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REVIEW ON FOOT AND MOUTH DISEASE IN ETHIOPIA: CURRENT STATUS

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SUMMARY

Foot and Mouth Disease (FMD) is an extremely contagious viral disease of cloven hoofed animals caused by seven immunologically distinct serotypes of FMD virus. Three of the seven known serotypes (Serotype O, A and SAT 2) have been identified in Ethiopia causing a widely distributed disease with a number of annual outbreaks. FMD is endemic in the country, though its prevalence may have significant variations across different farming systems and agro-ecological zones. Sero-prevalence studies showed higher prevalence of FMD in young and adult animals than claves, in female animals than males and in export abattoirs and feedlot animals than animals brought to veterinary clinics. Higher rates of FMD were also reported in extensively managed cattle farms than intensive farms. Presence large number of susceptible animals, absence of restriction of animal movement, as well as shared grazing pastures and watering points between wild and domestic animals are among the factors contributing for the frequent occurrence of FMD outbreaks in the country. The impact of the disease has been shown to be due to its direct effect on animal production, and its indirect effect on the economy of the country through disease control costs and losses due to restrictions from international trade acting as a barrier from high value markets. At present, only ring vaccination conducted around outbreak/infected area is used as a means of controlling FMD in the country, the inactivated trivalent vaccine consisting serotypes A, O and SAT2, produced by the National Veterinary Institute, is comprehensively utilized in view of the wide prevalence of the serotypes. Country-wide vaccination program aimed to control the disease, and restriction of movement of animals and animal products would be the recommended efficient control measure of FMD in the country

Key words: Cloven hoofed, Ethiopia, FMD, Serotype, Viral disease

1. Introduction

Foot and Mouth Disease (Aftosa, Aphthous fever) is an extremely contagious and acute viral disease of all cloven-hoofed animals and is a transboundary animal disease. FMD is caused by FMD virus (FMDV) that has seven serotypes (O, A, C, Asia 1, SAT 1, SAT 2 and SAT 3), with distinct immunologic, antigenic and genetic properties. So far, three serotypes (A, O, and SAT 2) of FMD virus have been reported in Ethiopia and frequent outbreaks occurred, each year, at different parts of the country (Sulayeman *et al*., 2018). Uncontrolled animal movement is the main reason for rapid spread among susceptible herds. Animals may acquire the infection from multiple circulating virus serotypes. Prevalence of FMDV is higher in the extensive management system than intensive system because animals travel long distance in search of good pasture and water leading to high contact with other cattle and wildlife reservoirs of different origin (Simwal *et al*., 2015).

FMD is the most contagious transboundary animal disease (TAD) affecting cloven hoofed animals of domesticated and wildlife. Among species of the domesticated animals; cattle, sheep, goats, pigs and buffalo are susceptible (Hirsh *et al*., 2004). Foot and mouth disease is a severe plaque of animal farming, since it is highly infectious and can be spread by infected animals. Symptomatical ly, the disease is characterized by fever, loss of appetite and weight, blisters on the mucus membranes, especially those of mouth, feet and udder (Radostitis *et al*., 2007). Under favorable condition of low temperature, high humidity, moderate wind and comfortable topography, the virus in aerosols may spread to for long distance. Generally, the integrations of these three factors are important for the disease occurrence, of which if one is not available, the disease does not occur (Molla *et al*., 2013).

The difficulty of herd isolation and movement restriction is inherent to the husbandry system of traditional extensive livestock production (Jemberu *et al*., 2015). Occurrence of FMD varies in different age groups; it is significantly higher in young and adult animals than claves (Tesfaye , 2016). There are significant differences in prevalence of FMD in different altitude (Mekonen *et a l*., 2011). Epidemiological studies based on identification and characterizations of serotypes of the

virus are crucial to understand dynamics of the disease and apply efficient prevention and control measures. Foot and mouth disease is subject to national and international control and the measures taken depend on whether the country is free from the disease, is subject to sporadic outbreaks or has endemic infection. In cattle, FMD should be considered whenever salivation and lameness occur as well as vesicular lesion is seen or suspected, the laboratory diagnosis and serotype identification of the virus should be done in a virus secure laboratory (OIE, 2012). Countries free of FMD impose strict import regulation on animals, animal products and potentially contaminated materials from FMD countries (Radostitis *et al*., 2007).

