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Economic Impact of Transboundary Animal Diseases in SAARC Countries

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Foreword

Livestock and poultry plays a vital role in national economy and contributing directly towards employment generation, poverty reduction and agricultural development in SAARC countries. But prevalence of Transboundary Animal Diseases (TADs) is one of the major constraints for livestock and poultry development in this region. SAARC countries share common borders and have formal and informal livestock trades, which causes the spread of TADs. Some of the important animal diseases with the potential to spread across the borders are Highly Pathogenic Avian Influenza (HPAI), Foot and Mouth Disease (FMD), Peste des Petits Ruminant (PPR), Haemorrhagic Septicemia (HS) and Classical Swine Fever (CSF).

TADs have a significant impact on national economies due to its high rates of morbidity and mortality in the susceptible animal populations, costs of control or eradication programmes and restrictions on international trade. These diseases negatively affect livestock or poultry production in the country because they impose heavy economic losses in the form of morbidity and mortality, and are thus considered serious threat to livestock production and livelihood of poor farmers, especially in those areas of the country where such diseases have assumed an endemic role.

Considering the economic importance of TADs SAARC Agriculture Centre initiated the program on "Economic Impact of Transboundary Animal Diseases in SAARC Countries"and worked with six nominated focal point experts from Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka to write up country paper on the existing scenarios of prevalence, surveillance, impact and preventive measures of these diseases for the benefits of the stakeholders. The present report provides an overview of these TADs with special reference to the present status of these diseases in South Asia; highlights possible economic impact of these diseases and compiles available information and predictions in this regards; and advocates possible policy intervention for prevention and control of these diseases.

The centre sincerely acknowledges the continuous support and contribution of all focal point experts who have kindly responded to our request and provided a comprehensive country status profile very sincerely and efficiently. My sincere thanks and appreciation to Dr. Md. Nure Alam Siddiky, Senior Program Officer (Livestock) who has successfully coordinated, compiled and edited the report.

Dr. Abul Kalam Azad
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Executive Summary

Transboundary Animal Diseases (TADs) are those that are of significant economic, trade and/or food security importance for a considerable number of countries; which can spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation among several countries. South Asian Association for Regional Cooperation (SAARC) member states share common borders and trade agreements, which are prone to TADs. Some of the important animal diseases with the potential to spread across the borders and affect economic relations between these countries are Highly Pathogenic Avian Influenza (HPAI), Foot and Mouth Disease (FMD), Peste des Petits Ruminants (PPR), Haemorrhagic Septicemia (HS) and Classical Swine Fever (CSF).

FMD, PPR and HS are endemic in Bangladesh, while there is no report on CSF outbreak. A total of 59,181 cases of FMD, 84,087 cases of PPR and 3,437 cases of HS were treated at Upazila Veterinary Hospitals of the country at 2010. Exact incidence of these diseases would be several fold higher as only a fraction of cases are brought to hospitals for treatment. Since the first incursion of HPAI in Bangladesh in February 2007, a total of 519 events have been reported to the World Organization for Animal Health (OIE) as of 14 November 2011. Eradication through stamping out without vaccination has been the policy for HPAI control. Vaccination is practiced, though at a suboptimal level, for control of FMD, PPR and HS.

Analysis of economic impacts of TADs in Bangladesh is rather limited. In the absence of published information, hypothetical predictions of economic impact of FMD, PPR and HS were performed for the present report. The predicted annual direct loss stands at Tk. 819 million (US$ 10.92 million) for FMD, Tk. 1,842 million (US$ 24.56) for PPR and Tk. 1,105 million (US$ 14.74 million) for HS. Indirect loss from the diseases and overhead cost of the state veterinary services were not considered for this analysis. A study on the economic impact HPAI outbreaks in 2007 and 2008 was conducted at Bangladesh Livestock Research Institute (BLRI). The study estimated a total loss of Tk. 38,583 million (US$ 551 million) due to HPAI outbreaks in the first two years. The estimate included direct loss of Tk. 86 million, indirect loss of Tk. 2,497 million and the loss due to production downtime effect of Tk. 36,000 million. If the figure adjusted to the outbreak data of total five years, 2007 – 2011, the total loss would stand at Tk. 51,720 million (US$ 690 million).

In Bhutan, FMD is the priority disease with major economic impact followed by Avian Influenza, Hemorrhagic Septicaemia, Swine Fever and PPR based on the disease outbreak trend and economic losses to the communities.

In India economic impact of FMD incidences in four districts of Andhra Pradesh was studied. The results obtained from the study were extrapolated to approximately understand the economic dimensions of FMD outbreaks in the state and the country. The extrapolation

was made based on an assumption that the proportion of different species of livestock and the disease prevalence would be similar in other areas too. From the projection, the estimated loss due to reduced milk output, the loss due to reduction in draught power, treatment of ailing animals, and the loss due to mortality and culling would be Rs. 388.58 crores, Rs.398.79 crores, Rs.351.41 crores and Rs.8.53 crores, respectively. Thus, the total economic loss estimated due to the setback that had occurred to livestock in study area in the form of FMD outbreak could have been to the tune of Rs.1147.31 crores in Andhra Pradesh.

In Nepal there are various infectious diseases of livestock and poultry prevalent in the country. The foot & mouth Disease (FMD), peste des petits ruminants (PPR), haemorrhagic septicemia (HS), classical swine fever (CSF), Newcastle disease (ND), highly pathogenic avian influenza and sheep & goat Pox are major TADs. The attempt has been made in this report to include the present status of the TADs and also the information available on the economic impact of some of the TADs in Nepal. However data on economic impact of TADs is scarce therefore it is necessary to carry out detail assessment of the economic impact of priority TADs in Nepal.

Pakistan has common borders with India, China, Iran and Afghanistan. Therefore, many of the transboundary animal diseases such as foot and mouth disease (FMD), peste des petites ruminants (PPR), hemorrhagic septicemia (HS) in livestock; and highly pathogenic avian influenza (HPAI) of poultry etc. prevalent in Pakistan. The federal and provincial departments of livestock and poultry production are engaged to control these TADS in close coordination with the federal institutions. The major disease control activities are treatment of sick animals, vaccination of susceptible populations, launching of TADs awareness campaigns for public and livestock/poultry owners, setting up of disease reporting and surveillance work in high risk areas. All the TADS reported in Pakistan cause losses worth billions of dollars every year despite the efforts by the government authorities.

Sri Lanka has been endemic for two main transboundary diseases foot and mouth disease (FMD) and hemorrhagic septicemia (HS) for decades. There have been outbreaks of classical swine fever (CSF) too. The low country dry zone where the livestock farming is one of main income source was the enzootic area for FMD and HS. The diseases has originated there and transmitted to other areas through cattle and buffalo transportation. The socio economics of livestock farmers those who earn their living out of livestock farming had severe impact due to HS and FMD for year and years. The prophylactic vaccination program on HS has succeeded to control the disease completely for 7 consecutive years in the country. Even though the classical swine fever had severe economic losses in swine sector before 1999, the disease has not reported been since then. The diseases of peste des petits and avian influenza have not been reported in Sri Lanka.

Apart from economic impact TADs also may have price and market effects, trade impairment, impacts on food security and nutrition, livelihood and employment, health and environment. However, these impacts would be different for different diseases. Although all

the important TADs could have impact on livelihood of the farmers and could affect food and/or nutritional security, HPAI also have impacts on employment, public health and environment.

Control of TADs usually demands a regional and global approach. Policy decision regarding control options for a TAD must be economically viable. This should be based on a cost benefit analysis, i.e., analysis of the benefit in terms of reducing economic impact of the disease against the investment in disease control. To begin with, a systematic structured survey on the incidence of selected TADs and their economic impact should be conducted in each country using a uniform economic analysis model.

The public health concern and severe economic impact of HPAI would justify eradicating the disease by stamping out approach. For FMD a progressive control could be the rational option. Targeted vaccination of high value animals, ring vaccination in the face of an outbreak could be the viable option for the time being. However, improvement of facilities for quick detection and sero-typing of virus as well as sero-monitoring of vaccinated animals is necessary. A similar strategy might fit for HS. However, it might be possible to target eradicating PPR through mass blanket vaccination across the region. The cost-benefit analysis of such control strategy for PPR is very likely to be economically viable.

Stronger coordination and collaboration amongst various institutions involved in disease diagnosis, its prevention and treatment, as well as disease monitoring and response, within the country and across the region so as to make it easier to exchange information on TADS at the national, regional, and international levels.

1. INTRODUCTION

Trans-boundary Animal Diseases (TADs) are highly contagious or transmissible diseases which have the potential for very rapid spread, irrespective of national borders and these diseases can cause serious socio-economic and possibly public health consequences" (FAO, 1999). Trans-boundary animal diseases (TADs) are those that are of significant economic, trade and/or food security importance for a considerable number of countries; which can spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation between several countries (Otte et al., 2004). TADs cause most serious impact on animal and human livelihood as these have the potential to threaten food security, proper livelihood of livestock owners & workers and rural economy which in certain instances could lead to political and social unrest in people. Due to the global distribution and persistence of TADs world animal agriculture, food security and international trade are being very badly affected (Domenech et al., 2006). TADs have a significant impact on national economies due to its high rates of morbidity and mortality in the susceptible animal populations, costs of control or eradication programmes and restrictions on international trade. Major TADs which affect livestock and poultry include Foot and Mouth Disease (FMD), Peste des Petits Ruminant (PPR), Haemorrhagic Septicaemia (HS), and Highly Pathogenic Avian Influenza (HPAI) (FAO, 1999). These diseases negatively affect livestock or poultry production in the country because they impose heavy economic losses in the form of morbidity and mortality, and are thus considered as vital threat to livestock production and livelihood of poor farmers, especially in those areas of the country where such diseases have assumed an endemic role.

South Asian Association for Regional Cooperation (SAARC) member states share common borders and have formal and informal trades, which are prone to TADs. Some of the important animal diseases with the potential to spread across the borders and affect economic relations between these countries are highly pathogenic avian influenza (HPAI), Foot and Mouth Disease (FMD), Peste des Petits Ruminant (PPR), haemorrhagic septicemia (HS) and Classical Swine Fever (CSF).

The present report provides an overview of these TADs with special reference to the present status of these diseases in South Asia; highlights possible economic impact of these diseases and compiles available information and predictions in this regards; and advocates possible policy intervention for prevention and control of these diseases.

2. OVERVIEW OF COMMON TRANSBOUNDARY ANIMAL DISEASES (TADs)

2.1 Foot And Mouth Diseases (FMD)

Foot and Mouth Disease (FMD) is perhaps the most contagious cattle disease known, spreading rapidly in cloven-hoofed animals. Infected animals show signs of lameness, and the disease may cause severe losses in reproduction, lactation, growth, and draught power.

Susceptible animals include cattle, water buffalo, sheep, goats, pigs, antelope, deer, and bison. It has also been known to infect hedgehogs, elephants. In laboratory experiments, mice, rats and chickens have been successfully infected by artificial means, but it is not

believed that they would contract the disease under natural conditions. Humans are very rarely affected.

The disease is characterized by fever and blister-like lesions followed by erosions on the tongue and lips, in the mouth, on the teats, and between the hooves. Most affected animals recover, but the disease leaves them debilitated. Sequelae may include decreased milk yield, permanent hoof damage and chronic mastitis. Young animals may succumb to infection.

Figure 1: Cow with drooling saliva with ruptured blisters with ulcers on the tongue

Foot-and-mouth disease is a severe plague for animal farming. Since it is highly infectious and can be spread by infected animals through aerosols, through contact with contaminated farming equipment, vehicles, clothing or feed, and by domestic and wild predators. Its containment demands considerable efforts in vaccination, surveillance, trade restrictions and quarantines, and in certain circumstances elimination of infected and in-contact animals.

The virus responsible for the disease is a picornavirus, the prototypic member of the genus *Aphthovirus*. There are seven immunologically distinct serotypes: O, A, C, SAT 1, SAT 2, SAT 3 and Asia 1, and over 60 sub-types within these serotypes. FMD virus (FMDV) serotypes and strains vary within each geographic region. Serotype O is the most common serotype worldwide. This serotype is responsible for a pan-asian epidemic that began in 1990 and has affected many countries throughout the world. Other serotypes also cause serious outbreaks.

Foot-and-mouth disease is endemic in parts of Asia, Africa, Middle East and South America. North America, New Zealand, Australia, Greenland, Iceland and most of Europe are free of this disease. Sporadic outbreaks have occurred in disease-free countries, with the exception

of New Zealand, Greenland, Iceland and the smaller islands of Oceania. The last outbreak in the USA occurred in 1929.

Control of FMD requires strict zoo-sanitary measures and/or vaccination. The present worldwide distribution of FMDV mirrors economic development; prosperous countries have eradicated it, whereas developing countries lack the resources and infrastructure to do so. FMD freedom offers significant trade opportunities for countries with livestock export potential, creating an incentive for some countries to invest in veterinary services and FMD control. However, the substantial investment required to guarantee an export market is usually beyond the capacity of many developing countries. Therefore, many countries have not identified eradication of FMD as a priority. Instead, they likes to reducing the disease incidence through preventive and control measures.

Preventive vaccination, coupled with stamping-out of cases, was adopted by most European countries in the 1950s until 1990, when freedom from FMD allowed vaccination to cease in Europe, with the exception of Turkey and parts of the Russian Federation. On the other hand, policies based on vaccination, mostly involving quarantine rather than slaughter of cases have been applied in other regions, such as south America, southern Africa and Asia.

Vaccination employs type-specific, inactivated vaccines that can be used prophylactically or as an emergency measure, alone or more effectively as an adjunct to zoo-sanitary measures. Prophylactic vaccination seeks to maintain immunity to one or more serotypes of FMDV by a programme of regular vaccination and revaccination.

Like other viruses, the FMD virus continually evolves and mutates, thus one of the difficulties in vaccinating against it is the huge variation between and even within serotypes. There is no cross-protection between serotypes (meaning that a vaccine for one serotype will not protect against any others) and in addition, two strains within a given serotype may have nucleotide sequences that differ by as much as 30% for a given gene. This means FMD vaccines must be highly specific to the strain involved. Vaccination only provides temporary immunity that lasts from months to years.

Currently, the World Organization for Animal Health (OIE) recognizes countries to be in one of three disease states with regards to FMD: FMD present with or without vaccination, FMD-free with vaccination and FMD-free without vaccination. Countries designated FMD-free without vaccination have the greatest access to export markets, and therefore many developed nations, including Canada, the United States, and the UK, work hard to maintain their current status.

FMD is endemic in Bangladesh. Out of seven serotypes four have been detected in Bangladesh, that include serotype O, A, C and Asia 1 (Freiberg et al., 1999, Marquardt et al., 2000, Islam et al., 2001, Loth et al., 2011). FMDVs of serotype O have been the most consistent isolates and all the virus isolates characterized from 2009 outbreaks belonged to Type O. FMDV Serotype C, Asia 1 and A were last detected in Bangladesh in 1992, 1996 and 2001, respectively. However, it should be noted that FMDV surveillance and serotyping in Bangladesh is rather casual. Limited quantity of FMD vaccine is produced at the vaccine production facility of the Department of Livestock Services (DLS) of Bangladesh. Bangladesh is in a process of adopting a National FMD Control Strategy following the directives of OIE – FAO endorsed Progressive Control Pathway.

The serotypes of FMD virus in Bhutan are O, A, C and Asia 1. As per the sero-typying done at World Reference laboratory at Pirbright, UK during 2002, out of a total of 20 samples submitted for the typing, 4 samples revealed "Asia 1 type", 10 showed type "O" and 6 samples did not reveal any virus. This shows that the most predominant type of FMD in Bhutan is "O" type. During 2001-02, Asia 1 was also involved in the outbreak of FMD in the country. As per the review on the disease outbreak from 2005 to 2010, a total of 75 outbreaks recorded with an average of 12.5 outbreaks per year involving the risk livestock population of 71911 animals with a total of 1053 cases. The number of outbreaks ranges from 5 to 29 per year with an average of 12.5 per year for the last 6 years w. e. f. 2005 to 2010. The most predominant FMD serotype found in Bhutan was "O" till 2002, which accounts for more than 99% among the different virus types. As per these findings, Bhutan embarked on monovalent O prophylaxis vaccination programme throughout the country during 2001 and 2002 which lead to the emergence of other virus strains from 2003 and so again switched on to tetravalent FMD vaccination comprising of O, A, C and Asia 1 for prophylactic purpose.

The outbreaks from 1982 to 2008 were caused by serotypes O, A, Asia 1, and C. The last recorded outbreaks of FMD in Bhutan due to serotypes C was in 1991, Asia 1 in 2002 and A in 2003. As per the review on the virus typed till 2003, serotype O comprised 70.6% of the outbreaks followed by serotypes A with 16.7%, Asia 1 with 8.8% and C with 3.9%. The O serotype isolated between 1998 and 2007 belonged to the Pan-Asia strain of the Middle East–South Asia (ME–SA) topotype as shown in table 1.

Table 1: FMD virus type isolated from Bhutan in 2002

Characters	**Virus Isolate details**	**For Two serotypes from Bhutan**
	BHU/2/2002	BHU/7/2002
Serotype	O	O
Date	23/06/2002	23/06/2002
Reported by	N. J. Knowles, WRL, UK	N. J. Knowles, WRL, UK
Seq. File name	BHU02-02	BHU02-07
Topotype	Middle-East-South Asia (ME-SA)	Middle-East-South Asia (ME-SA)
Genotype /strain	PanAsia	Ind2001
Regional Sequence	VP1	VP1
No. of nt determined/no. in gene	638/639	637/639
No. of ambiguities	1	2
Date. Seq. Last updated	23/06/2002	23/06/2002
Total no. of comparisons made	1253	1253

In India all the four Euro Asian serotypes (O, A, C and Asia1) has been recorded. Among the serotypes, type O is the most prevalent one followed by Asia 1 and A. Serotype C has not been reported in the country since 1995. Within serotype(s), different genotypes and lineages have been identified. Emergence and re-emergence of different strains have been witnessed

in the country. Control is mainly sought by vaccination (6 monthly) programme and constant monitoring and surveillance. The disease situation is complicated due to the plurality of the circulating virus and unrestricted movement of susceptible animals, in apparent infection in small ruminants and carrier status.

FMD is endemic in Nepal and is present in almost all parts of the country and occurs round the year. Out of the possible seven, only four serotypes, O, A, C and Asia-1 were reported in Nepal. Serotype 'C' has not been recorded in the country since 1995. With the launching of intensive cattle development programmes through cross-breeding of indigenous cattle with exotic breeds, the incidence of FMD has increased too in Nepal. The FMD virus sero-typing results from 1995 to 2010 revealed that the prevalence of O type was 79.24%, A type 5.15% and Asia 1 type 15.65% (DAH, 2010). In 2009 the positive samples was sent to Institute of Animal Health, Pirbright, UK further identified some of O type isolates as O type Pan Asia 2 strain and IND 2001 strain. According to Pirbright laboratory, based on Virus Neutralization Test O BFS or O IND R2/75 strain containing vaccine is likely to confer protection against O type in Nepal. Based on liquid phase blocking (LPB) ELISA O 4174 or O BFS 1860 or O IND 53/79 or OHkn 6/83 or O Manisa containing vaccine is likely to confer protection against O type in Nepal.

Vaccination coverage in Nepal against FMD is very low in the country. According to Veterinary Epidemiology Center (VEC) (2009) only 80,000 animals' vaccination was reported in the country. FMD vaccine is not produced in the country. The formal import record of FMD vaccine is only 0.15 million doses in the year 2010 (CAQO, 2010). This clearly shows that the practice of FMD vaccination is almost very low.

The initial FMD outbreaks in the United Indo-Pak subcontinent were reported during 1943 and till to-date it continues as an endemic disease to affect the livestock in Pakistan (Yasin and Haq, 1960). Prevalent serotypes O, A and Asia-I cause very heavy economic losses in cattle and buffaloes while serotype C isolation in Pakistan was reported only once in 1960 (Zahur et al., 2006). The FMD prevalence in susceptible animal populations in Pakistan is high because of wide movement of animals across the country and cross-breeding programme using exotic germplasm in cattle and also due to import of exotic cattle breeds as these factors contribute in the dissemination of FMD virus in susceptible populations (Klein et al., 2008). In some areas of Pakistan FMD is observed in the field round the year as a mild to acute illness (Klein et al., 2008). The prevalence rates for FMDV serotypes in Pakistan has been calculated for types O, Asia-1, and A as 70%, 25% and 4.7%, respectively (Zulfiqar, 2003). The serotype O identified in the Punjab province during 2006 – 2007 is genetically similar to the virus type identified in Sri Lanka, India, Iran, Iraq and China. On the other hand, Pan Asia-I lineage of serotype O was found similar to the FMDV responsible for outbreaks in UK in 2001 and in Saudi Arabia during 1994 (Saeed et al., 2011). The phylogenetic analyses of VP1 region of serotype O in Pakistan revealed that these isolates belonged to the Middle East–South Asia topo-type with the majority belonging to the Pan Asia-2 lineage (Saeed et al., 2011), suggesting cross border transmission of FMDV with the neighboring countries.

In Pakistan, a polyvalent vaccination using serotypes A, O, Asia-1 is being practiced for the control of FMD. In this regard vaccines are being manufactured locally and imported are used in the control of FMD, which has helped to reduce disease incidence significantly.

The Foot and Mouth Disease has been presented in Sri Lanka for last 100 years or so. Though it has been officially reported in Sri Lanka (Ceylon) in 1900 (Sturgess, 1900), a similar disease condition causing “sore mouth and sore hoof “in cattle had been recognized in 1869 or even much earlier. Foot and Mouth Disease caused by type "O" virus is endemic in Sri Lanka.

2.2 Peste des Petites Ruminants (PPR)

Peste des Petits Ruminant (PPR) is an acute/sub-acute, very contagious and frequently fatal viral disease of small ruminants; sheep, goats and wild small ruminants” (Furley et al., 1987). The PPR is characterized by high fever, muco-purulent oculo-nasal discharge, conjunctivitis, erosive and necrotizing stomatitis, gastro-enteritis and pneumonia which might lead to animal death. Goats are more severely affected than sheep. During the epidemics/pandemics, the PPR may destroy whole of the susceptible host population leading to damage of country’s economy along with food security and livelihood of poor livestock owners (FAO, 1999). PPR has been ranked among top ten diseases which affect the small ruminants (Perry et al., 2002). PPR is a notifiable disease as per OIE description.

When PPR occurs in an area for the first time, it is possible that acute high fever with extreme depression and death occur before any other typical signs have been seen. A more typical picture, often seen in fast-spreading outbreaks in sheep or goats, is characterized by the sudden onset of depression, discharges from eyes, nose and mouth, abnormal breathing with coughing, diarrhoea and deaths. The outbreak does not involve cattle, whether they are vaccinated against rinderpest or not, even if they are in contact with affected sheep or goats.

The PPR virus (PPRV) belongs to the genus *Morbillivirus* in the family *Paramyxoviridae*. It is closely related to the rinderpest virus of cattle and buffaloes, the measles virus of humans, the distemper virus of dogs and some wild carnivores, and the morbilliviruses of aquatic mammals. Genetic characterization of PPR virus strains has allowed them to be categorized into four lineages; Lineage I, II and III arising from Africa and Lineage IV from Asia. Trans-continental spread of PPRV lineages has been documented.

Figure 2: PPR lesions in goats with cracked lips

PPR was first reported in the Ivory Coast in 1942 but it now occurs in most African countries, south of the Sahara and north of the equator, and in nearly all Middle Eastern countries up to Turkey. PPR is also wide-spread in India and south and west Asia. Recently incursions of PPR into China (Tibet) and Morocco have been reported.

Control of PPR outbreaks relies on movement control combined with the use of ring vaccination and prophylactic immunization in high-risk populations. Previously, tissue culture rinderpest vaccine was used against PPR. Now-a-days homologous PPR vaccine is used.

In Bangladesh, PPR outbreaks occur quite frequently in goats and sheep. The outbreak was first reported in 1993. Tissue culture homologous PPR vaccine is produced to a limited extent at the vaccine production facility of the Department of Livestock Services, Bangladesh. However, there is no organized vaccination campaign.

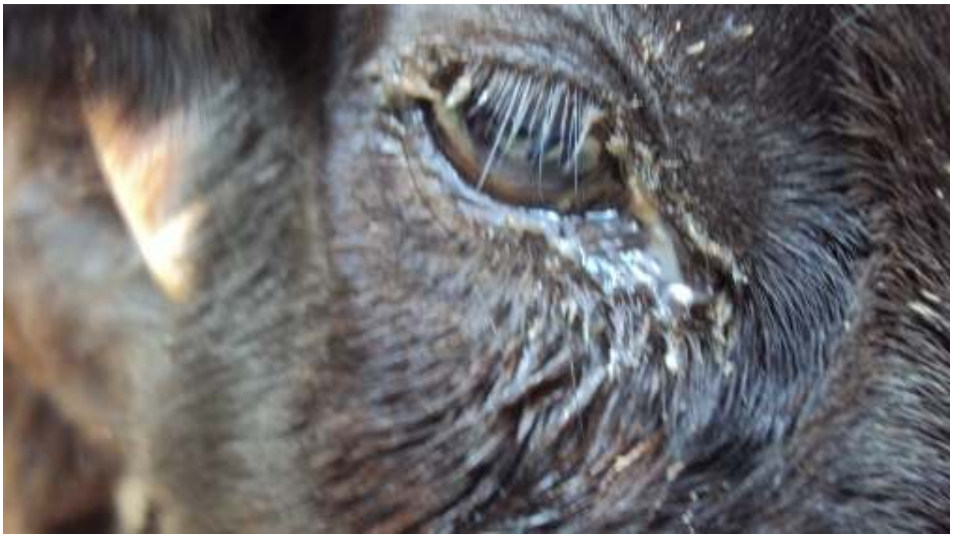


Figure 3: Ocular/eye purulent discharges and matting of hairs in and around the eyes

The first and only outbreak of PPR in Bhutan is from Tsethar goats in confined flock in Chukha district. This information clearly indicated that the disease could have been in the area since 2006 onwards. The virus has been isolated at Institute of Animal Health, Pirbirght,UK and the PPRV isolate is of lineage IV which is similar to the isolate identified in Nepal and Tibet.

The most devastating disease PPR entered in Nepal in the year 1995. Nepalese farmers mostly poor and in rural areas have suffered a lot from this disease in the last 15 years though PPR vaccine is produced in the country since the year 2000, coverage of vaccination is too limited to minimize the number of outbreaks. Compared to the 9.27 million goat and sheep in the country the vaccination coverage/year is not even 50% of the total population.

In Pakistan over 89 million goats and sheep are at risk of being infected with PPR virus. PPR was first recognized in goats during 1991 in and around Faisalabad district of Punjab province (Athar et al., 1995). The disease outbreak was controlled using Tissue Culture Rinderpest Vaccine. During the same period Rinderpest- like disease in goats was observed

in the area of district Lahore (Pervez et al., 1993). In 1996, a highly fatal pneumonitis syndrome was reported from parts of district Dera Ghazi Khan, (Ayaz, et al., 1997). The PPR as per all of the initial reports was diagnosed based on clinical, postmortem and epidemiological observations. The confirmation of PPR virus was made in 1994, when it was detected in blood and tissues of the affected goats using reverse transcriptase polymerase chain reaction (RT-PCR) (Amjad, et al., 1996). Hussain et al., (1998 and 2003) reported continued presence of PPR virus across the country using Ic ELISA and a pen side test. However, despite the enormous economic losses observed during these outbreaks little organized efforts were made to study disease epidemiology all over the country.

The PPR has not been reported clinically in Sri Lanka so far.

2.3 Highly Pathogenic Avian Influenza (HPAI)

Avian influenza (AI) is a viral disease ranging from mild or even asymptomatic infection to an acute fatal disease of all avian species. It is caused by viruses of the genus *Influenzavirus A,* placed in the family *Orthomyxoviridae*. Based on pathogenicity AI viruses are categorized into highly pathogenic avian influenza (HPAI) and low pathogenic avian influenza (LPAI) viruses. Based on polymorphism of surface glycoproteins - haemagglutinin (H) and neuraminidase (N) - Influenza A viruses are classified into antigenic subtypes. At present, 16 H subtypes (H1–H16) and 9 N subtypes (N1–N9) are recognized. To date, all the HPAI that produce acute clinical disease in chickens and turkeys have been associated only with the H5 and H7 subtypes.

Many species of birds have been shown to be susceptible to infection with influenza A viruses; while aquatic migratory birds are the major reservoir of these viruses. Most of the isolates from aquatic birds have been of low pathogenicity for chickens and turkeys. However, highly pathogenic avian influenza (HPAI) viruses emerge from time to time and cause fatal disease virtually in all species of birds. Avian influenza viruses also may transmit to human and cause fatal disease. So far H5, H7 and H9 viruses have infected humans.

Avian influenza was recognized more than 100 years ago. However, the earlier outbreaks usually remained confined in a particular locality or a country until the recent panzootic of H5N1 HPAI that started at the end of the year 2003 in the Far-east and Southeast Asia. This panzootic is believed to have its origin in 1996 outbreaks in China. Avian Influenza (HPAI) outbreaks due to H5N1 virus in poultry and wild birds are documented in 63 countries since 2005. The present H5N1 virus has spread across the world and evolved into many genetic lineages popularly identified as HA clades. The H5N1 HPAI viruses are still circulating in several countries in Asia and at Egypt in Africa. Egypt and Indonesia have declared themselves endemic for H5N1. Food and Agriculture Organization (FAO) considers H5N1 viruses endemic in poultry in six countries; Bangladesh, China, Egypt, India, Indonesia and Viet Nam (FAO, 2011). H5N1 HPAI viruses are also occasionally detected in poultry and/or in wild birds in other countries. H5N1 HPAI has already claimed 335 human lives as of 29 November 2011 (WHO, 2011). Adaptation of HPAI in human host through mutation or recombination could give rise “bird flu” pandemic in human as well. During year 2010 – 2011, 62 H5N1 cases were reported in human beings and of which 33 were fatal; in 2011, a total of 45 cases and 22 deaths were reported.

