ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

SEASONAL DYNAMICS OF TSETSE AND TRYPANOSOMOSIS IN SELECTED SITES OF SOUTHERN NATION, NATIONALITIES AND PEOPLES REGIONAL STATE (SNNPRS), ETHIOPIA

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A thesis submitted to the Faculty of Veterinary Medicine, Addis Ababa University in partial fulfillment of Degree of Master of Science in Tropical Veterinary Medicine

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DEDICATION

This work is dedicated to Jesus Christ, who is overall, God blessed for ever for that he crowns my soul with lovingkindness and tender mercies.

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LIST OF ABBREVIATIONS

bw	body weight
CI	Confidence Interval
ICIPE	International Centre for Insect Physiology and Ecology
ILRAD	International Laboratory for Research in Animal Disease
ISCTRC	International Scientific Council for Trypanosomosis Research and Control
ISMM	Isometamidium
kg	kilogram
km	kilometers
masl	meters above sea level
mg/h	milligram per hour
mm	millimeter
MoA	Ministry of Agriculture
NTTICC	National Tsetse and Trypanosomosis Investigation and Control Centre
OAU	Organizaton of African Unity
OWA	Office of Wereda Agriculture
PAs	Peasant Associations
PCV	Packed Cell Volume
SIT	Sterile Insect Technique
SRVL	Sodo Regional Veterinary Laboratory
Tc	*Trypanosoma congolense*
Tv	*Trypanosoma vivax*
Tb	*Trypanosoma brucei*

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ABSTRACT

A seasonal dynamics of tsetse and trypanosomosis study was carried out in selected sites of Southern Nation, Nationalities and Peoples Regional State (SNNPRS). The purposes of the study were to determine the seasonal apparent density of tsetse and prevalence of trypanosomosis, to identify tsetse and trypanosome species and to assess the curative/prophylactic effect of isometamidium chloride in selected sites (Badaye and Gadala PAs) of SNNPRS. Community members (n = 80) were interviewed using prepared questionnaire format. Cross sectional studies were carried out from October to April during late wet (October), early dry (December), late dry (February) and early wet (April) seasons in villages of Badaye and Gadala PAs. Samples for parasitological and entomological studies were collected from one villages of Badaye and two villages of Gadala PAs per season. Biconical traps used for entomological survey were deployed at grazing and watering points of animals in the villages of Badaye and Gadala PAs. For parasitological study, a total of 1,509 blood samples were collected from randomly selected cattle within four seasons. For longitudinal field study, parasitaemic Zebu cattle (n = 64) were selected for isometamidium chloride block treatment. Parasitaemic cattle with 39 (60.9%) *T. congolense*, 24 (37.5%) *T. vivax* and 1 (1.6%) mixed (*T. congolense* and *T. vivax*) infections were treated with prophylactic dose of (1mg/kg bw) isometamidium chloride at day 0 and monitored at day 15, 30, 60 and 90. The result of questionnaire revealed that 97.5% of respondents depend on smugglers for trypanocidal drugs and sick animals were treated by smugglers and owners with high treatment frequency (6 times per cattle per year). The entomological finding revealed three tsetse species namely, *G. m. submorsitans, G. fuscipes* and *G. pallidipes* at Badaye and Gadala PAs, respectively. Higher catches of *G. pallidipes* were registered during late wet (October) and early dry (December) seasons in comparison with late dry (February) and early wet (April) seasons. There was a significant difference ($p < 0.05$) in mean catches of *G. pallidipes* between seasons**.** The apparent density of *G. pallidipes* was positively correlated ($r = 0.5176$) with prevalence of trypanosome infection.The overall trypanosome infection prevalence in cattle was 15.77%. During late wet and early dry seasons, the prevalence of trypanosomosis was high (21.5%) and during late dry and early wet seasons low (10.8%). During early wet season, significantly ($p < 0.05$) higher prevalence was registered at village of Badaye PA (15.38%) than the villages of Gadala PA (8.51%). There was a significant

difference ($p < 0.001$) in trypanosome infection prevalence between seasons. Giemsa stained blood smear examination revealed the presence of *T. congolense* and *T. vivax* in the study area. *T. congolense* was dominant species and accounted for 63.4% in overall infections. The overall mean PCV value was 24.02%. The mean PCV values of different seasons were negatively correlated ($r = -0.3112$) with the prevalence of trypanosomosis of corresponding seasons. There was a statistically significant difference ($p < 0.0001$) between mean PCV values of parasitaemic and aparasitaemic cattle tested during different seasons**.** There was a significant difference ($p < 0.001$) in trypanosome infections between different age groups of cattle. In longitudinal field study, parasitaemia was demonstrated in 17 out of 64 cattle (26.56%) with in 15 days, 19 out of 64 cattle (29.7%) with in 30 days, 41 out of 64 cattle (64.06%) with in 60 days and 44 out of 64 (68.75%) with in 90 days post treatment of 1mg/kg bw isometamidium chloride. *T. congolense* was accounted for 85.5%, 89.5%, 78% and 79.5% of infections within 15, 30, 60 and 90 days post treatment of isometamidium chloride, respectively. Based on these results it is concluded that trypanosomosis is the major constraint of livestock production in the study sites.

Keywords: Season, Tsetse fly, Trypanosomosis, Trypanosomes, Prevalence, Drug resistance, Isometamidium chloride, PA

1. INTRODUCTION

Trypanosomosis is one of the major constraints on animal production in areas of Africa which have the greatest potential for significant increases in domestic livestock productivity (d' Ieteren *et al*., 1998). Tsetse flies occur over some 10 million square kilometer of Africa (Jordan, 1986) affecting a total of 38 countries. Currently, about 37% of the 147 million cattle in countries affected by tsetse are exposed to the disease. Africa produces 70 times less animal protein per unit area than Europe (Nantulya, 1986). In Africa the overall loss (both direct and indirect) is estimated at US 500 billion dollars a year (ILRAD, 1993/94).

In Ethiopia above 14 million heads of cattle are exposed to the risk of trypanosomosis, 20,000 heads of which die every year. Taking 200 birr per animal, the total loss will be 4,000,000 birr per year (Asfaw, 1986). In the years 1978-1982 a total of 9,675,575 doses of trypanocidal drugs were purchased with 17,920,780.70 birr (MoA, 1982/3). Although tsetse flies have existed in Ethiopia for a very long time, it has been noted that by early explorer and traveler, who lost their transport animals in the fly challenge belts. In 1885 Donalds and Smith made the earliest record of Gendi (Nagana) in their transport animals which were crossing tsetse fly belts in Southern Ethiopia (Maclennan, 1980). Later in 1895 Corti identified an insect collected in 1893 by Captain Bottogo, along the Walmal river which is the upper tributary of Shebelle river (Langridge, 1976). Brumpt in 1904 reported in the Ogaden (South west Ethiopia), one form of bovine trypanosomosis which was called "Alino" and which was readily transmitted by *G. longipennis*. (Langridge, 1976).

In 1962, the cattle survey in Southern Ethiopia, by the livestock division, established the bovine trypanosomosis had become a major cattle disease in the Omo valley. It was stated that the problem of trypanosomosis is the main cause of decline in the number of cattle and particularly draught oxen (Abebe and Jobere, 1996).

The distribution of tsetse fly and the prevalence of animal trypanosomosis was conducted from 1971-76 in Ethiopia. According to survey result, out of the 14 administrative regions seven (Wellega, Keffa, Gamo Gofa, Illubabor, Sidamo, Gojam and Shoa) had both tsetse and Nagana and all species of tsetse that were existing in Ethiopia were recorded. In each belt the distribution of tsetse and its spread was indicated (Langridge, 1976).

Depending on the tsetse breeding limit it was estimated that 66,000 km^2 (Ford, 1971), 98,000 km^2 (Langridge, 1976). Currently, the area coverage of tsetse fly is estimated to be 220,000km^2 (Slengenbergh, 1992). Over the past years it has been recorded that tsetse flies in the river valley of south western Ethiopia have progressively spread up stream wards and also up the valley walls. *G. m. submorsitans* had been reported (Fentie, 1989) to occupy and survive in highlands over 2000 masl near Fincha river valley (Asfaw, 1986).

Where tsetse transmitted trypanosomosis affects cattle production, trypanocidal drugs, both prophylactic and curative drugs and other tsetse control methods such as insecticide application on the back of animals are the most widely used methods of trypanosomosis control. However, resistance to one or more of the three trypanocidal drugs used in cattle (salts of isometamiduim, diminazene and homiduim) has been reported in at least 13 countries in sub-Saharan Africa (Burkina Faso, Chad, Cote d'Ivoire, Ethiopia, Kenya, Nigeria, Somalia, Sudan, United Republic of Tanzania, Uganda, Zimbabwe) (Peregrine, 1994), the Central African Republic and Zambia. This is probably an underestimation of the true situation, because in several countries surveys for resistance have not yet been carried out or cases of resistance have not been published (Leak, 1999). Moreover, the resistance of trypanosomes to trypanocidal drugs is widely reported and is considered to be increasing (McDermott *et al.*, 2000; Mulatu *et al.*, 1995).

On the other hand in Zimbabwe tsetse flies were cleared in the early 1970's as far as the border with Mozambique. However, the achievement was lost as most of the area cleared of tsetse was invaded in the absence of the any form of barriers along the border (Shereni, 1995).

In the South west Ethiopia for the control of *G. m submorsitans* deltametrin 1% pour on was applied to cattle (Keno and Mengistu, 1995). In the Ghibe valley, South west Ethiopia pour on insecticide for the control of cattle trypanosomosis was also applied for cattle exposed to high tsetse challenge of drug resistance trypanosomes and high tsetse re-invasion pressure. However the achievements were lost due to absence of barriers (Rowlands *et al*., 2000). In lowland of Damot woyde, South Ethiopia for the control of *G. pallidipes* NGU traps were deployed by community based tsetse control pilot program (ICIPE, 1996). However the continuity was failed due to reluctancy of communities to contribute money for trap purchase and deploy ICIPE made NGU traps (SRVL, 1998).

Currently the livestock product and productivity of southern region is highly affected by economic important tsetse species, the high incidence of the trypanosomosis and the existence of drug resistance problem. Trypanocides such as ithidium bromide and diminazene aceturate were used for the long time and the communities claimed that their effect was highly decreased. The communities in the region in general and in the lowlands lying along Omo river basin expend a lot of money to purchase trypanocidal drugs. Therefore, studies have to be conducted at seasonal basis to get the real situation of tsetse and trypanosomosis and thereto tackle the problem using disease management strategy.

Therefore, taking in to an account the above mentioned statements, the following objectives were designed to conduct studies in two selected PAs of the southern region.

The general objective of the study was to asses the situation of trypanosomosis in selected PAs of Boloso wereda along Omo river.

The specific objectives of the study were:

1. To get seasonal apparent density of tsetse, and prevalence of trypanosomosis
2. To identify tsetse and trypanosome species involved in the area
3. To estimate the curative/prophylactic effect of isometamidium chloride

2. LITERATURE REVIEW

2.1. Morphology and life cycle of tsetse fly and trypanosome

2.1.1. Morphology of tsetse fly

Genus *Glossina* comprises of 23 species and the smallest species is *G. austnai* and the largest are *G. longipennies* and *G. brevipalpis* (Mulligan, 1970). Tsetse flies are elongated and robust, of various shades of brown ranging from yellowish to grayish to dark or blackish brown but never metallic. The males are usually smaller than the females (Mulligan, 1970).

When the fly is at rest the wings over lap one over the other. In the middle of the each wing there is distinctive shape which a powerful imagination can compel with a butcher's cleaver with edge facing forwards. This is called a "hatchet cell" and is a useful diagnostic character which may make it possible to identify badly managed specimens as being certainly *Glossina* (Pallock, 1986; Soulsby, 1992; Itard, 1981,). The males are readily distinguished by the presence of hypopygium centrally at the tip of the abdomen. It is said that the male's eyes are larger, or alternatively that the space between the eyes is smaller, but this character is not distinctive enough for field use *(*Mulligan, 1970).

2.1.2. Life cycle of tsetse fly

As in other Dipteral, the female has a pair of spermathecae in which sperm acquired very early in life is stored and lasts the female's life span. The two sexes emerge in equal numbers; it follows that if one mating per life is usual in females, a male must on average mate only once. Females usually mate at the age of 2-3 days and the males after age of 7-8 days. During copulation, the sperm are transferred from the male to the uterus of the female. As the egg of a female fly passes from the ovary into the uterus it is fertilized by sperm, which pass down the duct from spermathecae (where they are stored after copulation) to the uterus. The egg hatches in uterus and the first instars larvae feeds by mouth on a secretion produced by milk gland. After a molt,

the second instars larvae continue to feed on the same milk. After the second molt the larva is extruded, it is now in its third instars and weighs nearly as much as its mother (Mulligan, 1970).

The third instars larvae have respiratory lobes called polypneustic lobes and it burrows and hides in the soil and assumes the shape of the barrel, its integument becomes rigid and darkens and is now known as a puparium. With in the puparium two moults take place, the first produces the pupa and the second the imago, a process often called eclosion of the adult (Newstead *et al.*, 1924).

The pupal stage lasts 2-13 weeks. It depends on temperature and humidity (Seifert, 1996). Emergence from puparium takes place between 12.00 and 18.00 hrs that is within a few hrs of the daily maximum temperature. This rhythm is maintained under conditions of constant temperature, but displaced if the temperature rhythm is altered. On emergence the wings are crumpled, but they are expanded in about five minutes and the tsetse can fly in an hour or two (Mulligan, 1970; Newstead *et al*., 1924).

2.1.3. Morphology of trypanosome

According to Hoare (1972), the classification of the genus tryanosoma rearranged in to two major sections. Sterocaria which are, with a few exceptions are non pathogenic and of no great economic importance to livestock. The salivaria are grouped in to four subgenera most of which are transmitted by tsetse flies (Hoare, 1972).

Subgenus *Duttonella* are monomorphic trypanosomes with a free flagellum, kinetoplast large and usually terminal and development in tsetse fly vector occurs only in proboscis. The members of this subgenus are *T. vivax* of ruminants and equids, *T. uniforme* of cattle, sheep, goats and antelopes (Richardson, 1963; Norman, 1985).

