

# The epidemiology of peste des petits ruminants in Pakistan and possible control policies

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## Summary

Peste des petits ruminants made its first clinical appearance in Pakistan during an epidemic in Punjab Province in 1991, but its level of activity in subsequent years was never systematically recorded. In 2003, 2004 and 2005 teams trained in participatory disease surveillance methods visited a large number of villages throughout Pakistan to record the prevalence and impact of key livestock diseases. Peste des petits ruminants has emerged from their study as a common and economically damaging disease of small ruminants within the country, appearing to be endemic in the north of Punjab and epidemic in Azad Jammu and Kashmir, and Sindh during the study period. It should be possible to reduce the incidence level using a combination of zoonosanitary measures and the intensive use of vaccine.

## Keywords

Disease control – Endemic spread – Epidemic spread – Pakistan – Participatory disease surveillance – Peste des petits ruminants – Vaccination.

## Introduction

Peste des petits ruminants (PPR) is an acute, contagious disease of domestic sheep and goats caused by a *Morbillivirus* within the family *Paramyxoviridae*. Using partial sequence data from the F gene it can be shown that all isolates of the virus fall within one or other of four phylogenetic lineages. Typically, lineages 1, 2 and 3 occur in sub-Saharan Africa, while lineage 4 is present in Turkey, the Arabian Peninsula, Iraq, Iran, Afghanistan, Pakistan, India, Bhutan and Bangladesh. Taylor and Barrett (12) suggest that, notwithstanding its discovery in West Africa in 1940, PPR probably originated in Asia and was then carried to Africa. On the sub-continent there is evidence

that it has persisted through epidemic and inter-epidemic phases, but that during the last half century its impact may have been held in check as an adjunct to rinderpest control. Now, with the eradication of rinderpest, this constraint has been lifted and at the present time lineage 4 is a major cause for concern, threatening to spread beyond the boundaries of its already considerably large geographic domain.

The existence of PPR has been recognised in Pakistan since 1991, when it gave rise to an epidemic in Punjab Province (2). Although sporadically recognised in subsequent years (6, 7), no systematic epidemiological impact assessment study has been undertaken. Isolates obtained in Pakistan in 1994 and 1998 were shown to belong to PPR lineage 4 (5).

For a short period, rinderpest tissue culture vaccine was used to protect Pakistan's sheep and goats against PPR, but this practice was discontinued in 2000 in compliance with the terms under which the country issued a declaration of provisional freedom from rinderpest. For emergency use a small vaccine bank was established by the Food and Agriculture Organization (FAO) of the United Nations using strain PPR Nig/75/1 (4), which demonstrated the protective power of a homologous strain and the need to establish its manufacture in Pakistan.

The disease surveillance programme reviewed in this article has allowed us to assess the prevalence of PPR across the country and draw some preliminary conclusions concerning its current epidemiology. Much still remains to be understood about the determinants of PPR occurrence in different ecological and farming systems, but the assembled evidence suggests that now is the time to develop a strategy aimed at bringing this important disease under progressive control.

## Materials and methods

### Participatory disease surveillance

Over the past three years participatory disease surveillance (PDS) teams (8, 9) have visited randomly selected villages across all the provinces of Pakistan, collecting and recording information relating to the presence or previous presence of rinderpest, foot and mouth disease and PPR at village level.

Through interviews, livestock keepers were asked to identify ongoing animal health problems and problems they had encountered in the past. The interviewers did not directly introduce a specific disease as a topic for discussion, but where a respondent mentioned PPR as a present or past problem, detailed information was elicited.

The data presented in this communication has been derived by summarising these interview reports.

## Results

### Small ruminant production systems in Pakistan

There are about 25 million sheep and 50 million goats in Pakistan, playing an important role in the national livestock economy. Most of the people engaged in sheep and goat-rearing are subsistence farmers, i.e. landless villagers for whom such activity provides the principal source of income. The main areas for small ruminant production are mountainous, semi-mountainous and arid areas where neither crop nor large ruminant production is feasible.

