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Seroprevalence of foot and mouth disease (FMD) and associated economic impact on Central Ethiopian cattle feedlots

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The study was conducted in central part of Ethiopia in 2011 with the objectives to determine seroprevalence and associated economic impact on cattle feedlots. From the total of 38,187 bulls examined for foot and mouth disease (FMD) antibody, 5,536 (14.5%) was found positive and subsequently rejected from international market. The seropositivity of FMD varied from site to site and the variations were statistically significant (χ^2 = 3.28, df = 9, p < 0.001). Similarly, there was statistically significant (χ^2 = 4.55, df = 9, p < 0.001) difference between months of the year. The total annual (2011) economic loss due to bulls rejection from international market was estimated to be 3,322,269 USD which is equivalent to 56,345,682.24 ETB (1 USD = 16.96 ETB). This study indicates that FMD resulted in bulls' rejection from international market which affect livelihood of actors in the value chain and have a major threat to national economies as they tend to affect the international trade. Therefore, directing surveillance and controlling activities at pastoral production system where FMD risk arise and appropriate intervention measures along the market chain are critical factors necessary to prevent the introduction and spread into feedlots.

Key words: Cattle, Central Ethiopia, feedlots, foot and mouth disease, sero prevalence.

INTRODUCTION

Foot and mouth disease (FMD) is one of the most important transboundary animal diseases that cause severe economic losses due to high morbidity and export trade restrictions imposed on affected countries. The etiology, foot and mouth disease virus (FMDv), has seven recognized serotypes (O, A, C, Asia 1, SAT 1, SAT 2 and SAT 3), with distinct immunologic properties. They also differ in distribution across the globe (FAO, 2002; 2007). Five of the seven serotypes of FMDv (O, A, C, SAT 2, SAT 1) are endemic in Ethiopia (Rufael et al., 2008; FAO, 2007; Ayelet et al., 2009; Negusssie et al., 2010). Studies undertaken on FMD so far revealed the existence of the disease in different parts of the country, with prevalence that vary from 8.18% in south Omo (Molla et al., 2010) to 44.2% in different parts of the country(Negusssie et al., 2010) and posing a major threat to cattle in many parts

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of the country, thereby causing considerable economic losses through morbidity, mortality and trade restriction.

Majority of bulls used for fattening are originated from Borena pastoral system where FMD epidemics have been reported (Rufael et al., 2008; Bayissa et al., 2011; Mekonen et al*.,* 2011). Borena cattle population has 55.2 to 58.6% herds which have at least one FMD infected cattle (Rufael et al., 2008; Bayissa et al., 2011).

Currently, in Ethiopia there is no government strategy in FMD control through vaccination and movement control (Bayissa and Bereda, 2009). Lack of vaccination strategies (quality, coverage and timing) and free animal movement without certification are thus the main factors that could increase the spread of FMD along the cattle market chain. Furthermore, lack of awareness of the intermediary cattle dealers regarding the risk and the relatively short distance between production and feedlot locations makes the feedlots particularly vulnerable to the introduction of the disease without diagnosis.

Direct effects of FMD on livestock productivity include reduced feed intake, changes in digestion and metabolism, increased morbidity and mortality and decreased rates of weight gain. Indirect losses are those related to the significant costs of FMD control and management and poor access to international markets. Indirect losses are often less visible than the obvious effects of clinical disease but may be equal or more important in their overall economic impact (FAO, 2002). Hence, the introduction of FMD into feedlots can lead to failure of the business and significant disruption of live cattle trade in international markets.

Therefore, if Ethiopia wishes to access the lucrative markets of the developed world for her livestock and livestock products, control of FMD will need to be addressed more aggressively and effectively. For this reason, strategies to reduce the constraints that FMD pose to commercialization and export need to be found urgently. Information and research works regarding its prevalence and associated economic impact in cattle feedlots are a prerequisite for the development of differential policies for prevention and eventual control of epidemics. Therefore, the objectives of this study were to determine seroprevalence and associated economic impact on Central Ethiopian cattle feedlots.

