National Gid Prevention, Control and Elimination Plan for Bhutan, 2021

(Second Edition)

SUPPORTED BY:

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Livestock Research and Extension Division

Department of Livestock

Ministry of Agriculture and Forests

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FOREWORD

Yak rearing is an age-old tradition and the primary source of income for the highlanders living across the northern belt of the country, stretching from Haa in the west to Trashigang in the east. The rugged terrains, harsh weather, diverse predators, pasture shortage, diseases, etc. are the main factors threatening the livelihood and sustainability of yak farming in these highland communities. Amongst livestock diseases, one of the main causes of yak mortality in the country is due to Coenurosis, commonly called in Bhutan as Gid.

The history of Gid in yaks in Bhutan dates to the 1950s. Since then, several measures were implemented to prevent and control the disease. Some success stories were documented on the reduction of Gid prevalence in some parts of the country. However, sustainable impact to prevent and control Gid in yaks could not be achieved.

Considering the socio-economic impact of Gid disease in yaks for the farmers in the high-altitude yak-rearing areas, in 2016, the National Gid Prevention and Control Plan (NGPCP 2016) was developed, wherein the past Gid disease prevention and control measures were reviewed and devised strategic approaches. However, an appreciable reduction in the prevalence of Gid in yaks could not be achieved.

I am happy to note that the National Centre for Animal Health and the National Highland Research and Development Centre collaboratively has taken the lead in reviewing the past Gid prevention and control strategies and developing a revised or updated version of the document, the National Gid Prevention, Control and Elimination Plan 2021.

I would like to extend my appreciation to all the agencies and individuals who contributed to revising and updating this very important document. Revision and development of the National Gid Prevention, Control and Elimination Plan 2021 have been conducted considering the issues and challenges encountered during the implementation of response measures as guided by the earlier plan document, NGPCP 2016.

I hope this revised plan document will be useful as a ready reference to all those involved in the prevention, control and elimination of Gid in yaks in Bhutan, which would immensely contribute to the livelihood of our vulnerable highlanders.

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ABBREVIATIONS/ DEFINITIONS

C. cerebralis	*Coenurus cerebralis*
DLS	Dzongkhag Livestock Sector.
DoL	Department of Livestock.
DPMU	Dog Population Management Unit.
DVH	Dzongkhag Veterinary Hospital.
DVL	Dzongkhag Veterinary Laboratory.
Dzongkhag	District, an administrative division composing of a group of Gewogs in Bhutan.
Gewog	Sub-district, an administrative division composing of a group of villages in Bhutan.
HDP	Highland Development Program.
LEC	Livestock Extension Centre.
MoAF	Ministry of Agriculture and Forests.
NCAH	National Centre for Animal Health.
NGPCEP	National Gid Disease Prevention, Control and Elimination Plan 2021.
NGPCP	National Gid Prevention and Control Plan 2016.
NHRDC	National Highland Research and Development Centre.
NVL	National Veterinary Laboratory.
RLDC	Regional Livestock Development Centre.
RNR EC	Renewable Natural Resources Extension Centre.
T. multiceps	*Taenia multiceps*
VIS	Veterinary Information System.
VPP	Veterinary Paraprofessional.
Yak	Includes its cross (with local cattle) breeds: Zo (male) and Zom (female).

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1. INTRODUCTION

Yaks (*Poephagus grunniens*) are the main livestock and the primary source of income for Bhutanese highlanders. These animals are reared under the traditional migratory system, reaching as high as 5000 masl in their summer pasture and travelling down to about 2500 masl during winter. As per the annual livestock statistics 2019, a total of 41,918 yaks and 9,904 crossbreeds were found in 11 of the 20 districts in Bhutan.

The main causes of yak mortality in Bhutan are fodder shortage, harsh weather, predation, accidents, yak diseases, etc. Amongst yak diseases, coenurosis, commonly known as gid, has been reported since the 1950s to be the main cause of yak calves' mortality in Bhutan. Gid is a parasitic neurological disease caused by the larval stage of *Taenia multiceps*, a dog tapeworm, mainly affecting sheep. In Bhutan, the disease is prevalent in yak calves, between 1 – 3 years, where the yak watchdogs act as the definitive host and yaks as the intermediate host. The disease has been associated with socio-economic losses and damage to the livelihoods, food security and nutrition of vulnerable pastoralists. In long run, loss of yaks to gid disease may force pastoralists to migrate away from the highland areas in search of alternative livelihoods. These may induce poverty, social and economic instability, and conflict. Globally, the disease is distributed notably in the yak and sheep rearing areas of Tibet in China, Mongolia, India and some Central Asian countries.

Several attempts were made in the past to prevent and control the disease. A few success stories were documented where reduction in the prevalence of gid disease in some target areas could be achieved; however, the impacts could not be sustained. Therefore, the disease remained uncontrolled in some yak rearing highland areas of Bhutan. Currently, the disease is prevalent in some yak-rearing areas under Haa, Paro, Thimphu, Gasa and Bumthang Dzongkhags.

Because of the economic impact of Gid disease in yaks for the farmers in the high-altitude yak-rearing areas, in 2016, the past Gid disease prevention and control measures were reviewed and devised strategic approaches as described in the National Gid Prevention and Control Plan 2016. However, an appreciable reduction in the prevalence of Gid in yaks could not be achieved.

Investing in the effective prevention, control and elimination of Gid in yaks will significantly contribute to food security, reducing poverty and consequently improving the livelihoods of Bhutan's most vulnerable pastoral and rural communities. Therefore, a consensus has been reached on the need to review past strategies, as described in the National Gid Prevention and Control Plan 2016 and adopt contemporary strategies.

This document, the National Gid Prevention, Control and Elimination Plan 2021, shall guide the field professionals and relevant agencies during the implementation of activities for the prevention, control and elimination of Gid in yaks in Bhutan. It also contains a chapter on the Gid elimination roadmap describing the strategies to achieve elimination of Gid in yaks in Bhutan at the end of 2025.

2. THE DISEASE

2.1. Aetiology

Gid disease or Coenurosis is caused by the larval stage, *Coenurus cerebralis*, of the dog tapeworm, *Taenia multiceps*, predominantly affecting young yaks of one to three years old. The adult tape worms cause taeniasis in dogs without showing any visible clinical symptoms even in heavy infection. Yaks get infected by grazing on pastures contaminated by yak watchdogs' faeces infested with *T. multiceps* eggs.

2.2. Hosts range

Figure 1: Definitive host (yak watchdogs) and intermediate host (young yaks) of *T. multiceps* causing Gid in yaks

2.2.1. Final/Definitive host

Dogs, foxes, jackals and other canine species are the final hosts for *T. multiceps*. In Bhutan, yak watchdogs are considered the main definitive host for the adult Gid tapeworm. Free-roaming dogs and other wild canids are other definitive hosts that could also be involved in the transmission of Gid disease. The dogs get infected mainly by ingestion of the yak brain and spinal cord infected with *Coenuros cerebralis*. In the small intestine of the final hosts (dog), the cystic larval stage develops into an adult tapeworm, causing taeniasis, which releases the eggs with the faeces thereby contaminating the pastures and environment.

2.2.2. Intermediate host

Yak, sheep, goat, cattle, and other herbivorous animals are the intermediate hosts for *T. multiceps*. Wild animals such as Antelope, Nubian Ibex, Goral, etc. were reported to be infected by Gid parasites. In Bhutan, yaks between 1 to 3 years of age are considered as the main intermediate host for this tapeworm. Humans can also get infected if hygienic measures are not taken while handling infected yak watchdogs; incidences of Coenurosis in humans have been reported from different parts of the world. The eggs of dog tapeworm develop into the cystic larval stage, *Coenuros cerebralis,* in the brain and spinal cord of these intermediate hosts causing Gid or Coenurosis.

2.3. Transmission

Dogs and other canine species harbouring adult parasites (*T. multiceps*) are the main source of transmission to the intermediate hosts and act as a continuous source of infection through the discharge of eggs in the faeces. In yak-rearing highland areas of Bhutan, pastures are contaminated by yak watchdog faeces containing eggs of the parasite. Yaks get infected by grazing on contaminated pastures and drinking water sources.

2.4. Life Cycle

Infected yak watchdogs and other wild carnivores excrete eggs of the parasites along with their faeces, thus contaminating the pastures. When yaks graze on the contaminated pastures, the eggs are ingested and develops into larvae, which are then released into small intestines. The larvae migrate through the bloodstream to the brain and spinal cord and develop into cysts; the process takes about 6 to 8 months. At maturity, the size of the cyst can grow up to 5 cm or more in diameter. The cysts can also be found lodged in the spinal cord of the affected yaks. The dog gets the infection from eating the infected brain, spinal cord, or contaminated meat.

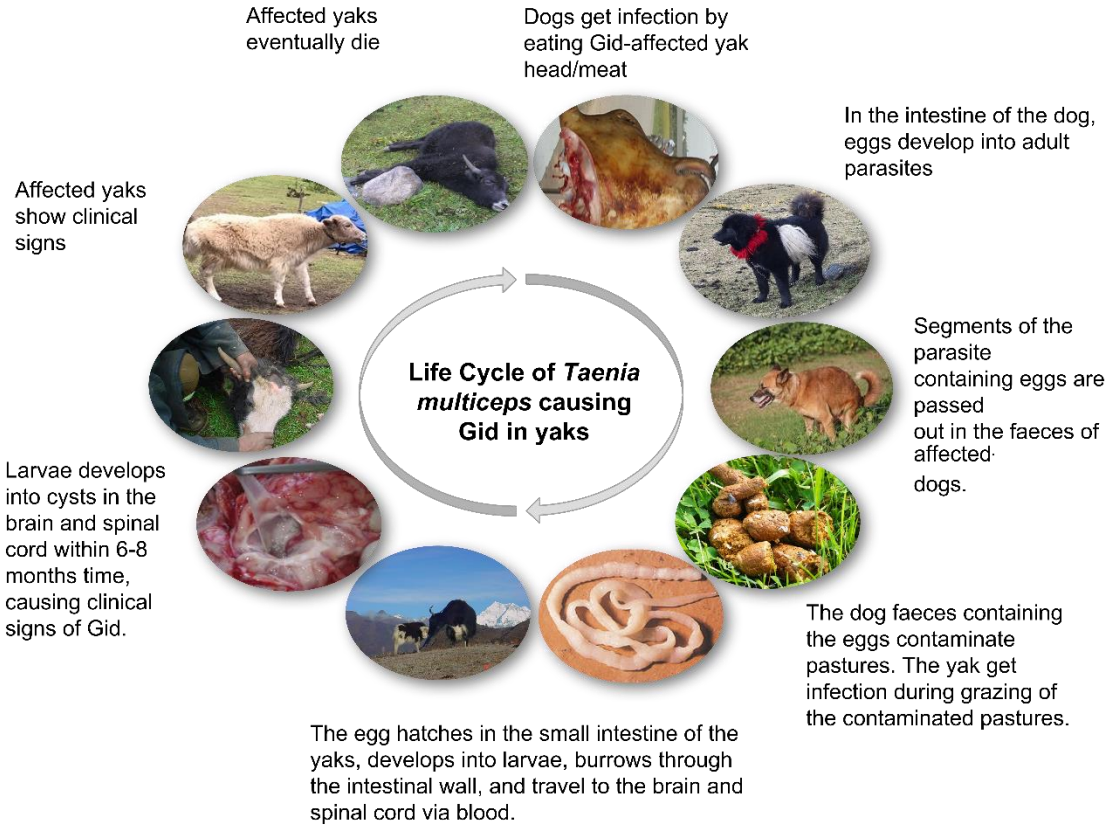

Figure 2: Life cycle of *T. multiceps* causing Gid in yaks

2.5. Pathogenesis

During the early stages of migration through brain tissues, the migrating larvae may cause signs of irritation, including nausea and convulsions. However, clinical signs are caused by the tapeworm cysts or Coenurus by exerting pressure on the brain tissue resulting in irritation and damage to the brain. It may exert sufficient pressure to soften cranial bones if the location of the cysts is on the surface of the brain. The cyst may take up to 6 to 8 months to develop to its full size of about 5 cm in diameter.

2.6. Clinical signs

The clinical signs of the disease develop when the central nervous system of the yak is invaded by the cyst (*Coenurus cerebralis*). The severity of the signs depends on the number of tapeworm eggs ingested by the animals and the location of the cysts. Coenurosis can occur in both acute and chronic forms.

Acute Coenurosis occurs during the migratory phase of the larvae, usually about 10 days after the ingestion of large numbers of tapeworm eggs. The signs are associated with an inflammatory and allergic reaction. There is transient pyrexia and relatively mild neurological signs such as listlessness and a slight head aversion (turning of the head to one side). Occasionally the signs are more severe, and the animal may develop encephalitis, convulse and die within 4 to 5 days.

From about 1 to 3 weeks after ingestion, when larvae wander in brain tissues, the animals will have raised body temperature and may show signs of nervous system disturbance such as listlessness and slight head aversion. This will however happen only when many parasites invade the brain tissue simultaneously.

In chronic Coenurosis, the time taken for the eggs to hatch, migrate and grow large enough to present nervous dysfunction varies from 2 to 6 months. The earliest signs are often behavioural, with the affected animal tending to stand apart from the herd and react slowly to external stimuli. As the cyst grows, the clinical signs progress to depression, unilateral blindness, circling, altered head position, incoordination, paralysis, recumbency and death.

Based on the position of cyst in the brain and spinal cord, various nervous system disturbance signs are shown by the animals:

- If the cyst(s) is in one side of the forebrain, the animal would hold its head on the same side and turns in a circle towards the affected side (circling movement). Such animals are blind in the eye on the opposite side.
- If the cysts are lodged in the anterior part of the brain, the head is held against the chest and the animal steps high or may walk in a straight line until it meets an obstacle and then remain motionless for some time.
- If the cyst(s) is lodged in the hind brain, the animal becomes excited, easily frightened and will show a jerky or staggering gait in the hind legs.
- If the cyst is localized in the lumber region of the spinal cord, it will cause progressive paralysis of one or both hind limbs.

- If the cyst is situated on the surface of the brain, the skull would become soft and the affected part can be palpated. The vision of the animals is also frequently affected and would show signs of blindness.

There will be grindings of the teeth, salivation, and complete loss of balance, convulsions and result in the death of animals.

