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Sanjeeva Kumar M Topan

Assistant Professor, SRDDL
Institute of Animal Health &
Veterinary Biologicals,
Karnataka Veterinary Animal &
Fisheries Sciences University
(KVAFSU), Hebbal, Bengaluru,
Karnataka, India

Special report on steep increase in lumpy skin disease outbreaks and deaths in India

Sanjeeva Kumar M Topan

Abstract

Lumpy skin disease is an economically important, notifiable, emerging, transboundary animal disease caused by Lumpy skin disease virus (LSDV) in the family Poxviridae. India reported its first outbreak of LSD during late 2019, since then LSD virus continued to percolate into the susceptible animal population through arthropod vectors causing pockets of outbreaks till 2020-21 with moderate morbidity and negligible mortality. However, from mid-2022, many states have evidenced a steep increase in LSD outbreaks, worst hit being North-western states. The disease rapidly spread to most of the states with in a short period. Pan India outbreaks with high morbidity and alarming mortality negatively impacted animal husbandry activities and challenged control and containment efforts in the initial stages. The limited spread and lower LSD outbreaks observed from 2019 to late 2021 may be because of widespread COVID-19 lockdowns that indirectly restricted animal movements and crowding due to less human activities. However, a steep increase in LSD outbreaks from mid-2022 may be attributable to prolonged moist humid climatic conditions that favored vector population and virus survival in the environment, possibly facilitating effective virus spread among susceptible population.

Keywords: LSD deaths, arthropod vectors, COVID-19 pandemic, climatic conditions

1. Introduction

Lumpy skin disease is an emerging, transboundary, viral infectious disease caused by Lumpy skin disease virus (LSDV) in the family Poxviridae. The disease is synonymously known as “LSD”, “Pseudo-urticaria”, “Neethling virus disease”, “exanthema nodularis bovis” and “knopvelsiekte” (Al-Salihi & Hassan, 2015) [2]. LSD is a non-zoonotic, vector borne disease with limited host range, restricted to ruminants viz. cattle and water buffaloes. The arthropod vectors are responsible for the mechanical transmission of the disease include biting flies, mosquitoes and ticks (Tuppurainen *et al.*, 2011, 2013a, 2013b) [18]. Natural infection of LSD in small ruminants like sheep and goats is not reported despite close association with LSD infected cattle and buffaloes. Lumpy skin disease was first reported from Zambia in 1929 (Sanz-Bernardo *et al.*, 2020) [12]. In the succeeding five decades LSD circulated in African continent, especially in the sub-Saharan countries and rapidly gained “endemic” status before transboundary transmission out of Africa to Egypt in 1989. In the subsequent years, Middle Eastern countries reported LSD outbreaks. European country reported its first LSD outbreak during 2013. European countries like Turkey evidenced LSD outbreaks from 2013-2019), Azerbaijan (2014), Armenia (2015), Greece (2015-2017), Russia (2015-2019), Albania (2016-2017), Bulgaria (2016), Montenegro (2016), Serbia (2016), Former Yugoslav Republic of Macedonia (2016-2017), and Georgia in 2016 and 2018. In recent years LSD is rapidly expanding its geographical territory in Europe and Asia and is being reported from many hitherto free countries. South Asian countries, countries like China, Bangladesh and India reported LSD outbreaks around the same time in mid-2019 (Lu *et al.*, 2020; Sudhakar *et al.*, 2020) [7, 15]. India, reported its first LSD outbreak from Odisha state. The outbreak coincided with monsoon season with wet, humid climate and high vector density. The first incident started from Khairbani, Betnoti, Mayurbhanj districts of Orissa, subsequently, the infection was reported from Patalipura, Rajendrapur, Bhandaripokhari, Bhadrak districts of Odisha, with laboratory confirmed LSD positive cases. First outbreak experience revealed below 10% morbidity and importantly, no mortality. Genetic homology of LSD virus from these outbreaks was linked to South African NI2490/KSGP-like strains rather than European strains (Gupta *et al.*, 2020) [5].

