Royal Government of Bhutan
Ministry of Agriculture and Forests
Department of Livestock
National Centre for Animal Health
Serbithang, Thimphu

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STATUS OF NOTIFIABLE ANIMAL DISEASES IN BHUTAN (2019)

Volume 6

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ROYAL GOVERNMENT OF BHUTAN
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FOREWORD

This report, Status of Notifiable Animal Diseases in Bhutan for 2019, compiled by Disease Prevention and Control Unit (DPCU) of the National Centre for Animal Health (NCAH), provides an overview of all notifiable – zoonotic and non-zoonotic – animal diseases reported in the country since 1996, and 2019 in particular. The main purpose of this bulletin is to provide an update on the notifiable animal disease situation in the country for information to all stakeholders including veterinarians, veterinary paraprofessionals, central and regional farms, and policymakers. The information contained in this report could also be used for developing preparedness and response plans by the concerned government agencies responsible for disease prevention and control.

Firstly, I would like to thank the Director General of Department of Livestock and the Chief Veterinary Officer, Animal Health Division, for their support and guidance. I would also like to thank the Regional Director of all Regional Livestock Development Centres (RLDCs); the Programme Director of Commodity Centres; Dzongkhag Livestock Officers, Veterinary Officers and Veterinary Paraprofessionals of 20 Dzongkhags; and the Managers of Central and Regional livestock farms, for their kind support and cooperation in implementation of animal disease prevention and outbreak control programmes in the field.

And also, I would like to acknowledge all the TAD*Info* focal persons at the RLDCs, National, City and Thromde Veterinary Hospitals (NVH, CVH and TVH) and Dzongkhag Veterinary Hospitals (DVH) for actively monitoring and reporting disease outbreaks information to the concerned authorities.

Lastly, I would like to thank Disease Prevention and Control Unit (DPCU) for taking the lead in producing this annual report.

The information in this report can be used as baseline data for strategic plan development, policy interventions and other related programmes.

We wish you a happy reading!

Dr RB Gurung
Programme Director

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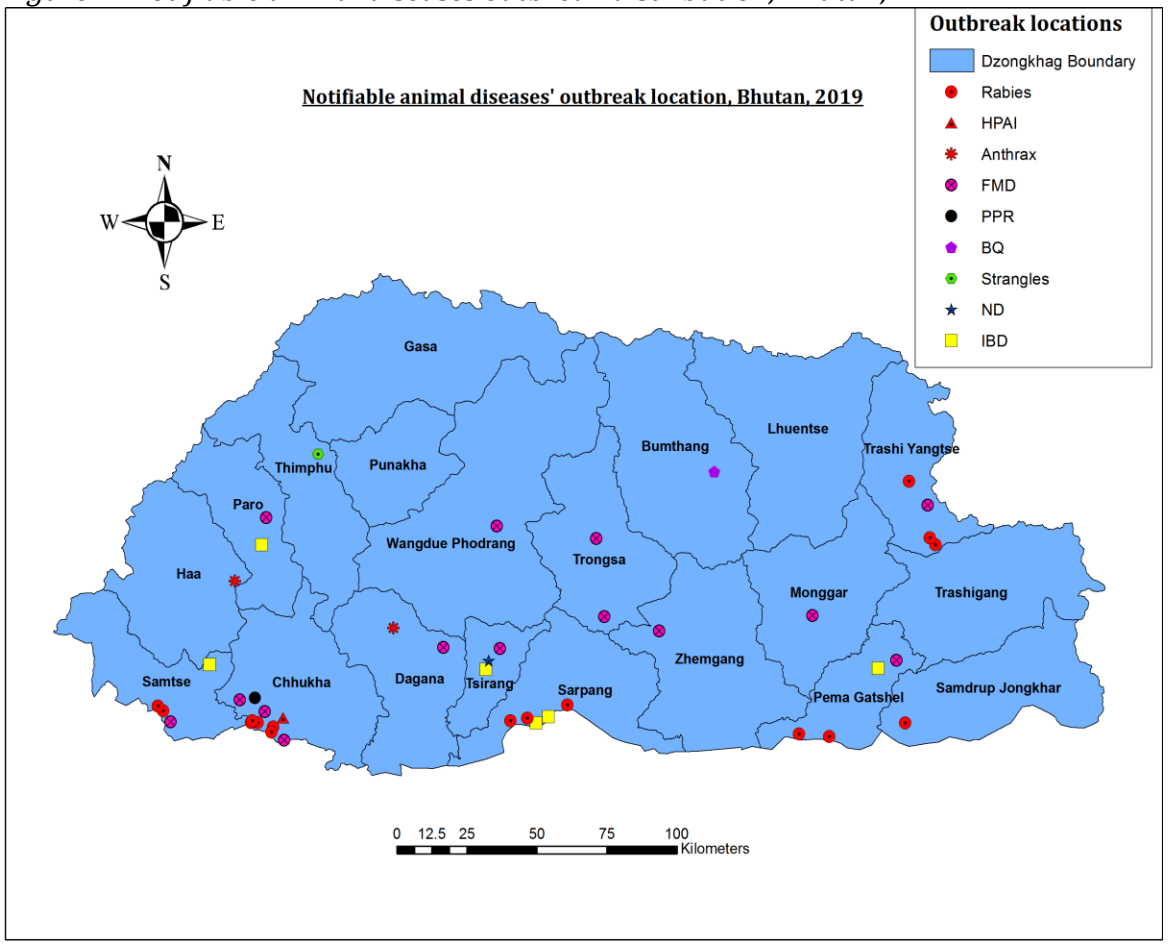
1. INTRODUCTION

Notifiable animal disease means a zoonotic or non-zoonotic animal disease listed by the veterinary administration in the country (Table 1), and that, as soon as detected or suspected, must be reported to the nearest animal health centres by the fastest means of communication. This report presents a brief descriptive analysis of the reported notifiable animal diseases during the calendar year 2019 (January-December), and the trend of outbreaks since 1996. The data used in this analysis were retrieved from the Veterinary Information System database (VIS), 1996 to 2010; the online Transboundary Animal Disease Information System (TAD*info* database), 2011-2019; and the offline disease outbreak database maintained at the Disease Prevention and Control Unit (DPCU), NCAH – prepared in reference to the flash and follow up reports submitted by the disease outbreak investigation team in the field.

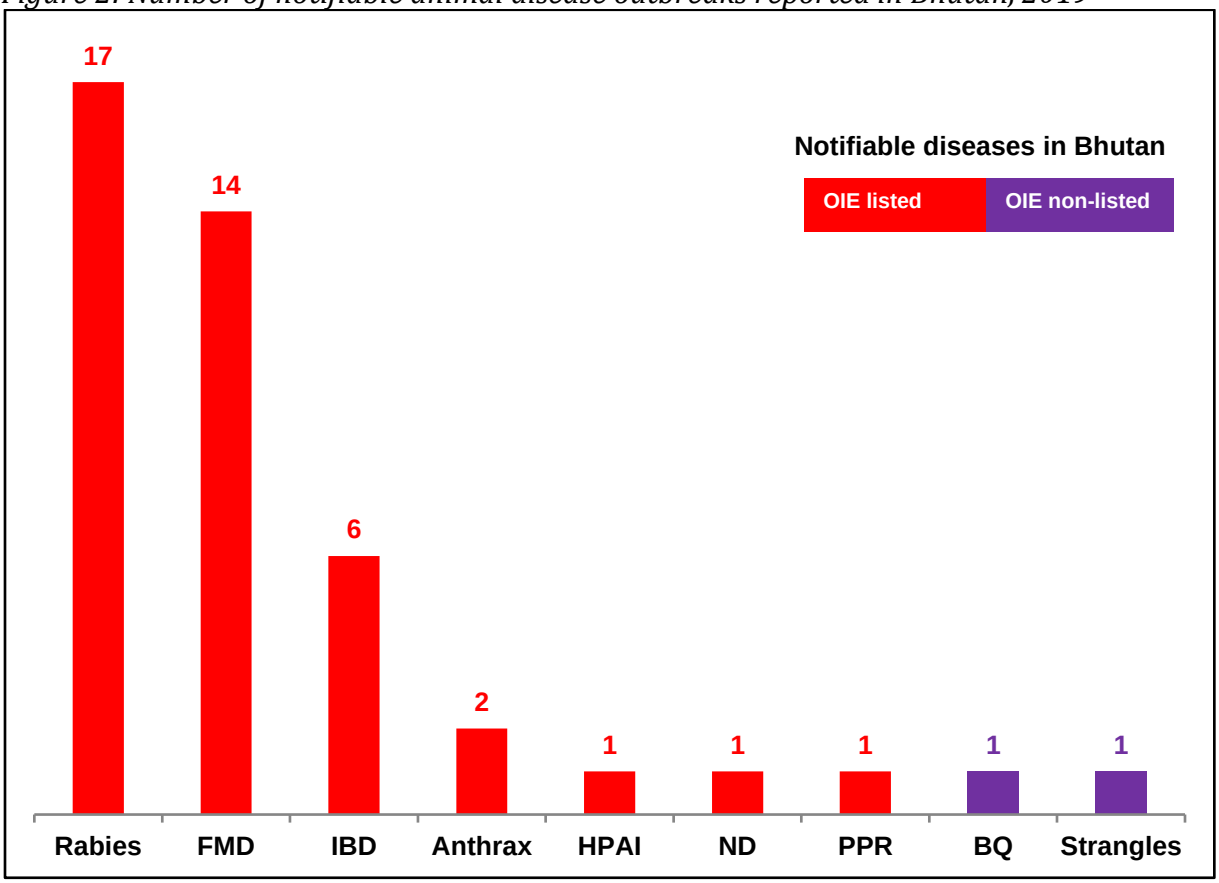
Figure 1: Notifiable animal diseases outbreak distribution, Bhutan, 2019



During the calendar year 2019, a total of 44 separate animal disease outbreaks were reported from across the country, of which rabies (17) and Foot and mouth disease (14)

were the major disease outbreaks reported – forming 72 percent of the total outbreaks (Figure 1). 17 dzongkhags, except Lhuentse, Punakha and Gasa, reported outbreak of different animal diseases, affecting 6,614 domestic chickens and 866 cattle, horses, yaks, goats, dogs and cats combined. During these outbreaks, a total of 4,344 domestic chickens and 85 other livestock species died.

Figure 2: Number of notifiable animal disease outbreaks reported in Bhutan, 2019



As per the Livestock Rules and Regulations of Bhutan 2017, there are 18 notifiable and 19 zoonotic diseases enlisted under the annexure II and III (Table 1) of the – which on mere suspicion must be reported to the nearest animal health centre or any relevant offices through the fastest means of communication.

Table 1: Notifiable and Zoonotic animal diseases of Bhutan, LRR 2017

Notifiable Diseases	**Zoonotic Diseases**
Anthrax	Anthrax
Avian Influenza	Brucellosis
Avian Leucosis Complex	Campylobacteriosis
Black Quarter	Crimean Congo Hemorrhagic Fever (CCHF)
Brucellosis	Colibacillosis(*E.Coli*)
Classical Swine Fever (CSF)	Cysticercosis
Contagious caprine pleuropneumonia (CCPP)	Dermatomycosis
Equine Influenza	Ehrlichiosis
Foot and Mouth disease (FMD)	Highly Pathogenic Avian Influenza (HPAI)
Glanders	Hydatidosis
Hemorrhagic Septicaemia (HS)	Leptospirosis
Infectious Bursal Disease (IBD)	Leishmaniasis
Marek's Disease (MD)	Listeriosis
Newcastle Disease (ND)	Rabies
Peste des petits ruminants (PPR)	Salmonellosis
Porcine Reproductive and Respiratory Syndrome (PRRS)	Trichenellosis
Rabies	Tuberculosis
Strangles	Toxoplasmosis
	Toxocariasis

To guide field professionals, concerned offices and other stakeholders for prevention and control of notifiable and zoonotic diseases, and other priority diseases; following official plan documents are in place:

- National Foot and Mouth Disease Prevention and Control Plan, 3rd Ed, 2016
- National Rabies Prevention and Control Plan, 2nd Ed, 2017
- National Influenza Pandemic Preparedness Plans and Standard Operating Procedures, 2014
- Guidelines for Preparedness, Surveillance and Control of Anthrax in Human and Animals in Bhutan, 2013
- National Gid Disease Prevention and Control Plan, 2016

2. MULTIPLE SPECIES DISEASES

2.1 FOOT AND MOUTH DISEASE (FMD)

2.1.1 The Disease

FMD is caused by a virus of the family Picornaviridae, genus *Aphthovirus*. There are seven immunologically distinct serotypes: A, O, C, SAT1, SAT2, SAT3, and Asia1, and they do not confer cross-immunity. Mutation from error-prone RNA replication, recombination, and host selection generate constant new FMDV variants.

All domestic cloven-hoofed animals are susceptible, including cattle, pigs, sheep, goats, and buffalo, and all wild cloven-hoofed animals are also susceptible, including deer, antelope, wild pigs, elephant, giraffe, and camelids. African buffalo are the only wildlife species to play a significant role in the epidemiology of FMD.
Strains of FMD virus that infect cattle have been isolated from wild pigs and deer. Rats, mice, guinea pigs and armadillos can be infected experimentally.
Transmission of the disease occurs as follows:

- Direct contact between infected and susceptible animals.
- Direct contact of susceptible animals with contaminated inanimate objects (hands, footwear, clothing, vehicles, etc.).
- Consumption (primarily by pigs) of untreated contaminated meat products (swill feeding).
- Ingestion of contaminated milk (by calves).
- Artificial insemination with contaminated semen.
- Inhalation of infectious aerosols.
- Airborne, especially temperate zones (up to 60 km overland).

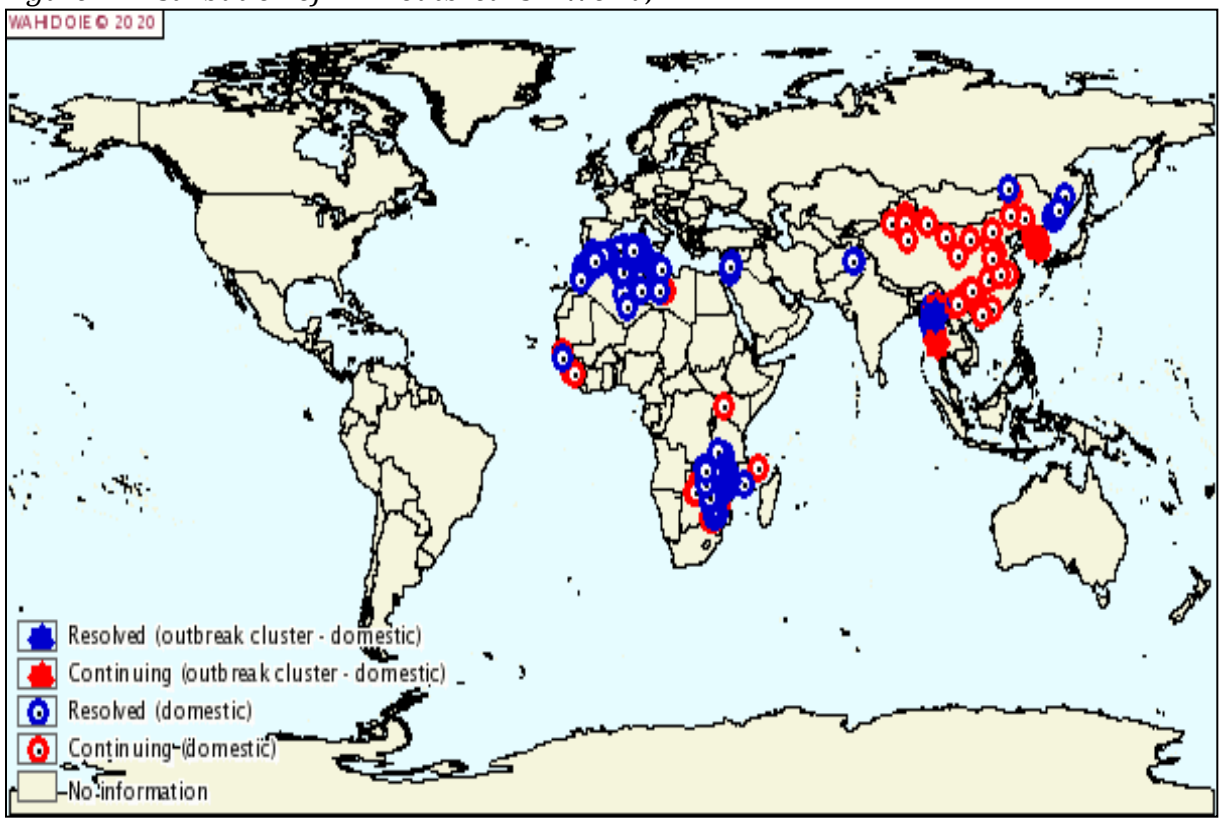
Incubation period is 2–14 days, and for the purposes of the OIE Terrestrial Animal Health Code, the incubation period for FMD is 14 days.
The severity of clinical signs varies with the strain of virus, exposure dose, age and breed of animal, host species, and degree of host immunity and signs can range from mild or in apparent to severe. Morbidity may approach 100%, and mortality in general is low in adult animals (1–5%) but higher in young calves, lambs and piglets (20% or higher). Recovery in uncomplicated cases is usually about two weeks. Generally observed signs of the disease are pyrexia, anorexia, shivering, reduction in milk production, smacking of the lips, grinding of the teeth, drooling, lameness, etc.
Typical lesions are vesicles or blisters on the tongue, dental pad, gums, cheek, hard and soft palate, lips, nostrils, muzzle, coronary bands, teats, udder, snout of pigs, corium of dewclaws and inter-digital spaces. During postmortem, erosions on rumen pillars in

ruminants and gray or yellow streaking in the heart from degeneration and necrosis of the myocardium in young animals of all species ('tiger heart') will be observed.

2.1.2 Geographical Distribution

Foot and mouth disease outbreak distribution in the world during the calendar year 2019 is as shown in the figure below.

Figure 3: Distribution of FMD outbreaks – World, 2019



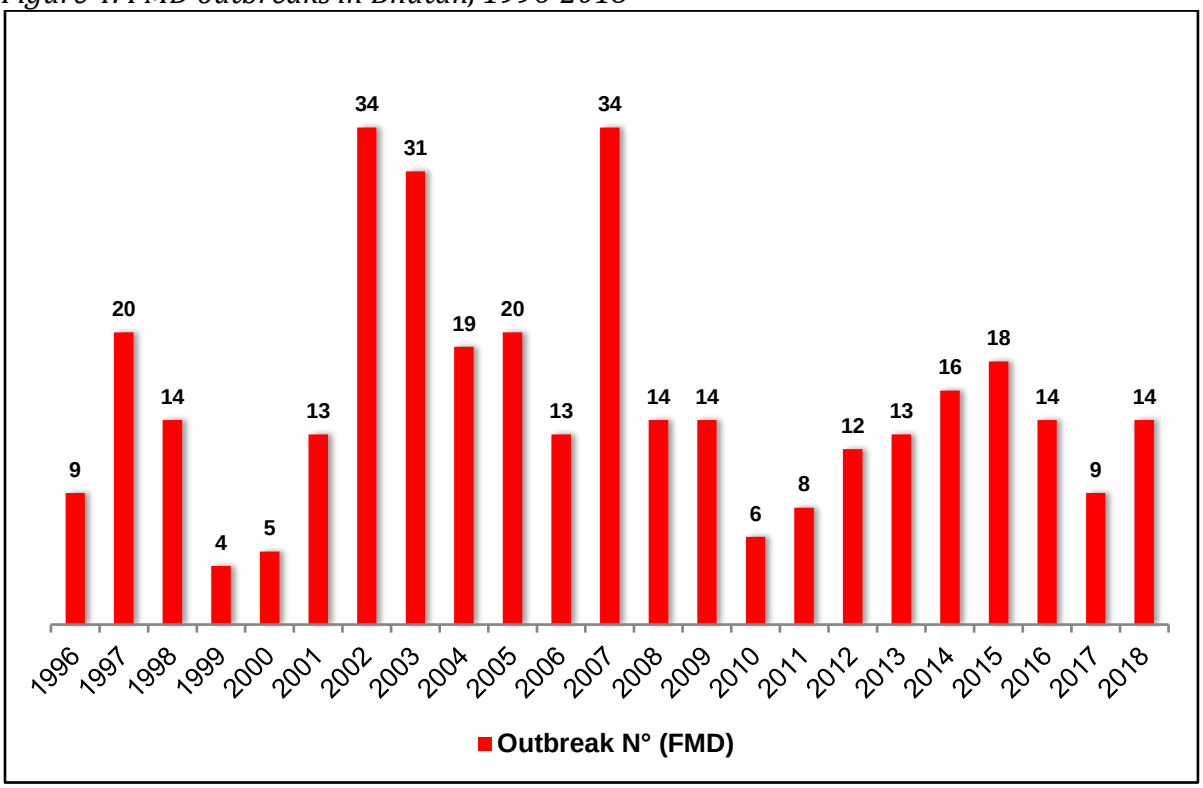
Source: WAHIS, January 2019

2.1.3 Past outbreaks in Bhutan

FMD is endemic in Bhutan and is reported from almost all parts of the country (Figure 4). Serotype O is the principal FMDV serotype involved in Bhutan, consistent with the disease epidemiology in the neighboring countries in the region (Figure 6).

