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Article

Investigation of peste des petits ruminants outbreaks in goat farms of Chuadanga District of Bangladesh in 2014

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Abstract: A case-control study was conducted in Chuadanga district of Bangladesh to investigate risk factors for Peste des petits ruminants (PPR) that occurred during November-December 2014 in goat farms. A total of 37 farms were reported to be PPR cases based on active and passive surveillance from 4 villages of Chuadanga Sadar and Damurhuda sub-districts. Fifty-five 'control-farms' were selected from the same 4 villages. Farmers of both case and control farms were interviewed using a pre-tested semi-structured questionnaire for data collection on potential risk factors. Logistic regression analysis was used to evaluate the association between potential risk factors and disease outcome. Focus group discussions with farmers and livestock personnel in the selected villages were conducted using 'participatory epidemiological' (PE) approach to identify issues with PPR in the villages. The results showed that 27% of the case-farms (n=10) were vaccinated, 60% (n=6) of which were vaccinated two times and 40% (n=4) single time in a year. About 50% (n=20) farms used 'perch/macha' and the other 50% used 'mud' type of housing. The morbidity and case-fatality rate in case-farms were 15.49%, 54.54%, respectively. Adoption of single time annual vaccination and using perch/ macha housing were significant protective factors (OR=0.03, 95% CI=0.008-0.1, p<0.001; OR=0.29, 95% CI= 0.11-0.74, p=0.004 respectively). Vaccination done twice in a year significantly lowered infection when compared to one time vaccination (OR=0.21, 95% CI=0.05-0.79, p=0.02). The results from PE showed that proper labeling of PPR vaccines, logistics for mass vaccination and spreading awareness, are necessary for successful PPR prevention. In conclusion, control of PPR in this district may be achieved by single time annual vaccination with a maximum coverage along with adoption of perch housing in all goat rearing farms in the district.

Keywords: peste des petits ruminants (PPR); goats; investigation; Chuadanga district; risk factors; Bangladesh.

1. Introduction

PPR is considered as one of the major threats to small ruminant population in Bangladesh. The disease causes severe losses to small ruminant production where morbidity and mortality reach up to 100%, 50-90% respectively in an outbreak (Rahman *et al.*, 2011; Islam *et al.*, 2003; Sil *et al.*, 2000, 2001). In 2010, there were 84,000 clinical cases reported, causing an estimated loss of 1,842 million Taka (US$ 24.6 million) (Chowdhury *et al.* 2014). The actual number of infected cases may not represent cases from remote rural areas. The first

outbreak of PPR in Bangladesh occurred in 1993 in Meherpur district, south western part of the country and continuing to occur since then (Sil *et al.*, 1995 and Islam *et al.*, 2001).

PPR is an economically important emerging trans-boundary animal disease, classified under the genus Morbillivirus under the family of Paramyxoviridae (Gibbs *et al.*, 1979). Incubation period of the disease is 2-6 days and is characterized by fever, pneumonia and necrotic enteritis. Goats and sheep are considered as natural hosts of PPR, goats being more susceptible (Taylor, 1984). There are 25.43million goats in Bangladesh (personal communication/ unpublished data), 52% of which are reared by landless marginal farmers (Chowdhury *et al*., 2002). Black Bengal goat is the species that is reared in most of the districts, helping in reduction of poverty in rural women and strengthening empowerment. Forty-one percent of the farm income is generated by goat rearing; 250 million Bangladeshi Taka (US$ 3.5 million) is being generated from goat leather export (Chowdhury *et al.*, 2002). Until last century, goats were reared in scavenging system and have gradually shifted to semi-intensive/ intensive management in many goat rearing districts. The housing system that most goat farmers use is mud-type. However, few farms use perch house/ macha system and have found to be protective in the community against goat diseases as it is conducive for good hygienic and management practices (unpublished data). It has been recognized that hygienic and good management practice can improve the recovery rate in PPR infected goats at the farm level (Yousuf *et al.* 2015).

