**Review on Epidemiology and Economic Impact of Bovine Typanosomosis in Ethiopia**

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# Abstract

*Trypanosomiasis is a worldwide disease caused by the species of the genus Trypanosoma, which affects humans, as well as domestic and wild animals. Trypanosomosis is one of the major protozoans and neglected tropical disease that impediments to agriculture and livestock production in Africa. In Ethiopia, bovine trypanosomosis is the main constraint of livestock production that causes a serious economic impact on livestock production and development of the country. The most important Trypanosoma species affecting cattle in Ethiopia are Trypanosoma congolense, Trypanosoma vivax and Trypanosoma brucei. The disease is widely distributed in western and south-western parts of the country, especially in the “tsetse belt” like, omo, borena, metekel zone of Benshangul Gumuz region. The distribution of tsetse fly and related trypanosomosis in Ethiopia is associated with the major river systems of the country; such as Abay/Didessa, Omo/Gibe, Baro/Akobo and the southern rift valley. A sound knowledge of the basic features of the various trypanosomes enables the identification of each species and the exact cause of the disease. Accurate diagnosis is a key for effective epidemiological studies, treatment and control of the disease. Several diagnostic methods can be used in the investigation of the disease. Besides clinical diagnosis, direct (parasitological), indirect (serological), and molecular diagnostic methods with varying degrees of sensitivity and specificity are available for trypanosomosis. Therefore, the national and regional veterinary laboratories should be fulfilled with sufficient laboratory equipment’s, reagents and specialized laboratory technicians to perform accurate diagnosis and to avoid tentative diagnosis, which leads to drug resistance.*

**Keywords:** *Bovine trypanosomosis; Diagnosis; Economic impacts; Epidemiology; Ethiopia*

# INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa (FAO, 2019). An estimate indicates that the country is a home for about: nearly 65.35 million cattle, 50.5 million goats, 39.89 million sheep, 2.11 million horses, 8.98 million donkeys, 0.38 million mules, 7.70 million camels (CSA, 2020). Livestock in Ethiopia represent the pillar of the economy and plays a vital role in the livelihood of the farming communities (Tikit and Addis, 2011) and serve as a source of food, income and foreign exchange to the country economy and contributes to 15 - 17% of GDP and 35 to 49% of agricultural GDP and 37 to 87% of the household incomes (FAO, 2019), but its development is hampered by different constraints (Bekele *et al*., 2010). Now a day parasitism represents a major obstacle to development and utilization of animal resource (FAO, 2019), particularly trypanosomosis (Hagos, 2010).

However, Ethiopia is one of the countries suffering from trypanosomosis with approximately 220,000 Km² of arable land is infested with five species of tsetse flies: namely *Glossina pallidipes, G. m. submorsitans, G. fuscipes, G. tachinoides and G. longipenni*s (NTTICC, 2004). The most important trypanosome species affecting livestock in Ethiopia are *T. congolense, T. vivax* and *T. brucei* in cattle, sheep and goats, *T. evansi* in camels and *T. equiperdum* in horses (Hagos, 2010). Trypanosomosis is a haemoprotozoan disease of animals and humans caused by several species of parasites of the genus Trypanosoma (CFSPH, 2009). The most common pathogenic trypanosome species affecting cattle in Africa are *T. congolense, T. vivax* and to a lesser extent, *T. b. brucei* (Simukoko *et al.,* 2007). In areas where more than one trypanosome species is present, mixed infections in domestic animals are often encountered (Moti *et al*., 2015).

Trypanosomosis is a vector-borne disease known to be transmitted cyclically by tsetse flies (WHO, 2012) and mechanically by a number of biting flies of genus diptera such as Tabanus, Hematopota, Chrysops and Stomoxys (Kone *et al.,* 2011). The main tsetse-transmitted trypanosomes include *T. congolense, T. vivax, T. b. brucei* and *T. simiae* (Namangala, 2011). Mechanical transmission of *T. congolense* has been shown under experimental conditions and can therefore not be excluded from contributing to its spread in Africa (Desquesnes *et al.,* 2009). In addition, *T. equiperdum* is transmitted sexually (Hagos, 2010). Moreover latrogenic transmission could also occur when using the same needle or surgical instrument on more than one animal, at sufficiently short intervals, that the blood on the needle or instrument does not dry (Desquesnes and Dia, 2003).

