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Importance of regular biannual foot-and-mouth disease vaccination for maintaining herd immunity in bovines

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Abstract

Foot-and-Mouth Disease (FMD) is one of the most economically important and highly contagious viral diseases affecting cloven-hoofed animals, including cattle, buffaloes, sheep, goats, and pigs. The disease results in severe economic losses due to decreased milk production, reduced draught efficiency, reproductive disorders, mortality in young animals, and restrictions on national and international livestock trade. In India, particularly in livestock-rich states such as Andhra Pradesh, effective prevention and control strategies are essential for sustaining dairy productivity and rural livelihoods. Regular biannual vaccination has emerged as the cornerstone of FMD control programs for maintaining adequate herd immunity among susceptible animal populations. Continuous vaccination at six-month intervals helps sustain protective antibody titres, minimizes disease outbreaks, and reduces virus circulation within the environment. This article highlights the importance of regular biannual FMD vaccination, the role of herd immunity in disease prevention, economic benefits of vaccination, challenges in implementation, and the contribution of veterinary services and diagnostic laboratories toward achieving long-term FMD control and eventual eradication.

Keywords: FMD, Herd immunity, biannual vaccination, antibody, monitoring, outbreaks, cold chain, surveillance

Introduction

Foot-and-Mouth Disease is caused by an RNA virus belonging to the genus *Aphthovirus* under the family *Picornaviridae* (Grubman and Baxt, 2004) [4]. The disease is characterized by fever and vesicular lesions in the mouth, feet, teats, and tongue of infected animals, leading to severe production losses. FMD spreads rapidly through direct contact with infected animals, aerosols, contaminated feed, equipment, vehicles, and movement of livestock (Alexandersen *et al.*, 2003) [1].

India possesses one of the world's largest bovine populations, and the livestock sector contributes substantially to the national economy and nutritional security. Andhra Pradesh is one of the leading milk-producing states, where dairy farming serves as an important source of livelihood for rural communities. Outbreaks of FMD can severely affect dairy productivity and farmer income, thereby creating major socio-economic challenges.

Vaccination remains the most effective and practical strategy for controlling FMD in endemic countries (Paton *et al.*, 2005) [7]. The Government of India has implemented nationwide vaccination programs under various disease control initiatives, including the Foot-and-Mouth Disease Control Programme (FMD-CP) and the National Animal Disease Control Programme (NADCP), emphasizing biannual vaccination for maintaining protective immunity in livestock populations.

Herd Immunity and Its Significance in FMD Control

Herd immunity refers to the resistance of a population to the spread of infectious disease when a sufficiently high proportion of animals possess protective immunity against the pathogen (Fine *et al.*, 2011) [3]. In the context of FMD, maintaining high herd immunity is essential for interrupting viral transmission and reducing the risk of outbreaks.

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When a majority of cattle and buffaloes are vaccinated regularly:

- The number of susceptible animals decreases significantly.
- Virus circulation within the environment is minimized.
- The probability of disease outbreaks declines considerably.
- Even partially immune or unvaccinated animals receive indirect protection.

However, immunity induced by FMD vaccines is not lifelong. Protective antibody levels decline gradually over time, especially in endemic regions where continuous viral exposure may occur (Doel, 2003) [2]. Therefore, revaccination at six-month intervals is necessary to sustain adequate immunity levels and ensure effective disease control.

