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Dr. S Kalavathi

Assistant Director, Veterinary
Biological Research Institute
(VBRI), Vijayawada, Andhra
Pradesh, India

Dr. G Sireesha

Assistant Director, Veterinary
Biological Research Institute
(VBRI), Vijayawada, Andhra
Pradesh, India

Dr. G Deepika Kumari

Associate Professor, College of
Veterinary Science, Garividi,
Andhra Pradesh, India

Dr. B Chandramouli Naik

Joint Director, Veterinary
Biological Research Institute
(VBRI), Vijayawada, Andhra
Pradesh, India

Dr. T Damodar Naidu

Director, Department of Animal
Husbandry, Vijayawada,
Andhra Pradesh, India

Corresponding Author:

Dr. S Kalavathi

Assistant Director, Veterinary
Biological Research Institute
(VBRI), Vijayawada, Andhra
Pradesh, India

Brucellosis seromonitoring in Andhra Pradesh under the national brucellosis control programme: A retrospective study (2022-2025)

**S Kalavathi, G Sireesha, G Deepika Kumari, B Chandramouli Naik and T
Damodar Naidu**

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Abstract

The National Brucellosis Control Programme (NBCP) was implemented by the Government of India in 2022 as part of a nationwide initiative aimed at controlling and progressively eliminating brucellosis in livestock populations. Under the programme, female bovine calves aged 4-8 months were identified and vaccinated in accordance with national vaccination guidelines. In Andhra Pradesh, the State Animal Husbandry Department implemented the programme in a phased manner, with Phase I conducted in July 2022, Phase II in November 2022, Phase III in February 2023, and Phase IV in August 2024 to ensure comprehensive vaccination coverage among eligible female bovine calves while adhering to prescribed operational guidelines and biosafety precautions. As part of post-vaccination surveillance, serum samples were collected 45-60 days following vaccination for seromonitoring studies to evaluate vaccine-induced seroconversion and immune status among vaccinated animals. The overall mean seroconversion percentages recorded during the four phases were 73.25% in Phase I, 71.51% in Phase II, 64.52% in Phase III, and 81.6% in Phase IV, respectively. The comparatively lower seroconversion observed during Phase III followed by improved responses in Phase IV indicates phase-wise variation in post-vaccination immune response and programme implementation efficiency. The implementation of the National Brucellosis Control Programme is expected to strengthen disease control measures and contribute significantly toward reducing the burden of Brucellosis among livestock populations.

Keywords: Brucella, ELISA, sera samples, control

Introduction

Brucellosis is an endemic disease (Aulakh *et al.*, 2008) ^[1] caused by *Brucella* *sps.* a Gram negative coccus bacilli bacterium, affecting almost all the livestock species except poultry and poses an important zoonotic threat to humans of all age groups. *B.abortus*, *B.melitensis* and *B. suis* are the common species affecting the livestock (Izadi *et al.*, 2024) ^[7]. Brucellosis is a prominent disease in India, with a sero-prevalance rate varying from 6.5% to 16.4% in different livestock species.

Brucellosis poses a major challenge to livestock production and public health in India due to its endemic nature, wide host range, and significant economic impact. Studies have shown that the disease causes substantial losses through abortion, infertility, repeat breeding, reduced milk production, extended calving intervals, and increased veterinary expenditures. Panchasara *et al.* reported that reduction in milk yield constituted the major proportion of economic losses associated with bovine brucellosis, accounting for nearly 86% of total losses, followed by treatment costs and loss of calves due to abortion. The authors further observed an average milk loss of 231 litres in infected cows and 177 litres in infected buffaloes, emphasizing the severe economic burden imposed on dairy farmers. In India, where slaughter-based eradication programmes are socio-culturally and economically challenging, vaccination remains the most practical and sustainable approach for disease control.