In Bangladesh the first outbreak of HPAI was noticed in February 2007. As of 14 November 2011 a total of 519 events of HPAI outbreaks in Bangladesh have been reported to World Organization of Animal Health (OIE), of which 166 events took place in the year 2011 (OIE, 2011). There also have been three non-fatal human cases. The Government of Bangladesh implemented the policy of stamping out to eradicate HPAI, which involved movement restriction, culling of infected and in-contact birds, decontamination of infected premises and temporary ban on poultry rearing at the infected premises. Initially culling of all birds within one kilometer radius of the infected farm was practiced. However, due to practical difficulties the culling was later restricted to the infected farm and its dangerous in-contacts. In case of backyard chickens culling over a half a kilometer radius was maintained. Surveillance has been intensified; SMS flash reporting system has been introduced with emphasis on rapid detection and rapid response. Vaccination against AI is not allowed but very recently is being practiced in experimental basis. H5N1 HPAI viruses of Clade 2.2 have been circulating in Bangladesh since its first introduction in 2007. However, in 2011 Clade 2.3.2 and 2.3.4 viruses also have been detected (Islam et al., 2011).

Bhutan was prepared to incursion of HPAI into the country when frequent outbreak occurred in West Bengal, Assam and Sikkim including the neighboring countries of Nepal, Bangladesh, Pakistan, China, Mongolia and most of countries in Asia. The experts from OIE and FAO always had the feeling that Bhutan is at low risk to HPAI outbreak but depending on the geographical terrain, porous border and being the route for migratory birds in the Trans-Siberian highway, the expert views was totally an unjustified comment. First confirmed outbreak reported in the local backyard farm on 14 February 2010 at Rinchending which was followed by the death of poultry on 15 February which were also dumped without information to the local livestock office. The other three poultry which died on 16 February were tested and found positive to rapid test and Colloidal Gold Card Test which was followed by the reference of the whole carcass to NCAH S/thang where both the tests were found positive to Avian Influenza A virus and H5. All of the poultry affected in the outbreak were 'scavenger' chickens: all chickens culled were in sector 4 management systems. The index case occurred on 14 February 2010 at Rinchending, Phuentsholing Geog (block or sub-district) adjacent to the main road in a Royal Bhutan Police colony lived in by officers who man the adjacent road check point with Bhutan Agriculture and Food Regulatory Authority (BAFRA) officers. Second confirmed outbreak at Pasakha Baazar confirmed on 19 February 2010. After every activities of 3D operation first before depopulation, then after depopulation and then after coop dismantling and disposal of litter, decontamination using Virkon@ as per the standard concentration of 10% was sprayed using the mist high force sprayer. The decontamination schedule was done on the day of depopulation, after 24 hours, 7 days and after 21 days of depopulation basically to completely make the area with minimal virus load if not free.

In Nepal the first outbreak of highly pathogenic avian influenza (HPAI) was reported in backyard chicken in Jhapa district of eastern Nepal on 16 January, 2009. Second outbreak was reported in a different VDC of the same district in backyard chicken on 20 February 2009. In 26 January 2010 the outbreak was confirmed in Kaski district and then in Rupendehi, Chitwan, Dang, Nawalparasi, Banke and Kailali districts. HPAI outbreaks in the country have caused enormous losses to the poultry farming especially backyard poultry.

Nepal is at high risk of HPAI because both migratory bird and illegal importation of poultry seems to be responsible for the outbreaks. For HPAI the 75 districts of Nepal have been categorized into 26 high risk districts, 18 medium risk districts and 31 low risk districts.

The clade of H5N1 viruses identified in Nepal was clade 2.2 in 2009 outbreak. In 2010 outbreaks clades 2.3.2 and 2.2 were identified. So far no human cases due to H5N1 have been reported in the country. There have been no reports of HPAI since October 2010. However, surveillance activities being implemented at the field level need to be further intensified.

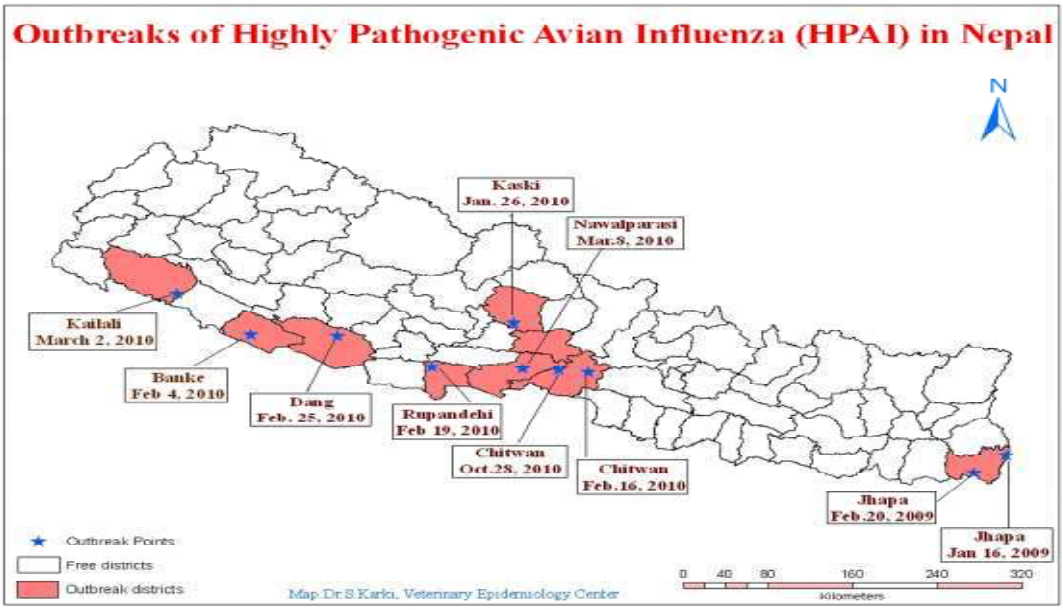


Figure 4: Locations of outbreaks of HPAI in Nepal during 2009 - 2010.

In Pakistan, HPAI H5N1 was first recorded in February 2006 at a chicken breeding farm in Khyber Pakhtoon Khwah (KPK) province in north-western part of the country, which in the subsequent years spread to other parts of the country. During this period, in 2007 two human deaths due to H5N1 were also recorded in KPK province. Later on stringent bio-security, bio-containment and vaccination strategies were employed to control AIV H5N1 spread, which led to its complete control in poultry in July-2008 in Pakistan.

Highly Pathogenic Avian Influenza (AI) has also never been reported in Sri Lanka, thus the disease is exotic to the country. Since the disease could enter into country in several ways viz. migratory birds, imports of live poultry or poultry products from affected countries ,import of pet birds, smuggling of above products, international passengers and format's, the DAPH adopt strict import regulations, quarantine and sero surveillance are being carried out regularly to prevent entry. However, Sri Lanka is being an island, the risk of HPAI is being introduced to the country has been minimized, if the possible routes of its introduction are identified and strict preventive measures are adopted. The collective efforts are being taken out by Ministry of Health, Department of Animal Production and Health and Department of Wild life through massive awareness programmes too.

2.4 Haemorrhagic Septicemia (HS)

Hemorrhagic septicemia (HS) is an acute and rapidly fatal septicaemic disease mainly of cattle and water buffaloes, caused by particular serotypes of *Pasteurella multocida*. HS is seen infrequently in swine and even less commonly in sheep and goats. It has been reported in bison, camels, elephants, horses, and donkeys, pig and there is evidence of its occurrence in yak.

HS is an important disease in Asia, Africa, some countries in southern Europe, and the Middle East. Epidemic of HS is caused by 1 of 2 serotypes of *P multocida*, designated as B: 2 and E:2. Serotype E: 2 has been detected only in Africa; B: 2 causes the disease elsewhere and also in some countries of Africa.

Radical changes in weather, including the advent of monsoons, debility caused by seasonal levels of low nutrition, and other stress are related to the explosive occurrences of the disease. The majority of cases in cattle and buffalo are acute or per acute with death occurring from 6 to 24 hours after the first recognized signs. In a few outbreaks, animals may survive as long as 72 hours. In endemic areas, 10 to 50 percent of the cattle or buffalo populations acquire solid immunity through exposure or subclinical infection. Up to 5% of recovered cattle and water buffalo may normally be carriers.

In endemic areas the only practical ways to protect animals are organized vaccination programme and maintenance of animals in good condition. Three kinds of vaccine are widely used: plain bacterin, alum- precipitated bacterin, and oil-adjuvanted bacterin. The most effective bacterin is the oil-adjuvanted one. A live HS vaccine prepared with an avirulent *P. multocida* strain has been used for control of the disease in cattle and buffaloes in Myanmar since 1989; it is administered by intranasal aerosol application.

Bangladesh is considered endemic for HS. An oil-adjuvanted bacterin is prepared by the vaccine production facility of the Department of Livestock Services.

In Bhutan the disease is mainly seen in cattle, yak, sheep, rabbits and pigs. The outbreaks of the disease are seen in sporadic forms with very few number of animals affected in a lot. There had been hardly few outbreaks with more than 5 to 10 animals affected at a time. The disease could be effectively controlled through ring vaccination and control on the movement of animals and their products during the outbreak time.

Haemorrhagic septicaemia outbreaks occur throughout the year irrespective of the season although it is perceived that the disease is mostly precipitated during the monsoon or post-monsoon period. In India, the incidence of disease outbreaks varies considerably in different states and from year to year in each state. Most cases in cattle and buffalo are acute or per acute with buffalo tend to have more severe clinical signs and a shorter course of disease. In India, the disease is endemic and has been reported from all parts of the country. There is a drastic reduction in reported deaths during the last two decades and the main reason behind this is the vaccination of the susceptible herds. Various vaccines used against this disease are formalinized bacterin, aluminium hydroxide gel vaccine and oil adjuvant vaccine. Treatment of appropriate antibiotic is carried out during outbreaks. The definitive diagnosis of the disease is carried out by culturing and by using various molecular biological tools like PCR for identifying the species and serotypes (Singh et al., 2009; Benkirane et al., 2002).

In Nepal, HS has been reported from all parts of the country throughout the year. A conservative estimate shows that HS causes an annual loss of NRs. 40.8 million to Nepalese livestock sector (Lohani & Rasali, 1992). Economically, HS is regarded as one of the important diseases of farm animals and is a serious cause of concern for farmers as the infected animals succumb to death. *Pasturella multocida* of serotype B: 2 were isolated from investigated outbreaks (Joshi and Joshi, 2003).

HS vaccine is produced in the country and also imported from foreign countries. Although routine HS vaccination is done in the dairy pockets in the crossbred animals however the coverage of vaccination in the local animals are at very low level. The protective immunity of locally produced alum precipitated vaccine was found to be for three months (Joshi and Joshi, 2003). The strategic period for vaccination would be at the beginning of the summer and autumn seasons and oil adjuvant vaccine would be better than alum precipitated vaccine for preventive vaccination due to its longer immunity. Since 2004 the Central Biological Production Laboratory (CBPL) in the country has started to produce HS aerosol vaccine as well.

Pakistan, being a sub-tropical region of South Asia has an early summer dry hot environment and late summer is hot and humid. Such conditions favor the explosive occurrence of HS. The disease is primarily seasonal in nature; occurring primarily during the rainy seasons of the year, and victims are only cattle and buffaloes. The clinical course of the disease is generally 1-2 days. The clinical signs of HS include high temperature, salivation, swelling of the throat and difficulty in breathing which could result in death. Successful treatment is reported if antibiotics are given at the initial stages of the disease (Khan et al., 2011).

The first major confirmed epizootic of hemorrhagic septicemia in Sri Lanka was recorded in 1955-56 (Perumal Pillai and Thambiayah, 1957). It has been postulated that the disease may have been present in certain pockets and that has not been confirmed by laboratory tests before that. The change in agricultural activity coupled with immediate increase in buffalo and cattle population prior to 1955 led to the major epizootic (Dissanayake, 1957., PerumalPillai and Thambiayah, 1957). Since then, it has been noticed a definite pattern of incidence of HS. The disease became enzootic in dry zone where the herds are in large sizes. In small area at the central hills HS was rear and outbreaks occur occasionally. Elsewhere sporadic outbreaks occur occasionally. The mortality among buffaloes was significantly higher to cattle (De Alwis, 1981). It has been observed the seasonal pattern of incidence commencing from August and reaching a peak in October while the seasonal monsoon rains started in September and reached a peak in November (De Alwis, 1980). The veterinary research institute has been producing two types of vaccines viz. Oil Adjuvant Vaccine (OAV) and Alum Precipitated Vaccine (APV) to control HS in Sri Lanka. Prophylactic vaccination programme is being carried out through regional veterinary surgeons prior to rainy season annually. It is very glad to declare that HS has not been reported after year 2004 due to successful implementation of vaccination programme in the country (DAPH, Administration Reports, 1997-2010).The vaccination programme is being continued yet.

2.5 Classical Swine Fever (CSV)

Classical Swine Fever (CSF), also known as hog cholera, is a contagious viral disease of pigs. The causative virus is a member of the genus *Pestivirus* of the family *Flaviviridae*, and

is closely related to the viruses of bovine viral diarrhoea and Border disease virus. There is only one serotype of CSF virus.

Pigs and wild boar are the only natural reservoir of Classical Swine Fever virus. All feral and wild pigs, including European wild boar, are susceptible. The disease occurs in much of Asia, Central and South America, and parts of Europe and Africa. Many countries are free of the disease.

Severity of the disease is related to strain of virus involved, age of pig and immune status of herd. The disease has acute and chronic forms, and virulence varies from severe with high mortality to mild or even subclinical. Acute disease is still the prevalent form in younger animals with sub-acute and chronic forms often observed in older animals. The severe acute form is characterized by fever, in appetence, and depression with death at 10-20 days after infection. In chronic disease, pigs often survive >30 days. After an initial acute febrile phase, pigs may show apparent recovery but then relapse, with anorexia, depression, fever, and progressive loss of condition.

Vaccination with modified live virus strains is effective in preventing losses in countries where Classical Swine Fever is enzootic, but is unlikely, on its own, to eliminate infection entirely. In countries which are free of disease, or where eradication is in progress, vaccination is normally prohibited.

Swine population is very small in Bangladesh and mostly limited to certain regions of the country. There has been no report on the outbreak of Classical Swine Fever in Bangladesh. However, the swine population in Bangladesh is at risk of incursion of Classical Swine Fever as the disease is prevalent in neighboring countries.

In Bhutan CSF is endemic in various parts of the country and mortality reported. Local production of lapinised Swine fever vaccine was initiated since early nineties, but due to practical field difficulties, the vaccination at the farm household level has been limited. At present, the immunization programme is mostly restricted to government piggery farms although this particular vaccination has been included in the national vaccination programmes.

The disease is mainly affecting the exotic breeds and few local breeds of pigs in Bhutan. But there is no evidence that species other than the domestic pig and the wild boar are susceptible to the infection under natural condition. In Bhutan before 1974, it was endemic for many years causing heavy mortalities and economic losses to the rural communities. Since 1974, vaccination was launched as a control programme. There are more than 5-10 outbreaks reported annually in the country and efforts are taken to control and contain the outbreak. As per the serological survey done from the pig population in Bhutan only 5.8% are positive to the disease. The positivity of the disease in the west and central regions are 4.4% and 26% respectively. The prevalence in older animals (2 years and older) is 11% and 5% in younger animals.

In Nepal pig population is more than 1.04 million which produces about 16992 metric tons of pork per year (MOAC, 2009). There are tremendous scopes of pig farming in Nepal, many factors are however, responsible to hinder the sustainability of pig industry. Among them infectious diseases in pigs particularly CSF is a major constraint to pig production system in Nepal. CSF has been in existence in the country for a long time and has reached

endemic status. Every year outbreaks of CSF have been reported in one or other parts of the country. CSF is identified as causing substantial deaths in pigs. Many outbreaks in the field go unreported making it difficult to know the actual status of the disease. In 2001-2009, a total of 203 outbreaks of CSF were reported in the country (VEC, 2009). Although CSF vaccine is produced in the country, the coverage of vaccination is too small to result in reduced outbreaks. Major reason for the frequent outbreaks of CSF in pigs is due to irregular or not vaccinating the pigs against this disease. This might be the lack of awareness among the pig farmers. So far there is no national CSF control programme in the country.

Classical Swine Fever was introduced to Sri Lanka in 1984. Since then the disease has been reported mainly in Western and North Western provinces where the swine population is comparatively high. An imported vaccine is used by the Department of Animal Production and Health to control the disease. The last substantial outbreak was reported in 1997 from four provinces viz. North Western Province, North Central province, Central province and Western province. A confined outbreak was found in Nucleus herd at government farm in 1998 and 1999. It has not been reported CSF after year 2000 in any area of Sri Lanka. Swine farmers are using imported vaccine which is available at the market at present to prevent the entry of the disease to their herds (DAPH, Administration Reports, 1997-2000).

3. PREVALENCE AND FATALITY OF TRANS-BOUNDARY ANIMAL DISEASES

3.1 Foot and Mouth Disease (FMD)

Foot and Mouth Disease is considered endemic in Bangladesh. However, no data is available on countrywide prevalence of FMD. The Epidemiology Unit of DLS receives passive surveillance data on disease events from each Upazila (Sub-district) Livestock Office. The total number of FMD cases reported to or treated at Upazila Veterinary Hospitals in each division during 2010 and 2011 (till August 2011) is presented in table 2.

Table 2: Number of FMD cases reported to or treated at Upazila Veterinary Hospitals in different Divisions of Bangladesh

Division	2010	2011 (till August)
Barisal	2,417	13,789
Chittagong	14,307	13,867
Dhaka	13,475	24,313
Khulna	5,085	7,639
Rajshahi	15,166	13,978
Rangpur	5,214	10,356
Sylhet	3,517	3,614
Total	**59,181**	**87,556**

A total of 59,181 and 87,556 cases were recorded in 2010 and 2011 respectively. Apparently, there has been a rise in the number FMD cases in 2011, but it remains to be confirmed if this was due to increased number of outbreaks or improvement in recording because of recent training and sensitization. It should be taken into consideration that the actual number of FMD outbreaks in Bangladesh would be much higher. In endemic settings, reporting of FMD by the farmers is not mandatory; hence Upazila Veterinary Hospitals records only the cases that come to hospital for treatment. Very limited active surveillance or outbreak investigation data is available. Howlader et al., (2004) investigated FMD outbreaks in 1999 at Baghabari milk-shed area of Sirajganj district. They observed 63%, 51% and 48% incidence of FMD in a population of 4,845 cattle, 938 sheep/goats and 329 buffaloes, respectively. Among the affected cattle 1,287 were calves, of which 125 (9.71%) died. High incidence of the disease specially during Eidul Azha is mainly due to trans-boundary movement of the animals.

Virological surveillance and serotyping of FMD viruses are performed only casually in Bangladesh. Based on Pirbright Laboratory data and other published information Loth et al., (2011) presented a temporal graphical distribution of FMDV serotypes isolated since 1958 in Bangladesh (Figure 5).

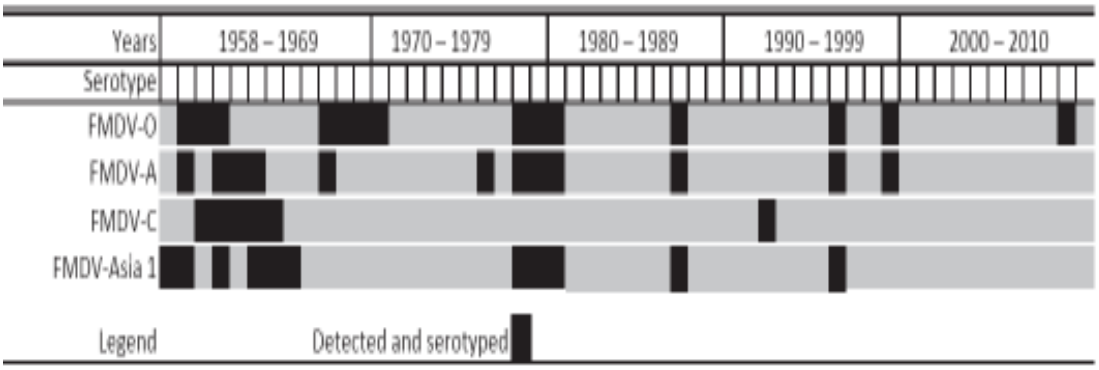


Figure 5**:** FMD virus serotypes isolated in Bangladesh by year (Loth et al., 2011)

The serotypes of FMD virus in Bhutan are O, A, C and Asia 1. As per the sero-typying done at World Reference laboratory at Pirbright, UK during 2002, out of a total of 20 samples submitted for the typing, 4 samples revealed “Asian 1 type”, 10 showed type “O” and 6 samples did not reveal any virus. This shows that the most predominant type of FMD in Bhutan is “O” type. During 2001-02, Asia 1 was also involved in the outbreak of FMD in the country. As per the review on the disease outbreak from 2005 to 2010, a total of 75 outbreaks recorded with an average of 12.5 outbreaks per year involving the risk livestock population of 71911 animals with a total of 1053 cases. The number outbreaks ranges from 5 to 29 per year with an average of 12.5 per year for the last 6 years w. e. f. 2005 to 2010 as shown in figure 6.

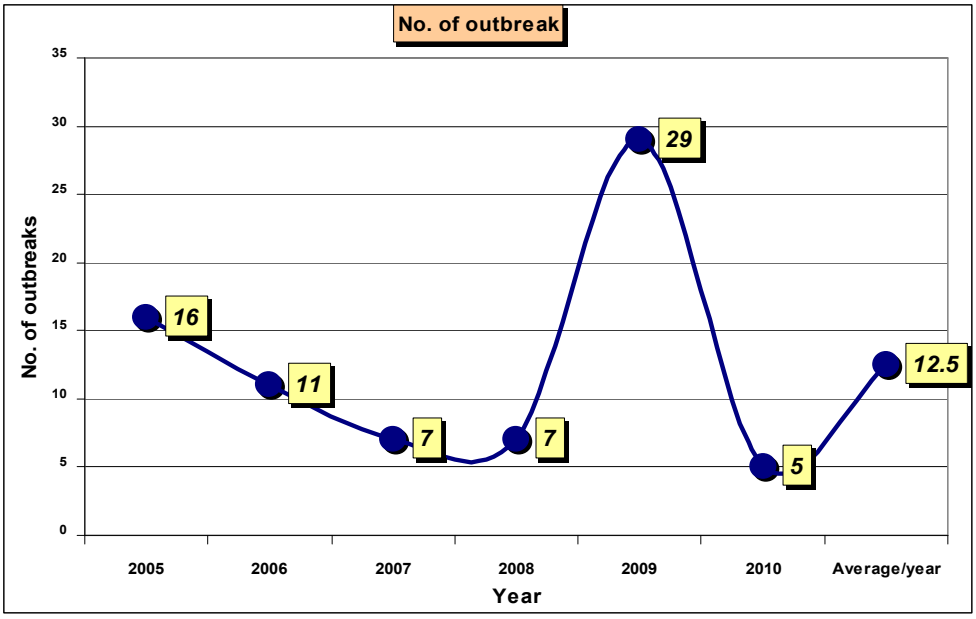


Figure 6: Number of FMD outbreaks in Bhutan since 2005 - 2010

The case fatality rate ranges from 0% to 6.67% with an average of 0.67% annually w. e. f. 2005 to 2010 with more than 95% affections in cattle followed by pigs and goats as shown in figure 7.

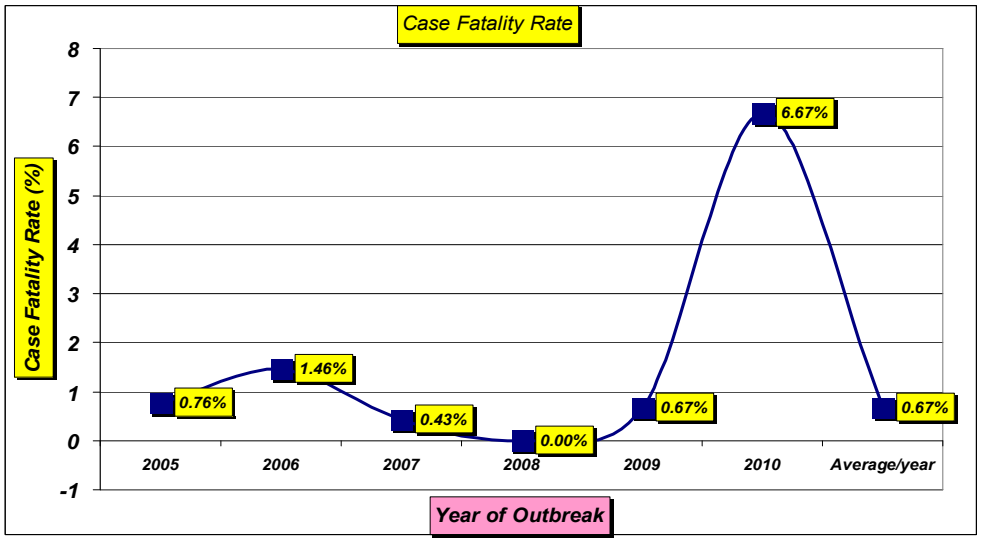


Figure 7: Case fatality rate with FMD for different years

The morbidity rate ranges from 0.77% to 48.43% with an average of 8.79% from the last 6 years from 2005 to 2010 with maximum rate during 2009 during which the strain of the virus was very severe compared to other years as shown in figure 4. But the outbreaks are more in winter and summer as shown in figure 8.

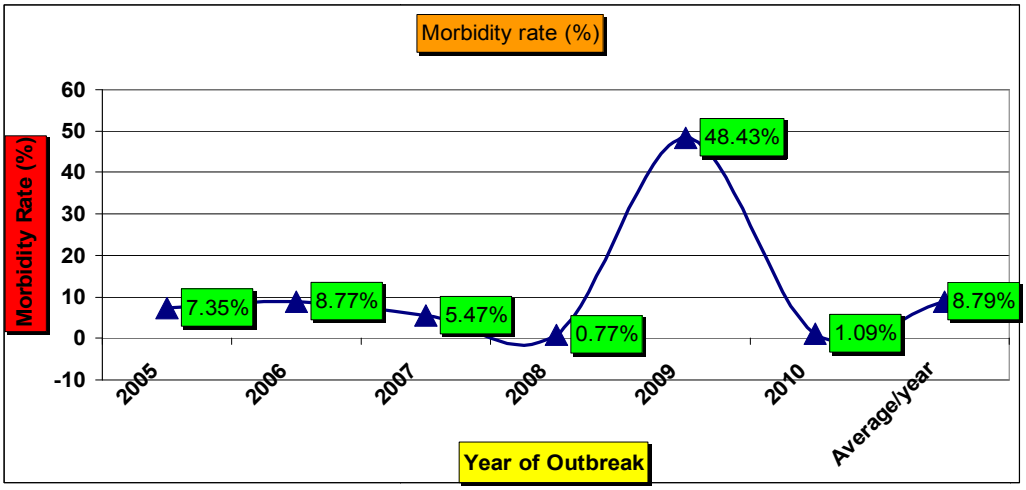


Figure 8: Morbidity rate with FMD from 2005 to 2010

The most predominant FMD serotype found in Bhutan was "O" till 2002, which accounts for more than 99% among the different virus type. As per this findings, Bhutan embarked on monovalent O prophylaxis vaccination programme throughout the country during 2001 and 2002 which lead to the emergence of other virus strains from 2003 and so again switched on to tetravalent FMD vaccination comprising of O, A, C and Asia 1 for prophylactic purpose.

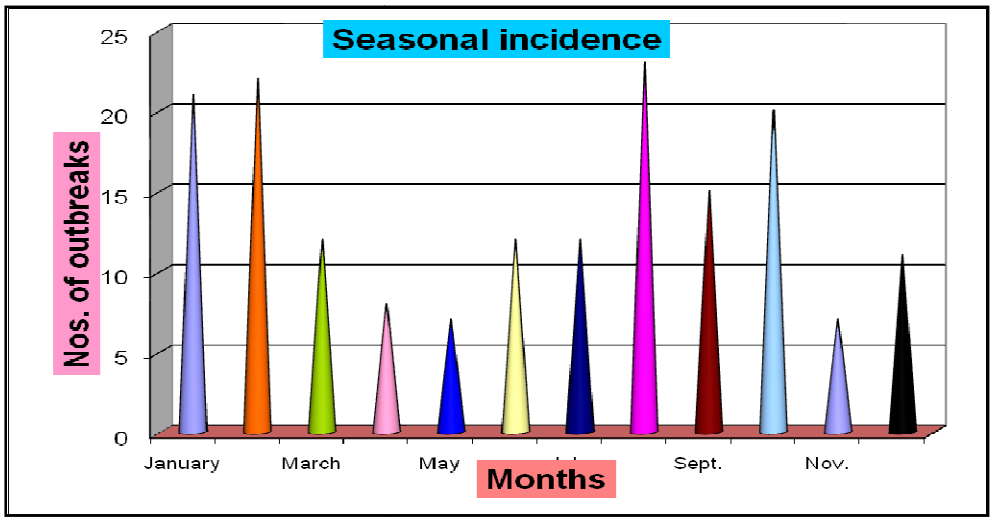


Figure 9: Seasonal distribution of FMD outbreak in Bhutan

In India since 2006-07, occurrence and severity of the disease have significantly reduced in areas under regular vaccination programme. Looking to the last five years data (2006-11), serotype O was responsible for around 80% outbreaks/cases, while Asia 1 and A caused 12% and 8% outbreaks/cases, respectively. Maximum proportions (43%) of the outbreaks/cases occurred in the eastern region (Bihar, Orissa, West Bengal and Jharkhand) followed by 31.5% in the southern region (Tamilnadu, Kerala, Karnataka and Andhra Pradesh), while

north eastern region (Assam, Manipur, Meghalaya, Mizoram, Arunachal Pradesh, Sikkim and Tripura) recorded 11.6% of the total incidence, and it was low (4%) in northern (Uttar Pradesh, Punjab, Haryana, Himachal Pradesh, Jammu& Kashmir and Uttarakhand), Western (4.4%) (States of Rajasthan, Gujarat and Maharashtra) and central region (5%) (Madhya Pradesh and Chhattisgarh).

