Lumpy Skin Disease Vaccination Strategy following the completion of first round of vaccination

1 Background

Lumpy Skin Disease (LSD) is caused by lumpy skin disease virus, a virus from the family Poxviridae and genus Capripoxvirus. LSDV is highly host specific and causes disease only in cattle and buffaloes (Al-Salihi, 2014). The transmission is mainly believed to occur through the bite of vectors such as biting flies, mosquitoes and ticks (Sprygin et al., 2019; Tuppurainen et al., 2013). Transmission can also occur mechanically through fomites, and while breeding, as virus is excreted through semen (Irons et al., 2005). Although the mortality rate in infected animals is low (1-5%), the morbidity rate can be as high as 20% (OIE, 2017). The disease has an economic significance as it causes marked reduction in the milk yield in lactating cattle, abortion in pregnant cows, anestrous in cows for several months, in addition to reduced carcass quality as the carcass affected with LSDV is not condemned for consumption from a zoonotic aspect. First detected in Zambia in 1929, it has gradually spread to other countries in the African continent (Davies, 1991a). Until 1989, Lumpy skin disease was limited to the African continent; however, the disease has moved outside Africa (middle east and Madagascar) causing serious economic loss to the cattle and water buffalo population (Al-Salihi, 2014). Since 2012, LSD has been spreading on an unusually large scale throughout Middle Eastern countries, including Israel and Turkey, and in the latter, it is now considered endemic (EFSA, 2017). In 2015, the first outbreak of LSD was reported from Russia and thereafter widely distributed across the country (Sprygin et al., 2018). Gradually, the disease has spread further into Eastern Asia in 2019 with countries like China, Bangladesh and India reporting cases for the first time. In the South Asian region, the first outbreak of LSD was reported in China on the 3rd August 2019, followed by Chinese Taipei on 12th August 2019, India on 12th August 2019, Nepal on 24th June 2020 and Bangladesh on 14th July 2020.

Preparedness to prevent LSD introduction into the cattle population of Bhutan started by 23rd July 2020 upon receipt of information from the FAO country office regarding the potential threat of disease introduction. On the 4th of October 2020, the National Centre for Animal Health received four samples from Samtse from cattle suspected of LSDV infection. Unfortunately, Bhutan confirmed the first encounter of LSDV on 5th October, 2020 from the samples received from Samtse. Subsequently, the disease died off without major implication in 2020, gradually, two years later, in 2022 LSD epidemic caused an enormous economic loss to livestock farmers and the government.

2 Situational analysis

In response to the unprecedented LSD outbreaks reported in the country, which affected over 19,000 cattle and yaks, resulting in the unfortunate loss of over 2,600 animals, the Department of Livestock, Ministry of Agriculture and Livestock implemented the nationwide LSD vaccination program from August 19, 2023 to 30 October 2023. During this time frame, a dedicated and impressive effort was undertaken to ensure the vaccination of 280,581 bovines. This included 243,336 cattle, 36,460 yaks, 807 mithuns, and 248 buffaloes. This vaccination campaign was carried out across 205 Gewogs and four Thromdes in the country. According to the Integrated Agriculture and Livestock Census 2022, there are a total of 293,614 bovine livestock in the country. Using IALC 2022 as a baseline, a vaccination coverage of 95.65% has been achieved. This achievement stands as a testament to the tireless work and dedication of our livestock professionals in the field and the collaborative efforts of all stakeholders, including the farmers and local leaders, involved in the LSD vaccination program. The protection of livestock in Bhutan is not only essential for the well-being of the animals but also for the overall agricultural and economic stability of our country. The success of this program represents a significant step forward in our ongoing efforts to prevent and control animal diseases, contributing to the sustainability and prosperity of our livestock sector, and welfare of the livestock animals in the country, thereby contributing directly to the food and nutrition self-sufficiency of the RNR sector.

As we rejoice in our success in containing the outbreak, it is important to consider how we will address the threat of similar epidemics in the future. Given that there will be reduction of protective antibody titre over time, population turnover leading to the introduction of susceptible individuals, and living in a region where LSD is highly prevalent, it is essential to strategize preventive measures. These measures must be maintained until the threat from the disease is reduced to a negligible level. In addition to enhancing management and biosecurity practices, vaccination is one of the most effective ways to prevent and control LSDV. Therefore, the best option at hand currently is to implement vaccination.