Further Brucellosis has a significant public health implication. Humans primarily acquire the infection through consumption of unpasteurized milk and dairy products or through direct

contact with secretions, aborted materials, and tissues of infected animals (Laine *et al.*, 2023; Hikal *et al.*, 2023) ^[6, 8]. Globally, more than 50,000 human cases of brucellosis are reported annually (Seleem *et al.*, 2009) ^[11], although the actual burden is believed to be considerably higher due to underreporting and misdiagnosis. In view of its zoonotic nature and *Brucella* being intracellular organism the innate and adaptive immune responses fail to recognize the pathogen (Ficht 2003, Gorvel *et al.*, 2003) ^[4, 5], besides the absence of an effective human vaccine, control of brucellosis in animal populations remains the most effective strategy for reducing transmission to humans. Therefore, systematic vaccination of livestock assumes critical importance in the prevention and control of both animal and human brucellosis.

The *Brucella abortus* strain 19 (S19) vaccine has been widely used for the control of bovine brucellosis and is considered one of the most effective vaccines for inducing long-lasting immunity in young female calves. Vaccination with S19 significantly reduces the incidence of abortion and transmission of infection in cattle populations, making it a key of brucellosis control programmes in endemic countries, including India (Chaudhuri *et al.*, 2021) ^[12].

Consequently, the Government of India initiated the National Brucellosis Control Programme (NBCP) focusing on systematic calfood vaccination with S19 vaccine, surveillance, and seromonitoring to reduce disease prevalence and transmission. Strengthening vaccination coverage, surveillance systems, farmer awareness, biosecurity practices, and intersectoral coordination are considered essential for long-term control and eventual elimination of bovine brucellosis in the country.

Brucella Control Programme

The National Brucellosis Control Programme aims to reduce the occurrence of brucellosis through systematic vaccination of female bovine calves aged 4-8 months, with the objective of achieving substantial disease control by 2025 and eventual eradication by 2030. As part of post-vaccination surveillance, serum samples are collected 45-60 days following vaccination in accordance with the scientifically designed sampling plan provided by the Indian Council of Agricultural Research-National Institute of Veterinary Epidemiology and Disease Informatics (ICAR-NIVEDI), Bengaluru, for conducting seromonitoring studies. Intensive implementation of the Brucellosis Control Programme in livestock contributes significantly toward effective disease management in both animals and humans, thereby supporting the One Health approach to zoonotic disease control. Under the programme, vaccination and seromonitoring data are digitally recorded and uploaded through the Information Network for Animal Productivity and Health (INAPH) platform, which has subsequently been integrated into the Bharat Pashudhan application for improved data management and monitoring.

Vaccination Programme

A comprehensive action plan was prepared in advance to

ensure systematic coverage of villages across the state during each phase of the programme. Deworming of calves was carried out two weeks prior to vaccination to improve overall health status and optimize immune response following vaccination. The target population included female bovine calves aged 4-8 months. Vaccination was performed using sterile syringes and needles under strict aseptic conditions. The vaccine was administered through the subcutaneous route at the recommended dose rate of 2 mL per calf, as per the manufacturer's instructions. Care was taken during administration to avoid injury to major blood vessels and associated complications.

Throughout the vaccination campaign, the vaccine and associated biological materials were maintained under an uninterrupted cold chain at the recommended temperature range of 2-8 °C to preserve vaccine potency. Vaccine wastage was minimized by careful handling during loading and administration, and all opened vaccine vials were utilized on the same day of reconstitution. Only the diluent supplied along with the vaccine was used for reconstitution as per standard operating procedures (SOPs).

Sero-monitoring

Pre-vaccination serosurveillance was not included under the Brucellosis Control Programme vaccination protocol. Post-vaccination seromonitoring was conducted according to the scientifically designed sampling plans issued by the Indian Council of Agricultural Research-National Institute of Veterinary Epidemiology and Disease Informatics (ICAR-NIVEDI), Bengaluru, separately for each vaccination phase. Serum samples were collected 45-60 days following vaccination for assessment of post-vaccination seroconversion and immune response.