2.7. Post-mortem lesions

- Animals, which die in the early stages show inflammation of brain tissue and several sinuous tracts on the brain. At the end of these tracts, young larvae can be found.
- Animals, which die in the later stages of the disease are emaciated and anaemic.
- One or more coenuri may be found in the brain, often lying in a cavity surrounded by necrotic materials.
- There may be pressure atrophy (softness of bones) or perforation of the skull. In some old cases, the cysts sometimes get degenerated and can be identified by findings hooks of Gid parasites.

2.8. Diagnosis

2.8.1. Clinical diagnosis

The disease is observed only in young yaks of 1 to 3 years of age since they are highly susceptible. The adult animals would develop immunity. Young yaks exhibiting neurological signs as described in section 2.6 could suggest Gid infection, however, recovery of coenurus cysts through surgical intervention or during post-mortem examination could only confirm the disease.

Acute Coenurosis is difficult to diagnose since there is sudden death and it should be differentiated from other diseases that cause blindness and other CNS lesions like fracture of the skull, meningitis, tumours, abscess, poisoning, etc.

2.8.2. Post-mortem examination

A definite diagnosis can be made by conducting a post-mortem examination for the presence of cysts and other lesions in the brain and spinal cord. The cysts or coenuri are readily recognized as a large fluid-filled sac measuring up to 5 cm or more in diameter which bears clusters of scoleces on its internal wall (Figure 3).

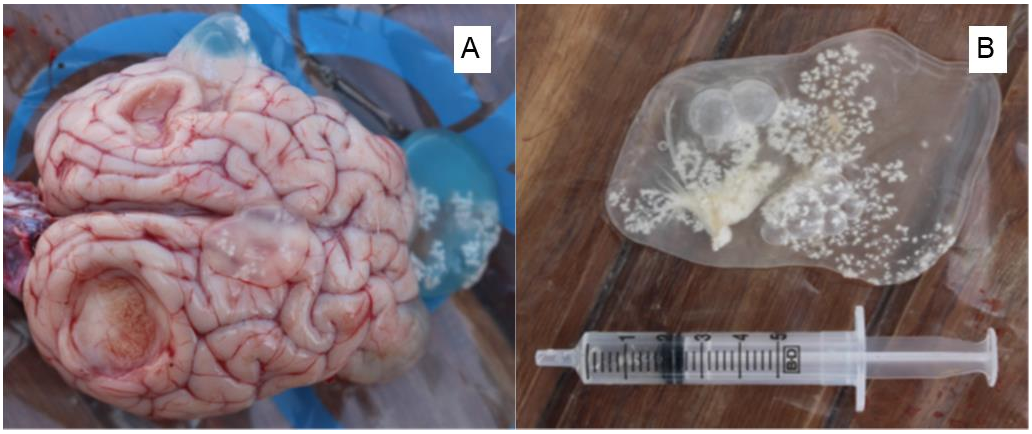

Figure 3: A – Multiple fluid-filled cysts and evidence of associated cerebral parenchymal loss; B – Coenurus cyst with multiple protoscoleces (Hughes et al., 2019)

2.8.3. Laboratory diagnosis

Identification of *T. multiceps* in the yak watchdogs' faces, scats and soil samples indirectly indicates the risk and prevalence of Gid disease in young yaks in that area. Laboratory examination of yak dogs' faeces, scats and soil samples must be conducted to see the presence of taeniid eggs, followed by molecular analysis to identify *T. multiceps*.

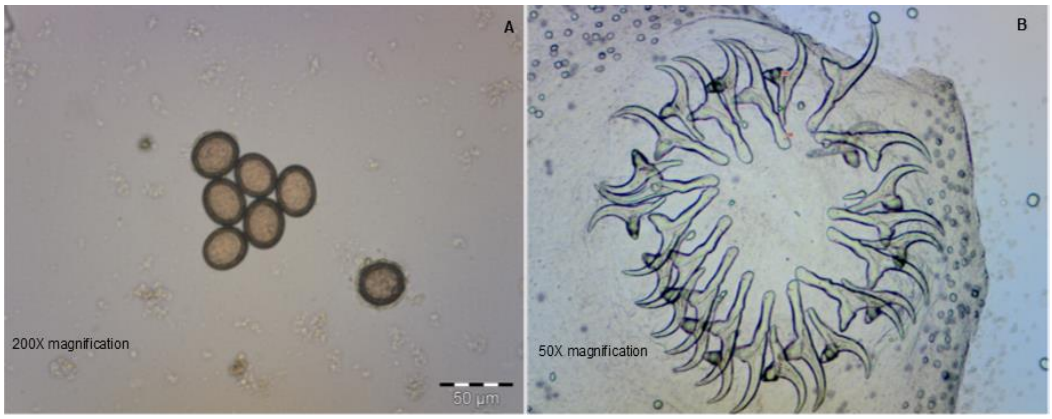

Figure 4: A – eggs of *T. multiceps*; B – hooks of protoscolex (Varcasia et al., 2015)

2.9. Treatment

Some studies have demonstrated that Praziquantel or Albendazole are effective for the treatment of Gid in sheep: Praziquantel tablet at a dose rate of 70mg/kg bodyweight can be given three times at five days intervals (day 1, day 5 and day 10); or Albendazole tablet at a dose of 25mg/kg bodyweight for 6 days after the onset of clinical signs. Studies have also shown effective control of Coenurosis in small ruminants using Fenbendazole or a combination of Praziquantel and Fenbendazole.

3. SITUATIONAL ANALYSIS

3.1. Yak population distribution in Bhutan

Yak-rearing is the main source of livelihood for the Bhutanese population living in high altitude areas, stretching from Haa in the west to Trashigang in the east. Milk and meat are the most important products, but yaks are also used as riding and pack animals, and they provide fibre, fuel and fertilizer. Yaks play an important role in the religious and cultural life, especially for the pastoralists but also for the Bhutanese population in general. Some of the yak-herding communities have their own distinct culture and dress habits.

The yaks are herded in a transhumance pattern, depending on the seasonal availability of pastures. The alpine summer pastures, at around 5000 meters above sea level (masl), are grazed until late September or early October, and the herds begin to descend to winter pastures on lower ground at an altitude of around 2500 – 3500 masl. All yak-herding families have permanent homes near their winter pastures.

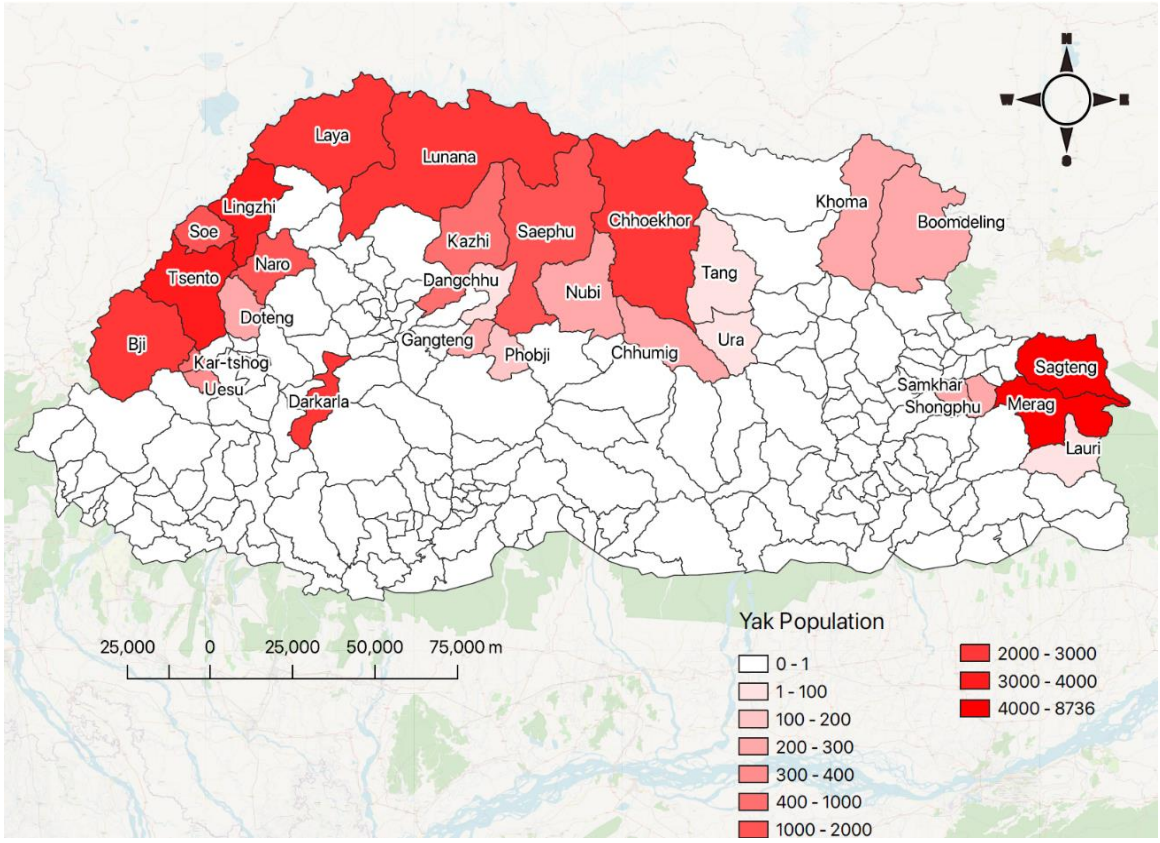

Figure 5: Yak population distribution in Bhutan, 2020

The genetic diversity within Bhutanese yak populations has been assessed using genetic distance, which is used as a measure of genetic similarity. It was proposed that Bhutanese yak populations could be categorized into two breeds, namely Merakpa yak of eastern Bhutan and Haapa yak of western and central Bhutan. Yaks from the eastern region of the country are distinctly smaller in size and body weight compared to those of western Bhutan.

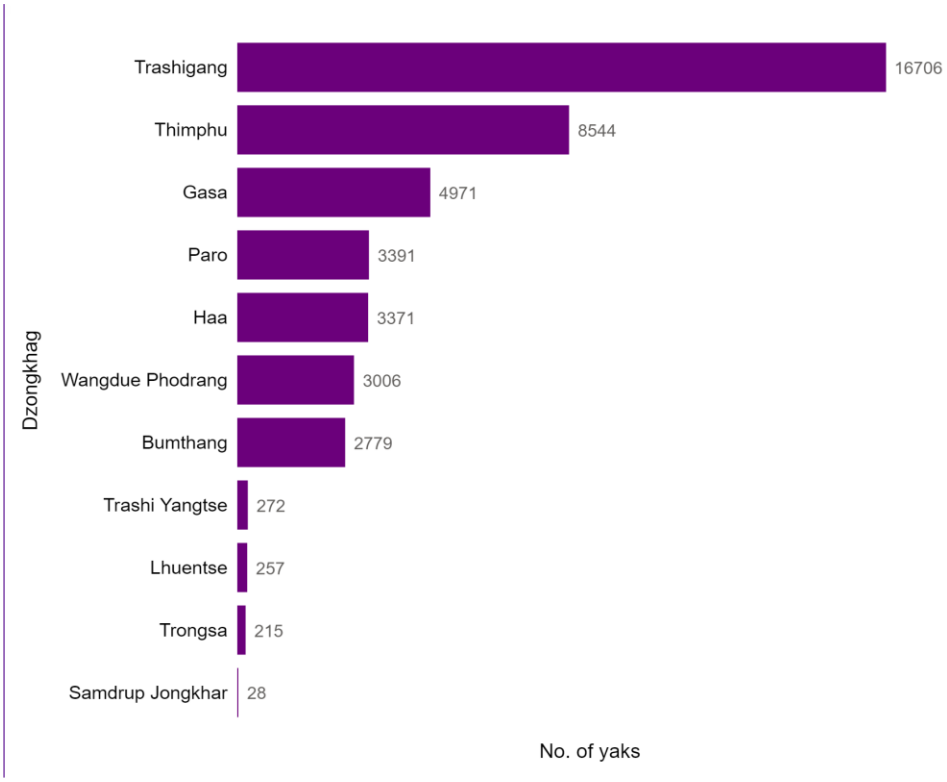

Figure 6: Dzongkhag-wise yak population distribution in Bhutan, 2020

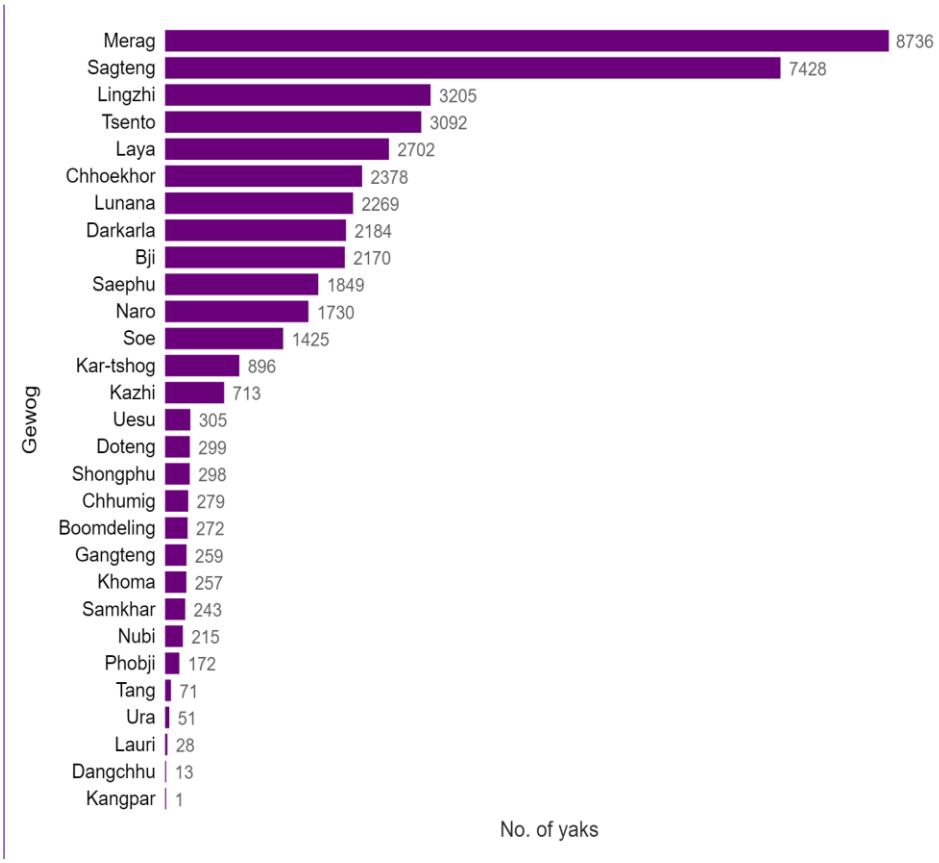

Figure 7: Gewog-wise yak population distribution in Bhutan, 2020

In Bhutan, the susceptible livestock population for Gid disease are yaks and their crossbreeds (with local cattle) known as Zo (male) and Zom (female). Yaks of less or equal to 3 years of age are predominantly affected by Gid. As per the annual livestock statistics 2020, there are 43,540 yaks and their crossbreeds in Bhutan distributed across 29 gewogs and 11 dzongkhags. The major yak-rearing highland dzongkhags are Trashigang in the eastern region; Gasa, Wangdue Phodrang and Bumthang in the central region; and Thimphu, Paro and Haa in the western region.

