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Impact of Prophylactic Vaccination in Cattle against Lumpy Skin Disease

Khem Chand, P. S. Birthal, and Subhash Kachhawaha

Diseases reduce animals' production and reproduction potential, the economic and social consequence of which are felt all along the food value chain and persist for a long, in terms of reduction in the incomes of farmers and entrepreneurs and higher prices of animal-source foods for consumers. The macroeconomic effects of a widespread disease outbreak could be devastating – increase in food inflation, reduction in exports, and increase in public expenditure on prevention and control of diseases. Smallholder-dominated agrarian economies, where livestock is an integral component of agriculture and contributes significantly to agricultural growth and food and nutrition security, will be affected more by disease outbreaks due to a lack of financial and human resources for disease management.

India has a huge livestock population – 303 million bovines, 223 million small ruminants, and 852 million poultry birds, contributing about 30% to agricultural gross domestic product and 13% to agricultural exports.¹ In recent years, the animal husbandry has performed exceptionally well – its gross value added increased at an annual rate of close to 8% since 2011-12. More importantly, animal husbandry is practiced primarily by small landholders and they will suffer the most from any threat to livestock production.

In the past, India has successfully eradicated some deadly diseases like rinderpest. However, it still experiences occasional outbreaks of diseases like Foot and Mouth Disease (FMD), Brucellosis, Peste des petits ruminants (PPR), Haemorrhagic Septicaemia (HS), and Black Quarter (BQ). The most recent episode is that of Lumpy Skin Disease (LSD) in cattle. According to the data available with the Ministry of Fisheries, Animal Husbandry

and Dairying, Government of India, between August 2022 and December 2023 over 4 million cattle, equalling 2.1 percent of the total population, were affected by LSD. Although the infection rate appears small, the disease has significant potential to cause direct loss in livestock production without preventive and curative management. For instance, in South, East, and Southeast Asia, LSD is reported to have caused a direct loss of US\$ 1.45 billion in livestock production.²

This brief note provides estimates of economic loss caused by the recent outbreak of LSD in cattle in India and the loss prevented through prophylactic vaccination.

Mechanism of disease infection

Cattle are the primary host for the LSD virus. LSD is not zoonotic, but because of its potential to cause significant production and reproduction loss, the World Organization for Animal Health (OIE) has categorized it as a notifiable disease.³

The LSD virus is found in blood, nasal discharge, lacrimal secretion, semen, and saliva and is transmitted through arthropods like mosquitoes, flies, and ticks. It also transmits through contact with infected animals and from mothers to calves/heifers through milk secretion and skin abrasions. The disease becomes severe during humid and hot climates, i.e., the rainy season, which is conducive to the multiplication of arthropod vectors.

Spatial spread of LSD

LSD does not recognize spatial boundary and can spread across countries or regions. For the first time, it was reported in Zambia in 1929 and progressively spread to several countries in Africa, Asia, and Europe. In India, it

Khem Chand is principal scientist, and P. S. Birthal is director at ICAR-National Institute of Agricultural Economics and Policy Research Institute, New Delhi. Subhash Kachhawaha is Subject Matter Specialist at Krishi Vigyan Kendra, Central Arid Zone Research Institute, Jodhpur, Rajasthan.

^{1&7} Government of India. (2023). Basic Animal Husbandry Statistics 2023. Ministry of Fisheries, Animal Husbandry and Dairying.

² Roche, X., Rozstalnyy, A., TagoPacheco, D., and others. (2020). Introduction and Spread of Lumpy Skin Disease in South, East, and Southeast Asia: Qualitative Risk Assessment and Management. FAO Animal Production and Health Paper 183, Food and Agriculture Organization, Rome, Italy.

³ OIE (2013). Lumpy Skin Disease: Technical Disease Card. World Organization for Animal Health, Paris.

was first reported in 2019 in the state of Odisha. However, it appeared in a severe form in several states during the rainy season of 2022. Since then, it has infected about 4 million cattle until December 2023, equalling 2.1% of the total cattle population (Table 1).

Table 1. Morbidity and mortality due to LSD in cattle, 2022-2023⁴

State/UT	Cattle population (No.)	No. of cattle infected	Morbidity rate (%)	No. of cattle deaths	Mortality rate (%)
Rajasthan	13937630	1567231	11.24	76030	4.85
Maharashtra	13992304	654247	4.68	55549	8.49
Assam	10909239	449395	4.12	3579	0.80
Karnataka	8469004	327592	3.87	31811	9.71
Gujarat	9633637	176175	1.83	6204	3.52
Punjab	2531460	174927	6.91	17932	10.25
Himachal Pradesh	1828017	148038	8.10	12018	8.12
Uttar Pradesh	19019641	122968	0.65	724	0.59
Haryana	1928682	114844	5.95	2938	2.56
Uttarakhand	1852123	57056	3.08	1675	2.94
Odisha	9903970	52572	0.53	125	0.24
Madhya Pradesh	18750828	36041	0.19	747	2.07
Kerala	1341996	21483	1.60	873	4.06
Northern Eastern Region (NER)	1175577	25594	2.18	5371	20.99
Union Territories (UT)	2575678	71737	2.79	2727	3.80
Other states (OS)	74180868	27024	0.04	355	1.31
Total	193462871	4026924	2.08	218658	5.43

