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# Serological Evidence of Porcine Reproductive and Respiratory Syndrome Virus Among Domestic Pigs in Busia County, Kenya

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## ABSTRACT

Porcine reproductive and respiratory syndrome virus (PRRSV) is a significant swine pathogen and one of the most damaging viruses affecting the global pig industry. Although clinical signs compatible with PRRS have been observed within Kenyan pig production systems, the virus has not yet been officially reported in the country. The present study sought to estimate the seroprevalence of PRRSV, describe farm characteristics, and identify risk factors associated with PRRSV infection among domestic pigs in Busia County, Kenya. Serum samples were collected from 398 pigs (52 piglets, 109 growers, and 237 adults) originating from 56 pig keeping farms/households and analyzed using a commercial indirect Enzyme Linked Immunosorbent Assay (ELISA). Farm characteristics, pig farming practices, pig husbandry, and biosecurity data were recorded via structured questionnaires. Pig-level seroprevalence was 1.3% (5/398), with positives detected in Matayos 0.8% (1/124), Nambale 2.0% (1/51), Teso South 2.8% (2/72), and Bunyala 2.9% (1/35) sub-counties, respectively. The farm-level seroprevalence was 8.9% (5/56). Seropositivity did not differ significantly by location, sex, or age category. Biosecurity uptake was generally low, with the use of dedicated clothing/aprons (14%), wearing of boots (32%), presence of footbaths (12.5%), quarantine of new pigs (11%), and handwashing after pig handling (16%). Not using separate clothing/aprons was the only risk factor significantly associated with farm seropositivity. The present findings provided evidence of PRRSV exposure in Kenyan pigs and reveal important gaps in farm-level biosecurity practices at the human-pig interface, underscoring the epidemiological relevance of these observations for pig industry in the region, although the small number of seropositive farms means that some degree of false positivity or false negativity may not be excluded.

**Keywords:** Biosecurity, Enzyme-linked immunosorbent assay, Porcine reproductive and respiratory syndrome virus, Seroprevalence

## INTRODUCTION

Pig farming is becoming an increasingly vital component of rural and peri-urban livelihoods in low- and middle-income countries, including Kenya, where it serves as a dependable source of income, nutrition, and employment (Mutua et al., 2011; FAO, 2012). The pig population in Kenya has grown significantly, from an estimated 335,301 pigs in 2009 to approximately 860,160 in 2023 (Kenya National Bureau of Statistics, 2024). The majority of these pigs (73%) are reared under backyard systems characterized by low inputs, minimal veterinary oversight, and limited biosecurity (Mutua et al., 2011). According to Mbuthia et al. (2015), the expansion of pig production is largely driven by the rising demand for pork in both rural and urban markets, coupled with the species' high reproductive potential, rapid growth rate, and relatively low production costs. Collectively, these factors enable farmers to achieve quick and attractive economic returns from pig farming. However, the growth of pig farming in the country is hindered by different diseases (Mutua et al., 2011), with African swine fever, Cysticercosis, and Leptospirosis being identified as some of the predominant porcine diseases, which contribute to high morbidity, mortality, and economic losses (Thomas et al., 2016; Ngugi et al., 2019; Mwabonimana et al., 2020).

Growing evidence indicates that farmers and veterinarians in Kenya have increasingly reported reproductive problems (abortions, stillbirths, and weak piglets) and neonatal deaths in pigs, which are sometimes unexplained by known endemic diseases such as African swine fever and Leptospirosis (Ngugi et al., 2019; Akoko et al., 2020). These recurrent and unexplained reproductive and neonatal losses have raised suspicion of porcine reproductive and respiratory



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syndrome (PRRS), a highly contagious viral disease that had not yet been investigated in Kenya. Porcine Reproductive and Respiratory Syndrome (PRRS) is caused by the porcine reproductive and respiratory syndrome virus (PRRSV), an enveloped, positive-sense, single-stranded RNA virus belonging to the genus *Arterivirus* and classified into two species, including PRRSV-1 (European) and PRRSV-2 (North American; Wensvoort et al., 1992; Nelsen et al., 1999; Walker et al., 2021). The virus spreads through both horizontal and vertical pathways, and infected pigs can remain persistent carriers (Cho and Dee, 2006). Clinical signs commonly include reduced appetite, elevated temperature, dullness, respiratory difficulty, blue or reddish ears and vulva, and edema affecting the limbs or subcutaneous tissues (Done et al., 1996; Cho and Dee, 2006). In breeding gilts and sows, infection is characterized by late-term abortions or preterm farrowing, frequent stillbirth, or mummified fetuses (Done et al., 1996; Cho and Dee, 2006). PRRS is regarded as among the economically damaging diseases of swine. Recent analyses estimate that PRRS causes losses of approximately US $1.2 billion annually in the United States pork industry, owing to both breeding herd and growing pig productivity declines (Osemeke et al., 2025). Since PRRSV emergence in North America in the late 1980s, PRRSV has spread widely across Europe and Asia, facilitated by global trade and poor farm biosecurity (Shi et al., 2010; Frossard et al., 2013). In Africa, the virus was first confirmed in South Africa in 2004, and more recently in Uganda and Namibia (Dione et al., 2018; Oba et al., 2022; Molini et al., 2024). Importantly, Uganda (Kenya's immediate neighbor) has reported reproductive and respiratory problems in pigs associated with PRRSV (Oba et al., 2022). The reported reproductive and respiratory failures in pigs of Uganda created a likelihood that the virus could spread into Kenya, particularly through cross-border trade of pigs and pig products in porous border regions such as Busia.