During Phase I of the Brucellosis Control Programme, a total of 1,417 serum samples were collected from 109 selected villages across Andhra Pradesh. In Phase II (2022-2023), 2,022 serum samples were collected from 108 selected villages. During Phase III (2023-2024), 1,825 serum samples were collected from 141 selected villages, while in Phase IV (2024-2025), 2,061 serum samples were collected from 222 selected villages across the state.

Serum collection was carried out under the strict supervision of district nodal officers, and all procedures were implemented in accordance with prescribed SOPs with proper documentation for reporting and communication to the Government of India. Following collection, serum samples were transported under recommended conditions and submitted to ICAR-NIVEDI, Bengaluru, for serological testing, analysis, and interpretation.

Results and Discussion

The seromonitoring results of the four phases of vaccination done are as follows.

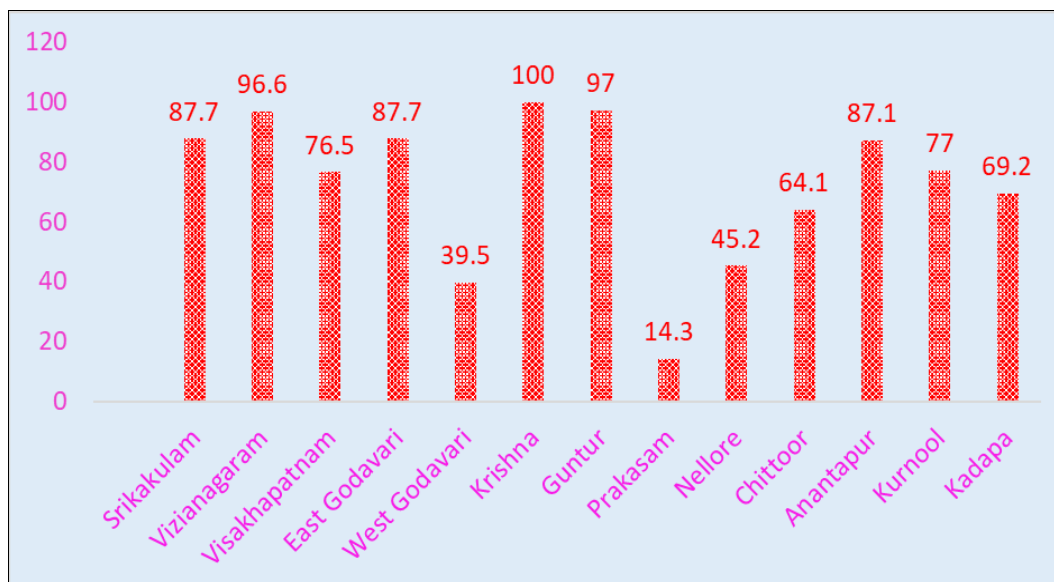


Fig 1: Graph depicting the seropositivity results during first phase of Vaccination

