Review on Small Ruminants Trypanosomosis in Ethiopia

Zelalem Ayana Dibessa

School of Veterinary Medicine, College of Agricultural Science, Bule Hora University, P.O. Box: 144, Bule Hora, Ethiopia

Abstract: In Ethiopia Trypanosomosis is one known as a haemoprotozoan disease, which affect the small ruminants and cattle’. The tsetse fly (Glossina spp.) and other biting flies mostly transmit this disease. Trypanosomosis cause severe disease in humans and livestock in Sub-Saharan Africa (SAA). The disease result in cause losses of livestock and agricultural productivity with serious socio-economic consequences. In Ethiopia, small ruminant trypanosomosis is widely distributed in Oromia, Amahara, Benishangul Gumuz, Gambella, Southern Nations, Nationalities and Peoples' Region and, in some cases in Tigray and Afar. Small ruminants could be potential reservoir hosts of animal infective trypanosome species in endemic different regions of Ethiopia. In Ethiopia, the most important trypanosomes in small ruminants and which do have economic importance are Trypanosoma congolense, T. vivax and T. brucei brucei. The pathogenesis of trypanosomosis depends on the pathogenicity of the strain; the host breed, genotype, age, sex, skin type. Besides clinical diagnosis, parasitological, serological and molecular methods with varying degrees of sensitivity and specificity are available for the diagnosis trypanosomosis. Small ruminant trypanosomosis could be treated by Homidium bromide, quinapyramine methyl sulphate and diminazene aceturate. Small ruminant trypanosomosis can be controlled by early treatment of infected animal and vector control. Thus, it is recommended that an appropriate use of antiprotozoal drugs, integrated prevention and control program should be implemented to reduce the impact of trypanosomosis and the risk of transmitting the diseases to other animals.

Key words: Small Ruminant - Prevalence - Ethiopia

INTRODUCTION

Livestock is backbone of the socio economic system of the most rural communities of Africa [1]. In Ethiopia, livestock are an important and integral component of agriculture, which is the pillar of the economy. Ethiopia have the largest livestock population in Africa, which is estimated as 59.5 million cattle, 30.70 million sheep, 30.20 million goat, 2.16 million horses, 8.44 million donkeys, 0.41 million mules, 1.21 million camels and 56.53 million heeds of chicken and widely distributed across the agro-ecological zones of the country [2].

Ethiopia is endowed with huge livestock resources, natural resources and diverse agro-ecological zones suitable for livestock production. These potentials make the country prominent repository for animal genetic diversity [3]. Livestock productions plays an important role to smallholder farmers and the national economy of the country in generating income to farmers, job opportunities, ensuring food security, providing services, contributing to asset, social, cultural and environmental values and sustain livelihoods [4, 5].

From the huge livestock potentials in Ethiopia, small ruminants are one of the major components. Small ruminants become attractive assets for development because of low cost of production, requirement of little land and higher profitably. Small ruminants are kept in a very broad range of agro-ecological zones such as hot and dry condition and provide an excellent opportunity to alternatively exploit potential of lowland areas [6].

Small ruminants provide both tangible benefits such as cash income from animal sales, meat for home consumption, manure, fiber and skins and intangible benefits such as savings and insurance against emergencies, employment, cultural and ceremonial purposes [7]. Thus, small ruminants contribute their share...
in fundamental issues related to reducing under-nutrition, enhancing food security, combating rural poverty and achieving rates and patterns of agricultural growth that would contribute to the overall economic development and environmental protection [8].

In smallholder production systems, goats and sheep are important because they require low initial capital and maintenance costs, are able to use marginal land and crop residues, produce milk and meat in readily usable quantities and are easily cared for by most family members. Small ruminants are prolific and need only short periods to increase flock sizes after catastrophes or in periods of high prices and thus off take rate can respond to price increases [9]. The sheep enterprise in the Ethiopian highland crop and livestock system is the most important form of investment and cash income and provides social security in bad crop years [10].

Sheep and goats have many advantages over large ruminants for most smallholder farmers, including lower feed costs, quicker turnover, easy management and appropriate size at slaughter [11-13]. They also have greater tolerance to less favorable conditions, suffering less mortality during periods of drought than large ruminants [11, 14]. In addition, subsistence farmers prefer sheep and goats, as the risk of losing large ruminants is often very high [15].

