

## Seroprevalence of Peste Des Petits Ruminants Virus from Samples Collected in Different Regions of Tanzania in 2013 and 2015

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### Abstract

Sero-surveillance was conducted to determine seroprevalence of peste des petits ruminants virus (PPRV) in sheep and goats population of Tanzania using samples collected in 2013 and 2015. A total of 3,838 samples were collected from villages in 14 of the 25 mainland regions. Samples were tested by competitive ELISA for detection of antibodies against PPRV. Overall, 998 of the samples were found to be positive for antibodies against PPR, giving a seroprevalence of 27.1%. In this study, there was no statistical significant difference of getting PPR between sheep and goats (odds ratio of 1.06, 95% CI 0.89-1.25). The overall seroprevalence indicates that PPR is prevalent in small ruminants in the study areas. The study also confirms the presence of antibodies against PPR in sheep and goats in regions of Tanzania that previously had little to no data on the disease, an indication that PPR is spreading within Tanzania with the possibility of spreading to neighboring countries.

**Keywords:** Peste des petits ruminants; Seroprevalence; cELISA; Tanzania

### Introduction

Peste des petits ruminants (PPR) is a highly contagious viral disease of goats and sheep characterized by oculo-nasal discharges, stomatitis, diarrhea and pneumonia [1]. It is a disease of economic significance because of its transboundary nature, high morbidity and mortality rates which result in loss of production, limitations on export and threat to human food chain [2]. The disease is caused by peste des petits ruminants virus (PPRV), belonging to the genus *Morbillivirus* of the family *Paramyxoviridae*. The virus is highly contagious and easily transmitted by direct contact through secretions and/or excretions of infected animals [3].

Peste des petits ruminants was first reported in West Africa in the early 1940s and later recognized as endemic in both West and Central Africa [4,5]. Currently, PPR is present in Central, Eastern and Western Africa, Asia, and the Near and Middle East [6]. In East Africa, PPR was detected serologically in Kenya and Uganda in 2007 [7].

Efforts to determine presence of PPR in sheep and goats in Tanzania can be traced back to Loliondo in 1995 through grey literature [8]. Three years later in 1998, the presence of antibodies against PPR was ruled out by a comprehensive study that did not find any antibodies against PPR in Tanzania sheep and goats [9]. A retrospective study done in Ngorongoro district using samples collected for Rift Valley fever virus and PPR surveys showed presence of antibodies against PPR in samples collected in 2004, suggesting the presence of PPRV at that period [8].

PPR was officially confirmed in Tanzania in 2008 and it was confined to the northern zone in districts bordering Kenya [10,11]. This follows the official confirmation of PPR in neighboring Kenya in 2007 [7]. The possible spread from Kenya to Tanzania may have been due to the difficulty in controlling transnational livestock movements across borders, especially where Maasai pastoralists are found on either side [12]. In 2011, an outbreak of PPR was reported in southern Tanzania [13]. In other areas of Tanzania, limited to no data is available about the disease. Therefore, the objective of this study was to determine seroprevalence of PPR in selected regions of Tanzania to have a current comprehensive view about the distribution of PPR in the country.

### Materials and Methods

#### Samples

A total of 3,838 serum samples from 118 villages collected from sheep and goats in 14 regions of Tanzania (Figure 1) in 2013 and 2015 were used (Table 1). Samples were collected from apparently healthy animals, that is did not show any clinical signs associated with PPR. These serum samples were submitted to Sokoine University of Agriculture for official confirmation of PPR in Tanzania before a PPR vaccination campaign. Unfortunately, sex of sampled animals could not be retrieved from information stated in the submission forms.

#### Detection of PPR antibodies using competitive enzyme linked immunosorbent assay (cELISA)

Sera were tested for antibodies against PPRV using a competitive ELISA kit (cELISA) (CIRAD EMVT, Montpellier, France). The test was performed according to manufacturer's instructions. Samples presenting a competition percentage of less than or equal to 50% were considered positive for PPRV antibodies.

