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# Evaluation of the Biennial Vaccination Campaign against Peste Des Petits Ruminants in the Bagamati Province in Nepal

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Peste des Petits Ruminants (PPR) is a highly contagious viral disease that primarily affects goats and sheep. Morbidity can reach 90%, and mortality can reach 50–100% in severe cases. PPR is brought on by the Peste des petits ruminant's virus. It is mostly transmitted by direct contact between infected and vulnerable animals. Bagmati Province, a potential province for goat and sheep farming, has conducted a weekly vaccination campaign against PPR disease with the approved action plan throughout the districts at the same time interval for two successive fiscal years, 2021 and 2022, aiming to facilitate systematic and effective immunization programs against this disease in Bagamati Province. Prior to the campaign, there was a continuous outbreak of PPR throughout

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the districts of Bagamati Province. Overall, vaccination coverage rates were found to be 70% and 77%, respectively, in FY 2021 and 2022. As a result, the community is now better protected against the infectious disease PPR, laying the foundation for improved animal health outcomes in the future. Seromonitoring was performed by the central veterinary laboratory in coordination with district veterinarians, and the results showed it to be effective. Due to the campaign, only two outbreaks have been reported to the date of the study, which in turn proved that the vaccination campaign was functional and has been a resounding success, effectively reaching a substantial portion of the target population. In conclusion, continued momentum in such campaigns is crucial to ensuring the longevity of this positive impact and fostering healthier and more quality products from sheep and goats.

*Keywords: PPR; vaccination; campaign; Bagamati province.*

## 1. INTRODUCTION

Peste des Petits Ruminants (PPR), often referred to as "goat plague," is a highly contagious viral disease that primarily affects goats and sheep, although other small ruminants can also be susceptible [1]. Morbidity can reach 90-100% and mortality can reach 50-100% in severe cases [2]. The severity of PPR varies, but in severe cases, the disease can lead to high mortality rates, especially in young or immunologically naive animals.

### 1.1 Causative Agent

PPR is brought on by the Peste des Petits Ruminants Virus (PPRV), which belongs to the family Paramyxoviridae and genus Morbillivirus [3,4]. Additionally, this genus contains the viruses that cause rinderpest in cattle and measles in humans.

### 1.2 Transmission

PPR (Peste des Petits Ruminants) is mostly transmitted by direct contact between infected and vulnerable animals, including interactions such as nose-to-nose contact, sharing of food and water supplies, sexual activity, grooming, and living in close proximity to sick animals [5]. Additionally, the virus is present in respiratory discharges, enabling aerosol transmission when sick animals cough or sneeze, releasing virus-laden droplets into the air that can be inhaled by animals who are close by who are vulnerable [6]. Through touch with contaminated things (fomites), such as feed troughs, bedding, etc., transmission can also happen indirectly.

### 1.3 Clinical Signs

Infected animals typically display a range of clinical signs associated with Peste des Petits Ruminants (PPR), including high fever as an early and consistent indicator, along with runny nasal and ocular discharges [2]. Respiratory symptoms like coughing, sneezing, and labored breathing arise due to respiratory tract inflammation, often accompanied by conjunctivitis marked by red, swollen, and teary eyes. Lesions in the mouth and on gums cause discomfort, hampering eating and drinking, while gastrointestinal effects encompass diarrhea, reduced feed intake, weight loss, and dehydration. Although less common, skin lesions like redness, swelling, or blisters can occur. Behavioral shifts like depression, isolation, and decreased movement.

Post-mortem examinations of animals affected by Peste des Petits Ruminants (PPR) often uncover distinctive lesions indicative of the disease, encompassing inflammation, ulceration, and hemorrhages in the gastrointestinal tract particularly the stomach and intestines and Zebra markings are a significant diagnostic feature of PPR and are typically seen in the posterior part of colon and rectum as discontinuous streaks of congestion, particularly the jejunum [7]. Additionally, respiratory tract involvement becomes evident through inflammation and congestion in the lungs and trachea, sometimes leading to lung consolidation and pleural effusion. Lymphoid tissues, central to PPR's impact, exhibit enlargement and congestion in the lymph nodes, spleen, and tonsils. Oral lesions manifest as erosions and ulcerations on the tongue, gums, and mucous membranes. Depending on disease severity, other observations might include organ congestion, such as in the liver and kidneys, and sporadically, skin lesions like blisters or erosions. These post-mortem findings play a crucial role in confirming PPR diagnoses and differentiating the disease from similar conditions in small ruminants.

