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Epidemiology of tick-borne haemoparasitic diseases in crossbred cattle during monsoon in coastal regions

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Abstract

Tick-borne haemoparasitic diseases rank among the most economically damaging constraints on cattle productivity in tropical Asia, yet their monsoon-season epidemiology in Philippine coastal farming systems has not been characterised. This research determined the prevalence, species composition and risk factors of haemoparasitic infections in 384 crossbred cattle sampled from 12 smallholder farms across three coastal provinces of Luzon during the southwest monsoon (June-October 2022). Giemsa-stained thin blood smears were examined microscopically, and half-body tick counts were performed concurrently. Overall haemoparasite prevalence was 57.3% (220/384). *Babesia bigemina* was the most frequent species (35.5%), followed by *Anaplasma marginale* (29.1%), *Theileria annulata* (17.3%), *Babesia bovis* (10.0%) and mixed infections (8.2%). Prevalence peaked in August (68.4%) and declined toward October (47.1%). Animals carrying more than 40 ticks had 3.8 times the odds of infection compared with those below 20 ticks (OR = 3.81, 95% CI: 2.14-6.78). Packed cell volume was negatively correlated with tick burden ($r = -0.72$, $P < 0.001$). Cattle aged two to four years and those with higher exotic-breed proportion ($\geq 75\%$ Holstein-Friesian) were at significantly greater risk. These findings confirm that the monsoon period concentrates haemoparasite transmission risk and underscore the need for strategic acaricide application timed to early June in Philippine coastal cattle systems.

Keywords: Tick-borne diseases, haemoparasites, *Babesia*, *Anaplasma*, *Theileria*, crossbred cattle, monsoon, coastal regions, Philippines, epidemiology

Introduction

While intensive dairy operations in temperate countries have largely controlled tick-borne diseases through systematic acaricide programmes and breed selection, smallholder cattle farms in tropical coastal zones remain heavily burdened by these parasites, with annual losses estimated at hundreds of millions of dollars across Southeast Asia alone ^[1, 2]. The contrast is stark: a Holstein cow in a climate-controlled barn in northern Europe faces virtually zero risk of babesiosis, whereas her crossbred descendant grazing a coastal Philippine paddock during the monsoon may harbour two or three haemoparasite species simultaneously.

Tick-borne haemoparasitic diseases principally babesiosis (*Babesia bigemina*, *B. bovis*), anaplasmosis (*Anaplasma marginale*) and theileriosis (*Theileria annulata*) are transmitted by ixodid ticks of the genera *Rhipicephalus* and *Hyalomma* ^[3]. In the Philippines, *Rhipicephalus microplus* is the dominant cattle tick, and its population dynamics are tightly coupled to monsoon rainfall, which raises pasture humidity and accelerates larval development ^[4]. Despite this well-known ecological link, few Philippine studies have quantified how haemoparasite prevalence fluctuates within a single monsoon season or how host factors interact with tick load to determine infection risk ^[5].

Crossbred cattle — typically Holstein-Friesian $\times$ native Philippine cattle — are increasingly popular because they combine reasonable heat tolerance with improved milk yield. However, exotic genetic backgrounds may reduce innate resistance to local haemoparasites, a phenomenon termed breed susceptibility, which has been documented in crossbred herds across tropical Africa and South Asia ^[6, 7]. Whether the same pattern holds in Philippine coastal systems, and at what threshold of exotic-breed proportion the risk becomes significant, has not been evaluated.

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This research aimed to determine the prevalence and species distribution of tick-borne haemoparasites in crossbred cattle during the southwest monsoon across three coastal provinces of Luzon, and to identify host- and management-level risk factors associated with infection.

