Pak. j. sci. ind. res. Ser. B: biol. sci. 2011 **54** (2) 76-82

# Peste Des Petits Ruminants of Goats, Outbreak and Economic Losses : A Case Study

**Ausraful Islam*[ac], Amitav Singha[a], Mohammad Amirul Islam[b] and Shankar Majumder[b]**
[a]Programme on Infectious Diseases and Vaccine Sciences, Health Systems and Infectious Diseases Division, International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh
[b]Department of Agricultural Statistics, Faculty of Agricultural Economics and Rural Sociology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[c]GPO Box 128, Dhaka 1000, Bangladesh

(received May 13, 2010; revised August 5, 2010; accepted August 25, 2010)

**Abstract.** In the determination of outbreak of peste des petits ruminants (PPR) and the economic losses caused by the disease 1392 distributed goats at Dimla thana of Nilfamari district, purchased from different markets, were studied during March, 2007 to May, 2007. Among the distributed goats, 54.7% died before treatment, 14.7% died after treatment and 30.6% survived after treatment. Survival rate was 67.51%. Maximum number (77.6%) of goats died before treatment in the flocks of Modhupur. Survival rate of the treated goats in the locally purchased flock was the highest (98.9%) whereas that in the goats purchased from Lalmonirhat was the lowest (34.3%). Survival percentage of the non-vaccinated goats was higher (71.60%) than that of the vaccinated goats (64.95%). Among the treated goats, 7.9% were pregnant, 4.4% of them aborted and 3.5% remained pregnant though they were infected. Infectious keratoconjunctivitis (IKC) was observed in 2.5% PPR infected goats. The total economic loss was estimated at Bangladesh Tk 10,16434 ($ 14520.49). Locally collected goats had the highest probability (80.6%) of survival after treatment whereas those collected from Rangpur had the highest probability (81.3%) of death before treatment. Probability that the goats will die after treatment was the highest among the goats purchased from Lalmonirhat (59.5%). Survival of goats was significantly ($P<0.05$) associated with place of purchase. Goats purchased from the local areas were 26.8 times more likely to survive than those collected from Modhupur. Goats of Lalmonirhat were 1.993 times more likely to survive than those of Modhupur.

**Keywords:** Peste des petits ruminants, goats, mortality rate, economic losses, Bangladesh

## Introduction

Goat is an economically valuable animal particularly for poor people due to its high prolificacy, capability of collecting its own food from nature and good survival rate (Devandra, 1979). At present the approximate number of goats in Bangladesh is 34.5 million (FAO, 2003). The productivity and economy of animal farming is influenced by the occurrence of various diseases (Singh and Prasad, 2008). However, among many constraints of goat production in Bangladesh, a highly pathogenic viral disease peste des petits ruminants (PPR) is the most dangerous one. The outbreaks of PPR cause 74.13% morbidity and 54.83% mortality in Black Bengal goats in Bangladesh (Das *et al*., 2007; Islam *et al*., 2001).

PPR is a highly contagious disease of goats (Islam *et al*., 2001). It was first detected in southern India in 1987. PPR virus is a member of the genus *Morbilli* of the family Paramyxoviridae. This virus was detected in Bangladesh after a severe outbreak in 1993 in the border belt areas of south western districts (Islam *et al*., 2003). Spreading of the disease mainly depends on close contact between animals (Ozkul *et al*., 2002). The disease is characterized by mainly three symptoms *viz*. discharges (nasal, ocular and oral), diarrhoea and death.

Various researchers have reported on the treatment, vaccine development, diagnosis etc. However, there is limited study on the outbreak, factors affecting its occurrence, common complications and economic losses due to this disease in the country. Outbreaks of PPR commonly occur in Pakistan, India, Nepal, Bangladesh and Afghanistan (Wang *et al*., 2009; Taylor *et al*., 1990). Hence, PPR is an economically important disease of goats as it causes high mortality, morbidity and abortion. (Kamaruddin and Islam, 2005; Singh *et al*., 2004; Dhar *et al*., 2002; Ismail *et al*., 1995; Wosu *et al*., 1992). Since poor farmers mainly rear goats, control of PPR can alleviate poverty (Diallo,

*Author for correspondence; E-mail: islam_ausraf@icddrb.org
[c]Permanent address

2006). Hence, this case study was conducted to determine the outbreak of the disease, the rate of mortality before and after treatment, the possible factors aggravating the situation and the economic losses due to the disease.

