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Lumpy Skin Disease: An Emerging Concern in Pakistan and its Impact on National Economic Loss

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ABSTRACT

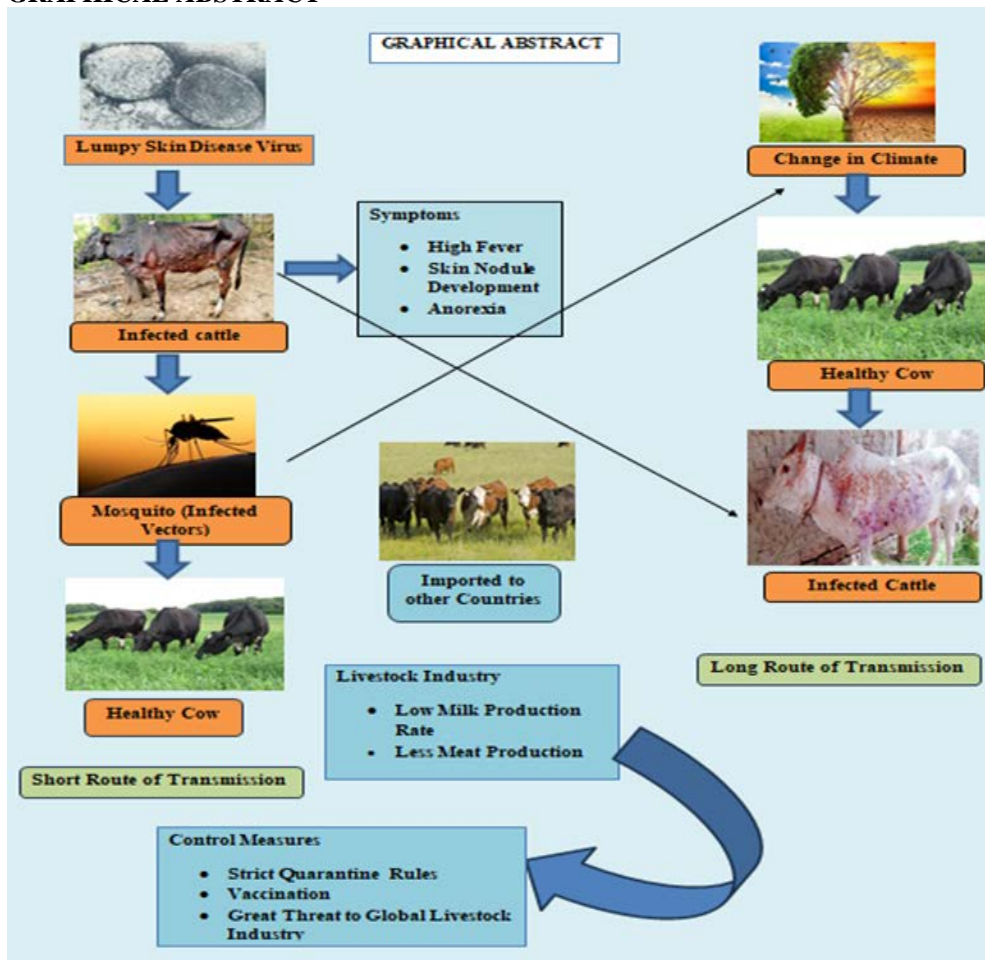
Lumpy Skin Disease (LSD), an emerging viral infection of cattle and buffalo, poses significant challenges to the livestock industry in Pakistan. Symptoms of this disease include enlarged appearance of lumps, high fever, discharge from the eyes and nose, and loss of appetite. The incubation period of this virus in cattle is approximately 28 days, as per the report of the Food and Agriculture Organization (FAO). This viral infection spreads through direct contact among herds. The World Organization for Animal Health (WOAH) and the FAO both warn that the spread of illnesses could lead to serious economic losses. A considerable financial loss in this industry is due to the mortality rate, reduced milk and meat production rate, and increasing management and treatment expenses. Generally, the best administrative approach to treating this disease is vaccination, which is also an economically effective strategy. This review aims to provide insights into the symptoms, risk factors, control, and disease administrative strategies, economic loss associated with Lumpy Skin Disease, and the potential role of vaccination in future disease management strategies.

