# Contagious Bovine Pleuropneumonia: The Epidemiology, Cotrol And Its Economic Impact

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**Summary:** Contagious bovine pleuropneumonia (CBPP) is an easily spread respiratory disease of cattle caused by the bacteria Mycoplasma mycoides mycoides small colony that infects the lungs of the animal. The principal route of infection is by the inhalation of infective droplets from animals active or carrier cases of the disease. An essential part of the pathogenesis of the disease is thrombosis in the pulmonary vessels, probably prior to the development of pneumonic lesions. The disease causes high morbidity and mortality losses to cattle. Contagious bovine pleuropneumonia impacts animal health and poverty of livestock-dependent people through decreased animal productivity, reduced food supply, and the cost of control measures. Contagious bovine pleuropneumonia is a barrier to trade in many African countries and this reduces the value of livestock and the income of many value chain stakeholders. The presence of CBPP also poses a constant threat to CBPP-free countries and creates costs in terms of the measures necessary to ensure the exclusion of disease. Control of CBPP is therefore important as a way to salvage the losses and increase the incomes. To carry out an effective control of CBPP through strategic vaccination the prerequisites are a thorough understanding of the seroprevalence of the disease.

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## 1. Introduction

Livestock is a major part of African agricultural sector and plays an important role in food and economic security through provision of a variety of products and services including hides, skins, meat, draught power, manure, fiber, energy and capital accumulation (ILCA, 1991). The ruminant livestock are main components of the livestock subsector and are sources of cash income and play a vital role as sources of meat, milk and wool for smallholder keepers in different farming systems and agro-ecological zones of the country (Getahun, 2008). They are also sources of foreign currency (Berhanu *et al*., 2007).

Ethiopia possesses the highest number of livestock in Africa with an estimated 53.99 million cattle, 25.5 million sheep and 24.06 million goats (CSA, 2013). However, the productivity of this livestock sector is lower than the potential level of the African production average. Traditional methods of animal husbandry render the output per unit of domestic breed of livestock to be too low (CSA, 2008). The major biological constraints contributing to low productivity include low genetic potential of the animals, poor nutrition and prevailing diseases. Among the prevalent diseases Foot and mouth Disease (FMD), Contagious Bovine Pleuropneumonia (CBPP), lumpy skin disease, trypanosomiasis, external parasites and tick borne diseases are main animal health problems in animal health context (Belay *et al.*, 2012).

Contagious bovine pleuropneumonia (CBPP) is a highly contagious trans-boundary disease of cattle and water buffalo caused by Mycoplasma mycoides mycoides Small Colony (MmmSC) causing the most economically important disease worldwide (OIE, 2008). It occurs in the hyperacute, acute, sub-acute, or chronic form, affecting the lungs and occasionally the joints particularly in calves. Clinically it manifests as fast, difficult or noisy breathing, discharges from the nose and/or mouth, and a painful cough which becomes worse on exercise. In the chronic stage, there is weight loss. Death may be sudden in the hyperacute stage or after prolonged illness in the chronic form (Masiga *et al*., 1996).

Control of the disease will involve vaccination, slaughter of sick and contaminated animals, control of cattle movement and implementation of strict quarantine measures to avoid introduction of the disease in clean areas. Active disease surveillance must be effective which needs a strong field services as well as proper laboratory facilities. Since CBPP has become a great concern in many African countries, it requires also cooperation network through which countries with this problem can share experiences, information and technology in order to stop transboundary transmission of the disease (Litamoi, 2000).

Contagious Bovine Pleuropneumonia in a herd results in direct losses due to its impact on cattle production, through increased mortalities, reduced milk yield, reduced weight gain and reduced fertility

rate, and therefore it compromises both household and national food security due to loss of protein and draught power (Tambi *et al.,* 2006). Contagious Bovine Pleuropneumonia also causes indirect losses through additional cost of treatment, preventive vaccination, field diagnostic testing, and slaughter of clinical cases, surveillance activities, disruption of trade and the limitation of investment opportunities due to reluctance in adoption of improved breeds (Rushton *et al.,* 1999). It also retards genetic improvement and limits the ability of cattle to work in arid and semi-arid pastoral areas affecting livelihoods of over a hundred thousand households (Kairu-Wanyoike *et al*., 2013). The disease is considered as one of the main stumbling blocks to the growth of the livestock industry on the African continent. Yearly losses directly or indirectly due to CBPP in Africa estimated to be is around two billion US dollars (FAO and OIE, 2004).