Materials and Methods

Research Area Description

The research was conducted across 12 smallholder cattle farms in three coastal provinces of Luzon Island, Philippines: Batangas (southern Luzon), Quezon (eastern seaboard) and Pangasinan (northwestern coast). These provinces share a tropical maritime climate with pronounced southwest monsoon influence from June to October. Mean annual temperature ranges from 26 to 28 °C, and monsoon-season rainfall averages 250-400 mm per month. Farms were located within 15 km of the coastline at elevations below 50 m above sea level. Herd sizes ranged from 18 to 47 crossbred cattle managed under semi-extensive grazing on improved Napier-grass and native pastures.

Climatic and Environmental Conditions

Monthly rainfall, temperature and relative humidity data for the sampling period (June-October 2022) were obtained from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) weather stations nearest to each farm cluster. Mean rainfall peaked in August (387 mm in Quezon, 342 mm in Batangas, 298 mm in Pangasinan). Relative humidity exceeded 85% throughout the monsoon in all three provinces. These conditions favour rapid completion of the *R. microplus* life cycle, which can drop from 21 days under dry conditions to as few as 14 days under sustained high humidity [4].

Material

A total of 384 crossbred cattle (Holstein-Friesian × native) were sampled. Animals were stratified by age (< 2 years, 2-4 years, > 4 years), sex and estimated exotic-breed proportion (< 50%, 50-75%, ≥ 75% Holstein-Friesian) based on farm

records. Blood was collected from the jugular vein into EDTA vacutainers during monthly visits in June, July, August, September and October 2022. Thin blood smears were prepared at the farm, air-dried, fixed in methanol and transported to the Manila Institute of Veterinary Parasitology [8].

Methods

Smears were stained with 10% Giemsa solution for 30 minutes and examined under oil immersion (×1000). At least 50 fields were scanned per smear. Haemoparasites were identified to species level based on morphological criteria [3, 9]. Packed cell volume (PCV) was determined by the microhaematocrit method. Half-body tick counts were performed on the right side of each animal; total tick burden was estimated by doubling the half-body count [10]. Tick species were identified morphologically using published keys [4].

Seasonal Variations and Temporal Patterns

To capture temporal fluctuation within the monsoon, prevalence was calculated separately for each monthly sampling round. Monthly tick burden was recorded concurrently. This within-season resolution allowed identification of the peak transmission window and assessment of whether prevalence tracked rainfall with a lag. Data were analysed in R 4.3.1. Prevalence was expressed as percentage with 95% confidence intervals. Risk factors were evaluated by multivariable logistic regression with haemoparasite status (positive/negative) as the binary outcome and age, sex, breed proportion, tick burden category, province and month as covariates. Odds ratios with 95% CI were reported. Pearson correlation assessed the tick-burden-PCV relationship. Ethical approval was granted by the Institutional Animal Care and Use Committee of the Manila Institute of Veterinary Parasitology (Protocol MIVP-IACUC-2022/003, dated 14 May 2022).

Results

Table 1: Risk factors for haemoparasite infection ranked by adjusted odds ratio (logistic regression, n = 384)

Risk Factor	Category	OR	95% CI	P-value
Tick burden > 40	vs. < 20	3.81	2.14-6.78	< 0.001
Breed ≥ 75% HF	vs. < 50%	2.94	1.63-5.31	< 0.001
Age 2-4 years	vs. > 4 years	2.17	1.28-3.68	0.004
Tick burden 20-40	vs. < 20	1.86	1.07-3.24	0.028
Quezon Province	vs. Pangasinan	1.72	1.01-2.93	0.046
Sex (male)	vs. female	1.14	0.71-1.83	0.58

OR = odds ratio; CI = confidence interval; HF = Holstein-Friesian. Factors ranked by descending OR magnitude.

Table 2: Monthly haemoparasite prevalence and mean tick burden during the monsoon season (June-October 2022)

Parameter	June	July	August	September	October
Prevalence (%)	48.2	58.6	68.4	61.3	47.1
Mean tick count	28.4	38.7	52.1	44.6	31.2
Rainfall (mm)	218	296	342	284	196
Mean PCV (%)	29.8	27.4	24.6	26.1	28.9

Prevalence and tick burden peaked in August, coinciding with maximum monsoon rainfall. PCV reached its nadir in the same month.