Keywords: cattle and buffalo, mortality, traditional measures, vaccination, viral infection

Highlights

- An emerging viral infection, Lumpy Skin Disease (LSD), in cattle and buffalo has affected the livestock industry in Pakistan.
- Symptoms in afflicted animals include enlarged appearance of lumps, a high fever, discharge from eyes and nose, and loss of appetite.
- Challenges include high mortality rate, reduced milk and meat production.
- This study analyzes various administrative measures to control infection in animals.

GRAPHICAL ABSTRACT



1. INTRODUCTION

Lumpy Skin Disease (LSD) is caused by a pathogen known as 'Capripox', as shown in figure 1, that affects cattle and buffalo exclusively. LSD initially appeared in Zambia in 1929. Initially it was thought to result from either toxicity or an allergy due to insect bites. In 1949, almost 8 million cattle were affected by a panzootic infection in South Africa, causing massive economic losses. LSD expanded across South Africa from 1950 to 1980, affecting cattle in Sudan, Somalia, Cameroon,

Tanzania, and Kenya [1]. The LSD epidemic appeared for the first time in 1989 in Israel. This outbreak was the very first occurrence of LSD outside of the African continent [2]. It was believed to be the outcome of infested *Stomoxys calcitrans* being carried via wind from Ismailia in Egypt. In the past 10 years, LSD cases have been reported in Middle Eastern, European, and West Asian regions. There is a growing concern about the potential for the further spread of this disease to other parts of the world [1, 3].

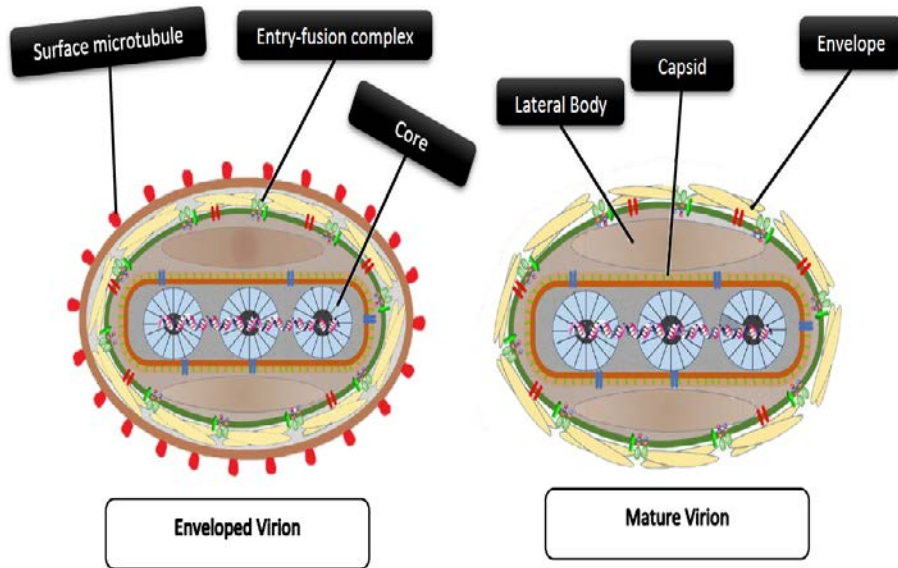


Figure 1. Structure of the Capripox Virus

1.1. Transmission

The transmission of LSD is multifactorial, with the virus capable of being transmitted through various means. Direct contact, involving exposure to aerosols and bodily fluids such as semen, is one mode of transmission. Additionally, arthropod vectors can indirectly disseminate the virus [4]. The vectors that have been implicated in poxvirus transmission include *Musca domestica*, *Aedes aegypt*, *Amblyomma hebraeum*, *Die Arachniden*, and *Stomoxys calcitrans* [5].

