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A REVIEW ON PREVALENCE OF BOVINE TRYPANOSOMOSIS AND TSETSE FLY DENSITY IN DIFFERENT REGIONS OF ETHIOPIA

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ABSTRACT: Background: Ethiopia is known for its large and diverse livestock resource endowments and Bovine Trypanosomosis has long been recognized as a massive constraint on animal husbandry, livestock production and mixed farming in vast areas of rural sub-Saharan Africa. In Ethiopia, trypanosomosis is widespread in domestic livestock in the Western, South and Southwestern lowland regions and the associated river systems. The tsetse flies in Ethiopia are confined to the southern and western regions. Out of nine region of Ethiopia, five (Amhara area, Benishangul-Gumuz, Gambella, Oromia and Southern Nations Nationalities and Peoples‟ Regional State) are infected with more than one species of tsetse flies and there are five species of tsetse flies in those mentioned regions. **Method and Results**: For this systematic review more than 56 published paper from 2011-2023 were reviewed in five regions of tsetse fly infested areas, namely: Amhara, Oromia, SNNPRs, Benishamgul Gumuz (BG) and Gambella regions. Consistently, overall prevalence of bovine trypanosomosis in five regions of Ethiopia revealed that 7.01%, 8.84%, 7.22%, 12.44% and 16.9% in Amhara, Oromia, SNNPRs, Benishangul Gumuz and Gambella, respectively. Besides this, this review indicated that high infestation of tsetse fly was in Oromia region by four species, namely Glossina pallidipes, Glossina morsitans, Glossina fuscipes and Glossina tachinoides followed by Glossina pallidipes, Glossina morsitans, G. pallidipes, G. fuscipes in BG; G.m.submorsitans and G. tachinoides were reported in Amhara region. Glossina pallidipes, and Gossina fuscipes in SNNPRS. Relatively, with the lowest f/t/d Glossina pallidipes, Glossina morsitans, Glossina fuscipes, and Glossina tachinoides were reported in Gambella. 93.96 f/t/d, 46.43 f/t/d, 39.34 f/t/d, 18.4 f/t/d and 7.31f/t/d of apparent tsetse fly density per trap per day were reported in BG, Oromia, SNNPRS, Amhara and Gambella region respectively. **Conclusion**: the review showed that there was a significant variation in prevalence of bovine trypanosomosis and Tsetse fly density in five regions. And there are high-risk factors that predispose the community to Human African Trypanosomiasis (HAT) due to the presence of trypanosome brucei rhodesiense and many animal reservoirs. The transmissions of Human African trypanosomiasis (HAT) are related to environmental, vector, and human factors. Therefore, Strategic Bovine, Human trypanosomosis and tsetse fly control and prevention methods should be implemented in tsetse fly infested region of the country in order to increase the animal husbandry, production, productivity and safeguard draft power as well as health aspect.

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1. INTRODUCTION

Trypanosomosis has long been recognized as a massive constraint on animal husbandry, livestock production and mixed farming in vast areas of rural sub-Saharan Africa (Oluwafemi, 2014). Ethiopia is known for its large and diverse livestock resource endowments. Livestock is primarily kept on small holdings where it provide drought power for crop production, manure for soil fertility and fuels, serves as a sources family diet and sources of cash income (from livestock and livestock products). Despite large livestock population, Ethiopia fails to optimally utilize this resource due to different constrains facing the livestock subsector (Bezabih *et al.*, 2015). Since more than 90% of crop production in Ethiopia are dependent on animal draught power mainly on ploughing oxen, many large fields lie fallow due to lack of these animals in trypanosomiasis infested area (Kenaw *et al*.,2015), which worsen the food supply and living conditions in

affected areas. Trypanosomes are flagellated protozoan parasites that live in the blood and other body fluids of vertebrate hosts (OIE, 2013).

Bovine trypanosome is one of the diseases that are caused by this flagellated protozoal parasite belonging to the genus trypanosome. This group of diseases caused by protozoa of the genus Trypanosoma affects all domestic animals (Jember *et al*., 2013). The major veterinary species are Trypanosoma congolense, Trypanosoma vivax, Trypanosoma brucei, and Trypanosoma simiae. Trypanosoma brucei rhodesiense and Trypanosoma brucei gambiense are zoonotic, with people as the predominant host. Animal are mainly affected by tsetse-transmitted trypanosomes and in geographic areas where tsetse transmitted trypanosomiasis occurs (Kahn, Line S., 2005). In Ethiopia, trypanosomosis is widespread in domestic livestock in the Western, South and Southwestern lowland regions and the associated river systems (that is Abay, Ghibe Omo and Baro/Akobo) (Tekle Y., 2012).

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. The infested area extends from the southern part of the Rift Valley, around the south-western corner of the country and along the western lowlands and escarpments to the Blue Nile (Bezabih m et al., 2015; Abebe G 2005). Out of nine region of Ethiopia, five (Amhara area, Benishangul Gumuz, Gambella, Oromia and Southern Nations Nationalities and Peoples Regional State) are infected with more than one species of tsetse flies (Bitew M. *et al*., 2011).

Currently about 220,000 km2 areas of the above mentioned regions are infested with five species of tsetse flies, namely Glossina pallidipes, Glossina morsitans, Glossina fuscipes, Glossina tachinoides and Glossina longipennis (Abebe, 2005; keno,2005; NTTICC , 2004).

Several studies have been done in Ethiopia on the prevalence and tsetse fly density but there was little documented data in collective manner which clearly shown the status of trypanosomosis and its vector in different regions of the country. Therefore, the objectives of this review paper are: to present the available evidence on prevalence of bovine Trypanosomosis and its vector in different regions of Ethiopia in a systematic way. And to show research gaps on prevalence of trypanosomosis and tsetse fly density in Ethiopia.

Therefore, the objectives of the study were:

- To review the prevalence of bovine trypanosomosis
- To review apparent density of tsetse flies in Ethiopia.