Subgenus *Nannomonas* are small forms, usually without free flagellum, kinetoplast medium sized, typically marginal and development in tsetse fly is in mid gut and proboscis. The posterior extreme of the parasite is usually blunt. The organism is actively mobile and in fresh preparations can be seen lashing about among the red blood corpuscles, but it remains in the same field for a long period of time. The members of this subgenus are *T. congolense* of

ruminants, equids and other animals and *T. simae* of swine monkey and cattle (Richardson, 1963).

Subgenus *Trypanozoon* are pleomorphic (slender intermediate and stumpy) forms with or without free flagellum. Kinetoplast is small, subterminal and invisible with light microscope. The short forms in average about 15 micron in length and have no free flagellum and in them the long axis of the nucleus is usually set transversely to the long axis of the body. The members have well developed undulating membrane. The members of this subgenus are *T. brucei brucei* of all domestic animals and many wild game animals, *T. brucei gambiense* and *T. brucei rhodesiense* of man and wild ruminants and cattle (Norman, 1985).

Subgenus *Pycnomonas* (or suis group). The member of this subgenus is *T. suis*, with short flagella and subterminal kinetoplast (Richardson, 1963; Norman, 1985).

2.1.4. Life cycle of trypanosome

The life cycle of trypanosome is complex. In both the tsetse fly vector and the mammalian host, trypanosomes undergo a series of transformations in to different forms (Seifert, 1996). The cyclic development of *T. vivax* in *Glossina*: At time of feeding on infected animal the fly sucks up blood and trypanosomes; some trypanosomes manage to attach them selves to the proboscis, but others are swept along the food canal to the gut where they perish. In the labrum the anchored trypanosomes transform into the epimastigote form which measures 16-35 micro metres in length. These epimastigotes multiply and attaches to to the inner wall of labium and labrum by the tip of their flagella. The epimastigotes are detached from the location at a certain stage and migrate to the hypopharynx where a morphological change occurs and these forms have been referred to as the pre-infective metacyclic trypanosomes. A further transformation then follows and the final, infective stage, the metatrypanosome (metacyclic form) is produced. (Lorne, 1986; Seifert, 1996).

The cyclic development of *T. congolense* in *Glossina*: When a respective species *Glossina* feeds on a suitable mammal harboring the right stage of *T. congolense,* the trypomastigote passes in to the mid gut of the fly in the blood meal, there it begins a cycle of development with in the lumen

of the peritrophic membrane. At this site the ingested trypanosomes change their morphology and become elongated trypomastigote forms. The vast majority of the migrating long thin forms make their way to lumen of esophagus and continue their foreword migration to the proboscis where they become attached to the wall of the labrum in the blood canal and transform into epimastigotes. Finally metacyclic forms appear in hypopharynx (Lorne, 1986; Norman, 1985).

The cyclic development of *T. brucei* in *Glossina*: The blood meal taken up by a species of *Glossina* from a mammal infected with trypanosomes of the *T. brucei* complex probably contains a variable percentage of long, slender, intermediate and short, stumpy forms of organism. The blood is sucked up through the food canal, pharynx and esophagus to the mid gut. In the mid gut the blood meal is enclosed with in the peritrophic membrane. The short, stumpy and some intermediate forms transform into a new trypomastigote form. The flagellates from the soft part of the peritrophic membrane begin to migrate through esophagus, pharynx and into the proboscis. From there again they migrate up to the hypopharynx, along salivary ducts and into the salivary glands. In the salivary glands they undergo further transformation to the epimastigote form. Epimastigote form multiply actively and change into metatrypanosome, or infective stage, which does not divide ((Lorne, 1986; Norman, 1985).

When the infected fly feeds, these metacyclic trypanosomes (*T. vivax, T. congolense* and *T. brucei*) are injected into the skin of the host, along with tsetse saliva. In the animal, the parasites differentiate in to a form specially adapted to live in mammalian blood. The blood stream parasites multiply by binary fission and enter the animals lymphatic and blood circulation. As flies feed on animals infected with the parasite, this may take up blood containing trypanosomes thus completing the parasites life cycle (Ford, 1971).

2.2. The distribution, habitat and importance of tsetse fly in Africa

The limits of *Glossina* distribution are determined primarily by the climate and secondly by the vegetation, which can often mitigate the severity of climate. It will be observed that the huge central tsetse area is bounded by country having less than twenty inches of rainfall. The area with over sixty inches of rain per annum which extends along the coast of longitude 30^{o} E; this is the area of equatorial forest. Surrounding it is a vast area, with sixty-twenty inches of rainfall, which is wood land savannah or grass land. The broad picture of rain forest, surrounded by savannah,

ending in desert or the sea, should be remembered, as the distribution of the different species of tsetse is closely related to it (Table 1). Nevertheless, it must be appreciated that the great forest belt used to be far more extensive than it is now, and that relict forest and forest species of tsetse still occur well out side the limits suggested by the over sixty-inch rainfall zone. There are other localized areas of forest, such as those found around mountains and down the east coast of Africa, which are hundreds of miles from the great equatorial forest belt and unrelated to it (Langridge, 1976; Ford, 1971).

Table 1. Distribution, habitat and importance of tsetse fly

Species	Indication of distribution	Habitat	Importance
G. pallidipes	Central and East Africa, Southwest Ethiopia, Uganda East Congo, Zambia, South Somalia and Zimbabwe	From light rain forest to dry thicket in arid savannah	Nagana and Rhodesian sleeping sickness
G. m. submorsitans	West Central and East Africa, Southwest Ethiopia, Uganda, Congo, Southeast Congo, Tanzania, Mozambique, Zambia and Somalia	Wood land savannah	Nagana and Rhodesian sleeping sickness
G. fuscipes	West and Central Africa from Dakar to South Sudan up to Ethiopian border from Dakar to Lake Tanganika and South Katanga from Dakar along coast to south border of Angola	Mangrove swamps, rain forest, evergreen vegetation along the streams and around lakes.	Nagana and Gambian sleeping Sickness
G. tachnoides	Western and central Africa along Niger, Sudan up to Ethiopia	Riverine vegetation and thicket along streams and around rivers, usually rain forest.	Nagana
G. brevipalpis	Central and East Africa, Eastern Congo to Indian Ocean, Northern Kenya and Northeast of South Africa	Dense ever green thicket often fringing rivers and lakes and in localized forest in savannah	Nagana
G. longipennis	East Africa, North Tanzania to Southeast Sudan, South Ethiopia and South Somali	From riverine thicket to thorn bush in dry savannah or semi desert	Nagana

Source: Ford (1971)

2.3. The distribution of tsetse flies and trypanosomosis in Ethiopia

2.3.1 Early records (up to 1950's)

G. m. submoristans was recorded in Ethiopia in 1937 from the Didessa valley in Wellega province and near Lake Awassa in Arusi/Sidamo province. Calcuvella in 1938 confirmed the existence of this tsetse at Awassa. In 1937 Roetti found it along the Birbir, and Birber-Uaha in Wollega/Kaffa and on the Abobo River along the Sudan border in Ilubabor (Langridge, 1976).

*G. pallidipes***,** first recorded in 1938 along the Didessa and Birbir rivers in Wollega and along the Akobo river in Ilubabor. It was found along the Gojab river in Keffa.

G. longipennis was first described in an insect collection made in 1893 from the Welmal river in Bale province. It was also recorded in 1895 along the Dighato river in the Ogaden region. It was also reported near Lake Abaya (Marquerite) in 1938 (Langridge, 1976).

G. fuscipes was found on the lower Omo river. In 1937 it was recorded from Lake Awassa in sidamo province and also on tributaries of the Akobo river in Ilubabor and in the Ghibe river (Langridge, 1976).

G. tachinides was recorded in 1930 on the Baro, Akobo and Gillo rivers in Ilubabor. In 1970 it was recorded near Ledo village in Didessa, on the upper Didessa near to Arjo in Wellega province. One male fly found near Wonago village near Dilla on east side of Lake Abaya, in Sidamo province and on the Jikao river in Illubabor (Langridge, 1976).

2.3.2. Records in 1960's and 1970's

2.3.2.1. Tsetse fly

According to survey result conducted by Langridge (1976) five species of tsetse flies were found and identified as:

The Fusca group: *G. longipennis*

The Moristans group: *G. m. submoristans* and *G. pallidipes*

The Palpalis group: *G. fucipes* and *G. tachinoides*

The fly belts (infested areas) in Ethiopia extend from the southern part of the rift valley, around the southwestern corner of the country and along the western lowland and escarpment to the Abay (Langridge, 1976).

G. m. submoristans

In the 1970 it was found in Didessa valley, near the villages of Wonago and Lado on the eastern side of Lake Abaya, the Amaurou village in Shambo sub district, on the Abay near Deru village on the Mugher river in Shoa province, on the Dabous river in Wellega, on the Baro and Gilo rivers in Gambella district, Illubabor, in the Savannah country near Turmi in south Gamu Gofa, and near Mizan Teferi in Keffa province (Langridge, 1976).

According to Langridge (1976), its infestation was associated with Abay (Blue Nile) river. *G. m. submoristans* in Wellega was associated with the southern border of the province and Baro river at its tributaries.The main areas of its infestation in Illubabor were associated with Akobo (Langridge, 1976).

G. pallidipes

In 1970, it was recorded from lower Omo river and on the Woitto river and at Keiafer (1550 masl) also near Bako in Gamu Gofa province. It was found along the Sagan river near Lake Chamo in Gemu Gofa. The whole of the Omo Bottego was infested with *G. pallidipes.* The Gojeb was also infested with *G. pallidipes* and this infestation extended about 20 kms above the bridge on the Jimma to Bonga road. The lower Omo was also infested with this species up to down wards as far as Omorate. The areas in Gamu Gofa are divided in to two parts concerning tsetse infestation. The division is formed by the strip of highlands which runs from north to south wards (Langridge, 1976).

The eastern part is comprised of the southern rift valley and Sagan river system. This area was infested with *G. pallidipes*. It was said that quite possible that *G. pallidipes* in Rift valley is connected with those in Omo river area. The link is likely to be across the narrow strip which separates the upper part of the Galana Dulei valley (Woitto) with the Maze river valley (Daramalo). It was predicted that unlikely *G. pallidipes* will spread much further in the rift valley beyond its limits with exception of the north ward movement along the western side of Lake Abaya. *G. pallidipes* infestation in Sidamo extended from lower Gidabo river down the eastern sides of lake Abaya and Chamo to the Sagan river along which it extends to Lake Chew bahir. This eastern belt also includes the large Galana river valley between Amaro mountains and the southern highlands. It had reached the limit of its movement eastwards to the southern high lands where it was prevented from going any further by the mountains. This species had extended along the southern border of Wollega and associated with Baro river vegetation and its upper tributaries (Langridge, 1976).

G. fuscipes

During early time the presence of *G. fuscipes* was recorded in 1901 and in 1938, and in 1970 recorded from the Maze, Gorgora, Bazo and Cuccia rivers in Gamu Gofa, on the Ketto tributary of the Birbir and at Degeno on the Birbir in Wellega, on the that tributary of the Gojeb in Kaffa and near the bridge on the Omo river, Addis Gimma high way. The Ghibe is only infested with *G. fuscipes* as other species have been found above the bridge. The whole upper and lower Omo also were infested with it (Langridge, 1976).

G. tachnoides

It was found along the Abai (Blue Nile) river system. It also had infested the Belles river valley. It was predicted that it may be able to spread along the gorge and infest the riverain vegetation up as far as Mota. In Akobo river system *G. fuscipes* was replaced by *G. tachnoides*, where the river comes out into the lowland plains (Langridge, 1976).

G. longipennis

The western infested area of lower Omo is connected with lowland of Sudan border. In this it had extended across the Kibbish hills (Langridge, 1976).

2.3.2.2. Trypanosomes

Surveys conducted in 1970's revealed that *T. congolense* and *T. vivax* were a very common trypanosomes. *T. brucei* is not a common trypanosome in cattle, sheep and goats. Its importance being that it is likely to be implicated when pack animals such as horses and mules come into contact with tsetse on the coffee trade routes. *T. evansi* causing "Surra" in camels is common in the southern and eastern regions. It is not transmitted by tsetse flies (Langridge, 1976).

2.3.2.3. The effect of man on vegetation and the ecology of tsetse

There had never been a large anti-tsetse bush clearing effort in Ethiopia. The only attacks on the fly destruction of its habitat has been made by small groups of individuals clearing bush for cultivation of crops, such areas never being more than a few kilometers in dimensions, and which are abounded as soon as the fertility of the soil exhausted. Such areas soon revert back to bush land.

The clearing of bush along the flood line of the Baro river from Gambella town down stream has no doubt reduced the number of tsetse along the river bank. The effect of man on tsetse by clearing of the riverain vegetation along the Baro westwards from Gambella has been that the riverine tsetse have been largely eliminated and the challenge from the wood land *G. m submoristans* greatly reduced. This reduction of man/tsetse association was reflected in the low incidence of human sleeping sickness along the Baro river during the 1967-70 epidemic. Another area where clearing of bush land has reduced tsetse infestation is in the low convex water shed between the Gumaide and Gidole hills that extend from Gatto to the southern tip of Lake Chamo. In this area much of the valley by people who, due to the over crowding in the higher regions, come annually to this area to grow crops of corn and sorghum. They were unable to use oxen to plough the land because of the presence of *G. pallidipes* in the surrounding bush along the lower

hill slopes and galleys (Langridge, 1976; Ford, 1971). In the Gatto valley a different pattern of events has taken place. According to Bromley this area was well-populated with people and they had large herds of cattle. Most of the area at the time was grassland with scattered trees, chiefly acacia species and some small areas of thickets. The people practiced a form of shifting cultivation, moving to a new piece of land as the fertility of the old area was exhausted. In the area that was abandoned trees and thicket-farming shrubs soon grew up which eventually produced tickets that were suiTable habitats for *G. pallidipes*. The invasion of the area by tsetse soon caused heavy losses in cattle. Most of those remaining being moved to the safety of the highlands and more land was abandoned.