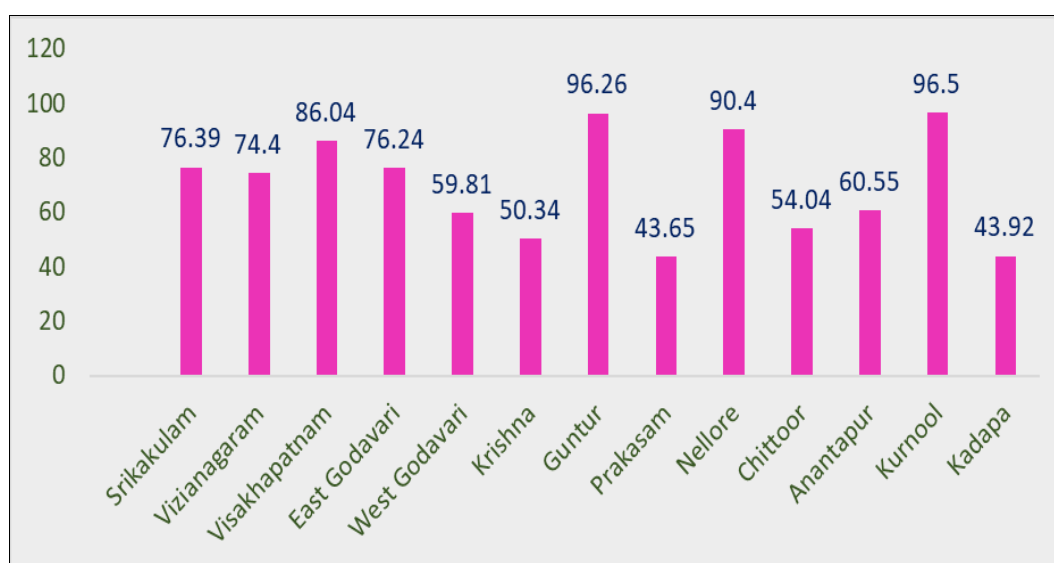


Fig 2: Graph depicting the seropositivity results during second phase of Vaccination

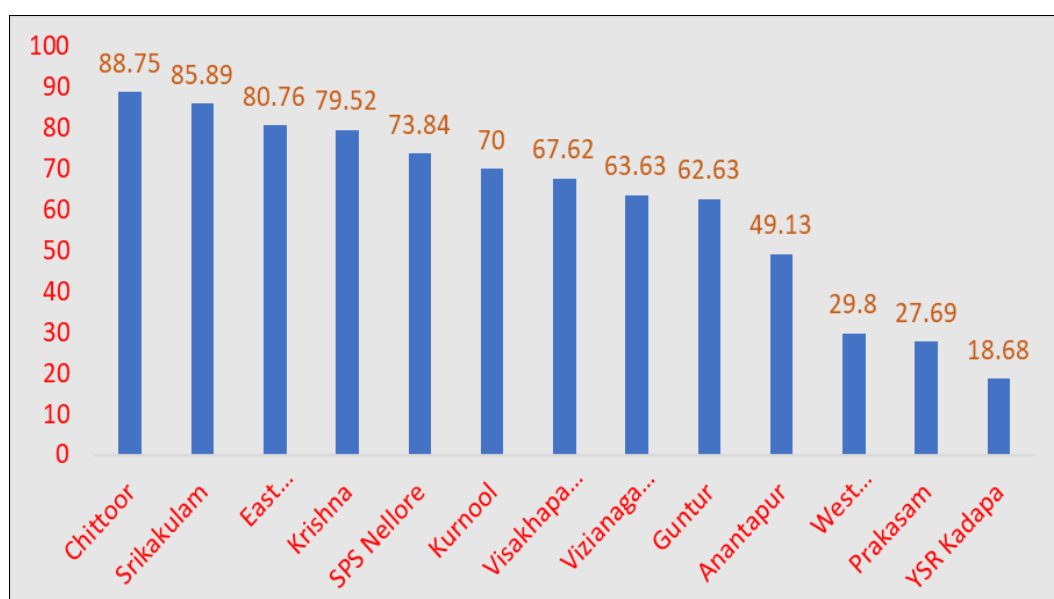


Fig 3: Graph depicting the seropositivity results during third phase of Vaccination

