A review on Foot and Mouth Disease and Its current status in Ethiopia

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Abstract: Foot and mouth disease (FMD) is an acute and serious disease of angulated animals particularly in cattle, sheep, pigs, goats, deer and others. FMD virus belongs to the genus Aphthovirus in the family Picornaviridae and possesses a single strand of positive-sense RNA genome. It has worldwide distribution and is one of the most infectious diseases found in nature which is characterized by fever and blister-like sores on the tongue and lips in the mouth, on the teats and between the hooves. The disease existing in seven immunologically distinct serotypes O, A, C, Southern African Territories (SAT) 1, SAT2, SAT3 and Asia1and numerous divergent strains within the serotypes can manifest continuous genomic and antigenic evolution. The disease has a wide host range and can beeasily transmitted by ingestion, direct and indirect contact, as well as by aerosols. It can cause high number of deaths among young animals and production losses in adult livestock. FMD imposes very serious impediments to international trade in live animals and animal products. In Ethiopia, the disease is endemic that affects the agricultural economy and international trading system. The disease is highly distributed in the pastoral low land of Ethiopia. Since the disease has devastating economic loss for both developed and developing countries, control of the import of live animal and animal products from infected countries, movement of visitors and illegal trading across national and international boundaries are recommended to prevent the disease.
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1. Introduction

Foot and mouth disease (FMD), which is known as Aphthous fever, is a major global animal health problem [1]. It is the most contagious transboundary animal disease (TAD) affecting cloven hoofed animals of domesticated and wildlife. Artiodactyla species of the domesticated animals: cattle, sheep, goats, pigs and buffalo are susceptible to foot and mouth disease. Foot and mouth disease is caused by Aphthous virus known as foot and mouth disease virus. It is an RNA virus with seven antigenically different serotypes such as A, O, C, Southern African Territeries (SAT)1, SAT2, SAT3 and Asia1 as well as over 50 subtypes. Serotype A was divided into 32 subtypes and serotype O was also divided into 11 subtypes. It affects all cloven-footed animals and is distributed in Africa, Asia, South America and parts of Europe. The disease can occur in any country, but Japan, New Zealand, Australia and some other countries are FMD free [2].

FMD is the most contagious viral disease of mammals and has great potential for causing severe economic loss in susceptible cloven-hoofed animals. It is characterized by fever, loss of appetite, salivation and vesicular eruptions on the feet, mouth and teats [3].

It is one of the most important livestock diseases in the world in terms of economic impact. The economic importance of the disease is not only due to the ability of the disease to cause loss in production, but also due to the restriction of trade of animals both locally and internationally [4]. Foot and mouth disease is an economically devastating disease of cloven hoofed animals which can severely constrain international trade of animals and animal products. The disease has a high morbidity and low mortality with low occurrence in adult animals. However, myocarditis may occur in young animals resulting to death [5].

The recovered animals remain in poor physical condition over long period of time leading to sustained economic losses for the livestock industry. Currently, it is present in two-third of the OIE member countries where it creates sever economic problems and provides a reservoir of disease ready to spread into disease free areas [6].

The highly contagious nature, worldwide distribution and its popularity of serotypes are features which have made it a major threat of livestock and agricultural production around the world (Quinn *et al.,* 2002). Foot and mouth disease is a severe plaque of animal farming, since it is highly infectious and can be spread by infected animals through aerosols, and contacts with contaminated farming equipments, vehicles, clothing or feed [7].

Its containment demands considerable efforts in vaccination, strict monitoring, trade restriction, quarantine and occasionally elimination of millions of animals. Heavy losses occur in small scale mixed farming systems when outbreaks affect draught oxen during cropping season. It causes considerable loss of milk yield and weight among dairy and fattening stocks, respectively [8].