In India the disease occurs in all species of susceptible livestock. The population of pigs in India is low and present mainly in north eastern states, the rest of the animals are scattered all across the country. Due to relatively lesser number of animals (Pigs) in several states, the incidence of FMD is also low in pigs. In susceptible populations, morbidity can be up to 100%. Mortality is generally less than 1% but can be up to 40% in younger animals. In many occasions, FMD infection in animals predispose it to secondary bacterial infection mainly Haemorrhagic Septicaemia (HS) and may result in fatality.

In Nepal on an average from 2001 to 2009, 937outbreaks per year have been reported in the country, being high in central region followed by mid-western, far-western, western and eastern development regions (VEC, 2009). Time and again, outbreaks of FMD have been reported throughout the country irrespective of season and altitude. However, peak level of occurrence is noticed during monsoon (May-August) and post-monsoon (Oct-Nov) period. High occurrence during monsoon is due to excessive movement of animals for agricultural activities. Uncontrolled animal movement within the country and unrestricted importation of animals (goat, sheep and buffaloes) from neighboring countries pose additional threat to spread of FMD.

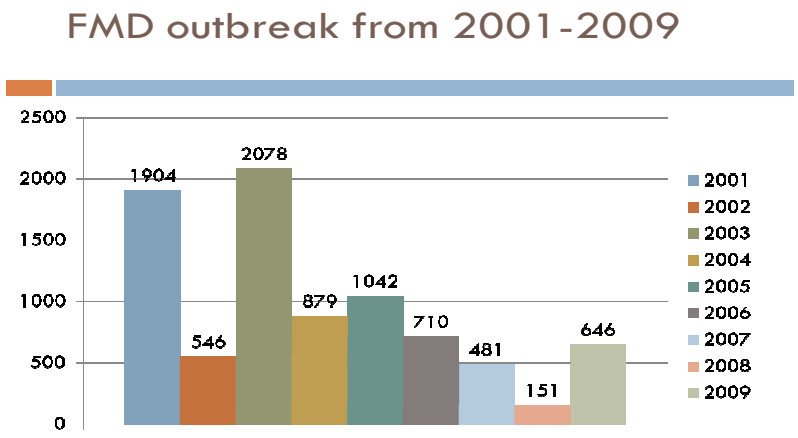


Figure 10: Number of outbreaks of FMD from 2001-2009 in Nepal

The outbreak pattern and case fatality rate of FMD from 2001 to 2010 is presented in table 3. Year-wise trend of FMD shows that the highest number of outbreaks was recorded in the year 2003 with more than 2000 outbreaks throughout the country followed by 1904 outbreaks in 2001. But in terms of number of animals affected, year 2009 was highest with more than 80,000 animals affected with only 646 outbreaks compared to around 57,000 in 2003 and around 51,000 in 2001. The emergence of Pan Asia strain in 2003 and Pan Asia 2 strain in 2009 might be the cause for higher number of animal death in the years 2003 and 2009 (VEC, 2011).

Table 3: FMD Outbreaks from 2001 to 2010 in Nepal

Year	No. of Outbreak	No. of Cases	No. of Death	Case Fatality %
2001	1904	51003	861	1.7
2002	546	7261	118	1.6
2003	2048	57076	1265	2.2
2004	179	19525	202	1.0
2005	1042	19949	461	2.3
2006	710	17389	105	0.6
2007	481	13590	145	1.0
2008	151	5278	109	2.06
2009	646	80357	1644	2.04
2010	294	16478	246	1.49

Source: VEC Annual Reports 2001-2010

Month-wise pattern of FMD revealed that this disease is prevalent throughout the year. However, occurrence of the disease was found to be slightly high in the month of May and June and again during November and December. The greater animal movement owing to the agricultural activities during those months might be the reason for the spread of the disease (VEC, 2010).

Spatial distribution of FMD during 2000-2009 shows that 74 districts were affected with FMD. Panchthar district has not reported the FMD since 1998. Fifty seven districts had reported the FMD outbreak in 2009 alone. The lowest number of districts affected during the last 10 years was 21 districts in 2008. Highest number of districts affected was 63 in 2003 when Pan Asia strain of 'O' serotype of FMD was involved in the outbreak (VEC, 2010).

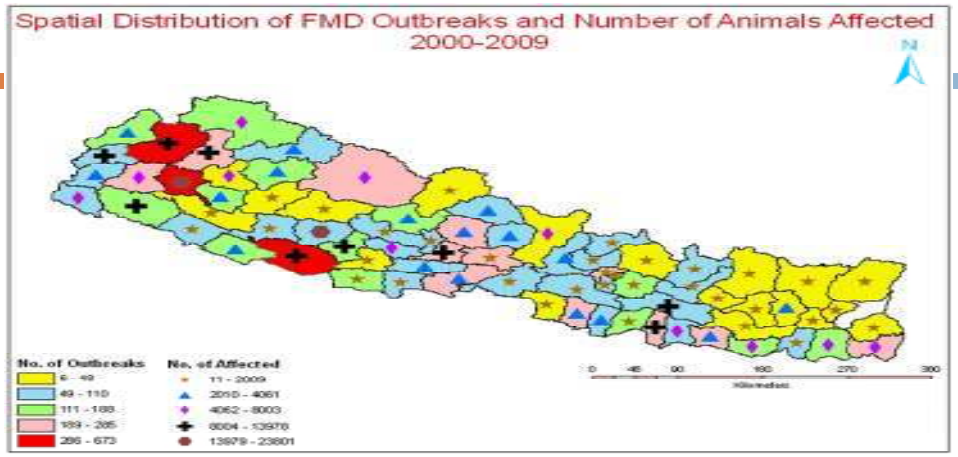


Figure 11: Spatial distribution of FMD outbreaks from 2000-2009 in Nepal

The data generated by Participatory Disease Surveillance (PDS) indicate FMD prevalence in all the provinces/regions of Pakistan. A total of 1286 FMD outbreaks were recorded during 2002-05 (Zahur et al., 2006), most of these were reported by the livestock farmers in Punjab followed by those in the provinces of Sindh, Khyber Pakhtoon Khawa, Balochistan; Azad

Jammu & Kashmir and Gilgit-Baltistan (Figure-12). FMD incidence corresponds with the animal density in the study areas. The highest FMD incidence of 70% was recorded in district Chagai in Balochistan province having its borders with Iran and Afghanistan, suggesting the role of cross border livestock movement in the spread of FMD amongst these countries.

The FMD has been ranked at top amongst the infectious diseases of economic importance in central Punjab and the disease morbidity reported in buffaloes and cattle has been 10.3% and 9.9%, respectively, and mortality has been only 1% (Awan et al., 2009). A survey during 2003-04, conducted in Landli Cattle Colony, Karachi, Sindh province, which houses over 0.2 million buffaloes, indicates the cumulative morbidity, mortality and case fatality rate of 3.6 %, 0.2 % and 11.2 %, respectively. Around 5.6 % of the diseased animals were sold to butchers (distress sale). At 74.3 % of the farms, new animals were introduced with the induction rate of 7.2 % at farms per month and at 77.1 % farms the newly inducted animals were vaccinated against FMD. No quarantine measures were observed for the newly introduced animals. Only 8.6% of the surveyed farms had the history of disease at nearby farms suggesting that disease is endemic in the Landhi Colony. Some field activities were conducted during 2009-10 under the TAD project of FAO-GTF. Here, serosurveillance was conducted in 80 randomly selected villages all over the country, where a total of 3840 samples were collected. In addition to this 1140 blood samples were also collected from abattoirs in Lahore, Karachi, Sakhur, and Gilgit districts. The FMD prevalence percentage in samples from Lahore, Karachi, Sakhur, and Gilgit was 80, 96, 19 and 42 percent, respectively. Of the 29 samples analyzed by FMD World Reference Lab, Weybridge, UK; 17 samples were found positive for serotype A, 02 for Asia-1, and 01 for serotype O (Ehtisham and Hussain, 2011- personal communication).

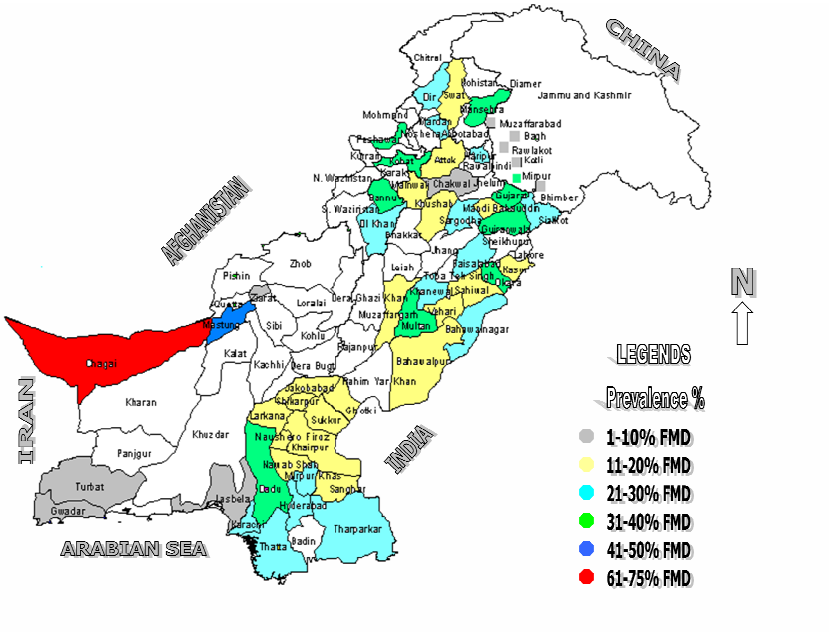


Figure 12: Prevalence of FMD in Pakistan (Participatory Disease Surveillance 2002-2005)

In Sri Lanka the FMD prevalence was recorded as 1.01%, 0.1% and 0.39% in 1997, 1998 and 1999 respectively. The prevalence was notably high in dry zone areas and in extensively managed large herd sizes. The case fatality rates were 0.025%, 0.001% and 0.003% in 1997, 1998 and 1999 respectively (Hettiarachchi, 2010).

The prevalence rates and the case fatality rates are depicted in table 04 from 2000-2010 based on data available in DAPH administration reports. It is noticed that the rate of prevalence has ranged from 0.00011 (2006) to 0.024 while case fatality rate was ranged from 1% to 9.8 % for given period. The read-through the data of prevalence rate and case fatality rate of FMD for last 11 years revealed that there is no definite trend (increasing or decreasing). A wave of cases for every four years pattern is observable in these figures.

Table 4: Prevalence and Case fatality Rates of FMD for last 10 years

Year	Cases	Prevalence rate	Deaths	Case fatality rate
2000	2109	**0.00141**	208	**0.09862**
2001	3627	**0.00242**	94	**0.02592**
2002	2836	**0.00189**	89	**0.03138**
2003	35590	**0.02373**	1413	**0.03970**
2004	3453	**0.00230**	126	**0.03649**
2005	450	**0.00030**	3	**0.00667**
2006	163	**0.00011**	2	**0.01227**
2007	341	**0.00023**	13	**0.03812**
2008	1926	**0.00128**	89	**0.04621**
2009	176	**0.00012**	2	**0.01136**
2010	930	**0.00058**	39	**0.04194**

Source: Annual Report, Department of Animal Production and Health (2000 -2010)

3.2 Peste des Petits Ruminant (PPR)

PPR is endemic in Bangladesh. The total number of PPR cases reported to or treated at Upazila Veterinary Hospitals in each division during 2010 and 2011 (till August 2011) is presented in table 5.

Table 5: Number of PPR cases reported to or treated at Upazila Veterinary Hospitals in different Divisions of Bangladesh

Division	2010	2011 (till August)
Barisal	2,212	3,742
Chittagong	6,264	7,420
Dhaka	15,273	15,023
Khulna	13,557	18,161
Rajshahi	28,326	23,975
Rangpur	16,211	15,897
Sylhet	2,244	1,068
Total	**84,087**	**85,286**

A total of 84,087 cases were recorded in 2010 and 85,286 cases in the first 8 months of 2011. Like FMD, there is also an increase in the reporting of PPR in 2011. This figure is certainly much lower than the actual incidence in the field. Sarker and Islam (2011) reported 20.51% prevalence of PPR among 627 goats examined at a veterinary clinic in Rajshahi district. Bhuiyan (2011) investigated 28 outbreaks of PPR in different parts of the country and recorded overall morbidity of 75% and mortality 59%. Sayed et al., (2005) conducted a study on 250 goat farms (1,264 goats) from 5 districts and observed overall 24% morbidity and 11% mortality; PPR accounted for 84% of total mortality. Molecular characterization of Bangladeshi isolates of PPR virus revels that along with other Asian isolates, Bangladeshi ones also belong to genetic lineage IV (Bhuiyan, 2011).

In Bhutan since the impounding of goats since 2006-07, a total of 83 goats were impounded as Tsedar by the project management out of which 43 died with signs of pneumonia. Since the introduction of 4 goats on 13 April 2010 from Tsimalakha village and 5 goats from Phuentsholing on 1 June 2010, the main cause of outbreak could be due to the change in weather condition or through these newly introduced goats whose origin are from Tsimalakha and across the border respectively.

PPR is a highly contagious and infectious viral disease of domestic and wild small ruminants in Nepal. The most devastating disease PPR entered in Nepal in the year 1995. The adverse impact is increasingly serious causing high morbidity and mortality in small ruminants. In last 9 years (2001-2009) there were 2547 outbreaks of PPR in the country (VEC, 2009).

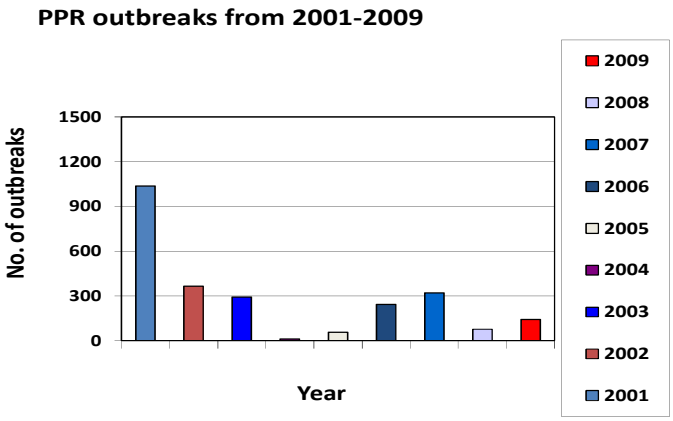


Figure 13**:** PPR outbreaks pattern from 2001-2009 in Nepal

The PPR virus activity has been comprehensively monitored through recording of PPR outbreaks in different provinces/ regions of the Pakistan during 2005-7 (Zahur, 2010). A total of sixty two outbreaks were investigated during this period and the involvement of PPRV virus in these outbreaks was reflected through necropsy findings, capture ELISA (cELISA), virus isolation and through the presence of virus specific antibodies using cELISA. Further, the spatial pattern of PPR outbreaks during 2005-07 was mapped in the country. The overall cumulative morbidity and mortality were estimated as 69.18% and 21.79%, respectively, and the case fatality rate was recorded at 31.49%.

Table 6: Epidemiological Investigation of PPR outbreaks during 2005-7 in Pakistan

Species	Parameter	Mean	Lowest*	Highest*
Goat	Morbidity	76.28	75.44	77.11
	Mortality	23.90	22.79	25.01
	Case fatality	31.22	29.84	32.60
Sheep	Morbidity	51.54	49.53	52.57
	Mortality	16.73	15.23	18.23
	Case fatality	32.46	29.83	35.09
Overall	Morbidity	69.18	68.17	69.69
	Mortality	21.79	20.88	22.69
	Case Fatality	31.49	30.27	32.71

*Lower and upper 95% confidence intervals

{Source: Zahoor et al., 2008; Rev. Sci. tech. OIE, 27: 877-884}

During this period a total of 2798 sera samples (n=1979 from goats; n=819 from sheep) were collected from randomly selected 152 villages located in 27 districts of Pakistan. The overall PPR sero-prevalence was estimated at 48.45%; the sero-prevalence in goats was 52.89% and in sheep it was 37.72%. AJK had the highest overall sero-prevalence (55.17%) and Punjab province had the lowest prevalence (44.56%). These findings indicate that virulent PPR virus is circulating in small ruminant's population of Pakistan and vaccination coverage of 53% in goats and 38% in sheep is required to break the transmission cycle of PPR virus.

PPR is not a notifiable disease in Sri Lanka

3.3 Highly Pathogenic Avian Influenza (HPAI)

Highly pathogenic avian influenza is notifiable both nationally and internationally. Since February 2007 a total of 519 events of HPAI outbreaks (as of 14 November 2011) have reported by DLS to OIE. Division-wise distribution of the outbreaks is presented in table 7. Considering a certain level of inevitable under reporting, the total number of actual outbreaks could be even higher.

Table 7: Division-wise distribution of HPAI outbreaks in Bangladesh during 2007 to 2011

Division	2007	2008	2009	2010	2011	Total
Barisal	0	14	1	0	16	31
Chittagong	2	33	9	11	25	80
Dhaka	33	108	11	9	77	238
Khulna	6	15	0	0	10	31
Rajshahi	27	52	10	10	27	126
Sylhet	0	3	0	0	1	4
Rangpur	0	0	0	0	9	9
Total	**68**	**225**	**31**	**30**	**165**	**519**

The spatial distribution of HPAI is shown in figure 14. Commercial poultry farm density map is also shown side by side. It appears that the commercial poultry farm density correlates with the intensity of HPAI outbreaks. However, involvement of other factors like poultry market chain and related activities cannot be ruled out.

The temporal distribution of HPAI outbreaks over the last 5 years is presented in figure 14**.** A seasonal pattern of HPAI outbreaks is noticed, the peak appears to be in the winter and spring every year. Apparently, a cool and dusty environment and the stress from the change of weather favour HPAI spread. The highest number of outbreaks was recorded in early 2008. Relatively smaller peaks were observed in 2009 and 2010. However, increased number of outbreaks was recorded again in 2011. It remains to be investigated if the increase in the number of outbreaks in 2011 was due to increased reporting following enhancement of compensation or due to introduction of more virulent new strains of virus. It may be mentioned that viruses of clade 2.3.2.1 and clade 2.3.4 have newly entered into Bangladesh in 2011 in addition to the previously circulating clade 2.2 viruses (Islam et al., 2011).

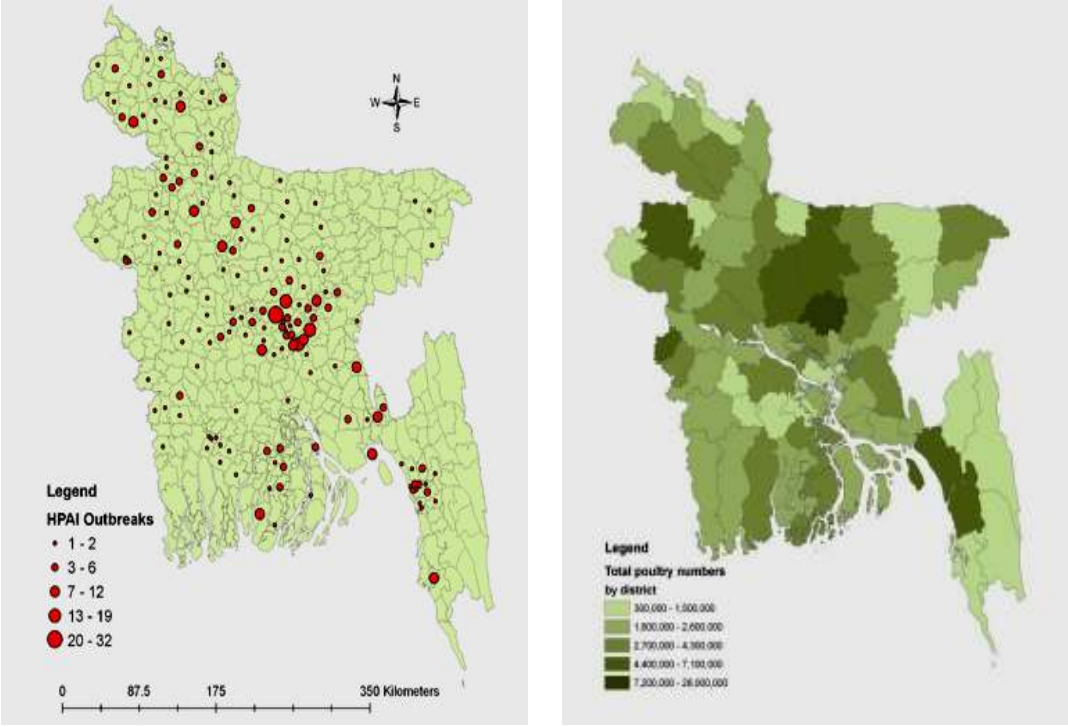
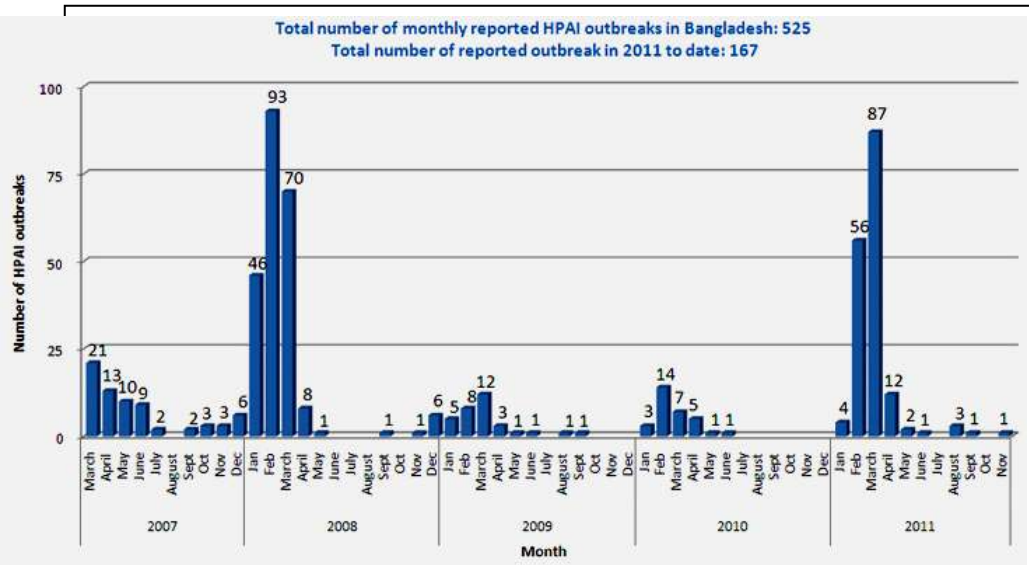


Figure 14: Spatial distribution of HPAI outbreaks in Bangladesh during 2007 – 2011 (Left) and poultry density distribution in different districts of Bangladesh (Right)



In Bhutan on 14 February 2010 the first poultry died in Rinchending with Bird Flu disease which was confirmed on 22 February 2010 from NIAH Bangkok and IVRI Bhopal. It is very difficult to exactly come up with the authentic source of Bird Flu outbreak in Bhutan. The trace back study is underway but may not come with the clear information on the source of outbreak although the illegal movement of poultry from across the border through Bangay Bazaar (Pasakha-Tooribari) and the Tsedar cock which was first tested positive to Bird Flu at Rinchending and the poultry at Pasakha Baazar all of which may be exposed through the illegal poultry import into the country. The chances of the backyard poultry in the remote and terrain land locked premises with no waterfowls and migratory birds are very minimal especially in the locations confirmed for Bird Flu outbreak at the latter outbreak epicenters.

The first outbreak of HPAI H5N1 in Nepal was reported in January 2009 in Jhapa district which was followed by a second outbreak in the same district in February 2009. In 2010 the HPAI H5N1 outbreaks were reported from 7 districts with a total number of 8 outbreaks.

Table 8: Number of outbreaks of HPAI in 2009 & 2010 at Nepal

Year	No. of Outbreak	No. of Cases	No. of Death	Case Fatality %
2009	2	164	164	100
2010	8	1114	1114	100

Source: VEC, 2011

The poultry products in Pakistan contribute 35% of the livestock internal net product of the country. It has become second biggest industry after cotton, with an annual turn-over of US $ 2 billion. Since 1995, Pakistan has been affected by five epidemic waves of highly pathogenic avian influenza (HPAI) caused by viruses of H7 and H5 subtypes. The first outbreak appeared in 1995, when HPAI virus of H7N3 subtype occurred in an isolated high density broiler breeder production area in northern part of the country (Naeem and Hussain,

1995). In this area 60% of the flocks were affected by HPAI H7N3 with mortality ranged between 60 to 80%, resulting in overall losses of USD 4 million. The next epidemic of HPAI H7N3 occurred in 2003-04 which primarily affected commercial layers and broiler-breeders (Naeem et al., 2007). During 2003-04, Pakistan was affected by a devastating epidemic of HPAI, caused by H7N3 that originated from the mutation of an LPAI virus of the same subtype. The LPAI virus was first isolated in the south in April, 2003 in the coastal town of Karachi, where 70% of the country's commercial layers are raised. Some of the flocks that were initially affected by LPAI of subtype H7N3 showed a 70% decline in production and 20% mortality. In November, 2003 the HPAI subtype H7N3 emerged in the Karachi area, with a sudden increase in mortality at some farms. The virus was confirmed as HPAI with IVPI index of 2.8. At some places, low path avian influenza virus subtype H9N2 was also isolated from the same flocks. During next few weeks, the disease had spread throughout the commercial layer estates within a radius of 80 kilometers. This resulted in heavy mortality among the affected flocks ranging between 70-80%. The disease later spread to northern part of the country where 80% of the broiler-breeder stocks of poultry were reared. Total losses to the tune of USD 22 million were estimated during 2 year period of H7N3 circulation. Later on during 2006, 2007 and 2008, poultry in Pakistan heavily suffered due to multiple outbreaks caused by HPAI H5N1 virus.

During 2006-08, 51 outbreaks of HPAI H5N1 were recorded in poultry, only in the provinces of Khyber Pakhtoon Khwah, Sindh and Punjab where whole the flocks were killed and destroyed.

3.4 Haemorrhagic Septicemia

The total number of HS cases reported to or treated at Upazila Veterinary Hospitals in each division during 2010 and 2011 (till August 2011) is presented in table 9.

Table 9: Number of HS cases reported to or treated at Upazila Veterinary Hospitals in different Divisions of Bangladesh

Division	2010	2011 (till August)
Barisal	92	569
Chittagong	325	669
Dhaka	1058	575
Khulna	503	464
Rajshahi	478	357
Rangpur	866	550
Sylhet	115	23
Total	**3,437**	**3,207**

A total of 3,443 cases were recorded in 2010 and 3,207 cases in the first 8 months of 2011. The actual incidence of HS is certainly much higher than the data recorded in this passive surveillance. There is no report on active surveillance of HS in Bangladesh to compare with.

In Bhutan the disease was once found very commonly in German Angora breeds in the national Sheep Breeding Center in Bumthang but after the closure of the rabbit farm, no

cases could be detected in the field rabbits. The disease has also been recorded in sheep population in the farm. Therefore, sheep and goats are also susceptible to the disease. The disease is also commonly seen in pigs but there had been very few confirmed cases recorded so far in the country. The profile on livestock diseases shows that 1 to 6 cases of HS outbreak are recorded every year in the country.

In endemic regions, outbreaks occur when healthy carriers are introduced into a herd. Most of the adult animals develop some immunity. The clinical cases normally occur in young animals between the ages of 6 months and 2 years and also massive epizootics sometimes occur with HS. The case fatality rate is nearly 100% unless the animal is treated at very early stage. Buffaloes are thought to be more susceptible to illness than cattle, with higher morbidity and mortality rates. According to Department of Animal Husbandry, Dairying and Fisheries, Government of India data 2009, the number of outbreaks of Haemorrhagic Septicaemia is 296 affecting a total of 3729 animals causing 1595 deaths (Anonymous 2011).

In Nepal, HS has been reported from all parts of the country throughout the year. A conservative estimate shows that HS causes an annual loss of NRs. 40.8 million to Nepalese livestock sector (Lohani & Rasali, 1992). Economically, HS is regarded as one of the important diseases of farm livestock and is a serious cause of concern for farmers as the infected animals succumb to death. *Pasturella multocida* of serotype B: 2 was isolated from investigated outbreaks (Joshi and Joshi, 2003)

Table 10: Number of outbreaks of HS from 2001-2010

Year	No. of Outbreak	No. of Cases	No. of Death	Case Fatality %
2001	1041	9949	1297	13.03
2002	878	7223	857	11.86
2003	768	4321	557	12.89
2004	665	11692	487	4.16
2005	532	5337	457	8.53
2006	668	2492	310	12.43
2007	442	2784	577	20.72
2008	335	2121	205	9.66
2009	163	1170	137	11.7
2010	272	3002	139	4.63

Source: VEC, Annual Reports 2001-2010

It can be seen in table 10 that from 2001 to 2010 the highest number of outbreak was in the year 2001. The case fatality percentage ranges from lowest 4.16 in the year 2004 where as in the year 2007 the case fatality rate was 20.72%.

Month-wise pattern of HS shows that this disease is prevalent throughout the year. However, there are more instances of the disease in the months of June to August which coincides with the rainy months of Nepal (VEC, 2011).