The estimated contribution of small ruminants’ population for economic growth and transformation in Ethiopia accounts for 21% and 16.8% of the total contribution of ruminant livestock meat outputs respectively, which plays a great role as source of foreign currency [16]. The small body size, broad feeding habits, resistance to disease, ability to walk long distance to search feed, highly tolerant to adverse climatic condition with endurance of drought and to low and fluctuating nutrient availability and their short reproductive cycle provide small ruminants with comparative advantage over other species to suit the circumstances of especially resource poor livestock keepers [17-19].

However, in Ethiopia the production and productivity of small ruminants are low due to various diseases. Among the challenging diseases, trypanosomosis causes constraints in health and production losses in small ruminants. Trypanosomes are flagellated protozoa, which belongs to the family trypanosomatidae. The family consists of several genera and many species. The species, which parasitize vertebrates, require a vector for transmission [20].

Some experimental and natural infection studies on small ruminant trypanosomosis showed the disease could have an adverse effect on health and productivity of sheep and goats [21-24]. Hematological changes such as, anemia, reduced packed cell volumes (PCV) value and reduced hemoglobin level were the major abnormalities recorded in small ruminant trypanosomosis. Weight loss, abortion and stillbirth were also recorded in experimental infection in sheep and goats [25]. Researchers [24, 26]. In general also considered the role of small ruminants as reservoirs in livestock trypanosomosis.

It occurs in the southwestern, western and northwestern parts of Ethiopia, in the regions Oromia, Amhara, Benishangul-Gumuz, Gambella and Southern SNNPR [27]. In recent years the small ruminant trypanosomosis also reported in Tigray and Afar regions [28]. Out of the nine region of Ethiopia, five (Amhara area, Benishangul-Gumuzs, Gambella, Oromia and Southern Nations Nationalities and Peoples? Regional State) are infected with more than one species of tsetse flies [29].

In Ethiopia, about 200, 000 km² of the land is infested with tsetse flies [30] and the main pathogenic trypanosomes in animals are Trypanosoma congolense, T. vivax and T. brucei. Although there have been several reports on livestock trypanosomosis.

According to National tsetse and Trypanosomosis Investigation and Control Center [31] tsetse transmitted animal trypanosomosis still remain as one of the largest causes of livestock production losses in Ethiopia. The effects of resulting from mortality, morbidity, infertility of thetrypanosomosis is not only the direct losses infested animals and costs of controlling the disease, but also due to indirect losses, which include exclusion of livestock and animal power based crop production from the huge fertile tsetse infected areas.

Trypanosomosis directly affects the milk and meat productivity of animals, reduces birth rates, increases abortion as well as mortality rates; all of these reduce the herd size and herd composition. The indirect impact of the disease mostly lies on crop production through the availability and cost of animals that provide traction power [32]. This disease is the most devastating disease in terms of poverty and loss of agricultural production [33]. These losses include reduced market value due to loss in body condition, drop in milk production, drop in lambing rate and prevention of mixed farming [32].

Despite the potential of being a reservoir host to human and animal infective trypanosomes as well as the resultant economic losses from infection, these livestock have relatively received less attention in the course of planning and execution of AAT-control activities [34-38].
Therefore, an urgent need to advocate for effective control measures is highly necessary. Determination of prevalence in small ruminants is first step to appraising the disease transmission risk and burden [39]. Even trypanosomosis has long been reported, in different regions there is no sufficient information on the prevalence, vector and effect of trypanosomes of sheep and goats in Ethiopia at national level.

Therefore, the objectives of this review paper are:

- To present the available evidence on prevalence of small ruminant Trypanosomosis in different regions of Ethiopia.
- To review the epidemiological information and economic significance of small ruminant trypanosomosis with a particular emphasis to Ethiopia.
- To highlight the most commonly used and effective control and preventive strategies against small ruminant trypanosomosis.

Small Ruminant Trypanosomosis

Etiology of the Diseases: 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 [40]. 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 [41]. Salivarian are further divided into four subgenera namely; Duttonella, Nannomonas, Trypanozoon and Pycnimonas [42]. Also trypanosomes have been classified into taxonomic groups based upon criteria: morphology, development in the tsetse fly vector and preference for certain vertebrate hosts [43]. T. congolense and T. vivax are the main species associated with clinical trypanosomosis in small ruminants in the sub-Saharan region. T. brucei and T. simiae are frequently encountered as asymptomatic infections in goats although the latter can cause an acute and fatal disease in sheep [44].

