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**Research Article**

# Assessing the vulnerability and economic burden of lumpy skin disease on indigenous and exotic cattle in Sindh, Pakistan

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**Abstract**

This study assesses the impact of Lumpy Skin Disease (LSD) on cattle farming practices in Sindh, Pakistan, focusing on farmers' knowledge and the direct and indirect losses incurred. The research was conducted across various regions chosen for their diverse climatic conditions, livestock farming practices, and cattle population density. A cross-sectional survey, spanning January to December 2022, involved 4221 farmers from selected districts using multistage sampling. Data on farmers' knowledge, practices, and the direct and indirect impacts of Lumpy Skin Disease (LSD) were analyzed through descriptive statistics and uni-variate logistic regression. Exotic breeds exhibited a higher vulnerability to LSD, with 57.1% of losses occurring in this group, compared to 18.0% in indigenous breeds. Exotic cattle farms experienced significant losses, with 9.2% mortality and a 22.1% decrease in milk yield. Indigenous breeds had lower mortality (5.5%) and milk yield losses (14.7%). Indirect losses due to vaccination and treatment costs were more burdensome for exotic cattle farms, with 55.2% of treatment costs and 73.7% of vaccination expenses incurred by these farms. Overall, the findings indicated the greater vulnerability of exotic cattle to Lumpy Skin Disease (LSD), with higher mortality, milk yield losses, and financial burdens for vaccination and treatment compared to exotic cattle breeds. This study demonstrated high direct and indirect losses and vulnerability in exotic cattle breeds compared to indigenous breeds, impact of the financial strategies and LSD management practices.

**Keywords** Breeds; Cattle; Exotic; Indigenous; Losses; LSD; Risk

## Introduction

Lumpy skin disease also known as knopvelsiekte, exanthema nodular bovis, Neethling virus disease, is highly economic important an infectious disease of cattle. The disease rapidly spread trans-bound regions and negatively influences cattle production. The World Organization for Animal Health (OIE), guidelines for LSD affected cattle for trade and export of live animals and/or their

products have been outlined [1]. Initial outbreaks of LSD have been reported in 2021in Pakistan, however, the disease notified and geographical distribution across African countries. The emergence of the disease produces a huge risk of transmission and control to farm animals and threat to livestock industry [2, 3]. Clinically, the disease is characterized by high temperature, production of distinctive nodules (typically forming necrotic centers and coalescing called sit-fasts) on the skin, [4] lymphadenopathy **(**lymph nodes swelling) and excessive salivation as described in 2021, by World Organization for Animal Health (WOAH) (OIE, 2012) [5]. Typically skin lesions is a visible clinical indication of LSD infections in herd and helpful for early diagnosis [6].

LSD infections in cattle cause significant health, production and economic losses that manifested in terms of decrease in meat and milk yield, damage and poor quality skin , abortion, reduced fertility (some cases permanent sterility) in male cattle, reduction in draft power of animals, disease prevention and control costs, and bio-security issues [5, 7-10]. The production and health losses needed to strategies to reduce disease severity, and control of LSD infections in cattle [11, 12]. Despite the low mortality rates due to LSD infections, it produces severe economic consequences to dairy industry. The LSD infections are not only restricted to dairy production but also associated industries including leather industry [11]. In Pakistan, the disease produced severe damages and consequences in recent years. Therefore, the present study aims to evaluate the impact of LSD infections on local cattle breeds, causing both direct and indirect economic losses and to assess herd management practices including, culling of animals, control measures, and vaccination strategies that help reduce disease's effects. In addition the study was performed to determine the impact of medium size herd and communal farming practices on the contribution of the disease.

## Materials and Methods

### Study area

The study was performed in different regions including Sukkur, Jamshoro, Umar Kot, Mirpur Khas, The Hyderabad, Thatta and Karachi of province Sindh, Pakistan, These regions of the study selected based on climatic conditions, livestock farming, cattle population density, dairy farming practices, and impact of dairy community. The geographical locations of the selected regions provide comprehensive influence of the disease perspectives in Province Sindh, Pakistan.

### Study design

A cross-sectional study was conducted from January to December 2022. A multistage sampling method was employed, selecting six districts from each region and three wards from each district based on different farming systems, geographical representativeness, accessibility, and the willingness of livestock farmers to participate after consultation with district livestock officers. Ward livestock extension officers prepared a sampling frame from the list of households, organized logistics for data collection, and employed systematic random sampling to select households.