3 Herd Immunity

Herd immunity following vaccination is a critical component in preventing and controlling LSD in susceptible animal populations. When a significant proportion (approximately 70% as per WOAH recommendation) of the herd is vaccinated against LSD, it reduces the overall number of susceptible individuals within the population, thereby decreasing the likelihood of disease transmission (reproductive score of LSDV). This collective immunity protects not only the vaccinated animals but also those that are unvaccinated or have weaker immune responses, as the spread of the virus is significantly curtailed. Achieving and maintaining herd immunity requires a comprehensive and strategic vaccination schedule, post vaccination monitoring (PVM) of antibody titre, and timely booster vaccination to counteract the declining antibody titre. This

approach is essential in regions where LSD is endemic, ensuring that outbreaks are minimized and the health and productivity of livestock are safeguarded. Generally, to achieve herd immunity, 70-80% of the population should be vaccinated.

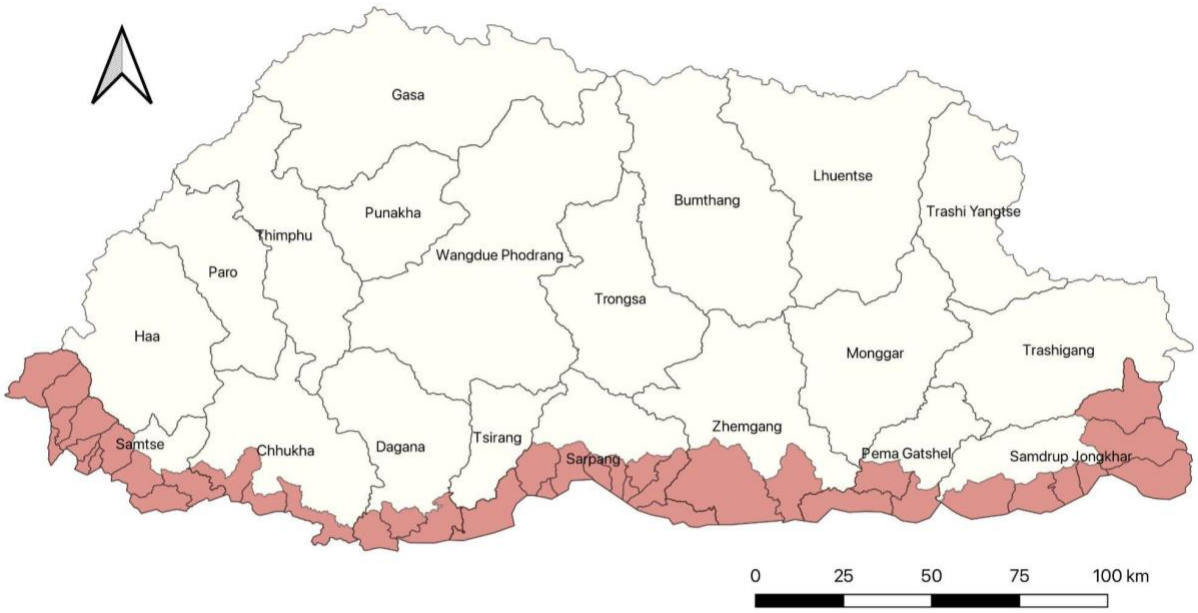
4 Resource and manpower challenges to vaccinate entire bovine population

Vaccinating the entire bovine population against LSD presents significant challenges. One major hurdle is the limited availability of animal health workers. In many areas, a single animal health worker is responsible for attending to a variety of animal-related cases within an entire geog. This limited workforce means that the vaccination campaign will require a substantial amount of time and effort, leading to delays and potential gaps in coverage. Furthermore, the financial cost of such a widespread vaccination effort is considerable, encompassing the expenses for vaccines, logistical support, and additional labor. From our experience with the emergency vaccination campaign implemented last year, it took approximately three months to achieve over 90% coverage. Given the logistical challenges and resource constraints, replicating this level of coverage will be challenging. Furthermore, the prolonged duration required to vaccinate the entire bovine population increases the risk of disease spread and complicates efforts to maintain herd immunity effectively.