Corresponding Author:

Sanjeeva Kumar M Topan

Assistant Professor, SRDDL
Institute of Animal Health &
Veterinary Biologicals,
Karnataka Veterinary Animal &
Fisheries Sciences University
(KVAFSU), Hebbal, Bengaluru,
Karnataka, India

Subsequently, aggressive outbreaks of LSD were observed from several Indian states like Andhra Pradesh, Punjab, Haryana, Gujarat etc. with far higher morbidity and mortality than initially observed. Besides, LSD significantly impacts farmers economy by way of production losses and hide damages, therefore, understanding the epidemiology of such an economically important exotic disease is crucial for timely planning and effective implementation of disease management strategies.

1.1 Biology of lumpy skin disease virus

The Poxviridae family is divided into two subfamilies Chordopoxvirinae, these infect vertebrates, while,

Entomopoxvirinae, viruses infect insects. Poxviruses are known to cause disease in most domestic animals, baring dogs. Poxviruses consists of large and complex genome with a single, linear DNA (ds DNA) that codes for approx. 200 proteins. Poxviruses including LSDV complete their replication cycle in the host cytoplasm. viral enzymes present in the virus particle aid in nucleic acid metabolism and genome replication. Virion assembly is fairly a complex process and is not well understood, finally new virions are released through budding. Poxviruses possess nearly 10 major antigens and a common nucleoprotein antigen, a reason for cross-reactivity among species (Burgers *et al.*, 2014) ^[4].

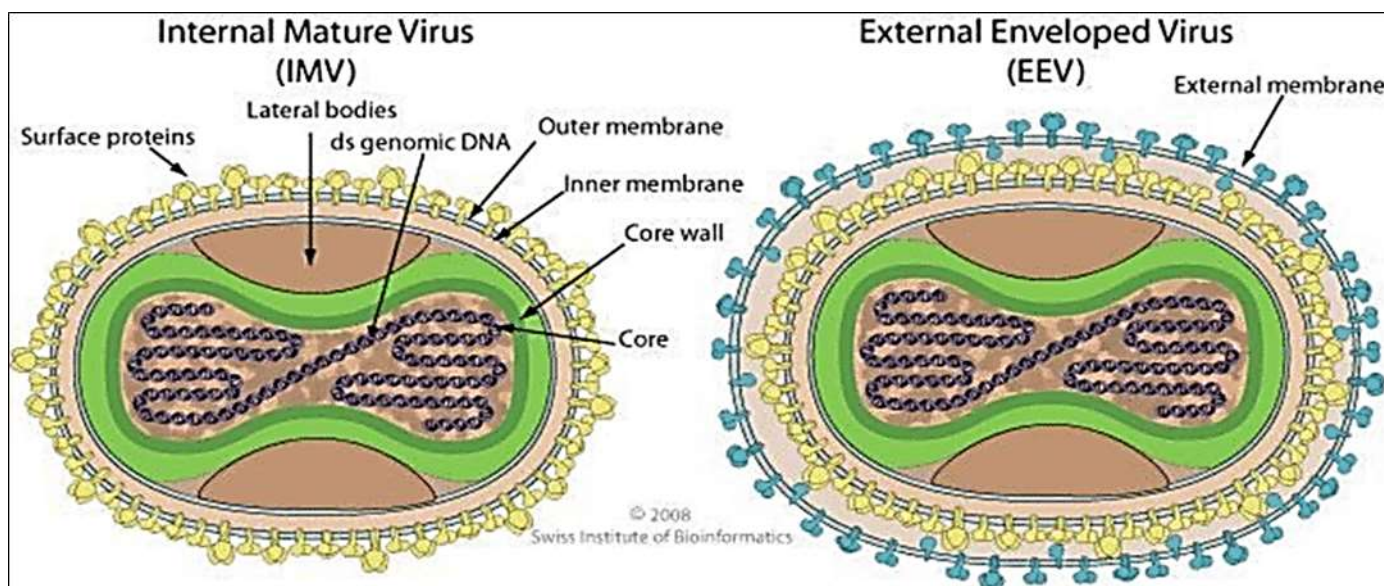


Fig 1: Morphological architecture of Lumpy skin disease virus (Farah Gumbe, 2018)