Busia County is among the major pig-producing areas in Western Kenya, where pigs are primarily managed in smallholder, free-range, or semi-intensive systems (Kagira et al., 2010). Frequent introduction of new pigs without quarantine, cross-border movements, sharing of equipment between farms, and absence of footbath are among factors that create a high-risk environment for the spread of infectious diseases (Pileri and Mateu, 2016). Moreover, factors such as limited knowledge of pig health, low adoption of vaccination, and minimal access to veterinary services further increase susceptibility. Risk factors related to pig demographics (age, sex, breed), management practices (housing, feeding, breeding), and biosecurity measures (quarantine, hygiene, movement control) are also well known to influence PRRSV transmission globally (Holtkamp et al., 2012; Frossard et al., 2013).

To date, there are no published reports on the occurrence, prevalence, or risk factors for PRRSV in Kenya. This lack of information leaves the pig sector vulnerable to undetected introduction and spread of the virus, with potentially severe economic and livelihood impacts. Busia County, given its pig population and strategic location along a porous international border, represents a critical hotspot for disease surveillance. Therefore, the present study aimed to indicate farm characteristics, estimate the seroprevalence of PRRSV, and identify risk factors associated with PRRSV infection in domestic pigs in Busia County, Kenya.

## MATERIALS AND METHODS

### Ethical approval

The ethical clearance for the present study was approved by the Jomo Kenyatta University of Agriculture and Technology, Kenya, Institutional Scientific and Ethical Review Committee (JKU/ISERC/02316/1725). In addition, a research permit was granted by the Kenyan National Commission for Science, Technology, and Innovation (NACOSTI) under license number NACOSTI/P/25/4173606. Authorization to carry out the research in Busia County was further provided by the County Veterinary Officer through a formal consent letter. Prior to data and sample collection, the objectives and procedures of the study were explained to all participating farmers, who were given the opportunity to ask questions and voluntarily decide whether or not to participate. Pigs were excluded if they had been presented with severe illnesses, physical injuries, or if owners declined participation.

### Study area

The present study was carried out in Busia County, located in the Western region of Kenya. The county lies immediately east of the border town of Busia, Uganda, and is bordered by Lake Victoria to the southwest, Siaya County to the southeast, and Bungoma and Kakamega Counties to the east. The county consists of seven sub-counties, namely Teso North, Teso South, Nambale, Matayos, Butula, Samia, and Bunyala (Figure 1). The county lies about 500 km west of Nairobi at an average altitude of 1,227 meters (4,026 feet) above sea level and is located between coordinates 00°27'48.0"N and 34°06'19.0"E (Latitude: 0.463333; Longitude: 34.105278). The county experiences a warm, bimodal climate, with long rains occurring from late March to late May and short rains from August to October, receiving between 760 and 2,000 mm of rainfall annually. Temperatures remain relatively consistent throughout the county, with mean annual maximums ranging from 26°C to 30°C and mean annual minimums ranging from 14°C to 22°C (County

Government of Busia, 2024). Busia County was selected purposively because of its known popularity of pig rearing and previous reports of PRRS in the neighboring country, Uganda (Oba et al., 2022). The pig population in Busia County stood at 86,220 in 2023 against the national population of 860,220 (Kenya National Bureau of Statistics, 2024). The pig farming system in Busia County primarily consists of free-range and small-scale intensive systems, providing a representative sample of the diverse management practices in the area (Chege et al., 2023).