The response to antibiotic treatment can be incomplete, creating chronic carriers; therefore slaughter is generally recommended for infected animals (Tambi *et al.,* 2006).

Therefore, the major objective of this paper is:

- to review the epidemiology, control and economic impact of contagious bovine pleuropneumonia

## 2. Literature Review Of Contagious Bovine Pleuroneumonia

### 2.1. Etiology

Contagious bovine pleuropneumonia (CBPP) is an acute, sub-acute or chronic respiratory disease of cattle caused by *Mycoplasma mycoides* subspecies *mycoides* (bovine biotype) SC (small colony) (OIÈ, 2002). The *Mycoplasmas (Mollicutes)*, formerly called PPLO (pleuropneumonia-like organisms), are non-sporulating, Gram-negative, non-motile bacteria, which do not posses a determined shape of the cell. *The Mollicutes* are members of the order *Mycoplasmatales* and class *Mollicutes* (soft skin) and they are the smallest of the free-living prokaryotes. *Mollicutes* is the correct term to use when collectively referring to members in this order; however, the trivial name *mycoplasma (s)* is also used for this purpose (Walker, 1999).

### 2.2. Epidemiology

2.2.1. Host range

Cattle, both Bos taurus and Bos indicus, are the main hosts. Infections have also been reported from Asian buffalo (Bubalus bubalis), captive bison (Bison bison) and yak (Poephagus grunnien, formerly Bos grunnien). Sheep and goats can also be naturally infected, but with no clear associated pathology. Wild bovids and camels seem to be resistant, and, so far, do not appear to be important in the transmission of CBPP (OIE, 2008).

2.2.2. Global Distribution of CBPP

*Mycoplasma mycoides subspecies mycoides SC* type can be grouped into two major, epidemiologically distinct, clusters. One cluster contains strains isolated from different European countries since 1980 and a second cluster contains African and Australian strains collected over the last 50 years. Epidemiological and clinical observations indicate that the European outbreaks of CBPP are less virulent than the disease encountered in Africa. Furthermore, CBPP in Europe seems to be far more insidious, as it is usually chronic, and affected cattle show few distinctive clinical signs and rarely die (Vilei *et al.,* 2000).

According to the World Organisation for Animal Health (OIE), 16 of its Member Countries were officially recognised as being free from CBPP in 2017: (OIE, 2017).

Current status of the Contagious Bovine Pleuropneumonia: free OIE Member Countries (figure1):

| | |
|---|---|
| Argentina | Australia |
| France | India |
| Singapore | Mexico |
| Brazil | Canada |
| Portugal | New Caledonia |
| China | Swaziland |
| Switzerland | Botswana |
| United States of America | South Africa |

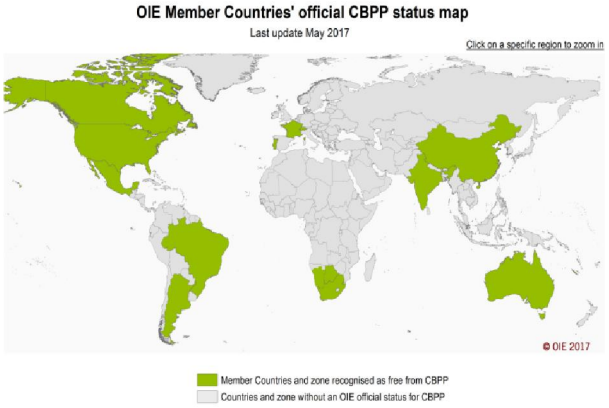



Figure 1: Map of OIE member countries official CBPP status map
Source: (OIE, 2017)

Contagious bovine pleuropneumonia has been present in some Mediterranean countries of Europe during the last decade (Italy, 1993; Spain, 1994). The disease may still be present in parts of Asia, but this is uncertain. Bangladesh is the only country currently

officially reporting its presence (Yigezu and Rojer, 1997).

