

A REVIEW :

Peste des Petits Ruminants in India: A review of economic losses

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SUMMARY : Small ruminants contribute a significant source of supplementary income to the poor rural people but this sector is highly affected due to high incidence of different diseases. Peste des petits ruminants (PPR) is one of the major diseases of small ruminants which is having high incidence rate, morbidity and mortality rate in India. The literature related to economic losses due to PPR has been carefully reviewed and presented in this paper. Various researchers had estimated the economic loss of PPR due to its mortality and morbidity and found it to be high; still they felt many of the incidence, morbidity and mortality in small ruminants might have not been reported. The reviews of various papers and reports had also clearly pointed out high incidence, morbidity and mortality rate due to PPR in India. High economic loss in small ruminants is a major concern as it is mainly practiced by the small, marginal and landless farmers in India. The losses due to PPR might have reduced a major portion of their farm income among these rural people. To combat this threat comprehensive national programme have to be taken through combined efforts of local and national authorities along with continuous support and strengthening by international agencies.

KEY WORDS:

Economic loss,
Morbidity, Mortality,
Peste des petits
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BACKGROUND AND OBJECTIVES

Small ruminants are friend of the weakest society and ray of hope in the areas where agriculture is not economically viable and ecologically sustainable. Small ruminants contribute a significant source of supplementary income to the poor rural people. But, it has been noticed that this sector is highly affected due to high incidence of different diseases (Roy *et al.*, 2015). At national level, the goat economy loses over Rs. 11,700 million per annum on account of

disease incidence (Kumar *et al.*, 2003). According to AICRP on ADMAS Annual Report 2011-12, PPR was the 2nd top disease reported in terms of incidence in India during 2010-11 (PDADMAS, 2012) and further the number of PPR outbreak (194) increased in West Bengal in comparison with last year (PDADMAS, 2011). This might be one of the reasons for decrease in goat population by 3.82 per cent in 19th livestock census, 2012 in respect to 18th livestock census, 2007 (GOI, 2009 and 2014).

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PPR is enzootic in India as outbreaks occur in small ruminants regularly throughout the country and is a major constraint in small ruminant production incurring great economic losses in terms of morbidity, mortality, productivity losses with trade restriction. High incidences of PPR in developing or under developed countries add to the economic miseries among rural poor engaged in livestock farming. Comprehensive information on epidemiology of PPR as a whole in India is not available except some papers and few reports. Economic loss due to PPR is not quantified comprehensively so far at the national and regional or state levels (PDADMAS, 2012).

Kulkarni *et al.* (1996) had carried out epidemiological investigations on goats in nine villages of the Latur district in Maharashtra and reported that goats of all ages were affected by PPR. Singh *et al.* (2004) have found that PPR causes large economic losses each year due to high mortality and morbidity rates in the infected sheep and goats and outbreaks were more severe in goats than sheep. PPR is an acute contagious disease affecting goat and sheep populations in the Indian subcontinent (Fentahun and Woldie, 2012). Morbidity and mortality rates vary, but have been reported to be as high as 100 per cent in goats and 90 per cent in sheep (Dhar *et al.*, 2002). The prognosis of acute PPR is usually poor. The severity of the disease and outcome in the individual is correlated with the extent of mouth lesions. Prognosis is good in cases where the lesions resolve within 2 to 3 days. It is poor when extensive necrosis and secondary bacterial infections result in an unpleasant, fetid odor from the animal's breath. Respiratory involvement is also a poor prognostic sign. A morbidity rate of 80-90 per cent and a case fatality rate of 50-80 per cent are not

uncommon, particularly in goats (Ezeibe *et al.*, 2008). Young animals (4 to 6 months) have more severe disease and morbidity and mortality are higher (Abubakar *et al.*, 2008; Srinivas and Gopal, 1996). Both field and laboratory observations indicate that PPR is more severe in goats than in sheep. Poor nutritional status, stress of movement and concurrent parasitic and bacterial infections enhance the severity of clinical signs (Ezeibe *et al.*, 2008). In a study based on official Government of India reports for a 15 years period (1991-2005), it was reported that PPR accounted for upto one-third of the disease incidence (32.3%) in goats in India and two-fifths of their deaths (41.5%) from all diseases (Singh and Prasad, 2008).