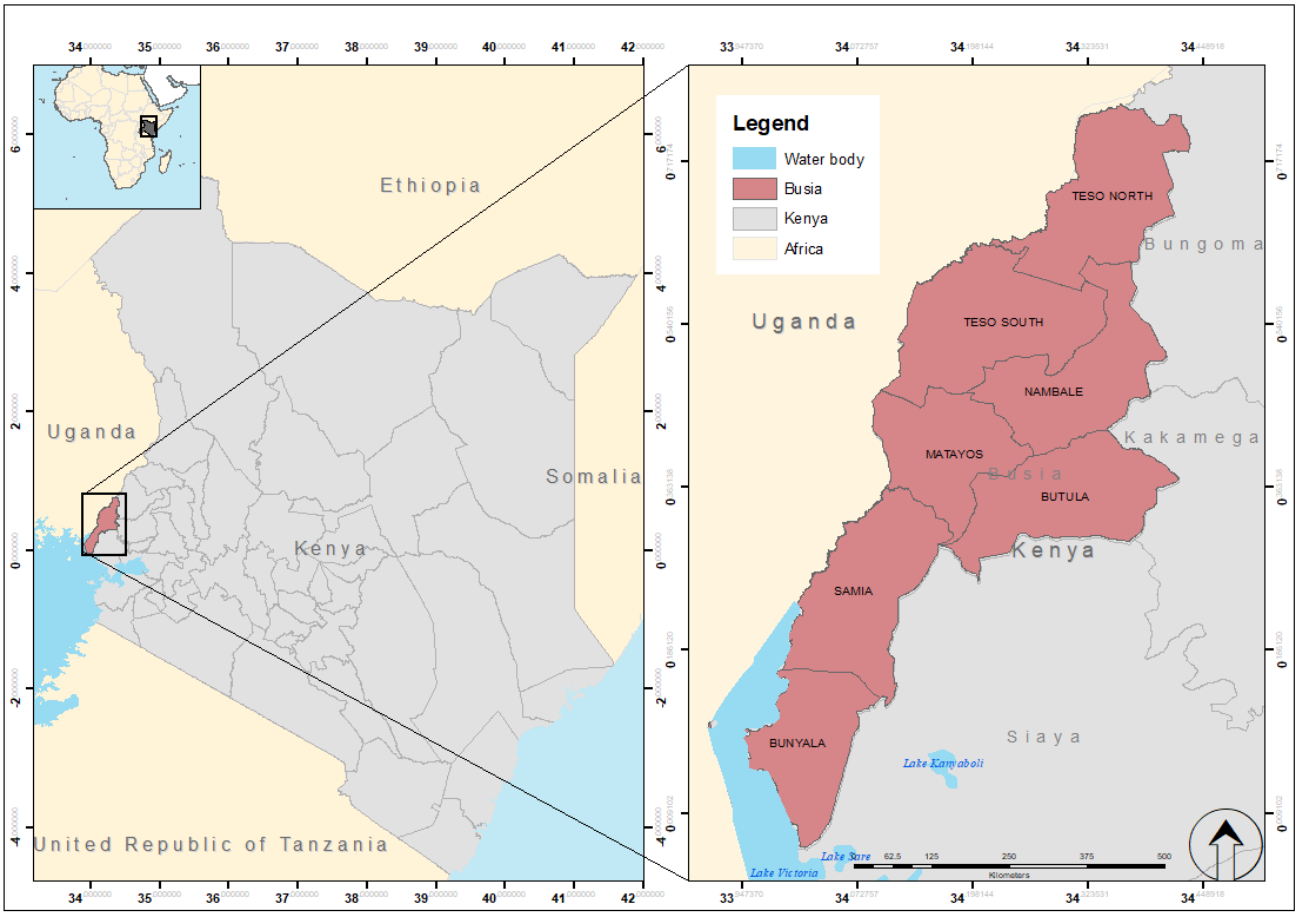


**Figure 1.** The study area in Busia County, Western Kenya, comprised seven sampled sub-counties. Map produced using ArcGIS Desktop 10.8 (Esri, Redlands, CA, USA)

**Study design**

The present study employed a cross-sectional design, and it was conducted between May and August 2025. The study population consisted of piglets, grower pigs, and adult pigs. A piglet was defined as a young pig from birth up to 8 weeks of age, a grower as a pig from just over 8 weeks to below 24 weeks of age, and an adult aged from 24 weeks of age (Ekesbo and Gunnarsson, 2018). Eligible herds were households keeping pigs across age categories (piglets, grower pigs, and adults). Pigs without a history of PRRS vaccination, including pregnant sows and gilts, were also eligible, because of ethical issues, pigs with severe illnesses (emaciation, lethargy, fever, and inappetence) and injuries were excluded after a physical examination by a veterinarian, and also any pigs whose owner declined participation were excluded.

**Sampling**

An initial sample size of 384 pigs was obtained using Cochran's formula for infinite populations (Cochran, 1977), based on a 95% confidence level, a 50% expected prevalence, and a 5% precision. To account for potential sample errors, the sample size was increased by 5% to 398 pigs, comprising 52 piglets, 109 growers, and 237 adults, guided by the relative availability and accessibility of animals within each category during field sampling, rather than strict proportional allocation. Sampling was structured to ensure representation across different management practices and pig breeds in the study area. A multistage sampling approach was applied. In the first stage, all seven sub-counties within Busia were purposely included to get a snapshot of the whole county. Within each sub-county, wards and villages were randomly chosen using random numbers, and pig-keeping households were identified. Households with pigs of different age groups were purposively included, and from each household, individual pigs were selected at random.

**Surveys of households**

Data were collected from the 56 sampled households using a structured questionnaire specifically designed based on study objectives to gather information on farm practices, husbandry, and biosecurity. The questionnaire was reviewed by two experienced researchers to ensure content validity, clarity, and relevance. Prior to the main survey, it was pre-tested on a small sample of 5 pig-keeping households to identify and correct any ambiguous or culturally inappropriate questions. The final questionnaire was printed and administered through face-to-face interviews with household heads or permanent adult residents of the respective farms. Although the questionnaire was written in English, interviews were conducted in Swahili, and questions were phrased to reflect local conditions. Global Positioning System (GPS) coordinates were recorded for each household to facilitate mapping. The questionnaire gathered information on farmers' demographic characteristics, pig farming practices, husbandry, and biosecurity measures. Biosecurity issues focused on the use of separate clothing when handling pigs, management of pig excreta, awareness of PRRS, isolation of sick pigs, quarantine of newly introduced pigs, fencing of pig units, handwashing practices, vaccination, and training in pig husbandry, among others. In addition, direct observations were made to validate responses and assess key practices, including the presence of footbaths, the wearing of boots, and control of access to pig units.

**Blood sample collection**

Before blood collection, biological information for each pig was recorded, including identification number, age, sex, breed, health status, and reproductive status (pregnant, lactating, or non-pregnant). Blood samples were collected by a veterinarian from the jugular vein of 398 pigs using sterile red-capped plain vacutainer tubes (without EDTA). The samples were transported in a cool box to the KEMRI Alupe Laboratory, Kenya, within 8 to 10 hours of blood collection, where blood was centrifuged at 3000 rpm for 10 minutes to obtain serum (Lee et al., 2024). The serum was harvested, aliquoted, and added to a 1.8 mL cryogenic vial and stored at -80°C before being transported on dry ice in Styrofoam boxes to the PAUSTI-JKUAT Laboratory, Kenya, for further analysis. To avoid adverse health effects, the volume of blood collected from each animal did not exceed 1% of its total blood volume at a single time point as recommended by Diehl et al. (2001).

