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Lumpy Skin Disease in Ethiopia: A Review Article

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Abstract

Lumpy skin disease is an acute infectious disease of cattle endemic in most Sub-Saharan African countries. It is caused by lumpy skin disease virus in the genus *Capripox virus*. The disease is characterized by fever, enlarged lymph nodes, firm, and circumscribed nodules in the skin and ulcerative lesions particularly in the mucous membrane of the mouth. However, *Bostaurus* cattle breeds are more susceptible than *Bosindicus* breeds, and young animals often experience more severe disease than adults. The most important method of transmission is mechanically through biting flies. The incidence of lumpy skin disease is high during wet seasons when biting-fly populations are abundant. The diagnosis of LSD could be diagnosed using appropriate serological and molecular techniques. There is no specific treatment for lumpy skin disease, but animals can be treated with antibiotics to prevent secondary bacterial complication. Control measure of the disease is through mass vaccination; animal movement restriction, import restrictions on livestock and their products, control of vectors, quarantine station, proper disposal of animals and contaminated material are the basic methods to control lumpy skin disease. Restrictions to the global trade of live animals and animal products, costly control and eradication measures such as vaccination campaigns as well as the indirect costs because of the compulsory limitations in animal movements cause significant financial losses on a national level.

Keywords: Control, Epidemiology, Ethiopia, Lumpy Skin Disease, Transmission

1. Introduction

Ethiopia is endowed with huge livestock resources. It is one of the countries with the highest concentration of livestock in Africa. According to CSA (2015), Ethiopian livestock sector is composed of 56.7 million cattle, 29 million sheep, 29 million goats and 4 million camels. Livestock contribute 15 to 17 % of GDP and 35 to 49 % of agriculture GDP and 37 to 87 % of the household income (EATA, 2013).

Export of livestock and livestock products accounts for 7.8% of the total export of goods. However performance in the production of the main food commodities of livestock origin in Ethiopia has been poor compared to other African countries. Wide spread diseases and poor health, inadequate feed and nutrition, poor breeding stock and inadequate livestock policies (Wondwosen,2013).Tranboundary animal diseases are major constraints for livestock development in Ethiopia. Some of the important animal diseases with the potential to spread across the borders are Foot and Mouth Disease (FMD), Peste des Petits Ruminant (PPR), Sheep Pox, Contagious Bovine puleoro pneumonia (CBPP), Contagious Caprine Puleoro pneumonia (CCPP) and Lumpy skin Disease (LSD) (Seifert, 1992; MOA, 2010).

Lumpy skin disease (LSD) is the most economically significant viral disease which is characterized by high fever, enlarged lymph nodes, firm, and circumscribed nodules. It is a disease with a high morbidity and low mortality rate and affects cattle of all ages and breeds.

It causes high significant economic losses as a result of reduced milk production, beef loss and draft power loss, abortion, infertility, loss of condition and damage to the hide (MOA, 2012). Regarded to the office international des epizootics consider LSD as list 'A' disease that has the potential for rapid spread with ability to cause serious economic loss (OIE, 2008).

Therefore, the objectives of this review article are:

- To insight the etiology, epidemiology, pathogenesis, clinical and pathological findings of lumpy skin disease.
- To avail baseline information the status of LSD in Ethiopia

2. Review on lumpy skin disease

2.1. Definition and etiology

Lumpy skin disease (LSD) is an acute to sub-acute viral disease of cattle that can cause mild to severe symptoms including fever, nodules in the skin, in the mucous membranes and in the internal organs, skin edema, lymphadenitis and sometimes death. The disease can result in economic losses due to decreased milk production, traction power loss, weight loss, poor growth, abortion, infertility and skin damage (OIE, 2008). LSDV is grouped under the family of pox viridae. Lumpy skin disease virus (LSDV) belongs to the genus Capripoxvirus. There is only one serotype of LSDV which is prototype strain of LSDV is the Neethling virus and it is closely related antigenically to sheep and goat poxvirus and can be distinguished by routine virus neutralization or other serological tests. The LSDV primarily affects cattle with significant morbidity (MOA, 2012).

