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Brucellosis surveillance and reproductive performance in an organized dairy herd of Uttarakhand: A seven-year retrospective analysis (2018–2024)

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ABSTRACT: Brucellosis remains a significant zoonotic disease affecting livestock productivity and public health in India. This study presents a seven-year retrospective surveillance of brucellosis in an organized dairy herd in Uttarakhand, correlating the disease burden with reproductive outcomes and vaccination coverage. Serological testing (ELISA, RBPT, STT), abortion records, and calfhoo vaccination data from 2018 to 2024 were analyzed. The findings indicate fluctuations in disease prevalence, with notable peaks in 2022, and reveal a negative association between calfhoo vaccination and abortion incidence. The study underscores the need for consistent vaccination and robust monitoring to achieve effective brucellosis prevention.

Keywords: Abortions, brucellosis, calfhoo vaccination, dairy herd, ELISA, RBPT, STT

Brucellosis, caused by *Brucella abortus*, is a highly infectious bacterial zoonosis that adversely affects the reproductive health of cattle. It leads to abortions, infertility, and reduced milk yield, causing significant economic losses. The disease is endemic in many parts of India, with sporadic outbreaks exacerbating challenges in herd management. Diagnostic tools such as RBPT, ELISA, and STT have been widely employed to detect the infection. Control strategies largely rely on early diagnosis, culling of infected animals, and calfhoo vaccination using *Brucella abortus* S19 or RB51 vaccines. This study aims to assess the temporal trend of brucellosis in a closed dairy herd and to evaluate its impact on reproductive outcomes over a seven-year period.

MATERIALS AND METHODS

The data was collected from a closed dairy herd located in District Udham Singh Nagar, Uttarakhand which had the average herd strength of 450 animals annually, with about 223 calvings per year. The data was based on the serum samples collected annually from randomly selected animals. Each sample was subjected to Rose Bengal Plate Test (RBPT), Enzyme-Linked Immunosorbent Assay (ELISA), and Standard Tube Test (STT). Year-wise data included

the total number of animals tested for brucellosis, the number of positive cases identified through each diagnostic method (ELISA, RBPT, and STT), the total number of abortions recorded during the respective years, and the number of calfhoo vaccinations administered annually. This comprehensive dataset enabled a year-by-year analysis of disease prevalence, reproductive outcomes, and the effectiveness of vaccination efforts in disease prevention.

RESULTS AND DISCUSSION

Perusal of Table 1 reveals significant year-wise fluctuations in both disease prevalence and reproductive outcomes in the monitored dairy herd. The year 2022 stands out with the highest abortion rate of 22.22%, which coincided with the peak seropositivity across all three diagnostic tests as ELISA (27.78%), RBPT (36.11%), and STT (30.56%). This indicates a likely outbreak or re-emergence of brucellosis despite a reasonably high number of calfhoo vaccinations (207). In contrast, 2019, 2021, and 2024 demonstrated relatively lower abortion rates (4.12%, 8.63%, and 10.34%, respectively). These years were also characterized by high vaccination coverage, especially in 2019 and 2021 with 219 and 211 vaccinations administered, respectively. This suggests

a partial protective effect of the vaccination program, where increased immunization likely contributed to reduced reproductive losses.

Across all years, the RBPT consistently detected the highest percentage of positive cases, followed by STT and then ELISA. This trend is in line with the established understanding that RBPT, being a rapid agglutination test, is more sensitive and prone to overestimating positivity due to cross-reactions. STT offers higher specificity, and ELISA, though slightly less sensitive, is regarded as a confirmatory test due to its accuracy and reliability in detecting chronic and latent infections.

These results collectively emphasize the cyclical nature of brucellosis outbreaks in endemic herds and the importance of continuous monitoring, effective vaccination coverage, and prompt biosecurity interventions. While the data shows that vaccination correlates with lower abortion rates, it also illustrates that vaccination alone is not a fool-proof strategy, especially in the absence of regular testing and culling of persistently infected animals.

