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Survey on Bovine Trypanosomosis and Trypanocidal Drug Management Practice in Goma District Jimma Zone, South Western Ethiopia

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Abstract: The present study was conducted in Goma district of Jimma zone south western Ethiopia from November 2011 to April 2012. The objective of the study was to assess the prevalence of bovine trypanosomosis and trypanocidal drug management practice. For this purpose blood samples from a total of 552 cattle randomly selected indigenous zebu cattle were taken and examined with hematological and parasitological techniques. Among the total cattle examined 31 (5.6%) were found positive for trypanosomosis infection. Most of trypanosome positive cases were due to *Trypanosoma congolense* which accounted for 83.8% and *T. vivax* which was 12.9%. The prevalence of *T. congolense* and *T. vivax* in cattle showed no significant difference between sexes ($P > 0.05$). However, there was statistically significant difference between different body condition and age groups ($P < 0.05$). Mean packed cell volume (PCV) of parasitaemic animals were significantly lower than those of aparasitaemic animals ($P< 0.05$). On the other hand, a questionnaire was administered in individual involving 100 respondent farmers. Based on this questionnaire survey bout 78 % of the respondents said that they got trypanocidal drugs from veterinary clinics. The common trypanocidal drugs in the area are Diminazeneaceturate, Isometamidium chloride and Homidium chloride. In the area there is smuggling of trypanocidal drugs by individuals who lacks knowledge on how to use the drug with its proper dosage and treatment was carried out by un trained local farmers. In general, the current findings revealed that animal trypanosomosis was economically important disease which halts productivity of animals with its negative impact on crop production.

Key words: Cattle · Farmers · Gomma · Prevalence · Trypanosomosis · Trypanocidal Drugs

INTRODUCTION

The majority of the developing countries are located in the tropics and livestock production is very important to their economy [1]. Ethiopia had the largest number of livestock population in Africa, which is estimated to be 35.5 million. Livestock contributes to the production of food, industrial raw materials, input for crop production and source of export earnings [2].

In Ethiopia the livestock sector contributes 12% of the total gross domestic product (GDP) and 30% of the agricultural GDP [3]. However, the animal productivity is found to be lower than expected, it should be due to a number of constraints such as poor genetic potential, high disease incidence, malnutrition, thermal stress and poor management conditions [4]. Trypanosomosis is caused by protozoan parasites of genus trypanosome, transmitted cyclically by the tsetse fly of *Glossina* species [5].

In Africa the most important species of trypanosomes, in terms of economic loss in domestic livestock include *Trypanosoma congolense*, *T. vivax, T. brucei* and closely related species of *T. rhdensiense* and *T. gambiense* which cause human sleeping sickness [6]. Mechanical transmission of trypanosomosis can occur through tsetse or other biting flies such as *Tabanus*, *Stomoxys* and other hematohpagous insects [7]. *T. vivax* has the ability to establish itself outside the tsetse fly zone and is probably the most important since it has a wide coverage [8].

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The 23 species of tsetse flies that live in one-third of Africa through the trypanosomes, they carry overshadow and darken the agriculture and public health sector in 38 African countries which is totally equal to the size of USA, exposing 160 million cattle to the risk of anemia, emaciation, death and 55 million people to the risk of fatal sleep [9]. Small portion (0.1%) of tsetse fly population is vectoring *T. brucei* while 5-10% of tsetse fly population has vectored other trypanosomes [10].

In Ethiopia trypanosomosis is the most prevalent and the biggest constraint to livestock production, where about 22, 000 square Kilometer of fertile land in South and South western parts of the country are infested with various *Glossina* species [11]. Five tsetse fly species (*G. pallidipes, G. tachinoides, G. morsitans sub morsitans, G. fuscipe sfuscipes* and *G. long pennies*) are present in Ethiopia to vector 5 trypanosome species (*T. vivax, T. congolense, T. brucei brucei, T. evansi* and *T. rhodendiense*) out of six trypanosome species in Ethiopia [12]. The direct loses from trypanosomosis in livestock include mortality, morbidity, impaired fertility and the cost of implementing trypanosomosis and tsetse fly control operations. Indirect loses from farmers responses to the perceived risk of the disease, includes the reduction and in some cases the exclusion from tsetse infested grazing lands and crop production due to insufficient animal drought power [13].