2.2. Distribution, host and transmission

Lumpy skin disease is endemic disease in Ethiopia. The incidence is highest in wet, warm weather (MOA, 2012). All cattle breeds appear to be equally susceptible to the disease. However, the severity of the LSD depends on the host susceptibility due to breed, age, physiological status of the host, endemicity of the disease and prevalence of the insect vectors. Exotic breeds (*Bostaurus)* are more susceptible than Local breeds (*Bosindicus)* and the young calves are more susceptible to the disease and may develop the characteristic lesion within 24 to 48 hours, although all ages groups of animals are susceptible (OIE, 2008).

LSDV is transmitted by biting insects such as mosquitoes in the genera Aedes and Culex. Flies (example *Stomoxys calcitrans*) and other insects might also be involved in transmission. There are variations in the attack rates from 10-15% to nearly 100% in different epidemics due to the differences in the active vector species that found in different situations. Stomoxys, the tabanids and tsetse flies, are likely to be doubtful in dry conditions and related to lower levels of transmission. However, huge mosquito-breeding sites are common in very high morbidity rates that occur after rain (MOA, 2012).

Direct contact is considered to be an ineffective means of transmission. Communal cattle grazing and watering points have been associated with the occurrence of LSD. Transmission of LSDV through semen (natural mating or artificial insemination) has not been experimentally demonstrated, but LSDV has been isolated in the semen of experimentally infected bulls (Davies, 1991).

All secretions of the infected animal virus are present in blood, nasal and lachrymal secretions, semen and saliva, milk, which may be sources for transmission alongside LSD virus when nodules on the mucous membranes of the eyes, nose, mouth, rectum, udder and genitalia ulcerate are also importance source. Additional, LSD is transmissible to suckling calves through infected milk (Getachew *etal.*,2011).Therefore; the main pathways for transmission are biting and blood-feeding arthropods, including biting flies, mosquitoes and ticks. Though rare, transmission also occurs through direct contact, and can also spread from contaminated feed and water (FAO, 2009).

2.3. Pathogenicity, clinical forms and lesions

The incubation period is 2-4 weeks in naturally infected animals (Seifert, 1992) but 6-10 days in experimental animals (Babiuk, *et al.*, 2008).Fever is the initial sign. The disease is characterized by large skin nodules covering all parts of the body, fever, enlarged lymph nodes, loss of appetite, reduction in milk production, some depression and reluctance to move nasal discharge and lachrymation. Young calves often have more severe disease than adults. Lumpy skin disease may be occur acute, sub-acute and chronic form. The nodules developed on skin are vary from 2 cm to 7 cm in diameter, appearing as round, well circumscribed areas of their thin skin, although younger animals are usually affecting and show more

severe disease than adult ones (Seifert, 1992).The nodules are particularly common on the head, neck, udder, genitalia, perineum and legs. The sub cutis is infiltrated by red watery fluid. Similar nodules may be scattered through the nasopharynx, trachea, bronchi, lungs, rumen, abomasums, renal cortex, testicles and uterus (Prozesky and Barnard, 1982).

Histopathological examination shows that the epidermis is extensively necrotic. While in the intact areas, some ballooning degeneration of squamous epithelial cells with occasional intra-cytoplasmic inclusions is seen. Prominent lesions of vasculitic necrosis with cell debris and severe diffuse infiltration with inflammatory cells mainly neutrophlis, were seen in the superficial and deep dermis (Prozesky and Barnard, 1982). Lesions in the skin, subcutaneous connective tissue, and muscles of the limbs, together with the severe skin inflammation caused by secondary infection of the lesions, greatly reduce mobility. Under nomadic pastoral conditions, animals affected in this manner may rapidly succumb to dehydration and starvation, thus increasing losses (Seifert, 1992).

