Peste des petits ruminants (PPR) in western Tanzania

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SUMMARY

An epidemiological study was carried out to determine the disease status of Peste des Petits ruminants (PPR) in Kigoma region bordering Burundi and Democratic Republic of Congo (DRC). The study aimed at establishing the seroprevalence, risk factors associated with the PPR and clinical cases in the study area. A total of 450 sheep and goats were sampled, 150 animals from each of the three Districts. The overall regional seroprevalence was 4.4 and 0.7% for goats and sheep respectively. Stratification of the seroprevalence by District indicated that Kibondo had the highest seroprevalence of PPR in goats (6%) followed by Kasulu (5.6%) and Kigoma rural (2.4%). In addition, Kibondo District recorded active clinical cases of PPR with overall morbidity of 19.3% and case fatality ratio of 71.1%. There were no active cases of PPR reported in Kasulu and Kigoma Rural Districts. Questionnaire survey to establish risks for PPR infection and spread was conducted in Kibondo District targeting the affected villages. Introduction of new animals in the flock was identified as the key risk factor for the PPR infection in the flock (p=0.0054). Furthermore, both sheep and goats were affected in spite of the lower number of sheep kept in the region. Being the first study on PPR in the western region of Tanzania bordering Burundi and Democratic Republic of Congo, the study will benefits the three countries and provides the basis for the joint efforts to control and eventually eradicate the disease.

Key words: PPR, Western-Tanzania, Seroprevalence, small ruminants, PPR, Kigoma

INTRODUCTION

Peste des Petits Ruminants (PPR) is caused by *Pest des Petits Ruminantis* virus (PPRv) of the genus Morbillivirus and the virus is known to cause up to 80% mortality rate in the affected population of small ruminants (Gibbs *et al.,* 1979) and (Kitching, 1988). The disease is clinically manifested by fever, diarrhoea, oculo-nasal discharges, erosive stomatitis and crusting scabs along the lips, development of pneumonias in late stages and high mortality rates up to 80% (Muse *et al*, 2012a). The distribution the disease is considered to spread from West Africa where the disease was first identified before it was later reported in East Africa, Middle East and Asia. Within the East African region, only Rwanda remains the only country which has not yet recorded clinical cases of PPR after recent outbreaks of PPR in central Burundi, the first clinical cases to be recorded in the country (Banyard *et al.,* 2010) and (WAHIS, 2018). In Tanzania, the first confirmed cases of PPR outbreak were reported in the north and central Tanzania between the year 2007 and 2009 (Kivaria *et al.,* 2009; Swai *et al.,* 2009; Torsson *et al.,* 2016). Since then, new cases have been reported spanning from the east,

north and southern parts of Tanzania (Misinzo *et al*, 2015; Muse *et al*, 2012a). Until recently no cases have been reported in western or central regions of Tanzania. However, the exact status PPR in the central and western regions of Tanzania is not currently known due to absence of active PPR surveillance in the region. The aim of this study was to conduct a cross sectional epidemiological investigation on PPR in the Kigoma region targeting the 50 kilometre strip along the western part of Tanzania bordering Burundi and Democratic republic of Congo.

MATERIALS AND METHODS

The study was conducted in administrative areas of Kasulu, Kibondo, and Kigoma rural Districts in Kigoma region along Burundi and Democratic Republic of Congo (DRC) borders. This area lies between latitudes 3.6º and 6.5º south and longitudes 29.5º and 31.5º east along the shores of Lake Tanganyika, bordering Burundi and DRC in the west between Nyanzige in the North and Nsunuka village in the south covering a 50 kilometres strip from the borders of Burundi and Democratic Republic of Congo (DRC) (Figure 1). A cross-sectional epidemiological study was adopted and three field visits were carried out. The first visit conducted in September 2011 and involved blood sampling and serological examination. The second visit was carried from January to February 2012 and adopted a case-control design. Cases in the second visit were farms/flocks with seropositive animals during the first visit and controls were flocks with negative animals which were matched to the positive flocks. The questionnaire survey was used and detailed interviewing of key respondents from households with seropositive animals. In addition, households with active PPR cases were included in the interview to determine possible risk factors of PPR infection and spread. The third visit was carried out in August-September 2018 to investigate clinical status of PPR in the previously visited Districts of following the reports of recent PPR outbreak in the neighboring regions of Burundi (WAHIS, 2018). During the third visit, PPR data were collected from records available at the District Veterinary Office.