Lumpy skin disease virus is a member of genus Capripoxvirus genus along with sheeppox and goat pox viruses, within the chordopoxvirinae. LSDV genome measures about 151 kbps and contains a central coding region bound by identical 2.4 kbp-inverted terminal repeats and 156 putative genes. Genomic comparisons studies have established that LSDV is closely related to other members of the Chordopoxvirinae, however the virus has a unique complement of genes that regulate viral host range and virulence (G.F.El-Bagoury,E.M. El-Nahas,A.S. El-Habbaa, 2009) ^[6]. The LSD virus encodes 30 homologues proteins that form structural or non-structural proteins and these are antigenically and genetically closely related to sheep pox virus (SPPV) and goat poxvirus (GTPV) with nucleotide sequence homology of upto 96% between species (Mulatu & Feyisa, 2018) ^[15]. LSDV is considerably stable virus and can sustain harsh climatic conditions for longer periods. LSD virus can survive at ambient temperature up to 35 days, and at least 18 days in air-dried hides. However, the virus is susceptible direct sunlight exposure and detergents containing lipid solvents, but in dark environmental conditions, such as contaminated animal sheds, it can persist for several months. The virus can be inactivated at temperature of 55 °C for 2 hours and 65 °C for 30 minutes. In contrast it can be recovered from skin nodules kept at -80 °C for 10 years and infected tissue culture fluid stored at 4 °C

for 6 months. It is susceptible to highly alkaline or acid pH but, no significant effect observed at neutral pH. The virus is susceptible to commonly used chemical agents like, ether (20%), chloroform, formalin (1%), phenol (2% for 15 minutes), sodium hypochlorite (2-3%), iodine compounds (1:33 dilution) and quaternary ammonium compounds (0.5%) (Gupta *et al.*, 2020) ^[5].

2. Transmission epidemiology of LSD in Asian countries

Lumpy skin disease was endemic and restricted to African continent during 20th Century. unfortunately, the virus rapidly expanded to newer geographical locations in middle Eastern and European reasions during 2012-2018 LSD epidemics (Sanz-Bernardo *et al.*, 2020) ^[12]. Since 2015, LSD outbreaks have been recorded in several new territories in the Northern hemisphere causing the disease in countries including Iran, Iraq, Jordan, Turkey, Russia, Kazakhstan, Greece, Albania, Serbia and Bulgaria (Sanz-Bernardo *et al.*, 2020; Sprygin *et al.*, 2020) ^[12, 14]. The unprecedented incursions of LSD into newer territories warrants the need for a global collective efforts for implementation of stringent control and containment strategies (Aleksandr *et al.*, 2020) ^[3]. World organisation for animal health statistics indicate reporting of LSD outbreaks by most Asian countries in the last five years period. (Figure-2).



Fig 2: Temporal distribution of LSD virus in Asian countries from 2018 to 2022
(Data source: <https://wahis.woah.org/#/dashboards/country-or-disease-dashboard>)

2.1 Role of arthropod Vectors in LSDV transmission

Vector mediated transmission is considered as the main route of transmission. The incidence of LSD in endemic countries, tends to rise with the increase in the vector population mostly with the onset of rainy season (Mulatu & Feyisa, 2018) [15]. Virus laden blood feeding flies/insects can deliver the virus for long distances without the animal movement. A decrease in the vector population during hot and dry weathers, results in steep reduction in the number of LSD outbreaks emphasizing the role of arthropod vectors in the disease transmission (Kondela AJ, Centres HM, Nyange JFG, 1984; Nawathe et al., 1982) [8, 16]. The blood feeding ticks like *Amblyomma* spp., *Rhipicephalus decoloratus*, *Rhipicephalus appendiculatus* and *Amblyomma hebraeum* (Lubinga, Clift, et al., 2014; Lubinga, Tuppurainen, et al., 2014; Tuppurainen et al., 2013a, 2013b) [8, 9, 16] and the biting flies (*Stomoxys calcitrans* and *Biomyia fasciata*) and mosquitoes (e.g. *Culex mirificens* and *Aedes natrionus*), are the major vectors that are

involved in mechanical transmission of disease.

Experimental studies have concluded a low rate of transmission by direct route. whereas, some investigations contradict the observations, stating that direct contact of animals has no role in transmission of LSD virus (Magori-Cohen et al., 2012) [10]. Virus laden body secretions and excretions like, nasal secretions, saliva, and lachrymal secretions may all be potential indirect source of virus for susceptible animals through common feeders and water troughs. It is established that infected bulls may shed virus in semen ejaculates (Tuppurainen et al., 2005) [19] an important consideration if the bulls are used for breeding purpose. The semen from LSD positive bulls should be used only once the bull tests negative after recovery. Usage of single syringe needle during mass vaccination camps can be an important means of iatrogenic transmission of virus from infected to healthy animals. The summary of transmission of virus is shown in Figure-3.