MATERIALS AND METHODS

Study area

The study was conducted in East Shewa Zone located in the central parts of Ethiopia. Absolute location of the Zone extends from 7° 33’ 50”N to 9° 08’ 56”N and 38° 24’ 10”E to 40° 05’ 34”E which indicate that this zone is located in tropical climatic zone; though the climate is influenced by altitudinal variation. The total area of East Shewa Zone is approximately 9,633.52 km^2. The altitude ranges from 500 to 4307 meter above mean sea level. The zone can be categorized under rift system of Ethiopia since about 93% of the total area of the zone is completely located in rift system. The zone comprises 32 districts of which 67% are mid altitudes and 33% are lowlands. The mean annual temperature varies between 18 and 30°C and its mean annual rainfall is 410 to 820 mm. Natural vegetations grown in area are grouped under the Acacia wood land and savannah vegetation.

Study animals, source of information and sampling technique

As part of sanitary and phytosanitary (SPS) requirements and rules and regulations of animal quarantine, it is a requirement that all animals being exported to Arabian countries are tested for FMD; hence, all bulls being exported were considered for sam-pling. Therefore, serum samples collected for one year (2011) from apparently healthy 38,187 bulls for certification purpose were used. All animals used for study were male with 3 to 5 years age category and vaccinated for FMD. Survey was performed in 31 feedlots found in central Ethiopia.

Questionnaire survey

A survey was performed on 31 feedlots found in central Ethiopia. Identified feedlots owner/manager were interviewed with semi-structured questionnaire and responses regarding facility design, source of cattle, buying system, diseases preparedness, veteri-nary service, handling of sick cattle, treatment and vaccination system, sanitation, disposal of carcasses were collected in database questionnaire.

Serum samples collection and processing

Serum samples (n = 38,187) collected over one year (2011) period for certification purpose from bulls were used for seroprevalence determination. Blood samples were aseptically collected using 10 ml plain vacutainer tubes from apparently healthy bulls through jugular venipuncure. The tubes were then labeled with tag number of animals and kept protected from direct sunlight in slant position until the blood clotted and sera were separated. The clotted blood or separated sera were transported to National Veterinary Institute laboratory (Debre Zeit) and National Animal Health Diagnostic and Investigation Centre (Sebeta) for investigation. Serum samples were examined for antibodies to 3ABC non structural proteins of FMD virus using a commercially-available enzyme-linked immunosorbent assay (ELISA) test for identifying infected animals from non infected ones.

Economical loss estimation

Economic loss caused by FMD was calculated based on rejection rate of bulls from international markets. Parameters used for economic estimation were the annual (2011) serum tested for FMD, average weight of the bulls, average market prices in terminal market for export and the rejection rates of bulls due to FMD. The annual economical losses due to FMD were calculated thus:

$$C = N \times M \times Rr$$

Where: C = annual economical losses estimated due to rejection of bulls from international market, N = total number of bulls at risk of FMD in East Showa Zone in 2011, M = average terminal market price, Rr = rejection rate.

Data management and analysis

Data were classified, filtered and coded using MS Excel, and

Table 1. Seroprevalence of FMD in relation to site of feedlot operations.

Site	No of tested	No of positive	Seropositive (%)	95% CI
Dera	2090	745	35.6	33.6-37.7
Modjo	484	16	3.3	1.7-4.9
Migra	12180	1468	12.1	11.5-12.6
Wanji	2136	77	3.6	2.8-4.4
Koshe	6399	888	13.9	13.0-14.7
Meki	3544	1327	37.4	35.8-39.0
Awash Melkasa	2417	518	21.4	19.8-23.1
Awash Sebat	4338	335	7.7	6.9-8.5
Nahmaled	3469	106	3.1	2.5-3.6
Adami Tulu	1130	56	5.0	3.7-6.2
Total	38187	5536	14.5	14.1-14.9

χ^2=3.28, df= 9, p=0.000.

were transferred to statistical package for social sciences software version 16. Descriptive statistics was performed to summarize seroprevalence and χ^2 test was used to assess risk factors. In all the analyses, confidence level was held at 95% and P ≤ 0.05 was set for statistical significance.