2.4. Diagnosis

The skin lesions are pathognomonic but may however be easily confused with dermathophilosis and pseudo-lumpy skin disease (Seifert, 1992).The diagnosis of LSD can be established based on the typical clinical signs or generalized nodular skin lesions and enlarged superficial lymph nodes in affected animals combined with laboratory confirmation of the presence of the virus or antigen. The gold standard method for the detection of Capri pox viral antigen and antibody are electron microscopy examination and serum or virus neutralization tests, respectively (OIE, 2008).

The OIE recommended serological tests used for LSD diagnosis are essentially IFAT (Indirect Fluorescent Antibody Test), VNT (Virus Neutralisation Test), ELISA and Western Blot Analysis (OIE, 2008).The performance of Indirect Fluorescence Antibody Test (IFAT) for serological diagnosis and screening of Lumpy Skin Disease (LSD) was evaluated in Ethiopia using Virus neutralization test (VNT) as the second test (Gari, *et al*., 2008). Identification and diagnosis of virological specimen could be by PCR, Virus neutralization test and transmission electron microscope. Restriction enzyme analysis is currently used to differentiate *LSD virus* from other *Capripox viruses* (OIE, 2008).

Confirmation of LSD in a new area requires virus isolation and identification.LSD virus can propagate in bovine, caprine or ovine cell cultures; especially lamb testis cells. Indirect Fluorescent Antibody Test (IFAT) demonstrated to be suitable for use in retrospective serological surveys in a study carried out in Ethiopia, and it was evaluated test for accuracy. The IFAT is a serological test for Capri pox Virus. It was used to detect serum antibody against Capri pox virus and differentiate serological positive and negative animals (OIE, 2008: Gari *et al.*, 2008).

2.5. Current Status of LSD in Ethiopia

2.5.1. History, prevalence and significance

LSD was seen in Zambia in 1929 and since then has extended to sub-saharan Africa. It became established in Egypt in 1988 and spread to Israel in 1989 (MOA, 2012; Seifert, 1992).For the first time LSD was seen in Ethiopia since 1983 in the western part of the country (Southwest of Lake Tana) (Mebratu *et al*., 1984). Studies based on clinical disease observation done around Nekemt town, Wolliso town and in Southern rangeland have reported different magnitude of LSD occurrence ranging 7-28% (Regassa, 2003; Asegid, 1991).

Seroprevalence study in southern Ethiopia (Yabello and Adola Districts) has reported a prevalence of 6% .Targeted sampling from outbreak areas in North Ethiopia (Kobo, Kalu and Dawa-chefa districts) reported the prevalence of 28% by IFAT and VNT serological tests. The study based on the symptomatic disease identification experience of the herd-owners complimented with the epidemiological records of veterinary office at different levels showed that apparent LSD prevalence was 8.1% (Gari *et al*., 2010).

Gari *et al*.,(2011) has been reported that the annual cumulative incidence of LSD infection in HF/crossbred and local zebu cattle were 33.93% and 13.41% respectively and significantly different. Annual mortality was also significantly higher in HF/crossbred 7.43% than in local zebu cattle 1.25%.
The retrospective analyses showed that, during the five-year period, a total of 1,675 outbreaks were reported, with 62,176 cases and 4,372 deaths. The highest number of outbreaks was reported in Oromia (1,066), followed by Amhara (365) and the Southern Nations, Nationalities and People's Region (123). Outbreaks were more frequently observed between September and December and the highest number of

outbreaks was reported in 2010. During the period studied, a total of 2,174 local zebu cattle were clinically examined and morbidity and mortality rates of 13.61% (296) and 4.97% (108) were recorded, respectively. Analysis of the active outbreaks revealed a relatively consistent morbidity rate, with the highest observed in Adama (15.38%), followed by Wenji (10.26%). The highest mortality rates were also observed in Adama (5.89%) and Wenji (3.42%) (Ayelet *et al*, 2015).