1.2. Risk Factors Associated

LSD is caused by the Capripox virus, and its distribution appears to be spreading due to various factors such as the insufficient availability of effective vaccines, deprivation among farming communities in the disease-prone region, and the proliferation in the trade of live animals, both lawful and illicit, coupled with the effects of climate change [6].

In 2022, epidemic LSD caused more than 6,999 cattle deaths in Pakistan. A same situation was reported in India, with over 80,000 cattle deaths attributed to LSD (NDTV, 2019). Currently, no defined antiviral drugs are available to treat Lumpy Skin Disease, although preventive measures can be taken to limit the spread of this disease [2].

1.3. Clinical Symptoms

Cattle acutely infected with LSDV may experience a fever that exceeds 41°C for up to a week. Additionally, all lymph nodes present on the surface of the cattle's skin become enlarged, and lactating cattle may experience a reduction in milk yield also shown in Figure 2. Lesions begin to mature on the body, typically on the head, neck, udder, scrotum, vulva, and perineum, approximately after 7 to 19 days of infection in cattle [2, 7].

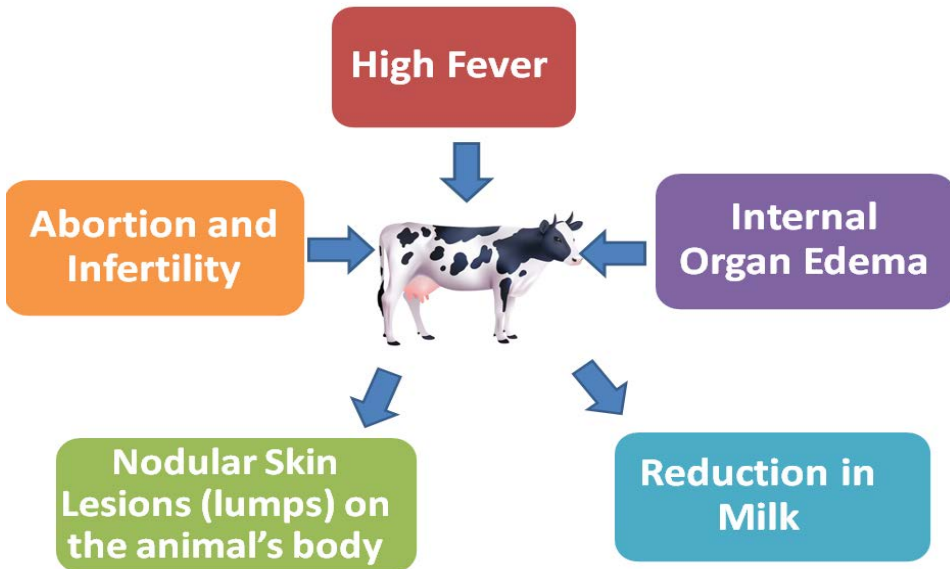


Figure 2. Clinical Signs of LSDV in Animals



Figure 3. Animals Affected by the Virus Show the Formation of Nodes

1.4. Epidemiological Situation

Globally, the spread of Lumpy Skin Virus disease in various regions of the

world, resulting a significant loss in the livestock industry, as shown in Figure 4.