In the country, in 2020, Trashigang dzongkhag has the highest number of yaks (n=16706), followed by Thimphu (n=8544), Gasa (n=4971), Paro (n=3391), Haa (n=3371), etc. At the gewog level, Merag has the highest yak population at 8736, followed by Sagteng (n=7428), Lingzhi (n=3205), Tsento (n=3092), Laya (n=2702), etc.

3.2. Yak watchdog population, 2021

A total of 42,874 free-roaming dogs were counted during the nationwide survey for the free-roaming dog population in the country conducted in 2015. As per the annual livestock statistics, 2020, there are 29,842 pet/utility dogs in Bhutan.

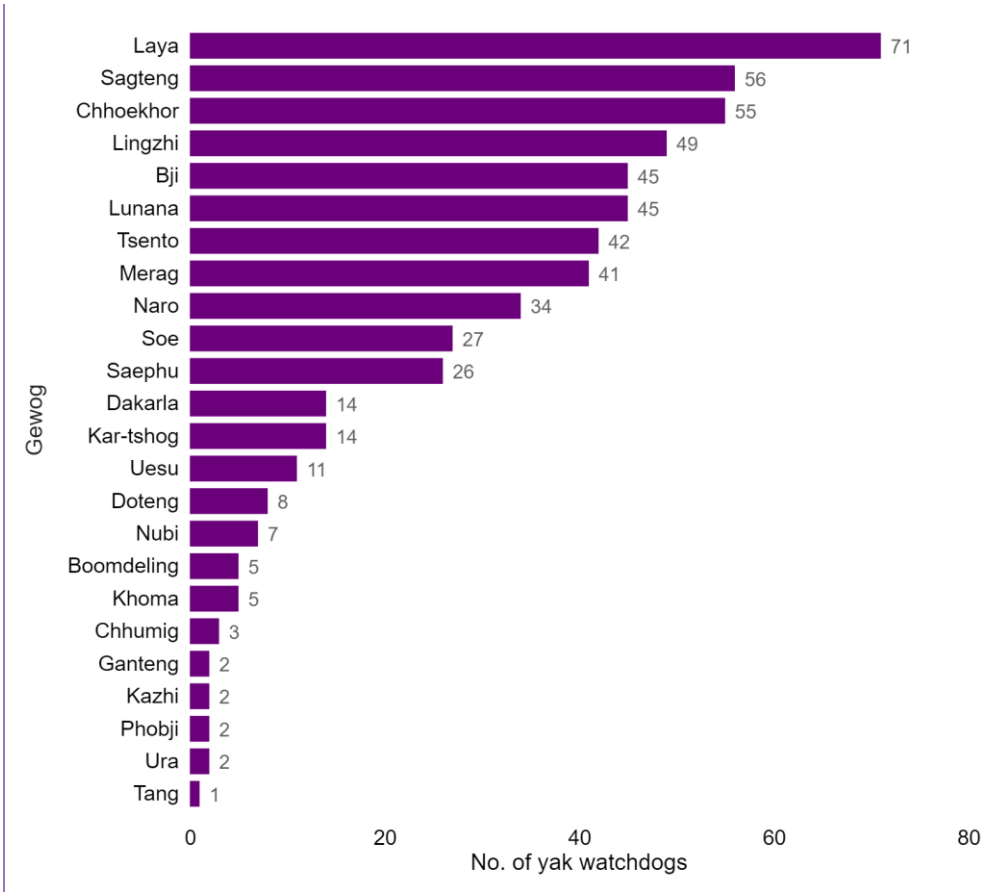

Figure 8: Gewog-wise distribution of yak watchdog population, 2021

Yak watchdogs are the main definitive host for *Taenia multiceps* which causes Gid disease in young yaks in Bhutan. As per the inventory of yak watchdog population in highland areas of Bhutan maintained by the National Highland Research and Development Centre (NHRDC), Bumthang, there are 567 dogs in 24 highland gewogs of Bhutan. Laya gewog has the highest

number of yak watchdogs (n=71), followed by Sagteng (n=56), Chhoekhor (n=55), Lingzhi (n=49), Bji and Lunana (n=45 each), Tsento (n=42), etc.

3.3. Status of Gid in yaks in Bhutan, till 2015

Gid disease in yaks in Bhutan has been reported since the 1950s. Since then, various measures have been implemented to prevent and control the disease. An eradication program for Gid was introduced consisting of deworming yak calves with Albendazole and Fenbendazole and dogs with Niclosamide, and it was recorded that the program was successful in reducing yak mortality due to Gid in yak herds in one of the worst-affected areas of Bhutan from 40.3 per cent in 1992 to 1.5 per cent in 1994. However, due to various reasons, the program could not be implemented sustainably. Therefore, the disease gradually has spread to different yak-rearing highland areas of Bhutan.

As per the national Gid surveillance data published in the National Gid Prevention and Control Plan 2016, between 2000 and 2015, a total of 9,464 yak calves have died due to Gid (Figure 9) – an annual average of 592 deaths, and the trendline shows a gradual increase in number of Gid cases in yaks.

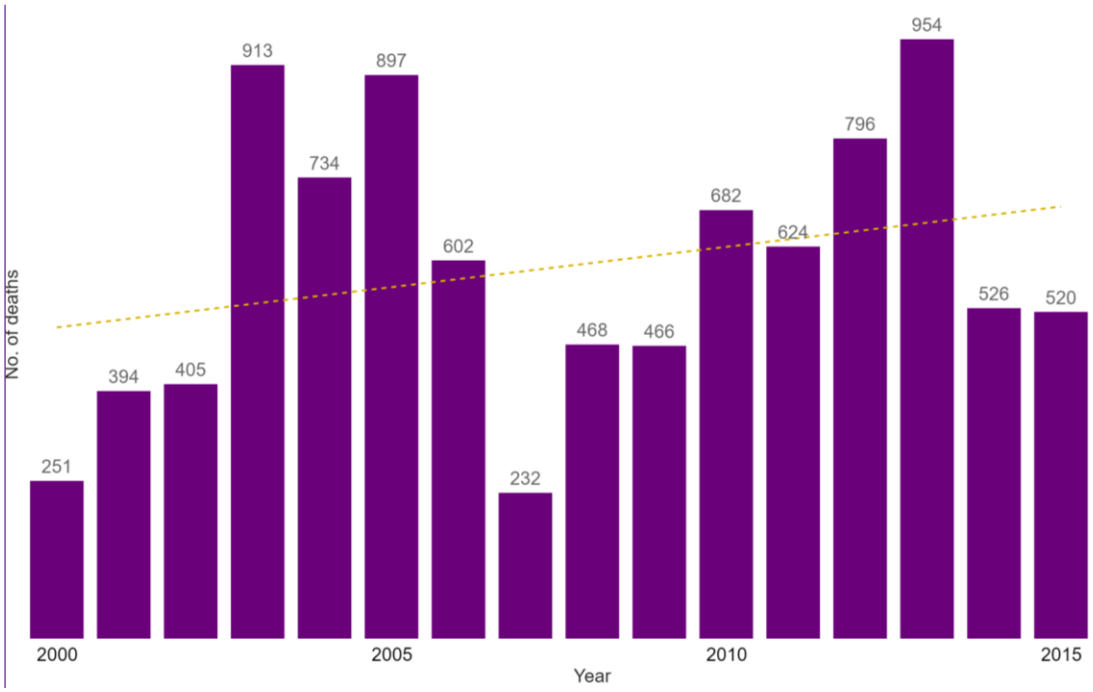

Figure 9: Yak mortality due to Gid, 2000 – 2015

The data presented concerning Gid prevalence in Bhutan between 2010 and 2015 has shown that a total of 10 gewogs under 5 different dzongkhags have reported Gid in yaks: Chhoekhor gewog under Bumthang dzongkhag; Laya and Lunana under Gasa dzongkhag; Lingzhi, Soe and Naro under Thimphu dzongkhag; Tsento under Paro; and Bji and Kar-tshog under Haa dzongkhag (Figure 10).

Gid disease period prevalence, 2010 to 2015, was recorded to be the highest in Tsento gewog (19.6 %), followed by Chhoekhor (15.1 %), Laya (11.9 %), Lunana (11.8 %), Lingzhi (8.4 %), Soe (8.3 %), etc. (Figure 10).

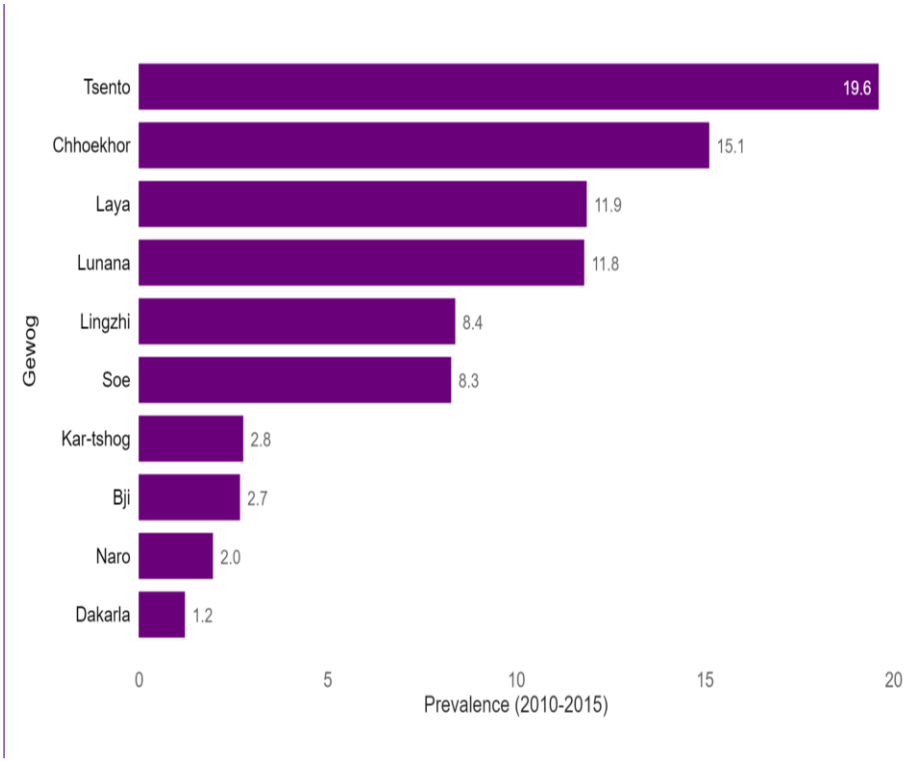

Figure 10: Gewog-wise Gid prevalence, 2010 – 2015

3.4. Prevalence of Gid in yaks in Bhutan, 2020

According to the national Gid surveillance data published in the National Gid Prevention and Control Plan 2016, between 2008 and 2015, the disease was reported from 11 gewogs of 5 dzongkhags, namely Bji, Kar-Tshog and Uesu gewogs under Haa; Tsento gewog in Paro; Soe, Lingzhi, Naro and Dakarla gewogs in Thimphu; Laya and Lunana gewogs in Gasa; and Chhoekhor gewog in Bumthang. However, Gid was not reported from some yak-rearing districts like Trashigang, Trashi Yangtse, Lhuentse and Wangdue Phodrang.

Sharma et al. (2021) conducted a nationwide study on the occurrence and genetic diversity of *Echinococcus* and *Taenia* species in Bhutan. For the study, environmental dog faecal samples (n = 953) were collected from 2016 to 2018 in all twenty districts of Bhutan, mainly in urbanised areas. 283 dog faecal samples were collected from yak rearing districts: Bumthang, Gasa, Thimphu, Trashigang and Trashi Yangtse. Only 6 samples (4 from Gasa and 2 from Thimphu) tested positive for *T. multiceps.* From the study, a few gaps identified concerning the prevalence of Gid and *T. multiceps* in highland areas are that the samples were mostly collected from urban areas, fresh dog faeces could not be collected, and the samples could not be collected from all the highland areas of the country. In addition, the samples were not collected from wild canids to determine the role they might play in the transmission cycle of coenurosis in yaks and other susceptible species.

The passive surveillance data concerning Gid disease in the country are inconsistent and not available for the years after 2015 and the past studies on the prevalence of *T.multiceps* in dog faeces did not cover yak watchdogs and wild canids in all the yak-rearing highland areas of Bhutan, therefore, a nationwide survey was conducted in 2020 to establish an updated baseline prevalence of Gid disease in yaks in all the highland areas of Bhutan. Simultaneously, laboratory surveillance was conducted wherein yak watchdog faeces, soil and scat (from wild

caids) samples were collected from all the highland areas to study the prevalence of *T.multiceps* in these areas.

The survey was conducted between February and June 2020 in all the yak-rearing highland areas of Bhutan, comprising 10 districts and 23 sub-districts (Figure 11). A semi-structured questionnaire was used to collect information on the number of yaks and their hybrids, Zo and Zom, of different age groups, and the numbers affected by Gid disease over the last year. Prevalence was calculated as the ratio of the number of yaks and their hybrids affected by Gid – observed through the exhibition of relevant clinical signs – to the total susceptible population (yaks and zo/zom of 3 years and below) in the area during the last year.