It has been further observed that the main limitations to effective livestock health management are an inadequate focus on preventive measures, lack of medicines and equipment in rural veterinary clinics and ignorance among the farmers (Dey *et al.*, 2007).

Economic losses :

The expected annual economic loss due to PPR in India ranged between US \$2 million and US \$1.6 billion. The most likely range of expected economic loss, based upon maximum frequencies for a class interval, was US \$653–669 million (Bardhan *et al.*, 2017).

Bardhan *et al.* (2017) reported the proportion of morbidity and mortality of PPR in sheep and goats in different states, based on official data. West Bengal, representing the Lower Gangetic Plains, accounted for the highest incidence of PPR (27.38%), followed by Gujarat (20.96%), representing Gujarat Plains and Hills region. The highest proportion of deaths were found in Gujarat (23.40%) followed by West Bengal (23.24%)

Table 1 : Proportional morbidity and mortality due to peste des petits ruminants among goat and sheep in different states in India

State	Region(a)	Goats and Sheep	
		Morbidity	Mortality
Uttar Pradesh	Spans three regions*	4.65	0.00
Haryana	Trans-gangetic plains	7.38	9.76
West Bengal	Lower gangetic plains	27.38	23.24
Odisha	Eastern plateau and hills	2.64	4.82
Maharashtra	Western plateau and hills	9.40	14.51
Tamil Nadu	Southern plateau and hills	10.69	17.09
Gujarat	Gujarat plains and hills	20.96	23.40
Rajasthan	Western dry region	16.91	7.19

Adapted from Bardhan *et al.* (2017).

Note: a) No incidence of peste des petits ruminants was officially reported during the period 2011–2015 in Jammu and Kashmir (representing the Western Himalayan Region) and Meghalaya (representing the Eastern Himalayan Region); *The state of Uttar Pradesh represents three agro-climatic regions in India, *i.e.* the Upper and Middle Gangetic Plains and the Central Plateau and Hills region

(Table 1).

Total annual loss due to PPR in India was Rs. 1.8 billion (US\$ 36 million) in which annual loss due to mortality was Rs. 1.5 billion, annual loss due to morbidity Rs. 200 million and annual indirect loss (export restriction etc.) was Rs. 100 million (Venkataramanan *et al.*, 2005).

Singh *et al.* (2014) reported that mortality and morbidity losses, contributed 34.34 per cent and 65.66 per cent, of total loss (Rs. 125.67 lakhs) due to PPR in goats, respectively. Disaggregated analysis revealed that among different components of losses, the maximum loss was observed due to direct body weight loss (33.05%). Losses due to treatment cost, reproductive failure and opportunity costs were the next major components of morbidity loss accounting for 14.9 per cent, 9.37 per cent

and 6.34 per cent of total loss, respectively. Direct milk loss accounted for the smallest proportion of total loss (2.01%) (Table 2).

Singh *et al.* (2014) also reported that mortality loss accounted for 33.78 per cent of total loss while morbidity contributed 66.22 per cent of total loss (Rs. 42.16 lakhs) due to PPR in sheep. Direct body weight loss contributed the highest proportion (36.39%) of total loss, followed by treatment cost (18.15%), opportunity costs (6.43%) and losses due to reproductive failure (4.91%). Wool loss accounted for negligible share of total loss (0.36%) (Table 3). Total annual economic loss due to PPR in small ruminants was thus estimated as Rs. 167.83 lakhs. Loss due to PPR in goats was higher (74.88%) as compared to sheep (25.12%).

Table 2 : Component wise losses due to PPR in goats (Rs. in lakhs)

Sr. No.	Components	Value	% loss
1.	Mortality loss	43.16	34.34
2.	Morbidity loss		
i	Direct milk loss	2.52	2.01
ii	Reproductive failure		
	Milk loss due to increased interkidding period	2.93	
	Milk loss due to increased abortions	3.21	
	Kids loss due to increased interkidding period	2.68	
	Kids loss due to increased abortion	2.94	
	Total loss due to reproductive failure	11.77	9.37
iii.	Direct body weight loss	41.53	33.05
iv.	Treatment cost	18.72	14.90
v.	Opportunity cost	7.97	6.34
	Total morbidity loss	82.51	65.66
	Total loss	125.67	100

Adapted from Singh *et al.* (2014).