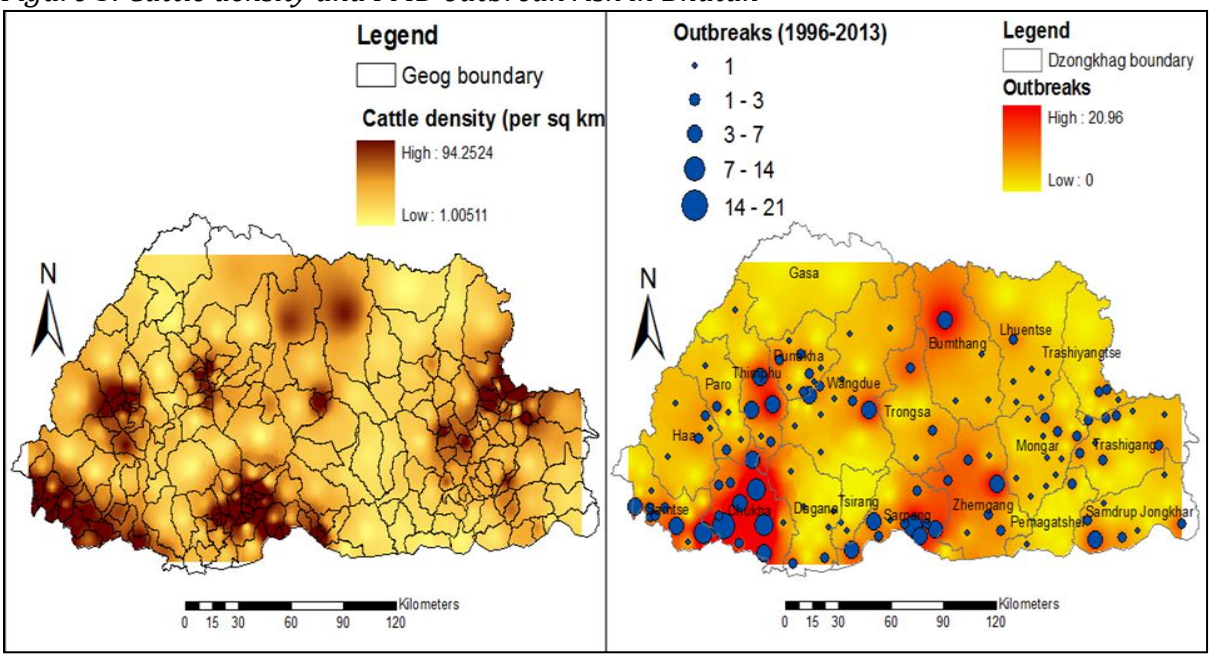
Foot and mouth disease outbreaks were recorded since 1996; a total of 354 separate outbreaks were reported till 2018, i.e., during this period, an average of 15 outbreaks was reported annually.

Figure 4: FMD outbreaks in Bhutan, 1996-2018



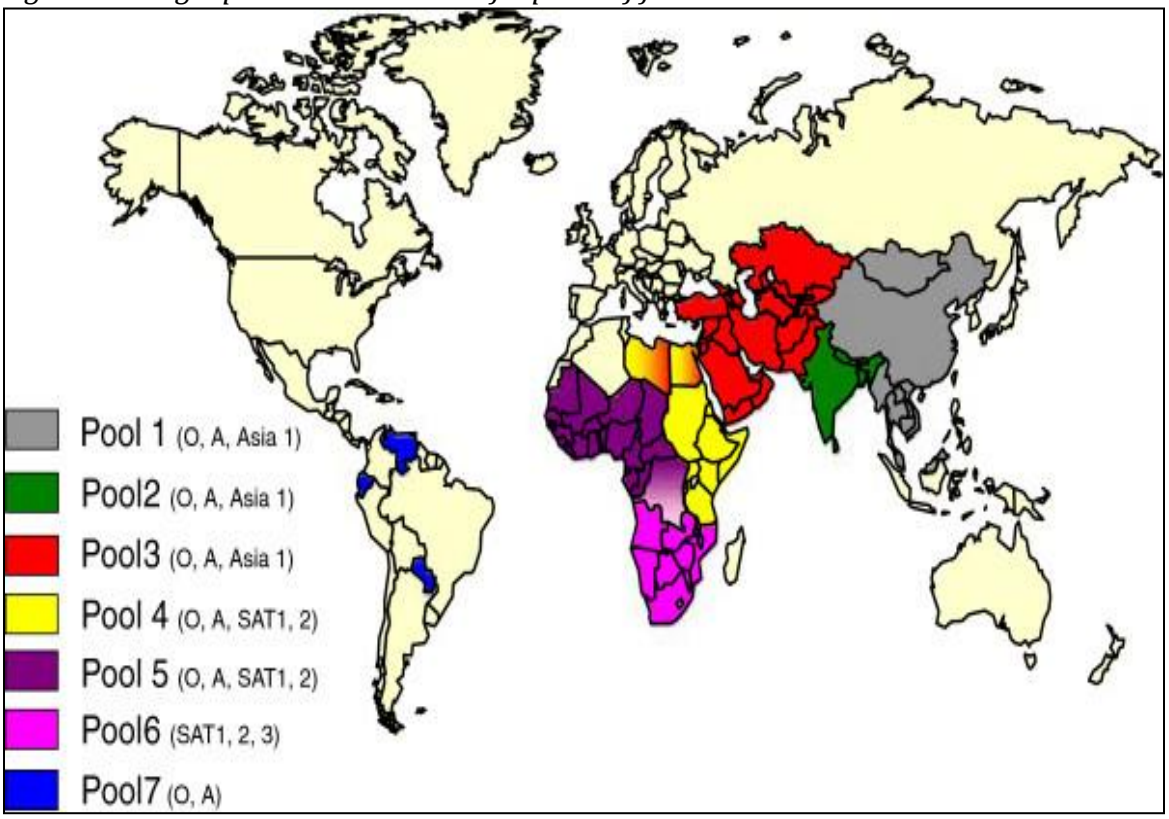
Source: Status of notifiable animal diseases in Bhutan, 2018

Figure 5: Cattle density and FMD outbreak risk in Bhutan



Source: Dr Tenzin

Figure 6: Geographical distribution of 7 pools of foot-and mouth disease viruses



Source: (Jamal & Belsham, 2013)

2.1.4 Current status in Bhutan

FMD is endemic in Bhutan and is reported from almost all parts of the country. Serotype O is the principal FMDV serotype involved in Bhutan, consistent with the disease epidemiology in the neighboring countries in the region.

During the calendar year 2019, a total of fourteen outbreaks of Foot and mouth disease were reported, affecting 647 cattle, 42 yaks and 3 goats, of which 3 cattle and 1 goat died (mortality rate = 0.6%) (See Annexure I). FMD outbreaks were reported in eleven dzongkhags: Samtse, Chhukha, Paro, Dagana, Wangdue Phodrang, Tsirang, Trongsa, Zhemgang, Mpnggar, Pema Gatshel and Trashi Yangtse (Figure 7).

In 2019, four FMD outbreaks were recorded in January month, followed by two outbreaks each in February and April; no outbreaks were reported in October, November and December month (Figure 8).

Figure 7: FMD outbreaks in Bhutan, 2019

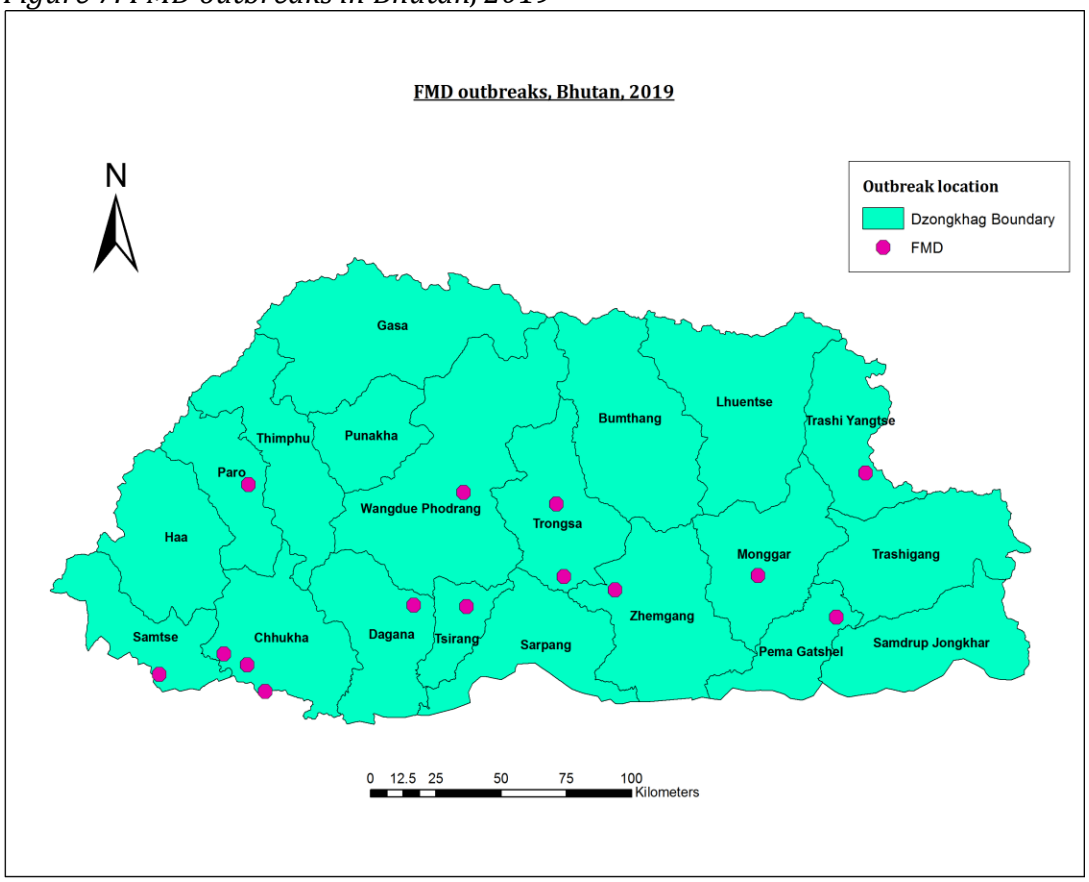
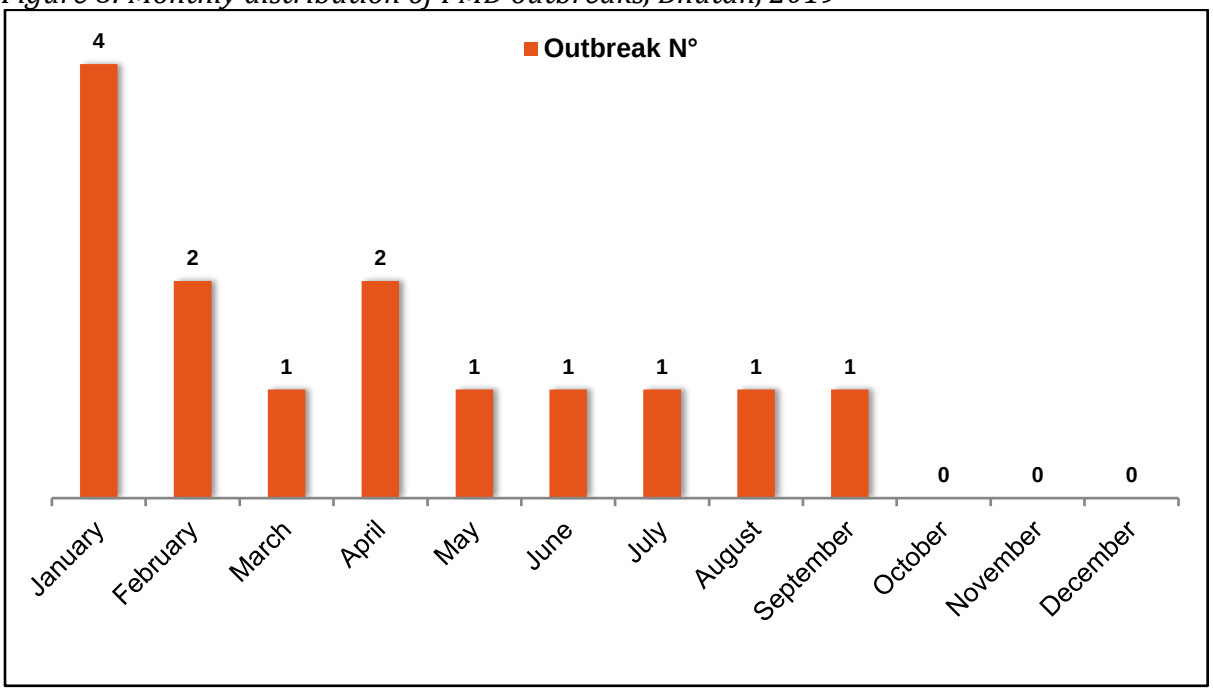
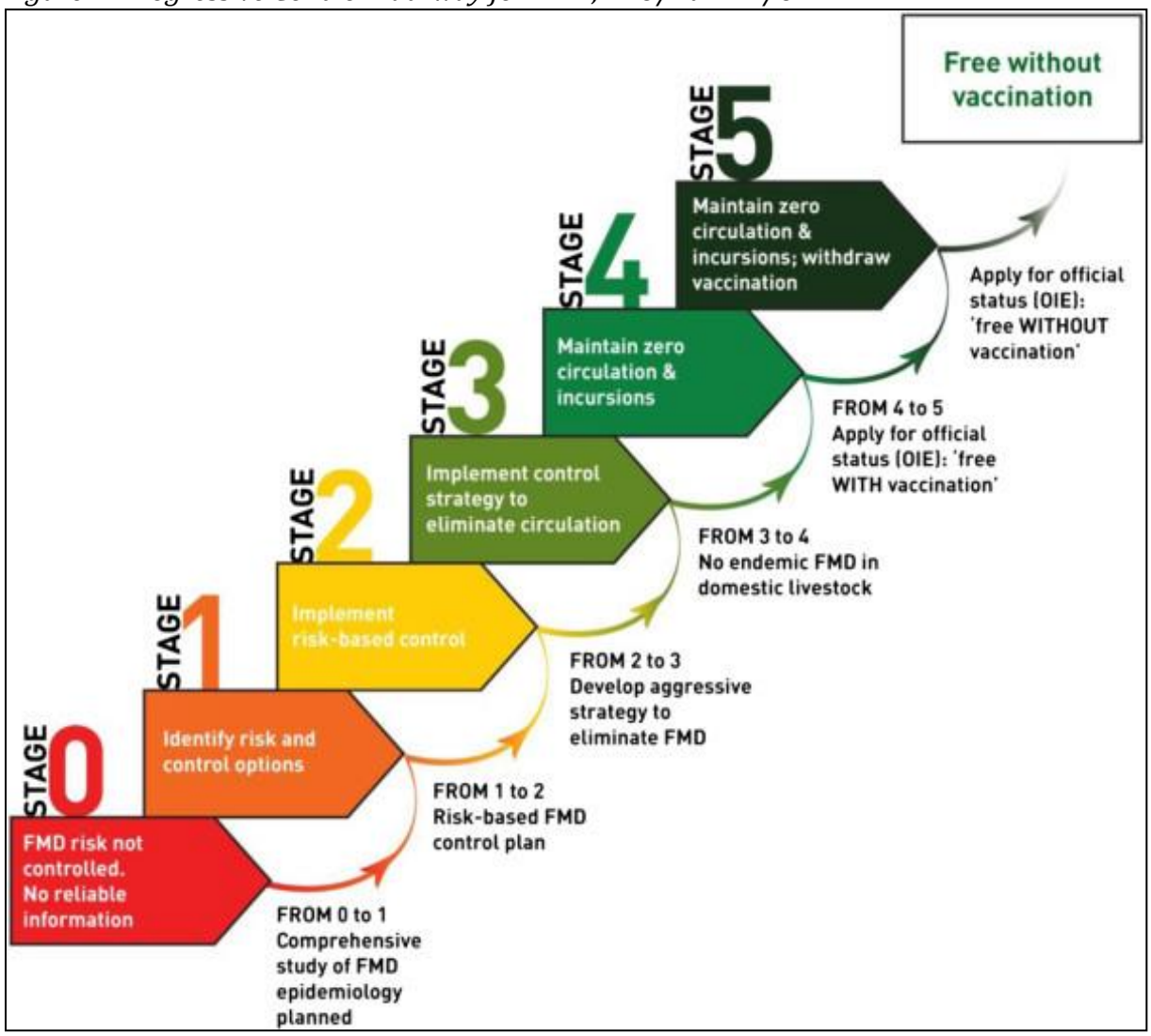


Figure 8: Monthly distribution of FMD outbreaks, Bhutan, 2019



A Progressive Control Pathway (PCP) approach for control of FMD is being implemented in the country with an ultimate objective to enable Bhutan reach Stage 3 of the PCP by the year 2020.

Figure 9: Progressive Control Pathway for FMD, FAO/EuFMD/OIE



2.2 RABIES

2.2.1 The Disease

Rabies is caused by neurotropic RNA viruses of the genus *Lyssavirus* in the family Rhabdoviridae of the order Mononegavirales and is transmissible to all mammals. Twelve distinct *lyssavirus* species can be distinguished within the genus, namely classical rabies virus (RABV), Lagos bat virus (LBV), Mokola virus (MOKV), Duvenhage virus (DUVV), European bat lyssaviruses type-1 (EBLV-1) and type-2 (EBLV-2), Australian bat lyssavirus (ABLV), Aravan virus (ARAV), Khujand virus (KHUV), Irkut virus (IRKV), West Caucasian bat virus (WCBV), Shimoni bat virus (SHIBV). Of all the lyssaviruses known to date, RABV is the most important one for public and animal health.

All mammals are susceptible to varying degrees, particularly members of the order Carnivora and Chiroptera. A broad spectrum of animals can be infected experimentally with rabies virus.

Rabies virus can be transmitted between mammals, whether they belong to the same or different species. It is primarily transmitted through the saliva of an infected animal - infection occurs primarily via bite wounds, or infected saliva entering an open cut or wound or mucous membrane, such as those in the mouth, nasal cavity, or eyes.

Occasional, albeit rare, transmission by inhalation of infected aerosol has been described.

The incubation period varies from a few days to more than 7 years. For the purposes of the OIE Terrestrial Code the incubation period is 6 months.

Clinical observations may only lead to a suspicion of rabies because signs of the disease are not pathognomonic and may vary greatly from one animal to another.

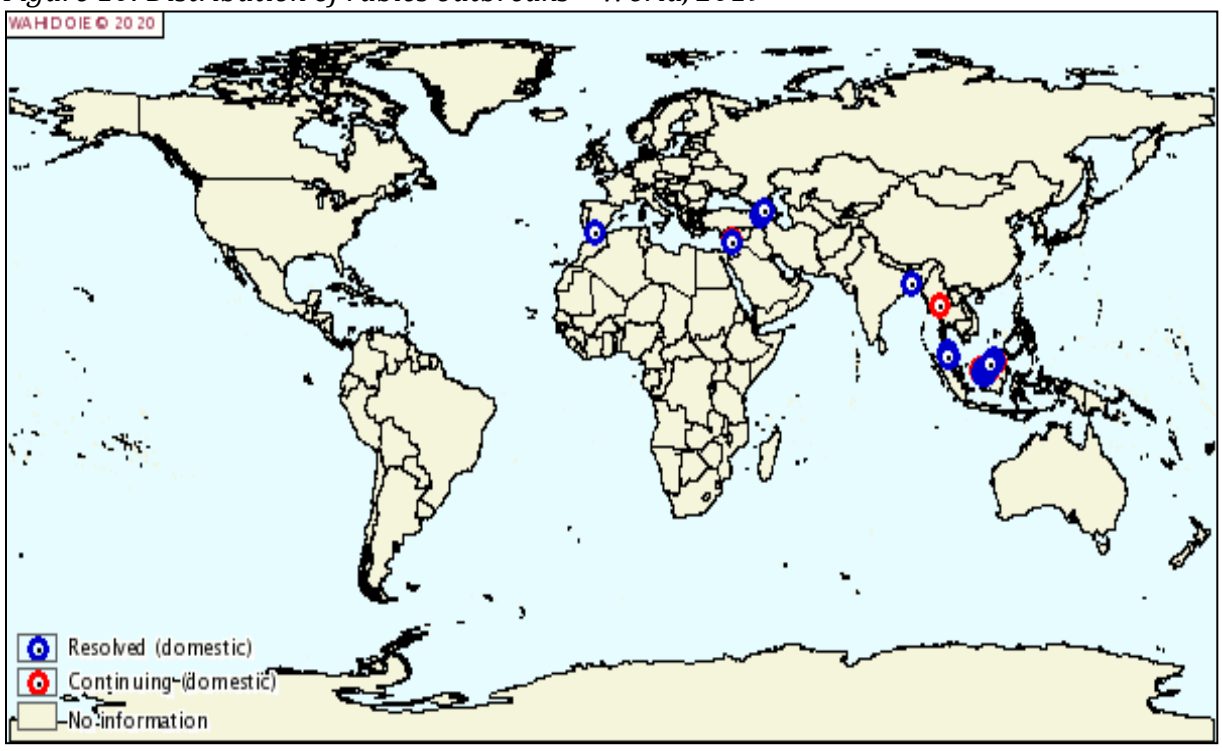
All lyssa viruses cause clinical disease indistinguishable from classical rabies. Typical signs include sudden behavioural changes that can lead to increased aggression and progressive paralysis leading to death. Clinical rabies could be presented in two different forms: *furious rabies* when animals show aggressive behaviour, and *dumb or paralytic rabies* that refers to infected animals in which the behavioural changes are minimal, and the disease is manifested principally by paralysis.

The typical histological signs, found in the central nervous system, are multifocal, mild, polioencephalo-myelitis and craniospinal ganglionitis with mononuclear perivascular infiltrates, diffuse glial proliferation, regressive changes in neuronal cells and glial nodules. Negri bodies can be seen in some but not all cases.