On the other hand, socio economic and ecological constraints involved in initiating and maintain vector control strategies have compelled the western Ethiopian livestock subsector to primarily rely on the three trypanocidal compounds, namely Diaminazene, Isometamidium and Homidium [11]. Meanwhile, few experimental studies conducted in different tsetse infested zones of the country.

However, scant studies using tests both in ruminants and mice have revealed the occurrence of varying degree of resistance in trypanosomes to the commonly applied trypanocides [14]. According to the report of the Ministry of Agriculture one to two doses of trypanocidal drugs are administered at the cost of some US $ 0.5 to 1.0 million per annual (excluding illegal and NGO) drug imports. In general, trypanocidal drugs leads to resistance due to the ability of trypanosomes to develop escape mechanism which is not under stood. Every time when the manufacturers released new drugs and used in the field, drug resistance has appeared.

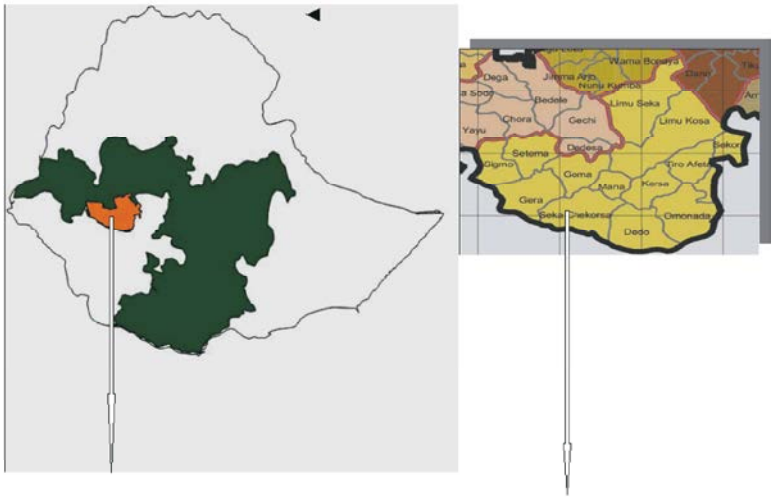
It is especially by misuse of trypanocides, under dosage, by their mistaken and inefficient application, that resistance develops [15].Updating the distribution and prevalence of trypanosomosis and trypanocidal drug management practice across the south western Ethiopia is important for understanding their epidemiology and feasible therapeutic strategies in the future. Therefore, the objective of this study was to estimate the prevalence of bovine trypanosomosis and assess trypanocidal drug management practices in the study area.

MATERIALS AND METHODS

Study Area Description: The present study was conducted from November 2011 to April 2012 at Goma district, located in mid-altitude sub-humid zone of the south western part of Ethiopia. The district is under Jimma zone of Oromia Regional State. Goma district is located 390 Kilometers south west of Addis Ababa and is bordered by six other districts in the zone (Gera in South West, Guma in North West, LimuSeka in North East, Mana in South East and Seka Chokorsa in South) (Figure 1). The topography of the study area ranges from gently sloping to hill lands with ridges and valleys in between. The total surface area of the district is about 1, 34, 912.72 hectors. The rainy season extends from May to September with highest rain fall usually recorded in August. The mean annual rain fall varies between 1400 to 1650 millimeter with average maximum and minimum temperature of 29.9°C and 13.4°C respectively and altitude is 1400 to 2270 meters above sea level [16]. Aro-ecologically, the area is divided into 88% mid-high lad 8% low lad and 4% high land with land coverage of forest, wooden grass land, bush land and cultivated land with human population of 1, 98, 992 [17].

Goma district relatively, high forest cover that serves as a source of livestock feed, habitat for different wild life, potential area of apiculture. The major forest tree species in the area include; *Militaferruginea, Albiziaebbeclk, Croton macrostachys, Juniperus procera, Cordia africana, Acacia spp and Podocarpus gracilior.* The forest area holds wild animal like; warthog, hyena, leopard, monkey and fox [18].

