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Economic impact of lumpy skin disease and cost effectiveness of vaccination for the control of outbreaks in Ethiopia

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ABSTRACT

Lumpy skin disease (LSD), an infectious viral disease of cattle, causes considerable financial losses in livestock industry of affected countries. A questionnaire survey with the objectives of determining direct economic losses of LSD (mortality loss, milk loss, draft loss) and treatment costs (medication and labour cost) per affected herd, and assessing the cost effectiveness of vaccination as a means for LSD control was carried out in the central and north-western parts of Ethiopia. From a total of 4430 cattle (in 243 herds) surveyed, 941 animals (in 200 herds) were reported to be infected. The overall morbidity and mortality at animal level were 21.2% and 4.5%, and at herd level these were 82.3% and 24.3%. There was a significant difference in animal level morbidity and mortality between categories of animals. Over 94% of the herd owners ranked LSD as a big or very big problem for cattle production. A large proportion (92.2%) of the herd owners indicated that LSD affects cattle marketing. A median loss of USD 375 (USD 325 in local Zebu and USD 1250 in Holstein-Friesian local Zebu cross cattle) was estimated per dead animal. Median losses per affected lactating cow were USD 141 (USD 63 in local Zebu cows and USD 216 in Holstein-Friesian local Zebu cross cows) and, USD 36 per affected ox. Diagnosis and medication cost per affected animal were estimated at USD 5. The median total economic loss of an LSD outbreak at herd level was USD 1176 (USD 489 in subsistence farm and USD 2735 in commercial farm). At herd level, the largest component of the economic loss was due to mortality (USD 1000) followed by milk loss (USD 120). LSD control costs were the least contributor to herd level losses. The total herd level economic losses in the commercial farm type were significantly higher than in the subsistence farm type. The financial analysis showed a positive net profit of USD 136 (USD 56 for subsistence farm herds and USD 283 for commercial herds) per herd due to LSD vaccine investment. It should be noted that only the noticeable direct costs and treatment costs associated with the disease were considered in the study. Generally, vaccination is economically effective and should be encouraged.

1. Introduction

Lumpy skin disease (LSD) is a severe systemic disease of cattle caused by the lumpy skin disease virus, which belongs to the genus *capripoxvirus,* family *poxviridae.* It is characterized by fever, nodular lesions on the skin and mucous membranes and lymphadenopathy (Murphy et al., 1999; Radostits et al., 2007). The morbidity during LSD outbreaks varies greatly from 5% to 100% depending on the immune status of the host and the abundance of arthropod vectors (Woods, 1988; Tuppurainen and Oura, 2012). LSD mortality is generally low (usually less than 5%) but occasionally may reach 20% (Woods, 1988; Babiuk et al., 2008; OIE, 2010). LSD is associated with reduction in milk production, temporary or permanent sterility in bulls and cows, weight loss, draft power loss, abortion, damage to hides and death. Disease control and eradication measures such as vaccination campaigns, removal of affected animals, biosecurity are costly (Woods, 1988; Radostits et al., 2007; Babiuk et al., 2008; OIE, 2010; Tuppurainen and Oura, 2012). For example in Israel the control of the initial LSD outbreak costed USD 750,000, and the indirect financial loss associated with compulsory animal movement restrictions was also significant (AU-IBAR, 2013). The economic importance of the disease is also due to convalescence of several months (Murphy et al., 1999). The World Organization for Animal Health (OIE) categorized LSD as a notifiable disease because of its substantial economic impact (Tuppurainen and Oura, 2012; OIE, 2015). Because of these considerable financial losses and the international trade restrictions on live animals and their

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products, LSD is one of the most important infectious diseases in countries where it is endemic.

Livestock is an important sector in Ethiopia's economy as it contributes 35.6% to the agricultural Gross Domestic Product (GDP), equivalent to 16.5% of the national GDP (Metaferia et al., 2011), and 37–87% to the household incomes (GebreMariam et al., 2010). The contribution of livestock to the annual foreign exchange earnings amounts to 12% (NBE, 2014). Households keep cattle for multiple purposes: milk production, draft power, beef production, manure for fuel and fertilizer, and breeding (GebreMariam et al., 2010; Negassa et al., 2011). The total cattle population of Ethiopia is estimated to be about 57 million heads (CSA, 2015). The benefit that cattle could have for the country is not attained for several reasons and one important reason is animal disease. LSD stands among the major diseases that limit the productivity of the cattle population (Gari et al., 2011; APHRD, 2012).

LSD was restricted to Africa and Middle East countries for decades, but recently it is spreading unusually beyond its territory into Europe and other Asian countries and increasingly becomes a risk for the livestock industry in these continents (Tuppurainen et al., 2015; Tasioudi et al., 2016; WAHIS, 2016). In Ethiopia, LSD was first observed in 1981 in the north-western part of the country (Mebratu et al., 1984). However, it has now spread to almost all regions and agro-ecological zones of the nation with seroprevalence ranging from 23 to 31% at animal level and 26–64% at herd level (Gari et al., 2010, 2012). The infection was reported to cause 33.93% and 13.41% morbidity and 7.43% and 1.25% mortality in Holstein-Friesian cross bred and local Zebu cattle, respectively (Gari et al., 2011).