In Pakistan, HS is endemic in certain areas and it is considered as disease of high economic value as it causes colossal losses to the livestock industry. Only in Punjab, yearly losses due

to HS have been estimated to be over USD 27 million. In Punjab province the prevalence of HS ranged between 5.37% in districts with scattered cattle population to 49% in districts with dense population of cattle. In KPK province, the highest HS prevalence of 22.25 % has been recorded in district Mansehra and the lowest prevalence of 1.94 % in Bajaur Agency. In Sindh province the highest HS prevalence of 29.97% and lowest prevalence of 2.05% were reported from the districts of Larkana and Tharparker, respectively. In AJK area the highest HS prevalence of 12.86% was noted in district Bhimber and the lowest prevalence of 8.40 % was in district Rawalakot. In Islamabad Capital Territory HS prevalence was 16.2%. The Participatory Disease Surveillance (PDS) studies did not report any HS cases in Baluchistan province, having very scanty cattle population (Farooq et al., 2007).

Various factors like animal husbandry practices, weather stress, poor host immunity, close herding and wetness in the animal surroundings affect the rate of HS morbidity. HS is generally known to cause a morbidity range of 6 to 90% among adult buffaloes to calves and between 1-2% among adult cattle to calves and a mortality rate of 6 to 22 % among adult buffaloes to buffalo calves, respectively. However, the mortality in sick cattle varies between 2.5 to 5%, among adult to young animal, respectively. In endemic areas, from 10 to 50 percent of infected cattle or buffaloes acquire solid immunity through field exposure or subclinical infection. Most of the animals that develop clinical signs usually die.

In Sri Lanka HS was reported in cattle and buffalo herds. The variation in mortality was observed by De Alwis (1980) in infections in cattle and buffalo. It was noticed that the mortality is high in buffaloes compared to cattle. It has been revealed that morality in buffaloes is three times higher as in cattle and the difference is more marked in non enzootic areas (De Alwis, 1981). The incidence of the disease is high in young animals (Anonymous, 1979). Further, it has been observed that the herd size had a significant effect on incidences of HS. The larger the herd size the greater the chance of HS epizootic. When outbreak occurred, the mortality is higher in small herds than in large herds (De Alwis, 1981).

Table 11. Prevalence and Case fatality Rates of HS

Year	Cases	Prevalence rate	Deaths	Case fatality rate
1997	139	0.00009	89	0.64
1998	59	0.00004	57	0.97
1999	227	0.00015	225	0.99
2000	0	0.00000	0	0.00
2001	76	0.00005	49	0.64
2002	13	0.00001	12	0.92
2003	0	0.00000	0	0.00
2004	28	0.00002	26	0.93

Source: Annual Report, Department of Animal Production and Health (1997-2004), Sri Lanka

The prevalence rate has ranged from 0.00001 to 0.00015 and case fatality was almost over 90% in most of the years (Table 11). The number of HS cases were seems to be reduced and it was not reported after 2004.According to the table 02 the prevalence rate ranged from 0 to 0.00015 in the population (cattle and buffalo) for the period of 1997-2004.

3.5 Classical Swine Fever

The Classical Swine Fever (CSF) is a highly contagious viral disease, which can run an acute, sub acute, chronic and in apparent course causing high mortalities and characterized by viral fever, septicaemia and haemorrhages in the skin and visceral organs. In Bhutan CSF is endemic in various parts of the country and most cases of mortality in pigs reported is due to Swine fever. The disease is mainly affecting the exotic breeds and few local breeds of pigs in Bhutan. But there is no evidence that species other than the domestic pig and the wild boar are susceptible to the infection under natural condition. There are more than 5-10 outbreaks reported annually in the country and efforts are taken to control and contain the outbreak. As per the serological survey done from the pig population in Bhutan only 5.8% are positive to the disease. The positivity of the disease in the west and central regions are 4.4% and 26% respectively. The prevalence in older animals (2 years and older) is 11% and 5% in younger animals.

In Nepal during 2001- 2010 the highest number of outbreaks of CSF were recorded in the year 2002, however the number of affected pigs were only 70 (Table 12). Twenty three outbreaks of CSF were reported in 2006 affecting more than 1100 pigs. The case fatality was highest in the year 2008 about 95% followed by 90.5% in the year 2005.

Table 12: Number of outbreaks of CSF from 2001-2010

Year	No. of Outbreak	No. of Cases	No. of Death	Case Fatality %
2001	11	41	21	51
2002	31	70	41	58.6
2003	15	114	58	51
2004	6	70	41	58.6
2005	19	1085	982	90.5
2006	23	1111	271	24.3
2007	30	936	305	32.6
2008	11	39	37	94.87
2009	29	358	64	17.87
2010	14	452	28	6.19

Source: VEC Annual Reports 2001-2010

During 2000-2009 the month-wise pattern of CSF showed that this disease is highly prevalent during the months of March and June, however the outbreaks are recorded throughout the year. Spatial distribution of CSF during 2000-2009 has shown that 26 districts were affected with CSF (VEC, 2010).

Sri Lankan prevalence rate and the case fatality rate of CSF are depicted in table 13 for 1997-1999 periods. According to the records it was shown there had been a decreasing trend of the disease in the country. It has not been reported in the country after year 1999. The numbers of outbreaks were 03, 02, and 01 in 1997, 1998 and 1999 respective years. The case fatality in 1997 had been 64 % in one outbreak and 100 % in both the other outbreaks. The case fatality had been ranged from 25% to 100 % in 1998 and it was 90% in year 1999.

Table 13: Prevalence and case fatality rates of CSE

Year	Cases	Prevalence rate	Deaths	Case fatality rates
1997	24	0.0003	18	0.75
1998	70	0.000875	54	0.77
1999	10	0.000125	9	0.90

Source: Annual Report, Department of Animal Production and Health (1997-1999), Sri Lanka

4. ECONOMIC IMPACTS OF TRANS-BOUNDARY ANIMAL DISEASES

The economic impacts of trans-boundary animal diseases can be very complex. Although the immediate losers are the farmers, the economic impact may affect the community beyond the farmers. The impact will vary depending on factors such as the transmissibility, nature and severity of TADs, farming system of the affected animals and dimension of forward and backward linkages. The complexity of the effects often makes the precise measuring of the economic impacts very difficult. Hence, the analysis of economic implications of TADs is hardly comprehensive; omissions are quite common. Another challenge in estimating the economic impact of TADs is unavailability of precise outbreak information data in a developing country, particularly in endemic setting with incomprehensive passive surveillance data due to limited state veterinary service coverage and absence of active surveillance. The assessment of economic impact of TADs is expected to address the following issues:

a) Production and productivity
b) Price and market effects
c) Trade (domestic & international)
d) Food security and nutrition
e) Health and environment
f) Cost of disease control

A) Production and productivity

The most direct economic impact of TADs is the loss of production, which could be due to mortality or reduced production efficiency of the affected animals. The reduced productivity of animals can be long-lasting. However, a short-lasting loss of productivity may have a long lasting impact. For instance, delays in reproduction due to illness may have bigger consequences; loss of a breeder animal is of paramount economic significance. Therefore, although the loss of output from TADs may appear easy to identify, it can nevertheless be difficult to measure in precise economic terms with regard to actual financial loss to the farmer.

B) Price and market effects

Loss of production and productivity is likely to influence the market price of the commodity, determined by the supply and demand effects induced by TADs. Limited supply can result in increase in market price but on the contrary public health concern associated with certain TADs may also decrease the demand. Moreover, relative effects on producers and consumers of the production shortfall will depend on the relative elasticities of demand and supply. Another dimension of the price and market effects is that it is not only the producers but also the traders who are directly affected.

C) Trade (domestic & international)

Trans-boundary diseases restrict international trade. The trade implications of trans-boundary animal diseases can cause a greater economic impact than the direct production losses themselves. Therefore, the countries which are free from major diseases will tend to protect their local agriculture by totally excluding the importation of livestock products from areas affected by specific animal diseases. Conversely benefits of elimination of trans-boundary animal diseases can be very large as it offers the opportunity of gaining access to high-value export markets. TADs also have implications on domestic trade as the veterinary authority imposes restriction on animal movement as a part of disease control measure.

D) Food security and nutrition

Trans-boundary animal diseases can often have significant negative impacts on food security and nutrition in developing countries. This impact could be very significant on poorer communities that do not have access to substitute supplies. In many countries unavailability of broiler meat could severely compromise with the nutritional security of a large part of the population.

E) Health and environment

Nearly 75% of infectious human diseases had their origins in animals. Many of them have adapted in humans with efficient human to human transmission, while others still remained zoonotic with frequent transmission from animals to humans. Such zoonotic transmission of diseases have increased in recent years, perhaps due to increasingly intensive livestock production in areas of proximity to human populations and loss of habitats of wildlife. Most of these are considered as emerging pandemic threat. An emerging zoonotic disease may affect humans accidentally and sporadically, but also may adapt sufficiently to human host to cause a deadly epidemic or pandemic in the immature human host population. Apart from public health concern the economic consequence of a human pandemic could be enormous.

Many TADs have some environmental concerns. This may be from the disease itself that has moved from wildlife to domestic animal and human population or from the huge amount of contaminated animal carcasses and farming materials. The economic concern is the cost of decontamination of infectious carcasses, materials and premises.

E) Cost of disease prevention and control

The cost of disease prevention and control depends on the control strategy of the specific disease. In general, the major heads of expenditure with regard to disease prevention and control include the cost of treatment, surveillance and detection including quarantine at the port of entries, public communication, stamping out operation including decontamination, vaccines and vaccination campaign, improved bio-security and management, compensation and overhead cost of state veterinary services. Most of the measures related to control of a trans-boundary disease are considered as public good, though there are scopes for private sector participation, such as sharing the cost of vaccination, improved bio-security and farm management. Ideally, the cost of disease prevention should be inversely correlated with the cost of disease proper. So, investment in disease prevention should reduce the loss from disease outbreaks. To determine economic viability of disease control programme, it is necessary to perform a cost-benefit analysis, where the cost is the financial involvement in

disease control and the benefit is the reduction of financial loss from the disease. Usually, such analysis is performed in the scenario of 'no control', 'status quo' and 'improved control'. Economic return from the inclusion of a new control element or improvement of a control element can be measured.

4.1 Economic Impact of TADs in Bangladesh

According to the House-hold Based Livestock and Poultry Survey 2009 of Bangladesh Bureau of Statistics (BBS, 2010), Bangladesh has got 26.82 million cattle, 0.54 million buffaloes, 16.24 million goats and 1.22 million sheep. There are some discrepancies between BBS statistics and DLS data. DLS estimate of 2011 shows 23.12 million cattle, 1.13 million buffaloes, 24.15 million goats and 3.07 million sheep (MoFL, 2011). For the present report BBS statistics were followed.

Apart from few isolated or fragmentary studies (Howlader et al., 2004; Sayeed et al., 2005), there have been no detailed country-wide studies on the economic impact of TADs in Bangladesh. However, Bangladesh Livestock Research Institute (BLRI) conducted a detailed analysis on the socio-economic impact of HPAI in Bangladesh during 2007 and 2008 outbreaks (BLRI, 2008). Systematic empirical study on country-wide economic impacts of TADs in Bangladesh is not within the scope this assignment. Under the given circumstances hypothetical predictions on possible economic impacts of FMD, PPR and HS have been made based on available secondary data and assumptions from a veterinarian's point of view. Only the direct losses and veterinary costs were included; indirect economic impacts and the overhead cost of the state veterinary services were not considered. These theoretical predictions would help designing future empirical research on economic impact of TADs in Bangladesh.

4.1.1 Foot and Mouth Disease

A hypothetical prediction of annual economic loss due to FMD outbreaks in Bangladesh is presented in annexure 1. This calculation is based on the following assumptions: every year 5% of cattle and buffaloes, and 1% of sheep and goats get infected with FMD virus (which is 10 times the number of cases reported to or treated at Upazilas Veterinary Hospitals across the country), 20% affected calves die, affected milch cows produce 25% less milk for 14 days, 50% of affected working cattle and buffaloes abstain from ploughing or pulling cart, and 30% of affected animals are treated with antibiotics and antiseptics and 30% treated with antiseptics only. These assumptions can only be validated by a systematic survey. From this analysis it appears that FMD outbreaks could cost about Tk. 819 million (US$ 10.92 million) per year. This figure does not include the possible indirect impacts of FMD.

No information is available on the impact of FMD on market price, trade, food security and nutrition, and health and environment in Bangladesh. FMD is endemic in Bangladesh. Although the disease is highly contagious, mortality is limited to younger animals only and the effect on older animals is limited to reduced productivity. When the animal population is dominated by low yielding animals, the overall impact of low productivity may not be large enough to influence market price significantly. The major global concern of FMD is due to the fact that it seriously hampers international trade. Recently a consignment of beef exported to Saudi Arabia was rejected as FMD is endemic in Bangladesh and exporting

company suffered a big loss. Export of other by products like gelatin may suffer owing to restricted market access of countries with endemic status. Although Bangladesh is not a regular exporting country, FMD could deter Bangladesh from entering into international trade in near future. In endemic setting, movement restriction of FMD affected animals is not seriously imposed in Bangladesh. However, at the height of the infection the affected animals cannot be moved and this may affect domestic trade. The zoonotic importance of FMD is rather insignificant; culling of infected animals is not practiced, so there is no obvious health and environmental issue related to FMD in Bangladesh.

4.1.2 Pesti des Petits Ruminants

PPR is the most costly disease of small ruminants. A hypothetical prediction of annual economic loss due to PPR outbreaks in Bangladesh is presented here in annexure 2. The calculation is based on the assumptions that PPR affects 7.5% of goat population of the country every year with a case fatality rate of 60%; surviving goats loose 25% of their value due to loss of body condition; and 60% of affected goats receive treatment either at Upazila Veterinary Hospitals or from private practitioner vets or animal health workers. From this analysis it appears that PPR outbreaks could cost about Tk. 1,842 million (US$ 24.56 million) per year. This figure does not include the possible indirect impacts of PPR. For instance, PPR could lead to decline in goat population with serious impact on national earning from leather export.

No information is available on the impact of PPR on market price, trade, food security and nutrition, and health and environment. Impacts of PPR on market price and domestic trade are not unlikely but that have not yet been assessed. If PPR hampers the growth of goat farming, this could have a negative impact on nutritional security. PPR has no public health concern.

4.1.3 Highly Pathogenic Avian Influenza (HPAI)

The poultry industry in Bangladesh has grown tremendously in the recent years. Weekly supply of commercial day-old broiler and layer chicks is around 0.5 million and 5.5 million, respectively. Annual replacement of parent stock stands at around 4.0 million, of which around 2.5 millions are produced locally. About 11 billion eggs (60% from commercial poultry and 40% from backyard poultry) and 500,000 MT poultry meat are produced annually (Figures derived from Dolberg, 2008).

Assessment of economic impact of HPAI is quite difficult because of complex structure of poultry industry and its extensive forward and backward linkages. The direct loss incurred by HPAI outbreaks comes from not only the death of infected birds but also from culling of birds in contact, destruction of eggs, contaminated feed and other dispensable materials and ban on restocking for a period of at least 3 months. Culling of birds induces loss not only at its present market value but also the loss of the un-harvested potential productivity of the culled birds. This could be huge in case of a culled breeder hen. The indirect loss from HPAI outbreaks can even surpass the direct loss. Because of public health concern HPAI outbreaks may have severe price effect; however, this effect could often be neutralized by demand supply effect. Among the indirect losses, the poultry farmers themselves can suffer from the price effects, unintentional closure of farming out of fear of HPAI, etc. However, other

stakeholders of the industry also may suffer indirect loss due to HPAI. The worst affected ones could be the feed mills, pharmaceuticals, feed and medicine sellers, chick distributors, etc. The traders are also affected, though the demand-supply effect could compensate the loss to some extent. BLRI conducted a study on the economic impact of HPAI in Bangladesh. The study concluded that the poultry industry of Bangladesh faced a terrific financial loss in 2007 and 2008 due to the incursion of avian influenza, which was estimated to be Tk. 38,583 million (US$ 551 million). The findings of economic impact analysis by BLRI are summarized in annexure 3**.** The analysis was based on the fact that during the year 2007 and 2008 there were a total of 287 outbreaks leading to culling of 1,673,000 chickens from 547 farms (112 broiler and 435 layer farms).

The number of HPAI outbreaks was the highest in 2008, which dropped significantly in 2009 and 2010, but increased again in 2011. The total number of outbreaks as of 14 November 2011 stands at 519 which led to culling of 2,445,244 birds from 789 farms/villages. If the BLRI assessment is adjusted for the whole period from 2007 to 2011, the figure of economic impact of HPAI would stand at Tk. 51,720 million (US$ 690 million).

The findings of BLRI study would need to be qualified on the basis of dynamic scenario of HPAI in the country. There have been ups and downs in market price of poultry and poultry products as well as in the interest in poultry farming. The shock of HPAI in the market was absorbed quite readily. The production downtime effect accounted for the highest cost element in the BLRI study, about 90% of the total estimate. This needs to be validated with solid data. Moreover, the production downtime effect is likely to change over the period of time with consumer response and adaptation of the farmers.

Bangladesh was preparing for poultry export just immediately before the incursion of HPAI. With the present near endemic situation of HPAI in Bangladesh the prospect of poultry exports appears to be quite gloomy. The imposition of movement restriction hampers domestic trade as well during the face of an outbreak.

Broiler meat is the cheapest source of animal protein in Bangladesh. If HPAI outbreaks seriously affect the supply of broilers, this can have a negative impact on food security and nutrition of the poor people who have no access to other source of proteins.

HPAI is a major public health concern. So far, only three non-fatal human cases of avian influenza have been reported, but this scenario might change at any moment. Culling of large poultry flocks and their disposal have environmental concern as well.

4.1.4 Haemorrhagic Septicaemia

Although HS seems to be a forgotten disease, it still remains as one of the most costly livestock diseases. The prevalence of HS could be lower than other viral contagious disease like FMD, but the high case of fatality may result in substantial economic loss to the farmers. A hypothetical prediction of annual economic loss due to HS outbreaks in Bangladesh is presented here in Table 8. The calculation is based on the assumptions that the overall prevalence of HS among cattle and buffaloes is 0.1% with 30% case fatality; and 60% of affected animals receive treatment at Upazila Veterinary Hospitals or through private practitioner vets or animal health care workers. The present analysis suggests annual

economic loss of Tk. 1,105 million (US$ 14.74 million) due to HS outbreaks. This figure does not include the possible indirect impacts of HS.

No information is available on the impact of HS on market price, trade, food security and nutrition, and health and environment. Apart from international trade, which is not yet an important issue in Bangladesh, the impact of HS on domestic trade, food security and nutrition, and health and environment is likely to be the minimum.

4.2 Economic Impact of TADs in Bhutan

4.2.1 Surveillance cost

The surveillance of TADs diseases is undertaken for all diseases as a regular work plan in order to regularly update the status of diseases and accordingly revise the national control programmes. The surveillance cost in the country is very high mainly due to scattered dwellings and geographical terrain. The surveillance programme also involves different expertise from different agencies and this also escalates the cost of surveillance.

As per the review on the surveillance programme undertaken for the last five years, and also taking into account the trend of the programmes, the average annual cost are shown in table 14**.**

Table 14: Surveillance cost for different TADs fro Bhutan

Sl. No.	Name of TADs	Nu. (in millions)	USD $ in million
1	Foot and Mouth Disease (FMD)	13.00	0.28
2	Peste des Petits Ruminant (PPR)	0.15	0.003
3	Highly Pathogenic Avian Influenza	18.00	0.39
4	Haemorrhagic Septicaemia (HS)	3.90	0.085
5	Classical Swine Fever (CSF)	3.70	0.081
Total		**38.75**	**0.839**

(Source: Analyzed from crude data from NCAH Serbithang)

4.2.2 Vaccine Production Cost

The production cost of vaccines against TADs diseases is reasonably low for locally produced vaccines against Haemorrhagic Septicaemia and Classical Swine Fever whereas it is exponentially high for Foot and Mouth Disease. Bhutan has not embarked on the use of vaccines against avian influenza and PPR due to the policy of the country. The use of vaccines for PPR has been mainly in countries with endemic nature and in the reduction of virus shed. As Bhutan has just one outbreak and is maintaining high border surveillance and border harmonization in the main entry gates in the country, PPR is the next disease for eradication without the use of vaccines.

Although the vaccine production or purchase cost is almost 5 to 10% higher on every year for almost all vaccines since 2009, the average cost of vaccines, for the last 5 years, has been used for the calculation of total vaccine cost incurred annually for the preventive control of the TADS in the country. The details are shown in table 15.

Table 15: Vaccine cost for the prophylactic measures for Bhutan

Sl. No	Name of TADs	Nu. (per dose)	No. of vaccinations /year	Cost of Vaccine (Nu in million)	USD $ (in million)
1	Foot and Mouth Disease (FMD)	12.25	400000	4.90	0.107
2	Peste des Petits Ruminant (PPR)	0.00	0	0.00	0.000
3	Avian Influenza	0.00	0	0.00	0.000
4	Haemorrhagic Septicaemia (HS)	1.00	40000	0.04	0.001
5	Classical Swine Fever (CSF)	13.00	6000	0.08	0.002
Total				5.02	0.109

(Source: Analyzed from crude data from NCAH, Serbithang)

4.2.3 Bio Security and Management Cost

The biosecurity and management cost for TADS depends on the type of diseases and the type of farms operating in different geographical zones in the country. The cost of biosecurity is greater in commercial than the semi-commercial and backyard farms of livestock and poultry farms. Bhutan does not have any highly automatized with high technology farms and so the cost of biosecurity is minimal compared to rest of the SAARC countries. The standard of biosecurity is satisfactory as no alarming outbreaks have occurred so far in the country accept for FMD and Bird Flu.

The standard cost of biosecurity and management cost for diseases has been assessed using the pilot crude analysis. The main cost components are the manpower, chemicals and sprayers, fencing, and management of foot dips. It also involves the management of human traffic in and around the farms and in outbreak areas. The detail cost is shown in table 17.

Table 17: Bio-security cost per farm category

Sl. No	Bio security cost	Nu. In million		USD $ in million	
	Name of TADs	Commercial Farms	Semi Comm to Backyard farms	Commercial Farms	Semi Comm to Backyard farms
1	Foot and Mouth Disease (FMD)	0.350	0.120	**0.008**	**0.003**
2	Peste des Petits Ruminant (PPR)	0.050	0.100	**0.001**	**0.002**
3	Bird Flu	0.109	0.060	0.002	0.001
4	Haemorrhagic Septicaemia (HS)	0.090	0.030	0.002	0.001
5	Classical Swine Fever (CSF)	0.350	0.080	0.008	0.002
Total		0.949	0.390	0.021	0.008

(Source: Analyzed from the crude data records from NCAH Serbithang Thimphu)

4.2.4 Compensation Cost

Bhutan does not have the system to pay compensation for the losses of livestock and poultry as a result of any diseases. If livestock and farm as a whole are insured, the insurance policy pays the cost. The only compensation mechanism existing in the country is for poultry and other livestock due to Bird Flu outbreak.

During the first outbreak of Bird Flu in Bhutan during 2010, a sum of Nu. 0.700 million was compensated to around 600 poultry farmers in the area. The compensation cost was higher than the rates projected in the region. The rates for compensation to different categories of poultry in Bird Flu are as follows:

Compensated @ of 75% of the market value: (the value of 1USD$=Nu.46).

- ✓ Adult bird-Nu.225 (based on market value of Nu.300).
- ✓ Young bird less than 5 months-Nu.83 (based on the market value of Nu.110)
- ✓ Day Old Chicks (DOC)-Nu.30 (based on the market value of Nu. 40).
- ✓ Eggs-Nu.6/egg (based on the market value of Nu.8/egg).
- ✓ Coops lump sum Nu.200/coop.
- ✓ Adult ducks-Nu.188 (based on the market value of Nu. 250).
- ✓ Young Ducks less than 5 months-Nu.75/ (based on the market value of Nu.100).
- ✓ Day Old chicks (DOC)-Nu.30 (based on the market value of Nu.40

In an average the annual compensation cost during Bird Flu outbreak is USD$ 0.20 million which includes only the compensation paid to the farmers for the cost of poultry, feed items and dismantable poultry houses.

4.3 Economic Impact of TADs in India

4.3.1 Foot and Mouth Diseases

In India, much emphasis is placed on epidemiology, diagnostics, vaccine and other technical aspects of FMD in order to achieve control of the disease. Only limited studies have been conducted on economic impact of the disease. There are direct and indirect losses due to this menace. Indirect losses to livestock sector are due to loss of productive function, breeding capacity, reduced draft capacity in working bullocks, loss of milk yields on a permanent basis, loss in flesh in meat animals, also flare up of opportunistic infections. There is also significant loss in cattle trade both national and international due to trade barrier, and massive expenditure by government on FMD control and cost of treatment.

The direct losses alone due to FMD in India are estimated to be more than US$ 4.5 billion per year and indirect production losses could be much more (Venkataramanan et al*.,* 2006, in a paper presented at a workshop on Global Roadmap for improving the tools to control foot-and-mouth disease in endemic settings during 29 November to 1 December, 2006, Agra, India). As per estimate (Saxena, 1994a and b) in a study conducted by the Institute of Rural Management, Anand in 1994, loss in milk production was 3508 million kg (Rs 12,520 million in terms of foreign exchange and Rs 16500 to 18370 million in terms of lost domestic economic surplus), and losses due to loss of draught power, animal deaths and cost of treatment were to the tune of Rs.18130 million/year. A study conducted in 2007 on economic impact of single FMD outbreak in a panchayath in the state of Kerala, the loss was

amounting to Rs 313,900. The economic loss was calculated on the basis of milk loss, abortion, mortality, treatment cost, loss of drought hours, vaccination cost and loss of manpower; 80.68% of the loss was due to loss in milk yield (Mathew and Menon 2008).

Economic impact of FMD incidences in four districts of Andhra Pradesh was studied by Ganesh Kumar (2011). The results obtained from the study were extrapolated to approximately understand the economic dimensions of FMD outbreaks in the state and the country. The extrapolation was made based on an assumption that the proportion of different species of livestock and the disease prevalence would be similar in other areas too. From the projection, the estimated loss due to reduced milk output, the loss due to reduction in draught power, treatment of ailing animals, and the loss due to mortality and culling would be Rs. 388.58 crores, Rs.398.79 crores, Rs.351.41 crores and Rs.8.53 crores, respectively. Thus, the total economic loss estimated due to the setback that had occurred to livestock in study area in the form of FMD outbreak could have been to the tune of Rs.1147.31 crores in Andhra Pradesh. Of the components of total direct losses estimated for the State, the loss due to draught power reduction contributed to about 35 per cent to total losses, followed by the loss due to milk yield reduction (34 percent), the loss due to treatment of FMD affected animals (30 per cent) and the loss due to mortality and culling (1 percent). The contribution of draught power to the total loss was found to be high in Andhra Pradesh, as still farmers rely on the animals for the cultivation operations, which might be the cause of their fragmented landholding pattern. Using the same farm-level estimates and with the same assumptions taking into the national level statistics, it was estimated that the country would stand to lose a staggering amount of Rs. 15575 crores on account of an outbreak in a year. By this, one can understand the enormous socio-economic impact it causes on the producers alone, notwithstanding the indirect impacts on the other players in the livestock sector as well as the whole lot of related sectors of the economy.

4.3.2 Haemorrhagic Septicemia

India has a population of 199 and 105 million cattle and buffaloes respectively and thus hold first and second position in world cattle and buffalo population. The milk production by cattle and buffalo during the report year 2010 is approximately 44.4 and is 60.9 million tonnes respectively. India is the largest producer of buffalo milk and contributes 68 percent of the total world buffalo milk produced. Thus considering the high population of buffalo and cattle in India and the susceptibility of these animals to HS, the disease outbreaks may lead to huge economic losses. Hence, HS has to be combated to prevent the huge economic losses due to the disease (Anonymous, 2011).

4.4 Economic Impact of TADs in Nepal

4.4.1 Production and Productivity

The economic impacts of TADs can be complex and go beyond the immediate impact on the directly affected agriculture producers. All TADs have the potential to kill the affected animals, but the severity of the disease will vary depending upon the factors such as animal species, breed, age, nutrition, disease agent etc. Many TADs have 50-90% mortality rates in susceptible animals (Otte et al, 2004).

The economic importance of FMD due to the loss of productivity following infection is enormous. Infection in draft cattle causes a serious problem in tillage on which the preparation of agriculture land is fully dependent. In dairy cows sharp drop in milk production, abortion and chronic mastitis is very common. In suckling calves the mortality rate is even high. Various study reports clearly indicated that FMD is the major livestock diseases that cause enormous economic losses in the livestock production system. Though economic losses due to FMD in Nepal has not been systemically quantified in the country, an economic loss in terms of 20 % reduction in milk and 10 % reduction in meat production is estimated to be 66 million US $ per year (Gongal, 2000). But the actual economic loss would be much higher if the reduction in breeding efficiency and draught power of animals are added. A study of the economic impact of livestock diseases in rural areas of Nepal estimated that FMD could account for 26% of the overall economic losses in livestock production (Lohani and Rasali, 1992).

Mandal (2010) conducted a study on evaluation of economic losses due to FMD in 2009 in Rajbiraj municipality of Saptari district and Duhabi and Mahendranagar VDC of Sunsari district. During research period altogether 160 households with the FMD outbreak in their livestock were surveyed. A total 200 animals were found to be affected by FMD. All the affected animals were non-vaccinated. The economic loss was calculated taking into consideration of milk loss for a period of 1 month after the onset of the disease outbreak. The loss in milk production was found to be 31.13%.

Since the entry of PPR in Nepal in 1995 there have been great losses to the goat and sheep rearing farmers. Most of the goats are reared by rural poor farmers. The high morbidity and mortality rate of this disease has caused enormous losses however there is no any literature available on the losses due to PPR in Nepal.

