Review on current status of FMD in Ethiopia: Spatiotemporal distribution, frequency and prevalence

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Abstract: Foot and mouth disease (FMD), which is a highly contagious transboundary viral disease that affects all domestic and wild ungulates and pig, is caused by a virus that belongs to the genus *Aphthovirus* of the family *Picornaviridae*. It was the first animal viral infection established and ranks first among the disease of animals. In Ethiopian context the disease is found distributed in all regions. This paper addresses the spatial and temporal distribution, frequency of outbreak and the sero-prevalences of FMD in Ethiopia. FMD outbreaks were reported from every part of the country with the highest and lowest outbreak reported from oromia and afar regional states respectively. As the temporal distribution shows the disease occurs at any time of the year however, the highest outbreaks of the disease are observed during extreme dry seasons of the years. On the past seven years on average 93 numbers of FMD outbreaks were reported to MoLF annually. The outbreaks were occurred every year, but the highest and lowest number of outbreaks were reported in 2012(205) and 2015(20) respectively. It seems that the frequency of FMD outbreak is decreasing in the last three years (2013-2015). The prevalence of the disease is varying from place to place with the highest prevalence in Borana and lowest in Afar. Nationally there is no vaccination program devised to control FMD. Only a prophyl active vaccination is practiced by some dairy farms through inactivated bivalent and trivalent vaccine produced by NVI and by importing bivalent and qudrivalent vaccines from Kenya and India respectively. In conclusion understanding the current status of FMD in Ethiopia is aprerequest to initiate country wise control and prevention methods.
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Introduction

Ethiopia is one of the richest country in livestock population. The 2016/17 CSA of Ethiopia estimated that farmers in Ethiopia had a total of 59.5million heads of cattle. This makes the country the first in Africa and fifth in the word. On average in the year 2000-2010, Ethiopia earned US$ 290 million from the export of live animal of which cattle play an important role. However, due to the high prevalence of some diseases like FMD and poor management practices, the country is getting less economic return from the livestock production (Asseged, 2005).

Foot and mouth disease (FMD) is a highly contagious transboundary viral disease that affects all domestic and wild ungulates and pigs. FMD, which is caused by a virus that belongs to the genus *Aphthovirus* of the family *Picornaviridae,* was the first animal viral infection established. According to the office of international des epizootics, FMD ranks first among the disease of animals (Mahy, 2005). Foot and mouth disease virus (FMDV) occurs in seven standard serotypes: A, O, C, and South African Territories (SAT) 1, SAT 2, SAT 3, and Asia 1. Within each serotypes, there are many bio typical strains and topotypes which can be identified by genetic and immunological tests (OIE, 2012). Of these seven serotypes, serotype O and A are the most widely distributed, whereas serotypes SAT 1, SAT 2, and SAT 3 and Asia 1 are normally restricted to Africa and Asia respectively (Rweyemamu et al., 2008a). The occurrence of serotype C has been declining during the last 30 years, and its distribution has become very limited in the recent decade; the last reported occurrence of serotype C was in Kenya in 2004 (Roeder and Knowles, 2008; Rufael.et al., 2008). However, a serotype C specific antibody was detected in Ethiopia from Borana cattle demonstrating that circulation of serotype C viruses in the country may have gone unnoticed (Rufael.et al., 2008).

Foot and mouth disease is one of the endemic viral diseases in Ethiopia causing several outbreaks every year (Ayelet et al., 2012). The serosurvey study carried out in different parts of the country reported that sero-prevalences of FMD in cattle range 9–26% and 48% at the animal and herd level respectively (Mekonen *et al*., 2011). Among the six serotypes established in the sub-Saharan Africa, four serotypes (A, O, SAT 1 and SAT 2) have been identified over the past ten years in Ethiopia. Available data somehow indicates that type O and A are the dominant serotypes

responsible for substantial economic losses (production loses, lose of traction power, impediment to livestock and livestock product export) (Negussie *et al*., 2011).