5 Strategies for future vaccination

5.1 Vaccination coverage

The vaccination in the subsequent years (2 and 3) will be focused on achieving 75% coverage in each Dzongkhags. However, in the areas under southern Dzongkhags that shares a border with the neighboring states of India where the environment is conducive for fly activities and disease transmission, the entire population should be vaccinated (100%). The geogs in which 100% vaccination coverage needs to be achieved is as provided in the figure and table below.



Sl.No	Dzongkhag	Geog
1	Chukha	Sampheling,Phuentshogling, Darla
2	Dagana	Nichula, Lhamoizingkha, Karmaling
3	Pema Gatshel	Norboogang, Dechhenling, Chhoekhorling
4	Samdrup Jongkhar	Serthig, Samrang, Phuentshogthang, Pemathang, Lauri, Langchenphu, Dewathang
5	Samtse	Yoseltse, Ugyentse, Tendruk, Tashicholing, Tading, Sangagcholing, Samtse, Phuentshogpelri, pemaling, Norgaygang, Norbugang, namgaycholing
6	Sarpang	Umling, Tareythang, Shompangkha, Serzhong, Senggey, Samteling, Gelegphu, Gakiling, Dekiling, Chhuzangang
7	Zhemgang	Pangkhar, Ngangla

In the remaining geogs, a minimum of 75% vaccination coverage should be achieved. Based on the assessment of risk on the ground considering the proximity to high-risk areas, climatic conditions and fly activities, the area specific coverage can vary but the overall coverage should sum up to 75%.

5.2 Vaccination frequency

Given that the protective immunity following vaccination is known to last at least for a year, the vaccination of the bovine population should be carried out annually.

5.3 Target species

The strategy involves mass vaccination utilizing the homologous vaccine. The strategy encompasses all susceptible bovine populations: cattle (all breeds), mithun, buffalo, yak and zo-zom.

5.4 Migratory herd including yaks

The migratory herds and yaks shall be vaccinated against LSDV at-least 28 days prior to their migration.

5.5 Exclusion criteria

The strategy is to vaccinate animals of all age groups and physiological status, however, following categories of animals are not eligible for vaccination:

- Calves below one month of age*
- Animal currently infected or showing clinical signs and symptoms of LSD
- Clinically sick animals due to any other disease**

** Calves below one month of age at the time of mass vaccination must be vaccinated once they attain the age of one month.*

***Clinically sick animals due to other diseases must be vaccinated after their recovery from the illness.*

5.6 Vaccine Procurement

Until a homologous vaccine becomes available in our region, we will obtain the homologous LSD vaccine from Vetal Animal Health Products Inc., Turkey.

5.7 Vaccine information

The following table shows a brief description about the vaccine.

Table 2: About Lumpyvac

Parameter	Description/ Value
Name of the product	LUMPYVAC®, (Lumpy Skin Disease Virus Vaccine)
Pharmaceutical Form	Attenuated live vaccine in lyophilized form

Volume for 1 dose	2 ml
Amount of virus contained in one dose	At least 104 TCID50
Quantitative Composition	Neethling virus strain, not less than 104 TCID50 / dose Lactalbumin hydrolyzate - 0.25 mg Sucrose - 0.50 mg
Presentation	50 and 25 doses per vial
Storage temperature	+2 to +8°C
Recommended dose per animal	2ml
Duration of immunity	At least 1 year
Duration for vaccine utilization after opening the vial	Recommended to use the opened vial 2 - 6 hours after opening the vial, however, it can be used afterwards if proper cold chain is strictly maintained.

5.8 Total doses required and approximate cost

In the high-risk geogs, where 100% coverage is necessary, 59,788 doses are required, whereas, in the low-risk geogs, with a minimum coverage requirement of 75%, 174,265 doses are required. While taking 10% handling loss and a 10% buffer stock, which amounts to 46,810 doses, therefore, the total number of doses required for procurement is 280,863.