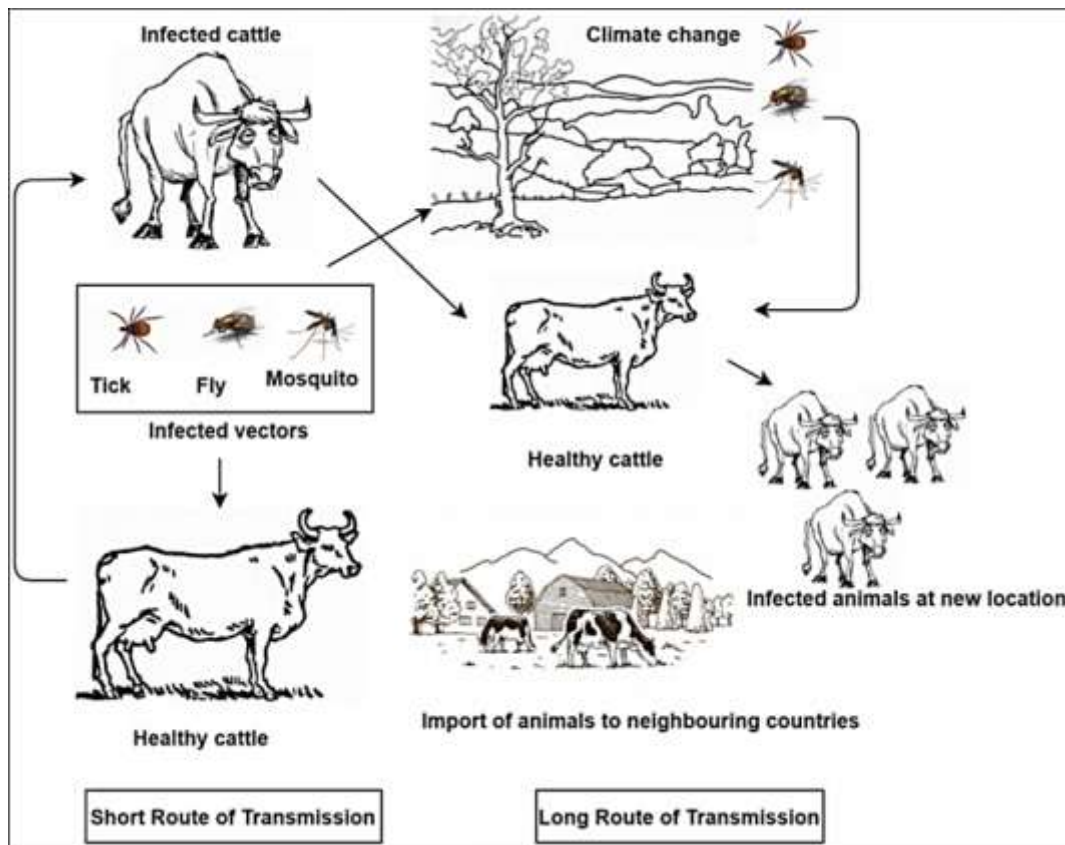


Fig 3: Summary of transmission of LSD virus (Gupta et al. 2020) [5]

3. Lumpy Skin disease outbreaks: Indian context

Hitherto, published data suggests that LSD is a disease of high morbidity and low mortality (Abutarbush *et al.*, 2015) [1]. Clinically, the disease is characterized by short span of raised body temperature or fever, swelling of superficial lymph nodes, appearance of circumscribed firm nodules (lumps) on skin leading to emaciation, limb and dewlap oedema, reduction in milk yield, infertility, poor hide quality, reduction in draft power of animals and reproductive inefficiency due to abortions and infertility. Overall, LSD affects the productivity of the animal hence impacts on the economic value of animal. India reported its first sporadic outbreak of LSD from Odisha state from the eastern region of the country during August 2019 (Gupta *et al.*, 2020) [5].