Within this framework, three production systems may be seen. A transhumant system exists throughout the Federally Administered Northern Areas (FANA) and in parts of the North-West Frontier Province (NWFP), Balochistan, Punjab and Sindh, characterised by the movement of animals and owners for seasonal utilisation of vegetation. The flocks move during early winter (October and November) from upland to lowland pastures. With the beginning of summer (April-May), the flocks move back to high altitude in the wake of the melting snows. Within this system, movements can be over considerable distances. In the lowlands, the stock graze in the irrigated crop growing areas of lower Punjab and upper and middle Sindh at the time of cotton picking and sugar cane harvesting. From Punjab, large numbers of small ruminants move from Jehlum, through Rawalpindi, Abbotabad and Manshera to Azad Jammu and Kashmir for the summer and return in the winter. The total involvement in this system is between 2 and 3 million head.

In addition, nomadic groups are found in the lowland desert areas of Thal (western Punjab), Cholistan (eastern Punjab), Tharparkar (eastern Sindh) and Balochistan. Grazing is generally free and availability is set by tribal custom. Furthermore, nomads (Kutchis) from the cross-border provinces of Afghanistan (Kunar, Paktia, Paktika, Nangarhar and Kandahar) have traditional entry routes into Balochistan and NWFP in Pakistan each September-October. Thereafter, they disperse and spend the winter in various parts of the country, returning to Afghanistan in April-May following the same routes. Nomadic Afghan animals also move to alpine pastures in the NWFP for summer grazing where they mix with local stock from Swat and Kohistan. Iran shares a border with western Balochistan, across which nomadic movement takes place but without the livestock penetrating deeply into either country. A further border is shared with China, but there is hardly any mixing of livestock. The total involvement in this system is again between 2 and 3 million head.

The remaining 70 million small ruminants comprise a sedentary, village-based system, with flocks searching for local grazing on a daily basis. In all three systems mixed flocks are the norm.

