ADDIS ABABA UNIVERSITY

FACULTY OF VETERINARY MEDICINE

EPIDEMIOLOGICAL STUDY OF BOVINE TRYPANOSOMOSIS IN GORO AND AMEYA-KOTA DISTRICTS OF SOUTHWEST SHOA ZONE, OROMIA NATIONAL REGIONAL STATE, ETHIOPIA

BY

TILAHUN AYELE DENU

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Debre-Zeit, Ethiopia

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ABBREVIATIONS

AAT.....................................African animal trypanosomes

AAU.....................................Addis Ababa University

Ab..Antibody

Ag..Antigen

ANOVA................................Analysis of Variance

BCT.......................................Buff coat technique

CFT.......................................Complement Fixation Test

CI..Confidence interval

CSA.......................................Central Statistics Authority

DACA...................................Drugs Administration and controlling authority

DNA......................................Deoxyribonucleic Acid

ELISA...................................Enzyme Linked Immunosorbent Assay

FAO.......................................Food and Agricultural Organization

G.f f.......................................Glossina f. fuscipes

G.m.m.................................. *Glossina m. submorsitans*

G.p....................................... *Glossina pallidipes*

GDP.......................................Gross Domestic Production

HCT.......................................Haematocrit centrifuge technique

ILCA......................................International Livestock Center for Africa

ILRAD..................................International Laboratory for Research on Animal Disease

m.a.s.l....................................meters above sea level

MOA......................................Ministry Of Agriculture

NTTICC............................... National tsetse and Trypanosomosis Investigation & Control Center

OARDB................................ Oromia Agricultural and Rural Development Bureau

OAU..................................... Organization of African Unity

OIE....................................... Office International des Epizooties

PATTEC.............................. Pan African Tsetse and Trypanosomosis Eradication Campaign

PCR.......................................Polymerase chain reaction

PCV.. Packed Cell Volume

SIT..Sterile Insect Technique

SIT...Sterile male insect technique

SPSS...................................... Statistical Package for Social Sciences

T. c... *Trypanosoma Congolense*

T. v... *Trypanosoma vivax*

TCS...................................... Tsetse Control Service

VSG.......................................Variant Surface Glycoprotein

WFP.......................................World Food Programme

WHO.....................................World Health Organization

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ABSTRACT

An epidemiological study of bovine trypanosomosis was carried out from September 2007 to March 2008 in Goro and Ameya-Kota districts of Southwest Shoa Zone, Oromia National Regional State, Ethiopia. The objectives of the study were to determine the prevalence of the disease and associated risk factors, evaluate the apparent densities and distributions of tsetse and other biting flies and to know the community awareness concerning the disease and control method in the study area. The study methodology comprises seasonal cross-sectional studies in late rainy and dry seasons in 2007/2008 by using parasitological, entomological and questionnaire surveys. A total of 1200 animals, 600 in the late rainy and 600 in the dry seasons, were examined and the prevalence of trypanosomosis was found to be 33.5% and 17.83% in the late rainy and dry seasons, respectively, with a statistically significant difference ($p<0.05$) between seasons. The mean PCV values of the parasitaemic and aparasitaemic animals during the late rainy season were 20.19% and 26.75% while during the dry season 18.75% and 23.97% respectively. The entomological survey showed that *G.pallidipes*, *G.m.submorsitans* and *G.f.fuscipes* were prevalent tsetse species along with other biting flies (tabanids and muscids) in the study area. The apparent densities of tsetse flies were statistically significantly different ($p<0.05$) between the late rainy season (1.05 fly/trap/day, 0.26 fly/trap/day, 1.56 fly/trap/day) and the dry season (0.56 fly/trap/day, 0.11 fly/trap/day 0.59 fly/trap/day) for *G. pallidipes, G. morsitans submorsitans*, *G.fuscipes fuscipes*, respectively. The overall apparent densities of tsetse flies were found to be 2.87 fly/trap/day (95% CI= 1.04-5.77%) and 1.26 flay/tap/day (95% CI= 1.17-2.07%) in late rainy and dry seasons, respectively. *G.f.fuscipes* and *G.pallidipes* appears to be dominant during the course of the study period, whereas lower catch was observed for *G.m.submorsitans* than *G.pallidipes* and G.*f.fuscipes.* The proportion of female tsetse flies caught was higher in both seasons. *G.pallidipes* was considered to be active transmitter of the disease compared to *G.m.submorsitans* and *G.f.fuscipes.* Also the apparent densities of other biting flies were significantly higher ($p<0.05$) in the late rainy season (1.49 fly/trap/day, 18.66 fly/trap/day) than the dry season (0.77 fly/trap/day, 15.04 fly/trap/day) for tabanids and muscids, respectively. The overall apparent densities of biting flies were found to be 20.15 fly/trap/day (95% CI= 14.23-26.03%), and 15.81 fly/trap/day (95% CI= 10.86-20.75%) in late rainy and dry seasons, respectively. The questionnaire survey revealed that trypanosomosis is the most economically important disease affecting cattle in Goro and Ameya-Kota sites of the study area. All of the interviewed farmers indicated that bovine trypanosomosis ranks first as the major animal health constraint impairing agricultural development. Also they suggested that the occurrence of trypanosomosis was higher in the late rainy season than the dry season. Most of the curative and preventive trypanocidal drugs in the study area were misused by drug smugglers and non professionals. Hence, trypanosomosis is the most important challenge for agricultural activity and animal production in Goro and Ameya-Kota districts, and the situation is getting worse as the control and prevention of trypanosomosis is facing a lack of vector control activities in the area.

Key words: Epidemiology, bovine, trypanosomosis, *Glossina pallidipes, G.m.submorsitans, G.f.fuscipes,* biting flies, tsetse, cross-sectional study, season, Goro district, Ameya-kota district

1. INTRODUCTION

Trypanosomosis is the widespread protozoan disease complex affecting cattle and other wide range of hosts, including humans in the sub-Saharan Africa. The course of the disease may run from a chronic long lasting to an acute and rapidly fatal one depending on the vector-parasite-host interactions, characterized mainly by intermittent fever, progressive anaemia and loss of condition of susceptible hosts which if untreated leads to heavy mortalities (Bourn, 2001).

Trypanosomes are transmitted cyclically by tsetse fly (*Glossina* species) and non-cyclically by other biting flies except *Trypanosoma equiperdum*, which follows another epidemiological route of transmission among the equine population in its endemic areas. Tsetse flies are grouped in the three categories: *Glossina morsitans* Group (Savannah areas), *Glossina fusca* group (forest areas) and *Glossina palpalis* Group (river and lake areas). The most important trypanosome species that affect cattle, sheep and goats are: *T congolense, T. vivax and T. brucei* ((Langridge, 1976; Luckins, 1992). In Africa at present about 3 million livestock die every year due to tsetse fly transmitted trypanosomosis which covers one third of the continent which is estimated to be 10 million km^2. In this region at least 70 million cattle exposed to the risk of contracting the tsetse borne trypanosomosis, as are millions of sheep, goats, donkeys, camels and horses (Reid *et al.,* 1998). A recent study estimated the direct annual cost of trypanosomosis to be about 1.34 billion USD (Kristjanson *et al.*, 1999). African livestock producers are administering an estimated 35 million curative and prophylactic treatments annually which costs the producers and the government 35 million USD (Geerts and Holmes, 1998).

Currently the human population of Ethiopia is estimated to be more than 70 million with 2.9% growth rate and 80% of the population is occupied in agriculture economy. Ethiopia has the largest livestock inventories in Africa, including more than 38 million cattle, 30 million small ruminants, more than 1 million camels and 4.5 million equines and 40 million chickens with livestock ownership (CSA 2002; CSA 2004). This amount of livestock population plays a significant role in the economy and has a great potential to assist the economic development by providing meat, milk other food products, cultivation power, transport, security in times of crop failure and farm yard manure (fertility and manure) and also plays a major role in export commodity. The sector contributes 12% of the growth Domestic Product (MOA, 1995).

In Ethiopia approximately 220,000 km^2 is infested with different species of tsetse flies, and 14.8 million cattle, 6.1 million sheep and goats, 1 million camels and 1.2 million equines are at risk of contracting trypanosomosis (MOA, 1995). There are 5 species of *Glossina* in Ethiopia *G.pallidipes, G.m.submorsitans, G.f.fuscipes, G.tachinoides* and *G.longipennis*. Several reports made in Ethiopia revealed that tsetse fly occupy over 66,000 km^2 areas (Ford *et al.*, 1976) based on 1500 m.a.s.l. breeding limit in the southern and southwestern valleys of the country. Langridge (1976) has reported that some 98,000 km^2 area 1600 m.a.s.l. breeding limit in the Southern and Southwestern parts of Ethiopia. However, due to the advancement of tsetse flies in to formerly free areas reaching a total of an estimated 220,000 km^2 of land is infested (NTTICC, 1996).

Trypanosomosis is one of the major constraints to livestock and mixed crop-livestock production with direct and indirect economic losses (Abebe and Jobre, 1996). The direct losses from trypanosomosis in livestock include mortality, morbidity, impaired fertility and the cost of implementing and maintaining tsetse fly and trypanosomosis control operations. Indirect losses stem from farmers responses to the perceived risk of the disease including the reduction and in some cases the exclusion of livestock from tsetse infested grazing lands and reduced crop production due to insufficient animal drought power (ILRAD, 1993).

In Ethiopia tsetse transmitted animal trypanosomosis is a serious constraint to livestock production and agricultural development. Increasing costs and other problems of initiating and maintaining tsetse control campaigns have led the livestock sector of Ethiopia to be completely dependent on the use of trypanocidal drugs. On average, 1 to 2 million doses of trypanocidal drugs are administered annually at an average cost of USD 0.5 per dose (MOA, 1995). Trypanocidal drugs are in use for more than 40 years in Ethiopia to control trypanosomosis in different domestic animals (NTTIC, 1996). However, the emergence of drug resistance is seriously hampering this effort. Multiple trypanocidal drug resistance has been reported in cattle in different parts of Ethiopia (Afewerk *et al.,* 2000). Similarly, multiple drug-resistant *Trypanosoma congolense* in naturally infected donkeys in the North Omo Zone of southern Ethiopia were reported (Assefa and Abebe, 2001). There are five economically important animal trypanosome species in Ethiopia: *T. congolense, T. vivax, T. brucei brucei* and *T. evansi* (Langridge, 1976) and *T. equiperdum* (Dagnachew and Shafo, 1981). The most prevalent trypanosome species in Ethiopia are *T. congolense* and *T.vivax*. Rawlands *et al*. (1993) reported that a prevalence rate of 37% for *T.congolense* in southwest Ethiopia. Abebe and Jobre (1996) reported an infection rate of 58.5% for *T.congolense*, 31.2% for *T.vivax* and 3.5% for *T.brucei* in southwest Ethiopia. In the same report it is also indicated 8.71% prevalence rate was recorded in the highlands (tsetse free areas) of which 99% is due to *T.vivax.* Different workers (Afework, 1998; Muturi, 1999 and Tewelde, 2001) reported that a prevalence rate 17.2%, 14% and 21% in Metekel district, in Southern rift valley of Ethiopia and in Upper Didessa valley areas of tsetse infested region, respectively. The dominant species was *T.congolense* found to be reported.

Treatment and prevention of bovine trypanosomosis rely essentially on three trypanocidal drugs, namely: Diminazene aceturate (Berenil or Veriben), Homidium bromide (Novidium or Ethidium) and Isometamidium chloride (Samorin) Mc Dermot *et al.,* (2003). However, in many parts of Africa all of these trypanocides are gradually losing their efficacy due to drug resistance. As indicated above trypanosomosis is the main constraint to the cattle production on the continent of Africa and prevents full utilization of land. Much of the best grazing land on which cattle can be raised is infested by tsetse flies which can transmit the pathogenic trypanosomes: *Trypanosoma congolense*, *T. vivax* and *T. b. brucei* (Luckins, 1992). Out of 165 million cattle found in Africa only 50 million are found within the tsetse belt. These are mainly low producing breeds that are maintained on high drug management regimen to keep trypanosomosis in check. The presence of tsetse flies and trypanosomosis forced people and livestock to crowd into partially environmentally fragile tsetse free areas leading to overgrazing and erosion (PATTEC, 2001).

The principle of prevention and control of tsetse-transmitted trypanosomosis depends on minimizing contact between domestic, game animals and tsetse flies. So far the methods used for the control of trypanosomosis in tsetse-infested areas include control of tsetse flies, use of curative or prophylactic trypanocidal drugs and use of livestock breeds that tolerate the disease. However, uses of these methods are highly variable. According to NTTICC (1996) due to the fear of trypanosomosis the majority of human and livestock populations are concentrated in the tsetse free areas leading to depletion of natural resources and recurrent attacks from drought and famine. All these factors being the major driving forces behind, the need is rapidly growing now to settle in the area of river basins including the tsetse-infested fertile valleys. Therefore, bovine trypanosomosis is the most important disease for the majority of Southwest Shoa districts of Oromia National Regional State; among of which Ameya and Goro districts are the most infested areas of land with tsetse and trypanosomosis by causing heavy mortalities and hampering the production and productivity of the livestock (OARDB, 2005 and ARDOSWSHZ, 2007).

As of any part of Ethiopia, trypanosomosis is a serious problem in Oromia National Regional State. Particularly information is not yet available on the status of the disease in Goro and Ameya-Kota districts of Southwest Shoa Zone, Oromia National Regional State. Complaints were also raised from the local community and farmers on the increased death rate of cattle probably due to trypanosomosis for the last some years.

The major objectives of this study were therefore:

To determine seasonal prevalence of bovine trypanosomosis in the study area,
To establish potential risk factors associated with the trypanosomosis,
To assess seasonal apparent density and distribution of tsetse and other biting flies,
To evaluate the community awareness on the effect of trypanosomosis and control methods.

2. LITERATURE REVIEW

2.1. Biology and Distribution of Tsetse Flies

The most distinctive feature of the life history of the tsetse flies, shared with only a few other small families of Diptera, is retention of the single egg in the uterus of the female, where it hatches to a larva and nourished by the products of a pair of modified accessory glands. This method of reproduction is referred to as adenotrophic viviparity (Langley and Weidehaas, 1986; Jordan, 1993; Leak, 1999). This form of reproduction involves cyclical production of eggs, which hatch in the uterus and the insect does not feed from the time it leaves the female fly as a mature larva until the adult emerges from the pupa (Phelps and Lovemore, 1994; Leak, 1999). Females are receptive to males as soon as they start seeking food and often mate when taking their first blood meal or soon after and mate once in lifetime. Male flies may not mate soon after emergence from the pupa and they are not fully fertile until they are a few days old. Active and viable sperms can remain in the sperm thecae, nourished by a secretion of layers of cells; surrounding the cuticular lining of the lumen of each sperm theca, throughout the life of the female. The whole pregnancy cycle takes about nine days although the rate of development of each stage is temperature dependent. By the ninth day the third in star larva with its two conspicuous black polypneuptic lobes at the posterior end is deposited through the vagina (larviposition) on the ground (Jordan, 1993). The successful burrowing in the soil by the deposited larva depends on various factors, for instance, soil particle size, moisture content of the soil and possibly the soil temperature are the most important ones.

Under favorable environmental conditions (temperature and moisture of the soil) newly deposited larva is transformed, within a few hours, into a hard almost black larva and moults to form the pre pupa, but remains within the third cuticle, which then harden to form the puparium within an hour of larviposition. Thirty days later adult fly emerges from the puparium with the sex ratio of 1:1. The puparial period is highly dependent on temperature. Jordan (1993) indicated that at a minimum temperature of 20 ^{0}C, the duration of puparium period is about 47 days while at 30 ^{0}C it is about 20 days only. At temperature below 17 ^{0}C and above 32 ^{0}C there are insufficient fat reserves within the puparium and development cannot be successfully completed. The optimum temperature for the puparium development is about 25 ^{0}C (Leak, 1999) and at this temperature male emerges after 27 days (Jordan, 1993). Both sexes of tsetse flies feed exclusively on blood of vertebrates (mainly from mammals but some species take the meal from reptiles and birds). They usually search for hosts and food when they are active. It has been noted that female flies live longer than males. As a result of this, there are always more females than males in any tsetse population. A female fly may produce about 8 - 10 offspring in her lifetime. Consequently the rate of reproduction is much lower than in any oviparous insects and in fact resembles that of small mammals (Langley and Weidehaas, 1986; Leak, 1999) that is why the sterile insect technique (SIT) control method is facilitated. Leak (1999) noted even though more precise limits of distribution, particularly in low densities, are not known the general distribution of tsetse flies is determined principally by climate and influenced by altitude, vegetation and the presence of suitable host animals.

The effect of climate on tsetse distribution is often through its effect on vegetation. Buxton (1955) discussed in detail the relationship between tsetse flies and different climatic factors and effect of temperature on the ecology of tsetse flies is through its effect on the interval and puparial duration and also the influence on the activity of the flies. In temperature below 15 ^{0}C tsetse flies are inactive and above 35 ^{0}C they seek refuge in root-holes in the trees and animal burrows and deep tissues in the barks, where they remain inactive (Phelps and Lovemore, 1994). Humidity is also important factor both for pupa and adult fly development (Nagel, 1995). Cumulative effect of long rainy season or dry season is thought to influence advances and depression in tsetse population (Leak, 1999). Humidity has also an important effect in relation to the behavior of the flies. Tsetse flies use light for searching food and most of them are active during day the time (Buxton, 1955). The effect of altitude on tsetse distribution is through its effect on climate, mainly temperature. As temperature falls with increasing altitude, the geographic limitations of different species may be due to their inactivity in low temperature (Vreysen *et al.*, 1999).

Different species of tsetse flies require particular vegetation type that would provide an optimal condition for growth and survival and vegetation is also important that provides shelter for their hosts (Buxton, 1955; Leak, 1999). Highest catches of *G. pallidipes* were in bushes and wooded grassland in the southern Rift Valley of Ethiopia (Vreyesen *et al.*, 1999). The presence of wide different types of host animals is essential component of tsetse fly distribution. The distribution and abundance of some species of tsetse flies such as *G. morsitans* and *G. pallidipes* which are often known as game tsetse flies are closely related to the number and habitats of certain wild animals. Nagel (1995) also described that the highest densities of certain tsetse fly species are reported from areas with very high densities of wild animals and low human population areas.

