

# The epidemiology of peste des petits ruminants in Pakistan

A.B. Zahur<sup>(1)</sup>, H. Irshad<sup>(1)</sup>, M. Hussain<sup>(2)</sup>, A. Ullah<sup>(1)</sup>, M. Jahangir<sup>(1)</sup>,  
M. Qasim Khan<sup>(1)</sup> & M. Sabir Farooq<sup>(1)</sup>

(1) Animal Health, Animal Sciences Institute, National Agriculture Research Centre, Park Road, Islamabad, Pakistan

(2) Food and Agriculture Organization of the United Nations, Islamabad, Pakistan

Submitted for publication: 18 July 2006

Accepted for publication: 17 June 2008

Administrative boundaries and designations employed in this article are indicative only and do not imply the expression of any opinion concerning the legal status of any area

## Summary

Peste des petits ruminants (PPR) is an acute and highly contagious viral disease of small ruminants, which is newly emerging in Pakistan. Information provided by participatory disease surveillance teams was used to develop a database for PPR outbreaks in Pakistan. Twenty-four villages were selected throughout the country and field investigations were conducted in each village to study the dynamics of the disease. In each area, flocks with a history of PPR were identified and serological sampling was conducted. Some 1,463 small ruminants (sheep and goats) were sampled and 1,096 tested positive for the presence of antibodies against PPR. These results clearly indicate that PPR is prevalent throughout Pakistan.

## Keywords

Caprines – Epidemiology – Goat – Ovines – Pakistan – Participatory disease surveillance – Peste des petits ruminants – Sheep – Small ruminant.

## Introduction

Peste des petits ruminants (PPR) is an acute, highly contagious viral disease of small ruminants, which is newly emerging in Pakistan. It is caused by a morbillivirus of the *Paramyxoviridae* family. Like other morbilliviruses, PPR is capable of destroying entire populations of immunologically naïve hosts by causing epidemics and pandemics that damage the economy of a country and undermine both food security and the livelihoods of farmers.

The clinical signs associated with this disease are very similar to those of rinderpest, i.e.:

- fever
- a purulent mucous discharge from the eyes and nose
- erosive lesions in the mouth
- diarrhoea
- pneumonia.

Morbidity and mortality rates vary from 80% to 100%, and 20% to 80%, respectively. Peste des petits ruminants is

considered to be one of the main constraints to improving the productivity of goats and sheep in regions where it is endemic (6).

In Pakistan, PPR was first confirmed in 1994 (1) by the Institute for Animal Health, Pirbright Laboratory, in the United Kingdom. Since then, a large number of outbreaks have occurred throughout the country, but only a few have been documented. Three of these documentations were based on laboratory confirmation (3, 5, 16); others were based on clinico-epidemiological observations. The remedial measures taken included treatment of the symptoms and disease prevention by cross protection, using tissue culture rinderpest vaccine (TCRV). However, with the provisional declaration of freedom from rinderpest in 2003, Pakistan entered the second phase of the World Organisation for Animal Health (OIE) pathway for eradication and so TCRV can no longer be used. At present, no PPR vaccine is available in Pakistan. However, a limited quantity is being imported by international agencies, including the Food and Agriculture Organization of the United Nations (FAO) and the European Commission (EC).

There is a growing awareness in Pakistan, at both government and private-sector levels, of the importance of livestock to the national economy as an essential element in the drive to alleviate poverty. Thus, considering the economic importance and transboundary nature of the PPR virus (PPRV), immediate studies are needed to ascertain the magnitude of the PPR problem and define the trends and causes of its occurrence in Pakistan. Based upon this knowledge, a national control policy should be developed and adopted. This paper provides information about PPR that has been collected by extensive participatory disease surveillance (PDS) in the field and investigations of suspected outbreaks.

## Materials and methods

### Disease intelligence and development of the outbreak database

Participatory disease surveillance was begun in Pakistan with a project of the Government Cooperative Programme (GCP/Pak/088-EC), which was implemented by the FAO with the objective of generating data on the main transboundary animal diseases: rinderpest, foot and mouth disease and PPR. There were 17 PDS teams working in Pakistan between May 2002 and June 2005 (4). The reports submitted by the teams and documented outbreaks of PPR were used to develop a PPR database for Pakistan. Entries contained the following information, where possible:

- the date of the outbreak
- the location of the outbreak

- the species involved
- the number of cases
- the number of deaths
- clinical signs
- differential diagnosis
- laboratory confirmation, if there was any.