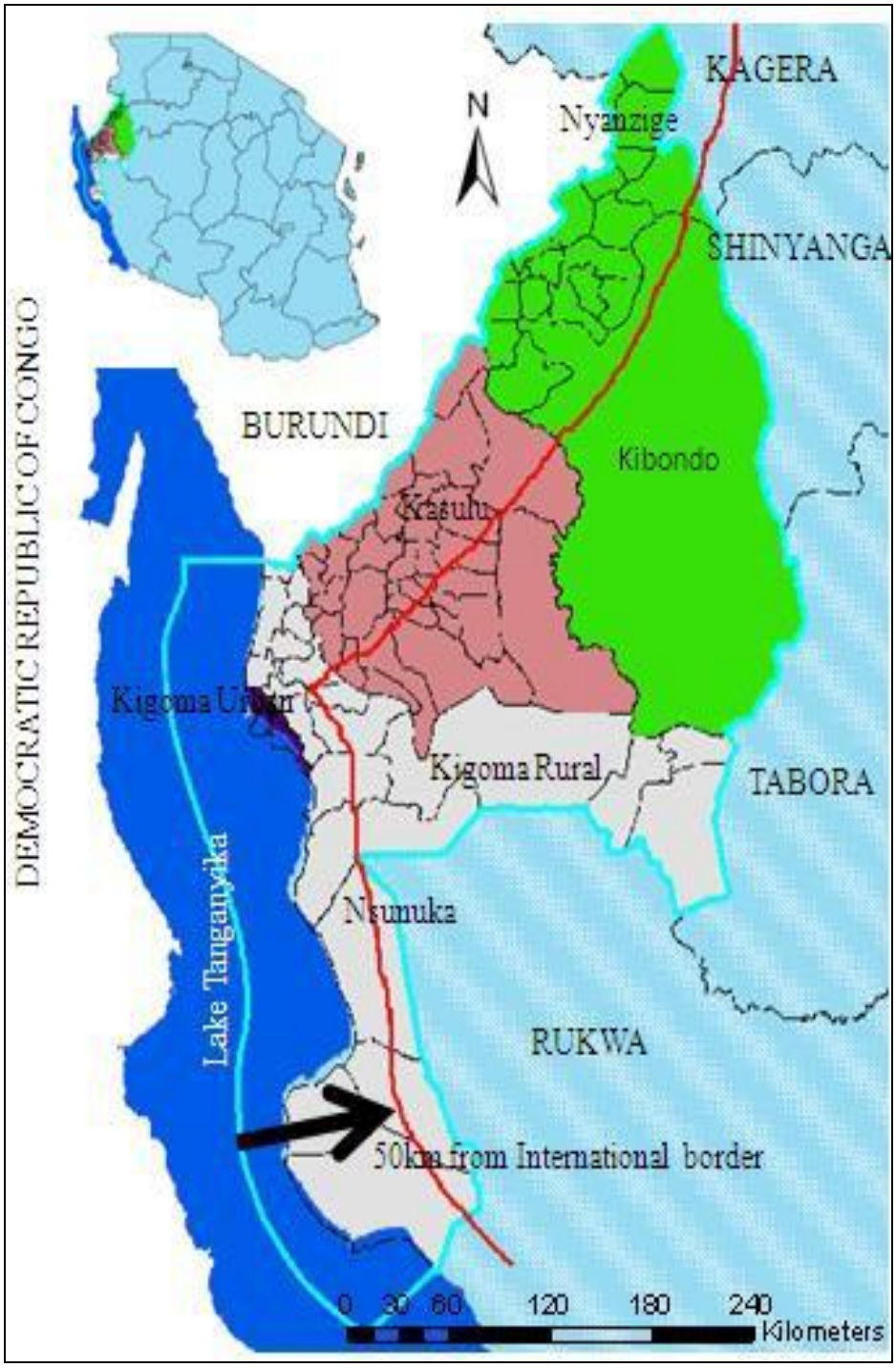

Figure 1. Map showing study area, a 50 km strip along the Tanzania-Burundi and Tanzania-Democratic Republic of Congo borders.