The results of this longitudinal surveillance study clearly demonstrate that brucellosis remains a persistent and cyclical disease threat within the monitored dairy herd in Uttarakhand. Despite continuous control efforts, including annual calfhoo vaccination, disease prevalence remained notable across the study years, with peaks indicating periodic flare-ups. The highest seropositivity and abortion rate occurred in 2022, suggesting a likely outbreak scenario. This year was marked by seroprevalence rates of 27.78%

(ELISA), 36.11% (RBPT), and 30.56% (STT), coupled with the highest abortion rate of 22.22%. These observations are concerning, particularly in light of the high vaccination numbers (207), and point toward possible failures in herd immunity due to management issues such as improper vaccine storage, handling, or administration, or the presence of latent or chronically infected animals acting as reservoirs as have been reported by Renukaradhya *et al.* (2002), who emphasized that vaccination alone is not sufficient and must be supported by herd management and test-and-slaughter policies.

Interestingly, years with higher calfhoo vaccination coverage, such as 2019 (219 vaccinations) and 2021 (211 vaccinations), were correlated with markedly lower abortion rates (4.12% and 8.63%, respectively), suggesting that vaccination offers partial but significant protection against reproductive losses aligning with the work of Singh *et al.* (2015), who highlighted that regular immunization programs can mitigate economic losses in endemic settings, even if full eradication remains elusive.

When comparing the diagnostic tests, RBPT consistently showed higher positivity rates than ELISA and STT, reaffirming its greater sensitivity. However, this also raises concerns regarding its specificity, as RBPT may yield false positives due to cross-reactivity with other pathogens or past vaccination history. In contrast, ELISA and STT, though slightly less sensitive, are known for higher specificity and are better suited for confirmatory diagnosis, especially in detecting chronic infections in agreement with Godfroid *et al.* (2011), who advocated for the combined use of multiple diagnostic tools to enhance accuracy, particularly in large herd surveillance.

The observed fluctuations in disease prevalence over the years may reflect multiple dynamic factors, including climatic stress, animal movement, herd replacement policies, and variable compliance with biosecurity measures. For instance, the moderate rise in prevalence in 2020 and 2021 could have been a result of cumulative stress or subclinical circulation of infection, later manifesting as the 2022 outbreak. Similar cyclical trends in brucellosis epidemiology

Table 1: Brucellosis Surveillance Data and Reproductive Outcomes in Cattle (2018–2024)

Year	Animals Tested	ELISA + (%)	RBPT + (%)	STT + (%)	Abortions (%)	Avg. Calfhoo Vaccinations
2018	200	17.5	19.5	18.0	10.5	202
2019	97	8.25	10.31	9.28	4.12	219
2020	142	11.97	14.79	12.68	6.34	124
2021	139	18.71	25.18	22.30	8.63	211
2022	72	27.78	36.11	30.56	22.22	207
2023	198	15.66	19.19	17.17	9.60	204
2024	203	16.75	20.20	18.23	10.34	202

have been documented in endemic regions across India, as discussed by Dhand and Singh (2005) and Thakur and Sharma (2018).

Moreover, the economic and public health implications of brucellosis cannot be overlooked. The disease not only compromises livestock productivity through abortions and infertility but also poses a significant zoonotic threat to farmers and veterinarians. This justifies the emphasis by OIE (2021) on adopting integrated brucellosis control strategies, including surveillance, vaccination, test-and-cull, and farmer education.

CONCLUSION

Brucellosis continues to pose a challenge to dairy herd health and productivity. The present study highlights the critical role of vaccination as a mitigating tool but reinforces that it must be part of a broader strategy including routine surveillance, accurate diagnostics, and strong farm biosecurity protocols. Disease persistence despite vaccination underscores the need for robust monitoring and traceability components along with ongoing national-level brucellosis control program.

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