Gari *et al.*, (2012) has indicated that Sero prevalence of the herd level was higher in the midland agro-climate zone 64% as compared to the highland 26% and the lowland 50% agro-climates. Animal level sero prevalence in infected herds was also higher in the midland agro-climate zone 31% than in the highland and lowland zones 24% and 23% respectively. As the result indicated that a total of 267 questionnaires were administered to the herd owners in selected districts of Afar and Tigray regional states from October 2011 and February 2012, which owned totally 3442 animals and out of which 379 animals were affected by LSD. The cumulative incidence and mortality rate of LSD were found to be 11% and 2 % respectively (Birhanu, 2015).

Birhanu *et al* (2015) reported that a questionnaire-based cross-sectional study was conducted from October 2011 to February 2012 in four selected districts of Afar and Tigray Regions to estimate the herd-level prevalence of LSD, and to assess its associated risk factors. Herd-owners were selected based on the willingness to provide information to complete the questionnaire. A total of 393 questionnaires were collected. Out of 393 herd-owners, 173 reported having LSD in their herds, giving an estimated herd- and animal-level prevalence of (44%, 95%CI: 37%-50%) and (7.4%, 95% CI: 6%-8%), respectively. Herd prevalence between regions and among the districts were significantly different ($\chi 2 = 8$, $p < 0.01$ and $\chi 2 = 9.9$, $p < 0.01$) respectively.

The average herd level LSD prevalence was 42.8% and it was significantly higher in the midland agro-climate 55.2% than in lowland and highland agro-climate zones (22.3% and 43.5%, respectively). The observed LSD prevalence and mortality at animal level were 8.1% and 2.12% respectively which were still higher in the midland zone (10.4% and 3.2%, respectively) than in lowland and highland zones. The risk factor analysis showed that three variables: the effect of agro-climates, communal grazing/watering management and introduction of new animals were significantly associated with LSD occurrence. The temporal association between LSD occurrence and increase in the biting-fly population was also positively correlated by Spearman rank correlation coefficient (0.88, 0.79 and 0.79 for highland, midland and lowland zones, respectively) and statistically significant (Gari *et al*., 2008).

Furthermost, four (2012-2015) retrospective data analysis had figured out the occurrence of 1015 outbreaks of LSD in 10 national regional states of the country (Tigray, Amhara, Oromia South Nation and Nationalities(SNN), Benishangulgumz, Gambella, Somali, Afar and Addis Ababa)(Figure1).Those reports were based on clinical signs that shown and reports were also from every corner of Ethiopia. Of these outbreaks 58.22 % of the out breaks were reported from the Oromia national regional state. Moreover, more than 46 % of the out breaks occurred during the 3 months of the years; September – December but the remaining outbreaks appeared randomly in the rest of the months of the years (Figure 2) (MoA, 2016).

Table 2. Occurrence and outbreaks of LSD in Ethiopia

No	Months	Number of outbreaks	Number of cases	Number of Death	Population at Risk
1	January	94	7278	186	737482
2	February	45	896	46	639730
3	March	52	1092	33	478381
4	April	35	338	39	305582
5	May	37	1398	170	358817
6	June	48	1234	132	557629
7	July	52	3804	170	105809
8	August	89	4964	301	1385365
9	September	146	10811	345	2412797
10	October	167	8816	539	2647687
11	November	154	6876	360	2228657
12	December	96	2603	229	983543

Table 3. Occurrence and outbreaks of LSD in Ethiopian Region

No	Regions	Number of outbreaks	Number of cases	Number of Death	Population at Risk
1	Tigray	20	318	44	164278
2	Amhara	246	8274	540	2509568
3	Oromia	591	31558	1292	8049485
4	SNNPR	116	8762	450	2809373
5	Benishangulgumz	6	395	18	54068
6	Gambella	2	35	15	2640
7	Somali	4	382	122	142000
8	Afar	2	90	2	46080
9	Addis Ababa	28	226	68	19217