**Serological analysis**

All serum samples were tested for IgG antibodies against PRRSV using a commercial indirect Enzyme Linked Immunosorbent Assay (I-ELISA) kit (INgezim® PRRS 2.0, Gold Standard Diagnostics, Spain) with a reported sensitivity of 99.3% and specificity of 98.2% for European strains, and 91% sensitivity with 96.5% specificity for North American strains, following the manufacturer's instructions. Optical densities (OD) were measured at 450nm using a microplate reader (BioTek Instruments, Inc®100 Tigan Street, Winooski, USA), and results were expressed as sample to positive (S/P) ratios. Samples with an S/P ratio of ≥ 0.40 were classified as positive for PRRSV antibodies, whereas those with an S/P ratio of < 0.40 were considered negative. A herd/farm was defined as positive if at least one pig tested seropositive. The test was considered valid when the $OD_{450}$ of the positive control minus the $OD_{450}$ of the negative control was higher than 0.35, and the negative control $OD_{450}$ was lower than 0.35.

**Statistical analysis**

Data collected from questionnaires and laboratory assays were entered, checked for consistency, and cleaned in Microsoft Excel. Subsequent analyses were conducted using IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize household and respondent characteristics, pig demographics, and the overall seroprevalence of antibodies to porcine reproductive and respiratory syndrome virus (PRRSV). At the farm level, the outcome was PRRS seropositivity, defined as having ≥1 sampled pig Ab-ELISA positive. For each binary farm-level risk factor (coded 1=Yes, 2=No), 2×2 contingency tables of the risk factor versus farm PRRS status were constructed, and associations were tested using Fisher's exact test (two-sided). For each risk factor, the odds ratio (OR) was computed with a 95% exact confidence interval (CI), oriented as No versus Yes, so that OR > 1 indicates higher odds of PRRS positivity among non-adopting farms. Statistical significance was set at $\alpha = 0.05$.

## RESULTS

**Characteristics of the sampled pigs**

Of the 398 pigs sampled, 52 (13%) were piglets, 109 (27%) were growers, and 237 (60%) were adults. By sex, 129 (32%) were males, and 269 (68%) were females (Table 1). By breed, 139 (35%) were Large White, 117 (30%) Crossbreeds, 97 (24%) Local breed, 28 (7%) Duroc, and 17 (4%) Landrace (Table 1).

**Table 1.** Distribution of sampled pigs by age category, breed, and sex in Busia County, Kenya, collected between May and August 2025.

| Category | Sampled (%) | Female (n; %) | Male (n; %) |
|---|---|---|---|
| **Age category** | | | |
| Piglets | 52 (13) | 35 (67) | 17 (33) |
| Growers | 109 (27) | 61 (56) | 48 (44) |
| Adults | 237 (60) | 173 (73) | 64 (27) |
| Total | 398 (100) | 269 (68) | 129 (32) |
| **Breed** | | | |
| Large white | 139 (35) | 98 (71) | 41 (29) |
| Cross breeds | 117 (30) | 81 (69) | 36 (31) |
| Local breed | 97 (24) | 64 (66) | 33 (34) |
| Duroc | 28 (7) | 15 (54) | 13 (46) |
| Landrace | 17 (4) | 11 (65) | 6 (35) |
| Total | 398 (100) | 269 (68) | 129 (32) |

**Seroprevalence of PRRSV**

Out of 398 pigs sampled across the seven sub-counties of Busia, five pigs (1.3%) tested seropositive for PRRSV antibodies (Table 2). Positivity was detected in Matayos (0.8%), Teso South (2.8%), Nambale (2.0%), and Bunyala (2.9%) sub-counties (Table 2). There was no significant difference in PRRS seroprevalence among pigs from the different sub-counties ($p > 0.05$). The distribution of PRRSV seroprevalence by sex indicated 0.5% seropositivity in males and 0.8% in females. There was no significant association between sex ($p > 0.05$) and PRRS seroprevalence. Seropositivity to PRRSV was detected only among grower and adult pigs, with 2 out of 109 growers (1.8%) and 3 out of 237 adults (1.3%) testing positive, while none of the 52 piglets were seropositive. Although all seropositive pigs were within the grower and adult age groups, the difference in seroprevalence among age categories was not statistically significant ($p > 0.05$). At the farm level, 56 pig farms were sampled, and the five positive pigs originated from five different farms, giving an overall farm-level seroprevalence of 8.9%. The positive farms were not clustered in one area but were distributed across multiple sub-counties, located near the Kenya-Uganda border, particularly in Teso South and Matayos sub-counties (Table 2 and Figure 2).

**Table 2.** A seroprevalence of porcine reproductive and respiratory syndrome in Busia County, Kenya, was conducted between May and August 2025.

| Category | Sampled (n) | Positive (n; %) | Negative (n; %) | P-value |
|---|---|---|---|---|
| **Sub-county** | | | | 0.790 |
| Teso North | 52 | 0 (0.0) | 52 (100.0) | |
| Butula | 28 | 0 (0.0) | 28 (100.0) | |
| Matayos | 124 | 1 (0.8) | 123 (99.2) | |
| Teso South | 72 | 2 (2.8) | 70 (97.2) | |
| Nambale | 51 | 1 (2.0) | 50 (98.0) | |
| Bunyala | 35 | 1 (2.9) | 34 (97.1) | |
| Samia | 36 | 0 (0.0) | 36 (100.0) | |
| **Total (pig-level)** | 398 | 5 (1.3) | 393 (98.7) | |
| **Farm-level (overall)** | 56 farms | 5 (8.9) | 51 (91.1) | |
| **Age group** | | | | 0.622 |
| Piglet | 52 | 0 (0.0) | 52 (100.0) | |
| Grower | 109 | 2 (1.8) | 107 (98.2) | |
| Adult | 237 | 3 (1.3) | 234 (98.7) | |
| Sex | | | | 0.716 |
| Male | 129 | 2 (1.6) | 127 (98.4) | |
| Female | 269 | 3 (1.1) | 266 (98.9) | |

Note: P-values are for the overall association within each block. Farm-level seroprevalence is defined as ≥ 1 positive pig in a farm/household.