Doses/vial	Unit value	Total doses required	Total vials	Total Cost	Conversion rate	Total in BTN
10	$ 11.40	280,863	28086.3	$ 320,183.82	83.52	Nu.26,741,752.65
25	$ 19.00	280,863	11234.52	$ 213,455.88	83.52	Nu.17,827,835.10
50	$ 33.25	280,863	5617.26	$ 186,773.90	83.52	Nu.15,599,355.71

In the previous year, purchasing all required vaccine doses in 50-dose vials incurred Nu. **15,599,355.71.** To optimize resource utilization and minimize wastage, procuring 50% of the total dose in 25-dose presentation vials and the remaining 50% in 50-dose vials would cost Nu. 16,713,595.6. However, this cost estimation is exclusive of transhipment and storage expenses. Considering the costs for transhipment, storage, and bank charges, the total anticipated expenditure for procuring and transporting vaccines to Bhutan is approximately 13 million ngultrums. However, our allocated budget for procuring LSD vaccine in the fiscal year 2024-2025 is 14.4 million ngultrums. Given that DVEU reported that several suppliers regret not being able

to supply medicines and vaccines this year, which may leave us with an unspent budget of about six million ngultrums from the previous fiscal year (2023-2024). If this balance can be carried forward, it would fully cover the expenses needed for procuring and transporting the LSD vaccine.

6 Annexure

1. Total number of animals to be vaccinated in high-risk geogs requiring 100% coverage

S.N.	Dzongkhag	Gewog	Total Bovine Population	Total Vaccine Doses
1	Chukha	Darla	2,195	2,195
2	Chukha	Phuentshogling	3,138	3,138
3	Chukha	Samphelling	1,849	1,849
4	Dagana	Karmaling	1,380	1,380
5	Dagana	Lhamoi Dzingkha	1,381	1,381
6	Dagana	Nichula	751	751
7	Pema Gatshel	Chhoekhorling	289	289
8	Pema Gatshel	Dechhenling	352	352
9	Pema Gatshel	Norboogang(pgatshel)	744	744
10	Samdrup Jongkhar	Dewathang	761	761
11	Samdrup Jongkhar	Phuentshogthang	1,744	1,744
12	Samdrup Jongkhar	Langchenphu	1,046	1,046
13	Samdrup Jongkhar	Lauri	804	804
14	Samdrup Jongkhar	Pemathang	930	930
15	Samdrup Jongkhar	Samrang	89	89
16	Samdrup Jongkhar	Serthig	702	702
17	Samtse	Tading	3,689	3,689
18	Samtse	Norboogang	2,817	2,817
19	Samtse	Phuentshogpelri	2,556	2,556
20	Samtse	Samtse	2,701	2,701
21	Samtse	Norgaygang	2,408	2,408
22	Samtse	Pemaling	2,056	2,056
23	Samtse	Tashichhoeling	1,000	1,000
24	Samtse	Tendruk	2,790	2,790
25	Samtse	Sang-Ngag-Chhoeling	2,573	2,573
26	Samtse	Namgyalchhoeling	2,497	2,497
27	Samtse	Ugyentse	1,353	1,353
28	Samtse	Yoeseltse	2,431	2,431
29	Sarpang	Samtenling	1,402	1,402

30	Sarpang	Chhuzanggang	1,225	1,225
31	Sarpang	Gelegphu	431	431
32	Sarpang	Serzhong	871	871
33	Sarpang	Tareythang	250	250
34	Sarpang	Umling	886	886
35	Sarpang	Dekiling	1,749	1,749
36	Sarpang	Gakiling	2,220	2,220
37	Sarpang	Senggey	1,081	1,081
38	Sarpang	Shompangkha	936	936
39	Zhemgang	Ngangla	728	728
40	Zhemgang	Phangkhar	983	983
Total			**59,788**	**59,788**

2. **Total number of doses required for vaccinating 75% bovine population in low-risk areas**

S.N.	Dzongkhag	Gewog	Total Bovine Population	Total Vaccine Doses (75%)
1	Bumthang	Chhoekhor	5,467	4,100
2	Bumthang	Tang	2,224	1,668
3	Bumthang	Chummig	1,751	1,313
4	Bumthang	Ura	2,197	1,648
5	Chukha	Bjagchhog	529	397
6	Chukha	Bongo	1,568	1,176
7	Chukha	Chapchha	753	565
8	Chukha	Getana	992	744
9	Chukha	Doongna	851	638
10	Chukha	Geling	1,099	824
11	Chukha	Loggchina	2,186	1,640
12	Chukha	Maedtabkha	995	746
13	Dagana	Drukjeygang	1,534	1,151

