



GLOBAL JOURNAL OF MEDICAL RESEARCH: G
VETERINARY SCIENCE AND VETERINARY MEDICINE
Volume 17 Issue 2 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

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GJMR-G Classification: NLMC Code: WA 360



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Major Transboundary Disease of Ruminants and their Economic Effect in Ethiopia

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Abstract- Trans-boundary animal diseases pose a serious risk to animal production and jeopardize international trade. The objectives of this paper were to give general overview about major trans boundary disease of ruminants and their economic effect in Ethiopia. Ethiopia has been facing devastating economic losses from major outbreaks of trans-boundary animal diseases (TADs) such as foot and mouth disease, contagious bovine pleuropneumonia, lumpy skin disease in cattle and pest des petites ruminants, contagious Caprine pleuropneumonia, sheep and goat pox, and brucellosis in small ruminants. These diseases impose major economic costs and risks to the country, the neighbors, and trading partners. Even though both the direct and indirect impact of these diseases causes devastating economic losses to the country, the indirect effect is more serious. The trade implication of TADs can cause a greater economic impact than the direct production losses themselves. The trade ban due to the existence of these major trans-boundary disease and other negative domestic impacts on agriculture and other sectors, can be raised as an example. Among other factors affecting the economic benefit of the country from livestock sector, increased outbreaks of highly contagious trans-boundary animal diseases (TADs) is considered as major cause of economy losses. To obtain, expected value from animal sub-sector government policy and roles of Veterinary Services in function of TADs control, rapid detection and early response need improvement.

Keywords: *ethiopia, economic lose, livestock, trans-boundary disease.*

I. INTRODUCTION

Trans-boundary animal diseases (TADs) have been described as those diseases that are of significant economic, trade and food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation between several countries [1]. These diseases are highly contagious and have the potential for rapid spread, irrespective of national borders, causing serious socio- economic consequences [2]. With increasing globalization, the persistence of trans-boundary animal diseases(TADs) in the world poses a serious risk to the world animal agriculture and food security and jeopardizes international trade [3].

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In recent decades, the world has been facing devastating economic losses to livestock farmers from major outbreaks of TADs, such as foot and mouth disease (FMD), in Europe, classical swine fever in the Caribbean and Europe(1996–2002), render pest (RP) in Africa in the 1980s, pest des petites ruminants in India and Bangladesh, contagious bovine pleura pneumonia in Eastern and Southern Africa (late 1990s), as well as Rift Valley fever in the Arabian Peninsula (2000)[4].

In Ethiopia, the aggregate annual economic losses from such animal diseases through direct mortality and reduce productive and reproductive performance were estimated at US\$ 150 million, equivalent to three billion Ethiopian birr per year [5]. The overwhelming majority of morbidity and mortality is caused by a finite set of common and predictably occurring disease problems that are conditioned by local geography, climate, and animal management system [6].

In the past two to three decades, public health authorities in industrialized countries have been faced with an increasing number of food safety problems. The situation is equally serious in developing countries. In addition to known food borne diseases, public health communities are being challenged by the emergence of new or newly recognized types of food-borne illnesses, often with serious health and economic consequences. For example, result of the BSE crises, the world suffered economic losses of more than 10 billion U.S. dollars [7].

Ethiopia has estimated livestock population of 57.4 million cattle, 58.6 million sheep and goat [8].However, Livestock production system, particularly in pastoral areas, is mainly constrained by rampant animal disease and seasonal feed and water shortages, which can be up to a level of losing the entire livelihood of the pastoral households. Besides the direct losses incurred by the disease, the trans-boundary nature of most diseases, with potential risk of introduction of notifiable diseases, which are not yet reported from Ethiopia, and its high rate of transmissibility among different herds and/or between domestic animals and wildlife increases the risk. In particular concern to South Omo Zone area apart from other areas of the region, is that it shares boundaries with other countries, Kenya and South Sudan, and there is no real avoidance of movement of animals among the different pastoral agro-pastoral communities in these different countries, which makes the situation most favorable for the introduction and/or

transmission of trans-boundary diseases; some are known to be found in neighboring countries, but, not in Ethiopia, like East Coast fever, Rift Valley fever, and Nairobi sheep disease [9].