### Selecting areas for field investigation and serological sampling

The data thus generated was used to select and target 24 villages from across Pakistan. Field investigations and serological sampling were then conducted in these villages (Table I). When selecting these areas, due consideration was given to the prevalence of and importance assigned to PPR by the farmers, along with the migratory pattern/production system for raising small ruminants in their regions.

### Field investigations and serological sampling

Field investigations were carried out in all selected areas. Structured interviews were conducted with key informants, including:

- livestock/veterinary authorities
- private veterinary practitioners
- para-veterinary staff
- non-qualified people who claimed to have treatments or cures
- affected livestock farmers.

Questions probed the following:

- the disease history in the area and of the flock/herd
- risk factors associated with the disease
- clinical signs
- the vaccination history of the flock/herd
- losses due to PPR.

Flocks of sheep and herds of goats with a history of PPR were identified in each area, for serological sampling. A total of 1,463 blood samples were collected from randomly selected animals in these herds. The serum was separated and stored at  $-20^{\circ}\text{C}$ . Competitive enzyme-linked immunosorbent assay (ELISA) (Biological Diagnostic Supplies Limited) for PPR was used to determine the level of antibodies against PPRV in these samples. All the samples were collected from small ruminant farms in rural areas on which flocks/herds were raised extensively. None of the sampled animals had a history of vaccination against PPR using either homologous PPR vaccine or TCRV.

**Table I**

**Peste des petits ruminants in Pakistan: results of serum samples collected from sheep and goats in selected areas analysed by competitive enzyme-linked immunosorbent assay between 2002 and mid-2005**

District	Goats		Sheep		Total	
	No. of samples taken	No. of positive samples	No. of samples taken	No. of positive samples	No. of samples taken	No. of positive samples
Punjab						
Chakwal	56	44 (78.57%)	18	16 (88.89%)	74	60 (81.08%)
Mianwali	38	32 (84.21%)	26	12 (46.15%)	64	44 (68.75%)
Attock	36	32 (88.89%)	36	36 (100%)	72	68 (94.44%)
Mandi Bahauddin	55	40 (72.73%)	0	0 (0%)	55	40 (72.73%)
Dera Ghazi Khan	49	23 (46.94%)	12	10 (83.33%)	61	33 (54.10%)
Bahawalpur	0	0 (0%)	56	4 (7.14%)	56	4 (7.14%)
Faisalabad	56	39 (69.64%)	0	0 (0%)	56	39 (69.64%)
Okara	60	41 (68.33%)	0	0 (0%)	60	41 (68.33%)
North Western Frontier Province						
Haripur	48	33 (68.75%)	3	2 (66.67%)	51	35 (68.63%)
Naushera	48	36 (75%)	16	16 (100%)	64	52 (81.25%)
Mansehra	48	48 (100%)	0	0 (0%)	48	48 (100%)
Sindh						
Ghotki	40	28 (70%)	24	24 (100%)	64	52 (81.25%)
Sukkur	72	72 (100%)	0	0 (0%)	72	72 (100%)
Jacobabad	66	60 (90.91%)	6	6 (100%)	72	66 (91.67%)
Sanghar	51	42 (82.35%)	7	7 (100%)	58	49 (84.48%)
Tharparkar	43	23 (53.49%)	13	4 (30.77%)	56	27 (48.21%)
Balochistan						
Loralai	39	32 (82.05%)	16	4 (25%)	55	36 (65.45%)
Islamabad Capital Territory						
Islamabad	68	30 (44.12%)	0	0 (0%)	68	30 (44.12%)
Azad Jammu and Kashmir (AJK)						
Bhimber	60	56 (93.33%)	0	0 (0%)	60	56 (93.33%)
Muzaffarabad	56	42 (75%)	0	0 (0%)	56	42 (75%)
Mirpur AJK	66	66 (100%)	0	0 (0%)	66	66 (100%)
Northern Areas	35	23 (65.71%)	16	8 (50%)	51	31 (60.78%)
Afghani nomads	0	0 (0%)	64	8 (75%)	64	48 (75%)
Local nomads	54	51 (94.40%)	6	6 (100%)	60	57 (95%)
<b>Total</b>	<b>1,144</b>	<b>893 (78.06%)</b>	<b>319</b>	<b>203 (63.64%)</b>	<b>1,463</b>	<b>1,096 (74.91%)</b>

