot-and-Mouth Disease in India. **Transboundary and Emerging Diseases.** 60(2013), 197-203
2. Sharma GK, Mohapatra JK, Pandey LK, Mahajan S, Mathapati BS, Sanyal A, Pattnaik B (2012). Immunodiagnosis of foot-and-mouth disease using mutated recombinant 3ABC polyprotein in a competitive ELISA. **Journal of Virologial Methods.** 185(1):52-60
3. Das B, Sanyal A, Subramaniam S, Mohapatra JK, Pattnaik B (2012). Field outbreak strains of serotype O foot-and-mouth disease virus from India with a deletion in the immunodominant βG-βH loop of the VP1 protein. **Archives of Virology.** 157(10), 1967-70
4. Sharma, G.K., Subramaniam, S., De,A., Das,B., Dash, B.B., Sanyal, A., Mishra, A.K. and Pattnaik. B (2012). Detection of Foot and Mouth Disease virus in semen of infected cattle bulls. **Indian Journal of Animal Science.** 82 (12): 1472–1476.
5. G. R. Gowane, A. K. Sharma, M. Sankar, K. Narayanan, Biswajit Das, S. Subramaniam and B. Pattnaik (2013). Association of *BoLA DRB3* alleles with variability in immune response among the crossbred cattle vaccinated for foot-and-mouth disease (FMD). **Research in Veterinary Science.** http://dx.doi.org/10.1016/j.rvsc.2013.03.001.
6. G. R. Gowane, A. K. Sharma, M. Sankar, P. Thirumurugan, K. Narayanan, S. Subramaniam and B. Pattnaik (2013). Evaluation of genetic and environmental parameters determining antibody response induced by vaccination against Foot and Mouth Disease. **Agricultural Research.** DOI 10.1007/s40003-013-0063-9.
7. G. R. Gowane, A. K. Sharma, M. Sankar, R. Vandre, P. Thirumurugan, S. Subramaniam and B. Pattnaik (2013). Association of Foot and Mouth Disease (FMD) virus vaccine elicited immune response with productive and reproductive performance in crossbred cattle. **Indian Journal of Animal Science (Accepted).**

Scientific Review

1. Bramhadev Pattnaik, Saravanan Subramaniam, Aniket Sanyal, Jajati K. Mohapatra, Bana B. Dash, Rajeev Ranjan and Manoranjan Rout (2012). Foot-and-mouth Disease: Global Status and Future Road Map for Control and Prevention in India **Agricultural Research** 1(2):132–147

Abstract presented/published in conferences

1. G.K. Sharma, S. Mahajan, P. Bisht, Aniket Sanyal A (2012). **High Throughput Liquid Phase Blocking ELISA for Quantitative Estimation of Antibody Titers against Structural Proteins of Foot-and-Mouth Disease Virus.** Appliance of Science in the Progressive Control of FMD. eufmd. 29-31, October 2012, Spain
2. B. S. Mathapati , A. Sanyal, G. K. Sharma, P. Bisht, L. N. Sarangi, S. Subramaniam (2012) **Antigenic Cartography For Analysis of Antigenic Variations in FMD Virus.** Appliance of Science in the Progressive Control of FMD. eufmd. 29-31,October 2012, Spain
3. S. Mahajan, J.K. Mohapatra, L.K. Pandey, B. Pattnaik (2012) **An Indirect ELISA for Differentiation of FMDV Infected from Vaccinated Animals using Recombinant Non-Structural Protein 2C.** Appliance of Science in the Progressive Control of FMD. eufmd. 29-31,October 2012, Spain