Accordingly, Trypanosomatidae is subdivided into two genera: Trypanosoma and Leishmania, which are classified according to their morphology and range of hosts the parasite, can infect [45]. The trypanosome species affecting man and domestic animals have been subdivided into two groups, the hematric group (T. congolense and T. vivax), which remains in the plasma and the tissue invading group found in extra and intra vascular spaces [46]. Because of their presence in the blood, these invading parasites produce numerous changes in the cellular and biochemical constituents of blood [47].

Epidemiology: The distribution of trypanosomosis in goats and sheep in sub-Saharan Africa is closely related to the ecology and distribution of the vector tssetse flies of the genus Glossina. Increased tsetse fly activity particularly during the rainy season is associated with increased incidence of the disease. Tssetse flies (Glossina spp.) are the principal vectors of trypanosomosis in sub-Saharan Africa and G. morsitans and G. pallidipes are the most commonly involved in the transmission of the disease. Other blood sucking flies such as Stomoxys spp and Tabanus spp may also transmit the disease. Wild animals such as bush pigs, bush bucks, kudus, warthogs and buffaloes act as reservoirs of the infection in endemic areas. Stress favours such as malnutrition, intense heat and intercurrent infections have been shown to render animals more susceptible to the disease. In general, trypanosomosis is an important disease of livestock in Ethiopia [44, 49, 50].

Pathogenesis: Following introduction into the body by an insect bite, the trypanosomes initially multiply and cause inflammation at the site of infection. The parasites are then carried through the lymphatic channels to the blood circulation. During the parasitaemic stage, trypanosomes release haemolysins and enzymes such as phospholipases, proteases and neuraminidases, which cause damage of the cell membranes of erythrocytes. Damage to the red blood cells is followed by disseminated intravascular coagulation. The trypanosomes may also block capillaries causing ischaemia and anaemia [44, 49, 51].

Life Cycle: The life cycle of trypanosome in tssetse involves cyclical development for varying length of time, depending on species and ambient temperatures. Most tssetse-transmission begins when blood from a trypanosome-infected animal is ingested by the tssetse fly. The trypanosome loses its surface coat, multiplies in the fly, then reacquires a surface coat and becomes infective. Trypanosoma brucei species migrate from the gut to the proboscis; the cycle for T. congolense stops at the hypopharynx and the salivary glands are not invaded; the entire cycle for T. vivax occurs in the proboscis. The animal-infective form in the tssetse salivary gland is referred to as the metacyclic form. The life cycle in the tssetse may be as short as one week with T. vivax or extend to a few weeks for T. brucei species [44, 49, 51].
**Clinical Signs:** Infection by one or more of these trypanosome species results in acute or chronic disease which is characterized by intermittent fever, emaciation, anaemia, loss of appetite, weakness, corneal opacity, occasional diarrhoea, parasitaemia, coma and death if not treated [53]. This disease usually leads to reduced reproduction and quality, low feed conversion ratio and possible death of animals, hence, affecting the farmer’s overall profit [54].

Regardless of the species of trypanosomes and host, the principal clinical signs are intermittent fever, progressive anemia and loss of condition. In addition, the superficial *T. congolese* is the most pathogenic species in the goats causing and acute, sub acute or chronic diseases. *T. simiae* can cause a highly acute and fatal diseases in sheep. *T. vaivax* less pathogenic while *T. brucie* may affect the goats causing an unapparent infection. Thus the severity of the diseases is determined by the pathogenicity of the strains of Trypanosomes.

The incubation period of acute trypanosomosis caused by *T. congolese* is 5-10 days. The disease is characterised by depression, anorexia, rigidity of the hind limbs, drooping ears, increased heart rate (up to 250 per minute), increased respiratory rate (up to 45 per minute), watery salivation and flaccidity of the tail. The temperature may be subnormal or may reach 41°C. Mucous nasal discharges, mild conjunctivitis, enlarged superficial lymph nodes and lethargy are also evident. Later on, the animal becomes unresponsive to external stimuli and pallor of the mucous membranes become apparent. Death may occur 4-6 weeks post-infection. The subacute syndrome lasts for 6-12 weeks and is characterized by enlargement and oedema of the superficial lymph nodes (especially the prescapular lymph node), pallor of the mucous membranes and marked jugular pulsation. Other superficial lymph nodes may also be enlarged and oedematous. Animals may recover or die in 10-12 weeks. The course of chronic trypanosomosis in
goats takes 12-24 weeks and is characterised by progressive weight loss, rough and dull hair coat, anaemia, weakness and paresis in terminal stages. It has been observed that trypanosomosis grossly impairs the fertility of the affected animals [44, 49, 51].