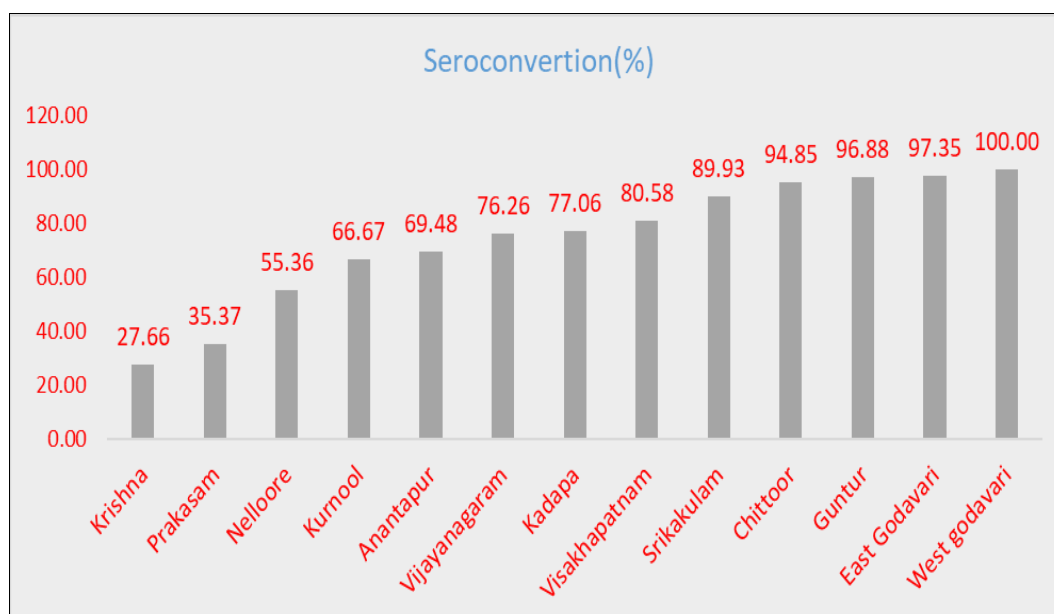


Fig 4: Graph depicting the seropositivity results during fourth phase of Vaccination

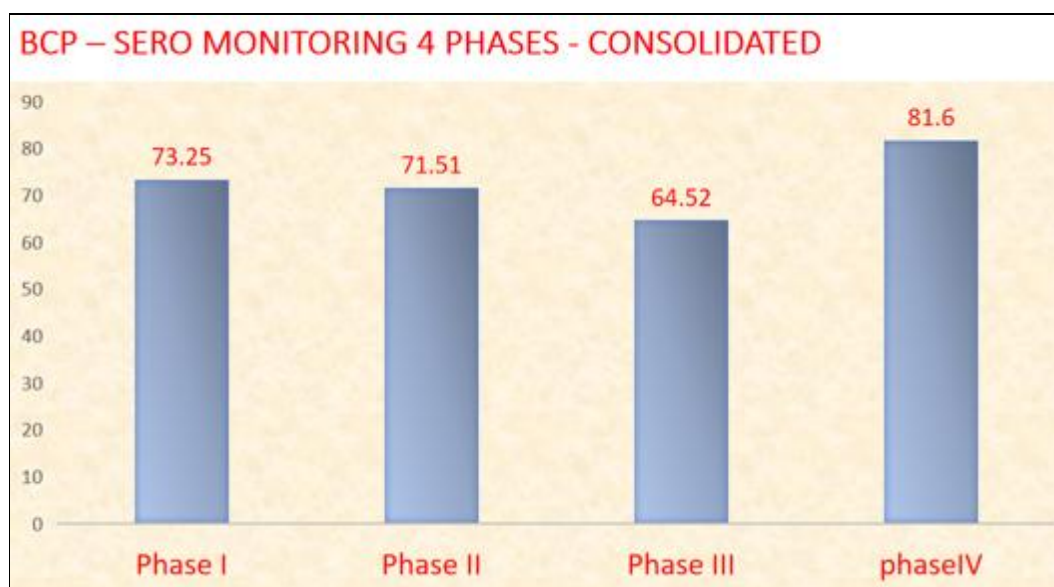


Fig 5: Phase-wise Brucellosis Seropositivity (%)