The main river system in the district is Didessa River which is a tributary of the Abay River. It arises in the mountains of Goma following in a north western direction to its confluence where the course of the Abaycorved to its south most point before turning north wards. The main tributaries in the right bank include; Enareya, Wama and Anger rivers; on the left side the most important tributary is the Dabana river [19].



Goma Jimma zone
Source: [18]
Fig. 1: Map of showing the study area Jimma Zone and map of Ethiopia

Livestock plays an important role in the area serving as drought animal and source of milk, meat. The livestock population in the area is about 2, 67, 037 of this cattle, 1, 24, 591 sheep, 37, 956 goats, 14, 794 poultry, 78, 591 and equines 11, 105 [17].

The major cash crop in the area includes; coffee, chat (*Catha endulis*), tropical and sub-tropical fruits (mango, avocado, papaya, banana, orange, pineapple) and among cereals maize, teff, barely are grown in the area. Amongst of which maize is the dominant cereal crop in the district [18].

Study Animals: In this study a total of 552 randomly selected indigenous zebu cattle were studied for the occurrence of trypanosomes in their blood. The animals were sampled randomly involving both sexes, age groups less than one year and above one year that able to move far distance away from homestead to graze and all types of body conditions

Study Design: A cross-sectional study was conducted during the late dry season of 2012. The total number of animals required for the study was calculated based on the formula given by Thrust field [20]. A precision level of 5% and 95% confidence interval was used to calculate the sample size using the formula.

$$N = \frac{1.96^2 (P\exp(1 - P\exp)}{d^2}$$

Therefore, 384 samples were calculated as the sample size of the study. But to increase the precision a total of 552 cattle were examined for trypanosomosis.

Parasitological and Hematological Examination: Blood samples were collected from superficial ear-vein of each animal by using sterile blood lancet and capillary tubes. A pair of heparinized capillary tubes were filled with blood from animals to ¾ of their height and sealed at one end with crystaseal. Then the capillary tubes were loaded on the microhaematocrit centrifuge symmetrically and centrifuged at 12, 000 revolutions per minute for 5 minutes. PCV was determined using the hematocrit reader [21].

After the PCV was read capillary tubes were broken 1mm below the buffy coat to include the red blood cell layer and the content was expressed on microscopic field. This content was examined for presence of trypanosomes on microscopic field under dark ground buff coat technique (BCT) [21].

From positive animals thin blood smears were prepared, air dried, fixed with methanol for 5 minutes and stained with Giemsa solution for 30 minutes, washed with distilled water and finally dried. Stained smears were examined under oil immersion for trypanosome species identification using their morphology [22].

Questionnaire Survey: A questionnaire was administered in individual involving a total of 100 respondent farmers. The major emphases was to assess the common treatment source, personnel participated in treating of cattle with trypanocidal drugs, common drugs in the area, dosage rates, frequency of treatment and information regarding indiscriminate use of trypanocidal drugs.

Data Analysis: Microsoft excel was used as the primary data base entrance and analyzed by using SPSS version 15.0 software. Prevalence on the basis of sex, age and body condition was compared using x^2 test (chi-square). In all cases $P < 0.05$. For questionnaire survey descriptive statistics was applied and analyzed using percentage.

RESULTS

Questionnaire Survey: Many of the farmers in the area responded that they knew the disease trypanosomosis in their area for more than two decades. Trypanosomosis is claimed to be the major cause of cattle loses. They added that trypanosomosis incurred a serious economic losses due to the treatment cost of sick animals on top of the usual mortality and production losses. The average treatment expense per animal is about 32.52 Birr for single treatment and the total expense incurred since last year in this study area was about 24, 293 Birr as indicated by farmers. The higher percentage of treatment to cattle against trypanosomosis is undertaken by assistant veterinarians and animal health technicians rather than local farmers and drug smugglers.

Personnel plays a part in the treatment of cattle against trypanosomosis were indicated in Figure 2. Cattle owners (farmers) account for 25% of the treatment, drug smugglers for about 15% of the treatment and 55% of the treatment carried out by assistant veterinarians and animal health technicians.