#### Statistical analysis

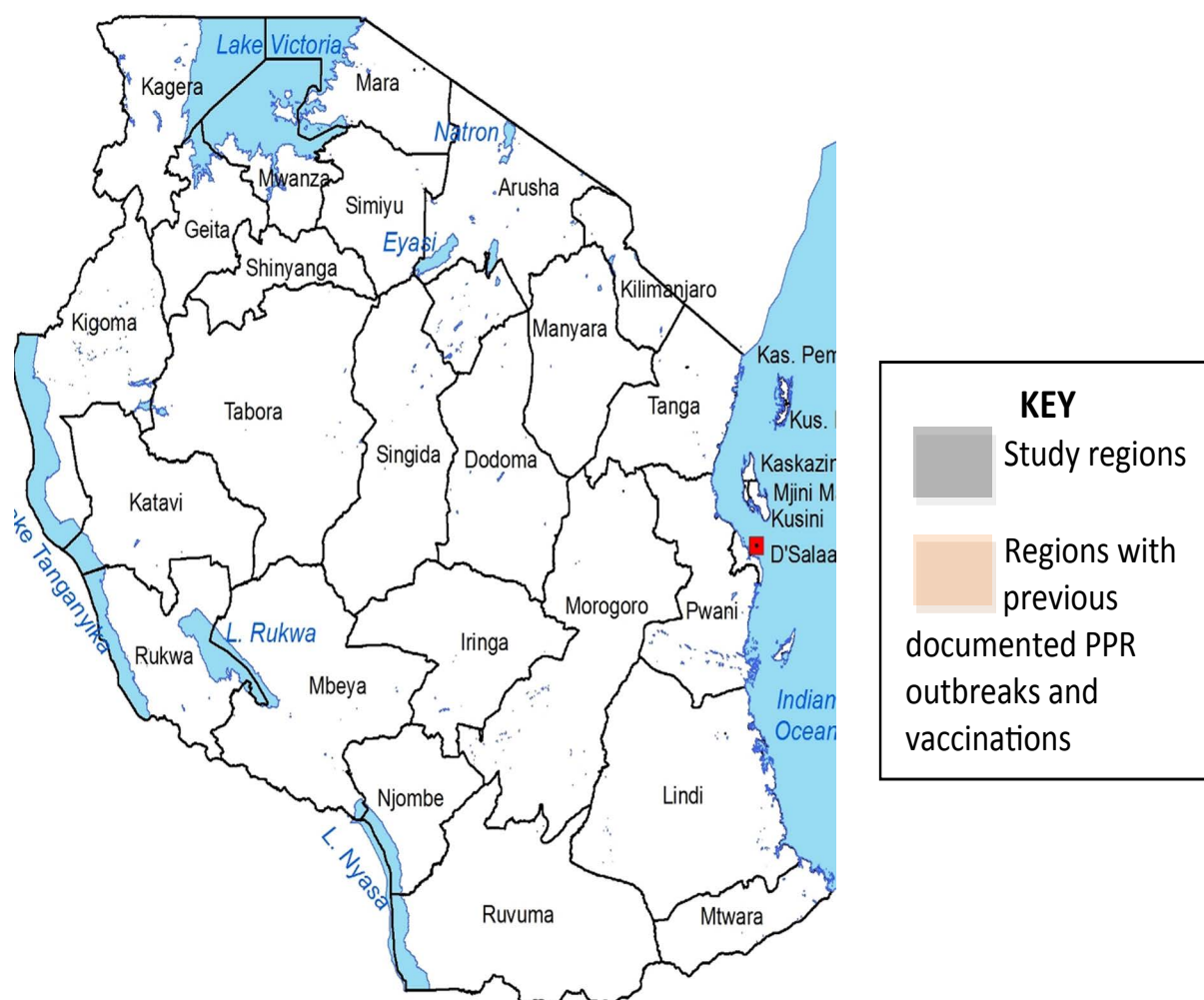
Apparent prevalence estimates were used to estimate true prevalence [14] and the kit's relative diagnostic sensitivity and specificity of 92.2% and 98.9% respectively [15]. The odds ratio was calculated to assess the association between being seropositive for PPR and animal species [16].

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**Figure 1:** Map of Tanzania showing study regions in colour (except Mtwara).