3.1 Emergence of LSD virus in Indian states

It is speculated that LSD might have entered India through porous borders with Bangladesh & China (Kumar *et al.*, 2021) [6] where LSD outbreaks were reported during the same time. The spread of LSD may be likely due to illegal movement of infected livestock and vector swarming across the borders. From the first epicenter, LSD gradually spread to the adjoining new districts and states in the country. LSD

cases were reported from Andhra Pradesh, Madhya Pradesh, Kerala and Assam in 2020-21 (Pandey *et al.*, 2021; Shen *et al.*, 2022) [11, 13]. On the north-western frontiers, the Kutch region of Gujarat reported the first outbreak of LSD during 2022. Subsequently, the disease was reported from Rajasthan and other northern states of Punjab, Haryana, and Himachal Pradesh (USDA 2022 report of August 12 2022). As per the GoI, DADF data, LSD rapidly spread to 251 districts spanning 15 states in the country and affected over two million animals by the end of September-2022. The states that are affected due to severe outbreaks of LSD included, Gujarat, Rajasthan, Punjab, Uttarakhand, Himachal Pradesh, Madhya Pradesh, Jammu & Kashmir, Uttar Pradesh, Haryana, Maharashtra, Goa, West Bengal, Andhra Pradesh, Karnataka, Delhi, and Bihar. Further, it was estimated that out of the affected animals, at least over 110,000 succumbed to the disease by October (BBC, October 19 2022). Certain observations suggest, two-fold increase in the mortality within a span of three weeks' time period, despite govt efforts in controlling the disease. Sudden and widespread outbreaks of LSD have remarkably impacted farmers economy hence a disease of potential concern to the farmers.

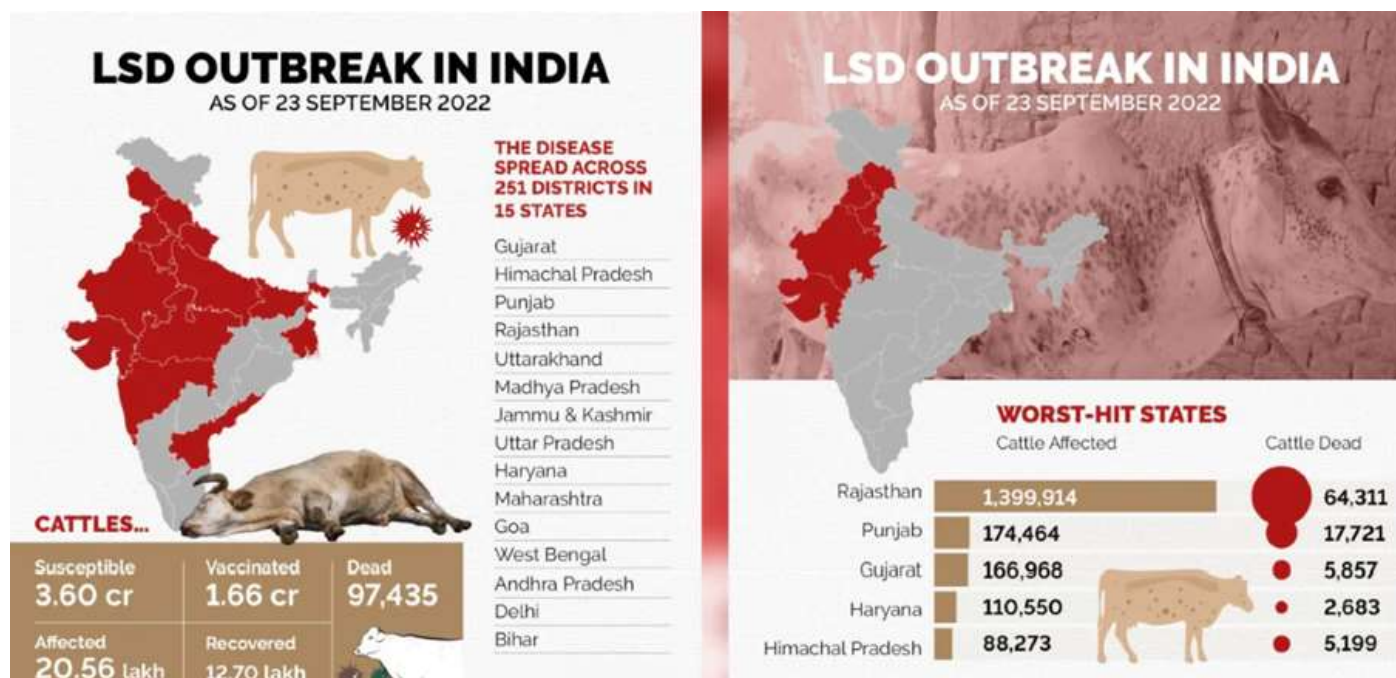


Fig 4: Summary of LSD outbreaks till September 2022 (Picture Credit: LSD in India; 2022)