In Ethiopia, trypanosomosis is one of the most important diseases that limit livestock productivity and agricultural development due to its high prevalence in the most arable and fertile land of southwest and northwest part of the country; following the greater river basins of Abay, Omo, Ghibe, and Baro (Abebe and Jobre, 1996). Approximately 15 % of all arable land is under tsetse and trypanosomosis challenge in Ethiopia. Extensive research as well as trypanosomosis control a program has been carried out in different parts of the country and in the Ghibe valley in particular (Tadesse and Tsegaye, 2010).

In trypanosome endemic areas, trypanocidal drugs; both prophylactic (Isometamidium chloride) (Young and Godfrey, 1983) and curative (Diminazene aceturate) (Berihu *et al*., 2014), are the most widely used methods of animal trypanosomosis control (Clausen *et al*., 2010). Trypanosomosis is controlled also either by vector or parasite control, or a combination of both. various efforts to control the disease and the associated economic losses have been directed mainly against the parasite through trypanocidal drugs and against the vector through odour- baited, insecticide- impregnated targets/traps/ and insecticide-treated cattle (Shaw *et al.,* 2015).

Even though there are several technologies exist for the control of trypanosomosis and tsetse flies, it is very difficult to be applied; because of economic problem as these technologies are so expensive to use and usually biologically unfriend to the environment. Although the use of trypanocidal drugs is the main method for trypanosomosis control, it is threatened by increasing cases of drug resistance (Geerts, 2001). However, Bovine trypanosomosis is one of the most prevalent and important disease in Ethiopia limiting livestock productivity and agricultural development (Hagos, 2010). Hence, this review is to give an insight on the epidemiology, diagnostic methods and economic significance of bovine trypanosomosis in Ethiopia.

**2. Trypanosomes**

## 2.1. Background of Trypanosomes

Trypanosomes are single celled flagellated protozoan parasites that live and multiply extracellularly in blood and tissue fluids of their mammalian hosts and transmitted by the bite of vector flies (OIE, 2013). The name Trypanosoma is derived from Greek word trypano- (borer) and soma (body) because of their cork screw-like motion (Hamilton *et al.,* 2004). The trypanosome consists of a single cell varying in size from 8 to 50 μm. The different trypanosome species differ in morphological characteristics as described by in appearance, shape and size between the various species, allowing specific identification (Maudlin *et al.,* 2004).

## 2.2. Etiological Agent of Bovine Trypanosomosis

The etiological agent of the disease is unicellular and blood borne flagellated protozoan parasite of a genus Trypanosoma dwelling in various body and tissue fluids (Baral, 2010). In cattle, the most widespread and most pathogenic to animals is *T. congolense* (Mulugeta *et al.,* 2013), *T. vivax* is the second most important trypanosome to cause nagana (Namangala and Odongo, 2014) and to lesser extent with *T. b. brucei* (Molyneux and Ashford, 1989).

## 2.3. Taxonomy and Classification of Trypanosomes

Trypanosomes belong to the family of the Trypanosomatidae, the order of the Kinetoplastida, the phylum of Sarcomastigophora, and the subkingdom of Protozoa (WHO, 2013). Trypanosomes are morphologically distinguishable from each other. The parasite is an elongated, flat, unicellular organism, with a characteristic flagellum (Itard, 1989). They are haemo-flagellated parasites characterized by one nucleus and one flagellum, either free or attached to the parasites body by means of an undulating membrane, which used for species identification. The classification of trypanosomes has been based solely on medical and veterinary features. The genus trypanosoma is subdivided into two sections: namely the Stercoraria and Salivaria, based on how the parasites are transmitted from the insect vector to the mammalian host (Uilenberg, 1998). Salivarian are further divided into four subgenera namely; Duttonella, Nannomonas, Trypanozoon and Pycnomonas (Stevens and Brisse, 2004).