Sampling and serology

Sampling of blood for serological analysis involved 15 villages per District covering a total of 45 border villages within the 50 km strip. Sample size was determined using a method recommended for 2-stage cluster sampling (Bennett *et al.,* 1991; Thrusfield and Christley, 2005). The estimated clusters (villages) were 38 based on the procedures described by (Bennett *et al.,* 1991). However, the number of clusters was increased to 45 to increase precision. Blood samples from 415 goats and 35 sheep were collected and allowed to clot at room temperature. The sera were separated by decantation and transferred labelled and chilled into 1.5 ml tubes and transported to the Central Veterinary Laboratory (CVL) for storage where they were preserved at −20°C until analysis.

Laboratory analysis of samples was done by using a monoclonal antibody (MAb) based competitive Enzyme Linked Immunosorbent Assay (cELISA) for the detection of antibodies in sera as previously described (Singh *et al.,* 2004). The GPS coordinate of the sampled flock was recorded using Universal Transverse Mercator (UTM) system using (GPS MAP device 60 CS, Garmin® Asia). A structured questionnaire administered during the first visit was used to collect information of flock size, animal species, health status, biodata and clinical information observed by the farmers. Clinical examination of affected animals was carried out by observation of animals at a distance for general body condition, posture, respiration and general body movement. Close examination was also conducted to document/ record presence of lesion observed throughout the body at the head, nostril, muzzle, eyelids, genital organs and the skin regions.

Data analysis

The descriptive data analysis and statistics were computed including the prevalence which was calculated as the proportion that tested positive in all samples. The multivariate logistic regression model was used to assess the association between the potential risk factors associated with the outcome variable defined by the seroprevalence of PPR. A risk factor with P-value ≤ 0.05 was considered to be significantly associated with PPR

RESULTS

Number of goats and households keeping goats is higher compared to sheep in all three studied Districts

Kigoma rural had the largest number of small ruminants amounting to 222,381 compared to 105,578 in Kibondo and 75,042 in Kasulu (Figure 2A). The proportions of goat to sheep in the studied Districts were 89.4% in Kibondo, 89.1% in Kigoma rural and 87.9% in Kasulu respectively (Figure 2A-B). Furthermore, the house holds keeping goats were higher in all Districts compared to sheep and Kigoma rural had only 16.3% of households keeping sheep compared to the other Districts which had 24-25% of households keeping sheep and the rest of the percentage being goats (Figure 2C-D).