About 78% of the respondents said that they get trypanocidal drugs from veterinary clinics, 10% from drug shops, 7% and 5% from drug smugglers and local farmers respectively. The common trypanocidal drugs in the area are Diminazeneaceturate, Isometamidium chloride and Homidium chloride. About 33% of the farmers could not know the usual dose of each trypanocides used to treat their cattle.

However, most farmers said those local farmers and drug smugglers are using one sachet of Berenil (1.05 g) for more than 3 cattle and one tablet of Ethidium for 2 cattle. In general, about 42% of the farmers use correct dose, about 33% of the farmers use under dose and about 25% of the farmers has no any idea on dose rates of the drugs (Figure 2). This under dosage of drug treatment by local farmers leads to indiscriminate use of trypanocidal drugs which could result in drug resistance in the area. The questionnaire survey indicates that about 47% of the farmers treat their cattle against trypanosomosis three times per year and, about 5% of farmers treat their animals one time a year. There is success for treatment as it is supported by many of the farmers, but sometimes claims of no change with treatment probably because of development of resistance, inappropriate diagnosis of the patient or under dosage of the drug. Number of treatment of cattle against trypanosomosis since last year as indicated by interviewee is illustrated in Figure 3.

Parasitological Findings: Out of the total 552 indigenous cattle examined during the study period 31 animals were found positive for trypanosomosis. Hence, overall prevalence of trypanosomosis in this study area is 5.6%. From the total trypanosomosis positive animals 4.5% were found to be infected with *T. congolense*, 0.7% *T. vivax* and 0.2% *T. congolense* and *T. vivax* mixed infection. Highest trypanosomosis prevalence 7.1% was recorded in Metikoticha village followed by 5.2% Baltokajelo and 4.7% Baltowarabo villages (Table 1).

The prevalence of trypanosomosis between sex categories was 5.3% in males and 5.9% in females. ($p > 0.05$) (Table 2).

The prevalence of trypanosomosis between ages was 0% in < 1year, 5.8% in 1-3 years and 5.7% in > 3 years. There was statistically significant difference between age groups ($P < 0.05$) (Table 3).

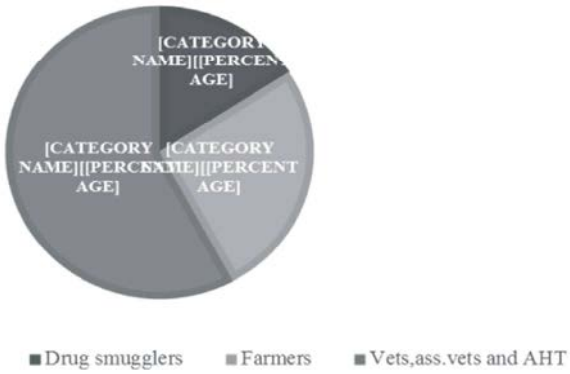


Fig. 2: Personnel involved in the treatment of cattle with trypanocidal drugs

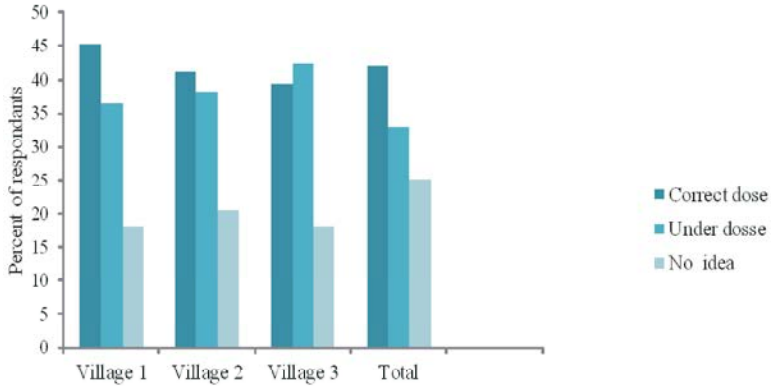


Fig. 3: Dosages of tryanocidal drugs utilized by farmers (village 1 n = 33, village 2 n = 34, village 3 n = 33 and total n = 100 farmers) in Goma district Jimma, Zone south western Ethiopia. Village 1 = Baltokajelo, Village 2 = Baltowarabo and Village 3 =Metikoticha