RESULTS

Questionnaire survey

The study revealed that 25 (80.6%) of feedlots operators (n = 31) use Borena markets as the main source bulls and 6 (19.4%) feedlots operators used Dera and Adama markets for purchasing bulls for their feedlots. However, none of these operators have any idea about previous health status of purchased bulls. All feedlots operators do not use veterinarian to perform pre-purchase inspection and selection of bulls in the market; however, pre-purchase inspections and selection have been conducted by feedlots operators or purchaser groups which involves a visual and physical evaluation of animal while moving freely in the market. In all studied feedlot, the purchased animals were not subjected to any tests before they were moved into feedlots. Only small proportion of feedlots operators [4 (12.9 %)] have trend of buying animals as single whereas majority [27 (87%)] of them have a tendency of buying stocks in a batch. The average time spent on transportation from Borena production areas to feedlots in Central Ethiopia was 1.65 days. In 93.5% assessed feedlots, carcasses are not disposed properly and the scavengers and insects have easy accesses. In all surveyed feedlots, staffs do not use any protective clothing while handling bulls and also do not take any sanitary and disinfection precautions to avoid contamination.

Seroprevalence of FMD

From the total of 38,187 bulls examined for the presence of antibodies to the 3ABC non-structural protein of FMD virus, 5,536 (14.5%) were found positive. The seropositivity of FMD varied from site to site and the variations were statistically significant (χ^2 = 3.28, df = 9, p < 0.001). The highest seropositivity was recorded in Meki (37.4%) and the lowest was recorded in Nahmaled site (3.1%) (Table 1). Similarly, there was statistically significant (χ^2 = 4.55, df = 9, p < 0.001) difference of seroprevalence between months of the year, with highest seropositivity on July (36.3%) and lowest was recorded on April (3.8%) (Figure 1).

Economic loss estimation from FMD

Economic loss caused by FMD was calculated based on FMD rejection rate from international market. According to FMD serology result, 14.5% of bulls in the feedlots were found positive for FMD and subsequently rejected from international markets. During study period, an average of 375 kg bull was sold with 600 USD (1.60 USD/kg) average price at terminal markets for export. Therefore, the total economic loss due to FMD rejection from international market was estimated to be 3,322,269 USD which is equivalent to 56,345,682.24 ETB (1 USD = 16.96 ETB).

DISCUSSION

Using Borena markets as main source of cattle for fattening was the same as reported by Farmer (Farmer, 2010). This might be due to the fact that feedlot owners show a strong preference for Borena cattle due to its large size, efficient feed conversion and superior meat quality (Legese et al., 2008). However, Borena pastoral area is one of the areas in which FMD epidemics have been reported (Rufael et al., 2008; Bayissa et al., 2011; Mekonen et al*.,* 2011). Moreover, these animals move

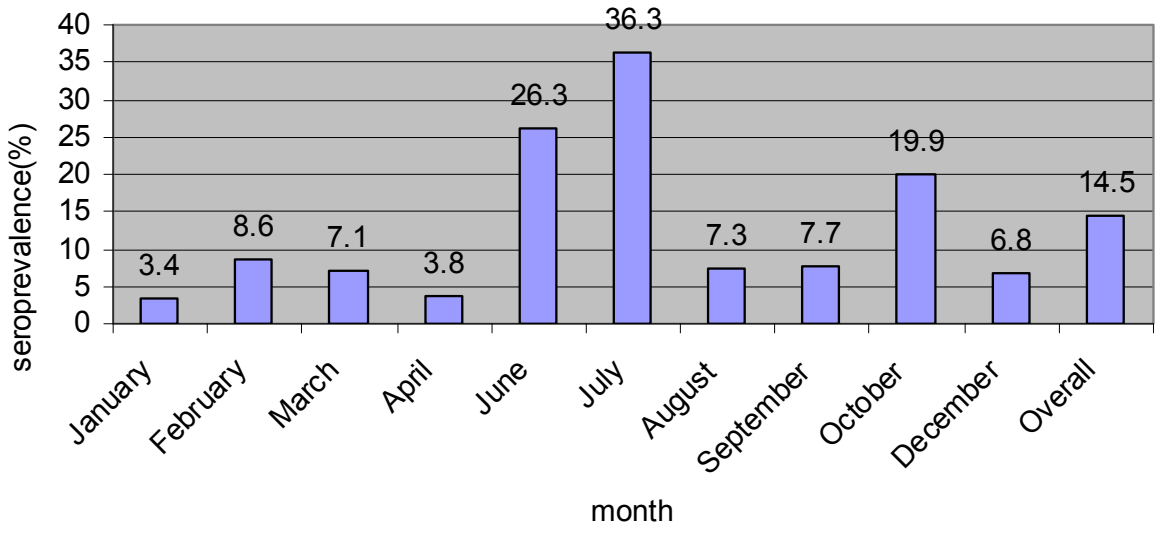

Figure 1. Monthly seroprevalence of FMD in cattle feedlots in Central Ethiopia in 2011.