- Killed trivalent (containing O, A and C strains) vaccines are in general use, but because of the increasing occurrence of antigenically dissimilar sub-strains the production of vaccines from locally isolated virus is becoming a more common practice (Mekonin *et al*., 2011). Cost of vaccini on is cheaper than that of treatment for several reasons (Bao *et al*., 2017). Knowledge of FMDV ci rculating in endemic region is critical to understand viral ecology as well as control of FMDV (Lu di *et al*., 2016). Therefore the objective of this review is to review the epidemiology and current status of foot and mouth disease in Ethiopia

2. LITERATURE REVIEW

2.1. History of Foot and Mouth Disease

Foot and Mouth Disease was identified for the first time in 1898 by Friedrich Loefffler and have different names in different regions of the world. FMD virus was defined in 1963 by the International Committee on Taxonomy of Viruses (ICTV) as belonging to the genus Aphthovirus, family Picornaviridae (Lefevere *et al*., 2010).

2.2. Etiology

Foot and Mouth Disease is caused by Aphthovirus of the family Picornaviridae. FMD is also known Aphtous fever. Aphthovirus is RNA virus with a positive-sense single-stranded genome. The name Picornaviridae is derived from the Latin word 'pico' (small) and 'ma' (RNA) which refers to the size and genome type while the genus name 'aphthvirus' refers to the vesicular lesions produced in cloven hoofed animals. It has a high mutation rate because the viral RNA–dependent RNA polymerase lacks proofreading ability, resulting in 7 immunogenically distinct serotypes (O, A, C, Southern African Territories SAT 1, SAT 2, SAT 3, and Asia 1) and numerous and constantly evolving variants showing a spectrum of antigenic diversity (Fredrick *et al*., 1990).

2.2.1. *Structure of FMDV*

The FMDV particle is roughly spherical in shape and about 25–30 nm in diameter. It consists of the RNA genome surrounded by a protein shell or capsid. The capsid is composed of 60 copies of the capsomers. Each capsomer consists of four structural polypeptides, VP1, VP2, VP3 and VP4. The VP1, VP2 and VP3 are exposed on the surface of the virus while VP4 is located internally. The RNA includes three separate parts i.e. the 5′ untranslated region (5′ UTR), a long coding region and the 3′ untranslated region (3′ UTR) (Sayde and Graham, 2013).

