

# Foot and mouth disease control and elimination in India:

## Importance of herd immunity and critical disease control measures

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*Foot and mouth disease (FMD) being a disease with strong trans-boundary nature, does not restrict with specific geography (state or the country). In a vaccination based disease control programme as implemented by government of India, collective efforts are required to achieve FMD control and elimination in a zone. The results which may be achieved on disease free compartments/zones may not be sustainable in longer run till country wide sustained efforts are not made for disease freedom. To fill the gaps, a series of capacity building programs on "Foot and Mouth Disease Elimination with Vaccination" are being conducted by ICAR-National Institute on Foot and Mouth Disease, for all veterinarians of the country. These programmes may act as a catalyst and refresher course for effective implementation of FMD control in the country. The present communication is therefore important for all veterinarians, vaccinators and progressive farmers to make FMD control a nationwide success story.*

**Keywords:** Disease elimination, FMD control, Foot and Mouth Disease, Herd immunity

Foot and mouth disease (FMD) is the most significant animal viral disease in India in terms of economic losses and the trade involved. It affects livestock productivity, impacting farmers' livelihoods and the broader agrarian economy. India is affected by three FMD virus serotypes: O, A, and Asia1. Serotype C has not been reported in the country since 1995. South African serotypes (SAT-1,2,3) have never been reported in the country. India has been actively working to control FMD since 2004, but with 100% financial support from Government of India, now. The programme has progressively expanded in terms of regional coverage, ensuring a more comprehensive approach to disease control. The National Animal Disease Control Programme (NADCP) was launched in 2019 by the Hon'ble Prime Minister which included FMD and Brucellosis. This initiative marks a significant commitment by the Indian government to control and eventually eliminate FMD from the country. Subsequently the

programme was named as Livestock Health and Disease Control Programme (LHDCP), which also included Peste des Petits Ruminants also known as goat plague (a disease of small ruminants) and classical swine fever as well. The Department of Animal Husbandry and Dairying (DAHD) has been implementing the FMD control programme with technical support from ICAR institutes, primarily the



A typical mouth lesion of FMD in a Buffalo

ICAR-National Institute on Foot and Mouth Disease Bhubaneswar, Odisha, which is dedicated solely to FMD research and development and knowledge-based services with a vision statement "To make India Free from FMD". Effective vaccination and comprehensive vaccination coverage have led to reduction in disease incidences in many parts of the country. Even in outbreak scenarios, the severity of the disease has decreased significantly. Effective (timely vaccination following complete cold chain), good vaccination coverage (95% or more), prompt disease reporting, sero-monitoring (vaccine effectiveness after vaccination), and sero-surveillance (indicator of infection) are important technical elements that aid in FMD control. There are 32 FMD network laboratories across the country working under the guidance, technology and knowledge support of ICAR-National Institute on Foot and Mouth Disease Bhubaneswar, Odisha, that carry out outbreak

“The FMD vaccine quality and quantity is now sufficient to eliminate the disease. it is time now to look in to the quality and quantity of realistic vaccination at the ground level with stakeholder's involvement

investigation, FMD diagnosis, sero-monitoring, and sero-surveillance. The samples for sero-monitoring and sero-surveillance are collected by state animal husbandry departments and sent to the network laboratories for testing. The results are analyzed, interpreted and communicated to the Department of Animal Husbandry and Dairying by ICAR-National Institute on Foot and Mouth Disease Bhubaneswar, Odisha.

#### FMD control and elimination

In terms of implementing the control program, FMD vaccines are supplied to state animal husbandry departments in a centralized manner by Department of Animal Husbandry and Dairying through outsourced agencies upto district level. Only quality-approved vaccines, tested by three central laboratories (ICAR-National Institute on Foot and Mouth Disease Bhubaneswar, Odisha, ICAR-Indian Veterinary Institute, Bengaluru, Chaudhary Charan Singh-National Institute on Animal Health, Baghpat, Uttar Pradesh), are supplied to the states. FMD vaccinations needs to be carried out biannually (every 6 months interval). Cold chain maintenance for vaccine and vaccination coverage have a major impact on FMD control in the field. The vaccine's effectiveness can be assessed directly by observing the declining trend of FMD outbreaks and reduced severity in affected animals in case of outbreaks. Indirectly, its effectiveness can be assessed by sero-monitoring (testing samples before and 28 days after vaccination), which indicates the level of sero-conversion and proportion of animals protected. This is an important indicator for herd immunity. In case of success

protein (NSP) antibody prevalence in susceptible population.