**The economic impact:** The economic impact of Peste des Petits Ruminants (PPR) is substantial, exerting far-reaching consequences on livestock and communities. When goats are infected with PPR, their productivity takes a hit on multiple fronts. Reproductive capabilities are impaired, causing a decrease in fertility rates and potentially leading to a rise in abortions and stillbirths. Additionally, growth rates among infected animals diminish, resulting in delayed maturation and reduced body weight gain. The combined effect of mortality and decreased productivity can result in significant economic losses, affecting not only individual goat herders but also entire communities that rely on these animals for their livelihoods and sustenance [8].

**The geographic distribution:** The geographic distribution of PPR is wide-ranging, primarily affecting regions in Africa, Asia, and the Middle East [9]. This disease is particularly prevalent in areas with substantial populations of goats and sheep, given that these species are highly susceptible to PPR. In these regions, where small ruminants are integral to the local economy and social fabric, outbreaks of PPR can lead to cascading economic and social challenges. The disease's impact extends beyond the immediate loss of animals to encompass disruptions in the supply of meat, and other byproducts and can even hamper access to resources such as leather and wool. This underscores the urgency of effective control measures to mitigate the disease's economic toll and preserve the livelihoods of those reliant on small ruminant husbandry.

**Prevention and control:** Prevention and control strategies for Peste des Petits Ruminants (PPR) encompass vaccination, considered the primary and most effective method, with various vaccines employed in endemic areas to safeguard vulnerable animals. Complementary biosecurity measures, including isolating infected animals, imposing movement limitations, and upholding hygiene standards, play a vital role in limiting disease transmission. Additionally, raising awareness among farmers and herders about the significance of vaccination and implementing biosecurity practices is crucial for comprehensive disease management [11,12].

## 1.4 Background

One of the seven provinces of Nepal established by the constitution is Bagmati Province. It is the second-most populous and fifth-largest province in terms of area in Nepal. The province, which has Hetauda as its provincial seat and is also where Kathmandu, the nation's capital, is located, is largely hilly and mountainous and is home to high peaks including Gaurishankar, Langtang, Jugal, and Ganesh. Bagmati Province, which makes up around 13.79% of Nepal's total area and has an area of 20,300 km2, contains 13 districts as shown in Fig. 1 and has a population of 6044022.

There have been several commercial goat farms as well as conventional farms that raise both native and foreign varieties of goats. Following Figs. 2 and 3 will illustrate the total number of goat and sheep in 13 districts of Bagamati Province and the meat production status of Bagamati Province among 7 provinces of Nepal. Bagamati Province have 89014 sheeps and 2593899 Goats in Number and total meat from sheep and goats of this province are 14096 Metric Ton in a year 2021/22 (Statistical-Information-on-Nepalese-Agriculture-2078-79-2021-22) which contributed to 18% of total meat production in Nepal.

PPR first appeared in the African country of Ivory Coast in 1942 [13]. This disease, which was initially confined to the continent of Africa, has now spread to many countries around the world. This disease has appeared first in 1995 [15] and had speeded in all districts of Nepal. When this disease appears in old places, the death rate is low, but if it spreads to new places, the death rate is high. The national PPR disease control program is currently being implemented throughout the country to control this disease, which causes great economic and social damage to farmers. In order to ensure the leading and significant role of Bagmati Province in eradicating PPR disease from the country by 2030 by implementing the same program effectively in all the districts within the Bagmati Province district, the Bagmati Province Government conducted a weekly vaccination program against PPR disease throughout the province in Fiscal Years 2021/22 and 2022/23.

In view of the fact that the World Animal Health Organization (Office International des Epizooties, OIE) and the United Nations Food and Agriculture Organization (Food and Agriculture Organization of the United Nations, FAO) have moved forward the strategy to eliminate PPR by 2030, and through the Animal Health Program Implementation Procedure, 2075 Chapter 3, the

implementation of the PPR disease control program, a clear action plan has been created to effectively control this disease, and a week PPR vaccination campaign in all districts of Bagamati Province at the same time is being conducted [16,17,18].