Contagious bovine pleuropneumonia is currently mainly a disease of Africa, where it is regarded as one of the most serious transboundary animal diseases. Most countries in sub-Saharan Africa are endemically infected. There was an upsurge in the incidence of CBPP in Africa in the 1990s and serious spread of the disease in eastern and parts of southern Africa, with re-introduction to areas that had been free for considerable periods. This culminated in introduction of CBPP to northern Botswana in 1995. It was eradicated from there by a stamping-out campaign and the country was able to declare provisional freedom in January 1997. The epidemiology of CBPP in Africa is dominated by different factors. These are; cattle are the only species affected; there is no reservoir host in wild animals; transmission is through the direct contact of susceptible animal with clinical cases or chronic carriers and cattle movements play a very important role in the maintenance and extension of the disease (Bessin and Connor, 2000).

2.2.3. Transmission

Transmission of the disease occurs through direct contact between an infected and a susceptible animal which becomes infected by inhaling droplets disseminated by coughing. Since some animals can carry the disease without showing signs of illness, controlling the spread is more difficult. There is no evidence of transmission through fomites (inanimate objects such as clothing, implements or vehicles) as the organism does not persist in the environment. Droplets can be carried on the wind for 200 m or more. Animals which recover from CBPP are resistant to further challenge (Aiello and Mays, 1998).

2.2.4. Morbidity and mortality

Morbidity rates for CBPP vary significantly between herds. Complement fixation test (CFT) results obtained from field surveys differ significantly from one study to another. For example, rate of 8.1% among cattle in Sudan. Other surveys reveal rates above 25% in Chad, Ethiopia, Guinea and Tanzania. Rates below 5% have been reported in Burkina Faso and Uganda. Outbreaks of CBPP also have been associated with various levels of mortality. In endemic situations mortality rates are generally low. However, higher mortality rates are not uncommon. In its acute form, the mortality rate can reach 50%. Mortality rates above 10% have been reported in Guinea and Ethiopia. Rates between 5% and 10% have been reported in Chad and Côte d'Ivoire, while rates below 5% have been reported in Tanzania, Uganda, Burkina Faso, Ghana and Mali (Tambi *et al.,* 2006).

2.2.5. Epidemiology of CBPP in Ethiopia

After Rinderpest has been brought under control, CBPP is considered to be among the most important cattle diseases in Ethiopia, particularly in the lowlands. CBPP is one of the great plagues which continue to devastate cattle herds on which so many people are dependent in the lowlands. In the highlands, the consecutive yearly blanket vaccinations with combined Rinderpest and CBPP have certainly contained the disease to a relatively low level during the past years. But with the adoption of a strategy towards Rinderpest eradication, the vaccinations in the highlands have ceased since 1992/93. Generally, the irregularity and low rate of vaccinations since 1993 seem to contribute to increased incidence of the disease and its further spread (MOA, 2003). The usual blanket coverage was around 50% and never reached the desired 80-100% level. It is one of the major threats in Ethiopia hindering and challenging the livestock production (Ermiyas *et al*., 2014).

Studies undertaken on CBPP so far revealed the existence of the disease in different parts of the country with prevalence varies from 4.3 % in Jijiga (Gedlu, 2004) to 96 % in Western Gojjam (Yigezu *and Roger.,* 1997). Although the disease is endemic in the country and brings a high economic loss in the livestock industry, there is not enough information regarding its distribution and control in livestock industry as a priority disease in the country (Belachew and Jemberu, 2003).

