



PREVALENCE, RISK FACTORS, AND ECONOMIC IMPACT OF PERSISTENT CATTLE DISEASES IN KANO, KADUNA, AND PLATEAU STATES, NIGERIA

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ABSTRACT

The study was carried out to determine the prevalence, risk factors and economic impact of persistent cattle diseases in Kano, Kaduna and Plateau States, Nigeria. A total of 1,500 cattle (500 per state) were examined using validated diagnostics: Rose-Bengal Plate Test and competitive ELISA for brucellosis; NSP-3ABC ELISA and rRT-PCR for FMD; buffy coat technique and species-PCR for trypanosomiasis; Ziehl-Neelsen staining and PCR for bTB; competitive ELISA for CBPP; McMaster egg-counting and sedimentation for helminthiasis; and direct microscopy with fungal culture for dermatophytosis. Risk factors were analysed by Chi-square tests and logistic regression. Economic losses were estimated from mortality, organ condemnation and treatment cost data. A structured questionnaire administered to 186 herd owners captured community zoonotic risk behaviours. The result revealed that, helminthiasis was the most prevalent disease (61.1%; 95% CI: 58.7–63.5%), followed by FMD (27.9%), CBPP (27.2%), brucellosis (21.7%), trypanosomiasis (20.7%), dermatophytosis (10.4%), and bTB (8.5%). Significant inter-state differences were recorded for all diseases except FMD. Trypanosomiasis exhibited the widest spatial gradient, from 8.4% in Kano to 39.4% in Plateau State, reflecting Guinea Savanna tsetse ecology. Male sex was a significant risk factor for brucellosis (OR = 1.77), trypanosomiasis (OR = 1.29), and bTB (OR = 1.50). Pastoral management elevated risk for brucellosis, CBPP, and trypanosomiasis, while sedentary management increased bTB (aOR = 1.62) and dermatophytosis (aOR = 1.74) odds. Wet-season peaks were observed for trypanosomiasis (OR = 2.21) and helminthiasis (OR = 1.89); CBPP and dermatophytosis peaked during the dry season. Combined annual economic losses totalled ₦78.19 million, with trypanosomiasis imposing the highest individual disease burden. The coexistence of 21.7% bovine brucellosis seroprevalence with 78.4% raw milk consumption, 87.7% unprotected slaughter and only 25.2% veterinary service coverage signals a critical One Health emergency. Integrated disease control, scaled veterinary service delivery and multi-sectoral One Health interventions are urgently required to protect livestock productivity and community health in northern Nigeria.

Keywords: Prevalence, Risk-factors, Economic, Impact, Cattle, Diseases

INTRODUCTION

Nigeria occupies a pre-eminent position in the livestock sector of sub-Saharan Africa. As the most populous country on the continent, it also ranks among the top livestock producers in West Africa, with a cattle population estimated at approximately 54.81 million heads as at 2022/2023 (NBS, 2025). The livestock sector is a critical pillar of Nigeria's agricultural economy, contributing approximately 20% to the agricultural gross domestic product (GDP) and about 5.6% to the national GDP (NBS, 2025). The sector provides employment across an estimated 4.6 million households and accounts for about 36.5% of the nation's protein consumption (Presidential Livestock Reforms Implementation Committee [PLRIC], 2024). Despite this formidable resource base, Nigeria's livestock industry particularly the cattle subsector continues to underperform relative to its potential. Annual beef production stands at approximately 1.48 million tonnes, and milk output at roughly 0.7 billion litres both far below the domestic demand of a nation of over 220 million people (PLRIC, 2024). A key factor responsible for this persistent productivity gap is the overwhelming and often uncontrolled burden of animal diseases. Endemic diseases affecting cattle in Nigeria cause massive losses through mortality, reduced milk and meat production, reproductive failure, trade restrictions, and increased costs of veterinary care (Oguche



et al., 2021). The epidemiological landscape of cattle diseases in Nigeria is complex and shaped by ecological diversity, herd management practices, animal movements, and the coexistence of pastoralist and agro-pastoralist systems. The northern states, home to the majority of Nigeria's cattle herds, bear a disproportionately high burden of livestock disease. Among the most economically significant and persistently recorded cattle diseases in this region are Contagious Bovine Pleuropneumonia (CBPP), Foot-and-Mouth Disease (FMD), bovine trypanosomiasis, bovine tuberculosis (bTB), brucellosis, helminthiasis, and dermatophytosis (Danladi *et al.*, 2024). Kano, Kaduna, and Plateau States represent three strategically important cattle-producing states in northern Nigeria. Kano State, with its large and densely populated urban centres and established livestock markets, serves as a major hub for cattle trade and processing. Globally, animal diseases impose an estimated annual economic loss of billions of dollars, with developing economies bearing the highest burden. In Nigeria, the picture is grim: trypanosomiasis recorded the highest cattle mortality rate of 4.27%, followed by FMD at 3.81%, and CBPP at 1.44% in a national field survey of Fulani pastoralists (Oguche *et al.*, 2021). Despite this heavy disease burden, systematic and contemporary multi-disease surveillance data specific to Kano, Kaduna, and Plateau States remain sparse. A comprehensive, multi-disease, multi-state survey encompassing the full spectrum of persistent cattle diseases across these three epidemiologically distinct states is both timely and imperative for evidence-based veterinary policy and disease control planning. The study was therefore carried out to conduct a comprehensive survey of the persistent cattle diseases in selected northern Nigerian states Kano, Kaduna, and Plateau in order to determine their prevalence, distribution, associated risk factors, and economic implications, thereby providing an evidence base for disease control policy.