Table 3 : Component wise losses due to PPR in sheep (Rs. in lakhs)

Sr. No.	Components	Value	% loss
1.	Mortality loss	14.24	33.78
2.	Morbidity loss		
i	Direct wool loss	0.15	0.36
ii	Direct body weight loss	15.34	36.39
iii	Losses due to reproductive failure		
	Body weight loss due to increased inter-lambing period	0.87	
	Body weight loss due to increased abortion	1.20	
	Total loss due to reproductive failure	2.07	4.91
iv	Treatment cost	7.65	18.15
v	Opportunity cost	2.71	6.43
	Total morbidity loss	27.92	66.22
	Total loss	42.16	100

Adapted from Singh *et al.* (2014)

The annual economic loss estimated on the basis of data reported by Department of Dairying Animal Husbandry and Fisheries, Government of India was too low (Rs. 167.83 lakhs), probably on account of under reporting of cases and deaths due to the disease. Based on cases and deaths as reported in sample survey studies, the estimated annual economic loss due to PPR disease in goats and sheep at the national level was Rs. 8895.12 crores, of which Rs. 5477.48 and Rs. 3417.64 crores are due to the incidence of the disease in goats and sheep, respectively (Singh *et al.*, 2014).

Singh and Prasad (2008) reported that the total annual average loss due to all diseases in goats was Rs. 264.8 lakhs to seven diseases in goats over a 15 years period (1991-2005) based on published reports. The average annual economic loss was highest due to PPR (Rs. 91.4 lakhs), followed by FMD (Rs. 37.8 lakhs), sheep and goat pox (Rs. 37.2 lakhs), CCP (Rs. 17.0 lakhs), enterotoxaemia (Rs.16.2 lakhs), fascioliasis / distomatosis (Rs. 13.1 lakhs) and anthrax (Rs. 5.2 lakhs).

Govindaraj *et al.* (2016) reported that the optimum incidence level (10%), the estimated total loss due to PPR in sheep was Rs. 5041.5 million (mortality loss amounts to Rs. 3904.2 million and morbidity loss was Rs. 1137.4 million). At the minimum (5%) and maximum (15%) incidence levels, the total loss estimated was Rs.

2520.8 and Rs.7562.3 million, respectively (Table 4). The age group wise loss estimation revealed that at the optimal incidence (10%), among the mortality loss, the major loss was in adult animals (Rs. 2576.7 million) than in young animals (Rs. 1327.4 million). Among the morbidity loss, the loss due to reduction in body weight was Rs. 261.6 million (Rs. 128.8 million in adult animals and Rs. 132.7 million in young animals). The live weight loss due to increased inter-lambing period and live weight loss due to abortion was Rs. 446 and Rs. 32.2 million, respectively. Among the other associated losses, the loss due to high feeding and rearing was Rs. 236.6 million and miscellaneous costs was Rs. 161 million. Around 67 per cent of the loss incurred for higher feeding and recovering was in young animals and 33 per cent in adult animals (Table 4).

Govindaraj *et al.* (2016) reported that the optimum incidence level (10%), the estimated total loss due to PPR in goat was Rs. 11074.6 million (mortality loss amounts to Rs. 8110.4 million and morbidity loss was Rs. 2964.2 million). At the minimum (5%) annual incidence levels, the loss due to PPR in goats amounts to Rs. 5537.3 million whereas, at the maximum annual incidence levels (15%), the total loss estimated was Rs. 11611.8 million (Table 5). The age-group wise loss estimation in goats revealed that at the optimal annual

Table 4 : Mortality and morbidity losses in young and adult sheep for various levels of annual incidence of PPR in India (Rs. Million)