In Ethiopia limited works has been done on this disease so far and few works have been reported on risk factors assessments, epidemiological aspects, seroprevalence and financial impacts in selected areas of the country. Therefore, the objective of this paper is to review major trans-boundary disease of ruminants and their economic effect in Ethiopia.

II. LITERATURE REVIEW

a) *Epidemiological Feature of Major Trans-boundary Diseases in Cattle*

Ethiopia is a resourceful country bestowed with the largest livestock resource in the Africa continent [10] with the potential to export substantial numbers of live animals and their products. Livestock is central to the Ethiopian economy, contributing for 20% of the GDP, supporting the livelihoods of 70% of the population and generating about 11% of annual export earnings [11]. However, the livestock sub-sector's contribution to the economy and foreign currency earnings in particular, is very low as per the country expectation and potential of the sectors. Some of the major factors contributing to the poor performance of the livestock sub-sector include the prevalence of highly contagious trans-boundary animal diseases (TADs) such as foot-and-mouth disease (FMD), lumpy skin disease (LSD) and contagious bovine pleura pneumonia (CBPP). These diseases continue to hinder international trade in live cattle and their products seriously in an era of globalization. Public concern is growing regarding the rapid trans-boundary spread of animal diseases through animals and animal products have forced importing countries to apply strict measures so that animals and their products exported should meet international sanitary phytosanitary (SPS) requirements [12].

i. *Foot and mouth disease*

Foot and Mouth Disease (FMD) also known as Aphtous fever, is a major global animal health problem [13]. It ranks first among the notifiable, list of infection animals disease. It is the most contagious trans-boundary animal disease (TAD) affecting cloven hoofed animals of domesticated and wildlife. Among species of the domesticated animals; cattle, sheep, goats, pigs and buffalo are susceptible. It is caused by RNA virus of genus Aphthous virus known as foot and mouth disease virus. There are seven recognized serotypes of FMD (O, A, C, Asia 1, SAT 1, SAT 2 and SAT 3), which differ in distribution across the world [14].

In Ethiopia, although its level of prevalence may have significant variations across the different farming systems and agro ecological zones of the country, FMD is endemic and known for its wider distribution. The

records of the Ministry of Agriculture and Rural Development (MOARD) from 1997 to 2006 showed that FMD outbreak occurred everywhere throughout the country with highest incidence in the central part [15]. The sero-prevalence of FMD among Borana pastoral cattle in 2008 was reported to be 24.6% (14). Another study that covered broader areas of the country showed sero-positivity of 44.2% with 1.6% and 8.9% mortality and case fatality rates [16].

Endemic distributions of five of seven serotypes of FMDV are maintained in Ethiopia: serotype O, serotype A, serotype C, serotype SAT 2, and serotype SAT 1. Infection or vaccination against one serotype does not provide protection against the other serotypes [17; 18; 15].

The disease was first recorded in Ethiopia in 1957 when serotypes O and C were found [19; 20]. FMD is transmitted by a variety of methods between herds, countries and continents. In endemic areas, the most important method of spread is probably by direct contact between animals moving across state and national boundaries as trade or nomadic cattle. The routes of spread include inhalation of aerosolized virus, ingestion of contaminated feed, and entry of the virus through skin abrasions or mucous membranes [21].

In Ethiopia, it is believed that infected animal's movement is common method of spreads of FMD. The movement of animal health workers and artificial inseminators from one farm to the other without taking into consideration the disease situation suggest that these could have been suspected in a spread of virus. On top of these, poor hygienic conditions on the farms notably the absence of foot bath, management practices like failure to isolate infected animals from the healthy ones and the absence of quarantine for newly introduced animals are also open doors for introduction of the virus to a farm [22;23]. In the most favorable circumstances, it is now estimated that sufficient virus to initiate an infection can be wind borne as far as 250 km (156 miles) [24].