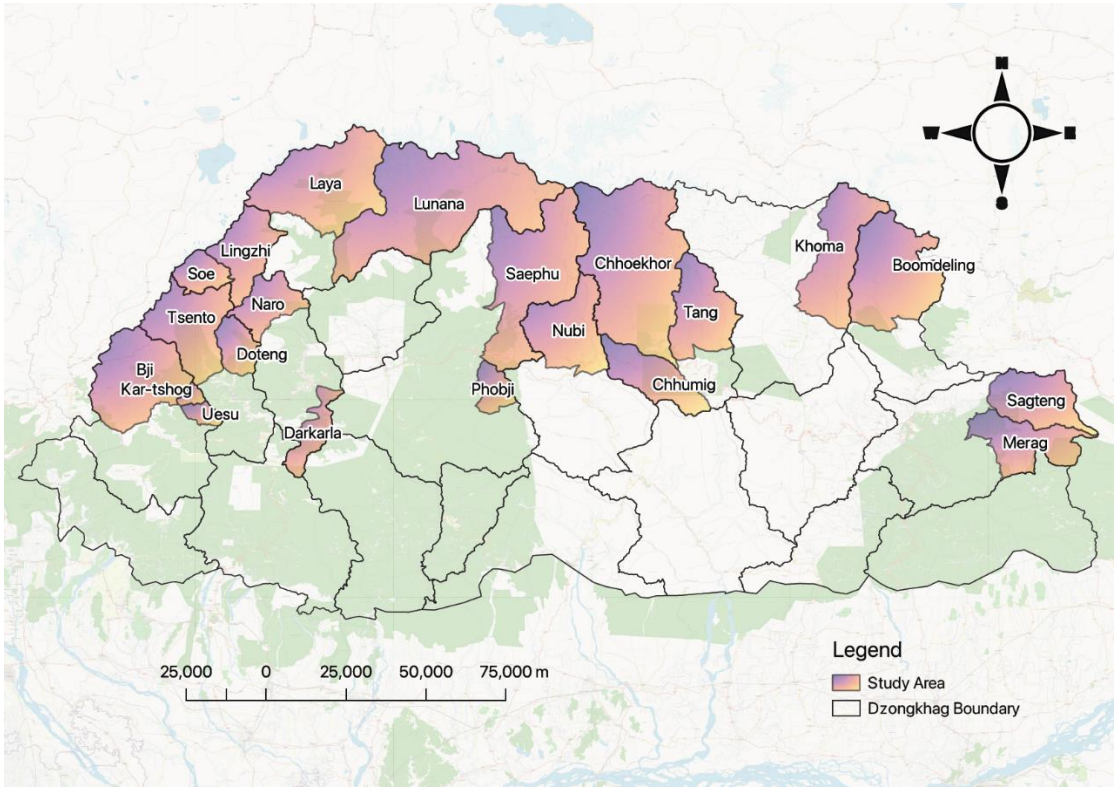

Figure 11: Map showing study areas

It was found that a total of 1,222 yaks were affected by Gid disease over the past one year from the total susceptible population of 8,541, thus attributing to the prevalence of Gid disease in yaks in Bhutan to 14.31 per cent.

At the regional level, the prevalence of Gid in yaks was found to be the highest in the West Central Region (34.40 %) followed by the West Region (13.05 %), the East Central Region (12.33 %) and the East Region (0.78 %) (Figure 12).

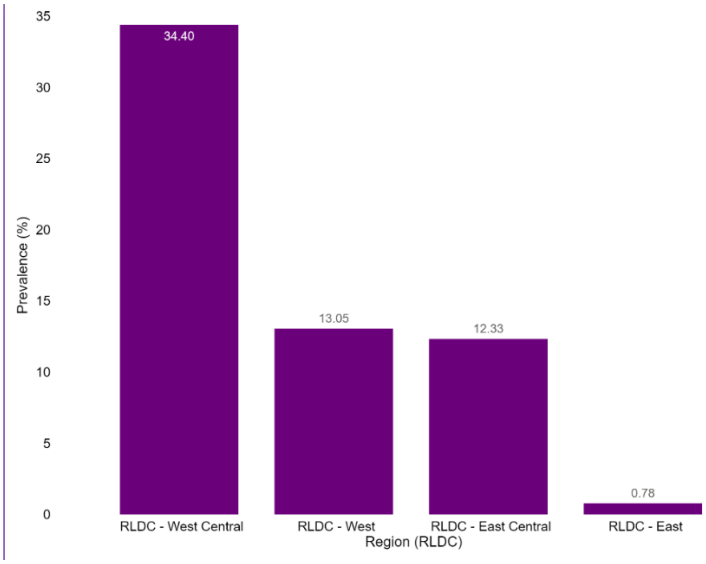

Figure 12: Region-wise Gid prevalence, 2020

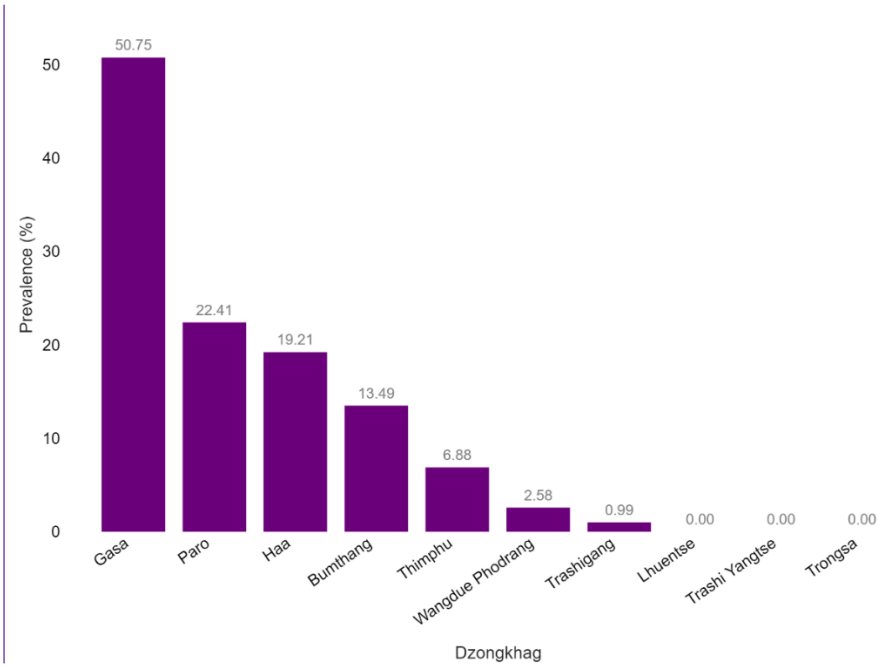

Figure 13: Dzongkhag-wise Gid prevalence, 2020

At the district level, the highest prevalence of Gid disease in yaks was reported from Gasa dzongkhag (50.75%) followed by Paro (22.41%), Haa (19.21%), Bumthang (13.49%), Thimphu (6.88%), Wangdue Phodrang (2.58%) and Trashigang (0.99%) (Figure 2). From the 10 target dzongkhags, the Gid case was not reported from Lhuentse, Trashi Yangtse and Trongsa dzongkhags (Figure 13).

During the survey, Gid cases were reported from Trashigang and Wangdue Phodrang dzongkhags, wherefrom Gid cases were not reported for many years, therefore, the ongoing laboratory surveillance shall validate the current findings, and if required, risk-based clinical surveillance shall be conducted to assess the situation.

At the gewog level, the prevalence of Gid disease in yaks was found to be the highest in Lunana gewog of Gasa dzongkhag with 71.31 per cent followed by Laya (35,92 %), Bji (32.85

%), Tsento (22.86 %), Doteng (20 %), Lingzhi (15.37 %), Chhoekhor (14.67 %), etc. (Figure 14).

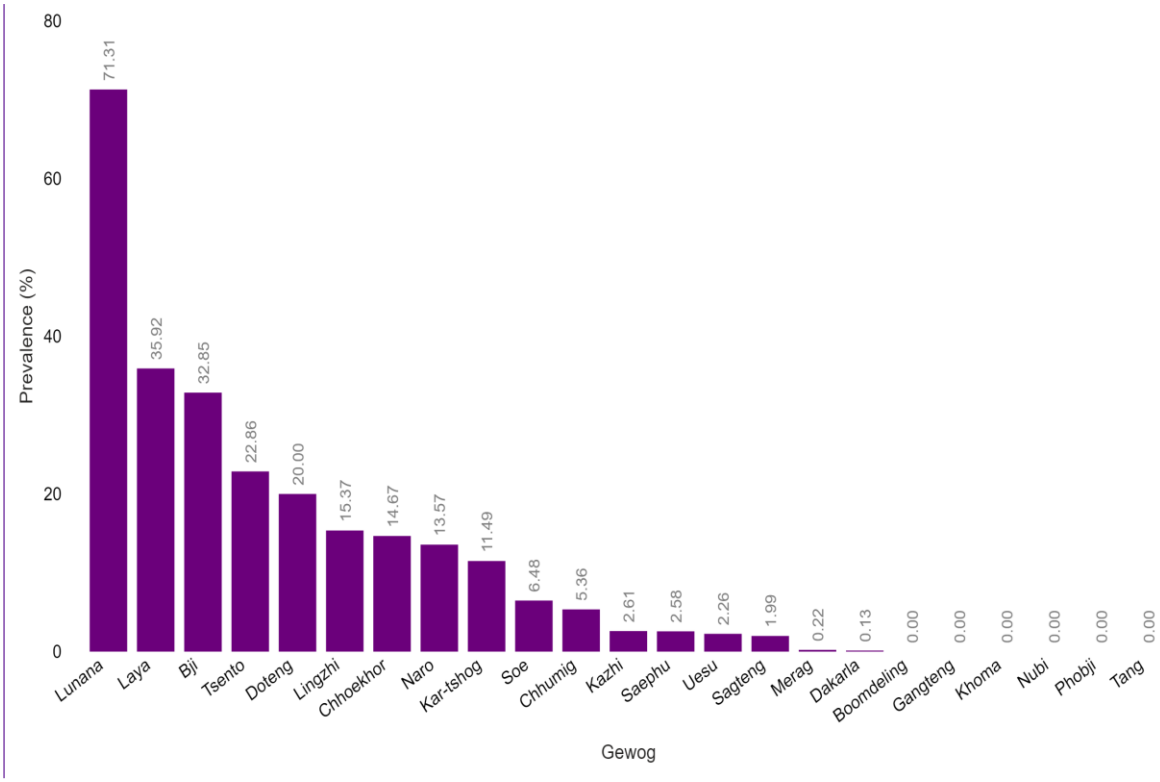

Figure 14: Gewog-wise Gid prevalence, 2020

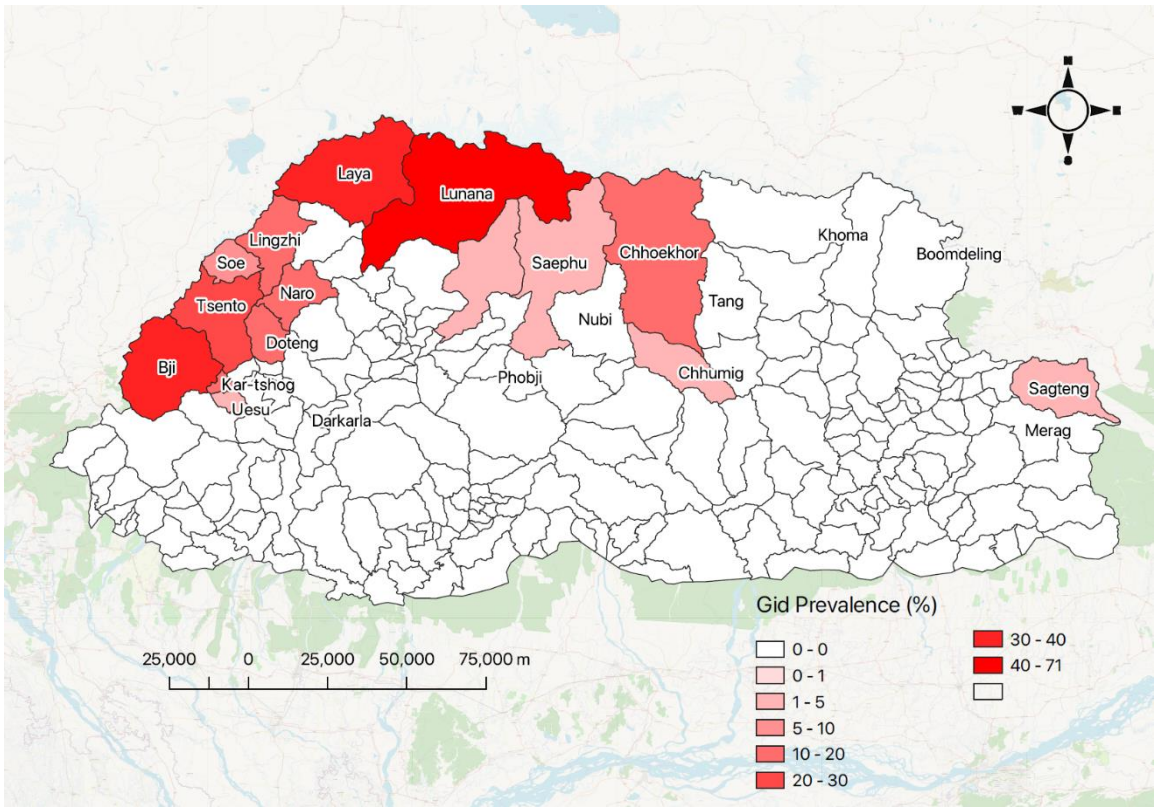

Figure 15: Gid prevalence distribution, 2020

4. PREVENTION STRATEGIES

4.1. In definitive hosts

4.1.1. Deworming of dogs

Control of *T. multiceps* infection in dogs using appropriate anthelmintic drugs is necessary to prevent transmission of the parasite to the yaks. Praziquantel is the drug of choice to deworm yak watchdogs against the tapeworm, *T. multiceps*.

The spectrum of action of praziquantel covers all the important species of cestodes in dogs. It specifically includes all *Taenia* species occurring in dogs, *Multiceps multiceps, Joyeuxiella pasquali, Dipylidium caninum, Mesocestoides species, Echinococcus multilocularis and E.granulosus*. The drug is effective against all stages of development of these parasites occurring in the intestines of dogs and cats. It impairs the normal tegument function of the parasite, making it permeable to excessive glucose loss and thereby more easily attacked by proteolytic enzymes. Because of this, whole tapeworms including the scolex are very rarely passed in the faeces following administration of the drug. Disintegrated and partially digested fragments may occasionally be seen in the faeces.

All the dogs should be dewormed once every three months (quarterly) using praziquantel tablets at the dose of 5 mg per kg body weight (SOP 2.1). The effectiveness of the deworming protocol should be assessed through regular laboratory surveillance by examining the dog faecal samples (SOP 2.2). During the submission of dog faecal samples to the regional or national referral laboratories, the concerned LEC in-charge must submit the sample details as per Form 3.2.

Considering the risk of spread of Gid disease by the dogs in the army outposts in the highland areas of the country, deworming of these dogs must be carried out as per the recommended schedule and monitored periodically by the concerned LEC in-charge.