Even though livestock is an important source of foreign currency earning for the national economy through export of meat and live animals, FMD is perceived as a major hindrance to international trades, in part, this perception is based on the assumption that disease freedom is required before export is possible (Behnke, 2011). It has a broad socioeconomic impact in developing countries both at national and house hold levels (Forman *et al*., 2009). The socioeconomic impact of the disease could be significant in Ethiopia where livestock, in particular cattle (which constitute about 71% of the total livestock biomass), play multiple roles in the household and national economies. In addition to the conventional meat and milk products, cattle provide about 80% of draft power for the cultivation of crop, manure for soil fertilizer and cooking fuel, and serve various social networking functions (Jibat *et al*., 2013.

The growing trend of private investments in the livestock sector and increasing in export of live animals and meat coupled with growing international concerns on the zoo sanitary importance of FMD have aroused interest in introducing control programs against the disease in Ethiopia (MoARD, 2006). Control of FMD in developing countries where the disease is endemic like Ethiopia is, however, difficult due to the complexity of the disease and the limited availability of financial resources to implement control measures (Paton *et al*., 2009). The presence of multiple serotypes and subtypes of FMDV and diversity of its hosts make FMD control hopeless. Moreover, available vaccines are expensive, fragile, and provide protection for only a short period. For controlling FMD in endemic countries, a long-term progressive risk reduction approach (= progressive control pathway) is advocated by FAO and OIE within the global framework for progressive control of trans boundary animal diseases (Rweyemamu *et al*., 2008b).

Currently, in Ethiopia there is planning of national FMD control program which is a part of the global effort through progressive control path way for global control of FMD. The progressive control path way requires epidemiological study to locate the spatiotemporal distribution of FMD in different regions of Ethiopia including the current status of the disease situation. Therefore the main objective of this paper is

- To overview the spatial and temporal distribution of FMD in Ethiopia.
- To highlight about the prevalence and frequency of FMD occurrence in Ethiopia.
- To assess the prevention method of FMD in Ethiopia.

Back ground about FMD

Definition

Foot and mouth disease (FMD) is defined as an infection of animals of the suborder ruminantia and the family suidae of the order Artiodactyla and Camelus bactrianus with FMDV (OIE, 2015). It is an extremely contagious, acute viral disease of all cloven-hoofed animals and pigs, characterized by fever, anorexia, salivation, vesicular eruptions in the mouth, on the feet and teats and sudden death of young animals (Quinn *et al.,* 2005). It is one of the OIE notifiable diseases of livestock due to its high infectiousness and trans-boundary distribution nature (Knight *et al*., 2013).

Etiology

FMDV was defined in 1963 by the International Committee on Taxonomy of Viruses (ICTV) as belonging to the genus *Aphthovirus*, family *Picornaviridae*. The name, *Picornaviridae* is derived from the Latin word 'Pico' meaning small and 'rna' meaning RNA (ribonucleic acid), which refers to the size and genome type, of the virus while the genus name '*Aphthovirus*' is given to refer the vesicular lesions of mouth and feet produced in cloven-hoofed animals (OIE, 2004). FMD virus is a single-stranded, non-segmented, positive sense RNA virus of approximately 8.2 kb that belongs to the genus *Aphthovirus* of the family *Picornaviridae*. The virus is inactivated when exposed to pH below 6.5 or above 9. However, the virus can survive pH of 4.6 in milk and milk products. The virus can be also easily inactivated by heat, UV radiation, and gamma irradiation, chemicals and disinfectants (Murphy *et al*., 1999).

There are seven FMDV serotypes (types A, O, C, Asia 1, and South African Territories (SAT) types 1–3) and many intra typic variants with no cross protection. Within these serotypes, 80 strains have been identified (Knowles, 2005). Serotypes O and A are widely distributed, whereas serotypes SAT 1- 3 and serotype Asia1 are normally restricted to Africa and Asia respectively (Domingo *et al*., 2005).