2. Literature Review

2.1 Review on prevalence of Bovine Trypanosomosis

Different literature shown that five regions in Ethiopia are infested with four species of Glossina namely, Glossina pallidipes, Glossina morsitans, Glossina fuscipes and Glossina tachinoides. The remaining one species G. longipennis are reported in SNNPRS, south Omo zone, particularly in Mago national park by Arba Minch tsetse fly and trypanosomosis investigation and control center. Based on this holistic review no report have been indicated, the prevalence of bovine trypanosomosis and tsetse fly in natural reservoir of the disease like wild animal and national parks which are believed to be the pocket area for the tsetse fly to live and this could be one of the research gap this review identified in Ethiopia.

2.1.1 Review on Amhara region

Amhara region is one of the potential regions in livestock population in the country and according to different authors in the region, the area is highly infested with two tsetse fly species. From 2011-2018 only 11 published paper from different article are included and some of them are done in the same woreda by different author but their finding was different this is due to the use of different diagnostic methods and traps for catching tsetse fly (Shemelis *et al*., 2017; melaku w *et al*.,2018; Gamechu F *et al*.,2015; Getaneh. A., 2017).

Based on this review out of 5,189 samples from different study area 364 (7.01%) was positive for the parasite, out of this the most prevalent species of Trypanosoma in the region was T. vivax followed by T. congolense; T. brucei was rare species only reported in few area as stated in the Table 1. This could be due to the experience of the personal to identify and the use of common laboratory technique. The entomological survey by different authors indicted that G. m. submorsitans and G. tachinoides are the two tsetse fly species in the region (Table 2). There was only few published work that shown tsetse fly density in the region and this was one of the area to further investigate the tsetse fly density in the region and to plan the control programme in the area.

Table 1: Summary of publication on prevalence of Bovine Trypanosomosis in Amhara Region.

No.	Study Area	Sample size	Prevalence (%)	Spp of Trypanosoma	Reference
1	Abi Tehenan and Bahar dar area	1435	75 (12.2%)	*Overall*	Shemelis D et al.,2017
			02 (7.1%)	*T. congolense*	
			7 (4.67%)	*T. vivax*	
			6(0.43%)	*mixed infection*	
2	Abi Tehnan District	164	25 (15.24%)	*Overall*	Melaku w., Tewodros A.2018
			20 (12.2%)	*T. congolense*	
			5 (3.04%)	*T. vivax*	
3	Chilga District	384	21(5.47%)	*Overall*	Zewdu S. & Dessie A. 2016
4	Jawi district	300	34(11.33%)		Shemelis Dagchew et al.,2011
5	South Achefer District	384	16(4.2%)	*Overall*	Denberga y etal.,2012
			5(1.3%)	*T.congolense*	
			10(2.6%)	*T.vivax*	
			1(0.26%)	*mixed*	
6	Wemberma district (West Gojjam)	384	30(7.81%)	*Overall*	Bishaw y etal.,2012
			24(6.25%)	*T.congolense*	
			6(1.56%)	*T.vivax*	
7	Mecha Woreda (west Gojjam zone)	384	8(2.10%)	*Overall*	Ayanaw. et al.,2012
			8(2.10%)	*T.vivax*	
8	Quara Woreda	384	26(6.77%)	*Overall*	GetanehA et al.,2017
			1(0.26%)	*T.congolense*	
			25(6.51%)	*T.vivax*	
9	Guangawa and Jawi (Awi zone)	405	39(9.6%)	*Overall*	Mekuria s. *et al*.,2011
			28(6.9%)	*Tcongolense*	
			7(1.73%)	*Tvivax*	
			30.74%	*Tbrucei*	
			1(0.23%)	*Mixed*	
10	Ankesha District (Awi Zone)	384	28(7.3%)	*Overall*	Gamechu F *et al*.,2015
			9(2.4%)	*T.congolense*	
			19(4.9%)	*Tvivax*	
11	Debre Eliays (North-western)	581	62(10.67%)	*Overall*	Achenef M et al.,2012
			27(4.65%)	*T.congolense*	
			35(6.02%)	*T.vivax*	

Table 2: Summary of publication on Tsetse fly density in Amhara Region.

No.	Study Area	Type of Trap Deployed	No. of Trap deployed	Glossina spp.	Tsetse fly density F/T/D	References
1	Debre Eliays (North-western)	Monoconical	4	Glossina spp	16.0	Achenef M et al ., 2012
2	Dembecha and Jabitehenan wereda (West Gojjam Zone)	Monoconical, Biconical and NGU traps	142	Glossina m. submorsitans	0.68	
3	Guangawa and Jawi (Awi zone)	Monopyramidal	138	G. tachinoides	1.71	Mekuria s et al.,2011

2.1.2 Review on Oromia Region

Oromia region According to CSA, 2017/2018 Oromia is the first in livestock population in Ethiopia but this huge resource is highly challenged by one of economically devastating disease and the region was one of the trypanosomosis and tsetse fly investigation and control center last one decade due to its high tsetse fly infestation. From the year 2011-2019 almost 8 published papers on prevalence of Bovine trypanosomosis were identified in Oromia as stated in Table 3. Based on the review of this paper out of 8,258 total samples 730 (8.84%) were positive for the disease and among which T. congolense was the most prevalent species in different Zones and Woredas of the region followed by T. vivax and T. brucei as indicated in the Table 3 below .

Among 16 published and reviewed papers 11 studies were reported the tsetse fly density of the region and out of five species of tsetse fly which are found in Ethiopia, four species of tsetse fly were infested the region namely G. morsitans, G. pallidipes, G. tachinoides and G. fuscipes and this region were highly infested with only Glossina longipennis is an exception (Table 4).

Table 3: Summary of publication on prevalence of Bovine Trypanosomosis in Oromia Region.