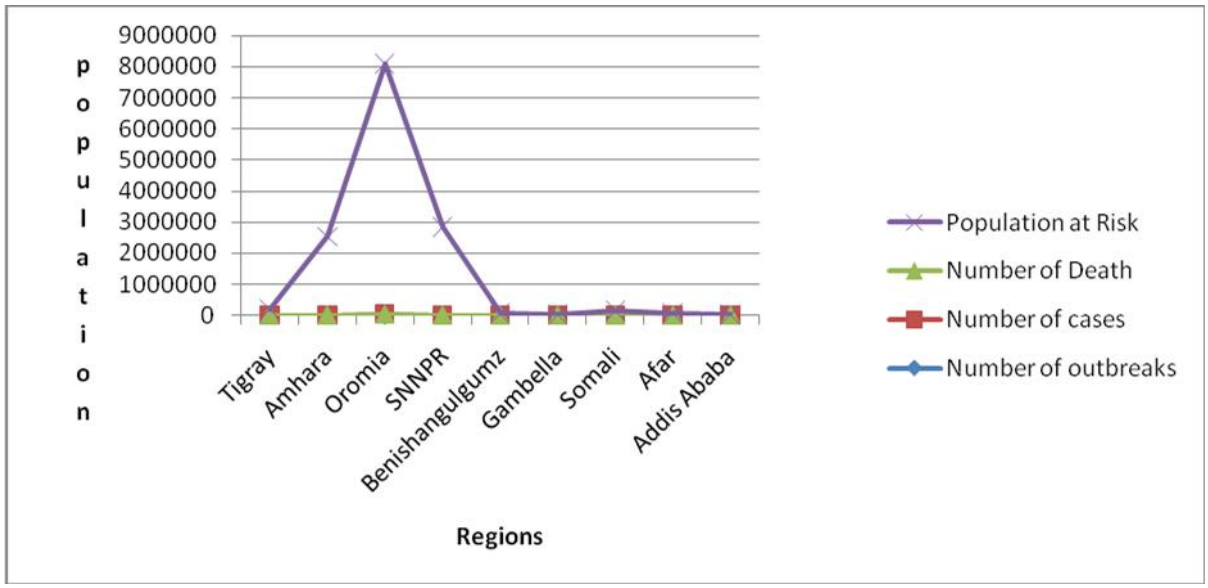

Figure 1: Four years 2012 to 2015 LSD outbreak reports from nine national regional states of Ethiopia (MoA, 2016).