2.2.2 Geographical Distribution

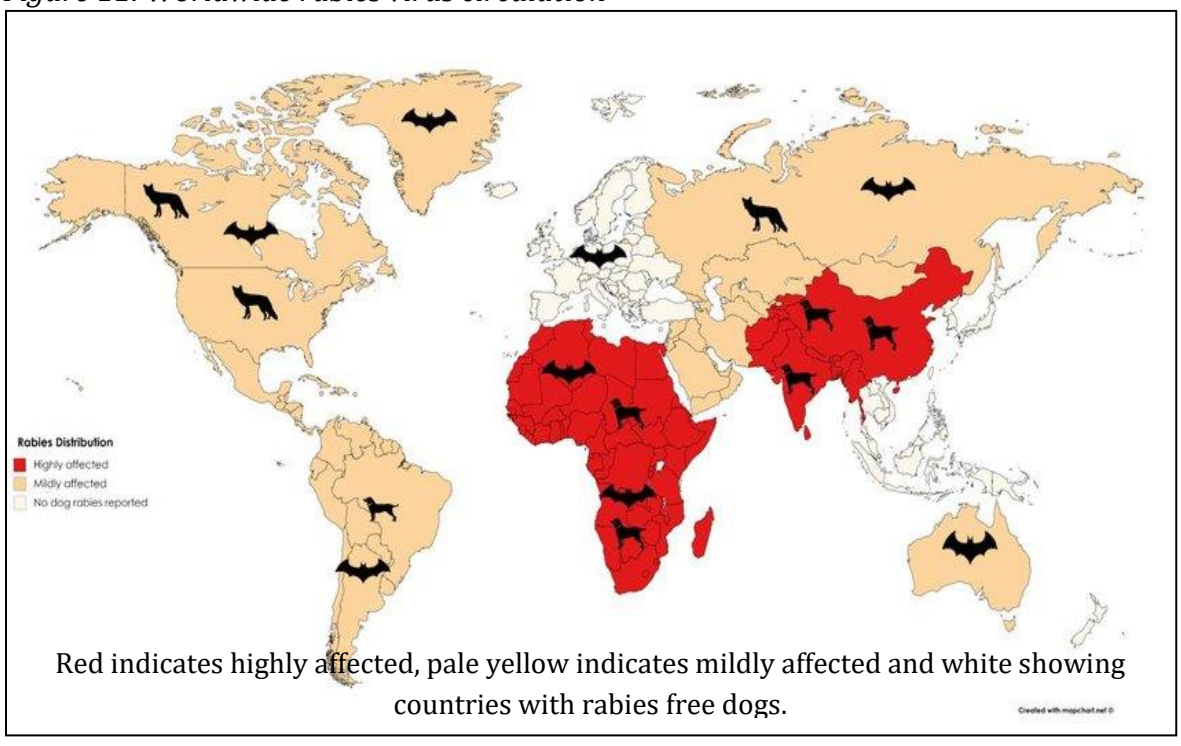
Rabies outbreak distribution in the world during the calendar year 2019 is as shown in the figure below.

Figure 10: Distribution of rabies outbreaks – World, 2019



Source: WAHIS, January 2020

Figure 11: Worldwide rabies virus circulation



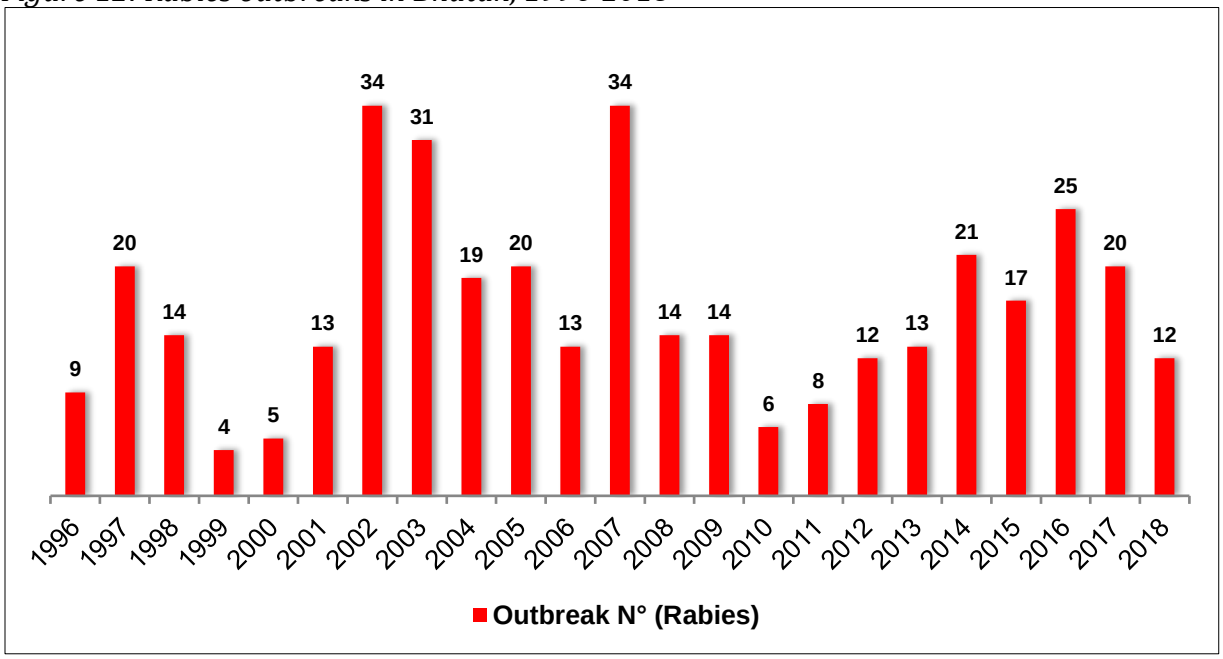
Red indicates highly affected, pale yellow indicates mildly affected and white showing countries with rabies free dogs.

Source: (Abraham et al., 2017)

2.2.3 Past Outbreaks in Bhutan

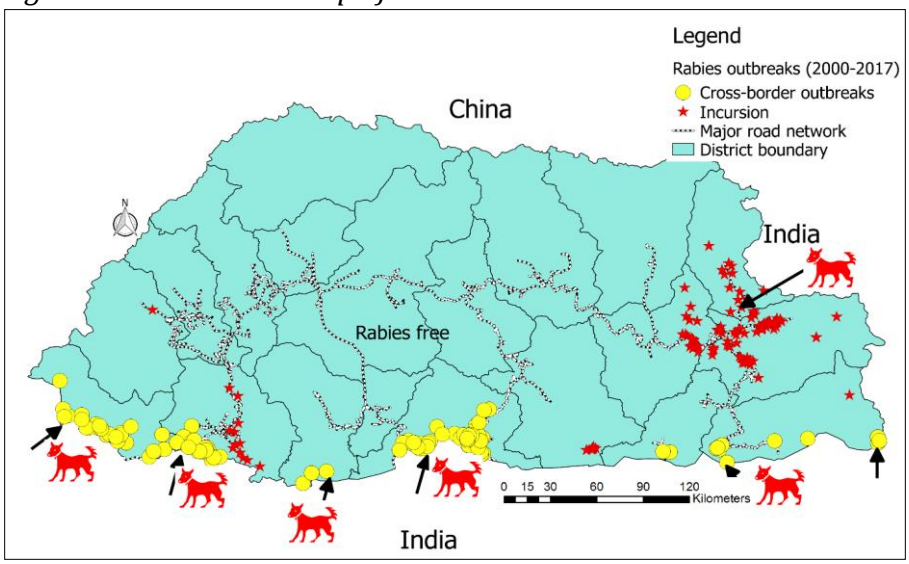
Since 1996, till 2018, a total of 378 separate outbreaks of rabies (annual average of 16 outbreaks) were reported from across the country (Figure 12) – affecting mainly the southern and eastern districts of Bhutan and further incursion, as shown in Figure 13 which was based on the rabies cases reported between 2000 and 2017.

Figure 12: Rabies outbreaks in Bhutan, 1996-2018



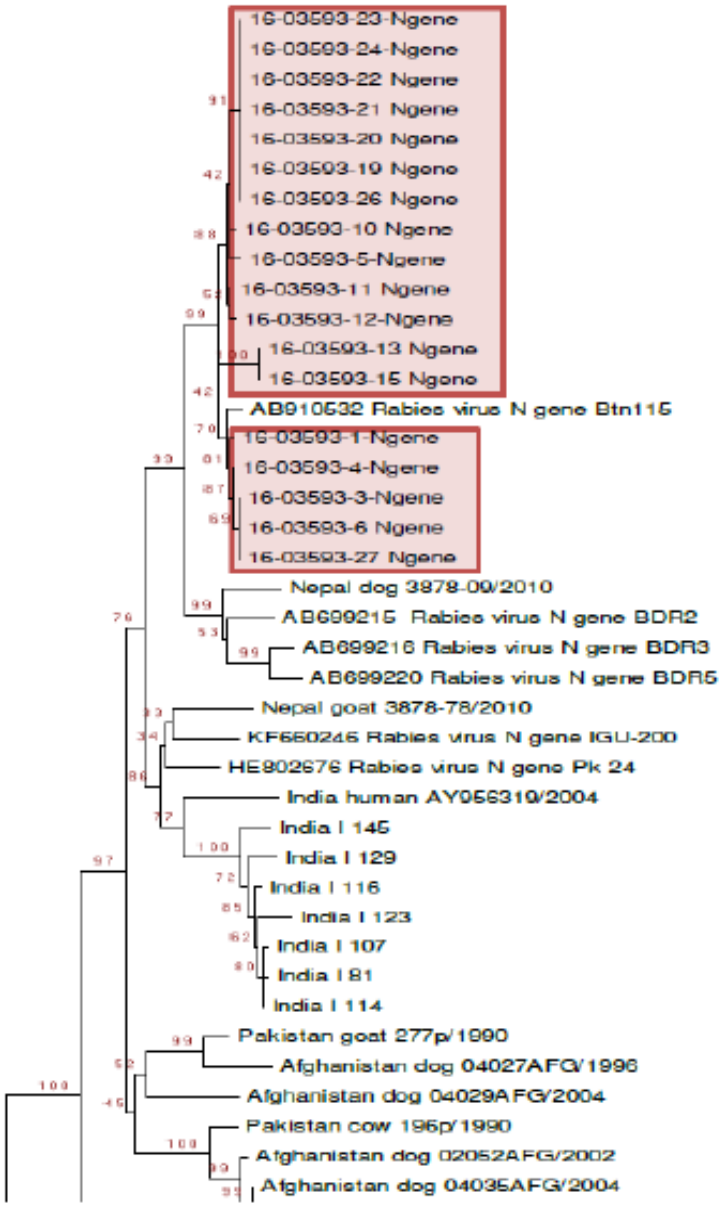
Source: Status of notifiable animal diseases in Bhutan, 2018

Figure 13: Rabies risk map of Bhutan



Source: Dr Tenzin

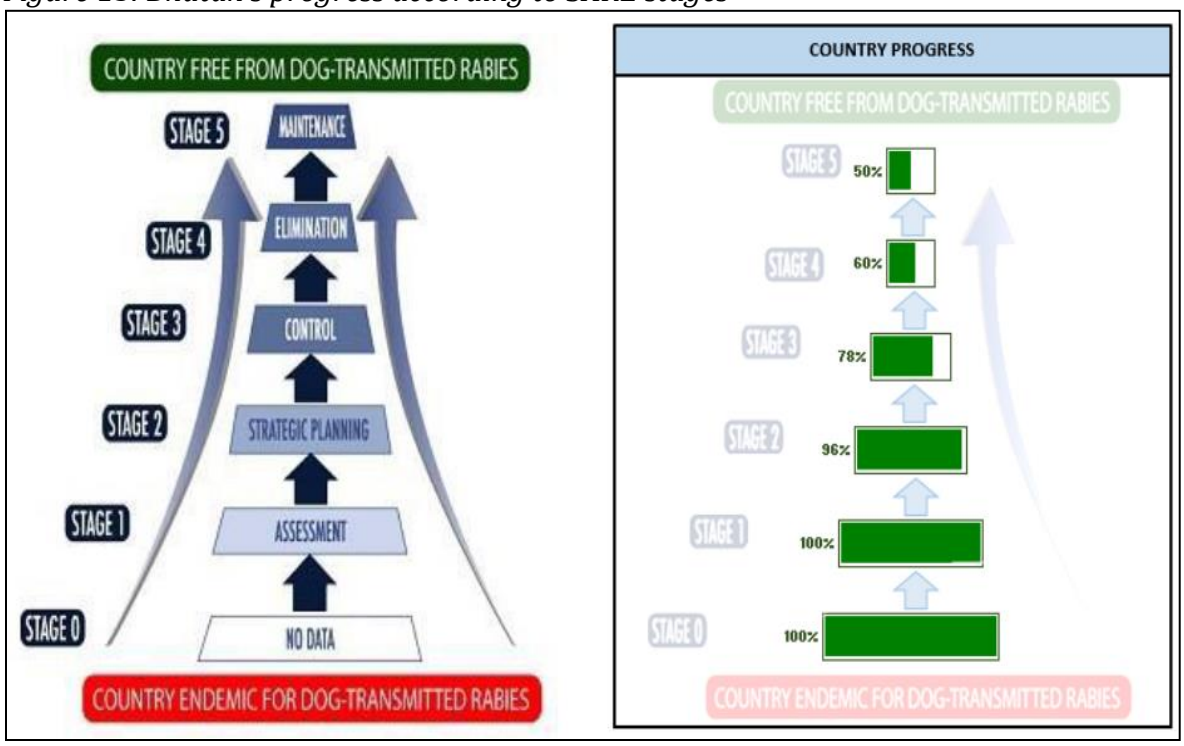
Figure 14: Phylogenetic analysis of rabies virus



Phylogenetic analysis of rabies virus based on N gene indicates that Bhutan viruses belong to the Arctic-related clade which is widely circulating in northern India. (Tenzin et al., 2011)

In humans, 17 deaths due to rabies had been reported between 2006 and 2016 with only one death in 2016. No human rabies cases were reported during 2014, 2015 and 2017 and 2018. In line with the global target of achieving zero dog-mediated human rabies death by 2030; Bhutan implements various activities enlisted in the Stepwise Approach Towards Rabies Elimination (SARE), the planning tool developed by FAO, GARC and WHO to support countries in planning the progressive control of dog-transmitted human rabies. For having achieved several stage-specific activities, Bhutan is believed to have progressed to stage 3.5.

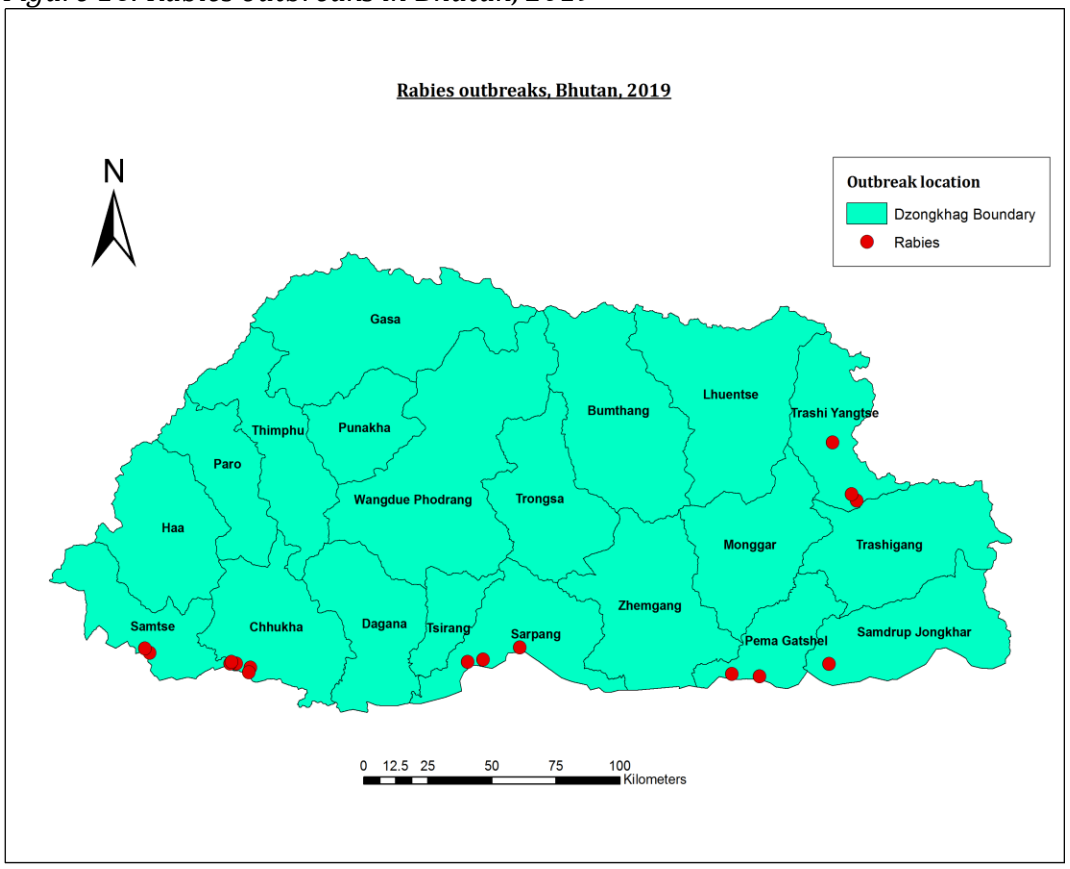
Figure 15: Bhutan's progress according to SARE stages



2.2.3 Current Status in Bhutan

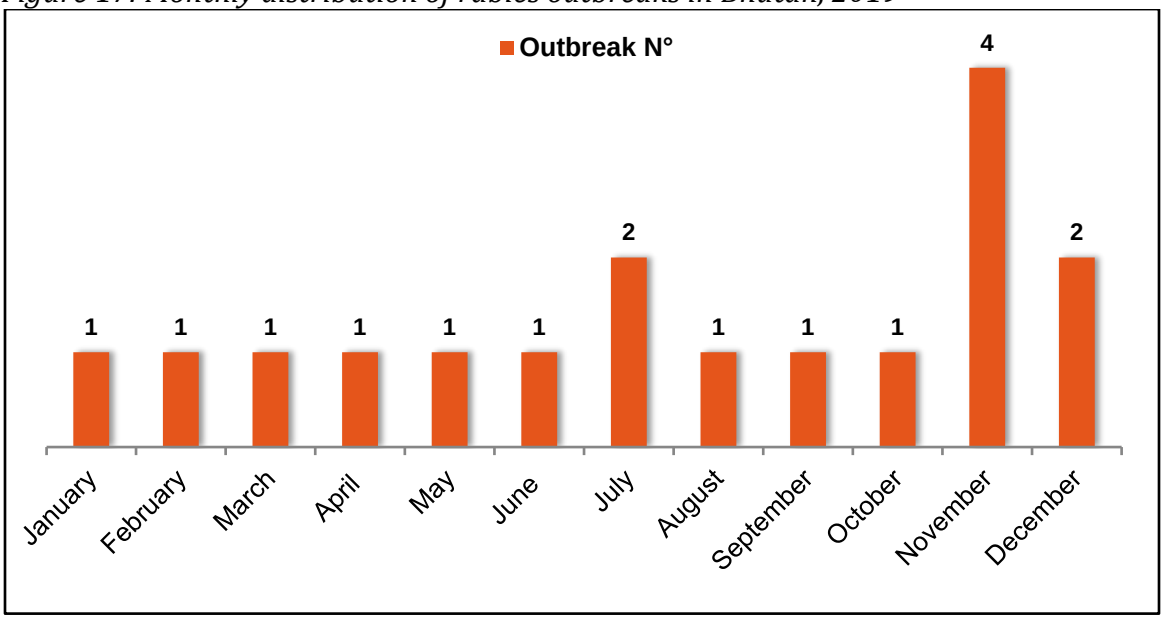
During the calendar year 2019, seventeen outbreaks of rabies were reported from Samtse, Chhukha, Sarpang, Pema Gatshel, Samdrup Jongkhar and Trashi Yangtse dzongkhags, during which, a total of 68 cases (dog, cattle and goat) were recorded (Figure 16 & Annexure II).

Figure 16: Rabies outbreaks in Bhutan, 2019



November month recorded 4 separate outbreaks, the highest of the year, followed by two outbreaks each in July and December, and one each in rest of the months (Figure 17).

Figure 17: Monthly distribution of rabies outbreaks in Bhutan, 2019



2.3 ANTHRAX

2.3.1 The Disease

Anthrax is caused by the spore-forming bacteria *Bacillus anthracis*. The name of the bacteria derives from the Greek word for coal, because of the ulcers with dark centres that develop on the skin of affected people. Anthrax spores are extremely resistant, and it can survive in the environment for decades, making the control or eradication of the disease very difficult.

Anthrax commonly causes high mortality, primarily in domestic and wild herbivores as well as most mammals and several bird species, and it is a serious zoonosis – transmitted from animals to humans.

Anthrax does not directly spread from animal to animal or from person to person. The bacteria produce spores on contact with oxygen; these spores are extremely resistant and survive for years in soil, or on wool or hair of infected animals, which if ingested or inhaled by an animal, or on entering through cuts in the skin, they can germinate and cause disease. Because the blood of infected animals sometimes fails to clot and may leak from body orifices, insects can spread the bacteria to other animals.

Carnivores and humans can become infected by eating meat from an infected animal. But typically, animals become infected by ingesting spores which are in the soil or in feed.

Per-acute, acute, sub-acute and, rarely, chronic forms of the disease are reported. Ante-mortem clinical signs may be virtually absent in per-acute and acute forms of the disease. Meanwhile, the only sign in chronic form may be enlarged lymph glands.

Ruminant animals are often found dead with no indication that they had been ill. In acute form, there may be high fever, muscle tremors and difficult breathing seen shortly before the animal collapses and dies. Un-clotted blood may exude from body openings and the body may not stiffen after death. Sub-acute form may be accompanied by progressive fever, depression, in-appetence, weakness, prostration and death.

In horses or sometimes in ruminants there may be digestive upsets and colic, fever, depression and sometimes swelling. These symptoms may last for up to four days before death results.

In carnivores when the animal feeds on an infected source there may be an intestinal form of the disease with fever and cramps from which animals sometimes recover.