Chuadanga is a district with higher density of goat population. Due to favorable climatic conditions and availability of feed resources, people of this district especially the poor have chosen 'fattening' of goats to alleviate their poverty level. Despite various initiatives like vaccination, farmers' awareness taken by Department of Livestock Services (DLS) towards prevention and control of the disease, it is challenging. The secondary surveillance data of DLS indicates that the disease prevails in this district year-round with peak of outbreaks during the winter (November-December) and continue until mid summer (March-April). The outbreaks are severe in the district where vaccination coverage is minimum (unpublished data/ personal communication). The vaccination coverage in national PPR programs is however, not satisfactory (SAARC, 2013). It is important to evaluate the disease burden as well as find out the factors that prevail or reduce PPR in goat farms in the country. A few studies have been conducted to assess the actual disease burden (Sarker *et al.*, 2011) and there is no specific program for eradication of PPR in Bangladesh. The objective of this study is to identify the risk factors associated with PPR outbreaks in Chuadanga Sadar, Damurhuda sub-districts of Chuadanga district during November to December 2014. The goal of the study is to recommend strategies to control PPR in the country.

2. Materials and Methods

2.1. Study area and study design

Damurhuda and Chudanga Sadar subdistricts of Chudanga District, Northwestern part of Bangladesh (Figure1) were selected to conduct the investigation of PPR outbreaks in goats during a period of November-December 2014.

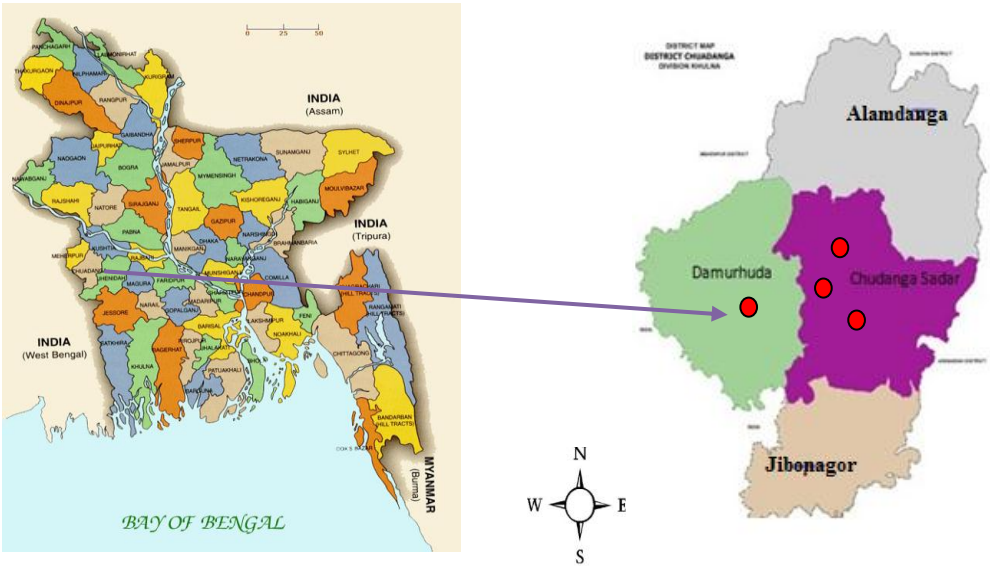

Figure 1. Map showing 4 villages for investigation of PPR outbreaks (Showing red circles)

A case-control study was designed to find out the risk factors associated with PPR. The data on 'suspect' PPR case-farms recorded through passive surveillance by Veterinary hospitals of the sub-districts were collected by our team. SAARC regional leading diagnostic laboratory for PPR, Bangladesh Livestock Research Institute, Savar, Dhaka was contacted for the data on 'confirmed' case-farms through active surveillance. Data from both 'suspect' and 'confirmed' case-farms were considered as 'cases' for data analysis. The 'control' farms were selected from the same sub-districts as case-farms by convenient sampling technique.