From the ongoing FMD sero-monitoring data and series of interactions at different platforms (state level and national level) it has been experienced that, there is a huge gap in the performance of the different states when it comes to the effective implementation of FMD control programme with a final vision of “FMD Free India”. The important gaps include management of a flawless cold chain for vaccine storage and transportation till vaccine is inoculated in the animal. Additionally, correct sampling for sero-monitoring and sero-surveillance, deficiencies in disease reporting system, prompt action on disease prevention and control, poor stakeholders involvement etc are also noticed. Keen observations indicated that those states which have prompt disease reporting, effectively implement the disease control programme in field. Some of the states have performed extremely well in FMD control and will have very good scope for creation of FMD free compartments/zones (disease free zones-DFZ) in future. Learnings from the outperforming states for good practices like last mile cold chain management (Andhra Pradesh, Karnataka), strong veterinary services (Haryana), effective animal movement with check points (Maharashtra) and combing (booster dose in primo vaccinated and vaccination to left out) vaccination strategies (Karnataka) are to be encouraged for the benefit of all other states. It has also been experienced from nationwide vaccine efficacy/ sero-monitoring data that the states which have robust vaccine cold chain infrastructure and management till last mile of

of disease control, FMD sero-surveillance, an indicator of FMD virus circulation, also suggests a decline in non-structural

vaccination performed much better and resulted in high herd immunity in short time with disease reduction at higher speed as compared to other states. Stakeholder's involvement and awareness (involvement of livestock farming community) is also key to success in such efforts. This indicated that there is, a huge possibility of learning and cross learning from each other for very effective implementation of the FMD control programme so as to realize the dream of “FMD Free India”.

#### Stages of FMD control and disease elimination:

As we progress in the disease control, defining different stages with correctness becomes important as these terminologies are used interchangeably. This is even more important in case of FMD, due to complex nature of disease and its recognition for disease freedom by national and international authorities. Different stages could be disease control, elimination and eradication could be

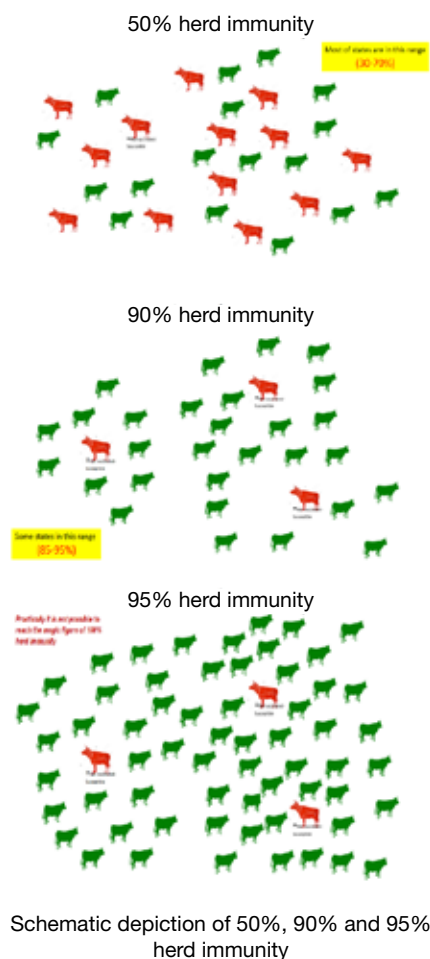
- **Disease control:** During this state, the interventions in the form of vaccinations, and other associated interventions (post vaccinal monitoring (PVM), sero-surveillance, movement control, ring vaccinations etc) continue. The disease burden and outbreaks are reduced. India has already achieved this stage.
- **Disease elimination:** This stage is characterized by no visible disease occurring in the livestock however infections may be occurring but these are not visible. This is a stage of zero incidence of FMD in a defined geography or state/region. There are no visible outbreaks because of very intensive repeated vaccinations and other interventions and contingency measures.
- **Elimination of infection:** Continuous vaccinations and other control measures for a longer period will lead to arrest of transmission of virus. At this stage, all the contingency measures are at the highest

level specially PVM and disease surveillance. Due to highest level of heard immunity, virus is unable to get susceptible host to replicate. This stage will require a lot of documentations and proofs that virus is not circulating in livestock.

- **Disease eradication:** During this stage, the virus is not present in the entire environment (in entire globe or in defined geography). All the interventions as described above, stop during this stage. The best example is global eradication of Rinderpest in the year 2011. Eradication of FMD from United States of America (USA) in the year 2029 can be another close example specific to the disease from defined geography. This stage is defined as permanent reduction of the disease. However, when the disease is eradicated from defined geography and not globally, precautions may be required to avoid disease entry from infected countries or regions.

#### How to progressively achieve FMD control and elimination in India:

**Building high heard immunity through vaccinations:** During disease control efforts in vaccination based programmes, if 50% animals are protected, FMD outbreaks and disease transmission cannot be stopped, but the virus burden and disease incidence and outbreaks may be reduced. This is a stage of initial disease control. If vaccination campaigns continue in a timely manner (vaccination every 6 months) with high density using good quality vaccine, the heard immunity may increase further reaching upto 90% (90% animals protected), and only 10% animals are susceptible. The protected animals at a stage of heard immunity, will act as shield for restriction of virus transmission if disease incidence occurs in susceptible population. There is a very low possibility of meeting susceptible animals (shown in red colour) with other susceptible animal. Therefore, under this situation virus transmission may