No.	Study Area	Sample size	Prevalence N %	Spp of Trypanosoma	Reference
1	Yayo District (Illubabor Zone)	488	19 (3.9%)	*Overall*	Geremew H. *et al.*,2016
			16 (3.3%)	*T. congolense*	
			2 (0.4%)	*T. vivax*	
			1(0.2%)	*T. brucei*	
2	Yayo District (Illuababora Zone)	408	30 (7.4%)	*Overall*	Kitile G *et al.*,2016
			20 (4.9%)	*T. congolense*	
			8 (2%)	*T. vivax*	
			2 (0.5%)	*Mixed*	
3	Dale Wabera District, Kellam Wollega Zone	391	48 (12.3%)	*Overall*	Taye IG, Kumela LD. (2017)
			29 (7.42%)	*T. congolense*	
			13 (3.32%)	*T. vivax*	
			6 (1.53%)	*Mixed*	
4	Darmu district (Illubabor zone	392	45 (11.5%)	*Overall*	Teferi B, Biniam T 2018
			40 (10.2%)	*T. congolense*	
			5 (1.3%)	*T. vivax*	
5	Didessa Woreda	364	21 (5.76%)	*Overall*	Netsa B, Abriham K,Enddalu M.2018
			13 (3.57%)	*T. congolense*	
			5 (1.37%)	*T. vivax*	
			2 (0.55%)	*T. brucei*	
			1 (0.27%)	*Mixed infection*	
6	Gidami district	930	131 (14.08%)	Overall	Efrem DB .,2020/19
			39 (9.07%)	Early dry season	
			92(18.4%)	Early rainy season	

7	Sayo district	860	65(15.11%)	Early dry	
			31(7.20%)	Early rainy season	
8	Dale wabera and Dale sadi districts	589	51(8.71%)	*Overall*	Bedaso K and Dereje.,2016
9	Jimma town	384	31(8.1%)		Mohamed H et al., 2020
			20(5.2%)	*Tcongolense*	
			5(1.3%)	*Tvivax*	
			6(1.8%)	*Tbrucei*	
10	Gudeya Bile district e.w.zone	384	25(6.5%)	*Overall*	Terefe A et al., 2016
			14(60%)	*Tcongolense*	
			10(36%)	*Tvivax*	
			1(4%)	*Tbrucei*	
11	Darimu District, illu Aba bora zone	650	46(7.1%)	*Overall*	Fedesa H *et al.*,2015
			38(82.61%)	*Tcongolense*	
			2(4.35%)	*Tvivax*	
			(t.v & t.b=2; t.c & t.v=4)=6(13.04%)	*Mixed*	
12	Sadi chanka district	426	88(20.6%)	*Overall*	Wabi E *et al.*,2022
			39(9.5%)	*Tcongolense*	
			13(3.75%)	*Tvivax*	
			23(5.16%)	*Tbrucei*	
			13(2.58%)	*Mixed*	
13	Jimma Arjo district, upper didessa valley	440	36(8.2%)	*Overall*	Debela A *et al.*,2022
			22(0.5%)	*Tcongolense*	
			8(1.82%)	*Tvivax*	
			6(1.36%)	*Tbrucei*	
14	Nonno distrct western shewa zone	544	23(4.23%)	*Overall*	Degim B *et al.*, 2019
			15(65.22%)	*Tcongolense*	
			6(26.08%)	*Tvivax*	
			2(8.69%)	*Mixed*	
15	Sayonole district,western oromia	599	101(16.9%)	*Overall*	Bedasa KK., 2015
			80 (9.2%)	*Tcongolense*	
			11(10.9%)	*Tvivax*	
			10(9.9%)	*Mixed*	
16	Limu Seka district of Jimma zone	409	35(8.5%)	*Overall*	Aliya N et al., 2021
			6(17.15%)	*Tcongolense*	
			29(82.85%)	*Tvivax*	

Table 4: Summary of publication on Tsetse fly density in Oromia Region.

No.	Study area	Type of trap deployed	No of trap deployed	Glossina spp	Season	No.	Tsetse fly density f/t/d	Reference
1	Didesa District	mononical traps	40	G. tachinoides			1.27	Gemechu F et al., 2015
2	Gidami		40	GMM	Early dry	24	1.87	Efrem DB., 2019 (2020)
				GP		126		
				G.tach		0		
				G.F		0		
			40	GMM	Early rainy	62	4.26	
				GP		279		
				G.tach		0		
				G.F		0		
3	Sayo		40	GMM	Early dry	164	5.66	
				GP		155		
				G.tach		7		
				G.F		127		
			40	GMM	Early rainy	47	2.68	
				GP		40		
				G.tach		62		
				G.F		65		
4	Diga and Sasiga districts (East Wollega zone)	mononical traps	21	Glossina tachinoides			13.04	Tafesew et al., 2012
5	pawe (Metekel Zone)		77	G. tachnoides			15.06	Mekuria s et al.,2011
6	Gimbi district (West Wollega)	mono-pyramidal	45	G. m. submorsitans			0.02	Geremew H et al., 2016
				G. tachinoides			0.41	
				Overall			0.43	
7	Dale Wabera district (Oromia)			*G. m .submorsistans*			11.98	Taye Itefa and Kumela Lelisa, 2017
				G. pallidipes				
				G. tachnoides				
8	Darimu dstrict, illu Aba bora zone	mono-pyramidal traps	70	GMM=5.87 FTD			6.87FTD	Fedesa H etal.,2015
				G.P=0.99 FTD				
9	Jimma Arjo district, upper didessa valley		26	In wet =GMM=363(6.98 f/t/d)			15.1 ftd	Debela A etal.,2022
				In dry =GMM=161(3.09f/t/d)				
			26	In wet =g.tach=749(14.4f/t/d)				
				In dry =g.tach=296(5.69f/t/d)				
10	Nonno district, w. Shewa zone		60	G.f.f=1.5f/t/d			2.73ftd	Degim B et al.,2019
				G.pallidipes=1.22f/td/				
11	Sayonole district w.oromiaya		43	Gmm=2(0.023 f/t/d			13.01 ftd	Bedaso KK.,2015
				g.p=308(3.58 f/t/d				
				g.f.f=791(9.19 f/t/d				
				G.tach=18(0.209 f/t/d				