The deworming program should be continued as long as there are cases of Gid disease in the locality or dogs faecal sample tests positive to the tapeworm. The frequency of deworming of yak watchdogs may increase or decrease depending on the prevalence of *T. multiceps* in the faecal samples collected from target areas. If the samples test negative for the parasite for two consecutive years, the frequency of deworming shall be reduced, however, other risk factors shall be considered as well.

4.1.2. Dog population management

In high altitude areas, yak herders keep dogs for guarding their yaks and these dogs are the main definitive host for the transmission of Gid disease. In addition, free-roaming dogs found in schools, army transit camps and nearby villages in the yak-rearing localities could also play an important role in transmitting the disease.

Therefore, dog population management in the highland areas by organizing mass dog sterilization campaigns is recommended to keep a minimum and a manageable number of dogs.

4.1.3. Pet registration

To keep a proper record of yak watchdogs about treatment, deworming, vaccination and other dog details, the registration of these dogs shall be facilitated through the LECs. Yak watchdog registration and the database maintained in the livestock extension centres help in identification and traceability, which is one of the important components of animal disease prevention and control.

The dog owners must be advocated about responsible pet ownership and the penalties for non-compliance according to the Livestock Act of Bhutan 2001 and the Livestock Rules and Regulations 2017.

The pet registration details must be entered into the online central registry and updated accordingly during the renewal of registration or transfer of ownership.

4.1.4. Movement control of free-roaming dogs

The movement of free-roaming dogs with tourists and other visitors to yak-rearing locations could result in the increase of the free-roaming dog population in yak-rearing areas. Such dogs could also be introducing Gid parasites into the locality free of Gid in yaks. Therefore, it is important to prevent the movement of free-roaming dogs along with the visitors/tourists to the yak-rearing areas through awareness education and in close collaboration with the tourism sector and other relevant stakeholders.

4.2. In Intermediate host

4.2.1. Deworming of young yaks

Prophylactic deworming of young yaks of 1 to 3 years of age with albendazole tablets at a dose of 7.5mg/kg body weight must be carried out two times a year (six-monthly). Albendazole was found to be effective against the larval stage of the dog tapeworm, *Taenia multiceps*, and it protects from other helminths as well. Preferably, all the young yaks should be dewormed in March/April and September/October, coinciding with their seasonal migration pattern: ascending to summer pastures in early spring and descending to lowland winter pastures in late autumn.

During deworming programs, the owner and animal details should be recorded (Form 3.3) by the respective gewog livestock extension agents and submit to the Dzongkhag, RLDC and NCAH. As required, yak deworming details must be entered into the available online central registry, currently the Veterinary Information System.

4.3. Surveillance (syndromic and laboratory)

4.3.1. In yaks and watchdogs

Like other animal diseases, Gid disease should also be kept under regular passive surveillance whereby the LEC in-charge investigate the reported suspected clinical cases of Gid in yaks and report to the higher authorities. Yaks exhibiting clinical signs and symptoms suggestive of Gid must be confined by fencing or tethering and observed carefully.

The concerned livestock extension agent should collect faecal samples from dogs/ environment (SOP 2.2) and submit (Form 3.3) to the nearest veterinary laboratory for examination, where a coprological examination shall be conducted (SOP 2.3). All the taeniid

positive samples must be packed and transported to the NCAH for molecular analysis. In addition, soil samples may also be collected and referred to the NCAH for further analysis.

Collection of faecal samples from yak watchdogs can be carried out during yak herd visits, Gid control campaigns and other relevant events, or when the yak herds descend to the lowest winter pastures.

4.3.2. In wild herbivores and canids

To understand the involvement of wildlife in the maintenance of the Gid disease life cycle at the yak-dogs-wildlife interface, it is also important to examine the faeces (scat) of wild canids for the presence of taeniid species. Such eggs can be differentiated by molecular analyses on species level. If found positive to taeniid species, control programs such as deworming of wild canids using bait (impregnated with praziquantel) can be initiated after conducting detailed feasibility studies. Wild herbivores, if found exhibiting Gid-like clinical signs and symptoms, must be reported to the nearest livestock extension office and examined. In the past, clinical cases of Coenurosis in Nubian Ibex, Gorals, Antelopes, etc. were reported from around the world.

4.4. Awareness and education

For the smooth and effective implementation of Gid control and elimination programs in the target highland areas, necessary supports could be garnered through sensitization of key stakeholders about the disease, its socio-economic impacts on the livelihood of highlanders and the disease's prevention and control measures.

For yak herders, regular awareness and education programs shall be organized at a local level on the aspects of Gid disease prevention and control measures. Every available platform such as highland or mountain festivals must be used for advocacy on national Gid prevention, control and elimination strategies. For the understanding of illiterate highlanders, information, education and communication (IEC) materials on Gid disease and its management shall be developed in the national language and disseminated to the livestock extension offices.

To reach wider highland communities in the country, radio programs must be developed and aired.

4.5. Early warning and preparedness

Detection of Gid case in a Gid-free herd must be reported immediately to the nearest LEC, and the information must be relayed to the Dzongkhag, RLDC and NCAH. Other yak herds at risk should be informed of the risk and necessary measures to be taken. If Gid case(s) is suspected in a historically Gid-free area of the country, yak herders are required to immediately notify their respective LEC in-charge for investigation and confirmation, in consultation with the Veterinary Officer of the Dzongkhag Veterinary Hospital.

In the Gid endemic areas, unusual morbidity or mortality of yaks due to Gid disease must be immediately reported to the nearest animal health centre.

Considering the high risk of introduction of the disease in Gid-free herds due to the movement of dogs (domestic and wild) and sharing of pastures during the practice of transhumance, the veterinarians and VPPs in the highland dzongkhags and gewogs must stay vigilant, and yak herders in their respective jurisdictions must be educated on the risks of introduction of Gid in their herd and the necessary preventive measures.

5. CONTROL STRATEGIES

5.1. Management of Gid-affected yaks

5.1.1. Isolation of affected yaks

The suspected or confirmed Gid affected yaks should be reported to the LEC in-charge, and its movement for grazing with other yaks should be restricted by tethering or fencing. The isolated yak should be kept under observation. This is because the affected yak may die at any time without the notice of the herders and the carcass may become accessible to yak watchdogs or wild canids resulting in further transmission of the disease.

5.1.2. Movement control to Gid-free areas

Although Gid affected yaks do not spread the disease to other yaks directly, the disease could be introduced in a previously free area if the yak watchdogs or other canids in the area gain access to a head or spine of a Gid affected yak brought in from a Gid endemic area. Therefore, movement of yaks, showing clinical signs and symptoms suggestive of Gid, from Gid endemic to Gid-free areas should be restricted. Procurement or distribution of young yaks, less or equal to 3 years, from Gid endemic to free areas, should be discouraged to avoid the introduction of Gid disease incubating yaks into Gid-free areas. If the newly introduced yaks exhibit Gid-like clinical signs, they should be immediately reported to the LEC and examined, and information must be shared further with the concerned Dzongkhag, Region and NCAH.

Before transporting any adult yak (>3 yrs.) to a Gid-free area for breeding or trading purposes, the yaks must be dewormed and vaccinated as per the recommended schedule.

5.1.3. Carcass disposal

The head, spine, or any contaminated meat of the Gid affected carcasses should be disposed of by deep burial to prevent accessibility to dogs and wild canids.

The farmers should be encouraged to inform the livestock extension officials to conduct a postmortem examination of the carcasses or submit Gid-affected yak heads to the respective LEC/DVH for confirming the disease and for proper disposal. Upon submission, the LEC/lab personal should conduct a postmortem and record the findings and submit the cyst sample to NCAH for analysis and archival.

5.1.4. Treatment

5.1.4.1. Surgery

If the cyst(s) is located on the brain surface, surgical removal is recommended, although the success rate is poor. The cyst can be detected by feeling the local softening of the skull with the fingers. Before the surgical intervention, the owner should be made aware of the risk involved and prior consent from the owner should be obtained before proceeding with such procedure.

Cystic fluid can also be removed by trephining and surgical drainage or can be punctured and drained aseptically. However, the evacuation of fluid from the cyst can be carried out only for those cysts located on the surface of the brain. Such a procedure may yield only a temporary improvement as the remaining cyst wall would produce the fluid.

5.2. Awareness and education

To break the transmission cycle of Gid disease and prevent further spread of infection, management of Gid affected animals is very critical. Therefore, awareness and education should be provided to the yak herders on the strategies to manage suspected or confirmed Gid affected yaks.

6. ORGANIZATIONAL STRUCTURE

6.1. Department of Livestock

The Animal Health Division (AHD) at the Department shall:

- Provide policy directives for the prevention and control of Gid in yaks
- Mobilize resources including funds for Gid disease prevention, control and elimination programs in the country
- Liaise with different stakeholders/agencies/international organizations for facilitating better implementation and ensuring the success of the program

6.2. National level

6.2.1. National Centre for Animal Health

The NCAH shall function as the national focal agency for the prevention, control and elimination of Gid disease in Bhutan. The job responsibilities for the national focal agency are as follows:

- Coordinate the overall planning and implementation of the National Gid disease prevention, control and elimination program
- Production of Information, Education and Communication (IEC) materials
- Ensure provision of required technical supports
- Maintenance of database, analysis and dissemination of information/ progress report to the Department/Ministry/other stakeholders
- Coordinate surveillance and research related to Gid disease
- Ensure adequate supply of deworming medicines to highland dzongkhags.
- Assess the progress of the Gid prevention, control and elimination programs implemented in the field
- Coordinate to review the National Gid Prevention, Control and Elimination Plan as and when required

6.2.2. National Highland Research and Development Centre

As a focal agency for Highland Development Program, NHRDC shall:

- Coordinate with relevant stakeholders for the prevention, control and elimination of Gid in yaks.
- Mobilize required resources for the implementation of the National Gid Prevention, Control and Elimination Plan.

6.3. Regional

The Regional Livestock Development Centres (RLDCs) would function as the regional focal agency for the implementation of Gid prevention and control measures in their respective regions. In line with the NGPCEP, the regional focal agency shall:

- Coordinate the overall planning and implementation of the Gid disease prevention and control program in the region, in consultation with concerned dzongkhags.
- Prepare regional Gid prevention and control plan including budget and coordinate activities in the field in consultation with the Dzongkhags.
- Liaise with different stakeholders at the regional level regarding the planning and implementation of the Gid prevention and control program
- Immediate notification about Gid case(s) incidence to NCAH through the fastest means of communication following the existing reporting channel
- Ensure provision of required technical supports in the region
- Facilitate mobilization of deworming medicines to highland dzongkhags
- Coordinate collection of samples (dog faeces and scats) and conduct coprological examination for monitoring the control program and submit Taeniid positive samples to NVL for molecular analysis
- Collaborate surveillance and research on Gid disease in the region
- Maintenance of database, analysis and dissemination of information/ progress report to the NCAH and the Department
- Monitoring of the implementation of effective deworming of yak watchdogs and young yaks
- Assess the progress of the Gid prevention and control programs implemented in the dzongkhags
- Collaborate to review the NGPCEP as and when required
- Submit an annual report about Gid prevalence, deworming and sample collection to the NCAH as per the recommended schedule (Annexure 3 – Reporting forms)

6.4. Dzongkhag

At the Dzongkhag level, the Dzongkhag Livestock Officer/Dzongkhag Veterinary Officer will be the focal person. The Dzongkhag focal person, In line with the NGPCEP, shall carry out the following tasks:

- Prepare dzongkhag Gid prevention and control plan including budget and coordinate activities in the field in consultation with the gewogs
- Liaise with different stakeholders at the dzongkhag level regarding the planning and implementation of the Gid prevention and control program
- Immediate notification about Gid case(s) incidence to the RLDC through the fastest means of communication following the existing reporting channel.
- Facilitate mobilization of deworming medicines to highland gewogs

- Ensure provision of required technical supports to the gewogs
- Implementation of effective deworming of yak watchdogs and young yaks
- Coordinate Gid disease awareness campaign for the yak herders
- Coordinate collection of samples (dog faeces and scats) and conduct coprological examination for monitoring the control program and submit Taeniid positive samples to NVL for molecular analysis.
- Collaborate surveillance and research related to Gid disease
- Assess the progress of the Gid prevention and control programs implemented in the gewogs
- Maintenance of database, analysis and dissemination of information/ progress report to the RLDC
- Collaborate to review the National Gid Prevention and Control Plan as and when required
- Submit an annual report about Gid prevalence, deworming and sample collection to the RLDC as per the recommended schedule (Annexure 3 – Reporting forms)

6.5. Gewog

The In-charge of the Livestock Extension Centre (LEC) in the gewog will be the focal person for that gewog.

In line with the NGPCEP, the main roles of the gewog focal person are as follows:

- Prepare gewog Gid prevention and control plan and coordinate related activities in the field
- Liaise with different stakeholders at the gewog level regarding the planning and implementation of the Gid prevention and control program
- Immediate notification about Gid case(s) incidence to the RLDC through the fastest means of communication following the existing reporting channel.
- Conduct regular disease awareness campaigns for the GT members, farmers, and other institutions in the gewog
- Implement Deworming of yak watchdogs and young yaks as per the standard schedule and SOPs in the NGPCEP
- Collection of samples (dog faeces and scats) and submission to the Dzongkhag Veterinary Laboratory for coprological examination.
- Collaborate surveillance and research related to Gid disease
- Maintenance of database, analysis and dissemination of information/ progress report to the dzongkhag
- Submit an annual report about Gid prevalence, deworming and sample collection to the dzongkhag as per the recommended schedule (Annexure 3 – Reporting forms)

6.6. Important Stakeholders

6.6.1. Department of Forest and Park Services

With the evidence of Coenurosis in wild herbivores and *T. multiceps* in the faeces of wild canids in other countries, a strong surveillance system in wildlife is critical to understand the disease at the domestic-wildlife interface in Bhutan. Syndromic and laboratory surveillance shall be conducted wherein the head and spine of dead herbivores or scats of wild canids could be collected by DoFPS officials during patrolling and referred to veterinary laboratories for examination.

6.6.2. Tourism Council of Bhutan

Over the years, the number of mountaineering tourists in Bhutan has increased. Jomolhari – Laya Trek, Druk Path Trek, Merak – Sakteng Trek, Snowman Trek, etc. are some of the alluring trekking trails in Bhutan. Sometimes, during the trekkings, dogs were found to be accompanying the trekking team. Some of these dogs are left in the highland areas as free roaming which could play a crucial role in the transmission of Gid disease to yaks. Therefore, the TCB shall play an important role in preventing such situations through policy interventions.