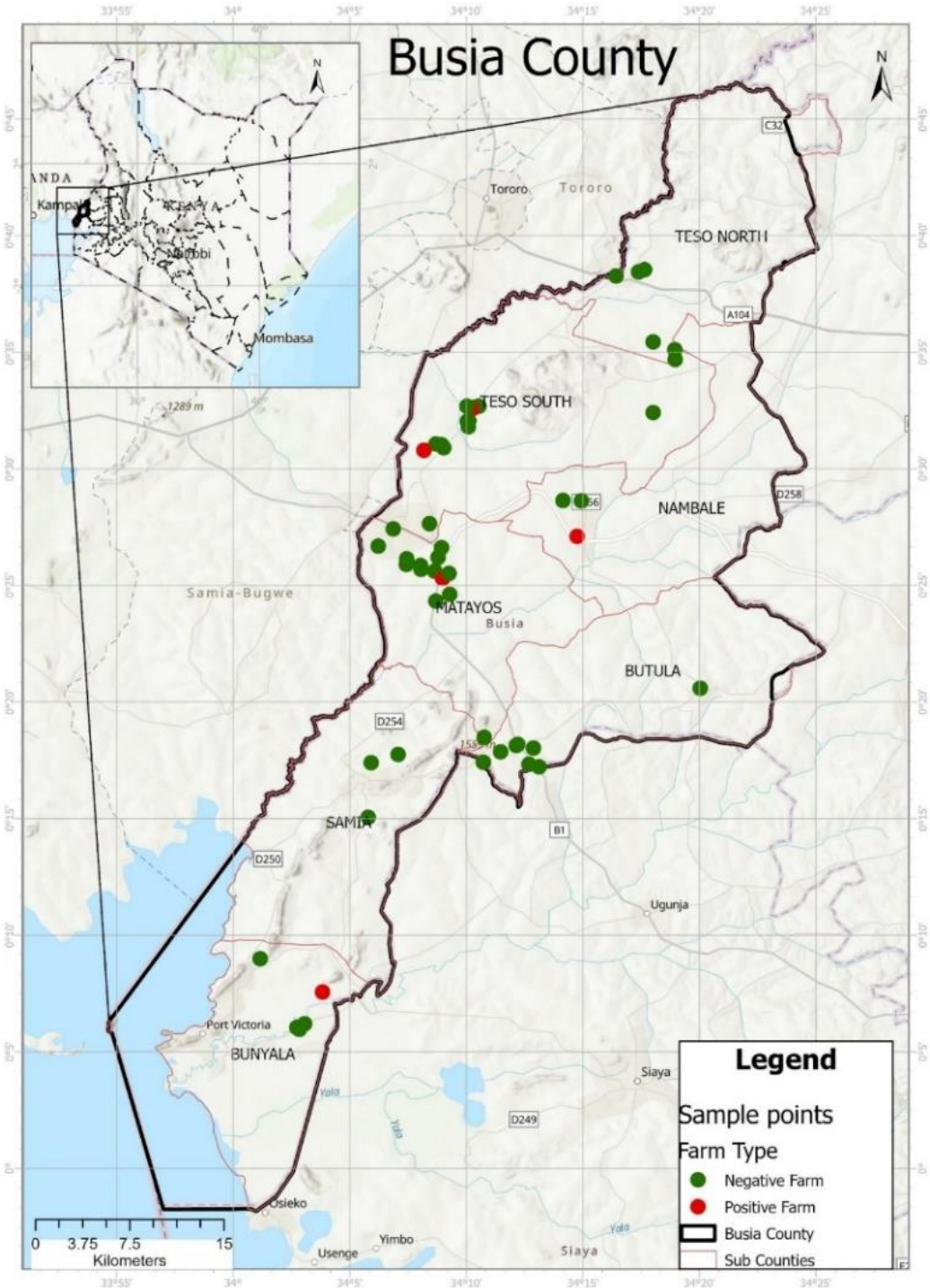


**Figure 2.** Distribution of sampled households/farms by PRRS serostatus in Busia County, Kenya. Red dots indicate seropositive and green dots indicate seronegative farms (Map produced using ArcGIS Desktop 10.8 Esri, Redlands, CA, USA).

**Questionnaire survey results**

***Farmer demographics and farming practices***

Among the 56 farmers surveyed, 66% were men, and most were above 50 years (37%), followed by 31-40 years (29%) and 41-50 years (25%). Education levels among respondents varied, with 45% having attained university or college education, 30% having completed secondary school (up to Form Four), 16% having completed primary education (up to Standard Eight), 5% having completed high school (Form Five and Six), and 4% having no formal education. Livelihoods were predominantly mixed crop-livestock farming (77%), with 21% employed and 2% in business (Table 3). Regarding pig farming practices, semi-intensive systems (37%) were most common, followed by backyard/scavenging (29%). Herds were generally small (5-10 pigs, 43%; 11-20 pigs 25%), and pig keeping was mainly commercial (95%). The breeds kept were exotic 46%, local 34%, and crossbreeds 20%. Experience in pig husbandry was typically 1-5 years (50%), with 41% having more than 5 years and 9% less than a year (Table 3).