2.1.3 Review on SNNPRS

Southern Nation Nationalities Peoples Regional State (SNNPRS), this region is the 2nd in livestock population in Ethiopia with high risk of bovine trypanosomosis and tsetse fly infestation. There are five national parks namely Omo, Mago, Nech Sar, Maze and Chebera Churchura which can be act as a good habitat for tsetse fly. From 2011- 2022 GC, 8 published studies were done on prevalence of Bovine trypanosomosis. Among 13 zones of the region; studies

were done by different author in 3 zones with various woredas. This indicated that most of the studies were concentrated in limited parts of the region, due emphases should be given to assess prevalence of the disease and its vector density in the region to alleviate the impact of this disease in the productivity of livestock. Out of 2,643 samples 191 (7.22%) animals were positive for the disease and of which *T. congolense* was the dominant species of Bovine trypanosomosis in the region followed by *T. vivax* and *T. brucei.* Wondewosen T *et al*.(2012); Seifemichael U *et al*.(2020); Bahilu Y *et al*.(2017); Migbaru *et al*.(2017), Adisu A.(2017), and Nigussu F. (2017) in Arbamich, Kindokoysha, Anderecha, Dara, Gena-Bossa, kindo Didaye Districts reported that, 4.43%, 5.91%, 2.1%, 14.8%, 15.38%, and 5.83% of Trypanosomosis prevalence respectively.

In this region, overall tsetse fly density was reviewed as 39.34% f/t/d. Nigatu S *et al.*, 2016 (G.P, G.F=0.067) in Upper Omer belt Southern Ethiopia, Wondewosen *et al.*, 2012 (G.P =14.97 f/t/d) in Arba minch; Bahilu Y *et al*., 2017 (GP=0.82f/t/d) in Anderacha); and Antenh w *et al*., 2017 (G.P =8.45 f/t/d) in Konta, were reported in Southern part of Ethiopia. This region was the most tsetse fly infested area in the country, due to this reason the country had been started to eradicate tsetse fly as a project (Southern tsetse fly eradication project) covering 25,000 square kilometers 20 years ago and this project brought important change in livestock sectors of the region and now it was changed in to National Institute of Trypanosomosis and Tsetse fly Investigation and Eradication, with expansion of its coverage in to 79, 000 square kilometers (mainly in Oromia, SNNPRs, Amhara, Benishangul Gumuz).

Based on this systematic review most of the studies done in this region were concentrated on prevalence of trypanosomosis and its vector density were. This review found that G. pallidipes and G. fuscipes, were the most infested species of tsetse fly in the region as Table 6 indicated.

According to the report by Arba minch trypanosomosis and tsetse fly investigation and control center; this region was the only region that G. longipennis is found but none of the studies were confirmed this hypothesis therefore due attention should be given on the assessment of tsetse fly species including G. longipennis found in the region particularly in different national parks (Table 6).

Table 5: Summary of publication on prevalence of bovine trypanosomosis in SNNPRS

No.	Study Area	Sample size	Prevalence N %	Spp of Trypanosoma	Reference
1	Dara District (Sidama Zone)	384	57 (14.8%)	Overall	Migbaru KB, et al.,2017
			26 (45.6%)	T. congolense	
			18 (31.6%)	T. vivax	
			8 (14.0%)	T. brucei	
			5 (8.8%)	Mixed	
2	Gena-Bossa (Dawuro Zone)	384	59 (15.38%)	All type	Adisu A, Wale T., 2017
3	Kindo Didaye district /Wolaita zone/	120	7 (5.83%)	Overall	Nigussu F., 2017
			4 (3.33%)	T.congolense	
			2 (1.67%)	T. vivax	
			1 (0.83%)	Mixed	
4	Enemorena Ener Woreda (Gurage Zone)	384	20 (5.2%)	Overall	Tamirat TG, TsegayeL,2018
			7 (4.42%)	T. congolense	

			3 (0.78%	T. vivax	
5	Zala Woreda (Gamo Gofa Zone)	384	10 (2.6%)	Overall	Wale T, Ermias BS, 2017
			6 (1.56%)	T. congolense	
			4(1.04%)	T. vivax	
6	Anderacha woreda (SNNPR	383	8(2.1%)	Overall	Bahilu Yigzaw *et al*., 2017
7	Wolaita zone , kindo koysha woreda	220	13(5.91%)	Overall	Seifemichael U and Amene F, 2020
			8(61.6%	T.congolense	
			4(30.8%)	Tvivax	
			1(0.69%)	Mixed	
8	Arbaminch	384	17(4.43%)	Overall	Wondewosen T *et al*.,2012
			14/82.35%)	Tcongeloense	
			2/11.76%)	Mixed	
			1(5.88%)	Tvivax	

Table 6: Systematic summary of publication on Tsetse fly density in SNNPRS.

No.	Study area	Type of trap deployed	No. of trap deployed	Glossina spp	Tsetse fly density f/t/d	Reference
1	Upper Omo Belt (Southern Ethiopia)	biconical traps	10	G. paldipes	0.067	Nigatuwa S.et al., 2016
				g. fuscipus	0.067	
2	Konta (SNNPR			*G. pallidipes*	8.45	Anteneh Wondimu *et al*., 2017
3	Arba Minch (SNNPR)			*G. pallidipes*	14.97	Wondewosen Teka *et al*., 2012
4	Anderacha woreda(SNNPR)			*G. pallidipes*	0.82	Bahilu Yigzaw *et al*., 2017
5	Arbaminch	NGU trap		*G. pallidipes*	14.97 f/t/d	Wondewosen T et al.,2012

2.1.4 Review on Benishamgul Gumuz region

Studies done in this region, on the prevalence of Bovine Trypanosomosis might be many but from 2016-2022 GC, at least 17 published studies were found in this review. Out of 9,604 samples 1195 animals were positive and the overall Trypanosomosis prevalence of the region were found to be 12.44% among which in Asossa district, Kamashi district, Bambasi woreda, Pawe District, Dangur District, Bullen district, Dibati district, Maokomo district, *T. congolense* was highly prevalent (Asmamaw A *et al*., 2016; 2017, 2022) whereas *T. vivax* was in Mandura District (Getachew D *et al*.,2016) as shown in the Table 7. Concerning the tsetse fly infestation of the region; ten studies in different woredas of the region's revealed that *G. morsitans, G. tachinoides, G. pallidipes* and *G.fuscipes* were the prevailing species in the region and 93.96 f/t/d of the tsetse fly density were recorded in the region. This was not enough to conclude the overall tsetse fly density and species in the region therefore, this review recommended to researchers in the area to study on the prevalence of bovine Trypanosomosis and vector activity of the region at large as (Table 8).