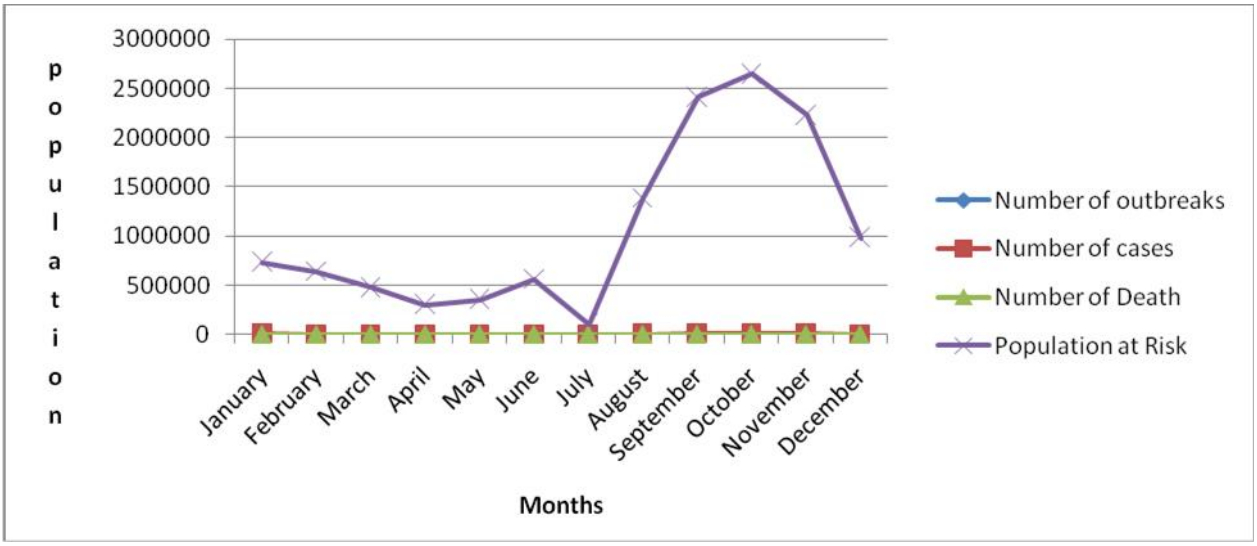

Figure 2:Four years 2012 to 2015 LSD outbreak reports from nine national regional states of Ethiopia (MoA, 2016)

2.6. Risk factors associated with LSD outbreaks

Susceptible cattle of all age groups could develop clinical disease if exposed to LSD infection. Different cattle breeds may show different susceptibility to LSD. Maternal immunity provides protection from LSD in cattle for at least 6 months (Davies 1991). Animals that have recovered from LSD virus infection do not remain carriers of the virus and develop long lasting immunity.

Environmental determinants play a great role in the epidemiology of lumpy skin disease. It had major impact on the agent, host and vectors as well as interaction between them. These predisposing factors have a great role in maintenance of arthropod vector and transmission of the virus to susceptible animals (Thomas, 2002). These are herd risk factors that have an influence on the outbreak of the disease. Animals share the same grazing and watering points and unrestricted movement of animals across different borders following rainfall were some of the factors. Distribution of the disease in various agro climatic conditions, introduction of new animals to the herd and the presence water bodies are among the other risk factors that would facilitate the spread of outbreaks in various localities (Gari *et al*., 2011).

2.6.1. Host risk factor

Lumpy skin disease is disease of cattle and causes several disorders. Though all breeds and all age group, both sexes are susceptible, Bos*taurus* are particularly more vulnerable to clinical disease than zebu cattle. Among *Bostaurus*,*fine*s kinned Channel Island breeds develop more severe disease because of their thin skin, although younger animals are usually affecting and show more severe disease than adult(OIE,2010). Even though, the clinical severity of disease depends on susceptibility and immunological status of the thin-skinned, the high-producing dairy animal *Bostaurus* breeds are highly susceptible against LSDV, whereas indigenous (*Bosindicus*) breeds such as zebu and zebu hybrids are likely to have some natural resistance against the virus (Gari *et al*.,2011).

2.6.2. Environmental risk factor

The effect of agroclimate, communal share of the same grazing and watering points and unrestricted movement of animals across different borders following rainfall were some of the risk factors. Distribution of the disease in various agro climatic conditions, introduction of new animals to the herd and the presence water bodies are among the other risk factors also that would facilitate the spread of outbreaks in various localities. The incidence of LSD occurrence is high during wet seasons when biting-season (Gari *et al.,* 2011).

2.6.3. Pathogen risk factor

LSDV is generally resistant to drying, survive freezing and thawing. Resistance to heat is variable but most are inactivated at temperatures above 60°C.It survives well at cold temperatures. LSDV is very resistant to physical and chemical agents. The virus persists in necrotic skin for at least 33 days and remains viable in lesions in air-dried hides for at least 18 days at ambient temperature. It may persist for up to six months in a suitable environment, such as shaded animal pens. The virus is also present in nasal, lachrymal and pharyngeal secretions, semen, milk and blood and it may remain in saliva for up to 11 days and in semen for 22days. The virus may persist for months in lesions in cattle hides. LSD virus may persist for 6 months on fomites, including clothing and equipment but there is no evidence that virus can survive more than four days in insect vectors (Gari *et al.,* 2011).

