Veterinary Letters
ISSN 2581-2416
DOI: https://dx.doi.org/10.29244/avl.10.3.87-88
https://journal.ipb.ac.id/index.php/arshivetlett

Quantifying slaughterhouse anthrax surveillance and economic loss prevention in Depok, Indonesia

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ABSTRACT: Slaughterhouses serve as central points for livestock aggregation and thus play an important role in disease surveillance. This study aimed to evaluate the economic impact of slaughterhouses through their role in the anthrax surveillance system in Depok, Indonesia. The economic impact of anthrax was evaluated using partial economic analysis, and the role of slaughterhouses was determined using pathway diagram analysis. The total economic impact of anthrax on livestock was estimated to be IDR 982.4 million (~USD 63,300). The largest proportion of this loss was attributed to mortality (76.9%), with cattle accounting for most commodity losses (56.0%). Slaughterhouse operations were estimated to mitigate anthrax-related economic losses of IDR 122.8 million (~USD 7,900). These findings highlight the effectiveness of slaughterhouses as surveillance units for reducing anthrax transmission and associated economic losses.

Keywords:
cattle, slaughter process, zoonosis, economic, meat supply chain

■ INTRODUCTION

Anthrax is considered a priority for zoonotic disease prevention in Indonesia, in addition to other prominent cattle diseases (Fitria *et al.* 2020, Nuriski *et al.* 2020, Syah *et al.* 2020). However, a critical concern remains the movement of livestock between areas, particularly from endemic regions that carry a higher risk of disease transmission, highlighting the importance of an effective surveillance system. Slaughterhouses serve as central points where cattle from several areas are gathered for slaughter and processed into meat; thus, they are well positioned to monitor the incidence of anthrax through proper standards for implementing ante- and postmortem measures (García-Díez *et al.* 2023). Despite their importance, slaughterhouse operations require substantial resources, including technical costs that often exceed revenue, particularly for those managed by local governments. Since their primary purpose is to prevent animal diseases and zoonoses, the public health benefits they provide outweigh their economic returns, leading to their perception as less profitable in economic terms. Therefore, this study aimed to evaluate the economic impact of slaughterhouses through their role in the anthrax surveillance system.

■ MATERIALS AND METHODS

This study was conducted in the Depok District, where the performance of a government-run slaughterhouse was evaluated. First, the economic impact of anthrax in livestock was estimated using data on livestock populations, including cattle, goats, sheep, and buffalo, as well as information on anthrax vaccination and treatment programs obtained from Indonesian statistics data (*Badan Pusat Statistik*) and expert opinions. Second, the contribution of slaughterhouses to anthrax prevention was assessed using a pathway diagram to estimate the probability of reducing the risk of anthrax across the entire supply chain.

■ RESULTS AND DISCUSSION

The estimated economic impact of anthrax in Depok was evaluated based on the type of ruminants and economic effects (Table 1). The total economic impact of anthrax in livestock was IDR 982.4 million (~USD 63,300), and the cost allocations of each impact are presented in Figure 1.

Table 1. Estimated economic impact of anthrax across livestock species and cost categories in Depok, Indonesia (in million IDR).

Economic effect	Livestock				Total (sub)
	Cattle	Goat	Sheep	Buffalo	
Death	480.0	135.0	123.0	17.6	755.6
Vaccine supply	11.6	17.8	16.1	0.4	45.9
Vaccination	34.8	53.4	48.3	1.3	137.8
Treatment	23.5	9.8	8.9	0.9	43.1
				Total	**982.4**

Received: 15-06-2026 | **Revised:** 18-07-2026 | **Accepted:** 27-07-2026

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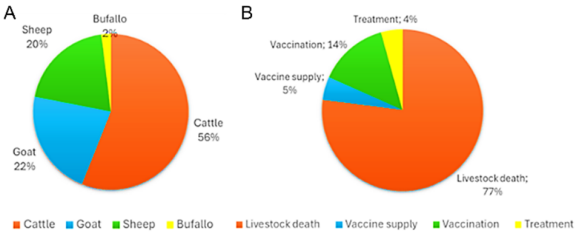


Figure 1. Overview of livestock demographics and anthrax cost allocations in Depok, Indonesia. (A) Livestock population distribution across target species. (B) Relative cost allocation of anthrax impact across disease control measures and mortality losses.

The highest impact cost was death loss (77%) due to anthrax, resulting from cattle commodity (56%). To determine the role of slaughterhouses in preventing anthrax losses, a pathway diagram was created (Figure 2).

The pathway diagram estimated that slaughterhouses had a 12.5% (P5; 25% × 1/2) probability of preventing anthrax transmission, derived from an initial 25% risk associated with the movement of ruminants from neighboring endemic areas. From this point, the supply chain diverges into two pathways, as traders may choose between slaughterhouses and private community slaughter practices. Based on this model, the slaughterhouse is estimated to prevent anthrax-related losses of IDR 122.8 million or ~USD 7.900 (1 USD = IDR 15,500).

The role of slaughterhouses could be further enhanced if private slaughtering activities were shifted to government-operated facilities that meet appropriate hygiene and disease monitoring standards. In this context, slaughterhouses should provide improved biosecurity practices to help prevent diseases such as anthrax (Wicaksono *et al.* 2017). This improvement can be achieved through government extension programs (Hidayati *et al.* 2019) and community empowerment (Arif *et al.* 2021).

This study would be more beneficial if it included an economic evaluation of slaughterhouses as an intervention for anthrax prevention, using approaches such as cost-benefit analysis (Wicaksono *et al.* 2024) or cost-effectiveness analysis (Wicaksono & Putro 2025). Furthermore, the analysis would be more comprehensive if it incorporated the human health sector using a One Health approach (Nugroho *et al.* 2019).

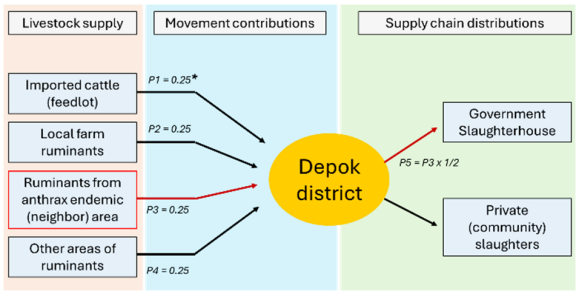


Figure 2. Pathway diagram modeling the probability of anthrax transmission mitigation and economic loss prevention by government slaughterhouses in Depok, Indonesia. Note: *) The initial transmission risk is assumed to be uniformly distributed across the four main livestock movement pathways entering the district.

■ CONCLUSION

Slaughterhouses have proven to be effective surveillance units for preventing anthrax transmission in Depok and for reducing its associated economic losses. To further enhance their role, slaughtering activities currently carried out by private communities should be shifted to slaughterhouses that operate under proper standards of hygiene and disease monitoring systems.

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■ ETHICS AND DECLARATIONS

Conflict of interest: The authors declare no conflict of interest.

Funding: This case report received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability: All data are included within the article.

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