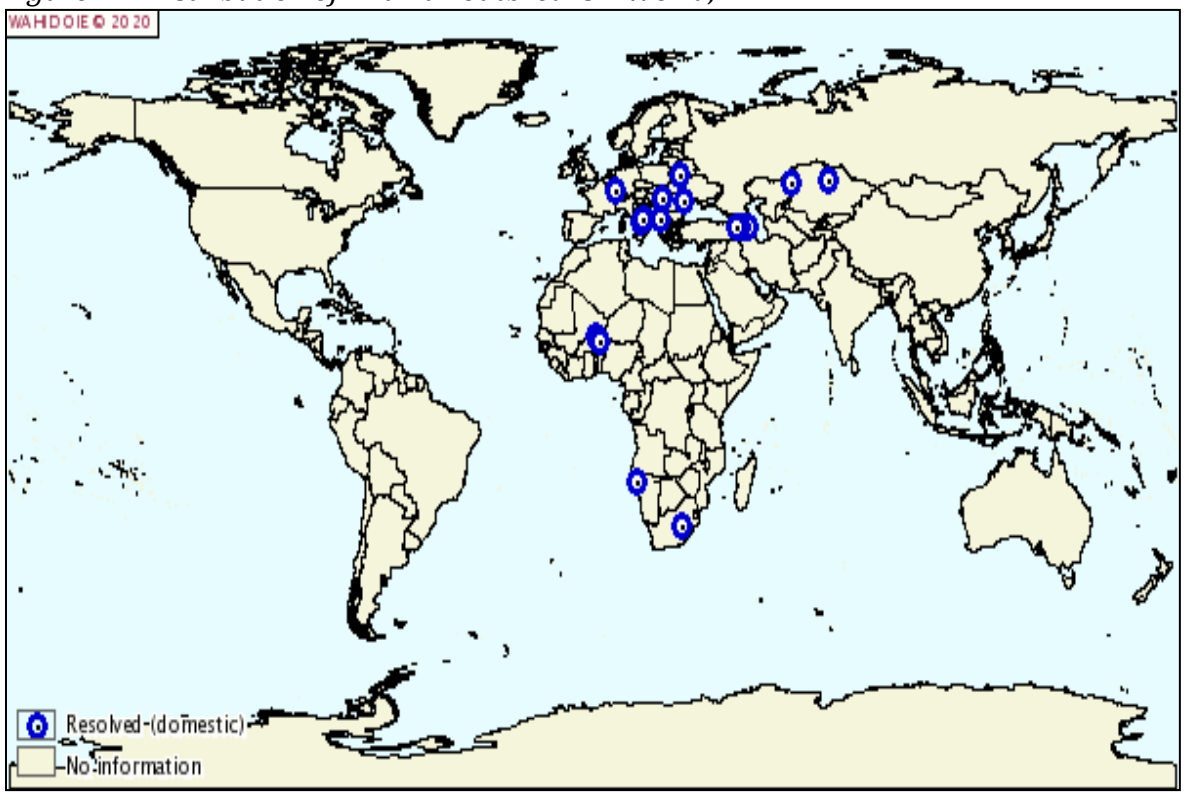
In humans, more than 95% of anthrax cases take the cutaneous form and result from handling infected carcasses or hides, hair, meat or bones from such carcasses. The disease manifests itself in three distinct patterns (cutaneous, gastrointestinal and inhalational). The most common is a skin infection, where people become infected handling animals or animal products that contain spores. This can happen to veterinarians, agricultural workers, livestock producers or butchers dealing with sick animals, or when infection has been spread by wool or hides. *Bacillus anthracis* is not invasive and requires a lesion to

infect. The spores enter the body through cuts or scratches in the skin and cause a local infection that if not controlled may spread throughout the body. The digestive form occurs when the spores are eaten. Tragically people who lose their animals may also lose their lives trying to salvage something and consuming the meat from an animal that died. Potentially the deadliest form is by inhalation. This has been called 'wool sorters disease' since spores on hides or hair could be inhaled. While inhalation anthrax is rare in nature, anthrax spores have been developed and used as a biological weapon. Clearly, preventing the disease in animals will protect human public health.

2.3.2 Geographical distribution

Outbreak distribution of anthrax in the world during the calendar year 2019 is as shown in the figure below.

Figure 18: Distribution of Anthrax outbreaks – World, 2019



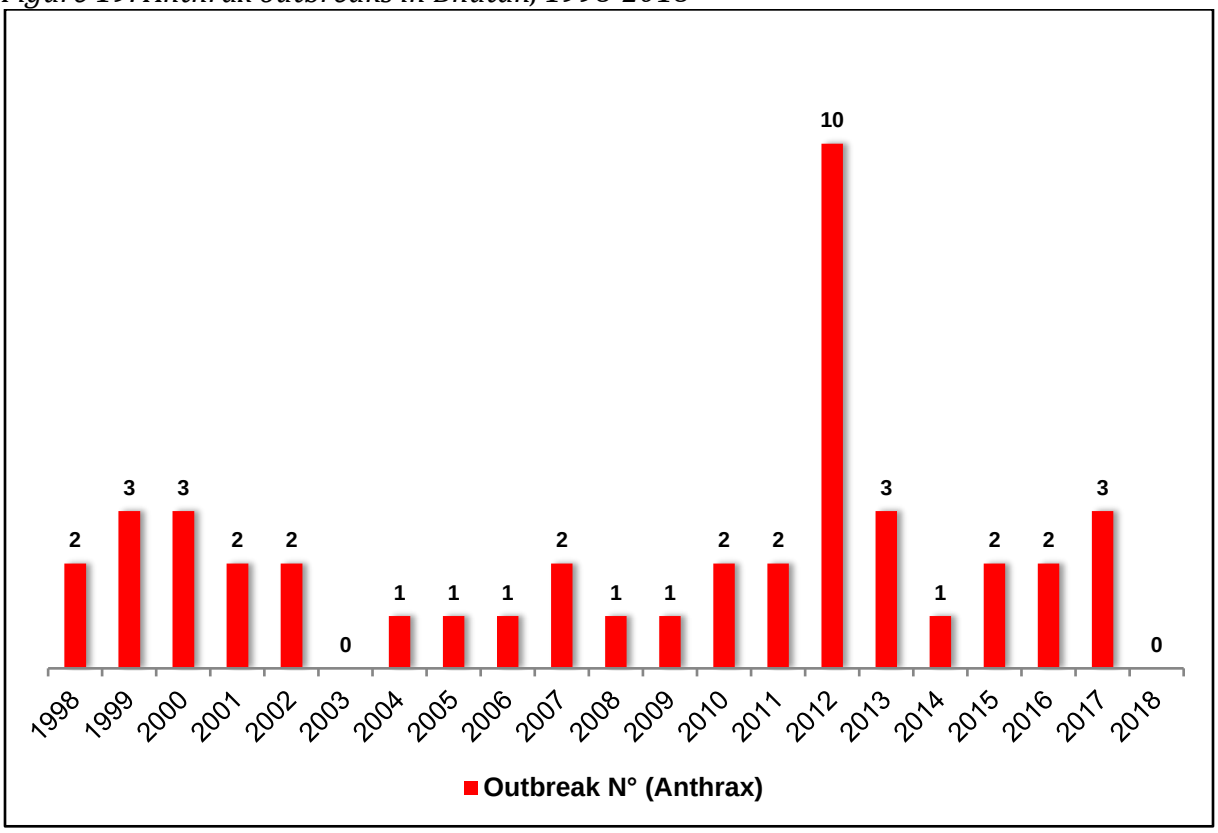
Source: WAHIS, 2020

2.3.3 Past outbreaks in Bhutan

In Bhutan, anthrax cases are sporadically reported in domestic animals, primarily cattle. Occasionally, cutaneous anthrax cases have been reported in humans following contact with infected animals.

Outbreaks of anthrax in Bhutan were recorded since 1998, and a total of 46 separate outbreaks were reported till 2018. The year 2003 and 2018 recorded no outbreak of the disease. Number of outbreaks remained consistent over the period of 20 years, except for the calendar year 2012, during which 10 separate outbreaks were recorded (Figure 19).

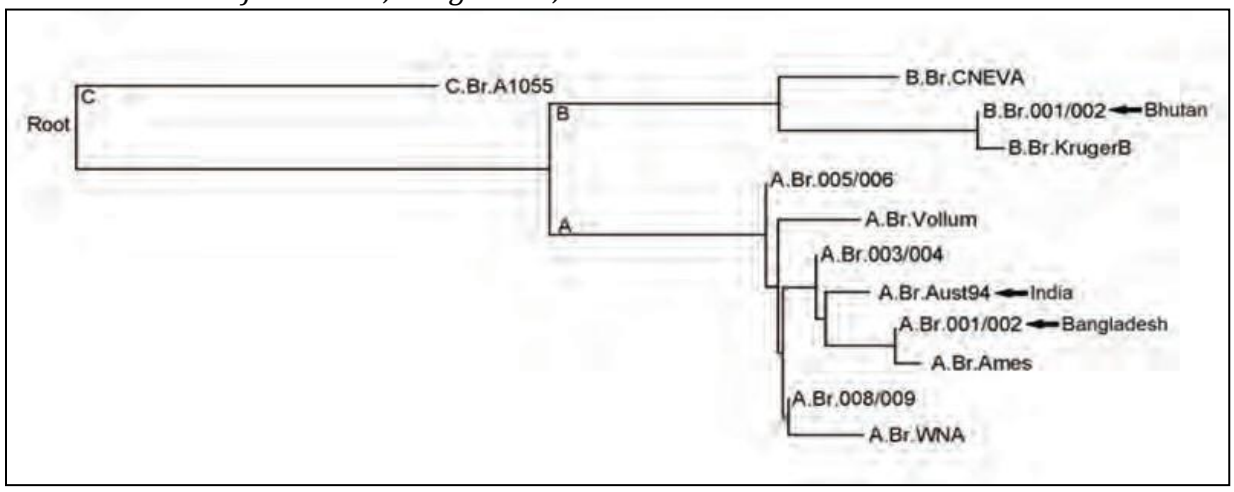
Figure 19: Anthrax outbreaks in Bhutan, 1998-2018



Source: Status of notifiable animal diseases in Bhutan, 2017

The anthrax isolate in Bhutan were found to be part of the multilocus variable-number tandem repeat analysis B1 lineage (genotype 83) and canonical single-nucleotide polymorphism subgroup B.Br 001/002 (Figure 20). The B lineage is less widespread and primarily associated with South Africa, but it has been reported in parts of US, Europe and Asia, including Caucasus region. In contrast, the strains from nearby Bangladesh and India belong to the more widely dispersed A lineage.

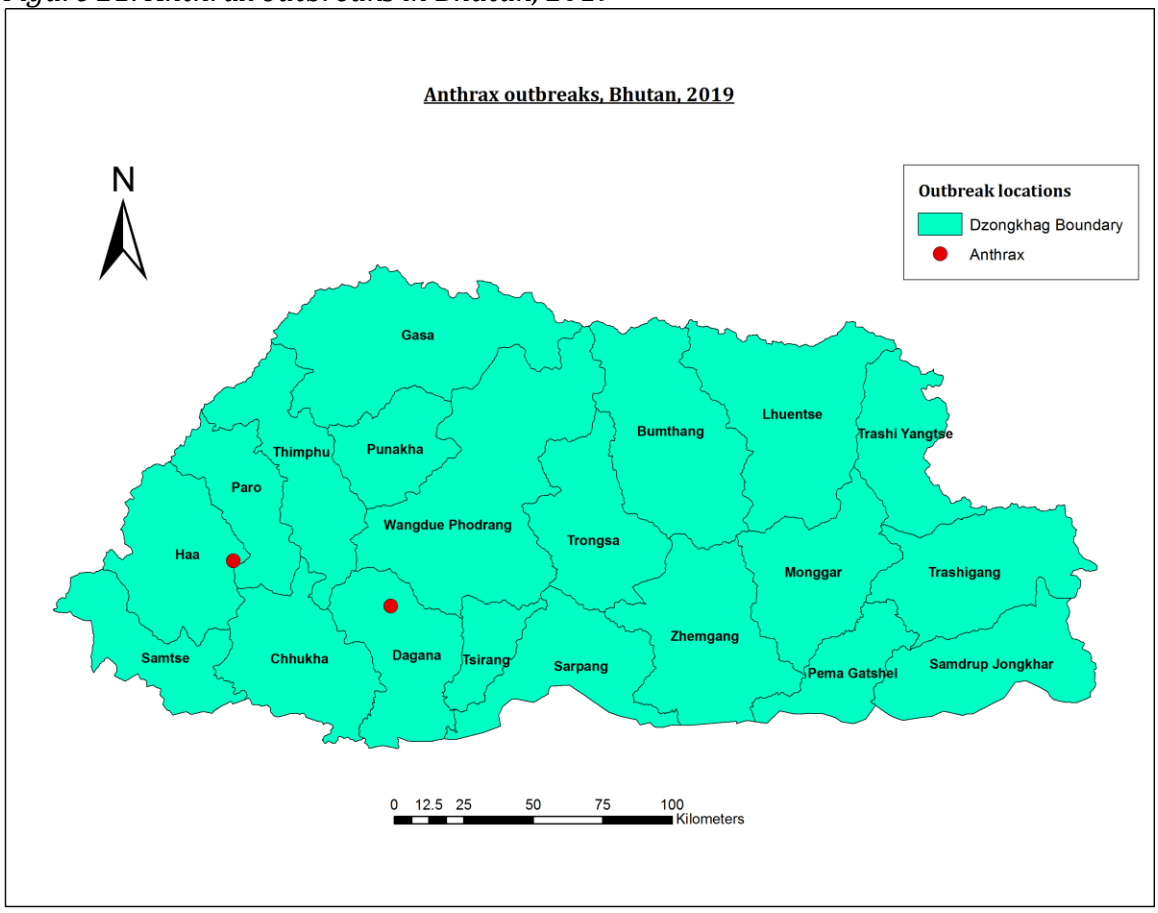
Figure 20: Phylogeny of major Bacillus anthracis groups as determined by using canonical single nucleotide polymorphisms. Arrows indicate the lineage/ groups of genotyped B. anthracis isolates from India, Bangladesh, and Bhutan.



(Source: Thapa et al., 2014)

2.3.4 Current Status in Bhutan

Figure 21: Anthrax outbreaks in Bhutan, 2019



During the calendar year 2019, two outbreaks of anthrax were reported from two dzongkhags: Haa and Dagana, affecting two cows (See Figure 21 and Annexure III).

2.4 BRUCELLOSIS

2.4.1 The Disease

Brucellosis is a contagious disease of livestock with significant economic impact. The disease was first identified during the Crimean war, and in 1887 Dr David Bruce identified the bacteria. In 1897 Dr. Bernhard Bang identified *Brucella abortus* thus giving the disease the name Bang's disease as well as Brucellosis.

The disease is caused by various bacteria of the genus *Brucella* – aerobic gram-negative bacillus – which tend to infect a specific animal species: Brucellosis in cattle by *B. Abortus*, in sheep and goats by *B. Melitensis*, and in swine by *B. Suis*. However, most species of Brucella are able to infect other animal species as well. Brucellosis is an important disease in wildlife, infecting feral pigs, bison, elk and European hares. The reservoir of disease in wildlife complicates eradication efforts. The bacteria have also been found in marine mammals.

Brucellosis is typically spread when the animal aborts or gives birth. High levels of bacteria are found in the birth fluids of an infected animal. The bacteria can survive outside the animal in the environment for several months, particularly in cool moist conditions. They remain infectious to other animals which become infected by ingesting the bacteria. The bacteria also colonise the udder and contaminate the milk. The disease can also infect animals and humans through cuts in the skin, or through mucous membranes.

The disease in animals is characterized by abortions or reproductive failure. While animals typically recover and will be able to have live offspring following the initial abortion, they may continue to shed the bacteria.

Typically, the disease is mild, with the infected animal showing few signs until she aborts. There may be swelling of the testicles in males, and occasionally the bacteria localise in the joints causing arthritis. In horses, it causes a condition called fistulous withers or poll evil, a swelling of the neck or back. However pregnant mares may either abort or give birth to weak and vulnerable foals.

The importance of Brucellosis is that it causes poor reproductive performance, due to abortions, infertility, retention of placenta, stillbirth or birth of weak offspring. It results in huge economic loses to dairy, sheep, goat and pig farmers.

Brucellosis is a zoonosis – highly infectious for human – causing a disease often called undulant fever or Malta fever, since it was first recognised in Malta during the 1850s. Symptoms in humans include intermittent or irregular fever, headache, weakness, profuse

sweating, chills, weight loss and general aching. Infections of organs including the liver and spleen may also occur.

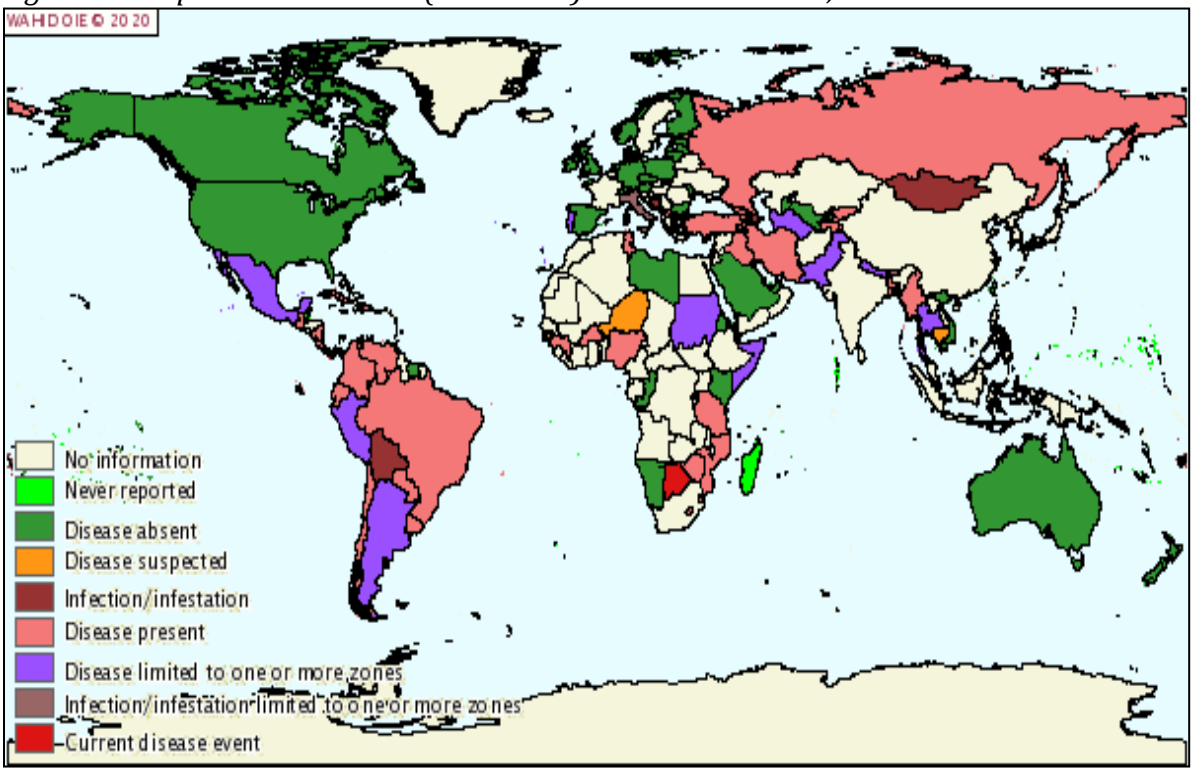
Veterinarians, farmers, and abattoir workers are vulnerable to infection as they handle infected animals and aborted fetuses or placentae. Brucellosis is one of the most easily acquired laboratory infections, and strict safety precautions should be observed when handling cultures and heavily infected samples, such as products of abortion.

The disease can also spread to people through consumption of unpasteurised milk coming from infected animals.

2.4.2 Geographical distribution

Distribution of *Brucella abortus* positive cases reported from around the world during the period between 2006 and 2009 is as shown the figure below.

Figure 22: Reported Brucellosis (B. abortus) cases in the world, 2006-2019



Source: WAHIS, January 2020

2.4.3 Clinical cases in Bhutan:

First recorded outbreak of Brucellosis occurred in late 2014 in National Jersey Breeding Farm (NJBF), Samtse dzongkhag, during which 13 cows were reported to have aborted.

In 2015, sero-surveillance for Brucellosis was conducted in 8 government farms; prevalence was highest in NJBF (24.6%). Series of longitudinal study were conducted, and in 2017, sero-prevalence in NJBF was found to have increased to 38% (42/110) – indicative of active circulation of the infection in the farm.

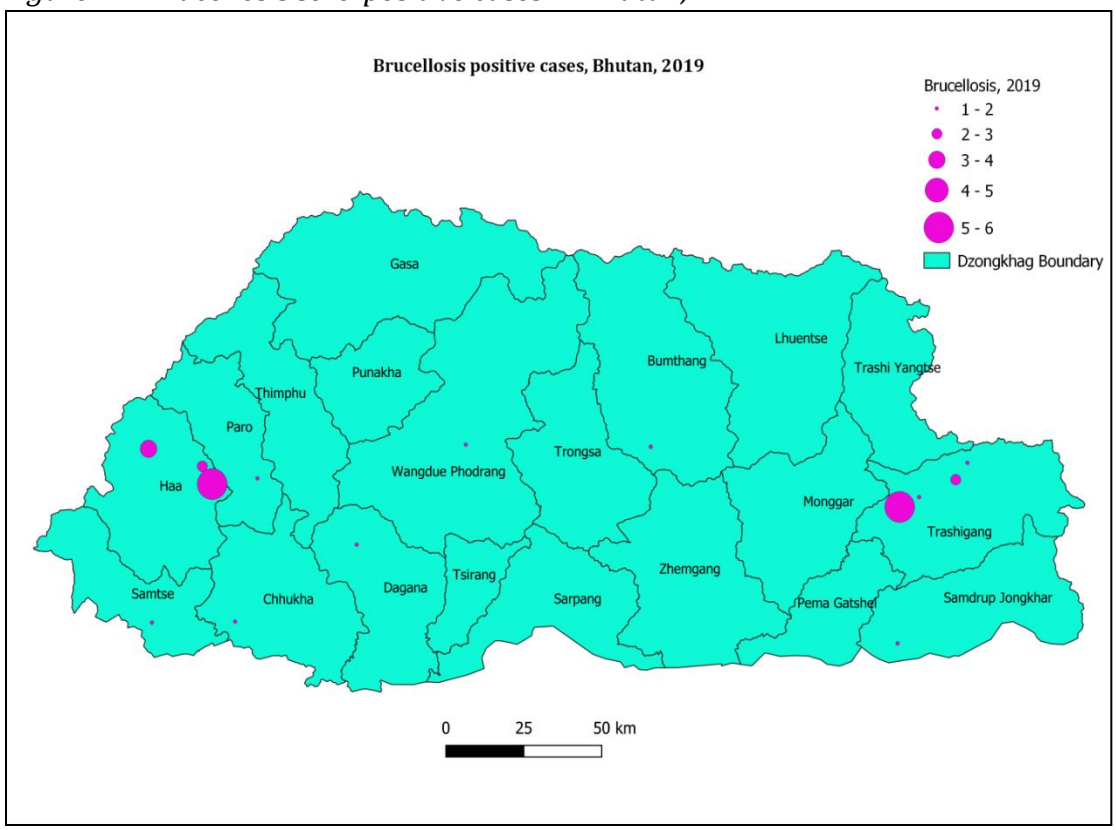
In 2017, few animals were moved from NJBF to Calf Rearing Centre (CRC), Wangkha, Chhukha dzongkhag; of the 81 animals tested, 11 were sero-positive. Brucellosis sero-positive cases were also detected in the imported animals at the quarantine station of Gelephu and Samdrup Jongkhar.