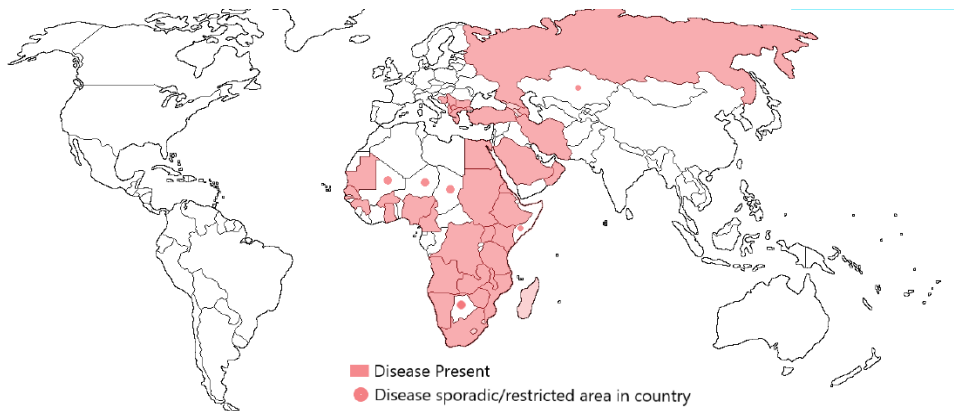


Figure 4. Global Situation of the Lumpy Skin Disease [FAO 2016]

In Pakistan, Sindh and most regions of the Punjab are highly affected by LSD, compared to other provinces. The livestock department of Sindh initiated an investigation on November 8, 2021, in response to an unknown skin ailment affecting cattle that rapidly proliferated across various areas of the Sindh province, resulting in significant cattle mortality. In 2022, Imran and his research group presented an epidemiological data that indicated a morbidity rate of 33% and a mortality rate of 0.6% in Pakistan.

The Sindh Livestock Department declared the lumpy skin disease epidemic in 2022 because of infection in approximately 36,000 cattle, which led to a mortality rate of 0.8% [8]. However, this particular study focuses on data from the Sindh province of Pakistan, and it encompasses information up to July 2022. The data in Figure 5 indicates the number of animals affected by LSD, while Figure 6 shows mortality rate in different regions of Sindh.