Table 7: Summary of publication on prevalence of bovine trypanosomosis in BG region.

No.	Study area	Sample size	Prevalence in%	Spp of trypanosoma	References
1.	Pawe district	519	29(5.58%)	*Overall*	Asmamaw A, Getachew D, 2016
			22(4.23%)	*T.ongolense*	
			7(1.25%)	*T.vivax*	
2.	Dangur district	543	46(8.5%)	*Overall*	Mulatu E et al.,2016
			44(8.1%)	*T.congolense*	
			2(0.4%)	*T.vivax*	
3.	Oda Buldigilu	395	47(11.89%)	*Overall*	Mekonen G, Negessem.,2017
			26(55.31%)	*T.congolense*	
			18(38.29%)	*T.vivax*	
			1(1.12%)	*T,brucei*	
			2(4.28%)	*Mixed*	
4.	Bambasi woreda	400	85(21.25%)	*Overall*	Shimelis TY,Bosona F, 2017
			4(11%)	*T.congolense*	
			24(6%)	*T.vivax*	
			0(2.5%)	*T,brucei*	
			7(1.75%)	*Mixed*	
5.	Asossa zone(asossa, bambai, oda, homosha,kurmuk ,meng,sherkole)	1645	162(9.85%)	*Overall*	Asmamaw a *et al*.,2016
			124(76.54%)	*T.congolense*	
			30(18.63%)	*T.vivax*	
			4(2.48%)	*T.brucei*	
			4(2.48%)	*Mixed*	
6.	Asossa district	458	21(4.58%)	*Overall*	Asmamaw a *et al*.,2016
			17(80.95%)	*T.congolense*	
			4(19.04%)	*T.vivax*	

7.	Bullen district	400	137(34.3%)	*Overall*	Asmamaw a *et al*.,2022
			110(80.29%)	*T.congolense*	
			17(12.49%)	*T.vivax*	
			6(4.37%)	*T.brucei*	
			4(2.92%)	*Mixed*	
8.	Bullen district	394	22(5.6%)	*Overall*	Asmamaw *et al*.,2016
			8(36.4%)	*T.congolense*	
			14(63.6%)	*T.vivax*	
9.	Kamashi district	413	37(8.96%)	*Overall*	Asmamaw et al.,2016
			27(73%)	*T.congolense*	
			5(13.5%)	*T.vivax*	
			1(2.7%)	*T.brucei*	
			4(5.4%)	*Mixed*	
10.	Bambasi	514	47(9.14%)	*Overall*	Asmamaw et al.,2016
			37(78.72%)	*T.congolense*	
			6(12.76%)	*T.vivax*	
			1(2.13%)	*T.brucei*	
			2(4.25%)	*Mixed*	
11.	Mandura district	391	52(13.3%)	*Overall*	Getachew D et al.,2016
			2(3.85%)	*T.congolense*	
			48(92.3%)	*T.vivax*	
			2(3.85%)	*Mixed*	
12.	Pawe	519	29(5.58%)	*Overall*	Asmamaw et al.,2016
			22(75.86%)	*T.congolense*	
			7(24.14%)	*T.vivax*	
13.	Mandura district	384	101(26.3%)	*Overall*	Asmamaw A et al.,2017
			88(87.13%)	*T.congolense*	
			6(5.94%)	*T.vivax*	
			2(1.98%)	*T.brucei*	
			5(4.95%)	*Mixed*	
14.	Dangur	382	87(22.77%)	*Overall*	Asmamaw A et al.,2017
			68(78.16%)	*T.congolense*	
			12(13.79%)	*T.vivax*	
			2(2.29%)	*T.brucei*	
			5(5.73%)	*Mixed*	
15.	Bambasi	385	173(45.1%)	*Overall*	Abebe B et al.,2017
			121(31.4%)	*T.congolense*	
			28(6.3%)	*T.vivax*	
			24(6.2%)	*Mixed*	
16.	Asossa and Bambasi district	1562	61(7.7%) in late season	*Overall*	Birhanu E., 2019
			37(4.8%) in dry season		
			39(64%) late	*T.congolense*	
			28(75.7%) dry		
			13(21.3%) in late	*T.vivax*	
			5(13.5%) in dry		
			1(1.6%) in late	*T. brucei*	
			8(13.1%) in late	*Mixed*	
			4(10.8%) in dry		
17.	Pawi (BGR)	300	22(7.33%)	*Overall*	Muleta k *et al*., 2017

Table 8: Systematic summary of publication on Tsetse fly density in BG region

No.	Study area	Type of trap deployed	No. of trap deployed	Glossina spp	Tsetse fly density f/t/d	season	Reference
1.	Bullen Districts	mono-pyramidal	5	G. tachnoides	5.35	Dry	Asmamaw A., 2022
		Mono conical (MC)	10		8.94	Late	
		Biconical(BC)	19				
2.	Bambasi and Asossa district	Bc	72	G.sub. morsitans	0.13	Dry	Birhanu E,.2019/2020
		MC	78		0.31	Late	
3.	Asossa zone (7 district)	mono-pyramidal (MP)	55		2.49		Asmamaw A., 2016
		Monoconical	156				
		Biconical	40				
		NGU	10				
4.	Asossa district	mono-pyramidal	18	G.sub .morsitans	2.84		asmamaw A., 2016
		Mono conical	15				
		biconical	12				
		NGU	4				
5.	Bullen district	mono-pyramidal	8	G.tachinoides	0.72		asmamaw A et al., 2016
		Mono conical	11				
		biconical	4				
6.	Kamashi district	mono-pyramidal	8	G. tachinoides	2.68		asmamaw A et al., 2016
		Mono conical	10				
		biconical	7				
7.	Bambasi	Mp	30	G.sub. morsitans (GM)	3.92		asmamaw A et al., 2016
		Mc	22				
		Bc	20				
		NGU	8				
8.	Mandura	mp	5	G. tachinoides (GT)	0.91		Getachew D et al 2016
		mc	4				
		Bc	2				
9	Pawe	mp	25	GT	5.03		asmamaw A et al., 2016
		mc	18				
		Bc	4				
		NGU	5				
10.	Mandura district	MP	14	GT	5.64		asmamaw A et al., 2017
		MC	23				
		BC	16				
11.	Dangur	mp	14	GT	6.06		asmamaw A et al., 2017
		Mc	23				
		Bc	16				
12	Mao-Komo special district (BGR)			*G. m. submorsitans*	1.41		Zelalem W *et al*., 2017
				G. fuscipes			
				G. pallidipes			