**Table 3.** Demographics of 56 farmers and farming practices in Busia County, Kenya, between May and August 2025

| Section | Characteristic | Category | N | % |
|---|---|---|---|---|
| **Demographics** | Sex | Male | 37 | 66 |
| | | Female | 19 | 34 |
| | Age | Below 20 | 0 | 0 |
| | | 20-30 | 5 | 9 |
| | | 31-40 | 14 | 25 |
| | | 41-50 | 16 | 29 |
| | | Above 50 | 21 | 37 |
| | Education | No formal education | 2 | 4 |
| | | Primary | 9 | 16 |
| | | Secondary | 17 | 30 |
| | | High school | 3 | 5 |
| | | University/college | 25 | 45 |
| | Primary occupation | Farming (livestock and crops) | 43 | 77 |
| | | Formal employment (public and private sector) | 12 | 21 |
| | | Business | 1 | 2 |
| **Farming practices** | Pig farming system | Backyard/scavenging | 16 | 29 |
| | | Semi-intensive | 21 | 37 |
| | | Intensive-small scale | 13 | 23 |
| | | Intensive-large scale | 6 | 11 |
| | Herd size | 5-10 | 24 | 43 |
| | | 11-20 | 14 | 25 |
| | | 21-30 | 6 | 11 |
| | | 31-40 | 3 | 5 |
| | | 41-50 | 1 | 2 |
| | | ≥ 50 | 8 | 14 |
| | Main purpose | Commercial (income generation) | 53 | 95 |
| | | Home consumption | 2 | 3 |
| | | Breeding purpose | 1 | 2 |
| | Breeds kept | Exotic | 26 | 46 |
| | | Local | 19 | 34 |
| | | Crossbreeds | 11 | 20 |
| | Experience | < 1 year | 5 | 9 |
| | | 1-5 years | 28 | 50 |
| | | ≥ 5 years | 23 | 41 |

***Biosecurity, management practices, and PRRS awareness***

Among the 56 farmers surveyed, biosecurity uptake was low; only 14% used separate clothing/aprons and 32% wore boots, 25% shared equipment between farms, and 12.5% had footbaths. About half of the farmers (50%) controlled farm entry, 30% isolated sick pigs, and 11% quarantined newly introduced pigs. While 52% of farms had fencing, only 16% of farmers reported washing their hands after handling pigs, despite 96% being aware that diseases can spread between pigs and farms (Table 4). Management practices indicated very low vaccination (5%), breeding relied on natural mating (96%), with stock sourced mainly from neighboring farmers (86%). Manure was mainly used on crop farms (94.6%), and when pigs were sick, 78.6% called a vet/animal health worker (10.7% used over-the-counter drugs and 10.7% sold/slaughtered the pigs). Feed was primarily commercial (69.6%), only 25% had received husbandry or disease prevention training, and barriers to veterinary access included cost (32.1%), lack of services (16.1%), and distance (14.3%; Table 4). PRRS awareness was very low (7%), reported clinical problems included respiratory issues (66% of farms) and reproductive losses (abortions 32%, stillbirths 46%, weak piglets 43%) while other signs (each ≤ 20%) included pneumonia, fever, diarrhea, coughing, sudden deaths, stunted growth, erythema, anorexia, mange, emaciation, hypersalivation, and congenital defects (Table 4).

**Table 4.** Biosecurity, management practices, and PRRS awareness among pig farmers in Busia County, Kenya, between May and August 2025