2.7. Control of LSD in Ethiopia

2.7.1. Treatment

There is no effective treatment for LSD. But only secondary infection of the nodules can be treated with antibiotic (Seifert, 1992).

2.8. Vaccination

There is no national strategy for LSD control or eradication in Ethiopia. Outbreak of LSD controlled by ring vaccination (MOA, 2012).So far, it has not been possible to prevent the introduction of the infection in non-infected areas by applying measures of restriction and quarantine. Nevertheless, attention should be paid to introducing only those animals which comes from infection free regions in to areas where the disease has not so far been prevalent (Seifert, 1992).

For active immunization of cattle, vaccines are available which have been prepared from origin of Nethling virus strain through attenuation on tissue culture or passages on embryonated hens eggs. They provide an immune protection which lasts for 3 years. After vaccination, local side reactions may appear in some of the animals which however disappear without complications (Seifert, 1992).

A vaccine made from a sheep and goat pox virus that affected both sheep and goats in Kenya was shown to effectively immunise sheep, goats and cattle against infection with Capri pox virus (Kitching *etal*., 1986; Davies 1991).In Ethiopia, the strain KSGP-O180 is being used for vaccine to control the LSD outbreak. This attenuated vaccine is produced at National Veterinary Institute in Ethiopia (NVI, 2000).This live attenuated vaccine is mainly stimulating the cell mediated immune response. The annual vaccination coverage of the nation seems far below the immunity threshold of the population that is necessary to control the outbreak occurrence.
According to MOA (2016).

Table: 1 Distribution LSD vaccine in Ethiopia

No	**Regions**	**LSD vaccine distribution by years**				**Total Vaccine distributed (Dose)**
		2012	2013	2014	2015	
1	Tigray	1700000	2400000	3100000	3100000	10,300,000
2	Afar	0	0	300000		300,000
3	Oromia	6687900	11832812	10108959	10342900	38,972,571
4	SNNPR	2679000	2132000	5147000	4005000	13,963,000
5	Gambella	0	0	0	310000	310,000
6	Benshangulgumz	23000	375000	204000	250000	1,059,000
7	Amhara	1561500	3443400	6142400	4685000	158,323,000
8	Dire Dawa	0	50000	50000	100000	200,000
9	Harara	0	5000	20000	0	25,000
10	Addis Ababa	0	11500	4000	8500	24,000
					Total vaccine(Dose)	223,476,571