## Results

### Outbreaks of peste des petits ruminants in Pakistan from 2002 to June 2005

According to PDS reports, 526 suspected outbreaks of PPR occurred during the period from 2002 to 2005, affecting 8,321 goats and sheep. The number of outbreaks, animals affected and animal deaths are given in Table II, by province and in total. The highest number of PPR outbreaks was reported in Sindh.

A seasonal calendar, showing the prevalence of PPR in Pakistan, is given in Table III. The incidence of PPR was higher during winter in all areas of the country.

**Table II**

**Occurrence of peste des petits ruminants in Pakistan, by province/administrative area, between 2002 and 2005**

(determined by participatory disease surveillance)

Province/ administrative area	No. of outbreaks	No. of animals affected	No. of animals that died*
Punjab	135	2,456	1,742 (70.93%)
Sindh	358	5,534	2,633 (47.58%)
NWFP	2	—	—
Balochistan	5	331	254 (76.74%)
AJK	25	—	—
Northern Areas	1	—	—
<b>Total</b>	<b>526</b>	<b>8,321</b>	<b>4,629 (55.63%)</b>

\* values in parentheses are case fatality percentages

— no data available

AJK: Azad Jammu and Kashmir

NWFP: North Western Frontier Province

**Table III**  
**The seasonal prevalence of peste des petits ruminants in Pakistan, by province/administrative area, using participatory disease surveillance**

Beans (out of 50) were used for proportional piling

Season	Punjab		Sindh		NWFP		Balochistan		Northern Areas		AJK	
	No. of beans	Percentage prevalence	No. of beans	Percentage prevalence	No. of beans	Percentage prevalence						
Spring	10/50	20%	–	–	12/50	24%	11/50	22%	7/50	14%	13/50	26%
Summer	5/50	10%	13/50	26%	3/50	6%	8/50	16%	6/50	12%	3/50	6%
Autumn	10/50	20%	17/50	34%	17/50	34%	13/50	26%	17/50	34%	12/50	24%
Winter	25/50	50%	20/50	40%	19/50	38%	18/50	36%	20/50	40%	22/50	44%

NWFP: North Western Frontier Province  
 AJK: Azad Jammu and Kashmir

### Serological status of sampled animals

Sample analysis with competitive ELISA showed that 1,096 of 1,463 (74.9%) serum samples tested positive for the presence of antibodies against PPRV (Table I).

## Discussion

During the campaign to eradicate rinderpest in Pakistan, it was found that the existing passive reporting system was unable to adequately record reports of outbreaks by livestock owners. Participatory disease surveillance, with clear and specific objectives, was introduced to improve the sensitivity and timeliness of the disease surveillance system and satisfy OIE requirements. It has since become clear that PDS has helped to disclose outbreaks of rinderpest and PPR which would probably otherwise have been misdiagnosed or not reported at all. The introduction of PDS into the disease-reporting system in Pakistan greatly enhances its sensitivity and creates a forum for the voices of livestock owners to be heard (10).

### Current status of peste des petits ruminants in Pakistan

It is evident from the results of the serum samples (Table I) that PPR is prevalent throughout the country.

### Possible sources of virus transmission and persistence in Pakistan

#### Animal movement

Animal movement is the most important factor in the spread of transboundary animal diseases. Possible factors influencing livestock movement are:

- the prevalent production systems
- changes in the weather and/or prolonged drought in the region concerned.

Pakistan has a population of around 77.4 million small ruminants (52.8 million goats and 24.6 million sheep). There are several production systems when farming small ruminants, namely, nomadic, transhumant, sedentary, or household. A total of 44% of all small ruminants are raised in the nomadic system; 38% are raised in the transhumant system and 18% are produced in either the sedentary or household system (7). Peste des petits ruminants is endemic in neighbouring countries, including Tajikistan, China, India, Iran and Afghanistan (8, 9, 12, 13, 17). The latter four of these countries share borders with Pakistan and there is a lot of cross-border movement between them, particularly between Pakistan and Afghanistan. The nomadic pattern of movement from Afghanistan to Pakistan is particularly important. Afghani nomads (Kuchi) have been moving between these two countries for centuries, following their traditional routes. The role of this migration in the transmission and persistence of PPR seems clear. Moreover, prolonged drought in this region during the past few years has forced the Kuchi to change their traditional routes in search of new pastures and water, thereby increasing the chances of introducing PPR to susceptible livestock in new areas through communal grazing.