from production areas to the feedlots without certifications and any test. In this study, we found almost nonexistence of common biosecurity practice in cattle feedlots found in Central Ethiopia, since export of live cattle and meat from Ethiopia are largely feedlot based. Maintaining high standards of biosecurity is one way of making sure that Ethiopian produce remains sought-after in an increasingly competitive market place. How-ever, an accidental animal disease outbreak in feedlots could cause large economic damages with significant international market and trade disruptions. This highlights the need for better understanding of factors reinforcing feedlots operators' decisions regarding implementation of biosecurity practices.

The overall seroprevalence of 14.5% reported for FMD in this study is indicative of its importance in feedlots business. The individual animal seroprevalence result obtained in this study was in close agreement with the previous findings from Andassa dairy farm (Mazengia et al., 2010) and Jijiga zone (Mohamoud et al., 2011) in which seropositivity of 14.6 and 14.05% were reported, respectively. On the other hand, the prevalence reported in this study is a higher value than previous reports of 8.18% (Molla et al., 2010) and 9.5% (Megersa et al., 2009) in South Ethiopia. The seropositivity finding of this study is lower than a record of 21% in the Borana pastoral area (Rufael et al., 2008) and 26.5% in the country (Sahle, 2004). The lower prevalence of FMD in the feedlots than in Borena pastoral system might be due to the fact that bulls were purchased based on their good body condition and health. Thus, the probability of chronically ill animals with poor body condition entering the feedlots is therefore low.

There was significant difference found between sites of feedlots operations with FMD prevalence of 37.4 and 3.1% at Meki and Nahmaled sites, respectively. This variation might be due to the difference of biosecurity measures of the feedlots used. Similarly, there was statistically significant (χ^2 = 4.55, df = 9, $p < 0.001$) difference between months of the year with highest seropositivity on July (36.3%) and lowest was recorded on April (3.8%). The relative low seroprevalence in April might be due to the fact that FMDV transmission over considerable distance by aerosol is less effective in hot and dry condition of the tropics (Hutber and Kitching, 2000). Therefore, the reported higher prevalence of FMD during cold and rainy month of July could be attributed to virus stability under such conditions (Klein et al*.,* 2008).

The total economic loss due to FMD rejection from international market was estimated to be 3.3 million USD. The total estimated economic losses caused by FMD in this study were 14.5% of the total income of the business owners from finished bulls. This loss estimated for individual business owner might be more than estimated since each feedlot operator incurred additional costs associated with treatment of sick bulls and maintenance of the rejected animals. Hence, the introduction of FMD into feedlots has measurable livelihood impact on downstream actors in the market chain and significant disruption of live cattle and their product trade in international markets. Movement restrictions and local quarantines mean the closure of livestock markets and reduced or no opportunities for sale of live animals (Rossiter and Hammadi, 2009). Therefore, smallholders and poor pastoral producers may be severely affected if markets are closed due to this disease (Rich and Perry, 2011).

The present study indicates that FMD was prevalent in the cattle feedlots and resulted in bulls mortality and morbidity which affected livelihood of actors in the value chain and have major threat to national economies as they tend to affect the international trade. Therefore,

directing surveillance and controlling activities at pastoral production area where FMDV risk arise and appropriate intervention measures along the market chain are critical factors necessary to prevent the introduction of FMDV and spread into feedlots. Further, as a novel diagnostic technique to monitor the spread of infection in large areas, there is a need of point of control diagnostics for developing nations (Liu et al., 2011; Cui et al., 2013; Li et al., 2014). Wadhwa et al. (2012a) described a bead based microfluidic assay for mycobacterial infections. Similar techniques should be developed for FMD. Active surveillance should be carried out based on samples which are less invasive and labor intensive (Wadhwa et al., 2012b; Wadhwa et al., 2012c). Molecular epidemiological, phylogenetic analysis and mathematical modeling should be carried out at the time of new outbreaks to understand the origin, efficacy of current vaccines and design control strategies (Kumar et al., 2013; Massaro et al., 2013).

Conflict of Interests

The author(s) have not declared any conflict of interests.

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