The morbidity rate in outbreaks of FMD in susceptible animal's involvement and complications such as secondary infection, exposure or malnutrition can rapid approach 100% but some strains are limited in their infectivity to particular species [25]. However, the case fatality is generally very low, about 2% in adults and 20% in young stock [26].

ii. *Lumpy skin disease*

Lumpy skin disease is one of the most economically significant trans-boundary, emerging viral diseases. It is a disease with a high morbidity and low mortality rate and affects cattle of all ages and breeds [27]. The disease is caused by Neethling virus prototype strain classified in the genus Capri poxvirus of family Poxviridae. It is acute to sub-acute infectious disease and cattle strain of *Capri poxvirus* does not infect and

transmit between sheep and goats [28; 29]. Lumpy skin disease occurs in different ecological and climatic zones and extends its boundaries to different areas [30]. It is currently endemic in most African countries and expanded to Middle East region [31]. It has been endemic in Africa for more than 70 years occurring in a wide range of ecotypes. In Ethiopia the disease was first observed in the western part of the country (southwest of Lake Tana) in 1983. Recently, Lumpy skin disease is found almost in all the regions and agro ecological zones of the country [32 and 33].

Lumpy skin disease is mechanically transmitted by different types of biting and blood feeding arthropods [34]. Direct contact could be a minor source of infection. LSDV occurs in cutaneous lesions, saliva, respiratory secretions, milk and semen. The virus is very resistant to inactivation, surviving in desiccated crusts for up to 35 days, and can remain viable for long periods in the environment and this favors its transmission for a long period [35].

Outbreaks of LSD are highly associated with seasonal peak of mechanical vectors in wet and warm weather conditions in Ethiopia. Therefore, morbidity and mortality rates for LSD vary greatly in different endemic areas depending on the severity of strain, prevalence of insect vectors and susceptibility of the host. During its occurrence it causes significant economic problems as a result of reduced milk production, beef and draft animals' loss, abortion, infertility, loss of condition and damage to the hide [36 and 28].

iii. *Contagious bovine pleuropneumonia*

Contagious Bovine Pleuropneumonia (CBPP) is a highly infectious cattle disease, which is caused by *Mycoplasma mycoides subsp. mycoides SC* (small colony, bovine biotype), is one of the major constraints to cattle-raising and trade in Africa. Contagious bovine pleuropneumonia is widespread in pastoral areas of African countries [37]. According to Tambi *et al.*, [38], Ethiopia is one of the countries in which CBPP is endemically maintained all over the country with 25% morbidity and more than 10% mortality rate. The economic effects of CBPP in a cattle population are enormous often resulting into heavy losses. In Zambia CBPP devastated livestock production and reduced the cattle from 650,000 herds in 1997 to about 400,000 herds in 2006 [39].

Cattle movements are responsible for the transmission of the CBPP from one herd, region or country to others. Close, repeated contact is generally thought to be necessary for transmission. In addition to contact *M. mycoides SC* can also spread through aerosol route if the climatic conditions are favorable [37,40].

b) *Epidemiological Feature of Major Trans-boundary Diseases in Small Ruminant*

Small ruminants form an integral and important component of pattern of animal production. Because of factors such as their low cost, little feed requirement, manageable quantities of products and high reproductive rate, keeping sheep and goats is preferable than large ruminants [41].

Development of small ruminant production in Ethiopia is constrained by widely distributed disease, lack of feed and improper management. Among diseases contributing to the poor production of small ruminants, highly contagious trans-boundary animal diseases (TADs) such as Pest des petites ruminants (PPR), Sheep and Goat pox, Brucellosis and Contagious Caprine Pleuropneumonia (CCPP) are found to be common in the country [42]. These diseases continue to hinder international trade of live goat and sheep and their products seriously in an era of globalization [43].

i. *Peste des petites ruminants*

Peste des Petits Ruminants (PPR) is an acute, highly contagious, infectious and notifiable trans-boundary viral disease of domestic and wild small ruminants [44]. *Pest des petitis Ruminants virus* (PPRV), the causative agent, belongs to the genus Morbillivirus of the family Paramyxoviridae [45]. Currently, PPR occurs in most African countries situated in the wide belt between the Sahara and the Equator (including the Sudan, Ethiopia, Kenya and Uganda), the Middle East, and the Indian subcontinent [46]. It is a disease that threatens the national food security of affected countries and also results in economic losses due to sanitary related trade embargoes. The disease has high morbidity and mortality rates and significant economic impacts in developing countries [47].