According to reports of various outbreaks, national serosurveillance and research results from 1997 to 2010, CBPP was found to be present in almost all regional states (Tuli, 2010). Studies conducted in Western Ethiopia (Regassa, 2001), Northwest Ethiopia (Takele, 1998), Southern Ethiopia **(**Wondimu, 1996) and different regions of the country revealed that CBPP is posing a major threat to cattle in many parts of the country thereby causing considerable economic losses through morbidity and mortality and warranting for serious attention (Afework, 2000).

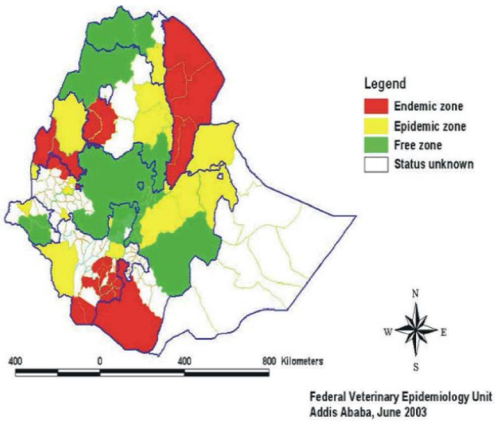



Figure 2: Map showing the different CBPP zones in Ethiopia

**2.3. Clinical Features of CBPP**

2.3.1. Clinical sign

The incubation period is generally 3 to 6 weeks, but may be as long as 6 months. In the acute form, there is fever (lasting 3 to 10 days), anorexia, loss of milk production in milking cows, severe depression and rapid breathing. This is soon followed by dry coughing, which progressively becomes more severe, and apparent chest pain, with the animal typically facing into the wind with its back arched, elbows out and head extended. There may be nasal discharge, sometimes streaked with blood, and frothy saliva accumulates around the mouth. Death usually occurs within 3 weeks of the onset of clinical signs. Animals that recover are extremely weak and emaciated. Many become chronic carriers. A hyperacute form may also occur in a few animals early in outbreaks – in this form, animals die with few premonitory signs. Sub-acute and chronic cases are common. The clinical signs are milder and may not be detected. There may be an intermittent fever, some loss of condition, and respiratory signs of difficult breathing (Figure 3). Subclinical cases also occur. In calves up to 6 months, CBPP may manifest itself only as arthritis, with lameness and a soft swelling of affected joints (FAO, 2002).

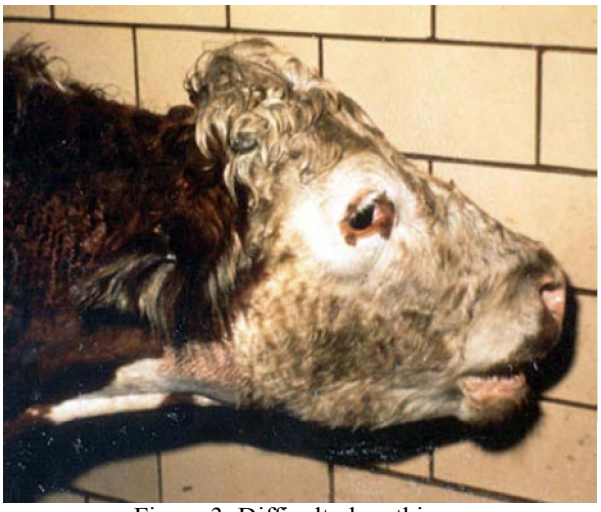


Figure 3: Difficulty breathing

2.3.2. Necropsy Findings

The characteristic post mortem findings in CBPP are localized in the chest cavity except in young calves where inflammation of the limb joints (usually the carpal and tarsal joints), with increased fluid, is sometimes seen. There is thickening and inflammation of the pleura often with heavy deposits of fibrin. A most striking feature of the acute disease is the very large volume of yellow fluid (up to 30 liters) containing clots, which can accumulate in the chest and therefore causing extremely difficult breathing (Figure 3) (FAO, 1997).