Mode of Transmission and Vectors: Tsetse flies are the main vectors responsible for the transmission of African Animal Trypanosomosis (AAT) and Human African Trypanosomosis (HAT) in the 37 sub-Saharan African countries between latitudes 140N and 290S. Over 11 million Km² of Africa (about 37% of the continent) is infested, putting millions of humans and livestock at risk of contacting trypanosomosis [55]. Tsetse flies comprise about 30 species and subspecies [56-58] classified into (i) savannah, (ii) riverine and (iii) forest groups [59].

On the basis of morphology and general structure, groups are also known as (i) morsitans, (ii) palpalis and (iii) fusca group [60, 61]. The savannah group includes G. morsitans, G. swynnertoni, G. longipalpis, G. pallidipes and G. austeni. This group, which is found at 900-1800 m above sea level, is a vector of both AAT and HAT in East and Southern Africa [62]. The presence of wildlife is the key factor controlling its distribution [63]. The riverine group, which prefers the shaded habitat, riverine and lakes, includes G. palpalis, G. fuscipes, G. martinii, G. quanzensis, G. caliginea, G. pallicera and G. tachinoides are mainly found in west and central Africa, transmitting T. b. gambiense, responsible for about 90% of all HAT cases in sub-Saharan Africa [64].

The vectors that involved in the transmission of small ruminants trypanosomosis, both tsetse flies of the morsitans group (Glossina pallidipes and G. morsitans submorsitans) and palpalis group (G. fuscipes fuscipes) and mechanical vectors of trypanosomosis that belong to the tabanidae family (tabanus) were captured in the lowlands of Didessa (1400–1780m above sea level) and Ghibe (1250–1700 m above sea level) valleys [22].

In Ethiopia the presence of several vectors of veterinary importance, particularly ticks and flies, have been documented [22, 65, 66, 67, 68, 69, 70]. On the entomologic perspective, Glossina morsitans morsitans, Glossina pallidipes, Glossina fuscipes, Glossina tachinoides and mechanical vectors including Tabanus, Stomoxys, Haematopota and Chrysops species were reported as vectors of trypanosomosis [22, 28, 66, 71-76]. The tsetse flies in Ethiopia are confined to the southern and western regions between longitude 33° and 38°E and latitude 5° and 12° N [77]. The infested area extends from the southern part of the Rift Valley, around the south-western corner lie in the low lands and also in river valleys of Baro, Akobo, Didesa, Abay, Ghibe and Omo of the country and along the western lowlands and escarpments to the Blue Nile [78-80].

In Ethiopia, about 200, 000 Km² of the land is infested with tsetse flies [30] and the main pathogenic trypanosomes in animals are Trypanosoma congolense, T. vivax and T. brucei. Although there have been several reports on livestock trypanosomosis. From the trypanosome species, T. congolense is the most pathogenic species in goats causing an acute, subacute or chronic disease. T. simiae can induce a highly acute and fatal disease in sheep. T. vivax is less pathogenic while T. brucei may affect goats causing an unapparent infection [44].

Apart from cyclical transmission of trypanosomosis by Glossina species, mechanical transmission is a potential threat to livestock productivity in some parts of Ethiopia [81] T. vivax infection can be transmitted mechanically by several tabanidea and large number of biting flies [82]. Biting flies have been reported as the major cause of T. vivax infection in three highland districts bordering Lake Tana [65].

Risk Factors: Risk factors of trypanosomosis are largely attributed to tsetse habitat suitability (Vegetation cover and water sources) and the presence of animals as sources of blood meal for the tsetse fly. Animals are the primary reservoir of infection. Cattle form the main vehicle for spreading the disease to new areas and initiating local outbreaks. Wild animals serve as reservoir for most species of trypanosome and thought to be responsible for sporadic transmission to humans as they visit game and forest reserves [83].

The management system of their cattle varies among age groups, sex and herd size. For instance, calves are left at home while older age groups are taken further afield to search for pasture and water [84].

Economic-Importance: Livestock productivity in sub Saharan Africa suffers from high prevalence of Trypanosomiasis with projected annual loses due to the direct and indirect consequences of the disease running into billions of dollars with disproportionate adverse effect in rural areas [85]. It creates the utmost constraint to livestock and crop production thus directly influencing hunger, poverty, protein malnutrition and suffering to entire communities in Africa [86].