Sr. No.	Type of loss	Age group	Annual incidence levels			
			5%	10%	15%	
1.	Mortality loss	Adult	1288.4(66)	2576.7(66)	3865.1(66)	
		Young	663.7(34)	1327.4(34)	1991.1(34)	
		Total	1952.1(100)	3904.2(100)	5856.2(100)	
2.	Morbidity losses	Direct losses due to reduction in body weight	Adult	64.4(49.3)	128.8(49.3)	193.3(49.3)
			Young	66.4(50.7)	132.7(50.7)	199.1(50.7)
			Total	130.8(100)	261.6(100)	392.4(100)
		Live weight loss due to increased inter-lambing period	Adult	223.0(100)	446.0(100)	669.0(100)
		Live weight loss due to increased abortion	Adult	16.1(100)	32.2(100)	48.3(100)
		3.	Other associated losses	Cost of high feeding and rearing inputs	Adult	38.7(32.7)
Young	79.6(67.3)				159.3(67.3)	238.9(67.3)
Total	118.3(100)				236.6(100)	354.9(100)
Miscellaneous loss	Adult			26.3(32.7)	52.6(32.7)	78.9(32.7)
	Young			54.2(67.3)	108.4(67.3)	162.6(67.3)
	Total			80.5(100)	161.0(100)	241.5(100)
Total economic losses			2520.8	5041.5	7562.3	

Adapted from Govindaraj *et al.* (2016)

incidence levels (10%), among the mortality loss, the major loss was in adult animals (Rs. 5271.8 million) than in young animals (Rs. 2838.6 million). Among the morbidity loss, the loss due to reduction in body weight was Rs. 547.5 million (Rs. 263.6 million in adult animals and Rs. 283.9 million in young animals). The live weight loss due to increased inter-kidding period and due to abortion was Rs. 1459.9 million and Rs. 52.7 million, respectively. The annual milk loss estimated was Rs. 65.9 million due to PPR in sheep and goats at the optimum incidence level. Among the other associated losses, the loss due to high feeding and rearing was Rs. 498.8 million and

miscellaneous costs were Rs. 339.5 million. Around 68 per cent of the loss incurred for higher feeding was in young animals and 32 per cent in adult animals (Table 5). Among the miscellaneous costs, major losses were in young animals (Rs. 231.8 million) than the adult animals (Rs. 107.6 million).

Govindaraj *et al.* (2016) reported that at the optimum incidence level (10%), the estimated total loss due to PPR in sheep and goats was Rs. 16116.1 million (mortality loss amounts to Rs. 12014.5 million and morbidity loss was Rs. 4101.6 million). The sensitivity analysis results revealed that at the minimum (5%) annual

Table 5 : Mortality and morbidity losses in young and adult goat for various levels of annual incidence of PPR in India (Rs. Million)

Sr. No.	Type of loss	Age group	Annual incidence levels		
			5%	10%	15%
1.	Mortality loss	Adult	2635.9(65)	5271.8(65)	7907.6(65)
		Young	1419.3(35)	2838.6(35)	4258.0(35)
		Total	4055.2(100)	8110.4(100)	12165.6(100)
2.	Morbidity losses				
	Direct losses due to reduction in body weight	Adult	131.8(48.1)	263.6(48.1)	395.4(48.1)
		Young	141.9(51.9)	283.9(51.9)	425.8(51.9)
		Total	273.7(100)	547.5(100)	821.2(100)
	Live weight loss due to increased inter-kidding period	Adult	729.9(100)	1459.9(100)	2189.8(100)
	Live weight loss due to increased abortion	Adult	26.4(100)	52.7(100)	79.1(100)
3.	Milk loss	Adult	32.9(100)	65.9(100)	98.8(100)
4.	Other associated losses				
	Cost of high feeding and rearing inputs	Adult	79.1(31.7)	158.2(31.7)	237.2(31.7)
		Young	170.3(68.3)	340.6(68.3)	511.0(68.3)
		Total	249.4(100)	498.8(100)	748.2(100)
	Miscellaneous loss	Adult	53.8(31.7)	107.6(31.7)	161.4(31.7)
		Young	115.9(68.3)	231.8(68.3)	347.7(68.3)
		Total	169.7(100)	339.5(100)	509.2(100)
	Total economic losses		5537.3	11074.6	11611.8

Adapted from Govindaraj *et al.* (2016).

