Abstract

Foot-and-mouth disease (FMD) is a highly infectious viral disease of all cloven-hoofed animals. It can have a significant impact on the livelihood of livestock owners, especially in developing nations such as Bhutan.

Prior to the study reported in this thesis, there was limited understanding of the epidemiology of FMD in Bhutan in terms of its spatiotemporal distribution, risk factors, role of animal movement, and disease surveillance. Retrospective and prospective studies were conducted to unravel the epidemiology of FMD in Bhutan in order to support and refine the current control programme.

The study demonstrated that FMD is endemic and periodically epidemic in Bhutan with the districts and sub-districts bordering India being at higher risk of disease than the interior districts. The districts and sub-districts bordering India appear to behave like primary endemic areas for the introduction and persistence of FMD virus through frequent unofficial movements of cattle across the porous border. The interior districts and sub-districts appear to behave like secondary endemic areas where virus propagation occurs due to limited vaccination coverage and unrestricted movement of animals.

The study showed that O was the principal serotype in Bhutan, consistent with the disease epidemiology in the neighbouring countries. Cattle are the most susceptible animal while small ruminants and pigs seem to have minor roles in the disease’s epidemiology. However, unvaccinated small ruminants can be used as tracers for disease surveillance in areas where cattle are routinely vaccinated. Waves of outbreaks of FMD, in cyclical patterns, have occurred in Bhutan due to the incursion of the PanAsia strain of the O serotype, possibly through transboundary movement of livestock from neighbouring countries. The devastating capacity of the PanAsia strain of the O serotype, especially in a
FMD-naïve population, was shown through the large scale morbidity and mortality of cattle and pigs during the 2007 epidemic in Bhutan. The disease produced significantly higher morbidities and mortalities in Zhemgang district (36.5% vaccination coverage) as compared with Sarpang district (87.6% vaccination coverage).

Husbandry practices, such as mixing of cattle within and between villages at grazing and watering areas, and feeding kitchen wastes to cattle significantly increased the risk of transmission of FMD in FMD-endemic herds. The seroprevalence of FMD in the migratory herds (24.8%, 95% CI: 20.6, 29.5) was significantly higher than in the sedentary herds (17.5%, 95% CI: 15.6, 19.5) thus underlining the significance of this livestock production system for the disease’s epidemiology.

Animal movements occurred in several forms including the daily movement of animals within and between villages for grazing and watering purposes; livestock trading within and between villages, sub-districts, and districts; and the traditional migratory practices. All these movements pose significant risks for disease transmission given the ineffective regulatory and quarantine services. The animal movement patterns were more complex in an FMD-endemic district (Sarpang) compared with an FMD-free district (Tsirang). There were more inward than outward movements for all species in the endemic district as compared with the FMD-free district. The presence of numerous unofficial trading routes along the Indo-Bhutan border in Sarpang district could be an important determinant for the frequent incursion and persistence of FMD in this district.

Active serological and questionnaire-based surveys have validated the usefulness of the country’s passive surveillance system. Although the current findings have increased the level of confidence in the passive surveillance system of Bhutan, there is a need to complement this with active serological and clinical surveys from time to time.
Several factors, such as extensive livestock husbandry practices, rugged terrain, inadequate vaccination coverage, ineffective regulation of movement control, porous borders, a lack of awareness of the disease by the farming community, and budgetary constraints, pose significant challenges to the prevention and control of FMD in Bhutan. Given the disease’s endemicity, controlling FMD for the whole country is currently both difficult and costly. Therefore alternative approaches using the concepts of zoning are proposed. Longitudinal studies, using active serological and clinical surveillance, indicated the absence of FMD infection in the district of Tsirang at the time of this study. This has now paved the way for initiation of progressive zoning approaches as an alternative control method in line with the global framework for the control of transboundary diseases.

It is concluded that a regional approach is needed in order to successfully control this transboundary disease in Bhutan and neighbouring countries.