## 2.4. Life Cycle of Trypanosomes

The life cycle of pathogenic trypanosomes involve mammalian and arthropod hosts (Brun *et al.,* 2009). Although mechanical transmission through other insects occurs, the tsetse fly is the only cyclical vector of the African trypanosomes (WHO, 2013). The African trypanosomes have four major life cycle stages. The procyclic form (PF), epimastigote form (EMF) and metacyclic form (MCF) all develop in tsetse while the blood stream form (BSF) is found in the mammalian host (Peacock *et al.,* 2012). Tsetse flies ingest infective blood stream trypomastigotes when they feed on infected hosts and may remain infected, acting as a continual source of infection (WHO, 2012). The BSF trypanosomes enter the tsetse midgut where most will perish (Peacock *et al*., 2012).

## 2.5. Economic Impacts of Trypanosomosis

In domestic animals, trypanosomosis is a disease with a great economic impact, affecting not only the wellbeing of the livestock population, but also efficient food production in crop-livestock production systems (Shaw *et al*., 2014). It is estimated that about 37% of the African continent or approximately 10 million km² is infested by tsetse flies (Mattioli *et al*., 2004). African animal trypanosomiasis puts 50 million cattle at risk and leads to the death of three million animals every year, inflicting a direct annual loss of US$ 1.0-1.2 billion in cattle production (Cecchi *et al.,* 2014). The main economic losses attributed to AAT are related to cattle mortality and morbidity, diagnosis and treatment costs, the reduction in meat and milk production and the reduction of livestock production areas (Oluwafemi *et al*., 2007) and limiting the optimal utilization of land for agricultural production (Mahama *et al*., 2003). In Ethiopia, animal trypanosomosis has been described as a major impediment to the livestock development and agricultural production; contributing negatively to the overall development in general and to food self-reliance efforts of the country in particular. The annual losses to the national economy are estimated to exceed US$200 million, due to its direct and indirect impact to the agricultural and livestock production (Abebe, 2005).

## 2.6. Pathogenesis and Clinical Sign of Trypanosomes

The pathogenesis of Trypanosomes depends on several factors, including parasite-related aspects (species and virulence), host (species, breed, age, and nutritional status, presence of co-infection and physical condition), vector (species, density, and infection rate and host preference) and the environment (the availability of food and water and the season (Van den Bossche and Delespaux, 2011). In the pathogenesis of African animal trypanosomosis four features: chancre, anaemia, tissue damage, and immunosuppression are prominent (FAO, 2000).

In cattle, the pathogenesis is dominated by three features: anaemia, tissue lesions and immunosuppression. Other symptoms include pyrexia, splenomegaly, ataxia, lethargy, weight loss, oedema, abortion and decrease in milk production. Anaemia is a clinical sign of trypanosomosis in many domestic animals, and the etiology is probably similar in all species (Taylor and Authié, 2004), and in conjunction with other systemic lesions, can contribute to death through eventual congestive heart failure (Singla *et al.,* 2010).

## 2.7. Diagnosis of Trypanosomosis

The diagnosis of trypanosoma infection is based on clinical signs and on the demonstration of the parasites by direct or indirect methods. The clinical signs are indicative, but are not sufficiently pathognomonic and diagnosis must be confirmed by laboratory methods. The available laboratory diagnosis of trypanosomes is divided into three main methods parasitological, serological and molecular (Wastling and Welburn, 2011; Sinshaw *et al*., 2006). Indirect methods rely on serological tests by detecting specific antibodies developed by the host against the infection or, inversely, to demonstrate the occurrence of circulating parasitic antigens in the blood by the use of characterized specific antibodies. Compared to standard parasitological techniques and serological methods, molecular diagnostic tools in particular the polymerase chain reaction (PCR); allow the detection of trypanosome infections with much lower parasite numbers, both in the vertebrate and in the insect host (OIE, 2013).

## 2.8. Treatment of Trypanosomosis

Treatment and prophylaxis of pathogenic trypanosome infections in animals relies on (Diminazene aceturate, Homidium bromide (chloride) and Isometamidium chloride, most dating back to the first half of the 20th century (Leach and Roberts, 1981). Most trypanocides have therapeutic rather than prophylactic activity, but Isometamidium chloride is mostly used for its prophylactic effects (Stevenson *et al.,* 1995)

## 2.9. Prevention and Control Strategies

The control of trypanosomosis in enzootic countries involves control of tsetse fly population, prophylactic treatment, good husbandry of animals at risk and use of trypano-tolerant animals. Before the 1950s, Tsetse & trypanosomes control mostly involved methods with negative environmental impacts: (such as bush clearing, ground spraying with DDT and wildlife culling) (Sutcliffe *et al*., 2014), insecticide-treated traps and targets (Hamilton *et al*., 2008), insecticide-treated cattle used as live baits and eventually the sterile insect technique (SIT) (Vreysen *et al*., 2013). Recently, several studies showed that restricted applications of insecticides on cattle (spray on lower body parts, footbaths) were an effective cheaper control option (Muhanguzi *et al*., 2015).