Calculation of crude losses due to PPR

As per the number of animals affected and dead during 2001-2010 (VEC, 2010) the calculation of crude losses due to PPR is presented as follows.

Number of affected animals = 100135
Number of animals dead = 30944
Number of animals affected but survived = 69191
Average cost of dead animal = NRs 6000/goat
Therefore the loss due to mortality of goats = 30944 x 6000 = NRs 185664000.0
Considering average weight of affected goats to be 20 Kg then total weight of affected but survived animals = 69191 x 20 = 1383820 Kg
Considering 25% weight loss in the affected goats but survived then the total weight loss = 25% x 1383820 = 345955 Kg
The market price of live goat is NRs 270/Kg Therefore loss due to weight loss = 345955 x 270 = NRs. 93407850.0
Hence Total loss due to death of goats and weight loss of the survived goats = 185664000 + 93407850 = NRs 279071850.0

4.4.2 Price and Market Effects

In addition to impacts on production, there can be variations in prices, which are determined by the supply and demand effects induced by the TADs. Market effects can similarly induce variations in wages for farm and processing employment and can otherwise spread through to upstream and downstream activities. Depending on the market for the affected agricultural products, an affect of outbreak can lead suddenly to higher prices if most production is domestically consumed, or to lower prices if most production is exported and quarantine prevents such export but not domestic consumption (FAO, 2001).

Price and market effects of H5N1 outbreaks in 2009 in Nepal

Series of outbreak of H5N1 in Bangladesh and India had been alerting Nepal for, organizing effective response mechanism in the event of an outbreak of Avian Influenza in Nepal. While the World Bank supported Avian influenza control project/animal health component (AICP/AH) in Nepal, along with other donors USAID, WHO were very much engaged in building the capacity of Department of Livestock Services, first outbreak of H5N1 was confirmed in Mechi municipality ward 10 of Jhapa district on 16 January 2009. With the project support, Department of Livestock Services managed for application of standard operation procedures for the containment of the outbreak at its best international standard. With the public reluctant to eat chicken, price of chicken was down from NRs 230 to NRs 170 per kg immediately after government confirmed the first case of avian influenza in Nepal. In some places even the price of the poultry meat went down to NRs 120-130 per kg. Poultry farmers also refrained from rearing the birds. Chicken prices had touched an all time high of NRs 250 per kg in June 2009 due to sharp decline in poultry farming after the outbreak of H5N1 bird-flu in the country in January (MDTL & PACL, 2011).

The news paper Republica Kathmandu, 19 January 2009 stated that the first outbreak of HPAI in Nepal affected the situation in the poultry industry. There was a decrease of about 25 percent in the consumption of poultry products since bird flu was confirmed. The production of chicks was already low due to the decreased import of parent chickens. When the government banned importing poultry products from India after the detection of bird flu there, hatcheries started buying parent chickens from third countries. There was the availability of about 35 to 40 percent parent chickens only in the country. Low production prevailed for about next three months. Many farmers did not produce chicks for weeks till the situation returned to normal.

4.4.3 Trade (National and International)

There is numerous entry and exit points on the Nepal-India border but Kakarvitta, Biratnagar, Janakpur, Birganj, Bhirahawa, Nepalganj, Dhangadhi and Mahendranagar are the cross-over cities that are well connected by road, rail and air transport. There are eight animal quarantine offices and 24 animal quarantine check-posts throughout the country. Tribhuvan International Airport in Kathmandu is a major entry point for foreigners. There is a regular mass movement of people across the India-Nepal border in search of employment, education and trade. The frequency of this movement of people varies according to the seasons, festivals and available/emerging opportunities for employment. India and China are Nepal's biggest trading partners. Cattle, buffaloes and goats are imported for milk or meat

production, draft power and breeding. Eggs, fish, hide and skins are major livestock products that are traded with India. Nepal has a long and porous border with India and the movement of people and animals across it is difficult to regulate. Mass movement of live animals across the Indo-Nepalese border and uncontrolled animal movement within the country have been responsible for outbreaks of FMD, PPR and CSF and other TADs. The pattern of disease outbreak is related to the frequency of animal movement across the border and within the country. The internal livestock and poultry market is greatly influenced by availability, cost of production and the demand-supply situation in the markets in India. When India had HPAI outbreaks, the Nepal government had restricted the import of poultry and poultry products from India from time to time due to the potential threat of HPAI (WHO, 2007)

The livestock sector is facing a major challenge in cross-border collaboration due to unregulated and unchecked animal movement both within the country and across international borders. The predominance of informal trading practices for livestock and livestock products, lack of institutional mechanisms for information exchange and technology transfer, and lack of standardization and absence of harmonized practices in matters related to information, laboratory, quality control and quarantine systems are also discernible challenges.

The situation of livestock and livestock products import and export of Nepal is presented in tables 18 and 19.

Table 18: Situation of Livestock Import & Export (Figures in thousand)

Fiscal Year	Cattle	Buffalo	Goat	Sheep	Pig	Poultry Chicks	Eggs
2004/05	Import	2.5	135.1	270.1	8.9	69.9	27.9
	Export	0.6	5.0	17.1	5.1	11.3	14.1
2005/06	Import	3.6	179.1	279.1	12.6	1.7	97.4
	Export	0.1	3.3	4.2	0	1.4	26.5
2006/07	Import	7.3	203.6	275.2	10.4	1.5	334.7
	Export	2.3	4.9	2.8	1.6	0.2	25.1
2007/08	Import	1.8	173.1	279.0	5.3	3.0	440.0
	Export	2.1	4.8	2.3	0.9	0.67	0
2008/09	Import	1.2	35.0	333.3	5.8	4.4	411.2
	Export	1.2	1.8	0.3	0.3	0.03	2.0
2009/10	Import	0.5	46.2	476.6	9.7	4.8	787.6
	Export	0.6	2.1	0.9	0	0	9.2

Source: Annual Report, DLS (2009/10) and Annual Report CAQO (2009/10)

Table 19: Livestock Products Import Situation during 2009/10 in Nepal

S.N.	Commodities	Value '000 NRs
1	Dairy Product	860729
2	Meat and edible meat offal	53357
3	Raw hide & Skin	24409

Source: Annual Report, DLS (2009/10)

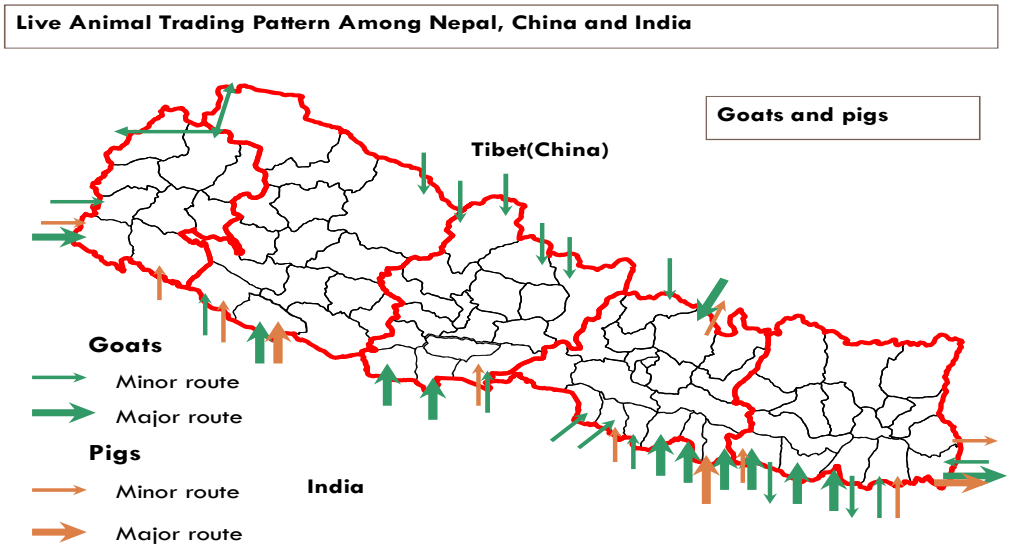


Figure 15: Trading pattern of goats and pigs

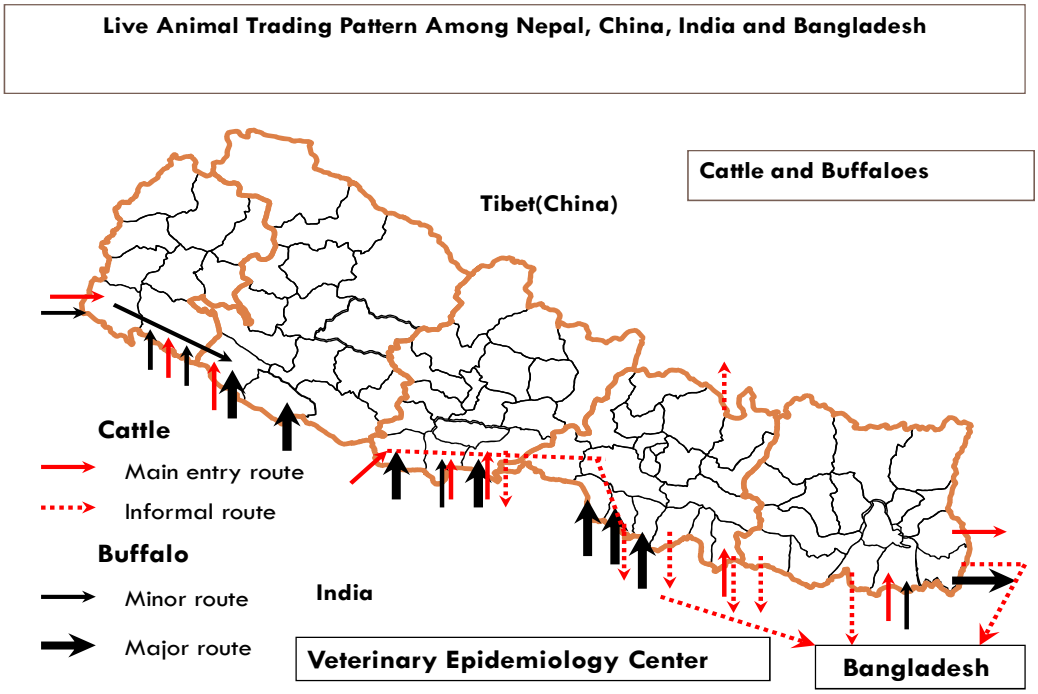


Figure 16: Trading pattern of cattle and buffaloes

4.4.4 Food Security and Nutrition

Trans-boundary animal diseases can often have significant negative impacts on food security and nutrition in developing countries. The growth of international trade in agricultural produce buffers the potential impacts on food availability, but there can still be major impacts on poorer communities that do not have access to substitute supplies. The food security impact is the paramount concern of many national policy-makers in developing countries and provides one of the main arguments in favour of international assistance for control programmes (FAO, 2001).

Agriculture is the main source of livelihood for over three quarters of the population in Nepal. In rural areas, over 70 percent of income is spent on food. Farmers have difficulty in accessing basic agricultural inputs due to their high costs, limited local seed production capacity and poor road networks. An increased frequency of floods, droughts and hail storms has impacted crop production. The lack of fodder and access to veterinary services, combined with animal disease outbreaks, continually threaten the food security of families reliant on livestock, a vital livelihood asset for rural communities, especially the landless (FAO, 2010).

Every year various infectious disease outbreaks such as PPR, CSF and HS hit the livestock and cause high case fatality. There is no doubt that these outbreaks affect on various aspects including food security and nutrition situation in poor and rural areas. However the actual socioeconomic impacts due to TADs in Nepal still needs to be evaluated.

4.4.5 Health and Environment

The main threat to human health arises from zoonotic diseases. Such diseases appear to have increased in recent years, perhaps owing to increasingly intensive livestock production in areas of proximity to human populations. The human deaths associated with HPAI in South-east Asia have shown that HPAI can also be a great threat to public health and could become a major human pandemic.

In Nepal rabies, anthrax and tuberculosis are zoonotic problems. Well fortunately no human death due to HPAI was recorded in the country but threat has not become over because of the antigenic changing pattern of the avian influenza virus.

Increasing concern is arising over threats to the environment, either from TADs themselves or from the control measures used against them. Control measures have become a matter of serious concern since attention has focused on pesticide dangers and stockpiles of unused pesticides. There is also growing concern about invasive species, brought in by trade or movements of people, which dominate or otherwise harm the native ecology (FAO, 2001). Environmental concerns have had a negative effect on investment in livestock-disease control (FAO, 2002)

4.4.6 Surveillance Cost

The major activity for the control and prevention of TADs require surveillance programme which helps for early detection and early response. In Nepal although there are various TADs prevalent in the animal population and disease outbreak occurs time and again but the epidemiological surveillance is limited to only few diseases.

Passive surveillance occurs regularly, but the Veterinary Service (VS) needs to better prioritize what information they need passively collected and sent to the VEC for analysis. Active surveillance currently only exists for HPAI. While for HPAI this is a fairly robust, internationally funded and managed programme, there is only one official animal disease national control programme in Nepal: PPR. The goals for this control programmes are not clear, activities related to the programme are not well-organized, and do not utilize resources and personnel well (Barisic & Johnson, 2008). There is a regulatory provision in Animal Health and Livestock Services Act of Nepal by which is required from the animal owners, animal health workers and veterinarians to inform the livestock services centre or sub centre on any suspicion of occurrence of infectious diseases. In case of listed diseases, Veterinary Officer is obliged to inform the Department of Livestock Services within 24 hours.

In 2007, on request of Government of Nepal, the World Bank assistance in the form of grant was received for four years period (Fiscal Year 2007/08 to 2010/11) for the AICP/AH project. During this period the animal health component had various 7 sub components of which surveillance and epidemiological investigation was one of the sub components. Under the surveillance and epidemiological investigation sub component, among the various activities surveillance of domestic poultry, surveillance of wild/migratory birds, participatory disease intelligence constituency, capacity building of veterinary/wildlife professionals for surveillance and bio safety, development of GIS based animal disease surveillance and information system were the major activities (AICP/AH, 2010). The total amount spent for this sub component is presented in table 20.

Table 20: Surveillance cost for Avian Influenza

Fiscal Year	Surveillance Cost in NRs Thousands
2007/08	10405
2008/09	5680
2009/10	10276
2010/11	9665
Total	36026

Source: Planning Section of AICP/AH Project, 2011

The National PPR Control programme started in the country from 2001 and the major activities in this programme are PPR vaccination, sero-monitoring, PPR evaluation and planning workshops, monitoring and supervision and publication of awareness materials. Therefore looking at the programmes menu there is no particular activity for the regular surveillance of PPR except the sero-monitoring of the vaccinated animals. According to DAH officials responsible for this programme implementation it could be found that roughly NRs 700-900 thousand/year only is spent for the sero-monitoring purpose.

4.4.7 Vaccine Production Cost

The history of animal vaccine production in Nepal dates back to 1961 when a veterinary investigation laboratory was established in Kathmandu with the objectives to deliver diagnostic services for animal diseases and produce Goat Tissue Vaccine (GTV) to be used

for rinderpest control programme. Currently the Central Biological Production Laboratory (CBPL) of the government is producing a range of vaccines for livestock and poultry.

Table 21: Cost of vaccines produced by the CBPL

S.N.	Name of Vaccine	Vaccine Price (NRs)
1	HS	40/20 dose
2	HS Aerosol	-
3	HS & BQ combined	150/50 dose
4	PPR	250/100 dose
5	Anthrax	200/50 dose
6	CSF	210/20 dose
7	ND-F strain	200/1000 dose
8	ND-R2B strain	100/500 dose
9	Fowl pox	120/200 dose
10	IBD Live (Intermediate)	415/1000 dose
11	ND-Lasota strain	125/500 dose

Source: CBPL Vaccine booklet, 2009

According to chief of the CBPL (Personal Communication) the price of vaccine has been set as per the vaccine production cost however the salary of the manpower involved has not been included in the vaccine production cost.

4.4.8 Biosecurity and Management Cost

Trans-boundary animal diseases can be prevented, controlled and even eliminated through the application of biosecurity measures along production and marketing chains. Biosecurity progressively reduce the risk of disease transmission. Better prevention and control of trans-boundary animal diseases can be achieved when public services and producers work together to include practical and cost-effective biosecurity measures in all good animal production management practices (FAO, 2010).

In Nepal due to the outbreak of HPAI in 2009 and 2010, the commercial poultry sector has become very much aware about the importance of biosecurity of their farms. The application of biosecurity measures in the large scale poultry farms has become a common practice in the farm management. The AICP/AH project conducted various workshops, awareness programmes and distribution of extension materials on biosecurity measures. Animal Health and Livestock Services Act, 1998, and Regulations, 1999 of the country has also the provision of veterinary inspection of the livestock farms and the veterinary inspector can assess the biosecurity measures adopted in the farms and if necessary enforce to apply biosecurity measures.

The biosecurity management cost could not be evaluated because of lack of sufficient information in this area.

4.4.9 Compensation Cost

Except for HPAI, compensation funding for other TADs emergencies is essentially not available. The compensation to farmers for their culled and killed birds started in this country for the first time for containment of the birds during the HPAI outbreaks.

In 2009 the government rate for the compensation was NRs. 500 for each layer parent, NRs 250 for each broiler parent. Irrespective of breed, sex, age backyard and broiler chicken and ducks rate was NRs 100/ bird, 50 paisa/ egg, NRs 5/kg of feed, poultry meat NRs 50/Kg. The total compensation given to farmers in Jhapa outbreak in 2009 was NRs 3089596.00 (MDTL & PACL, 2011).

Table 22: Details of birds culled and killed during HPAI (H5N1) outbreak in Jhapa district in 2009

Total households covered	Chicken	Duck	Pigeons	Other birds	Eggs
2951	29669	484	700	12	6191

Source: MDTL & PACL, 2011

In 2010 the compensation rate was revised by the government. NRs 500 for each layer parent, NRs. 250 for each broiler parent, domesticated bird below 6 months NRs 50/bird, above 6 months 130, broiler up to 4 weeks 50/bird, broiler above 4 weeks 130/ bird, NRs 3 /egg , NRs 10/Kg of feed and NRs 100/ Kg of meat. The compensation paid to the farmers in various outbreaks of HPAI in 2010 was a total of NRs 2912260.00 (MDTL & PACL, 2011).

Table 23: Details of birds culled and killed and other products destroyed during HPAI (H5N1) outbreak in 2010

Poultry	Duck	Pigeon	Egg	Feed (Kg)	Other birds	Meat (Kg)
28115	886	346	4512	114	1	148

Source: MDTL & PACL, 2011

4.5 Economic Impact of TADs in Pakistan

4.5.1 Foot and Mouth Disease (FMD)

Among the spectrum of diseases maximum exploitation of productivity in cattle and buffalos is due to FMD and is responsible for substantial losses in term of productivity, loss of milk, meat and work ability. The disease is endemic in Pakistan and cyclic in nature and is observed throughout the year. Economic impact of FMD on the livestock industry has been primarily worked out taking into consideration the reported animal mortality, milk loss, work loss, distress sale, vaccination and treatment cost.

4.5.1.1 Production & Productivity

The buffalo, cow, sheep and goat population of Pakistan is growing at a slow but consistent rate. As per Economic Survey of Pakistan (2010-11), the country's buffalo, cows, sheep and goat population is 31.7, 35.6, 28.1 and 61.5 million animals, respectively. The total beef and mutton production during this period is reported at 2327 thousand tones. The buffalo, cattle, sheep and goat are also a source of skins and hides for the leather & tanneries industry. In

2010-11, 59,098 thousand skins were obtained from these animals. In addition 42.5 thousand tones of sheep wool and 23.2 thousand tones of goat hair were produced. During the period total milk production from these animals is estimated 45622 tones. The population of these animals is constantly growing around 3 percent despite poor husbandry practices, poor feed/fodder and grazing facilities, poor health cover especially the vaccination coverage against multiples of infectious diseases like HS, PPR, FMD, blue tongue, anthrax, etc. In general livestock is not reared under the production friendly environment using good housing, grazing in organized pastures, stall feeding, and proper balanced nutrition despite the fact that these animals are the source of meat and milk which are direly needed to feed the people. These animals are also a source of earning of foreign exchange, Holdings of 2-5 cattle, buffaloes and 50-100 sheep/ goat herds are quite common in rural areas, In case TAD infectious diseases (FMD, PPR, HS) affecting the livestock are brought under control, there is a good potential for increasing numbers and productivity of these animals.

FMD has direct economic impact on the livestock production, and reproductive efficiency and income of the farmers**.** In case the FMD outbreaks are not handled properly, the reduced productivity of the animals may continue even if apparently there are non clinical cases of the disease. The reproductive efficacy of the animals may also be compromised as animals with improper recovery from this disease may give birth to lesser number of off-springs. FMD often coincides with stress, change in weather conditions like excessive heat and cold, rain fall, and some other seasonal variants. Various risk factors attributed to FMD prevalence include regional/area (prevalence is more in grazing mountain and plain areas), farming system (prevalence lesser in controlled animal holdings), animal species (disease incidence higher in buffalo & cattle as compared to sheep/goats), season (incidence higher in months of February to April, as stress months due to shortage of grass), rate of participation in cattle markets and animal shows as well as animal movement, etc.

Taking into consideration the FMD morbidity, mortality, meat and milk losses, distress sale etc, losses in a herd of 100 buffaloes affected by FMD are estimated at US$ 3000. This estimated loss is in addition to loss of jobs, cost of treatment and increased cost on vaccination, loss of meat weight during the disease period, loss of draught power, infertility and reproductive disorders, cost on basic bio-security and disinfection, increased cost of milk in the market, negative effect on the business of animal traders butchers, milk industry etc., A study conducted through the PDS reported a loss of USD 6.25 million due to FMD in a population of one million livestock in Pakistan. Various indicators on loss included milk loss, weight loss, work lost, distress sale, abortions, infertility, mortality etc. (Raheed, 2006; PDS report). Kazimi and Shah (1981) reported annual losses due to milk and body weight losses due to FMD at USD 1.2 million and USD 1.8 million, respectively. However, in the present times, these losses could be much higher than those reported earlier.

4.5.1.2 Price and Market Effects

The prices of buffalo, cattle, sheep and goats remain variable throughout the year depending on the factors like demand and supply, age, sex, health, body condition, pregnancy, stage of lactation, type of animal (milk or meat), reproductive cycle, fertility, carcass dressing ratio, location of animal (urban, peri-urban, rural, remote area etc.), number of parties and marriage ceremonies held, or those sold at religious festivals such as annual Eid ceremonies where such animals are sacrificed. The meat type animals usually fetch high prices around

such festivals or when the animals are exported. However, under optimum conditions the general prices for lactating cattle vary between US $ 500-900 and for buffaloes from US $ 600 to 1000, depending on their lactation cycle, time of pregnancy or lactation period, off spring etc. The beef prices in cities are higher than those in the rural areas. The processed and value added meat fetches more market price than the simple slaughtered retail sale. In general the beef price ranges between US$ 3-5 /kg. At country level the animal and meat prices are generally governed by the following factors.

1) Animal Population at slaughtering age
2) Export demand of livestock
3) Mortality due to diseases
4) Grazing practices and availability of fodder
5) Type and number of ceremonial events like Eid, marriages etc.

FMD incidence in the country affects the price of animals and their by-products in many ways. This could be due to shortage of young, breeding or lactating animals as a result of mortality, lowered production, movement ban and poor growth rate in the affected herds, As regards market effects of FMD, the trading system of milk and meat is dependent upon the middle-man. In this system, the middle man purchases animals from farmer and supplies them to livestock markets for their slaughtering or export. Similarly, milk collection is done by a middle man who collects the milk from door to door and brings it to the big markets of major cities adjacent to these areas. In some instances, the farmer himself takes animals to market near butcheries for selling or brings the milk or butter to the market for sale. In some high milk producing areas big companies have introduced their milk collection centers where the milk is brought by the individual farmer and later on processed before shipping to the nearby milk plants. Once the FMD outbreaks appear in a particular area, the above mentioned activities are badly affected, thereby disturbing this supply chain of milk and meat. In certain situations there is supply of more FMD affected animals to the markets resulting in decline in prices of meat. However, this effect is very short lived and eventually the market prices get increased because of shortage of meat and other products soon after major FMD outbreaks.

4.5.1.3 National and International Trade of Livestock

Movement of animals for the national and international trade of livestock also contributes to the incidence of FMD in various regions of Pakistan. The animal movement for the purpose of selling, within the country includes that from one village to another, tehsil to district, across districts, provinces, and also to-and-from countries like India, Afghanistan, Iran etc sharing borders with Pakistan. Although Pakistan usually does not legally import buffalo/cattle or their meat for local usage, however, meat and cattle are exported to other countries. Similarly, swine meat which may harbor the virus, could serve as a risk factor for the indigenous animal population, is imported for consumption by some foreigners residing in Pakistan.

The international trade of livestock and their products such as, semen, leather, wool etc. is now a major factor for strengthening of country's economy. Pakistan is earning foreign exchange worth billions of rupees by exporting livestock/livestock products to countries in the middle-east and Afghanistan. In some cases farmers are also importing selected high

yielding diary animals and semen for local production and cross breeding of local animals. This practice is not so safe as imported semen or animals may harbor the FMD virus and thus may endanger the local livestock population. To avoid FMD an international/national certification on the status of imported items need to be regulated. Moreover, the animal quarantine and FMD virus detection facilities need to be strengthened within the country or at borders where animals are exported. Efforts have to be made to control the illegal trade of animals between neighboring countries with Pakistan which may be the source of introduction of major outbreaks.

4.5.1.4 Health and Environment

There are reports from the interior Sindh and Punjab provinces that FMD virus in the vesicles on teats sometime infects the hands of milker, thus creating working problems for them. However, no human outbreak due to FMD virus has been reported in Pakistan. FMD is quite severe disease in the younger livestock. As FMDV has the potential to infect large population of animals, it can also have negative effects on the environment in terms of its contamination and as a risk to other susceptible animal population and humans. In cold northern regions of Pakistan, the virus might survive for longer periods on pastures. The virus can persist in contaminated fodder and environment up to one month depending on ambient temperature and pH. In suspensions the virus may survive at 80 ^{0}C up to 1 hr, 50 ^{0}C for 2 days, and 37 ^{0}C for seven days. It is stable when associated with dried organic matter. In the presence of carrier animals, different predisposing factors in unvaccinated susceptible animals, the FMD virus present in the environment can flare-up and cause clinical disease (Alexandersen et al., 2002).

4.5.1.5 Surveillance Cost

There is a very weak disease reporting and response mechanism in different provinces of the country. A regular FMDV surveillance programme with the support of lab for the detection of viral presence or its circulation among cattle, buffalos, sheep, goat or camels is not operational at present. Similarly, no comprehensive data regarding the virus free areas/zones, its prevalence, in sheep, goats and camels are available. The surveillance work is usually short lived and very much objective oriented and it terminates soon due to paucity of funds. The allocation of in-adequate funds from the donor agencies/government/private livestock owners/associations has been an important concern for planners to devise appropriate long lasting strategy for the control of FMD in this country. However, some preliminary work with the financial and technical support of FAO has helped Pakistan to gain level 1 in the international scheme of Progressive Control of FMD. Anjum et al. (2006) recorded the prevalence of FMD in Pakistan under the PDS programme during 2002-05. They stressed that animal movement was the most significant cause for the increased FMD incidence. As the disease has acquired epidemic status in this country, there is a dire need for establishing continuous surveillance system for studying the overall impact of the infectious diseases on livestock production in this country along with developing appropriate control strategy accordingly. A national programme for progressive control of FMD in Pakistan has recently been started in March 2011 with the technical and financial assistance of FAO.

4.5.1.6 Vaccine Production Cost

FMD virus vaccines are being manufactured both at the public and private institutions in Pakistan. In the government sector, three provincial Veterinary Research Institutes located at Lahore, Peshawar, and Quetta manufacture and supply FMD vaccines of water-base origin in the market and to the farmers. Although, the vaccine quality is not up to the mark as all the FMDV circulating strains are not incorporated in this vaccine, to some extent its use by the livestock farmers has helped in keeping the disease under control. However, due to lack of sufficient FMD vaccine production facilities and use of conventional stationary cell culture technology it is not possible to fulfill the national requirements of this vaccine. The government is making due efforts to renovate and expand the existing FMD vaccine facilities and support private vaccine manufacturers to get involved in FMD vaccine production for meeting the overall requirements of livestock in this country. It is estimated that around US$ 100 million is required to renovate and expand the existing vaccine production facilities at the government institutions for producing required FMD vaccine doses in this country. In addition, there are two small FMD production units in private sector, but their capacity to produce the FMD vaccine is quite low.

4.5.1.7 Bio-security and Management Cost

The livestock rearing in Pakistan is practiced under diverse environmental conditions in the field. In most parts of the country, farmers at the same premises keep mixed population of cattle, buffalo, sheep, goat, and occasionally camel. Even at the rearing places, there is no practical separation of one species of animals from the other. Majority of the owners keep 2-3 buffaloes without following proper husbandry system. Milking animals are mostly kept in the urban and peri-urban areas and even in the big cities. The nomads (travelling livestock owners especially in Baluchistan, KPK, and to some extent in hilly areas of Punjab provinces) keep their livestock moving from one place to another in search of green fodder, grazing pastures and water. If an outbreak is identified, there are no facilities for isolation of sick animals where they could be treated and provided with good husbandry environment. There is need to construct houses keeping areas with good facilities of potable drinking water, housing of the milking, pregnant, sick and disabled animals. In general, presently, there is no practice of bio-security in ruminant management and bio-security measures but to some extent are only undertaken in the organized government livestock farms. Therefore, there is immense need for educating the livestock farmers on the bio-security practices: concept of animal hygiene, cleaning, washing and disinfection of premises, quarantining newly introduced animals, isolation of sick animals, and proper disposal of dead carcasses for controlling FMD. It means a cost of constructing such facility that will have to be worked out while designing FMD control programme in this country, but unfortunately it would be only possible to adopt such practices at some of the bigger and well organized farms under the present set up of livestock rearing.