Nationwide brucellosis surveillance was completed in 2017, during which risk-based sero-survey was conducted in 220 milk cooperatives and collected 1,099 serum samples from 1,099 cattle: 21 tested (2%) positive to Brucellosis from 10 Dzongkhags.

In 2018, while examining the samples referred by Regional Livestock Development Centre, Kanglung, 22 of the 33 samples tested sero-positive to Brucellosis, including 12 sero-positive samples of Norzinthang dairy farm, Chenary, Trashigang dzongkhag.

2.4.4 Current Status in Bhutan

Figure 23: Brucellosis sero-positive cases in Bhutan, 2019



Sero-surveillance by Re-sampling of the positive cases of 2018 nation-wide surveillance and some suspected animals from other dzongkhags was carried out. In line with the

Emergency Control Plan for Brucellosis, all these animals were tested 3 times (25 days interval): 0, 25 and 50, using RBT and ELISA. A total 32 animals from 15 villages of 13 gewogs under 8 dzongkhags tested positive for Brucellosis (See Figure 23 and Annexure IV).

2.5 BLACK QUARTER (BQ)

2.5.1 The Disease

Black quarter, also known as blackleg or quarter evil or quarter ill is an infectious bacterial disease most commonly caused by *Clostridium chauvoei*, a Gram-positive, rod-shaped, anaerobic, and motile bacteria, and can produce environmentally persistent spores when conditions are not ideal for growth. These spores can remain in the soil for years in an inactive state, and return to their infectious form when consumed by grazing livestock.

It is seen in livestock all over the world, usually affecting cattle, sheep, and goats. Most losses due to blackleg occur when the cattle are between the ages of six months and two years, although it can occur when they are as young as two months. Typically, cattle that have a high feed intake and are well-conditioned tend to be the most susceptible to blackleg. Furthermore, many blackleg cases occur during the hot and humid summer months or after a sudden cold period, but cases can occur at any time during the year.

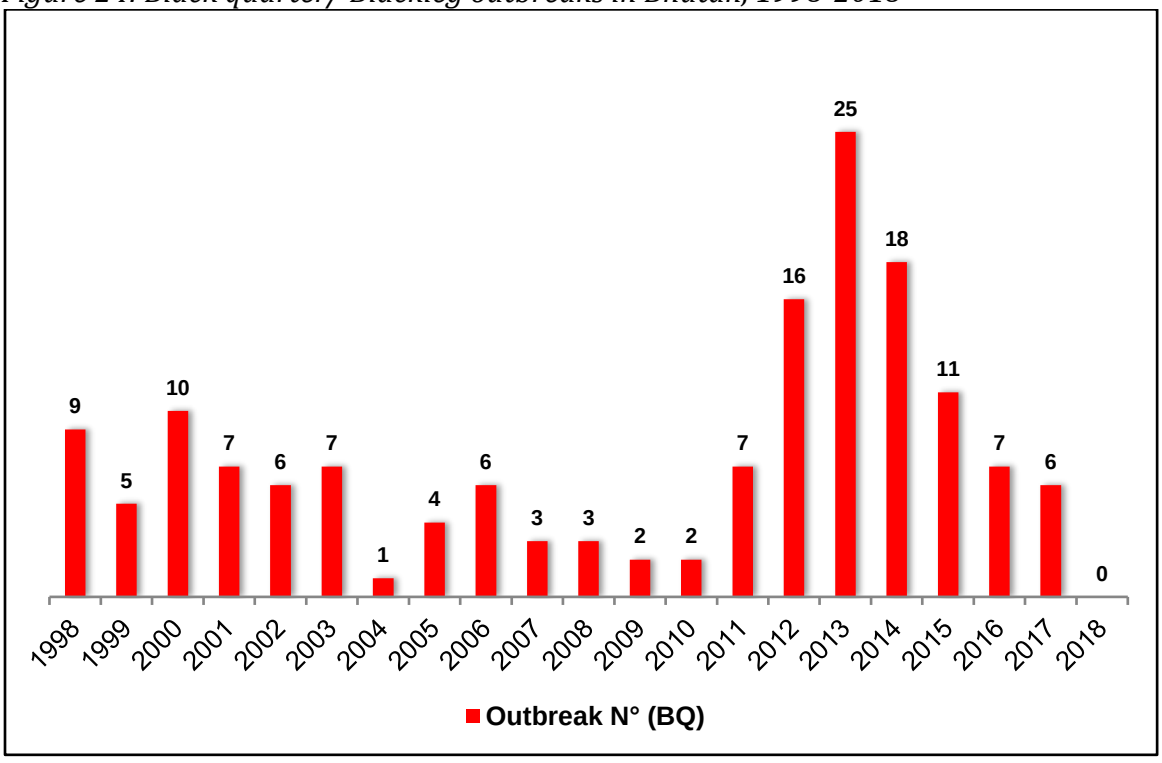
When infection begins, the animal may develop a fever, and the affected limb can feel hot to the touch. The limb usually swells significantly, and the animal can develop lameness on the affected leg. *C. chauvoei*, when growing and reproducing can produce a large amount of gas as a metabolic byproduct which builds up in infected tissue, usually large muscles, and causes the tissue to make a crackling or popping sound - Crepitation (the sensation of air under the skin) – when pressed. Large gas-filled blisters can also form, which can be extremely painful as they build up in the tissues.

Once clinical signs develop, the animal may only live a short while, sometimes as few as 12 hours. Occasionally, cattle succumb to the disease without showing any symptoms, and only a necropsy reveals the cause. During a necropsy, a diagnosis is usually made very quickly, as the affected muscle is usually mottled with black patches, which are dead tissue, killed by the toxins the bacteria release when they infect live tissue. If viewed under a microscope, small rod-like bacteria can be seen to confirm the diagnosis.

2.5.2 Past outbreaks in Bhutan

Black quarter outbreaks were recorded in Bhutan since 1998, and until 2017, a total of 155 different outbreaks were reported – annual average of 8 outbreaks. Outbreak of the disease was not reported during the calendar year 2018 (Figure 24).

Figure 24: Black quarter/ Blackleg outbreaks in Bhutan, 1998-2018

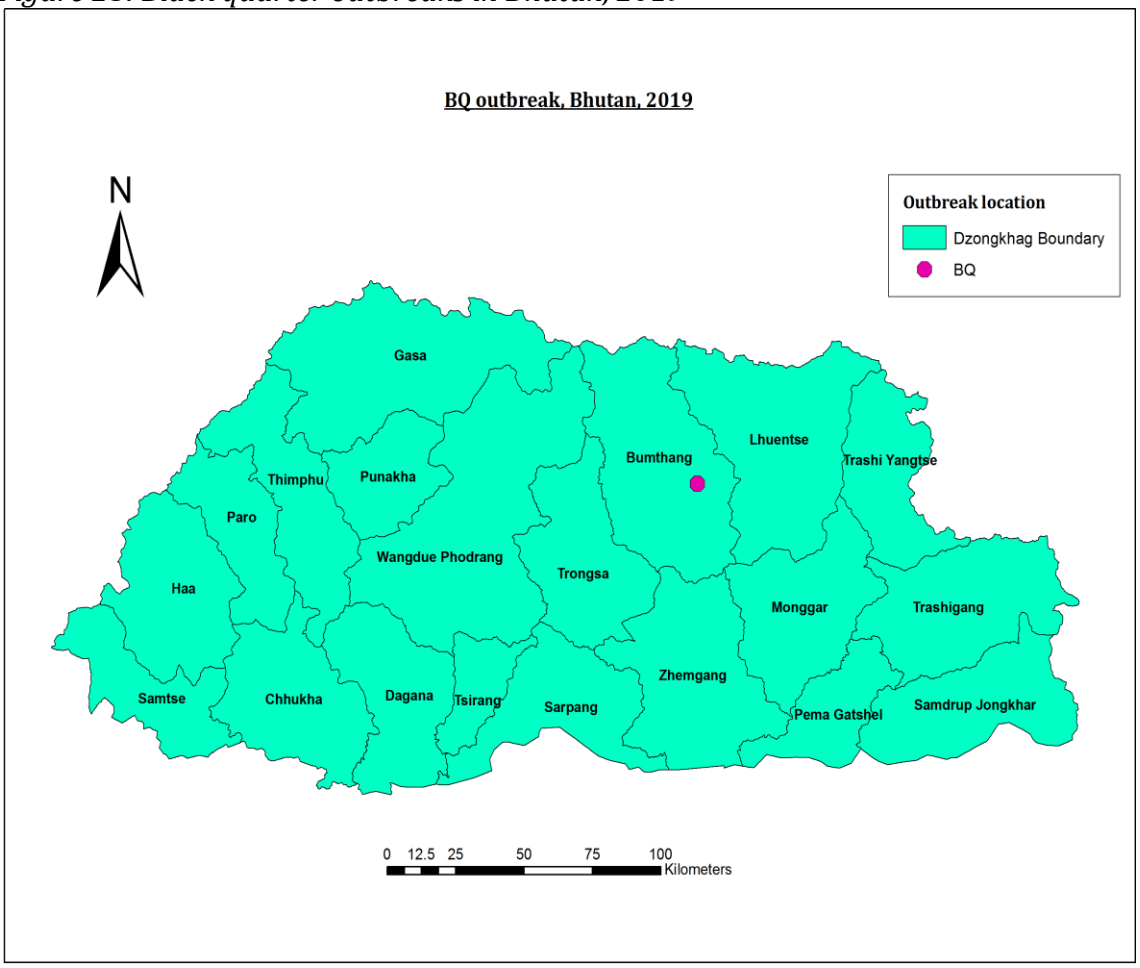


Source: Status of notifiable animal diseases in Bhutan, 2017

2.5.3 <u>Current Status in Bhutan</u>

During the year 2019, an outbreak of BQ was reported from Wobthang community cattle farm under Tang gewog of Bumthang dzongkhag; three cattle succumbed to the infection (See Figure 25 and Annexure V)

Figure 25: Black quarter outbreaks in Bhutan, 2019



3. DISEASE IN SHEEP AND GOATS

3.1 PESTE DES PETITS DES RUMINANTS (PPR)

3.1.1 The Disease

It is caused by Peste des petits ruminant virus (PPRV) classified in the family Paramyxoviridae, genus *Morbillivirus*. By means of nucleic acid sequencing, PPRV can be differentiated into four lineages (1–4). It is antigenically similar to rinderpest virus.
Goats (predominantly) and sheep are susceptible to the infection by PPRV. Cattle and pigs develop inapparent infections and do not transmit disease.
Spread of the disease occurs by following means:

- Mainly by aerosols or direct contact between animals living in close quarters.
- Fomites: bedding, feed and water troughs.

- Seasonal variations: more frequent outbreaks during the rainy season or the dry cold season

The incubation period is typically 4–6 days but may range from 3–10 days. For the purposes of the OIE Terrestrial Animal Health Code, the incubation period for the PPR is 21 days.

Acute form of the disease manifests through sudden rise in body temperature (40–41°C); serous nasal discharge becoming muco-purulent and resulting, at times, in a profuse catarrhal exudate which crusts over and occludes the nostrils; erosive lesions in the oral cavity with excessive salivation and necrotic stomatitis with halitosis; Congestion of conjunctiva, crusting on the medial canthus and sometimes profuse catarrhal conjunctivitis; Severe, watery, blood-stained diarrhoea in later stages; bronchopneumonia evidenced by coughing – rales and abdominal breathing; and sometimes abortion. Per-acute form is frequently observed in goats - especially situations of immuno-naïve introductions into instances of circulating PPRV – where it's manifested by high fever, depression and death. Sub-acute form is commonly seen in experimentally infected animals.

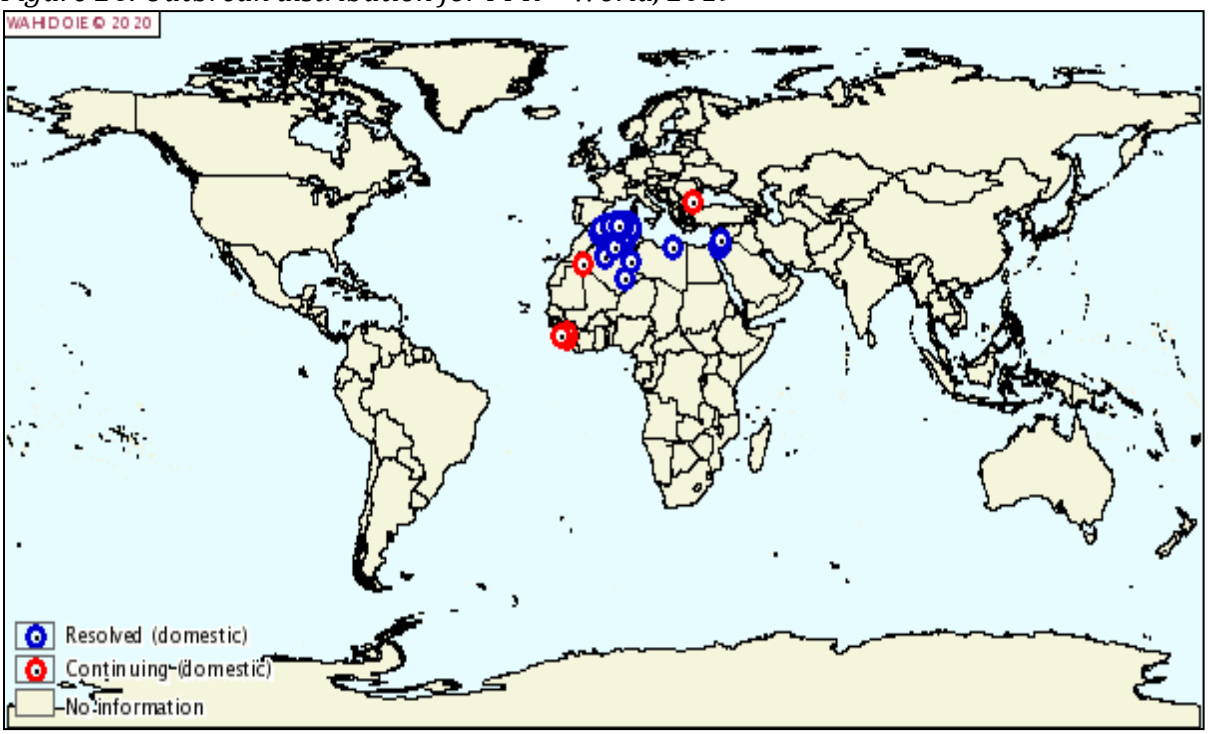
Following lesions associated with PPR:

- Small streaks of haemorrhages and sometimes erosions: in the first portion of the duodenum and the terminal ileum.
- Necrotic or haemorrhagic enteritis with extensive necrosis and sometimes severe ulceration of Peyer's patches.
- Congestion around the ileo-caecal valve, at the caeco-colic junction and in the rectum; 'Zebra stripes' of congestion in the posterior part of the colon.
- Bronchopneumonia is a constant lesion.
- Congestion and enlargement of spleen and liver

3.1.2 Geographical Distribution

PPR outbreaks reported from around the world during the calendar year 2019 are as shown in the figure below.

Figure 26: Outbreak distribution for PPR – World, 2019



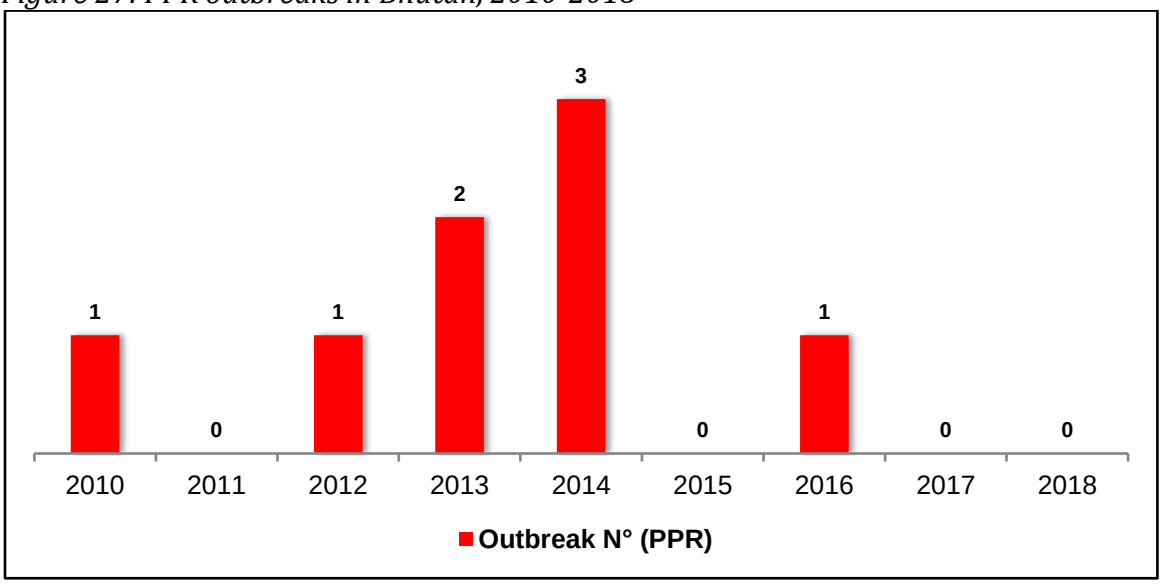
Source: WAHIS, January 2020

3.1.3 Past outbreaks in Bhutan

Peste des petits ruminants (PPR) was first reported in Bhutan in June 2010 from Chhukha dzongkhag, from an animal holding facility for goats kept for Tshethar (goats from across the international border with India – to be slaughtered – being rescued from by animal saving spiritual groups). Thereafter, 7 separate outbreaks were reported till 2016; no outbreaks were recorded in 2011, 2015, 2017 and 2018 (Figure 27).

The outbreaks in Dagana and Sarpang in 2014 and 2016, respectively, were observed soon after the legal import of animals from India by the department of livestock. The first PPR virus involved in 2010 outbreak was found to be lineage 4 which is antigenically related to Nepal and Tibet Autonomous Region of China.

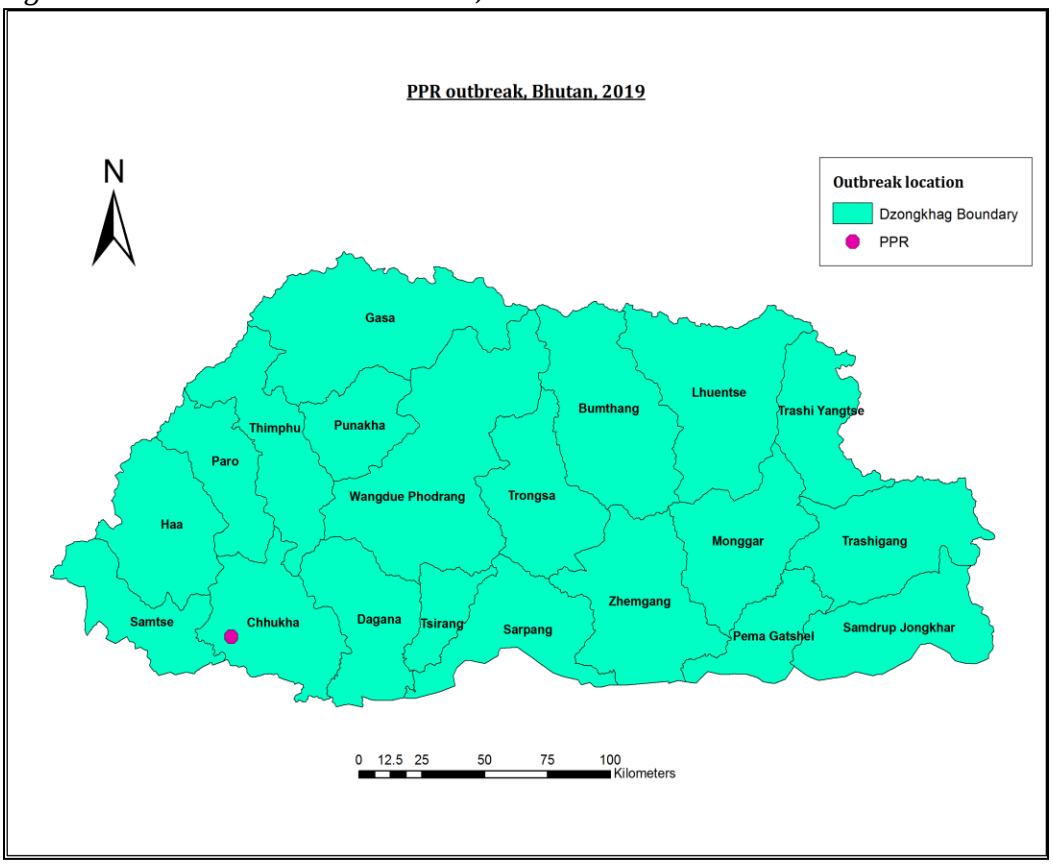
Figure 27: PPR outbreaks in Bhutan, 2010-2018



Source: Disease Prevention and Control Strategy, DoL, 2019

3.1.4 Current Status in Bhutan

Figure 28: PPR outbreaks in Bhutan, 2019



During the calendar year 2019, in February month, one outbreak of PPR was reported from Baidangtar village under Phuentshogling gewog of Chhukha dzongkhag; 26 goats were affected and 4 died (15.3% CFR) (See Figure 28 and Annexure VI).