Importance of Biannual FMD Vaccination

1. Maintenance of Protective Antibody Levels -The immunity generated after FMD vaccination declines progressively within a few months. Studies have demonstrated that antibody titres may decrease below protective levels if booster vaccination is delayed (Parida, 2009) [6]. Biannual vaccination helps maintain sufficient circulating antibodies against prevalent FMD virus serotypes and ensures continuous immune protection in bovine populations.
2. Prevention of Disease Outbreaks -Regular vaccination substantially reduces the occurrence of FMD outbreaks in villages, dairy farms, and organized livestock production systems. High vaccination coverage interrupts disease transmission cycles and limits the spread of infection among susceptible animals (Knight-Jones and Rushton, 2013) [5].
- Reduction in Economic Losses - FMD produces severe economic consequences due to Reduced milk yield, Weight loss, Decreased fertility, Delayed growth in calves and Increased veterinary and treatment costs. The economic burden associated with FMD outbreaks can be substantial in dairy-intensive regions. Regular biannual vaccination significantly minimizes these production losses and improves the overall profitability of livestock farming systems.
3. Improvement in Dairy Productivity -Healthy vaccinated animals maintain better productivity and reproductive efficiency. Since Andhra Pradesh is an important contributor to India's dairy sector, effective FMD prevention directly supports milk production and the economic sustainability of dairy farming communities.
4. Support for FMD-Free Status - Sustained vaccination and disease surveillance are critical for achieving and maintaining FMD-free zones in accordance with international animal health standards established by the World Organisation for Animal Health. Regular vaccination strengthens disease control programs and enhances opportunities for livestock trade and export certification.
5. Protection of Young and Vulnerable Animals - Young calves, immunocompromised animals, and stressed livestock are highly susceptible to FMD infection. Maintaining high herd immunity through systematic biannual vaccination provides both direct and indirect protection to vulnerable animal populations.

Role of Herd Immunity in Andhra Pradesh

In Andhra Pradesh, mass vaccination campaigns conducted every six months play an essential role in developing uniform herd immunity across districts. High vaccination coverage:

- Prevents long-term virus persistence,
- Limits inter-district disease spread,
- Protects dairy-intensive production areas,
- Enhances farmer confidence in livestock farming.

Field veterinarians, laboratory scientists, and livestock owners collectively contribute to monitoring vaccine effectiveness through sero-monitoring and sero-surveillance activities. These programs help assess antibody responses and identify areas requiring improved vaccination coverage.

Role of Veterinary Services and Diagnostic Laboratories

Veterinary institutions and diagnostic laboratories are integral components of FMD control strategies. Their major responsibilities include: Monitoring post-vaccination antibody titres, Detecting circulating FMD virus strains, Conducting serological surveillance, Evaluating vaccine efficacy and Supporting evidence-based vaccination strategies. Institutions such as ICAR-NIVEDI and regional FMD collaborating laboratories play a crucial role in scientific disease surveillance and immunological monitoring. Laboratory-based sero-monitoring assists in evaluating herd immunity levels and identifying immunity gaps within livestock populations.

Challenges in Maintaining Herd Immunity

Despite large-scale vaccination campaigns, several challenges continue to affect effective herd immunity maintenance:

- Missed vaccination in remote and inaccessible villages,
- Inadequate vaccine cold-chain maintenance,
- Improper vaccine handling and administration,
- Lack of farmer awareness regarding booster vaccination,
- Introduction of unvaccinated animals into herds.

Addressing these challenges requires continuous awareness campaigns, improved veterinary infrastructure, effective cold-chain management, and strong coordination among veterinary departments, laboratories, and livestock farmers.

Recommendations

The following measures are essential for strengthening herd immunity against FMD in bovines:

1. Ensure near-complete vaccination coverage during every campaign.
2. Conduct regular awareness programs regarding the importance of booster vaccination.
3. Strengthen vaccine cold-chain systems at field level.
4. Expand sero-monitoring and active disease surveillance programs.
5. Encourage timely vaccination of newly introduced and young animals.
6. Improve coordination among veterinarians, laboratories, government agencies, and farmers.

Conclusion

Regular biannual vaccination against Foot-and-Mouth Disease is essential for maintaining effective herd immunity in bovine populations. Sustained vaccination programs significantly reduce disease outbreaks, minimize economic

losses, improve dairy productivity, and support long-term livestock health management. In endemic regions such as Andhra Pradesh, continuous vaccination combined with surveillance and scientific monitoring remains fundamental for achieving the long-term objective of FMD control and eventual eradication. Collaborative efforts involving veterinarians, scientists, government agencies, and livestock farmers are indispensable for establishing a resilient and disease-protected livestock sector.

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Conflict of Interest

Not available

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