Foot and mouth disease is the most important livestock disease which is endemic and known for its wider distribution in Ethiopia. In Ethiopia, where the local economy is heavily dependent on livestock, losses incurred due to foot and mouth disease in reduced production and efficiency of livestock may be severe and local food security is impaired [9].

In Ethiopia context, traditional livestock management with uncontrolled movement of animals, foot and mouth disease spread is attributed to moving of infected cattle [8]. In general, extensive movement of livestock, the high rate of contact among animals in communal grazing areas, watering points and at commercial markets could be considered as major transmission and dissemination factors for the virus [10].

Therefore, the objectives of this seminar are:

- To review the epidemiology of foot and mouth disease.
- To identify the major factors for dissemination of disease across boundaries.
- To review the economic impact of foot and mouth disease.
- To highlight the prevention and control measures.

2. Foot and Mouth Disease

Foot and Mouth Disease (FMD) is caused by a virus of the genus Aphthovirus, family Picornaviridae which is small (26 nm diameter), non-enveloped single-stranded, plus sense RNA virus, the members of which cause a variety of diseases including FMD [11]. There are seven serotypes of the virus namely: A, O, C, SAT1, SAT2, SAT3 and Asia1. Infection with one serotype does not confer immune protection against another. The disease is characterized by high fever, loss of appetite, salivation and vesicular eruptions on the feet, mouth and teats [3]. The disease has high morbidity, although mortality is rare in adult animals. However, myocarditis may occur in young animals resulting in death. The recovered animals remain in poor physical condition over long periods of time leading to economic losses for livestock industries [12].

2.1 Etiology

Foot and mouth disease is associated with foot-and-mouth disease virus (FMDV), which is classified within the Aphthovirus genus as a member of the Picornaviridae family, being small, a non-enveloped, single stranded RNA virus, icosahedral and is 26 nm in diameter [13]. There are seven immunologically distinct serotypes of foot and mouth disease virus, namely, serotypes A, O, C, Southern African Territories (SAT)1, SAT2, SAT3 and Asia1 [14]. However, there are a number of immunologically and serologically distinct subtypes with different degrees of virulence, especially within the A and O types. As there is no cross-immunity between serotypes, immunity to one type does not confer protection against the others. This presents difficulties to vaccination programs [15].

Furthermore, there can be great changes in antigencity between developing serotypes; virulence also change dramatically. There are also biotypical strains which become adapted to particular animal species and then infect other species only with difficulty [12].

2.2 Epidemiology

2.2.1 Host range

FMD is highly contagious and affects over 70 domestic and wild Artiodactyla species [16]. Of the domesticated species; cattle, pigs, sheep, goats, and buffalo are susceptible to FMD [14]. The susceptibility of these animals can vary with breed of animal and strain of virus. The disease is considerably less obvious or sub-clinical in breeds of cattle, sheep, and goats indigenous to Africa and Asia, where FMD is endemic [15]. Two closely related camel species of Bactrian and Dromedary camels possess noticeably different susceptibility to FMD virus [17]. Dromedary camels appeared to be susceptible with FMD, but they are unlikely to play significant role in the natural epidemiology of FMD [5]. A wide range of wild cloven-footed animals contract FMD including, deer and wild pigs. African buffalos play an important role in the maintenance of FMDV infection [18].

2.2.2 Occurrence

Foot and mouth disease affects all cloven-footed domestic animals and wildlife and is enzootic in Africa, Asia, South America and parts of Europe [19]. The disease can occur in any country, but Japan, New Zealand, and Australia are disease free countries [12]. Many countries in Europe are now free of the disease, but out breaks occur from time to time in Britain and in the Channels of Island. United state, Canada and

Mexico eradicate foot and mouth disease at different times by test and slaughter programs [20].

A devastating epidemic occurred in Taipei, China, in1997 and over 4 million pigs died or were slaughtered within a few months [5]. The virus was believed to have been introduced from neighboring countries, through mingling of animal products. Spread with in the country and to the other countries was mostly through the movements of livestock which were not showing obvious clinical signs [21].