The grass fires are started by man with the primary intention of providing areas of fresh green vegetation to attract game animas so that they can be hunted more easily and also to colon the area of high grass which can be two or three meters high and a solid grass is burnt off honey hunters can penetrate the area in search of the wild beehives. The tsetse which inhabits this type of country is *G. m. submorsitans* which has exploited the grassland phase brought about by fires. The time at which the burning of the grassland takes place can be very important of tsetse. Large grass fires sweeping through the country at the end of the dry season when the grass is tidier dry could destroy a very large portion of the adult tsetse population if they are caught in the burning areas without the sanctuary of every green thicket (Langridge, 1976).

2.4. The distribution of tsetse and trypanosomosis in southern region since 1980.

2.4.1. Tsetse fly

During the course of survey the distribution of tsetse and trypanosomosis were recorded in two main belts (Omo and Rift valley belts) of the eastern part of the region. Tsetse species identified from two belts were *G. m. submorsitans, G. fuscipes, G. pallidipes* and *G. longipennis* (NTTICC, 1996; Amare, 1995; SRVL, 2000).

The largest belt is Omo belt which includes Ghibe, Gojeb and Omo river systems. The Ghibe river system of the region lies from junction with Gojeb river to up words up to bridge- high way from Addis Ababa to Jimma. This belt includes also little Ghibe around Yem special wereda.

The Gojeb river system lies from Junction with Ghibe up to Central highlands of Mocha. The second belt in the eastern part of the region is the Rift valley belt which includes Bilate river system, Abaya and Chamo Lakes and Sagan river system up to Woitto and Chew Bahir (Langridge, 1976; SRVL, 2000).

3.4.1.1. *G. m. submorsitans*

Its infestation was associated only with Omo river system. It seems that this species had spread from two sides: 1. Langridge (1976) in his report predicted that the species can spread south ward in the lower Omo valley from upper Akobo and then Maji which is tributary of lower Omo at west. Therefore it seems through this area infestations took place to lower and middle Omo belt. 2. This species is also present on the Ghibe river system up to Gurage weredas in the south and its origin and route of spread to Ghibe valley was not well known, but it seems that the invasion might be from Didessa belt (ILRAD, 1993/94; SRVL, 2000).

2.4.1.2. *G. pallidipes*

The areas of both Rift valley and Omo belts which are indicated above are infested with *G. pallidipes*. In Omo belt it was associated with Gojeb and Ghibe river systems including middle and lower Omo river system. Prior to survey undertaken in 1996 around Kindo Koyisha it was ecorded, but later (1996, 1997, and 1998) repeatedly searches were made and failed to record it. In Lomma wereda, which is adjacent to Kindo Koisha during 1994 and 1996 *G. pallidipes* was also not caught (SRVL, 1998; NTTICC, 1996).

In Rift valley belt the whole areas are infested with only *G. pallidipes*. On the northern side, the area above Dimtu near Bilate River and the whole lower part of Damot Woide and Humbo weredas are also infested with this species (Birhanu, 1995; SRVL, 1996; NTTICC, 1996; Vreysen, *et al.*, 2000).

On the southern side around Arbaminch zuria, Nechsar, Lake Chamo, Segen and Woitto river systems area is also infested with it (SRVL, 1995). On the western side of Lake Abaya, Merab Abaya and part of Humbo areas are also infested with this species (Muturi *et al*., 1998; SRVL,

1998; Bergene, 2001). On the eastern Abaya side, around lower Gidabo and Gelana river systems up to Dilla is lightly infested (SRVL, 1998; Vreysen *et al.*, 2000). The flies/trap/day in Omo and Rift Valley belts for *G. pallidipes* ranged from 0.01 - 108.5 and 0.2 - 54.6 respectively (Table 2, 3).

2.4.1.3. *G. fuscipes*

It was found along the Omo river system. The whole Gojeb and its tributaries were infested with *G. fuscipes*. It was also found along Ghibe and its tributaries. Several surveys undertaken in the region showed the absence of this fly in rift valley belt (SRVL, 1996; NTTICC, 1996; Birhanu, 1995). The flies/trap/day for *G. fuscipes* ranged from 0.05 - 32 (SRVL, 1998).

2.4.1.4. *G. longipennis*

G. longipennis was recorded in south Omo. Currently Mago national Park and its surroundings are infested with this species (SRVL, 1996; NTTICC, 1996). *G. longipennis* can be easily caught through the window of moving car during evening 6-7 pm around Mago national park (SRVL, 1996).

2.4.2. Trypanosomosis

In Omo as well as in Rift valley belts, *T. congolense, T. vivax and T. brucei* were involved. The ratio of *T. brucei* was very low. The prevalence of trypanosomosis in Omo and Rift valley belts ranged from 3.3% - 49% and 0.5% - 32.6%, respectively. In general in south Omo of pastoralist area the prevalence is low and the fly catches were higher than other areas. In the Rift valley belt of western Abaya the prevalence of trypanosomosis is greater than eastern Abaya side areas (Table 2, 3 and 4).

As indicated in Table 4, the ratios of *T. congolense, T.vivax, T. brucei* and mixed infections in Gamu Gofa were 48.8%, 20.3%, 5.9%, and 8.5%, respectively (Argaw and Abebe,1988). The ratios of *T. congolense, T. vivax, T. brucei* and mixed infections in both belts were 52.67%, 40.71%, 2% and 4.58%, respectively (Table 5). The proportion of *T. congolense, T.vivax,* and

mixed infections in Omo belt was 58%, 36.4%, and 5.6%, respectively (Table 5). The ratios of *T. congolense, T. vivax, T. brucei* and mixed infections in Rift valley belt were 48.3%, 44.3%, 3.7% and 3.7%, respectively (Table 5) and the ratios of *T. congolense, T. vivax, T. brucei* and mixed infections in western Abaya belt were 66%, 20.9%, 7.2% and 5.9%, respectively (Table 6).

Table 2. Tsetse and trypanosomosis survey result of Rift valley belt

Zone	Wereda	Month/Year	Altitude (masl)	Tsetse	Flies/trap/day	Prevalence (%)
N. Omo	Humbo	11/1996	1200-1700	*G. p*	0.67	8.64
N. Omo	Merab Abaya	10/1996	1100-1300	*G. p*	54.6	25
N. Omo	Boreda	7/1996	1550- 1650	*G. p*	0.25	12
N. Omo	Arbaminch zuria	3/1996	1000-1100	*G. p*	15.28	20
Amarokele	Amaro	1/1997	1370-1400	*G. p*	0.2	7.3
Gedeo	Wonago	3/1997	1140-1680	*G. p*	0.15	0.5
N.Omo	Damot woyde	1992	1400-1600	*G. p*	39.2	32.6
N. Omo	Damot woyde	1994	1400-1600	*G. p*	0.7	26.8
N. Omo	Damot woyde	1995	1400-1600	*G. p*	0.32	16.5

Source: SRVL, (1996; 1998), *G. p*: *G. pallidipes*, N. Omo: North Omo

Table 3. Tsetse and trypanosomosis survey result of Omo belt

Zone	Wereda	Month/Year	Altitude (masl)	Tsetse species	Flies/trap/day	Prevalence (%)
N. Omo	Kindo-Koyesha	1996	1000-1400	*G. f*	2.1	20
N. Omo	Kucha	5/1997	1160-1320	*G. p*	2.94	
				G. m. sub	0.04	17
N. Omo	Daramalo	6/1996	980-1700	*G. p*	0.01	
				G. f	2.56	
				G. m. sub	0.027	22.98
N. Omo	Lomma	10/1997	1000-1500	*G. m. sub*	0.08	
				G. f	0.61	5.2
N. Omo	Goffa	6/1997	910-1300	*G. p*	0.57	
				G. f	0.23	8
Konso	Konso (woyito)	9 /1995	400-500	*G. p*	15	10
N. Omo	Gofa zuria	4/1998	1400-1600	*G. p*		
				G. f	20	17.2
Gurage	Cheha	2/1999	1500-1650	*G. m. sub*	0.4	16
				G. p	1	
				G. f	3	
Kefa-	Ginbo	1/1998	1350-1460	*G. m. sub*	0.16	
sheka	Yeki	2/1998	1150-1650	*G. p*	0.5	24
South Omo	Maki valley	11/1989	600-800	*G. p*	108.5	8.33
				G. long	1.05	
South Omo	Hamer	5/1996	450-800	*G. p*	2.5	8.6
				G. f	32	
Hadiya	Soro	3/1996	1400-1500	*G. p*	0.12	6.8
				G. f	0.7	
N.omo	Lomma	10/1994	1000-1500	*G. m. sub*	0.77	
				G. f	3	18.71
N. Omo	Kindo Koysha	12/1994	1000-1400	*G. p*	0.35	
				G. f	0.53	18.5
N. Omo	Kindo Koysha	11/1996	1000-1400	*G. m. sub*	0.28	20
KAT	Tambaro	3/1995	1320 – 1760	*G. p*	0.15	6.8
					0.05	
N. Omo	Boloso	2/1995	1120 -1470	*G. p*	0.06	19.0
				G. f	0.4	

Source: SRVL, (1996; 1998), *G. f*: *G. fuscipes*, *G. p*: *G. pallidipes*, *G. m. sub*: *G. m. submorsitans*, *G. long*: *G. longipennis*, KAT: Kembata Alaba Tambaro, N. Omo: North Omo

Table 4. Trypanosomosis survey result in Gamu Gofa

Wereda	Sample size	*Tc*	*Tv*	*Tb*	Mixed	Prevalence (%)
Gardula	265	19	9	3	3	15
Arba Minch zuria	1184	121	45	21	30	22
Merab Abaya, Kucha and Deramalo	229	39	18	2	5	36
Gofa	184	49	23	2	2	49
Total	1862	228	95	28	40	25.08

Source: Argaw and Abebe (1988), *Tc*: *T. congolense*, *Tv*: *T. vivax*, *Tb*: *T. brucei*,

Table 5. The ratio between different trypanosomes in animals at Omo and Rift valley belts

Wereda	Tsetse belt	Positive	*T. congolense*	*T. vivax*	*T. brucei*	Mixed

		samples				
Kindo Koysha	Omo	132	75	50		7
Arba Minch zuria	Rift valley	95	60	30		5
Sodo zuria	Rift valley	82	25	55		2
Damot woyde	Rift valley	35	17	9	8	1
Tambaro	Omo	9	4	4		1
Boloso	Omo	30	16	12		2
Hamer	Omo	10	10			
Total		393	207	160	8	18

Source: SRVL (1996; 1998)

Table 6. Trypanosomosis survey result of Rift valley belt

Site	Sample size	Positives	*Tc*	*Tv*	*Tb*	Mixed	*Prevalence (%)*
Eastern Abaya	663 *	175	117	36	12	10	*25.9*
Eastern Abaya	650 **	61	39	13	5	4	*9.4*
Total	*13 13*	*236*	*156*	*49*	*17*	*14*	*17.97*

Source: Muturi *et al.* (1999), * <1600 masl, ** 1600-2000 masl, *Tc*: *T. congolense, Tv*: *T. vivax, Tb*: *T. brucei,*

2.5. Pathogenesis of trypanosomosis

The pathogenesis of trypanosomosis is however, rather complex and depends on the trypanosome species and the species of the transmitting vector as well as on the resistance of the host. On the other hand, it is believed that the parasite releases toxic substances when it is destroyed with in the circulatory system it damages the lining of blood vessels. In some cases, the sudden release of large amounts of such toxins triggers a chain of reaction, which produces a shock like syndrome (Seifert, 1996).

Anaemia appears with progressing parasitaemia and there is lysis of large numbers of red blood cells resulting in a drop in PCV (Coetzer *et al*., 1994). Metabolic disorders are observed in the

host due to a trypanosome induced hypothyroid status (Abebe and Eley, 1992) and pituitary dysfunction during trypanosomosis (Abebe *et al*., 1993a; Abebe *et al*., 1993b). The ability of trypanosomes to change their surface coat antigen continuously leads to the exhaustion of the antibody production of the host leading to immunosuppression (Brown *et al*., 1990).

2.6. Diagnosis of trypanosomosis

The diagnosis is important both in clinical medicine and epidemiological investigations. The disease shows a variety of clinical manifestations, which are also common to other diseases. The disease may run an acute, chronic or sub clinical course and fever can be observed which can be intermittent due to the variation of parasitaemia, and if the animal survives, the disease becomes chronic and there is development of anemia and emaciation (Blood *et al.,* 1989). Anemia, fever and loss of condition are important parameters, which are routinely used for the tentative diagnosis of trypanosomosis in areas where the disease is endemic and laboratory services are not available. However clinical signs of trypanosomosis are not pathognomonic to the disease and diagnosis is solely attained by parasitological methods like dark ground phase contrast buffy coat technique (Murray *et al*., 1977), which can be used under field condition to detect the presence or absence of trypanosomes and trypanosome species are identified from thin or thick smears of positive samples. Generally trypanosomosis is a chronic disease and parasitological techniques used to diagnose trypanosomosis are not fairly sensitive in detecting most of infections this is because, trypanosomes are often scanty in the perferal blood at chronic stage of the disease, while *T. congolense* is mainly confined to the blood. *T. vivax* and *T. brucei* occur also in body tissues such as the lymph nodes, the chamber of the eye as in case of *T. vivax* and the central nervous system as in case of *T. brucei* (Uilenberg, 1997).

Serological methods, which may have advantage over direct methods and applied to detect anti trypanosome antibodies are very sensitive but often show too many false positive cases as a result of the persistence of anti trypanosome antibodies after treatment. It was also not possible to differentiate between *T. congolense, T. vivax* and *T. brucei*. Moreover, the serological tests lucks well defined antigens necessary for designing simple and accurate tests that are easily adaptable for field use (Voller, 1977). Tests used for detection of circulating trypanosomal antigens are more sensitive means of diagnosis and could increase the reliability of detection of current infection in animals. This test can detect the relapse infections in animals undergoing

trypanocidal drug therapy during a period at which it is not possible to isolate parasite from the peripheral circulation. Species specific monoclonal antibodies have been widely tested and distributed to National Agricultural Research Systems (NARS) in Africa for the diagnosis of trypanosomosis. It has, however, become apparent recently that the sensitivity of this type of test is not as high as it was claimed, and even positive results are not reliable (Eisler *et al.*, 1998)

The other diagnostic tests are molecular tests, which demonstrate the occurrence of sequences of nucleotides, specific for a trypanosome subgenus, species or even type of strain. These tests detect parasites in the mammalian host as well as in the insect vector and they can only be carried out reliably in well equipped laboratories by specifically trained staff, and are still mainly research tools (Geerts and Holmes, 1999).