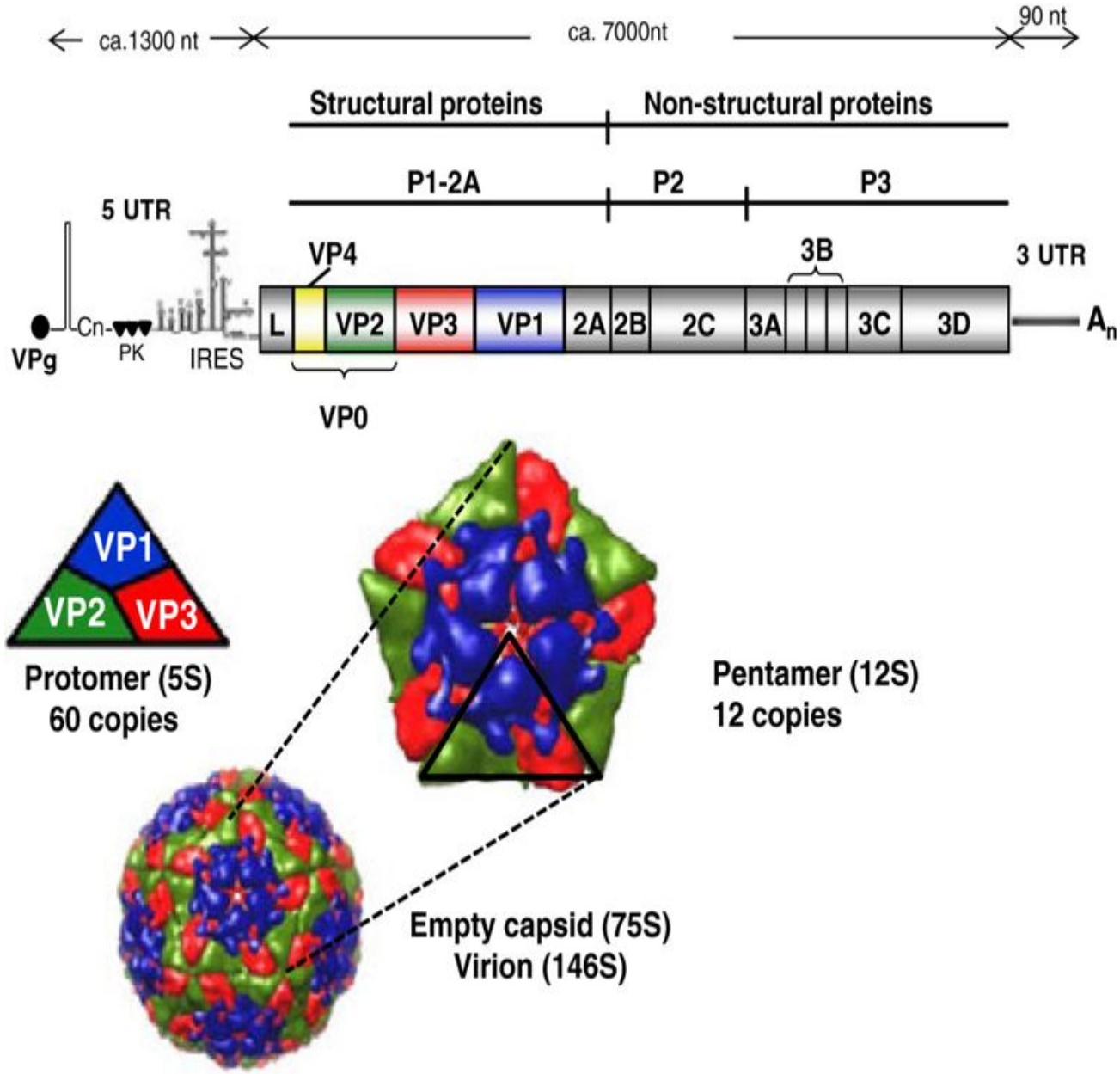

Figure 1: Genome organization of FMDV and the structure of virus

(**Source**: Sayde and Graham, 2013)

The virus is resistant to external influences including common disinfectants and the usual storage practices of meat trade. It may persist over one year in infected premises, for 10-12 weeks on clothes and feeds. 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 (Dinardo *et al*., 2011). The seven serotypes of FMD virus (O, A, C, SAT1, SAT2, SAT3 and Asia1) were named after the phylogenetic classification and geographical area where they caused FMD outbreak for the first time (Kasanga *et al*., 2014).

2.3. Global epidemiology of Foot and Mouth Disease

2.3.1. *Occurrence and host range*

FMD has occurred in most parts of the world. Europe has experienced a number of sporadic outbreaks since the cessation of vaccination on the continent during 1990 - 1991 (Rweyemamu and Astudillo, 2002). Global surveillance for FMD aims to identify the current hazards and to predict heightened risk so that appropriate diagnostics and vaccines are available for their detection and control. This requires sustained effort directed towards the monitoring of FMD outbreaks and ideally also of FMDV circulation and persistence, along with collection and characterization of FMDVs and integration of findings with associated epidemiological intelligence. Current trends show that globally the most common serotype identified is type O (OIE, 2012). FMD is highly contagious and affects over 70 domestic and wild Artiodactyla species. Of the domesticated species; cattle, pigs, sheep, goats, and buffalo are susceptible to FMD (OIE, 2001).

FMD serotypes are not uniformly distributed in the regions of the world where the disease still occurs. Africa has the greatest diversity of FMD serotypes. Six of the seven serotypes of FMD virus, except Asia 1, are prevalent in Africa. Three of the South African Territories (SAT) serotypes are unique to Africa. Asia contends with four serotypes (O, A, C, Asia 1), and South America with only three (O, A, C). Serotype Asia1 is restricted only to Asia subcontinent and the capacity to invade free areas is common to all serotypes (Rweyemamu *et al*., 2008). The epidemiology of FMD in sub-Saharan Africa is probably more complicated than in any other regions of the world. Wildlife plays a unique and important role in the epidemiology of the disease in Africa although this aspect has been investigated only in Southern Africa (FAO, 2006). Global FMD situations were listed in figure 2 below.