2.2.3 Prevalence

There are no reliable figures for the prevalence of foot and mouth disease in different countries. In general it occurs in the forms of outbreak that rapidly spreads from herd to herd before it is controlled. Of the seven standard serotypes, serotype A, O, and C are prevalent in all continents where the disease occurs, SAT1 is found in Africa and Asia, and SAT2 and SAT3 are limited to Africa, where as Asia1 occurs only in Asia. This limitation is more due to the pattern of meat trade than to any inherent properties of serotypes. Overall, outbreaks of type O and A occur more frequently than the others [12].

Table 1: Geographical distribution of foot and mouth disease virus serotypes

Foot and mouth disease virus serotypes	Geographical distribution
O, A and C	South America
O, A and C	Eastern European countries
O, A, C, SAT1, SAT2 and SAT3	Africa
O, A, C and Asia1	Asia

Source: [19].

2.2.4 Methods of transmission

Foot and mouth disease is transmitted by a variety of methods between herds, countries and continent, but spread from one animal to another animal is inhalation, ingestion and contact with fomites [22]. In endemic areas, the most important methods of spread are probably by direct contact of animals moving across state and national boundaries as trade or nomadic cattle [19].

In non-endemic areas such as Europe, the first introduction to a new area is often via pigs which contract infection by ingestion of infected meat scraps. Spread of the disease from pigs to pigs is through physical contact with infected secretions containing large amount of virus. Besides, as pigs are commonly kept on concrete floor, pre-existing damage to the integument may increase the chance of being infected and to cattle is common via movement of people, abattoir waste or animals [23]. Furthermore, spread between cattle is more likely to be by airborne means [12].

The virus can persist in aerosol form for long periods in temperate or sub tropical climates but not in hot and dry climates. The speed and direction of the wind are important factors in determining the rate of air borne spread. In the most favorable circumstance, it is now estimated that sufficient virus to initiate an infection can be wind borne as far as 250km. Generally, foot and mouth disease can be transmitted in number of ways, including close contact of animal to animal spread, long distance aerosol spread and fomites, or inanimate objects, typically fodder and motor vehicles [12]. Aerosol dissemination of the virus occurred in considerable distance depending on the weather condition [7].

Fomites are important in the spread of infection. Contaminated material may introduce virus into the skin or mucous membranes, e.g., via brushes and surgical instruments, or into food, e.g., via faeces, urine and contaminated fodder. Infected aerosols, e.g., slurry spray, may be produced from contaminated fomites. Those handling infected animals, such as farm workers, dealers and veterinarians, may carry the virus on their hands, underneath their fingernails, inside their nostrils and on their clothing and footwear [24].

2.2.5 Morbidity and case-fatality rate

The morbidity rate in outbreaks of foot and mouth disease in susceptible animals can rapidly approach 100%, but it does depend on the condition under which the animals are kept [12]. Consequently, sheep kept under intensive condition indoors may have high morbidity, while sheep kept under low intensive condition outside may have a much lower morbidity. Morbidity in susceptible wildlife is quite variable from high to very low, depending on the foot and mouth disease virus subtype and the species involved [1].

Mortality in adult animals is usually low to negligible; up to 50% of calves may die due to cardiac involvement and complications such as secondary infection, exposure or malnutrion [21]. Mortality in suckling pigs and lambs ranges from 20-75% in most extreme cases and it is highly age dependent. In animals infected under 4 weeks of age, the mortality is high and decrease rapidly as animals get older (>4weeks). During outbreaks in endemic and developed countries, most deaths are due to a slaughter policy that usually involves all susceptible animals and herds in contact with or within a certain radius of infected herds [19].