The temporal data show a clear bell-shaped curve through the monsoon, with August representing the apex of both tick infestation and haemoparasite prevalence. Interestingly, the prevalence peak lagged roughly one month behind the onset of heavy rains in July, which is consistent with the two- to

three-week larval development period of *R. microplus* — newly hatched larvae from eggs deposited in July would reach their infective nymphal stage by mid-August. PCV tracked inversely, bottoming out at 24.6% in August and recovering as tick pressure eased toward October.

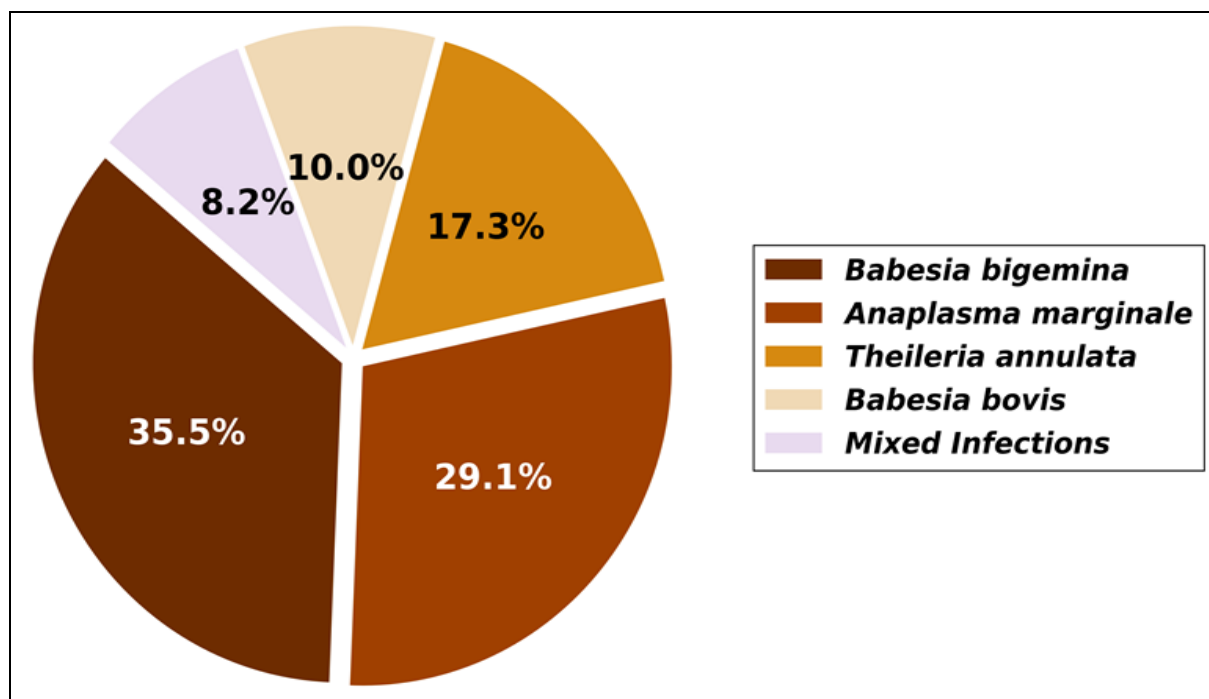


Fig 1: Relative distribution of tick-borne haemoparasite species identified in 220 positive crossbred cattle during the monsoon season across three coastal provinces of Luzon, Philippines.

