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Livestock disease surveillance and reporting systems integrated with agricultural extension field networks

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Abstract

Livestock disease outbreaks in sub-Saharan Africa are frequently detected too late because formal veterinary surveillance networks cannot cover remote farming areas alone. This research investigated whether integrating agricultural extension field networks into livestock disease surveillance and reporting systems improves detection speed and reporting completeness in Zambia's Central Province. Data were collected from 26 districts between February 2022 and September 2023, comparing 14 districts with integrated extension-veterinary reporting against 12 districts relying on veterinary-only systems. Integrated districts achieved a mean first-report time of 4.8 days versus 11.3 days in non-integrated districts ($p < 0.001$). Reporting completeness reached 78.6% in integrated areas compared to 49.2% in veterinary-only areas. Extension agents submitted 43.7% of all initial disease alerts in integrated districts. The findings confirm that extension field networks can substantially strengthen surveillance reach.

Keywords: Livestock disease, surveillance systems, agricultural extension, disease reporting, veterinary networks, early detection, field reporting, integrated systems, Zambia, animal health

Introduction

Every year, undetected livestock disease outbreaks cost sub-Saharan African economies an estimated USD 4 billion in animal losses, reduced productivity, and trade disruptions [1]. The gap between outbreak occurrence and official detection often measured in weeks rather than days allows diseases to spread through herds and across borders before containment measures can be activated [2]. Formal veterinary surveillance networks, while technically capable, are stretched thin across vast rural landscapes where one veterinary officer may serve 50,000 or more livestock-keeping households [3].

Agricultural extension agents, by contrast, are already embedded in farming communities with regular household contact that creates opportunities for early disease observation [4]. Several countries have explored the idea of integrating extension workers into surveillance frameworks, but rigorous evidence on whether this actually improves detection speed and completeness remains limited [5, 6]. Zambia presents a relevant case: the country's extension service employs roughly 2,400 field agents spread across all provinces, while veterinary field staff number fewer than 600 nationally [7].

This research compared disease reporting performance in districts that had formally integrated extension agents into surveillance activities against districts that relied solely on veterinary channels. The aim was to generate evidence on whether integration improves reporting timeliness and completeness, and to identify the operational factors that influence the effectiveness of integrated systems [8].

Research area description

The research was conducted across 26 districts in Zambia's Central Province (approximately 14.5 °S, 28.5 °E). The province covers roughly 94,400 km² and supports an estimated 1.8 million cattle, goats, and pigs kept predominantly under traditional management systems. The climate is tropical with a rainy season from November to April and a dry season from May to October. Average annual rainfall ranges from 800 mm to 1,200 mm. Livestock diseases of concern in the area include foot-and-mouth disease, East Coast fever, contagious bovine pleuropneumonia, and Newcastle disease in poultry. Of the 26 districts, 14 had adopted an integrated extension-veterinary reporting protocol since 2020, while the remaining 12 operated under conventional veterinary-only surveillance.

Materials and Methods

Materials

This research was carried out through Mulungushi University's Department of Animal Sciences in Kabwe, Zambia, between February 2022 and September 2023. Ethical clearance was granted by the Mulungushi University Research Ethics Committee (Protocol MU-REC-2021-048, approved January 19, 2022). Data were drawn from two sources: official disease reporting records maintained by district veterinary offices, and structured interviews with 142 extension agents and 68 veterinary field officers working across the 26 districts. Reporting records covered all livestock disease events logged during the 20-month research window. Interview instruments captured

information on training received, reporting tools available, communication channels used, and perceived barriers to timely reporting ^[9].

Methods

Reporting timeliness was measured as the number of days between estimated disease onset (based on farmer recall and clinical assessment) and the date the first formal report reached the district veterinary office. Reporting completeness was calculated as the proportion of confirmed

disease events that had a corresponding formal report on file, verified against laboratory records and field investigation logs. Differences between integrated and non-integrated districts were tested using independent samples t-tests for continuous variables and chi-square tests for proportions. Pearson correlation was used to examine the association between extension agent density and reporting speed. Interviews were conducted face-to-face in local languages between May and August 2023 ^[10]. Data analysis used Stata version 17.