14	Dagana	Gozhi	1,355	1,016
15	Dagana	Karna	2,438	1,829
16	Dagana	Khebisa	2,179	1,634
17	Dagana	Largyab	1,358	1,019
18	Dagana	Tseza	724	543
19	Dagana	Tsangkha	1,378	1,034
20	Dagana	Dorona	648	486
21	Dagana	Gesarling	689	517
22	Dagana	Tashiding	1,435	1,076
23	Dagana	Tsenda-Gang	1,097	823
24	Gasa	Khamaed	294	221
25	Gasa	Lunana	2,787	2,090
26	Gasa	Khatoed	206	155
27	Gasa	Laya	2,399	1,799
28	Haa	Bji	2,300	1,725
29	Haa	Kar-tshog	959	719
30	Haa	Uesu	926	695
31	Haa	Gakiling(haa)	1,265	949
32	Haa	Samar	1,229	922
33	Haa	Sangbay	1,263	947
34	Lhuentse	Gangzur	2,136	1,602
35	Lhuentse	Khoma	1,297	973
36	Lhuentse	Kurtoed	633	475
37	Lhuentse	Minjey	1,048	786
38	Lhuentse	Jarey	1,103	827
39	Lhuentse	Maenbi	1,419	1,064
40	Lhuentse	Maedtsho	1,301	976

41	Lhuentse	Tsaenkhar	1,204	903
42	Mongar	Balam	720	540
43	Mongar	Chagsakhar	2,046	1,535
44	Mongar	Dramedtse	1,717	1,288
45	Mongar	Na-Rang	970	728
46	Mongar	Ngatshang	1,030	773
47	Mongar	Shermuhoong	1,807	1,355
48	Mongar	Thang-Rong	1,785	1,339
49	Mongar	Gongdue	842	632
50	Mongar	Jurmed	1,208	906
51	Mongar	Kengkhar	1,274	956
52	Mongar	Saling	1,673	1,255
53	Mongar	Silambi	2,053	1,540
54	Mongar	Chhaling	1,270	953
55	Mongar	Drepoong	1,122	842
56	Mongar	Monggar	1,629	1,222
57	Mongar	Tsakaling	1,130	848
58	Mongar	Tsamang	786	590
59	Paro	Dokar	739	554
60	Paro	Loong-nyi	875	656
61	Paro	Nagya	2,296	1,722
62	Paro	Sharpa	970	728
63	Paro	Dopshar-ri	875	656

64	Paro	Doteng	667	500
65	Paro	Hoongrel	61	46
66	Paro	Lamgong	664	498
67	Paro	Tsento	3,231	2,423
68	Paro	Wangchang	342	257
69	Pema Gatshel	Chhimoong	339	254
70	Pema Gatshel	Chongshing	287	215
71	Pema Gatshel	Dungmaed	582	437
72	Pema Gatshel	Khar	512	384
73	Pema Gatshel	Yurung	338	254
74	Pema Gatshel	Nanong	1,100	825
75	Pema Gatshel	Shumar	1,273	955
76	Pema Gatshel	Zobel	984	738
77	Punakha	Barp	416	312
78	Punakha	Guma	671	503
79	Punakha	Goenshari	290	218
80	Punakha	Kabisa	871	653
81	Punakha	Talog	392	294
82	Punakha	Toedpaisa	669	502
83	Punakha	Chhubu	1,146	860
84	Punakha	Dzomi	1,326	995
85	Punakha	Lingmukha	637	478
86	Punakha	Shelnga-Bjemi	728	546