2.7. Tsetse and trypanosomosis control

At the moment, there are different proven and effective tsetse control/ eradication methods. These methods are aerial spraying, ground spraying, odor baited and non-insecticide impregnated traps, insecticide impregnated odor baited traps/targets, Sterile Insect Technique (SIT), insecticide treated cattle, and use of trypanocidal drugs (Jordan, 1986).

2.7.1. Vector control

Sequential aerial spraying has been used to treat several thousand km^2 in Botswana, Kenya, Nigeria, Somalia, Uganda, Zambia and Zimbabwe with varying successes. Aerial spraying can be used to treat large areas rapidly and is particularly appropriate in epidemic situations (Allsopp, 1991).

The first attempts at control of tsetse using insecticides were by ground spraying. It has been used with great success in many parts of Africa (Allsopp, 1991). However, spraying using persistent and long acting insecticide is environmentally polluting and ground spraying is banned throughout the continent. Apart from this, the technique is too laborious and costly (Allsopp, 1991).

Despite successful field trials, livestock farmers and national governments in Africa have been slow to embrace traps and targets as a means of tsetse control.The reasons for this were difficulties associated with deployment and maintenance of traps and targets over large and often inaccessible areas and the cost of odor attractants and insecticides (Allsopp, 1991).

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Insecticide treated cattle offer numerous advantages over odor-baited traps and targets. Cattle are used as moving targets and hence no cost on odor baits, besides cattle can be moved to spray races or dips rather than staff traveling to widely dispersed traps/targets. However, fly-cattle contact is necessary if tsetse flies are to be controlled. This requires alternative means of protection of cattle using prophylactic trypanocidal drugs when they are first introduced in to tsetse infested areas; and consequently, accepting a low level of disease incidence. The technique was field tested and found successful in a number of African countries such as Ethiopia (Keno and Mengistu, 1995), Zimbabwe, Tanzania, Zanzibar, Kenya and Burkina Faso (FAO, 1992).

The value of eradicating tsetse from the vast tsetse infested areas using the SIT lies to large extent on the economic justification and on its sustainability. The benefits of tsetse eradication depend mainly on the rate and extent at which cleared areas are put to productive use and the sustainability of the operation which in turn is dependent on whether or not re-invasion of the cleared areas does not occur. SIT was applied in large scale tsetse eradication programs in Burkina Faso and Northern Nigeria (Jordan, 1986). Perhaps the most notable example of the success of the SIT, after tsetse population suppression with targets and pour-ons, is the case in Zanzibar where *G. austeni* has been eradicated from the Island (Vreysen *et al*., 2000).

2.7.2. Trypanosomosis control

2.7.2.1. Use of trypanotolerant livestock

It is well known that genetically determined innate resistance of many diseases occurs in animals populations which have been subject to natural selection by exposure to disease pressure over many generations. Taurine (humpless) breeds of cattle were the first to be introduced into Africa. At present, they persist in the sub humid and humid northern parts of sub-Saharan Africa where they live and produce in tsetse areas (Uilenberg, 1997). Such taurine breeds such as N'Dama, are now mainly confined to West African, from Senegal to Nigeria. Apart from cattle, breeds of sheep and goats living in tsetse areas are also relatively trypanotolerant. This is particularly true of the Djallonke sheep and dwarf goats in West Africa (Uilenberg, 1997).

2.7.2.2. Use of trypanocidal drugs

While tsetse control has been successful in several African countries (Jordan, 1986) and use of trypanotolerant livestock is the basis for livestock development in many countries of West and Central Africa (d'Iteren *et al*., 1998), the major strategy used to control bovine trypanosomosis in sub-Saharan Africa is based on trypanocidal drugs (Peregrine, 1994). Chemotherapy of trypanosomosis in domestic livestock is at present dependent upon the salts of a relatively small number of synthetic compounds; namely, homidium, isometamidium, diminazene and quinapyramine. However there are reports of drug resistance in *T. congolense* and *T. vivax* in many parts of Africa (Peregrine *et al*., 1994). In other words, trypanasomosis control using trypanocidal drugs is the only approach possible for technical, logistic, financial or ecological reasons in most African countries. It can also be argued that cattle only occur in many parts of Africa because of the availability of trypanocidal drugs (Jordan 1986). If trypanocidal drugs are properly used, they can provide a cost effective and sustainable approach to trypanosomiasis control (Trail *et al*., 1985).

Drugs can be highly effective provided they are continuously available and treatments are given regularly and at appropriate dose rates. Moreover, drugs can offer the possibility of reducing the disease to level where infested land can be exploited most economically with minimum risk of contracting trypanosomosis. However, if sufficient intensity of land use does not result following treatment of animals with trypanocidal drugs and tsetse habitats remain, then the presence of cattle can even cause an increase in the number of flies. This is because treated

animals will serve as readily available sources of blood meal to tsetse flies. Therefore, the use of drugs to protect cattle owned by peasant farmers could be most efficacious in such circumstances when it increases the amount of land in effective cultivation, which in turn decreases the amount of suitable tsetse habitat (Jordan, 1986).

2.8. Drug resistance

When modem trypanocidal drugs first became available, there were hopes that they would result in increased cattle production in tropical Africa. But they have several short comings such as delayed toxicity, severe local reactions and drug resistance (Whiteside, 1960).

Under field conditions, some of the factors resulting in resistance in cattle are repeated use of drugs (Leak, 1999), too small doses, underestimation of animals weights, an abscess at the site of injection (Itard, 1981), and under estimation of local trypanosomiasis challenge leads to drug resistance (Jordan, 1986). Moreover, irregular treatment with chemoprophlactic or termination of the treatment while the animal is still exposed to the infection and if prophylactic drugs are given to an infected animal instead of curative drugs (Itard, 1981; Jordan, 1986).

In Ghibe Valley, South west Ethiopia where *G. pallidipes*, *G. fuscipes* and *G. m. submorsitans* are prevalent species, All 12 cases produced infection with *T. congolense* showed resistance to treatment with diminazene aceturate at dose of 7.0 mg/kg bw, 92% of infections were also resistant to isometamidium chloride at a dose of 0.5 mg/kg bw and homidium chloride at a dose of 1.0 mg/kg bw (Peregrine *et al*., 1994).

In southern region drug efficacy studies with 1mg/kg, 3.5 mg/kg, and 0.5 mg/kg bw, ethidium, diminazene and isometamidium showed that 18.4% and 35.4% of cattle were infected with recurrent parasitaemia by ten and twenty days respectively (Habtewold, 1993).

2.8.1. Mechanisms and genetics of resistance to trypanocides

2.8.1.2. Isometamidium

Peregrine (1994) showed that the trypanosome kinetoplast is the primary site of isometamidium (ISMM) accumulation.The mechanism of resistance to ISMM, however, is less clear. Decreased levels of drug accumulation have been observed in drug resistant populations of *T. congolense*. Recently, Mulugeta *et al*. (1997) showed that the maximal uptake rates (Vmax) of ISMM in resistant *T. congolense* were significantly lower than in sensitive populations. Although contradictory observations have been reported on the genetic stability of ISMM resistance, recent field observations in Ethiopia, based on cloned populations, showed that the drug-resistant phenotype of *T. congolense* had not altered over a period of four years (Mulugeta *et al.,* 1997).

2.8.1.3. Homidium salts

Although their mutagenic activity has been known for along time, homidium chloride and especially homidium bromide or ethidium are still widely used as trypanocidal drugs. The mechanism of their antitrypanosomal action is not well understood. The mechanism of resistance by trypanosomes to these drugs is unknown. There are indications; however that it is similar to that described for ISMM (Leak, 1999).

2.8.1.4. Diminazene

Although diminazene probably exerts its action at the level of the kinetoplast DNA, this has not been proven in vivo, and other mechanisms of action cannot be excluded. The molecular basis of resistance to diminazene in trypanosomes is not clear. Similarly to ISMM, contradictory reports have also been published on the stability of resistance to diminazene. Mulugeta *et al*. (1997), however, showed that the phenotype of multiple drug-resistant (including diminazene) *T. congolense* remained sTable over a period of four years. In conclusion, it is clear that much more work is required in order to elucidate the mechanism of resistance to the three currently used drugs (Geerts *et al*., 1999).

3. MATERIALS AND METHODS

3.1. Study area

Boloso Sore wereda: It is one of the weredas of SNNPRS located along Omo river (Fig. 1). The altitude ranges from 700 (Omo river) to 2370 (Zaba mountain) masl. Boloso Sore wereda has livestock population of 113,939 cattle, 66,508 sheep, 6,441 goats, 116 horses, 438 mules and 4897 donkeys. Livestock species are bovine, caprine, ovine and equine (mule, donkey, horse).The predominant species in the area is bovine. Livestock management system is mixed farming system. The study sites are two lowland peasant associations (PAs) (Badaye and Gadala) of Boloso Sore wereda. The peasant associations where the study was conducted are located at 75 km distance from Sodo Regional Veterinary Laboratory. The study sites were selected due to road accessibility during wet seasons, high prevalence of trypanosomosis and short distances from regional veterinary laboratory. These areas lie along Omo river valley. The altitude of study PAs ranges from 700 (Omo river) – 1600 masl (Boloso Sore WOA). Mechancho river of Badaye PA, Woybo and Ajacho rivers of Gadala PA are tributaries of Omo river.

The local human population is principally engaged in livestock crop (mixed) farming system. Cattle, goats, equine and poultry are often kept in the study PAs.The cattle populations of Gadala and Badaye were estimated to be 2600 and 2400, respectively. The animals in the area mainly depend up on communal grazing fields as feed source and watering points are the tributaries of Omo river. The community use to grow crops which are early maturing, high yielding and draught resistant. Major crops growing in the area are maize, teff, ginger, sweat potato, enset and others are common.

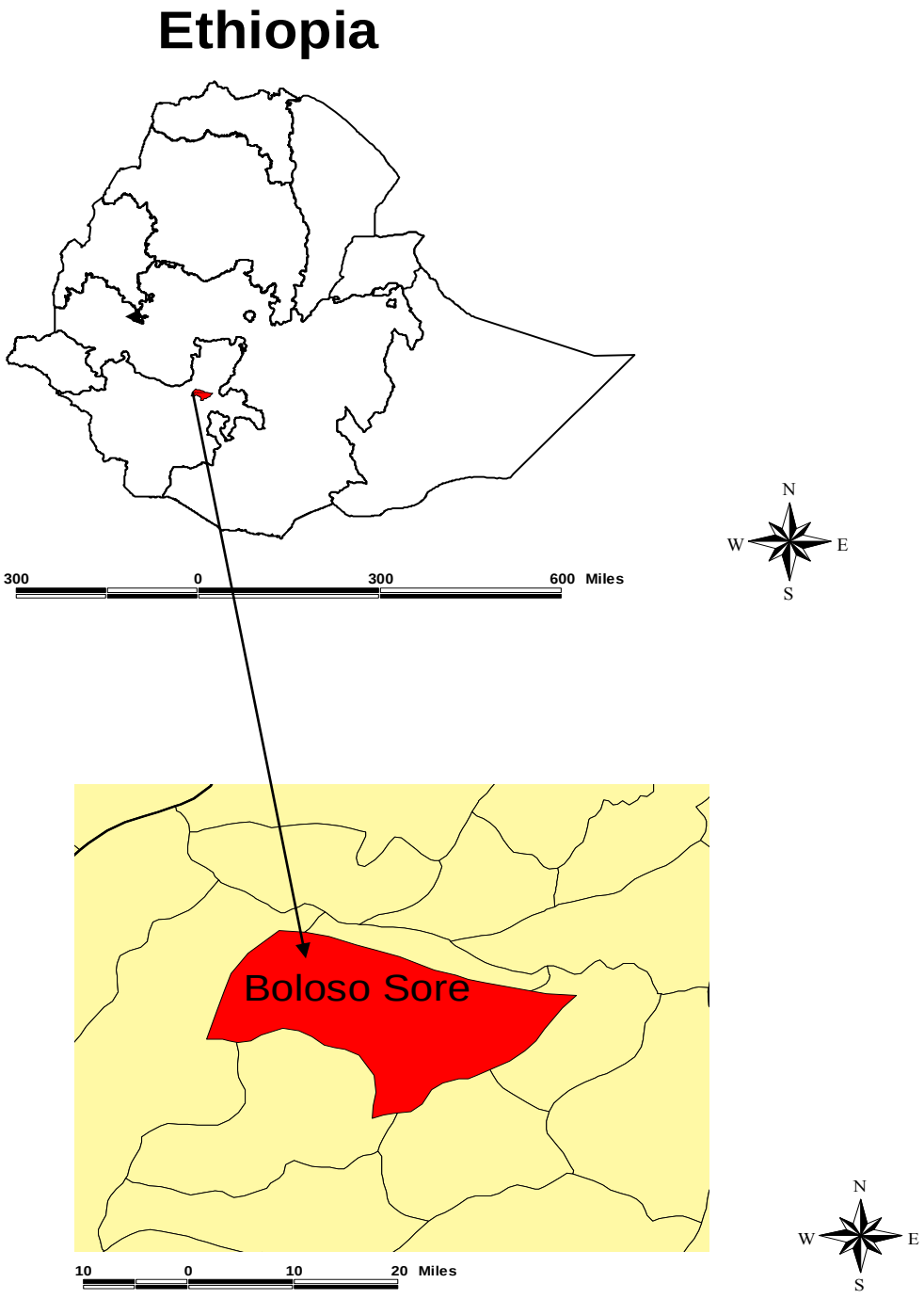
Tsetse transmitted trypanosomosis is the priority disease in the lowland areas along the Omo river.Tsetse and trypanosomosis survey undertaken in 1996 by Sodo Regional Veterinary Laboratory revealed 19.02% prevalence of trypanosomosis and the catches of *G. pallidipes* and *G. fuscipes* were 0.06 and 0.42 flies/trap/day, respectively. Communities of these areas use trypanocidal drugs for the control of animal trypanosomoses. However, studies conducted on assessment of trypanocidal drug efficacy revealed the resistance of trypanosome species in the region.