| Section | Characteristic | Category | N | % |
|---|---|---|---|---|
| **Biosecurity** | Use of separate clothing/apron when handling pigs | Yes | 8 | 14 |
| | | No | 48 | 86 |
| | Wearing of boots | Yes | 18 | 32 |
| | | No | 38 | 68 |
| | Share equipment between farms | Yes | 14 | 25 |
| | | No | 42 | 75 |
| | Presence of disinfectant/footbath at entrance | Yes | 7 | 12.5 |
| | | No | 49 | 87.5 |
| | Control entry (visitors/buyers/vehicles) | Yes | 28 | 50 |
| | | No | 28 | 50 |
| | Isolate sick pigs | Yes | 17 | 30 |
| | | No | 39 | 70 |
| | Quarantine new pigs | Yes | 6 | 11 |
| | | No | 50 | 89 |
| | Quarantine location | Near (< 25 m) | 5 | 9 |
| | | Far (> 25 m) | 1 | 2 |
| | Fencing present | Yes | 29 | 52 |
| | | No | 27 | 48 |
| | Aware diseases spread pig-to-pig/farm-to-farm | Yes | 54 | 96 |
| | | No | 2 | 4 |
| | Handwashing after handling pigs | Yes | 9 | 16 |
| | | No | 47 | 84 |
| **Management** | Manage pig excreta | Use on crops | 53 | 94.6 |
| | | Sell | 2 | 3.6 |
| | | Other uses | 1 | 1.8 |
| | When pigs are sick | Call a vet | 44 | 78.6 |
| | | Over-the-counter drugs | 6 | 10.7 |
| | | Sell or slaughter | 6 | 10.7 |
| | Source of breeding pigs | Neighboring farmers | 48 | 86 |
| | | Breeding farms | 8 | 14 |
| | Method of breeding | Natural mating | 54 | 96 |
| | | Both (natural + AI) | 2 | 4 |
| | Any vaccination? | Yes | 3 | 5 |
| | | No | 53 | 95 |
| | If vaccinated, against which disease | Brucellosis | 2 | 3.6 |
| | | Parvovirus | 1 | 1.8 |
| | Main feed source | Commercial feed | 39 | 69.6 |
| | | Pasture/grazing | 7 | 12.5 |
| | | Kitchen leftovers | 6 | 10.7 |
| | | Crop residues | 2 | 3.6 |
| | | Swill feed | 2 | 3.6 |
| | Any training received on husbandry/disease prevention | Yes | 14 | 25 |
| | | No | 42 | 75 |
| | Challenges in accessing vet services | None | 19 | 33.9 |
| | | High cost | 18 | 32.1 |
| | | No services | 9 | 16.1 |
| | | Long distance | 8 | 14.3 |
| | | No awareness | 1 | 1.8 |
| | | Other challenges | 1 | 1.8 |
| | Contact with an animal health worker | Yes | 52 | 93 |
| | | No | 4 | 7 |
| **PRRS awareness** | Heard of PRRS | Yes | 4 | 7 |
| | | No | 52 | 93 |
| | Reproductive problems | Abortions | 18 | 32 |
| | | Stillbirths | 26 | 46 |
| | | Born weak piglets | 24 | 43 |
| | Respiratory problems (any) | Yes | 37 | 66 |
| | | No | 19 | 33 |
| | Other signs (in the past 6 months) | Pneumonia | 11 | 20 |
| | | Fever | 10 | 18 |
| | | Diarrhea | 10 | 18 |
| | | Coughing | 8 | 14 |
| | | Sudden death | 8 | 14 |
| | | Stunted growth | 8 | 14 |
| | | Erythema | 7 | 13 |
| | | Loss of appetite | 7 | 13 |
| | | Dullness | 6 | 11 |
| | | Mange | 5 | 9 |
| | | Emaciation | 4 | 7 |
| | | Hypersalivation | 2 | 4 |
| | | Congenital defect | 1 | 2 |
| | | Experienced none | 8 | 14 |

Note: Yes or No responses indicate the number of farms practicing or not practicing the respective activity, and do not represent the number of PRRSV-positive farms within each category.

**Risk factors associated with farm-level PRRS seropositivity**

Not using separate clothing/apron was the only factor that was significantly associated with PRRS farm seropositivity (OR = 13.89, 95% CI 1.84-100, $p < 0.05$). All other risk factors (wearing boots, sharing equipment, presence of footbath, controlling visitors, isolation, quarantine, fencing, handwashing, vaccination, and training) had $p > 0.05$, indicating no statistically significant evidence of association (Table 5).

**Table 5.** Association between farm-level practices and PRRS farm seropositivity in Busia County, Kenya, between May and August 2025

| Predictor | Yes (n) | No (n) | OR (PRRS+, No versus Yes) | 95% CI | P-value |
|---|---|---|---|---|---|
| Use of separate clothing /Apron while dealing with pigs | 8 | 48 | 13.889 | 1.842 - 100 | **0.017*** |
| Wearing boots | 18 | 38 | 1.459 | 0.221 - 9.615 | 0.652 |
| Sharing of equipment between farms | 14 | 42 | 0.235 | 0.012 - 4.520 | 0.316 |
| Presence of disinfectants/footbath at the entrance | 7 | 49 | 1.877 | 0.179 - 19 | 0.501 |
| Do you control who enters your pig unit? | 28 | 28 | 4.505 | 0.469 - 43 | 0.352 |
| Isolation of sick pigs? | 17 | 39 | 1.600 | 0.242 - 10 | 0.634 |
| Quarantine of new pigs before introducing them into the farm? | 6 | 50 | 2.299 | 0.213 - 25 | 0.445 |
| Fencing of piggery units/farms? | 29 | 27 | 4.167 | 0.435 - 40 | 0.353 |
| Washing of hands after dealing with pigs | 9 | 47 | 4.184 | 0.591 - 29 | 0.178 |
| Have you ever vaccinated your pigs? | 3 | 53 | 6.135 | 0.451 - 83 | 0.249 |
| Have you ever received any training on husbandry? | 14 | 42 | 2.163 | 0.323 - 14 | 0.590 |

Note: *Significant Fisher's exact test ($p < 0.05$).

## DISCUSSION

Kenya's smallholder pig systems create conditions conducive to PRRSV transmission, yet detection may be limited by subclinical infection and sparse surveillance. The low pig-level and farm-level seroprevalence of 1.3% and 8.9% respectively, in the present study fits a pattern seen in other African settings where detection of PRRSV has tended to cluster in smallholder herds while larger and biosecure herds test negative against PRRSV (Dione et al., 2018; Molini et al., 2024). Within the region, the neighboring Uganda has also reported a low PRRSV seroprevalence of 1.55% (Dione et al., 2018). Another study in Uganda reported a prevalence of 24.65% and 2.73% for PRRSV-1 and PRRSV-2, respectively, by real-time PCR (Oba et al., 2022), highlighting heterogeneity across methods, time, and production systems. In Namibia, PRRSV was found only on three epidemiologically linked rural farms with a pig-level prevalence of 4.76% and a within-farm prevalence of 14 to 30% as detected by RT-PCR, while all industrial herds remained negative, underscoring the role of basic biosecurity in preventing introduction (Molini et al., 2024). On the contrary, higher seroprevalence has been reported in southwest Nigeria and in some parts of Nepal, where they reported a seroprevalence of 53.8% and 20% respectively, detected using ELISA assays (Aiki-Raji et al., 2017; Prajapati et al., 2023).