Region	Districts (Villages)	Goats			Sheep			Total		
		Total	Positive (%)	TP (95% CI)	Total	Positive (%)	TP (95% CI)	Total	Positive (%)	TP (95% CI)
Morogoro	2 (10)	178	124 (69.7)	73.5 (66.4 - 81.7)	38	25 (65.8)	69.4 (53.4 - 85.5)	216	149 (70.0)	72.8 (66.3 - 79.4)
Shinyanga	3 (4)	217	16 (7.4)	7.2 (3.5 - 10.9)	33	0 (0)	<0	250	16 (6.4)	6.2 (2.9 - 9.4)
Coastal	3 (14)	310	90 (29.0)	30.3 (24.9 - 35.7)	41	13 (31.7)	33.1 (18 - 48.3)	351	103 (29.3)	30.6 (25.5 - 35.7)
Simiyu	3 (7)	202	15 (7.4)	7.3 (3.4 - 11.1)	59	6 (10.2)	10.2 (2 - 18.4)	261	21 (8.1)	7.9 (4.4 - 11.4)
Kagera	3 (16)	198	6 (3.0)	2.6 (0 - 5.1)	12	0 (0)	<0	210	6 (2.9)	2.4 (0 - 4.8)
Mwanza	7 (23)	414	15 (3.6)	3.2 (1.3 - 5.1)	92	0 (0)	<0	506	15 (3.0)	2.5 (0.9 - 4.1)
Kilimanjaro	1 (5)	80	29 (36.3)	38 (26.7 - 49.2)	66	12 (18.2)	18.7 (8.8 - 28.6)	146	41 (28.1)	29.3 (21.5 - 37)
Manyara	1 (5)	92	67 (72.8)	76.9 (67.2 - 86.6)	55	30 (54.5)	57.4 (43.4 - 71.5)	147	97 (66.0)	69.6 (61.5 - 77.8)
Arusha	1 (5)	97	66 (68.0)	71.8 (61.8 - 81.7)	56	37 (66.1)	69.7 (56.5 - 82.9)	153	103 (67.3)	71.1 (63.1 - 79)
Dodoma	3 (12)	420	240 (57.1)	60.2 (55.2 - 65.3)	180	104 (57.8)	60.9 (53.2 - 68.6)	600	344 (57.3)	60.4 (56.2 - 64.6)
Singida	2 (8)	167	39 (23.4)	24.2 (17.4 - 31.1)	79	0 (0)	<0	246	39 (15.9)	16.2 (11.4 - 21.1)
Tabora	3 (3)	245	31 (12.7)	12.8 (8.4 - 17.3)	115	11 (9.6)	9.5 (3.8 - 15.3)	360	41 (11.4)	11.5 (8 - 15)
Katavi	3 (3)	130	5 (3.8)	3.5 (-0.1 - 7)	62	0 (0)	<0	192	5 (2.6)	2.1 (-0.3 - 4.5)
Kigoma	3 (3)	136	16 (11.8)	11.9 (6.1 - 17.7)	64	2 (3.1)	2.7 (-1.9 - 7.2)	200	18 (9.0)	8.9 (4.7 - 13.2)
<b>Total</b>	<b>38 (118)</b>	<b>2 886</b>	<b>759 (26.3)</b>	<b>27.4 (25.7 - 29.1)</b>	<b>952</b>	<b>240 (25.2)</b>	<b>26.2 (23.3 - 29.1)</b>	<b>3 838</b>	<b>998 (26.0)</b>	<b>27.1 (25.6 - 28.5)</b>

Total: total number of animals sampled, Positive: number of animals tested positive with percentage given in parenthesis, TP: true prevalence with 95% confidence interval in parenthesis.

**Table 1:** Regions where serum samples from sheep and goats were collected in Tanzania.

From 3,838 serum samples tested, 998 (26.0%) were positive; 759 (26.3%) of 2 886 from goats and 240 (25.2%) of 952 from sheep were positive (Table 2 and Figure 2). Overall true seroprevalence was 27.1% (95% CI, 25.6-28.5) and seroprevalence for goats and sheep was 27.4% (95% CI, 25.7-29.1) and 26.2% (95% CI, 23.3-29.1), respectively. Morogoro region had the highest overall seroprevalence (72.8%, 66.3-79.4) of antibodies against PPRV while Katavi region had the lowest (2.1%, -0.3-4.5). The odds of being seropositive to PPR was 1.06 (95% CI 0.89-1.25) times higher in goats compared to sheep, a figure that is not statistically significant (Table 3).