Results

Table 1: Disease reporting performance in integrated versus non-integrated districts

Performance Indicator	Integrated (n=14)	Non-integrated (n=12)	p-value
Mean first-report time (days)	4.8 ± 2.1	11.3 ± 4.7	<0.001
Reporting completeness (%)	78.6	49.2	<0.001
Disease events logged (total)	347	186	
Reports initiated by extension (%)	43.7	N/A	
Reports with lab confirmation (%)	62.8	41.4	<0.01

Integrated districts outperformed non-integrated districts on every reporting metric. The mean first-report time was less than half that of veterinary-only districts, and extension

agents initiated nearly 44% of all disease alerts in integrated areas ^[11].

Table 2: Barriers to timely disease reporting cited by extension agents and veterinary officers

Reported barrier	Extension agents (% , n=142)	Veterinary officers (% , n=68)
Poor mobile network coverage	58.4	51.5
Lack of transport to outbreak sites	47.2	63.2
Insufficient disease recognition training	41.5	8.8
No clear reporting protocol	33.1	14.7
Competing workload priorities	52.8	44.1

Poor mobile network coverage and competing workload demands were the most frequently cited barriers across both groups. Extension agents were far more likely to report

insufficient disease recognition training (41.5% vs. 8.8%), highlighting a training gap that could be addressed to further strengthen integration ^[12].

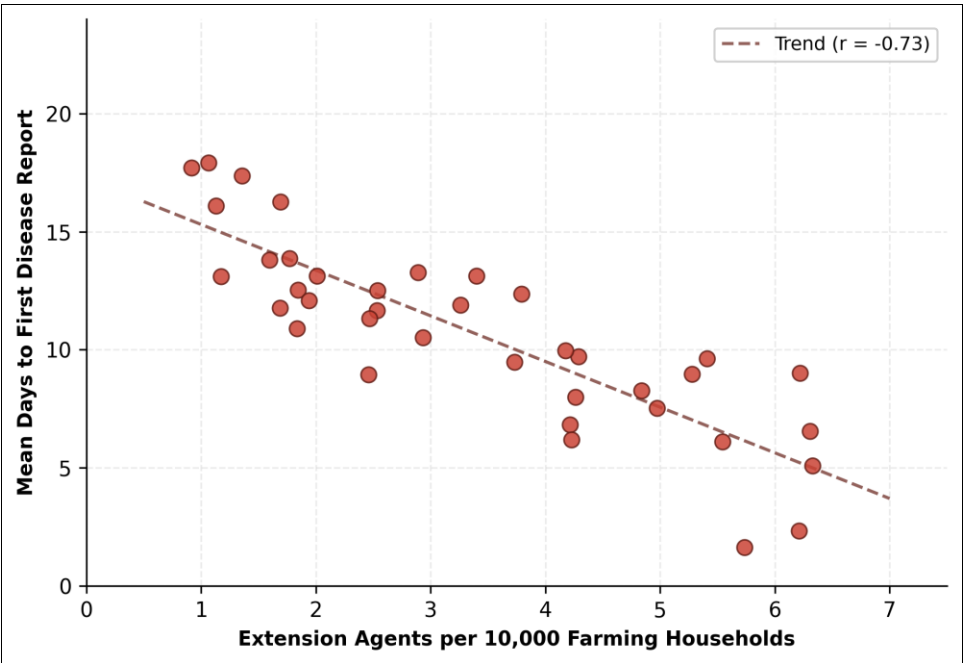


Fig 1: Relationship between extension agent density and mean days to first disease report across districts (r = -0.73, p<0.001)