The present study found no significant differences in PRRSV seroprevalence by sub-county or sex, and the positive pigs in the present study were between 4 to 6 months of age. Although this may suggest possible age-related exposure dynamics, the observation is based on a small number of positive cases and should therefore be interpreted with caution. This finding agrees with other reports of no significant sex effect (Prajapati et al., 2023). However, other studies observed significant geographic heterogeneity by district and topography, and a strong age gradient with the highest prevalence in pigs of more than 18 months, contrary to the 4 to 6-month-old positive pigs in the present study (Kim et al., 2002; Ferrara et al., 2023; Prajapati et al., 2023). Regionally, a study in Uganda showed similarly low overall prevalence but district-level differences (Masaka 1.3% versus Lira 1.7%), underscoring that locality can matter even when absolute prevalence is low (Dione et al., 2018).

The farm characteristics and biosecurity profiles in the present study indicated a low uptake on the use of separate clothing while dealing with pigs (14%), footbaths (12.5%), handwashing after pig handling (16%), and quarantine (11%), the findings which were consistent with prior descriptions of pig farmers in western Kenya, Uganda and comparable country like Nepal (Kagira et al., 2010; Ekakoro et al., 2023; Prajapati et al., 2023). In Busia's smallholder

free-range systems, tethering, minimal housing, locally sourced feeds, and disease or feeding constraints have long been documented (Kagira et al., 2010), aligning with the low-input profile observed in the present study. Similar patterns of weak biosecurity and limited PRRS knowledge have been noted by a study in Nepal, where 40% had footbaths, 25% used separate boots, and 43% were aware of PRRS, reinforcing that awareness does not automatically translate into practice without supportive systems (Prajapati et al., 2023).

Mechanistic work and field observations emphasize that contaminated clothing, tools, and vehicles can mechanically carry PRRSV between pens and farms, the pathway targeted by measures such as dedicated use of aprons/boots, visitor control, and disinfection points (Pitkin et al., 2009; Prajapati et al., 2023). Against this backdrop, the finding that not using separate clothing/aprons was significantly associated with PRRS farm seropositivity is biologically and operationally plausible, as dedicated clothing directly interrupts fomite transmission at the human-pig interface (Fablet et al., 2016; Prajapati et al., 2023). Several other practices in the present study, such as not washing hands after pig handling, not controlling visitors, and a lack of fencing/footbaths, indicated elevated odds but were not statistically significant. These directions are consistent with the known role of hygiene and perimeter control in reducing between-pen and between-farm spread, even if the present study was underpowered to confirm those associations definitively. The relatively high (but non-significant) odds ratios observed for some of these practices suggest that they may represent true risk factors, and future studies with larger numbers of positive farms or longitudinal follow-up will be important to clarify their potential contribution to PRRSV introduction and spread.

Management practices also align with recognized risk pathways. Most farms sourced breeding stock locally and relied on natural service, a pattern that can connect otherwise separate herds (Kagira et al., 2010). In Namibia, rapid local spread was plausibly linked to sharing boars for breeding, a practice discouraged in favor of certified semen for artificial insemination (Molini et al., 2024). Reported vaccination coverage in the present study was very low, comparable to broader African contexts where vaccine access and uptake for swine pathogens are limited outside commercial systems, underscoring the importance of non-vaccine biosecurity in smallholder herds.

## CONCLUSION

Based on the findings of the present study, this study provided the first serological evidence of PRRSV exposure among pigs in Kenya, with an overall pig-level seroprevalence of 1.3% and farm-level seroprevalence of 8.9%. Although the infection was detected at low levels and showed no significant differences by age, sex, or sub-county, it highlights the presence of PRRSV in the region and the need for improved farm-level disease prevention measures. It is recommended that the farmers be advised to focus on simple and high-yield biosecurity measures such as dedicated clothing, use of boots, visitor control, quarantine of newly introduced pigs, use of foot baths, fencing, and hand hygiene, also expanding surveillance programs beyond the commonly known diseases to include PRRSV and other respiratory and reproductive pathogens. However, the cross-sectional design, the small number of positive farms, and the use of ELISA limit causal inference and could fail to detect very recent infections, and the potential for false positives or false negatives due to limited test specificity may also be considered. Seropositivity could also reflect past infection since no farms used PRRS vaccines. Future studies should use larger samples, longitudinal designs, and include molecular detection and typing to define transmission pathways and PRRSV species at the Kenya and Uganda border.

## DECLARATIONS

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### Authors' contributions

Julius Luvanga, Patrick Bisimwa, and Juliette Ongus made substantial contributions to the conception and design of this study. Julius Luvanga was also involved in the acquisition of data, laboratory work, data analysis, and interpretation of data. All authors have been involved in preparing the manuscript and revising it critically for important intellectual content. All authors gave final approval for the manuscript to be published.

### Availability of data and materials

The original data presented in the study are available in the article.

**Competing interests**

The authors declare no competing interests.

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**Ethical considerations**

All authors affirmed that the study adheres to the highest ethical standards. Issues related to plagiarism, publication consent, research misconduct, data fabrication, duplicate submission, and redundant publications have been thoroughly addressed. No Artificial Intelligence (AI) tools were used to generate text or figures.

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