At Dimla thana of Nilfamari district, goat distribution was conducted by an international NGO Mennonite Central Committee under "Monga Mitigation Project" with a view to distributing 12000 goats among 3000 ultra poor farmers. This was one of the largest goat distribution projects in this country. Firstly, 1392 distributed goats became infected with PPR. Nevertheless, after treating the infected goats and implementation of proper vaccination schedule for the newly distributed goats, this problem was solved successfully and now the total project is running smoothly.

## Materials and Methods

**Sample size**. Female goats (total 1392) were distributed among the selected ultra poor farmers of Dimla thana of Nilphamari District during March, 2007 to May, 2007. All the goats were less than 1 year of age and belonged to the Black Bengal breed. The goats were purchased not only locally but also from various distant places such as Modhupur of Tangail district, Dinajpur, Rangpur and Lalmonirhat area by truck. Few goat suppliers were given contract who purchased these goats from different markets and households. Goats were transported to the project when 60-150 goats were gathered, they were carried by a truck. This process took atleast seven days and the goats from different places were kept in a temporary shelter. The goats were vaccinated 1 day after transportation using live attenuated PPR vaccine (LRI, Mohakhali) following the manufacturer's directions.

**Diagnosis of the disease.** The disease was diagnosed from the epidemiology, history, clinical signs and laboratory tests (Commercial PPR C-ELISA jointly produced by BDSL Flow Laboratories and Institute for Animal Health, Pirbright, Surrey, England). For laboratory diagnosis, blood was collected from 10 goats, showing symptom of PPR (a total of 70 goats), belonging to each purchase area and sent to BLRI (Bangladesh Livestock Research Institute). Postmortem examination was conducted in some cases. Some complications such as infectious keratoconjunctivitis and abortion were also recorded.

**Study of economic losses.** To determine the economic losses, the cost of goat and the cost of drugs were taken into consideration only. The commonly used antibiotic was the tetracycline. Saline and sulpha drug were commonly used for all the affected goats (Wosu, 1989). But in case of pregnant goats, penicillin was used instead of tetracycline (Benjamin and Newman, 1971). Ciprofloxacin eye drops were used in goats suffering from infectious keratoconjunctivitis. Atropine was used at the primary stage of the disease.

**Statistical analysis.** Binary and multinomial logistic regression models were fitted for identifying the risk factor (s) that significantly influences the outbreak of disease in goats (Hosmer and Lemeshow, 1989). For multinomial logistic regression, as odds ratios are improper, results are presented in terms of probability for better interpretation.

## Results and Discussion

**Survival of goats.** All the goats (1392) were distributed among the beneficiaries of the project area all of which became infected with PPR virus. This virus is found in large amounts in the eye discharge, nose and mouth, as well as in loose faeces. Affected goats release fine infective droplets through coughing and sneezing into the air. Healthy goats (non-vaccinated) become infected by inhaling these droplets. So close contact is the most important way of transmitting the disease. A good example of such place is the market where goats from different areas are brought into close contact with one another, which increases the opportunities for PPR transmission (FAO, 1999). Similar finding was observed by Al-Majali *et al*. (2008). As all the distributed goats were purchased from different areas and kept confined till transportation to the project area, the risk of disease transmission was higher. Moreover, during transportation in the truck, the goats were in close contact, too. So there was ample opportunity for disease transmission; due to this reason all the goats may become infected.