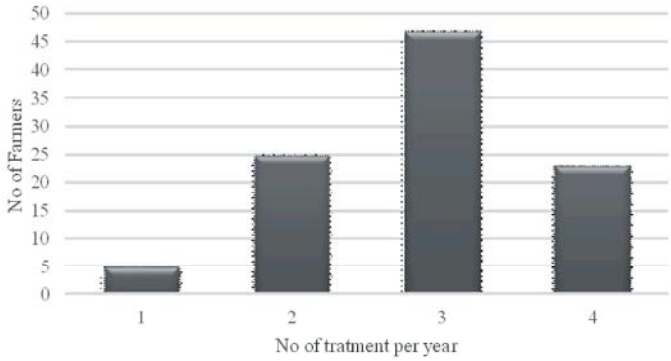


Fig. 4: Number of treatments of cattle against trypanosomosis since last year in Goma district Jimma zone south western Ethiopia 2010/2011

Table 1. Prevalence of trypanosomes detected in Goma district Jimma zone south western Ethiopia

		Number of positive samples				
Villages	Sampe Size	*T. congolense*	*T. vivax*	Mixed infection	Total	Prevalence
Baltokajelo	192	9	1	0	10	5.2
Baltowarabo	192	7	1	1	9	4.7
Metikoticha	168	10	2	0	12	7.1
Overall	552	26	4	1	31	

Table 2: Prevalence of bovine trypanosomosis based on sex

Sex	No of samples	No of positive sample	No of negative sample	Prevalence
Male	264	14	251	5.3
Female	288	17	271	5.9
Overall	552	31	521	5.6

Table 3: Prevalence of trypanosomosis based on age group

Age groups	No of exam. Animals	No positive of cases	No of negative cases	Prevalence
<1	12	0	12	0
1-3	138	8	130	5.8
>3	402	23	379	7.5
Overall	552	31	521	5.6

Table 4: Prevalence of trypanosomosis based on body condition

Body condition	No of examined Animals	No of positive cases	No of negative cases	Prevalence
Good	82	1	81	1.2
Medium	219	11	208	5.0
Poor	251	19	232	7.6
Overall	552	31	521	5.6

Table 5: Mean PCV of parasitaemic and aparasitaemic animals

Health status	Number of animals	Mean PCVs
Parasitemic	31	19.5
Aparasitemic	521	25.7

Prevalence of trypanosomosis between body conditions category was 1.2% in good body condition, 5% in medium body condition and 7.6% in poor body condition. There was significant difference between body conditions ($P < 0.05$) (Table 4).

Hematological Findings: For all sampled animals during the study period PCV was conducted to estimate the degree of anemia. From trypanosome positive 31 animals 93.5% were found with less than 24% PCV values. Mean PCV values of parasitaemic cattle (19.5 %) was significantly lower than that of aparasitaemic cattle (25.7%) (Table 5).

DISCUSSION

Many of the farmers in Gomma area responded that they knew the disease trypanosomosis in their area for more than two decades. About 78% of the respondents said that they get trypanocidal drugs from veterinary clinics, 10% from drug shops, 7% and 5% from drug smugglers and local farmers respectively. The common trypanocidal drugs in the area are Diminazeneaceturate, Isometamidium chloride and Homidium chloride. Trypanosomosis is claimed to be the major cause of cattle loses. They added that trypanosomosis incurred a serious economic losses due to the treatment cost of sick animals on top of the usual mortality and production losses. The average treatment expense per animal is about 32.52 Birr for single treatment and the total expense incurred since last year in this study area was about 24, 293 Birr as indicated by farmers.

According to the questionnaire 25% of livestock owners treating their cattle themselves against trypanosomosis and drug smugglers for about 15% of the treatment and the rest 55% of the treatment carried out by assistant veterinarians and animal health technician. About 33% of the farmers could not know the usual dose of each trypanocides used to treat their cattle. However, most farmers said those local farmers and drug smugglers are using one sachet of Berenil (1.05 g) for more than 3 cattle and one tablet of Ethidium for 2 cattle. In general, about 42% of the farmers use correct dose, about 33% of the farmers use under dose and about 25% of the farmers has no any idea on dose rates of the drugs.