PPR disease causes many sheep and goats to die each year in Nepal, costing farmers a fortune. This makes it imperative to take strong measures to control this disease, and the vaccine program may be a key first step.


**Fig. 1. Districts of Bagamati province**
*Source: NepalNews, 2022 (https://www.nepalnews.com ) [10]*

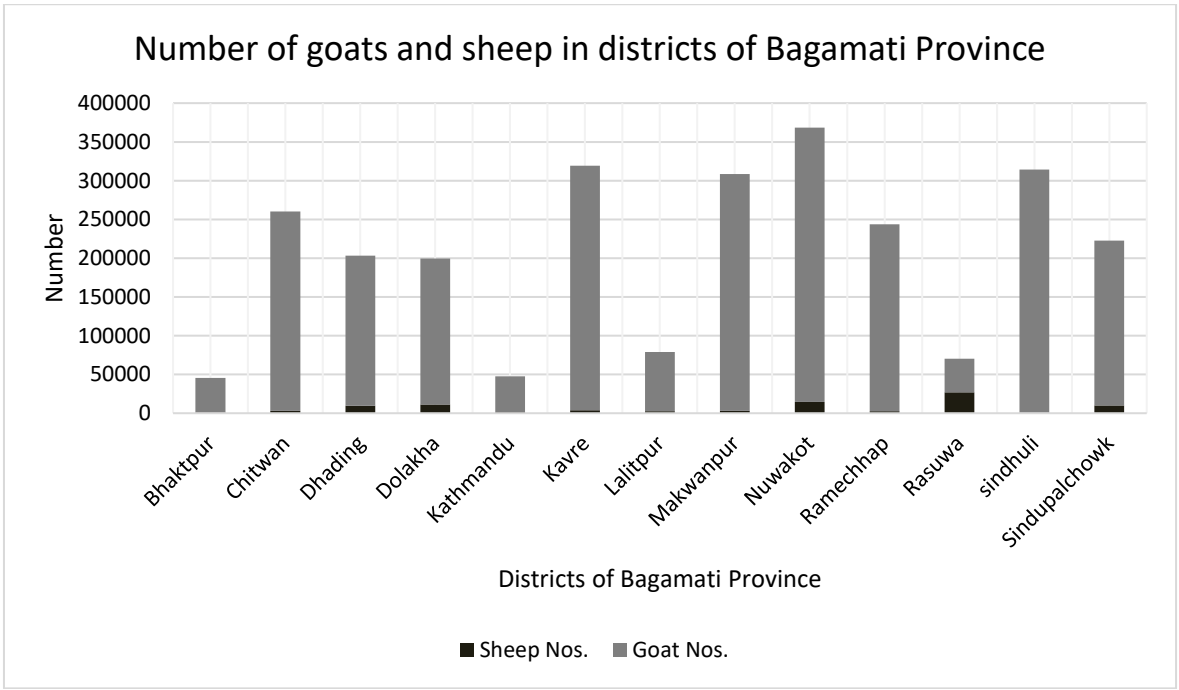


**Fig. 2. Total number of goats and sheeps in year 2021/22 of Bagamati Province**
*Source: (Statistical-Information-on-Nepalese-Agriculture-2078-79-2021-22)*