Out of the distributed 1392 goats, 966 (69.40%) died and 426 (30.60%) survived. Among those, 54.7% died before treatment, 14.7% died after treatment and 30.6% survived after treatment (Table 1). Survival rate was 67.50% among the treated goats. The present findings are similar to those of the earlier scientists (Shankar *et al*., 1998; Joshi *et al*., 1996; Wosu *et al*., 1992; Abu-Elzein *et al*., 1990) who reported that mortality in susceptible goat flocks varies from 10% to 100% and

**Table 1.** Survival of goats by different characteristics

| Categories | Goats no. (%) | | | | |
|---|---|---|---|---|---|
| | Total no. | Dead before treatment | Dead after treatment | Alive after treatment | Survival rate of treated goats |
| Place of purchase (p=0.00) | | | | | |
| Modhupur | 152 | 118 (77.6) | 6 (3.9) | 28 (18.4) | 82.4 |
| Dinajpur | 320 | 214 (66.9) | 19 (5.9) | 87 (27.2) | 82.0 |
| Dinajpur, Bogra, local | 340 | 197 (57.9) | 42 (12.4) | 101 (29.7) | 70.6 |
| Dinajpur, local | 244 | 110 (45.1) | 62 (25.4) | 72 (29.5) | 53.7 |
| Local | 108 | 20 (18.5) | 1 (0.9) | 87 (80.6) | 98.9 |
| Rangpur | 112 | 91 (81.3) | 6 (5.4) | 15 (13.4) | 71.4 |
| Lalmonirhat | 116 | 11 (9.5) | 69 (59.5) | 36 (31.0) | 34.3 |
| Vaccination (p=0.00) | | | | | |
| Non-vaccinated | 464 | 221 (47.6) | 69 (14.9) | 174 (37.5) | 71.6 |
| Vaccinated | 928 | 540 (58.2) | 136 (14.7) | 252 (27.2) | 65.0 |
| Total | 1392 | 761 (54.7) | 205 (14.7) | 426 (30.6) | 67.5 |

Note: values within bracket expressed in percentages. P-values are based on Chi-square tests

morbidity from 50% to 100%. On the basis of 15 years (1991-2005) data, in India PPR accounted for the maximum number of incidence (32.3%) and deaths (41.5%), 64.7% morbidity and 13.4% mortality in goats due to PPR in nine villages of Maharastra of India; (Singh and Prasad, 2008; Kulkarni *et al*., 1996). In the present study, the morbidity (100%) and mortality (69.40%) was very high as 54.7% goats died before treatment. But after the treatment, the mortality rate (14.7%) decreased. Infection with PPR virus commonly causes immunosuppression which makes the animals more susceptible to secondary bacterial infections that account for most of the mortality (Olaye *et al*., 1989). May be for this reason, the mortality decreased after initiation of treatment with antibiotics.

Transportation stress makes the goats more immune suppressed resulting in more morbidity and mortality (Saliki, 1998). May be for this reason, the highest mortality was observed among the goats of Modhupur as the distance from Modhupur to the study area was the greatest. Since in locally purchased goats, there was no such stress, so the survival rate was the highest.

Among the distributed goats, 464 were non-vaccinated and 928 were vaccinated. Among the non-vaccinated goats 47.6% died before treatment, 14.9% died after treatment and 37.5% survived after treatment. Among the vaccinated animals, 58.2% died before treatment, 14.7% died after treatment and 27.2% survived after treatment. Survival percentage of non-vaccinated goats was higher (71.60%) than that of the vaccinated ones (64.95%) (Table 1). As the goats were collected from different markets and kept together at a place until distribution, the disease may have been transmitted to the whole flock from the infected goats. It is assumed that these goats were vaccinated during the incubation period or that the goats may have been infected before the mounting of immune response produced by the vaccine. As PPR vaccine causes marked immuno-suppression, it is guessed that vaccination made the situation worse (Rajak *et al*., 2005; Shope, 1970).