2.2 Definition of case and control-farms

2.2.1. Case-farm

***'Suspected case-farm'*:** The farm consisting of goats from Chudanga Sadar (Hazrahati, Jaforpur and Pourosova) and Damurhuda (Bisnopur) sub-districts of Chuadanga district showing at least 2 clinical signs among the following: fever (104-106°F), diarrhea with foul smell, discharges from eyes, nose and mouth, mouth sores, loss of appetite, abortion in pregnant does, during November - December 2014.

***'Confirmed case-farm'*:** The farm from above mentioned geographical areas and time period, with at least one suspected goat case and confirmed positive for PPR (nasal swab samples) using RT-PCR (Couacy-Hymann *et al.* 2002).

2.2.2. Control-farm

The farm from the same geographical location as case-farm, consisting of goats not showing any of the above mentioned clinical signs during November - December 2014.

2.3. Data collection, management and statistical analysis

The data on demographics and risk factors were collected from both case and control-farms using pretested semi-structured questionnaires. The risk/ protective factors included in the questionnaires were: History of single time vaccination within 1 year, introduction of new goat within 1 year, sharing goat house with neighbor, having perch/ macha house, fattening of goat, selling of infected goats, use grazing land after outbreak along with practicing two time vaccination within 1 year. The data on demographics, risk/ protective factors and disease outcome were entered and validated in Microsoft excel® worksheet and imported into Epiinfo 7 program (CDC, 2012) for statistical analysis. Univariate logistic regression analysis was performed to evaluate associations of potential risk factors with the PPR disease outcome (case-farms versus control-farms). A p-value of 0.05 was used to determine statistical significance. Due to missing data, the total number of case and control-farms varied in relation to some variables and are indicated in results accordingly.

Focus group discussions with goat farmers were conducted using participatory epidemiological (PE) approach on PPR in the villages. Topics such goat breeds, problems in goat rearing, problems in vaccination and suggestion for improvement of vaccination procedure and any other business (AOB) were discussed. Similar approach was undertaken with focus group discussions with livestock personnel (veterinarians/ para-veterinarians). Data from both discussions were recorded in pre-formatted questionnaires. Proportions were calculated to describe the data and to prioritize the issues related to PPR.

3. Results

The data included 37 case-farms and 55 control-farms. The 37 cases consisted of 22 suspect-farms and 15 confirmed case-farms. At the farm level, 5% (n=2) of the case-farms and 25% (n=14) of the control-farms represented Damurhuda sub-district; 95% (n=35) of the case-farms and 75% (n=41) of the control-farms were from Chuadanga Sadar sub-district. The 37 case-farms represented a total of 284 goats. The animal level morbidity in the case-farms was (44/284) 15.49% and case-fatality rate was (24/44) 54.54%. The clinical sings of suspected PPR infected goats (n=44) shown in Figure 2 and outcomes of the suspected goats shown in Figure 3.

3.1. Vaccination

Of the 37 case-farms, 73% (n=27) and of the 55 control-farms, 93 % (n=51) did not practice PPR vaccination. Eleven percent (n=4) of the case-farms vaccinated their goats once annually and 16% (n=6) vaccinated twice annually. The single annual vaccination status significantly varied between case and control-farms. The farms that vaccinated once within past 1 year had significantly lower likelihood of PPR infection (OR=0.03, 95%

CI=0.008-0.101, p-value<.001). Annual vaccination done twice yearly significantly lowered infection when compared to one time vaccination (OR=0.21, 95% CI=0.02 -0.79, p=0.02) (Table 1).

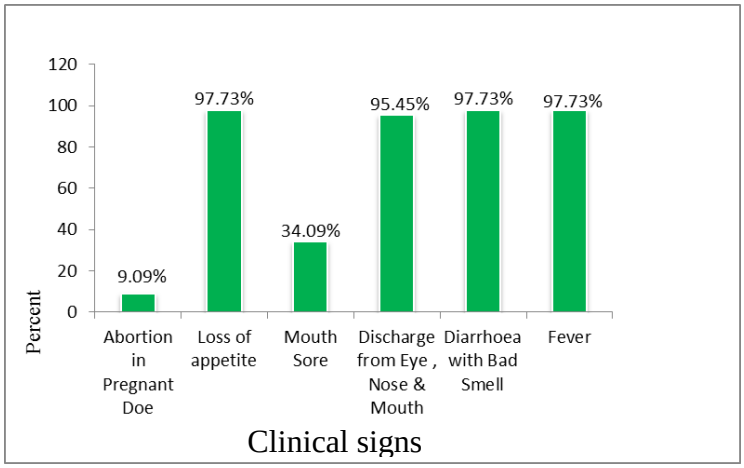

Figure 2. Clinical signs of PPR infected suspected goats(n=44).