This disease usually leads to reduced reproduction and quality, low feed conversion ratio and possible death of animals, hence, affecting the farmer’s overall profit.
Studies on trypanosome infection rate and its impact on livestock production have revealed that they vary with sex, age, species of trypanosomes and the tsetse fly, locality, season and depend largely on the level of interaction between tsetse flies, domestic and game animals [87-89].

**Diagnosis:** The epidemiology, particularly the presence of tsetse flies in the area, clinical and pathological features may be useful in a provisional diagnosis of the disease. Wet blood smears are useful in field diagnosis of the disease but they may be unreliable for the detection of light infections. Air-dried thin or thick blood smears stained with 10% Giemsa for 20 minutes are used for specific diagnosis of trypanosomes. In light infections with *T. congolense* and *T. vivax*, the trypanosomes can be concentrated by centrifugation and demonstrated by examination of cells at the leucocyte/plasma interface of heparinised blood by dark ground illumination. This is considered to be the most sensitive method of diagnosis of trypanosomosis. If EDTA is used as anticoagulant, trypanosomes can be demonstrated in Giemsa stained smears of cells from the buffy coat region. The common serological methods of diagnosis are indirect haemaglutination test and ELISA. Monoclonal antibodies against *T. congolense*, *T. vivax* and *T. brucei* are available. DNA probes are being developed in some specialised laboratories [44].

Besides clinical diagnosis, direct (parasitological) and indirect (serological) diagnostic methods with varying degrees of sensitivity and specificity are available for diagnosis of AAT and HAT [90]. Due to the multisystemic nature of trypanosomosis and the variety of clinical signs, diagnosis faces a lot of challenges. Novel sensitive molecular diagnostics including polymerase chain reaction (PCR) [90] and loop-mediated isothermal amplification (LAMP) [91] are more useful diagnostic methods. Diagnosis of trypanosome infections in humans or domestic livestock is a basic requirement for prevalence determination as well as for planning and implementing chemotherapy and for monitoring vector control operations. Early and accurate detection of these parasites is essential for successful interventions of HAT [92].

**Treatment and Control:** Homidium bromide (1 mg/kg), quinapyramine methyl sulphate (5 mg/kg) and diminazene aceturate (3.5 mg/kg) are used for the treatment of *T. congolense* and *T. vivax* infections in small ruminants. Chemoprophylaxis is an important control strategy in endemic areas and isometamidium (0.5 mg/kg) and pyrithidium bromide (2 mg/kg) are the drugs commonly used in small ruminants. Control of the disease depends on the prevention of contact between susceptible animals and vectors particularly tsetse flies. The methods of control of tsetse flies include bush clearing, spraying of animals and habitats with effective insecticides and the use of tsetse fly traps. The use of trypanotolerant breeds of goats and sheep is also being adopted in some countries. Avoidance of stress factors such as malnutrition, intense heat and intercurrent infections can reduce the incidence of clinical cases in endemic areas [44].

**Control:** Trypanosomosis is controlled either directly by trypanocidal drugs or indirectly by controlling tsetse fly and there by breaking the disease transmission cycle. Wide variety of tsetse control techniques have been developed and have undergone trial and gave satisfactory control of tsetse within any given target region. These control techniques include clearing of vegetation, game elimination/exclusion, Insecticides Ground spraying, Sequential aerial technique (SAT), Traps and targets and use of sterile insect technique [93, 94].

In Ethiopia, very few national disease control programs are underway and the livestock disease control process is mainly dominated by prophylaxis. Since 1997, eradication of the tsetse fly, the vector of the protozoa *Trypanosoma*, has been carried out in the southern Great Rift Valley of Ethiopia with the support of the International Atomic Energy Agency [95]. The Ethiopian government through NICETT (National Institute for the Control and Eradication of Tsetse and Trypanosomosis) organizes tsetse control program. Their strategies comprise the use of insecticidal pour-ons and insecticide impregnated traps and targets. Complementary to those vector control activities, trypanocidal drug treatment remains the most widely used control strategy because it is available and most affordable for livestock breeders. Trypanocides minimize the impact of the para-site on animal health and reduce the period that the animal is infectious for possible vectors [96].