Table 6 : Mortality and morbidity losses in goat and sheep for various levels annual incidence of PPR in India (Rs. millions)

Sr. No.	Type of loss	Annual incidence levels		
		5%	10%	15%
1.	Mortality loss	6007.3(74.6)	12014.5(74.6)	18021.8(74.6)
2.	Morbidity losses			
	Direct losses due to reduction in body weight	404.5(5.0)	809.0(5.0)	1213.5(5.0)
	Live weight loss due to increased inter-kidding period	952.9(11.8)	1905.8(11.8)	2858.8(11.8)
	Live weight loss due to increased abortion	42.5(0.5)	84.9(0.5)	127.4(0.5)
3.	Milk loss	32.9(0.4)	65.9(0.4)	98.8(0.4)
4.	Other associated losses			
	Cost of high feeding and rearing inputs	367.7(4.6)	735.4(4.6)	1103.1(4.6)
	Miscellaneous loss	250.2(3.1)	500.5(3.1)	750.7(3.1)
	Total economic losses	8058.0	16116.1	24174.1

Adapted from Govindaraj *et al.* (2016).

incidence level, the loss amounts to Rs. 8058 million whereas at the maximum (15%) annual incidence, the total loss was around Rs. 24174.1 million (Table 6).

Dixit *et al.* (2016) reported that the average economic loss per study household was estimated to be Rs. 14156 out of which Rs. 12320 was loss due to mortality of affected goats. This loss accounted for 87 per cent of total economic loss, possibly due to high rate of case fatality (73%). Moreover, no vaccination against PPR before outbreak delay in diagnosis and unavailability of veterinary services during the outbreak were also the important reason for high magnitude of mortality loss. The high severity of the disease was reported by the goat farmers first time as they recalled their memories. The morbidity loss was estimated to be Rs. 1567. This includes loss due to reduction in milk yield and reduction in market value due to weight loss of Rs. 374 and Rs. 1192, respectively. The reduction in market value due to body weight loss alone constituted about 9 per cent of total economic losses due to PPR outbreak. The average opportunity cost borne by the household was Rs. 269. This includes expenses on veterinary care on survived goats (Rs. 164.5), extra labour charges (Rs. 63.44) and other charges (Rs. 41). Considering average flock size of study household is 13.3 goats, the loss per goat due to PPR disease was estimated to be Rs. 1064.

Roy *et al.* (2015) reported that total economic losses for PPR due to mortality losses was Rs. 14,26,699 among 180 respondents from West Bengal and Uttar Pradesh for last two years and mortality loss per goat was Rs. 2,558 and morbidity loss calculated was Rs. 301 per goat. They had further stated that the morbidity loss and mortality loss per goat in West Bengal was Rs. 3318 and Rs. 375 whereas the morbidity loss and mortality loss per goat in Uttar Pradesh was Rs. 2378 and Rs. 259. They reported that the differences in economic losses for morbidity and mortality due to PPR between the two states might be due to differences in market rate of the goat and differences in animal healthcare status between the two states. The total economic losses due to PPR disease have been found to Rs. 523 per affected animal (Awase *et al.*, 2013). Thambore and Sinha (2009) reported that total loss due to PPR disease was found to be Rs. 945 in goat.

Conclusion :

PPR is the major disease which has high incidence

and mortality rate and has highest economic losses in small ruminants in general and goat in particular in India. High economic loss in goat is a major concern as goat farming is mainly practiced by the marginal and small farmers in India. The losses due to PPR might have reduced a major portion of farm income among marginal and small farmers. The quantification of economic losses due to any disease in animals is very important since it helps in prioritizing the research on animal health issues; and designing appropriate control programme for PPR disease in turn it helps in optimal utilization scarce resources.

Although different initiatives have been taken for the progressive control of PPR in India yet there is need to have comprehensive national program to combat this menace. This could only be achieved by the combined efforts of local and national authorities as well as political will; along with continuous support and strengthening by international agencies.

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