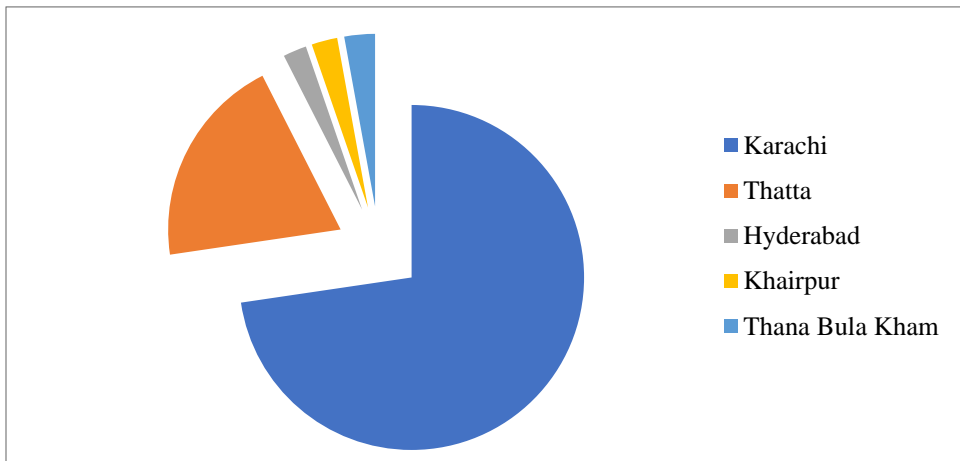


Figure 5. Number of Animals Affected in Different Districts of Sindh

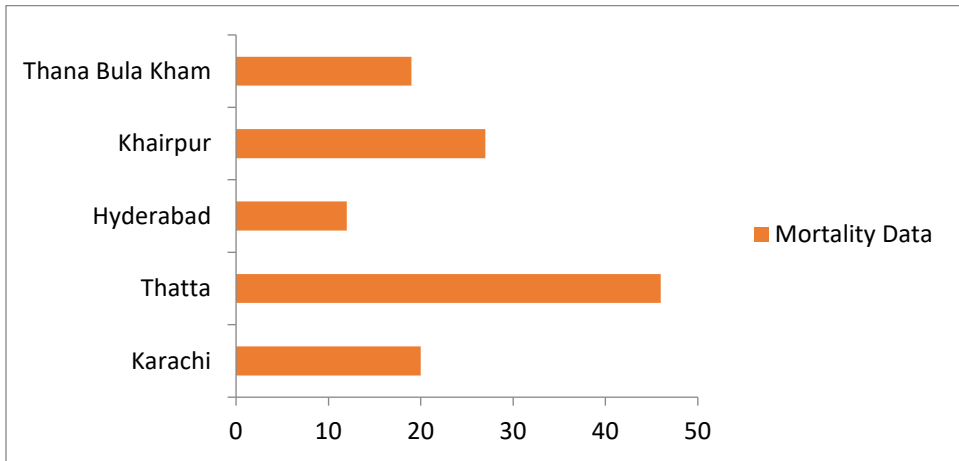


Figure 6. Showing Mortality Data in Different Districts of Sindh

In terms of case numbers, the Karachi district had the most significant incidence of lumpy skin disease, with 16,000 cases, albeit with a relatively lower mortality rate of 0.125%. In the province of Haripur, KPK, there was a substantially higher mortality rate of 67% among 300 cattle and certain buffalos, according to Dawn News on July 1, 2022.

This outbreak then spread to various regions of Punjab and caused deaths of more than 570 cows in Taunsa Sharif, 2022. Subsequently, this disease continued to spread throughout the province. Moreover, southern Punjab experienced a more pronounced impact of lumpy skin disease in cattle compared to the northern region [4]. On March 25, 2022, the LSD outbreak also occurred in the Islamabad, the capital territory of Pakistan, and presented a nationwide issue. To date, more than 100,000 animals, predominantly cattle have been afflicted by lumpy skin disease in Pakistan.

1.5. Economic Impact

The World Organization for Animal Health (OIE) categorizes LSD as a

notifiable disease due to its significant economic impact. LSD has been declared agro-terrorism because it can spread from Africa to other parts of the world [9]. Despite low mortality rates, LSD imposes substantial economic implications primarily due to its high morbidity rate. The significant losses are due to severe emaciation; hide damage, mastitis, a drop in milk production and abortions, temporary or permanent infertility in males and females, and mortality of up to 40%, although mortality rarely exceeds 3% [5].

Consequently, these losses have profound implications for herd owners, consumers, and the industrial sector alike. Due to the reduction in the quality or quantity of the animal, the effect can be seen in the overall trade of live animals and animal products. This may cause huge economic and financial losses to the meat industry, milk industry, leather industry, and other industries associated with livestock and its products. Not only industries, but poor farmers holding livestock also have to suffer from the crisis due to the disease.

In countries like Ethiopia, the total loss on account of milk, meat, beef, and power of draft, treatment, and vaccination was estimated to be 6.43 USD per head in local cattle and 58 USD per head for exotic breeds [10]. Jordan is another country that costs 27.9 British pounds per head for antibiotic treatment, vaccination, etc. [9].

In India, the reduction in milk production during the LSD breakout was estimated to be 1.5 l per farm per day for those who are keeping local breeds and 9.9 l per farm per day for those who are keeping exotic breeds of cattle.

Pakistan's livestock sector is a critical component of its economy, contributing significantly to the GDP. With a staggering number of nearly 49.6 million cattle and 41.2 million buffaloes, this sector is instrumental in the country's agricultural production. It generates Rs. 1466 billion as value addition, representing a 2.5% increase compared to previous years. The livestock sector contributes 60.6% in value addition to the overall agriculture sector and makes up 11.7% of the GDP. Moreover, it contributes 3.1% to the total exports, serving as a vital source of foreign exchange. Approximately 8 million families directly rely on livestock, with 35% to 40% of their livelihood coming from this sector, as reported by [11].

The outbreak had far-reaching economic repercussions in Pakistan, significantly destabilizing the livestock industry. In a country like Pakistan, where agriculture plays a pivotal role and boasts the world's second-largest population of cattle, the emergence of lumpy skin disease (LSD) poses a grave threat [4].

The economic consequences of such a devastating disease, especially in a nation already grappling with a fragile economy, could be profound and enduring. The

anticipated trade restrictions on livestock and a decline in the rural economy would compound the challenges faced by eight million households [12].