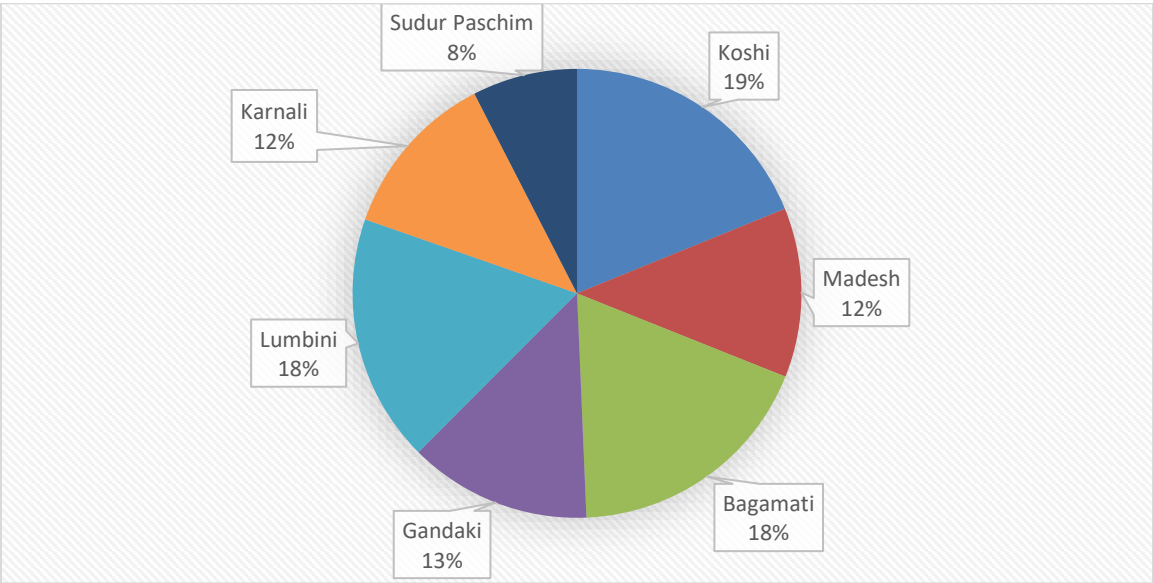


**Fig. 3. Percentage of meat production from goat and Sheep in Year 2021/22 of 7 Province in Nepal**

*Source: (Statistical-Information-on-Nepalese-Agriculture-2078-79-2021-22) [14]*

## 2. OBJECTIVES OF THE PROGRAM

- To conduct a vaccination program against PPR in Bagamati Province at the same time duration for a week throughout the provincial districts.
- Facilitating, systematic and effective immunization programs against PPR in Bagamati Province.
- To eliminate PPR by 2030 from Bagamati Province.

## 3. METHODOLOGY

The Ministry of Agriculture and Livestock Development, Bagamati Province, had approved the action plan model for the vaccination campaign against PPR, which includes three main parts explaining the procedure to follow before the vaccination campaign, during the vaccination week, and after a successful vaccination campaign. There is a division of work that has to be performed by each government, namely the federal government, the provincial government, and the respective local government, throughout the Bagamati Province. These campaigns are mainly implanted through the Veterinary Hospital and Livestock Services Expert Center, which is under the Directorate of Livestock and Fisheries Development, and the Ministry of Agriculture and Livestock Development, Bagamati Province. The basic action plan model was explained in List 1.

### 3.1 Immunization Program Conducted in FY 2021/22 and FY 2021/22

**Financial Management:** The available vaccines were provided by the federal government, and the Department of Livestock Services has allocated budget for logistics support through the Federal State Program. The remaining needed budget was supplied by the provincial government to the Veterinary Hospital and Livestock Expert Services Center, which is located in 8 districts and has working areas in 13 districts of Bagamati Province. Seromonitoring was performed by the Central Veterinary Laboratory, Tripureswor. Besides vaccines and seromonitoring, the total budget allocated was approximately 91,500 USD in one year.

## 4. PROBLEMS ENCOUNTERED IN CONDUCTING THE VACCINATION CAMPAIGN

Conducting an effective vaccination program is a difficult task, especially during a global epidemic like COVID-19. The challenges experienced can vary depending on the geography, the resources available, and the level of coordination amongst various parties. Let us expand on the points raised:

- **Inadequate Vaccine Supply:** Providing a constant and sufficient supply of vaccines is one of the most difficult difficulties in

immunization programs. When there is a vaccine scarcity, it can cause delays in the immunization process and frustration among the people. Manufacturing constraints, distribution challenges, strong global demand, or supply chain interruptions could all contribute to this.

- **Geographic Difficulties:** Some places may have geographical difficulties, such as distant areas, rough terrain, or areas with little infrastructure. These variables can make it difficult to distribute vaccinations and deploy immunization teams efficiently. This can cause delays in reaching all communities, particularly those in difficult-to-reach areas.
- **Inadequate Vaccinators:** A successful campaign requires adequate staffing of vaccination centers and teams. If there are fewer vaccinators than there is demand for immunization, vaccination rates may slow. Time and money are required to train and mobilize a sufficient number of technician experts to deliver vaccines.
- **Limited Publicity:** Effective communication is required to inform the public about the importance of vaccination, the vaccination process, and the advantages of vaccination. There may be skepticism or disinformation flowing among the population if there is a lack of publicity and clear information regarding the campaign. This may reduce people's willingness to have their pets vaccinated.
- **COVID-19 Nationwide Transmission:** The extensive transmission of COVID-19 inside a country can make a vaccination program difficult.