**Complications due to the disease among the survivals.** Among the treated goats, (50) 7.9% were pregnant, 56% (28) of which aborted and 44% (22) remained pregnant though they were infected. Abubakar *et al*. (2008) observed three outbreaks in Pakistan and found high rate of abortion ranging from 28 to 45% in each outbreak. Abortion is one of the symptoms of this disease (FAO, 1999). Infectious keratoconjunctivitis (IKC) was observed among 16 goats (2.5% of surviving after PPR attack). During PPR infection, there is continuous ocular secretion and it may be that for this reason the carrier fly of IKC can easily transmit the disease. However, it may be that due to the effective treatment in the beginning, this disease was limited to very small number of animals. After treatment, all of the infected goats were cured of IKC (Table 2).

**Economic losses including cost of drug and dead animals.** Total drug cost was estimated at BD Tk 50,

434 ($720.49) and total cost of dead animals was Tk, 9,66000 ($13800). Thus, the total loss was Tk. 10, 16434 ($14520.49) (Table 3). This is the picture of a very small goat flock in the context of the country. However, there is no definite picture of loss due to PPR in the whole country. Annual economic loss due to PPR is US$39 million in India (Bandyopadhyay, 2002). Saliu *et al*. (2008) found that the economic loss due to PPR in Nigeria was more than 40 billion Naira ($2655161). In Iran, an outbreak of PPR caused loss of at least US$1.5 million to the Iranian owners of sheep and goats in 1995 (Bazarghani *et al*., 2006).

Relating to the indirect cost of the beneficiaries, the employees and the organization, that of the beneficiary included the involvement of time and effort for taking extra care of goats, obstruction in the daily work and loss of production. On the other hand, the employees had to spend more time in different activities such as disposal of carcass, monitoring the sick goats, treating the goats following the prescription of the veterinarian and purchasing and supplying of drugs. The organization had to train the staff, repurchase the goats and replace the dead goats. However, the indirect costs could not be recorded in detail for calculation due to lack of resources.

**Stress as determinants of living condition.** Table 4 represents the estimated probabilities corresponding to the estimated coefficients of multinomial logistic regression fitted to identify the determinants of survival of goats (alive after treatment, dead before treatment and dead after treatment) in the analysis. Only place of purchase was found to be significant. The results show that the locally collected goats had the highest probability (80.6%) of survival after treatment, which is followed by goats collected from Lalmonirhat (31%). Goats collected from Rangpur had the highest probability (81.2%) of death before treatment, which is followed by those of Modhupur (77.6%). Probability that the goats will die after treatment was the highest in Lalmonirhat (59.5%). The cause may be the stress of movement which usually aggravates the clinical signs (Saliki, 1998).

**Determinants of animals survived after treatment.** Vaccination had a significant (P<0.01) effect on the survival of goats. The negative sign of the coefficient indicates that vaccination had a negative effect on the survival of goats meaning vaccinated goats showed higher mortality. The vaccinated goats were 0.344 times less likely to survive than the non-vaccinated goats. It may be that the goats were affected before vaccination and so the disease became more severe (Shope, 1970).

**Table 2.** Complications due to the disease among the survivals

| Categories | Total | Goats no. (%) | | |
|---|---|---|---|---|
| | | Pregnant | Abortion | Remained pregnant |
| Pregnancy | 631 | 50 (7.92%) | 28 (56%) | 22 (44%) |
| | | Present | Absent | Cured |
| IKC* | 631 | 16 (2.5%) | 616 (97.6%) | 16 (2.5%) |

*infectious keratoconjunctivitis

**Table 3.** Economic losses including cost of drug and dead animals

| Drugs | Used in animals (No.) | Cost per animal (BD Tk.) | Total (BD Tk.) |
|---|---|---|---|
| Tetracycline | 573 | 38.8 | 22232 |
| Antihistaminics | 576 | 7.5 | 4320 |
| Saline | 626 | 12 | 7512 |
| Atropine | 348 | 16 | 5568 |
| Penicillin | 53 | 20 | 1060 |
| Eye drop | 16 | 22 | 352 |
| Sulfa drug | 626 | 15 | 9390 |
| Total cost of drugs | | | 50,434 |
| Total distributed goats | Total dead goats | Cost per goat (Tk.) | Total (Tk.) |
| 1390 | 966 | 1000 | 9,66,000 |
| Total loss = (Total cost of drugs+ Total cost of goats) | | | 10,16,434 |