4.5.1.8 Compensation Cost

There is no mechanism of payment of compensation for the animals dying from infectious diseases in this country. Moreover, insurance policy for the livestock production to provide security to farmers against losses in the form of mortality/morbidity, poor growth, non-profitable production performance etc is also not in practice. Non-payment of compensation

especially to farmers affected by highly fatal animal diseases such as anthrax, HS, clostridium infections, poisoning etc by the government/livestock breeder associations many times puts the livestock owners out of the business. Introduction of compensation policy and insurance system for livestock may attract the farmers to practice the required precautions and undertake various bio-security measures for saving their animals from infectious diseases. Based on our successful experience of bird flu in Pakistan, it is very important to point out that a comprehensive compensation policy is essential for the control of contagious diseases like FMD. In this regard creation of a compensation fund through collaboration of public-private partnership needs to be established.

4.5.2 Peste des Petits Ruminant (PPR)

Based upon the estimates of epidemiological parameters and the data collected from the field regarding milk & meat loss and cost of treatment during an outbreak, the cost of PPR outbreak during 2005-07 was estimated using cost benefit analysis design. It was assumed that PPR is endemic in Pakistan and it affects 15% of small ruminant's population annually. On this basis, the expected overall morbidity and mortality during next five years is depicted in table-24. The parameters quantified in this regard included mortality, meat loss, milk loss and cost of treatment during outbreaks adding upto US $ 342.14 million (Table-25). However, if losses due to fodder lost and poor feed efficiency, distress sale during an outbreak, loss of lambs and kids due to abortions, high risk of other secondary infections due to immune-suppression in survivors of an outbreak and losses due to international trade restrictions are also pooled, the economic losses due to PPR in livestock sector will be much higher than those referred above (unpublished data, Zahur, AB, 2011).

Table 24: Overall Morbidity and Mortality (2005-07)

Species	Total Population	Affected population @15%	Morbidity			Mortality		
			Lower	Most likely	Upper	Lower	Most likely	Upper
Goat	61.90	9.29	5.52	6.31	7.09	2.23	2.80	3.38
Sheep	25.50	3.83	1.46	1.85	2.23	0.37	0.60	0.82
Overall	87.40	13.11	6.99	8.15	9.32	2.60	3.40	4.20

[Source: Zahur, AB.2011; Animal Health Programme, NARC}

Table 25: Total annual losses (2005-06)

Losses	Cost (Millions)		
	Lower	Most likely	Upper
Animals Lost- Goat	7799.40	9814.25	11829.09
Animals Lost-Sheep	1124.55	1790.10	2455.65
Meat Lost-Goat	4834.03	5517.26	6207.02
Meat Lost- Sheep	1281.85	1616.54	1951.23
Milk lost (goat only)	629.06	567.49	839.13
Treatment cost	1048.43	1222.94	1398.56
Total (Million Rs)	16717.30	20528.57	24680.68
Total (In US $)	278.62	342.14	411.34

4.5.2.1 Production & Productivity

Sheep and goat population of Pakistan are growing at a slow but consistent rate. As per Economic Survey of Pakistan (2010-11) country's sheep population is 28.1 million and goat population is 61.5 million (Table 26). The total mutton production during this period is estimated to be at 616 thousand tones. Sheep produced 36 thousand tones and goat produces 759 thousand tones of milk annually. The sheep and goat are also a source of skins and hides for leather & tanneries industry. In 2010-11, 48478 thousand of goat and 10620 thousand sheep skins were produced in Pakistan. In addition 42.5 thousand tones of sheep wool and 23.2 thousand tones of goat hair were produced. The population of sheep/goats is constantly growing around 3 percent despite poor husbandry practices, substandard feed/fodder and grazing facilities, weak health cover especially the vaccination coverage against multiple infectious diseases like PPR, FMD, blue tongue, HS, enterotoxaemia, etc. In general small ruminants are not reared under the good husbandry environmental conditions using good housing, grazing in organized pastures, stall feeding, and provided proper balanced nutrition despite the fact that in Pakistan small ruminant meat is more popular among the population as compared with beef or poultry. Furthermore, these animals are major attraction for any religious or social event where they are sacrificed more often than other food animals. These animals and their meat are also a source of earning of foreign exchange because of Halal status of this meat. Holdings of 50-100 sheep/goat herds at one place are quite common in rural setting in this country. It is envisaged that if the TADs affecting sheep/goats are brought under control in this country, there is a huge potential for increasing the productivity of these animals for public consumption and export.

Table 26. Sheep and Goat Production During 2010-2011

	Population (million)	Mutton (000 tones)	Milk (000 tones)	Skins (000 No's)
Sheep	28.1 million	116	36	10,620
Goat	61.5 million	500	759	48,478

(Source: Economic Survey, Govt. of Pakistan, 2010–11).

Morbidity and mortality due to PPR has direct economic impact on the sheep/goat production, farmer's income and his livelihood**.** In case the PPR outbreaks are not handled properly, the indirect losses to farmers continue in the form of reduced productivity of the animals even if apparently there is no clinical case of the disease. The reproductive efficacy of such animals may also be compromised and animals with improper recovery from PPR may give birth to fewer off springs. The loss of animals may also affect the routine working of leather and garments industry along with the business of butchers, because of increased cost of meat on account of its shortage. This will also affect the work efficiency of farmers and veterinarians.

4.5.2.2 Price and Market Effects

The prices of live sheep and goats are variable as these are governed by demand and supply phenomena. These animals usually yield high prices around Eid ul Azha festival or when the animals are exported. However, under optimum market conditions the general prices of

mutton now-a-days range between US $ 5-7 per kg. However, when PPR strikes, it affects the cost of production in a flock and shortage of its produce result in hike in prices.

There is middle-man marketing system for mutton animals in Pakistan. As there exists no organized direct system of sale and purchase of animals by the slaughter house authorities, there is no value addition of the slaughtered animal and whole of the carcass is sold to butchers for retail meat selling. Market system also affects negatively to livestock owners under the circumstances when there is more supply of animals from various parts of the country to major trading areas. Due to transportation stress, the animals become sick and this leads to poor price of animals for the farmers, especially during outbreaks when farmers usually opt for distress sale. The skin and hides are sold to leather industry, wool and hair to garment industry, fat to soap and cosmetic industry and meat for human consumption. Since PPR infection leads to heavy morbidity (sheep, 51.54%; goats, 76.54%), and quite significant mortality (sheep 16.73%; goats 23.90%), the outbreaks definitely affect the marketing system negatively. There will be less number of animals supplied to the markets and slaughter houses as the diseased animals cannot fetch reasonable prices in the markets and distress sales will cause economic loss to the farmer and middle man. Furthermore, transportation of sick animals from an infected foci results in introduction of infection into new areas.

4.5.2.3 National and International Trade

Live sheep/goats trade is quite common in this country and there is movement of animals between all the provinces/regions of the country. The animals reared in marginal areas are transported to slaughter houses near big cities by traders. Beside this weekly livestock markets are organized near all cites/ towns of livestock rich regions of the country for the sale and purchase of animals. The whole sale of the dressed carcasses takes place at the slaughter houses from where the meat is transported to retail shops on private vehicles lacking proper cooling/refrigeration facilities. Occasionally in small towns, there is street slaughtering of animals by the retailers. The retail meat shops also lack good hygienic facilities. The PPR incidence affects the national trade negatively as it is not desirable to trade sick animals in the markets. Transport of sick animals to market in the far flung areas render them vulnerable to more infection and ultimately pushes them towards death.

Live animals and occasionally the dressed mutton are exported to middle- east and Arabian Peninsula. Beside this, illegal trade or smuggling also exists between the neighboring countries especially Afghanistan. There looks to be good scope for the international trade of small mutton type ruminants in this country, provided good management and disease control measures are adopted along with offering halal meat certification by the government. PPR negatively affects the international trade and a PPR disease free certification of the animal is required before its international shipment.

4.5.2.4 Health and Environment

There is no report on PPR virus infecting humans. However, the disease is very severe in small domestic and wild ruminants. Since the PPR virus has the potential to infect large population of animals, it can have adverse effects on the environment in terms of its contamination which in turn can infect other susceptible animal population. In cold regions, the PPR virus might survive for longer periods on pastures. However, the virus is destroyed

in 60 minutes at 60 ^{0}C. The virus survival in the environment is challenging for the health of susceptible animal population, especially when they suffer from some other physical stress factors.

4.5.2.5 Surveillance Cost

There exists no regular surveillance programmes for the livestock infectious diseases in general and PPR in particular in this country. The surveillance investigations are initiated only in the event of increased losses by diseases like PPR. The surveillance work is usually patchy, short lived and terminates soon after the disease incidence subsides or upon completion of a short term project. The limited allocation of funds from the donor agencies/government/private livestock owners/associations is of major concern. The poor farmer who rears small ruminants to sustain and support his family does not have the capacity to pay for the cost of surveillance for TADs. There is a dire need to undertake surveys for various infectious diseases like PPR as these are the diseases which can cause major economic blow to the sheep/goat owners and lead to the very poor availability of animal proteins at exceptionally high cost. A nation and region-wise PPR surveillance programme is required for its proper control.

4.5.2.6 Vaccine Production Cost

The use of tissue culture based PPRV live vaccine has shown promising results in the field. The vaccine is commercially available in Pakistan. However, there are only two public sector veterinary institutes engaged in the production of this vaccine. Because of the other priorities and irregular provision of funds, these institutes are unable to produce sufficient quantity of PPR vaccine to cater the local demand. Therefore, there is a need to develop effective business plan for improving and enhancing PPR vaccine production at the existing vaccine production units in public sector and to support any private sector initiatives in this regard. Some funds would need to be diverted to undertake research in the areas of improvement of existing vaccines as well as monitoring post-vaccination response in the field. This vaccine can be dispensed through the existing system of livestock department immunization programmes.

4.5.2.7 Bio-security and Management Cost

As mentioned above, sheep/goat rearing in Pakistan is practiced under very hard and non-conducive environmental conditions in the field. There are several production systems for farming small ruminants in the country, namely; nomadic, transhumant, sedentary and/or household (Zahur et al., 2008). A total of 44% of small ruminants are raised under nomadic system; 38% are raised in the transhumant system and 18% are produced in either sedentary or household system (Ishaque, 1993). Therefore under such circumstances the concept of bio-security is difficult to implement. If an outbreak of PPR is identified in a particular flock, there are no facilities for isolation of sick animals where they can be treated and provided with good husbandry environment, nor any immediate veterinary service is available for treating the sick animals and implementing the outbreak control measures. During PPR outbreak usually 2-3 months of additional management cost will have to be borne by the flock owner and the effectiveness and duration of this management would depend upon the quality of housing facilities at a particular place. Even in case of organized

farms, there is a need to construct animal houses keeping areas with good facilities of potable drinking water, housing of the milking, pregnant, sick and disabled animals. Recently, in all the provinces a department of publication and awareness has been established which provides the relevant disease control information to the farmers and field veterinarians through print and electronic media and public gatherings. Cost of such activities is usually borne by the livestock department in all the provinces. However, further investment is to be made for improving functioning of such departments.

4.5.2.8 Compensation Cost

There is no mechanism of payment of compensation for the sick or dead animals in Pakistan for the PPR outbreaks. Moreover, insurance policy for the livestock production to provide security to farmers against losses in the form of mortality/morbidity, overall disease incidence, poor growth, non-profitable production performance etc is also not in practice. Due to non-existence of such production security system, outbreaks of major fatal animal diseases such as anthrax, PPR, HS, clostridium infections, and poisoning in small ruminants do occur repeatedly and compel the livestock owners to suffer and go out of business. This usually affects the overall productivity of small ruminants in the country and the price is eventually paid by the public who have to face shortage of small ruminants resulting in an increase in meat prices in the market. Introduction of compensation policy and insurance system for livestock will definitely attract the farmers to practice high technology based animal production which will eventually help in increasing the animal number with better growth potentials. The compensation can be either paid through the government funding linked with compulsory vaccination policy or through the policy of insurance of animals by state owned or private agencies.

4.5.3 Avian Influenza

In 2006, a few poultry farms in the provinces of NWFP and Punjab were diagnosed as infected with AIV H5N1. There was high morbidity and mortality in the affected flocks. Following the laboratory confirmation, all the birds at those affected farms were destroyed under the advice of state veterinarians. The deadly HPAI virus infection along with depopulation of chickens caused heavy economic losses to the poultry farmers rearing commercial and breeding flocks. There were additional losses in terms of cost of medication, isolation, quarantine, carcass disposal, disinfection etc. The panic of bird flu had worst economic impacts for the farm owners as some went out of business due to loss of their total investments. Moreover, the public in general stopped to consume poultry meat and eggs. The farmers became reluctant to rear new flocks. This situation led to the closure of over 60 percent of commercial broiler and layer farms in the high density areas of commercial poultry in the provinces of NWFP and Punjab. Many of the breeding flocks, although not infected with HPAI virus, had to be culled as the sale of progeny chicks had almost ceased during outbreak period. Later on, after regaining the trust of egg and meat consumers upon reports on the absence of bird flu from most parts of the country, some recovery in demand and supply situation was noticed. Subsequently, there was a jump in the prices of eggs and meat due to their shortage in the market. However, this impact on the business of poultry and poultry products fluctuated next three years till H5N1 was eliminated from the poultry in July 2008. In addition to the above economic stress to the farmer, the labor working at the affected farms also faced the situation of redundancy and lesser job opportunity in the

poultry business. In Pakistan the overall economic impact of HPAI is summarized as under:

There was very heavy mortality (range 60-75%) in the infected flocks and the laboratory officially confirmed HPAI infected flocks along with any feed bags, eggs, vaccine stock etc were destroyed. Additionally, international regulations imposed a ban on the export of chicken and chicken products from Pakistan. As reported above, the indirect losses to the breeder farmers were in the form of poor prices for day old chicks; costs on bird killing and carcass disposal, disinfection etc; keeping the farm vacant (loss of farm rent) for 1-3 months during post outbreak period; increased cost on bio-security implementation; culling of some un-infected flocks due to poor sale of eggs, chicks, meat; additional cost on repeated vaccinations of AIV in subsequent flocks; reduced market price of chicken meat and eggs especially in outbreak areas. During these outbreaks there were totally negative effects on poultry business (feed manufacturer, street butchers, caterers, chicken meal serve in hotels). Most of the farm workers in outbreak areas lost their jobs due to economic stress on their employers (Muneer and Azim, 2009). During the post HPAI outbreak period the prices of beef and mutton also increased due to its higher demand in place of chicken meat.

4.5.3.1 Production & Productivity

The current investment in poultry sector of Pakistan is over Rs. 200 billion and the sector continues to grow annually at a rate of 8-10 percent. Commercial poultry production a well organized sector consists of broiler grand-parent, breeder, and commercial flocks housed mainly in Punjab, Sindh and Khyber-Pakhtoon Khawa (KPK). In addition to this, there are layer breeder and commercial layer flocks and rural poultry (reared as back yard, and scavenger birds). As per Economic Survey of Pakistan 2010-11; of the total 3094 million tones of meat, the share of poultry meat production per annum is 767 tones (24.78 percent). Moreover, commercial and rural poultry annually produce 12457 million eggs for the human consumption. The poultry sector generates employment for about 1.5 million people. Three types of poultry production systems exist in this country. In case of rural backyard poultry a flock consisting of 5-50 birds-occasionally consisting of mixed population of chicks, ducks, pigeons, quails etc are reared at one place. The semi-commercial broiler flocks consist of 100-2500 birds; and commercial flocks of broilers, layers, and breeders usually comprise of 5000-100000 birds. The management conditions in terms of shed environment, vaccination-medication and disease control, bio-security etc. are optimal for the flocks having higher number of birds. Since the days of bird flu, it has been realized that better productivity can be obtained by raising chickens in environmentally controlled housing system. In this regard during the past four years over 3000 new environmentally controlled housing system have been installed throughout Pakistan, which resulted in improving poultry production potential. Although in peri urban and urban areas commercial poultry is mostly housed in environment controlled farms with automated feed, water and light availability; a major component of poultry is still reared under open-shed system where birds are exposed to extreme weather conditions and pathogens that circulate in abundance around the farm environment. The weather stress and poor husbandry conditions predispose birds to infectious diseases such Newcastle, Gumboro, Avian Influenza etc. As a whole, the HPAI had an overall negative effect on the production and productivity of poultry in Pakistan.

4.5.3.2 Price and Market Effects

The price and market effects on poultry are never constant due to non-existence of statistics on production-demand-supply index at national level. The chicken prices are dependent on routine demand and supply and on certain Islamic ceremonial days, marriages, parties and also upon the international demand of poultry. During the outbreaks of H5N1 during 2006-08 the prices of day-old chickens varied between US $ 0.1 to 0.60. Similarly, the live chicken meat price also varied from US$ 1.00 to 2.00 per kg. During this period, per dozen eggs price remained highly variable between US $ 0.70 to 1.00. As a whole the market price of poultry products generally lowered by 40-60% during different stages of AI outbreak. This decline negatively affected the price and market of related products such as, poultry feed, drugs, vaccines, utensils and machinery used in poultry rearing, production etc.

4.5.3.3 National and International Trade

Poultry trade is quite well undertaken through out Pakistan. Movement of live birds is practiced through poultry estates, regions, provinces, AJK, FATA, and Gilgit-Baltistan. Table eggs are transported from production pockets to urban areas and big cities in the country. Fertile eggs are transported from the breeding farms to hatcheries located throughout the country mostly in the sub-urban areas. Dressed and processed poultry is also transported across country from slaughtering points to urban and peri-urban areas. In metropolitan cities poultry is sold in open markets where inefficient, small scale poultry slaughtering and dressing facilities are available. Many shops at the weekly bazaars keep and sell mixed populations of chickens, ducks, quails, pigeons, parrots, finches etc. and table eggs. During the outbreak season of HPAI H5N1, above described markets were badly affected. Due to ban on commencement of various weekly markets and bird shows during outbreak period, most of the small poultry and pet bird businesses were badly affected. Furthermore, due to movement ban in some affected poultry areas huge losses were faced by the farmers by storing hatching eggs and table eggs along with delayed delivery of broilers to the market.

Live poultry including culled birds are exported to some countries in the middle- east and neighboring Afghanistan. This trading remained suspended till the time Pakistan was declared free from bird flu in July 2008. Furthermore, pet and wild bird marketing and export also remained suspended during this period, which badly affected the exports of such birds. Movement of day old chickens and hatching eggs out of the country also remained suspended resulting in economic losses at individual as well as national level. With the introduction of new rules of zoning of clean areas for export, there is a chance to deal with these issues more effectively in case of any future outbreaks of TADs.

4.5.3.4 Health and Environment

The avian influenza in human is well recognized as a major zoonotic infection. With the previous history of major pandemics of humans arising from avian influenza viruses, it is quite logical to believe that new pandemic may arise anytime because of vast circulation of different avian influenza virus types. Therefore, the emergence of H5N1 virus infection in poultry and subsequently its selective transmission to human beings in this country and else-where resulted in huge impact on the economy of the country as it demanded undertaking required precautions and preparations for reducing the anticipated losses due to HPAI.

Strong national preparedness and response plans for encountering H5N1 infection both in poultry and human health sectors were developed and financed by the government as well as by the international donors like the WHO, FAO, EU, USAID etc. This included stock piling of antiviral drugs for humans, strengthening of early reporting, and response against AI, improvement of lab diagnosis, capacity building of institutions involved in disease surveillance, reporting and response, launching numerous awareness campaigns, along with publishing of relevant literature.

For improving the environment, a number of efforts were made in terms of improving bio-security at the farms, proper disposal and disinfection of H5N1 affected farms, decontamination of environment at affected farms, introduction of better disposal of chicken waste, improving hygienic conditions at chicken rearing, slaughtering and marketing places.

During 2006-2008, HPAI H5N1 virus outbreaks were quite frequent in poultry and 51 outbreaks recorded in broiler-breeder, commercial broiler, layer flocks and migratory wild birds in the provinces of KPK, Punjab, and Sindh were reported to OIE. The infection resulted in culling of over 272639 birds. The affected farms were thoroughly cleaned, disinfected and made operational after some time break. The farmers were paid compensation for their losses as per earlier approved procedure by the government. In this case a total of US $ 0.3 million was paid in compensation to the HPAI H5N1 virus affected farmers (Table 27) (Muneer, 2010).

Table 27: Mortality and Stamping out Data for HPAI H5N1 (2006-10)

Year	Flocks Affected				Flock Culled [a]			
	Beeders	Broilers	Layers	Backyard	Breeder	Broiler	Layer	Backyard
2006	07	02	03	0	88263	13000	22780	0
2007	06	05	09	06 + 6*	90824	14474	18449	12
2008	01	06	0	0	6558	18279	0	0
2009	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
Total	14	13	12	12	185645	45753	41229	12

*Pigeons, turkeys, Peacocks, geese etc., Total birds culled=272639

[a] All infected poultry culled and any hatching eggs destroyed

[aa] A total of Rs. 23.525 m paid as compensation to HPAI H5N1 virus affected flock owners

4.5.3.5 Surveillance Cost

In Pakistan, there is very little information on the routine surveillance for infectious diseases in poultry and livestock at public or private levels. However, serious efforts were made during the outbreak of HPAI H7N3 in 2004-5 by setting up eight AI Provincial Surveillance Units, coordinated by the National Reference Lab for Poultry Diseases (NRLPD) at federal level. This facility was subsequently expanded in 2007 under the "National Programme for the Control & Prevention of avian influenza" (NPCPAI) which was executed in this country during 2007-11. Under this programme a set up of 40 AI surveillance units and 66 Rapid Response Units were added to the earlier existing provincial/area surveillance units. Further, at federal government level a Federal Surveillance Coordinator (Animal Husbandry Commissioner), was appointed to collaborate with Regional Surveillance Officers, Provincial Surveillance Officers at designated provincial/regional/area diagnostic and/or

surveillance units for generating a national level surveillance data for the information of Federal Government and also sharing with international organizations like OIE, WHO, FAO, USDA, UNICEF etc (Table 28). It is estimated that around US$ 40 million was invested in terms of capital cost and training cost to establish this network between 2005-08 and a sum of around US $ 1.2 million was spent annually to run the network activities. These efforts paid off quite effectively when in July-2008, Pakistan was eventually declared free from HPAI H5N1 by OIE. Although this country is currently free from bird flu, however, the AI surveillance network is still operational through the coordination of NRLPD, where circulation of new serotypes of AI viruses in poultry is still being monitored. The NRLPD has repeatedly reported isolation of low path AIV H9N2 during the past few years.

Table 28. AI Surveillance Data under NPCPAI (2007-11)

Year	Number & Type of Samples Analyzed				Sero-Conversion (Non AI-Vaccinated)			Isolation		
	Tissues	Swabs	Blood	Total	H9	H7	H5	H5	H7	H9
2007-08	23785	46543	60085	130413	-	-	6046	66	00	61
2008-09	6009	164681	152290	322980	20907	1053	-	-	-	09
2009-10	7993	96581	145947	250521	62	70	-	-	-	35
2010-11	16100	37555	54115	107770	1163	1009	-	-	-	10
Total	53887	345360	412437	811684	22132	2132	6046	66	00	115

4.5.3.6 Vaccine Production Cost

Since the first introduction of Avian Influenza in Pakistan in 1994, attempts have been made to develop AI vaccines locally by the institutions in public and private sector. In the mean time during different periods over the past 10 years AI vaccines of H5, H7, & H9 have been imported to this country as well. In this regard it has been noticed that the locally manufactured vaccines provide better immunity against the circulating strains of these viruses. At present two institutions in public sector and four institutions in private sector are involved in the production of AI vaccines. The local production of vaccine has helped to reduce the cost of available AI vaccines. Despite the fact that huge cost has been made to develop production units for AI vaccines, this has somehow helped to strengthened local vaccine production sector in this country. Especially with the involvement of private sector in poultry vaccine production, there has been expansion in the area of livestock vaccine production as well. This has in fact helped to save millions of dollars of foreign exchange which was earlier spent in the import of such vaccines. Furthermore, the local vaccine production has helped the poultry industry to revive at a faster rate because of better efficacy and regular availability of these vaccines. So, as a matter of fact the investment made by the public and private sectors in the area of AI vaccine production has been economically more beneficial. These capabilities can be further expanded to develop vaccines against other TADs with very little investment in future as well.

4.5.3.7 Bio-security and Management Cost

Bio-security practices at poultry farms in Pakistan are quite variable. The open shed system commercial broiler and layer farms observe only negligible bio-security principles, and this practice results into colossal production losses mainly due to occurrence of infectious

diseases such as avian influenza at those open shed farms. Occasionally the occurrence of these infectious diseases can compel the farmers to close down their business due to very high bird mortality.

Farmers rearing the Grand Parent and Breeder flocks, however, implement stringent bio-security measures at their operations. In contrast to open broiler and laying bird farms, the grand parent and breeder farm buildings are built taking into consideration the bio-security requirements. Major emphasis is laid on the construction of environment controlled sheds, provision of automation facilities, wearing of gum-shoes, use of disinfectants and restricted entry for the common people. Generally the constructed sheds do not allow the entry of wild birds, wild and stray animals: rats, cats, dogs etc. Since the ambient temperature in these sheds is controlled, therefore, the air-flow in the shed is regulated by closing free air entry-and-exit (air-tight closed environment). The water and feed supply in these sheds is fully automated. At present cost of one such unit to raise 100,000 broilers is estimated around US $ 180,000 and in Pakistan around 3000 such units have been constructed since the introduction of H5N1 in 2006.

The major bio-security management costs in old fashioned open housing systems include the followings:

1. Construction of bio-secure farm buildings
2. Construction of farm boundary walls so as to prevent the entry of wild animals, wild birds, un-authorized persons
3. Provision of uniform clothing to each farm worker
4. Provision of washing and bathing facilities
5. Construction of dead bird disposal pits
6. Provision of a separate area for culled and sick birds
7. Use of disinfectants in the contaminated areas, surfaces, and on farm vehicles

Farm construction costs are usually very high and come to around US $ 10 per square foot. However, the cost to routinely practice bio-security is not so high and it may be around US $ 5-6 per 1000 breeder chickens. During the NPCPAI implementation farmers, veterinarians, vaccinators, feed manufacturers, butchers, etc were offered trainings on implementing bio-security at different levels by the local and foreign experts. The joint efforts of the stake holders helped to achieve control of AI in poultry.

4.5.3.8 Compensation Cost

In Pakistan, there is no scheme for poultry farm/flock insurance or payment of compensation to farmers who suffer from the high economic losses due to mortality of birds caused by contagious lethal infectious diseases. In the absence of any such schemes, the affected farmers who suffer heavy losses often go out of poultry business which is a direct loss to the national economy. Taking into consideration the heavy mortality caused by HPAI (H5N1) virus, and the fact that the HPAI infected flocks were force-fully culled by the Livestock and Poultry authorities of the provincial governments, the Government of Pakistan allowed for the payment of compensation @ 75 percent of cost of birds, feed, eggs etc to the HPAI (H5N1) affected farmers under the circumstances when their HPAI positive flocks were culled by the Government authorities. During 2007-08 period, a total of 272639 HPAI

infected birds were culled as per AI control policy and a sum of around US$ 0.3 million was paid to the affected poultry farmers as compensation to encourage them to come back in poultry business. Payment of compensation to the farmers helped in early reporting of suspected HPAI outbreaks and subsequent culling of infected flocks.

4.5.4 Hemorrhagic Septicemia

Hemorrhagic Septicemia is economically significant disease for the livestock owners in Pakistan and other countries in the region. Since Hemorrhagic Septicemia runs an acute or subacute course in the susceptible subjects, therefore infected animals are seen in the advanced clinical picture and mostly die due to non-availability of treatment required to be administered without wasting even a moment. The losses due to Hemorrhagic Septicemia to the livestock farmers are in the form of very low milk yield, expenses on vaccination and treatment, distress sale, and mortality among the infected herds.

Buffalos are kept preliminary for milk production and rarely used as drought animal where as cattle are also kept for milk production as well as drought animal. HS is considered to be economically most important disease of livestock which causes highest mortality in buffaloes in a country. This is one of the major routine diseases of Pakistan, among the six identified in this category namely, HS, FMD, Mastitis, Diarrhea, Hemoglobin urea and sudden death in livestock.

4.5.4.1 Production & Productivity

As per Economic Survey of Pakistan, 2010-2011, country's buffalo, cow, sheep and goat populations are 31.7, 35.6, 28.1 and 61.5 million animals, respectively. The total beef and mutton production during this period is reported at 2327 thousand tones. Both skins and hides of these animals are major source of leather for local industry. In 2010-11, a total of 59,098 thousand tones skins were obtained from these animals. In addition, during this period 42.5 thousand tones of sheep wool and 23.2 thousand tones of goat hair were also produced. During the period total milk production from these animals is estimated at 45622 tones. The population of these animals is constantly growing around 3.00 percent annually despite poor husbandry practices, poor feed/fodder and grazing facilities, poor health and management coverage including vaccination against different infectious diseases like HS, PPR, FMD, blue tongue, anthrax, etc. In general livestock is not reared under the production friendly environment and provided good housing, grazing in organized pastures, stall feeding, and/or nutritionally balanced rations despite the fact that these animals are the source of nutritionally rich meat, mutton and milk which are direly needed to feed the human population. Livestock is also a source of earning of foreign exchange. Holdings of 2-5 cattle/buffaloes and 50-100 sheep/goat per herds are quite common in rural areas. In case the TADs like FMD, PPR and HS, which inflict heavy losses in livestock industry, are brought under control there is a good potential for increasing animal number and their productivity.