## 5. PREVIOUS SITUATION

A report of Situation analysis of Peste des Petits Ruminants (PPR) for past 10 (2008–2017) years in Nepal shows there was approximately 180 outbreaks throughout the Bagamati province as can be seen in Fig. 4.

In an annual report of Central veterinary laboratory of Nepal a serum sample of 29 goats from different outbreak areas from district Kathmandu, Dhadhing and Chitwan were tested against PPR through ELISA 96.5% sample were found to be positive against PPR in Fiscal Year 2019/20.

## 6. RESULTS

### 6.1 Vaccine Coverage Report

Vaccine Coverage Report in Table 1.

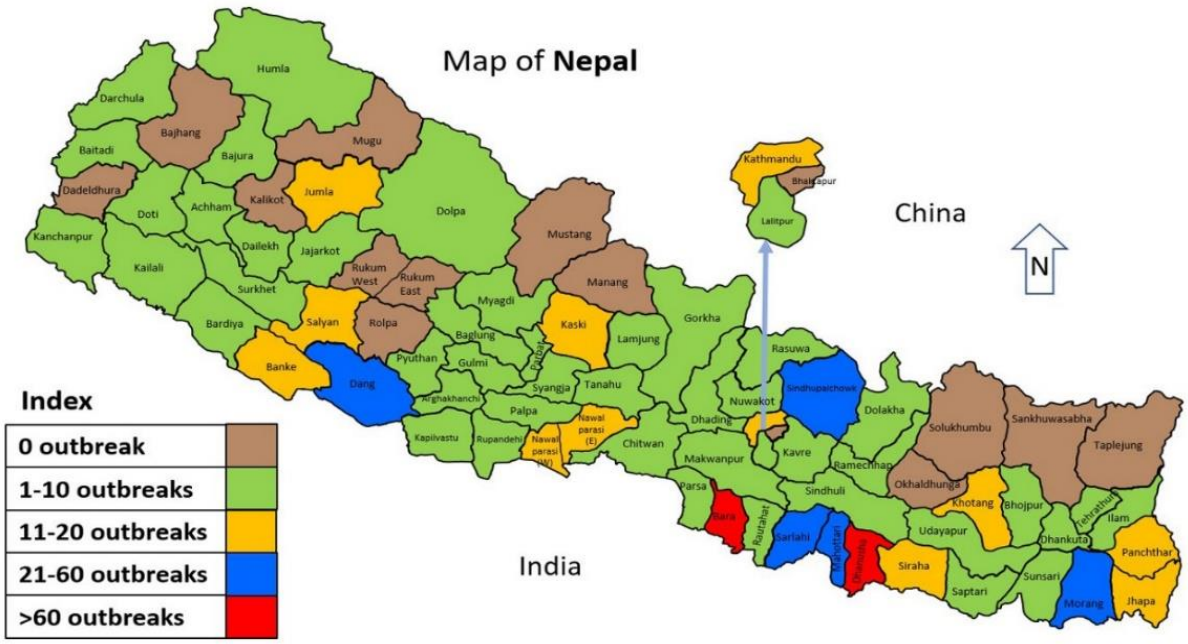


**Fig. 4. District-wise distribution of PPR in Nepal**

*Source: (1) and Situation analysis of Peste des Petits Ruminants (PPR) for past 10 (2008–2017) years in Nepal, Veterinary Epidemiology Section, Animal Disease Investigation and Control Division, Tripureshwor, Kathmandu*