### Inclusion and exclusion criteria

The data obtained from the Dairy farms that experienced LSD infections within 1 year. Dairy farms that have no experienced LSD infections in cattle during the past year were excluded from the survey.

### Limitations

During the survey, LSD impact on dairy cattle practices and types, potential biases may influenced data collection particularly infection outbreak history and financial losses.

**Data analysis**

Data was entered into Microsoft Excel (2013) and analyzed using Epi Info statistical package version 7.2.5.0. Descriptive statistics were used, and proportions were summarized in tables. Knowledge scores were calculated as the proportion (%) of respondents from each category of the selected variable who had knowledge of LSD signs, transmission, losses, and control, and those who perceived LSD's impact, risk of occurrence, and preventability. Univariate logistic regression models at a 95% confidence level and a 5% p-value were used to establish associations between socio-demographic factors.

**Survey proforma**

The survey proforma included household-level putative risk factors for Lumpy Skin Disease (LSD) and direct and indirect losses due to LSDV infection. Variables such as breed, cattle herd size, dipping system, breeding system, LSD vaccination status, source of replacement cattle, watering system, and grazing system were categorized and their frequencies recorded. Direct losses like mortality and milk losses per affected farm, and indirect losses such as the cost of treatment and vaccination, were documented for both indigenous and exotic cattle farms.

**Ethical considerations**

All participants were residents of the study area and consented freely to participate in the study. Socio-demographic factors such as age, herd size, respondent's district, time in livestock farming, education level, role in the household, main source of income, animal type, and past experience of LSD in the herd were included in the questionnaire to assess their influence on knowledge and attitudes towards LSD.

**Statistical analyses**

Data analyses were performed by uni-variate logistic regression and descriptive statistics using Epi. Info. version 7.2.5.0. Data determined direct and indirect losses by Lumpy Skin Disease (LSD), including milk yield, mortality, and treatment, and vaccination costs. The confidence intervals determined for precision. Chi-square tests and logistic regression were used to observe significant differences in LSD impact across indigenous and exotic cattle breeds, socio-demographic factors and farm practices.

**Results**

**Impact of LSD on herd size, cattle breeds and farm practice**

Data regarding various putative risk factors of farmers (n = 4221) toward lumpy skin disease (LSD) is encapsulated in (Table 1). The survey highlights that Exotic breeds are predominantly affected, with 55.2% of cases reported. Medium-sized herds (4–9 cattle) constitute the largest segment at 46.0%**,** suggesting a correlation between herd size and LSD incidence. A significant 73.7% of farmers use home spraying as their preferred disease control method. The adoption of vaccination is high, with 77.9% of herds vaccinated against LSD. Internal replacement of cattle is practiced by 57.5% of farmers, indicating a strategy to control disease spread. Watering practices show 40**.**9% reliance on communal dams, and 36.8% of farmers practice free-range grazing, both of which may influence LSD transmission.

**Lumpy skin disease: Breed vulnerability**

In this study, data regarding direct and indirect losses incurred by farmers due to Lumpy Skin Disease virus (LSDV) infections are presented in (Table 2). The results revealed that 72.4% farmers resorted to replacement of animals, from external herds. These findings suggest statistically significant ($p < 0.001$) impact of LSDV infections on herd population and their replacement from outside sources. The data indicated that the losses 57.1% exotic breeds were in relation to higher vulnerability to the disease. In comparison to exotic breeds,

indigenous breeds were less affected 18.0% of cases. The impact of LSD on mixed breeds accounted as 24.9% losses, suggesting the infection challenge a risk across diverse cattle breeds. Significant differences ($p < 0.01$) were observed in the frequency of exotic, indigenous and mixed breeds of cattle.