The lungs (almost always only one, the left) and pleura are affected and in most cases, only the diaphragmatic lobe is involved. Affected lobules show various stages of gray and red hepatization and the interlobular septa are greatly distended with serofibrinous exudates-the classical 'marbled' lung of this disease (Figure 4) (Radostits *et al*., 1994). In the recovered and chronic form, fluid is rarely seen in the pleural cavity but adhesions between lung lobes and between lungs and the chest wall are commonly found. Infarcts, varying in size from about 10-300 mm, are frequently preset in the affected lung tissue, which are the result from thrombosis of inter- or intra-lobular arteries and lymph vessels (FAO, 1997).

Lymph nodes in the chest may be enlarged and wet (edematous), with small necrotic foci and pinpoint hemorrhages. In the kidney cortex, white spots of dead tissue of variable size, called infarcts, can sometimes be seen (Radostits *et al*., 2007).

Figure 4: "marbling" in a section of lung affected with CBPP

2.3.3. Pathogenesis

An essential part of the pathogenesis of the disease is thrombosis in the pulmonary vessels, probably prior to the development of pneumonic lesions. The mechanism of development of the thrombosis is not well understood, but is considered, at least in part, mediated through induction of cytokines (Rosendal, 1993). Contagious bovine pleuropeumonia is lobar variety of pneumonia in which the inter-lobular septa are dilated and prominent due to a great out pouring of plasma and fibrin in to them and this dilated septa that give the "marbling" effect to the lung in these areas (Radostits *et al*., 1994).

It is characterized by substantial unilateral pulmonary necrosis, sometimes sequestration, and

marked serosanguinous fluid accumulation in interstitia and pleura (FAO, 1997). Vasculitis appears to be an important component of the pathological changes in this disease, explaining the marked exudation and pleurisy. Thrombosis can explain ischemic necrosis and infarcts of the lung. Death results from anoxia and presumably from toxaemia (Walker, 1999).

**2.4. Diagnosis of CBPP**

2.4.1. Field diagnosis

Clinical diagnosis of CBPP is difficult. At postmortem the gross lesions of CBPP are somewhat distinct. Often there is an extensive deposition of fibrin and a large quantity of straw-colored fluid in the thoracic cavity with a prominent marbling of pulmonary parenchyma. Generally, all stages of pathologic changes, from acute to chronic, are present. In some chronic cases the nodules of inflammation may not be readily apparent from the pleural surface but can be palpated within the parenchyma. The detection of specific lesions is an important factor in identifying cattle infected subclinically. The "organising centres" observed in the interlobular septa of lungs with lesions are considered pathognomonic for CBPP (Di Francesco *et al*., 1998).

2.4.2. Laboratory Diagnosis

Definitive diagnosis is based on isolation and identification of the causative agent (Nicholas *et al*., 2009) and/or the finding of specific antigens or antibodies by appropriate serological tests. The most reliable test for detecting serum antibodies that is currently prescribed test for international trade by the OIE is the Complement Fixation Test (CFT) which applies at herd level. Great care is needed in collecting and storing sera to be used for this test which is complex to perform. False negative results can be found both early and late in the disease course (OIE, 2000).

A competitive ELISA (C-ELISA) test has undergone evaluation and is possible to apply at animal level and when compared with CF test, the C-ELISA has equal sensitivity and greater specificity. The C-ELISA is an individual test but you can aggregate the results and therefore interpret it at herd, and it is easier to perform than CFT but its performance characteristics have not yet been fully assessed (Amanfu *et al.,* 1998).

2.4.3. Differential diagnosis

In carrying out a CBPP diagnosis, it is necessary to differentiate this disease from other diseases which may present similar clinical signs or lesions. The way the disease behaves in the herd is as important as the findings in a single animal when carrying out an investigation. The following diseases should be considered in differential diagnosis of CBPP: Rinderpest, Haemorrhagic Septicaemia, East Coast Fever, Bronchopneumonia Resulting from Bacterial or Viral Infections, Acute Pasteurellosis, Bovine Tuberculosis, Actinobacillosis, Traumatic Pericarditis, Abscesses, or Hydatid Cysts. It is therefore important that the field diagnosis be confirmed by laboratory tests (Zelalem *et al.,* 2016).