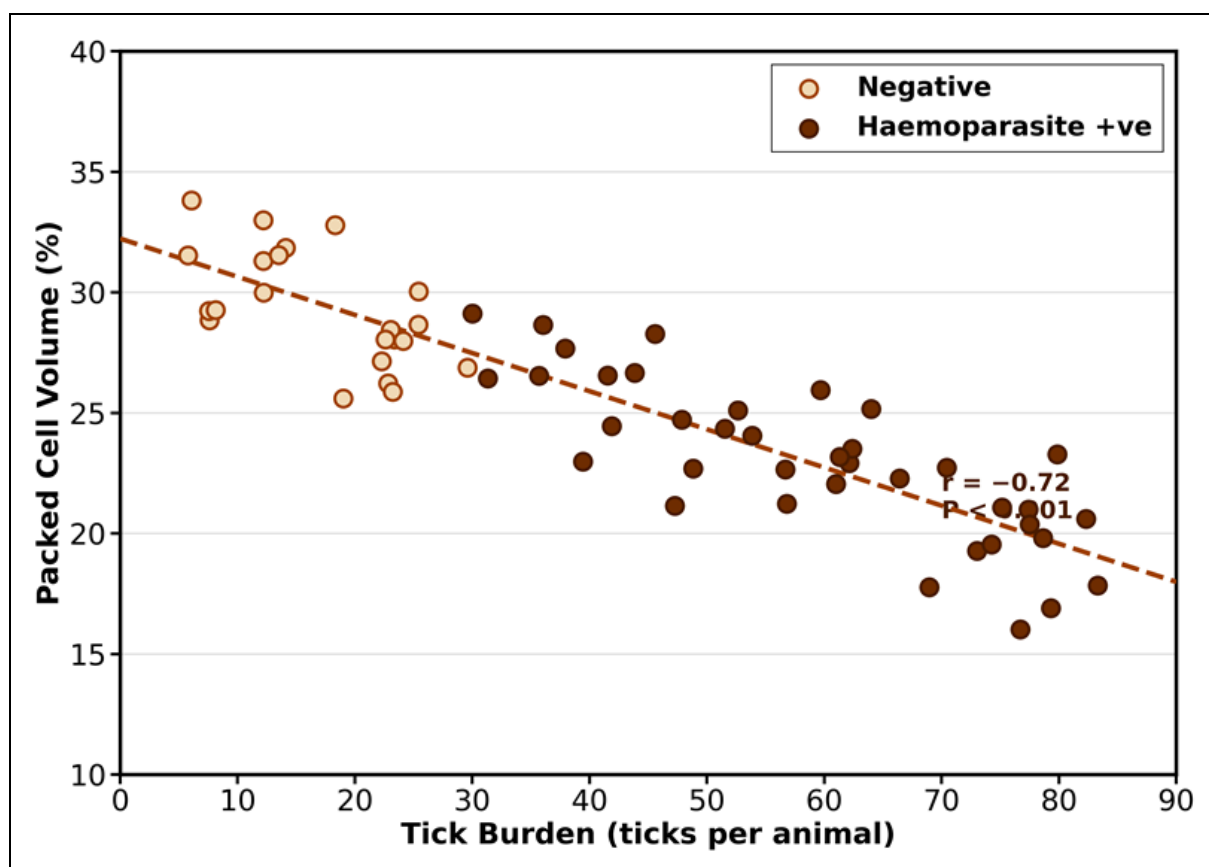


Fig 2: Relationship between half-body tick count and packed cell volume (PCV) in sampled cattle. Dark markers indicate haemoparasite-positive animals. Dashed line shows the linear regression fit ($r = -0.72$, $P < 0.001$).