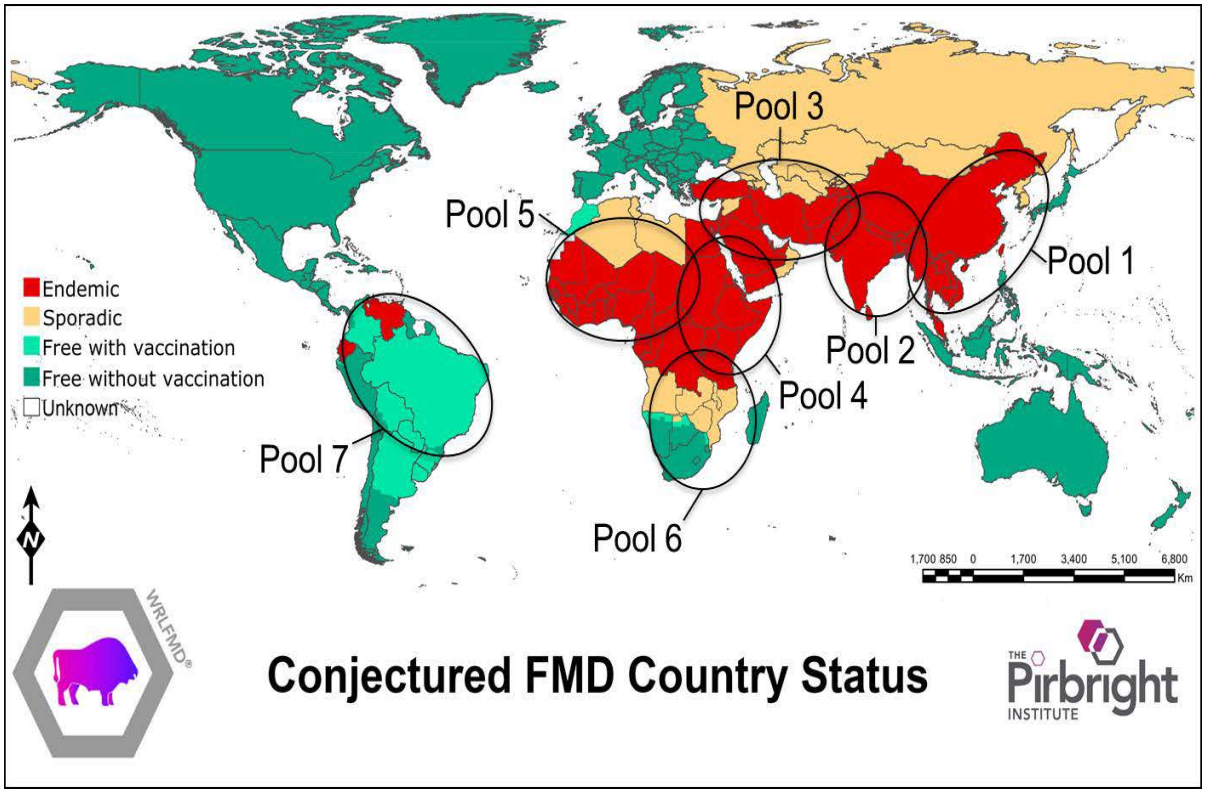

Figure 2: **Distribution of the seven endemic pools of FMD showing conjectured status of FMD in countries (Source: Donald & Mark, 2014)**

Trans-boundary live animal movements are part of the main characteristics of husbandry systems in African regions during drought circumstances; refugee movements and frequent cross-border trade have probably increased the risk of the entry and spread of FMD. In most pastoral areas of the continent livestock trade is active across border areas, dynamic and driven by price differential, and hence, livestock movement plays an important role in the spread and epidemiology of FMD (Vosloo *et al*., 2002). Currently almost all European countries are recognized by the World Animal Health Organization (OIE) as free of FMD. The disease is common in most developing nations of South America, Asia, Middle East and it is highly endemic in most sub-Saharan African countries (FAO, 2006).

2.3.2. *Prevalence*

FMD 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 (Radostits *et al*., 2007). It is one of the most globally important notifiable diseases of livestock due to its high infectious and transboundary distribution nature (Knight *et al*., 2013).

2.3.3. *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. FMD can be transmitted over a long distance via affected animals and their products. The virus persists for longer periods in lymph nodes and bone marrow and when discarded as garbage can constitute a mechanism of infection for dog, cat and swine. Animal hides can serve as a source of infection for extended period of time (Hirsh *et al*., 2004). The most important features of disease are extremely rapid replication and transmission of the virus (Biswal *et al*., 2012). FMD is endemic and large numbers of susceptible domestic and wild ruminants exist in Ethiopia, as limited vaccination and disease report and investigations as well as serological surveys (Ayelet *et al*., 2012). There are strong associations of contact pattern to wild animals to domestic animals with the transmission of FMD in cattle (Molla *et al*., 2013).

Following recovery from the acute stage of infection, infectious virus disappears with the exception of low levels that may persist in the oropharynx of some ruminants. Live virus or viral RNA may continue to be recovered from oropharyngeal fluids and cells collected with a probang cup. The carrier state in cattle usually does not persist for more than 6 months, although in a small proportion, it may last up to 3 years (OIE, 2012).

2.3.4. *Humans as vectors for FMDV*

People can act as mechanical vectors for FMDV transmission, by carrying the virus on clothing or skin. The virus might also be carried for a time in the nasal passages, although several studies suggest prolonged carriage is unlikely (Benson, 2013). Because factors such as suboptimal facility sanitation or poor compliance with personal hygiene and biosecurity protocols could also influence transmission to animals, these studies might not apply directly to the situation in the field (Aftosa, 2015).

2.3.5. *Pathogenesis*

The incubation period for FMD is highly variable, and depends on the strain and dose of virus, the route of transmission, the animal species and the husbandry conditions. Initial replication in pharynx and/or skin, then viremia and generalization with high level of replication in the skin.