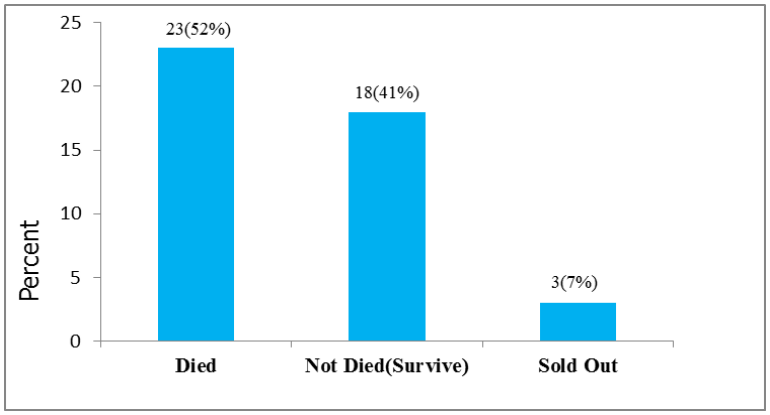

Figure 3. Outcome of suspected goats (n=44).

The mean (±SD) age of the case-farm owners was 38.2 (±9.2) years, 54% (n=20) of them were women and 46% were men (n=17). The mean (±SD) age of the control-farm owners was 38.81 (±9.70) years, 85% (n=47) of them were women and 15% were men (n=8).

3.2. Introduction of new goat within year

Of the 37 case-farms, 35% (n=13) introduced new goat within past 1 year and 65% (n=24) did not introduce new goat. Of the 55 control-farms, 38% (n=21) introduced new goat where as 64% (n=34) farms did not introduce new goat within past 1 year. However, no significant association between introduction of new goat within one year and PPR infection was found.

3.3. Sharing goat house with neighbor

Of the 37 case-farms, only 24% (n=9) and of the 55 control-farms, 15% (n=8) shared their goat house with the neighbor. However, no significant association between sharing goat house with neighbor and PPR infection was found.

3.4. Having perch/macha house

Of the 37 case-farms, 54% (n=20) used perch/ macha housing, whereas, 46% (n=17) farms used mud housing to keep the goats. Of the 55 control-farms, 80% (n=44) used perch/ macha house, whereas, 20% (n=11) farms used mud housing. The use of perch/ macha housing showed significantly lower likelihood of PPR infection (OR=0.29 95% CI=0.11-0.74, p=.008).

3.5. Fattening of goat

Of the 30 case-farms, only 17% (n=5) fattened their goats, whereas, of the 55 control-farms 22% (n=12) fattened their goats. No significant association was found between fattening of goats and the likelihood of PPR infection.

3.6. Selling of infected goats

Of the 29 case-farm data available, 21% (n=6) sold their infected goats, and of the 55 control-farms, 35% (n=19) sold their infected goats. However, no significant association was found between selling infected goats and the PPR infection.

3.7. Utilizing grazing land after previous outbreaks

Of the 36 case-farm data available, 14% (n=5) used grazing land after previous outbreaks and of the 55 control-farms, 22% (n=12) grazed their goats on the land of previous outbreaks. However, no significant association was found with the PPR disease.

Table 1. Result of univariate logistic regression analysis between potential risk factors and PPR infection (number of case-farms= 37, number of control-farms= 55).