**Table 4.** Stress as determinants of living condition: estimated probabilities (in % scale) from multinomial logistic regression model

| Places of purchase | Alive after treatment | Dead before treatment | Dead after treatment |
|---|---|---|---|
| Modhupur | 18.4 | 77.6 | 4.0 |
| Dinajpur | 27.2 | 66.9 | 5.9 |
| Dinajpur, Bogra, local | 29.7 | 57.9 | 12.4 |
| Dinajpur, local | 29.5 | 45.1 | 25.4 |
| Lalmonirhat | 31.0 | 9.5 | 59.5 |
| Local | 80.6 | 18.5 | 0.9 |
| Rangpur | 13.4 | 81.2 | 5.4 |

**Table 5.** Results of a binary logistic regression model fitted to the data of goats survived after treatment (survived=1, died=0)

| Variable | Category | Coefficient | S. E. (b) | OR | 95% CI |
|---|---|---|---|---|---|
| Vaccination (ref: Non-vaccinated) | | -1.068** | 0.342 | 0.344 | 0.176-0.672 |
| Place (ref: Modhupur) | Dinajpur | 0.503* | 0.244 | 1.654 | 1.025-2.668 |
| | Dinajpur, Bogra, local | 0.627** | 0.241 | 1.871 | 1.168-2.999 |
| | Dinajpur, local | 0.996** | 0.311 | 2.707 | 1.472-4.979 |
| | Local | 3.288** | 0.369 | 26.790 | 13.001-55.207 |
| | Lalmonirhat | 0.690* | 0.290 | 1.993 | 1.129-3.518 |
| Constant | | | | | |

Significance level: **P<0.01; *P<0.05.

Survival of goats was significantly (P<0.05) associated with the place of purchase. The goats of Dinajpur were 1.654 times more likely to survive than those of Modhupur. The goats of Dinajpur, Bogra and local area were 1.871 times more likely to survive than those of Modhupur. The likelihood of survival of goats of Dinajpur and local goats was 2.707 times higher than those of Modhupur. For locally collected goats, odds ratio of survival was the highest. Goats purchased from local area were 26.8 times more likely to survive than those collected from Modhupur. Goats of Lalmonirhat were 1.993 times more likely to survive than those of Modhupur (Table 5). The longer was the distance, the longer was the close contact between the goats which facilitated the spreading of disease. In addition to it, the stress of transportation might be involved in making the goats more susceptible. May be for these reasons, locally purchased goats showed the highest survival rate (ILRI, 2010; Kannan *et al*., 2000; Wous, 1995).

From this study, it can be said that goats collected from different districts were not vaccinated properly. As a result, there was loss from mortality, from abortion, from treatment besides and from the loss of time. Therefore, a proper and timely vaccination schedule should be followed throughout the country. Further large scale study is required to get a picture of the annual losses throughout the country due to this disease.

**Limitation of the study.** Detailed information could not be collected for calculating indirect costs due to lack of available resources at that time. Only one diagnostic test (ELISA) could be conducted as no other test was easily accessible at the time of the study in the Bangladesh.

## References

Abubakar, M., Ali, Q., Khan, H.A. 2008. Prevalence and mortality rate of peste des petitis ruminants (PPR): possible association with abortion in goat. *Tropical Animal Health and Production*, **40:** 317-321.

Abu-Elzein, E.M.E., Hassanien, M.M., Al-Afaleq, A.I., Abd-Elhadi, M.A., Housawi, F.M. 1990. Isolation of peste des petits ruminants from goats in Saudia Arabia. *Veterinary Record*, **127:** 309-310.

Al-Majali, A.M., Hussain, N.O., Amarin N.M., Majok. A.A. 2008. Seroprevalence of, and risk factors for, peste des petits ruminants in sheep and goats in Northern Jordan. *Journal of Preventive Medicine*, **85:** 1-8.