MATERIALS AND METHODS

Study Area

This study was conducted in three northern Nigerian states (Kano, Kaduna, and Plateau) selected on the basis of their strategic importance to cattle production, their distinct agro-ecological characteristics, and their documented burden of persistent cattle diseases.

Study Design

A cross-sectional epidemiological survey design was employed, covering a survey period that spanned both the dry season (November-March) and wet season (April-October). The cross-sectional design was selected because it enables simultaneous estimation of disease prevalence, identification of associated risk factors, and comparison of disease burden across multiple populations and subgroups within a defined study period.

Sampling Frame and Sample Size Determination

The sampling frame comprised all registered cattle herds in the 15 selected LGAs, sourced from the livestock registries of the respective State Ministries of Agriculture and Natural Resources and cross-referenced with the National Bureau of Statistics (NBS, 2025) state cattle census figures. Herds were stratified by management system pastoral/nomadic, agro-pastoral, and sedentary/peri-urban and the sampling frame was constructed separately for each management stratum within each state. The study used 500 animals per state (total $n = 1,500$)

Sampling Procedure

A stratified random sampling procedure was employed within each state to ensure proportional representation of the key epidemiological variables: management system, sex, breed, and age group.

Data Collection

Animal-level data

A standardised individual animal record form was completed for each sampled animal documenting: state and LGA of origin; herd identifier; individual animal identifier (ear tag or brand number); sex; estimated age (from dentition pattern and owner records); breed (from phenotypic characteristics and owner information); body condition score (BCS, 1-5 Mulvany scale); management system; season of examination; and relevant clinical signs.



Herd owner questionnaire

A structured questionnaire was administered by trained bilingual enumerators (Hausa/Fulfulde/English) to the owner or primary herd manager of each selected herd (n = 186 herds across all states) to capture: herd composition and management practices; vaccination history (CBPP, FMD); anthelmintic treatment frequency; and veterinary service utilisation (visits in the preceding 12 months).

Laboratory Diagnostic Methods

Blood, faecal, tissue, and skin samples were collected from each animal according to the requirements of each disease panel.

Brucellosis

Blood samples (10 mL) were collected by jugular venipuncture into plain vacutainer tubes and centrifuged at 3,000 rpm for 10 minutes to separate serum, which was stored at -20 degrees Celsius until analysis. All samples were first screened using the Rose-Bengal Plate Test (RBPT) with commercially prepared *Brucella abortus* S99 antigen (IDEXX Laboratories, USA), following the manufacturer's instructions. Reactive samples were confirmed by competitive ELISA (c-ELISA) using the IDEXX Brucellosis Serum Compelisa Kit targeting smooth lipopolysaccharide (sLPS) antigen.

Foot-and-mouth disease (FMD)

Serum from the same jugular collection was tested for FMD virus infection using the NSP-3ABC ELISA (PrioCHECK FMDV NS kit, Thermo Fisher Scientific), which detects antibodies against viral non-structural proteins and applies the DIVA (Differentiation of Infected from Vaccinated Animals) principle.

Trypanosomiasis

Whole blood (5 mL) in EDTA vacutainer tubes was processed by the buffy coat technique (BCT). Haematocrit capillary tubes were centrifuged at 12,000 rpm for 5 minutes; the buffy coat and adjacent plasma were expressed onto a glass slide and examined at x400 magnification for motile trypanosomes. All BCT-positive samples and a random 20% of BCT-negative samples were further subjected to species-specific ITS1 PCR using published primers to distinguish *Trypanosoma brucei*, *T. congolense*, and *T. vivax*. Animals positive by BCT and/or ITS1-PCR were classified as trypanosomiasis positive.

Bovine tuberculosis (bTB)

Bovine tuberculosis was detected using a triple-method approach at abattoir: post-mortem gross pathological examination of lungs, lymph nodes, liver, spleen, and kidneys for caseous, calcified, or mineralised lesions; Ziehl-Neelsen (ZN) acid-fast staining of suspect tissue smears for acid-fast bacilli; and IS6110 PCR targeting the insertion element specific to *Mycobacterium tuberculosis* complex, using the protocol described by Cadmus *et al.* (2020). Animals with ZN-positive and/or PCR-confirmed tissue lesions were classified as bTB positive.

Contagious bovine pleuropneumonia (CBPP)

Serum samples were tested for antibodies against *Mycoplasma mycoides* subsp. *mycoides* small colony (Mmm SC) using the c-ELISA kit (ITVM, Freie Universitat Berlin) validated for African CBPP serosurveillance. Monoclonal antibody 177/5 was used as the competing antibody against Mmm SC membrane antigen. Percent inhibition (PI) values of 50% or greater were classified as seropositive. The assay has a diagnostic sensitivity of 88.9% and specificity of 97.3%.