**List 1. Action plan model for campaign**

| Date | Job description | Responsible body |
|---|---|---|
| 15 days before campaign | Publish notification for appointment of vaccinator. To hold a coordination meeting regarding the vaccination campaign with the Goat Traders Federation. | ▪ Related Veterinary Hospital and Livestock Services Expert Center in coordination with the concerned local level<br>▪ Ministry of Agriculture and Livestock Development, Bagmati Province |
| 10 days before campaign | ▪ To appoint the vaccinator in the area of work.<br>▪ Designate the vaccination center as per requirement and request the related ward office for assistance along with the information.<br>▪ Farmers raising more than 20 sheep and goats can be identified and vaccinated at the same place.<br>▪ Production and printing of PPR vaccination cards, campaign logos, jingles, pamphlets and brochures etc. | ▪ Related Veterinary Hospital and Livestock Services Expert Center in coordination with the concerned local level |
| 7 days before campaign | ▪ Spreading propaganda through various media including radio FM newspapers.<br>▪ Storing vaccines and purchasing the necessary materials for vaccination and providing them to the vaccination center.<br>▪ Identify the areas with high risk of disease and determine the first priority location for vaccination.<br>▪ Making the necessary arrangement for insufficient vaccine quantity<br>▪ To inform the relevant local level and security agencies about the vaccination campaign. | ▪ Veterinary hospital and local government<br>▪ Directorate of Livestock and Fisheries Development and Ministry of Agriculture and Livestock development<br>▪ Veterinary hospital |
| One day before campaign | ▪ Press briefing regarding vaccination campaign | ▪ Ministry of Agriculture and Livestock Development, Bagamati Province |
| 1st day of campaign | ▪ Inaugurate the vaccination campaign.<br>▪ | ▪ Ministry of Agriculture and Livestock Development, Bagamati Province |
| 2nd to 7th day | ▪ Expert centers should collect vaccination data from the relevant local animal service branch or vaccination center and send it to the Directorate of Livestock and Fisheries Development. | ▪ Vetrinary Hospital |
| After vaccination campaign | ▪ In order to monitor the efficacy of the vaccine, the relevant laboratory will collect the serum and provide the preliminary test report to the Directorate of Livestock and Fisheries Development located in the province and the Directorate will inform the relevant local level through the Veterinary Hospital and Animal Services Expert Center.<br>▪ Monitoring and follow-up of vaccination work. | ▪ Directorate of Livestock and Fisheries Development, Bagmati Province, related expert centers and Central Livestock Disease Research Laboratory, Tripureshwar, Kathmandu<br>▪ Directorate of Livestock and Fisheries Development and Ministry of Agriculture and Livestock development |

*Source: PPR control action plan, 2021 and 2022*

**Table 1. Vaccination coverage of one week campaign against PPR in year 2021/22 of Bagamati Province Vaccine coverage during a week vaccination campaign in the Year 2021/22**

| S.N. | District | Vaccine available in 2021/22 | Vaccinated number in 2021/22 | Coverage Rate | Remarks |
|---|---|---|---|---|---|
| 1 | Bhaktpur | 30000 | 6181 | 21 | |
| 2 | Chitwan | 127000 | 71418 | 56 | |
| 3 | Dhading | 107000 | 83270 | 78 | |
| 4 | Dolakha | 96000 | 94998 | 99 | |
| 5 | Kathmandu | 36000 | 31557 | 88 | |
| 6 | Kavre | 165000 | 99182 | 60 | |
| 7 | Lalitpur | 56000 | 27587 | 49 | |
| 8 | Makwanpur | 176000 | 166423 | 95 | |
| 9 | Nuwakot | 220000 | 120019 | 55 | |
| 10 | Ramechhap | 102000 | 44610 | 44 | |
| 11 | Rasuwa | 29000 | 23165 | 80 | |
| 12 | sindhuli | 30000 | 45825 | 153 | Local governments also allocated budget for vaccine |
| 13 | Sindupalchowk | 16000 | 15952 | 100 | |
| | Total | 1190000 | 830187 | 70 | |

**Table 2. Vaccination coverage of one week campaign against PPR in year 2022/23 of Bagamati Province Vaccine coverage during a week vaccination campaign in the Year 2022/23**

| S.N. | District | Vaccine available in 2022/23 | Vaccinated number in 2022/23 | Coverage Rate | Remarks |
|---|---|---|---|---|---|
| 1 | Bhaktpur | 32000 | 4153 | 13 | |
| 2 | Chitwan | 135000 | 86802 | 64 | |
| 3 | Dhading | 114000 | 97407 | 85 | |
| 4 | Dolakha | 102000 | 84176 | 83 | |
| 5 | Kathmandu | 38000 | 40143 | 106 | Local governments also work together. |
| 6 | Kavre | 176000 | 132270 | 75 | |
| 7 | Lalitpur | 60000 | 44513 | 74 | |
| 8 | Makwanpur | 188000 | 159007 | 85 | |
| 9 | Nuwakot | 235000 | 145281 | 62 | |
| 10 | Ramechhap | 109000 | 106202 | 97 | |
| 11 | Rasuwa | 31000 | 30440 | 98 | |
| 12 | sindhuli | 32000 | 30400 | 95 | |
| 13 | Sindupalchowk | 17000 | 19135 | 113 | Local governments also work together. |
| | Total | 1269000 | 979929 | 77 | |