Epidemiology

Spatial distribution

The serotypes of FMDV are not uniformly distributed throughout the world. Serotype O and A viruses have had the widest distribution and have been responsible for outbreaks in Europe, Asia and Africa (Table1). The occurrence of serotype C has been declining during the last 30 years and its distribution has become very limited in the recent decade; the last reported FMD outbreak due to serotype C was in Kenya during 2004 (Rodriguez and Grubman, 2009) and so serotype C viruses may not exist outside of laboratories. However, a serotype C specific antibody

was detected in Ethiopia from Borana cattle (Rufael *et al*., 2008).

The SAT1-3 viruses are normally restricted to sub-Saharan Africa. However, there have been some limited outbreaks of FMD due to SAT1 viruses in the Middle East between1962–1965 and 1969–1970 and then in Greece in 1962 (Knowles and Samuel, 2003). Similarly, there have been reports of minor incursions of the serotype SAT2 in Yemen in 1990 and in Kuwait and Saudi Arabia in 2000. Moreover, FMD outbreaks due to serotype SAT2 spread from sub-Saharan Africa through northern African countries (Egypt and Libya) and into Palestine (Grubman and Baxt, 2004).

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

Region	Serotype of Virus
South America	O, A, C
Europe	O, A, C
Africa	O, A, C, SAT1, SAT2, SAT3
Asia	O, A, C, Asia1
North and Central America	Virus free
Caribbean	Virus free
Oceania	Virus free

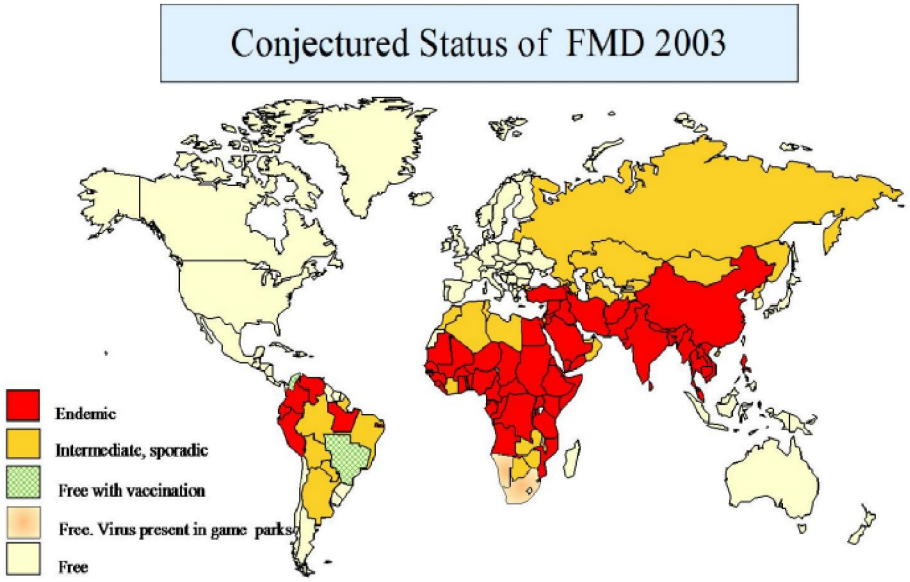

Figure 1: The geographical distribution of FMD virus serotypes in the world
Source: (Knipe and Howely, 2001)

Transmission

FMD viruses may occur in all secretions and excretions of acutely infected animals, including expired air and can be transmitted in two ways. Contact transmission between acutely infected and susceptible individuals, which is likely to account for the majority of infections, and occasional transmission between carrier buffalo and susceptible individuals. It is widely accepted that the most common mode of FMD transmission is through physical contact between infected and susceptible animals, often as a result of movement of infected animals (Pharo, 2002). Generally cattle and pig mainly get infection through inhalation and ingestion respectively. Under specific climate conditions (particularly downwind), aerosolized FMDV produced by infected pigs can travel a significant distance infecting cattle and sheep from 20 - 300 km and 10–100 km away respectively (Bartering *et al.,* 2003).