<https://www.moneycontrol.com/news/photos/india/lumpy-skin-disease-infesting-cattle-in-india-heres-all-you-need-to-know-9259041.htm>

The states like Gujarat, Himachal Pradesh, Punjab, Rajasthan, Uttarakhand, Madhya Pradesh, Jammu and Kashmir, Uttar Pradesh, Haryana, Maharashtra, Goa, West Bengal, Andhra Pradesh, Delhi and Bihar alone accounted for an about 3.60 crore susceptible population at the time of outbreak. It is to be noted that authorities have vaccinated approximately 50-55% of susceptible population by the end of September-2022. The leading states that reported highest mortality were, Rajasthan, Punjab, Gujarat, Himachal Pradesh and Haryana. The episodes of LSD started in Rajasthan state during July-2022, by September all 33 districts in Rajasthan reported LSD. Rajasthan government reported that about one lakh animals

affected across the state and Bikaner district (84,369) itself accounted for the highest number of lumpy skin disease outbreaks as on September-2022. Similarly, Southern states of Karnataka, Tamil Nadu, Telangana Kerala all reported steep increase in LSD outbreaks during August-December-2022 period. Control and containment measures including mass vaccination campaigns (with Goat pox vaccine) against LSD were taken on war footing basis in all the affected states, which helped to bring back the situation under control. Several states announced, compensation for LSD deaths which also relieved the farmers to greater extent.

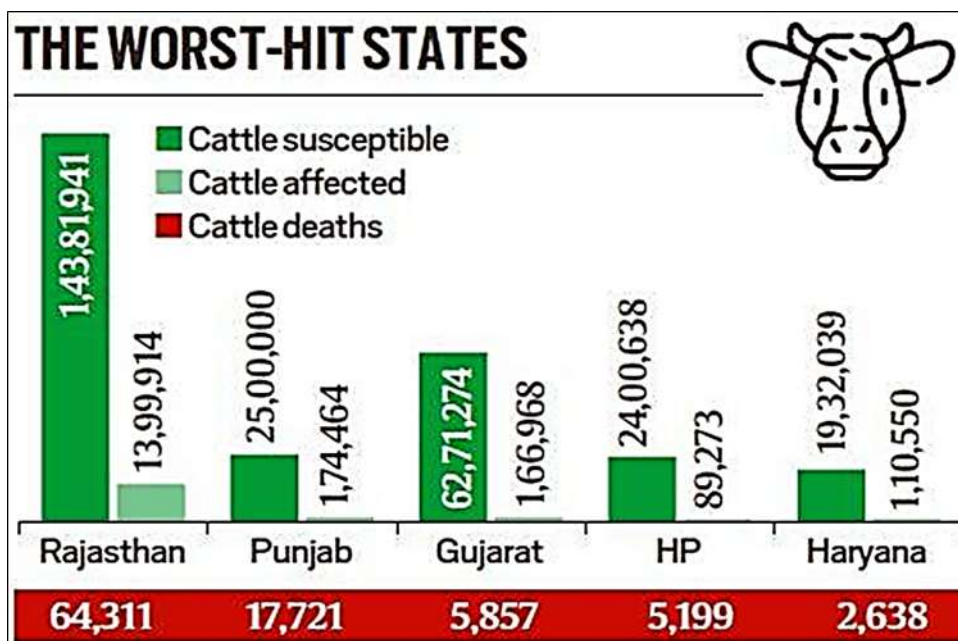


Fig 5: State wise comparative data LSD deaths

Source: <https://indianexpress.com/article/india/lumpy-skin-disease-punjab-haryana-hp-together-see-over-25000-deaths-8172890/>