4. DISEASE IN EQUINE

4.1 STRANGLES

4.1.1 The Disease

It is an infectious, contagious disease of Equidae characterized by abscessation of the lymphoid tissue of the upper respiratory tract.

The causative organism, *Streptococcus equi equi*, is highly host-adapted and produces clinical disease only in horses, donkeys, and mules. It is a gram-positive, capsulated β-hemolytic Lancefield group C coccus, which is an obligate parasite and a primary pathogen. *S equi equi* is highly contagious and produces high morbidity and low mortality in susceptible populations.

Transmission occurs via fomites and direct contact with infectious exudates. Carrier animals are important for maintenance of the bacteria between epizootics and initiation of outbreaks on premises previously free of disease. Survival of the organism in the environment depends on temperature and humidity; it is susceptible to desiccation, extreme heat, and exposure to sunlight and must be protected within mucoid secretions to survive. Under ideal environmental circumstances, the organism can survive ~4 wk outside the host.

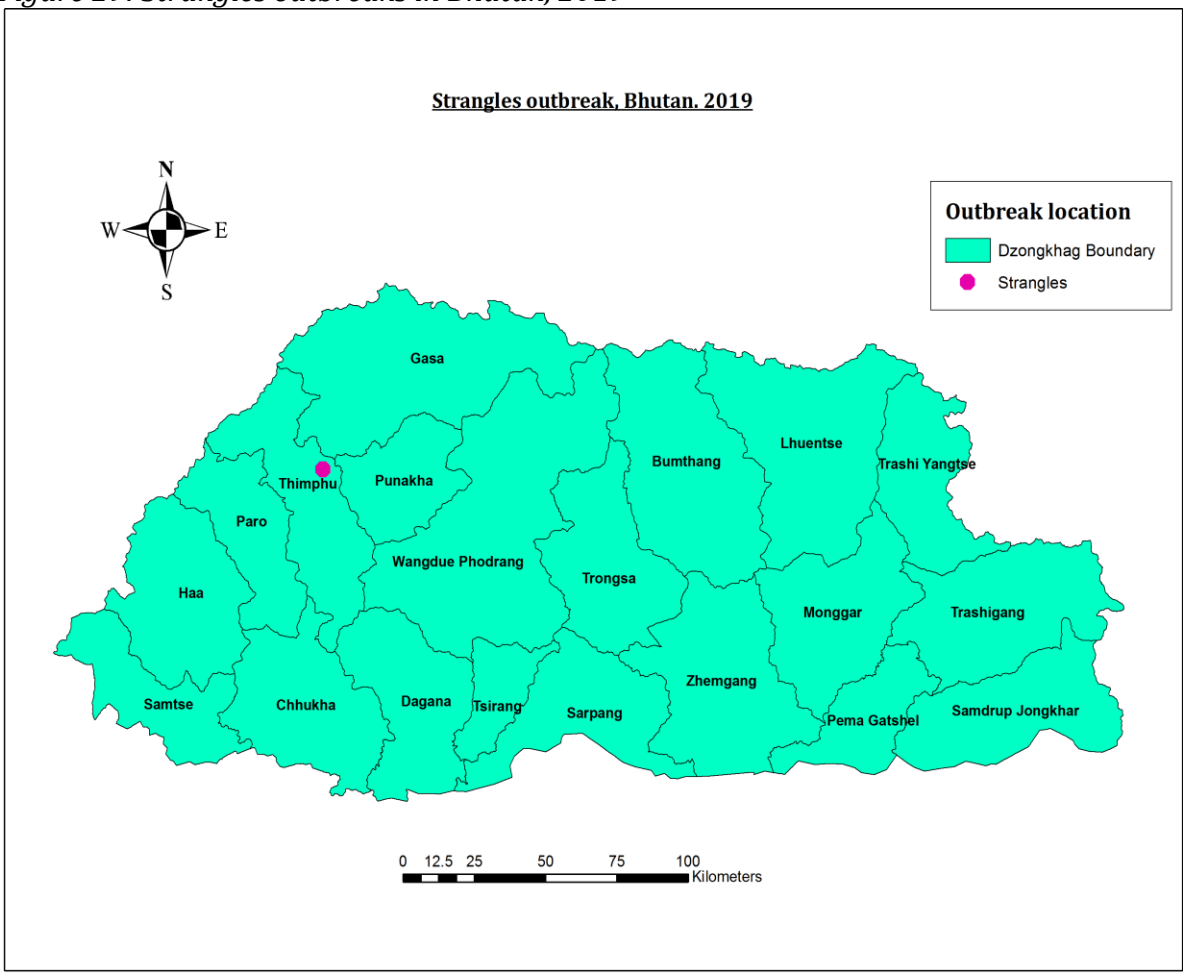
The incubation period of strangles is 3–14 days, and the first sign of infection is fever (103°–106°F [39.4°–41.1°C]). Within 24–48 hr of the initial fever spike, the horse will exhibit signs typical of strangles, including mucoid to mucopurulent nasal discharge, depression, and submandibular lymphadenopathy. Horses with retropharyngeal lymph node involvement have difficulty swallowing, inspiratory respiratory noise (compression of the dorsal pharyngeal wall), and extended head and neck. Older animals with residual immunity may develop an atypical or catarrhal form of the disease with mucoid nasal discharge, cough, and mild fever. Metastatic strangles ("bastard strangles") is characterized by abscessation in other lymph nodes of the body, particularly the lymph nodes in the abdomen and, less frequently, the thorax.

4.1.2 Outbreak in Bhutan

An outbreak of Strangles was reported in October 2019, from Barshong village of Naro gewog, Thimphu dzongkhag (Figure 29). Out of total susceptible population of 111 horses

in the locality, 77 (69.4% morbidity) were reported have been affected and 4 (5.2% fatality) of them succumbed to the infection (Annexure VII). The outbreak was controlled successfully through prompt treatment and isolation of affected horses, movement restriction, awareness, etc.

Figure 29: Strangles outbreaks in Bhutan, 2019



5. DISEASES IN POULTRY

5.1 HIGHLY PATHOGENIC AVIAN INFLUENZA (HPAI)

5.1.1 The Disease

The infection is caused by viruses belonging to the species influenza A virus, genus *influenzavirus A* and family Orthomyxoviridae. These viruses are also called type A influenza viruses. Influenza A viruses are classified into subtypes based on two surface proteins, the hemagglutinin (HA) and neuraminidase (NA). A virus is defined as HPAI or LPAI by its ability to cause severe disease in intravenously inoculated young chickens in the laboratory, or by its possession of certain genetic features that have been associated with high virulence in HPAI viruses (i.e., the sequence at the HA cleavage site). With rare exceptions, HPAI viruses found in nature have always contained the H5 or H7 hemagglutinin.

Avian influenza viruses are shed in the feces and respiratory secretions of birds, although the relative amount of virus can vary with the specific virus, host species and other factors. The feces contain large amounts of virus in aquatic birds such as waterfowl. Some viruses that have adapted to gallinaceous poultry, such as recent isolates of Asian lineage H5N1 HPAI viruses can be found in higher quantities in respiratory secretions than the feces, even in wild waterfowl. Once an avian influenza virus has entered a poultry flock, it can spread on the farm by both the fecal–oral route and aerosols, due to the close proximity of the birds. Fomites can be important in transmission, and flies may act as mechanical vectors.

People and other mammals are usually infected with avian influenza viruses during close contact with infected birds or their tissues, although indirect contact via fomites or other means is also thought to be possible. Respiratory transmission is likely to be an important route of exposure, and the eye may also act as an entry point.

The incubation period in poultry can be a few hours to a few days in individual birds, and up to 2 weeks in the flock. A 21-day incubation period, which takes into account the transmission dynamics of the virus, is used for an avian population in the context of disease control.

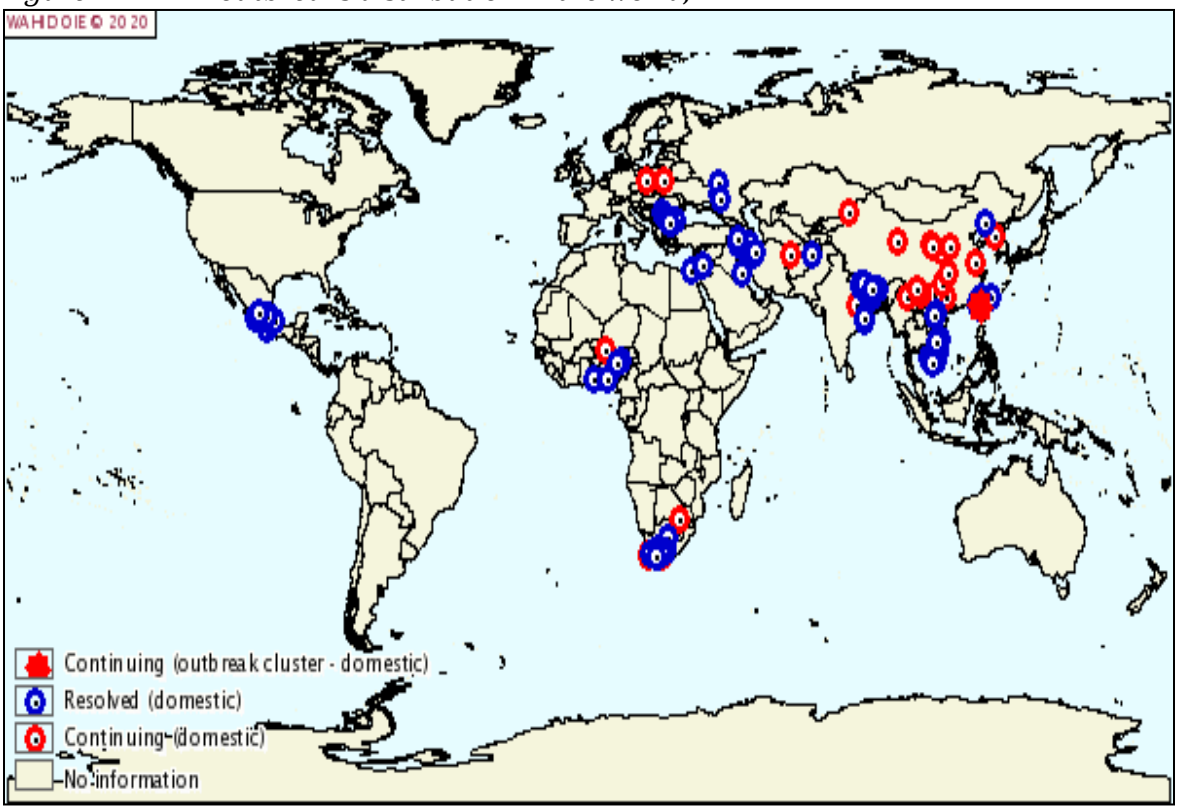
HPAI viruses usually cause severe illness in chickens and turkeys, and few birds in infected flocks typically survive. Marked depression, decreased feed and water intake, and other systemic, respiratory and/ or neurological signs are often seen, but no signs are pathognomonic, and sudden death can also occur. Commonly reported signs include coughing, sneezing, sinusitis, blood-tinged oral and nasal discharges, ecchymoses on the shanks and feet, oedema and cyanosis of the un-feathered skin on the head, comb and wattle (and snood in turkeys), and diarrhea. Egg production decreases or stops, and depigmented, deformed and shell-less eggs may be produced. Because a virus can be

defined as highly pathogenic based on its genetic composition alone, HPAI viruses may rarely be found in chicken or turkey flocks that have mild signs consistent with low pathogenic avian influenza. HPAI virus infections can be asymptomatic, mild or severe in other birds, including gallinaceous birds other than chickens and turkeys.

5.1.2 Geographical Distribution

Highly pathogenic avian influenza outbreaks reported from across the world during the calendar year 2019 is as shown in the figure below.

Figure 30: HPAI outbreaks distribution in the world, 2019



Source: WAHIS, January 2020

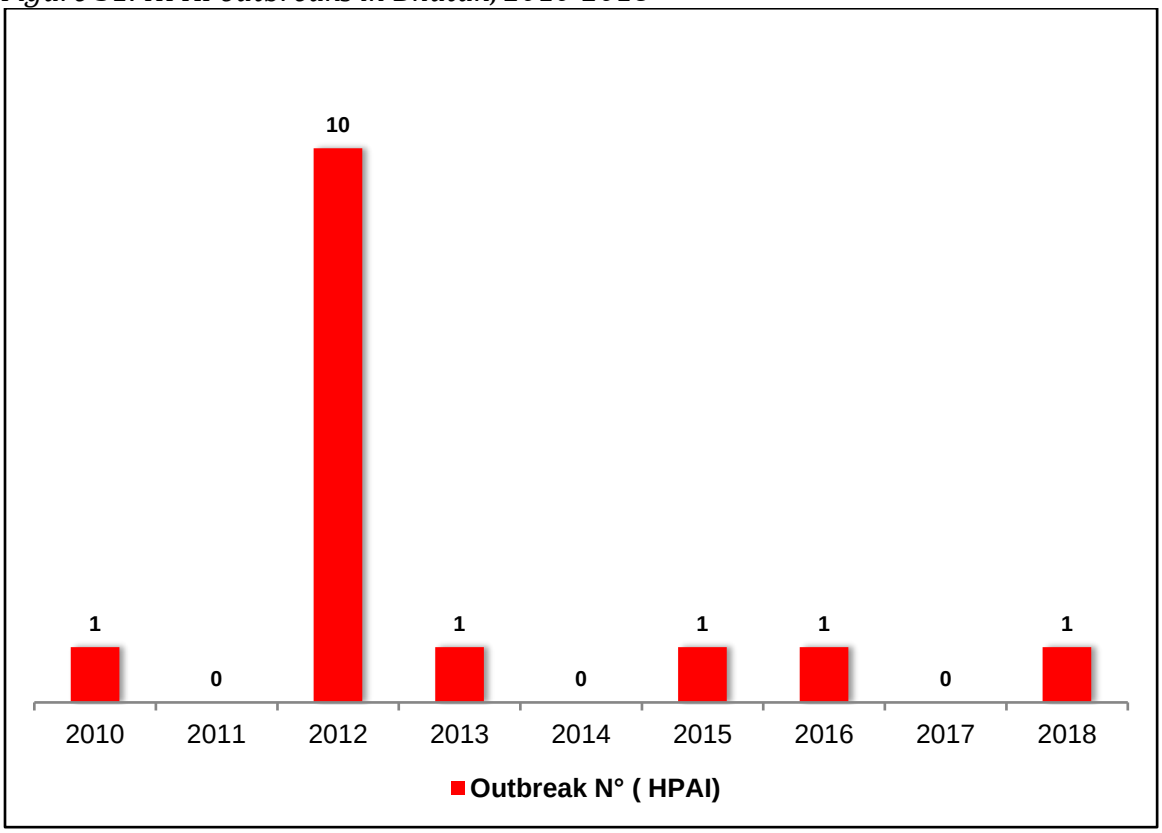
5.1.3 Past outbreaks in Bhutan

First outbreak of highly pathogenic avian influenza (HPAI) H5N1 in Bhutan was reported on 18th February 2010 from Rinchending village, Phuentshogling gewog, Chhukha dzongkhag, followed by 10 outbreaks in 2012 and one outbreak each in 2013, 2015, 2016 and 2018 (Figure 31).

The phylogenetic analysis of the first Bhutan isolates belonged to 'Qinghai like lineage' virus clade 2.2 (sub clade 2.2.3) and shared common progenitor virus with Bangladesh

virus. Based on phylogeny and molecular markers, it was concluded that the outbreaks in Bhutan and Bangladesh in 2010 were due to independent introductions of virus probably through migratory birds. The outbreaks during 2012 in Chhukha, Thimphu and Monggar involved clade 2.3.2.1 which is antigenitically similar to 2011 chicken virus clade of India.

Figure 31: HPAI outbreaks in Bhutan, 2010-2018

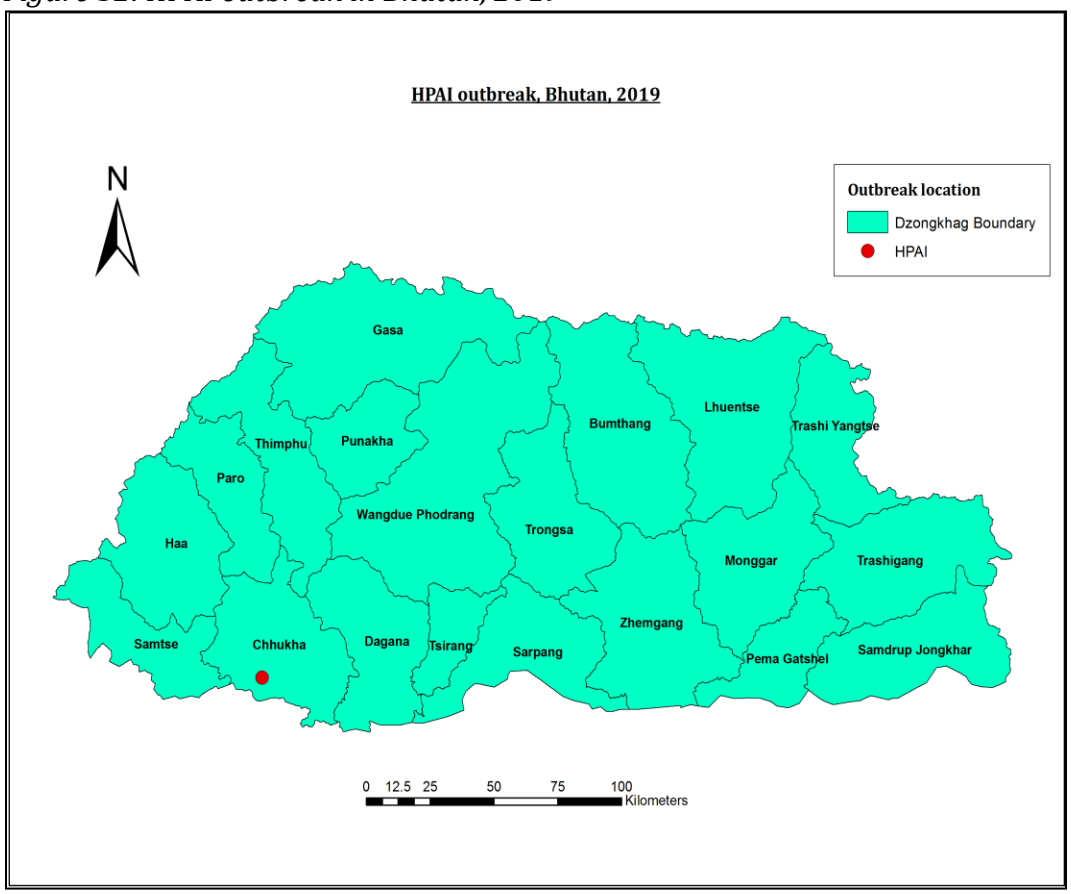


Source: Disease Prevention and Control Strategy, DoL, 2019

5.1.4 Current Status in Bhutan

During the calendar year 2019, an outbreak of Highly pathogenic avian influenza H5N1 was reported from Dhamdara village, Phuentshogling gewog, Chhukha dzongkhag on 6th April (Figure 32). A total of 264 domestic chickens were affected and died consequently (Annexure VIII). In response to the outbreak, 1117 chickens and 13 turkeys were culled, and the outbreak was successfully contained by the end of April 2019.

Figure 32: HPAI outbreak in Bhutan, 2019



5.2 INFECTIOUS BURSAL DISEASE (IBD)

5.2.1 The Disease

Infectious bursal disease also known as Gumboro is an immuno-suppressive disease of domestic poultry caused by a birnavirus. There are three types of IBD: the highly virulent (vv IBD), the US IBD and the subclinical IBD.

The domestic fowl is the natural host; sub-clinical infection may occur in turkeys.

Chickens infected with the IBD virus shed the virus in their feces. Feed, water, and poultry house litter become contaminated. Other chickens in the house become infected by ingesting the virus. Because of the resistant nature of the IBD virus, it is easily transmitted mechanically among the farms by people, equipment and vehicles

The incubation period is very short: two to three days. Mortality commences on the third day of infection, reaches a peak by day four, then drops rapidly, and the surviving chickens recover a state of apparent health after five to seven days.