Status of FMD in Ethiopia

Historically Foot and mouth disease was first recorded in Ethiopia in 1957 by FAO, which indicated that FMD serotypes O, A and C were responsible for FMD outbreaks during the period of 1957 to 1979 (Tafesse *et al.,* 2007; Gulima, 2011). SAT 2 and SAT 1 were first isolated and reported in 1989 and in 2008 respectively (Legesse, 2008). Endemic distributions of five of seven serotypes of FMDV are maintained in the country and these five serotypes caused FMD outbreaks during 1974–2007 (Legesse, 2008; Ayelet *et*

al., 2009; Negussie *et al*., 2010). The most dominant serotype is O, accounting for 72% of the investigated outbreaks occurring in the country, followed by A (19.5%). Serotype C has not been reported in Ethiopia since 1983 (Ayelet *et al*., 2009). However, a serotype C specific antibody was detected in cattle indicating that circulation of serotype C viruses in the country may have gone unnoticed (Rufael *et al*., 2008). Recently Jemberu *et al*. (2015) identified serotypes O, SAT 2, A, and SAT 1 as the causal serotypes for the outbreaks occurred in the years 2007–2012 and during the studied period serotype SAT 2 has overtaken the rank of serotype A, with a proportion of 21%.

Spatial Distribution 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 (Ayelet *et al*., 2009). This is mainly due to lack of effective polyvalent 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 (Leforaban, 2005). According to Foot and mouth disease outbreaks annual report recording data summary of Ministry of Livestock and Fishery (MoLF)/ formerly said Ministry of Agriculture and Rural Development (MoARD) from 2009-2015 the highest and lowest number of FMD outbreak were reported from Oromia and Afar regional state respectively (Figure 2) (MoLF, 2016).

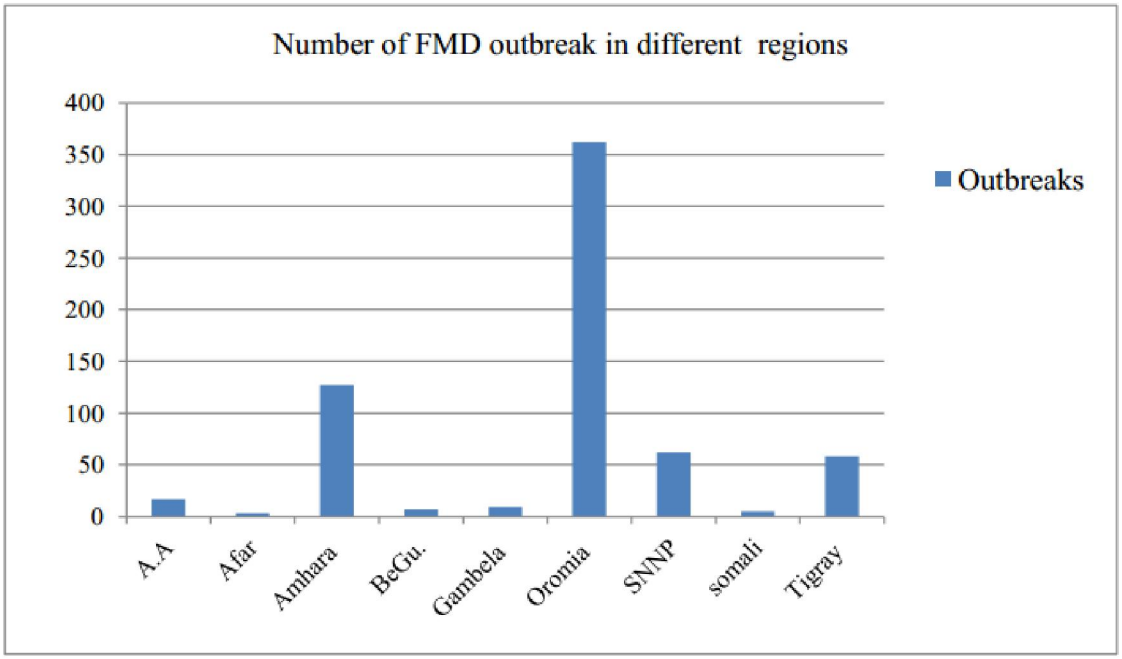

Figure 2: FMD outbreaks reported to MoLF from 2009-2015 from different Regional States of Ethiopia