Infected cattle may shed virus 1-4 days before and 7-10 days after clinical signs. During the viraemic stage FMDV is present in all excretions and secretions (breath, saliva, faeces, and urine; milk and semen). Most animals recover after 10-15 days. Carrier, in FMD, is defined as an animal from which FMD virus can be isolated from the esophageal pharyngeal area, more than 28 days after infection. Although it is well established that FMD virus persists in buffalo (up to 5 years), cattle (up to 3 years), Sheep (up to 9 months), and goats (between 3-6 month), the mechanisms underlying persistence and the Immunological pathway that eventually leads to viral clearance are not well understood. However, the carrier state can develop either after the acute stage or without any clinical disease, in vaccinated animals exposed to live virus (OIE, 2012).

2.3.6. *Morbidity and mortality*

The morbidity rate in outbreaks of FMD in susceptible animals can rapidly approach 100% but some strains are limited in their infectivity to particular species. 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 malnutrition. However, the case fatality is low, about 2% in adults and 20% in young stock (Molla *et al*., 2013).

2.3.7. *Clinical findings*

FMDV can be found in all secretions and excretions from acutely infected animals, including expired air, saliva, milk, urine, feces and semen, as well as in the fluid from FMD-associated vesicles, and in amniotic fluid and aborted fetuses in sheep. The amount of virus shed by each route can be influenced by the host species and viral strain (Aftosa, 2015). The severity of clinical signs of the disease varies with the strain of the virus, the exposure dose, the age and breed of animal, the host species and their status of immunity. Viremia in cattle lasts for 3-5 days and the lesions develop 2-14 days post infection. In acutely infected cattle, the initial signs are fever or a rise in temperature (40-40.6^{o}C), dullness, anorexia and marked drops of milk production. Within 24 hours, there appears excessive salivation, the saliva hanging in long, ropy strings and leads to nasal discharge (Woodbury, 2005). These signs are accompanied by vesicle formation on the dorsum of the tongue, soft palate, dental pads, lips and gums, which result in opening and closing of their mouth with characteristic smacking sound. Vesicles may also be found in areas where there is high friction, such as inter-digital space and coronary band of feet with consequent lameness, on nostrils, muzzle and teats. Pregnant cows may abort, presumably as a consequence of fever (Quinn *et al*., 2005).

2.3.8. *Zoonotic Importance*

Foot and mouth disease is not considered to be a public health problem, as infections seem to be very rare and their consequences mild. In the past, many people who worked with FMDV in vaccine laboratories or other locations developed antibodies to this virus, but there were few clinical cases. One laboratory reported only 2 cases in more than 50 years, and a large FMD vaccine manufacturer documented 3 cases among its workers. It may be that exposure to extremely large amounts of virus or a predisposing condition is necessary for infection (Catley *et al*., 2004).

2.3.9. *Differential Diagnosis*

Vesicular stomatitis, swine vesicular disease and vesicular erythema are the primary disease that needs to be differentiated from FMD. Due to the relative ease of isolating virus from tonsil swabs compared to traditional sampling techniques and infection with FMDV is not clinically distinguish able from other vesicular diseases. There are some other diseases that have some signs that can be mistaken for FMD, such as rinderpest, mucosal disease, infectious bovine rhinotracheitis (IBR) and bluetongue (Giancarlo *et al*., 2016)

2.3.10. *Necropsy Findings*

The lesions of foot and mouth disease consist of vesicles and erosions in the mouth, on the feet and udder. The erosions become ulcers especially if secondary bacterial infection has occurred. Grossly, the ventricular walls appear streaked with patches of yellow tissue interspersed with apparently normal myocardium giving the typical “tiger heart” appearance. 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 include. 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 of material is often secondary (Radostitis *et al*., 2007).

2.4. Diagnosis

Epithelium collected from an unruptured or recently ruptured vesicle is suitable for antigen demonstration. Convalescent animals and in persistent or subclinical infections, samples of oesophageallpharyngeal fluid can be obtained with a probang (sputum) cup. Demonstration of specific antibody by virus neutraliza- tion or ELISA can be used to confirm a diagnosis in unvaccinated animals. In endemic areas, interpretation of antibody titres may prove difficult. The accurate diagnosis of infection with FMDV is of prime most importance for both control and

eradication campaigns in FMD endemic areas and as a supportive measure to the stamping out policy in FMD-free areas. The detection of antibody to the polyprotein 3ABC is a useful indicator of FMD virus infection regardless of the serotype involved. Antibody to the 3ABC is only found in virus-infected animals, but not in vaccinated animals. Virus Isolation and characterization of the virus is the "golden standard" for the diagnosis of viral diseases. In Eastern Africa the laboratory capacity for FMD in terms of tests equipment and skilled manpower is still limited and thus all reported outbreaks are not properly serotyped and characterized leading to insufficient knowledge of the regional FMD status (Namatovu *et al*., 2013).