Table 1: District-wise Protection Coverage (%) Across Four Rounds

S. No	Name of the District	First round% Protected	Second round% Protected	Third round% Protected	Fourth round% Protected
1	Srikakulam	87.7	76.39	85.89	89.93
2	Vizianagaram	96.6	74.4	63.63	76.26
3	Visakhapatnam	76.5	86.04	67.62	80.58
4	East Godavari	87.7	76.24	80.76	97.35
5	West Godavari	39.6	59.81	29.8	100
6	Krishna	100	50.34	79.52	27.66
7	Guntur	96.9	96.26	62.63	96.88
8	Prakasam	14.3	43.65	27.69	35.37
9	Nellore	45.2	90.4	73.84	55.36
10	Chittoor	64.1	54.04	88.75	94.85
11	Anantapur	87.2	60.55	49.13	69.48
12	Kurnool	76.9	96.5	70	66.67
13	Kadapa	69.2	43.92	18.68	77.06
	Total	73.2	71.66	64.52	81.60

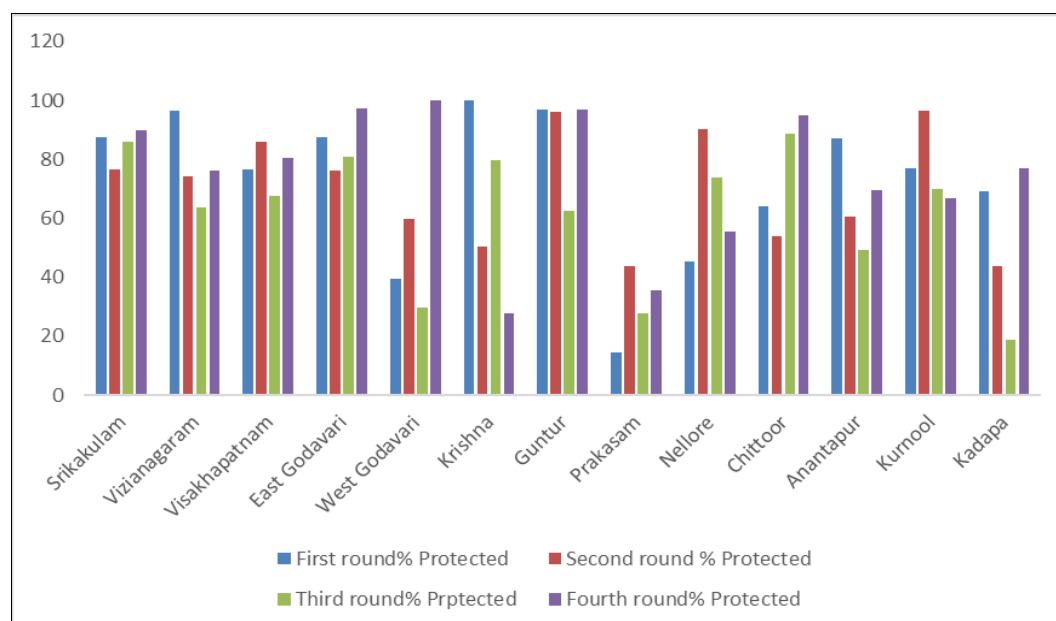


Fig 6: District-wise Protection Coverage Across Four Rounds (%)

Discussion

The present retrospective study evaluated the post-vaccination *Brucella* seromonitoring outcomes generated under the National Brucellosis Control Programme in Andhra Pradesh during 2023-2025. The programme was implemented across the state in a phased manner targeting female bovine calves aged 4-8 months with uniform vaccination, sample collection, and laboratory testing procedures. The findings of the study provide important field-level insights into vaccine-induced serological response, programme implementation efficiency, and district-wise variations under practical livestock farming conditions prevailing in Andhra Pradesh.

A total of 7,325 post-vaccination serum samples were collected during the study period from scientifically selected villages as per the sampling plan designed by ICAR-National Institute of Veterinary Epidemiology and Disease Informatics (ICAR-NIVEDI), Bengaluru. During Phase I, 1,417 serum samples were collected from 109 villages, while Phase II covered 2,022 samples from 108 villages. In Phase III, 1,825 samples were collected from 141 villages, and during Phase IV, 2,061 samples were collected from 222 villages across the state. The progressive increase in village coverage in subsequent phases reflects the strengthening of surveillance activities and improved field-level coordination under the programme.