2.2.6 Risk factors

Host: The species of animals is an important factor that make cattle and pigs more susceptible, but goats, sheep, buffalo and other wildlife such as antelope, deer, hedgehogs, elephants, llama and alpaca also develop mild symptomatic disease. Although, cattle, sheep and goats can be carriers, they are not the regular source of infection [25]. Immature animals are relatively more susceptible. The wildlife species also play a great role as reservoirs of infection for domestic animals which makes it difficult to eradicate the disease as well as important for disease control when an outbreak occurs [12].

Agent: The virus is resistant to external influences including common disinfectants and the usual storage practices of meat trade. It may persist for over 1 year in infected premises, for 10-12 weeks on clothes and feeds [1]. Foot and mouth disease virus can survive in dry fecal material for 14 days in summer, up to 6 months in slurry in winter, for 30 days in urine and 3 days in summer and 28 days in winter on the soil. The virus can survive for more than 60 days in bull semen frozen by -79^0c and it is relatively susceptible to heat and insensitive to cold. However, it is sensitive to acid and alkaline condition outside the range of pH 6.0-9.0 and also antigenic variation (antigenic drift and antigenic shift) play a great role [12].

Environment: Under favorable condition of low temperature, high humidity, moderate wind and comfortable topography, the virus in aerosols may spread to long distance. Generally, the integrations of these three factors are important for the disease occurrence, of which even if one is not available, the disease does not occur [12].

2.3 Pathogenesis

Foot and mouth disease is transmitted between animals by inhalation, entry through abrasion in the skin or mucosa, ingestion, insemination and other routes. All secretions and excretions become infectious during the course of the disease [1].

When the virus is inhaled by recipient animals, the proportions of the particles are deposited in respiratory systems. The sites of deposition determined mainly by the diameter and the mass of the virus deposited in respiratory system [19]. Large particles are deposited in the upper respiratory tract (nares); medium sized particles are deposited at middle to upper respiratory tract (pharynx, trachea, bronchi) and small particles in the lower regions (small bronchioles and alveoli) [7].

Primary viral replication after inhalation takes place in the mucosal and lymphatic tissues of the pharynx. Viremia follows primary multiplication with further viral replication in lymph nodes, mammary glands, and other organs as well as epithelial cells of the mouth, muzzle, teats, inter digital space and coronary bands [1].

The virus first attaches to mucosal epithelial cells penetrate into the cytoplasm and replicate until the cells disintegrate. This releases more viral particles to infect other cells [12]. Virus rapidly moves from the blood during viremia to infect the epithelium of the oral cavity and feet, where lesions develop [1]. Once infection gains access to the blood stream, the virus is widely disseminated to many epidermal sites, probably in macrophages, but gross lesions develop only in areas subjected to mechanical trauma or unusual physiological condition, such as epithelium of the mouth and feet, the dorsum of the snout of pigs and teats [15].

Bacterial complication generally aggravates the lesions, particularly those of the feet and the teat, leading to sever lameness and mastitis, respectively. In young animals, especially neonates, the virus frequently causes necrotizing myocarditis and this lesion may also be seen in adults infected with some strains of the virus particularly type O [12].

2.4 Clinical findings

Large numbers of virus particles are shed in secretions and excretions of infected animals [19]. Virus shedding begins during the incubation period, about 24 hours before the appearance of clinical signs. Incubation period ranges from 2-14 days, depending on the infecting dose, susceptibility of the host, and the strain of the virus [26].

Infected animals develop fever (41^0C), drop milk production, inappetance, profuse salivation, drooling and smacking of lips, accompanies the formation of oral vesicles which ruptures and leaving pain full ulcers [19]. They stamp their feet and salivate when the vesicles develop on the tongue, dental pad, gums, lips, coronary band and inter digital cleft of the feet. Ruptured vesicles in the interdigital cleft and on the coronary band lead to lameness [12]. Young calves, lamps, kids and piglets may die before showing any vesicles because of necrotizing myocarditis. Vesicles may also develop in the skin of teats and udders of lactating cows in which milk yield drops dramatically resulting in mastitis [19].