Fig 6: Pictorial illustrations: Image a-Examination of LSD affected animal. b-Suffering LSD infected animals (Photo: Praveen Jain/ ThePrint). c- Mass burial of LSD diseased animal. d- Load of carcasses being carried for disposal. (c&d image source: Photo: Vikas Choudhary / CSE <https://www.downtoearth.org.in/news/health/wild-spread-of-lumpy-skin-disease-in-rajasthan-may-have-been-triggered-by-climate-change-85210>)

3.2 Plausible reasons for aggravated LSD outbreaks from August-2022

3.2.1 COVID-19 Pandemic restrictions: Although, the first episodes of LSD outbreaks started way back in 2019-20, but a detrimental outbreak was only recorded from august-2022 onwards. As India has experienced global pandemic of COVID-19 during 2019-20, there were lot of preventive measures like movement restriction, prevention on gatherings and widespread lockdowns imposed across the country. Imposition on people’s gatherings and movement restriction due to lockdown, in a way indirectly controlled domestic animal movement and crowding in the grasslands. This in turn might have greatly restricted the transmission of lumpy skin disease from infected to susceptible animals during 2019-21. Possibly this may be the reason for observing only

pockets of LSD outbreaks during 2019-21 period.

3.2.2 Climatic influence: Second and most important factor is that, in most parts of country including southern states, the monsoon rains received during 2022 was fairly higher compared to preceding years. The rains and the moist weather persisted for longer months than usual, without any bouts of intermittent dry weather. This phenomenon of prolonged wet humid and moist climatic conditions are conducive for both vector abundance and virus survivability in the environment. These complementing factors may have favored both vectors and LSD virus survival leading to enhanced disease transmission. Biting by a naïve arthropod vector to an LSD infected animal will make arthropod vector to get infected, thus precipitously increasing the virus-carrying population.

Previous studies also attributed changing climatic conditions as an important factor that influence spread of LSDV in the population (Tuppurainen *et al.*, 2013a) ^[16], since changes in both rainfall and temperature may influence the distribution and abundance of disease-causing vectors.

4. Control and containment strategy and vaccination

As lumpy skin disease is a notifiable disease, one has to strictly follow the GOI advisory for effective control and containment of the disease. Important control measures are enlisted below for implementation in case of disease incidence.

- a) Immediate isolation of sick/infected animals from the healthy animals.
- b) Any animal suspected of febrile nodular skin disease should not be introduced into the unaffected holding or farm, also avoid common grazing of healthy & affected animals.
- c) Efforts should be made to reduce the vector population in affected areas (flies and mosquitoes). Unaffected animal should be applied with insect repellent sprays or creams (ticks, flies, mosquitoes, fleas, midges) to minimize mechanical transmission of LSD.
- d) Ensure strict control of animal movement from affected areas to disease free areas and to local animal markets). Trade of live cattle, arranging large animal gatherings should be banned immediately in the affected areas.
- e) Thorough cleaning and disinfection of affected personnel, premises and contaminated vehicles plying through the affected animal holdings should be carried out with appropriate chemicals/disinfectants [Ether (20%), chloroform, formalin (1%), phenol (2%/15 minutes), sodium hypochlorite (2-3%), iodine compounds (1:33 dilution), quaternary ammonium compounds (0.5%)].
- f) Stray animal movement should be controlled.
- g) Prophylactic vaccination should be carried out with available LSD or GPV vaccines.

4.1 Awareness campaign

Awareness campaign regarding the clinical signs and production losses due to LSD should be organized among stake holder. Farmers should be sensitized to report to the veterinary authority immediately when suspected cases are noticed.

4.2 Future ready preparedness packages

Early warning signals are key factors in mitigating any eventuality, same can be applied even in the implementation of disease control strategies. Early warning signs of disease or sporadic cases should be viewed seriously and control measures implemented immediately. The supply chain should be well established for purchase of essential medicines and vaccines in emergency. Biosecurity is an integral part of farm activities; adequate farm biosecurity should be implemented to check infection entry in to the premises. Co-ordination with the line departments is an essential strategy for successful implementation of disease control strategy. Finally, public awareness is the essential for taking up primary control measures at farmers level, therefore, farmers should be educated to deal with suspected infectious disease incidence and intimate veterinary authorities on priority.

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