Livestock markets, especially those held before Eid-ul-Azha (an Islamic feast day on which a domestic animal is sacrificed), also play a significant role in the transmission of PPRV to new areas.

### Trends of the occurrence of peste des petits ruminants in Pakistan

In most of the areas visited, an outbreak of PPR usually follows the introduction of new animals into the flock and the subsequent spread of the disease due to communal grazing. Most outbreaks occur around the festival of Eid-ul-Azha.

It was observed, in more than one instance, that the disease mainly affects goats, whereas there are few or no losses in sheep. Losses are higher in kids and lambs.

In some areas, particularly in North Punjab, the disease shows a three-year cyclic pattern. As far as morbidity and mortality are concerned, goats of all breeds in Pakistan appear equally susceptible and there is no suggestion of high innate resistance in any one breed.

### Seasonal patterns

Participatory disease surveillance reports reveal that PPR is seen throughout the year. However, the incidence of disease is higher in late autumn and in winter, peaking during the months of December and January. This may be related to the movement of animals at this time, the fact that it is the lambing and kidding season, and/or stress due to movement and the scarcity of food. Moreover, the risk of secondary bacterial infections of the respiratory tract is increased during the cold dry season, and such infections are a major complication of PPR (2). A high incidence of PPR has also been observed during the summer months, especially in Sindh Province. This could be caused by the early movement of animals, due to drought.

### Lack of awareness of peste des petits ruminants

Peste des petits ruminants is a newly emerging disease in Pakistan. While visiting different areas, it was found that there was a great lack of awareness about PPR among veterinarians, para-veterinarians and farmers. In many areas, para-veterinarians and farmers, in particular, did not know about PPR and it was only when the disease was described, and photographs of the clinical signs were shown to them, that they were able to recognise the disease. Farmers and para-veterinarians had been treating PPRV-infected animals as having a mixed infection of enterotoxaemia (ET) and contagious caprine pleuropneumonia (CCPP). In addition, farmers had not given PPR a name in their regional languages as they were confusing it with ET and CCPP.

### Role of wildlife

During field visits, a veterinarian reported a suspected outbreak of PPR in deer kept on a private farm in Faisalabad. Another similar suspected outbreak of PPR over 1997 and 1998 was reported in deer kept in the grounds of the house of the Governor in Peshawar. Some deer died in this outbreak. Both of these outbreaks were confirmed on the basis of clinical signs and lesions.

There was a laboratory-confirmed outbreak of PPR (by indirect competitive ELISA) in mouflon sheep (*Ovis orientalis*) kept at the Wildlife Breeding Centre, Faisalabad (16). In Nigeria, one study of African grey duiker (*Sylvicapra grimmia*) reported that 10.5% of the serum samples (4 of 38) tested positive for the presence of antibodies against PPR using competitive ELISA (11). This information clearly underlines the need to carry out a study to clarify the role of wild small ruminants in the spread of PPR.

### Illegal vaccines

Homologous PPR vaccine is imported from Jordan and provided to provincial livestock departments only in the event of an outbreak. It was noticed that PPR vaccine smuggled in from Afghanistan is also available in some areas of Balochistan, Punjab and North Western Frontier Province and that farmers frequently use this vaccine. However, there is no assurance of its quality.

### Control measures adopted in the field

The policy adopted for the control of PPR in Pakistan includes ring vaccination if a suspected outbreak is reported. There is no control of the movement of small ruminants in the area.

### Serological status of sampled animals

The present study is unique in that this is the first time efforts have been made to correlate the history of PPR outbreaks reported by PDS teams with the seroprevalence of the disease.