Secondary bacterial invasion of the ruptured lesions may interfere with healing and may lead to severe involvement of the deep structure of foot and mouth. In most outbreaks, the rate of spread is high and clinical signs are as described earlier, but there is great deal of variation in virulence and this may lead to difficulty in field diagnosis [12].

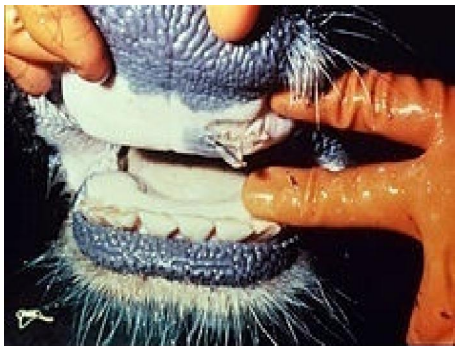

Figure 1: Ruptured oral and feet blisters in diseased cow and pig (Source [27]).

2.5 Necropsy findings

The lesions of foot and mouth disease consist of vesicles and erosions in the mouth and on the feet and udder [12]. The erosion often becomes ulcers, especially if secondary bacterial infection has occurred. In some cases, vesicles may extend to the pharynx, esophagus, fore stomachs and intestines. The teats and mammary gland are often swollen. In the malignant form and in neonatal animals, epicardial hemorrhages with or without pale discoloration are present [19]. Grossly the ventricular walls appeared streaked with patches of yellow tissues interspersed with apparently normal myocardium, giving the typical “tiger heart” appearance. Histologically, start as foci of progressive swelling, necrosis and lysis of keratinocytes in the deeper layers of the epidermis and accumulation of fluid in the space [12].

Figure 2: Tiger heart appearance (Source [16]).

Tissues to be submitted for histopathology should include oral mucosa and skin containing vesicles or fresh erosions. The heart, mammary gland and pancreas should also be included. Most animals infected with foot and mouth disease will not die and since it is important to make prompt diagnosis from clinical cases, histopathology of necropsy material is often secondary [12].

2.6 Diagnosis

2.6.1 Epidemiological Diagnosis

Taking into account the contagious nature of the disease, FMD develops rapidly in herds that have not been immunized, especially in intensive cattle and pig production units [28]. Recent contact with animals which may have been infected or the recent introduction of a new animal can create suspicion [12]. In the same way national Authorities need to consider the environment risks of introducing live animals and animal products either legally or illegally from potentially infected countries. The contact history of wild animals, farming system, the movement of animals across the national and international boundaries and the herd size are valuable pointers to the diagnosis [29].

2.6.2 Laboratory Diagnosis

Serological diagnosis: Serological tests are performed for diagnostic purposes when an infection is suspected and to check the health of animals by detecting the presence of antibodies in the serum. There are several serological techniques that can be used depending on the antibodies being studied. These include: ELISA, agglutination, complement-fixation, and fluorescent antibodies [16].

Virus Isolation: The isolation and characterization of the virus is the "golden standard" for the diagnosis of viral diseases. The suspensions of field samples suspected to contain FMD virus are inoculated into cell cultures (primary pig kidney cells), incubated at 37^0c and examined for cytopathic effect (CPE), 24 to 48 hours post infection. No CPE confirms the absence of FMDV in the samples [25].

Nucleic acid recognition methods: The polymerase chain reaction (PCR) can be used to amplify the genome fragments of FMD virus in diagnostic material. Specific primers have been designed to distinguish between each of the seven serotypes and in-situ hybridization techniques have been developed for investigating the presence of FMD virus RNA in tissue samples [26]. Reverse-transcriptase (RT) when combined with PCR provides a rapid and powerful technique for studying diverse RNA genomes. Reveres transcription PCR (RT-PCR) amplification of FMD virus RNA, followed by nucleotide sequencing, is the current preferred option for generating the sequence data to perform these comparisons [6].