2.5. Economic importance

Foot and mouth disease remains one of the most important livestock diseases of the world, its highly infectious nature, its broad economic impacts on animal wellbeing and productivity, its implications access to domestic and export markets for livestock and products. The impacts of the disease vary between developed and developing countries, and also within many developing countries depending on the species involved, the genotype, the level of productivity, the significance of livestock to livelihoods, and the effectiveness of indigenous coping mechanisms for controlling the effects of FMD (Radostitis *et al*., 2007). Although a disease of low mortality, FMD is considered one of the most economically devastating diseases of animals worldwide. Impact of FMD on farmers or producers is considered in terms of cattle productivity that means reduction in milk yield, age specific mortalities, weight loss and abortions (Emma, 2017).

2.6. Control and Prevention

Vaccine matching or antigenic characterizations of FMD viruses are important to select the most immunologically appropriate vaccine strain for use in particular circumstances and to monitor on a continuing basis the suitability of vaccine strains maintained in vaccine banks (Donaldson, 2012).

2.7. Epidemiology of Foot and Mouth Disease in Ethiopia

2.7.1. *Prevalence*

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 (Ayelet *et al*., 2009). Type O is the most prevalent serotype identified with the degree of 73.3% and widely distributed throughout the country, while the rate for serotype A (19.5%),

SAT 2(4.1%) and SAT 1 (1.8 %) with limited distribution in the country (Deribe *et al*., 2017). Three serotypes (A, O, and SAT 2) of FMD viruses are isolated in different areas of the country. Serotype O from Kolfe district (Addis Ababa). Serotype A from Kolfe and Guna district of Addis Ababa and Arsi zone. Serotype A from Guna District is classified to genotype IV of African topotype. Serotype SAT 2 FMD viruses from cattle in Ludehitosa district (Arsi zone), Adama, Boset district (East shewa zone) and Kolfe district (Addis Ababa). The SAT 2 serotype is clustered to topotype VI (Sulayeman *et al*., 2018). FMD serotype prevalence in Ethiopia was summarized according to figure 3 below.