87	Punakha	Toedwang	1,222	917
88	Samdrup Jongkhar	Gomdar	2,013	1,510
89	Samdrup Jongkhar	Orong	1,452	1,089
90	Samdrup Jongkhar	Wangphu	1,702	1,277
91	Samdrup Jongkhar	Martshala	1,779	1,334
92	Samtse	Duenchhukha	3,192	2,394
93	Samtse	Dophuchen	4,174	3,131
94	Samtse	Doomtoed	1,323	992
95	Sarpang	Jigme Chhoeling	3,227	2,420
96	Sarpang	Chhudzom	2,064	1,548
97	Thimphu	Kawang	333	250
98	Thimphu	Lingzhi	2,638	1,979
99	Thimphu	Naro	2,215	1,661
100	Thimphu	Soe	1,440	1,080
101	Thimphu	Chang	295	221
102	Thimphu	Darkarla	4,285	3,214
103	Thimphu	Ge-nyen	549	412
104	Thimphu	Maedwang	1,203	902
105	Trashigang	Bartsham	861	646
106	Trashigang	Bidoong	636	477
107	Trashigang	Yangnyer	1,333	1,000
108	Trashigang	Shongphu	1,520	1,140
109	Trashigang	Kanglung	1,723	1,292

110	Trashigang	Samkhar	1,313	985
111	Trashigang	Udzorong	1,998	1,499
112	Trashigang	Merag	8,001	6,001
113	Trashigang	Phongmed	1,181	886
114	Trashigang	Radhi	1,267	950
115	Trashigang	Sagteng	6,882	5,162
116	Trashigang	Kangpar	1,948	1,461
117	Trashigang	Thrimshing	925	694
118	Trashigang	Khaling	1,750	1,313
119	Trashigang	Lumang	2,003	1,502
120	Trashi Yangtse	Boomdeling	2,103	1,577
121	Trashi Yangtse	Jamkhar	570	428
122	Trashi Yangtse	Tongmajangsa	982	737
123	Trashi Yangtse	Yangtse	1,338	1,004
124	Trashi Yangtse	Ramjar	772	579
125	Trashi Yangtse	Khamdang	1,205	904
126	Trashi Yangtse	Toedtsho	1,032	774
127	Trashi Yangtse	Yalang	582	437
128	Trongsa	Draagteng	1,488	1,116
129	Trongsa	Korphu	337	253
130	Trongsa	Langthil	1,752	1,314
131	Trongsa	Nubi	3,363	2,522
132	Trongsa	Tangsibji	1,278	959

133	Tsirang	Barshong	1,106	830
134	Tsirang	Patshaling	841	631
135	Tsirang	Kilkhorthang	1,118	839
136	Tsirang	Mendrelgang	798	599
137	Tsirang	Rangthangling	1,216	912
138	Tsirang	Tsholingkhar	887	665
139	Tsirang	Doonglagang	1,255	941
140	Tsirang	Gosarling	822	617
141	Tsirang	Pungtenchhu	986	740
142	Tsirang	Semjong	1,231	923
143	Tsirang	Tsirang Toed	938	704
144	Wangdue Phodrang	Athang	1,319	989
145	Wangdue Phodrang	Bjenag	1,783	1,337
146	Wangdue Phodrang	Darkar	974	731
147	Wangdue Phodrang	Gase Tshogongm	848	636
148	Wangdue Phodrang	Gase Tshowogm	577	433
149	Wangdue Phodrang	Nahi	438	329
150	Wangdue Phodrang	Thedtsho	572	429
151	Wangdue Phodrang	Ruebisa	1,512	1,134
152	Wangdue Phodrang	Dangchhu	1,593	1,195
153	Wangdue Phodrang	Gangteng	2,284	1,713
154	Wangdue Phodrang	Kazhi	1,626	1,220
155	Wangdue Phodrang	Nyishog	1,237	928

156	Wangdue Phodrang	Phangyuel	884	663
157	Wangdue Phodrang	Phobji	3,728	2,796
158	Wangdue Phodrang	Saephu	2,948	2,211
159	Zhemgang	Bardo	1,836	1,377
160	Zhemgang	Nangkor	1,718	1,289
161	Zhemgang	Shingkhar	1,370	1,028
162	Zhemgang	Trong	1,073	805
163	Zhemgang	Bjoka	664	498
164	Zhemgang	Goshing	610	458
165	Government Farms	Multiple	753	565
Grand Total			**232,353**	**174,265**