## 6.2 Seromonitoring

Seromonitoring was performed after 21 days of campaign and with collaboration of Central Veterinary Laboratory, Tripureshswor and they have provided the following report as can be seen in Table 3.

In the year 2021/22, after the vaccination campaign was conducted in all the districts of Bagmati Province, there has been only 2 outbreak notification of PPR disease infection in this province till 14$^{th}$ of March, 2023 which in the sense, proving the weekly campaign vaccination against PPR to be successful.

**Table 3. Report provided by central veterinary laboratory to Bagamati province on seromonitoring of PPR**

| S.N. | District | Seroconversion percentage 2021/22 | Seroconversion percentage 2022/23 |
|---|---|---|---|
| 1 | Chitwan | 92.66 | 59 |
| 2 | Dhading | 83.66 | 54.93 |
| 3 | Dolakha | 85.37 | |
| 4 | Kathmandu | 85.9 | |
| 5 | Kavre | 61.5 | |
| 6 | Lalitpur | | 74.29 |
| 7 | Makwanpur | 87.37 | 71 |
| 8 | Nuwakot | 92 | |
| 9 | Ramechhap | 88.83 | |
| 10 | Rasuwa | 52.53 | |
| 11 | Sindhuli | 43.59 | |

## 7. CONCLUSION

In conclusion, Bagamati Province, a potential province for goat and sheep farming with a total number of 89014 sheep and 2593899 goats and total meat from sheep and goats of 14096 metric tons in the year 2021–2022, has conducted the one-week vaccination campaign throughout the districts at the same time interval for two successive fiscal years, 2021 and 2022, aiming to facilitate systematic and effective immunization programs against PPR in Bagamati Province. The Ministry of Agriculture and Livestock Development had approved the action plan model for the campaign. The collaborative efforts of the federal government, the Ministry of Agriculture and Livestock Development, Bagamati Province, the Directorate of Livestock and Fisheries Development, the Veterinary Hospital and Livestock Services Expert Center, and related local governments have led to a significant increase in vaccine uptake. The campaign's strategic planning, efficient execution, and accessibility have played pivotal roles in achieving widespread immunization coverage within a short timeframe. With a 70% coverage rate in FY 2021/22 and 77% in FY 2022/23, the vaccination campaign should be considered successful. Seromonitoring was performed by the central veterinary laboratory in coordination with district veterinary, and the results showed it to be effective. Prior to the campaign, there was a continuous outbreak of PPR throughout the districts of Bagamati Province. Due to the campaign, only two outbreaks have been reported till the date of the study, which in turn proved that the vaccination campaign was functional and has been a resounding success, effectively reaching a substantial portion of the target population. As a result, the community is now better protected against the infectious disease PPR, laying the foundation for improved animal health outcomes in the future. Continued momentum in such campaigns is crucial to ensuring the longevity of this positive impact and fostering healthier and more quality products from sheep and goats.

## 8. RECOMMENDATIONS

Addressing these issues would necessitate a multifaceted approach combining government agencies, non-governmental organizations, and foreign partners. Some potential strategies include:

- Increasing Vaccine Production: Collaborating with vaccine manufacturers to increase production and maintain a consistent supply of vaccines.
- Infrastructure Improvement: investing in infrastructure to facilitate vaccine distribution to remote and hard-to-reach areas
- Vaccinator Training: Fast-track the training and deployment of veterinary technician to serve as vaccinators.
- Communication efforts: Starting information and awareness efforts to educate the public about the importance of vaccination and the details of the campaign.
- Adapting to Conditions: Flexibility in campaign planning to adapt to changing COVID-19 transmission rates and related restrictions

Successfully conducting a vaccination campaign requires a well-coordinated effort that addresses

the unique challenges posed by the pandemic and the specific circumstances of each region.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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