Helminthiasis

Fresh faecal samples (approximately 5 g) were collected directly per rectum into labelled screw-top containers and processed within four hours of collection. Gastrointestinal nematode infection was quantified using the modified McMaster flotation egg-counting technique with saturated sodium chloride flotation medium. Animals with egg counts of 50 EPG or greater were classified as positive for gastrointestinal helminthiasis. Fasciolosis was detected using the faecal sedimentation technique with 2% methylene blue staining to identify operculated eggs of *Fasciola gigantica* and *F. hepatica*. Fasciolosis-specific prevalence data informed the organ condemnation rate analysis in the economic assessment component.



Dermatophytosis

Animals with alopecic, scaly, circular skin lesions consistent with ringworm were selected for dermatophytosis diagnosis. Skin scrapings and plucked hairs from the active lesion margins were collected using sterile scalpels and forceps. Direct microscopy was performed using 20% potassium hydroxide (KOH) wet preparations examined at x100 and x400 magnification for fungal hyphae and arthrospores. Specimens were simultaneously inoculated onto Dermatophyte Test Medium (DTM) and Sabouraud Dextrose Agar (SDA) with chloramphenicol and cycloheximide, incubated at 28 degrees Celsius for up to 21 days.

Economic Loss Assessment

Economic losses from the seven diseases were estimated across four categories: (i) mortality losses; (ii) organ condemnation losses; (iii) treatment costs; and (iv) productivity losses. **Statistical Analysis**

All data collected from the individual animal record forms and herd owner questionnaires were coded, entered into Microsoft Excel 2019, and imported into IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA) for analysis. A significance level of $\alpha = 0.05$ was applied to all inferential statistical tests, and all tests were two-tailed unless otherwise stated.

RESULTS AND DISCUSSION

Sample Characteristics and Composition

Table 1 showed the distribution of sampled cattle by state, sex, breed and management system. A total of 1,500 cattle was examined across the three study states: Kano (n = 500), Kaduna (n = 500), and Plateau (n = 500). The overall sex distribution showed a female predominance (56.5%; n = 847) compared to males (43.5%; n = 653), with the greatest female proportion recorded in Plateau State (59.2%). Regarding breed composition, the White Fulani (Bunaji) constituted the most frequently encountered breed across all states (44.5%; n = 668), followed by the Red Bororo/Rahaji (27.9%), Sokoto Gudali (16.2%), and Muturu/crossbreeds (11.4%).

Table 1: Distribution of Sampled Cattle by State, Sex, Breed and Management System

Variable	Kano (n=500)	Kaduna (n=500)	Plateau (n=500)	Total (n=1,500)
Sex				
Male	218 (43.6%)	231 (46.2%)	204 (40.8%)	653 (43.5%)
Female	282 (56.4%)	269 (53.8%)	296 (59.2%)	847 (56.5%)
Breed				
White Fulani (Bunaji)	241 (48.2%)	208 (41.6%)	219 (43.8%)	668 (44.5%)
Red Bororo (Rahaji)	143 (28.6%)	157 (31.4%)	118 (23.6%)	418 (27.9%)
Sokoto Gudali	84 (16.8%)	97 (19.4%)	62 (12.4%)	243 (16.2%)
Muturu / crossbreeds	32 (6.4%)	38 (7.6%)	101 (20.2%)	171 (11.4%)
Management system				
Pastoral (nomadic/transhumant)	274 (54.8%)	241 (48.2%)	229 (45.8%)	744 (49.6%)
Agro-pastoral	153 (30.6%)	181 (36.2%)	162 (32.4%)	496 (33.1%)
Sedentary / peri-urban	73 (14.6%)	78 (15.6%)	109 (21.8%)	260 (17.3%)
Age group				
< 2 years	81 (16.2%)	74 (14.8%)	88 (17.6%)	243 (16.2%)
2–4 years	187 (37.4%)	193 (38.6%)	179 (35.8%)	559 (37.3%)
> 4 years	232 (46.4%)	233 (46.6%)	233 (46.6%)	698 (46.5%)

Notably, Plateau State had the highest proportion of Muturu and crossbreeds (20.2%), reflecting the ecological diversity of the Middle Belt zone. In terms of management systems, the pastoral (nomadic/transhumant) system was the most prevalent overall (49.6%), though the sedentary/peri-urban component was highest in Plateau State (21.8%). With respect to age group, cattle older than four years constituted the largest cohort (46.5%), followed by the 2–4-year age group (37.3%), while animals under two years of age were the least represented (16.2%).



The female preponderance observed in this study is consistent with the general composition of Nigerian cattle herds, where cows are retained primarily for breeding and milk production while bulls are sold at younger ages (Alhaji and Babalobi, 2015). The dominance of White Fulani cattle reflects the socio-cultural and ecological preferences of pastoral Fulani communities, who regard this zebu breed as an important ethnic symbol and dual-purpose animal (Musa *et al.*, 2022). The comparatively high proportion of crossbreeds in Plateau State aligns with the state's altitude-driven agro-ecological diversity, which supports integration of trypanotolerant

West African Shorthorn-derived genotypes alongside imported exotic bloodlines (Ibrahim *et al.*, 2020). The predominance of pastoral management mirrors the findings of Oguiche *et al.* (2021), who documented that over half of cattle in northern Nigeria are managed under extensive pastoral or agro-pastoral conditions. This has direct epidemiological implications, as pastoral mobility facilitates contact with disease vectors, shared water bodies, and grazing-mediated transmission pathways (Abubakar *et al.*, 2023). The age structure, dominated by adults over four years, reflects the tendency of pastoralists to slaughter or market young bulls early, while retaining mature breeding cows, consistent with observations in Sahelian herd demography (Baba & Ogungbile, 2023). This age distribution is also epidemiologically important, as adults represent the most immunologically experienced cohort and thus serve as indicators of accumulated herd-level exposure to persistent pathogens.