Risk/protective factors	Number of farms				Odds Ratio (95 % CI)	P-value
	Exposure to risk factor		No Exposure to risk factor			
	Case	Control	Case	Control		
Having history of single time vaccination within 1 year	10	51	27	4	0.03 (0.008-0.101)	<0.001
Practicing two time vaccination in a year	4	39	6	12	0.21 (0.05-0.79)	0.02
Introduction of new goat within 1 year	13	21	24	34	0.87 (0.36-2.08)	0.38
Sharing goat house with neighbor	9	8	28	47	1.88 (0.65-5.45)	0.12
Having perch/macha house	20	44	17	11	0.29 (0.11-0.74)	0.008
Fattening goat	5	12	25	43	0.71 (0.22-2.27)	0.29
Selling Infected goats	6	19	23	36	0.49 (0.17-1.42)	0.10
Use same grazing land after the outbreak	5	12	31	42	0.52 (0.16-1.61)	0.19

3.8. Focus group interviews

Focus group discussions of goat rearing farmers consisted of 4 women and 1 man representing 31-54 years of age. The occupation of the farmers was homemaker and agriculture. Ninety-five percent were rearing Black Bengal goat, 0.5% Jamunapari and 4.5% cross breed (Black Bengal and Jamunapari). One hundred percent of them use PPR vaccination in their goat farms. Ninety percent of them reared goat for commercial purposes and 10% for hobby.

A second focus group discussion consisted of 5 veterinarians and para-veterinarians from 2 sub-districts. The outputs of the focus group discussion were recorded categorically and shown in Table 2 with regards to issues encountered in PPR vaccination.

Table 2. Result of focus group discussion in 2 groups.

Issues discussed by farmers	%	Issues discussed by Veterinarians/ Para-veterinarians	%
No labeling of vaccine(less trust)	40	No labeling of vaccine(less trust)	10
Manpower(Paravets) -	30	Manpower Less	30
Less Vaccine	20	More Vaccine /all area covered	-
Price: More	10	Price less	-
		Less Logistics	60

Both the groups separately opined on the issue of insemination by breeding bucks in Black Bengal goats due to their scarcity in number. They also discussed that breeding with crossbreeds of Black Bengal and Jamunapari bucks induces ruining of genetic entity of Black Bengal goats. Farmers showed less interest in keeping breeding bucks in the farms.

A few suggestions that have been noted through the 2 focus group discussions were:

(i) Vaccination could be done properly with twice a year regimen in high PPR disease prone areas**,** (ii) More nutritional supplements for pregnant goats should be provided as multiple birth (twins, triplets) may deplete nutrients and predispose to diseases including PPR (iii) Farmers especially women, need more awareness as they constitute the majority of goat farmers.

4. Discussion

Jaforpur village was badly affected (n=13, 100%) when compared to other 3 villages of Chuadanga district in the study. This finding relates to 0% vaccination status in the village. The case fatality rates in all the study case-farms were high. High case fatalities among goats were reported by many researchers in other countries (EMPRESS, 1999, Mondal *et al.*, 2014, Chowdhury *et al.*, 2014, Wohlsein *et at.*, 2015).

Vaccination has been shown as a significant protective factor against PPR infection in this study; the vaccinated farms having lower likelihood of getting infection compared to the unvaccinated farms. This result is in compliance with the result by Wohlsein *et al.*, 2015, who opined that vaccine coverage must be close to 100% and to achieve 70% to 80% herd/flock immunity. Bangladesh produces 4.8 million doses of PPR vaccine that could not fulfill the demand of 28 million goat and sheep population, as a result the disease is found endemic in the country (SAARC, 2013).Two-time vaccination in a year is established protective factor at the field level when compared to one-time vaccination. Though there are no studies on adopting two time vaccination regime in susceptible goat population, it has had good result and is being practiced in a few goat rearing districts of Bangladesh. Uncontrolled goat movement and introduction of unvaccinated goats at flock level may increase chances of PPR outbreaks in vaccinated flocks (Mbyuzi *et al.*, 2015). Hence, two-time vaccination in a year can be recommended to cover immunity in animals at the community level.