As the climate is mainly influenced by altitude, metrological data recorded from 1988–2002 at town of Areka of Boloso Sore wereda revealed the range of average annual values of 24.6–26.1^{0}C and 11.4–14.9^{0}C maximum and minimum temperature, respectively. The mean annual rainfall ranged from 101–158 mm. There are two main seasons.The rainy and dry seasons extend from November to February and March to October, respectively (Boloso Sore WOA).

Dense and light bushes dominate the vegetation of Gadala PA. Different villages of Gadala PA have similar type of vegetation. The vegetations of Badaye PA consisted of open woodland savannah.

There were various types of wild ungulates in the area: *Tragelaphus scriptus* (bush buck); *Phoeochoetus aethiopicus* (warthog); *Potamochoerus parcus* (bush pig); *Hippotradus niger* (antelope); *Panthera pardus* (leopard) and others were common.

Figure 1. A map of Ethoipia showing the study area



3.2. Study design

3.2.1. Sample Size

Totally, 1,509 samples were collected during the study period. A total of 380 and 369 cattle from both PAs were sampled in each of the first three rounds and in the fourth round study, respectively. The first round sample was collected in October 2003, which represented LWS (late wet season). The second round sample was taken in December 2003, which represented EDS (early dry season). The third round sample was taken in February 2004, which represented the LDS (late dry season). Finally, in the fourth round sample was collected in April 2004, which represented EWS (early wet season). The sample size was decreased in April 2004 by 11 cattle because; communities were occupied with farming activities and became reluctant to submit their cattle for bleeding, respectively (Table 7, 8).

Samples were collected from all four and eight villages of Badaye and Gadala PAs by using simple random sampling method respectively. Only cattle were sampled from one and two villages of Badaye and Gadala PAs in each season respectively. The sample size is determined using 95% level of confidence and expected prevalence was 19% of trypanosomosis with desired absolute precision 4% and simple random sampling method was used.

$$n = \frac{1.96^2 \, pexp \, (1-P)}{d^2}$$

n = required sample size

pexp = expected prevalence

d = desired absolute precision

P = prevalence

Table 7. Samples collected for parasitological survey at Gadala PA

Season	Villages	Sample size	Cattle population
LWS	East Ajora	90	303
LWS	Sangana Woybo	87	294
EDS	Gadala Woybo	92	310
EDS	Lower Ajacho	94	317
LDS	Gadala Ajacho	109	368
LDS	Lower Samine	85	287
EWS	Gadala Ajora	93	314
EWS	Upper Samine	120	405

Source of cattle population: Gadala peasant association development agent, LWS: late wet season (October), EWS: early wet season (April) EDS: early dry season (December), LDS: late dry season (February)

Table 8. Samples collected for parasitological survey at Badaye PA

Season	Village	Sample size	cattle population
LWS	South Badaye	203	659
EDS	West Badaye	194	630
LDS	Kirko	186	605
EWS	Solko	156	506

Source of cattle population: Badaye peasant association development agent, LWS: late wet season (October), EWS: early wet season (April) EDS: early dry season (December), LDS: late dry season (February)

3.2.2. Study type

Study type was questionnaire, cross sectional and longitudinal. Interview was made once using prepared questionnaire format. In cross sectional studies seasonal tsetse and trypanosomosis survey was included. For cross sectional studies the samples were collected four times: in October 2003, which represented LWS (late wet season, in December 2003, which represented EDS (early dry season), in February 2004, which represented the LDS (late dry season) and in

April 2004, which represented EWS (early wet season). Longitudinal studies were undertaken in October 2003.

Questionnaire

Eighty individual farmers were interviewed from both PAs using prepared questionnaire format (Annex 1). The following informations were collected: history of tsetse and trypanosomosis, drug resistant problem, treatment frequency of trypanocidal drugs, seasonal abundance of animal feeds, seasonal grazing sites and watering points, types of game animals, seasons of cash availability to purchase trypanocidal drugs etc.

Cross sectional study

Entomological survey

Tsetse fly density follow up was made once in each season and totally four times (October and December 2003 and February and April 2004) with in a study period. For savannah and reverine species biconical traps baited with cow urine and acetone were positioned for 48 hours at seasonal grazing areas and watering points of both PAs (Gadala and Badaye). At Badaye PA, for savannah tsetse species 18 traps were positioned at each seasonal grazing areas of South Badaye, Solko, West Badaye and Kirko villages during LWS, EWS, EDS and LDS respectively. For riverine species of tsetse fly 2 traps were positioned at tributaries of Mechancho river and Mechancho river watering points at above mentioned villages during LWS, EWS, EDS and LDS, respectively.

At Gadala PA out of 8 villages 4 are along Woybo river and the others are along Ajacho river. At each village seasonal grazing areas and watering points of Gadala PA 8 and 2 traps were positioned during LWS, EWS, EDS and LDS, respectively. All villages of Badaye have similar altitude and vegetations.The villages of Gadala also have similar altitude and vegetations except different watering points. The villages along Ajacho and Woybo rivers use Ajacho and Woybo rivers watering points through out the year, respectively.

The sampling of tsetse populations was carried out in order to study the distribution of tsetse species and to get apparent density, since there are no alternative and easily used means to do so.

For this purpose, the biconical traps (Challier and Laviessiere, 1973), which are the most widely, used traps for sampling tsetse flies were used. The portability and ease of setting this trap are practically useful when sampling. The traps were stored in a clean and dry place. Before they are set, they were checked carefully to make sure that there are no holes or tears in the material, particularly in the net cone or in the cages. Prior to setting traps, vegetations were cleared with in a set radius around the trap to standardize visibility of the trap (FAO, 1992).

All traps were set at the same height above ground level. The caught flies were adequately protected from ants by coating part of trap supports with car grease. A needle and thread, were carried to repair any minor damage on the trap. Cow urine (100%) and acetone were used as attractants for tsetse flies. The hole of dispenser for acetone was a diameter of 2-6 mm in order to get a release rate of more than 150 mg/h and the hole of dispenser for cow urine was a diameter of about 45 mm in order to get a release rate of about 1000 mg/h (FAO, 1992). The collected catches of tsetse flies were identified, sexed, counted recorded. Moreover biting flies (tabanus) were also counted and recoded as well.

Parasitological survey

Blood samples were collected randomly from cattle of Badaye and Gadala PAs during study periods (Table 7, 8). It was collected from the ear vein by using sterile blood lancet and capillary tubes. A pair of heparnized capillary tubes were filled with blood from animals to ¾ of their height and sealed at one end with crystal seal. The capillary tubes were loaded on the micro hematocrit centrifuge symmetrically and centrifuged at 12000 rpm for 5 minutes (Murray *et al.*, 1977). Packed cell volume (PCV) was determined using hematocrit reader (Woo, 1969). After the PCV was read, capillary tubes were broken 1mm below the buffy coat to include the red blood cells layer and the content were expressed on microscopic slide and mixed and covered with a 22x22 mm cover slip. The content was examined under x40 objective using dark ground buffy coat technique (Murray *et al*., 1977). From positive samples thin blood smears were made, fixed with methanol for 5 minutes and stained with Giemsa solution for 30 minutes and examined using oil immersion under x100 objective to detect the species of trypanosomes.

Longitudinal study

During cross sectional study, in the begining of October 64 zebu cattle with trypanosome infections were selected from South Badaye (Badaye PA), East Ajora and Sangana Woybo villages (Gadala PA) to asses curative/prophylactic effect of isometamidium chloride (1mg/kg bw. The areas were selected because of informations gathered from wereda veterinary clinic, SRVL and moreover, in order to conduct activities together with seasonal tsetse and trypanosomosis studies program. According to culture of communities, each animal has its own name. Based on this each of the 64 cattle name and owner's name were registered in order to identify easily during monitoring days. Cattle were treated intramuscularly with isometamidium chloride (Trypamidium Lot. No. W 384972 A Rhone Merieux, France) (1 mg/ kg bw). For calculating treatment dose, the body weights of each of the study cattle was estimated before treatment using tapes for measuring heart girz (Arora *et al*., 1981). Treated animals were monitored on 15, 30, 60 and 90^{th} days post-isometamidium chloride block treatment. The PCV value of each sample was determined and the relapse cases were also recorded (Annex 2). Parasitaemic animals were treated with 7 mg/kg bw of diminazene aceturate and excluded from study.

3.2.3. Data analysis

Statistical analysis were employed with Stata 7.0 soft ware for data management and analysis. The tested hypotheses were seasonal apparent density, prevalence of trypanosomosis, PCV value, the relation between tsetse apparent density and prevalence of trypanosomosis, the relation between PCV value and prevalence of trypanosomosis, frequency of treatment with trypanocidal drugs and dependency on veterinary clinics and others were tested. Kinds of descriptive statistics which were used are standard deviation, confidence interval, mean, rate, and frequency analysis. Kinds of analytical statistics, which were implemented, were Chi-square tests, t-test, regression and correlation analysis methods.

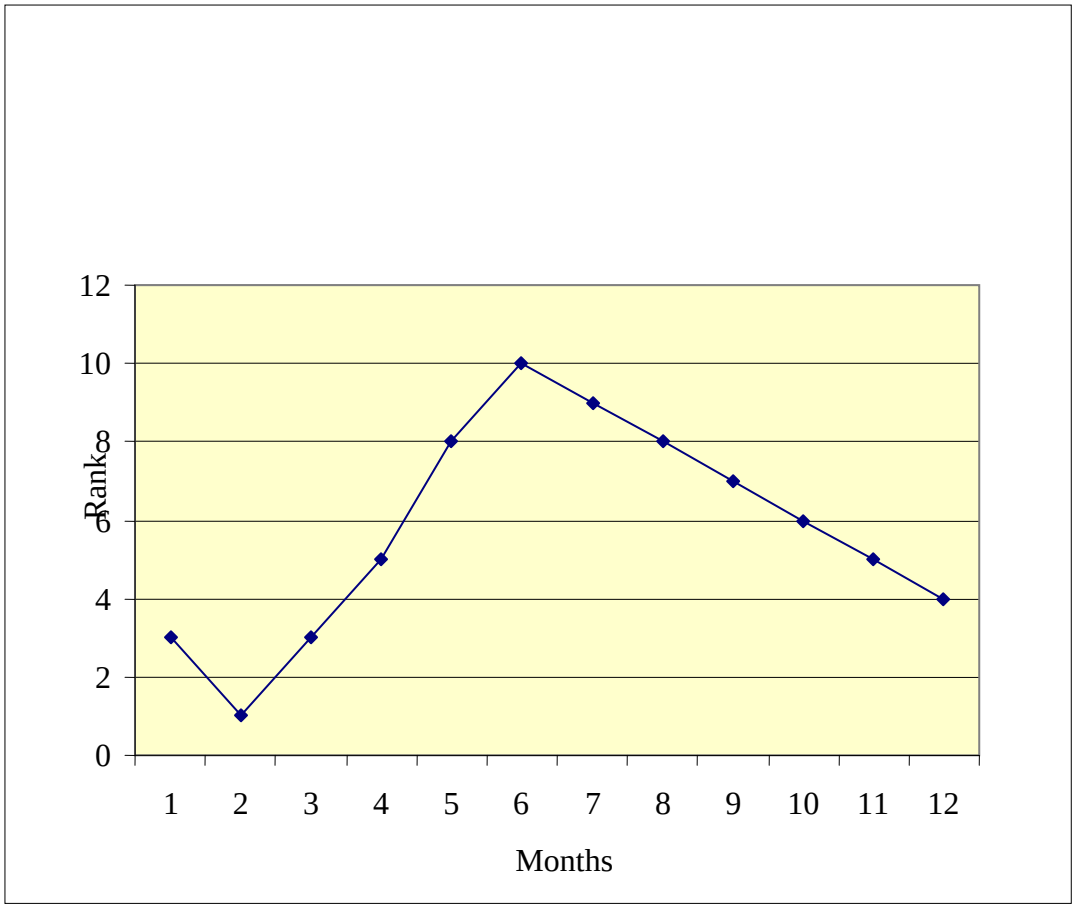
4. RESULTS

4.1 Questionnaire

Most of elder farmers responded that they knew the disease trypanosomosis in the lowlands of Boloso Sore wereda for the last 40 years. Since then trypanosomosis became a major constraint to livestock production and productivity in the area. As they responded prior to introduction (with in 5 years time) due to lack of knowledge about disease and trypanocidal drugs high morality was registered. Most of the interviewed farmers claimed the disease did not respond to different types of trypanocidal drugs for the last 20 years and its magnitude is increasing from time to time.

Different types of livestock are kept in the study site. These are cattle, goats, sheep, donkeys and mules. Cattle and poultry are the most predominant livestock in the area. Cattle herd size of respondents in the study area was found to be between 1-10 and the average herd size was 3.36. Free grazing covers highest proportion (97.5%) of the livestock feed at Badaye PA. At Gadala PA only free grazing, free grazing and tether and only tether cover 66.6%, 30.6% and 2.8% of the livestock feed, respectively. Livestock watering points were more close to grazing areas (1-3 km) except watering points (Mechancho river) of Badaye PA, where during the end of early dry season and late dry season animals move as long as 5 km. Livestock of Badaye PA use grazing area as far as 5 km from 8^{th} - 3^{rd} month. From 4^{th} -7^{th} month they use grazing area around homestead. The animals of Gadala PA use watering points of Woybo and Ajacho rivers. Seasonal livestock feed abundance is indicated by Rapid Rural Appraisal (RRA) technique (Snow and Rawlings, 1999) (Fig. 2).