Temporal distribution

As the MoLF, division of epidemiology directorate disease outbreaks report summary shows that, FMD occurs at any time of the year however, the highest outbreaks of the disease are observed during extreme dry seasons of the years which is January to march (Figure 3). Various researchers reported that this might be associated with factors such as drought. During dry seasons especially pastoralists are obliged to move their herds long distances in search of pasture and water which exacerbated transmission of highly contagious diseases like FMD at herd gathering sites or communal points (Rufael, 2006; Legesse, 2008; Molla, 2009; Bayissa, 2009). On the other hand in most highland parts of the country during rainy seasons of the year wide areas of farm land is planted with crops. During this time huge numbers of domestic animals are kept on confined small plots of communal grazing lands that could favor occurrence and transmission of the disease (self observation).

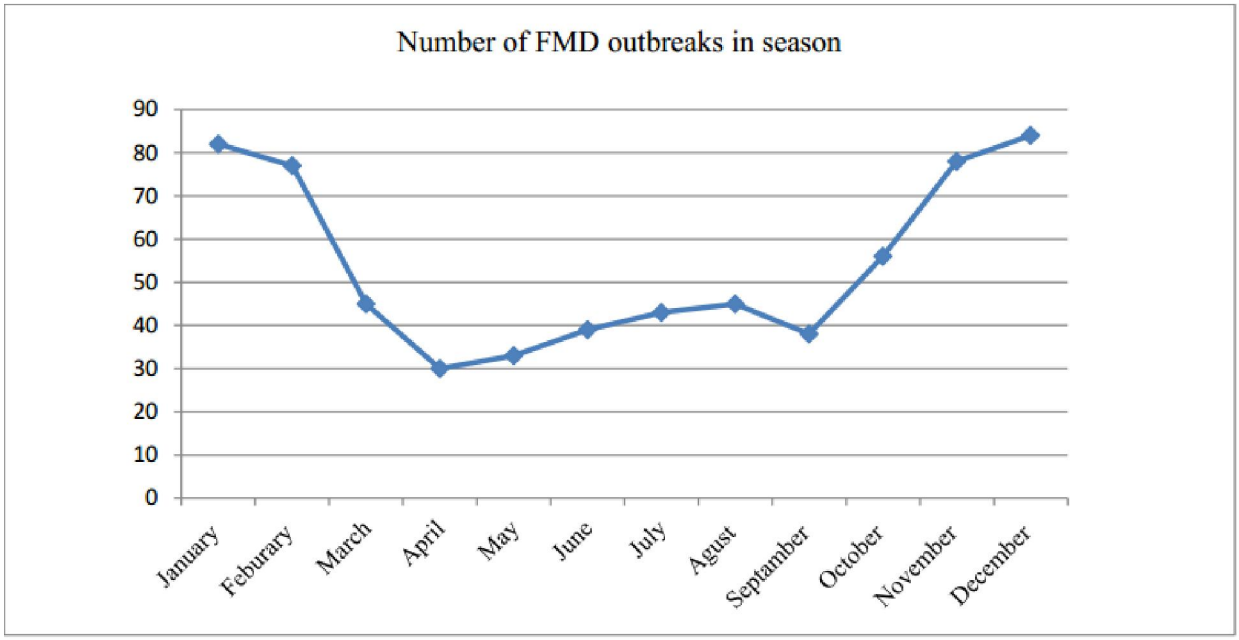

Figure 3: FMD outbreaks reported to MoLF by monthly bases, from 2009-2015

Disease occurrence

FMD outbreaks are reported frequently throughout the country (Asfaw and Sintaro, 2000). The