This under dosage of drug treatment by local farmers leads to indiscriminate use of trypanocidal drugs which could result in drug resistance in the area. This indicates that still need of awareness of farmers on dosage rates, drug resistance and avoiding of treatment by drug smugglers. The result of the present cross sectional study indicated that trypanosomosis is a disease of cattle retarding agricultural development in Gomma district. Bovine trypanosomosis is prevalent in current studied district with an overall prevalence of 5.6%. Different figures were reported from different parts of Ethiopia.

A prevalence of 15.1% in western Ethiopia [23], 21% in southern Rift Valley areas of tsetse infected regions [24], 18.0% from west Gojjam [25]. 17.2% in Mekele [27] and 17.5% in the upper Didessa of tsetse infected regions [28] were reported. The dominant species in the Uupper Didessa of tsetse infested regions was *T .congolense* [28]. Other author reported 8.71% prevalence in the high lands of tsetse free areas of which 99% was due to *T. vivax* 6.5% in the Quara district was reported [28]. However, lower prevalence was found in the present study compared to the workers of these authors.

This lower prevalence of the present work comes from many factors that explain the lower trypanosomosis prevalence observed in the study area. The study period affects the vector population [29], expansion of veterinary services up to peasant association, deforestation for crop cultivation (settlement), frequent usage of trypanocidal drugs and the control strategy implemented by National Tsetse and Trypanosomosis Investigation and Control Center and the husbandry practice on

animals. The present work revealed that *T. congolense* and *T. vivax* were the main species of trypanosomes causing trypanosomosis in the area.

The result in study showed that from the total trypanosomepositive animals 83.8% were found to be infected with *T. congolense* and the rest 12.9% and 3.3% were infected with *T. vivax* and mixed infection of both respectively. These findings are in agreement with the previous works of 84.4% [30], 84% [31]. The 12.9% prevalence for *T. vivax* in this study also in agreement with the previous reports of 14% in Gibe [31, 32]. The predominant of *T. congolense* infection may be also due to the high number of variable surface glycoprotein (VSP) of *T. congolense* as compared to *T. vivax* and the development better immune response to *T.vivax* by the infected animal [33]. There was no *T. brucei* infection observed in this study and this might be due to the low level of parasitemia seen in *T. brucei* infection and it is characterized by periodic absence of trypanosomes in circulation [34] and one might miss many latent infections which only became apparent after rat inoculation [35].

Higher prevalence was observed in female animals in the present study which is 5.9% in females and 5.3% in males but statistically has no significant difference $P > 0.05$. This result is in contrary with other works like [26, 27] who reported higher prevalence in males than in females. The most probable reason for this variation could be due to lactation stress in female as has suggested by Shimelis [6] and Langridge [35]. In this study age was a risk factors as a higher prevalence was observed in animals between 1-3 years (5.8%) and >3 years (5.9%) (Young and adult animals) and low prevalence was observed in animals age of less than one year (0%). This could be associated to long distance travel for grazing, drought in areas of high tsetse challenge [35]. Animals less than one year have low prevalence in this study area. In Goma district calves did not go out with their dams but graze at homesteads until they are weaned off and many of the farmers present only young and adult animals during examination. This could result in low prevalence in calves. Lower prevalence was observed in adult animals (5.8%) when compared to young animals (5.3%).

This is maybe due to chronicity of the disease in most adult animals that obscure the detection of organisms in blood smears and the phenomenon of self-cure [25]. Mean PCV values of parasitemic animals (19.5%) were more significantly lower than aparasitemic animals (25.7%) in this study. Similar results were reported by Tewolde [27], Muturi [31] and Afework [36]. By considering the values of 24-46% as normal values of bovine [37], (93.5%) parasitemic and (44.7%) of aparasitemic animals had PCV values less than 24%. From this we can understand that other factors can also be the cause for the reduced PCV values. Hence, other diseases considered to reduce the PCV values of the animals include helmenthiasis, tick borne diseases and inadequate nutrition.