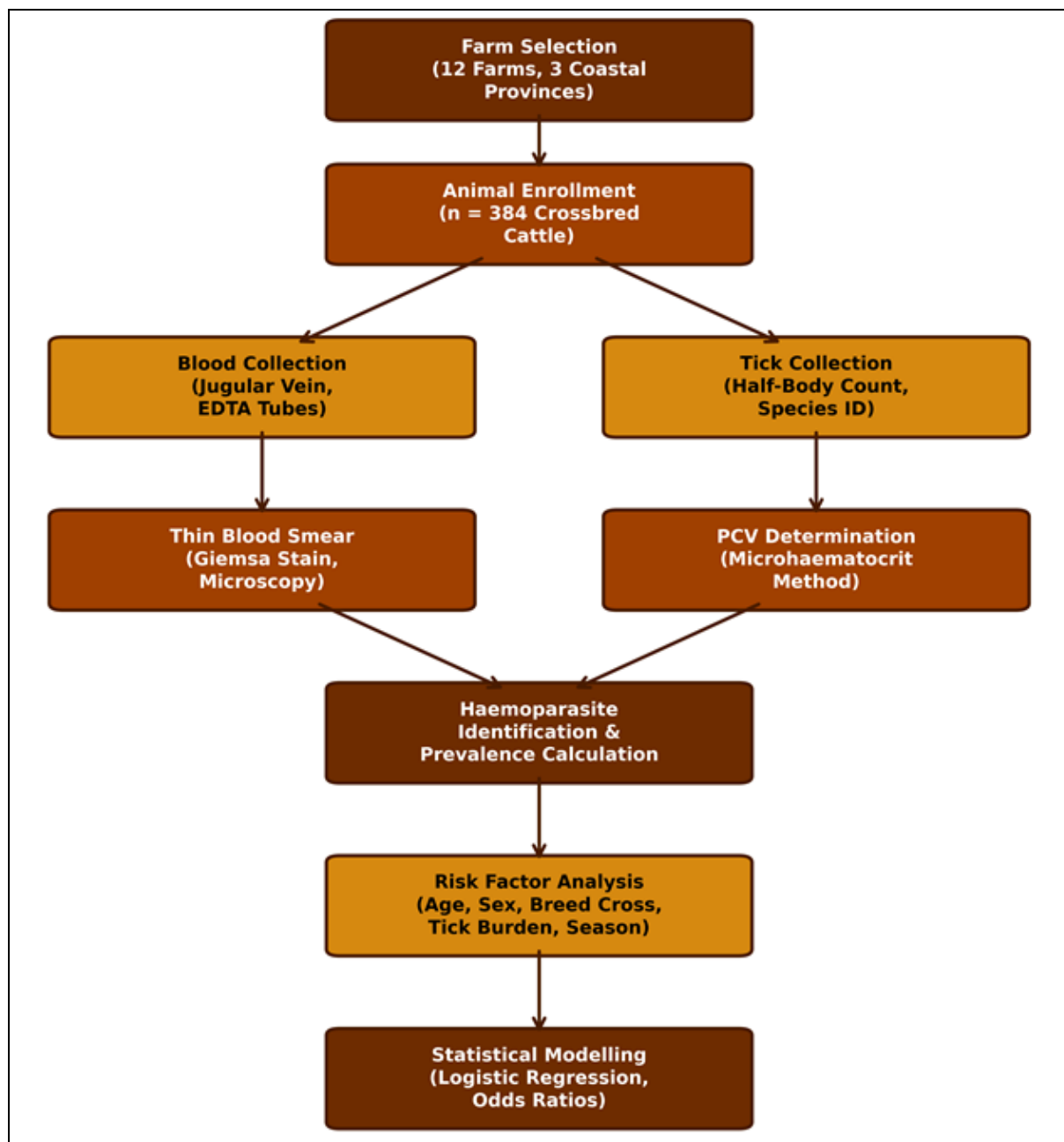


Fig 3: Flowchart of the sampling strategy, diagnostic procedures and statistical modelling workflow used in the epidemiological investigation.