4. P. Bisht, B. Das, G. K. Sharma, J.K. Mohapatra, J. K. Biswal, and B. Pattnaik (2012) **Development of RNA Transfection method for rescue of FMD Virus in susceptible cell.** Appliance of Science in the Progressive Control of FMD. eufmd. 29-31,October 2012, Spain
5. S. Subramaniam, B. Das, J.K. Mohapatra, B.B. Dash, B. Pattnaik (2012) **Emergence of novel genetic lineage of Serotype O Foot-and-Mouth Disease Virus in India.** Appliance of Science in the Progressive Control of FMD. eufmd. 29-31,October 2012, Spain
6. B. S. Mathapati , A. Sanyal, , G. K. Sharma, L. N. Sarangi, B. Das, S. Subramaniam (2012) **Evidence of recombination in structural and non-structural coding regions of Serotype O FMD Virus.** Appliance of Science in the Progressive Control of FMD. eufmd. 29-31,October 2012, Spain
7. G.K. Sharma, S. Mahajan, Amit Kanani, Aniket Sanyal (2012) **Ready-to-use multiplex PCR kit for rapid detection of foot-and-mouth disease virus serotypes in India.** Appliance of Science in the Progressive Control of FMD. eufmd. 29-31,October 2012, Spain
8. M. Rout, M.R. Senapati, J.K. Mohapatra, B.B. Dash, A. Sanyal, B. Pattnaik (2012) **Sero-surveillance of foot and mouth disease in small ruminants of India.** Appliance of Science in the Progressive Control of FMD. eufmd. 29-31,October 2012, Spain
9. S.D. Audarya, A.Sanyal, J.K.Mohapatra, S.Pawar and B. Pattnaik (2012). **Comparison of IL-2 mRNA levels in natural outbreak of Foot-and-Mouth disease and vaccinated cattle.** Immunobiology and Management of Viral Diseases in 21st centuary. VIROCON-2012. 8-10 November.
10. L.N.Sarangi, J.K. Mohapatra, B.B. Dash, S. Subramaniam, A. Sanyal and B Pattnaik (2012) **Selection of amino acid substitution on the capsid of FMD virus serotype O propagated *in vitro* under vaccinal serum antibody pressure.** Immunobiology and Management of Viral Diseases in 21st centuary. VIROCON-2012. 8-10 November.
11. L.K. Pandey, J.K. Mohapatra, B.B. Dash, **A. Sanyal and B. Pattnaik (2012).A single amino acid substitution preceding RGD-motif in the VP1 βG-βH loop confers resistance to antibody-mediate neutralization of serotype A FMD virus infectivity *in vitro.*** Immunobiology and Management of Viral Diseases in 21st centuary. VIROCON-2012. 8-10 November.
12. G.R. Gowane, A.K. Sharma, M. Sankar, K. Narayanan, Biswajit Das, S. Subramaniam and B. Pattnaik (2012). **Association of BoLA DRB3 alleles with variability in immune response among the crossbred cattle vaccinated for Foot-and-Mouth Disease (FMD).** Immunobiology and Management of Viral Diseases in 21st centuary. VIROCON-2012. 8-10 November.
13. M. Rout, M.R. Senapati, J.K. Mohapatra, A. Sanyal, M. Ayub, H.K. Naurla, R. K. Sawal and B. Pattnaik (2012). **Serological evidence of Foot-and-Mouth Disease Virus circulation in an organised sheep farm at Bikaner, Rajasthan, India.** Immunobiology and Management of Viral Diseases in 21st centuary. VIROCON-2012. 8-10 November.

15.0

Human Resource Development

Participation in conference/workshop

1. Scientists participated in the "Regional Training on Proficiency Testing for Veterinary Diagnostic Laboratories in SAARC Countries" between 21st - 26th May 2012, sponsored by FAO of the United Nations, organized by SAARC Regional Leading Diagnostic Laboratory, PDFMD, Mukteswar, India, facilitated by Australian Animal Health Laboratory, Geelong, Victoria, Australia.
2. Scientists participated in the Regional Training on vaccine matching for analyzing the homology of field isolates/strains in relation to the in-use vaccine strain(s) of Foot and Mouth Disease was conducted during 29 October – 7 November 2012
3. Participated in the XXI National Conference of Indian Virological Society and National Seminar on "Immunobiology and Management of Viral Diseases in 21st century" held during 8th-10th November 2012 at the Division of Virology, IVRI, Mukteswar.

Foreign deputation

1. Dr. Brahmadev Pattnaik, Dr. A. Sanyal and Saravanan Subramaniam participated in FAO sponsored Second Laboratory Directors Meeting and Workshop on Enhancing Laboratory Expertise through Quality Management Systems in SAARC Countries held at Colombo, Sri Lanka from 12-13 March, 2013.
2. Dr. A.Sanyal participated in the FAO-FMD consortium with FAO-Wide Meeting held at FAO Headquarters, Rome from 11-12 December, 2012
3. Dr. A.Sanyal was deputed by FAO to initiate the process of Proficiency Testing of FMD at National Laboratories of Nepal, Bhutan, Bangladesh and Sri Lanka between December 2012 and February 2013.
4. Dr. G.K.Sharma was deputed to participate in the EuFMD Open session and OIE/FAO Refernce Laboratory network meeting at Jerez De la Frontera, Spain from 29 October to 2 November 2012.

Students' Research Programme

During 2012-13, the following students completed their thesis at PDFMD for PhD and master degree various universities

Name of the student	Thesis title	Degree	University	Year of completion
L.N. Sarangi	Isolation and molecular Characterization of FMDV serotype O grown under immune pressure	PhD	IVRI	2012
Nihar Mohanty	Genetic and antigenic characterization of FMDV isolates from Odisha	MVSc	OUAT	2012

Training Organized

National

Seven training Programmes on sandwich ELISA, LPBELISA and DIVA were organized, in which scientists from network units/regional centres of AICRP on FMD and three scientists from FMD vaccine manufacturing companies, and SAARC countries participated.

International

Regional Training on Proficiency Testing for Veterinary Diagnostic Laboratories in SAARC countries was conducted during 21-26 May 2012.

Regional Training on vaccine matching for analyzing the homology of field isolates/strains in relation to the in-use vaccine strain(s) of Foot and Mouth Disease was conducted during 29 October – 7 November 2012.

Scientists from Sri Lanka, Bangladesh, Pakistan, Nepal, Bhutan and Afghanistan participated.

16.0

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