CONCLUSIONS

The present study was conducted in Goma district Jimma zone south western Ethiopia. Both cross sectional and questionnaire survey revealed that animal trypanosomosis was economically important disease which halts productivity of animals with its negative impact on crop production. The overall prevalence of the final study in the district was 5.6%. *T. congolense* was the dominant species that causes the disease (83.8%) followed by *T. vivax* (12.9%) and mixed infection of both (3.3%). This implies that tsetse transmitted trypanosomosis is potentially a serious threat in affecting health and productivity of animals. In addition to this in the area there was smuggling of trypanocidal drugs by individuals who lacks knowledge on how to use the drug with its proper dosage and treatment was carried out by un trained local farmers. As a result animal owners have access to illegal drug usage, which leads to the emergency of drug resistance problem.

Conflict of Interest: The author (s) declared no any conflicts of the interest with respect to the research work.

REFERENCES

1. Assey, R.J., B.M. Kessy, J.A. Matevelo and V. Minga, 1998. Incidence of gross reproductive abnormalities in small East African zebu cattle. Top. Anim Healthprod, 30: 361-368.
2. FAO, 2003. FAO year book, food and agricultural organization. Rome Italy.
3. MoA, 1998. Etiopian Ruminant Livestock Development strategy. Ministry of Agriculture (MoA) Addis Ababa Ethiopia, pp: 112-113.
4. Radostitis, O.M., D.C. Blood and C.C. Gary, 2000. Veterinary medicine, A text book of the diseases of cattle, sheep, goat pigs and horses. Vet med 9th ed. ELBS and Baileir, Tindall, London, pp: 90-95.

5. Radostitis, O.M., D.C. Blood and C.C. Gary, 1994. Trypanosomatidae. A text book of the diseases of cattle, sheep, goat pigs and equines. Vet med. 8th ed. ELBS and BaileirTindall London, pp: 1171-1220.
6. Shimelis, K., 2009. Study on prevalence of bovine trypanosomosis and tsetse fly in Daramalo District of GamoGofa zone southern Ethiopia, AAU, FVM, DVM Thesis, Debre-Zeit, Ethiopia.
7. Holmes, P.H., 1998. Trypanosomosis. In the Merk Veterinary Manual, 8 th ed. eds. US White House Station, pp: 33-37.
8. Cox, F.E.G., 1996. Trypanosomes of domesticated animals. In: Modern parasitology. A text book of parasitology, 2nd ed. Blackwell Science Ltd, pp: 4.
9. OIE, 2004. Standard techniques for the diagnosis of tsetse transmitted trypanosomosis.OIE Terrestrial manual, Rome, pp: 49.
10. Morlais, I., P. Grebaut, J.M. Bodo, S. Djoha and G. Cuny, 1998. Characterization of trypanosome Infections by polymerase chain reaction (PCR) Application in Wild tsetse flies in Cameron Parasitol., 116(6): 547-554.
11. Tasew, S., 2010. Prevalence of cattle anemia, trypanosomosis and trypanocidal drug resistance and apparent tsetse fly density in Western Oromia, AAU, FVM, DVM Thesis and DebreZeit, Ethiopia.
12. Abebe, G., 2005. Trypanosomosis in Ethiopia. Ethio. J. Bio. Sci., 4(1): 75-121.
13. ILRAD, 1993. Estimating the cost of animal trypanosomosis in Africa. ILRAD Nairobi, Kenya.
14. Yeshitila, A., G. Abebe, H. Ashenafi and A. Basu, 2006. Prevalence of bovine trypanosomosis in Sokoru district, Jimma Zone, Oromia, South west Ethiopia, Bulletin of Animal Health and Production in Africa, 54: 242-258.
15. Aseffa, E., 2000. Efficacy of trypanocidal drugs in naturally infected Donkeys in North Omo Zone, AAU, FVM, DVM Thesis, Debre-Zeit and Southern Ethiopia.
16. Kinati. Ch, W., 2010. Honey production, marketing system and quality assessment in GomaWoreda, south western Ethiopia. JU, College of Agricultural and Veterinary Medicine MSc Theses, Jimma: 1-86.
17. GDAO, 2003. Goma district agricultural office.
18. Shenkute, B.G., 2009. Production and marketing system of small ruminants in Goma district of Jimma zone, HU, MSc Thesis, Hawassa, western Ethiopia, pp: 24-29.
19. En.wikipedia.org/wiki/Didessa_River Accessed on March, 22/5/2012.
20. Thrusfield, M., 2005. Veterinary Epidemiology. 2nd ed. Ltd, UK, Black Well Publishing, pp: 339.
21. Murray, M., P.K. Murray and W.I.M. McIntyre, 1977. An improved parasitological technique for the diagnosis of African trypanosomosis. Trans. R. Trop. Med. Hyg., 71: 325-327.
22. Bitaw, M., Y. Amedie, A. Abebe and T. Tolesa, 2011. Prevalence of bovine trypanosomosis in selected areas of JabiTehenan district, West Gojam of Amhara regional State, North Western Ethiopia, JU, College of Agricultural and Veterinary Medicine, Jimma. African Journal of Agricultural Research, 6(1): 1-5.
23. Terefe, W., 2008. Studies on bovine trypanosomosis and therapeutic efficacy of selected trypanocidal drug in Birbirvally of Gawo Dale district in west oromia, AAU, FVM, MSc thesis Debrezeit, Ethiopia.
24. Bekele, J., K. Asmare, G. Abebe, Ayelet and E. Gelaye, 2010. Evaluation of Deltamethrin application in the control of tsetse and trypanosomosis, in southern Rift Valley areas of Ethiopia, Vet. Parasitol., 168: 177-188.
25. Terefe, G. and G. Abebe, 1999. Prevalence of bovine rypanosomosis in two woredas of western Gojjam Zone, Amhara Region. Journal of the Ethiopian Veterinary Association, 3: 1-8.
26. Afework, Y., P.H. Clausen, G. Abebe, G. Tilahun and D. Mehlitz, 2000. Multiple drugs Resistant Trypanosomacongolense populations in Murray village cattle of Metekel District North West Ethiopia. Actatropica, 76: 231-238.
27. Tewolde, T., 2001. Study on the occurrence of drug resistant trypanosomes in cattle in the farming in tsetse controlled areas (FICA) Project in western Ethiopia. AAU, FVM, MSc Thesis. Debre-zeit, Ethiopia.
28. Misganaw, T., 2006. Study on bovine trypanosomosis and tsetse fly in Quara settlement area of north Gondor zone, Amhara national regional state AAU, FVM, DVM Thesis, Debre-Zeit, Ethiopia.
29. Leak, S.G.A., W. Mulatu, E. Authie, A.S. Peregrrie, G.J. Rowlands and J.C.M. Trail, 1993. Tsetse challenge and its relationship to Trypanosomosis prevalence in cattle. Acta Trop, 53: 121-134.
30. Rowlands, G.J., W. Mulatu, E. Authie, G.D.M. d'Ieteren, S.G. Leak, S.M. Naga and A.S. Peregrine, 1993. Epidemiology of bovine trypanosomosis in Ghibe Valley, south western Ethiopia. Acta Trop, 53: 135-150.