Knowledge of disease impact is essential when deciding on the level of expenditure that can be justified for a disease control programme (Knight-Jones and Rushton, 2013). The economic impact of LSD can be largely influenced by the methods used to control and eradicate outbreaks. In general, LSD prevention and control programmes are based on one or more of the following three elements: routine vaccination, stamping-out and movement restriction (Davies, 1991; Carn, 1993; Horst et al., 1999). The main LSD prevention and control scheme in Ethiopia is through vaccination. Vaccination costs depend on the number of animals vaccinated, vaccine cost, vaccination frequency, and labour and distribution costs (Horst et al., 1999). In Ethiopia, vaccination cost is borne by the government, i.e. vaccines are provided free of charge to the livestock owners.

Disease impacts are generally easy to identify but may be difficult to quantify. Disease outbreaks often have broad, long-term effects on livestock industry. The costs of animal disease can roughly be divided into direct costs, which include losses related to animal illness, death and less immediate impacts such as reduced fertility, and indirect costs, which encompass control costs, losses in trade and other revenues (Rushton, 2009; Oxford-Analytica, 2012). Understanding the impact of animal disease and assessing its losses is useful for policy makers and farmers who may weigh the losses against the costs of disease control each at their own level (Pritchett et al., 2005). There has been very limited work carried out on the financial analysis of herd-level control of LSD. Therefore, the objectives of this study were to determine the direct financial losses of LSD related to milk loss, draft power loss, mortality and indirect losses due to treatment, and to assess the cost effectiveness of vaccination as a means of LSD control.

2. Materials and methods

2.1. Study design and population

A questionnaire survey targeted to assess the economic impact of LSD was carried out in the central and north-western parts of Ethiopia (Fig. 1). In central part, it was undertaken in Ada'a, Sebeta Hawas, Ambo, Dendi, Debrelibanos, Kuyu and Hidabu Abote districts in Oromia National Regional State. In north-western part, the data were collected from Dejen, Gozamen, Hulet Ejju Enessie and Jabitenan districts in Amhara National Regional State. Furthermore, another five commercial dairy farms (Selale Dairy Development PLC at Muketuri, Aser at Ecoefobabo, Sululta; Selam Children Village in Addis Ababa, Holeta dairy cattle genetic improvement nucleus farm and Holeta agricultural research centre farm at Holeta) were included in the study.

The livestock production systems in the study area can be classified into two broad categories: subsistence crop-livestock production and commercial dairy production. In the subsistence production system the small holding farms are mainly kept for draft power, milk and meat production (Mengistu, 2003) and the composition of the herd is dominated by local Zebu cattle. The commercial dairy farms are market oriented and include medium (10–50 animals) to large-scale (> 50 animals) farms of crossbred Zebu with Holstein-Friesian. They are mostly located around peri-urban and urban areas practicing intensive and semi-intensive production (Mengistu, 2003). Milk and calf production are the main source of income.

2.2. Data collection

The questionnaire survey was undertaken from October 2014 to May 2015. The time span for the financial analysis was one year i.e. May 2014 to April 2015. A total of 243 herd owners from 15 districts (comprising 34 kebeles and 5 farms) enrolled in the study, a number close to numbers used in comparable studies (Jemberu et al., 2014; Jibat et al., 2016; Chenais et al., 2017). Kebele is the smallest administrative division in Ethiopia. The districts were selected based on the occurrence of an LSD outbreak and three kebeles were randomly selected from each of 10 districts, four kebeles from one district, 2 farms from 1 district and 1 farm each from the other 3 districts. From each kebele, five to eight herd owners that were willing to participate were interviewed. The data were collected by face to face interview using the local language. An oral consent to use the data for scientific research was obtained from each participating herd owner before the interview started.

The questionnaire was designed primarily to record the magnitude of production losses, mortality, and cost of control for LSD in several categories of bovines in a herd (a group of cattle owned by a household or an organization), and perception of farmers on livelihood impact and its influence on cattle marketing during the outbreak period. The farmer's ability to identify LSD infection was cross-checked by enquiring about the main epidemiological and clinical features of LSD. If the herd owner's description was consistent with the classical clinical signs and epidemiologic features of LSD (nodular lesions on skin and mucosal surface, enlargement of superficial lymph nodes, swelling of the limb or the lower body, discharge from eyes, nostrils and mouth, reduced milk production in lactating cows, depression, morbidity varying from 5 to 45% and mortality less than 10%) (FAO, 2010), they were considered to know the disease and the interview was continued. Farmers were also asked to estimate the daily milk production of their cattle before and after infection, the duration of infection, the milk price per litre, the renting price of an ox, the market value of animal, labour time lost for an animal getting treated and wage of a daily labourer. Commercial farms and some of subsistence herd owners estimated the volume of the daily milk produced in litres. However, the majority of subsistence herd owners estimated the volume of milk produced by each LSD affected cow using the local container (gourds or bucket) which normally is used for milking. This was later converted to litre after filling the container with water to the level indicated by the owner and measured using a graduated jug. Additional information such as treatment and vaccination cost were collected from veterinary practitioners. Financial information was collected first in Ethiopian currency (Birr) and later converted to USD at an exchange rate of 20 Birr = USD 1 (8 October, 2014).