**2.5. Control of CBPP**

CBPP is controlled by reduction of the number of infected animals in cattle populations (through stamping out); preventing transmission of the disease (through cattle movement controls and quarantine); and reducing the number of susceptible cattle (by vaccination) or a combination of these. The main problems for control or eradication of CBPP are the frequent occurrence of sub-acute infections and the persistence of chronic carriers after the clinical phase. In most continents, control strategies are based on the early detection of outbreaks, control of animal movements and a stamping-out policy. This has successfully eliminated the disease from North America and Europe (FAO, 2002).

2.5.1. Treatment

Under practical field conditions, when the disease breaks out in a new area, treatment is not applicable and not recommended because of reasons of disease prevention. Treatment is usually undertaken and indicated only in areas where the disease is endemic (Radostits *et al.*, 1994), but in practice farmers are treating their animals when they have no other alternative. Although the Mycoplasmas are susceptible to a number of antibiotics *in vitro*, treatment failures are common (Walker, 1999).

Tylosin and spiramycin are effective in the control of excessive vaccination reactions and should be of value in the treatment of clinical cases. Resistance to some of these antimicrobials has been noted. Animals that do not respond to treatment often become carriers. Penicillin is of little value, streptomycine has some curative effect (Radostits *et al*., 1994).

2.5.2. Vaccination

The policy for control of CBPP in most countries relies on mass vaccination of susceptible cattle (Kairu-Wanyoike, 2009). In Africa control of the disease is currently based mainly on vaccination campaigns. Surveillance of the disease through slaughterhouse inspection is a very efficient method of detecting clinical cases. Vaccination with an attenuated strain of the bacteria is used to reduce the level of infection (OIE, 2008). The major control method practiced in Ethiopia also Vaccination (targeted and ring vaccination in the face of outbreaks) carried out for the last 30 years in Ethiopia. Previously the consecutive yearly blanket vaccination with combined Rinderpest and CBPP vaccine was adopted as a strategy to control CBPP. It was strategy that is believed to have

contained the disease to a relatively low level until 1992/93 and this method was considered as a successful achievement in the control of CBPP. However with the adoption of a strategy towards Rinderpest eradication, the vaccinations in the highlands and most parts of the Somali region have ceased since 1992/93. Besides, the vaccination coverage was around 50% and did not reach the desired 80 – 100% level (MOA, 1997).

Different attenuated live *Mmm*SC strain vaccines have been used and the vaccines currently recommended by the OIE are the live strain vaccines T1/44 and its streptomycin resistant derivate T1-SR (Litamoi, 2000). Both T1-SR and T1/44 are freeze-dried vaccines that are thermostable until reconstituted, but after reconstitution they have to be used within a short period of time, approximately one hour. This is a serious disadvantage when undertaking vaccination in areas with poor infrastructure and relative small herds (Nicholas *et al*., 2009).

2.5.3. Movement control

The most important factor to reduce the spread of the disease is achieving complete movement control. No animal allowed to be moved across international borders without a movement permit issued at the point of departure, and declared that the origin of the herd has been inspected and is free of clinical CBPP and serologically negative (herd test) (Bashiruddin,1994).

2.5.4. Test and slaughter

In eradication campaign, infected animals may be slaughtered to remove source of infection. Eradication of a disease from herds involves a test and removal strategies, in each all are tested and only those positive are removed and slaughtered. It is essential that owners are encouraged to indicate sick animals, and this is only possible on the basis of trust and immediate compensation (Thrusfield, 2005).

The implementation of test and slaughter as a control policy is unattractive to cattle producers in sub-Saharan Africa, but the strategy was instrumental for CBPP eradication from Australia (Newton and Norris, 2000). Likewise, the policy was applied in Botswana during an outbreak in Ngamiland district in 1996, although its application resulted in food security challenges to children under 5 years of age who suffered malnutrition (Boonstra *et al*., 2001).