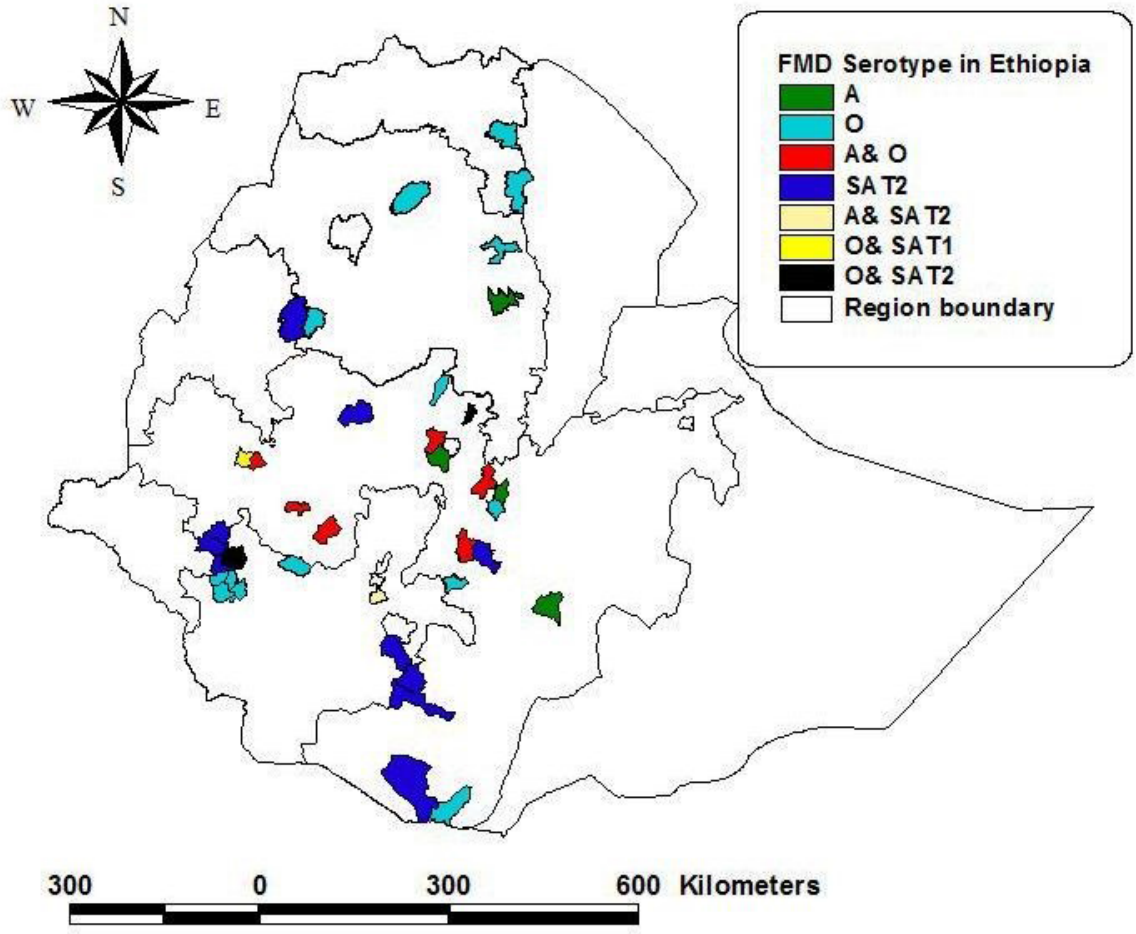

Figure 3: **FMD Outbreak identified serotypes during 2006 – 2016 at district level in Ethiopia**

Source: Sahle *et al*., 2017

Prevalence of FMD is different in different age groups in which significantly higher seroprevalence in young and adult animals than in claves (Tesfaye *et al*., 2016). The prevalence of

FMD is higher in female animals than male (Fanta *et al*., 2014). Highest prevalence of Foot and Mouth Disease is recorded in export abattoirs and feedlot than animals brought to veterinary clinic. 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 (Belina *et al*., 2016). Seropositivity variation occurs in individual animals breed, immune status, and interaction of cattle with other animals and production system as well as differences in geographical area or the existence of recent outbreak (Milkessa *et al*., 2016; Beksisa, 2017).

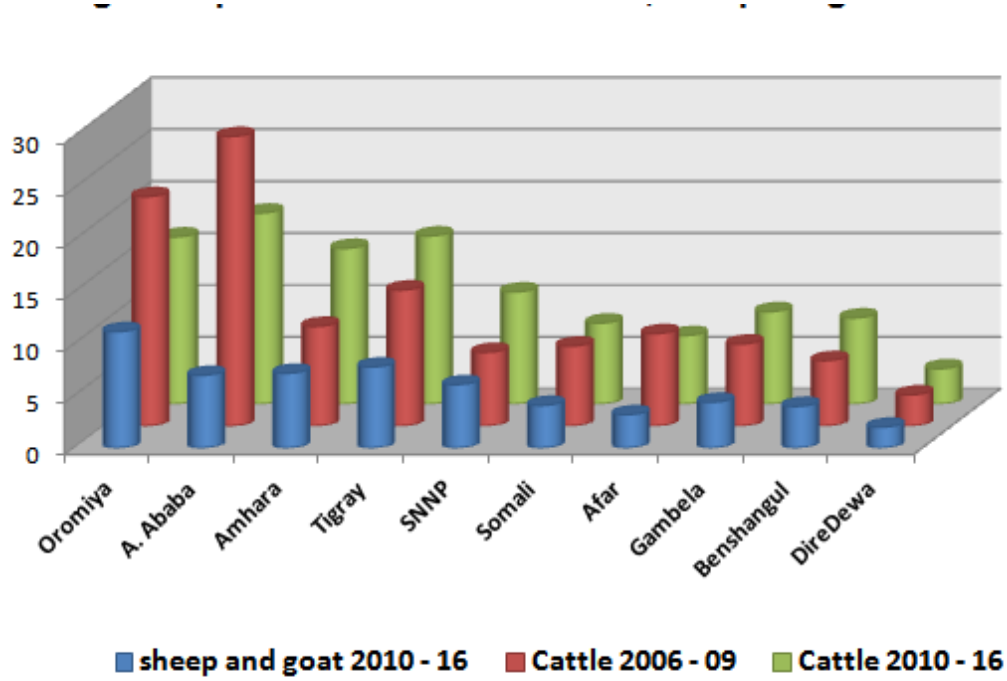

Figure 4: Seroprevalence of FMD in Cattle, Sheep and Goat (Source: Sahle *et al*., 2017)

2.7.2. *Economic Importance*

The impacts of FMD can be separated into two types: those that arise from the direct effects of the disease on production, and those that have indirect effects through the costs of disease control, trade restrictions and use of sub-optimal livestock practices (Tariku *et al*., 2013). Production losses are greatest in low to middle income countries with endemic FMD infection, where communities are often dependent on the health of their livestock. The disease causes the greatest losses in Ethiopia, particularly, in livestock trade. FMD status is an important determinant of

international trade in livestock products and the existence of FMD is an effective barrier from the markets with the highest prices for these products (Tadesse *et al*., 2017).