The overall mean seroconversion percentages observed during the four phases were 73.25% in Phase I, 71.51% in Phase II, 64.52% in Phase III, and 81.6% in Phase IV. These findings indicate that the vaccination programme was generally successful in inducing satisfactory immune response under field conditions, although some phase-wise and district-wise variations were observed. Such variations are expected in large-scale vaccination programmes implemented under diverse agro-climatic and management conditions.

The relatively higher seroconversion recorded during Phase I suggests effective initial implementation of the programme with proper vaccination practices, maintenance of cold chain, and timely collection of serum samples. Districts such as Krishna, Guntur, Vizianagaram, East Godavari, Anantapur, and Srikakulam showed good serological response during this phase as per the reports of Tanuja *et al.*, 2025^[12] indicating satisfactory vaccine handling and field-level implementation.

Phase II also maintained satisfactory seroconversion levels, particularly in districts such as Kurnool, Guntur, Nellore, and Visakhapatnam. However, the variations observed among districts indicate that programme performance was not completely uniform throughout the state. Accessibility of remote villages, farmer awareness, and local management practices may also contribute to district-wise differences in programme outcomes.

Among all phases, Phase III recorded the lowest mean seroconversion percentage (64.52%). Lower responses were particularly observed in districts such as Kurnool, Kadapa, Prakasam and West Godavari. Although standardized vaccination and testing protocols were followed throughout the programme, several field-level factors may have influenced the reduced antibody response during this phase. Climatic stress, transportation difficulties, delays in sample collection, nutritional deficiencies, and transient immunosuppression in young calves may have contributed to lower seroconversion. At the same time, districts such as Chittoor, Srikakulam, East Godavari, and Krishna continued to maintain satisfactory responses, suggesting that localized environmental and managerial factors played an important role in influencing vaccine response.

Phase IV showed marked improvement with the highest overall mean seroconversion percentage (81.6%) among all phases. Districts such as West Godavari, East Godavari, Guntur, Chittoor, and Srikakulam recorded excellent serological responses, with some districts approaching near-complete seroconversion. The improved performance during this phase may reflect better coordination among field staff, improved awareness regarding programme implementation, strengthened cold-chain maintenance, and increased familiarity of veterinarians and livestock owners with vaccination procedures. The increased village coverage during this phase further demonstrates the strengthening of surveillance and monitoring systems under the programme.

One of the major strengths of the present study is the uniformity maintained throughout programme implementation. All animals included in the study belonged to the recommended age group of 4-8 months, ensuring standardization of vaccination eligibility. Deworming was carried out prior to vaccination, vaccines were administered through the subcutaneous route at the recommended dose of 2

mL per calf, and strict cold-chain maintenance between 2-8 °C was ensured throughout the vaccination campaign. In addition, serum sampling plans were scientifically designed by ICAR-NIVEDI, Bengaluru, and testing of all serum samples was carried out by the same institute using standardized procedures. These measures helped minimize analytical variation and improved the reliability and comparability of the seromonitoring data across all phases.

The variations observed in seroconversion rates across districts and phases are likely multifactorial and may be influenced by environmental, nutritional, host-related, and management-associated factors. Immune response following vaccination can vary depending on animal health status, nutritional adequacy, climatic conditions, and overall management practices. Andhra Pradesh consists of diverse agro-climatic regions including the drought-prone Rayalaseema belt with limited pasture availability and extensive coastal regions with relatively better fodder resources with good nutritional values (Najam *et al.* 2023)^[9] and agricultural activity. Such regional differences may influence the immune status of animals and subsequently affect post-vaccination antibody responses.