frequent occurrences of FMD outbreaks in the country are attributed to the presence of high numbers of susceptible animals, wild and domestic animals sharing common grazing pastures and watering points in areas where wildlife occur, as well as a lack of control of animal movement (Sahle *et al*., 2004). In the past seven years (2009-2015) on average 93 numbers of FMD outbreaks were reported to MoLF annually. The outbreaks were occurred every year, but the highest and lowest number of outbreaks were reported in 2012(205) and 2015(20) respectively (Figure 4). By considering the endemic nature of the disease and unreported cases, the figure provided shows that the frequency of the disease is decreasing in the last three years (MoLF, 2016).

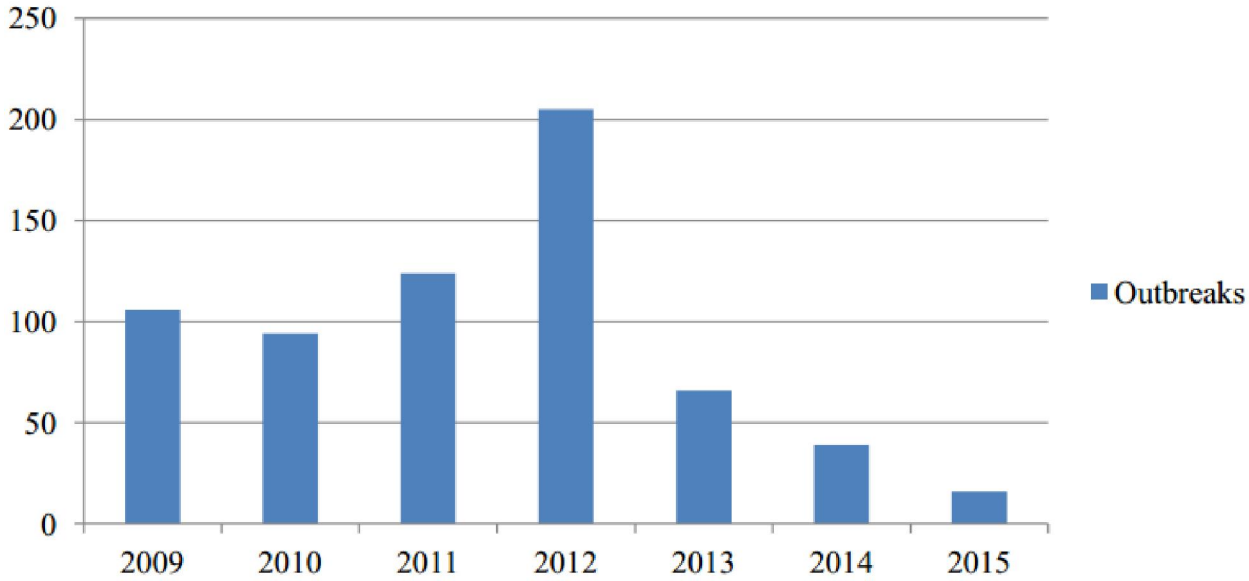

Figure 4: Numbers of FMD outbreaks reported to MoLF from different part of the country from 2009-2015

Despite the widespread occurrence of the disease, clinical, serological and virological studies to characterize the disease have never been exhaustive. The prevalence of the disease is varying from place to place with the highest prevalence in Borana and lowest in Afar (Table 2). The studies conducted so far did not come up across the country. The lack of well equipped regional veterinary laboratories, remoteness of certain areas and suboptimal routine surveillance and reporting could hinder to have the overall estimate of the disease magnitude at a national level contrary to its endemicity (Sahle, 2004). The detail individual level seroprevalence of FMD in different region of Ethiopia is indicated in table 2.