BGR= Benishangul Gumuz region, LRS= Late rainy season, DS= dry season, BC= biconical, MC= monoconical, MP= mono pyramidal

2.1.5 Review on Gambella region

This region is among highly infested area in Ethiopia and has good potential in livestock resource. From 2016-2020 at least three published papers were found in this review and the prevalence of Bovine trypanosomosis in this region revealed that out of 1449 sample, the overall prevalence is 245 (16.9%) and T. congolense, T. vivax and T. brucei are available among which T. vivax is the most prevalent species in the region (Kedir m et al., 2016; Jirata SA et al., 2020). 7.31 f/t/d of fly density per trap per day were reported in the region as three published papers noted. Researchers should work more in uncovered parts of the region to know the overall prevalence of bovine trypanosomosis since the area is highly infested with tsetse fly vector (Table 9).

Table 9: Summary of publication on prevalence of bovine trypanosomosis in Gambella region.

No.	Study area	Sample size	Prevalence in%	Spp of trypanosome	References
1.	Gambela and Abobo District	862	143(16.6%)	Overall	Kedir m *et al*., 2016
			36(4.2%)	*T.congolense*	
			94(10.9%)	*T.vivax*	
			4(0.46%	*T,brucei*	
			10(1.04%)	*Mixed*	
2	Itang district of Gambella region	203	36(17.7%)	*Overall*	Jirata SA *et al*., 2020
			16 (44.4%)	*T.congolense*	
			14(38.88%)	*T.vivax*	
			6(16.66%)	*T.brucei*	
3	Itang especial, and Gambella town, region	384	66(17.2%)	*Overall*	Jemberu.A, Eshetu.G, 2018
			51.5%	*T. congolense*	
			39.4%	*T vivax*	
			27.7%	*T brucei*	
			7.58%	*Mixed*	

Table 10: Systematic summary of publication on Tsetse fly density in Gambella region

No.	**Study area**	**Type of trap deployed**	**No. of trap deployed**	**Glossina spp**	**Tsetse fly density ftd**	**Reference**
1.	Gambela and Abobo districts	mono-pyramidal trap	145	*G. m. submorsitans*	-	kedir m *et al*., 2016
				G. pallidipes	-	
				G. fuscipes fuscipes	-	
				G. tachnoides	-	
				Overall	0.75	
2	Gambella S.W.Ethiopia			*Overall*	315(6.56 f/t/d)	Tekola E *et al*.,1997
				G.pallidipes	16(0.33ftd	
				G.tachinoides	4(0.083 ftd	
				G.fuscipes	295(6.14 ftd)	

2.1.6 Review on Human African Trypanosomiasis in Ethiopia

Sleeping Sickness, Human African Trypanosomiasis (HAT) is a vector borne disease caused by Trypanosoma brucei (T.b). Sleeping sickness in Ethiopia was reported in 1967 for the first time. Recently in Southern parts of Ethiopia, in August 2022, five (5) cases of sleeping sickness (T. b. rhodesiense) were confirmed (Abate W *et al*., 2023 in Kucha alpha & Demba Gofa districts, SNNPR, November 2022). Following this outbreak, the current investigation was aimed to identify the entomological and epidemiological drivers for the reemergence of HAT outbreak and recommend appropriate interventions. NGU and bio-conical traps were used to determine the distribution (density and abundance) of the vector. About 10µl of blood was collected from the marginal ear vein of 301 cattle using the heparinized microhematocrit capillary. The parasite detection was carried out through vector dissection under binocular stereo-microscope (magnification of 60X) and microscopic examination from serum of Animals using the Buffy coat method (Abate W *et al*., 2023 in Kucha alpha & Demba Gofa districts).

A total of 329 tsetse flies were captured and identified to Glosina (G.) palidipes 259 (60.4%) and Glossina fuscipes 70 (16.3%). 188 (51.1%) of tsetse flies were collected from Dembagofa with 94 apparent density. Among all captured Tsetse fly, 39 (11.8%) of Tsetse were fed with high female apparent density in each ecological variation: wood land (51), Bush land (20) and grass land (11). Overall, the apparent density of tsetse fly was high in Wood land (93): G. pallidipes (76.5) and Bush land (36.5). Among all examine cattles for the presence of parasite, 9 cattles were detected positive with an overall prevalence of 3%. T. congolense 6 (2%) and T. vivax 1 (0.3%) with 2 (0.7%) suspected brucei. The parasite prevalence Trypanosoma was 4 (4.6%) in poor body a condition (Bcs) cattle. The animals in age range 5 - 9 years were infected high with 7 (5.3%) prevalence. Therefore, the high-risk factors that predispose the community to Human African Trypanosomiasis (HAT) due to the presence of two different species of Tsetse flies and many animal reservoirs and the transmissions of Human African trypanosomiasis (HAT) are related to environmental, vector, and human factors((Abate W *et al*., 2023 in Kucha alpha & Demba Gofa districts).