In addition to biological factors, operational efficiency plays a major role in determining the success of vaccination programmes. Timely communication among field veterinarians, proper identification of eligible calves, strict maintenance of cold chain, correct route of vaccine administration, and accurate collection of serum samples from vaccinated animals are essential for achieving reliable seromonitoring outcomes. Any deviations in these procedures under field conditions may influence the final seroconversion rates observed during monitoring.

Nutritional interventions and immune-enhancing strategies may also have a role in improving vaccine responsiveness in livestock. Previous studies have indicated that improved nutritional status and micronutrient supplementation can positively influence humoral immune response following vaccination. However, further field-based studies are necessary to evaluate the practical applicability of such interventions under bovine brucellosis control programmes.

The present findings once again highlight the importance of systematic vaccination (Tulu 2022)^[13] and seromonitoring in controlling bovine brucellosis in endemic regions such as India, where test-and-slaughter strategies are often difficult to implement because of socio-economic and cultural reasons. Brucellosis continues to cause major economic losses to livestock farmers through abortion, infertility, repeat breeding, reduced milk production, and increased veterinary expenditure, apart from posing a significant zoonotic risk to humans. Therefore, sustained vaccination coverage, regular seromonitoring, and continuous field surveillance are essential not only for improving livestock productivity but also for strengthening the one health approach toward zoonotic disease prevention (Deepika Kumari *et al.*, 2016)^[3].

The district-wise variability observed in the present study emphasizes the need for targeted district-level interventions rather than depending solely on state-level averages. High-performing districts such as Guntur, Srikakulam, East Godavari, and Chittoor may serve as useful operational models for improving programme implementation in comparatively low-performing districts such as Prakasam and Kadapa. Regular training programmes for field veterinarians and para-veterinary staff, strengthening of cold-chain monitoring, timely sample collection, and improved farmer awareness regarding the importance of vaccination and

zoonotic risks associated with brucellosis are likely to improve overall programme effectiveness.

Certain limitations of the present study should be acknowledged. Although the study was retrospective in nature, the sampling strategy and serological testing procedures were scientifically designed and uniformly implemented by ICAR-NIVEDI, Bengaluru, thereby ensuring consistency across all phases. However, the analysis did not incorporate detailed animal-level variables such as breed, nutritional status, body condition, concurrent infections, or management practices, which may influence post-vaccination immune response. Environmental and seasonal factors that could potentially affect seroconversion rates were also not evaluated separately. Furthermore, the present study primarily assessed short-term serological response following vaccination and did not evaluate long-term protective immunity or reduction in disease incidence under field conditions. Future studies incorporating epidemiological, immunological, and management-related parameters along with long-term monitoring of vaccinated animals would provide a more comprehensive understanding of vaccine performance under field conditions.

Conclusion

The present retrospective study demonstrates that the National Brucellosis Control Programme achieved generally satisfactory post-vaccination serological responses among female bovine calves in Andhra Pradesh during 2023-2025. Analysis of 7,325 serum samples collected from scientifically selected villages across four phases revealed overall mean seroconversion percentages ranging from 73.25% to 81.6%, indicating effective induction of immune response under field conditions.

The study highlights the importance of standardized vaccination protocols, scientifically designed sampling strategies, strict cold-chain maintenance, and centralized laboratory testing in achieving reliable programme outcomes. Although considerable district-wise and phase-wise variations were observed, the improved seroconversion during Phase IV suggests progressive strengthening of programme implementation, surveillance activities, and field-level coordination over time.

The findings emphasize the importance of sustained calfhood vaccination, regular seromonitoring, and targeted district-level interventions for effective control of bovine brucellosis. Continued strengthening of surveillance systems, field supervision, farmer awareness programmes, and digital monitoring platforms such as Bharat Pashudhan will be essential for achieving the national goal of brucellosis control and eventual eradication. Effective implementation of the programme will not only reduce economic losses in livestock production but also contribute significantly toward protection of public health through the One Health approach.

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Author's Contribution

Not available

Conflict of Interest

Not available

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