HS has direct economic impact on the livestock production in Pakistan as its incidence is quite high in animals especially those populations raised under stressed conditions. Most of the infected animals die, thus this disease has direct negative effect on income and livelihood of the farmers**.** Pakistan has been confronted with the problems of high morbidity (buffaloes;

adult 5.49, calves 95.25%: adult cattle 2.51%, young cattle 3.94%) and mortality (Buffaloes; adult 5.49; claves 22.25%: Cattle; adult 0.39%, calves1.77%) due to HS. In case the HS outbreaks are not handled properly, the disease may continue killing the animals which may ultimately influence productivity and population of livestock. A calculation of economic impact of HS in a herd of 100 buffaloes in terms of direct losses indicates that losses in milk production due to morbidity, mortality, treatment and vaccination cost, and losses due to distress sale may amount to US$ 1359, 1200, 150, and 240, respectively (Tables, A, B, C, D).

A) Losses in milk production potential

Suppose an animal on an average was producing per day milk at @	11.21 liters
Average milk production per day decreased due to HS to	1.14 liters
Loss per day milk production per day due to HS	10.07 liters
HS disease duration	8 days
Milk loss during 8 days	80.57 liters
Average per day milk production after disease recovery	6.18 liters
Milk loss after disease recovery in 90 days	453.21 liters
Milk price per liter in 2010	$.0.50 per liter
Value of milk loss per animal	0.5X453.21=$ 226.60
Suppose morbidity rate in 100 buffaloes is	6
Loss of milk in 6 buffaloes	453.21X6= 2719 Liter
Total Value of milk loss (@ $ 0.5/ liter)	2719X $ 0.5= US $ 1359

B) Losses due to mortality

Reported mortality in 100 animals (Buffaloes)	2 animals
Average sale price of one female buffalo	$ 600
Total loss due to mortality of buffalo/cattle	$ 1200

C) Losses incurred upon treatment of HS cases

Treatment and vaccination cost per sick animal	$ 25
Total sick buffaloes percentage	6
Total Value of treatment cost in buffaloes	25X6= $ 150

D) Losses due to distress sale

4% of diseased animal (buffaloes)	4
Value of loss in buffaloes	4X 600=2400
Total loss due to distress sale in buffaloes	$ 2400

4.5.4.2 Price and Market Effects

The prices of buffalo, cattle sheep and goats are quite variable throughout the year and are based on factors like demand and supply, age, sex, health, body condition, pregnancy, stage of lactation, type of animal (milk or meat), reproductive cycle, fertility, carcass dressing

ratio, location of animal (urban, peri-urban, rural, remote area etc.), parties, meetings, or those sold for sacrificing at religious events such as eid-ul-azha (Celebrated by sacrificing livestock), In Pakistan, the meat type animals usually fetch higher prices around religious festivals or upon their export to other countries. However, under routine conditions the general prices for a lactating cattle vary between US $ 600-900, for a buffalo from US $ 650-1000. In case of an HS outbreak, the owner gets very little time to get the sick animal treated. Therefore, most of the sick animals usually, die or are slaughtered and carcass is sold in distress. This results in financial losses to the farmer in terms of loss of diseased animals and it also negatively affects the livelihood of the affected farmer's family as it loses the source of income. In view of broad variation in HS prevalence under different types of production systems for raising cattle and buffaloes in this country, the losses due to HS also remain variable being higher in the animals raised under various stress conditions as mentioned above. As a matter of fact, frequent outbreaks of HS in a particular area may ultimately lead to shortage of dairy and draught animals, eventually resulting in increase in milk and meat prices in the market in the affected areas. Shortage of such animal force may also affect their usage in agriculture work. Due to HS incidence thousands of animals are lost every year resulting in reduced population of animals and creating shortage in the local livestock markets, ultimately creating reduced availability of beef and milk to the common consumer of animal products in the country.

4.5.4.3 National and International Trade

High rates of morbidity and mortality due to HS may have major implications for the farmers who plan to rear the animals for the national needs and for the export purpose. Movement of animals for the purpose of trade, within the country includes their transportation and supply from one village to another, tehsil to district, across districts, and also across the provinces. Similarly, trade or movement of such animals to and from the countries like India, Afghanistan, Iran, China etc, having borders with Pakistan also contributes to the incidence of HS in the susceptible non-vaccinated populations. Although Pakistan does not export much of the buffalo/cattle or their meat but the sheep/goats are exported in a reasonable number. However, there is huge potential of raising beef animals and exporting them to the middle-eastern countries and also to other Halal meat consumer markets in the region. The prevalence of TADs, including HS is negatively affecting the production economics and growth of livestock sector in this country.

Under a different scenario, the existence of TADs in this country and region at large is detrimental to the policy of importing high producing dairy and beef animals for its cross breeding with the local animals, as the imported animals are highly susceptible to these TADs. Elimination and control of HS in Pakistan will definitely help the farmers to gain access to high value international markets.

4.5.4.4 Health & Environment

There are no reports on the public health concerns regarding HS infection. However, as HS bacterium has the potential to infect large population of animals, it can also have negative effects on the environment in terms of its contamination and to act as a risk to other susceptible animal populations in the outbreak area. As in most of the cases *Pasteurella multocida* is known to stay as carrier in healthy animals, where it can continuously

contaminate the environment and eventually may trigger disease in susceptible, unvaccinated, nutritionally and temperature stressed animals The carrier state of animals following HS infection is very dangerous as the around 20% of the carrier animals keep on shedding the HS causing bacteria in the environment, which might be resulting in new outbreaks of HS in the area.

4.5.4.5 Surveillance Cost

There are no organized regular surveillance programmes for monitoring the prevalence of HS in cattle, buffaloes, sheep, goats or camels despite the fact that the disease is endemic in many areas of Pakistan.

4.5.4.6 Vaccine Production Cost

HS vaccines are being manufactured both in public and private sectors in this country. In the government sector, four Veterinary Research Institutes at various places manufacture and supply both water & oil-based HS vaccine in the market and to the farmers. Moreover, these types of vaccine are also manufactured by five private pharmaceutical companies in the country. Due to the availability of local vaccine production capability at local level, Pakistan does not import HS vaccine. Use of HS vaccines by the livestock farmers has helped in keeping the disease under control to greater extent. However, the capability of these units is still very low in comparison with the demand of this vaccine at the country level. Therefore, despite the existence of local HS vaccine production capability, it is the high time to increase production capability of the existing vaccine production units in the country.

4.5.4.7 Bio-security & Management Cost

The livestock rearing in Pakistan is practiced under diverse environmental conditions in the field. In most parts of the country, farmers at the same premises keep mixed populations of cattle, buffalo, sheep, goat, and occasionally camel. Even at the rearing places, there is no practical separation of one species of animals from the other. Majority of the owners keep 1-2 cows or 2-3 buffaloes or both along with 2-4 sheep or goats without focusing on proper husbandry practices. Milking animals are mostly kept in the urban and peri-urban areas. The nomads (travelling livestock owners especially in Baluchistan, KPK, and to some extent in hilly areas of Punjab) keep their livestock moving from one place to other in search of green fodder, grazing pastures and water. If an outbreak is identified, there are no facilities for isolation of sick animals where they could be treated and provided with good husbandry environment. Even the animal sickness is seldom reported to the veterinary authority. There exists a need for constructing the animal houses keeping areas with good facilities of potable drinking water, housing of the milking, pregnant, sick and disabled animals. Although in general good bio-security measures are only in practice in the organized government livestock farms or at a few modern dairy farms, an immense need does exist for educating the livestock farmers in the remote areas and those who keep their animals in open holdings regarding the bio-security practices such as concept of animal hygiene, cleaning, washing and disinfection of premises, isolation of sick animals, restricted movement of animals in the event of various disease outbreaks, proper dead carcasses disposal, rearing only one species of animals at one place for avoiding circulation of infectious disease agents in their animal

populations. Initiation of programmes on practice bio-security at various farm and husbandry levels will definitely have positive effects on the livestock rearing and control of TADs.

4.5.4.8 Compensation Cost

At present, there is no mechanism of payment of compensation for the dead or moribund livestock in this country. Moreover, insurance policy for the livestock production to provide security to farmers against losses in the form of mortality/morbidity, overall disease incidence, non-profitable production performance etc. is also not in practice. Therefore, non-payment of compensation especially to farmers affected by highly fatal HS or other TADs by the government or livestock breeder associations or by an insurance company sometimes puts the livestock owners out of their business. It may, therefore, be appropriate to propose that some sort of compensation policy or livestock insurance scheme may be introduced in this country which will definitely attract the farmers to undertake the required disease control measures by practicing better bio-security, hygiene, and vaccination for the control of HS. This will help in increasing the animal number and their growth potentials to benefit the farmer and government.

4.6 Economic Impact of TADs in Sri Lanka

4.6.1 Production and Productivity

Hemorrhagic septicemia (HS) and Foot and Mouth Disease (FMD) had been given a significant economic impact on dairy farming industry in Sri Lanka for past few decades. Both HS and FMD are enzootic in low country dry zone where livestock farming is major livelihood in the society. Over 70% of the low country dry zone is earning their living through farming (agriculture and livestock).

Most of the cattle and buffalo farms as well as other animals concentrated in these areas. The number of cattle and buffalo farms in the area is 57.64 % and 53.47% of the total farms respectively in the country. Similarly the heads of cattle and buffaloes are 75.96% and 82.39% of the total population of the country respectively.

The predominant extensive management systems in the area are some of the animals are reared in semi intensively. Average number of animals per farm in extensive system was 64.2 with a minimum of11 to maximum of 485. The average Milk production per animal was 1.6 L/day in low country dry zone in extensive management system (Kothalawala, 2009). Though the average productivity is quite low in this system there are animals with 6.2 L/day in some farms. The total milk production per farm has ranged from 2 .2 l- 40 .5 l per day. The area contributes over 70 %of the total milk production in the country (Census and Statistics, 2010). Since the fat content (4.5% -6.0 %) and SNF content is high (8.5 %– 9.8 %) in milk in this area, farmers may fetch best farm gate price (52.00 SLR) for their milk according to the local milk payment system. The FMD has recorded significant losses on milk production and meat production.

It was recorded that the average of 50 % of the milking herd, 10% pregnant dry cows , 20% of the heifers and 30 % of the calves has been infected in extensive management system and only 25 % of milking herd,5 % of the dry cows and 8 % of the calves was infected in commercial semi intensive system. The total deaths out of infected animals were 12 % in

extensive system and that was 04 % in semi intensive commercial farm. The milk production loss per farm even after 3 months of the disease was recorded as 41.4 % and 11.2 % in extensive system and semi intensive management systems respectively (Badralatha and Kothalawala, 2010). However, the treatment cost per infected animal was higher (Rs. 54.39) in semi intensive management system than that of extensive system (Rs. 9.25) according to the study conducted by Badralatha and Kothalawala in 2010 in Dry zone, Sri Lanka.

Table 29 depicts the annual total cost estimated direct losses viz. milk loss, calf mortality, meat loss due to prolonged off food, cost on additional labour involvement on diseased animals, cost on treatment for animals, cost on delaying artificial insemination from year 2005 to 2010 to the farmers (Farmers' cost) . The cost on vaccine and vaccine administration (cost to the government) is not included here. It shows that the country has to bear an average of 16.27 million SLR annually (except cost on vaccines and vaccinations) as the direct cost on production and productivity due to FMD.

Table 29. Estimated Direct Cost on FMD Outbreaks to the farmer from 2005-2010

Year	Cost on milk loss	Cost on calf deaths	Cost on meat loss	Cost on labor	Cost on treatment	Cost on delaying AII	Total cost
2005	1,659,600	15,000	6,640,000	414,900	22,410	1,475,200	10,227,110
2006	651,600	10,000	2,608,000	162,900	8,802	579,200	4,020,502
2007	1,364,400	65,000	5,456,000	341,100	18,414	1,212,800	8,457,714
2008	7,736,400	445,000	30,944,000	1,934,100	104,436	6,876,800	48,040,736
2009	559,800	10,000	2,240,000	139,950	7,560	497,600	3,454,910
2010	3,772,800	190,000	15,088,000	943,200	50,922	3,353,600	23,398,522
Av. (6 years)	**2,624,100**	**122,500**	**10,496,000**	**656,025**	**35,424**	**2,332,533**	**16,266,582**

Source: Estimated based on unpublished data

The socio economic impact due to HS is verge to FMD in past few decades in Sri Lanka.

On an average a total of 5.12 billion SLR has been lost annually prior to year 2004 due to mortality and milk loss on HS infection in enzootic areas in the country. The estimated annual loss due to animal deaths (mortality) is around 1.27 billion SLR in buffaloes and 1.12 billion SLR in cattle for the same period. The estimated annual loss due milk loss due to HS is around 1.44 billion SLR in buffaloes and 1.29 billion SLR in cattle.

The country has experienced heavy losses on CSF in pig farms in 1997 and 1998. The estimated loss on swine production due to deaths on CSF in year 1997and 1998 was around 0.162 million SLR and 0.487 million SLR. It has reduced to 0.097 million SLR in 1999. The condition had huge economic impact on pig farmers and further processing meat industry in the country.

4.6.2 Price and Market effects

Disease outbreak of HS and FMD cause significant impact on market prices in milk, and meat. In a severe outbreak it has to be declared the area as infected area and movements has to be restricted for given period in an infection of both the diseases. Therefore, all the livestock related activities (Artificial inseminations, development, extension, marketing, etc.) are restricted not only in infected farms but also for all the farms in the area. Demand for

milk, meat and breeding animals drop considerably in the locality, but rises drastically in the national market due to lower supply. It was observed that the rise of fresh milk, beef and breeding heifers were 15%, 27% and 17% respectively in an outbreak compared to disease free period in the same year (unpublished data).

The outbreak of CSF in 1998 caused significant effect on pork market, market prices and whole industry. It had taken another 1-2 years to come to the normalcy. The price hike in pork due to CSF infection was 27 % in 1998 in fresh pork market. The pork producers of infected farms had lost their market share by 18% due to short supply to the processors within that period (unpublished data).

Though the country is free of HPAI, the pandemic situation in the region or elsewhere has had a significant impact on broiler meat and egg market in Sri Lanka. It has been noticed price drops in 1998, 2002, 2004, 2006 and 2009 years. Most of these price drops are coin sided with HPAI outbreaks in the other countries

Table 30. Change of Retail Prices of the Chicken Meat from 1997-2010

Year	Retail Price (SLR/kg)	Price Increase (%)
1997	130.48	
1998	128.02	-1.89
1999	144.61	12.96
2000	148.76	2.87
2001	164.82	10.80
2002	158.03	-4.12
2003	177.98	12.62
2004	177.00	-0.55
2005	211.64	19.57
2006	206.86	-2.26
2007	285.42	37.98
2008	333.93	17.00
2009	285.63	-14.46
2010	333.75	16.85

Source: Unpublished data

4.6.3 Trade (Local and International)

Transboundary animal diseases have severe economic impact on local and international trade. According to the animal disease act number 59 of 1992, the infected premises should be gazetted and notified to the public. The local trade related to livestock sector of the area is completely affected due to the disease. The surrounding areas are also affected. The low country dry zone where the HS and FMD are enzootic is the main meat purpose animal supplier to the entire country. Some parts of this area are proclaimed as infected area time to time for 6-8 months of the year. Therefore, it has severe impact on live animal market for beef industry mainly. The impact on local milk trade is also important. Since the Sri Lanka started exporting beef and beef products to certain middle east countries, it was impaired according to OIE standards. In addition Sri Lanka imports 74 % of the milk requirement of

the country mainly from New Zealand and Australia. Therefore the disease situation in those countries affects local milk availability in substantial way.

Further, all most all the inputs of poultry industry (Grand Parents, Parents, P, feed raw materials, drugs, equipment) are being imported to the country. HPAI disease situation in importing county has impact on local poultry industry. Sri Lanka imports soya been meal, maize, fish meal and some other material for poultry industry mainly from India and China. The recent (2009/2010) HPAI situation in both countries has raised the local feed prices by 13 % resulting 25.47 % increase in cost of production of chicken meat and 14 % of eggs in Sri Lankan market.

4.6.4 Food Security and Nutrition

Livestock sector provides protein with high biological value in food supply to the nation. Since dairying and back yard poultry is mainly popular in rural poor, milk and eggs are main source of animal proteins to them. Milk is one of the cheapest sources of animal protein in Sri Lanka .Disease outbreaks cause considerable drop of milk, meat and egg consumption due to low supply, less income compared to other periods and high price in the market. It is estimated to get an average of 22 % drop of expenditure on total food items by rural farm families in an animal disease outbreak (movement restricted condition) in Sri Lanka. It was revealed that the drop of expenses on costly protein source such as milk, meat and eggs in FMD outbreak situation was ranged from 31% to 46 % in rural families in those areas (unpublished data). There was negative correlation of (R^2= 0.78) length of the disease period and reduction of expenditure on food items by rural farm families (unpublished data)

4.6.5 Health and Environment

Sri Lanka does not impose a slaughter policy in disease outbreaks in ruminants**.** Therefore much environment cost is not experienced in outbreaks. Anyhow data and studies are very less in this context.

4.6.6 Surveillance cost

Surveillance is being carried out for HS carrier status and FMD status in cattle and buffalo population. The department of Animal Production and Health is in the process of carrying out sero surveillance to detect HS antibodies and FMD antibodies in vaccinated population. On an average a total of 2.1 million SLR is spent annually for these surveillance activities.

Further, surveillance is carried out for HPAI in migratory bird route hot spots, and surrounding poultry farms regularly. It is spent a total of 1.9 million SLR for these surveillance activities.

The ministry of Health is doing a passive surveillance in patients with positive clinical sign of HPAI at main hospitals. The annual cost is around 0.97 million SLR

The total annual cost for surveillance is estimated as 4.97 million SLR approximately.

4.6.7 Vaccine Production Cost

Sri Lankan livestock sector uses local as well as imported vaccines in disease control. HS vaccine is produced at the Veterinary Research Institute (VRI). The annual total cost is around 2.0 million for vaccine production.

FMD vaccine is being imported and annual average cost is around 16.5 million SLR. It has gone up to 23.4 million SLR in year 2010. The number of doses vary from 500,000 - 800,000 doses per annum. The vaccination coverage varies from 40% -80% in endemic areas.

The animal virus laboratory which is a branch of Veterinary Research Institute is in the process of doing research for development of local FMD vaccine. The production will be commenced by end 2011. It is planned to produce 1800,000 doses to give greater coverage with less cost. It spent around 75 million SLR on investment so far.

4.6.8 Bio Security and Management Cost

Sri Lankan poultry industry spent a lot on bio security to prevent entry of exotic diseases (eg. HPAI) to their farms. Capital cost on bio security measures viz. vehicle bath, foot bath, washing areas, uniforms with boots, caps, mask, good fencing, security services, waste disposal system (incinerators, bio safety pits, drainage systems) is very high in breeder farms. Almost all the grandparent farms, parent farms and most of large scale commercial poultry farms have to allow this cost. On an average the investments on bio security are approximately 2.2 million SLR, 1.4 million SLR and 0.74 million SLR in good large scale farm, average large scale farm and medium scale farm respectively. The capital cost on bio security in well managed excellent condition breeder farm is around 3.4 million SLR per year. In addition, 28,000 -129,000 SLR has to spend as variable cost on bio security farm depending on their scale of operation.

The small scale poultry farms and backyard farms do not have much concern about bio security measures thus has to spend very nominal rate on that. The dairy farms (large scale and small scale) too do not concern much on bio security measures.

4.6.9 Compensation cost

Since the slaughter policy is not adopted in the country compensation cost to the farmers are not finalized. But, in the case of HPAI the birds should be slaughtered and compensation cost at the rate of market price of full grown live bird is accepted by the department to be paid to the farmers.

5. SOCIAL IMPACT ON LIVELIHOOD AND EMPLOYMENT

Animal diseases have multiple direct and indirect effects on human welfare. In order to achieve a better understanding of the importance of controlling animal diseases from the perspective of poor livestock keepers, however, a sustainable-livelihood approach is valuable. A key consideration is that to improve livelihood for poor people directly and effectively, approaches should focus on poor livestock keepers, traders, labourers and consumers. In smallholder crop/livestock systems, poor farmers often rely on subsistence crops and smaller livestock species including poultry and small ruminants (goats and sheep) and pigs. Village chickens are owned throughout the developing world by poor farmers, for whom ND is a major constraint (FAO, 2002).

An FMD outbreak can have significant social impacts, such as enormous psychological damage, especially on families and localities directly affected by the outbreak, as the U.K.

experience in 2001 illustrates. For example, in May 2001, the Welsh Institute of Rural Health found that individuals affected by the FMD outbreak experienced a range of symptoms, including tearfulness, lack of sleep, loss of appetite, increased anger, irritability, and general depression. An increase in marital discord was also noted. One general practitioner reported that 50 percent of his patients affected by the FMD outbreak required anti-depressant drugs. Some farming families even sent their children away from home during the outbreak rather than have them witness the slaughter and disposal of the family's livestock. An outbreak also significantly disrupts daily life. According to one study on the effects of FMD on farm life in the Cumbria area of the United Kingdom, most farming households had to curb their usual daily activities and only the most essential movements on and off the farms were permitted. Lost income caused stress to families because they had to cut back on their household expenditures and some had to renegotiate loans.

5.1 Bangladesh

The impact of TADs on livelihood and employment depends on the nature of the disease and type of farming system. Such impact can be expected in both subsistence as well as commercial farming systems. FMD outbreak in a dairy herd could have serious impact on the livelihood of the farmer. Loss of one of a pair of bullocks of a farmer could adversely affect his crop cultivation. Loss of a couple of goats due to PPR of a small scale goat raiser could be unbearable. The similar impact could be expected for small scale poultry farmers. Growing livestock and poultry industry in Bangladesh has generated a good employment opportunity. However, outbreaks of TADs put this emerging employment opportunity at risk.

5.2 Bhutan

Livestock plays an important role in farming households. In addition to providing supplementary food for the farming households, it also provides employment opportunities, business and food security. Diversification of income through livestock and intensification of livestock activities through improved breeds has helped many households improve their socio-economic status and nutritional consumption of food habits especially in the rural areas of Bhutan.

5.3 India

In India, about 22.45 million people work in the livestock sector and the sector plays a vital role in improving the socio-economic conditions of rural masses and FMD severely reduces the labour potential and also creates negative feeling among farmers.

5.4 NEPAL

Livestock are important in supporting the livelihoods of poor farmers, consumers, traders and labourers throughout the developing world. The greatest impact of livestock in sustainable development designed to help the poor is enhancement of livestock-production systems. Animal diseases are crucial constraints in this: the animals of poor people are particularly vulnerable to disease because of the expense, absence or unsuitability of animal-health and production inputs. Poor farmers have few animals and few reserves on which to

survive during lean times and use for recovery, so the loss of individual animals has a proportionally greater impact (FAO, 2002).

Epidemic diseases such as FMD, PPR, and CSF threaten national livestock industries by direct effects. These include high levels of morbidity and mortality, control or eradication programme costs and restrictions to trade in livestock and livestock products. Livestock producers, workers in livestock industries and consumers are all affected.

In Nepal, 66% of the populations are directly engaged in agriculture (DLS, 2009). The agriculture is mainly subsistence-oriented, and crop-livestock or crop-livestock-forest integrated farming systems. Livestock is an integral part of complex farming system (livelihood, food security, nutrition, agricultural operation, soil fertility, transport etc.). Majority of the poor farmers in the rural areas have a few small ruminants, poultry and/or pigs depending upon the ethnicity of the people. Mostly the prosperous farmers have large ruminants but the poor farmers may have a few as well. Livestock are crucial source of financial capital for the rural poor. For many, livestock ownership is the only form of shaving available. Livestock can be a critical reserve against emergencies and decrease vulnerability to financial shocks from ill health, crop failures and other risks. Therefore looking at the importance of livestock for the rural farmers it is quite obvious that the occurrence of TADs in the rural poor farmer's livestock can lead to heavy economic losses and also create negative social impact on livelihood and employment of the people.

5.5 Pakistan

5.5.1 Social Impact of FMD

Many Infectious diseases like FMD have negative socio-economic impact on the livelihood and employment opportunities of the livestock owners and livestock workers. As reported earlier, the FMD may cause losses to the farmers in the form of animal morbidity (53.20 %) and mortality (15.25%) The morbidity, mortality and case fatality rates are higher in younger stock, the imported cattle and also in cross bred animals.

FMD affected farmers primarily suffer due to loss of milk from their diary animals as there is sudden drop (60-80%) for at least 2-3 weeks. Overall the FMD may lead to 20% milk production loss. The recovered animals never get back to their normal milk production levels. These losses result in low milk supply to the market and eventually pushing a number of people out of job or business in the chain of this milk supply. Secondly, due to higher abortion rates, there is increase in related issues of infertility and poor pregnancy rate of these animals during future breeding. This will obviously disturb the cycle of animal production, resulting in decline in business expansion and thereby affecting the employment rate in this business. As the infected animals cannot take feed and water properly due to formation of vesicles in the buccal cavity, there is around 20% loss in growth and weight of affected animals. Additionally there are losses on the treatment of infected animals, extra care of sick animals, in the form of distress sale to butchers especially in case of sheep/goat. All this results in severe damage to the livestock production business and eventually affect the livelihood of all those involved in this business chain (Kazimi and Shah, 1981; Gorsi, 1998; Upton and Shields, 1988).

5.5.2 Social Impact of PPR

Infectious diseases like PPR have quite significant effects on the livelihood and employment opportunities of the sheep/goat herd owners and field workers. As reported earlier, the PPR may cause very significant morbidity (69.18 %) and mortality (21.79 %) in the affected herds (Zahur, 2010). Moreover, the surviving animals also suffer from abnormal growth pattern and lower weight gains. In adult animals the milk production performance of the female goats/sheep declines to 50% of its pre-outbreak level. On certain occasions severity of PPR may lead to losing all the genetic pool of infected population which means very little or no progeny for next few years from a particular flock and losing its expansion potential for quite some time. Under such circumstances the farmers losing their animals due to PPR will suffer very badly and may be out of business, becoming socially dependent on the society for raising their families.

5.5.3 Social Impact of HPAI

The HPAI outbreaks usually have very negative impact on the livelihood of the poultry farm owners, farm workers, and feed/vaccine suppliers. For the breeder flock owners, there is no sale of day old chicks to the commercial flock raisers. There are a few consumers available for the sale of ready-to-market chicken as the chicken meat and egg consumption is rated as lowest during the early days of bird flu outbreaks The consumers in general develop a fear of getting infected with Bird Flu virus through handling and eating the meat and eggs from even non-infected flocks. In-fact, the total functions of poultry business gets disturbed as the sale and purchase of poultry during the HPAI outbreaks is almost halted. The following overall impact on the livelihood of individuals involved in this business was observed during HPAI outbreaks in Pakistan:

- Birds in the infected flocks suffered exceptionally high mortality (occasionally 70-100%) leading to total investment loss to affected farmer.
- Wherever earlier HPAI outbreak related mortality was reported and confirmed all the chickens at such farms were culled by the Government Authorities. In addition, any feed and egg stocks at these infected farms were also destroyed. The culling of high price laying and growing chickens also led to loss to the farmers, as only 75% cost of these items as per approved rates were paid to the affected farmers.
- The colossal economical loss to HPAI affected farmers in terms of high morbidity/mortality and due to culling of infected flocks forced a few of them to close the business.
- At the affected poultry farms, hundreds of farm workers lost their jobs due to closing of farms.
- Since the incidence of HPAI outbreaks in poultry caused panic in the public in general due to its public health significance, the consumption of poultry and eggs was significantly reduced by public.
- The HPAI outbreaks also had direct impact on the purchasing potential of common people. After the HPAI outbreaks were over, there was acute shortage of poultry meat and egg supply in the sale centers and upon gaining the confidence of public for eating chicken and eggs, the cost of these items increased many folds and remained high for quite some time.

- As a whole the poultry business suffered a major set-back for almost one year especially in the areas of construction of farms, recovery of finances on the feed, vaccines, medicines etc from the affected farmers. However, the ill effects of HPAI on poultry industry waned slowly but progressively in about three-year time.

5.5.4 Social Impact of HS

HS has a negative socio-economic impact on the livelihood and employment opportunities of the livestock owners and livestock workers. The direct economic impact in the form of high morbidity and mortality along with indirect losses narrated above clearly reflect that HS has significant financial and social impact on the livelihood of livestock owners. Obviously, the high rate of new infections of HS and its spread among high producing and very young animals would result in losses of animal along with its products, eventually resulting in stress on the agriculture economy of the country.

5.6 Sri Lanka

Agriculture and livestock is a main income generating source of rural poor in Sri Lanka. Milk is a cash crop that gives regular income throughout the year unlike other seasonal agriculture crops. Dairying is a way of converting rural labour into value added market commodity in most instances. Further, it converts underutilized female labour into a marketable product. The transboundary diseases are real disturbance to their regular income flow to the family in rural areas.

There are two scenarios in controlling TADs in Sri Lanka.

In a severe outbreak declare the region as infected premises, restrict all movements, temporary stop all livestock development activities and marketing by a gazette notification. That condition affects all the farmers such as infected and non-infected. The cost is very high in this scenario.

In a minor outbreak the restrictions are imposed only to infected farm. The cost is not as high as in first scenario.

In a diseases outbreak in dairy animals (HS, FMD) farmer has to spend more time with the animals for treatment, feeding, etc. On an average a farm family has to spend 4-6 hrs per day for 14 days additionally for their herd in an outbreak. It costs around 3580 SLR per farm. Further, it prevents gain of off farm income for some days. On an average the cost on labors around 2526.00 SLR per outbreak per farm in FMD infection in intensively managed cattle farm in the country (Kothalawala et al., 2011).