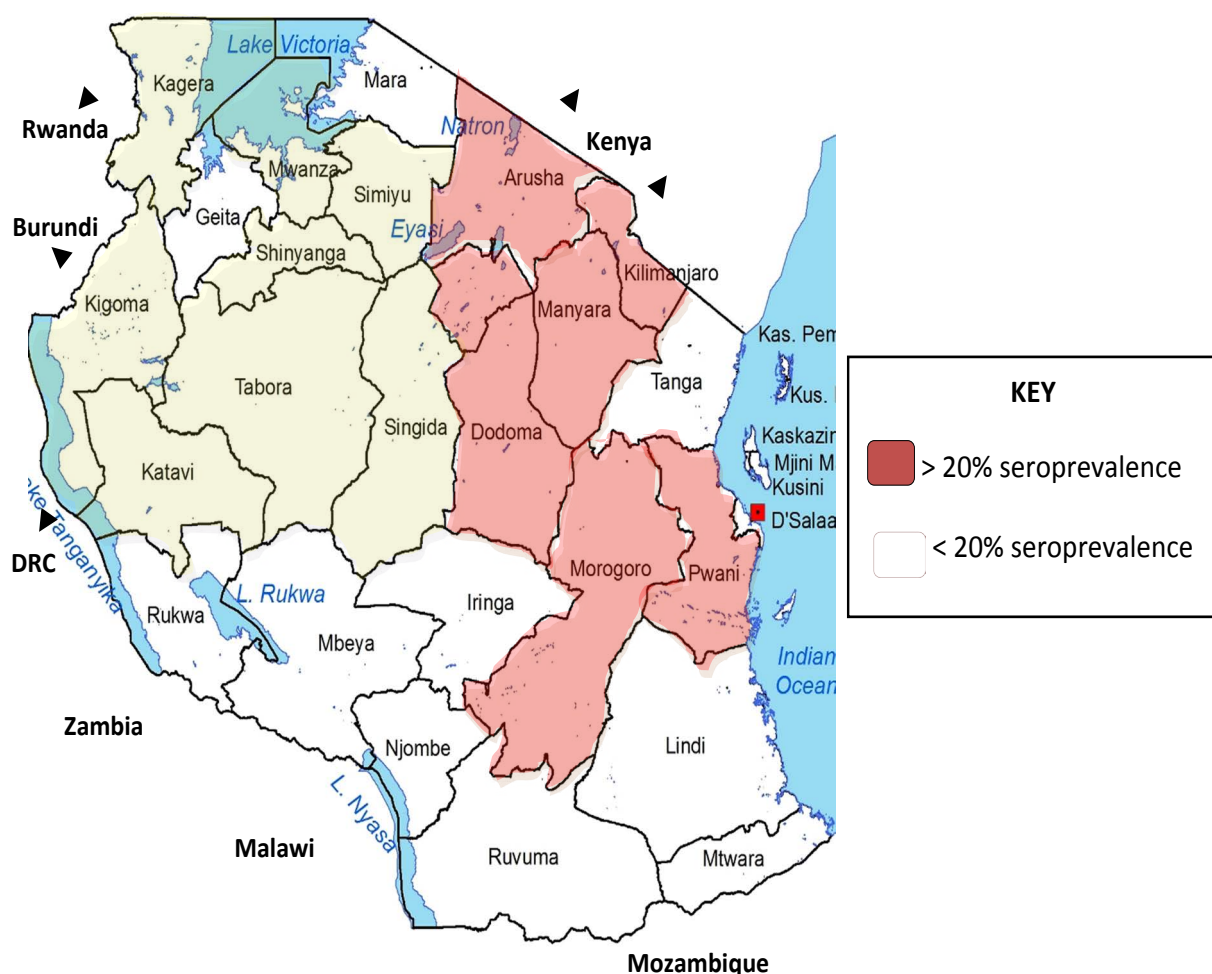
## Discussion

This study shows that PPR was widely prevalent in small ruminants in the study areas. All regions had seropositive cases. The overall observed seroprevalence (27.1%, 25.6-28.5) (Table 2) is low compared to previous reports from northern and southern Tanzania performed in 2009 at 45.4% [11] and 2012 at 31.0% [13] respectively. There is a statistical significance ( $p < 0.05$ ) between the studies and years. This difference may be attributed to vaccination campaigns (Figure 1). Though the seroprevalence is low, the figure is highly significant in a

country with an estimated population of sheep around 8 million and goats around 16.7 million [17].