2.2 Review on Chemotherapy and chemoprophylaxis

Drugs such as ISMM and Quinapyramine sulphate or chloride can be used as prophylactic drugs during transhumance or high seasonal parasitic pressure. Diminazene aceturate and Quinapyramine methyl sulfate are drugs which can be used as curative and sanative (OIE, 2013). But, a very widely used chemotherapeutic drug is DIM, which is effective against all of the three AAT. However, chemo resistance may occur and care must be taken due to the presence of fake drugs on some markets (OIE, 2013).

Some of the documented Glossina and trypanosomosis control operations implemented in Ethiopia since 1980 include control measures in upper Didessa valley (4,500 km2) by NTTICC from 1986-1989 using insecticide treated traps and targets (Feyesa Regassa and Getachew Abebe, 2009) and southern Rift valley (25,000 km2) by PATTEC using insecticide treated traps and targets, treating cattle with insecticide, trypanocidal drugs, sequential aerial spraying, sterile insect technique, and ground spraying methods (Taye Messele *et al*., 2012). Control measures for Glossina and trypanosomosis are summarized in Figure 2.4. Source: (Meyer *et al*., 2016)

Chemotherapy and chemoprophylaxis are the major means of combating the disease. The compounds in common use for chemotherapy or chemoprophylaxis of animal trypanosomosis are DIM derivatives, suramin, quinapyramine, homidium, ISMM and pyrithidium (Mira *et al*., 1989). However, effectiveness of these drugs is limited by a factor such as parasite resistance (Achenef Melaku and Bekele Birrasa, 2013). The emergence of drug resistant trypanosome strains is considered as a serious problem in trypanosomosis control, particularly for the resource poor farmers in Africa (Kagira and Maina, 2007).

Drug resistance can be defined as the heritable loss of sensitivity of a microorganism to a drug to which it was sensitive (Sinyangwe *et al*., 2004). When trypanocides do not produce an expected cure or protection; there is a tendency to assume that drug resistance has arisen. Whilst this may be true, there are many other reasons which contribute to drug treatment failure. Only after carefully investigating the practical points of drug administration and eliminating other causes of failure, is it valid to investigate the likelihood of there being true drug resistance (Leach and Roberts, 1981).

The problem of drug resistance in animal trypanosomosis is highly spreading geographically to many regions where the disease occurs (Grace *et al*., 2009). Decades after the first case of drug resistance in trypanosomes, Clausen *et al*. (1992) confirmed multiple drugs resistant trypanosome isolates in the pastoral area of Burkina Faso. Moreover, resistance developed by trypanosomes to trypanocidal drugs has been reported from East Africa (Wubet Mulugeta *et al*., 1997).

There is a report on a five-fold increase in the prevalence of DIM resistance over a seven year period in the eastern province of Zambia, suggesting that, there might be a worsening of the problem. Trypanocidal drug resistance has been officially

reported in 17 African countries (Burkina Faso, Chad, Ivory coast, Ethiopia, Kenya, Mali, Somalia, Sudan, Tanzania, Uganda, Zimbabwe, Zambia, Mozambique, Cameroon, Nigeria, Guinea, and Central African Republic) (Delespaux *et al*., 2008). But recently, this number is increased to 21 African countries (Biniam T *et al*., 2015).

Table11. Trypanocidal drug resistance in some African countries

Country	**Trypanosmes spp**	**Resistance to**	**References**
Zambia	Tc	ID	Chitanga *et al*. (2011)
Mali	Tv/Tc	I/ID	Mungube *et al*. (2012)
Burkina Faso	Tv	ID	Sow *et al*. (2012)
Mozambique	Tc	ID	Jamal *et al.* (2005)
Uganda	Tb	ID	Kazibwe *et al.* (2009)
Zimbabwe	Tc	D	Joshua *et al*. (1995)
Kenya	Tc	I	Gray *et al.* (1993)
Ethiopia	Tc	ID	Hagos Ashenafi *et al*. (2014)
	Tv	ID	Shimelis Dagnachew *et al*. (2015)

Tc = *T. congolense*, Tb = *T. brucei*, Tv = *T. vivax*, I= isometamidium; D: diminazene; ID: both isometamidium & diminazene

A report from Ethiopia has demonstrated the value of a field appraisal to determine the efficacy of trypanocidal drugs in an area where trypanocide failure occurred (Rowlands *et al*., 2008). Resistance seems to develop in a stepwise manner with trypanosomes resistant to a low dose of trypanocide being removed by a higher dose of the same compound (Connor, 2013). Nowdays, the most commonly used trypanocidal drugs for T. congolense and T.vivax infection in Ethiopia are ISMM and DIM. The current situation on the phenomenon of trypanocidal resistance particularly against T. congolense infection is well documented in the Ghibe valley (Moti Yohannes, 2014).

2.3 Trypanocidal drug practices in Ethiopia

In Ethiopia, the problems of drug resistance against one or both of the drugs(ISM and DA) have been reported by different researches (Moti *et al*., 2012; Hagos *et al*., 2014; Dagnachew *et al*., 2015b) in Table 12. The continued use of the same trypanocides for years has resulted in drugs resistance that has been largely responsible for the current chemotherapeutic failures in Ethiopia (Geerts *et al*., 2010; shiferaw *et al*.,2015). As in other African countries (Holmes *et al*., 2004). The emergence of drug resistance is also linked bad handling and utilization prac tices as well as poor drug quality (Zewdu *et a*l.,2013).

Table 12.Summary of Trypanocidal drug resistance in Ethiopia

Country	Trypanocidal species	Resistance to trypanocidal drugs	References
Ethiopia	*T.congolense*	ISM, HOM and DA	Mulugeta *et al*., 1997
	T Congolense	ISM and DA	Afework *et al*.,2000
	T b,brucei	ISM	Afework *et al*.,2006
	T.congo, t brucei	ISM	Tewolde *et al*.,2004
	T. congolense, T.vivax	ISM and DA	Dagnachew *et al*.,2008
	T.vivax	ISM and DA	Desalgn *et al*.,2010
	T.congolense	ISM and DA	Moti *et al*.,2012

3. DISCUSSION

For this systematic review more than 56 published paper from 2011-2023 were reviewed in five (Amhara, Oromia, SNNPRs, Benishangul Gumuz and Gambella) regions of tsetse fly infested areas. 7.01%, 8.84%, 7.22%, 12.44% and 16.9% of Bovine Trypanosomosis was reported in Amhara, Oromia, SNNPRs, Benishangul Gumuz and Gambella, respectively. High bovine trypanosomosis was recorded in Gambella while the lowest was investigated in Amhara, followed by Southern parts as Figure 1 indicated.