### Incidence and distribution of peste des petits ruminants in Pakistan

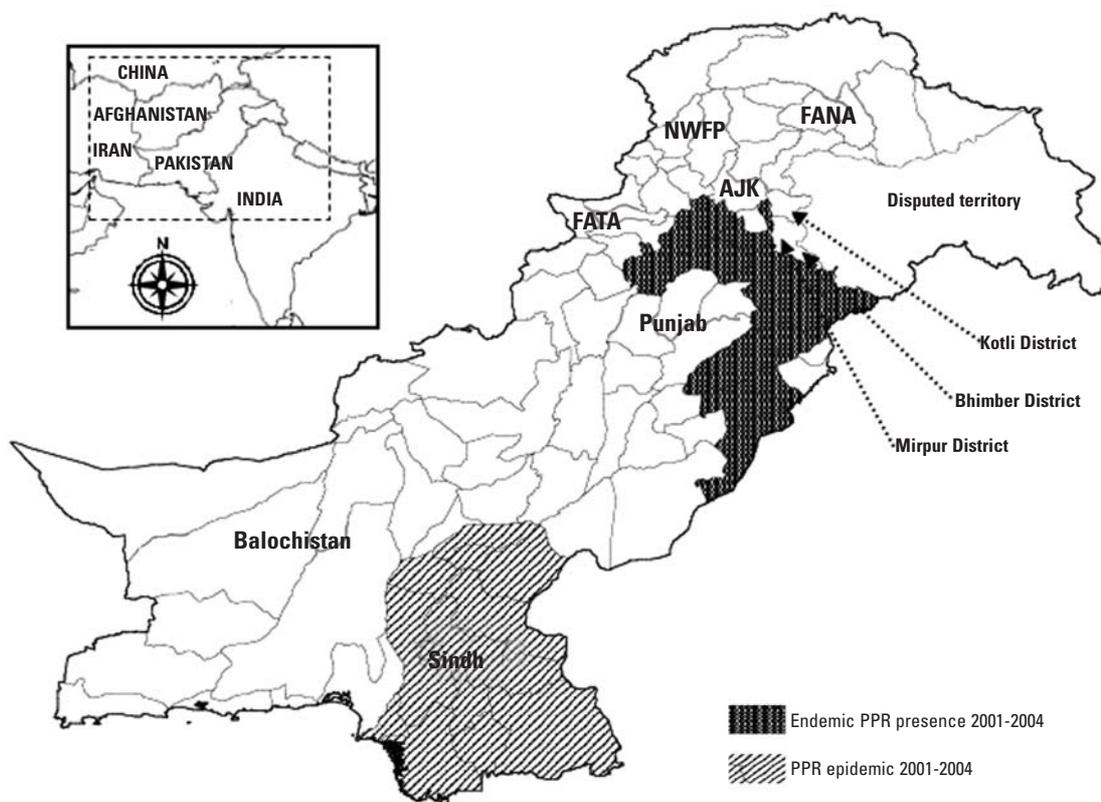
#### Sindh Province

The number of villages reporting current or past outbreaks of PPR in the cross-section visited in 2003, 2004 and 2005 is shown in Table I. Based on these results it appears that Sindh has experienced a widespread epidemic of PPR involving all districts of the province (Fig. 1). The epidemic curve for the outbreaks in Sindh is shown in Figure 2.

**Table I**  
**The prevalence of outbreaks of peste des petits ruminants in various districts of Sindh from 2000 to 2005**

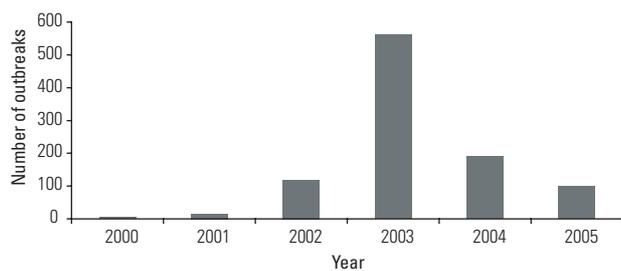
District	No. of villages searched	Year of search	Number of villages with owners recalling a PPR outbreak in their livestock					2005*
			2000	2001	2002	2003	2004	
Badin	142	2003, 2004 & 2005	2	–	2	16	7	8
Dadu	182	2004 & 2005	2	–	18	100	15	–
Ghotki	103	2003, 2004 & 2005	–	–	1	41	–	3
Hyderabad	79	2003, 2004 & 2005	2	7	3	13	9	11
Jacobabad	128	2004 & 2005	–	–	2	53	6	3
Khairpur	167	2003, 2004 & 2005	–	–	5	41	2	11
Larkhana	150	2004 & 2005	–	–	20	75	45	–
Mirpurkhas	143	2003, 2004 & 2005	–	2	6	32	9	21
Nausharo Feroz	177	2003, 2004 & 2005	–	–	21	50	19	5
Nawabshah	151	2003, 2004 & 2005	–	–	1	3	61	5
Sanghar	96	2004 & 2005	–	4	29	59	3	3
Shikarpur	87	2003, 2004 & 2005	–	–	–	34	–	6
Sukkur	134	2003, 2004 & 2005	–	–	5	31	5	4
Tharparkar	46	2003, 2004 & 2005	–	1	5	5	4	13
Thatta	198	2003, 2004 & 2005	–	2	1	8	6	6
<b>Total</b>	<b>1,983</b>		<b>6</b>	<b>16</b>	<b>119</b>	<b>561</b>	<b>191</b>	<b>99</b>

– : no outbreak recalled  
 \* the study ended in May 2005



FANA: Federally-Administered Northern Areas  
 FATA: Federally-Administered Tribal Areas  
 AJK: Azad Jammu and Kashmir  
 NWFP: North-West Frontier Province

**Fig. 1**  
**The location of districts in Pakistan affected by peste des petits ruminants**



**Fig. 2**  
**Epidemic curve showing the rise and fall in the number of outbreaks recorded per year between 2000 and 2005 in Sindh Province**

The epidemic appeared to start in 2000 in the contiguous southern districts of Badin, Dadu and Hyderabad, spreading to the neighbouring districts of Mirpurkhas, Sanghar, Tharparkar and Thatta in 2001. By 2002 the epidemic had reached all central and northern districts except Shikarpur, which it reached in 2003. In all but two districts, outbreaks peaked in 2003. In Nawabshah the peak was in 2004, while in Tharparkar, where outbreaks have occurred every year since 2000, the peak year (to date) was 2005. That the overall epidemic has passed its peak is further suggested by the lowered incidence level for 2004 and the absence of outbreak reports in Dadu and Larkhana Districts in the first five months of 2005. Conversely, however, the outbreak level in Mirpurkhas and Tharparkar Districts was higher in 2005 than in 2004. Overall, by the end of spring 2005 PPR had affected small ruminants in one in every two of the villages visited (992/1,983).