Though some regions registered seroprevalence of less than 20% (Figure 2), this indicates that PPR is widely prevalent in small ruminants in areas where the study was conducted. Data from studies in west, east and central Africa indicate that PPRV antibodies can be widespread among goats and sheep flocks raised in the tropics [9,3,18,19]. Studies also indicate eLISA as a preferred diagnostic test for screening antibodies against the PPRV. This is because the test is simple, rapid, specific and sensitive for intensive surveillance [20]. Screening for antibodies against PPRV in different geographical areas of a country with varying climatic conditions has been helpful in developing disease control strategies [21]. Hence these results can be helpful to government officials in developing control strategies for Tanzania.

The seropositivity difference between sheep and goats remains unclear in literature. In this study, prevalence between the two species was sheep 26.2% and goats 27.4%. The odds of being seropositive were 1.06 (95% CI 0.89-1.25) in goats than in sheep, which implies there is no difference between the species. This is in contradiction with some studies, including one carried out in Tanzania [11], which reported a



**Figure 2:** Map of Tanzania showing seroprevalences of study regions.

Region	Year collected	Sheep	Goats	Total
Morogoro	2013	38	178	216
Shinyanga	2013	33	217	250
Coastal	2013	41	310	351
Simiyu	2013	59	202	261
Kagera	2013	12	198	210
Mwanza	2013	92	414	506
Kilimanjaro	2015	66	80	146
Manyara	2015	55	92	147
Arusha	2015	56	97	153
Dodoma	2013	180	420	600
Singida	2013	79	167	246
Tabora	2013	115	245	360
Katavi	2013	62	130	192
Kigoma	2013	64	136	200
<b>Total</b>		<b>952</b>	<b>2886</b>	<b>3838</b>

**Table 2:** Regional seroprevalence of antibodies against PPRV in goats and sheep in Tanzania.

Variable	Odds ratio	95% CI	P value
Species (goats vs sheep)	1.06	0.89-1.25	0.507

**Table 3:** Association of species and being seropositive for PPR.

higher seroprevalence in goats than in sheep and linked it to higher fecundity in goats compared to sheep [2,18,22]. Other studies have reported higher seroprevalence in sheep than goats, attributing it to lower number of sheep sampled or due to the fact that goats are often affected more severely by the disease hence die prior to sampling [19,23]. Therefore, more investigations are needed to further determine the variation between the species.

In 2008 and 2010, PPR vaccination was carried out around the 2008 outbreak foci (Arusha region) with another vaccination ring in Morogoro and Mtwara regions, shown in Figure 1 [24]. Arusha and Mtwara regions were chosen because they had already been seen as hotspot areas while Morogoro region acted as a buffer zone for spread of the disease from south (Mtwara region) to north. The use of antibiotics in managing clinical cases is also believed to increase survival rate of sick animals [8] thus the surviving animals will carry antibodies against PPRV. These two factors may have contributed to the high seroprevalence because cELISA cannot discriminate from previously PPRV infected animals and vaccinated animals. Small ruminants vaccinated on a large scale with PPR vaccines will still test positive for antibodies against PPRV [25]. Despite this, presence of antibodies against PPR in regions that previously were thought to be free and no vaccinations have been performed, such as Mwanza, Shinyanga, Kigoma and Tabora, indicates that the disease is spreading (Figure 2). The data means future vaccinations should cover all regions of the country and not concentrate in known high risk areas. Small ruminants are easily moved especially for sale in markets. Live animal markets are an important vehicle for transmission of infectious diseases [25]. This was demonstrated in a study [13] that found out that lack of appropriate veterinary services and inadequate infrastructure especially in the local animal markets in Tanzania may be facilitating transmission of PPR. Trade also brings about livestock theft that has been found to play a major role in maintaining transmission of infectious diseases in many areas of East Africa [19].

In conclusion, this study has confirmed the presence of PPR in regions of Tanzania that previously had little to no data on the disease. This is a step forward to getting information about the disease situation that can help to properly put into place systems and proper control

measures to improve animal welfare and reduce episodes of disease outbreaks.

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## Conflict of Interest Statement

The authors declare that there is no conflict of interests regarding the publication of this article.

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