## 2.10. Epidemiology of Trypanosomosis

The epidemiology of vector-borne diseases is complex due to variability in the ecology of the different actors involved, i.e. parasites, vectors and hosts. Due to environmental changes (land use, demographic changes and deforestation) the epidemiology of animal trypanosomosis is changing (Van den Bossche and Delespaux, 2011). Tsetse-borne trypanosomosis is a widespread protozoal disease-complex affecting wildlife, livestock and people in sub- Saharan Africa, with a range of pathologies, from chronic and long lasting to acute and rapidly fatal, depending on circumstances (Bourn *et al.,* 2001).

The epidemiology of Africa Animal Trypanosomosis (AAT) in tsetse infected areas of Africa is determined by four biological factors, namely: trypanosomes, tsetse flies, reservoir hosts and livestock. However, cattle are the domestic species in which the disease is most frequently diagnosed and treated. When dealing with the tsetse transmitted trypanosomosis, much depends on the distribution and the vectoral capacity of Glossina species responsible for transmission. Of the three groups of Glossina, the savannah and riverine are the most important since they inhabit areas suitable for grazing and watering (Urquhart *et al.,* 1987).

### *2.10.1. Geographical Distribution*

The epidemiology of animal trypanosomosis is determined mainly by the ecology of the tsetse fly which is found only in tropical Africa. Ethiopia is situated at the East end of the African tsetse belt and in Ethiopia, tsetse flies are confined to south western and north western regions between longitude 33° and 38 °E and latitude 5° and 12°N of an area covers 220,000 km² (NTTICC, 2004). Bovine trypanosomosis (Nagana) is found in the low lands of Ethiopia, especially in the “tsetse belt”. For example, Rift valley, Omo, Borena, Metekel zone of Benshangul Gumuz region (Aschalew *et al*., 2015). According to NTTICC report, tsetse infested area of the Benishagul Gumuz Regional State is around 31,000 km2. The most important trypanosmes affecting cattle in Ethiopia are, *Trypanosoma congolense, T. vivax* and *T. brcei* (Mekuria and Gadissa, 2015) The general distribution of tsetse flies is determined principally by climate and influenced by altitude, vegetation, and presence of suitable host animals (Leak, 1999). In Ethiopia, tsetse infested areas lied in the low lands and also in the river valleys of Blue Nile, Baro Akobo, Didessa, Ghibe and Omo. Out of the nine regions of Ethiopia five (Amhara, Beninshangul Gumuz, Gambella, Oromia and Southern Nation Nationalities and peoples region) are infested with more than one species of tsetse flies. To date five species of Glossina (*Glossina morsitans submorsitans, G. Pallidipes, G. tachnoides, G. f. fuscipes and G. longipennis*) have been recorded from Ethiopia (Keno, 2005).

### *Transmission Methods of Trypanosomes*

Trypanosomes are transmitted through tsetse saliva when the fly feeds on an animal host (Van Den Abbeele *et al*., 2010). Inside the host, metacyclic forms undergo multiplication by binary longitudinal fission at the site of inoculation, causing a local skin reaction called a chancre (Kennedy, 2008; Mulugeta *et al*., 2013). The Glossina is responsible for tsetse-transmitted trypanosomosis due to *T. congolense, T. vivax* and *T. brucei* in 10 million square kilometers of Africa (Hoare, 1972). The disease is widespread in sub-Saharan Africa, where it is cyclically transmitted by the tsetse fly (Matovu *et al.,* 2003). In animals, tsetse flies can also transmit trypanosomes mechanically when they begin a blood meal on an infected host and end it on another one, provided that the time between the two meals is short enough to ensure survival of parasites in the insect mouthparts (Moloo *et al*., 2000).