There are often a number of risk factors that contribute to the overall risk of disease transmission in a particular community, production system or value chain [48]. These risk factors are often quite simple attributes of the sub-population such as the amount of movement, exchange of animals between households and flocks as a result of social practices and changes in economic conditions that exhibit seasonal patterns, distance from services, lack of large scale vaccination campaigns, altitude, season, and inter-species contact or interaction with wildlife [26]. In Ethiopia the morbidity and mortality rates from PPR can be up to 100% in severe outbreaks. In milder outbreaks, morbidity is still high but the mortality rate may be closer to 50% [49].

ii. *Contagious caprine pleuropneumonia*

Contagious Caprine pleuropneumonia (CCPP) is a highly fatal Caprine disease firstly reported in Algeria in 1873 [50]. It is a devastating disease of goats [51] included in the list of notifiable diseases of the Office International des Epizooties (OIE) and caused by *Mycoplasma capricolum subsp. Capripneumoniae*

(Mccp) [52]. It is a major threat to the goat farming industry in developing countries [53] and is pandemic in Africa, the Middle East and Asia [54].

This disease is the major trans-boundary disease in Ethiopia and characterized by fibrinous pleuro-pneumonia with increased straw colored pleural fluid in the infected lung [55]. The disease has been reported to affect only goat species and does not infect sheep [56]. In Ethiopia CCPP has been suspected to occur for a long period, especially in areas found at the vicinity of endemic areas of Kenya and Sudan. It has been confirmed to be present in Ethiopia since 1980s. The disease has been reported from almost all regional states of Ethiopia [57]. It is more prevalent in the arid and semi-arid low land of rift valley, Borena rangelands, South Omo, Afar and other pastoral areas of Ethiopia where about 70% the national goat population are existed. Sero prevalence rate from different authors varies from 6% to 77% in different parts of the countries [58].

CCPP is transmitted directly by an aero genic route through contaminated droplets. The outbreak of the disease follows the introduction of an infected animal into a group of susceptible goats [59]. Disease outbreak may occur after heavy rain, animal transportation over a long distance, poor climatic conditions and primary infections. This is because recovered carrier begins shedding the infectious agent during stress [56]. CCPP is a major cause of economic losses in the goat industry globally as these intracellular bacteria can infect domestic as well as wild breeds of goat [58,60,61], with 100% morbidity and 60–80% mortality rates [55].

iii. *Sheep and goat pox*

Sheep and goat pox (SGP) is viral diseases of sheep and goats characterized by fever, generalized papules or nodules, vesicles (rarely), internal lesions (particularly in the lungs) and death [62]. The virus that causes SGP is a *Capri poxvirus*, one of the largest viruses (170-260 nm by 300-450 nm) [63]. There is only one serotype of SGP virus (SGPV). Various strains of SGPV cause disease only in sheep, others only in goats, and some in both sheep and goats [64].

Sheep and Goat Pox (SGP) is one of the most important diseases of sheep and goats in Ethiopia following Pest des Petites Ruminants (PPR) and Contagious Caprine Pleuropneumonia (CCPP). This disease is among the commonest of the diseases that affect small ruminants entailing a huge economic loss and Office International des Epizooties (OIE) listed as trans- boundary disease of animal affecting the economy of the country through limiting international trade of animals and their products [65]. Morbidity rates in indigenous breeds can be 70-90% with mortality ranging from 5-10%. Mortality and morbidity rates in newly imported animals can reach 100% [66].

The most likely manner for SGP to enter a new area is by introduction of infected animals. Restrictions on the movement of animals and animal products (meat, hair, wool, and hides) are important to prevent SGP [67].

iv. *Brucellosis*

Brucellosis is an infectious bacterial disease that's caused by different species of *Brucella*. Each *Brucella* spp. has a preferred natural host that serves as a reservoir. Brucellosis in small ruminants is caused mainly by *B.melitensis*[68]. *Brucella* infection follows a very strict, host-related hierarchy of pathogenicity [69]. Thus, goats are the natural hosts of *B.melitensis* and sheep are preferred hosts of the pathogen [70]. Prevalence rates vary throughout and even within the same geographical zones operating different husbandry techniques [71].

This disease is common trans-boundary disease in Ethiopia that cause huge economic loses and trade restriction [72]. The herd level important risk factors for small ruminants brucellosis identified are large flock size, addition of new animals from unscreened sources, intensive system of management, history of abortion, grazing communal pasture, keeping sheep and goat together [73].