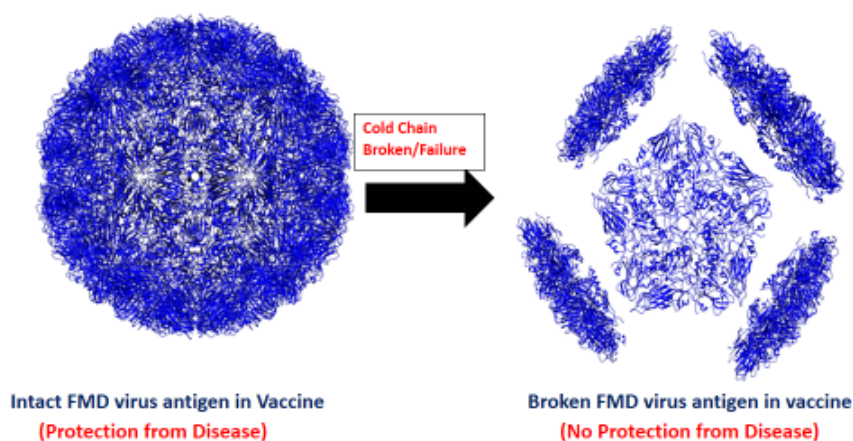
stop. Further, this level of heard immunity should be achieved for the entire period in random sampling.

This may also lead to a stage of no visible disease appreciated in the livestock (disease elimination). Currently very few of the states are trying to entre in this stage. If we continue vaccinations further and also adapt innovative practices such as combing vaccination (booster to primo vaccinated calves, left out animals due to any sickness

or any other reason, stray animals etc.) we may build further more head immunity, say 95%. At this stage, there is a possibility that long term such interventions may lead even to stronger shield for virus transmission. This further reduces possibility of contacts of susceptible and infected animals with susceptible animals. Such a situation may lead to elimination of virus transmission from the animal, and may be defined as stage infection elimination. If this continues for a longer period, with verifications, a possibility of disease eradication without vaccination (intervention) can be created. Achieving disease eradication (without vaccination) may be a herculean task under Indian socioeconomic conditions, with porous international borders.

#### Importance of cold chain management for vaccine efficacy:

FMD vaccine is very sensitive to temperature exposure, and becomes ineffective if exposed to higher temperature than recommended or frozen in deep freeze by mistake. Storage temperature required is 4–6°C in refrigerator. In order to achieve the high level of heard immunity to the tune of 90% and higher will require perfect cold chain management system till the lower level (last mile cold chain) of villages and veterinary hospitals. The intact virus particle in case of FMD is called 146-S. In case of exposure to higher temperature, this 146-S virus particle is broken in to smaller particle, which makes vaccine in-effective. The antibodies produced from temperature



Effect of Temperature on FMD Vaccine



exposed vaccines are not sufficiently protective in nature. Therefore, maintaining cold chain for vaccine efficacy is very important. Also there is an effort going on for development of thermostable/thermotolerant vaccine, to reduce the problem of temperature exposure due transient failure in cold chain. In general, higher level of herd immunity has been observed in south Indian states in addition to Maharashtra. This could be due to better cold chain management, high level of stakeholders' involvement and more committed veterinary services. This also, opens a possibility of early FMD elimination from southern peninsular region.

**High density and timely vaccinations:** The application of vaccine is to be implemented at the earliest after receiving vaccine in order to keep vaccine efficacy at the highest due to possible cold chain failure. Vaccinations, to the extent possible are to be carried out in

pulse polio mode in the entire state/region. The unique practice being adapted by Karnataka state in the form of combing vaccinations need to be encouraged in all the states. In this practice, the local veterinarians are given responsibility to visit the villages covered under mass vaccination, again after 30 days to vaccinate left out animals, animals which require booster dose (primo vaccinated calf), cow/buffaloes in last month of pregnancy, sick animals etc. which could not be vaccinated.

**Stakeholders' involvement:** As we improve the programme towards disease elimination, response of farming community will be more challenging because the visible disease problems disappear by this time. Acceptance of repeated vaccinations at farmers doorstep will require their involvement and sometimes incentivization to take disease elimination to next level. Stakeholder's involvement

can be improved through public representatives at appropriate level of vaccination programmes (state/district/block/taluk/village) as is extensively practiced by Karnataka state. Under reporting of FMD is a very common phenomenon. Further with the involvement of farming community the issue of under reporting of disease can be solved to great extent. The invisible cases are always more than visible cases. It has also been seen that those states which report the disease more efficiently, put more sincere efforts in disease control.

### SUMMARY

In order to improve FMD vaccination and other contingency measures, the senior management of concerned animal husbandry department should insist to adapt the same good practices, as is being adapted by a state which received good result. This may be possible by making field visits/learning and cross learning from progressive states like Karnataka. Similarly the districts with good performance within each states can be a source of learning for other districts. Such activities can also be promoted at state level seminars and meetings on animal health, where central agencies like Department of Animal Husbandry and Dairying, and ICAR-National Institute on Foot and Mouth Disease Bhubaneswar, Odisha, can also participate. Preparation of SOPs for last mile cold chain in particular depending upon the infrastructure and adoption of SOPs for the entire process of vaccination from a most progressive state need to be encouraged. Because of poor cold chain, poor commitment, low stakeholders involvement the herd immunity varies extensively between states, even though vaccine quality remains same due to independent vaccine quality control.



Iceberg showing proportion of FMD reported/visible and not reported/non-visible

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