The extensive impact of the Lumpy Skin Disease Virus (LSDV) on over 190,000 animals in Pakistan carries significant implications for the nation's economy. Pakistan ranks as the third-largest milk-producing country worldwide, with an annual milk production exceeding 47 million tons. However, the presence of LSD in cows has led to prolonged periods of reduced milk production, resulting in a substantial decline in milk output [13]. The economic fallout from the LSD outbreak is affecting an estimated five million dairy farmers and meat vendors [14]. Cattle farmers in Karachi, Pakistan, are facing significant challenges, with milk and meat sales plummeting by 60% to 70%, despite repeated assurances from veterinary experts that LSD cannot be transmitted to humans through meat or milk. The spread of lumpy skin disease to 22 districts in Sindh has contributed to an overall decline in milk and meat sales, as noted by [15]. Furthermore, even after recovery, it will take a considerable amount of time for these affected cows to regain their previous levels of production, further impacting the country's economy .

To gauge the financial losses incurred by Pakistan, insights can be drawn from Ethiopia's experience, which reported a median financial loss of USD 375 per deceased animal and a financial loss of USD 141 in milk production per affected cow. Such losses can exert a profound influence on Pakistan's overall economic situation, emphasizing the urgency of implementing effective measures to control and mitigate the repercussions of LSDV outbreaks.

Despite a relatively low mortality rate (1-3%), the economic damage caused by the eruption of LSD remains substantial. This is due to decreased milk yields, higher rates of miscarriages, infertility, damaged hides, and fluctuations in weight, all of which have a notable impact on the economy. Moreover, this ailment hinders international trade, given its status as a highly contagious disease. The leather industry has notably suffered due to the permanent damage to hides and skins, preventing the international export of cattle and leading to enduring economic losses [16].

1.6. An Insight in Pakistan

LSD is considered a disease of high economic loss due to its effect on the trade of cattle, loss in meat production for locals, increased death rate as compared to birth rate, and large amount of vaccination of cattle [9].

LSDV is a contagious bovine disease that has caused a significant outbreak in Pakistan. In different cities of Pakistan, LSDV is spreading rapidly due to a lack of resources in farming communities and restricted access to efficacious vaccines in affected regions. The livestock industry is suffering a considerable loss due to this disease. To control the spread of LSD, different prophylactic precautions should be taken, which include vaccination, elimination of contaminated animals, prohibiting the trade of live animals, stopping animals' movement, and proper nursing care. Additionally, using antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs) can also assist in the prevention of additional infections. Testing for LSDV is recommended for bulls used in breeding, and ensuring that effective vaccines are available in endemic regions is crucial [17].

According to Salib, a combination of anti-inflammatory, antimicrobial, and antiseptic solutions and supportive therapy is effective in managing LSDV. According to the study, proper treatment can recover mastitis, myiasis, pneumonia, dysentery, and lameness within a period of 2-3 weeks [18]. However, the cost of treatment is significant and may not be available to all farmers in the country. Therefore, to minimize economic losses such as milk loss and damage to hides and skins, it is advisable to adopt preventive measures such as vaccination. Gari, conducted another study showing that vaccination can reduce the loss of milk and animal products due to fever, death, myiasis, and abortion [19]. He also found similar results, suggesting that vaccination is the best method to stop the spread of LSDV [20].

Pakistan is one of those countries that is largely affected by LSD. In Jamshoro, district of Sindh, the first case of LSDV was reported [4, 14]. Despite this, the livestock department of Sindh did not pay any serious attention until the disease affected 36,000 cattle in just 5 months, resulting in a death rate of 0.8%. The pandemic of LSD has impacted five million dairy farmers and local or imported meat sellers, causing a significant economic breakout [4]. Moreover, scientists have also found evidence that this virus can infect people if they take milk or meat from animals affected by it.