Perch/macha housing was a protective factor against PPR infection in this study. It has manifold advantages and is being practiced for goat rearing by some organizations (PKSF, 2012; Wave Foundation, 2013). The perch/macha mainly made of wood, bamboo, or concrete/ brick keeps the goats above soil (ground). The goat house (perch method of housing) is now more popular in this district. The piloted perch method has been adopted in some sub-districts like Damurhuda and Chuadanga Sadar of Chuadanga district by a good number of farmers since 2008 (Wave foundarion, 2013). It has been recognized that perch housing decreases mortality rate in goats exposed to PPR and also other goat diseases in the community (Personal communication/ unpublished data). The perch method is comparatively better on biosecurity grounds and management practices compared to mud house as it excludes contamination and would be suggested to replicate this to the other parts of the country especially in the goat rearing zones.

Initiatives should be taken for appropriate instructions for vaccine storage and leveling to help in increasing trust among farmers as well as veterinarians/ para-veterinarians. Adequate manpower and logistics should be ensured to cover whole area of the districts in mass vaccination campaign. Development of awareness is necessary among the farmers and to avoid inappropriate practices for control and prevention of PPR in Bangladesh. Action should to be taken for conservation of genetic materials of Black Bengal goats by ensuring the genetics of breeding bucks.

The study has a few bias/ limitations, such as: all areas of outbreaks were not covered in the study. There might be recall bias by respondents/ women were less interested to provide information. Some missing data caused

bottlenecks for further multivariable analysis. The sheep species was not included in the study. Only one type of sample (nasal swab) was used to confirm the positive cases of PPR.

5. Conclusions

Successful eradication and control of PPR in Bangladesh can be achieved by vaccination of all susceptible goats and sheep at least once a year with maximum coverage. Moreover, targeted vaccination twice a year could be adopted where goat population is denser in some selected high risky districts. Goat famers need appropriate awareness regarding goat husbandry and vaccination. Adequate manpower/logistics should be ensured for maximum vaccination coverage. DLS should use proper labeling of the PPR vaccine for boosting trust of framers and livestock personnel as well. The perch/macha method of goat rearing could be recommended to the other goat rearing zones by sharing the knowledge, experience with other farmers. Action should be taken for conservation of genetic materials of Black Bengal goats by supplying genetically proven breeding bucks among the goat farmers. Further study is necessary to explore the real scenario/understanding the epidemiology of recurrent PPR outbreaks in such high risk areas.

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Conflict of interest

None to declare.

References

Annual Disease Report 2014, 2015. Epidemiology Unit, Department of Livestock Services, (personal communication/ unpublished data).

Centers for Disease Control and Prevention (CDC).2012. Epi Info 7. User Guide. Available from: http://www.cdc.gov/epiinfo.

Chowdhury EH , AR Bhuiyan, MM Rahman, MSA Siddique and MR Islam, 2014. Natural peste des petits ruminants virus infection in Black Bengal goats: virological, pathological and immune histo-chemical investigation. BMC Veterinary Research, 10:263.

Chowdhury SA, MSA Bhuiyan and S Faruk, 2002. Rearing Black Bengal Goat under Semi-Intensive management 1. Physiological and Reproductive Performances. Asian Australas. J. Anim. Sci.15(4): 477-484. doi: http://dx.doi.org/10.5713/ajas.2002.477

Couacy-Hymann E, F Roger, C Hurard, JP Guillou, G Libeau and A Diallo, 2002. Rapid and sensitive detection of peste des petits ruminants virus by a polymerase chain reaction assay. J.Virol. Methods, 100:17–25.

EMPRES, 1999. A field manual on Recognizing Peste des Petits Ruminants. Food and Agriculture Organisation of the United Nations, Rome.p-12.Available: http://www.fao.org/docrep/003/x1703e/x1703e00.HTM

Gibbs EPJ, WP Taylor, MJP Lawman and J Bryant, 1979. Classification of peste des petits ruminants virus as the fourth member of the genus Morvillivirus. Intervirology, 11: 268-274.