6.6.3. Royal Bhutan Army

The dogs in the army outposts area accompany the patrolling team in the highlands and cross paths with yak herds. Therefore, dog population management and regular deworming of these dogs in consultation with livestock officials must be implemented.

6.6.4. Local Government

The local government support is required to facilitate the implementation of Gid prevention and control measures at the gewog level through community engagement and responsibility-sharing.

6.6.5. Others

It is important to collaborate with other relevant agencies such as the Royal Society for Protection of Nature, Bhutan Trust Fund for Environmental Conservation, Bhutan Foundation, etc. for fund support for the sustained implementation of prevention and control of Gid diseases in yaks and infectious diseases at the domestic-wildlife interface.

International organizations such as FAO, OIE, ICIMOD, etc. should also be consulted for supports in terms of finance and technical resources.

7. SUPPORT PLANS

7.1. Surveillance, Reporting, Monitoring and Evaluation

Regular surveillance and monitoring of Gid disease in yaks is important to assess the impact of the Gid control program in the country. Any case(s) of Gid in yaks should be reported on a real-time basis through the existing veterinary information system (VIS) and a detailed report concerning the prevalence of Gid must be reported annually (November – December) by the concerned LEC to the Dzongkhag. The Dzongkhag Livestock Sector, after compiling the reports from Gid prevalent gewogs, must submit the annual report to the RLDC, where regional annual Gid prevalence report must be compiled and submitted to the NCAH. Gid prevalence report should be submitted using Form 3.1.

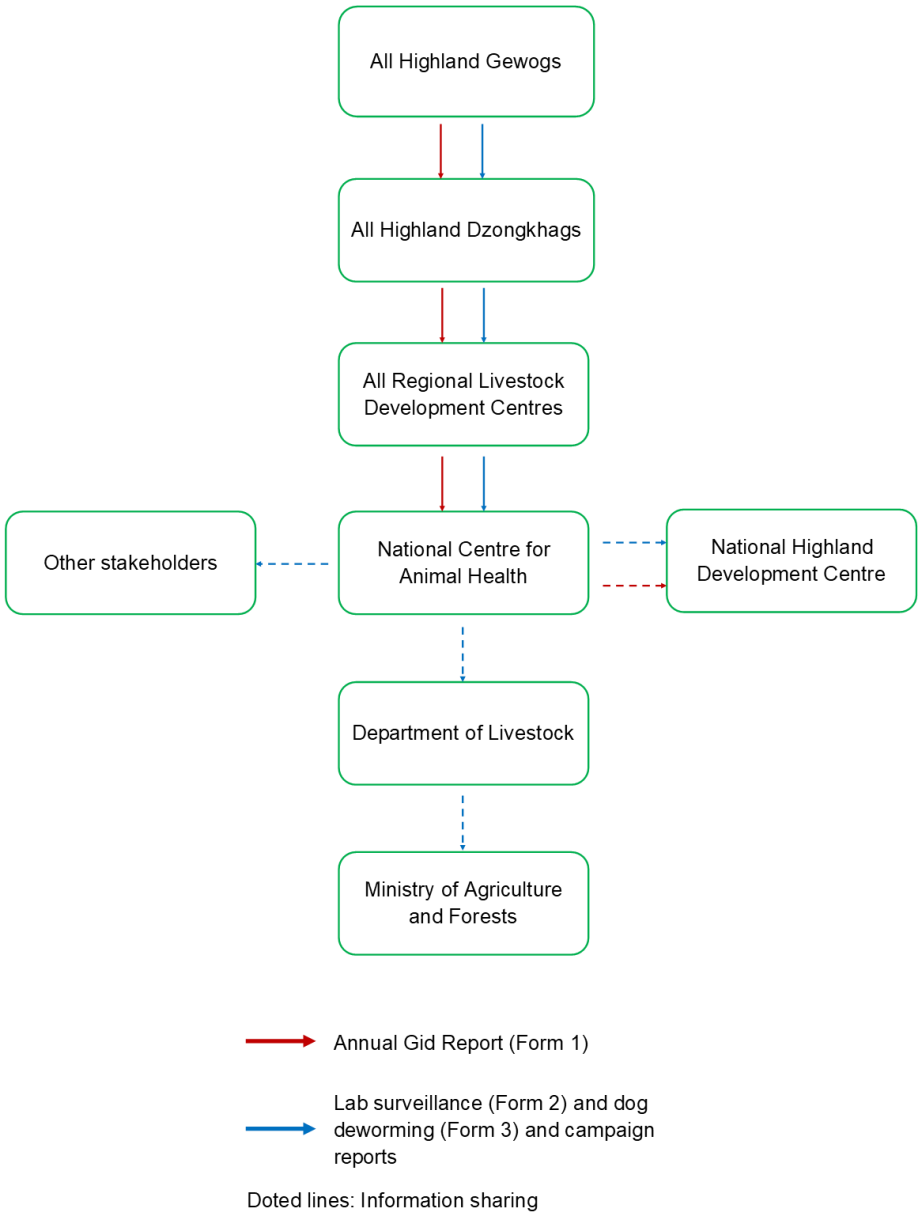

Figure 16: Surveillance and reporting flowchart

Other Gid prevention and control activities such as deworming of dogs and yaks shall be submitted after the program using Form 3.3. Faecal samples collected from yak watchdogs and wild canids must be submitted, using Form 3.2, to the Dzongkhag Veterinary Laboratory or Regional Veterinary Laboratory for coprological examinations, and the Taeniid positive samples must be further referred to the National Veterinary Laboratory for molecular analysis. If any other Gid prevention and control activities are implemented such as treatment, awareness education, etc., a descriptive report must be shared with the Dzongkhag, RLDC and NCAH.

The NCAH, as the national focal agency for Gid prevention, control and elimination program, shall collate and analyse data concerning Gid prevalence and activities implemented in the field. An annual report on Gid prevalence and associated activities shall be compiled and shared with relevant stakeholders.

Periodic surveys through screening of yak dog faeces would indirectly describe the prevalence of parasites in dogs and also Gid disease in yaks, and wildlife surveillance through examination of faecal samples of the wild canids would provide information to understand the Gid parasites at yak-dog-wildlife interface.

As a part of the monitoring and evaluation program, the Gid prevalence data submitted by the field office must be validated through the conduct of a risk-based survey by RLDC and NCAH, whereby yak herds shall be visited to understand the actual Gid prevalence in the area. The M&E team shall collect faecal samples from yak watchdogs and wild canids to assess the risk of Gid disease transmission in the area.

7.2. Research activities

In parallel to the implementation of Gid prevention and control activities, it is critical to conduct need-based research on Gid. The research activities should be coordinated by NCAH in collaboration with other stakeholders and share the research findings with relevant stakeholders.

Some of the priority research areas concerning Gid disease and its prevention and control are:

- The sylvatic cycle of *T. multiceps*
- Understand the prevalence of Coenurosis in wild herbivores
- Active surveillance to demonstrate freedom of Gid in yaks in some highland areas believed to be free of the disease: Merag and Sakteng in Trashigang, Boomdeling in Trashi Yangtse, Khoma in Lhuentse, and yak-rearing gewogs under Wangdue Phodrang.
- Efficacy of different treatment methods for the control of Gid in yaks.

7.3. Program financing

In line with this plan document, Livestock Extension Centres, Dzongkhag Livestock Sector, RLDC, NHRDC and NCAH should prepare an annual work plan in context to Gid prevention and control and secure fund to implement the program.

8. GID ELIMINATION ROADMAP, 2020 – 2025

8.1. Goal

The goal of this program is to eliminate Gid (Coenurosis) in yaks in Bhutan by 2025 through the intensive implementation of strategic Gid prevention and control measures.

The term “Elimination” in this chapter refers to the reduction to zero of the prevalence of Gid disease in yaks caused by *Coenurus cerebralis*, the larval stage of *T. multiceps*, in the yak-rearing highland areas of Bhutan as a result of strategic efforts put in through the Highland Development Program. Following the elimination of the disease, continued measures are required to prevent the re-establishment of transmission.

Achieving this goal shall contribute to improving the livelihood of yak-rearing highland communities in the country and conserve the age-old tradition of yak-rearing and pastoralism in Bhutan. The achievement of this goal shall be monitored through verification of the absence of Gid cases in yaks, further supported by the absence of *T. multiceps* in the samples (faecal and soil) collected from the focus areas during risk-based laboratory surveillances.

8.2. Objectives

The main objectives of the program are:

- Review past interventions and adopt contemporary strategies.
- Understanding the epidemiological situation of Gid disease in yaks at all levels: gewog, dzongkhag, regional and national.
- Facilitate intensive implementation of strategies to prevent and control Gid disease and achieve eventual elimination.
- For non-infected areas, to educate and develop the capacity to prevent the introduction of Gid disease in their respective areas.

8.3. Approach

The main activities to be implemented for prevention, control and elimination of Gid in yaks in Bhutan shall be guided by the strategies adopted under NGPCP 2021.

The annual work plan of the program at all livestock Centres concerning Gid disease prevention, control and elimination in the country must be aligned with this chapter of the Gid Elimination Roadmap for Bhutan.

The goal of elimination of Gid in yaks in Bhutan could be achieved at the end of 2025 through the adoption of a stepwise approach to prevent, control, and eliminate Gid disease in Bhutan, whereby the following milestones must be achieved (Figure 17):

- 2020: Gid prevalence baseline established.
- 2021: 20 per cent reduction from the baseline prevalence.
- 2022: 40 per cent reduction from the prevalence of the preceding year.
- 2023: 60 per cent reduction from the prevalence of the preceding year.

- 2024: 80 per cent reduction from the prevalence of the preceding year.
- 2025: 100 per cent reduction from the prevalence of the preceding year.

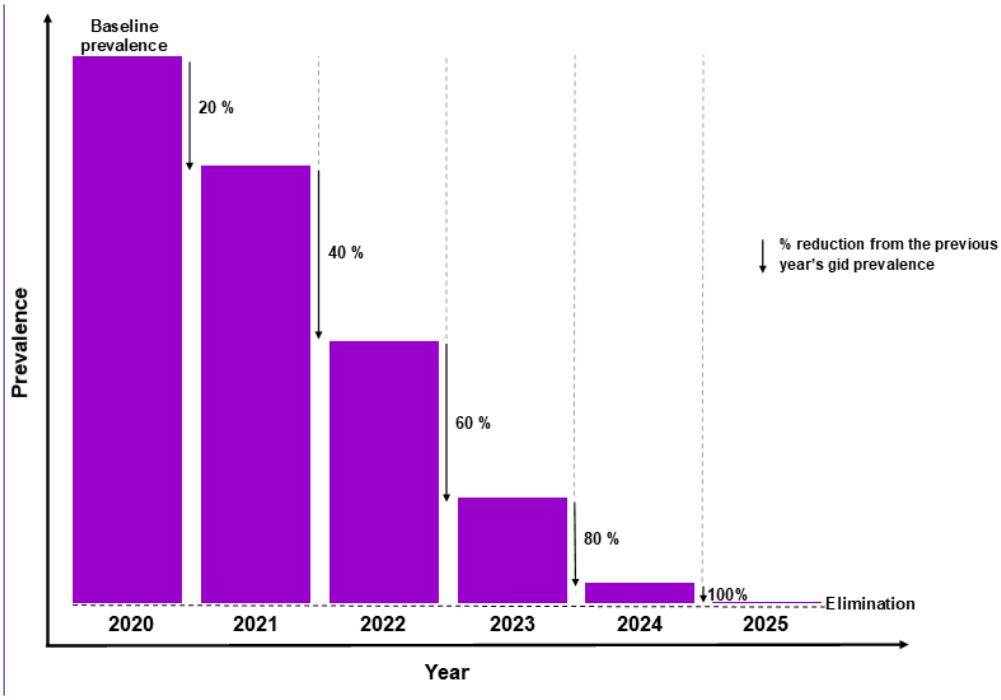

Figure 17: Formulated Gid elimination target projection, 2020 – 2025

8.4. Strategies

Strategy 1: Establishment of current Gid prevalence

To assess the current situation of Gid in yaks and validate past data concerning the absence of Gid in yaks in some highland areas of Bhutan, a nationwide survey was conducted (Refer to section 3.4). The selection of focus areas for the implementation of Gid prevention, control and elimination measures was based on the findings from the survey.

In parallel to the above survey, laboratory surveillance has been conducted whereby faecal samples from dogs (owned and free-roaming), scat samples from wild canids, and soil samples from all the target yak-rearing areas were collected, stored, and transported to the National Veterinary Laboratory (NVL), NCAH for analysis. The taeniid positive samples have been referred to the Institute of Parasitology, University of Zurich, Switzerland for molecular analysis to find out the prevalence of *T. multiceps* in the examined samples, which would indirectly validate the Gid prevalence in the highland areas, as depicted by the survey results.

Strategy 2: Adoption of strategies – as per NGPCEP

Strategies adopted in the National Gid Prevention, Control and Elimination Plan 2021, following the review of past interventions and limitations, shall serve as the guiding document for prevention, control and elimination of Gid in yaks in Bhutan as projected under this roadmap.

The program shall focus mainly on the preventive measures described in NGPCEP; however, control measures would also be advocated during awareness and education campaigns.

Strategy 3: Implementation of the adopted strategies, as per NGPCP 2021

3.1. Deworming of yak watchdogs

The strategic deworming of yak watchdogs shall be implemented as per the dose regimen and schedule described under section 4.1.1.

The first deworming in all the focus areas shall be implemented as a campaign whereby the technical team lead by NCAH and NHRDC would demonstrate the deworming procedure as described in the revised standard operating procedure. After the first deworming, the remaining 3 doses of the deworming cycle shall be dispensed, and the concerned gewog in-charge must follow up with the yak herders to remind them of the recommended deworming schedule.

During the dog deworming campaigns, along with Praziquantel, Piperazine citrate will also be administered orally to protect the dog from other parasites, primarily roundworms.

During the program period, the concerned dzongkhags and gewogs shall work on the medicine requirement based on the estimated number of dogs (owned/ free-roaming) in the highland areas under their respective jurisdictions. The indents shall be submitted to the NHRDC before the start of the next fiscal year to enable a timely procurement and distribution cycle.

3.2. Deworming of young yaks

The strategic deworming of young yaks (≤ 3 yrs) shall be implemented as per the dose regimen and schedule described under section 4.2.1.