2.2. Morphology of Trypanosomes

*2.2.1. Trypanosoma (*Nannomonas*) congolense*

Trypanosomes of this subgenus range 8-24 μm in length. Free flagellum is absent at any state in the life cycle, which is an unusual characteristic. The flagellum thus terminates at anterior end of the parasite. The posterior end of the body is usually rounded but can be slightly pointed in longer parasites. The medium sized kinetoplast is usually marginal and sub-terminal in position. Trypanosoma congolense is one of the smallest trypanosomes with an average length of 12-17 μm. *Trypanosoma simiae,* the porcine trypanosome is mostly pleomorphic in its characteristics and the average length is 15-19 μm slightly longer than *T. congolense*. Nannomonas trypanosomes are very active in fresh blood films but do not tend to move far across the microscope field. They also demonstrate agglutinating properties by tending to adhere to host tissue in vivo (Molyneux and Ashford, 1983).

2.2.2. *Trypanosoma* (Duttonella) *vivax*

Trypanosoma (Duttonella) *vivax* has an average length of 20-26 μm, a long free flagellum and a large terminally placed kinetoplast, distinguishing it from the other pathogenic salivarian trypanosomes. *Trypanosoma vivax* is a very mobile and “lively” parasite. It crosses the field of a microscope rapidly, which makes it difficult to follow its movements (Stephen, 1986).

2.2.3. *Trypanosoma* (Trypanozoon) *brucei*

The blood forms of *T. brucei* measure from 11-39 μm in length and they are typically pleomorphic represented by three forms:

- Slender forms (average length 14-39 μm) possess a long free flagellum and a well developed undulating membrane, elongated nucleus, sub- terminal kinetoplast and narrow posterior end drawn out to a blunt point or sometimes truncated.
- Stumpy trypanosomes (average length 17-22 μm) which are stout and usually without a free flagellum, undulating membrane is well developed, nucleus rounded (displaced to the posterior end in posterior nuclear forms), kinetoplast near broadly rounded and pointed posterior end.
- Intermediate forms (average length 20-25 μm) in which the flagellum is shorter, the posterior end blunt and kinetoplast nearer to the extremity than in the slender forms. The kinetoplast in trypanozoon is smaller than in any of the other salivarian trypanosomes. Animal and human infective T. brucei are morphologically indistinguishable (Stephen, 1986).

*2.2.4. Trypanosoma (*Pycnomonas*) suis*

The total length of *T. suis* has a range from 13-19 μm with a normal distribution, indicating that this species is monomorphic. A free flagellum is typically present. Its body is very broad and short. The posterior end usually terminates in a short point but sometimes it is rounded. The small kinetoplast is usually situated near the posterior end and in the majority of cases occupies a marginal position while the voluminous nucleus lies in the anterior part of the body and the undulating membrane is conspicuous (Mulligan, 1970).

2.3. Tsetse and Trypanosomosis Challenge

2.3.1. In Africa

Nearly 10 million km square of Africa is infested by tsetse flies. Part of this large area is composed of fertile land that is left uncultivated, a so-called green desert abandoned by humans and cattle. Eradicating the tsetse and with trypanosomosis, the disease it carries, would allow rural Africans to reclaim areas of their continent and greatly increase food production. The tsetse fly transmits a deadly parasite, trypanosome that attacks the blood and tissue of its victims. It causes African Animal Trypanosomosis (AAT) known as Nagana in livestock and sleeping sickness in humans (FAO, 2002). The genus Glossina, which encompasses around 30 species and sub-species members of this group of biting flies, is commonly termed tsetse flies. These flies are confined to a belt of tropical Africa extending from the Southern Sahara (Latitude 15^0 N) and in the South (Latitude 20-30^0 S). The species are restricted to various geographical areas according to habitat. The three main groups, named after the commonest species in each group, being *Palpalis, Morsitans and Fusca,* found to be in riverine, savannah and forest areas, respectively. The first two groups because of their presence in the major livestock rearing areas are the most important from the veterinary point of view.

The disease in human (sleeping sickness) caused by *T. b. gambiense* and *T. b. rhodesiense* is always fatal if left untreated. It causes malaise and associated waves of parasitaemia in affected individual (Jordan, 1986). Tsetse keeps people poor by preventing them from producing the food they need to survive. In fact, tsetse and trypanosomosis are major impediments to the development of sustainable agricultural systems in the region, hitting the poorest of the poor rural people in the most indebted countries in Africa (FAO, 2002).

Trypanosomosis is one of the most devastating diseases in Sub-Saharan Africa, killing 80% infected victims. The World Health Organization of the United Nations (WHO) reports over 60 million people, mainly living in rural areas of Sub-Saharan Africa, are at risk of becoming infected with the disease. Out of the estimated 500,000 people already infected 25,000 die every year and the situation is rapidly deteriorating with more than 40,000 new cases being registered every year, excluding the many unreported cases from inaccessible rural areas (surveillance covering only 5-7 % people at risk).

Trypanosomosis kills 3 million livestock animals each year and reduces the productivity of sick animals. About 50 million animals are at risk from Nagana. Domestic livestock in Africa are important as sources of protein (meat and milk), animal traction and investment (social security) and measure for enhancing agricultural or crop production (Erkelens *et al.*, 2000). The Food and Agricultural Organization of the United Nation (FAO) has estimated that 35 million doses of trypanocidal drugs (worth about USD 35 million) are bought every year in futile efforts to maintain livestock free of the disease.

The annual losses directly attributed to trypanosomosis, in terms of reduced meat and milk production and in terms of the costs related to treating the disease or controlling the vector, have been estimated at US $ 1.2 billion. This figure rises to over USD 4.5 billion per year, if losses in potential crop and livestock production attributable to the disease are considered and excludes the losses attributable to the effects of sleeping sickness in humans. Majority of the areas that are infested with tsetse flies are most suitable for livestock and crop production extending from Senegal in the north to South Africa in the south. These areas, however, are virtually devoid of cattle and other domestic livestock (Figure 1).

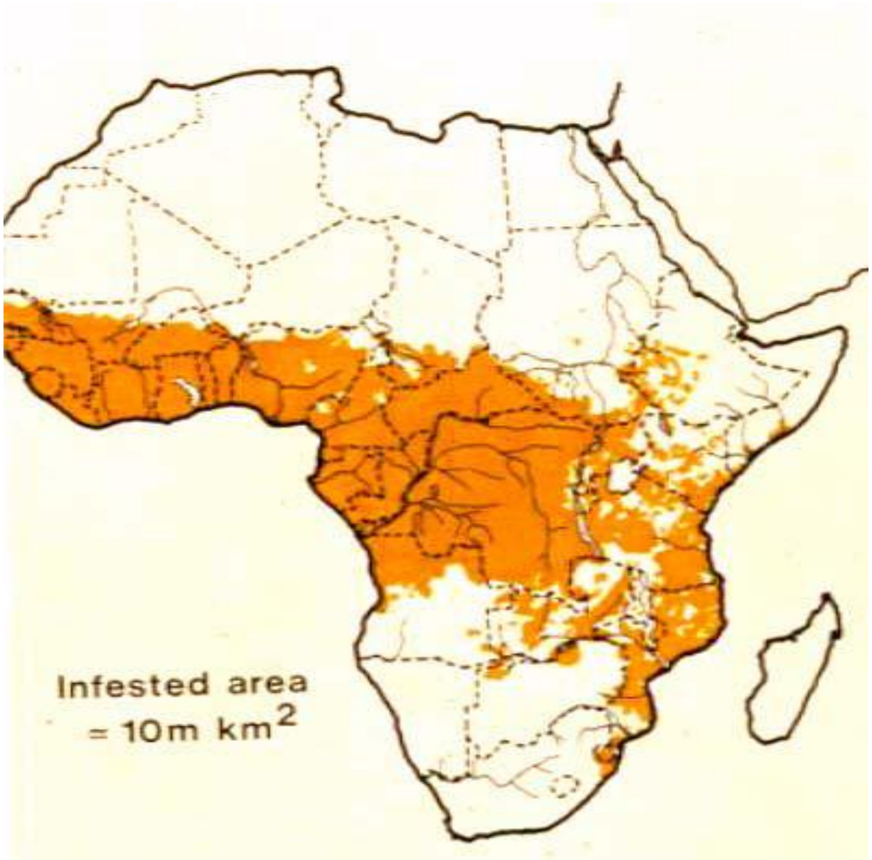

Figure 1: Distribution of tsetse flies in Africa (Source: WFP, 1998).

Reports of reinfestation of areas that had previously been cleared of the tsetse fly are frequent. The numbers of cases recorded of the disease in man and domestic animals have reached unprecedented levels. Despite this situation, no vaccine against the disease is available and no new drugs are being developed. Some of the drugs used to treat sleeping sickness are highly toxic. All drugs currently used to treat trypanosomosis have been rendered largely ineffective by widespread drug-resistance. The future availability of drugs against trypanosomosis is uncertain since their continued production is threatened for commercial reasons. The only market is Africa where the purchasing power of the consumers affected is poor and rapidly deteriorating (PATTEC, 2001).

2.3.2. In Ethiopia

Ethiopia is located in the Horn of Africa between latitude 3^0-15^0 N and longitude 33^0 - 48^0 E is an agrarian country. The rural agricultural sector makes up 85% of the total population and accounts for 95% of all crop and livestock production (Slingenberg, 1992). Previous workers have estimated the potential area of tsetse infestation as 98,025 km square based on 1600 meters above sea level of breeding limit (Langridge, 1976). However, in more recent years tsetse flies have progressively invaded productive potential agricultural areas in the west and Southwest parts of the country. It is estimated that a total area of 220,000 km square is currently infested with different species of tsetse flies in which case livestock below 2000 meters above sea level contour are exposed to various levels of trypanosomosis risk (NTTICC, 1996).

Five species of tsetse are known to exist in the tsetse belt areas namely: *G. pallidipes, G. m. submorsitans G. f. fuscipes* and G. *tachinoides and G. longipennis*. Pertaining to their specific ecology, *G. pallidipes* almost always associated with extensive and fragmented thickets including evergreen species. *G. m. submorsitans* is usually found in deciduous woodland and wooded grassland; often mix together with evergreen vegetation. *G.f.fuscipes* and *G. tachinoides* are common to valley forests, thickets and fringing vegetation on streams, rivers and lake shores (Langridge, 1976). *G. longipennis* inhabits in dry acacia, thorny bush and is very active after sunset and before nightfall. Tsetse infested region of the country is indicated on Figure 2.

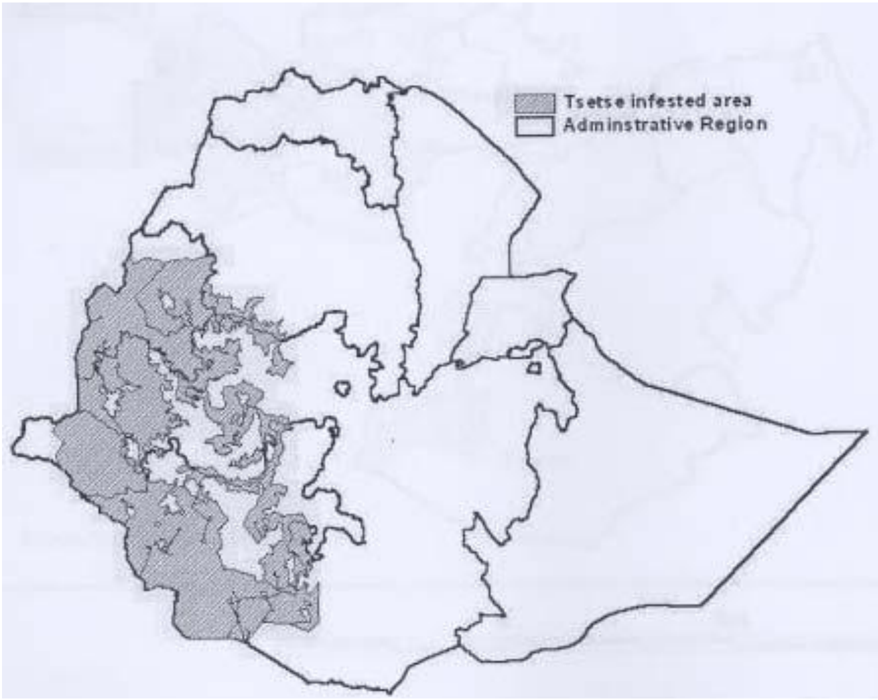

Figure 2: Distribution of tsetse flies in Ethiopia (Source: WFP, 1998).

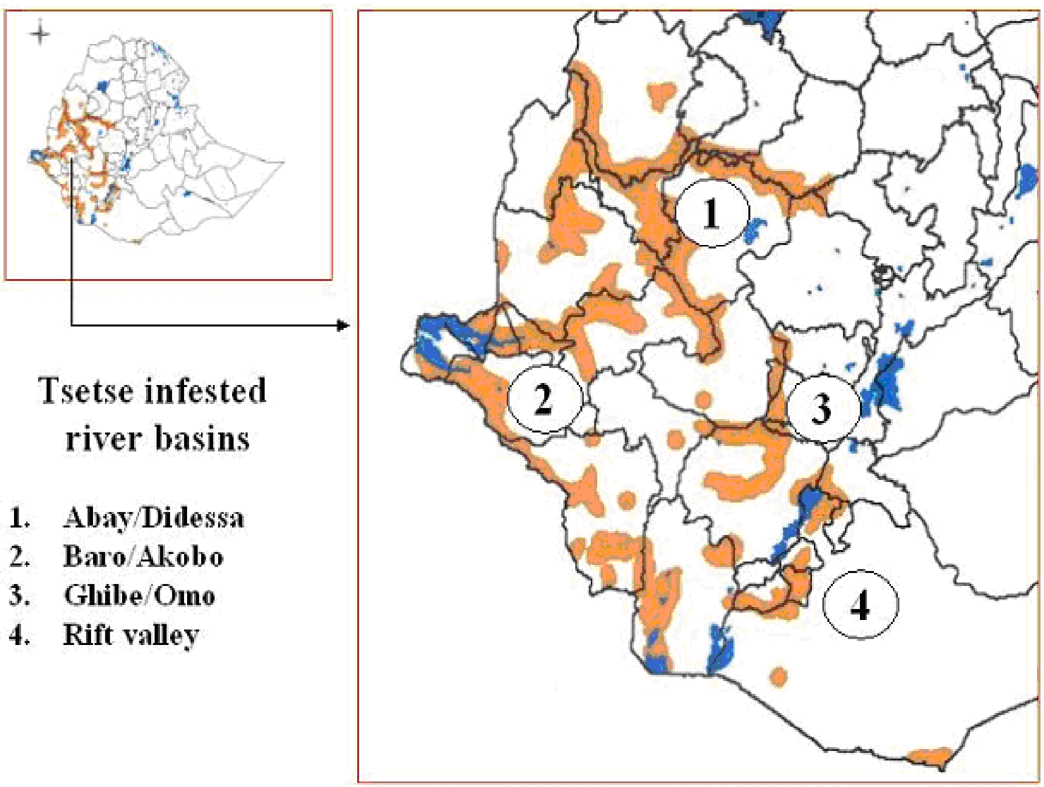

Figure 3 Tsetse infested river basins of Ethiopia (Source: Abebe, 2006).

Four species of tsetse borne trypanosomes are known to exist namely: *T. congolense T. vivax, T. b. brucei* of livestock and *T. b. rhodesiense* of humans were identified and their distribution and frequency in hosts are recorded. *T. vivax* was detected in almost all regions of the country below 2500 meters above sea level altitude limits (Lemecha, 1994). Also *T. evansi* and *T. equiperdem* are known to exist in the country Hagos (2005). Some prevalence studies on animal trypanosomosis are indicated on Table 1.

Table 1: Some of the published papers on prevalence studies on animal Trypanosomosis

Hosts	Study sites	Prevalence (%)	Major trypanosomes	Authors
Cattle	Arbaminch	32%	*T. congolense* *T. vivax*	Argaw and Abebe, 1988
,,	Southwest Ethiopia	17.7%	*T. congolense* *T. vivax*	Abebe and Jobre, 1996
,,	Metekel	17.2%	*T. congolense* *T. vivax*	Afewerk *et al.*, 2000
,,	Didessa	21.3%	*T. congolense* *T. vivax*	Tewelde *et al.*, 2004
Donkey	North Omo	18.2%	*T. congolense* *T. vivax*	Assefa and Abebe, 2001
Camel	Borena	10.9%	*T. evansi*	Tekle and Abebe, 2001

2.4. Epidemiology of Bovine Trypanosomosis

Three elements influence the epidemiology of the disease, namely distribution of the vectors, the virulence of the parasite (trypanosome) and response of the host. Any discovery, even if it is only partial, leads not only to a better understanding of this complex group (parasite-vector-host and their multiple interactions) but also to a better control of the disease (Clair, 1987).

2.4.1. The Parasite

Trypanosomes are insect-borne and their epidemiology is determined by the ecology of their insect vector, the tsetse. Cyclical African trypanosomes are transmitted by several species of the tsetse fly Glossina found only in Sub-Saharan Africa excluding areas of high altitude, extreme drought or cold temperatures. The flies have strict requirements of temperature and vegetation. The carrier state reservoirs of the trypanosomes are found in many wild animals and in domestic ones that are affected by the chronic disease. Tsetse flies caught in and around game reserves tend to have relatively high infection rates. For this reason, animals grazing close to a game reserve or park are at higher risk. Furthermore, the relative abundance of wild life in East Africa, as compared to West Africa may explain, at least in part, why the prevalence of the disease appears to declining more rapidly in the west. Once trypanosomes have been introduced into a herd (non-cyclical), transmission is possible even in the absence of *Glossina.* Therefore, biting flies such as Tabanidae, Stomoxyinae, and Hippoboscoidae are capable of mechanically transmitting trypanosomes in their mouthparts if they feed on more than one host within a short interval. This is how *T. vivax* is spread in areas outside the tsetse belt in Africa, Central and South America. Mechanical transmission can also occur through the needle during inoculations and in carnivores feeding on infected carcass. In addition, intrauterine infections occasionally occur with different species of trypanosomes (Radostits *et al.*, 2000).