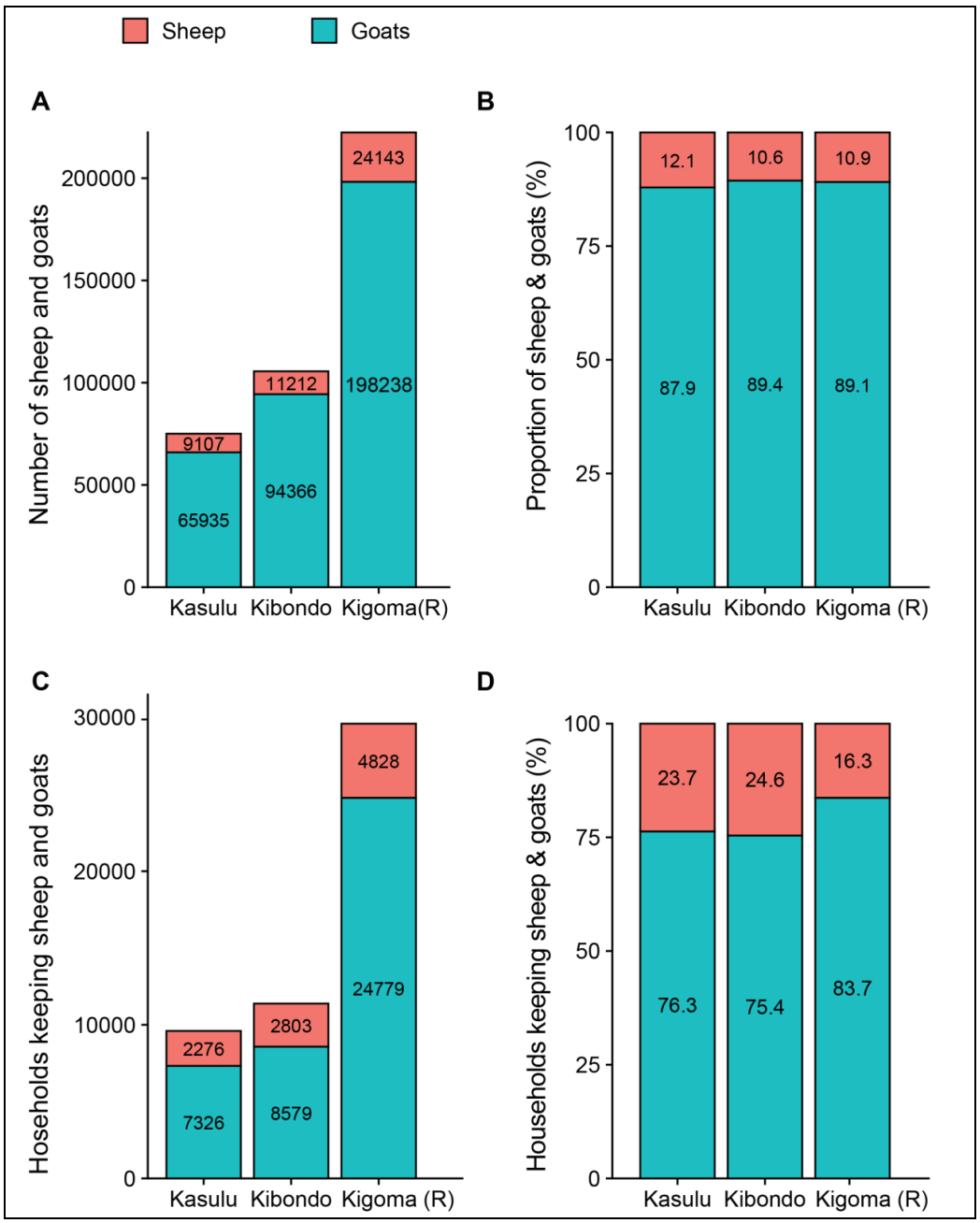

Figure 2. Number of sheep and goats by District (A), proportion of sheep and goats in each District in percentage (B), number of households keeping sheep and goats (C) and proportion of households keeping sheep and goats in each District (D). Source of data: The respective District Agriculture & Livestock Development Offices

High prevalence of PPR in Kibondo Districts

The flock level seroprevalence sampled was defined as the presence of at least one seropositive goat or sheep in the flock. Distribution of animals that were found positive to PPR shows that, Kibondo had the highest seroprevalence whereas Kigoma rural recorded lowest seroprevalence (Table 1). However, when prevalence was compared based on animal species, Kigoma rural had the highest seroprevalence in sheep and no seropositive sheep was detected in the Kibondo and Kasulu Districts (Table 1).

Table 1. Seroprevalence by Districts in goats and sheep

District	Kasulu (N=150)			Kibondo (N=150)			Kigoma(R) (N=150)		
Status	(+ve)	n	%	(+ve)	n	%	(+ve)	n	%
Goat	8	142	5.6	9	149	6.0	3	124	2.4
Sheep	0	8	0.0	0	1	0.0	3	26	11.5

Table legend: (+): Positive, n: Sample size, N: Total number including sheep and goats, (R): Rural

Active Clinical cases of PPR in Kibondo District

There were no active clinical cases of PPR encountered in Kigoma rural and Kasulu Districts during the study. On the other hand, 32 clinical cases were observed in Kibondo District. Among these 17 cases were observed during flock visit while 15 cases were reported by respondents in goats to the local Veterinary Officer. The most frequently observed signs were the presence of nodules on the skin, mostly on the oral-nasal and the genital organs, thick and yellowish oculo-nasal discharges (Figure 3).

Figure 3. Oral-nasal nodules, crusts and ocular discharges in one of the affected goat

Interactions of animals from different sources increases risk for PPR

Because of relatively higher prevalence of PPR in Kibondo District, further analysis was done to identify possible factors likely to increase risk for PPR infectivity. Univariate logistic regression analysis of different risk factors related to husbandry and management of sheep and goats (Figure 3 & Table 2), and identified three potential factors which are ventilation in animal house, introduction of new animal in the flock and grazing system (Table 2). From the potential risk factors identified during the univariate analyses, introduction of new animals in the flock was the only significant risk factor (p= 0.0054) (Table 2). Goats and sheep were housed in burnt brick houses thatched with grasses in most households. The majority of animal houses had earthen floors with poor ventilation and few household had wooden raised floors thatched with grasses or old iron sheets (Figure 4).