During the program period, the target dzongkhags and gewogs shall work on the medicine requirement based on the estimated number of yak calves in highland areas under their respective jurisdictions. The indents shall be submitted to the NHRDC before the start of the next fiscal year to enable a timely procurement and distribution cycle.

3.3. Sensitization of key stakeholders and awareness for yak herders

To garner necessary support during the implementation of the Gid prevention, control and elimination program in the targeted highland areas, a sensitization program shall be organized for important stakeholders such as Local Governments, DoFPS, Tourism Council, RBA, etc.

During the sensitization program, the involved stakeholders would be advocated about Gid disease and its epidemiology, its socio-economic impact on the livelihood of highlanders, and the measures to be implemented for the prevention, control and elimination of the disease in the country and the supports needed from these stakeholders.

During yak watchdog deworming campaigns and other relevant events, yak herders would be targeted with awareness and education about the disease and its impact, and the necessary prevention and control measures to be implemented at the herd or community level.

3.5. Laboratory surveillance and diagnostic supports

During the program period, dog faecal samples would be collected on three occasions in the target areas: the beginning of the 1st and 2nd deworming cycle, and in the final year of the program. The collected samples shall be transported to the NVL, NCAH to assess the internal parasitic burden, including *T.multiceps*. The main purpose of this laboratory surveillance

activity is to keep track of the program's progress, whereby the laboratory examination findings would be compared to see the expected decline in the prevalence of *T.multiceps* in the area. If necessary, ad hoc lab-based surveillance might be conducted in target areas to validate the Gid prevalence data submitted by concerned gewogs and dzongkhags. The dog faecal sample collection and examination in the final year of the program shall verify the achievement of the Gid elimination target of zero prevalence at gewog, dzongkhag, regional and national levels.

To efficiently conduct the laboratory surveillance activities, the program shall support the NVL, NCAH through annual procurement of necessary laboratory reagents and consumables during the program period.

3.6. Education and capacity development of field professionals in all highland areas

Information, education and communication materials about Gid and other priority yak diseases shall be developed and distributed to all the highland gewogs and relevant Centres across the country. The technical team from NCAH and NHRDC, during the conduct of mass deworming campaigns, shall involve the officials from the concerned dzongkhag and gewog and demonstrate the procedures as per the corresponding SOPs.

3.7. Dog population management

Under the Highland Development Program, the dog population management program shall be conducted in consultation and aligning with the activities of the Dog Population Management Unit (DPMU), NCAH.

3.6. M&E to assess the progress of the program

Like the laboratory surveillance activities described above, during the entire program period, assessment of knowledge, attitude and practices (KAP) shall be conducted three times: beginning, mid and end. The KAP study would provide insights on the level of yak herder's awareness of Gid disease and management acquired through awareness and education campaigns during the program period.

Depending on the KAP assessment findings, the activities shall be reviewed and implemented with necessary changes incorporated.

Reporting and information sharing about Gid prevalence and activities implemented to prevent, control and eliminate Gid disease must be in line with the surveillance and reporting system described under section 7.1 of the NGPCEP.

The annual Gid prevalence of respective highland areas (regions, districts and gewogs) shall be defined based on the annual Gid report submitted, data analysed, and report generated. However, risk-based active laboratory and clinical surveillance programs shall be conducted to verify the actual prevalence in the field.

Strategy 4: Responsibility sharing

To achieve the national Gid elimination target of zero prevalence by 2025, responsibilities must be shared among all the Gid prevention and control strategy implementing agencies.

In line with the Gid elimination target projection formulated and as illustrated in Figure 17, based on the Gid prevalence baseline (2020) established, the national gid elimination target has been projected. To achieve the national targets set for the program period, respective

regions, dzongkhags and gewogs would be required to achieve the projected targets as illustrated in Figure 18. The highland dzongkhags and gewogs with a record of zero prevalence should also be required to maintain the status quo.

Risk-based active surveillance shall be conducted to validate the Gid prevalence data submitted by respective dzongkhags and gewogs.

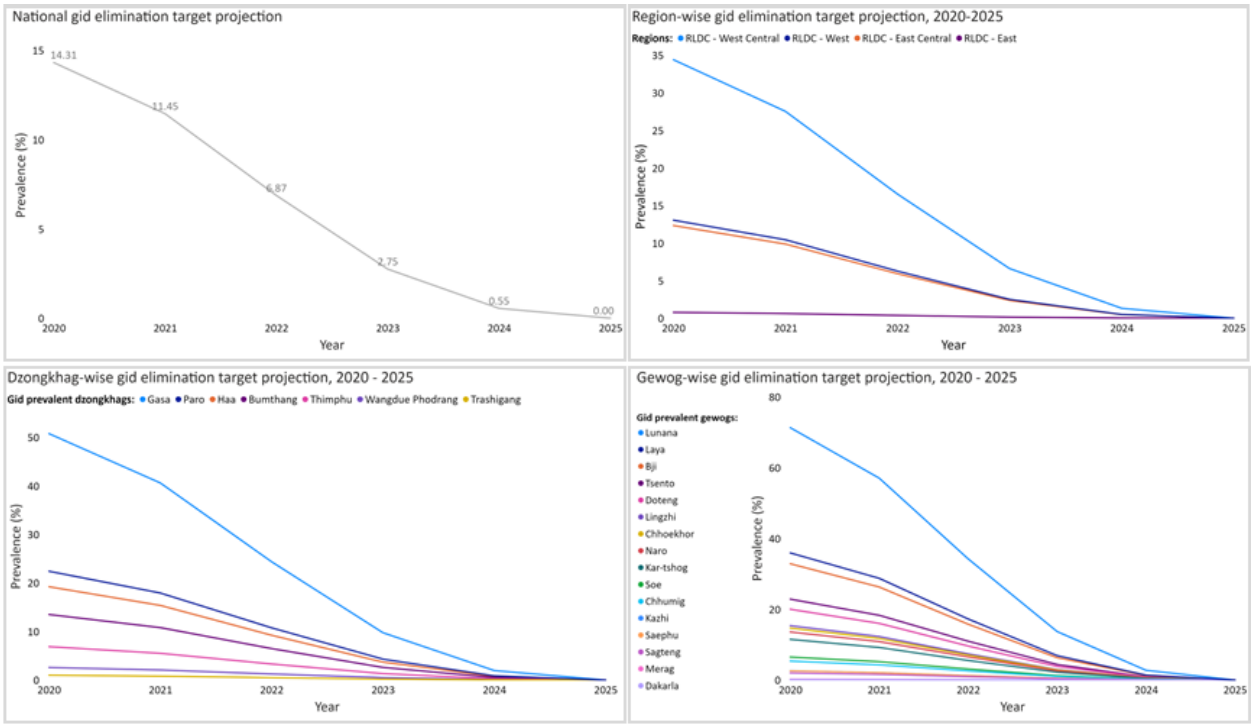

Figure 18: Gid elimination target projection at National, Regional, Dzongkhag and Gewog levels

See annexure 4.4 for detailed national, regional, dzongkhag and gewog level Gid elimination target projections.

Strategy 5: Sustainability

Sustainability is defined in multiple ways; however, all the definitions focus on the continuity of a service or program. Sustainability is a tactical necessity, and it should be considered as one of the main components of any program. One of the reasons for not being able to achieve a gradual reduction in Gid prevalence in Bhutan in the past could be due to the lack of sustainable planning during past interventions and programs to prevent and control Gid in Bhutan.

The current program targets to eliminate the disease, not to eradicate it, and the probability of re-establishment of Gid disease transmission cycle remains high if the risk factors exist, yak watchdogs being the main factor. Therefore, the implementation of measures to prevent the recurrence of Gid disease must be continued in all the highland areas in Bhutan beyond this program.

During the program period, the leading agencies, NCAH and NHRDC, shall participate fully in the initial phase of the implementation of Gid prevention and control activities. The core technical team shall train – through demonstration and participation – the dzongkhag and gewog officials on the adopted strategy for prevention, control, and elimination of Gid in yaks in highland areas of Bhutan. However, the activities would be gradually handed over to the

extension supervisors. The intensity of participation by the core technical team shall gradually decrease down the line. The team would focus more on monitoring and evaluating the program to assess the progress and validate the achievements.

Strategy 6: Funding

The estimated cost for implementation of the strategic Gid prevention and control program to eliminate Gid in yaks in Bhutan by 2025 accounts for Bhutanese Ngultrum 8.32 million, as shown in the following table.

Table 1: Estimated cost for the implementation of Gid prevention, control and elimination, 2020 - 2025

Sl. No.	Component	Estimated cost (Nu.)
1	Establishment of current Gid prevalence	1.60
2	Review past interventions and adopt contemporary strategies	0.00
3	Implementation of adopted strategies	3.53
4	Monitoring and Evaluation	1.22
5	Others	1.96
Total estimated budget (Nu.)		8.32

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ANNEXURE

1. Population of yak and zo/zom in Bhutan, 2020 (Livestock statistics, 2020)

Dzongkhag	Gewog	Nos. of Yak	Nos. of Zo/Zom	Total
Bumthang	Chhoekhor	2,369	9	2,378
	Tang	71	0	71
	Chhumig	279	0	279
	Ura	51	0	51
Gasa	Lunana	2,269	0	2,269
	Laya	2,702	0	2,702
Haa	Bji	2,170	0	2,170
	Kar-tshog	896	0	896
	Uesu	305	0	305
Lhuentse	Khoma	193	64	257
Paro	Doteng	299	0	299
	Tsento	3,092	0	3,092
Samdrup Jongkhar	Lauri	17	11	28
Thimphu	Lingzhi	3,205	0	3,205
	Naro	1,730	0	1,730
	Soe	1,425	0	1,425
	Darkarla	2,184	0	2,184
Trashigang	Shongphu	21	277	298
	Samkhar	68	175	243
	Merag	3,048	5,688	8,736
	Sagteng	3,067	4,361	7,428
	Kangpar	0	1	1
Trashi Yangtse	Boomdeling	178	94	272
Trongsa	Nubi	215	0	215
Wangdue Phodrang	Dangchhu	13	0	13
	Gangteng	259	0	259
	Kazhi	713	0	713
	Phobji	172	0	172
	Saephu	1,849	0	1,849
Total		32,860	10,680	43,540

2. Standard Operating Procedures (SOPs)

2.1. SOP for deworming of yak watchdogs and faecal sample collection for laboratory testing

A. Scope

- For all the animal health extension workers in the yak-rearing highland areas in Bhutan.

B. Objective

- To describe the procedure for deworming, faecal sample collection and proper disposal of the faeces of yak watchdogs for the prevention and control of gid disease in yaks and other canine diseases caused by tapeworms.

C. Procedure

- Deworming should be done quarterly: 1st month – 4th month – 7th month – 10th month.
- Properly leash or chain the yak watchdog and let the dog calm down.
- Deworm the yak-dog with the administration (orally) of Praziquantel at a dose of 5mg/kg body weight.
- Collect faecal samples whenever the dog defecates after reaching the deworming point. If the dog does not defecate naturally, take the dog for a short walk after deworming to induce defecation or collect samples per-rectally.
- Collect voided faeces and dispose of them by deep burial or burning. Underlying soil should be collected and disposed of with the faeces.
- Advise the yak-dog owner to dispose of the dog faeces properly (burial or burning) for at least a month following deworming.

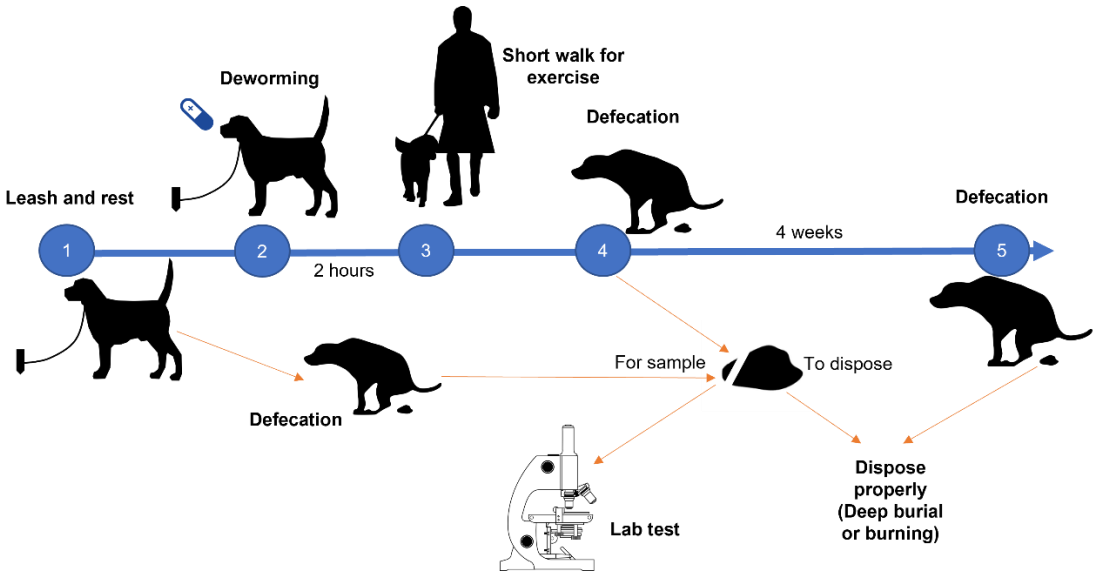

Figure 19: Picture showing procedures for deworming, sampling and disposal of faeces.

- Dispense 3 doses of praziquantel and instruct the dog owner to mandatorily deworm the dog(s) three times: 4th, 7th, and 10th month.
- Repeat the cycle.

D. General considerations/precautions

- Fasting is not required.
- Praziquantel can be administered with or without food.
- It is safe in pregnant bitches.
- After deworming a lactating bitch, she should not be let to nurse her puppies for the following four days.
- Deworming age of a dog is four weeks and above – advise the owner to deworm the under-age puppies later, after turning four weeks of age.

2.2. SOP for collection of dog faeces, scats and soil samples for the detection of Taeniid eggs.

A. Purpose

- The purpose of this SOP is to describe the procedure for the collection of dog faeces, scat and soil samples for Taeniid eggs, and *Taenia multiceps* in particular.

B. General information

- Eggs produced by adult *T. multiceps* in the definitive hosts (wild and domestic canids) are often passed out in the faeces. The demonstration of eggs in faeces can indicate the presence of *T. multiceps* infection and facilitate the diagnosis of Gid disease in yaks.