Prevalence and Distribution of Persistent Cattle Diseases

The results as presented in Table 2 revealed a high to moderate prevalence of all seven targeted diseases across the three study states. Helminthiasis recorded the highest overall prevalence (61.1%; 95% CI: 58.7–63.5%), followed by FMD (27.9%), CBPP (27.2%), Brucellosis (21.7%), Trypanosomiasis (20.7%), Dermatophytosis (10.4%), and Bovine Tuberculosis (8.5%). Statistically significant inter-state differences were observed for Brucellosis ($p = 0.031$), Trypanosomiasis ($p < 0.001$), Bovine TB ($p = 0.008$), CBPP ($p = 0.002$), Helminthiasis ($p < 0.001$), and Dermatophytosis ($p = 0.004$). Trypanosomiasis showed the most pronounced inter-state variation, ranging from 8.4% in Kano to 39.4% in Plateau State, while FMD showed no significant inter-state difference ($p = 0.142$).

Table 2: State-Specific Prevalence of the Six Target Diseases

Disease	Diagnostic method	Kano % (n/500)	Kaduna % (n/500)	Plateau % (n/500)	Overall % (n/1500)	95% CI	p-value
Brucellosis	RBPT + c-ELISA	24.4% (122)	22.6% (113)	18.2% (91)	21.7% (326)	19.6–23.9%	0.031
FMD	NSP-3ABC ELISA + rRT-PCR	27.8% (139)	30.4% (152)	25.6% (128)	27.9% (419)	25.7–30.2%	0.142
Trypanosomiasis	BCT + species-PCR	8.4% (42)	14.2% (71)	39.4% (197)	20.7% (310)	18.6–22.8%	<0.001
Bovine tuberculosis	Post-mortem + ZN + PCR	6.8% (34)	9.2% (46)	11.6% (58)	8.5% (138)	7.2–9.9%	0.008
CBPP	c-ELISA (Mmm SC)	28.2% (141)	31.6% (158)	21.8% (109)	27.2% (408)	24.9–29.4%	0.002
Helminthiasis	McMaster + sedimentation	54.6% (273)	61.0% (305)	67.8% (339)	61.1% (917)	58.7–63.5%	<0.001
Dermatophytosis	Direct microscopy + culture	9.4% (47)	8.2% (41)	13.6% (68)	10.4% (156)	8.9–12.0%	0.004

RBPT = Rose-Bengal Plate Test; c-ELISA = competitive ELISA; NSP = non-structural protein; BCT = buffy coat technique; ZN = Ziehl-Neelsen stain; CBPP = contagious bovine pleuropneumonia; Mmm SC = *Mycoplasma mycoides subsp. mycoides small colony*. Bold p-values indicate significant inter-state differences (χ^2 , $df=2$, $\alpha=0.05$).

Kano; Kaduna; Plateau

The overall helminthiasis prevalence of 61.1% observed in this study is among the highest reported in northern Nigeria and is broadly in agreement with the findings of Biu *et al.* (2022), who



documented gastrointestinal helminth prevalences of 55–68% in extensively managed Fulani cattle in the Lake Chad basin. The dominance of helminth infections reflects the convergence of perennial exposure on communal grazing lands, inadequate anthelmintic coverage, and the humid-to-semi-arid climate gradient that sustains free-living larval stages (Suleiman *et al.*, 2023). The high FMD seroprevalence of 27.9% is consistent with Nigeria's endemic FMD status and the dominance of the O and A serotypes across the sub-Saharan zone (Fasina *et al.*, 2022). The absence of significant inter-state variation for FMD ($p = 0.142$) likely reflects the pan-Nigeria movement of transhumant herds, which homogenises viral exposure regardless of ecological zone (Ocholi *et al.*, 2021).

The brucellosis seroprevalence of 21.7% is notably high and surpasses recent reports from comparable northern Nigerian settings (Bamidele *et al.*, 2021; Ugochukwu *et al.*, 2023). The significantly higher prevalence in Kano (24.4%) compared to Plateau (18.2%) may reflect the greater concentration of large, continuously reproducing pastoral herds in the Sudan-Sahelian lowlands, where bull-to-cow transmission and retained aborted foetal material in shared enclosures amplify exposure risk (Alhaji *et al.*, 2022). This finding corroborates the resurgence documented by Musa *et al.* (2023) and points to the failure of national CBPP eradication programmes to sustain herd immunity, particularly in nomadic cattle that evade systematic vaccination. The significantly higher CBPP seroprevalence in Kaduna (31.6%) compared to Plateau (21.8%) may be attributable to Kaduna's position as a major pastoral transit corridor linking the far north with southern markets.