31. Muturi, K.S., 1999. Epidemiology of bovine trypanosomosis in selected sites of southern Rift Valley of Ethiopia. AAU, FVM, MSc Thesis, Debre-zeit Ethiopia.
32. Rowlands, G.S., W. Mulatu, G.D.M. d'Ieteren, S.M. Nagda and R.B. Dolan, 1995. Genetic Variation of Packed cell volume and frequency of parasiteamia in east African zebu Cattle exposed to drug resistant trypanosomes. Livestock Production Science, 43: 75-84.
33. Machennan, K.J.R., 1970. Tsetse transmitted trypanosomosis in relation to the rural economy. Wild. Anim. Rev., 36: 2-22.
34. Losos, G.J. and A. Chovinard, 1978. Pathogenicity of trypanosomosis: Proceeding of a Workshop held at Nairobi, Kenya.
35. Langridge, W.P., 1976. Tsetse and Trypanosomosis survey of Ethiopia. Ministry of Overseas Department of UK, pp: 121-134.
36. Afework, Y., 1998. Field investigation on the appearance of drug resistance population of trypanosomosis in Metekel district, north western Ethiopia. Frie University FVM MSc. Thesis Berlin Germany.
37. Susan, E.A., 1998. The Merk Veterinary Manual 8th ed. Merk and Co. INC. White House tation N.J, U.S.A, pp: 2190-219.