C. Equipment/materials:

- Permanent marker pen

- Coolbox
- Biohazard bag
- Alcohol (70% ethanol)
- Polypod/ Faecal vial (screw-capped)
- Zip-lock dispensing plastic bags
- Gloves
- Sample collection form
- Phosphate Buffer Saline

D. Procedure

I. Dog faecal and scat sample collection

- Put on gloves
- Collect about 10-15 gm of dog faecal sample directly from the rectum or freshly dropped faeces or 10-15 gm of fresh scat (wild canid faeces) sample into a faecal vial
- Close the vial with a cap tight enough to prevent leakage
- For dry faeces (dog/wild canids), collect the whole mass and put it into a zip lock dispensing plastic
- Label the vial with sample ID
- Put the sample into a cool box
- Complete the sample collection form
- Store the sample in a cool place until delivered to the laboratory
- Take off the gloves and collect them in a biohazard bag for proper disposal
- Clean your hands with 70% ethanol

II. Cyst collection (from yaks that died of gid)

- Put on gloves
- Open the skull of a dead animal
- Collect intact cyst in a histopathology sample vial and add PBS (3/4 volume of the cyst)
- Close the vial with a cap tight enough to prevent leakage/spill
- Label the vial with sample ID
- Put the sample into a cool box
- Complete the sample collection form
- Store the sample in a cool place until delivered to the laboratory
- Take off the gloves and collect in a biohazard bag for proper disposal
- Clean your hands with 70% ethanol

III. Soil sample collection

- Put on gloves
- Collect about 30 gm of soil from the area where the dog usually defecates. The soil sample should be from just below the subsoil. The location for sample collection is as shown in the following figure. If dog faeces are not found, collect soil from where the dog usually defecate.

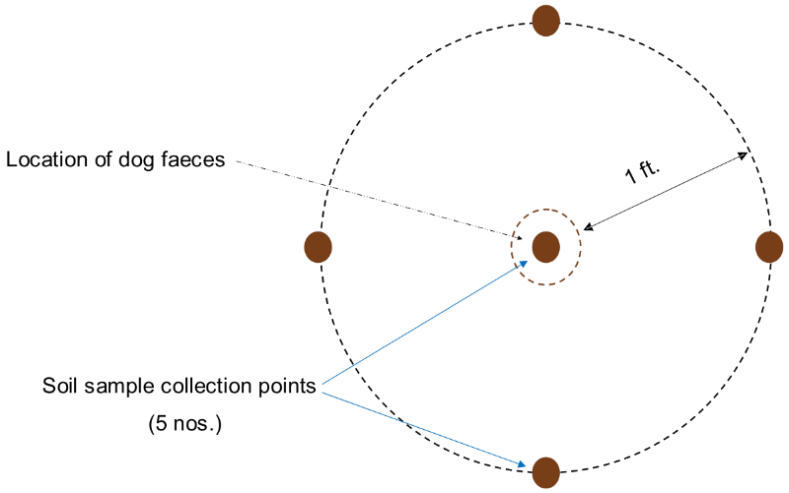

Figure 20: Picture showing soil sample collection points.

- Close the vial with a cap tight enough to prevent leakage/spill
- Label the vial with sample ID
- Put the sample in a cool box
- Complete the sample collection form
- Store the sample in a cool place until delivered to the laboratory
- Take off the gloves and collect them in a biohazard bag for proper disposal
- Clean your hands with 70% ethanol

E. Sample details recording

- Sample ID: First letter of Dzongkhag/ First two letters of Gewog/ 3-digit serial numbers.
- Example: T/Sa/001 for first sample of Trashigang dzongkhag, Sakteng gewog.
- Name of wild canids: write their local name – as they say.

F. Safety

- Utmost care should be taken to avoid the infection to the collector; Organisms like Echinococcus, Coccidia, Giardia, Toxoplasma, etc. are infectious to humans.

G. Troubleshoot

- It is difficult to distinguish the dog (wild and domestic) faeces in a dried state from the faeces of other species. In such cases, the faeces content should be examined. Especially if the faeces are from wild canids or stray dogs, we may find bone pieces and hair in the stool.

2.3. SOP for coprological examination to detect Taeniid eggs by floatation and sieving technique.

A. Principles

The flotation method is a qualitative test for the detection of *Taenia* eggs in the faeces. It is based on the separating of eggs from faecal material and concentrating them using a floatation fluid with appropriate specific gravity.

B. Purpose

- This test is used for the detection of *Taenia* eggs in the faeces

C. Objective

- To describe the procedure for detection of Taenia eggs in the faeces by floatation techniques

D. Materials required:

- Beakers or plastic containers
- A tea strainer or cheesecloth
- Measuring cylinder
- Stirring device (fork, tongue blade)
- Test tubes
- Test tube rack
- Micro slide, coverslips
- Balance or teaspoon
- Microscope

E. Reagents, solution and buffer

- Sugar solution

F. Procedure

- About 3 g of faeces are taken in a 50 ml tube and added the 45ml of (1:2) concentrated sugar solution.
- After thoroughly shaking, the mixture is centrifuged at 1500 to 2000 RPM for 10 minutes.
- The supernatant containing taeniid eggs (diameter about 32 µm) is sieved with mesh sizes 100 µm and then 41 µm, and then sieved with a mesh of 20µm, where eggs are retained.
- Both the 100 µm and then 41 µm sieves are washed with water, and then the eggs are sucked by a Pasteur pipette from the 20 µm sieve.
- The collected material is examined microscopically for taeniid eggs. If eggs were detected, the material is centrifuged at 15000 RPM for 2 minutes and the pellet will be stored at -80^{0}C for DNA extraction

G. Result Interpretation

All the *taeniid* eggs will appear circular with radially striated eggshells.

H. Waste Disposal

- The faecal samples should at least be stored at -70 to -800C for a minimum of 3 days. By this, the infectivity of the eggs is lost, following which they can be processed for examination. For hydatid cyst, after the study or examination, it should be dipped in 2% sodium hypochlorite solution for about 1 hr, following which it can be disposed of.
- The materials after the tests should be dipped in 2% sodium hypochlorite solution for about 1hr. Then it should be washed thoroughly and can be disposed of or reused in case of glassware.

I. Risk Assessment

There is a risk of infecting humans with taeniid eggs. Hence, proper measures should be taken while handling the samples.

J. Troubleshooting

The eggs of *Taenia* spp and *Echinococcus* spp cannot be differentiated by microscopic examination; PCR methods are required. Direct microscopic examination of faecal samples or faecal flotation may reveal the eggs of *Spirometra mansonoides*, which are sometimes mistaken for trematode eggs, although they are larger and possess an operculum that is often difficult to see.

3. Reporting Forms

3.1. Annual Gid prevalence reporting form

Name of the staff: **Reporting period:**

Name of the Centre: **Gewog:** **Dzongkhag:**

Owner details			No. of adult yaks* (>3yrs)		No. of Young yaks*						No. of yak watchdogs		No. of yaks* (live) affected by Gid						No. of yaks* died of Gid		Basis of diagnosis		Remarks
					≤1 yr.		1 - 2 yrs.		2 - 3 yrs.				≤1 yr.		1 - 2 yrs.		2 - 3 yrs.						
Name	Village	Phone no.	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	Clinical signs	Post-mortem	

*Includes zo and zom.

3.2. Sample submission form

Name of the staff: **Sample submission date:**

Name of the Centre: **Gewog:** **Dzongkhag:**

Owner details			Sample ID*	Sample type (Faeces/Scat/Soil/Cyst)	Sample collection date	Sample collection points (Coordinates)		Scat of which wild canid (if known)	Dog details				Remarks
Name	Village	Phone no.				Lat.	Long.		Age	Sex	Breed	Month & Year of last deworming	

*Refer to the SOP for sample collection

3.3. Form for deworming of yak watchdogs and young yaks

Name of the staff: **Reporting date:**

Name of the Centre: **Gewog:** **Dzongkhag:**

Owner details			No. of young yaks* dewormed with Albendazole						Month and year of yak* deworming	No. of dogs dewormed with Praziquantel		Month and year of dog deworming	Remarks
			≤1 yr.		1 - 2 yrs.		2 - 3 yrs.						
Name	Village	Phone no.	M	F	M	F	M	F		M	F		

*Includes zo and zom.

4. Gid elimination roadmap, 2020 – 2025

4.1. Logical framework

Goal and Purpose	Description	Performance Indicator	Means of verification	Assumption	Time frame	Lead Agency	Collaborators
Goal	Eliminated gid (coenurosis) in yaks in Bhutan by 2025 through the intensive implementation of strategic gid prevention and control measures.	National gid prevalence reached zero at the end of the program period.	Survey and surveillance (lab-based) report at the end of the programme period.	Human resource and budgetary support in place	2020 – 2025	NHRDC and NCAH	RLDC, DLS
Purpose	To establish current baseline gid prevalence, adopt strategies for prevention and control of gid disease in yaks in Bhutan to achieve eventual elimination of the disease in the country.	Annual reduction of gid prevalence achieved as per the roadmap.	Annual reports on the status of gid disease in Bhutan.	National, Regional and Dzongkhag collaboration in place.	2020 – 2025	NHRDC and NCAH	RLDC, DLS

4.2. Program timeline

Sl. No.	Strategies	Activities	2019-2020		2020-2021		2021-2022		2022-2023		2023-2024		2024-2025	
			Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun
1	Adoption of gid prevention and control strategies													
2	Establishment of current gid prevalence	Questionnaire survey												
		Laboratory surveillance												

Sl. No.	Strategies	Activities	2019-2020		2020-2021		2021-2022		2022-2023		2023-2024		2024-2025	
			Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun
3	Implementation of gid prevention and control strategies	Awareness and education for yak herders												
		Strategic deworming of dogs												
		Strategic deworming of yak calves												
4	Monitoring and Evaluation	Laboratory surveillance												
		Assessment of KAP on gid disease and management.												
		Streamlining of gid disease reporting system												
5	Support plans	Sensitization and advocacy for relevant stakeholders												
		Education and capacity building												
		Dog population management												
		Revision of NGPCP 2016												

Sl. No.	Strategies	Activities	2019-2020		2020-2021		2021-2022		2022-2023		2023-2024		2024-2025	
			Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun
		Delineation of responsibility and accountability of different stakeholders.												
		Diagnostic supports												

4.3. Budget estimates

Sl. No.	Strategies	Activities	2019-2020		2020-2021		2021-2022		2022-2023		2023-2024		2024-2025		Total
			Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	
1	Adoption of gid prevention and control strategies														0.00
2	Establishment of current gid prevalence	Questionnaire survey		0.80											0.80
		Laboratory surveillance		0.80											0.80
3	Implementation of gid prevention and control strategies	Sensitization, awareness and education for yak herders			0.08	0.15	0.12	0.13	0.40	0.30					1.18
		Strategic deworming of dogs			0.12	0.18	0.18	0.16	0.33	0.30					1.27

		Strategic deworming of yak calves			0.15	0.15	0.14	0.14	0.25	0.25					1.08
4	Monitoring and Evaluation	Laboratory surveillance			0.08	0.07	0.08	0.07	0.08	0.07			0.08	0.07	0.60
		Assessment of KAP on gid disease and management					0.04	0.04	0.04	0.04			0.04	0.04	0.24
		Streamlining of gid disease reporting system					0.03	0.03	0.08	0.08	0.08	0.08			0.38
5	Support plans	Sensitization and advocacy for relevant stakeholders		0.08			0.75								0.83
		Education and capacity development													0.00
		Dog population management					0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.48
		Revision of NGPCP 2016						0.20							0.20
		Responsibility and accountability													0.00
		Diagnostic supports					0.15		0.15				0.15		0.45
Six-monthly total (Million BTN)			0.00	1.68	0.43	0.55	1.55	0.83	1.39	1.10	0.14	0.14	0.33	0.17	8.32
Annual total (Million BTN)			1.68		0.98		2.38		2.49		0.28		0.50		8.32

4.4. Target projection for Gid elimination in Bhutan by 2025

4.4.1. National level

2020 (Baseline)	2021	2022	2023	2024	2025
Annual reduction	20.00%	40.00%	60.00%	80.00%	100.00%
14.31	11.45	6.87	2.75	0.55	0.00

4.4.2. Regional level

Year	RLDC - West Central	RLDC - West	RLDC - East Central	RLDC - East
2020	34.40	13.05	12.33	0.78
2021	27.52	10.44	9.87	0.62
2022	16.51	6.26	5.92	0.37
2023	6.61	2.51	2.37	0.15
2024	1.32	0.50	0.47	0.03
2025	0.00	0.00	0.00	0.00

4.4.3. Dzongkhag level

Dzongkhag	Gasa	Paro	Haa	Bumthang	Thimphu	Wangdue Phodrang	Trashigang	Trashi Yangtse	Lhuentse	Trongsa
2020	50.75	22.41	19.21	13.49	6.88	2.58	0.99	0.00	0.00	0.00
2021	40.60	17.92	15.37	10.80	5.50	2.07	0.80	0.00	0.00	0.00
2022	24.36	10.75	9.22	6.48	3.30	1.24	0.48	0.00	0.00	0.00
2023	9.74	4.30	3.69	2.59	1.32	0.50	0.19	0.00	0.00	0.00
2024	1.95	0.86	0.74	0.52	0.26	0.10	0.04	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.4.4. Gewog level

Gewog	Lunana	Laya	Bji	Tsento	Doteng	Lingzhi	Chhoekhor	Naro	Kar-tshog	Soe	Chhumig
2020	71.31	35.92	32.85	22.86	20.00	15.37	14.67	13.57	11.49	6.48	5.36
2021	57.05	28.74	26.28	18.29	16.00	12.29	11.74	10.86	9.20	5.18	4.29
2022	34.23	17.24	15.77	10.97	9.60	7.38	7.04	6.51	5.52	3.11	2.57
2023	13.69	6.90	6.31	4.39	3.84	2.95	2.82	2.61	2.21	1.24	1.03
2024	2.74	1.38	1.26	0.88	0.77	0.59	0.56	0.52	0.44	0.25	0.21
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Gewog	Kazhi	Saephu	Uesu	Sagteng	Merag	Dakarla	Tang	Khoma	Boomdeling	Nubi	Gangteng	Phobji

2020	2.61	2.58	2.26	1.99	0.22	0.13	0.00	0.00	0.00	0.00	0.00	0.00
2021	2.09	2.06	1.81	1.59	0.18	0.10	0.00	0.00	0.00	0.00	0.00	0.00
2022	1.25	1.24	1.08	0.95	0.11	0.06	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.50	0.49	0.43	0.38	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.10	0.10	0.09	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00