Notes: NER includes Mizoram, Sikkim, Meghalaya, Nagaland and Tripura; UT includes Jammu & Kashmir, Dadar & Nagar Haveli, Daman & Diu and Andaman & Nicobar; OS includes Chhattisgarh, Delhi, Goa, Tamil Nadu, Jharkhand, West Bengal, Andhra Pradesh, Telangana and Bihar.

Rajasthan has suffered the most from the LSD, accounting for 38.7% of the infected cattle in the country. The morbidity rate is also the highest in Rajasthan (11.2%), followed by Himachal Pradesh (8.1%), Punjab (6.9%), and Haryana (6.0%). The intensity of morbidity in different states is also shown in Figure 1.

The average mortality rate is estimated at 5.4%, but it varies significantly across states. Punjab has the highest mortality rate (10.3%), followed by Karnataka (9.7%), Maharashtra (8.5%), and Himachal Pradesh (8.1%).

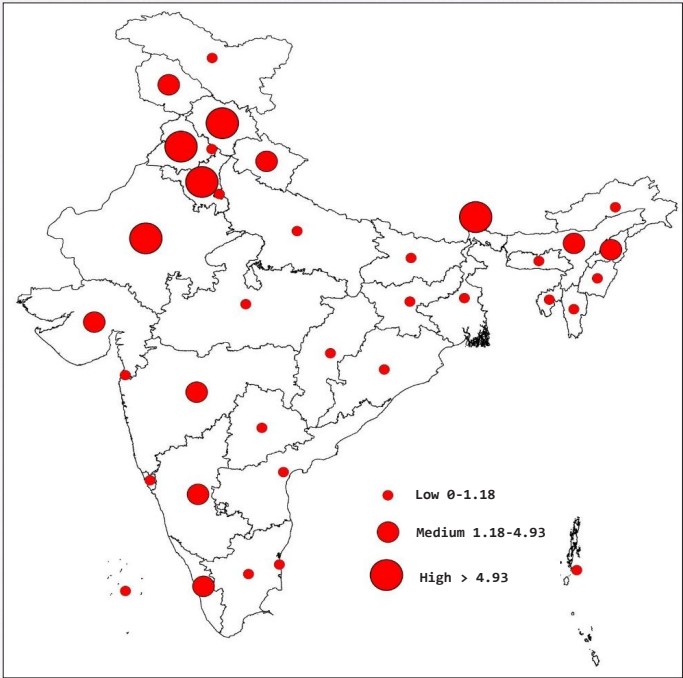


Figure 1. Incidence of LSD in states (morbidity rate, %)

Crossbred cattle are relatively more vulnerable than indigenous cattle⁵ — the states with a significant proportion of crossbreds in the total cattle population have a higher mortality rate. For example, Punjab has 83% crossbreds in the total cattle population and also the highest mortality rate. On the other hand, Rajasthan has a similar proportion of indigenous breeds in the total cattle population but has one of the lowest mortality rates. Yet, Rajasthan accounts for 35% of the total cattle deaths, followed by Maharashtra (25%) and Karnataka (15%). In these states, animals are often grazed on pastures and common lands, which provide a friendly environment for the multiplication of arthropod vectors. This is perhaps one of the reasons for the higher incidence of LSD in these states.

Economic loss due to LSD

Economic loss due to LSD has been estimated using the mortality and morbidity rates reported in Table 1. The information on loss in milk yield during disease infection, reproduction loss due to abortion and delayed pregnancy, and treatment costs were gathered through personal interviews of about 1800 dairy farmers in nine severely LSD-affected states and discussion with veterinarians and officials of the Animal Husbandry Departments of the states.

Total economic loss, thus, comprises (i) the market value of dead animals, i.e., mortality loss, (ii) the value of milk lost, i.e., morbidity loss, and (iii) the cost of treatment. Milk loss is reported to be in the range of 32-58% in different states. It also includes the loss in milk due to abortion and increased inter-calving period. The disease recovery period ranges from one to two months, and the average cost of treatment

⁴ Data were taken from LSD Reports available with the Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, New Delhi.
⁵ Al-Salihi, K. A. (2014). Lumpy skin disease: Review of the literature. *Mirror of Research in Veterinary Sciences and Development*, 3 (3): 6-23.