Figure 2. Seasonal livestock feed abundance as indicated by RRA



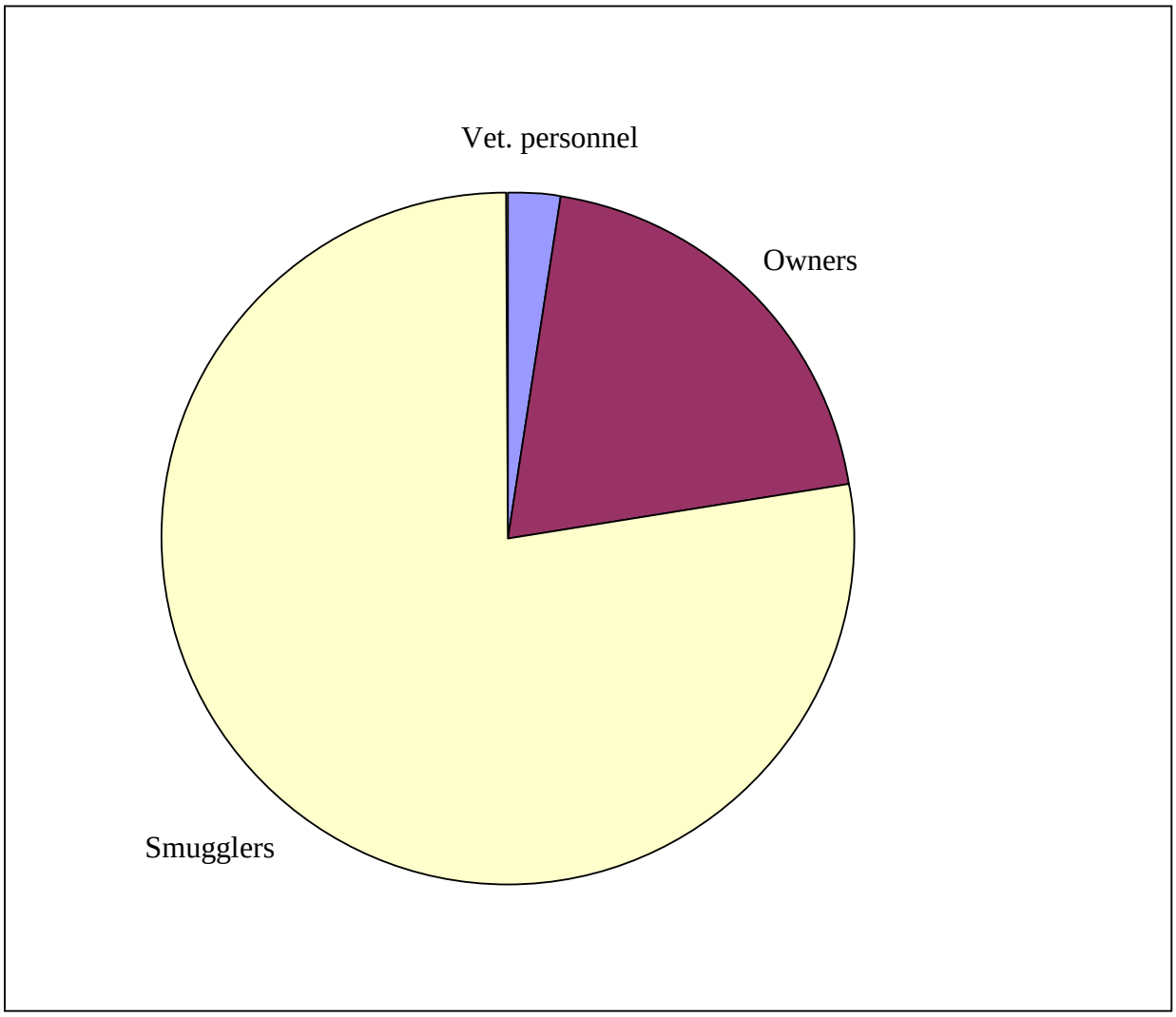
Rank = low abundance: 1-3, medium abundance: 4-6, high abundance: 7-10,
1st month = January

Almost all interviewed community members ranked trypanosomosis as most economic important disease of cattle followed by blackleg and anthrax. The interviewed community members claimed trypanosomes have got clinical sign of diarrhoea, emaciation, reduced appetite, weakness, low milk yield and reduced draught power. According to community members response, trypanosomosis occur through out the year. However, its magnitude of occurrence depends on the type of season. About 65% of Badaye and 70% of Gadala respondents said that the magnitude of occurrence of trypanosomosis becomes high during wet season and out of them 79% and 71.8% agreed that the magnitude of occurrence increases during early months (May and June) of wet season, respectively.

About 92.5% and 75% of Badaye and Gadala PA community member respondents said that the trend of trypanosomosis is increasing, respectively. According to questionnaire, 77.5%, 20% and 2.5% of both PAs sick animals were treated by smugglers, owners, and veterinary personnel,

respectively. Those who depend (2.5%) on veterinary personnel are only from Gadala PA. Personnels involved in the treatment of livestock are indicated in Figure 3.

Figure 3. Personnels involved in the treatment of animal trypanosomosis



The common trypanocidals used in the area were diminazene aceturate followed by ethidium bromide. They use ethidium bromide especially for pregnant animals and milking cows. 96.2% of interviewed community members from both PA's responded that they use appropriate dosage (one sachet of diminazene aceturate or one tablet of ethidium bromide) per adult animal. With regard to treatment frequency, community members of both PAs responded that they treat with trypanocidal drugs an average of 6 times each cattle per year. Concerning about availability of money to purchase trypanocidal drugs through out the year, most of community members

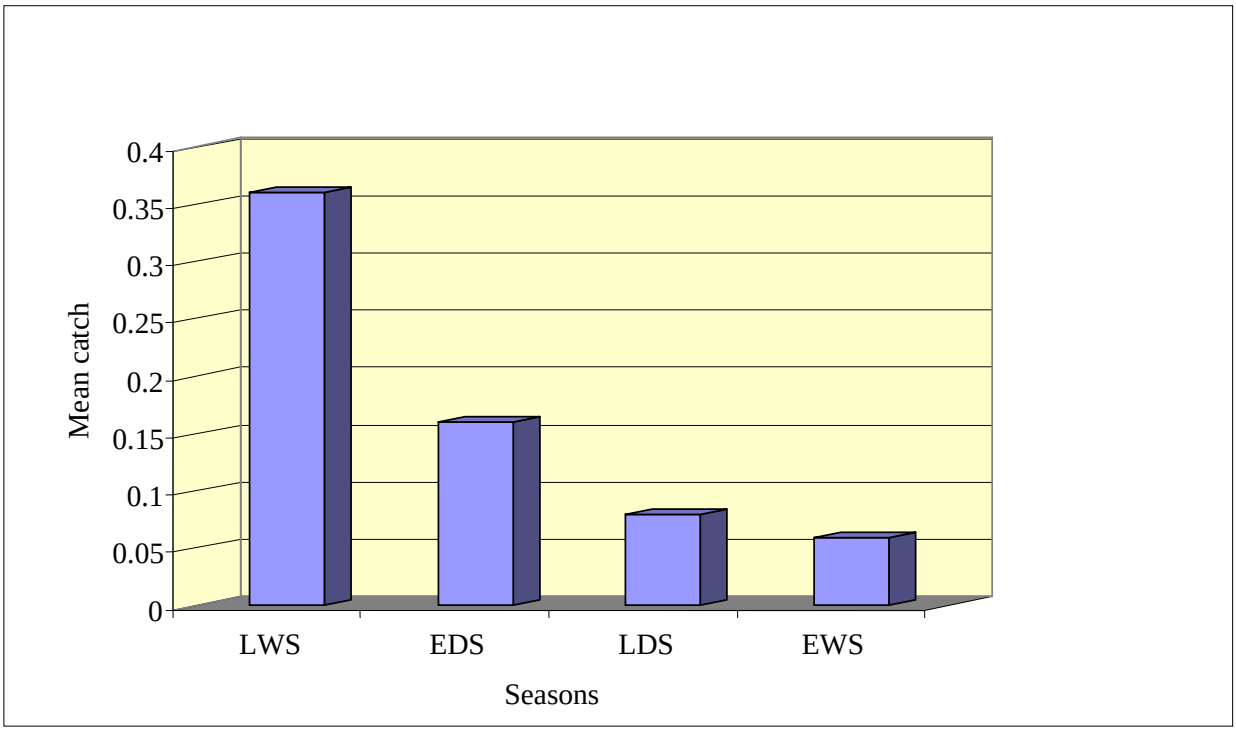
responded, that they make 2-3 and 7-15 days delay to treat their cattle after observation of clinical signs during dry and wet seasons, respectively.

4.2. Tsetse survey

During the survey periods, three species of tsetse flies were identified. These were *G. m. submorsitans*, *G. fuscipes* and *G. pallidipes.* The first two and the latter species were caught at Badaye and Gadala PAs, respectively. During late wet season (October) one *G. m. submorsitans* and 13 *G. pallidipes* were sampled at Badaye and Gadala PAs, respectively. The mean catch of *G. pallidipes* at East Ajora and Sangana Woybo villages of Gadala PA was 0.36 flies/trap/day (95 % confidence interval = 0.21, 0.54) (Fig.4). The highest catches were registered at East Ajora village (Ajacho grazing areas) of Gadala PA (Table 9).

No catches were registered at Upper Samine village of Gadala PA during early wet season. However, at each of Solko and Gadala Ajora villages two *G. m. submorsitans* and *G. pallidipes* were caught, respectively (Table 9). The mean catch of *G. pallidipes* during early wet season at Gadala PA was 0.06 flies/trap/day (95 % confidence interval = 0.007, 0.18) (Fig. 4).

Figure 4. Comparison of mean catches of *Glossina pallidipes* by seasons



LWS: late wet season, EDS: early dry season, LDS: late dry season, EWS: early wet season

Table 9. Tsetse flies and tabanids catches during late and early wet seasons

PA	Village	Season	Altitude (masl)	Tsetse flies				F lies/trap/day	
				Spp	M	F	Total	Tsetse	Tabanids
Badaye	South Badaye	LWS	1380-1410 *	*G. m. sub.*		1	1	0.03	0.06
Gadala	Sangana Woybo	LWS	1380-1420 *	*G. p*	1	1	2	0.11	0.05
	East Ajora	LWS	1420-1430 *	*G. p*	4	7	11	0.61	-
Badaye	Solko	EWS	1380- 1410 *	*G. m. sub.*		2	2	0.05	
Gadala	Upper Samine	EWS	1390-1420 *	-	-	-	-	-	-
	Gadala Ajora	EWS	1410-1420 *	*G. p*	-	2	2	0.1	-

LWS: late wet season (October), EWS: early wet season (April), Flies/trap/day: flies per trap per day, *G. p*: *G. pallidipes*, *G. m. sub.*: *G. m. submorsitans*, Spp: species, M: male, F: female, * traps positioned at grazing areas

During early dry season the mean catch of *G. pallidipes* at Gadala PA was 0.16 flies/trap/day (95% confidence interval = 0.05, 0.3) (Fig.4). No catches of tsetse fly was registered at Badaye PA. Whereas during late dry season only one *G. m. submorsitans* and three *G. fuscipes* were registered at homestead grazing area and Mechancho watering points of Badaye PA, respectively

(Table 10). Mechancho river is the only watering point used only during late dry season (January, February and even up to middle of March if dry season is prolonged). During late dry season catches of *G. pallidipes* were registered at Woybo grazing area and watering points, but no catches were registered at Ajacho grazing areas as well as watering points (Table 10). The mean catch of *G. pallidipes* at Gadala PA during late dry season was 0.08 flies/trap/day (95% confidence interval = 0.017, 0.22) (Fig. 4)**.** The samples were biased in all seasons in favour of females. The mean catches of *G. pallidipes* was significantly differed ($X^2 = 15$, df = 3, $p < 0.05$) between seasons. During study period of different seasons very low catches of tabanids were recorded (Table 9, 10).

Table 10. Tsetse flies and tabanids catches during early and late dry seasons

PA	Village	Season	Altitude (masl)		Tsetse flies				F lies/trap/day	
					Spp	M	F	Total	Tsetse	Tabanids
Badaye	West Badaye	EDS	1370-1410	*	*G. m. sub.*	-	-	-	-	-
Gadala	Gadala Woybo	EDS	1410-1420	*	*G. p*		2	2	0.13	0.06
	Lower Ajacho	EDS	1410-1430	*	*G. p*	2	1	3	0.19	-
	Kirko	LDS	1360-1410	*	*G. m. sub.*	-	1	1	0.03	-
Badaye										
	Kirko	LDS	1330-1350	**	*G. f*	1	2	3	0.75	-
	Lower Samine	LDS	1400-1420	*	*G. p*	-	1	1	0.06	0.06
Gadala		LDS	1390-1400	**	*G. p*		2	2	0.5	-
	Gadala Ajacho	LDS	1410-1420	*	*G. p*	-	-	-	-	0.01

EDS: early dry season (December), LDS: late dry season (February), Flies/trap/day: flies per trap per day, *G. p*: *G. pallidipes*, *G. m. sub.*: *G . m. submorsitans*, Spp: species, M: male, F: female, ** traps positioned at watering points, * traps positioned at grazing areas

4.3. Parasitolgical results of cross sectional study

The overall trypanosome infection prevalence in cattle of both PAs was 15.77% (95 % confidence interval = 14, 17.56). In the beginning of October which represented late wet season 380 cattle were examined at Badaye and Gadala PAs for the presence of trypanosome infections and 18.42% (95% Confidence interval = 14.4, 21.9) of trypanosomosis prevalence was recorded (Fig. 5). Out of this prevalence 16.3% (95% confidence interval = 11, 21) and 20.9% (95% confidence interval = 15, 26) trypanosome infections were registered at South Badaye of Badaye PA and Sangana Woybo, East Ajora villages of Gadala PA, respectively. The highest prevalence rate was recorded at villages of Gadala PA (Table 11).