The livestock population of Pakistan comprises a mighty population of 49.6 million cattle and 41.2 million buffaloes with a 3.1 million and 1.2 million annual increment in numbers, respectively. Livestock is the largest sub-sector of the country's agricultural production contributing Rs. 1466 billion as value addition, which is 2.5% more than [12].

1.7. Clinical Administration Strategies

Prophylactic actions for LSD in epidemic situations are rarely attempted, except symptomatic and supportive treatments such as wound repair sprays and antibiotics to prevent secondary bacterial infections of skin abrasions [21, 22].

Hygiene and sanitation measures should be implemented regularly to prevent the spread of LSD. Farm sheds and equipment should be cleaned and disinfected regularly. Washing contaminated premises with disinfectants can also help us stop the transmission of the disease from spreading. The use of pest repellents and strict quarantine measures can further help to control the disease [23]. There are additional methods that can be fruitful in controlling LSD in household animals. Animal movement and grazing restrictions should be implemented to prevent the spread of the disease between different regions or farms. Infected animals should be isolated, and new animals brought to a farm should be screened and tested for LSD before being introduced. Euthanizing harshly affected animals and proper destruction of infected carcasses are essential measures to prevent the further spread of the disease [22, 24].

Raising awareness about the symptoms and signs of LSD, as well as the significance of vaccination and other control measures, is critical in educating veterinary students and professionals, farmers, herdsmen, animal traders, and truck drivers about the disease. Regular disease surveillance should be carried out to detect any new cases of LSD, and all suspected cases should be reported immediately to the local veterinary authorities for investigation and control [25]. Intrauterine insemination (IUI) can

help prevent the disease from spreading in Pakistan and globally.

Implementing these measures can significantly reduce the spread of LSD and minimize its impact on livestock populations. Disease awareness campaigns are crucial in educating stakeholders about the disease's risks, prevention, and control measures. By doing so, we can ensure that appropriate measures are taken to prevent and control LSD outbreaks effectively [22, 26, 6, 27, 23].

Farmers utilize two types of vaccines to immunize their livestock against lumpy skin disease. One is called a Sheep Pox Virus (SPPV) vaccine. Initially, Jovivac® was assembled by Jordan Bio-Industries Centre (JOVAC), while the second vaccine used was not properly labeled, and it was later discovered through PCR testing that it contained a strain of the lumpy skin disease virus (LSDV). Samples of blood and skin were collected from vaccinated cattle, and PCR was used to detect the presence of LSDV [28]. The study's results indicated that the unlabeled vaccine used for cattle vaccination was identified as a strain of LSDV through PCR analysis using both general and species-specific primers. In contrast, samples collected from cattle that had been administered the Jovivac® vaccine did not exhibit any evidence of LSDV presence. Furthermore, this study also reported that the negative responses that cattle receive after the LSDV vaccine are more severe than the ones visible after the Jovivac® vaccine is given, and are similar to scientific symptoms and symptoms discovered in herbal infections. This study highlights the importance of using appropriate and effective vaccines for the prevention of LSD in livestock. Vaccination with the Jovivac® vaccine was shown to be effective and did not cause adverse reactions in the vaccinated animals,

while the unlabeled LSDV vaccine caused severe adverse reactions [29].

1.8. Worldwide Vaccines Used

There are several vaccines used worldwide for the mitigation of Lumpy Skin Disease (LSD) in domestic animals. The easily available vaccines are based on live attenuated strains of the LSD virus that are either homologous (i.e., based on the same strain as the local outbreak) or heterologous (i.e., based on a different strain from the local outbreak). Some of the most widely used LSD vaccines include the Neethling vaccine, the Sheep and Goat Pox vaccine, and the Lumpy vax. Neethling vaccine is a homologous live attenuated vaccine that is widely used in Africa, where LSD is endemic. It is based on a strain of the LSD virus isolated from a cow in South Africa in the 1930s. The Sheep and Goat Pox vaccine is a heterologous live attenuated vaccine that is commonly used in many countries, including Europe, Asia, and Africa. It is based on a closely related virus that causes a similar disease in sheep and goats but also provides cross-protection against LSD. Lumpy vax is a commercial heterologous live attenuated vaccine developed by MSD Animal health that is approved for use in several countries, including Bangladesh and some African nations. It is based on a strain of the LSD virus isolated from a cow in Israel in the 1980s [30]. These are some of the most commonly used vaccines for LSD worldwide, but there may be other vaccines used in specific regions or countries as well.