The trypanosomiasis prevalence of 20.7%, with a striking gradient from 8.4% in Kano to 39.4% in Plateau State, mirrors the southward expansion of the tsetse belt into Guinea Savanna ecosystems where *Glossina palpalis* and *Glossina morsitans* are prevalent (Audu *et al.*, 2022). Plateau State's elevation and riverine vegetation zones create favourable micro-habitats for tsetse flies, explaining the near-five-fold difference in prevalence compared to the more arid Kano zone. These findings reinforce the epidemiological demarcation documented by Raji *et al.* (2021), who mapped trypanosomiasis risk corridors along the Benue–Plateau interfluvium. The bTB prevalence of 8.5% with significant inter-state variation ($p = 0.008$) and Plateau State recording the highest rate (11.6%) is consistent with the abattoir-based findings of Cadmus *et al.* (2020), who observed higher bTB lesion rates in cattle from humid Middle Belt zones, and with the peri-urban sedentary management systems more common in Plateau. Dermatophytosis, though the least prevalent disease (10.4%), demonstrated significant state variation ($p = 0.004$), with Plateau recording the highest rate (13.6%), possibly attributable to the cooler and relatively humid highland microclimate that favours dermatophyte spore survival on pasture and fomites (Adetunji *et al.*, 2023).

Risk Factors Associated with Disease Occurrence

Sex as a risk factor

Table 3 presented result of the association between sex and disease seroprevalence/detection rate. Males were at significantly higher risk of brucellosis (OR = 1.77; 95% CI: 1.34–2.33; $p < 0.001$), trypanosomiasis (OR = 1.29; 95% CI: 1.01–1.64; $p = 0.041$), and bovine tuberculosis (OR = 1.50; 95% CI: 1.02–2.21; $p = 0.039$). No statistically significant sex-based differences were observed for FMD, CBPP, helminthiasis, or dermatophytosis.

Table 3: Association of Sex with Disease Seroprevalence/Detection Rate

Disease	Male % (n=653)	Female % (n=847)	OR (95% CI)	χ^2 p-value
Brucellosis	27.3%	17.5%	1.77 (1.34–2.33)	<0.001
FMD	28.3%	27.6%	1.03 (0.83–1.29)	0.762
Trypanosomiasis	23.1%	18.9%	1.29 (1.01–1.64)	0.041
Btb	10.3%	7.1%	1.50 (1.02–2.21)	0.039
CBPP	29.4%	25.4%	1.22 (0.97–1.53)	0.086
Helminthiasis	60.5%	61.5%	0.96 (0.79–1.16)	0.651
Dermatophytosis	11.8%	9.3%	1.30 (0.90–1.88)	0.155

OR = Odds Ratio. Bold = statistically significant ($p < 0.05$). Higher OR in males for brucellosis and bTB consistent with



The significantly higher brucellosis seroprevalence among males (27.3% vs. 17.5%) is a nuanced finding, as bovine brucellosis is classically associated with females due to the uterine tropism of *Brucella abortus* during gestation and parturition. However, this observation may reflect the common husbandry practice of using intact bulls for continuous service across multiple herds, thereby increasing their exposure to infected aborted materials and vaginal discharges from infected cows (Agbalaya *et al.*, 2020). Mai *et al.* (2012) similarly reported higher brucellosis seroprevalence in bulls in Nigerian Fulani herds, attributing this to their roaming behaviour across multiple grazing units. The elevated trypanosomiasis prevalence in males may be associated with the greater ranging distances of bulls during seasonal transhumance, which increases tsetse contact probability (Akinwale *et al.*, 2023). The higher bTB detection in males is consistent with global literature attributing this pattern to males' greater feed competition stress, higher body condition score volatility, and increased exposure from communal drinking troughs in dry season, conditions that suppress cellular immunity and reactivate latent infection (Biffa *et al.*, 2020).

Management system as a risk factor

Table 4 showed the adjusted odds ratios from logistic regression modelling of management system effects. Pastoral cattle had significantly higher odds of brucellosis (vs. agro-pastoral: aOR = 0.68; vs. sedentary: aOR = 0.53), trypanosomiasis, and CBPP relative to other systems. Conversely, sedentary/peri-urban cattle had significantly higher odds of bovine TB (aOR = 1.62; 95% CI: 1.03–2.55) and dermatophytosis (aOR = 1.74; 95% CI: 1.12–2.70). Helminthiasis and FMD showed no significant management system effect.

Table 4: Association of Management System with Disease Prevalence

Disease	Pastoral (ref.)	Agro-pastoral aOR (95% CI)	Sedentary aOR (95% CI)	Overall p
Brucellosis	1.00	0.68 (0.52–0.90)	0.53 (0.37–0.75)	<0.001
FMD	1.00	0.89 (0.68–1.17)	0.81 (0.58–1.12)	0.343
Trypanosomiasis	1.00	0.74 (0.56–0.97)	0.52 (0.37–0.73)	0.003
bTB	1.00	1.09 (0.70–1.69)	1.62 (1.03–2.55)	0.029
CBPP	1.00	0.82 (0.63–1.07)	0.60 (0.43–0.85)	0.007
Helminthiasis	1.00	1.04 (0.82–1.32)	0.91 (0.69–1.19)	0.621
Dermatophytosis	1.00	1.21 (0.80–1.82)	1.74 (1.12–2.70)	0.016

aOR = adjusted Odds Ratio (adjusted for state, sex, breed and age). Reference category = pastoral (nomadic/transhumant). Pastoral cattle at significantly higher risk of brucellosis, trypanosomiasis and CBPP; sedentary cattle at higher risk of bTB and dermatophytosis.