Islam MR, M Shamsuddin , PM Das and ML Dewan, 2001. An outbreak of Peste des petits ruminants in Black Bengal goats in Mymensingh, Bangladesh.The Bangl. Vet., 18: 14-19.

Mbyuzi AO, EVG Komba, R Cordery-Cotter, HB Magwisha, SI Kimera, and DM Kambarage, 2015 . Descriptive survey of Peste des Petits Ruminants and Contagious Caprine Pleuropneumonia outbreaks in traditional goat flocks in Southern Tanzania: producers concerns, knowledge and attitudes, Livestock Research for Rural Development., 27 (4).

Mondal SP and M Yamage, 2014. A Retrospective Study on the Epidemiology of Anthrax, Foot and Mouth Disease, Haemorrhagic Septicaemia, Peste des Petits Ruminants and Rabies in Bangladesh, 2010-2012. PLOS ONE. Volume 9, Issue 8, DOI: 10.1371/journal.pone.0104435

Islam MR, M Giasuddin, MM Rahman and MA Kafi, 2003. Antibiotic Combined Hyper immune Serum therapy for Peste des ruminants infected goats. Bangl. J. Vet. Med., 1: 49-51.

Palli Karma-Sahayak Foundation (*PKSF*), *2012*. Annual Progress Report. Prime and Lift 2012-13.Sustainable Income and Employment Generation for the Poor Engaging them in Rearing Black Bengal Goats at Farm and Family level. Annex-A, p 105.

Rahman MA, I Shadmin , M Noor , R Parvin , EH Chowdhury and MR Islam , 2011. Peste des Petits ruminants virus infection of goats in Bangladesh: Pathological Investigation, molecular detection and isolation of the virus. Bangl. Vet., 28:1-7

Sarker S and MH Islam, 2011. Prevalence and Risk Factor Assessment of Peste des petits ruminants in Goats in Rajshahi, Bangladesh. Vet. World, 4:546-549.

Sil BK, MM Rahman, MJFATaimur and AJ Sarker, 1995. Observation of outbreaks of PPR in organized goat farms and its control strategy. Presented at the Ann. Con. of the Bangl. Soc. of Vet. Edu. and Res, BARC, Dhaka.

Sil BK, MJFA Taimur, KM Hossain, M Giasuddin, ME Haque, ER Chowdhury, MR Alam and AJ Sarker, 2000. Preliminary study towards the development of inactivated PPR vaccine. Bangl. J. Livest. Res., 7-8:1-6.

Sil BK, MJFA Taimur, KM Hosain, M Gaisuddin, ME Haque, MM Rahman, A Roy, J Alam , MR Islam, MR Alam, B Rashid, N Akter, BK Pramanick and AKMM Anowar. 2001. Development of Mab- based enzyme linked Immuno-slide assay (ELISA) for the rapid and accurate field diagnosis of peste des petits ruminants virus . Bangl. J. Livest. Res., 7-8: 48-63.

Taylor WP, 1984. The distribution and epidemiology of PPR. Prev Vet Med, 2:157–166.

Wave foundation, 2013. Annual Report 2012-13.Value and Supply Chain Initiatives. Black Bengal Goat, p-32.

Wohlsein P, RP Singh, 2015. Peste des Petits Ruminants Virus,– Springer (Peste des Petits Ruminants in Unusual Hosts: Epidemiology, Disease, and Impact on Eradication.Chapter-6.p-95-118. DOI10.1007/978-3-662-45165-6_6. Wave access http://www.bookmetrix.com/detail/chapter/893416a3-e6eb-4430-a25b-2212ac0aef59#downloads.

Workshop on progressive control of peste des petits ruminants (PC-PPR) for South Asian countries (SAARC).2013. Summary of the country reports on the PPR situation and status of control initiatives in the SAARC Member States, Bangladesh, 19-20 December, 2013. Kathmandu, Nepal, p-55.

Yousuf MA, M Giasuddin, SS Islam and MR Islam, 1995. Management of an outbreak of peste des petits ruminants with antibiotic combined hyperimmune serum therapy. Asian J. Med. Biol. Res., 1: 230-234.