In a number of interviews the village livestock owners were able to identify the month in which an outbreak started. From this data, given in Table II, it appears that outbreaks were more common in the winter and spring months than in the summer ones. It is also clear that outbreaks continued throughout the summer, increasing again at the start of the approaching winter.

In a number of instances, PPR reportedly persisted in a particular village for two to three months. Based on the estimates of livestock keepers, around 60% of clinically affected animals died of the disease.

### Punjab Province

In Punjab the evidence is of a less explosive situation. In 10 districts in the centrally situated irrigated areas, village livestock keepers failed to report PPR. Districts that did report the presence of PPR at village level tended to lie in the north of the province or along its eastern border (Fig.

**Table II**  
**The monthly incidence of peste des petits ruminants in villages throughout Sindh during the epidemic**

Month	Number of new cases			
	2002	2003	2004	2005
January	*	66	61	25
February	5	457	520	34
March	4	57	13	31
April	4	44	19	4
May	5	43	4	**
June	1	17	3	
July	1	12	4	
August	1	9	3	
September	3	10	5	
October	0	3	4	
November	1	4	4	
December	20	8	16	

\* no data available

\*\* end of observations

1). Table III shows the extent to which the virus is active in these districts.

In the districts from which PPR was reported between 2000 and 2005 in Punjab Province, only 15% of the villages visited by the PDS teams had been infected. In general then, the yearly district prevalence levels are low compared to Sindh, where the disease is epidemic, which probably reflects a more endemic situation in Punjab. Even so, local surges in incidence level could apparently occur, as with Attock District in 2003 and Dera Ghazi Khan District in 2005. Looking at the annual incidence levels it appears that there has also been an epidemic in the Punjab, peaking in 2004, but at a somewhat low-key level compared to Sindh, possibly due to a higher level of background immunity within the population. As with Sindh, there is evidence that PPR is also a winter disease in the Punjab.

### Other provinces

Participatory disease surveillance efforts failed to unearth the presence of PPR in Balochistan. In NWFP the only location from which PPR was reported was Manshera District in 2004, while in the Northern Areas it was reported from Skardu and Ganche Districts, again in 2004.

In Azad Jammu and Kashmir, the disease has been found in all three of the districts of Mirpur Division, Kotli, Bhimber and Mirpur. In Kotli District it appeared in the summer of 2003 followed by an epidemic the next winter. In the other two districts it first appeared in the summer (August) of 2004 and went on to cause severe outbreaks in the winter of 2004/2005. In Muzzafrabad District it was detected in goats belonging to nomads.

**Table III**  
**The incidence level of peste des petits ruminants in the districts and villages of Punjab that reported the disease**

District	No. villages searched	Year of search	Number of villages where owners recalled experiencing PPR in their livestock				
			2001	2002	2003	2004	2005*
Attock	107	2003 & 2005	1	8	24	2	–
Bahawalnagar	114	2004 & 2005	–	–	21	9	ns
Bhukkar	37	2005	–	–	–	8	1
Chakwal	116	2003 & 2005	1	10	8	–	2
Dera Ghazi Khan	24	2004 & 2005	–	–	–	5	15
Faisalabad	180	2004 & 2005	–	–	6	5	4
Gujranwala	80	2004	–	–	1	1	ns
Gujrat	105	2004 & 2005	–	–	7	13	2
Hafizabad	40	2004	–	–	1	1	ns
Jhang	80	2004 & 2005	–	–	–	3	2
Jhelum	79	2004 & 2005	–	–	10	8	2
Mianwali	62	2003 & 2004	3	11	–	–	ns
Mundi Baha-ud-Din	78	2003 & 2005	–	1	6	1	1
Narowal	80	2004	–	4	3	–	ns
Okara	90	2003 & 2005	–	–	1	1	8
Pakpattan	56	2003	–	2	1	–	ns
Rawalpindi	80	2004	–	5	10	–	ns
Sialkot	82	2004	–	–	1	3	ns
Sheikhupura	124	2004	–	–	–	1	ns
Toba Tek Singh	60	2003	–	1	8	–	ns
<b>Total</b>	<b>1,674</b>		<b>5</b>	<b>42</b>	<b>108</b>	<b>61</b>	<b>37</b>