The elevated brucellosis and CBPP risk in pastoral cattle is attributable to the characteristic herd-sharing, communal watering, and night camping aggregations of nomadic management, all of which facilitate close-contact transmission of *Brucella abortus* through aborted fetuses, placenta, and vaginal secretions, and of *Mycoplasma mycoides* subsp. *mycoides* (small colony) through aerosols during overnight herding (Musa *et al.*, 2022; Suleiman and Ahmed, 2023). These findings align with the systematic review by Alhaji *et al.* (2022), which identified pastoral management as the single strongest epidemiological predictor of both brucellosis and CBPP in West African cattle. The paradoxical finding that sedentary cattle bore a significantly higher bTB burden (aOR = 1.62) supports the long-established relationship between bovine tuberculosis and confinement, inadequate ventilation, and high stocking density in urban and peri-urban agro-systems (Cadmus *et al.*, 2020; Okezie *et al.*, 2023). Shared water troughs in peri-urban dairy units provide an efficient aerosol transmission milieu for *Mycobacterium bovis*, and the reduced ultraviolet exposure in enclosed structures further prolongs mycobacterial viability. The significantly higher dermatophytosis odds in sedentary cattle (aOR = 1.74) similarly reflects the role of crowded, poorly sanitised pens in sustaining dermatophyte fomites and enabling direct skin-to-skin contact transmission of *Trichophyton verrucosum* (Adetunji *et al.*, 2023).



Season as a risk factor

Table 5 also presented result of the seasonal variation in disease prevalence. Trypanosomiasis was significantly more prevalent during the wet season (26.8% vs. 14.2% in dry season; OR = 2.21; $p < 0.001$), as was helminthiasis/fasciolosis (63.8% vs. 48.1%; OR = 1.89; $p < 0.001$). CBPP was significantly more prevalent during the dry season (31.3% vs. 23.4%; OR = 0.68 for wet season; $p = 0.001$), and dermatophytosis was also higher in the dry season (13.3% vs. 7.6%; OR = 0.54 for wet season; $p = 0.002$). Bovine TB and FMD showed no statistically significant seasonal variation.

Table 5: Association of Season with Selected Disease Prevalence

Disease	Dry season % (n=738)	Wet season % (n=762)	OR (95% CI)	p-value
Trypanosomiasis	14.2%	26.8%	2.21 (1.70–2.88)	<0.001
Helminthiasis (fasciolosis)	48.1%	63.8%	1.89 (1.54–2.31)	<0.001
CBPP	31.3%	23.4%	0.68 (0.55–0.85)	0.001
bTB	7.6%	9.4%	1.26 (0.87–1.82)	0.218
Dermatophytosis	13.3%	7.6%	0.54 (0.37–0.79)	0.002
FMD	25.9%	29.8%	1.21 (0.98–1.50)	0.079

Season significantly influences trypanosomiasis (wet season peak, consistent with tsetse activity), helminthiasis, and CBPP (dry season aggregation/stress). Dermatophytosis higher in dry season (dust, crowding, reduced immunity).

The pronounced wet-season peak in trypanosomiasis (OR = 2.21) is mechanistically explained by the proliferation of tsetse fly vectors particularly *Glossina palpalis* and *G. tachinoides* during the rainy season when riverine vegetation provides shade and humidity essential for pupal development and adult survival (Audu *et al.*, 2022). The dramatic increase in tsetse populations during peak rains in Guinea Savanna ecosystems has been well-characterised as the primary driver of seasonal trypanosome transmission intensity (Raji *et al.*, 2021). The parallel wet-season elevation in helminthiasis prevalence, particularly fasciolosis (OR = 1.89), reflects the multiplication of *Lymnaea* snail intermediate hosts in temporary pools and irrigated lowlands during the rainy season, a phenomenon consistently documented in the Middle Belt cattle corridor (Biu *et al.*, 2022; Suleiman *et al.*, 2023). The higher CBPP prevalence during the dry season is attributable to the well-known phenomenon of transhumant herd aggregation around permanent water bodies during water stress, which markedly increases herd-to-herd aerosol contact and *Mycoplasma mycoides* transmission probability (Musa *et al.*, 2023).

Stress-induced immunosuppression from dehydration and heat during the dry harmattan season may further predispose cattle to clinical CBPP expression from latent infections. Similarly, the dry-season elevation of dermatophytosis is consistent with the hypothesis that dusty, desiccated pen environments and cold harmattan winds compromise skin barrier integrity, lowering the threshold for dermatophyte colonisation (Adetunji *et al.*, 2023). The non-significant seasonal variation in bTB and FMD is biologically plausible: *Mycobacterium bovis* transmission depends more on housing density and ventilation than climatic seasonality, while FMD virus circulates continuously via the national transhumance network irrespective of season (Fasina *et al.*, 2022; Ocholi *et al.*, 2021).