Additionally, it was reported a massive FMD outbreak in Kundasala and Teldeniya veterinary range in central hills in Sri Lanka. The area is declared as infected area by the authorities and movement restriction was imposed accordingly for 35 days' time period. The status caused a severe socio economic loss for the dairy farmers in the area. On an average direct income loss on milk withdrawal for 35 days were 6593 SLR/ farm in Kundasala range and 5823 SLR / farm in Teldeniya VS ranges for all the dairy farmers(infected and non-infected) in the area. Apart from the income loss (milk), the other cost viz. cost of treatment for infected animals, man days involved, meat loss and deaths for infected farms for 24597.75 SLR and 21216.00 SLR in Kundasala and Teldeniya VS ranges respectively. On

an average the cost incurred by the government on vaccines, vaccination, losses on AII, losses on extension and breeding activities were Rs. 10.2 million for two ranges. The total estimated economic loss for the farmers as well as the government in (infected) two VS ranges was around Rs, 19.6 million that is higher to annual average vaccine importation cost for the entire country (Kothalawala et al., 2011)

It was noticed that the debt ness of the dairy has increased by 78% of rural families due to FMD outbreak in Central hills in 2009 (unpublished data).

Poultry and swine farming sectors are more commercialized in Sri Lanka. Disease outbreaks (CSF) in swine farms have long term impact on their labor supply, middle men, farm income, etc… The condition loses employment of casual labors of farms and some of other stake holders (input suppliers). It causes severe social impact on this stake holders life style.

Even though the HPAI is never reported in Sri Lanka, the pandemic nature of outbreak in the region brings significant social impact on poultry sector stake holders too. Its impact on farm labors family life is more prominent than other categories. However, the HPAI outbreak in Asia in 2008/2009 causes 42% drop in poultry sector investment in Sri Lanka. It had long term impact on poultry production, employment generation until later part of 2010. But, being a country with free from HPAI Sri Lankan poultry industry has great opportunity to exploit export market in future.

6. PREVENTION AND CONTROL STRATEGY OF TRANS-BOUNDARY ANIMAL DISEASES

6.1 Bangladesh

Control of TADs usually demands a regional and global approach. This is even truer for Bangladesh which shares a long border with neighbouring India and Myanmar. It is virtually impossible to control any of the TADs in isolation. The strategies and priorities of controlling TADs are largely influenced by the prospect of export and that could vary from country to country. However, without harmonized concerted efforts across the region none of the countries could achieve the target of a sustainable status as an exporting country. So, there is no alternative of effective regional cooperation for controlling TADs.

Policy decision regarding control options for a TAD must be economically viable. This should be based on a cost benefit analysis, i.e., analysis of the benefit in terms of reducing economic impact of the disease against the investment in disease control. To begin with, a systematic structured survey on the incidence of selected TADs and their economic impact should be conducted in each country using a uniform economic analysis model.

The public health concern and severe economic impact of HPAI would justify eradicating the disease by stamping out approach. However, in case of FMD in its endemic setting, in a country having mostly low producing livestock, it might not be cost effective to target immediate eradication through stamping out approach. Even mass blanket vaccination against FMD might not be economically viable. Progressive control could be the rational option. Targeted vaccination of high value animals, ring vaccination in the face of an outbreak and improvement of facilities for quick detection and sero-typing of virus as well as sero-monitoring of vaccinated animals could be the viable option for the time being. A similar strategy might fit for HS. However, it might be possible to target eradicating PPR

through mass blanket vaccination across the region. The cost-benefit analysis of such control strategy for PPR is very likely to be economically viable.

6.2 Bhutan

Bhutan has prevention and control strategies for major TADs and other non-TADs diseases which are of importance to the country. There is also the policy for the prevention and control of any notifiable diseases which is used as standard guidelines for diseases without specific strategies.

6.2.1 Prevention and Control for FMD

The most important prevention of the disease had been the strict mass immunization of susceptible population covering at least 80% annually. The strict legislative measures on the movement of live animals and their products from border towns from neighboring countries is another step taken up very strictly in the country. This is very well tackled under the national FMD control programme of the country. The main points under the national FMD control programme revised in 1996 are as follows:

- ✓ Vaccination strategy- the vaccination coverage is below the expected level of 80% and the vaccination of the migratory animals and crossbreeds and draught animals were given on priority basis. However, identification and recording of the vaccinated animals was not possible or practical at this stage of development.
- ✓ FMD control programme -The creation of a buffer zone in the four southern districts by the half yearly vaccination of all sensitive livestock within the belt of 20-30 km parallel with the Indian border, with a coverage of at least 80% was implemented but the success was only satisfactory. This was also implemented in the farms located on the sides of the main high way and major migratory routes. There had been strict enforcement of the restriction on the animal movements during the outbreaks and imposition on the ban on import and internal transport of susceptible livestock and livestock products. There had been adoption of strict disease reporting system, extension education of the farmers to ensure their understanding and participation and also creation of the enzootic, sporadic and disease free areas in the districts.
- ✓ Cold chain facilities- Large quantities of vaccine were purchased for achieving a wider coverage in accordance with the new control strategies. Cold chain equipments were purchased but were not sufficient for a wide coverage or distribution due to inadequate financial resources.
- ✓ Virus typing- the most predominant type of FMD virus was “O” and it is this monovalent vaccine used for routine mass vaccination as prophylactic and polyvalent/tetravalent vaccine used as ring vaccination during outbreaks.

Control Measures

The National FMD control programme of the country dictates the future plans on the control of FMD. The national programme is reviewed and updated after 2 to 3 years and the loopholes thoroughly discussed and effective programmes set forth for implementation. The National control programmes are designed to concentrate on the following issues:

- ✓ Revision of vaccination strategy.
- ✓ Assessment of results of the migration survey.
- ✓ Enhancement of extension activities.
- ✓ Intensification of Zoosanitary measures.
- ✓ Typing of the virus strains.
- ✓ Epidemiology and economic effects of the disease and
- ✓ Assessment and evaluation of vaccination and other control strategies.

6.2.2 Prevention and Control strategy for PPR

Although there is no specific prevention and control strategies for PPR, Bhutan is adopting the standard guidelines for any diseases. This is mainly due the low economic impact of the disease in the country and also due to only one time outbreak which was controlled without further spread. However few strategies have been put in place for the disease in the country as follows:

1. Passive and clinical surveillance is done at sub-district, district, regional and national level at different capacities.
2. During any outbreak all the sick and exposed animals kept under strict isolation and treatment.
3. There is strict ban on the movement of livestock and its products out of the outbreak areas which is regulated by Bhutan Agriculture and Food Regulatory Authority (BAFRA) with technical support from department of Livestock.
4. The dead animals disposed and fenced to avoid the spread to other animals.
5. The regular disinfection of sheds and safe disposal of dung materials including the burial of goat and sheep carcass undertaken till the last case subsides and the area declared freedom from the disease by the Government.
6. The neighbor livestock owners informed and strict bio-security measures undertaken in their farms.
7. The confirmation of the disease done suing the molecular techniques through the support of the national and international laboratories.
8. In case the disease spread and uncontrolled, stamping out of the sheep and goat population in the affected premises shall be undertaken.
9. As the first outbreak of PPR occurred in the TSEDAR animals, such practice is now stopped and in case religious bodies would like to take up such activities, animals should be imported as per BAFRA rules and the incoming animals kept under quarantine for 14 days before releasing into the destination station.

Bhutan will soon embark on the National programme for PPR in order to know the incidence of the disease in goats and sheep and then to decide on the programme either for eradication or reduction of the disease outbreak. Although antibody of PPR was detected during 1990s during the Rinderpest eradication programme, Bhutan never thought PPR would be a disease of concern when Bhutan is gearing towards income generation through goat enterprises. With the increasing demand for goat meat and milk, the import of goat will continue. In order to prevent the disease and to avoid such outbreaks in future, a national eradication programme for PPR will soon be made for the country.

6.2.3 Prevention and Control strategy for Avian Influenza

Realizing the potential for H5N1 to cause pandemic and given that Bhutan does not have a pandemic preparedness plan, the Government felt that it is critical to have an explicit influenza pandemic preparedness plan to ensure that core capacities are developed to respond effectively to any outbreak of HPAI and pandemic influenza in Bhutan. Accordingly MoA and MoH drafted the National Influenza Pandemic Preparedness Plan (NIPPP).
This NIPPP was developed to ensure that all the required resources, expertise and services can be mobilized and deployed rapidly to reduce the morbidity, mortality and social disruption to the minimum. In addition establishment and strengthening of core capacities to preempt and control the next pandemic would also be useful in dealing with other infectious disease epidemics and public health emergencies of international concern as required under IHR (2005).

6.2.4 Prevention and Control for Haemorrhagic Septicaemia

There is an annual vaccination programme mainly in the paddy growing and low land livestock population which are annually vaccinated against HS using the combined vaccine for BQ and HS which amounts to a vaccination coverage of less than 5% of the livestock population. This strategy is enough at this stage due to the low risk of the disease and also due to the lesser part of the country with the outbreak history. The vaccination with alum precipitated formalin killed vaccine @ 4 ml subcutaneously in cattle and buffaloes are done annually. The vaccination is done before monsoon and needs revaccination every year.

6.2.5 Prevention and Control for Classical Swine Fever

The prevention and control strategies for Classical Swine Fever are mainly centered in commercial and government breeding farms. Annual vaccination against Classical Swine Fever @ 1ml s/c at 45 to 60 days of age followed annually. The country does not have a national control programme against Classical Swine Fever and it is mainly due to the less commercial farms and also due to the maximum dependence for import for pork and breeding stocks.

6.3 India

6.3.1 Foot and Mouth Diseases

In India, control is mainly affected by regular six monthly vaccinations and rigorous monitoring of protective antibody response and virus circulation. A trivalent (O, A and Asia1) vaccine is currently used in the vaccination programme. The control programme (FMDCP) was launched in India in 2003-04 in 54 districts selected in 08 states of the country covering 30 million cattle and buffalo with an objective of creating FMD free zones and then expanding these zones to cover the entire country. The basic approach is to vaccinate all cattle and buffalo every 6 months and create disease free zones. Due to initial success, additional 167 districts (another 80-90 million cattle and buffalo) have been included under the programme in 2010-11. Currently, this programme includes 221 districts of the country covering states of Southern peninsula (Kerala, Tamilnadu, Puducherry, Karnataka and Andhra Pradesh), Maharashtra, Goa, Daman and Diu, Gujarat, Punjab, Haryana, Delhi, Dadra and Nagar Haveli, Andaman & Nicobar Islands, Lakshadweep and 16

districts in Uttar Pradesh, and targeting 120 million cattle and buffalo. The target of this progressive zoning approach is that all animals are vaccinated twice a year (six monthly) and certain number of random serum samples are tested in each district for pre and post vaccination antibody level by a liquid phase blocking ELISA (LPB-ELISA) and concurrent disease surveillance. Gradual increase in protective antibody response was observed subsequent to phase-1 vaccination. Number of outbreaks is also in decline in vaccinated areas since 2006-07.

6.3.2 Haemorrhagic Septicaemia

Vaccination is considered as the prime control measure for HS, which has to be followed in routine basis in endemic countries like India. Routine vaccination will help in increasing the herd immunity against the disease, which will prevent the occurrence of huge catastrophe affecting larger population. The economic losses caused by the disease are huge as compared to the cost of vaccination in endemic countries. The competent authorities should implement active surveillance studies across the country. In India, out breaks of HS mainly occur during the monsoon season probably due to increased stress and hence it is advisable to start the prophylactic measures two to three months before monsoon season. Constant efforts should be taken by the authorities to build awareness of the disease among farmers. In endemic areas, where routine outbreaks occurs there are possible carriers and hence, avoid carrying animals from endemic to non-endemic regions.

6.4 Nepal

6.4.1 Foot and Mouth Disease

The socio-economic situation in the country is not conducive to adopt a slaughter policy in the control of FMD. As outbreak of FMD occur everywhere irrespective of altitude and climatic variation which results from extensive movement of animals throughout the country without proper veterinary sanitary inspection and vaccination of susceptible livestock animals. Regular vaccination as a prophylactic measure alone could be the option for which a potent vaccine with a long duration of protective immunity is required. Existence of antigenic variation within a serotype has been recognized as a major impediment in launching a successful campaign against FMD. At present, FMD vaccine which includes serotype O, A and Asia1 is being imported from India and recommended to protect improved and crossbred animals against FMD. Department of Livestock Services has initiated mass vaccination campaign in some of the dairy pockets since 1998 but it's not on regular basis.

Control of FMD outbreaks through ring vaccination in the surrounding outbreak areas are in practice. On many occasions, individuals and /or group of farmers/cooperatives particularly in the commercial pockets pay the cost of vaccine. Control of FMD outbreaks are not very effective in particular to uncontrolled animal movement due to lack of legislative support.

6.4.2 Peste des Petits Ruminants:

PPR control strategy currently adopted in the country is as follows:

- Mass vaccination in high endemic zone (cross border areas, highways, corridors).
- Point vaccination of migratory flocks in strategic location.

- Compulsory vaccination of all sheep and goats at the border quarantine check-posts.
- Ring vaccination to control outbreaks.
- Animal movement control.
- Flash reporting.
- Sero-monitoring of vaccinated animals.

Future programmes for PPR control should be focused in the increase in coverage of the PPR vaccination, development of heat stable PPR vaccine, development and implementation of PPR contingency plan and regional approach and cooperation for the eradication of the disease.

6.4.3 Highly pathogenic avian influenza:

Current control strategy for HPAI is as follows:

- Stamping out of birds up to 3 km radius (infected zone) from the epicenter.
- Intensification of active surveillance in 7 Km radius outside the infected zone and throughout the country.
- Cleaning and disinfection.
- Movement control.
- Quarantine inspection inside the country and across the border.
- Import ban on poultry and products from infected countries.
- Compensation
- No Vaccination
- No treatment of affected birds

6.5 Pakistan

6.5.1 Foot and Mouth Diseases (FMD)

FMD vaccination has been identified as one of the major strategies for disease control in this country. In this regard, a trivalent killed vaccine of water base and oil-based composition comprising of FMDV serotypes A, O, Asia-1 is used in this country. The vaccine is produced at three veterinary Research Institutes in public sector and by two companies in private sector, however, only 5% of the total requirement of this vaccine is coming from these sources. On the other hand FMD vaccine is imported from four other sources, which only fulfills another 20% of the national requirements of this vaccine. Efforts are underway to improve vaccine production and its availability in accordance to the requirement of the country.

Apart from increasing the availability of FMD vaccine the following steps are being undertaken to launch an effective disease control strategy in this country:-

- ❖ Establish country wide FMD surveillance and rapid response network
- ❖ Increase awareness among the farmer to set up animal quarantine facilities at farms and introduce allied biosecurity measures.
- ❖ Develop relevant legislations for control over animal movement
- ❖ Increase facilities for early FMD diagnosis, virus isolation, and its characterization through vaccine matching for choosing the right vaccine for future usage.

- ❖ Launch focused FMD control programme on the border regions and coordination with neighboring countries on FMD surveillance data sharing.
- ❖ Mobilization of private livestock sector for adopting strategic disease control measures with efforts to establish FMD free zones.

6.5.2 Peste des Petits Ruminant (PPR)

In case of PPR, vaccination has been the main disease prevention strategy among sheep and goats in this country. At present two Veterinary Research Institutes in the country are producing live PPR vaccine, but it is only providing 10% of the total requirements. In addition to this PPR vaccine is being imported into this country, which covers another 20% of the demand. This vaccine is still not being manufactured in the private sector in this country.

In addition to the use of vaccination strategy in the prevention of PPR, the following steps are being undertaken through the National TAD Control programme for better control of this disease in this country:

- ❖ Improvement of the existing disease reporting and information system along with strengthening the on-going PPR surveillance and epidemiological investigation in high risk areas
- ❖ Awareness among the farmers is being enhanced to implement zoo sanitary measures in high risk areas for PPR.
- ❖ Facilities for reliable and prompt disease diagnosis including virus isolation and its characterization have been established for assisting in proper and early diagnosis of PPR.
- ❖ Efforts are underway to introduce the concept of practicing bio-security and management of sick animals to the sheep flock owners for control of infectious diseases including PPR. This includes hygienic rearing practices, isolation of sick animals, availability of balanced feed on stalls, provision of good housing area, adequate drinking water; use of disinfectants, timely slaughter of seriously sick animals and proper burial of carcasses using disinfectants.
- ❖ As part of national surveillance strategy more emphasis is being placed for expanding the PPR surveillance and control programme on the border regions and its coordination with the neighboring countries especially regarding PPR disease data sharing for reducing the phenomena of cross border disease transmission.

6.5.3 Avian Influenza

To achieve control and prevent further incursion of HPAI viruses into Pakistan, a National Contingency Plan was developed and implemented in 2005 with the following salient features:-

- ❖ HPAI disease awareness of poultry farmers, feed and vaccine manufacturers, medicine suppliers, and public at large was increased through print, audio and visual media, seminars, workshops etc.
- ❖ For the veterinarians, poultry farm supervisors, laboratory personnel, professionals, veterinary practitioners in private practice etc. awareness on AI diagnosis and

control measures was advanced using corner meetings, seminars, training workshops and through presentation on HPAI by the subject specialists at national level and also by inviting foreign experts.

- A mechanism of early disease reporting, its confirmation & onward transmission of this information to the Chief Veterinary Officer followed by rapid response including culling and disinfecting the affected premises was established through strong collaboration and coordination between 40 newly established Regional Surveillance Units, 10 Provincial Diagnostic labs and the National Reference Laboratory for Poultry Diseases (NRLPD), at federal level. The laboratory and surveillance staffs in these labs were given training on AI reporting, sample collection, dispatch and diagnosis of AI.
- To encourage reporting on AI outbreaks, a compensation policy for the loss to the HPAI affected farmers for forced culling of their HPAI positive flocks was implemented. This step prompted the early reporting of suspected cases by the farmers.
- To prevent AI in poultry both local and imported AI vaccines were used as a routine disease preventive tool along with its usage as ring vaccination in the outbreak areas.
- For containment of the outbreak and further virus spread, 66 rapid response units consisting of District Livestock Officers and other professional workers were established throughout Pakistan. These were facilitated to operate and cull the flocks declared positive for HPAI and also to dispose of the culled/dead birds properly followed by decontamination at the farm.

As regards the policy of using vaccine against HPAI in poultry, the government of Pakistan had earlier adopted the policy of selected culling of affected flocks as well as ring or strategic vaccination of HPAI in the high risk area of the country. However, as no imported vaccine was available in early 2005, local vaccine against HPAI was developed by the local Research Institutes and was subsequently produced in the public and private sector vaccine production units in this country. In the subsequent years imported HPAI vaccine was also made available to the commercial farmers, as a result of this policy 100% demand of poultry sector is being fulfilled at present regarding HPAI vaccine availability in this country.

6.5.4 Haemorrhagic Septicaemia (HS)

In HS endemic areas the best practical method to protect the susceptible animal populations are by an organized programme of vaccination, monitoring for its successful sero conversion and improved hygiene, thereby maintaining animals in good condition. In this country, four vaccine producing units in public sector and six units in private sector are producing sufficient quantities of HS vaccine to fulfill the national needs at present. Some efforts have been made on experimental basis to introduce live HS vaccine in cattle and buffaloes in this country with excellent results, however, the same has not been introduced at large scale. Due to increased awareness among the farmers regarding seasonal outbreaks of HS and effectiveness of its vaccine, as well as satisfactory level of its availability to the farmer, the disease is being kept under control.

6.6 Sri Lanka

The mandate for the animal disease control lies with the Department of Animal Production and Health. The department functions in disease control in two ways.

6.6.1 To prevent exotic diseases in to the country

Being an Island Sri Lanka has an opportunity to minimal exposure to the exotic diseases in to the country. Sri Lanka follows strict regulations in importation of animals, germ plasm, biological and animal product to the country. The country has agreed to adopt some non-tariff barriers to prevent entry of exotic diseases to the country. Further, the department follows strict quarantine procedures (eg. on farm quarantine) for longer period even after importation.

6.6.2 To control existing diseases in the country

A disease control plan is being implemented by the department of animal production and health, Sri Lanka through departmental veterinary officers, veterinary investigation centers and veterinary research institute. There are 297 veterinary surgeons to carry out prophylactic vaccination programme. Apart from the vaccination regular treatment and farmer awareness is also being carried out by veterinary surgeons. Additionally, there are 17 Veterinary Investigation Centers to do regular sero surveillance, treatments, further investigations with regard to disease outbreak.

Veterinary Research Institute and the division of animal health in DAPH are mandated to carry out research, sero monitoring, epidemiological investigations, disease confirmation, vaccine production, vaccine research in the country.

All of these institutional arrangements are in line to control livestock diseases in the country.

6.6.3 FMD Vaccination Programme

A realistic and an economical control/eradication programme are being implemented to prevent the introduction of disease from exotic sources. Intensive vaccination of all susceptible domesticated animals within and surrounding the enzootic zones and control of the movement of animals to and from the enzootic zones is practiced.

Therefore, a strategic vaccination plan is adopted. On that back ground the regular blanket coverage for FMD in bovine population is practiced only in endemic areas (low country dry zone) in the country. At the same time the animals in boarder areas, animal transportation routes are also being vaccinated regularly. The ring vaccination of 3 KM radius area is practiced (Outer to inner) in an outbreak. The average coverage of FMD and HS vaccination ranged from 40-80 % depending on the risk nature of the disease (Kothalawala and Kodituwakku, 1996).

An imported mono valent type ‘O’ vaccine is being used in annual vaccination programme for FMD at present. On an average 600,000 FMD vaccines are being imported annually. Only the susceptible population in endemic areas, there boundaries and transportation routes are being vaccinated. Vaccination starts prior to monsoon rains of dry zone (July – August) and last for 3-4 months.

The Veterinary Research Institute (VRI), Sri Lanka is in the process of research in producing vaccine for FMD using local (field) strain. It is planned to produce 1.8 million doses of vaccine to vaccinate whole cattle and buffalo population with a booster from year 2012.

6.6.4 HS Vaccination Programme

Annual vaccination is carried out for HS using locally produced HS by the VRI, Sri Lanka as preventive measure. HS vaccination is carried out in endemic areas (Northern and Eastern Provinces) of Sri Lanka. On an average a total of 37, 840 doses of locally produced vaccines has been used HS vaccination programme in 2010 (Annual Report, 2010).

6.6.5 Avian Influenza Surveillance Programme

The national surveillance programme against HPAI is initiated in year 1997 and continued until 2011.A large number of migratory birds annually visits Sri Lanka during the period of September to November through Central Asian Fly Way in to the Northern, Southern and Western Regions of the country. Migratory bird might stay until the month of February. Surveillance is being carried out in bird resting places and at the entry points to monitor these pathways for HPAI entry jointly by the Departments of Wild life and Animal Production and Health. Poultry farmers are advised to adopt strict bio security measures surrounded to these areas.

Backyard poultry farming system in rural areas are very susceptible to get the disease and spread the disease.

Resultant to disease control activities, two of listed diseases viz. HS, CSF, has not been reported in the country for few years. Moreover, HPAI and Paste des Petis is never reported. Therefore, the country has laid down a concrete plan to move forward to be free from all five diseases in near future.

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Annexure 1. A hypothetical prediction of annual economic loss due to FMD outbreaks in Bangladesh Annual Economic Loss due to FMD Outbreaks in Bangladesh (Hypothetical prediction based on secondary data and assumptions*)

(Indirect losses and state veterinary service overhead cost are not included) **Parameter**	**Unit**	**Quantity**	**Unit cost (Tk.)**	**Total loss (Tk.)**
DIRECT LOSS				
Livestock Population				
Cattle (Total)	No.	26,828,000		
Milch cows (14% of cattle population)	No.	3,755,920		
Working cattle (10% of cattle population)	No.	2,682,800		
Calves (25% of cattle population)	No.	6,707,000		
Buffalo (Total)	No.	544,000		
Milch buffalo (9% of buffalo population)	No.	48,960		
Working buffalo (23% of buffalo population)	No.	125,120		
Buffalo calves (20% of buffalo population)	No.	108,800		
Goat	No.	16,242,000		
Sheep	No.	1,221,000		
Affected with FMD (5% prevalence in cattle & buffalo; 1% prevalence in goat and sheep)				
Cattle	No.	1,341,400		
Milch cows	No.	187,796		
Working cattle	No.	134,140		

Calves	No.	335,350		
Buffalo	No.	27,200		
Milch buffalo	No.	2,448		
Working buffalo	No.	6,256		
Buffalo calves	No.	5,440		
Goat	No.	162,420		
Sheep	No.	12,210		
Deaths due to FMD (20% case fatality in calves)				
Calves (cattle and buffalo)	No.	68,158	3,500	238,553,000
Reduction in milk production (25% reduction in milk production for 14 days)				
Average milk production / day / milch cow (cattle and buffalo)	Litre	2		
Loss of milk production per affected cow /day (@ 25%)	Litre	0.5		
Loss of milk production per affected cow for14 days	Litre	7		
Loss of milk production of all affected milch cows (cattle and buffalo)	Litre	1,331,708	40	53,268,320
Loss of draft power (50% working cattle or buffaloes are scheduled to work; affected animals abstain from work for 14 days)				
Abstaining from ploughing or cart pulling	animal-days	982,772	200	196,554,400
Sub Total (direct loss)				**488,375,720**

VETERINARY COST				
Cost of treatment (medicine only)				
Antibiotic treatment of affected cattle & buffaloes (30% of affected animals)	No. of animals	410,580	500	205,290,000
Antibiotic treatment of affected sheep & goats (30% affected animals)	No. of animals	52,389	200	10,477,800
Antiseptic treatment of affected cattle & buffaloes (30% of affected animals)	No. of animals	410,580	50	20,529,000
Antiseptic treatment of affected sheep & goats (30% of affected animals)	No. of animals	52,389	50	2,619,450
Vets' or animal health workers' fee				
Treated at vet hospitals (10% cases)	No. of animals	154,323	0	0
Treated by private practitioners and animal health care personnel (50% cases)	No. of animals	617,292	100	61,729,200
Vaccination				
Cattle vaccinated (locally produced vaccines)	No.	300,000	30	9,000,000
Cattle vaccinated (imported vaccines)	No.	300,000	70	21,000,000
Sub-Total				**330,645,450**
GRAND TOTAL				**819,021,170**
GRAND TOTAL (US$)				**10,920,282**

Annexure 2. A hypothetical prediction of annual economic loss due to PPR outbreaks in Bangladesh-Hypothetical prediction based on secondary data and assumptions*
(Indirect losses and state veterinary service overhead cost are not included)

Parameter	Unit	Quantity	Unit cost (Tk.)	Total loss (Tk.)
DIRECT LOSS				
Population				
Goat	No.	16,242,000		
Sheep	No.	1,221,000		
Affected with PPR (7.5% prevalence)				
Goat	No.	1,218,150		
Sheep	No.	91,575		
Deaths due to PPR (60% case fatality)				
Goat	No.	730,890	1,500	1,096,335,000
Sheep	No.	54,945	1,500	82,417,500
Loss of market value of surviving goats due to weight loss and poor appearance (25%)				
Loss of market price of surviving goats by 25% [40% of affected goats & sheep surviving]	No. of animals	523,890	375	196,458,750
Sub-Total (direct loss)				**1,375,211,250**
VETERINARY COST				
Cost of treatment (medicine only)				

Treatment of affected goats and sheep (60% affected animals being treated)	No. of animals	785,835	200	157,167,000
Vets' or animal health workers' fee				
Treated at vet hospitals (10% cases)	No. of animals	130,973	0	0
Treated by private practitioners or animal health workers (50% cases)	No. of animals	654,863	100	65,486,250
Vaccination				
Goats and sheep vaccinated	No.	2,168,000	5	10,840,000
Sub-Total (veterinary cost)				**233,493,250**
GRAND TOTAL (Tk.)				**1,842,197,750**
GRAND TOTAL (US$)				**24,562,636**

*Note: Population data is based on the Livestock and Poultry Survey 2009 of Bangladesh Bureau of Statistics. Other assumptions were based on published information and veterinarian's experience

Annexure 3. Summary of the economic impact analysis of HPAI outbreaks in Bangladesh in 2007-2008 (BLRI, 2008)

	No. of farms culled	**No. of poultry culled**	**Direct loss (Million Tk.)**	**Indirect loss (Million Tk.)**	**Total (Million Tk.)**
Broiler	112	501,900	61	25	86
Layer	435	1,171,100	300	2,197	2,497
Production downtime loss*				36,000	36,000
Total	**547**	**1,673,000**	**361**	**38,222**	**38,583**

*Calculated as 30% of the value of total poultry produce (Tk.120 million/year) over a period of 6 months each year

Annexure 4. A hypothetical prediction of annual economic loss due to HS outbreaks in Bangladesh- Annual Economic Loss due to HS Outbreaks in Bangladesh (Indirect losses and state veterinary service overhead cost are not included) Hypothetical prediction based on secondary data and assumptions*

Parameter	**Unit**	**Quantity**	**Unit cost (Tk.)**	**Total loss (Tk.)**
DIRECT LOSS				
Population				
Cattle	No.	26,828,000		
Buffalo	No.	544,000		
Affected with HS (0.1% prevalence)				
Cattle	No.	268,280		
Buffalo	No.	5,440		
Deaths due to HS (30% case fatality)				
Cattle	No.	80,484	12000	965,808,000
Buffalo	No.	1,632	21700	35,414,400
Sub Total				**1,001,222,400**

VETERINARY COST				
Cost of treatment (medicine only)				
Antibiotic treatment of affected cattle & buffaloes (60% of affected animals)	No. of animals	164,232	500	82,116,000
Vets' or animal health workers' fee				
Treated at vet hospitals (10% cases)	No. of animals	27,372	0	0

Treated by private practitioners and animal health care personnel (50% cases)	No. of animals	136,860	100	13,686,000
Vaccination				
Cattle vaccinated	No.	275,000	30	8,250,000
Sub-Total				**104,052,000**
GRAND TOTAL				**1,105,274,400**
GRAND TOTAL (US$)				**14,736,992**

*Note: Population data is based on the Livestock and Poultry Survey 2009 of Bangladesh Bureau of Statistics. Other assumptions were based on published information and veterinarian's experiences