– : no outbreak recalled

\* the study ended in May 2005

ns : no search

## Means of virus spread

Based on the remarks of livestock farmers, markets – especially those held before the Eid ul Azha (presently a winter festival) – are seen as playing an important role in the spread of PPR. At the time of such festivals there is a large-scale local movement of animals for slaughter, in the course of which many fresh cases are created. Where this movement ends in the slaughter of infected animals the risk of further spread is probably very small, but outbreaks have been seen where surplus animals are returned from market unsold or are sold by dealers and subsequently introduced into clean flocks. Such a situation was reported in the Tharparkar District of Sindh, and in Gujranwala and Rawalpindi in the Punjab, the villagers indicated that after introducing a truck load of goats for sale at Eid, the disease erupted among their village goats.

## Discussion

Although it might have been present on the Balochistan border with Afghanistan as long ago as 1976 (Sheikh

Masood Ahmed, personal communication), the first written account of PPR in Pakistan dates from late 1991, when it was recognised on the basis of clinical and post-mortem findings by Athar *et al.* (2). These authors examined some 590 goats presented at the Department of Clinical Medicine and Surgery at the University of Agriculture in Faisalabad with a necrotic stomatitis, excess salivation, ocular and nasal discharges, diarrhoea and pneumonia. Starting in December 1991, the outbreak appeared to peak between May and June 1992 and had totally subsided by the end of July. Necropsy findings included erosions in the oral cavity and blackening of the folds of the abomasum. Unable to make a laboratory confirmation, the authors concluded that the clinical signs they were encountering were consistent with PPR. Furthermore, they successfully protected goats with rinderpest cell culture vaccine, thereby demonstrating that they were dealing with a *Morbillivirus*. According to field reports the disease was present throughout Punjab Province, affecting only goats. From the neighbouring city of Lahore, Pervez *et al.* (10) reported the same outbreak between November 1991 and August 1992. Jointly then, these authors recorded the first epidemic of PPR in Pakistan even though the first confirmation of the presence

of PPR in Pakistan – based on a reverse transcriptase polymerase chain reaction (PCR) – was still two years off (1).

Subsequent workers have demonstrated the continuing presence of the virus in Pakistan (6, 7, 11) but, in the absence of meaningful disease reporting statistics, no national epidemiological assessments have been possible. Now, with the advent of PDS reporting this situation has changed. While we cannot determine what happened in the intervening years, it now appears that the virus has become endemic in a restricted number of districts within Punjab Province where its incidence shows periodic upward surges – presumably in response to the accumulation of fresh susceptible animals.

Senior veterinary officers recall that the disease may have spread from Punjab to Sindh Province in the early 1990s, but at village level there is no collective memory of any large-scale disaster at that time. However, since then Sindh Province has experienced a very severe PPR epidemic. It appears at the time of writing (late 2005) that the virus has moved from the south of the province to the north in the space of a few months and is causing severe losses among the sedentary village small ruminant population. While it is possible that transhumant movements may have introduced the infection, it is highly likely that the epidemic has been fuelled by the local redistribution of infected stock and that, while on the wane in some districts, the epidemic is still very active in the south-east of the province.

Villagers in northern Punjab ascribe the onset of PPR to the passage of Kashmiri nomads, although it would probably be just as correct to say that the virus has been endemic in the province's northern districts for a number of years.