Since parasitaemic animals commonly survive for prolonged periods, there are ample opportunities for fly transmission, especially of *T. brucei* and *T. congolense*. In contrast some strains of *T. vivax* in cattle and *T. simiae* in domestic pigs kill their hosts within 1-2 weeks so that the chances of fly infection are more limited. Perhaps the most important aspect of trypanosomosis, which accounts for the persistent parasitaemia, is the way in which the parasite evades the immune response of the host. Metacyclic and blood stream trypanosomes possess a glycoprotein (Variable Surface glycoprotein, VSG) coat, which is antigenic and provokes the formation of antibodies that cause opsonization, and lysis of the trypanosomes. Unfortunately by the time the antibody is produced, a proportion of the trypanosomes have altered the chemical composition of their glycoprotein coat and now, displaying a different antigenic surface, are unaffected by the antibody.

Those trypanosomes possessing this new variant antigen multiply to produce a second wave of parasitaemia; the host produces a second antibody, but again the glycoprotein coat has altered in a number of trypanosomes so that a third wave of parasitaemia occurs. This process of antigenic variation associated with waves and remissions of parasitaemia, often at weekly intervals, may continue for months, usually with a fatal outcome.

The repeated switching of the glycoprotein coat is now known to depend on a loosely ordered sequential expression of an undefined number of genes, each coding for a different glycoprotein coat. The complexity of antigens potentially involved has also defeated attempts at vaccination (Urquart *et al.*, 1996).

2.4.2. The Vector

Of the three groups of Glossina, the savannah and riverine are the most important as they inhabit areas suitable for grazing and watering. Although the infection rate of Glossina with trypanosomes is usually low, ranging from 1 to 20 % of the flies, each is infected for life. Their presence in any number makes the rearing of cattle, pigs and horses extremely difficult (Urquhart *et al.*, 1996).

Apart from the tsetse, which is the main vector of trypanosomosis, other biting insects can transmit the disease (tabanidae, muscidae, hippoboscidae) through interrupted blood meals. This "mechanical transmission" is difficult to study and there is still little information on it. It concerns primarily *T. vivax*, which is also transmitted cyclically. This phenomenon undoubtedly plays a role in the spreading and growth of the disease. However, in the absence or disappearance of tsetse it becomes less serious.

It is obvious that disease risk depends primarily on the density of the vector. All factors influencing tsetse populations, disease risk and consequently the evolution of the disease should be considered, i.e. climatic and ecological factors, presence of trypanosomes, food sources (hosts) etc. Tsetse flies (*Glossina* species) are larviparous and have low reproductive rate. Both sexes are bloodsuckers and are vectors all their lives (Seifert, 1996).

The general distribution of tsetse flies is determined principally by climate and influenced by altitude, vegetation and presence of suitable host animals. Each of these factors may directly affect the birth, death or migration rates of the vector and thus the population size (Hay *et al.*, 1996).

The most favorable temperature for Glossina is between 21-24^{0}C for the adult stage while too high (>35^{0}C) or too low temperature (<14^{0}C) hinders puparia from completing their development. The condition of the soil is more important than the type. If it is hard and compacted or if it is very fine dust, the tsetse larva cannot burrow into it to pupate. Badly drained soil can become water logged and drown the pupae. Vegetation is an important ecological component for the tsetse. It spends most of its life in woody vegetations and consequently shelter from unsuitable weather conditions is of great importance. Therefore, shrubs and trees by providing shelter are deciding factors for the distribution of tsetse species (TCS, 1980).

2.4.3. The Host

Trypanosomosis is fundamentally an infection of wildlife in which it has achieved a mode of survival in that the animal hosts are parasitaemic for prolonged periods, but generally remain in good health. This situation is known as trypanotolerance. In contrast, rearing of domestic livestock in endemic areas has always been associated with excessive morbidity and mortality. However, there is evidence that a degree of adaptation or selection has occurred in several breeds. Precisely how trypanotolerant animals cope with antigenic variation is unknown. It is thought that the control and gradual elimination of the parasite may depend on the possession of a particularly rapid and effective antibody response, although other factors may also be involved (Urquhart *et al.,* 1996).

With regard to host factors in the mammalian host, the effect of the infection varies with the host in most wild animals and some domestic ones establish a balance with the parasite and remain as clinically normal carriers for long periods. Also some breeds of cattle indigenous to Africa can tolerate light to moderate challenge with tsetse flies by limiting the multiplication of trypanosomes in their blood. This phenomenon of trypanotolerance is both generic and environmental in origin. The Taurine breeds such as N' Dama and Baoule are more tolerant than the West African Zebu. Amongst the East African zebu cattle, the Orma Boran has superior tolerance. Trypanotolerance also occurs in some indigenous breeds of small ruminants, notably the West African Dwarf sheep and goats and the East African goats (d'Ieteren, *et al.*, 1998b)

Environmental factors: the density of tsetse fly population in the area and the level of their contact with the host will determine the level of infection that will occur. This is further influenced by the vectoral capacity of the fly and the availability of its preferred host, which is not necessarily domestic livestock. Trekking of cattle through tsetse-infested vegetation is a risk. Agricultural and industrial developments generally lead to a lowering of tsetse density by destroying its habitat where as the establishment of game or forest reserves provides large numbers of preferred hosts or a suitable habitat for tsetse, respectively.

Pathogen factor: in cattle *T. vivax* generally produces higher level of parasitaemia than the other species. Its life cycle in the tsetse fly is also shorter. *T. vivax* is readily transmitted than the others when animals are introduced into a tsetse infested area. It can also be transmitted mechanically.

Immune mechanism: animals recovering from infection with one strain or species of trypanosome are not immune to infection with another strain or species. Animals infected with trypanosomes are more susceptible to secondary infections by other microorganisms, particularly bacteria. The mechanisms involved in the immunosuppressant are not fully understood but may vary among species of animals.

Zoonotic implication: the species of trypanosomes that infect livestock are generally not transmissible to humans with the possible exception of *T. brucei*, which is morphologically indistinguishable from human pathogens, *T. rhodesiense* and *T. gambiense*. Humans contract the disease when bitten by tsetse flies, which generally abound in game parks, forest reserves and along streams. Consequently the disease is seen essentially in rural populations and in visitors to those areas (Radostits *et al.*, 2000).

The epidemiology of animal trypanosomosis is extremely complicated as the wild animals constitute a range of reservoirs of the disease (Clair, 1987). The principal host animals of *G. m. submorsitans* are warthog (30 to 45% of food source) and some bovids, (25 to 40%), of which kudu is the most important followed by buffalo, bushbuck and eland. *G. pallidipes* obtains 80% of its food from bushbuck and the remaining chiefly from bushpig. *G. fuscipes* and *G. tachinoides* take most of their meals from reptiles (crocodiles, varanus lizard, and snake) and thicket haunting bovids such as bushbuck. These species can persist on diets of human and domestic animal blood in the absence of their favorable hosts and hence become important vectors in epidemics of sleeping sickness. The natural hosts of *G. longipennis* are rhinoceros, elephant, giraffe and buffalo. The degree of risk for domestic animals varies based on their proximity to tsetse habitat. High risk is considered when animals are in contact or within 10 km of tsetse and where the infection rate in herds may exceed 30% (TCS, 1980).

2.5. Diagnosis

Accurate diagnosis of trypanosome infection in livestock is required for a proper understanding of the epidemiology of the (parasite, vector and host) in any geographical locality. Besides clinical diagnosis, direct (parasitological) and indirect (serological) diagnostic methods with varying degrees of sensitivity and specificity are available for trypanosomosis.

2.5.1. Clinical diagnosis

In general, diagnosis of trypanosome infection based on clinical signs alone is rather difficult, but haematological parameters like PCV value could be reliable indicators of the progress of the disease. In regions where the disease is known to occur; fever, anaemia and loss of body condition are important parameters used routinely for tentative diagnosis of trypanosomosis in areas where the disease is endemic and laboratory services are not available (Uilenberg, 1998). Definitive diagnosis of the disease is ultimately dependent on the detection of the trypanosome in blood samples from infected animals.

2.5.2. Parasitological diagnosis

Parasitological diagnosis is the direct demonstration of the parasite in blood or less commonly in other body fluids using a microscope. The scarcity of the parasites and the fluctuating nature of the parasitaemia limit the use of the laboratory tests based on demonstration of trypanosomes in accessible body tissues such as the peripheral blood (Doyle, 1977). Therefore, several techniques for the concentration of blood trypanosomes have been developed, which increase the chance of trypanosome detection.

Dark ground/ Phase contrast/ Buffy coat technique (BCT): the buffy coat zone prepared in a microhaematocrit capillary filled with 70 μl of blood and centrifuged for 5 minutes at 12000 rpm is examined for trypanosomes by cutting the capillary tube to include 1 mm of erythrocytes and 1 cm of the plasma. The buffy coat is poured on a slide and covered with a 22 x 22 mm cover slip. The preparation is examined using a microscope with a phase contrast and dark ground illumination. The use of 10x eyepiece in combination with a 25x objective gives optimal viewing by allowing large visual fields and sufficient magnification for ready identification of trypanosomes. This technique is the most sensitive of the parasitological tests for the detection of *T. congolense* and *T. vivax* detecting trypanosomes to an estimated level of just over 10^2 parasites per ml (Murray *et al.,* 1977). In addition, species identification based on size and movement is easier to assess (Paris *et al.,* 1982). Trypanosomes can be identified and the level of parasitaemia is estimated using a scoring system. The PCV is measured before examination of the blood for parasitaemic detection.

Haematocrit Centrifugation Technique (HCT): a microhaematocrit capillary tube containing 70 μl of blood is centrifuged for 8 minutes at 10,000 rpm to measure PCV. Two rectangular pieces of glass from a standard microscope slide (1.2 mm thick) are fixed 1.5 mm apart on a microscope slide. The prepared capillary is then placed in the slot and a drop of immersion oil put on top of capillary tube. The oil fills the space between the capillary tube and the two pieces of glass, thus reducing the effect of light diffraction. By slowly rotating the tube the buffy coat plasma junction is examined using a long working distance (6.7mm) objective that allows considerable depth of focus through the capillary unlike the standard objective where the average working distance is approximately 0.5mm. Depending on the trypanosome species the analytic sensitivity for this method is 1 - $5x10^2$ trypanosome per ml of blood. Other diagnostic methods including capillary concentration technique, biochemical tests, serological tests to detect specific humoral antibody and circulating antigens (Ab-ELISA, Ag-ELISA, CFT, Passive Haemagglutination test), and the molecular tests DNA–Probes and PCR technique could used.

2.6. The Growing Need for More Fertile Land in the Tsetse-Infested Areas

Of 165 million cattle in Sub-Saharan Africa, 155 million are in tsetse free areas such as the highlands or the semi-arid Sahel Zone, leading to overgrazing by animals and overuse of land by people for food production. Breaking the cycle of poverty and hunger must therefore incorporate decisive action against trypanosomosis (FAO, 2002). The human population of Africa is growing at high rate of 3% a year, while food production lags behind in growth rate at 2% (Masiga, 1995). The livestock population of Ethiopia is estimated at 30 million heads of cattle, 21.7 million sheep, 16.7 million goats, 7.02 million equines and 1 million camels (CSA, 2002). In Ethiopia considering only the highland and lowland agro-ecological Zones, which roughly constitute 35 % and 65 % of the general composition respectively, the highland Zone is estimated to accommodate 85 % of human population, 80 % of cattle, 75 % of sheep and 90 % of equine population which subject it to high population pressure. This huge concentration of population at highland is badly hitting the ecologically fragile Zone as the result of overgrazing, over ploughing, soil erosion and depletion of natural resources. Thus, the end result is being recurrent attack of drought and famine and hence poverty. Now all these prevailing bad features of the livelihoods are being the major driving forces to move the affected people to the vast fertile areas of the country, which are mainly tsetse affected.

To this effect the settlement Programme planned by government is in operation since 2003 targeting to resettle 2.2 million people within 3-5 years time .Therefore, to break the cycle of hunger and poverty farming in the tsetse affected areas should be possible. To achieve this goal the extensive fertile lands in the tsetse affected areas of the country must be cleared of tsetse and trypanosomosis, which give opportunities for improving livestock productivity and the integration of livestock with cropping sector. Livestock are the integral part of the rural economy.

The direct impacts of trypanosomosis incidence are the morbidity, mortality, lower work efficiency and the costs of treatment for the animals that contract the disease. The indirect impacts of trypanosomosis incidence are the changes in human settlement, crop production and land use that occur due to the reduced productivity of existing animals raised under trypanosomosis risk (Swallow, 1997).

2.7. Tsetse and Trypanosomosis Control

Options available for controlling animal trypanosomosis in Africa are identified as following: Autonomous, anthropogenic impacts that influence and modify the extent and severity of the disease are distinguished from more purposive, managed and intentional control measures. Autonomous control includes the environmental impacts of human population growth, the expansion of agriculture, settlements and road networks, and the elimination of wild life, through hunting and habitat loss (Bourn *et al.,* 2001). Purposive control measures fall into three categories: those related to animal husbandry and breeding; those directed against the trypanosomes and those targeted at tsetse.

Experience has shown that no one single technology or approach will result in the eradication of tsetse flies from an area. Therefore, integrated approach and use of appropriate combinations of available technologies in the tsetse eradication effort is very important. These will include the promotion of agricultural development in suitable areas, the linking of ongoing and planned projects, the detection and treatment of trypanosomosis, the provision of support for the development and application of appropriate conventional and new technologies for fly population control, the establishment of barriers (PATTEC, 2001).

Many of the large valleys in the South and Southwestern Ethiopia, which are at present infested with tsetse, favor deluxe growth of vegetation and are suitable for profitable cultivation. At present people are generally reluctant to utilize these fertile valleys for fear of disease such as malaria and also because they are unable to keep their cattle if tsetse flies are present there. So carefully planned control measures are necessary. Where tsetse control operations are successful, the development of a number of other activities including mixed farming may become possible and eventually lead to a permanent change in land use.

Combining different control methods against a parasitic disease is called integrated control or integrated disease management. It is generally not intended to achieve eradication of the parasite in question. Such a cost - effective combination of technologies adapted to each particular set of circumstances are very relevant for the control of African animal trypanosomosis (Uilenbergh, 1998).

Successful strategies for controlling animal trypanosomosis is based on accurate appraisals of the impacts of the disease constraints on village farming system and the development of cost-effective sustainable disease control packages which can be adapted by producers. In many circumstances, using combinations of tsetse control and chemotherapy is more effective than employing either method alone. Any control method should be integrated into overall control strategies rather than replacing existing control methods (ILCA, 1993/94). Methods used to control trypanosomosis include: vector control, parasite control and exploitation of trypanotolerant livestock (Uilenbergh, 1998).

2.7.1. Parasite control

Considering consequences of widespread chemoprophylaxis, the earlier investigators observed that trypanosomes could retain their drug resistance during transmission. One of the recommendations given was the use of alternative treatments of two or more drugs of different chemical groups to delay the appearance of dug resistance. The idea of a ″sanative pair″ was then introduced later. After forty years, the same recommendation is given in a review by other workers as one of the guidance to control resistance (Murilla, 1999).

Treatment and prevention of bovine trypanosomosis rely essentially on three drugs, namely: Homidium, Diminazene and Isometamidium. However, as in many parts of Africa, in Ethiopia all of these trypanocides are gradually losing their efficacy due to drug resistance (Afewerk, *et al.*, 2000). Standard doses of Isometamidium chloride and diminazene aceturate fail to cure donkeys of *T. congolense* infection. The epidemiology of drug resistant populations of trypanosomes is dynamic; once established the incidence progressively spread within the population. For instance, the incidence of recurrent infection in the Ghibe valley of Ethiopia was 7% in 1986 and it increased to 14% in 1989 (Rowlands *et al.,* 1993). Transmission by tsetse flies does not appear to affect the drug sensitivity of trypanosomes and drug resistant strains remain resistant after passage through tsetse flies (Mollo and Kutuza, 1990). The long-term occurrence of *T. congolense* resistance to diminazene, isometamidium and homidium in the Ghibe valley of Ethiopia (Mulugeta *et al.,* 1997) indicated the magnitude of the problem once drug resistance is established in a herd. The resistance trait is known to be stable for a long time and such stocks can spread to wider areas through animal movement and/or the spread of tsetse populations. Results suggest that resistant population established in an area can be disseminated in different animal hosts, for example from cattle to donkeys or vice versa, in a given locality.

2.7.2. Vector control

In the past, control of trypanosomosis both in human and in animals depended mainly on large scale killing of game animals which act as reservoirs. It was also common to clear large areas of bush in order to destroy the habitats of the adult flies. These methods were fairly successful, but are now largely unacceptable on ecological and economic grounds (Urquhart *et al.,* 1996). These methods were effective in eradicating or controlling tsetse flies in some parts of Africa but they resulted in destroying valuable plant and animal resources and also led to soil erosion.

The methods have been replaced by the use of insecticides especially endosulfan, applied strategically in the form of ground and aerial spraying over large expanses of land. As tsetse flies are very sensitive to insecticides and no resistance has developed, considerable successes have been achieved in some countries. However, the method is costly and harmful to the environment. The costs and the environmental effects can be considerably reduced if the insecticides for example, synthetic pyrethroids are applied directly on the animal in the form of spray or pour-on formulation. The development of live bait technology for the control of tsetse flies and trypanosomosis of livestock depends upon using cattle, or other livestock as living, mobile targets with built-in natural odours mostly produced in their breath to attract tsetse flies

These flies are then killed or suffer ″knockdown″ paralysis effects as they land on cattle and attempt to feed. The killing or "knock-down” effects are produced by treating the animals with insecticide. The approach of turning cattle into mobile targets where animals are dipped or sprayed with insecticide or the compound is poured on them. The effectiveness of this strategy depends on cattle density, grazing pattern and fly distributions. The strategy works best where livestock are the main host of tsetse (Radostits *et al.*, 2000).