Table 2: Prevalence of FMD in different parts of Ethiopia

Study area	Sample size	Prevalence %	Reference
Oromia region			
Borana	341	53.6	Rufael (2006)
Moyale	174	16.1	Rufael (2006)
Adama-Modjo Livestock export	4321	12.5	Birhanu (2014)
Tigray region			
Tigray central zone	139	26.6	Ayelet *et al* (2012)
Tigray eastern zone	41	41.5	Ayelet *et al* (2012)
Tigray western zone	195	16.9	Zerabruk *et a l* (2014)
Tigray southern zone	75	24	Zerabruk *et al* (2014)
Amhara region			
South achefer	101	52.5	Negussie *et al* (2010)
Habru	218	38.7	Negussie *et al* (2010)
Dangela	104	43.3	Negussie *et al* (2010)
SNNP Region			
Hammer	104	13.5	Molla *et al* (2010)
Arbaminchi zurai	90	7.3	Megersa *et al* (2009)
Jinka	162	4.9	Molla *et al* (2010)
Semen bench	153	5.8	Gelaye *et al* (2009)
Addis Ababa			
Yeka	40	30	Ayelet *et al* (2012)
Bole	40	12.5	Abunna *et al* (2013)
Afar region			
Zone 4	299	4.7	Ayelet *et al* (2012)
Somalia region			
Awabere	225	14.2	Mohamoud *et al* (2011)
Babille	159	15.1	Mohamoud *et al* (2011)

Control program of FMD in Ethiopia

Currently, FMD is considered as one of the most important livestock diseases demanding urgent control intervention that should result in minimizing the impact of FMD to the level that won't be a major cause of international trade barrier. Conversely, the complex nature of the disease, its wider distribution across the country and absence of proper vaccination program with FMD vaccine within Ethiopia demanded that control strategies be implemented progressively on a short and medium to long-term basis. Measures such as establishment of disease free zones and mass vaccination of the national cattle herds may have important contributions to minimize the impact of the disease. However, these measures will require huge financial and logistic resources that their consideration should be viewed from long term perspective (MoARD, 2006).

In Ethiopia, currently there is no national FMD regular vaccination programme devised to control

FMD. Only a prophylactive vaccination is practiced by some dairy cattle keepers containing exotic cattle (Ayelet *et al*., 2009) and ring vaccination during an outbreak around the infected area to limit further spread of the outbreak to other areas. Considering the wide prevalence of serotypes O and A, the National Veterinary Institute (NVI) is producing inactivated bivalent vaccine, largely designed for prophylactics in urban and peri-urban commercial dairy farms and export cattle. However, this strategy has not given significant impact due to limitations in producing sufficient doses and prevalence of other serotypes that are not included in the vaccine formulation. Bivalent vaccine produced by NVI and imported from India and qudrivalent vaccines imported from Kenya are the available vaccine in Ethiopia market. The Ethiopian government has envisaged importing millions of polyvalent FMD vaccines with the intention of maintaining and enhancing export of livestock and livestock products in short term and establishing FMD free export zones in long term (Ashenafi, 2012). More recently by considering the wide prevalence of serotype SAT2, NVI is producing inactivated trivalent vaccine that in corporate serotypes SAT2 in addition to serotypes O and A (Tesfaye, 2014).

Conclusion

FMD is the first animal viral infection established and ranks first among the disease of animals. In Ethiopia the disease is endemic and found distributed widely. Four serotypes have been identified in the country in recent years. FMD outbreak occurred everywhere in all regional states of the country being the highest in Oromia and lowest in afar regional state. The highest outbreaks of the disease are observed during extreme dry seasons of the years. In the period 2009-2015 on average 93 numbers of FMD outbreaks were reported to MoLF annually with 205((highest) number of FMD outbreak recorded in year 2012. It seems that its frequency is decreasing in the last three years. The prevalence of the disease is varying from place to place with the highest prevalence in Borana and lowest in Afar. Vaccination is the only control method of the disease practiced at individual commercial farm with domestic bivalent and trivalent and imported bivalent and qudrivalent vaccine. Understanding the current status of the disease is fundamental prerequest to initiate the best and cost effective control methods in Ethiopia.

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