In both Sindh and Punjab Provinces PPR appears to be a winter disease involving goats more severely than sheep (although not necessarily more frequently). The explanation for this seasonality may lie either in differences in small ruminant husbandry practices between summer and winter, or in other factors bringing about seasonal changes in the virulence of the virus. We do not know if, prior to the recent epidemic in Sindh, there was a situation in which the virus was endemically established at a sub-clinical level. Indeed, a similar situation may exist in those districts of the Punjab that are not currently reporting outbreaks. So, it may be that PPR is represented by epidemic, endemic and sub-clinical strains in concurrent circulation or, there may be strains that vary in virulence by season. Bearing such possibilities in mind, it is important to ensure that continuing studies determine whether the virus can remain at large in the population

represented by strains of differing virulence, as certainly can be the case for rinderpest. Such studies require the availability of local PPR isolates with which to make virulence comparisons and accordingly, further epidemiological studies are urgently required.

In the expectation that Pakistan will exploit its capacity to manufacture homologous PPR vaccine, an examination of possible control strategies is needed to ensure that vaccines are used appropriately.

Apart from addressing explosive outbreaks, such as the outbreak afflicting Sindh in 2005, by emergency mass vaccination, a more routine and systematic approach is an additional requirement. The study of Awa *et al.* (3) indicates that against a threat of PPR, small ruminant farmers may expect increased profit margins if they vaccinate their stock against the disease. However, for the immediate future the initiative in breaking the epidemic–endemic cycle should involve the public sector Livestock Departments in the delivery of PPR vaccine to small ruminant keepers throughout the country. Such an approach would have to be combined with a sound zoosanitary understanding, policed by district veterinary staff, to ensure that infected animals are not sold to dealers for resale elsewhere. At this time it is for the public sector delivery system to improve its capacity to deliver the required weight of vaccine and rectify any deficiencies. To what extent cost-recovery for PPR vaccine services could, or indeed should, be built into 'public good' immunisation programmes is unclear at present but needs consideration.

In the short term the existing PPR vaccine will provide an adequate tool for the control of the disease, but in the medium term protection with an antigenically modified form of the virus must be the preferred solution given the likelihood of the presence of sub-clinical wild-type strains and the need to serologically monitor their field persistence while simultaneously attempting to protect against the disease.

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## Peste des petits ruminants au Pakistan : épidémiologie et possibilités de lutte

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### Résumé

La peste des petits ruminants a été observée cliniquement pour la première fois au Pakistan en 1991, lors d'une épidémie qui a frappé la province du Pendjab ; depuis lors, le niveau d'activité du virus n'a pas fait l'objet d'une évaluation systématique. En 2003, en 2004 et en 2005, des équipes formées aux méthodes de la surveillance sanitaire participative ont visité un grand nombre de villages sur tout le territoire pakistanais afin de recueillir les taux de prévalence et l'impact causé par les principales maladies du bétail. Lors de cette étude, il est apparu que la peste des petits ruminants est une maladie courante chez les petits ruminants du pays, avec des conséquences économiques néfastes ; la maladie était endémique au nord du Pendjab, et des épidémies ont été observées à l'Azad Cachemire à Sind. Il devrait être possible de réduire le taux d'incidence en combinant des mesures zoonitaires avec une vaccination intensive.

### Mots-clés

Endémie – Lutte contre les maladies – Pakistan – Pandémie – Peste des petits ruminants – Surveillance sanitaire participative – Vaccination.



## Epidemiología de la peste de pequeños rumiantes en Pakistán y posibles políticas de control

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### Resumen

La peste de pequeños rumiantes hizo su primera aparición clínica en Pakistán durante una epidemia que asoló la provincia del Punjab en 1991, pero en los años subsiguientes nunca se llegó a registrar de forma sistemática su nivel de actividad. En 2003, 2004 y 2005, varios equipos con formación en los métodos de la "vigilancia sanitaria participativa" recorrieron todo el país y visitaron gran número de aldeas para determinar la prevalencia y los efectos de varias enfermedades importantes del ganado. De sus resultados se infiere que la peste de pequeños rumiantes es una afección común y económicamente muy perjudicial en el país, que parece ser endémica en el norte del Punjab y, en el periodo cubierto por el estudio, epidémica en Azad Jammu y Cachemira y en Sindh. Debería ser posible reducir el nivel de incidencia combinando una serie de medidas zoonitarias y un uso intensivo de la vacunación.

### Palabras clave

Control de enfermedades – Pakistán – Peste de pequeños rumiantes – Propagación endémica – Propagación epidémica – Vacunación – Vigilancia sanitaria participativa.



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