(i.e., expenses on medicines and veterinarian's fee) during this period has been estimated in the range of Rs 990 to Rs 1678 per infected animal across states with an average of Rs 1236. It may be noted that loss in draught animal power and additional feed cost during the post-recovery period have not been considered in estimating the total loss.

At the national level, economic loss due to LSD is estimated at Rs 76.07 billion (Table 2). Loss in milk production comprises over 90% of it. The cost of treatment contributes 6.4%, and the mortality rate is 3.1% to the total loss. In all the states, milk loss comprises the main component of the total economic loss but it varies widely. Expectedly, Rajasthan accounts for 40% of the total loss, followed by Maharashtra (16%), Punjab (12%) and Karnataka (10%) (Figure 2).

Table 2. Economic loss due to LSD in cattle, 2022-23 (Rs million)

State/UT	Mortality loss (A)	Morbidity loss (B)	Treatment cost (C)	Total loss (A+B+C)
Rajasthan	629.59	27772.63	1709.85	30112.07
Maharashtra	550.36	10533.02	912.67	11996.06
Punjab	328.44	8957.07	216.21	9501.71
Karnataka	398.43	6833.58	499.91	7731.91
Gujarat	67.26	2869.52	174.41	3111.20
Haryana	37.39	2704.36	141.95	2883.70
Himachal Pradesh	170.47	2083.87	159.88	2414.22
Assam	19.99	1275.88	555.45	1851.31
Uttar Pradesh	7.46	1451.54	122.48	1581.48
Uttarakhand	16.18	899.72	75.09	990.98
Kerala	16.05	800.03	26.55	842.64
Odisha	0.78	279.23	88.22	368.23
Madhya Pradesh	4.60	255.33	37.88	297.81
Northern Eastern Region (NER)	76.64	176.27	31.64	284.55
Other States (OS)	3.84	314.14	33.39	351.37
Union Territories (UT)	34.93	1626.41	88.66	1750.00
Total	2362.41	68832.60	4874.24	76069.25

Economic impact of vaccination

The LSD, being a transboundary disease, needs to be controlled at its origin as to contain its spatial spread. At the time of the outbreak of LSD in August 2022, the country had no vaccine available for its control. Recognizing its significant damage potential, the Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India launched an immunization campaign using the 'goat pox vaccine'. Besides, it also advocated use of several other prophylactic measures such as (i) isolation of healthy animals from infected ones, (ii) restriction on movement of animals in grazing lands, (iii) bio-security and vector control through insecticides, repellents, and other chemical agents, (iv)

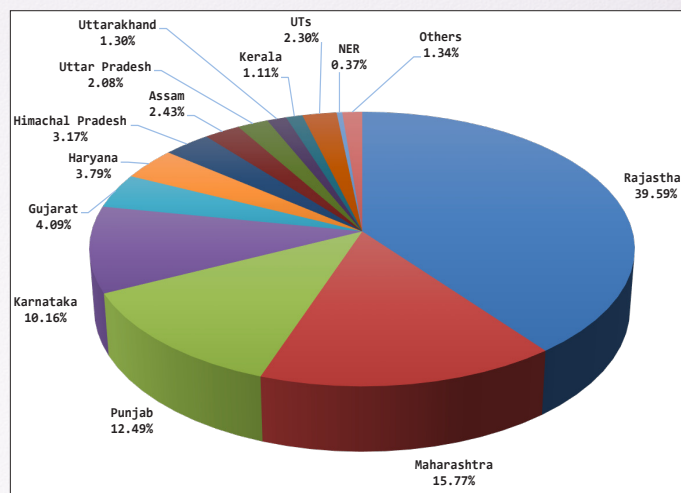


Figure 2. % share of states in total economic loss

cleaning and disinfection of premises at a regular interval, (v) proper disposal of dead animals, (vi) sanitary measures after handling infected animals, their bedding material, saliva and other secretions, (vii) restriction on entry of visitors in animal sheds, (viii) creating awareness about disease, and (ix) surveillance in and around infected zones.

In collaboration with state governments, the Government of India launched a vaccination campaign, and by the end of December 2023 about 181.93 million cattle had been vaccinated. The cost of vaccinating an animal (including the price of vaccine and cost of its administration) is estimated at about Rs 15. Thus, by spending Rs 2729 million on prophylactic vaccination of 181.93 million cattle, the country could avert a potential direct loss of Rs 58930 million (Table 3). Expectedly, Rajasthan benefitted the most from vaccination, followed by Maharashtra, Karnataka, and Punjab.