2.7 Differential Diagnosis

Clinically, it is impossible to distinguish foot and mouth disease from the other vesicular diseases of the viral origin. Bovine viral diarrhea, Blue tongue, Rinderpest, Malignant catarrhal fever, and Lumpy skin disease are easily differentiated by lesions which develop in the mucosa and sometimes on the feet [12]. The lesions are never vesicular, commencing as superficial erosions and proceeding to the development of ulcers, but Vesicular stomatitis, Vesicular exanthema and Swine vesicular disease required laboratory studies to differentiate them from foot and mouth disease [30].

Samples for laboratory diagnosis are epithelium or vesicular fluid collected from foot and mouth disease suspected animals. Samples of choice in the cattle are lesions from tongue tissue, buccal mucosa, wounds from feet and hoofs. In pigs fluid filled vesicles wound from the tongue, snout, coronary band hoof shall be collected [1].

2.8 Treatment

No treatment exists for foot and mouth disease [19]. However, proper animal husbandry practices and treatment of secondary bacterial infection and dressing to inflamed areas to prevent secondary infection is recommended in endemic countries where slaughter policy is not enforced. Treatment is not given against viral disease. Affected animals will recover however with loss of production based on the infection state of the disease. Infected animals are usually killed depending on economy [22].

2.9 Control and prevention

Control of foot and mouth disease is difficult due to its highly contagious nature, multiple hosts, viral stability, multiple antigenic types and sub types and short term immunity. The type of control strategies applied in a country depends on the goal of the control program. The control strategies varies from country to country based on their epidemiological condition, importance of livestock sector in the national economy and economic capability of the country to invest in control strategies [12].

In developing countries, control by eradication is too costly, hence, in most of African countries FMD control is mainly through regular vaccination in conjunction with the control of animal movement [29]. Many countries free of the foot and mouth disease have a policy of slaughter of all affected and in contact susceptible animals (economically affordable countries) and strict restriction on movement of live animals, animal products and vehicles around infected premises [19]. After slaughter, the carcasses must be disposed of safely by incineration, rendering, burial, the building are thoroughly washed and disinfected with mild acid or alkali and by fumigation (Ayelet *et al*., 2009).

Rodents and other vectors may be killed to prevent them from mechanical dissemination of the virus. In areas or countries free of FMD in which this is not possible, control is by movement restriction, quarantine of infected premises and vaccination around (and possibly within) the affected premises [22].

Vaccination

Vaccination is instrumental in the control of FMD in endemic countries. Foot and mouth disease vaccines commonly contain more than one serotype of the virus depending on the epidemiological condition of the particular country. Mass vaccination campaigns usually involve a bi-annual or annual schedule [12].

The current foot and mouth disease vaccine confers protection for 6 months and hence at least two vaccinations are recommended for prophylactive protection in endemic areas. In vaccinated animals the peak antibody response is attained in 21-28 days and protection can be achieved within one to two weeks post vaccination. Vaccination can be used to reduce the spread of foot and mouth disease or protect specific animals [19].

Eradication

Eradication is policies and actions designed to eliminate completely FMD virus following an outbreak of disease. This includes both 'stamping out', defined by OIE as the slaughter of all infected and in-contact animals, together with cleaning and disinfection, and all the other measures that are necessary in the event of an outbreak in an FMD-free country, region or zone. Stamping out involves: slaughter and disposal, cleaning and disinfection, movement controls, zoo sanitary measures and epidemiological monitoring [32].

3. Current status of FMD in Ethiopia

3.1 Distribution of FMD

Ethiopia has the largest livestock inventories in Africa [33]. Livestock ownership currently contributes to the livelihoods of an estimated 80% of the rural population. This productivity is being hampered by different livestock diseases including FMD. FMD in cattle in Ethiopia was first recorded by FAO, which indicated that FMD serotypes O, A and C were responsible for FMD outbreaks during the period of 1957 to 1979 [34].