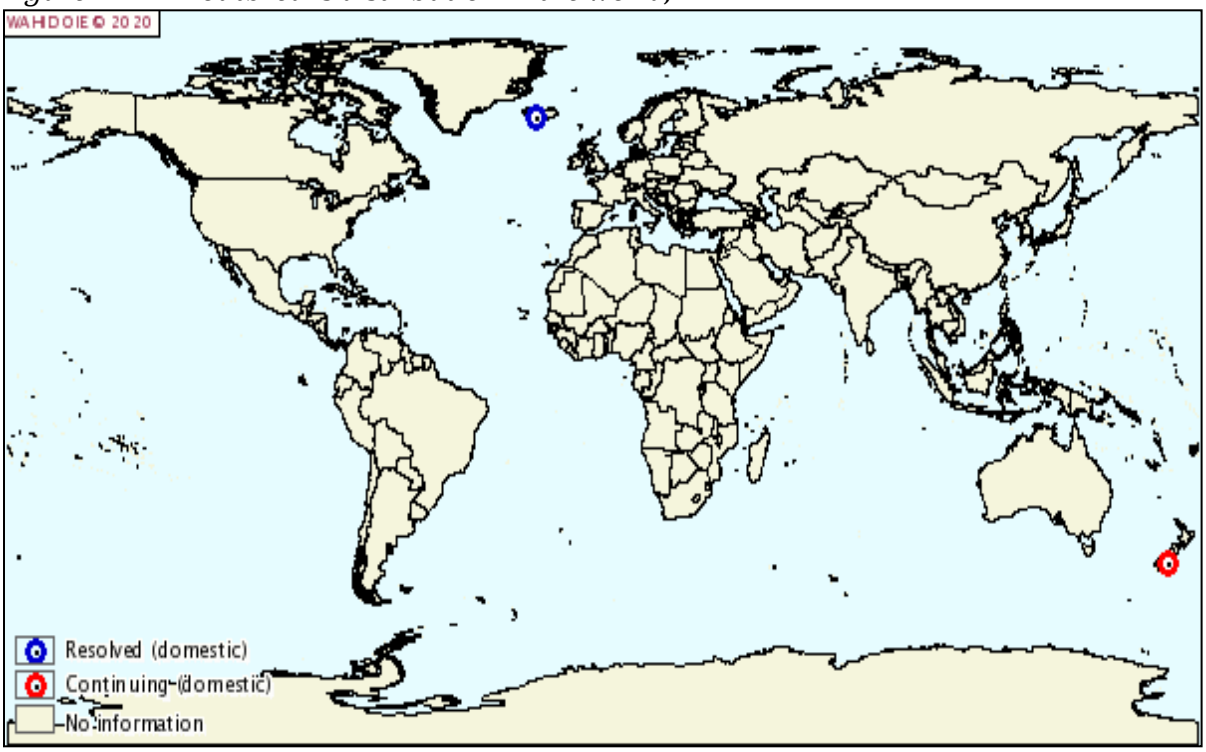
Disease is most common in 3 to 6 weeks old birds; however severe infection occurs in Leghorn up to 18 weeks. One of the earliest signs is for birds to pick at their own vent.

Other signs include infection by opportunist germ which are not normally pathogenic; poor body weights and feed conversions; reluctance to move; depression; anorexia ruffled feathers; trembling; watery diarrhoea; and sudden death.
Post-mortem findings include enlarged cloacal bursa, swollen and haemorrhagic, and it is atrophied in recovered birds; skeletal muscles dark with haemorrhages (especially thigh and pectoral muscles); thymus opaque with thickened gelatinous capsule; liver may be swollen; kidneys swollen and fatty; and increased mucus in the intestines.

5.2.2 Geographical Distribution

The first report of a specific disease affecting the bursa of Fabricius in chickens was made by Cosgrove in 1962 (21). The first cases were observed in the area of Gumboro, in Delaware (United States of America), which is the origin of the name, although the terms 'IBD' or 'infectious bursitis' are more accurate descriptions.
Outbreaks of Infectious bursal disease reported from around the world during the calendar year are as shown in the figure below.

Figure 33: IBD outbreaks distribution in the world, 2019

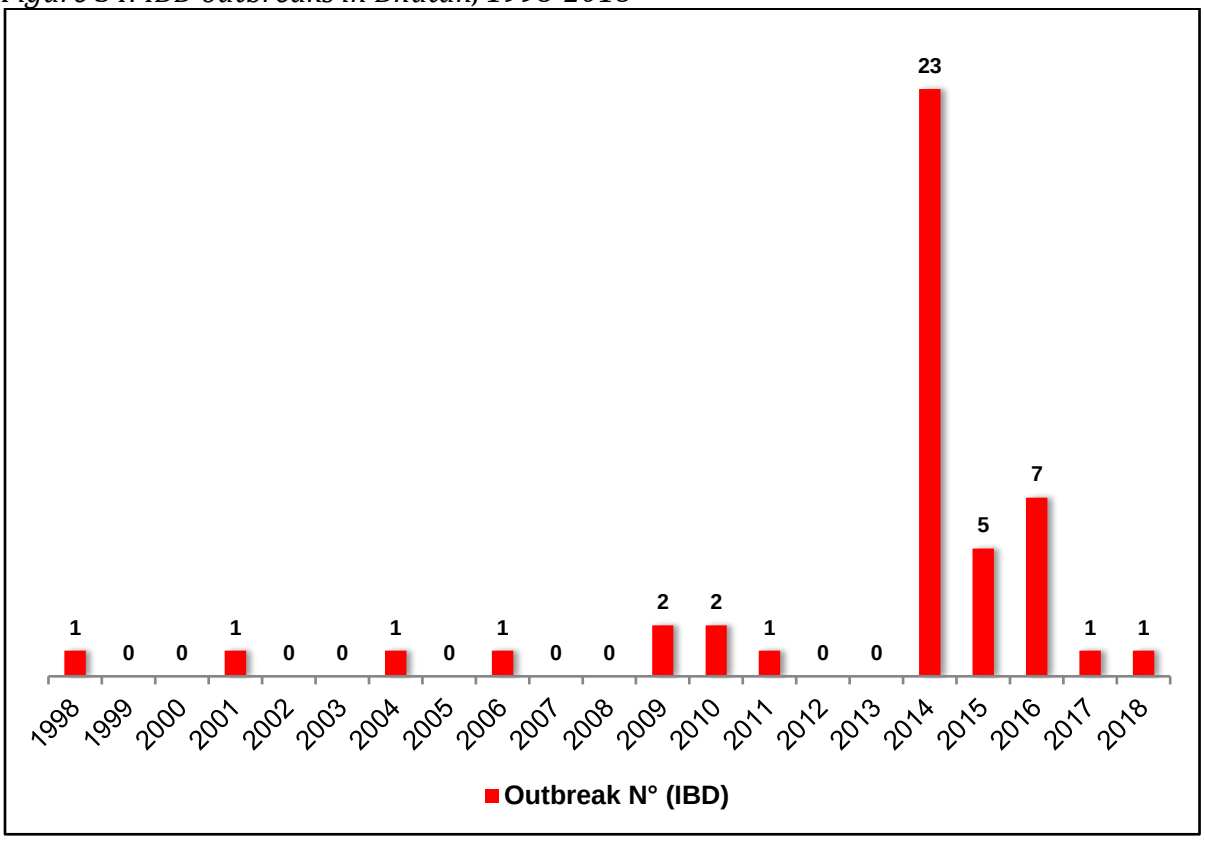


Source: WAHIS, January 2020

5.2.3 Past outbreaks in Bhutan

Since 1998, till 2018; a total of 46 separate outbreaks of Infectious bursal disease were reported in Bhutan (Figure 34). Major outbreaks of the disease were observed during the calendar year 2014, reporting a total of 23 different outbreaks from 5 dzongkhags: Sarpang, Tsirang, Wangdue Phodrang, Punakha and Thimphu; of the susceptible population of 23,158 chickens, 8000 were affected and 3,890 died.

Figure 34: IBD outbreaks in Bhutan, 1998-2018



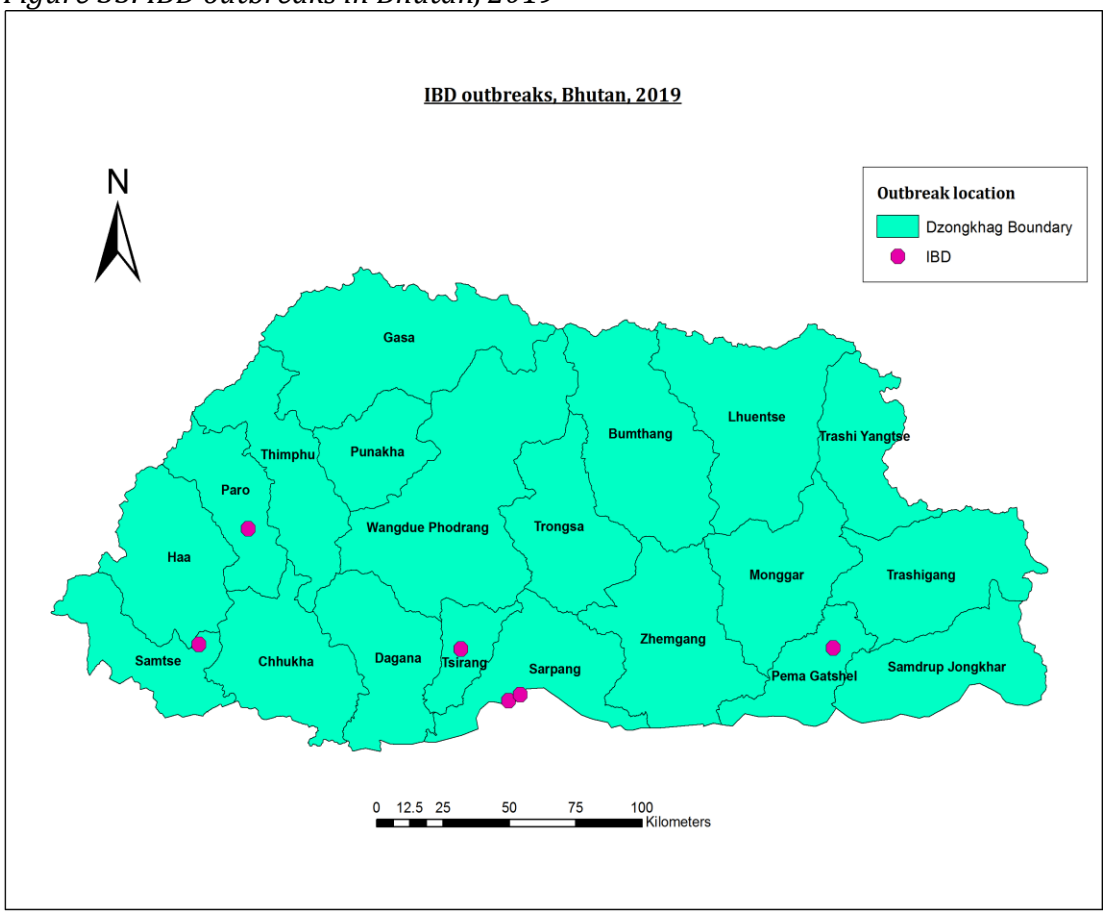
Source: Disease Prevention and Control Strategy, DoL, 2019

5.2.4 Current Status in Bhutan

During the calendar year 2019, six different outbreaks on Infectious bursal disease were reported from five dzongkhags: Sarpang, Tsirang, Paro, Pema Gatshel and Samtse. During these outbreaks, a total of 3,750 birds were affected and 3,380 died (Figure 35 and Annexure IX).

First outbreak of the year was reported from Regional Poultry Breeding Centre, a government farm located in Khangkhu area, Wangchang gewog, Paro dzongkhag; 1,269 birds succumbed to the infection.

Figure 35: IBD outbreaks in Bhutan, 2019



5.3 NEWCASTLE DISEASE (ND)

5.3.1 The Disease

The disease is caused by Newcastle disease virus (NDV), a member of the family Paramyxoviridae in the genus *Avulavirus*. There are ten serotypes of avian paramyxoviruses designated APMV-I to APMV-10 and ND virus has been designated APMV-1. NDV has also been categorised into five pathotypes based on clinical signs in infected chickens, designated: a) viscerotropic velogenic, b) neurotropic velogenic, c) mesogenic, d) lentogenic or respiratory and e) asymptomatic.

Many species of birds, both domestic and wild are affected. Chickens are highly susceptible to disease; turkeys do not tend to develop severe signs. Wild birds and waterfowl may harbor virus sub-clinically. Humans may become infected; manifested by unilateral or bilateral reddening, excessive lachrymation, oedema of the eyelids, conjunctivitis and sub-conjunctival haemorrhage.

Transmission of the infection occurs by following mechanisms:

- Direct contact with secretions of infected birds; principally via ingestion (faecal/oral route) and inhalation.
- Fomites: feed, water, implements, premises, human clothing, boots, sacks, egg trays/crates, etc.
- Survival of agent is prolonged by presence of faeces; as in soiled egg shells.
- Hatching chicks may be infected through egg for some NDV strains; transmission of highly virulent isolates is uncommon.

Incubation period is 2–15 days with an average of 5–6 days; some species may be over 20 days. For the purposes of the OIE Terrestrial Animal Health Code, the incubation period for ND is 21 days.

Lentogenic strains are usually associated with subclinical disease marked by mild respiratory disease; coughing, gasping, sneezing and rales. Mesogenic strains may cause acute respiratory disease and neurologic signs in some species.

Velogenic strains commonly cause severe disease in chickens with mortality; signs being respiratory and/or nervous. Initial clinical signs vary but include lethargy, inappetence, ruffled feathers, oedema and conjunctivitis. As the disease progresses birds may develop greenish or white watery diarrhoea, dyspnoea and inflammation of the head and neck often with cyanotic discoloration. In later stages of disease, neurologic signs may be manifested as: tremors, tonic/clonic spasms, wing/leg paresis or paralysis, torticollis, and aberrant circling behaviour. Sharp drop in egg production is also observed; eggs contain a watery albumin and appear misshapen with abnormally coloured, rough or thin shells. Birds that survive serious infection may develop neurologic and partial or complete cessation of egg production. Morbidity and mortality rates may approach 100% in unvaccinated chickens.

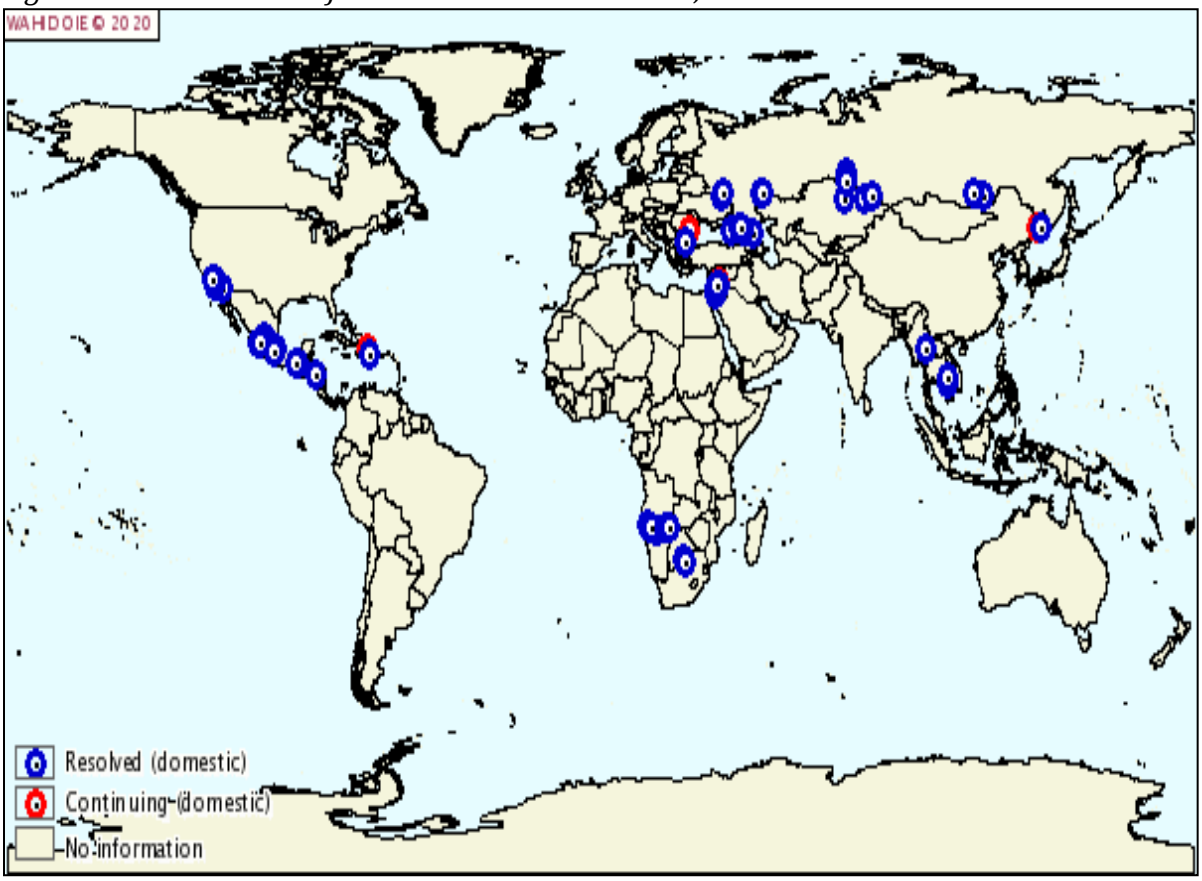
Velogenic strains produce significant gross lesions, some of which are enlisted below:

- Swelling of periorbital area or entire head;
- Oedema of the interstitial or peritracheal tissue of the neck; especially at the thoracic inlet;
- Congestion and sometimes haemorrhages in the caudal pharynx and tracheal mucosa; diphtheritic membranes may be evident in the oropharynx, trachea and oesophagus;
- Petechiae and small ecchymoses on the mucosa of the proventriculus, concentrated around the orifices of the mucous glands;
- Oedema, haemorrhages, necrosis or ulcerations of respiratory/digestive lymphoid tissue, including cecal tonsils and Peyer's patches.

5.3.2 Geographical Distribution

Outbreaks of Newcastle disease reported from around the world during the calendar year 2019 are as shown in the figure below.

Figure 36: Distribution of ND outbreaks in the world, 2019

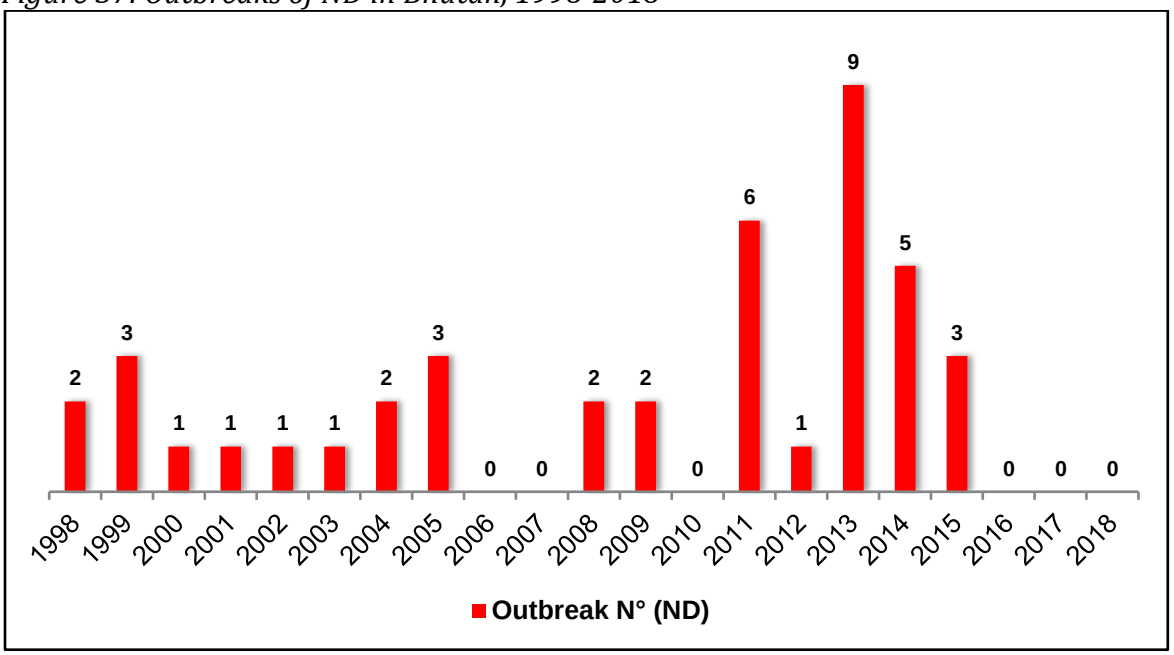


Source: WAHIS, January 2020

5.3.3 Past outbreaks in Bhutan

Since 1998, till 2015; a total of 42 separate outbreaks of Newcastle disease were reported in Bhutan, and no outbreaks were reported between 2016 and 2018 (Figure 37). During the period between 2011 and 2016, a total of 5,268 chickens were affected and 1,486 died.

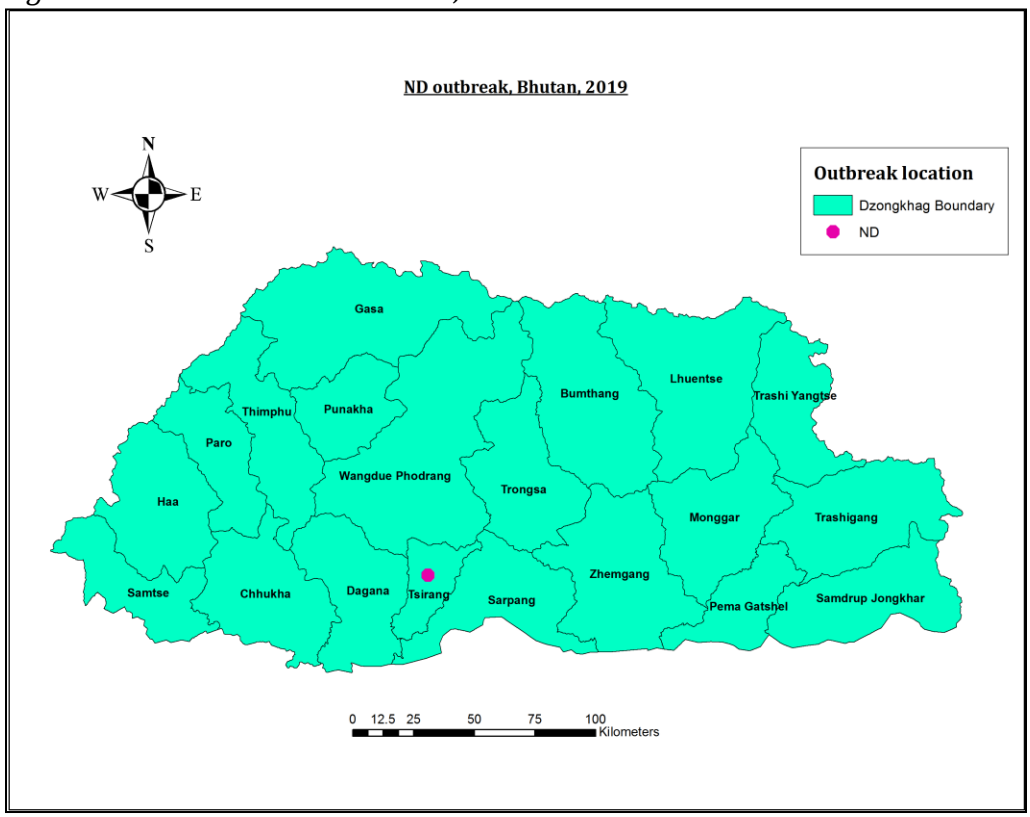
Figure 37: Outbreaks of ND in Bhutan, 1998-2018



Source: Status of notifiable animal diseases in Bhutan, 2015

5.3.4 Current Status in Bhutan

Figure 38: ND outbreak in Bhutan, 2019



During the calendar year 2019, one outbreak of Newcastle disease was reported from Phuentenchu gewog of Sarpang dzongkhag (Figure 38), affecting 4 households in two villages: Burchhu and Dhansiri; a total of 2600 chickens were affected, of which 700 died (Annexure X).