Tsetse traps, targets and pour on insecticides are used to impose a small but steady mortality on a fly population sufficient to keep fly numbers down to an acceptable low level. While eradication may be both feasible and desirable in some places, tsetse populations are highly resilient and will often recover from very low number once control measures are relaxed. Furthermore barriers against re-invasion of cleared areas need to be about eight to ten kilo- meters wide to be effective. Demands for cheap and simple tsetse control methods have driven much of the efforts behind modern trap design (ILRAD, 1993).

Targets impregnated with insecticides and traps that attract and catch the flies are effective, simple, and cheap and could be constructed and maintained by local communities. Furthermore they do not pollute the environment, are suitable for both the small and large-scale farmer. They have been used to reduce tsetse fly population by over 97% within 7 months in a community in the Congo. However, steps must be taken to ensure that individuals do not steal traps or destroyed by wildlife (Radostits *et al*., 2000).

Light sensory and smelling organs assist the tsetse to recognize its host from a distance. It has a special preference for dark objects. This piece of knowledge has been used to the construction of flytraps. The constructions based on the knowledge that tsetse flies are attracted by the contrast between light and shade and seek shade or dark spots. They choose resting places as well as the sites where they feed (on the under the belly) in the shade consequently traps have been constructed in such a way that the entrance is placed on the underside and made out of dark-coloured material. The tsetse fly is attracted from a distance by the blue colour and then, when approaching, by the dark colour. Several variations of the construction of the classical Challier traps have been developed Challier, (1965) and Challier,Laveissiere, (1973). They all follow the principle but are different in design (one or two-cone, or only square cage).

Targets are also being used for tsetse fly control. They are placed on appropriate sites at determined intervals. Tsetse flies are attracted at a distance by blue and black colour when approaching. In addition, 50 ml bottles with acetone plastic bags/containers with octenol or phenol or bottles with pig or cattle urine are placed at the foot of the target as a lure. In order to kill the flies which settle on the target, it is sprayed with the pyrethroids (Deltamethrin 0.1%) at regular intervals (8 months). Four targets per km square located 1 km apart are enough to reduce the fly infestation considerably (Seifert, 1996).

In the pilot tsetse control programme in the Didessa valley, western Ethiopia, the striking differences in health (mortality rate) and productivity (calving rates and off take rates) of cattle among the four villages with different levels of trypanosomosis suggest an impact of the pilot tsetse control programme on the health and productivity of cattle in the Didessa valley (Jemal and Hugh-Jones, 1995).

In the Ghibe valley in Southwest Ethiopia, a Cypermethrin (pour-on) insecticide was applied to trypanosusceptible zebu cattle regularly treated with trypanocidal drug diminazene aceturate. The cattle at Ghibe have been monitored regularly since 1986 but the tsetse control programme started only in 1991. By December 1993, the tsetse control programme had reduced the relative density of tsetse flies by over 90% compared with mean values for 1986-90 and reduced trypanosome prevalence in cattle by 74% (ILCA, 1993/94).

With the sterile insect technique (SIT) a large number of sterile males are introduced in a ratio of about 6:1 into a population. The sterile males will thus have a greater chance than the wild males of copulation with the females. Since the females can only mate once they are unable to produce offspring. Radioactive cobalt or caesium is used for the radiation, the dose of radiation being adapted to the resistance of each species. The mating of released sterile male insects with indigenous fertile female insects causes infertility in the target population (Seifert, 1996).

2.7.3. Trypanotolerant animals

Animals that can survive and produce in tsetse-infested areas without the aid of trypanocidal drugs offer one of the most sustainable options for boosting agricultural rural development. Trypanotolerant livestock are often combined with tsetse control and trypanocidal drug in integrated trypanosomosis control strategies. According to evaluation of differences in susceptibility in East African cattle to trypanosomosis studies have indicated that the Orma Boran cattle are less susceptible to trypanosomosis than are the Kenyan Boran. The resistance was independent of the previous exposure to the disease. The resistance thus appears to be innate rather than acquired. More extensive use of trypanotolerant livestock can open new areas to animal production and reduce farmers' dependence on using imported drugs to control both the disease and the vector (ILCA, 1993/94).

2.8. Sustainability of Control Programmes

2.8.1. Community participation

It is easy to kill tsetse but much more difficult and very expensive to keep an area free of tsetse when the conventional methods of tsetse control are used. Therefore, full and active participation of the community should be employed to resolve the tsetse and trypanosomosis problems. The problems of tsetse and trypanosomosis should not be tackled in isolation from other constraints of integrated rural development since it is one of the major factors affecting food security and public health in many parts of Africa. Hence, the strategy and tactic that should be employed to resolve the problem in a systematic way should take full and active participation of the community (Tikubet, 1993).

The appropriateness of the available control methods should be evaluated in view of their suitability, transferability and sustainability under the particular situation of the local community (Bossche and Doran, 2001).

2.8.2. Settlement programmes and development of the land cleared of tsetse fly

Once a tsetse-infested area is reclaimed or broken through an effective control method or combinations of methods applied, it is liable to reinvasion if left undeveloped. Thus, complete exclusion of the tsetse from the area could be effected through a well-planned and systematized settlement schemes. This can be realized by expanding agricultural and industrial development as well as via expansion of trade and road networks. Therefore, it is very relevant to our particular situation in line with the national policy of poverty reduction to ensure the nation's food security at household level. Tsetse control Programme needs to be closely linked with land use planning in tsetse-controlled areas. Resources such as woodland and grazing areas need to be well managed by promoting sound and sustainable agricultural development in areas cleared of tsetse (Salmon and Barret, 1994).

2.8.3. Involvement of other stakeholders

Tsetse control and/or eradication are not merely a simple task undertaken by an individual, a group of individuals or any other body in isolation. A joint effort and participatory approaches have crucial effects. In tsetse eradication process the participation of major stakeholders, national governments, donors, international organizations and other partners must be achieved (PATTEC, 2001).

2.9. Socio-Economic Impact of Animal Trypanosomosis

Among the factors influencing the productivity and profitability of livestock, animal diseases deserve special attention because they diminish the capacity of the animal to achieve its inherent potential level of production, for any given feeding and management regimen. It is well established that animal trypanosomosis depresses livestock productivity, crop yields and farmers' income across a wide swathe of Africa (Swallow, 1997). Owing to trypanosomosis, the use of animal draught power in agriculture and transport and the practice of mixed farming are not well developed in most of Africa.

Fear of contracting sleeping sickness and exposing their animals to trypanosomosis continues to prevent people from living in tsetse-infested areas. This renders large expanses of land uninhabitable and under-developed leading to overcrowding in the few available tsetse-free areas. The limitations imposed by the tsetse and trypanosomosis problem continue to frustrate efforts and hamper progress in crop and livestock production. This contributes to hunger, poverty and the suffering of entire communities in Africa (PATTEC, 2001). In Ethiopia trypanosomosis is one of the most important diseases, which contribute to the direct and indirect economic losses to the livestock industry. Animals at risk of trypanosomosis are estimated at 14.8 million cattle, 6.12 million sheep and goats, 1 million camels and 1.23 million equine populations are prone to contract the disease. Non-tsetse transmitted trypanosomosis also affects a substantial amount of animal production in tsetse-free areas of the country (MOA, 1995). Animals at risk of trypanosomosis are shown on Table 2.

Table 2: Animals at risk of trypanosomosis in Ethiopia

Category of assets	At risk	Total
Livestock (in million)	23.15	76.42
Cattle	14.80	30.0
Sheep and Goats	6.12	38.4
Equines	1.23	7.02
Camels	1	1.00

Source: Ministry of Agriculture (1995)

In tsetse-infested regions of Ethiopia, the problem of trypanosomosis is the main cause of decline in the population of cattle and particularly draught oxen (Abebe and Jobre, 1996). Therefore, draught animals cannot be used for ploughing and other purposes where the situation forces the farmers to cultivate manually, as the majority of the peasant farmers cannot afford costly machinery. The end result is that only a small fraction of potential agricultural land is cultivated for crop production (Tikubet, 1993).

Economic losses due to trypanosomosis in tsetse-affected areas are attributed to mortality and morbidity of livestock, treatment and control costs and denied access to land resources. Thus, a total of 9,672,575 doses of different compounds of trypanocidal drugs have been imported to the country and distributed during the fiscal years of 1980-82. A total amount of 17,920,780.70 Ethiopian Birr was spent both for buying the drug and cost of inoculation (TCS, 1983).

According to Lemecha (1994), an indication of some US $ 1.5 million is annually spent on the importation of trypanocidal drugs. This budgetary allocation is regular every year although insufficient to make any strong impact on tsetse research and control. The losses in livestock and overall agricultural development are estimated to exceed USD 236 million annually (Vreysen *et. al.,* 1999). The general situation in Ethiopia regarding animal trypanosomosis is therefore found to be very serious and of great national concern which requires to be adequately redressed (Lemecha, 1994).

3. MATERIALS AND METHODS

3.1. Study area

3.1.1. Description of the area

The present study on the epidemiology of bovine trypanosomosis was conducted in two districts of Oromia, namely Goro and Ameya-Kota from the Southwest Shoa Zone of Oromia National Regional State, South West Ethiopia. For the study three adjacent main sites, namely Goro, Ameya and Kota consisting of two peasant associations each were selected. The two peasant associations selected for the three study sites are Burka and Adami, Arba-saden and Mari-magari, and Robahi and Gimbi for Goro, Ameya and Kota, respectively.

The two adjacent study districts were selected purposely based on the extent of the existing problems and the complaints of farmers in both districts. The three study sites (Goro, Ameya and Kota) are bordering each other and intercepted by the Walga River and its tributaries. The study site is situated about at a distance of 160, 185 and 205 Southwest of Addis Ababa, respectively. The altitude of the districts ranges from 1500 to 1700 m.a.s.l receiving an average annual rainfall of 1200-1500 mm during the long rainy season extended from June to nearly the end of September with a mean average temperature of 27 ^{0}C, and relative humidity of 30-80 %.

The area is covered with a variety of vegetation pattern of cultivated land, bush, savannah grassland, and patches of dense forests and strips of riverine forests along the riverbanks. Oromia is one of the five regions of Ethiopia infested with tsetse flies. The tsetse distribution in Oromia is unique in nature that all the five tsetse fly species reported in Ethiopia are found along the main river basins of Oromia. Almost all the major rivers of Ethiopia, which originate or pass through the Oromia, region have tsetse and trypanosomosis. The Ghibe and Walga basins, which are known for their high tsetse challenge and trypanosomosis, are adjacent to Goro and Ameya-Kota districts, where the current prevalence study was conducted. The levels of tsetse challenge are supposed to be medium to high because of its vicinity to tsetse challenge areas.

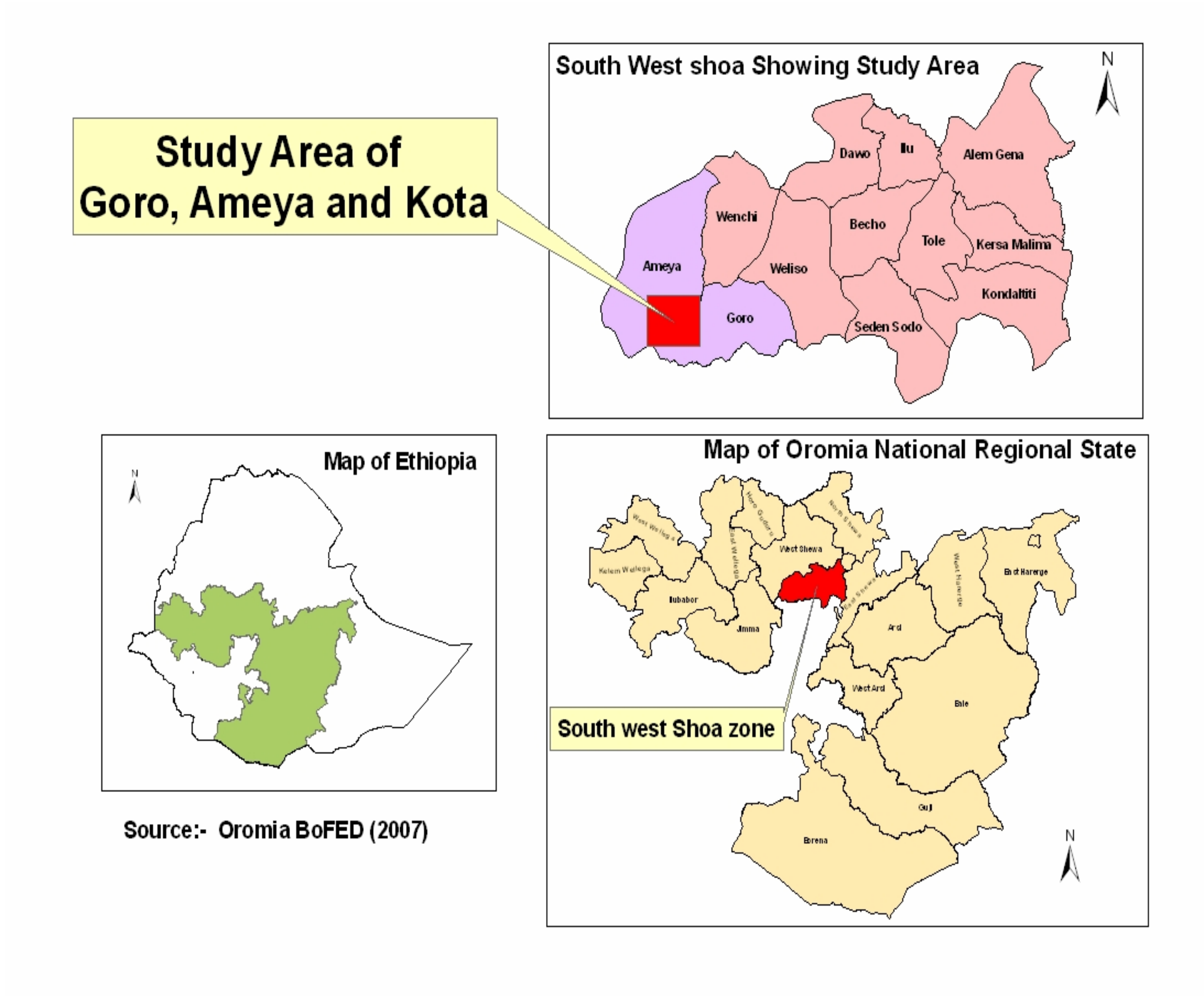

Figure 4: Map of Ethiopia and Oromia National Regional State Showing the study Area

3.1.2. The Scio-economic and farming system in the area

Agriculture is the mainstay of the livelihoods of the settlers with the mixed crop-livestock farming system. Livestock play an important role in the agricultural activities whose main functions are to provide meat, milk, cash income, transportation and source of traction power whereby draught oxen are the key animals for the production of food crops. The Climate is characterized by wet and dry seasons with ample rainfall in the rainy seasons and conducive for agricultural practices. The coverage of vegetation in the districts varies from the highland to the lowland. In the highland there are naturally grown and artificially planted dense forests distributed in scattered condition including shrubs and bushes. Open woodland forest and riverine forest along the river banks mostly covers the area in the mid altitude and open wood grass land savanna is widely available in the ecosystem. Agriculture is the most important economic sector in the districts. About 95% of the farmers practice mixed farming condition on labour-intensive base. The crops commonly produced in the areas are maize, teff, sorghum, millet, wheat, barley; pulses are produced among others ARDOSWSHZ, (2007).

The main livestock constraints in the study area include livestock diseases (Trypanosomosis, internal and external parasites, black leg, pasteurellosis, anthrax and abortion). There is a limited modern veterinary service. Above all vector-borne trypanosomosis particularly tsetse-transmitted trypanosomosis is the most widespread disease in the study area (Goro and Ameya-Kota). The Cattle population in the two districts is estimated to be 57,673 and 156,527 for Goro and Ameya-Kota, respectively. Totally there are about 214,200 heads of cattle contributing significantly to the economy and hence in the study area ARDOSWSHZ, (2007). Therefore, animal rearing plays an essential role in providing traction power, generating cash as income and for home consumption.

3.2. Study Population

The study population in the three sites together constitutes 6,700 indigenous East African zebu breeds managed under smallholder mixed crop livestock farming system. They are kept under traditional extensive husbandry system with communal herding. During the day, cattle are herded together and looked after by herd's men. Animals work usually during the morning, particularly during wet season and graze the rest of the days. They are watered in small and big rivers. Cattle return to their owner's farmstead in the evening. Male cattle over three years of age are used as ploughing oxen. They are also classified into three age groups on the basis of the age composition of the source population. The first group composed of animals less than one year, the second and third groups categorizing animals of 1 to 4 and above 4 years old, respectively ARDOSWSHZ, (2007).

3.3. Study Design and Methodology

3.3.1. Sampling method and sample size determination

The sampling method applied in the present study was a multi stage random sampling. The two districts namely Goro and Amey-Kota were selected purposely based on the extent of the existing problems, the complaints of farmers and the level of medium to high tsetse challenge in the areas. The subjects have been selected randomly from the population up to the household-cattle level whereby all the animals in the selected areas had equal chances to be selected for this study (Thrusfield, 1995). The sample size was determined using Winepiscope 2.0: improved epidemiological soft ware for veterinary medicine based on the expected prevalence rate of 20% and absolute desired precision of 5% at confidence level of 95% study (Thrusfield, 1995). As a result, a total of 843 animals were needed to be sampled in both seasons. But in case of multi stage random sampling the larger the sample size the more accurate the result will be. Therefore, in order to increase the representativeness of study animals, sample size of 1200 animals were considered. Thus, the optimum sample size required for trypanosomosis prevalence study was a total of 1200 animals (600 in late rainy season and 600 in the dry season).

3.3.2. Cross-sectional study

A cross-sectional study was conducted to determine the prevalence of bovine trypanosomosis and seasonal dynamic of tsetse population and other biting flies in late rainy and dry seasons, which covered the period from October to November 2007 and from February to March 2008, respectively.