Bandyopadhyay, S.K. 2002. The economic appraisal of a PPR control programme in India. In: *Proceedings of the 14th Annual Conference and National Seminar on Management of Viral Diseases with Emphasis on Global Trade and WTO Regime of Indian Virological Society* (IVRI), 18-20 January, 2002, Hebbal, Bangalore, India.

Bazarghani, T.T., Charkhkar, S., Doroudi, J., Bani Hassan, E. 2006. A review on peste des petits ruminants (PPR) with special reference to PPR in Iran. *Journal of Veterinary Medicine*, **B53:** 17-18.

Benjamin, G., Newman, M.D. 1971. Tetracycline in Pregnancy? *Annals of Internal Medicine*, **75:** 648-649.

Das, K.K., Shil, N.K., Islam, M.R. 2007. Sero-epidemiological investigation on Peste des Petits Ruminants in black Bengal goats, Bangladesh. *Journal of Microbiology*, **24:** 143-145.

Devandra, C. 1979. Goat Production in the Asian Region: Current Status, Available Genetic Resources and

Potential Prospects. Paper presented at International Workshop on the Development of Goats in Asia, Karnal, India, 5-11 March, 1979.

Dhar, P., Sreenivasa, B.P., Barrett, T., Corteyn, M., Singh, R.P., Bandyopadhyay, S.K. 2002. Recent epidemiology of peste des petits ruminants virus (PPRV). *Veterinary Microbiology*, **88:** 153-159.

Diallo, A. 2006. Control of peste des petits ruminants and poverty alleviation. *Journal of Veterinary Medicine*, **53:** 11-13.

FAO 2003. *World Goat Population*. www.fao.org.

FAO 1999. *Recognizing Peste des Petits Ruminants*. A field manual. http://www.fao.org/docrep/003/x1703e/x1703e00. htm.

Hosmer, D.W.(Jr.), Lemeshow, S. 1989. *Applied Logistic Regression*. John Wiley and Sons, New York, USA.

ILRI 2010. International Livestock Research Institute, *Village sheep and goat production in the humid zone*. http://www.ilri.org/InfoServ/Webpub/fulldocs/Bulletin13/Village.htm.

Islam, M.R., Giasuddin, M., Rahman, M.M., Kafi, M.A. 2003. Antibiotic combined hyperimmune serum therapy (ACHST) for peste des petits ruminants (PPR) infected goats. *Bangladesh Journal of Veterinary Medicine*, **1:** 49-51.

Islam, M.R., Shamsuddin, M., Das, P.M., Dewan, M.L. 2001. An outbreak of peste des petits ruminants (PPR) in black Bengal goats in Mymensingh, Bangladesh. *Bangladesh Veterinarian*, **18:** 14-19.

Ismail, T.M., Yamanaka, M.K., Saliki, J.T., el-Kholy, A., Mebus, C., Yilma, T. 1995. Coloning and expression of the nucleoprotein of peste des petits ruminants virus in baculovirus for use in serological diagnosis. *Virology*, **208:** 776-778.

Joshi, V.B., Nagal, K.B., Sharma, M., Katoch, R.C., Batta, M., Sharma, A.K. 1996. Peste des petits ruminants virus among Gaddi sheep and goats in Himachal Pradesh. *Indian Journal of Animal Science*, **66:** 1126-1127.

Kamaruddin, K.M., Islam, M.R. 2005. Transboundary diseases in Bangladesh: PPR and rinderpest. In: *Proceedings of 11th BSVER (Bangladesh Society of Veterinary Education and Research) Annual Scientific Conference*, Bangladesh Agricultural University, Mymensingh, Bangladesh, **29:** 19-20.

Kannan, G., Terrill, T.H., Kouakou, B., Gazal, O.S., Gelaye, S., Amoah, E.A., Samake, S. 2000. Transportation of goats: effects on physiological stress responses and live weight loss. *Journal of Animal Science*, **78:** 1450-1457.