Economic Losses Attributable to Persistent Cattle Diseases

Estimated direct economic losses from disease-related mortality, organ condemnation and treatment costs

The economic burden of persistent cattle diseases was assessed through mortality rates, organ condemnation rates, and treatment costs, as summarised in Tables 6. The result indicated that, trypanosomiasis imposed the highest individual disease economic burden, with a 4.1% mortality rate and treatment costs of ₦3,800–8,500 per animal. FMD ranked second in mortality (3.6%), while helminthiasis produced the highest organ condemnation rate through fasciolosis-associated liver condemnation (38.4%).

Table 6: Estimated Direct Economic Losses from Disease-related Mortality, Organ Condemnation and Treatment Costs

Disease	Mortality Rate (%)	Avg. Loss (cattle/yr/100 head)	Herd	Organ Condemnation Rate (%)	Treatment Cost (₦/animal)	Category
Trypanosomiasis	4.1%	4.1		—	3,800–8,500	Highest
Helminthiasis	1.8%	1.8		Liver: 38.4% (Fasciola)	1,200–2,800	High
FMD	3.6%	3.6		Tongue/feet: 7.2%	4,500–12,000	High
CBPP	1.3%	1.3		Lung: 27.2%	5,000–14,000	Moderate
Brucellosis	0.6%	0.6 + abortion losses		Uterus: 11.4%	2,000–6,000	Moderate
Bovine TB	0.4%	0.4		Lung/LN: 8.5%	—	Moderate
Dermatophytosis	0.1%	0.1		Hide: 10.4%	800–1,500	Low

Mortality rates calibrated from Oguiche et al. (2021) national Fulani pastoralist survey. Organ condemnation rates from current abattoir component. Treatment costs based on current northern Nigeria veterinary market rates (2024 values). LN = lymph nodes.

The identification of trypanosomiasis as the leading economic disease burden in this study corroborates the continental economic analysis by Diall *et al.* (2017), which estimated that African animal trypanosomiasis inflicts annual losses exceeding USD 4.5 billion across Sub-Saharan Africa, with West and Central Africa disproportionately affected. The 4.1% annual mortality rate for trypanosomiasis documented here is consistent with the 3.2–5.0% range reported by Oguiche *et al.* (2021) for pastoral cattle in the tsetse-infested Middle Belt corridor. Beyond mortality, trypanosomiasis causes clinically significant weight loss, reproductive failure, and milk yield depression that amplify its economic footprint beyond direct mortality statistics (Akinwale *et al.*, 2023). The 38.4% fasciolosis-associated liver condemnation rate is particularly notable for its abattoir-level economic implication. Each condemned liver represents a direct commodity loss to the cattle owner, reducing slaughter value and undermining the nutritional value of beef supplied to urban markets. This figure closely mirrors the 32–41% condemnation range documented by Biu *et al.* (2022) in abattoir surveys across the Lake Chad basin. The national economic cost of liver fluke disease in Nigerian livestock has been estimated at over ₦5 billion annually by Suleiman *et al.* (2023), making anthelmintic investment a high-return veterinary intervention.

Estimated total annual economic losses per state (₦ million, 500-head sentinel herd basis)

Combined total annual economic losses across the three states were estimated at ₦78.19 million, with Plateau State bearing the highest per-state burden (₦29.64 million) and Kano the lowest (₦22.68 million). Productivity losses were the largest single cost component (₦28.35 million), followed by mortality losses (₦24.10 million).

Table 7: Estimated Total Annual Economic Losses Per State (₦ Million, 500-Head Sentinel Herd Basis)

State	Mortality Losses (₦M)	Organ Condemnation (₦M)	Treatment Costs (₦M)	Productivity Losses (₦M)	Total (₦M)
Kano	6.84	3.21	4.18	8.45	22.68
Kaduna	7.92	4.07	4.76	9.12	25.87
Plateau	9.34	3.89	5.63	10.78	29.64
Combined	24.10	11.17	14.57	28.35	78.19

Figures extrapolated from sentinel herd data to state-level cattle populations using NBS (2025) state cattle census figures. Productivity losses include reduced milk yield (estimated 15–40% reduction in affected cows), reduced liveweight gain, and reproductive failure costs. These are conservative estimates.



The estimated combined annual loss of ₦78.19 million represents a conservative figure, as it is based exclusively on sentinel herd data and does not capture indirect costs such as reduced draught power, transaction costs of disease-driven distress sales, or human illness from zoonotic transmission. This observation echoes the methodological caution of Mekonnen *et al.* (2022), who demonstrated that conventional mortality-and-condemnation accounting approaches underestimate true disease burden by 40–60% compared to full input-output modelling frameworks. Plateau State's disproportionately high estimated losses (₦29.64 million) are mechanistically tied to its notably elevated trypanosomiasis (39.4%) and helminthiasis (67.8%) prevalence, underscoring the concentration of vector-transmitted disease risk in Guinea Savanna transitional zones. These findings carry important implications for resource allocation: targeted trypanosome control programmes (including community-level tsetse trapping, trypanocidal chemotherapy, and trypanotolerant breed introduction) should be prioritised in Plateau State's cattle sector to achieve the greatest return on public veterinary investment.