Parasitological Survey: To determine the seasonal prevalence of bovine trypanosomosis and to estimate the potential risk factors associated with the disease in the study areas, a cross-sectional parasitological survey has been conducted. The survey was performed twice during the study period in the late rainy season and the dry period. Sample collection and parasitological examination were performed according to the following two procedures. Procedure one: blood sample was collected after properly securing the animal and aseptically by puncturing with the tip of lancet on the marginal of ear vein followed by filling heparinized capillary tubes. Pair of capillary tubes were filled three fourth of their length (Murray et al., 1977). Procedure two: parasitological examination was used to determine the prevalence of trypanosomosis by undertaking the buff coat /phase contrast/ dark ground technique (BCT) as described by (Murray et al., 1977). After blood samples were taken the capillary tubes were sealed by using cristaseal at one end. The blood in the capillary tubes were centrifuged at 12,000 revolutions per minute (rpm) for five minutes and consequently the PCV of each sample were taken by using a hawksley micro-haematocrite reader. The capillary tubes were cut 1 cm below the buffy coat intersection to include the top layer of red cells. The content of the capillary tubes was then expressed on to a clean microscope slide, mixed and covered with 22 x 22 mm cover slip. Then, the slide was examined using a microscope with 25 x objective. Confirmation of trypanosome species by morphological characteristics was done after staining the blood smear with Giemsa and examination with oil immersion microscopy with 100x power of magnification (Murray et al., 1977). All the relevant data (owner of the animal, village, species of trypanosome detected, number or identification of the animals by farmer, parasitaemic and aparasitaemic animals, PCV values, age and sex of the animals were recorded for analysis. Animals found positive for trypanosomes were reported to the owner and the nearby veterinary clinic.

Entomological Survey: to assess the apparent densities, distributions and species of tsetse flies and other biting flies the entomological data were collected twice in late rainy and dry seasons of the year 2007/08. Mono-conical traps baited with acetone, octenol and three-week-old cow urine (Brightwell et al., 1992) were used to assess the fly density. Site selection was done to include suitable tsetse habitats like savannah area, river valleys, livestock grazing areas and watering points and wild game reserve areas.

In all study sites a total of 90 mono-conical traps (Annex 4), 45 in each season were deployed early in the morning and maintained in position for 24 hrs at six different sites in late rainy and in dry seasons at the same trapping sites. The cages from these traps were emptied daily. Caught tsetse flies and other biting flies were counted, identified, sexed and live flies have been dissected for trypanosome detection using the methods of Lloyd and Johnson, (1924) and for other biting flies according to their morphological characteristics such as size, color, wing venation structure and proboscis at the genus level (Walle and Shearer, 1997). During trapping, acetone and octenol were dispensed from open small vials through an approximately O-sized hole while cow urine from open bottles was inserted with filter paper to facilitate odour diffusion. All odours were placed on the ground about 15 cm upwind of the traps. The trap poles were greased to avoid the entry of insect predators like ants. Fly challenge has been taken as the product of the relative density of tsetse flies, their trypanosome infection rates and the proportion of feed that they have taken from domestic livestock. Average ageing of tsetse was done by categorizing the degree of wear of wings on scales of 1-6 using wing fray method described by Jackson, (1946) and Challier, (1965). Sexing was done just by observing the posterior end of the ventral aspect of the abdomen by stereoscope: male flies were identified by enlarged hypopygium in the posterior ventral part of the abdomen. Tsetse apparent density is the mean catches in traps deployed, expressed as the number of tsetse fly catch/trap/day (Leak *et al.*, 1987).

3.3.3. Questionnaire survey

The questionnaire survey has been tested in the field before administered to individual farmers. The types of questions included in the question survey were open and close ended types. As much as possible leading questions were avoided to get reliable information about the disease. For the present questionnaire survey a total of 300 randomly selected and volunteer farmers from the study sites were interviewed. Another is that the researcher is able to speak, write and understand Afan-Oromo (Regional and working language of Oromia National Regional State), therefore bias due to interpretation was avoided. The questionnaire survey set to be interviewed to individual farmers comprises the perception of the farmers on the occurrence of tsetse and trypanosomosis, livestock constraints, livestock management and herd structure, control method of trypanosomosis and the vector tsetse fly, treatment and use of trypanocidal drugs and source of trypanocidal drugs as well as delivery of the drugs for treating their animals. The structured questionnaires to interview individual farmers during the study are shown in Annex 1.

3.4. Data Management and Analysis

Data from trypanosome infection survey, entomological (vector fly) and questionnaire survey, were collected and entered in to MS excel spread sheet programme to create data base. For the analysis of data statistical software programmes: Inter cooled stata 7.0 and SPSS 11.5 for windows and winepiscope 2.0 versions were used.

Parasitological (data on trypanosome prevalence) were analyzed by applying chi-square test to evaluate the association with different variables like age, sex and seasons. Data collected on PCV values were analyzed by two sample t-test to compare the mean PCV values of parasitaemic and aparasitaemic animals. Entomological (vector survey data) were analyzed by using ANOVA to compare seasonal mean catches. In all cases differences between parameters have been tested for significance at probability levels of 0.05 or less. The result of the questionnaire survey was analyzed by using descriptive statistics to compute or calculate frequency of responses and percentage to summarize the data.

4. RESULTS

4.1. Parasitological Survey

4.1.1. Trypanosome infection and prevalence

The prevalence of trypanosomosis during the late rainy season was 33.5% (201 infected out of 600) (95% CI= 0.33-0.45) of which 61.19 % (95% CI= 0.63-0.86) was *T. congolense* infection. *Trypanosoma vivax* infection was 34.32% (95% CI=0.26-0.87) and mixed infection (*T. congolense* and *T. vivax*) was 4.49% (95% CI= 0.01-0.17). Similarly, in the dry season the prevalence was 17.83% (106 infected out of 600) (95 % CI = 0.17-0.0.29) of which *T. congolense* was 58.49% (95% CI= 0.24-0.43), 32% (95 % CI = 0.11-0.38) for *T. vivax* and the remaining infection 9.51% (95 % CI = 0.02-0.29) were due to mixed infection (*T. congolense* and *T. vivax*) (Table 3).

Table 3: Prevalence and trypanosome species identified in the late rainy and dry seasons in the study area

Season	Total Infected	Total sampled	Prevalence rate (%) and trypanosome species			
			T. c (%)	*T. v (%)*	Mixed (%)	Prevalence
Late rainy	201	600	123(20.5)	69(11.5)	9(1.5)	33.5%
Dry season	106	600	62(10.66)	36(6)	8(1.33)	17.83%
Total	307	1200	185(15.58)	105(8.75)	17(1.42)	25.66%

T. c= T. congolense, T. v =T. vivax; Mixed refers = *T. congolense* and *T. vivax*

The risk of infection with trypanosomes during the dry season was lower than the late rainy season, with a statistically significant difference for *T. congolense* infection in both seasons ($p<0.05$); where as there was no statistically significant difference observed in mixed infection *T. congolense* and *T. vivax*) ($p >0.05$).

Table 4: Prevalence of trypanosomosis in male and female cattle during the late rainy and in the dry seasons

Season	Sex groups	Total Infected	Total sampled	Trypanosome species identified			
				T. c	*T .v*	Mixed	Prevalence
Late rainy	Male	138	412	85	47	6	33.495%
	Female	63	188	38	22	3	33.510%
	Total	201	600	123	69	9	33.5%
Dry season	Male	73	412	43	25	5	17.72%
	Female	33	188	19	11	3	17.55%
	Total	106	600	62	36	8	17.64%

T.c= T. congolense, *T.v= T. vivax;* Mixed refers = *T. congolense and T. vivax*

During the late rainy season the prevalence of trypanosomosis infection in male cattle was 33.495% (95% CI= 0.22-0.56) and 33.5% (95% CI= 0.13-0.30) for female and the difference was not significant difference ($p >0.05$) (Table 4). Similarly, the prevalence of trypanosomosis infection was 17.72% (95% CI = 0.36-0.90) for male and 17.55% (95% CI = 0.95-1.05) for female during the dry season, there is also statistically not significant difference ($p>0.05$) between sex groups. In both seasons the prevalence of trypanosomosis in sexes groups was proportionally the same. But the prevalence of trypanosomosis infection between the late rainy season (33.5%, 95% CI = 0.68-1.71) and the dry season (17.64%, 95% CI = 0.24-0.62) was significantly different ($p<0.05$).

Table 5: Prevalence of trypanosomosis in different age groups of cattle in the late rainy and dry seasons

Season	Age group	Total Infected	Total sampled	Trypanosome species diagnosed			
				T. c	*T. v*	Mixed	Prevalence
Late rainy	<1 year	16	75	5	9	1	21 %
	1-4 years	57	197	39	15	4	29 %
	>4 years	101	328	59	36	6	31 %
	Total	174	600	102	61	11	27 %
Dry season	<1 year	12	75	4	7	1	16 %
	1-4 years	44	197	24	18	2	22 %
	>4 years	77	328	52	22	3	24 %
	Total	133	600	80	47	6	21 %

In the late rainy season higher infection rate was observed in older animals (>4 years) with a percentage of 31% (95% CI= 0.84-1.19) than calves (<1year old) with a value of 21% (95% CI= 0.11-0.30) the difference of which was significant ($p<0.05$) (Table 5).

In the dry season relatively, lower infection was observed in calves (<1year old) 16% (95% CI= 0.17-0.47) and in adult animals (1-4 years old) 22% (95% CI= 1.51-2.02) than older animals (>4 years old) 24% (95% CI= 2.8-3.2). However, the difference in prevalence among age groups was not significant ($p> 0.05$).

4.1.2. Hematological finding

The mean PCV (%) values of parasitaemic and aparasitaemic animals during the late rainy season was 20.19 % (95% CI=18.72-21.64) and 26.75% (95% CI=25.34-26.18) while during the dry season 18.75 % (95% CI=17.85-19.63) and 23.97% (95% CI=23.52-24.40) respectively. There was a statistically significant difference in mean PCV values between seasons ($p<0.05$) (Table 6).

Table 6: Mean PCV (%) values of parasitaemic and aparasitaemic cattle in late rainy and dry seasons in the study area

Season	Mean PCV value of parasitaemic	Mean PCV value of aparasitaemic
Late rainy	20.19% (95% CI= 18.72-21.64)	26.75% (95% CI= 25.34-26.18%)
Dry season	18.75% (95%CI= 17.85-19.63)	23.97% (95% CI= 23.52-24.40)
Overall	19.47% (95% CI= 18.85-19.98)	25.36% (95% CI= 24.95-25.66)

The overall mean PCV values were also significantly different between parasitaemic and aparasitaemic animals 19.47% (95% CI=18.85-19.98) and 25.36% (95% CI=24.95-25.66 ($p<0.001$), respectively. The range of PCV values in parasitaemic animals was from 10-32% and in aparasitaemic animals was from 12-38% in the late rainy season while in the dry season was from 10-24% in parasitaemic animals and 11-35% in aparasitaemic animals.

4.2. Entomological Survey

4.2.1. Fly collection

To assess tsetse apparent density, distribution and species prevailing as well as other biting flies in the study area 90 mono-conical traps were deployed based on both seasonal surveys and a total of 3385 flies were caught in the late rainy and dry season. By deploying 45 mono-conical traps in each season 1944 and 1441 flies were caught in the late rainy and dry seasons, respectively (Table 7). The tsetse flies found during the study period were *Glossina pallidipes*, *Glossina m. submorsitans*, *G.f.fuscipes* and other biting flies like *G. tabanids* and muscids groups were also caught along with the tsetse flies and in areas where tsetse flies were not caught.

Table 7: Different flies catch in the late rainy and dry seasons in the study area

Season	Tsetse fly (%)	Biting flies %		Total
		Tabanids (%)	Muscids (%)	
Late rainy	243 (12.5)	126 (6.48)	1575 (81.02)	1944
Dry Season	107 (7.43)	65 (4.51)	1269 (88.06)	1441
Total	350 (9.98)	191 (5.49)	2844 (84.54)	3385

Of the total fly catch tsetse flies accounted for 12.5% and 7.43%) while tabanids accounted for 6.48% and 4.51% and Muscids covers 81.02% and 88.06%, during the late rainy and dry seasons, respectively. The tabanid flies include: *Tabanus, Haematopota* and *Chriosops* while the majority of muscids were *Stomoxys.*

Relatively higher mean catch (5.40) and higher apparent density (2.87) were obtained during the late rainy season than (2.37) and (1.26) in the dry season, the difference of which was statistically significant ($p<0.05$) (Table 8).

Table 8: The apparent density of tsetse flies in the late rainy and dry seasons

Seasons	Tsetse flies caught	Total caught	Mean caught	Apparent density	95% CI
Late rainy season	*G.Pallidipes*	89	1.98	1.05	0.08-3.09
	G.morsitans	22	0.49	0.26	0.06-0.46
	G.fuscipes	132	2.93	1.56	0.90-2.22
	Total	243	5.40	2.87	0.04-5.77
Dry Season	*G.Pallidipes*	48	1.06	0.56	0.08-1.04
	G.morsitans	9	0.20	0.11	0.03-0.19
	G.fuscipes	50	1.11	0.59	0.34-0.84
	Total	107	2.37	1.26	0.45-2.07

Mean catches = fly/trap, Apparent density = mean fly caught/trap/day

The apparent density of tsetse flies in late rainy season and in the dry season was *G. pallidipes* 1.05 fly/trap/day (95% CI = 0.08-3.09), *G. m. submorsitans* 0.26 (95% CI = 0.06-0.46), *G.f.fuscipes* 1.56 fly/trap/day (95% CI = 0.90-2.22), and 0.56 fly/trap/day (95% CI= 0.08-1.04), 0.11 fly/trap/day (95% CI= 0.03-0.19) and 0.59 fly/trap/day (95% CI= 0.34-0.84), respectively, with a statistically significant difference ($p< 0.05$). The overall apparent densities of tsetse flies were found to be fly/trap/day 2.87 (95% CI= 0.4-5.77%) and flay/tap/day 1.26 (95% CI= 0.45-2.07%) in late rainy and dry seasons, respectively (Table 8). *G.f.fuscipes and G.pallidipes* appears to be dominant during the course of the study period, where as the apparent density of *G.m.submorsitans* was lower than *G.pallidipes* and *G.f.fuscipes.*

A higher number of tsetse flies were caught during late rainy season, and there was statistically significant difference between seasons in the apparent density of tsetse ($p<0.05$).

Table 9: The apparent density of biting flies caught during the late rainy and dry seasons

Seasons	Biting flies	Total caught	Mean caught	Apparent density	95% CI
Late rainy season	Tabanids	126	2.8	1.49	0.56-2.39
	Muscids	1575	35	18.66	13.67-23.64
	Total	1701	37.80	20.15	14.23-26.03
Dry Season	Tabanids	65	1.44	0.77	0.34-1.20
	Muscids	1269	28.20	15.04	10.52-19.55
	Total	1334	29.64	15.81	10.86-20.75

Mean fly caught = fly/trap while apparent density = mean fly caught/traps/day

Also the apparent densities of biting flies were significantly higher ($p<0.05$) in late rainy season (1.49 fly/trap/day, 18.66 fly/trap/day) than in the dry season (0.77 fly/trap/day, 15.04 fly/trap/day) for tabanids and muscids, respectively, and the overall apparent densities of biting flies were found to be 20.15 fly/trap/day (95% CI= 14.23-26.03%), and 15.81 fly/trap/day (95% CI= 10.86-20.75%) in late rainy and dry seasons, respectively (Table 9).

Table 10: Total tsetse and species caught during late rainy and dry seasons in the study area.

Season	Total tsetse flies caught			Total percentage
	G.p	*G.m.m*	*G.f.f*	
Late rainy	89	22	132	243(69.43%)
Dry season	48	9	50	107(30.57%)
Total	137(39.14%)	31(8.85%)	182(52%)	350(100%)

G.p. = Glossina pallidipes, G.m.m. = Glossina morsitans, G.f.f. = Glossina fuscipes

The mean catch of tsetse flies caught between late rainy and the dry seasons was statistically significantly different ($p < 0.05$) (Table 10).

Observation of male and female tsetse: A total of 350 tsetse flies 243 and 107 were caught during the late rainy and the dry seasons, respectively, were subjected for sexing in the late rainy season 97 males (39.91%) and 132 females (60.08%) were observed while in the dry season 37 males (34.57%) and 70 females (65%) were observed with a significant statistical difference ($p<0.05$) between the two sexes in both seasons (Table 11).

Table 11: Percentages catch of male and female tsetse flies during the late rainy and in the dry seasons

Season	*G.pallidipes (%)*		*G.m.submorsitans (%)*		*G.f.fuscipes (%)*	
	Male	Female	Male	Female	Male	Female
Late rainy	37(42)	52(58)	10(45)	12(55)	50(38)	82(62)
Dry season	16(33)	32(67)	4(44)	5(56)	18(36)	32(64)
Total	53(37.5)	84(62.5)	13(44.5)	18(55.5)	68(37)	114(63)

Dissection of tsetse flies: Out of a total of 58 tsetse flies dissected (*G.pallidipes* 19, *G.m.submorsitans* 11, and *G.fuscipes* 28), 24 (41.38 %) were found to be infected with trypanosomes. The infection rates for *T.conglense* were more frequent 17 (70.83%) than *T. vivax* 7 (29.17%) (Table 12).

Higher infection rates were observed in *G.pallidipes* (66.66 %) followed by *G.m.submorsitans* (50 %) and *G.f.fuscipes* (25 %) in the late rainy season. In the dry season 57%, 40% and 25%, infection rates were recorded for *G.pallidipes*, *G.m.submorsitans* and *G.f.fuscipes*, respectively.

In both seasons *G.Pallidipes* appeared to be the active transmitter of the disease in the study area. The overall infection rates recorded by dissection were 44.12 % and 37.5 % in the late rainy and in the dry season, respectively.

Table 12: Infected tsetse flies observed during the dissection in both seasons in the laboratory

Tsetse Species	Season	Dissected	*T.C (%)*	*T.V (%)*
G.Pallidipes	Late rainy	12	5 (41.7)	3(25)
	Dry	7	2 (28.6)	2(28.5)
	Total	19	7(36.8)	5(26.3)
G.m.morsitans	Late rainy	6	2 (33.3)	1(16.6)
	Dry	5	1(20)	1(20)
	Total	11	3(27.3)	2(18.2)
G.f.fuscipes	Late rainy	16	4(25)	-
	Dry	12	3(25)	-
	Total	28	7(25)	-

T.c = Trypanosoma congolense, T.v = Trypanosoma Vivax

4.3. Questionnaire Survey

All the interviewed farmers responded to the structured questionnaire. A total of 300 randomly selected and volunteer farmers were interviewed and they were entirely the farming communities and livestock keepers. About 85% of the respondents started to live in the present study area since they were born, except some framers who came to the study areas in the settlement program during the previous "Derg" regime because of the combined effect of lack of farm land and prevailing drought condition for seeking fertile land.