6. VACCINES DISTRIBUTED

For prevention and control of commonly reported notifiable animal diseases in Bhutan, different livestock vaccines are produced at Biological Production Unit of National Centre for Animal Health: Anthrax and Classical swine fever; and imported: FMD, HS, BQ, PPR, Rabies, DHPPi+L, IBD, ND, MD and Fowl pox; and distributed throughout the country on regular basis and immediately during disease outbreaks.
During the fiscal year 2018-2019 (July 2018-June 2019), a total of 5.36 million doses of aforementioned vaccines were distributed to various dzongkhags, regional and central government farms and other agencies (Table 2).

Table 2: Vaccines distributed to dzongkhags and central agencies in Bhutan, FY18-19

Dzongkhags/ Central Units	Locally Produced		Imported									
	Anthrax	**SFever**	**FMD Oil**	**HS BQ**	**IBD**	**Fowl Pox**	**ND B_1**	**R_2B**	**Marek's**	**Rabisin**	**DHPPi + L**	**PPR**
Dzongkhags												
Bumthang			5000	2700						800		
Chhukha		200	8000	540	118600	10000	63600	17000		1500		500
Dagana			7000	5400	8000	1000	13400			50		
Gasa			800	600						30	2	
Haa			2000	450	9000	6000		6000		1250		
Lhuentse			10000	6000	7000		2000	9000		300	2	
Mongar			11900	8880	108000			31000		1000	3	
Paro		50	16500	600	92400	34000	24000	16000		2000	79	
Pemagatshel			5000	3000	40000	5000		17000	2500	700		200
Punakha			10500	1020	50000	17000	26000	27000		1500		
Samdrup Jongkhar			10000	9000	20000	5000		10000	10000	1000		
Samtse		300	40000	3000	155000	35000	150000	17000		2800		3000
Sarpang		1700	32000	11490	528000	320000	226000	280000		2000		
Thimphu			7800	3510	60800	29500	27200	16400		230		

Trashigang			5000	4500	40000			20000		1350		
Trashiyangtse			6000	6000	6000	5000	4000	5000	5000	1000		
Trongsa			6500	4500	6800	8000	1000	4000		1000		
Tsirang		1250	8200	1200	355000	155000	293000	110000		1100	20	
Wangdue Phodrang			18000		6000		4000	1000		1600	50	
Zhemgang	500		6000	4050	11000		7000	37000		1400		
Central Units												
NDRDC, Yusipang			100	120								
RCBF, Bumthang			300	120								
NJBF, Samtse	400		600	420								
NNBF, Trashiyangphu			500	480						20		
NPRDC, Sarpang					43200	30000	16400	29800	257500			
NPBC, Yusipang		1470	1350									
NSBC, Bumthang			1000	900						20		
NPiRDC, Gelephu		2000	1850									
CRC,Wangkha			350	330								
RPPBC, Lingmethang		1400	800		10600	7000	3600	3500	124000			
RMBF, Arong			200	180						20		
RMBF, Wangdigang												
RPBC, Paro					10800	4000	3600	3500	100500			
NVH										3500		
Pvt Poultry Farm					19400	1000	14600	8800	105000			
BLDCL			150	150	148400	86000	92200	95500	12000			100
RLDC Wangdue												
RLDC Tsimasham										3500	50	800
RLDC Zhemgang										500		
RLDC Kanglung			100		17600		11000	11500		3600	3	
NDPM & RCP										500		
CNR					1800	1000	1200			60		

NPHBF, Lhuentse			150	150	400	1000	400	400	500			
NCD				30								

Source: Biological Production Unit, NCAH

7. ACKNOWLEDGEMENTS

The National Centre for Animal Health, Serbithang would like to thank TAD*info* focal points of National Veterinary Hospital, Regional Livestock Development Centres, Thromde Veterinary Hospitals, Dzongkhag Veterinary Hospitals, Central and Regional livestock farms and other agencies under the department of livestock for timely reporting animal disease outbreak(s) information through flash and follow-up reports, and regularly updating information into the TAD*info* database.

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ANNEXURE

Annexure I: Foot and mouth disease outbreaks in Bhutan, 2019

Index case	Village	Gewog	Dzongkhag	Sp.	C*	D*	O*
03-01-2019	Gongza and Chamkha	Toedtsho	Trashi Yangtse	Cattle	57	1	1
10-01-2019	Koenchogsum and nearby	Chhoekhor	Bumthang	Cattle	77	0	0
14-01-2019	Chhungkhar	Zobel	Pema Gatshel	Cattle	15	0	1
17-01-2019	Phunoob	Doteng	Paro	Cattle	2	0	1
21-01-2019	Tsenakha	Dogar	Paro	Cattle	1	0	0
28-01-2019	Thramo and Lizhing	Sherimuhung	Monggar	Cattle	31	1	1
28-01-2019	Neptingkha(Royal herd)	Toedwang	Punakha	Cattle	122	0	0
01-02-2019	Rangrekha	Kabisa	Punakha	Cattle	8	0	0
07-02-2019	Bepzur	Tang	Bumthang	Cattle	35	0	0
09-02-2019	Tokhey	Lajab	Dagana	Cattle	6	0	1
09-02-2019	Yaba	Sombaykha	Haa	Cattle	30	1	0
12-02-2019	Nubgang	Samar	Haa	Cattle	7	0	0
18-02-2019	Pana -C	Samphelling	Chhukha	Cattle	10	0	1
12-03-2019	Goumouney and Malbashey	Samphelling	Chhukha	Cattle	45	0	0
14-03-2019	Yebisa	Chhubu	Punakha	Cattle	8	0	0
25-03-2019	Tashidingkha	Drakteng	Trongsa	Cattle	4	0	1
25-03-2019	Yuesa	Drakteng	Trongsa	Cattle	4	0	0
02-04-2019	Chilauni B	Phuentshoglin g	Chhukha	Cattle	3	0	1
25-04-2019	Dogsel	Phobji	Wangdue Phodrang	Cattle	79	0	1
02-05-2019	Lamjupang	Kazhi	Wangdue Phodrang	Cattle	2	0	0
02-05-2019	Chimsabu	Phangyul	Wangdue Phodrang	Cattle	5	0	0
12-05-2019	Chungsikha, Chungoen, Hampikha	Phangyul	Wangdue Phodrang	Cattle	7	0	0
14-05-2019	Gogona	Gangtey	Wangdue Phodrang	Cattle	4	0	0
14-05-2019	Gogona	Gangtey	Wangdue Phodrang	Yak	42	0	0
18-05-2019	Army camp	Samtse	Samtse	Cattle	2	0	1

26-06-2019	Menchuna	Phuentenchu	Tsirang	Cattle	14	0	1
29-06-2019	Goenteykha and Jiligang	Phuentenchu	Tsirang	Cattle	29	0	0
03-07-2019	Khaireny,Dzedokha	Loggchina	Chhukha	Cattle	22	0	1
28-08-2019	Nabji	Korphu	Trongsa	Cattle	12	0	1
09-10-2019	Tingtibi	Trong	Zhemgang	Goat	3	1	1
18-10-2019	Gresphai	Trong	Zhemgang	Cattle	2	0	0
19-10-2019	Wangdigang	Trong	Zhemgang	Cattle	4	0	0

Source: TADinfo online database and DPCU offline database for notifiable animal diseases

C* *- N° case(s),* ***D**** *- N° death(s),* ***O**** *- N° outbreak(s)*

Annexure II: Rabies outbreaks in Bhutan, 2019

Index case	Village	Geog	Dzongkhag	Sp.	C*	D*	O*
17-01-2019	Wangdigatshel	Phuentshogling	Chhukha	Dog	2	2	1
20-01-2019	Wangdigatshel	Phuentshogling	Chhukha	Dog	1	1	0
25-01-2019	Majuwa	Phuentshogling	Chhukha	Dog	1	1	0
28-01-2019	Pana B	Sampheling	Chhukha	Dog	1	1	0
29-01-2019	Shongphu	Shongphu	Trashigang	Dog	1	1	0
02-02-2019	Rametey (Milerapa temple)	Sampheling	Chhukha	Dog	1	1	0
03-02-2019	Majuwa	Phuentshogling	Chhukha	Cattle	1	1	0
03-02-2019	Tokshingmang school below	Radi	Trashigang	Dog	1	1	0
04-02-2019	Ashom Drillo	Kanglung	Trashigang	Cattle	1	1	0
08-02-2019	Pana B	Sampheling	Chhukha	Cattle	1	1	0
15-02-2019	Rangaytung dara	Sampheling	Chhukha	Dog	1	1	0
20-02-2019	Melongkhar	Radi	Trashigang	Dog	1	1	0
26-02-2019	Tsenkari Nganlam	Norbugang	Pema Gatshel	Dog	1	1	1
27-02-2019	Pekarshing/Toribari	Phuentshogling	Chhukha	Goat	1	1	0
07-03-2019	Melongkhar	Radi	Trashigang	Dog	1	1	0
09-03-2019	Melongkhar	Radi	Trashigang	Dog	1	1	0
10-03-2019	Melongkhar	Radi	Trashigang	Dog	1	1	0
11-03-2019	Rongthung	Kanglung	Trashigang	Cattle	1	1	0
12-03-2019	Lengkhar	Kanglung	Trashigang	Dog	1	1	0

15-03-2019	Housing colony (above post office, T/gang)	Samkhar	Trashigang	Dog	1	1	0
18-03-2019	Serthi (near Zangdopelri, Kanglung)	Kanglung	Trashigang	Cattle	1	1	0
26-03-2019	Karbaytar/daemon Guest house	Phuentshogling	Chhukha	Cat	1	1	1
26-03-2019	Dovan	Phuentshogling	Chhukha	Dog	1	1	0
27-03-2019	Yonphula	Kanglung	Trashigang	Dog	1	1	0
01-04-2019	Housing colony (above post office, Tgang	Samkhar	Trashigang	Dog	1	1	0
08-04-2019	Saurini	Samtse	Samtse	Dog	1	1	1
10-05-2019	Pipla cattle herd	Dophuchen	Samtse	Cattle	1	1	0
31-05-2019	Shatsalo	Norbugang	Pema Gatshel	Dog	1	1	1
01-06-2019	Philing	Gakidling	Sarpang	Dog	1	1	1
07-06-2019	Maenchhulam	Gakidling	Sarpang	Cattle	8	8	0
08-06-2019	Tshagay	Gakidling	Sarpang	Goat	4	4	0
30-06-2019	Shatsalo	Norbugang	Pema Gatshel	Cattle	1	1	0
04-07-2019	Sadumadu	Phuentshogling	Chhukha	Goat	1	1	0
06-07-2019	Shatsalo	Norbugang	Pema Gatshel	Cattle	1	1	0
07-07-2019	Shatsalo	Norbugang	Pema Gatshel	Dog	1	1	0
09-07-2019	Shatsalo	Norbugang	Pema Gatshel	Cattle	1	1	0
27-07-2019	Industrial area, near KD Workshop	Dewathang	Samrup Jongkhar	Dog	1	1	1
31-07-2019	Army camp	Samtse	Samtse	Dog	1	1	1
01-08-2019	Sheychamthang town area	Gakidling	Sarpang	Dog	1	1	1
05-08-2019	Sjongkhar town	Dewathang	Samrup Jongkhar	Dog	1	1	0
14-09-2019	Wangringmu	Ramjar	Trashi Yangtse	Dog	1	1	1
14-09-2019	Wangringmu	Ramjar	Trashi Yangtse	Cattle	1	1	0
03-10-2019	Doksum	Khamdang	Trashi Yangtse	Dog	2	2	1
11-11-2019	Taxi parking, town	Yangtse	Trashi Yangtse	Dog	2	2	1
11-11-2019	Near Karmaling hotel, town	Yangtse	Trashi Yangtse	Dog	1	1	0
14-11-2019	Below TYLSS	Yangtse	Trashi Yangtse	Dog	1	1	0
18-11-2019	Jigmeling	Dekiling	Sarpang	Dog	1	1	1
18-11-2019	Jigmeling	Dekiling	Sarpang	Dog	1	1	0
21-11-2019	NPPF colony,	Phuentshogling	Chhukha	Dog	1	1	1

	town						
25-11-2019	Yangtse town	Yangtse	Trashi Yangtse	Dog	1	1	0
29-11-2019	Ferro Alloys, Pasakha	Sampheling	Chhukha	Dog	1	1	1
29-11-2019	Children park, town	Yangtse	Trashi Yangtse	Dog	1	1	0
01-12-2019	Baychen (Above TYLSS)	Yangtse	Trashi Yangtse	Dog	1	1	0
16-12-2019	Samdrup Gatshel	Dewathang	Samdrup Jongkhar	Cattle	1	1	1
17-12-2019	Kabraytar	Phuentshogling	Chhukha	Cattle	1	1	1

Source: TADinfo online database and DPCU offline database for notifiable animal diseases

Annexure III: Anthrax outbreaks in Bhutan, 2019

Index case	Village	Geog	Dzongkhag	Sp.	C*	D*	O*
09-01-2019	Peling	Tseza	Dagana	Cattle	1	1	1
03-10-2019	Kana	Uesu	Haa	Cattle	1	1	1

Source: TADinfo online database and DPCU offline database for notifiable animal diseases

Annexure IV: Brucellosis positive cases from nation-wide surveillance, 2019

Date	Village	Gewog	Dzongkhag	Species	Case N°
13-08-2019	Chenari	Dewathang	Samdrup Jongkhar	Cattle	1
13-08-2019	Chenari	Dewathang	Samdrup Jongkhar	Cattle	1
13-08-2019	Langteng	Radi	Trashigang	Cattle	1
13-08-2019	Langteng	Radi	Trashigang	Cattle	1
13-08-2019	Langteng	Radi	Trashigang	Cattle	1
13-08-2019	Mankang, Dorshing	Phongmey	Trashigang	Cattle	1
13-08-2019	Norzinthang	Kanglung	Trashigang	Cattle	1
13-08-2019	Norzinthang	Kanglung	Trashigang	Cattle	1
13-08-2019	Norzinthang	Kanglung	Trashigang	Cattle	1
13-08-2019	Norzinthang	Kanglung	Trashigang	Cattle	1
13-08-2019	Norzinthang	Kanglung	Trashigang	Cattle	1
13-08-2019	Lungtenzampa	Samkhar	Trashigang	Cattle	1
13-08-2019	Lungtenzampa	Samkhar	Trashigang	Cattle	1
13-08-2019	Rongthong	Kanglung	Trashigang	Cattle	1
13-08-2019	Zatsha, Gogona	Gangtey	Wangdue Phodrang	Cattle	1
13-08-2019	Tsanglekha	Tseza	Dagana	Cattle	1
13-08-2019	Bangyana	Uesu	Haa	Cattle	1

13-08-2019	Bangyana	Uesu	Haa	Cattle	1
13-08-2019	Bangyana	Uesu	Haa	Cattle	1
13-08-2019	Bangyana	Uesu	Haa	Cattle	1
13-08-2019	Bangyana	Uesu	Haa	Cattle	1
13-08-2019	Bangyana	Uesu	Haa	Cattle	1
13-08-2019	Ingo	Katsho	Haa	Cattle	1
13-08-2019	Ingo	Katsho	Haa	Cattle	1
13-08-2019	Ingo	Katsho	Haa	Cattle	1
13-08-2019	Yangthang	Bji	Haa	Cattle	1
13-08-2019	Yangthang	Bji	Haa	Cattle	1
13-08-2019	Chumpa	Bji	Haa	Cattle	1
13-08-2019	Chumpa	Bji	Haa	Cattle	1
13-08-2019	Heyphu	Shaba	Paro	Cattle	1
13-08-2019	Kharbandi (A)	Samtse	Samtse	Cattle	1
13-08-2019	Gaytse	Chhumig	Bumthang	Cattle	1
24-12-2019	Pasakha	Phuentshogling	Chhukha	Cattle	1

Annexure V: Black quarter outbreak in Bhutan, 2019

Index case	Village	Geog	Dzongkhag	Sp.	C*	D*	O*
29-10-2019	Wobthang	Tang	Bumthang	Cattle	3	3	1

Source: TADinfo online database and DPCU offline database for notifiable animal diseases

Annexure VI: Peste des petits des ruminants outbreak in Bhutan, 2019

Index case	Village	Geog	Dzongkhag	Sp.	C*	D*	O*
28-02-2019	Baidangtar	Phuentshogling	Chhukha	Goat	26	4	1

Source: TADinfo online database and DPCU offline database for notifiable animal diseases

Annexure VII: Strangles outbreak in Bhutan, 2019

Index case	Village	Geog	Dzongkhag	Sp.	C*	D*	O*
21-10-2019	Barshong	Naro	Thimphu	Horse	77	4	1

Source: TADinfo online database and DPCU offline database for notifiable animal diseases

Annexure VIII: Highly pathogenic avian influenza outbreak in Bhutan, 2019

Index case	Village	Geog	Dzongkhag	Sp.	C*	D*	O*
06-04-2019	Dhamdara	Phuentshogling	Chhukha	Chicken	264	264	1

Annexure IX: Infectious bursal disease outbreaks in Bhutan, 2019

Index case	Village	Gewog	Dzongkhag	Sp.	C*	D*	O*
17-01-2019	Khangkhu	Wangchang	Paro	Chicken	1269	1269	1
21-01-2019	Lobsibotey	Goserling	Tsirang	Chicken	340	340	1
21-01-2019	Bokrey	Kikhorthang	Tsirang	Chicken	480	110	0
25-02-2019	Dzamlingthang	Goserling	Tsirang	Chicken	250	250	0
28-04-2019	Mayona	Denchukha	Samtse	Chicken	543	543	1
04-06-2019	Darjaythang	Shompangkha	Sarpang	Chicken	640	640	1
09-10-2019	Nangkhor	Shumar	Pema Gatshel	Chicken	150	150	1
17-10-2019	Tashiling	Dekiling	Sarpang	Chicken	78	78	1

Source: TADinfo online database and DPCU offline database for notifiable animal diseases

Annexure X: Newcastle disease outbreak in Bhutan, 2019

Index case	Village	Gewog	Dzongkhag	Sp.	C*	D*	O*
02-04-2019	Burichu	Phuentenchu	Tsirang	Chicken	800	15	1
02-04-2019	Burichu	Phuentenchu	Tsirang	Chicken	600	35	0
02-04-2019	Dhansiri	Phuentenchu	Tsirang	Chicken	600	400	0
02-04-2019	Burichu	Phuentenchu	Tsirang	Chicken	600	250	0

Source: TADinfo online database and DPCU offline database for notifiable animal diseases

Annexure XI: Laboratory diagnostic capacity at NCAH, 2019

Disease	Bhutan*	OIE**
Anthrax	Agent identification	-
Foot and mouth disease	ELISA, real time RT-PCR, Rapid test	ELISA, VN, CF
Leptospirosis	Agent identification, MAT	MAT
Paratuberculosis (JD)	ELISA	ELISA, DHT
Rabies	Rapid test, FAT, RIAD, VNT	ELISA, VN
Trichinellosis	Agent identification	Agent identification, ELISA
Trypanosomiasis	Agent identification	-
AI (A, H5N1, H7N9)	Real time RT-PCR, HAI, Rapid test	VI, AGID, HAI
Avian Mycoplasmosis	ELISA, SAT	SAT, HAI
Salmonellosis	Agent identification	-
E coli	Agent identification	-
Staphylococcus aureus	Agent identification	-
IBD (Gumboro disease)	ELISA, Rapid test	ELISA, AGID

NCD	Real time RT-PCR	VI, HAI
Bovine anaplasmosis	Agent identification	CAT, CF
Bovine babesiosis	Agent identification	CF, ELISA, IFA
Bovine brucellosis	RBT, MRT, ELISA, Conventional PCR	BBAT, CF, ELISA, FPA
Bovine cysticercosis	Agent identification	Agent identification
Bovine tuberculosis	IDT	IDT, IFN gamma
Bovine viral diarrhoea	ELISA	Agent identification
CBPP	ELISA	ELISA, CF
HS	Agent identification, Conventional PCR	Agent identification
IBR	ELISA	Agent identification, ELISA, PCR, VN
Theileriosis	Agent identification	Agent identification, IFA
Trypanosomiasis	Agent identification	IFA
EI	Rapid test, ELISA	AGID, ELISA
Equine piroplasmosis	Agent identification	ELISA, IFA, CF
PPR	Rapid test, ELISA	VN, ELISA
CSF	Real time RT-PCR, ELISA	ELISA, FAVN, NPLA
PRRS	Real time RT-PCR	ELISA, IFA, IPMA
Toxoplasmosis	ELISA	Agent identification
African swine fever	Real time PCR	Real time PCR
CCHF	ELISA, IF test	-
CPV	Rapid test	-
CD	Rapid test, ELISA	-
PPMV	Real time RT PCR	-
AMR	Disk diffusion	Disk diffusion, MIC (Agar dilution and broth micro dilution)
Mastitis	CMT	Cell count
Fascioliasis	Agent identification, ELISA	Agent identification
Fungal infection	Agent identification	-
Aflatoxin	ELISA, Rapid test	-
Ochratoxin	ELISA, Rapid test	-
Fuminosin	ELISA, Rapid test	-
Mineral estimation (P, Ca and Mg)	ELISA	**-**

Source: Laboratory Services Unit, NCAH

*Test of practical value, **OIE prescribed test