Non-tsetse transmitted *T. vivax* infection in cattle is also recognized in parts of Africa, for example in regions of Ethiopia, Chad and Sudan (Ahmed *et al*., 2016). In addition to tsetse flies, it has been reported that *T. vivax, T. evansi* as well as *T. congolense* can also be mechanically transmitted by various blood feeding dipteras (Desquesnes *et al.,* 2009). Trypanosomes can also pass through the placenta and in to the fetus in pregnant animals (WHO, 2010).

### *Status of Bovine Trypanosomosis in Ethiopia*

In tsetse infested areas 14 million of cattle, equivalent number of small ruminants and more than 7.5 million equines and 1.2 million of camels are at risk of contracting trypanosomosis (CSA, 2005). The most important trypanosome species affecting livestock in Ethiopia are *T. congolense, T. vivax* and *T. brucei* in cattle, sheep and goats, *T. evansi* in camels, and *T. equiperdum* in horses (Getachew, 2005). The prevalence of trypanosomosis in tsetse infested areas range from 11.85-37%. In Ethiopia, significantly large numbers of works have been conducted to determine the prevalence of bovine trypanosomosis. However, the studies were limited in spatial scope and the results significantly vary between the studies. Most of the studies conducted in Ethiopia on trypanosomosis focused on tsetse transmitted trypanosomosis to determine the prevalence and impact of the disease (Fikiru *et al.,* 2012). The studies were conducted mainly in endemic areas for bovine trypanosomosis and non-endemic regions and remote regions may possibly be under-represented (Table 1).

Table 1: Occurrence of Bovine Trypanosomosis in Different Part of Ethiopia

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| --- | --- | --- |
| **Study areas** | **Prevalence (%)** | **References** |
| East Wollega Zone | 8.55 | Tafese *et al.,* 2012 |
| Abobo and Gambela Districts | 16.59 | Kedir *et al*., 2016 |
| Northwest Ethiopia | 14.68 | Dagnachew *et al.,* 2005 |
| Southern Ethiopia | 17.33 | Zeleke, 2011 |
| Ilu Aba Bora Zone | 12.28 | Regasa *et al.,* 205 |
| Metekel and Awi Zones | 12.41 | Solomon and Fitta, 2010 |
| Southwest Oromia | 23.0 | Tilahun *et al*, 2012 |
| Arbaminch, Gamogofa Zone | 1.3 | Girma *et al*., 2014 |
| Gamo-Gofa | 5.1 | Sheferaw *et al.,* 2019 |
| Southern Ethiopia | 27.5 | Zeryehun and Abraham, 2012 |

# CONCLUSION AND RECOMMENDATIONS

Trypanosomosis is one of the most prevalent protozoal diseases of cattle with greatest effects in terms of serious economic loss and pathogenic impact. In Ethiopia bovine trypanomosis is highly prevalent in the low lands of tsetse infested area. Currently five regional states are directly affected by the tsetse problem. These are Amhara, Beneshangul Gumz, Gambella, Oromia and Southern Peoples Nations and Nationalities Regional State. Most studies were conducted mainly in endemic areas for bovine trypanosomosis and non-endemic regions are underrepresented, that means large number of surveys were conducted mainly in the above mentioned five regions, but only a few surveys had conducted in the remaining regions of Ethiopia. Bovine trypanomosis is transmitted from the infected animal to susceptible host both by mechanical and biological vectors. This disease is characterized by enlargement of lymph node, chronic emaciation and others. It can be diagnosed by clinical sign, parasitological, serological and molecular diagnostic tests. Once the infection of bovine trypanomosis is happened, it can be treat by trypanocidal drugs mainly *Diaminazine aceturate* and *Isometamidium chloride*. Bovine trypanomosis can be controlled by early treatment of infected animal, vector control and other strategies.

Therefore, based on the above conclusion the following recommendations are forwarded:

* Awareness creation about the devastating economic impact of trypanosomosis is mandatory.
* The national and regional veterinary laboratories should be fulfilled with sufficient laboratory equipment’s, reagents and specialized laboratory technicians to perform accurate diagnosis and to avoid tentative diagnosis, which leads to drug resistance.
* Restriction of cattle movement from an infected area to the disease free area to prevent and control of further expansion of bovine trypanosomosis.
* Further researches should be done on the epidemiology of bovine trypanosomosis in different regions of Ethiopia.

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