In Ethiopia, studies conducted on brucellosis in small ruminants indicated that; prevalence proportions of 1.5% in sheep and 1.3% in goats in the central highlands [74], prevalence proportions of 15% in sheep and 16.5% in goats in the Afar region[75] and 1.6% in sheep and 1.7% in goats in the Somali region [76]. The presence of this disease has also been reported in the Southern Nations, Nationalities and Peoples' Regional State and pastoral areas of Borana[77]. The disease is known by its high mortality rate in lambs and kids [78].

c) *Factors Spread Trans-boundary Diseases*

Traditionally, trade and travel have been instruments for disease spread. Now, changing climate across the globe is adding to the misery. Climate change is creating new ecological platform for the entry and establishment of diseases from one geographical region to another. Several new trans-boundary diseases emerge, and old diseases reemerge, exhibiting increased chances for unexpected spread to new regions, often over great distances[79].

Other common ways of spreading of trans-boundary diseases to a new geographical location are through entry of live diseased animals and contaminated animal products, importation of contaminated biological products such as vaccines or germplasm or via entry of infected people (in case of zoonotic diseases). Even migration of animals and birds, or natural spreading by insect vectors or wind currents, could also spread diseases across geographical border [80, 2].

d) *Economic Effect of Trans-boundary Diseases*

TADs impose major economic costs and risks to infected countries, their neighbors, and trading partners. The varying impact of TADs among stakeholders and the threat to existing and potential trade in wealthier countries complicates the question of appropriate control. For all livestock producers, the threat of TADs increases the risk of lost production and impacts on livelihood, increasing vulnerability to poverty particularly for small-scale producers. The impact of TADs and of their control varies depending on the virulence of the disease, number of animals at risk, dependency on livestock for livelihood, and method of control [81].

Direct effects of TADs on livestock productivity include reduced feed intake, changes in digestion and metabolism, increased morbidity and mortality and decreased rates of reproduction, weight gain, reduced draught power and manure and milk production. These have aggregate effects that limit economically important herd-management decisions regarding animal selection and optimal longevity. Many TADs have mortality rate 50-90% in susceptible animals [2]. For instance, in the wake of the rinder pest pandemic of 1887 was estimated to have killed about 90% of Ethiopian cattle and more than 10 million cattle on the continent as whole [82]. On other hand, the socio-economic significance of PPR is a result of heavy losses at production level and market effects along the value chain. It is estimated that 10% of the total impact of the disease is on trade and public expenditure and 90% on herd productivity [83]. In Ethiopia, FAO estimated that losses associated with PPR reached an average of US\$ 375 per flock, with an average of 143 small ruminants per flock (an average loss of more than US\$ 2 per animal) [84].

Indirect losses are often less visible than the obvious effects of clinical disease but may be equally or more important in their overall economic impact. Disease control has costs including vaccine purchase, vaccine delivery, disease surveillance, laboratory diagnosis and testing, quarantine and movement management, expensive antibiotic treatment [85]. Movement restrictions and local quarantines mean the closure of livestock markets and reduced or no opportunities for sale of live animals and possibly meat and other products. In addition to the measurable economic impact on a national economy the inability to sell one steer or some sheep or goats can bring severe hardship to a pastoral family with no other income of sources of support [86].

The trade implication of TADs can cause a greater economic impact than the direct production losses themselves [87]. The trade ban From February 1998 to April 1999, by Saudi Arabia and Other Gulf states of live animals from the Horn due to Rift Valley fever outbreak in Kenya is estimated to have cost US

\$32 million in lost exports and other negative domestic impacts on agriculture and other sectors such as transport and services [72]. In addition to this FMD is one of the major diseases in Ethiopia that hampering export of livestock and livestock products to the Middle East and other African countries, in which the country lost more than US\$14 million [88]. These bans have disrupted trade patterns and dealt severe economic blows to the region. Following the 1998 ban, for instance, exports from the port of Berbera in Somaliland ,a major export point for Ethiopian livestock from Somali Region, dropped from nearly three million head in 1997 to just over one million in 1998, representing an export loss of approximately \$100 million. As a result livestock prices in Ethiopia and Somalia fell by approximately 30 percent [89]. Traders have found ways of circumventing trade bans, for instance by exporting livestock to Yemen for re-export to Saudi Arabia, but, such measures do not address the root problem of SPS concerns from Gulf States. Indeed, the length of the bans suggests that Saudi Arabia and other Gulf States lack confidence in the Horn's disease surveillance and regulatory systems. The most recent ban was finally lifted in October 2009 [90].