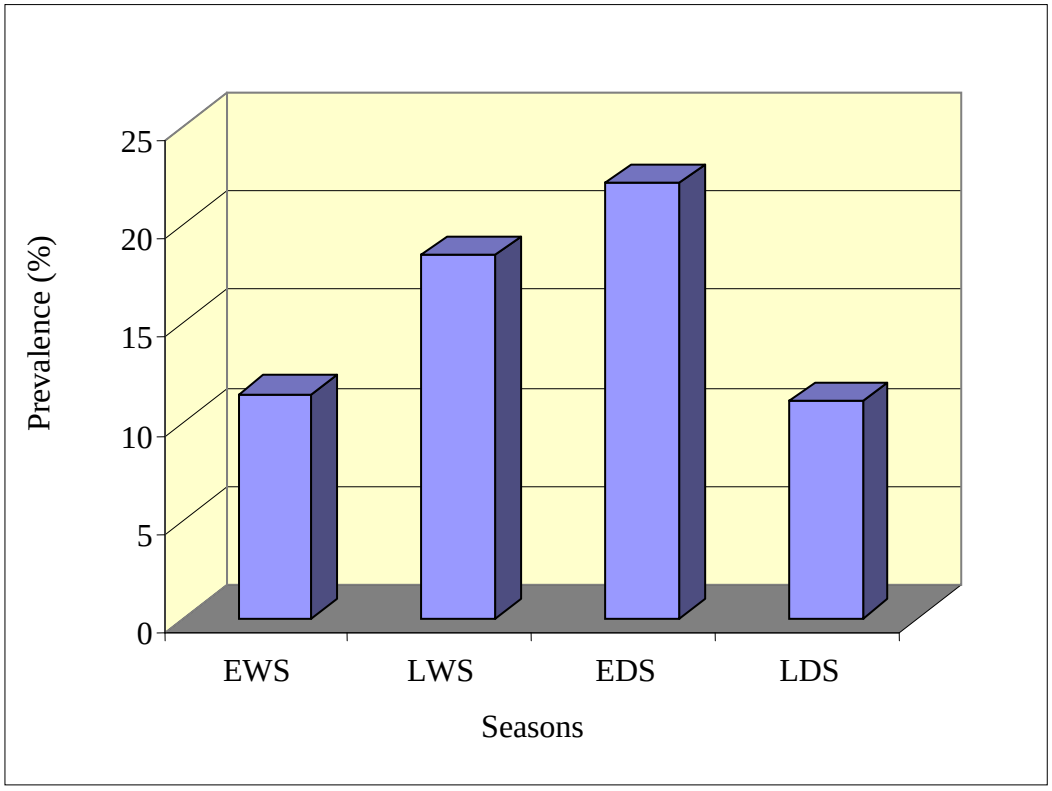
Table 11. The prevalence of trypanosomosis in early and late wet seasons

PA	Village	Season	Total sample	Positives	*Tc*	*Tv*	Mixed	Prevalence (%)
Gadala	East Ajora	LWS	90	19	12	7	-	21.1
	Sangana Woybo	LWS	87	18	11	6	1	20.7
	Total	LWS	177	37	23	13	1	20.9
Badaye	South Badaye	LWS	203	33	19	14	-	16.3
Gadala	Gadala Ajora	EWS	93	5	2	3	-	5.4
	Upper Samine	EWS	120	13	10	3	-	10.8
	Total	EWS	213	18	12	6	-	8.5
Badaye	Solko	EWS	156	24	17	7	-	15.38

LWS: late wet season (October), EWS: early wet season (April), *Tc (T. congolense*), *Tv (T. vivax*), Mixed (*T. congolense* and *T. vivax*)

During early wet season 11.38% (95% confidence interval = 9.9, 13.03) prevalence of trypanosome infection was recorded at Badaye and Gadala PAs, respectively (Fig. 5). Out of this prevalence 15.4% (95% confidence interval = 12.5,18.3) and 8.45% (95% confidence interval = 4.75, 12.19) were registered at Solko village of Badaye PA and Upper Samine, Gadala Ajora villages of Gadala PA, respectively. The highest prevalence was registered at Solko village of Badaye PA (Table 11). There was a significant difference ($X^2 = 4.29$, df = 1, $p < 0.05$) in trypanosome infection prevalence between Solko village of Badaye PA and villages (Upper Samine, Gadala Ajora) of Gadala PA during early wet season (February).

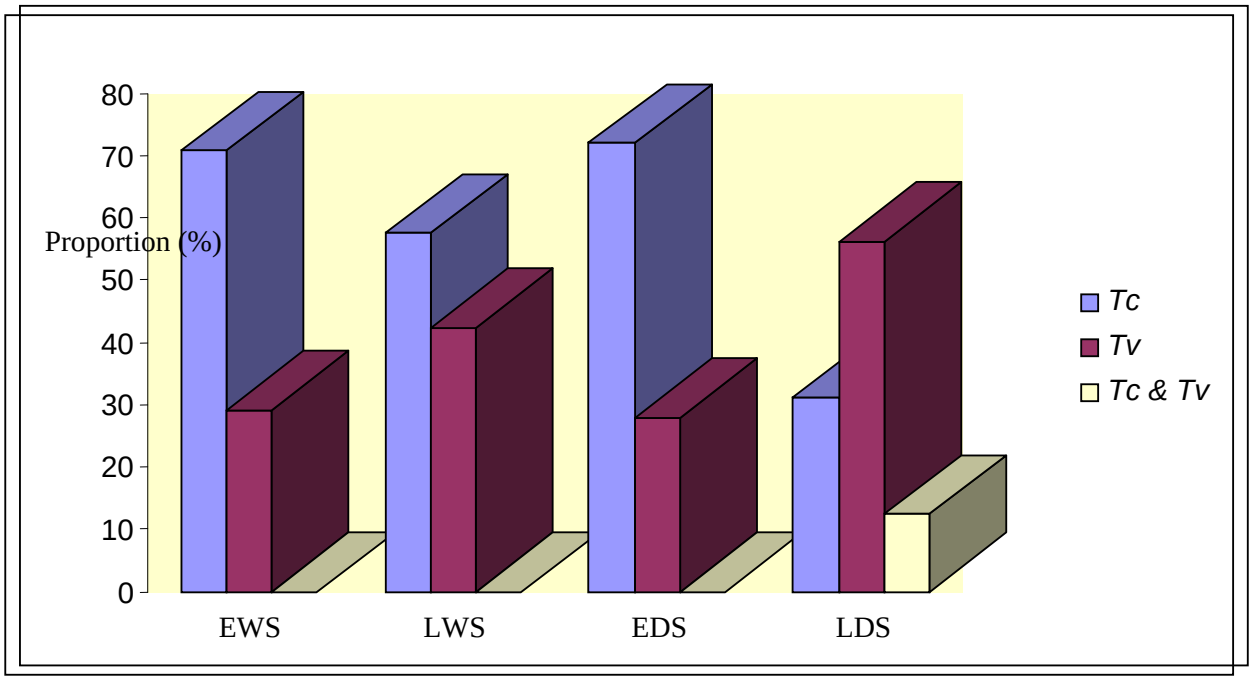
Figure 5. The prevalence rates of trypanosomosis by seasons at Badaye and Gadala PAs



LWS: late wet season (October), EWS: early wet season (April) EDS: early dry season (December), LDS: late dry season (February)

At Badaye, during late wet and early wet seasons examination of Giemsa stained thin smears revealed 57.6% (19/33) *T. congolense,* 42.4% (14/33) *T. vivax* and 70.8%(17/24) *T. congolense,* 29.2% (7/24) *T. vivax* infections, respectively (Fig. 6). Whereas at villages of Gadala during late and early wet seasons 59.5% (22/37) *T. congolense,* 37.8% (14/37) *T. vivax,* 2.7% (1/37) mixed infections and 66.7% (12/18) *T. congolense,* 33.3% (6/18) *T. vivax* infections in cattle were identified, respectively (Table 11).

Figure 6. The relative importance of different species of trypanosomes at Badaye PA



LWS: late wet season (October), EWS: early wet season (April) EDS: early dry season (December), LDS: late dry season (February)

The trypanosome infection rate in cattle at both PAs (Badaye and Gadala) during early and late dry seasons was 22.1% (95% confidence interval = 18, 26.26) and 11.08 % (95% confidence interval = 8, 14.15), respectively (Fig. 5). The trypanosomosis prevalence during early and late dry seasons at West Badaye and Kirko villages of Badaye PA was 22.1% (95% confidence interval = 19.2, 25) and 8.6% (95% confidence interval = 4.47, 10.5), respectively (Table 12). On the other hand, the trypanosomosis prevalence during early dry season at Gadala Woybo and Lower Ajacho villages of Gadala PA was 19.57% (95% confidence interval = 16, 24) and 24.47 % (95 % confidence interval = 19.6, 28.4), respectively (Table 12).

Table 12. The prevalence of trypanosomosis in early and late dry seasons

PA	Village	Season	Sample size	Positives	*Tc*	*Tv*	Mixed	Prevalence (%)
Gadala	Gadala Woybo	EDS	92	18	13	5	-	19.57
	Lower Ajacho	EDS	94	23	15	7	1	24.47
	Total	EDS	186	41	28	12	1	22.04
Badaye	West Badaye	EDS	194	43	31	12	-	22.16
Badaye	Kirko	LDS	186	16	5	9	2	8.6
Gadala	Lower Samine	LDS	85	17	12	5	-	20
	Gadala Ajacho	LDS	109	9	4	4	1	8.26
	Total	LDS	194	26	16	9	1	13.4

EDS: early dry season (December), LDS: late dry season (February), *Tc (T. congolense*), *Tv (T. vivax*), Mixed (*T. congolense* and *T. vivax*)

With regard to late dry season, the trypanosome infection prevalence rates at Lower Samine and Gadala Ajacho villages of Gadala PA were 20% and 8.26%, respectively. Higher prevalence rates were registered at Lower Ajacho and Lower Samine villages of Gadala PA during early and late dry seasons, respectively (Table 12).

The relative importance of different species of trypanosomes during early and late dry seasons at Badaye PA was 72.09% (31/43) *T. congolense*, 27.91% (12/43) *T. vivax* and 31.13% (5/16) *T. congolense*, 56.25% (9/16) *T. vivax*, 12.5 % (2/16) mixed infections, respectively (Fig. 6). The trypanosome species prevalence during early and late dry seasons at Gadala PA was 68.29% (28/41) *T. congolense*, 29.27% (12/41) *T. vivax*, 2.4% (1/41) mixed and 61.5% (16/26) *T. congolense*, 34.6% (9/26) *T. vivax*, 3.8% (1/26) mixed infections were diagnosed, respectively (Table 12). The most dominant parasite was *T. congolense* and accounted for 63.4% in over all infections. *T. congolense* contributed for 60% (42/70), 70% (59/84), 50% (21/42) and 69.05% (29/42) infections during late wet (October), early dry (December), late dry (February) and early wet (April) seasons in cattle of both PAs, respectively (Table 11, 12). There was a significant difference ($X^2 = 25.20$, df = 3, $p < 0.001$) in trypanosome infection prevalence between seasons.

4.4. Haematological results

The over all mean PCV value of cattle at Badaye and Gadala PAs was 24.02% (95% confidence interval = 23.8, 24.26) (Table 16). Out of tested cattle, 61.5% had PCV values of less than 26%. The mean PCV value of cattle tested during early wet season (April) was 24.65% (Table 15). Out of tested cattle, 59.07% had PCV values of less than 26%. The mean PCV value of parasitaemic and aparasitaemic cattle was found to be 20.6% and 25.17%, respectively (Table 14). 90.6% and 55% of parasitaemic and aparasitaemic cattle had PCV values less than 26%, respectively (Table 13).

Table13. Proportion of parasitaemic and aparasitaemic cattle of Badaye and Gadala PAs

Season	No. of cattle	Parasitaemic PCV < 26%	Parasitaemic PCV ≥ 26%	Aarasitaemic PCV < 26%	Aparasitaemic PCV ≥ 26%
EWS	369	38 (90.6%)	4 (9.4%)	180 (55 %)	147 (45%)
LWS	380	60 (85.7 %)	10 (14.3 %)	196 (63.2%)	114 (36.8%)
EDS	380	77 (91.7 %)	7 (8.3 %)	199 (67.2%)	97 (32.8 %)
LDS	380	28 (66.6 %)	14 (33.37 %)	150 (44.3%)	188 (63.7%)

LWS: late wet season (October), EWS: early wet season (April) EDS: early dry season (December), LDS: late dry season (February)

The mean PCV value of cattle tested during late wet season (October) was 23.42% (Table 15). Out of tested cattle, 67.37% had PCV values of less than 26%. The mean PCV value of parasitaemic and aparasitaemic cattle was found to be 20.23% and 24.15%, respectively (Table 14). 85.5% and 63.2% of parasitaemic and aparasitaemic cattle had PCV values of less than 26%, respectively (Table 13).