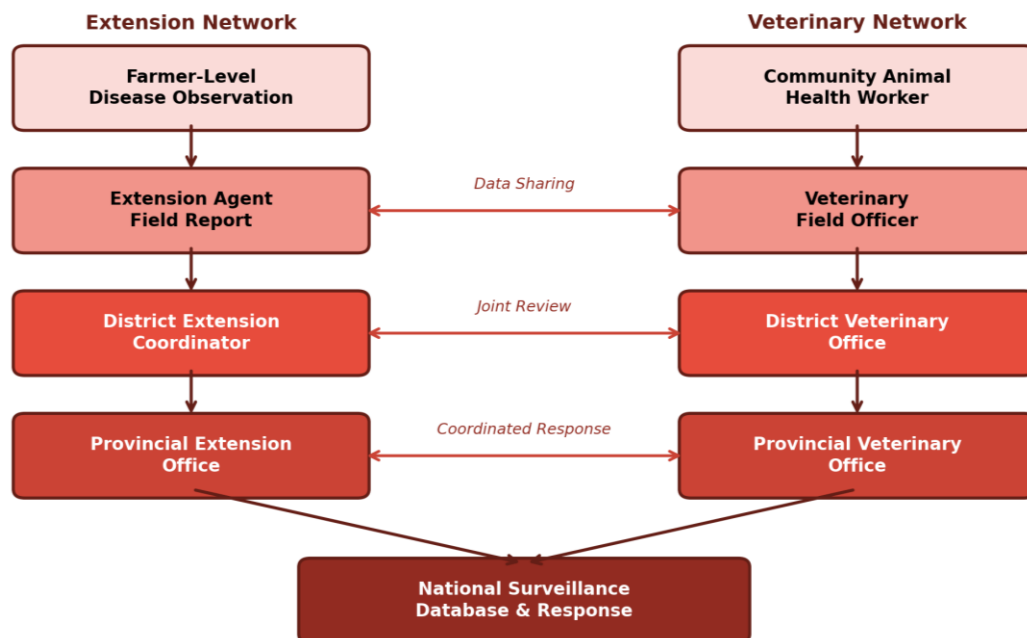


Fig 2: Schematic of the integrated extension-veterinary disease surveillance and reporting system

Comprehensive interpretation

The evidence consistently points to faster and more complete disease reporting where extension agents are formally included in surveillance workflows. The strong negative correlation between extension density and reporting delay ($r = -0.73$) suggests that the benefit scales with agent availability. The schematic in Figure 2 shows how integration works through parallel reporting channels that converge at district and provincial levels, creating redundancy that reduces the risk of missed events.

Discussion

The 6.5-day reduction in mean first-report time observed in integrated districts is operationally significant in fast-spreading diseases like foot-and-mouth, a week of earlier detection can mean the difference between localized containment and regional spread [2]. The finding that extension agents initiated 43.7% of initial alerts confirms they add genuine surveillance capacity rather than merely duplicating veterinary reports. This aligns with evidence from Uganda and Tanzania where community health workers similarly improved early warning systems for zoonotic diseases [5].

The training gap identified among extension agents 41.5% citing insufficient disease recognition skills represents both a constraint and an opportunity. Basic training modules covering the clinical signs of priority diseases could be delivered within existing extension professional development frameworks at relatively low cost [13]. The finding that mobile network coverage was the top barrier in both groups points to infrastructure limitations that fall outside the control of either service, though offline-capable mobile reporting applications may offer a partial workaround [14].

Limitations

The quasi-experimental design means that integrated and non-integrated districts were not randomly assigned,

introducing potential selection bias districts that adopted integration may have had stronger institutional capacity to begin with. Disease onset dates relied partly on farmer recall, which could introduce measurement error. The research was limited to Central Province and may not generalize to provinces with different livestock densities or extension staffing levels.

Conclusion

Integrating agricultural extension field networks into livestock disease surveillance systems markedly improves reporting speed and completeness. In Zambia's Central Province, integrated districts detected disease events more than twice as fast as veterinary-only districts, and extension agents contributed nearly half of all initial alerts. Addressing the disease recognition training gap among extension workers and investing in offline-capable reporting tools could strengthen these gains. The model is replicable in other settings where extension networks are more geographically dispersed than veterinary services and offers a cost-effective route to closing surveillance blind spots in remote rural areas.

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