About 100% of the respondents' livelihood depends on mixed crop livestock production system. Therefore, in the study areas livestock are the integral part of agricultural activity and are used as food, source of income and for transport purposes. The composition of livestock species in the study areas were cattle (80%), small ruminants (15%) and equines (5%). The average numbers of cattle were 3 to 5 cattle/household and the cultivated land was 2 hectares/household level.

The results of the questionnaire survey revealed that cattle, sheep, goats and equines are common livestock kept by farmers in the study area. Cattle are kept in herds. Feed is less available in the dry season due to shortage of grazing land. Better feed is available during the late rainy season and early rainy season when the pasture is green and the feed biomass is relatively high. Livestock are reared primarily for draught purposes, source of income, for milk and meat, and for transport purposes. The herd is kept together for grazing by the herdsman and watering in the day time and at night time is kept in their owner's barn locally called "dalla". Milking is carried out in their barn at 7 am in the morning and 6 pm in the afternoon by the wife of livestock keepers. About 50 % of the respondents grazed and watered their animals by trekking 3 to 5 km away from their homestead during the dry period.

The main livestock constraints in the study area include livestock diseases, shortage of grazing land and scarcity of modern veterinary services. Based on the interview result the main livestock diseases in order of importance are: trypanosomosis, blackleg, pasteurellosis, anthrax, internal and external parasites and abortion. Trypanosomosis locally known as "Koksa" or "Gendi" in Oromo language is the most important disease affecting their livestock production and productivity. All of the interviewed farmers indicated that bovine trypanosomosis ranks first as the major animal health constraint impairing agricultural development in the study area and they have shown that the occurrence of trypanosomosis is high during the rainy season (early and late rainy season).

Concerning knowledge of disease transmission, 60% of the farmers responded that biting flies (tabanids and muscids) and other flies identified as small in size, brown in colour which bites their animals while grazing and watering in the forest and savanna vegetation types, the tsetse flies are responsible, while 40% do not know anything about the vector for trypanosomosis. The main clinical signs of trypanosomosis as told by the interviewed people included, ruffled hair coat, diarrhea, emaciation, weakness, unwilling to move, depression, inappetence and abortion.

The impacts of trypanosomosis are: loss of draught power, abortion, and reduced fertility, loss of milk and meat production and mortality.

From the total interviewed, about 65% of the respondents have treating their animals using trypanocidal drugs, as a sole means of control and managing the disease. Animals that showed clinical signs are diagnosed and injected at government and private veterinary clinics by animal health assistants. Diminazene aceturate (Berenil) and isometamidium chloride (trypamidium) have been used extensively. About 35% of the respondents have reported that they were using as a treatment different types of trypanocidal drugs but buy from illegal traders on market days and these illegally smuggled trypanocidal drugs in the study area are called "Shiro" by the local community.

In respect to frequency of treatment, during the long rainy season and when their cattle showed clinical signs and emaciation 10%, 72%, 15% and 3% cattle are treated once, two times, three times and more than three times per month, respectively.

Percentage of frequency treatment per month responded by interviewed farmers

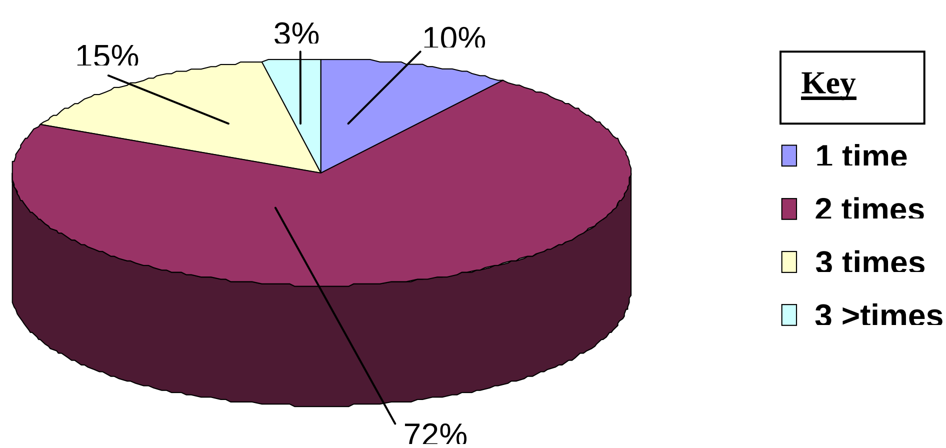

Figure 5: Frequency of treatment for the control of trypanosomosis in the study area

The curative efficacy of trypanocidal drugs was reported to be good by 30% of the respondents, very good by 20%, poor by 45% of the respondents and unknown by 5%. For this reason frequent treatment of drugs was a conventional solution accepted by the respondents.

Percentage of efficacy trypanocidal drugs on cattle clinically treated

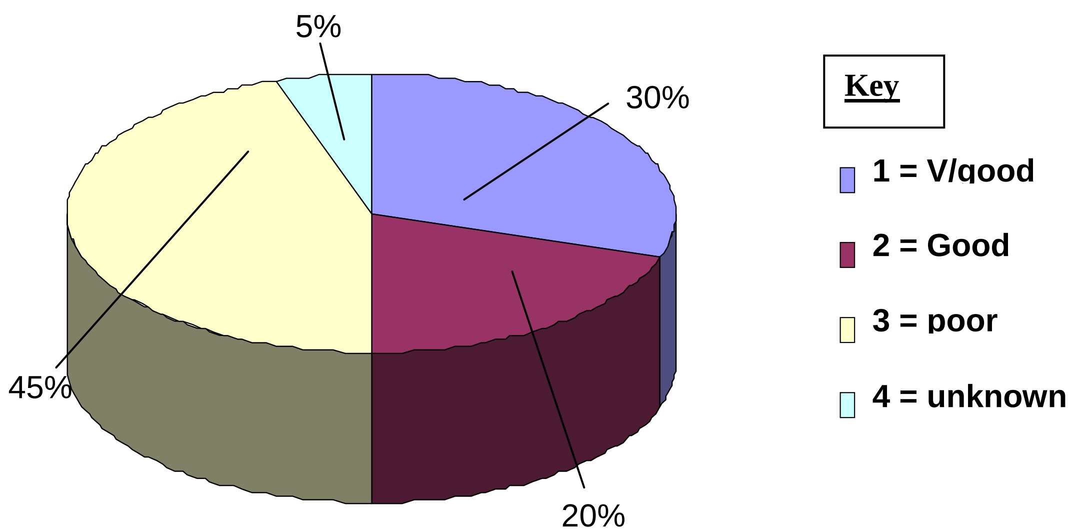

Figure 6: Efficacy of trypanocidal drugs responded by the interviewed farmers

5. DISCUSSION

The highest prevalence of trypanosomosis observed in the present study was found to be in agreement with the previous studies. The most prevalent trypanosome species in tsetse infested areas of Ethiopia are *T. congolense, T. vivax* and *T. brucei.* Rowlands *et al.,* (1993) reported a prevalence of 37% for *T. congolense*, in Southwest Ethiopia. Similarly Abebe and Jobre (1996) reported an infection rate of 58% for *T. congolense*, 31.20% for *T. vivax* and 3.5% for *T. brucei* in Southwest Ethiopia. In the same report it was also reported that 8.71% prevalence was recorded in the high lands of tsetse free area of which 99% was due to *T.vivax.* In Metekel district, different workers (Afework, 1998; Muturi, 1999; Tewelde, 2001) reported prevalences of 17.2% and 17.5% in the upper Didessa valley and southern rift valley areas of tsetse infested regions, respectively, where the dominant species was *T. congolense.*

In the present study, there was higher prevalence of trypanosomosis in both the dry (17.66%) and late rainy (33.5%) seasons; however, the difference between them was statistically significant ($p < 0.05$). Similar results were reported by Muturi (1999) in North Omo Zone, that was 21.2% and 14.2% in the late rainy and in the dry season, respectively. This might be attributed to the difference in tsetse apparent density and infection rates in both seasons. It is known that the risk of trypanosomosis is influenced by tsetse apparent density and infection rate in flies. Riordan (1977) demonstrated that a high tsetse apparent density and infection rate of 50% in tsetse results 42% trypanosome prevalence in cattle exposed to tsetse flies.

The dominant species in this study was 20.5% and 11.5% for *T. congolense,* and 10.6% and 6% for *T. vivax* during the late rainy and in the dry season, respectively. The same trend is also reported by Rowlands *et al.,* (1995) that was *T. congolense* (66.17%) followed by *T. vivax* (20.8%) in Southern Rift Valley of Ethiopia during the late rainy season. In Ghibe prevalence 84% and 14% was recorded for *T. congolense* and *T. vivax,* respectively (Muturi, 1999., Rowlands *et al.,* 1995). In Northwestern and Southwestern Ethiopia the dominant species was *T. congolense* (Afework, 1998; Abebe and Jobre, 1996; Tewelde, 2001). The predominance of *T. congolense* infection in cattle may be due to the high number of serodems of *T. congolense* as compared to *T. vivax* and the development of better immune response to *T. vivax* by the infected animal (Mac lennan, 1970 Leak *et al*., 1999). In addition the result agrees to the known "Vivax Ratio" (Ford, 1976) in cattle in which the area affected by the species of tsetse *G. pallidipes* and *G. morsitans* are efficient in the transmission *T. congolense* than *T. vivax* in Africa (Langridge, 1976). Similarly, in the present study *G. pallidipes* and *G. morsitans submorsitans* caught might increase the infection due to *T. congolense*.

Different workers reported that higher infection rate was observed in male cattle than in female (Afework, 1998; Muturi, 1999; Tewelde, 2001) and the possible suggestion to this finding could be that male animals are more used for draught purposes; travel long distances for draught in an area of tsetse challenge and as a result the risk of contracting trypanosomosis is high. In the present study, sex was not found to be one of the risk factors and it was not in agreement with the previous studies and this finding could be in high tsetse challenged areas both males and females can be affected uniformly.

In this study age was also found to be one of the risk factors. A higher infection rate was observed in adult animals and animals above one year of age in the study area. This could be associated to the fact that animals travel long distance for grazing and draught as well as harvesting crops in areas of high to tsetse challenge. (Rowlands *et al,*. 1995), in Ghibe valley indicated that suckling calves don’t go out with their dams but graze at homesteads until they are weaned off. Young animals are also naturally protected to some extent by maternal antibodies (Fimmen *et al.*, 1992). This could result in low prevalence in calves. *T. congolense* infection is a chronic disease increasing with age of animals. *T. congolense* infection is usually higher in adult animals than young (Mc Dermott *et al*., 2003). Rawlands *et al., (*1995) found that cows $\geq$ 9 years old had 1.2 times higher trypanocidal drug treatment than < 3 years old animal. This is an indication of higher risk of trypanosomosis in adult animals than the young/calves.

In the present finding the overall mean PCV values for parasitaemic cattle was 19.47% while in aparasitaemic 25.36% was recorded. The same trends of mean PCV values were reported for parasitaemic and aparasitaemic animals by other researches. Muturi (1999) obtained the mean PCV values of 16.7 % and 28.0 % in North Omo Zone; Feyisa (2004) reported 21.65% and 25.54% in southwest Ethiopia for the parasitaemic and aparasitaemic; Takele (2006) reported 20.22% and 27.23% in selected sites of East Wollega Zone, Tekle (2007) recorded 18.8% and 24.8% in cattle, respectively. Therefore, the infection of trypanosome and overall mean PCV obtained between parasitaemic and aparasitaemic cattle animals were significant difference ($p<0.05$).

In this study, trypanosome infection and mean PCV values obtained between parasitaemic and aparasitaemic animals had statistically significant difference. It was in agreement with the previous work done in Ghibe, Southwest Ethiopia where treatment was given for animals with PCV value of less than 26% and for positive animals. Rowlands *et al.,* 2001) indicated that in an increased PCV value, the proportion of positive cases will decrease and hence mean PCV was a good indicator for the health status of the herd in an endemic area and cattle with mean PCV values less than 26% were considered as anaemic which is said to be the principal sign of trypanosomosis. A low mean PCV value in parasitaemic and aparasitaemic animals is reported by several authors (Leak, 1988; Afework, 1998; Muturi, 1999; Tewelde, 2001).

The development of anaemia is one of the most typical signs of trypanosomosis caused by *T. congolense* in susceptible cattle breeds (Murray and Dexter, 1988). The level of anaemia or the PCV usually gives a reliable indication of the disease status and productive performance of an infected animal (Trial *et al.,* 1991b). Bovine trypanosomosis control aims at reducing the prevalence of infection with a concomitant increase in the average PCV (Bauer, 2001). Therefore, the knowledge of relationship between prevalence of trypanosome infection and mean PCV could be a useful tool for the assessment of impact of control on intervention. However, the mean PCV is affected by factors other than trypanosomosis (Conner, 1994) and these confounding factors are not always identifiable but they are likely to affect both trypanosomosis positive and negative animals.

Further analysis of PCV values revealed that 81.6% of all parasitaemic animals had a mean PCV below 26% which agrees with different works (Leak *et al.,* 1993; Rawlands *et al*., 1995; Abebe and Jobre, 1996; Afework, 1998; Muturi, 1999). As anaemia is the classical symptom of the disease pathogencity (Murray *et al.,* 1977; Seifert, 1996) the low PCV in parasitaemic animals could have contributed in reducing the mean PCV for cattle in the dry season.

The consequence of low PCV value may not solely be due to trypanosomosis, however, the difference in mean PCV value between parasitaemic and aparasitaemic animals indicates that trypanosomosis involves in reducing the PCV values in infected animals. Other diseases considered to reduce the PCV values of the animals in the study area include helminthiasis, tick borne diseases and inadequate nutrition. On the other hand, most of the parasitaemic animals in the late rainy season were in good body condition despite having low PCV values. This could be attributed to the fact that animals in the late rainy season were at high plan of nutrition due availability of sufficient pasture.

Conner (1994) indicated that anaemia associated with trypanosomosis causes weakness; sluggishness and lack of energy which ultimately decrease the efficiency of working animals. The consequence of anaemia is one of the most typical sign of trypanosomosis caused by *T. congolense* in susceptible cattle breeds (Murray and Dexter, 1988; Abebe, 1991). Swallow (2000) indicated that animals in tsetse infested areas has lower calving rate, lower milk yield, calf mortality, more treatment with trypanocidal drugs and trypanosusceptible animals can be devastated by sudden exposure to high levels of trypanosomosis risk.

In the present survey there was three species of tsetse detected, namely G.*Pallidipes*, *G.m.submorsitans* and *G.f.fuscipes* with apparent density of 1.05, 0.26 and 1.56 fly/trap/day in the late rainy and 1.05, 0.26 and 1.56 fly/trap/day in the dry season, respectively. Similarly, the apparent densities of tsetse fly reported by Tekle, (2007) in settlement area of Nono district, Oromia National Regional State, Southwest Ethiopia showed that 1.9, 0.37 and 2.37 fly/trap/day in the late rainy and 1.3, 0.2 and 1.8 fly/trap/day in the dry season for G.*Pallidipes*, *G.m.submorsitans* and *G.f.fuscipes*, respectively. The finding of the present study with regard to the prevailing tsetse species in the study area of Goro and Ameya-Kota districts of southwest Shoa Zone, Oromia National Regional state was in agreement with the survey reported in newly established settlement area of Nono district, southwest Ethiopia.

Generally the apparent density of tsetse flies and other biting flies were significantly higher during the late rainy season as compared to the dry season in the present survey. Similar findings reports were reported in previous works (Msangi, 1999; Terzu, 2004; Takale, 2006 and Tekle, 2007). This could be explained by an absolute increase in the number of flies due to favorable environment such as enough moisture, vegetation growth and suitable habitat. In another study Bright well *et al., (*1992) and Leak *et al.,* (1993) reported that the spread of flies from riversides and thickets, where they usually inhabit during the dry season and during the rainy season they increases relative density to more an open areas.

The present study revealed that the apparent tsetse density varies significantly between seasons in parallel with the risk of trypanosomosis. A high tsetse apparent density during the wet season has been reported in Somalia (Mohammad and Diarri, 1987), in Coted'Ivore, Togo, Gabon and Zaire (Leak *et al.,* 1987) and in Ethiopia (Msangi, 1999). The level of infection rate is determined by the density of tsetse fly population in the area and the level of their contact with the host. This is further influenced by the vectoral capacity of the fly and availability of its preferred host, which is not necessarily domestic livestock (Radostits *et al.,* 2000). Similarly, higher tsetse apparent density guide to an increase in trypanosome challenge prevailing during the sampling seasons (late rainy season October 2007 and dry season February 2008) resulted in the study area.

The result of tsetse fly survey agrees with the general knowledge on the ecology of tsetse species found in Southwest Ethiopia. The habitat pattern of the study area was found for the savannah species (*G.m.submorsitans* and *G.pallidipes*) which prefers the savannah grass land, acacia and combritum trees and for the riverine species patchy vegetation, forest and bush land. The savannah species i.e. *G.m.submorsitans* and *G.pallidipes* were concentrated in the savannah and the riverine species was concentrated along the river banks and in the bushes.

Sex ratio and age composition of the flies were assessed and a higher number of female and adult flies were recorded during the present study. According to Msangi (1999), Mohamed and Diarri (1987), and Leak (1999) showed female flies would comprise 70-80% of the mean population. The only host like bait that gave fair representation of the relative abundance of each sex was the traps and odours. The mean age of flies was 34 days in the late rainy season and 27 days in the dry season with wing fray analysis. Wing fray analysis for the estimation of the age of fly population was also supported by Msangi (1999) as compared to ovarian dissection which showed that provided the flies are collected with less than 24 hours. It is more reliable in savanna species than riverine species. *G.Pallidipes* has a higher efficiency in the transmission of trypanosomosis and the potential occupation of the savannah wood land in the valley than *G. M. submorsitans* group (Jordan, 1986).