**Table 1. Putative risk factors for Lumpy Skin Disease (LSD) among surveyed cattle herds**

| Variable | Category | Frequency | Percentage (95% CI) |
|---|---|---|---|
| **Breed** | Exotic | 300 | 55.2 (50.8–59.5) |
| | Indigenous | 120 | 22.1 (18.3–26.4) |
| | Mixed | 123 | 22.7 (19.0–26.9) |
| **Cattle herd size (categorical)** | Small (1–3) | 200 | 36.8 (32.7–41.2) |
| | Medium (4–9) | 250 | 46.0 (41.7–50.4) |
| | Large (≥10) | 93 | 17.1 (14.0–20.7) |
| **Dipping system** | Home spraying | 400 | 73.7 (69.8–77.3) |
| | Community dip | 143 | 26.3 (22.6–30.1) |
| **Breeding system** | AI | 200 | 36.8 (32.6–41.3) |
| | own bull | 150 | 27.6 (23.7–31.9) |
| | Shared bull | 80 | 35.5 (31.2–40.0) |
| **LSD vaccination** | Yes | 423 | 77.9 (74.2–81.3) |
| | No | 120 | 22.1 (18.6–25.9) |
| **Replacement cattle** | From own herd | 312 | 57.5 (53.1–61.8) |
| | From outside | 231 | 42.5 (38.1–46.9) |
| **Watering system** | In rivers | 111 | 20.4 (17.1–24.0) |
| | Communal dams | 222 | 40.9 (36.6–45.3) |
| | Communal boreholes | 110 | 20.3 (16.9–24.0) |
| | Piped and harvested water | 100 | 18.4 (15.2–22.0) |
| **Grazing system** | Tethering | 150 | 27.6 (23.7–31.9) |
| | Zero-grazing | 193 | 35.5 (31.3–40.0) |
| | Free-range | 200 | 36.8 (32.6–41.3) |

**Table 2. Distribution of replacement sources and cattle breeds due to impact of LSD**

| Variable | Category | Frequency | Percentage (95% CI) |
|---|---|---|---|
| **Replacement cattle** | From own herd | 150 | 27.6 (23.7–31.9) |
| | From outside | 393 | 72.4 (68.1–76.3) |
| **Breed** | Exotic breeds | 98 | 18.0 (14.5–22.1) |
| | Indigenous | 310 | 57.1 (52.7–61.4) |
| | Mixed breeds | 135 | 24.9 (21.2–29.1) |

**Direct Losses from lumpy skin disease**

The analyses of direct losses (milk yield and mortality) incurred by cattle farms due to Lumpy Skin Disease (LSD) are presented in (Table 3). The study comprised of a diverse group of both indigenous and exotic cattle breeds. The mortality rate 9.2% (95% CI: 6.5–12.4), were observed among exotic cattle farms (n=50) affected. The mortality rate of 5.5% (95% CI: 3.6–8.1), was determined in indigenous cattle farms (n=30) affected. It was observed that milk

yield 22.1% (95% CI: 18.3–26.4) severely affected at exotic cattle farms. The losses incurred due to milk yield 14.7% (95% CI: 11.8–18.7) was observed at exotic cattle farms. The findings suggested that no immediate impact of the disease, however, vulnerability existed among exotic cattle breeds.

**Table 3. Direct Losses incurred from Lumpy Skin Disease (LSD) in cattle breeds**

| Losses | Item of loss | Frequency | Proportion (95% CI) |
|---|---|---|---|
| **Direct losses** | Mortality losses per affected exotic cattle farm | 50 | 9.2% (6.5–12.4) |
| | Mortality losses per affected indigenous cattle farm | 30 | 5.5% (3.6–8.1) |
| | Milk losses per affected exotic cattle farm | 120 | 22.1% (18.3–26.4) |
| | Milk losses per affected indigenous cattle farm | 80 | 14.7% (11.8–18.7) |

**Indirect losses from lumpy skin disease**

The indirect losses in relation to vaccination and treatment of LSD affected cattle are presented in (Table 4). The data analyses indicated high burden of treatment expenses 55.2% (95% CI: 50.8–59.5) were recorded at LSD affected 300 exotic cattle farms. While, LSD affected herd treatment expenses 27.6% (95% CI: 23.7–31.9) were recorded at 150 indigenous cattle farms. The expenses incurred due to vaccination carried out at exotic cattle breeds 73.7% (95% CI: 69.8–77.3) and 26.3% (95% CI: 22.6–30.1) were recorded for indigenous cattle breeds. The finding suggested the disparities of vaccination and treatment financial impact of the disease at exotic and indigenous cattle breed farms.