2.7.3. Diagnosis

The suspensions of field samples suspected to contain FMD virus are inoculated into cell cultures (primary pig kidney cells), incubated at 37°C and examined for cytopathic effect (CPE), 24 to 48 hours post infection (Akinaw, 2016).

2.7.4. Prevention and Control

Foot and mouth disease is subjected to national and international control and the measures taken depend on whether the country is free from the disease, is subject to sporadic outbreaks or has endemic infection. Countries free of FMD impose strict import regulation on animals, animal products and potentially contaminated materials from FMD countries. Quarantine and vaccination programs are also used to control outbreaks and to prevent spread of the disease (Hirsh *et al*., 2004).

In Ethiopia, factors such as the presence of high numbers of susceptible animals, wild and domestic animals sharing common grazing pastures and watering points in areas where wild life occur, as well as lack of control of animal movement contribute to the frequent occurrence of FMD outbreaks and to the difficulty in controlling the disease (Ayelet *et al*., 2008). Control of FMD is practiced by involvement of quarantine, restriction of animal movement, isolation of infected animals, vaccination programs, and proper disposal of infected carcass. Currently, there is no country-wide vaccination program aimed to control FMD and a ring vaccination is carried out around infected area. A small-scale vaccination practice against FMD is realized in occasions like FMD outbreaks in different parts of the country. Considering the wide prevalence of serotypes O, A and SAT 2 the National Veterinary Institute is producing an inactivated trivalent vaccine (Tesfaye, 2016). However, FMD control by vaccination does not seem cases, animals' vaccinated using bivalent A and O vaccine were found to be affected by sever outbreaks (Deribe *et al*., 2017).

2.7.5. Vaccination

One or more of a variety of serotypes and strains of FMDV can be incorporated into FMD vaccines and the quality of vaccines can vary widely. Selection of an appropriate vaccine in terms of quality and strain composition is a prerequisite for a successful vaccination programme, without which all other efforts will be in vain. Foot and mouth disease vaccines provide relatively Short-

lived protection. When using high-potency vaccines to provide a rapid onset of short-term, emergency protection, revaccination may not be required (Giancarlo *et al*., 2016).

At present, the National Veterinary Institute (NVI) is producing an inactivated trivalent vaccine containing serotype O-ETH/38/2005, A-ETH/7/2008 and SAT2-ETH/76/2009 (Ayelet *et al*., 2013). Another aspect of effective vaccination is the reduction of transmission of FMDV from vaccinated and subsequently infected animals to naive or other vaccinated animals by direct or indirect contact that may reduce the intra-herd and inter-herd spread of FMDV during field outbreaks. For efficient control of FMD, vaccination and restriction of the movement of infected animals and animal products are crucial. In endemic situations, prophylactic vaccination every 6 months or more depending on the local epidemiological situation, and in FMD-free countries, emergency vaccination (vaccinate-to-live) along with culling of infected animals, may be a suitable option to control FMD (Satya, 2009). In an experimental study by all animals vaccinated against FMDV 14 days prior to infection with FMDV developed no clinical signs of FMD, nor any signs of viremia. In contrast all animals not vaccinated prior to exposure to FMDV developed clinical FMD and viremia (Stenfeldt *et al*., 2015)

3. Conclusion and Recommendations

FMD is one of the most important economic diseases of livestock throughout the developing world. It is an endemic disease of cattle and other cloven hoofed animals caused by three serotypes of FMD virus (Serotype O, A and SAT 2) in Ethiopia. Occurrence of the disease showed significant variations across different farming systems, animal groups and agro-ecological zones. The impact of the disease on the national economy of the Ethiopia is thought to be extremely high mainly due to restriction of animal sell to high value international markets. At the moment, ring vaccination, using the inactivated trivalent vaccine, is the only control method applied in the country. Failure to eradicate FMD in the country may be due to variability of serotype in different areas and investigation of matching vaccine. Therefore, based on the above findings, the following recommendations are forwarded:

- Restriction of free movement of animals and establishing quarantine stations in boarder areas

- Regular surveillance of the FMD and investigation of serotypes in different regions of the country
- Separate crash should be used for treatment, vaccination and artificial insemination of animals
- Veterinarian should be informed to report FMD outbreaks to concerned authorities to enhance investigation of serotypes
- In FMD endemic area, awareness should be created to vaccinate all animals at the recommended yearly schedule.

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