Besides this, this review indicated that high infestation of tsetse fly was in Oromia region by four species, namely Glossina pallidipes, Glossina morsitans, Glossina fuscipes and Glossina tachinoides followed by Glossina pallidipes, Glossina morsitans, G. pallidipes, G. fuscipes in Benishangul Gumuz region with the highest f/t/d. G.m.submorsitans and G. tachinoides were reported in Amhara region. Glossina pallidipes, and Gossina fuscipes in SNNPRS. Consistently, with the lowest f/t/d Glossina pallidipes, Glossina morsitans, Glossina fuscipes, and Glossina tachinoides were reported in Gambella as Figure 2 showed.

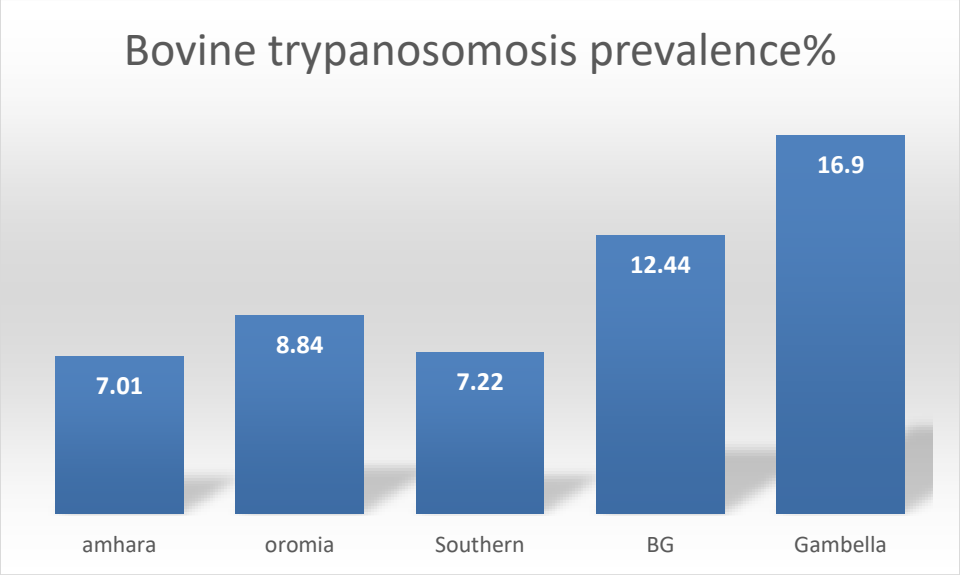

Figure1. Five regions, Bovine Trypanosomosis from 2011-2023

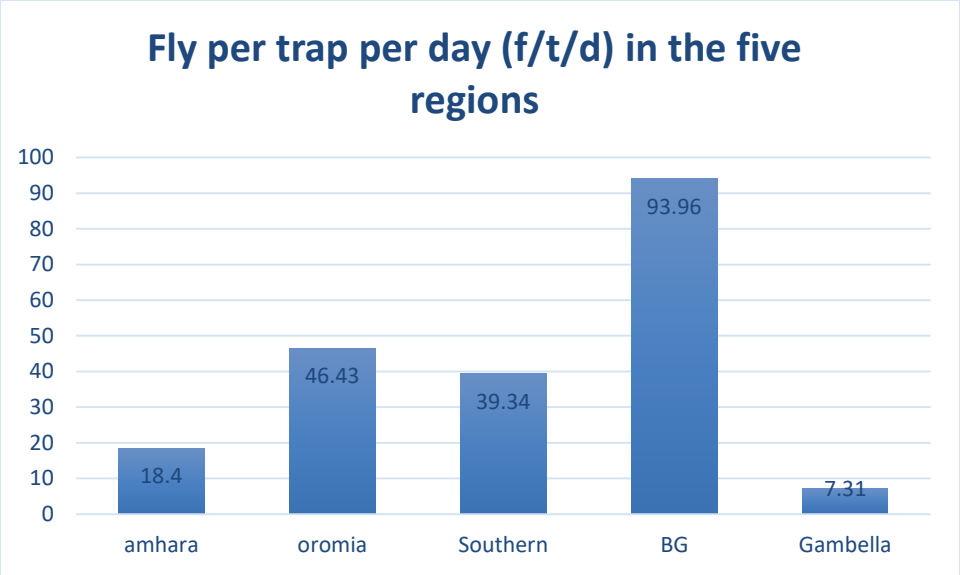

Figure 2. Five regions, Tsetse fly density FTD from 2011-2023

4. CONCLUSION AND RECOMMENDATIONS

The review showed that there was a significant variation in prevalence of Bovine Trypanosomosis and Tsetse fly density in five regions. And there are high-risk factors that predispose the community to Human African Trypanosomiasis (HAT) due to the presence of trypanosome brucei rhodesiense and many animal reservoirs. The transmissions of Human African trypanosomiasis (HAT) are related to environmental, vector, and human factors. Therefore, Strategic Bovine, Human trypanosomosis and tsetse fly control and prevention methods should be implemented in tsetse fly infested region of the country in order to increase the animal husbandry , production, productivity and safeguard draft power as well as health aspect.

Based on the current findings, the following recommendations are forwarded:-

- Development of control options that could minimize the tsetse fly and biting flies in the study area should be introduced in a wholistic approach.
- Proper and strict follow up of trypanocidal drug distribution, therapeutic strategies and alternative control measures should be implemented by concerned stake holders.
- Further, review on the trypanosomosis, and tsetse fly in the Region's should revealed further information's for researchers.

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