In Ethiopia, outbreak of FMD frequently occurs in the pastoral herds of the marginal lowland areas of the country [35]. This is mainly due to lack of effective vaccine, absence of livestock movement control and absence of systematic disease surveillance and reliable epidemiological data. It is however likely that the disease is underreported due to comparatively high tolerance of local breeds to the clinical episodes of the disease [30].

3.2 Prevalence of FMD

FMD is endemic and known for its wider distribution in Ethiopia, although its level of prevalence may have significant variations across the different farming systems and agro-ecological zones of the country. The records of the Ministry of Agriculture and Rural Development (MOARD) from 1997 to 2006 showed that FMD outbreak occurred everywhere throughout the country with highest incidence in the central part [31]. The sero-prevalence of FMD among Borana pastoral cattle in 2008 was reported to be 24.6% [29].

Another study that covered broader areas of the country showed sero-positivity of 44.2% with 1.6% and 8.9% mortality and case fatality rates [36]. Serotype O, A, C, SAT1 and SAT2 were identified in Ethiopia [31]. Serotypes O and A are more prevalent and are the major causes of economic losses. FMD impedes export of livestock and livestock products and causes production losses and the number of outbreaks reported annually varies between 12 in 1997 and 198 in 1999 [8].

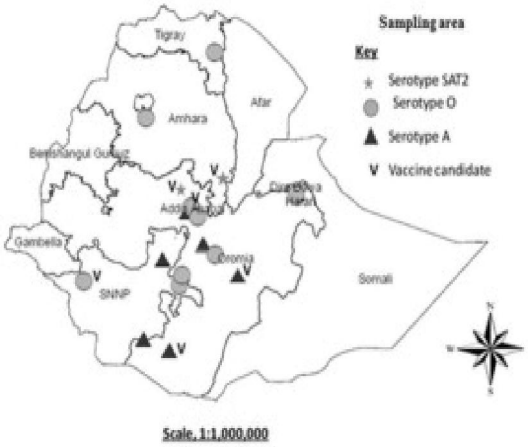

Figure 3: Map of Ethiopia showing the distribution of FMD virus serotype O and A isolated in Ethiopia during study period (Source [37]).

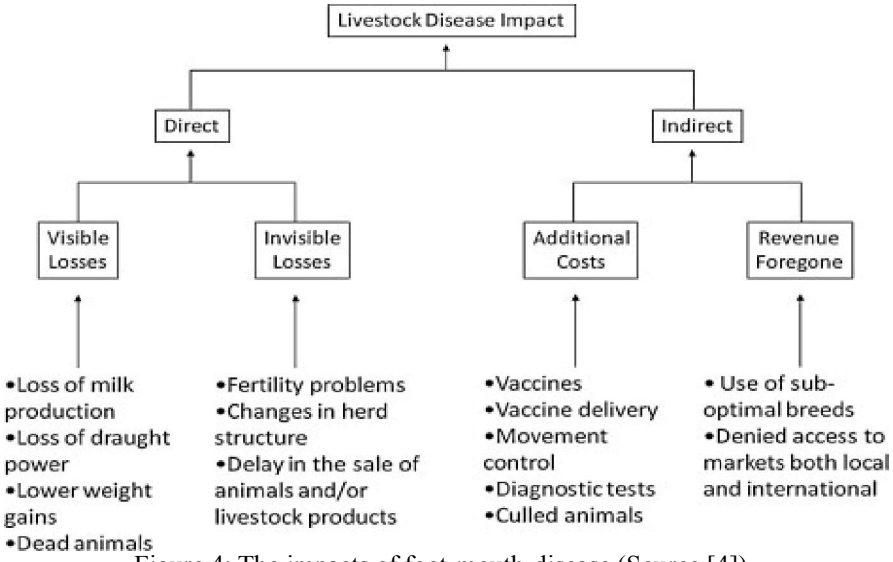

Figure 4: The impacts of foot-mouth-disease (Source [4]).