**Table 4. Indirect Losses incurred from Lumpy Skin Disease (LSD) in cattle breeds**

| Indirect losses | Cost of treatment or vaccination | Frequency | Proportion (95% CI) |
|---|---|---|---|
| Cost of treatment | LSD in case exotic case farms | 300 | 55.2% (50.8–59.5) |
| | LSD in indigenous farms | 150 | 27.6% (23.7–31.9) |
| Cost of vaccination | LSD in exotic case case farms | 400 | 73.7% (69.8–77.3) |
| | LSD farms with indigenous breeds | 143 | 26.3% (22.6–30.1) |

**Discussion**

Lumpy skin disease is a highly contagious disease that produce financial burden to farmers and national economy. The diseases has been notified a threat for food security and poor cattle farming community. Since, the farming community is mostly dependent on milk, meat and their dairy products and using cattle for draught purposes **[13]**. This study performed to evaluate the various risk factors associated to financial losses and their impact on farming community and various cattle breed due LSD in province Sindh, Pakistan. The disease has emerged as a threat to rural farming community and

cattle livestock industry, and impact at small and/or large-scale [11].

The findings indicated that exotic cattle and medium size herd (4-9 cattle) are highly affected by LSDV infections suggested there may be association exists between herd size and LSD outbreak. The adoption of protective measures including home spraying (73.7%), and vaccination (77.9%) has impact on the disease control efforts. Also, internal cattle replacement (57.5%) strategy suggested it may reduce further spread of the disease in the herd. In contrast, factors such as free-range grazing (36.8%) and reliance on communal dams (40.9%) might enhance risk of LSD spread. The data indicated that the increased incidences of LSD in 57.1% indigenous breed's than exotic breeds 22.0% were in relation to higher vulnerability to the disease susceptibility. The susceptibility among the breeds may influence the genetic and environmental influences to predisposition of the disease [14]. The losses incurred due to milk yield were observed at exotic cattle farms. The findings suggested that no immediate impact of the disease, however, vulnerability existed among exotic cattle breeds. These findings are in continent to previous report [11]. The disease control strategies vaccination program 77.9% and 57.5% replacement of herds, reflecting the farmers' contribution to combating LSD. Farmers are active in replenishing cattle within the herds, as a strategy to conserve herd immunity and minimize the risk of disease spread from outside sources [14]. The impact of Lumpy Skin Disease (LSD) on cattle farms is notably severe. Farms with exotic breeds report a mortality rate of 9.2% (ranging from 6.5% to 12.4%), while those with indigenous breeds have a slightly lower mortality rate of 5.5% (3.6% to 8.1%). Additionally, milk production suffers significantly, with 22.1% (18.3% to 26.4%) of exotic cattle farms and 14.7% (11.8% to 18.7%) of indigenous cattle farms recording production losses [11] and comparative insights into the performance and disease susceptibility of different cattle breeds [15]. The risk factors and economic impact of LSD outbreaks in cattle farms in Nakuru County, Kenya, which provides insights into the farm-level consequences of the disease [8]. Research on the epidemiology and genetic characterization of LSD in cattle in Sharkia, Egypt, which includes morbidity and mortality rates associated with the disease [16]. A dynamical study of an LSD model with optimal control, had discussed the financial losses due to the disease and its threat to the livestock industry [17]. The results revealed a higher financial burden for treatment LSD in exotic cattle breeds 55.2%, compared to 27.6% for indigenous cattle breeds. Moreover, vaccination expenses were considerably higher for exotic breeds (73.7%) than for indigenous breeds (26.3%), suggesting the greater financial impact of LSD on different breeds. Immunization against LSD which may relate to the costs with different vaccination approaches [18]. The differences in distribution highlight the associate in resources and veterinary management [14]. Further the association of financial impact of LSD outbreaks in cattle farms in Nakuru County, Kenya, to the direct and indirect expenses incurred [8]. This study signifies the importance of employing disease management strategies to address the particularly susceptibility of indigenous and exotic cattle breeds and expenditure incurred.

**Conclusion**

In summary, this study demonstrated impact of Lumpy Skin Disease (LSD) on cattle farms, and a higher vulnerability of exotic cattle than indigenous cattle breeds. The economic losses were found in exotic breeds experiencing higher mortality and milk yield losses compared to indigenous breeds. Furthermore, the financial burden of

vaccination and treatment and was detected higher at exotic cattle farms. These disparities highlight the need for targeted disease management strategies, to reduce the affect of LSD.

**Authors' contributions**

Conceived and designed the experiments: MA Memon, SH Abro & DH Kalhoro, Performed the experiments: MA Memon, Analyzed the data: SH Abro, NH Kalhoro & R Abro, Contributed materials/ analysis/ tools: MA Memon & NH Kalhoro, Wrote the paper: MA Memon, SH Abro, DH Kalhoro, NH Kalhoro, R Abro

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