The Ethiopian government also assisted by the International Atomic Energy Agency (IAEA)-initiated a project in the Southern Rift Valley called the Southern Tsetse Eradication project (STEP). The STEP was preparing for large-scale field operations, including the sterile insect technique. The creation of the tsetse-free zone in the entire target area was expected to be completed since 2017. The project was focusing on an area of 10,500 km² which has considerable potential for
agricultural development. Operational activities to clear this area will depend on the built-up of a sufficiently large colony of target tsetse fly species in captivity and other essential preparatory work, particularly in the field [97].

**Distribution of Small Ruminant Trypanosomosis in Ethiopia:** Among many disease that affect small ruminants in Ethiopia, Trypanosomosis is the most important one. The prevalence of small ruminants in Ethiopia was recorded in different regions such as Oromia, [72, 73, 98-101], Amahara [65, 102, 74], Benishangula Gumuz [75, 76, 103], in Tigray and Afar [28 and in SNNP [104, 110].

According to many researchers in Ethiopia, the higher prevalence of trypanosomosis was reported in sheep when we compare to that of goat [22, 65, 73, 72, 75, 76, 105, 98, 103, 104]. This may result from different combination behavior of sheep. This behavior of sheep allows tsetse flies to feed long and therefore increasing the chances of acquiring infection. Additionally, sheep are covered with thick wool on the sides of their body and this wool provides shade for tsetse flies feeding on the exposed ventral region [22]. Although tsetse flies may prefer sheep to goat for blood meal, pigs are most preferred which perhaps might have contributed to high prevalence in sheep [37, 64, 111-115].

However, in Ethiopia some authors have reported, high prevalence of goats Trypanosomosis than sheep [28, 104, 105, 107]. But in most cases, prevalence is often tended to be higher in sheep than goat possibly because of innate differences and distinctions in behavioral characteristics as well as a likely feeding preference of tsetse flies between goats and sheep [116, 117]. Regarding innate differences, sheep and goats are trypanotolerant; however, it is likely that the trypanotolerance trait is stronger in goat. Further, goat exhibit what has been referred to as anti-feeding behavior, which is aimed at discouraging tsetse fly bites [116, 118, 119]. During bites, goats, depending on the body part being bitten, usually kick and stamp their legs, swing tail, move head, flick ear or ripple skin. On the contrary, sheep are docile and do not move their bodies as much as goats during tsetse bites [118]. This behavior of sheep allows tsetse flies to feed long and therefore increasing the chances of acquiring infection. Additionally, sheep are covered with thick wool on the sides of their body and this wool provides shade for tsetse flies feeding on the exposed ventral region [22].

According to research of many authors the predominant trypanosome species in small ruminants were *T. congolense* and *T. vivax* and in some reports *T. brucei* were found. mixed infection of *T. congolense* and *T. vivax* in goats and sheep were reported by different researchers [22, 71, 72, 120, 121].

In general, small ruminant trypanosomosis are found in different regions of Ethiopia and hindering the small ruminant production [75, 98]. Even though the small ruminant is considered as trypanolerant, it is better to think about their potential reservoir of trypanosome infection to other animals.