Comprehensive Interpretation

The combined epidemiological picture is one of intense, seasonally concentrated haemoparasite transmission driven primarily by tick burden, exotic-breed proportion and the August rainfall peak. The ranking of risk factors (Table 1) provides a clear hierarchy for intervention targeting: reducing tick load below 20 per animal — achievable through strategic acaricide treatment in early June, before the monsoon intensifies — would have the single largest impact on infection probability. Breed management comes second; farmers pushing exotic-breed proportion above 75% should be aware of the disproportionately higher parasite risk and may benefit from crossbreeding schemes that retain at least 25-50% native genetics for innate resistance.

Discussion

The overall prevalence of 57.3% falls within the range reported for monsoon-season surveys in other Southeast Asian countries. Uilenberg ^[1] compiled estimates of 40-70% across tropical Asia, and Jonsson *et al.* ^[2] recorded 52% in Queensland cattle during the wet season. The dominance of

B. bigemina (35.5%) over *B. bovis* (10.0%) is consistent with the known vector competence of *R. microplus* in the Philippines, where transovarial transmission efficiency is higher for *B. bigemina* ^[3, 11].

The strong tick-burden-PCV correlation ($r = -0.72$) mirrors findings by Jongejan and Uilenberg ^[12], who demonstrated that each additional 10 ticks per animal reduced PCV by approximately 1 percentage point through combined blood-feeding loss and haemoparasite-mediated erythrocyte destruction. That animals with $\geq 75\%$ Holstein-Friesian genetics were nearly three times as likely to be positive aligns with the breed susceptibility concept: exotic cattle lack the innate resistance mechanisms (splenic filtration efficiency, cytokine-driven parasite clearance) that centuries of co-evolution have conferred on native breeds ^[6, 7].

From a management perspective, the one-month lag between rainfall peak and prevalence peak offers a practical window. Applying acaricide in early June before the first generation of monsoon-bred ticks reaches infective stage could preempt the August surge. Complementing chemical control with pasture

spelling (alternating grazing paddocks every 3-4 weeks) would further disrupt the tick life cycle^[13].

Conclusion

This research set out to quantify the prevalence, species composition and risk-factor profile of tick-borne haemoparasites in crossbred cattle during the southwest monsoon in coastal Philippine farming systems. A total of 384 animals across 12 farms in three provinces were sampled monthly from June to October 2022, and haemoparasites were identified by Giemsa-stained blood smear microscopy alongside concurrent tick counts and PCV determination.

The key findings are as follows. More than half (57.3%) of the sampled cattle tested positive for at least one haemoparasite species, with *B. bigemina* predominating. Prevalence tracked monsoon rainfall intensity, peaking at 68.4% in August and declining as rains eased in October. Tick burden above 40 per animal was the strongest risk factor (OR = 3.81), followed by high exotic-breed proportion (OR = 2.94) and the 2-4 year age class (OR = 2.17). PCV fell to its lowest in August, consistent with the combined haemolytic and blood-feeding burden at peak transmission.

The practical message for Philippine smallholder farmers is twofold. First, a single well-timed acaricide application in early June — before the monsoon drives tick populations to critical density — could substantially reduce mid-season infection pressure at modest cost. Second, maintaining at least 25-50% native genetics in the crossbreeding programme preserves a degree of innate resistance that pure exotic cattle lack, and this genetic buffer may be the most sustainable long-term strategy against enzootic haemoparasitosis.

Future research should extend this work in three directions. First, molecular confirmation (PCR-based) of species identification would improve sensitivity and detect sub-microscopic infections missed by smear examination. Second, economic modelling that translates the observed PCV reductions and morbidity into milk-yield loss and treatment costs would strengthen the case for preventive investment at the farm and policy levels. Third, a multi-year longitudinal design spanning two or three consecutive monsoon seasons would reveal whether the August peak is consistently reproducible or varies with El Niño-La Niña rainfall anomalies, information that would help calibrate climate-adaptive control strategies.

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Contributions Not Qualifying for Authorship

Mr. Ernesto Villanueva assisted with field tick collection and blood smear preparation. Ms. Anna Liza Corpuz performed tick species identification under supervision.

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