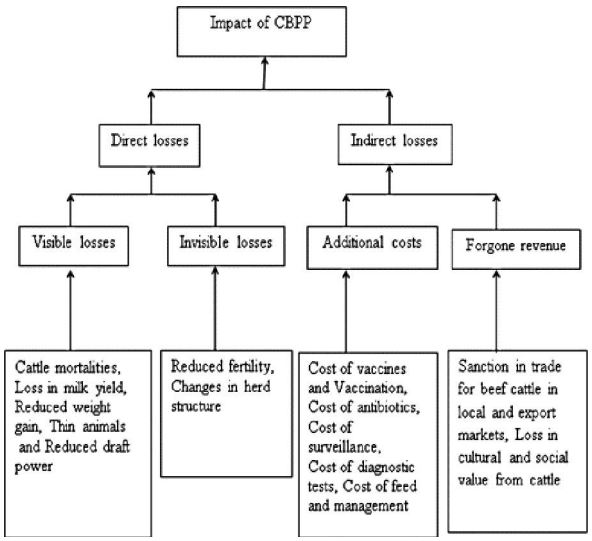
2.5.5. Stamping Out

The ideal method to control a transboundary disease like CBPP is the application of the stamping out policy of complete elimination of infected and exposed animals along with attendant zoo-sanitary measures. This strategy is generally design to for slaughtering of animals during the epidemicity of the disease to reduce the risk of transmission (OIE, 2000).

**2.6. Economic Impact of CBPP**

CBPP impacts through direct losses due to reduction in yields (increased morbidity and mortalities, reduced milk production, reduced live weight gain, reduced fertility rate and changes in herd structure, and indirect losses that relates to the cost of control and management, poor access to markets and limited use of improved technologies (Rushton *et al*., 1999).

The framework for assessment of CBPP impact is shown in this figure.




2.6.1. Economic Lost due to Carcass condemnation

Carcass of an animal affected with contagious bovine pleuropneumonia is condemned if the disease is associated with fever, inadequate bleeding of carcass, serous infiltration of the brisket and emaciation. Recovered animals showing no generalized signs of the disease are approved and the affected organs are condemned (FAO, 2001).

2.6.2. Cost of production losses

Production losses included mortality losses and losses of milk, beef and draught power through disease morbidity. The production losses due to CBPP can be derived from the difference between the production parameters for "with CBPP" scenario and those from "without CBPP". In cross-sectional study and outbreak investigation, if a draught animal is infected with CBPP there is total loss of draught power for at least a full year whether the animal dies or not. Other production losses were milk and calf losses resulting from death of pregnant cows, abortions and reduced calving rate (Onono *et al*., 2014).

**Morbidity Losses:** The animals considered for calculation of morbidity losses were those with CBPP, did not die but had reduced production. The direct morbidity losses were the reduction in milk yield, meat production, and reduced fertility rate. The loss in

milk was estimated from the reduction in milk output from dead cattle that no longer produced milk, and reduction due to diseased cattle that did not produce the same quantity of milk when compared to healthy cattle. The losses are based on prevalence estimates for CBPP in pastoral herds which have been predicted through mathematical modelling (Onono, 2014).

**Mortality Losses:** The mortality losses can estimate by applying the impact of CBPP on mortality rate in each age and sex group of cattle at risk. The output losses due to CBPP mortality was derived from the difference between the number of dead cattle from "with CBPP" scenario and those from "without CBPP" scenario. (Byekwaso and Nyamutale, 2001).

2.6.3. Impact of CBPP on International Trade

The occurrence of such diseases impacts both poor and richer livestock producers by marginalizing them from higher price livestock markets and restricting their capacity for value-added trade (FAO, 2002).

Movement restrictions and local quarantines mean the closure of livestock markets and reduced or no opportunities for sale of live animals and possibly meat and other products. In addition to the measurable economic impact on a national economy, the inability to sell their animal can bring severe hardship to a pastoral family with no other income of sources of support (Holleman, 2002).