3.3 Economic impact of the disease

Livestock especially cattle play an important livelihood role in Ethiopia as source of draught power for 80% crop production and major source of subsistence milk for pastoral community [38]. These added to the country's large potential for export of livestock and livestock products could make the socioeconomic impact of FMD substantial and investment in its control an economically rational consideration [31].

In Ethiopia, where the local economy is heavily dependent on livestock, the burden may be severe and local food security impaired [31]. The impact of reduced productivity of animals can be long lasting and diseases can have lasting effects on livestock output in a number of "hidden" ways (such as delays in reproduction leading to fewer offspring and the consequences of a reduced population) which often exceed the losses associated with clearly visible illness [39]. At the local level, FMD reduces farmers' income and food availability for consumption. At the national level, FMD slows economic growth by severely limiting trade opportunities [8].

Heavy losses occur in small scale mixed farming system when outbreaks affect draft oxen during the planting season. It causes considerable losses of milk yield and weight gain among dairy and fattening stock [10]. It's role in contributing to the suffering and death

of livestock particularly when affected at periods of drought (by limiting their access to feed and water) or at early ages is believed to be significant. The impact of the disease in affecting our export trade has been witnessed by import bans imposed by different countries at different times [40].

3.4 Control and prevention in Ethiopia

FMD endemic countries do not follow stamping out policy and use only vaccination as a measure of control. For effective control of FMD about 60-80% of animals need to be covered under vaccination so as to control the outbreak of disease [9].

Absolute country or zone freedom from FMD is difficult to achieve in Ethiopia in the short term, thus production of disease free animals is proposed as the alternative for promoting safer trade in livestock and livestock products [41]. In Ethiopia context the control of FMD is practiced by involvement of quarantine, restriction of animal movement, isolation of infected animals, vaccination programmes, proper disposal of infected carcass and other methods which are feasible to Ethiopian economy [42].

In Ethiopia, currently there is no country wide vaccination programme aimed to control FMD and ring vaccination is carried out around an infected area. Considering the wide prevalence of serotypes O and A, the National Veterinary Institute (NVI) is producing an inactivated vaccine [39].

4. Conclusion and recommendations

Foot-and-mouth disease (FMD) is a highly contagious viral disease of cloven-footed animals and is one of the most important economic diseases of livestock. It is caused by a virus of the genus Aphthovirus, in the family Picornaviridae, of which there are seven immunologically distinct serotypes; O, A, C, South African Territories (SAT)1, SAT2, SAT3 and Asia1. There is no cross-immunity between serotypes, immunity to one type does not confer protection against the others, and this presents difficulties to vaccination programs. The disease is characterized by fever and vesicular eruptions in the mouth, on the feet and teats. FMD is a global disease that is distributed throughout the world, most commonly in Asia, Africa, South America and parts of Europe. The disease is spread through importation of live animals and animal products as well as visitors from infected countries to the other countries. It causes greatest production losses and a major constraint to national and international trade in livestock and their products. Foot-and-mouth disease is endemic in Ethiopia. The presence of foot and- mouth disease in the country is a major obstacle to the development of agriculture because of its adverse effects on livestock production and agricultural exports. The current review indicated that transboundry movement of livestock between Ethiopia and the neighboring countries might be the major risk for the distribution of FMD. Based on the above conclusion, the following points are recommended:

- ❖ Restriction of cross border animal movement and establishment of quarantine station around the border area should be applied.
- ❖ Regular surveillance and monitoring is necessary.
- ❖ Research should be strengthened to produce polyvalent vaccine containing the dominant serotype.
- ❖ Vaccination of all susceptible animals against the different serotype is advisable.
- ❖ Control of the transportation of live animals and animal product as well as visitors from FMD infected countries should be practiced.

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