Kulkarni, D.D., Bhikane, A.U., Shaila, M.S., Varalakshmi, P., Apte, M.P., Narladkar, B.W. 1996. Peste des petits ruminants in goats in India. *Veterinary Record*, **138:** 187-188.

Olaleye, O.D., Oyejide, A., Ikede, B.O. 1989. Correlation of humoral immune responses with clinical presentation, pulmonary lesions and mortality patterns of goats experimentally infected with PPR virus. *Cytobios*, **57:** 141-147.

Ozkul, A., Akca, Y., Alkan, F., Barrett, T., Karaoglu, T., Dagalp, S.B., Anderson, J., Yesilbag, K., Cokcaliskan, C., Gencay, A., Burgu, I. 2002. Prevalence, distribution, and host range of peste des petits ruminants virus, Turkey. *Emerging Infection Diseases*, **8:** 708-712.

Rajak, K.K., Sreenivasa, B.P., Hosamani, M., Singh, R.P., Singh, S.K., Singh, R.K. , Bandyopadhyay, S.K. 2005. Experimental studies on immuno-suppressive effects of peste des petits ruminants (PPR) virus in goats. *Comparative Immunology Microbiology and Infectious Diseases*, **28:** 287-296.

Saliki, J.T. 1998. Peste des petits ruminants. In: *Foreign Animal Diseases: The Gray Book*, 6th edition, Part IV: V. A. Richmond (ed), US Animal Health Association, Committee on Foreign Animal Diseases, Richmond, VA, USA.

Saliu, O.J., Audu, S.I., Sanda, M.E., Aribido, S.O., Olaolu. M. 2008. Adoption of vaccination and ethnoveterinary treatment for peste des petit ruminants (PPR) among sheep and goat farmers in Ijumu local government area of Kogi State, Nigeria. *Agricultural Journal*, **3:** 404-408.

Shankar, H., Gupta, V.K., Singh, N. 1998. Occurrence of peste des petits ruminants like disease in small ruminants in Uttar Pradesh. *Indian Journal of Animal Sciences*, **68:** 38-40.

Shope, R.E.Jr. 1970. Limitations and possible side effects of virus vaccines. *Journal of Dairy Science*, **53:** 628-630.

Singh, B., Prasad, S. 2008. Modelling of economic losses due to some important diseases in goats in India. *Agricultural Economics Research Review*, **21:** 297-302.

Singh, R.P., Sreenivasa, B.P., Dhar, P., Shah, L.C., Bandopadhyay, S.K. 2004. Development of a monoclonal antibody based competitive ELISA for detection and titration of antibodies to peste des petits ruminants (PPR) virus. *Veterinary Microbiology*, **98:** 3-15.

Taylor, W.P., Al-Busaidy, S., Barrett, T. 1990. The epidemiology of peste des petits ruminants (PPR) in the Sultanate of Oman. *Veterinary Microbiology*, **22:** 341-352.

Wang, Z., Bao, J., Wu, X., Liu, Y., Li, L., Liu, C., Suo, L., Xie, Z., Zhao, W., Zhang, W., Yang, N., Li, J., Wang, S., Wang, J. 2009. Peste des petits ruminants virus in Tibet, China. *Emerging Infectious Diseases*, **15:** 299-301.

Wosu, L.O., Okiri, J.E., Enwezor, P.A. 1992 Optimal time for vaccination against peste des petits ruminants (PPR) disease in goats in the humid tropical zone in southern Nigeria. In: *Small Ruminant Research and Development in Africa*, B. Rey, S. H. B. Lebbie and L. Reynolds (eds.). Proceedings of the First Biennial Conference of the African Small Ruminant Research Network ILRAD, Nairobi, Kenya.

Wosu, L.O. 1989. Management of clinical cases of peste des petits ruminants (PPR) disease in goats. *Beitrage zum Tropischen Landwirtschaft und Veterinarmedizin*, **27:** 357-361.

Wous, L.O. 1995. Large-scale outbreak of peste des petits ruminants in sheep and goats in Thar Desert of India. *Mysore Journal of Agricultural Science*, **29:** 158.