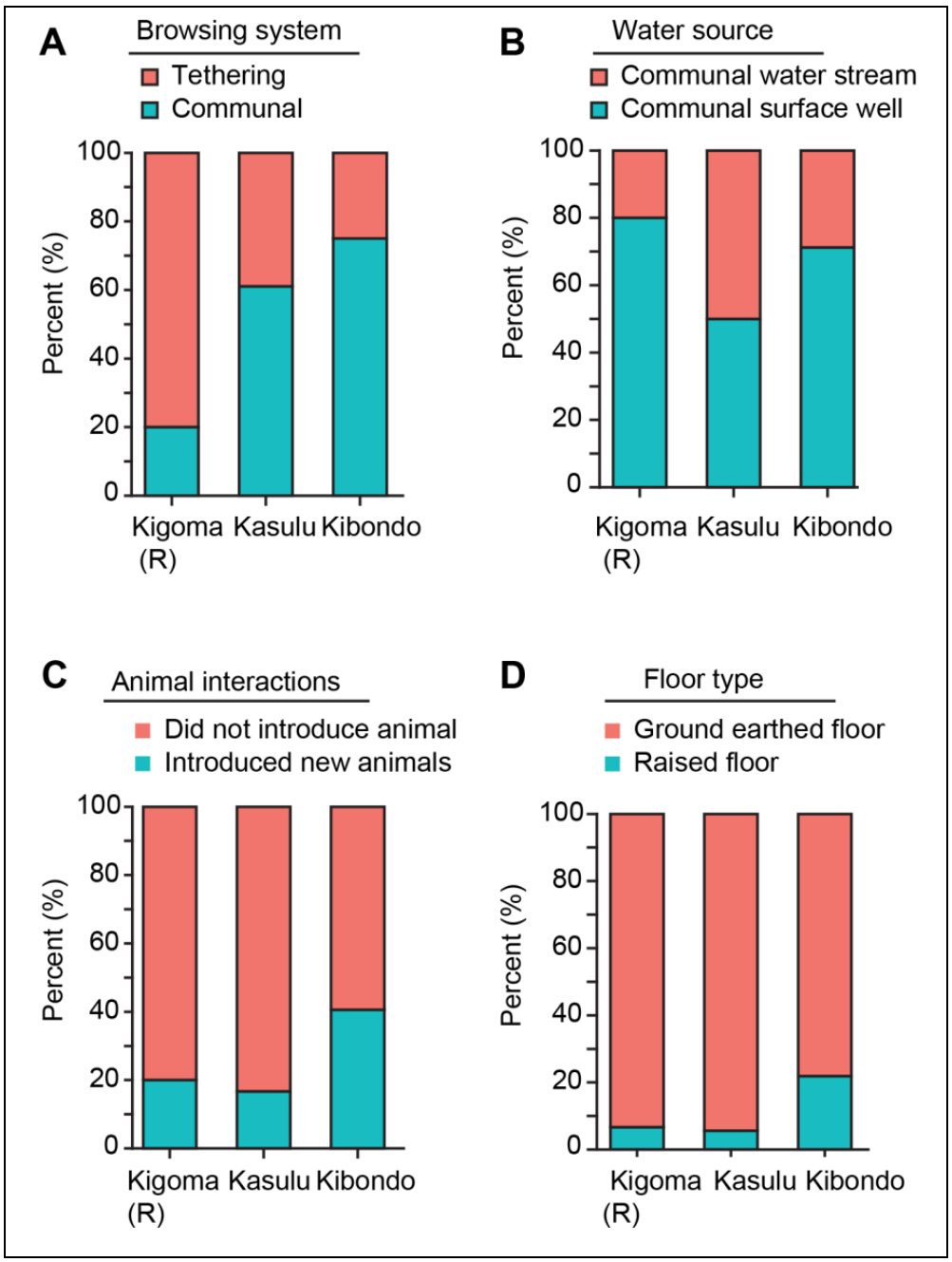

Figure 4. Risk factors and proportion of respondents by District (n=65). Proportion of respondents who practiced tethering or allowed their animals to browse in communal land (A), proportion of respondents who allow their animals to drink in communal water stream or well (B), proportion of respondents who introduced new animals in their flock (C) and proportion of respondents who have earthed or raised floor (D)

Table 2: Associations of risk factors with PPR seropositivity in Kibondo District

Risk factor	OR	95%	C.I	S.E	p-value
House ventilation , (Good /poor)	0.3676	0.0624	2.1674	0.9052	0.269
Introduced new animal in the flock, (Yes/No)	6.9333	1.7726	27.1187	0.6959	0.0054
Tethering / Communal browsing	0.2715	0.0961	0.7668	0.5295	0.0138

OR: odds ratio, CI: Confidence interval, SE: standard error

The overall economic impact of PPR defined by morbidity, crude mortality, and case fatality in Kibondo District is summarized in Table 3.