The results of questionnaire survey revealed that trypanosomosis is the most important problem for agricultural activity and animal production in the two adjacent districts of Goro and Ameya-Kota, Southwest Shoa zone, Oromia National Regional state, Southwest Ethiopia. The livelihood for all interviewed farmers depends on mixed agriculture farming system which is consistent with the general situation of the country where 85% of the population is occupied in the mixed farming system. The majority of the respondents started to live in the present study area since they were born, except for some 15% of framers who came to the study area in the settlement program during the previous "Derg" regime because of the combined effect of lack of farm land and prevailing drought condition for seeking fertile land.

The major type of livestock population reared in the study area was cattle followed by small ruminants and equines. All of the interviewed farmers in the study area invariably reported the seriousness of bovine trypanosomosis, locally known as “Koksa or Gandi”. They said the disease hampering the overall agricultural activity and livestock productivity. Twelde (2001) and Afework (1998) reported the same finding in Western and Northern parts of the country.

Even though trypanosomosis occurs throughout the year, major infections are observed during the late rainy season. Similar results were reported by Afework (1998), Ngare and Muendia (2000) and Tewelde, (2001). Absence of integrated tsetse control activity in the study area generally made the farmers dependable on the use of chemotherapy.

Most of the respondents have been using chemotherapy based on trypanocidal drugs, as a sole means of control and managing the disease and they take their animals to nearby veterinary clinic when their animals showed clinical signs of the disease. About 35% of the respondents have shown that they were using different types of trypanocidal drugs but buy them from illegal traders on market days and these illegally smuggled trypanocidal drugs in the study area are called "Shiro" by the local community.

The available trypanocidal drugs in the study are Diminazine aceturate and Isometamidium chloride and the required dosage for the treatment was not properly known by most of the respondents and they didn't have any idea about the sites of administration. Analogous results were reported by Afework (1998) and Tewelde (2001) where about 48% of the treatments were given below the recommended dose while 52% didn't have any idea. About 70% of the treatment was given for clinical cases and 30% for non clinical cases. Similar results were observed in the Upper Didessa Valley of Ethiopia. Tewelde, (2001) showed 85% of the treatment were given for clinical cases.

On the other hand, careful use of trypanocidal drugs was not strictly followed by the concerned government body. Therefore farmers were supplied the drugs by their money from animal health workers to do the treatment at home while they were ignorant of handling the drug as seen in the study area. Similar results reported by Afework *et al.*, (2000) indicated that the abuse of drugs could certainly lead to a serious consequence of devastating appearance of drug resistant population of trypanosome strains.

In the study area the frequency interval of treatment, during the late rainy season and when their cattle showed clinical signs of trypanosomosis as indicated by 10%, 72%, 15% and 3% of the interviewed farmers their cattle are treated one times per month, two times per month, three times per month and more than three times per month, respectively. Similar results were reported by Tekle (2007) 2 to 3 times per month in the late rainy season as indicated by 80% of the interviewed people. Tewelde (2001) reported 2.5 to 3.5 per month and Afework (1998) reported treatment was delivered every 4 months, where as Uilenberg (1997) reported that the number of treatment over a year reflects the magnitude of trypanosomosis challenge in the area.

6. CONCLUSIONS AND RECOMMENDATIONS

The study conducted on the epidemiology of bovine trypanosomosis in Goro and Ameya-Kota area, Southwest Shoa Zone, Oromia National Regional Sate, Southwest Ethiopia, has provided vital information on the current situation of the disease in the study areas. The results of the present study revealed that trypanosomosis is a serious bottleneck of agricultural activity and animal production in the study area of Goro and Ameya-Kota districts and the situation is getting worse as the control and prevention of trypanosomosis is facing a challenge due to limitation of vector control activities. The prevalence of bovine trypanosomosis was found to be high in adult animals in both seasons and the infection is higher than in the late rainy than in the dry seasons. The most common trypanosome species found in the study area were *T. congolense* and followed by *T. vivax*. The infection rate was higher in adult animals when compared with young animals in both seasons. The overall mean PCV values of parasitaemic and aparasitaemic animals in the study area indicated that poor health status and trypanosome infection has been found to cause further poor body condition by declining the PCV values among the infected cattle. The study also provided information on vector flies as well as their apparent densities and distribution in both seasons. Three types of tsetse flies (*G.Pallidipes, G.m.submorsitans* and *G.f.fuscipes)* were caught during the study period. *G.pallidipes* and *G.m.submorsitans* are considered to be the main vector of the pathogenic trypanosome in the study area. Biting flies such as tabanids and muscids were also caught in the study period. The catchments of vector flies in the late rainy season were much higher than the dry season; likewise a higher number of female tsetse flies were caught during the rainy than the dry season.

Based on the results of this the following recommendations are forwarded:

- Control strategies of trypanosomosis should be centered on the community based; sustainable, simple, cost effective, environmentally affable, integrated approach (vector control and chemotherapy) and attention should be given towards the awareness creation of the disease in the study area.

- Attention should be given towards control and treatment strategies of trypanosomosis. Hence, proper and strict follow-up of trypanocidal drugs and treatment in the study area should be conducted by professionals and field supervision should be practiced by experts.

- In general, concerned government offices should give special attention to the distribution and delivery of veterinary drugs especially trypanocidal drugs in order to avoid misuse and to control the risk of trypanocidal drug resistance in the study area.

- Further studies should be carried out on the economic impact assessments of the disease and on trypanocidal drugs efficacy for the overall control of tsetse transmitted trypanosomosis in Goro and Ameya-Kota districts.

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8. ANNEXES

Annex 1: Structured questionnaire to interview individual farmers

A. General information

1. Full name of the farmer --
2. Village or peasant association --
3. Name of the district --
4. Date interviewed ---

B. History of individual farmer

1. When did you settle in this area and what are your main activities? ---------------------------------
----
----
2. Where did you come from and how long lived in this area? ---
----
----
3. If you are settler for this area, why did you leave your previous home place? A) Draught; B) Lack of farmland; C) Disease epidemics; D) Civil conflict E) Forced to come F) if other specify

C. Livestock Management

1. Which livestock do you keep? A) Cattle, B) Small ruminant, C) Both A and B D) Others
2. Name dominant livestock species in the area owned by the farmer?

----
3. How do you manage cattle? A) Free grazing B) Tether C) Stall feed D) if any describe ---------
----

----

4. If cattle are allotted to free grazing scheme, are they in herd or in small group?

----

5. What is the source of watering? Is there is scarcity of water in the area? --------------------------

----

----

6. Is there seasonality in the availability of watering for livestock? If yes, describe ----------------

----

----

7. How long is the distance of watering point from the grazing area? --------------------------------

----

----

8. How long is the distance of watering point from the cattle shed /barn? ----------------------------

----

----

9. In which season /month of the year is most livestock feed most available? -----------------------

----

----

10. In which season /month is least feed available? ---

----

11. Can you mention the feed types available in different season?

Season	Feed type
-----------------------------------	---
-----------------------------------	---
-----------------------------------	---

D. Disease occurrence in the study area

1. What are the most common diseases affecting your livestock? Write in order of importance.

----

2. If trypanosomosis is in the list of common diseases, indicate frequency of occurrence.----------
----

----

3. Species most commonly affected by trypanosomosis (Gandi) a) Cattle b) Small ruminant c) Other (specify) ---
----

4. What signs do you commonly observe when your animals get sick with trypanosome (Gandi)?

----

5. Does the disease (trypanosomosis) cause mortality in your herd? If yes, how many animals will die due to the disease from the herd? ---
----

6. Is there seasonality of occurrence of trypanosomosis in the area? ----------------------------------
----
----

7. Was trypanosomosis present when you settle in this area? A) Yes, B) no. If yes, what do you expect for the occurrence trypanosomosis (Gandi)? ---
----
----

8. From how many years did you know and encounter the problem of trypanosomosis in your cattle? A) 1 year after settlement; B) 5 year after settlement; C) 10 year after settlement D) unknown time

9. Since you first encountered trypanosomosis in this area A) It is getting worse; B) it is getting better; C) unchanged in this area D) I don't know

10. How do you think trypanosomosis is transmitted among animals? -------------------------------
----
----

11. If fillies are known by local farmers as disease, do you know local name or vector flies transmit trypanosomosis ---
----

12. If yes, what do you call it in your area? --
----

13. In which season /month are these flies most abundant?

----

14. Where is these flies population high? A) In areas close to river; B) In the grazing scheme; C) In the bush; D) in the savannah area

E. Treatment

1. Where do you treat your animals suffering from trypanosomosis? A) At Government veterinary clinic B) At private veterinary clinic C) both at public and private veterinary clinic D) if any other describe? ---
----

2. What are the sources of getting drugs against trypanosomosis? A) From traditional medicine B) from illegal traders /smugglers C) if other describe, --
----

3. Do you have any trypanocidal drug in your stock at present? If yes, can you show please and how many months since you acquired it and how do you use it for your animals? ------------------
----
----

4. If you are getting treatment for your animals apart from professionals, who is applying the

treatment (Rx)? A) Local farmers B) Community animal health workers (CAHW's) C) if others, specify --
----

5. Explain the type of drugs used in the area in terms of colour, if possible name and or other describe them --
----
----

6. Which drugs do you think are most effective to treat your animals against trypanosomosis?

----

7. For how long did you start using drugs against of trypanosomosis? A) Since 20 years B) Since 10 years C) Since 5 years D) if other, describe ---
----

8. How is your treatment scheme (strategy)? A) All animals will be treated B) Only sick animals will be treated C) Only mature oxen sick will be treated D) Only milking and sick cows will be treated E) if other specify ---
----

9. Can you estimate usual doses used per course of treatment per animal of different body weight? --
----

10. Are there traditional treatments or management practices to cure animals suffering from trypanosomosis? If yes, what and who? --
----
----

11. Do you think that the problem of trypanosomosis is expanding to new areas? A) Yes, B) no, C) you don't know; I f yes, what are the new areas affected and how frequent? ---------------------
----
----

12. How many times did each animal get treatment against trypanosomosis since last year? A)

One time only B) two times C) three times D) more than three times

13. Can you roughly estimate the expense of treatment against trypanosomosis for your herd since last year? ---
----

14. Do you think that the treatment given for animals suffering from trypanosomosis last time is effective? If yes, how many get curried? ---
----
----

15. Is there relapse after treatment of trypanosomosis? If yes, after how many days does it relapse? --
----
----

16. If there is effectiveness in the treatment of trypanosomosis, how do you express efficacy? ----
----
----

17. If there is any more to say about trypanosomosis problem in your area, please mention some about --
----

Thank you!

Name of interviewer: Tilahun Ayele (Dr.)

Date: ---

Signature------------------------------------

Annex 2: Data collection Format for Parasitological survey of trypanosomosis

Village name or P.A --------------------- ----------------------

Name of Village---

Seasonal collection ---

Date of collation ---

No.	Owner's Name	Age	sex		Body wt.	PCV	Parasitaemia				Remarks
			M	F			*T. c*	*T. v*	Mix	*T. b*	

T. c. = T. congolense, T. v. = T. vivax, Mixed = *T. congolense and T .vivax and T. b = T. brucei*

Annex 3: Data collection format for the Entomological study of trypanosomosis

Seasonal collection --

Collection site ---

Type of trap used --

Date of collection --

No. of Traps	Bait used	Tsetse flies						Biting flies				
								Muscids		Tabanids		
		G. p		*G. m. m*		*G. f. f*		Mos.	Stom.	Tab.	Chri.	Haema.
		M	F	M	F	M	F					

Muscids = Moscas and *Stomoxys;*

Tabanids = (Tab. = *Tabanus;* Chri. = *Chriosops* and Haema. = *Haematopota*).

Annex 4: Pictures showing survey materials, study animals, tsetse flies and parasites

Image 1: Mono-conical trap under deploying in Ameya-Kota by the researcher and his colleagues during the entomological survey

Image 2: Mono-conical trap fixed in the site of study to capture vector fly (tsetse and biting flies) during the study period

Image 3: Cow suffering from Trypanosome, the parasite that causes the disease "Koksa or Gandi" in Oromo language

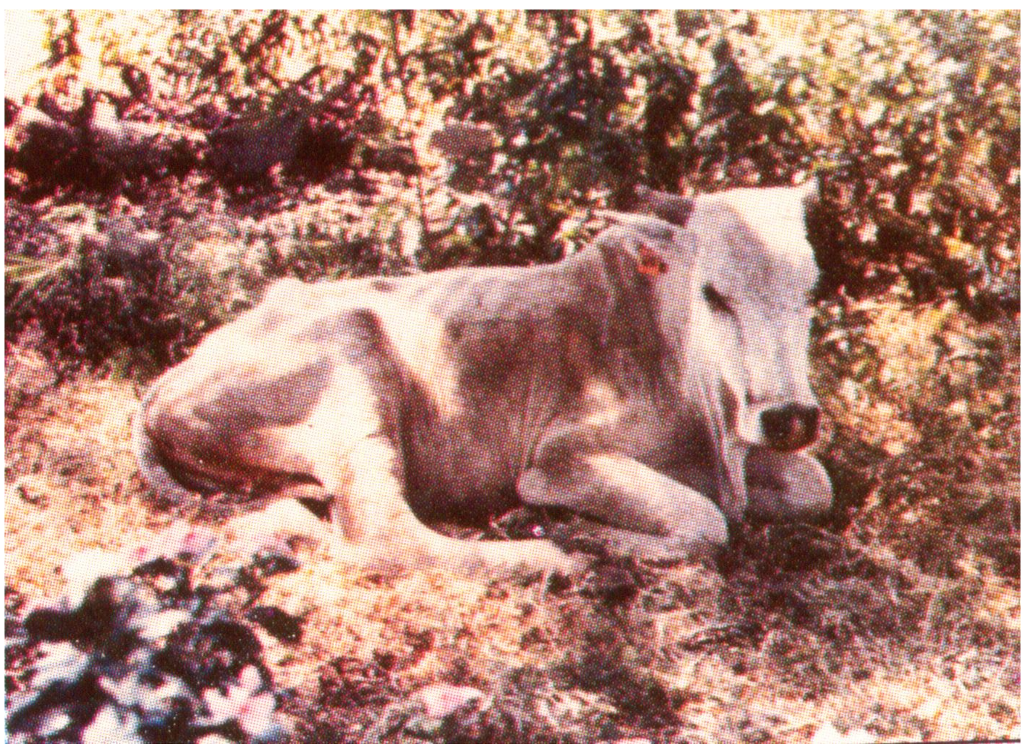

Image 4: Incapacitated animal with chronic trypanosomosis in the study area

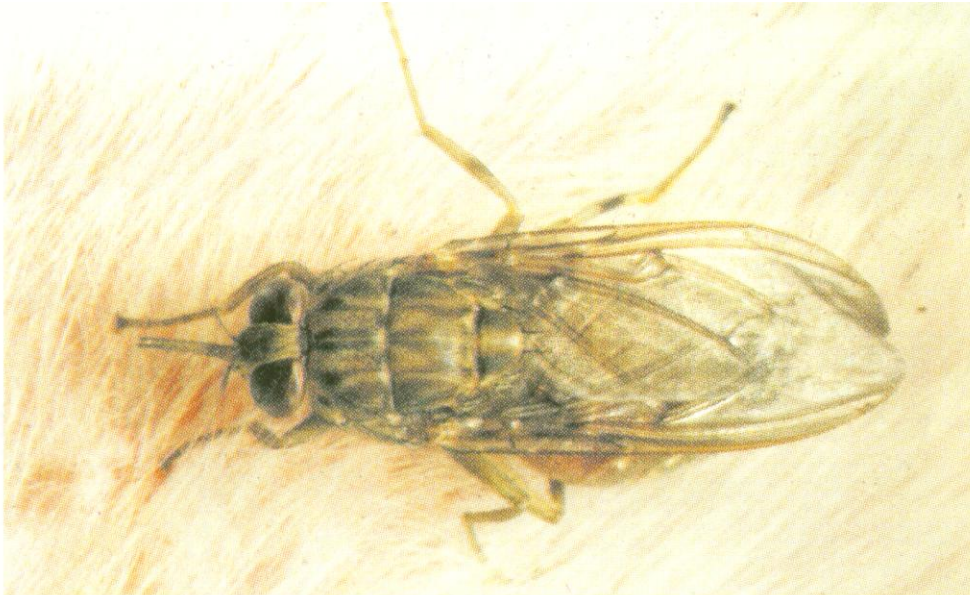

Image 5: Tsetse fly feeding on the blood of domestic animal that helps to transmit the disease, as it feeds.

Figure 6: Tsetse fly with blood taken or fed from its host (non teneros).