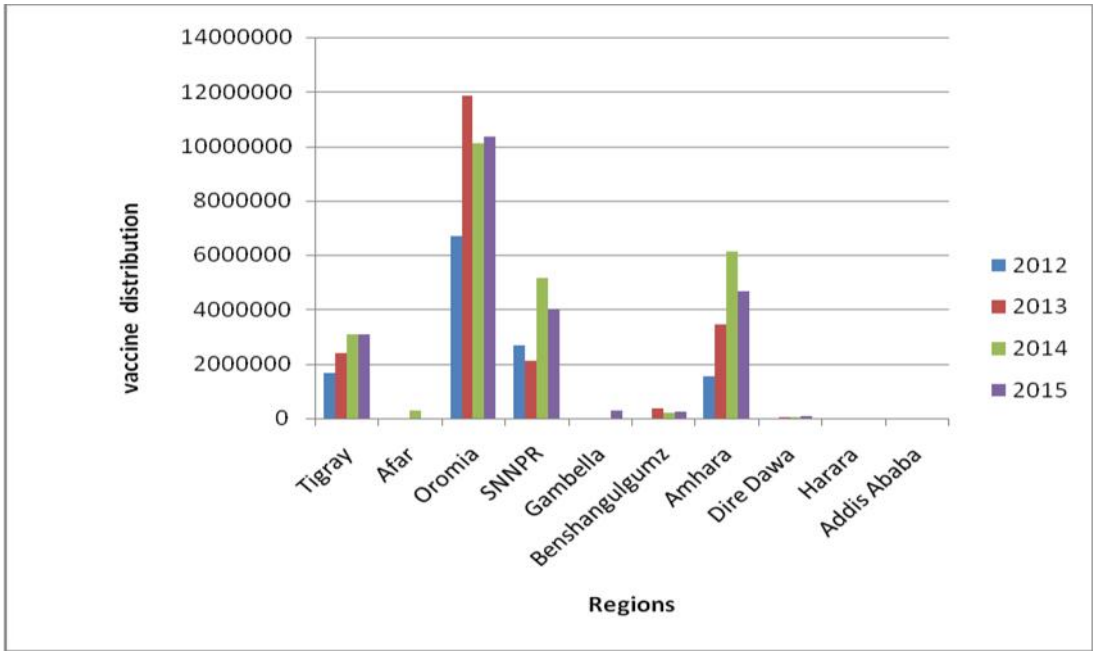

Figure 3: Four years (2012-2015) of Annual Distribution of Vaccine (MoA, 2016)

2.9. Economic importance of LSD in Ethiopia

In Ethiopia the wide spread of LSD in all the regions and agro-ecological zones has rendered LSD as one of significant livestock disease problem in the country. It causes chronic debility in infected cattle, reduced milk production, poor growth, loss of traction power, infertility and, sometimes abortion and death of the animal. Severe and permanent damage from the skin lesions could occur (Davies, 1991).In addition, the disease is an important notifiable disease and hampers the international trade (Babiuk *et al.,* 2008).

Reports from Ethiopia indicated that the financial loss estimated based on milk , beef, draught power, mortality, treatment and vaccination costs in individual head of local zebu were lost 6.43 USD and for the Holstein Friesian 58 USD (Gari *et al*., 2010).

In general LSD is considered as a disease of high economic pressure because of its ability to compromise food security through loss, draft power, reduced output of animal production, increase production costs due to increased costs of disease control, and disrupt livestock and their product trade. Moreover, severe economic losses may be high due to condemnation of carcass and cost of inspecting meat as it damage to the hides (Kumar, 2011). Permanent damage to the skin and hide greatly affect leather industry. It causes ban on international trade of livestock and causes prolonged economic loss as it became endemic and brought serious stock loss. Restrictions to the global trade of live animals and animal products, costly control and eradication measures such as vaccination campaigns as well as the indirect costs because of the compulsory limitations in animal movements cause significant financial losses on a national level (Alkhamis, 2016).

3. Conclusion and Recommendations

Lumpy skin disease (LSD caused by a virus associated with the *Neethling poxvirus* in the genus Capri poxvirus of the family Poxviridae and occurs in other most African countries and currently endemic in most African countries and has recently spread out of Africa into the observed in 1983 in the north-western part of the country (south-west of Lake Tana). Pathogen, environment and host factors are considered as main risk factors for the disease. The disease is economically important disease in Ethiopia. The lesions consequently, results in overwhelming economic losses due to reduced hide quality, chronic debility, reduced milk yield, weight loss, infertility, abortion and death. The control of LSD can be achieved through vaccination, restriction of animal movement and eradication of infected and exposed animals.

Based on the above conclusion the following recommendations are forwarded.

- Develop and implement quarantine system before new animals introduced to the herd.
- Importation of livestock and their products should be prohibited from countries with LSD.
- Cattle should be regularly vaccinated in LSD endemic areas.
- Ring vaccination and prophylactic immunization in high risk population should be implemented
- Vector control and animal movement restriction should be implementing during outbreak of LSD.

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