The majority of samples testing positive from the sera of convalescent animals had percentage inhibition (PI) values of between 80% and 95%, whereas PI values of samples from animals exhibiting clinical signs of PPR ranged between 61% and 75%. Singh *et al.* (14) reported that samples testing positive for antibodies against PPRV have a peak frequency distribution of between 81% and 91% PI in the goat population but not in sheep. They further suggest that only those goats capable of mounting a strong humoral response were likely to survive the infection. In Pakistan, goats show more severe clinical signs of PPRV exposure than sheep. However, the authors of this paper did not observe any difference in the serological status of sheep and goats. These results are in agreement with those of W.P. Taylor (15), who reported a similar serological status profile for both sheep and goats.

## Conclusion

It is clearly evident, from the serological results of this study, that the spread of PPRV is extensive in Pakistan.

These results further expose the weakness and inadequacy of the prevailing disease-reporting and surveillance systems in Pakistan, before PDS was introduced. The authors strongly recommend that PDS should be continued so that the concerns of farmers can reach the appropriate authorities. Moreover, PDS can be a very efficient way of creating awareness among farmers about different aspects of animal health and production.

Though the sample size was small, and the areas were deliberately selected for field investigations and serological sampling, these samples are not representative of the target population of the area. However, this study will provide a 'baseline' of information on the prevalence of PPR in Pakistan. It seems an opportune time to begin extensive serosurveillance for PPRV in Pakistan, so that regions can

be demarcated into endemic, infected and PPR-free zones. This will help in launching a comprehensive control programme for PPR.

## Acknowledgements

This study was supported by a trust fund project, funded by the European Community and implemented by the Food and Agriculture Organization of the United Nations: FAO-UN GCP/PAK/088-EC (Support for Emergency Prevention and Control of Main Transboundary Diseases in Pakistan: rinderpest, foot and mouth disease and peste des petits ruminants). ■

## Épidémiologie de la peste des petits ruminants au Pakistan

A.B. Zahur, H. Irshad, M. Hussain, A. Ullah, M. Jahangir, M. Qasim Khan & M. Sabir Farooq

### Résumé

La peste des petits ruminants (PPR) est une maladie virale aiguë, extrêmement contagieuse qui affecte les petits ruminants ; son émergence au Pakistan est récente. Les équipes de surveillance participative ont permis de recueillir les informations nécessaires pour alimenter une base de données sur les foyers de PPR au Pakistan. Vingt-cinq villages ont été sélectionnés dans tout le pays pour y effectuer des enquêtes de terrain visant à élucider la dynamique de la maladie. Dans chaque secteur, des prélèvements ont été réalisés sur les troupeaux présentant un historique de PPR. Près de 1 463 petits ruminants (ovins et caprins) ont ainsi été prélevés et testés ; la présence d'anticorps dirigés contre le virus de la PPR a été détectée dans 1 096 des prélèvements. Ces résultats démontrent clairement la prévalence de la PPR sur tout le territoire pakistanais.

### Mots-clés

Caprin – Chèvre – Épidémiologie – Mouton – Ovin – Pakistan – Peste des petits ruminants – Petit ruminant – Surveillance sanitaire participative. ■

## Epidemiología de la peste de pequeños rumiantes en Pakistán

A.B. Zahur, H. Irshad, M. Hussain, A. Ullah, M. Jahangir, M. Qasim Khan & M. Sabir Farooq

### Resumen

La peste de pequeños rumiantes (PPR), enfermedad vírica aguda y extremadamente contagiosa que afecta a los pequeños rumiantes, está empezando a aparecer en Pakistán. A partir de información suministrada por equipos de vigilancia sanitaria participativa se elaboró una base de datos sobre los brotes de PPR en Pakistán. Se seleccionaron veinticinco aldeas de todo el país y se investigó en ellas la dinámica de la enfermedad. En cada zona se determinaron los rebaños con un historial de PPR y se les extrajeron muestras séricas: de los 1.463 pequeños rumiantes (ovejas y cabras) analizados, 1.096 dieron resultado positivo a la presencia de anticuerpos contra la enfermedad. Tales resultados indican claramente que la PPR es prevalente en todo el país.

### Palabras clave

Cabra – Caprino – Epidemiología – Oveja – Ovino – Pakistán – Pequeño rumiante – Peste de pequeños rumiantes – Vigilancia sanitaria participativa.