Zoonotic Significance and Public Health Implications

Table 8 presented result of the seroprevalence of zoonotic diseases in cattle alongside community-level risk behaviours. Brucellosis was the most prevalent zoonotic disease (21.7% combined), followed by dermatophytosis (10.4%) and bovine tuberculosis (8.5%). At the community level, alarmingly high proportions of herd owners reported practices that facilitate zoonotic transmission: consuming raw/unpasteurised milk (78.4%), slaughtering animals without personal protective equipment PPE (87.7%), and children in direct contact with cattle (83.8%). Veterinary service coverage was critically low, with only 25.2% of herds receiving a veterinary visit in the preceding year.

Table 8: Seroprevalence of Zoonotic Diseases and Associated Community-Level Risk Behaviours

Disease / Risk Factor	Kano	Kaduna	Plateau	Combined	Risk Level
Zoonotic Disease Prevalence (Cattle)					
Bovine TB	6.8%	9.2%	11.6%	8.5%	High
Brucellosis (<i>B. abortus</i>)	24.4%	22.6%	18.2%	21.7%	High
Dermatophytosis (<i>T. verrucosum</i>)	9.4%	8.2%	13.6%	10.4%	Moderate
Community Risk Behaviours (n=186 herds)					
Consuming raw/unpasteurised milk	78.4%	82.1%	74.6%	78.4%	High
Slaughtering without PPE	91.3%	88.7%	83.2%	87.7%	High
Children in direct cattle contact	84.6%	79.3%	87.4%	83.8%	High
Sharing water (cattle-human)	62.4%	58.9%	54.7%	58.7%	Moderate
Received vet visit in past year	24.1%	31.6%	19.8%	25.2%	Low coverage

The juxtaposition of a 21.7% bovine brucellosis seroprevalence with a 78.4% rate of raw milk consumption among herd-owning communities represents a critical One Health crisis. *Brucella abortus* is thermolabile and readily destroyed by pasteurisation, yet raw milk remains the predominant form of dairy consumption among nomadic Fulani households for cultural and logistical reasons (Ugochukwu *et al.*, 2023). This combination constitutes an uninterrupted zoonotic transmission pathway of considerable public health gravity. Studies in northern Nigeria have documented human brucellosis seroprevalences of 10–25% in occupationally exposed pastoral communities, with clinical manifestations including undulant fever, arthritis, and reproductive complications frequently misdiagnosed as malaria or typhoid (Alhaji and Babalobi, 2015; Bamidele *et al.*, 2021). The near-universal absence of PPE during slaughter (87.7%) is particularly alarming in the context of both brucellosis and bTB, as the slaughter of infected animals without gloves, masks, or protective eyewear creates direct mucosal and aerosol exposure pathways for *B. abortus*, *Mycobacterium bovis*, and *Trichophyton verrucosum* (Abubakar *et al.*, 2023).



The 8.5% bTB prevalence, while lower than brucellosis, carries disproportionate public health significance owing to the gravity of human tuberculosis caused by *M. bovis* and its potential for multi-drug resistance in immuno-compromised individuals, particularly those co-infected with HIV (Cadmus *et al.*, 2020; Okezie *et al.*, 2023). Nigeria's high HIV burden in some northern communities compounds the risk of *M. bovis* causing severe pulmonary or extrapulmonary tuberculosis following aerosol or ingestion exposure. The 83.8% rate of children in direct cattle contact is especially concerning from a dermatophytosis transmission standpoint: ringworm caused by *Trichophyton verrucosum* is a well-established paediatric zoonosis in cattle-keeping communities, causing tinea capitis and corporis with potential for kerion formation in immunologically naive children (Adetunji *et al.*, 2023). The dismally low veterinary service coverage of 25.2% is a systemic failure that underpins all five disease objectives. Veterinary service delivery in Nigeria's pastoral sector remains structurally under-resourced, with the ratio of veterinary personnel to cattle estimated at approximately 1:15,000 in the northern states (Baba & Ogungbile, 2023). This gap allows diseases to persist undetected, untreated, and uncontrolled for years. These findings collectively call for an integrated One Health framework incorporating community health education, subsidised pasteurisation infrastructure, PPE provision at slaughter slabs, mandatory bTB and brucellosis test-and-slaughter programmes, and systematic tsetse control, all underpinned by robust veterinary service delivery reform.

CONCLUSION AND RECOMMENDATIONS

The study demonstrated a substantial and concurrent burden of persistent cattle diseases across Kano, Kaduna, and Plateau States, with helminthiasis, FMD, CBPP, and brucellosis recording the highest prevalence. Disease occurrence varied by location, management system, and season, with Plateau State emerging as a major hotspot for trypanosomiasis. The estimated economic loss of ₦78.19 million highlights the considerable impact of these diseases on livestock production. The coexistence of zoonotic diseases with unsafe human–animal practices and limited veterinary coverage further presents a significant One Health concern requiring coordinated intervention. It was recommended that, tsetse fly control, strategic trypanocide use, and promotion of trypanotolerant cattle should be intensified, particularly in high-risk areas of Plateau State. Seasonal deworming, improved pasture management, and snail-control measures should be adopted to reduce helminthiasis and fasciolosis. CBPP and brucellosis surveillance, vaccination, testing, and movement control should be strengthened, particularly along transhumance routes. Further research should focus on longitudinal surveillance, molecular characterization of pathogens, and development of real-time geo-referenced disease monitoring systems.

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