1.9. Vaccines Used in Pakistan

In Pakistan, the most commonly used vaccine for Lumpy Skin Disease (LSD) is the homologous live attenuated Neethling vaccine. The vaccine is produced by several government and private manufacturers, including National Veterinary Laboratories

(NVL), Islamabad that produces the Neethling vaccine under the brand name "Pak-Lumpy", Biological Production Division (BPD) produces the Neethling vaccine under the brand name "Lumpyvax" and Intervet Pakistan Limited produces the Neethling vaccine under the brand name "Lumpivac".

Other LSD vaccines used in Pakistan include the heterologous Sheep and Goat Pox vaccine, which is produced by several manufacturers under various brand names, and the homologous KS-1 vaccine, which is produced by the Indian Veterinary Research Institute (IVRI) and is used in certain regions or situations in Pakistan [29].

1.10. Vaccination: A Future Management Strategy

In endemic areas, the only effective method to control the disease is vaccination [7]. Literally, due to the lack of antiviral medications available for the treatment of Lumpy Skin Disease (LSD), vaccination is considered the most suitable and effective method to prevent the spread of the disease. The recommended method of medical prophylaxis is through prophylactic immunization with either a homologous (Neethling strain) or heterologous attenuated live vaccine, as evidenced by various studies [31, 2]. In a recent effort to control LSD outbreaks in Bangladesh, the government procured a commercially available vaccine called "Lumpyvax" from MSD Animal Health [30].

Cattle and buffalo are susceptible to a viral infection known as Lumpy Skin Disease Virus (LSDV), which causes significant economic losses in dairy farming. As there are no specific antiviral medications present to cure LSD, vaccination is considered the most effective medical prophylaxis. Prevention of LSD

can be achieved through prophylactic immunization with either a homologous (Neethling strain) or live attenuated vaccine derived from a different species of animal, such as sheep or goat and, then the host species (cattle) affected by LSD. The vaccination campaign should be carried out regularly, and all animals should be vaccinated to achieve herd immunity [31, 32, 33, 6].

It is endemic in Ethiopia and significantly impacts the health and productivity of the country's bovine population. Hence, a field study was conducted to avoid putting the bovine population in contact with LSDV. Lumpy skin disease virus (LSDV) can be controlled through vaccination, avoiding movement, and culling infected and in-contact animals. However, vaccination is considered the most practical and feasible approach in resource-poor countries where LSD is endemic. Various live attenuated vaccines can be used to protect the bovine population. Moreover, two effective vaccines can help are known as sheep pox virus (such as KS1 O-180) and LSDV (Neethling strain) have been utilized to control the spread of LSD, as reported by various studies [34, 35, 26, 6].

CONFLICT OF INTEREST

The author of the manuscript has no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

DATA AVAILABILITY STATEMENT

The data associated with this study will be provided by the corresponding author upon request.

2. CONCLUSION

Lumpy Skin Disease is an emerging concern in Pakistan, especially within the livestock sector, which industry is a major sector in the country and a source of livelihood for many. Livestock industry also plays a significant role in uplifting the economy of Pakistan. Therefore, it is imperative to stop the transport of animals from one region to another without testing to prevent the spread of this disease. The most efficient method to control this disease is vaccination of cows. The utilization of control measures also aid in controlling the spread of this disease, thereby minimizing the economic loss associated with it. In this review, two attenuated vaccines, namely the sheep pox virus (such as KS1 O-180) and LSDV (Neethling strain) have been recommended for effective control of Lumpy Skin Disease.

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