2.6.4. Cost of CBPP Control and prevention

The economic cost of CBPP control is the sum of output losses (L) and expenditures (E) incurred on treatment or preventive measures taken against CBPP. Treatment expenditures represent strategies to mitigate the impact of CBPP once an outbreak has occurred, while preventive expenditures are incurred to avoid occurrence of CBPP. Therefore expenditures on CBPP control represented the total value of resources which are used to reduce potential loss from output reductions. The direct costs included expenditure on treatment, vaccination and home slaughter of clinical cases. High expenditures on treatment and prevention of CBPP will result in low output loss and vice versa. Minimum costs of CBPP control was determined according to the additional expenditure on CBPP control and this minimum cost will result in lower reduced output losses because all technically available tools are insufficient (Mclnerney *et al.* 1992).

**Costs associated with outbreak occurrence:** These were considered as the cost of ring vaccination and antibiotic treatment, costs of disease reporting, costs of sampling and testing prior to vaccination and costs due to adverse post vaccination reactions including deaths, abortions, and treatment of reactors. Ring vaccination occurs when there is an outbreak with or without a preceding annual vaccination in the outbreak herd and up to 30 km radius around the outbreak herd. The cost of ring vaccination was calculated by multiplying the average number of animals vaccinated in ring vaccinations per year by the cost of vaccination of one animal. The cost of treatment was obtained by estimating the number animals treated per year and multiplying by the average cost of treating one animal as derived from the responses of the farmers. Ring vaccination occurs after farmers report the disease to the District Veterinary Office. The cost of reporting the disease was calculated by applying the proportion of households experiencing disease to the proportion of farmers reporting the disease. The product was then multiplied with the cost of reporting per household which can be high due to poor infrastructure and sometimes need for repeated reporting before response. Adverse reactions to vaccination included deaths, abortions and other reactions (Wanyoike, 1999).

According to Tambi *et al.,* (2006) direct disease control cost was discussed as follows:

**Vaccination cost:** Costs of vaccinating one animal in current and past CBPP vaccination programs considered variable and attributable fixed costs. The fixed cost items included automatic syringes, camping equipment, cold chain (refrigerators and freezers), vaccination crushes and vehicles. The variable cost items included were CBPP vaccine, vaccination consumable materials, repairs to equipment, vehicles and crushes, vaccination staff allowances, gas and electricity, fuel, vaccination awareness creation campaigns, expected profits for the vaccinating agency and contingencies.

**Treatment cost:** The cost of antimicrobial treatment was based on the average cost that incurred on treatment of sick animals from their preferred animal health service providers.

**Culling cost:** The cost incurred on home slaughter for clinical cases was estimated through summation of data gathered from cattle traders, butchers and brokers on prices of hides and skins at abattoirs, value of meat from a culled cow and the average market prices for cattle purchased for slaughter.

## 3. Conclusion And Recommendations

Contagious bovine pleuropneumonia (CBPP) is an infectious and highly contagious disease of cattle and water buffaloes, and considered to be amongst the most important infectious diseases. Affected animals have difficulty in breathing due to damage to the lungs, lose condition and a proportion die. All ages of cattle are susceptible, but young cattle develop joint swellings rather than lung. It causes high morbidity and mortality losses to cattle. The financial implications of these losses are of great significance to both cattle owners and to the nation. Control of CBPP

is therefore important as a way to salvage the losses and increase the incomes of cattle owners. Economic cost can be evaluated in terms of the direct and indirect production losses attributed to morbidity and mortality plus the disease control cost. Production losses comprised of cattle deaths and reductions in beef, milk and draft power.

Therefore, based on the above conclusion the following recommendations are suggested;

- Further Study will need to consider other control strategies and will need to undertake sensitivity analysis of the different parameters implementing based on technical and financial feasibility system in areas where CBPP is endemic,
- As a short-term intervention, that regular vaccination should be started in CBPP-seropositive areas,
- In the long term, annual vaccination with cattle movement control should be carried out,
- Awareness creation among the farmers about the means of transmission of the disease and its economic importance and,
- The magnitude of the disease at a National level should be studied.

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