Table 3: Proportions of the households affected by PPR in Kibondo District

Parameter	n (N)	Percentage
Household affected	22 (32)	68.8
Morbidity	45 (233)	19.3
Crude mortality	32 (233)	13.7
Case fatality	32 (45)	71.1

N: Total number of households and cases examined, n: observations

No new cases of PPR

Despite of the recent outbreaks of PPR in neighboring country of Burundi, no new active cases of PPR was recorded in Kibondo, Kigoma rural and Kasulu since the last outbreak in the year 2012.

DISCUSSION

The present study has confirmed the presence of PPR exposure and infection in western part of Tanzania. It is the first study to describe the existence of seropositive cases in goats and sheep and clinical cases in goats in this region bordering Burundi and DRC. This study therefore compliments the information on the prevalence of PPR in other parts of Tanzania as reported by (Muse *et al.,* 2012b) in Southern and (Kivaria *et al.,* 2009; Swai *et al.,* 2009) innorthern regions. Since no animal was vaccinated against PPR, the observed seroprevalence in goats and sheep is believed to be attributed to field infection with PPR virus. Tracer study conducted by Kibondo District Veterinary Authority noted that the source of clinical cases in Kibondo was from a flock of small ruminants collected from different locations and kept for business in Malagarasi Street, Kibondo District Council. This was followed by imposition of quarantine in early December 2011. It is therefore speculated that imposition of quarantine might have positive impact and prevented the spread of PPR to other neighboring Districts and therefore limiting the occurrence of clinical cases only to Kibondo District. Furthermore, Kibondo District is relatively large, and its geographical location exposes the District to free movement of animals from Kagera region in the north, Shinyanga and Tabora regions in the east, and from neighboring Districts and Burundi in the west. Therefore it is not possible to precisely ascertain the source of the disease without a comprehensive investigation.

The overall regional seroprevalence of 4.4 % of PPR observed in goats in western Tanzania is relatively lower compared to 31% in the north (Kivaria *et al.,* 2009; Swai *et al.,* 2009) as well as 45.8 in southern Tanzania (Muse *et al.,* 2012b). The cause of this difference it is currently not known, it is speculated that, this difference is partly caused by differences in

animal management system such as tethering and watering by using bucket which is mainly practiced in western Tanzania and which reduces instances of animal interactions compared to communal browsing and communal water sources practiced in other parts of Tanzania and therefore increases the risks of PPR spread. PPR cases being relatively new in the region, the introduction of PPR in western region may be attributed to various practices including introducing new animals in the flock from neighboring regions (Table 2) and across the international borders of Burundi, Tanzania and the Democratic Republic of Congo. Interestingly, PPR outbreaks were reported in different parts of the Democratic Republic of Congo almost during the same year of 2012 (WAHIS, 2018) raising the possibility that cross interactions of animals from the two countries could be the main source of PPR in either country between Kibondo in Tanzania and the Democratic Republic of Congo. Other possible sources of infection could be from Burundi due to the existing cross-border interactions between small ruminant keepers. However, there were no active cases of PPR reported in Burundi during or before the year 2012 until recent outbreak in early 2018 (WAHIS, 2018). The observed higher seroprevalence of PPR in goats compared to sheep is in agreement with other studies (Dhar *et al.,* 2002). Similarly, (Abraham *et al.,* 2005) also confirmed that goats react more severely to PPR virus exposure and suffer severe clinical cases than sheep. The higher prevalence in goats is linked to a greater susceptibility of the goat population to infection with PPRv while recovery rate of goats to PPRv infection is considerably less than that of sheep (Dhar *et al.,* 2002). However, comparison in seroprevalence between sheep and goat in this study cannot be accurately made due to a relatively uneven distribution of sample size between the sheep and goats (Figure 1).

Lastly, serological and clinical findings from this study have established the prevalence of PPR in western areas of Tanzania along DRC and Burundi boarders. Being an important contagious transboundary disease (TADs), there is a need of strengthening the strategies for combating the disease including implementation of regular surveillance and take deterrence measures to avert more serious economic losses associated with high mortality and limitations in international trade.

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