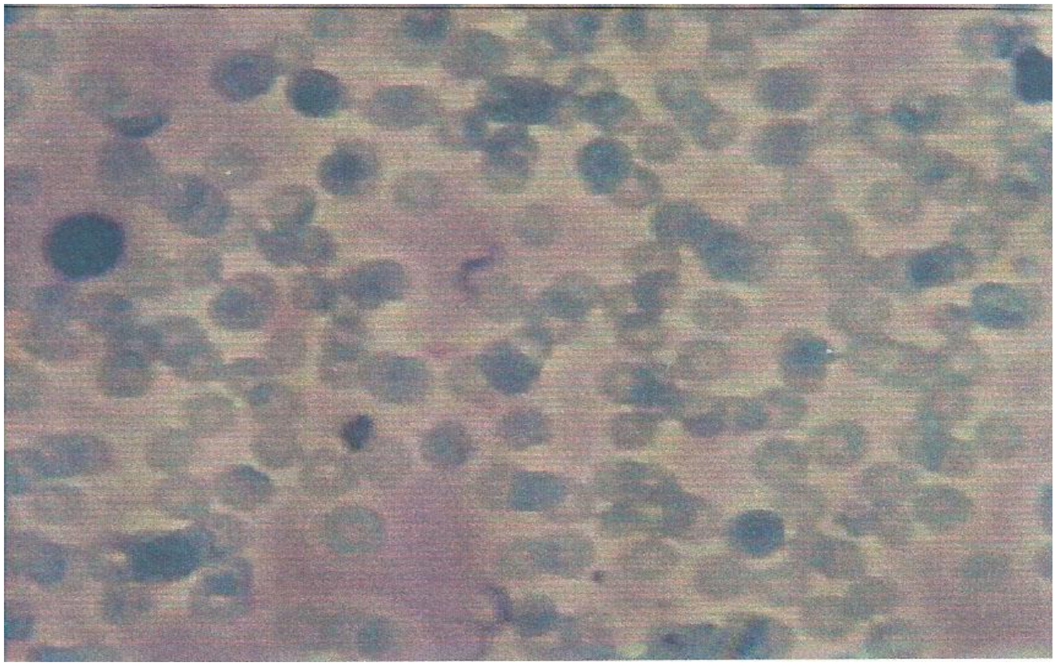

Image 7: Picture showing parasite of *T. congolense* taken from Giemsa stained

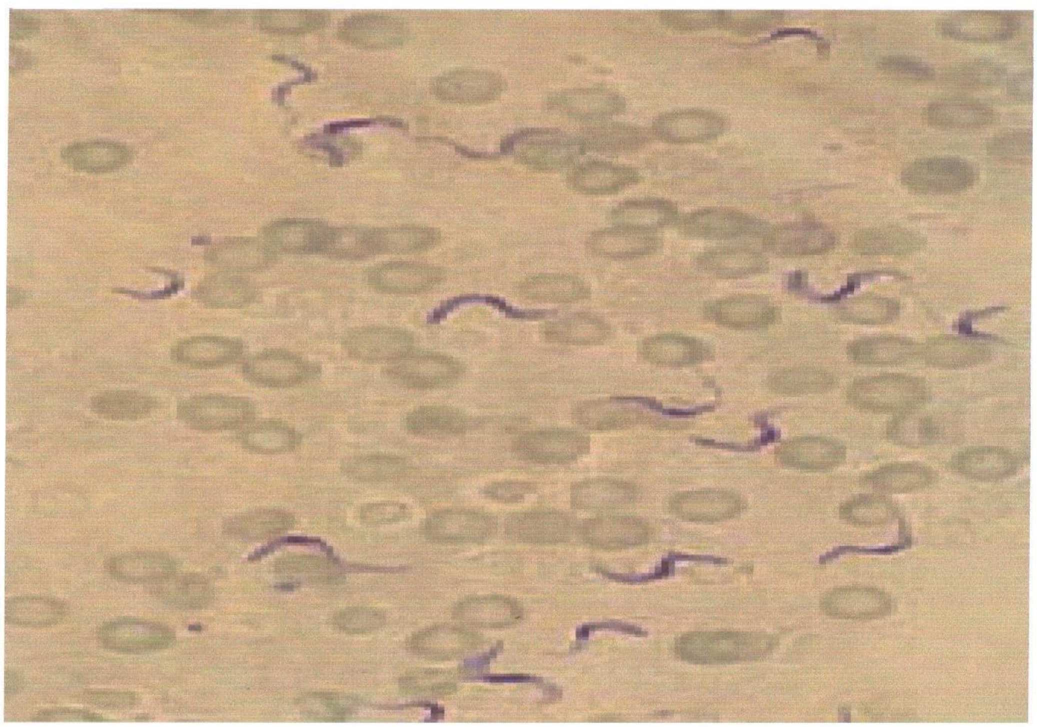

Image 8: Picture showing parasite of *T. vivax* detected in the above animals

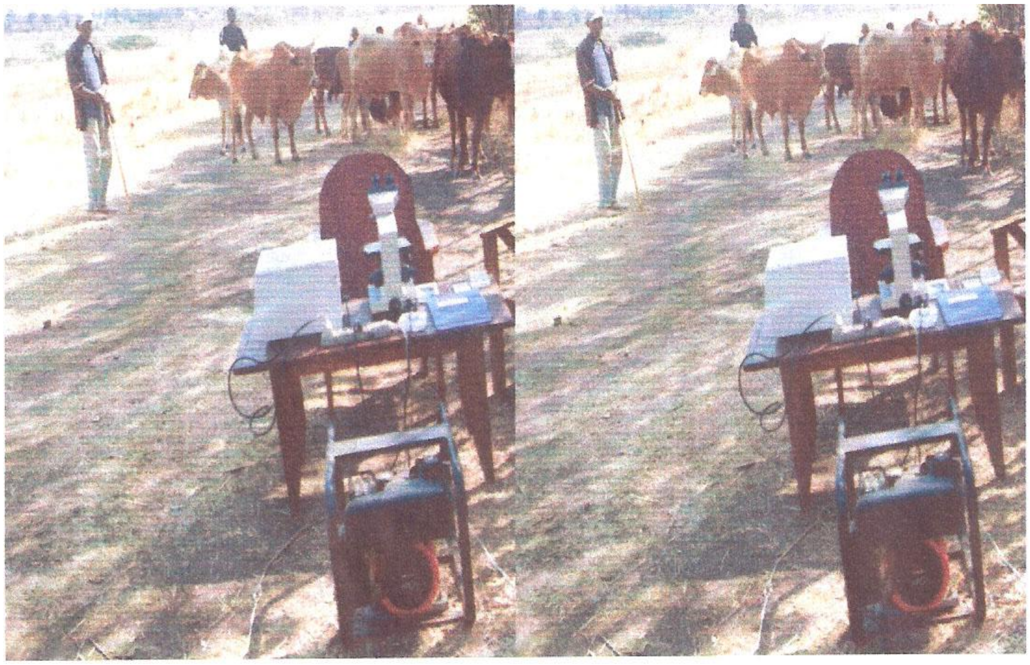

Image 9: Laboratory equipments and materials used for the analysis of PCV vales

Image 10: Different types of trypanocidal drugs caught by Goro district policeman being sold on an open market by illegal traders.

Image 11: Different types of Veterinary and human drugs caught by the legal bodies being sold on an open market by illegal youngsters traders in the study area

Image 12: Some of illegal Veterinary drugs traders being caught at Goro district on market day

9. CURRICULUM VITAE

I. Personal Information

Name... Dr. Tilahun Ayele Denu

Nation……………………........................Oromo

Nationality.. Ethiopian

Sex.. Male

Date of Birth.. April 04, 1966.

Place of Birth.. Nedjo Wollega.

Marital Status... Married and with one child

Working place.. OARDB, Animal Health Department;

Full Address ....Mobile: 09-11-40-90-71 & Home Telephone 01-12-59-23-59, E-mail: Tilahunayele19_@yaho.com; Addis Ababa, Ethiopia.

II. Language Ability

Afan Oromo...............................Read, Write and Speak Excellent.

English..................................... Read, Write and Speak V. Good.

Amharic...................................... Read, Write and Speak V. Good.

Spanish....................................... Read, Write and Speak Excellent.

III. Educational Background

1. **1981 October ……July 1986:** DVM degree with excellent results in veterinary medicine from Camaguey University, Republic of CUBA with the G.P.A of 4.58, which is equivalent to 3.66 in corresponding to Addis Ababa University.
2. **1979......................1980**: I joined Addis Ababa University faculty of natural science and completed fresh man program studies, and later on I withdrew for the chance I obtained to go abroad for farther studies in Veterinary Medicine in the Republic of CUBA
3. **1975 ....1978**: Successfully completed 12th grade and awarded certificate at Nekempte Comprehensive H/School. During this time I obtained Diploma in Agriculture at Nekempte Agricultural training center as a vocational study.

4. **1968………1974:** Grade 8 completed at Nedjo Junior Secondary High School.

IV. Training and & Its Experience

I Obtained Certificate (Diploma) in Computer Science and I have got 12 years of working experience within it and the following courses have been attended:

- Introduction to PC & Microsoft Disk operating system (PC&MS-DOS);
- Microsoft Windows (MS - Windows);
- Microsoft Word / Windows (NCI Package);
- Microsoft Excel / Windows (NCI Package);
- dBASE IV and Ethiopian Soft Ware Family (Amharic).

V. Work Experience

I have 22 years work experience in which I was assigned and realized as main activities were:

- In veterinary field services team leader;
- In quarantine and meat inspection Service team leader;
- In preparing working manual of veterinary privatization up to delivering, managing and controlling of its duties in Oromia National Regional State;
- In preparing Strategic Planning of Animal Health (SPAH) and Business Process Reengineering (BPR) of Veterinary activities of the region on behalf of the Department;
- In different committee tasks as adhock committee; in development project preparation for the region on behalf of Oromia Agricultural and Rural Development Bureau;
- Chair man and Board member of Oromia Development Association (ODA) as a founder since February 1993, organizing and managing of this development project at the main office of Addis Ababa, sequentially listed here below:

1. From March 10, 2004…………….. Up to date:

I am working in Animal Health Field Service Team, in controlling contagious diseases and in the promotion Veterinary Privatization in Oromia National Regional State of Oromia Agricultural and Rural Development Bureau (OARBB).

2. From July 08, 2002…………….. March 9, 2004:

Animal Health Field Service & Veterinary Privatization Promotion Team Leader: In Oromia Agricultural Development Bureau (OAB) Animal Health & Fishery Department.

3. From July 8, 1996 ………………June 7, 2002:

Team leader of Quarantine and Meat Inspection Service, Veterinary filed service and Veterinary Privatization Promotion in the region: In Oromia Agricultural Bureau (OAB) Animal Health Department.

4. From March 10, 1993........................ July 7, 1996: Activities and Responsibilities under taken at the Head Office of ODA:

- Chairman of Oromia Development Association (ODA) for a year,
- Executive committee and Board member of ODA for two year,
- Project officer and Board member of the Association for 1 year,
- Project officer & membership organizer for 2 years at ODA head office.

5. August 01, 1992.............. March 9, 1993 February:

Animal Health and Production section Head of South East Range lands Development project (SERP) at Jijiga Head Office.

6. December 10, 1987................. July 31, 1992:

Head of Veterinary Field Service and Technical Coordinator of South East Range Lands (SERP) at Gursum Province Development Project Centre

5. October 11, 1987................. December 10, 1987:

Veterinarian and Technical Coordinator of South East Range Lands (SERP) at Gursum Province Development Project Centre

VI. Short Term Training, Workshops and Seminar Participations

- Certificate given for the 1st training of trainer's workshop on Render pest Disease Surveillance held at ILCA, A.A, Ethiopia from 1st - 11th December 1992.
- Certificate obtained for the successfully completed of a training programme in the filed of Planning, monitoring and evaluating of trypanosomosis control at KETRI & ILRI-Nairobi, Kenya from 09 August 2002 –13 Sep. 2002.
- Participated on the workshop of Integrated Rural Development project (Implementation methods, Monitoring and Evaluation) of the project held at Jijiga June 9, 1990.
- Participated and Certified on the workshop prepared by the Ministry of Agriculture Fourth Livestock Development Project on joint CDIL /VEEU/ Diredawa May 8th - 10th, 1990.
- Certificate obtained for the participation on the National Environmental Education workshop given by Swedish International Development Agency (SIDA) conducted in Nazareth, Ethiopia 18-22 September 1995.
- On introductory meeting to prepare an Ethiopian NGO/CSO common position on Social Development Nov. 15,1994 and meeting of NGO'and CSO's in Ethiopia for the world summation on Social Development in Africa /ECA hall October 5, 1994.
- Participated on the workshop of Annual Report and Agricultural Researches Presented at Alamaya Agricultural University (AAU), June 28th- July 4th, 1991.
- Certificate given for the participation of scientific production practice paper done at Camaguey University celebrated October 3, 1984.
- Certificate given for the participation on scientific Diploma paper done at Camaguey Univ. celebrated October 2, 1985.
- Certificate given for the participation on the workshop of village Animal Health Care Kenya, 15th February to 3rd March 1992.
- Participated on Organization and Management Development Resources workshop prepared at ODA Head Office Nov. 25th -26th, 1996 and on participatory Rural Appraisal (PRA) work shop of ODA from August 13-15, 1996.
- I have invited and participated on different meeting of Agenda's with the reference of Integrated Rural Community Development projects during my past work experience.

VII. Research Papers

1. Fertility evaluation and effect of oxytocin in heat repeaters heifers during Artificial Insemination (AI) DVM thesis (1986), Republic of Cuba, Camaguey University, Faculty of Veterinary Medicine (published).
2. Andrological Analysis in 30 Seminal Bulls of Zebu type in different ages and body weights at Camaguey University (Published).
3. Evaluation of some traditional or local Medicinal plants and toxic plants in the pastoral area of SERP project (unpublished).
4. Comparative studies and its prevalence of GIT (Gastro Intestinal) parasites in high and low land animals of SERP project area (unpublished).
5. Variation of ticks and their diseases they can transmit in SERP project area (unpublished).
6. Seminar review text prepared on epidemiological study of Echinococosis/ Hydatidosis in cattle, sheep and gats, and its economic and public health importance (2007), Addis Ababa University, Faculty of Veterinary Medicine (unpublished).
7. Epidemiological study of bovine trypanosomosis in Goro and Ameya-Kota districts of Southwest Shoa Zone, Oromia National Regional State, Ethiopia, MVSc thesis (2008), Addis Ababa University, faculty of Veterinary Medicine.

VIII. Letter of Recommendations Awarded

I have been recommended and so doing efficiently by the letter written to the Ministry Agriculture in Ethiopia on May 6th, 1987 from my previous Faculty of the Camaguey University, in that I was participated effectively as a teaching assistant in Artificial Insemination and on the productive research obtained during my thesis.

IX. Project Documents and some Research papers Produced

1. Effect of the Administration of Oxytocin in the Artificial Insemination over the fertility of heifers. Review of Animal Production University of Camaguey page 243-246. Vol.4 No.3, 1988.
2. Preliminary study on 30 bulls semen producers of Zebu x Holstein Frieshian type

considering of their different ages and body weights. VIII Journal of Veterinary Sciences, Camaguey University, Cuba.

3. Produced project Conducted in western Oromia on Animal Trypanosomosis and Tsetse fly control, as the chairman team of the study group Nov. 1994.
4. Prepared training materials and documents for the trainees of Meat Inspectors, vet-scouts and paravets programmers as a coordinator of the Department.
5. Prepared training materials for the meeting of management approach training for the vet. Staff of SERP conducted at Jijiga Nov. 14 –16' 1993.
6. Prepared and participated on the work shop of Haemoparasites, Internal parasites, Sample and data collection with their Laboratory techniques at Jijiga March 9th- 10th, 1993.
7. Prepared and participated on the workshop of community planning development and veterinary epidemiological data with the aim of providing the appropriate information required. Jijiga Sep. 29-30, 1992.
8. Prepared five different development project documents within it is an action plan up to the implementation programs, and concerning to these topics I have awarded letter of recommendation from Oromia National Regional government, president Office.

X. Conferences and Work Shops Participations

- ✓ Two workshops are given for the staff basically on management of Vet. Services and Animal Health Care of SERP integrating with extension and Institutional Development section at Jijiga Nov. 14th -16th, 1993.
- ✓ Participated as a committee member in the profession of Veterinary Association at eastern Hararghe Region.
- ✓ Participated in the Fund raising of Oromia Development Association (DA) by organizing and inviting volunteer NGO'S, Private investors, individual participants and some Regional States.
- ✓ I was a member of Oromia National Regional Committee on traditional practices which affecting the health of women and children conducted on Jan. 26, 1995.
- ✓ Participated on the workshop of farm Research technical requirements held at Jijiga

(SERP) Jan. 5th-6th, 1993.

- ✓ Participated on the workshop of tsetse flies infestation in Ethiopia, activity of Ectopor against ticks, tsetse and effectively of Fasinex against Faciolasis prepared by CIBA-GAGEIY Company A. A. August 2, 1994.
- ✓ Participated on the workshop of Animal trypanosomosis in Oromia Region prepared by Oromia Agricultural Bureau July 8th-10th, 1994 held at A.A.
- ✓ Participated in teaching of fattening programs activities of some PA's as a model in SERP.
- ✓ Participated on the workshop of tsetse and trypanosomosis control strategies in Oromia Region on July 11-12, 1992, A. A.
- ✓ Participated on the expansion of Dairy farm in goat production with collaboration of Farm Africa at Gursum Rural District of their PA'S.

XI. Other Skills

- ➢ Gained experience of community based approach in identifying and preparing on some basic animal Health and social problems.
- ➢ I have involved and participated in the implementation, evaluation and management of some projects in the Region
- ➢ Gained experience in organizing and coordinating the staffs as a social committee leader ship for the targeted programme.
- ➢ I have achieved various experiences in leading and guiding the rural communities towards the Dev. during my working time in ODA.
- ➢ I have assigned to work in many task forces as a technical committee member and performed it efficiently.
- ➢ Capability to speak and write in 4 languages and to simple communicates only in two Dialectics; and also I am capable to formulate and evaluate any type of projects concerned under the ministry of Agriculture and on the regional animal health status.

XII. Reference

1. Dr. Berhe G/Igizehabiher DVM, MVSc in veterinary medicine and PhD in Molecular Biology: Ministry of Agriculture, Animal and Plant Regulatory Department Head, Mobile: 09-11-25-43-74, Addis Ababa, Ethiopia.

2. Ato Siraj Kedir, Agricultural Economist BA, MSc. Degree: Inspection Team Leader at Oromia Presedent Office, Mobile Tel.09-11-43-65-83, and 01-16-46-10-21 Res. A.A.

3. Dr. Samu'el Assefa, MSc, PhD degree in Agronomy: Crop protection Department Head at Oromia Agricultural and Rural Development Bureau. Tel.01/53-54-63 office, Mobile 09/47-15-38.A.A.

4. Ato Awad Jibril BA in Economy: Oromia Development Association General Manager.Tel.011-15-50-68-18; 011-15- 50-68-37 office and Mobile: 09-11-20-28-85.

10. SIGNED DECLARATION SHEET

"This thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly recognized".

Name: Dr. Tilahun Ayele Denu

Signature: ___________________

Submission date: June 20, 2008

This thesis has been submitted for examination with our approval as university advisors.

1. Dr Yilkal Asfaw (DVM, MSc) ____

2. Dr Yacob Hailu (DVM, MVSc, PhD) ____