Policy implications

India has a huge population of dairy animals raised primarily in mixed farming systems by small farm households to earn livelihoods. Hence, they will be the most affected by any threat to livestock production. Our findings provide a strong economic justification for prophylactic management of LSD. A few important policy issues that merit attention are as follows.

Target achieving herd immunity: Herd immunity is considered to have been achieved if at least 85% of the population of a species is vaccinated continuously for three years. In the case of cattle, if herd immunity is achieved, the country can avoid a potential loss of Rs 152.1 billion by spending Rs 7.5 billion. Towards this, there is a need to launch a nationwide vaccination campaign strongly emphasizing the doorstep delivery of vaccination and other services.

Develop an extension system: Livestock extension, essential for creating awareness among farmers regarding

Table 3. Economic loss avoided due to vaccination, 2022-2023 (Rs million)

State/ UT	% population affected, 2022	% population affected, 2023	Cost of vaccination, 2022 (A)	Cost of vaccination, 2023 (B)	Total cost of vaccination C=(A+B)	Loss avoided, 2022 (D)	Loss avoided, 2023 (E)	Total loss avoided F=(D+E)	Net benefits G=(F-C)
Rajasthan	11.2	0.0	162.9	145.5	308.4	23015.9	0.2	23016.1	22707.7
Maharashtra	3.4	1.3	213.5	223.8	437.2	9144.6	3837.7	12982.2	12545.0
Karnataka	3.9	0.0	151.7	118.9	270.6	9690.6	18.5	9709.0	9438.5
Punjab	6.9	0.0	13.8	37.5	51.3	3398.1	0.0	3398.1	3346.8
Haryana	6.0	0.0	26.1	0.0	26.0	2525.9	0.0	2525.9	2499.9
Gujarat	1.8	0.0	94.8	38.3	133.0	2071.4	0.4	2071.8	1938.8
Uttar Pradesh	0.6	0.1	236.8	239.6	476.5	1212.2	118.2	1330.4	854.0
Himachal Pradesh	7.6	0.5	7.0	11.9	18.9	615.7	74.1	689.8	670.9
Uttarakhand	1.8	1.3	9.9	24.7	34.6	212.8	386.4	599.1	564.5
Kerala	0.6	1.0	0.5	13.4	13.9	8.8	336.8	345.7	331.7
Odisha	0.4	0.1	71.3	152.0	223.3	147.0	92.9	239.9	16.6
Assam	0.0	4.1	0.0	15.0	15.0	0.0	164.4	164.4	149.4
Madhya Pradesh	0.1	0.1	52.3	151.4	203.6	39.4	49.5	89.0	-114.7
Northern Eastern Region (NER)	0.0	1.0	1.0	6.4	7.4	0.0	139.4	139.4	132.0
Union Territories (UT)	2.7	0.0	29.5	0.0	29.5	1409.2	0.0	1409.2	1379.7
Other States (OS)	0.0	0.0	150.7	329.0	479.7	80.1	140.3	220.4	-259.3
Total	1.7	0.4	1221.7	1507.3	2729.0	53571.7	5358.8	58930.5	56201.5

sanitary and phytosanitary measures such as disinfecting animal sheds, quarantining diseased animals, proper disposal of dead animals, and restrictions on control of movements of infected animals, is weak. At present, spending on livestock extension comprises only about one percent of the total public expenditure on livestock sector. Hence, investing in livestock extension is imperative for cost-effective disease management.⁶

Strengthen surveillance and monitoring: More emphasis is required to strengthen the country's disease surveillance and monitoring systems to generate real-time information for proactive policy decisions and actions to prevent and control diseases.

Vaccinate other species potentially prone to LSD: Buffalo is reportedly more resistant to LSD infection. However, given its significant contribution to milk (45%) and meat (18%) production⁷, the need for prophylactic vaccination of buffaloes should not be undermined. Buffalo meat is one

of India's flagship exports, accounting for approximately 8% of the global exports of bovine meat, and meat export will be significantly affected in the absence of preventive management of the disease. The likely cost of achieving herd immunity through the vaccination of 109.85 million buffaloes is estimated at Rs 4.20 billion.

Acknowledgment

We gratefully acknowledge the Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India for sharing data, and the officials of States' Animal Husbandry Department for sharing their insights into LSD-induced losses. Our sincere thanks are due to Dr Abhijit Mitra, Animal Husbandry Commissioner, and his predecessor, Dr Parveen Malik, Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, for their valuable comments and suggestions on an earlier draft of this piece of work. Technical assistance of Mrs Sonia Chauhan, Chief Technical Officer, is greatly acknowledged.

⁶ Birthal, P.S., Hazrana, J., and Saxena, R. (2023). Livestock Farmers' Information Needs, Search Behaviours, and their impact: Lessons for Extension policy. Policy Paper 38, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

April 2024