<table>
<thead>
<tr>
<th>Study Region</th>
<th>Study areas</th>
<th>In sheep</th>
<th>In goat</th>
<th>Overall prevalence</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNNP</td>
<td>1. In walyita</td>
<td>2.18%</td>
<td>7.79%</td>
<td>5.45%</td>
<td>[107]</td>
</tr>
<tr>
<td></td>
<td>2. In Dawro Zone,</td>
<td>7.2%</td>
<td>9%</td>
<td>8%</td>
<td>[105]</td>
</tr>
<tr>
<td></td>
<td>3. In Gamogofa area.</td>
<td>0%</td>
<td>30.63%</td>
<td>22.97%</td>
<td>[104]</td>
</tr>
<tr>
<td>Oromia</td>
<td>1. In the southwest of Ethiopia</td>
<td>7.6%</td>
<td>3.6%</td>
<td>5.1%</td>
<td>[22]</td>
</tr>
<tr>
<td></td>
<td>2. East Wellega zone</td>
<td>2.76%</td>
<td>1.70%</td>
<td>2.11%</td>
<td>[73]</td>
</tr>
<tr>
<td></td>
<td>3. Ilubabor, (Harro Tatessa new settlement area).</td>
<td>4.5%, 3.7%</td>
<td>3.75%</td>
<td></td>
<td>[72]</td>
</tr>
<tr>
<td></td>
<td>4. Yayo District and Chewaka Settlement Area,</td>
<td>4.35%</td>
<td>1.75%</td>
<td>3.24%</td>
<td>[98]</td>
</tr>
<tr>
<td></td>
<td>5. Oromia, Central Ethiopia</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>[102]</td>
</tr>
<tr>
<td></td>
<td>6. Illubabor South West</td>
<td>0%</td>
<td>4.91%</td>
<td>4.91%</td>
<td>[100]</td>
</tr>
<tr>
<td></td>
<td>7. around Debre-Zeit, Central Ethiopia</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>[122]</td>
</tr>
<tr>
<td></td>
<td>8. In Ethiopia.</td>
<td>2.0 %</td>
<td>0.4%</td>
<td>1.3%</td>
<td>[123]</td>
</tr>
<tr>
<td>Benishalgul Gumuz Regional</td>
<td>1. Benishalgul Gumuz Regional</td>
<td>3.6%</td>
<td>3.17%</td>
<td>6.8%</td>
<td>[75]</td>
</tr>
<tr>
<td></td>
<td>2. Assosa and Homosha District</td>
<td>3.82</td>
<td>1.78</td>
<td>2.6%</td>
<td>[76]</td>
</tr>
<tr>
<td></td>
<td>3. Dangur District</td>
<td>3.70%</td>
<td>1.96%</td>
<td>2.56%</td>
<td>[103]</td>
</tr>
<tr>
<td>Amahara region</td>
<td>1. Demhecha and Jabitehnan districts of Northwestern Ethiopia</td>
<td>7.8%</td>
<td>3.5%</td>
<td>6.3%</td>
<td>[74]</td>
</tr>
<tr>
<td></td>
<td>2. In Guangua district of Awi Zone, northwestern Ethiopia</td>
<td>8.7%</td>
<td>(4.1%)</td>
<td>5.6%</td>
<td>[71]</td>
</tr>
<tr>
<td></td>
<td>3. Bahir Dar Zuria</td>
<td>0.82%</td>
<td>0.15%</td>
<td>0.25%</td>
<td>[65]</td>
</tr>
<tr>
<td>Tigray, Afar region</td>
<td>1. Selected area of Tigray and Afar</td>
<td>12.71%</td>
<td>13.26%</td>
<td>13.03%</td>
<td>[28]</td>
</tr>
</tbody>
</table>
CONCLUSION

In Ethiopia, small ruminant trypanosomosis is the main constraint in smallholder rural development. The disease resulted in serious economic losses specially western and southwestern parts of Ethiopia posing a significant impact on the country development. It is also clear that small ruminants could be potential reservoir hosts of animal infective trypanosome species in endemic different regions of Ethiopia. The farmers does not seen clinical signs as such seen in cattle as much as possible. Because of this reason, small ruminant does not treat timely and as result of this, they serve as potential source for other hosts. Different options are available for the diagnosis of small ruminant trypanosomosis; however, in Ethiopian practical situation the diagnosis of Small ruminat trypanosomosis is mainly relies on the less sensitive parasitological diagnosis techniques. Both the prophylactic and curative drugs can treat small ruminant trypanosomosis. Based on this conclusion, the following recommendations are forwarded.

- Sensitive and specific diagnostic tools having the capability of discriminating subspecies during epidemiological surveys must be applied whenever there is trypanosome control program of small ruminant must be considered which one the potential source.
- Further epidemiological studies should be conducted in areas where small ruminant trypanosomosis is endemic in order to determine the impact of the disease on the productivity as well as its economic impact.
- An integrated control measures, using modern methods of fly control and management of this disease should be implemented to improve the Camel productivity.

Competing Interests: No competing interests exist.

Author’s Contributions: The authors read and approved the final manuscript.

ACKNOWLEDGEMENTS

I’m very much grateful to the inhabitants of all staff members of Bule Hora University, school of Veterinary Medicine for their valuable advice, provision of materials and necessary supports during my work.

REFERENCES

1. Elnasri, H., 2005. Prevalence and Ranking of Bovine trypanosomiasis in Unity State, Sudan, MSc thesis, University of Khartoum, Faculty of Veterinary Medicine, Unity State, Sudan, pp: 1-76.


97. Assefa, K., A. Hagos and D. Terzu, 2015. A Review on Sterile Insect Technique (SIT) and its Potential towards Tsetse Eradication in Ethiopia. ISSN 2224-7181 (Paper) ISSN 2225-062X (Online), 37: 24-44.