Trans-boundary animal diseases have significant and measurable effects on human welfare in developing countries. Particularly in pastoral societies, livestock contribute directly or indirectly to food security and nutrition a source of protein, micronutrients, animal power and tradable asset [91].

e) *Prevention and Control of Trans-boundary Diseases*

Techniques and tools for the control of major TADs are already existed. They have been used successfully in many countries that most have been eradicated from or prevented from infecting North America, much of Europe, much of Southern Africa, Australia and New Zealand. In these countries there is now nothing other than sporadic and localized outbreaks which are usually quickly dealt with [92,93].

The following techniques are used for prevention and control of Trans-boundary disease these are: Preventing incidence of trans-boundary diseases and disease transmitting vectors and minimizing the movement of animals across the borders is essential. Also, prompt practice of quarantine protocol would reduce many trans-boundary diseases [94], Reducing man-made disasters that have adverse implications on climate [79], Interrupting the human-livestock wildlife transmission of infections, Breaking the cycle of disease transmission [95], Establishing regional biosecurity arrangement with capacity for early disease warning system for surveillance, monitoring and diagnosis of emerging disease threats [96], Undertaking animal breeding strategies to create disease resistant gene pools[97], Strengthening government policies to enhance agricultural/animal research and training, and

technology development [98], Ensuring appropriate preparedness and response capacity to any emerging disease and Intensification of international cooperation in preventing spread of TADs [96,99].

In addition to this the International Organization for Animal Health recognizes the improvement of national standards in animal health, should be parallel to the improvement of veterinary services in terms of increasing the capacity of early epidemiological detection, diagnosis and control of TAD [59]. Roles of Veterinary Services in function of TADs control, rapid detection and early response are crucial for the control of TADs. This function is highly linked with the transparent and timely notification of disease for effective control of such diseases at source. To achieve those, national Veterinary Services (VSs), as a public good, play quite important roles and need to be strengthened in various areas of their important mission, including human and financial resources, legislation for animal health and diagnostic and surveillance capability, and disease control measures. The World Organization for Animal Health, has supported Member Countries/Territories to evaluate Performance of Veterinary Services, by applying the OIE Public Veterinary Service tool, which is designed to assist VSs to identify gaps and weaknesses regarding their ability to comply with OIE International Standards on animal health, to form a shared vision with stakeholders and to establish priorities and carry out strategic in control of TADs [100].

III. CONCLUSION AND RECOMMENDATION

Trans-boundary diseases is becoming ever more important since it can spread throughout an entire region, impact trading partners and commerce, tourism, consumer confidence, and occur in distant countries, with devastating economic and livelihood consequences. With the globalization of trade and the increasing movements of people, these major crises will continue to menace the global animal and human populations. In Ethiopia the Livestock sub-sector's contribution to the economy and foreign currency earnings in particular, is very low as per the country expectation and potential of the sectors. Some of the major factors contributing to the poor performance of the livestock sub-sector include the prevalence of highly contagious trans-boundary animal diseases (TADs) such as foot-and-mouth disease (FMD), lumpy skin disease (LSD) and contagious bovine pleura pneumonia (CBPP) in cattle and pest des petites ruminants, contagious Caprine pleuropneumonia, sheep and goat pox, and brucellosis in small ruminants. These diseases continue to hinder international trade in live animal and their products seriously in an era of globalization.

Based on above conclusive remarks the following recommendations are forwarded:

- ✓ Strategies to improve veterinary service delivery by field staff and laboratories should be designed.
- ✓ In the medium to long term, health facilities and laboratories need to be better equipped and the number of veterinary staff in the public and private sectors should be increased.
- ✓ Rapid detection and early response are crucial for the control of TADs at source and national level.
- ✓ Government policies to enhance agricultural/animal research and training, and technology development should be strengthened.
- ✓ Animal movement from region to region should be controlled and quarantine should also be established.

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