## References

1. Amjad H., Islam Q.U., Forsyth M., Barrett T. & Rossiter P.B. (1996). – Peste des petits ruminants in goats in Pakistan. *Vet. Rec.*, **139** (5), 118-119.
2. Diallo A. (1997). – Peste des petits ruminants: an overview. Food and Agriculture Organization (FAO) Emergency Prevention System (EMPRES) for Transboundary Animal and Plant Pests and Diseases FMD and contingency planning workshop, 28 July-1 August, Hanoi, Vietnam. FAO, Rome.
3. Hussain M., Afzal M., Muneer R., Ashfaq M. & Haq E.U. (1998). – An outbreak of peste des petits ruminants in goats in Rawalpindi. *Pakistan vet. J.*, **18** (4), 224-226.
4. Hussain M., Malik M.A., Fatima Z. & Yousuf M.R. (2005). – Participatory surveillance of livestock diseases in Islamabad Capital Territory. *Int. J. Agric. Biol.*, **4**, 567-570.
5. Hussain M., Muneer R., Jahangir M., Awan A.H., Khokhar M.A., Zahur A.B., Zulfiqar M. & Hussain A. (2003). – Chromatographic strip technology: a pen-side test for the rapid diagnosis of peste des petits ruminants in sheep and goats. *J. Biol. Sci.*, **3** (1), 1-7.
6. Ikede B.O. (1983). – Histopathology of natural cases of PPR, characteristics, lesions and changes occurring during the disease. In Peste des petits ruminants (PPR) in sheep and goats. Proc. International workshop held at the International Institute of Tropical Agriculture, Ibadan, Nigeria, 24-26 September 1980 (D.H. Hill, ed.). International Livestock Centre for Africa, Addis Ababa, Ethiopia.
7. Ishaque S.M. (1993). – Sheep management system. In Sheep production in Pakistan (J.B. Mackintosh, ed.). Pakistan Agricultural Research Council, Islamabad, Pakistan.
8. Kwiatak O., Minet C., Grillet C., Hurard C., Carlsson E., Karimov B., Albina E., Diallo A. & Libeau G. (2007). – Peste des petits ruminants (PPR) outbreak in Tajikistan. *J. comp. Pathol.*, **136** (2-3), 111-119. Epub.: 23 February 2007.
9. Majok A.A. (2001). – FAO/UNDP Project PEACE-II: Food security through sustainable crop production and livestock development (AFG/00/015). Annual Report – Animal Health Component. FAO, Islamabad, Pakistan.

10. Mariner J.C., Hussain M., Roeder P.L. & Catley A. (2003). – The use of participatory disease searching in Pakistan as a form of active disease surveillance for rinderpest and more. In Proc. 10th Symposium of the International Society of Veterinary Epidemiology and Economics (ISVEE), November, Viña del Mar, Chile.
  11. Ogunsanmi A.O., Awe E.O., Obi T.U. & Taiwo V.O. (2003). – Peste des petits ruminants (PPR) virus antibodies in African grey duiker (*Sylvicapra grimmia*). *Afr. J. biomed. Res.*, **6** (1), 59-61.
  12. 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. *Emerg. infect. Dis.*, **8** (7), 708-712.
  13. Shaila M.S., Shamaki D., Forsyth M.A., Diallo A., Goatley L., Kitching R.P. & Barrett T. (1996). – Geographic distribution and epidemiology of peste des petits ruminants viruses. *Virus Res.*, **43** (2), 149-153.
  14. Singh R.P., Saravanan P., Sreenivasa B.P., Singh R.K. & Bandyopadhyay S.K. (2004). – Prevalence and distribution of peste des petits ruminants virus infection in small ruminants in India. *Rev. sci. tech. Off. int. Epiz.*, **23** (3), 807-819.
  15. Taylor W.P. (1984). – The distribution and epidemiology of PPR. *Prev. vet. Med.*, **2**, 157-166.
  16. World Organisation for Animal Health (OIE) (2000). – Manual of Standards for Diagnostic Tests and Vaccines, 4th Ed. OIE, Paris, 114-122.
  17. World Organisation for Animal Health (OIE) (2007). – Peste des petits ruminants, China (People's Republic of). OIE Alert Message CHN 27-07-07. Received by e-mail, Friday 27 July 2007.
-