Table 14. Mean PCV value of parasitaemic and aparasitaemic cattle by seasons

Season	Parasitaemic		Aparasitaemic	
	Mean PCV (%)	Std. Dev.	Mean PCV (%)	Std. Dev.
EWS	20.6	4.04	25.17	4.6
LWS	20.23	4.48	24.15	4.2
EDS	20.05	4.04	23.43	4.3
LDS	22.69	4.98	25.67	4.3

LWS: late wet season (October), EWS: early wet season (April) EDS: early dry season (December), LDS: late dry season (February)

The mean PCV value of cattle tested during early dry season (December) was 22.68% (Table 15). Out of tested cattle 72.63% had PCV values of less than 26%. The mean PCV value of parasitaemic and aparasitaemic cattle was found to be 20.05% and 23.43%, respectively (Table 14). 91.7% and 67.2% of parasitaemic and aparasitaemic cattle had PCV values of less than 26%, respectively (Table 13). The mean PCV value of cattle tested during late dry season (February) was 25.34% (Table 15). Out of tested cattle, 46.8% had PCV values of less than 26%. The mean PCV value of parasitaemic and aparasitaemic cattle was found to be 22.69% and 25.67%, respectively (Table 14). 66.6% and 44.3% of parasitaemic and aparasitaemic cattle had PCV values of less than 26%, respectively (Table 13). Cattle examined during early dry season had the lowest mean PCV value. Totally, 61.5% of sampled cattle had PCV value less than 26%. Kruskal-Wallis Chi-square test showed that there was no significant difference ($X^2 = 0.301$, df = 3, $p > 0.05$) between mean PCV values of cattle tested during different seasons**.**

Table 15. The mean PCV value of cattle by seasons

Season	Mean PCV (%)	Standard deviation	Frequency
EDS	22.68	4.46	380
EWS	24.65	4.75	369
LDS	25.34	4.47	380
LWS	23.42	4.51	380
Total	24.02	4.66	1509

Comparision of mean PCV values of parasitaemic and aparasitaemic cattle at Badaye and Gadala PAs was performed by using the student t-test. There was a statistically significant difference ($p < 0.0001$) between mean PCV values of parasitaemic and aparasitaemic cattle tested during different seasons (Table 16)**.**

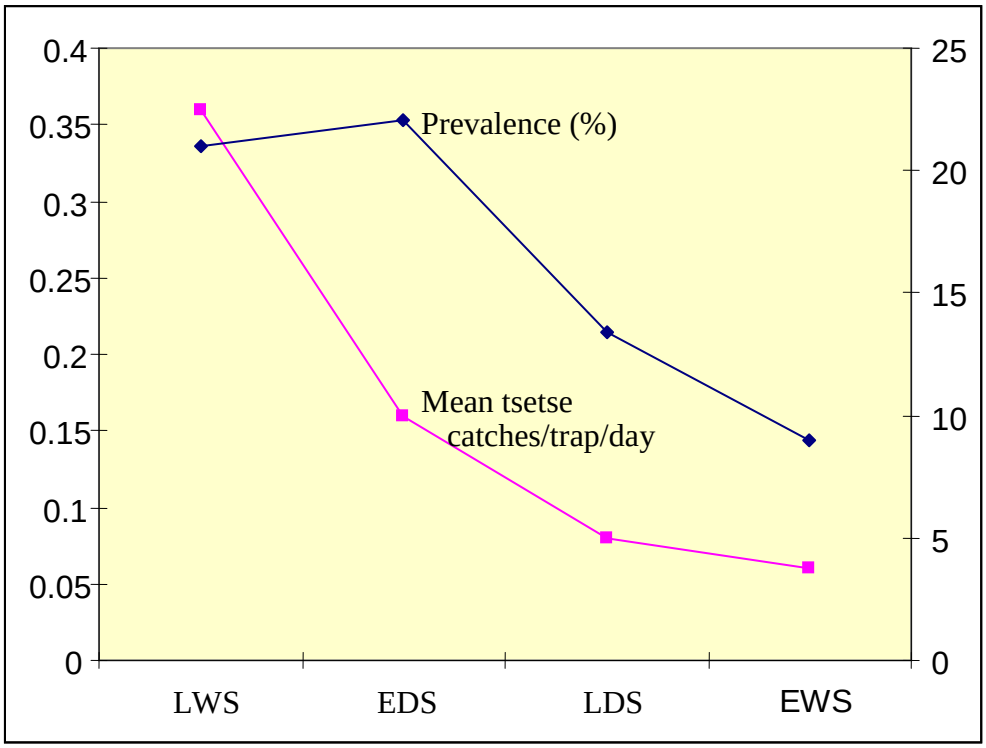
Table 16. Comparison of mean PCV between parasitaemic and aparasitaemic cattle

Group	Total	Mean	(95% confidence interval)
Aparasitaemic	1271	24.65	24.40,24.89
Parasitaemic	238	20.67	20.10, 21.23
Combined	1509	24.02	23.8, 24.26
Difference		3.98	3.37, 4.6

4.5. Association of trypanosome prevalence, PCV value and tsetse apparent density

The association was analysed for *G. pallidipes*, which was the principal vector at Gadala PA. Because of very low catches, the analysis was not performed for *G. m. submorsitans* and *G. fuscipes*, which were the vectors of trypanosome species at Badaye PA. The prevalence of trypanosome infection was high during late wet (20.9%) (95% confidence interval = 17, 25) and early dry seasons (22.04%) (95% confidence interval = 18, 26) at Gadala PA. In contrary, the prevalence was low during early wet (8.45%) (95% confidence interval = 5.2, 10.8) and late dry seasons (13.4%) (95% confidence interval = 10, 16.8). On the other hand, the apparent density of *G. pallidipes* during late wet (0.36 flies/trap/day) (95% confidence interval = 0.21, 0.54) and early dry season (0.16 flies/trap/day) (95% confidence interval = 0.05, 0.3) was higher than early wet (0.06 flies/trap/day) (95 % confidence interval = 0.007, 0.18) and late dry seasons (0.08 flies/trap/day) (95% confidence interval = 0.017, 0.22), where the catches were low. Therefore, the prevalence of trypanosomosis in different seasons was positively correlated (r = 0.5176) with tsetse catches (Fig.7).

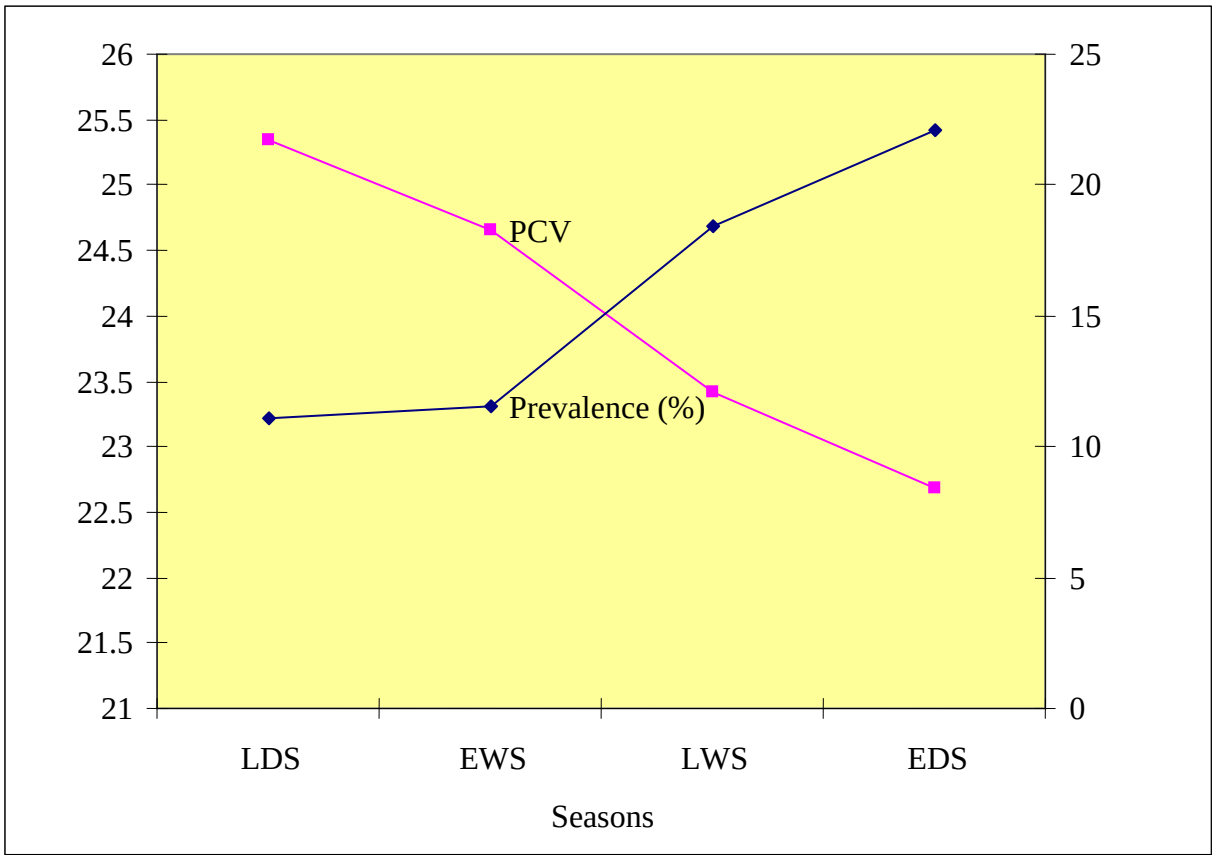
Figure 7. The relation between prevalence of trypanosome infection and mean tsetse catch



LWS: late wet season (October), EWS: early wet season (April) EDS: early dry season (December), LDS: late dry season (February)

The result of study conducted during different seasons revealed that as proportion of samples detected parasitaemic increased PCV value decreased. This indicates that PCV value is negatively correlated (r = -0.3112) with the prevalence of trypanosomosis (Fig. 8).

Figure 8. The relation between mean PCV value and prevalence of trypanosome infection



LWS: late wet season (October), EWS: early wet season (April) EDS: early dry season (December), LDS: late dry season (February)

4.6. Risk factors on trypanosome prevalence

4.6.1. Age

Samples were stratified according to age and based on this, during study time young cattle (less than or equal to three years of age) and adult cattle (greater than three years of age) were considered. With regard to infections, 16.87% (185/1096) and 12.83% (53/413) infections were in adult and in young cattle, respectively. The proportion of *T. congolense* was higher in adult cattle and in contrary; the proportion of *T. vivax* was higher in young cattle (Fig. 9). Moreover, when the age of cattle increased the prevalence rate was also increased (Fig.10). There was a significant difference (X^2 = 29.93, df = 10, $p < 0.001$) in trypanosome infection between different age groups.

Figure 9. The relative importance of different trypanosomes by age groups in years

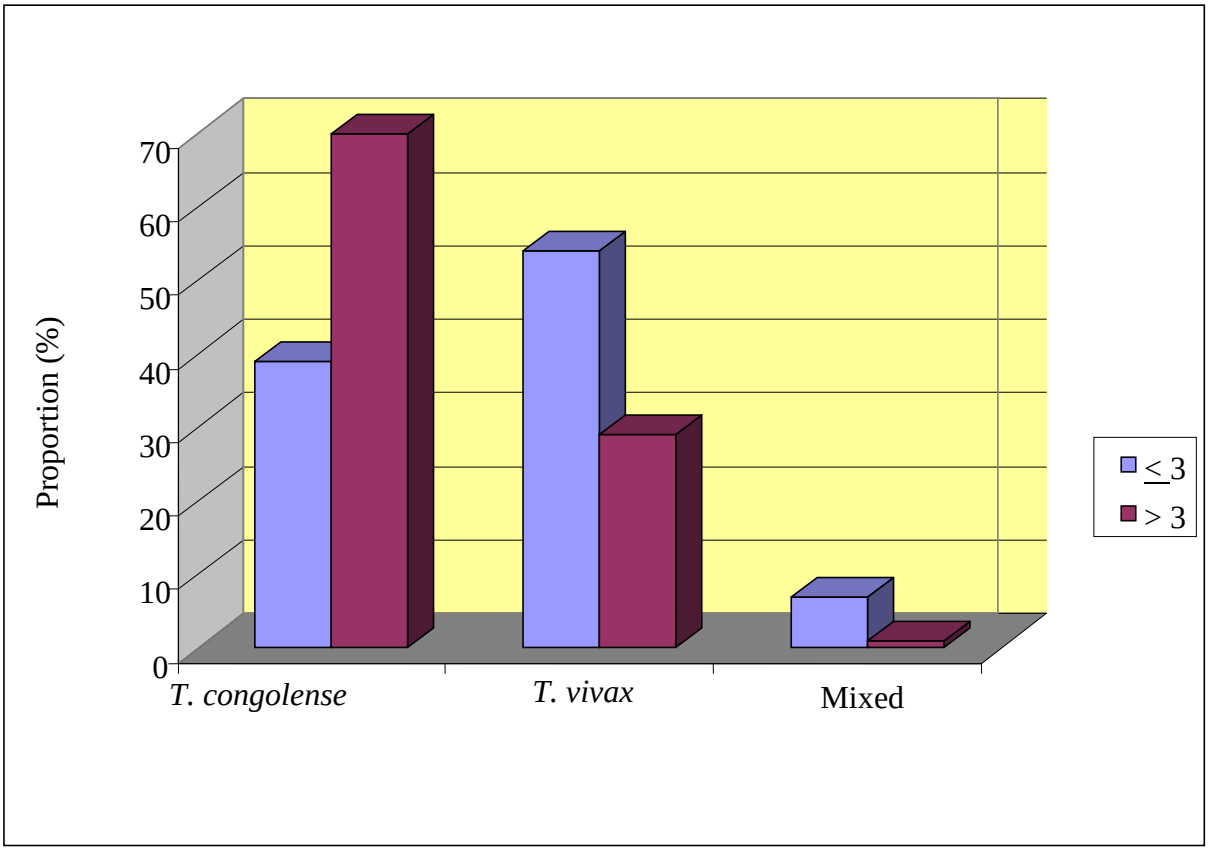


Figure 10. The relation between age and trypanosome infection

4.6.2. Sex

A comparison of trypanosome infection between males and females were made to know whether the infection in males was attributed to work load in draught oxen as stress factor or not. Based on this factor, the over all trypanosome infection prevalence in males and females was 17 % (95% confidence interval = 14.2, 19.8) and 15 % (95% confidence interval = 12.4, 17.57), respectively. The prevalence of trypanosomes in males was apparently higher than females. However, there was no significant difference (X^2 = 1.68, df = 1, p > 0.05) in trypanosome infection between males and females.

4.6.3. Interaction of risk factors

Logistic regression analysis was used to get the level of interactions between risk factors. According to multivariate analysis the odds ratio of the risk of trypanosomosis in cattle with

different age groups in early wet (April), late wet (October) and early dry (December) seasons was 1.45, 1.1, and 1.13 times higher than that of late wet season (February), respectively. There was significant difference ($p < 0.05$) between odds ratio of late dry and early wet seasons.

4.7. Longitudinal studies

4.7.1. Parasitological findings

The cross sectional study revealed 16.3%, 21.1% and 20.8% of trypanosome infections at South Badaye, East Ajora and Sangana Woybo villages, respectively. The proportion of trypanosome species (*T. congolense, T. vivax* and mixed infections (*T. congolense* and *T. vivax*) of infected cattle were determined prior to treatment with parasitological methods indicated in cross sectional study. At the day 0 of the study, from 64 positive animals 39 (60.94%) *T. congolense*, 24 (37.5%) *T. vivax* and mixed (*T. congolense* and *T. vivax*) infections were recorded (Table 17).

The study animals were followed for 90 days (day 15, 30, 60 and 90**).** Parsitological and haematological results are attached in Annex 2. At day 15, 30, 60 and 90 of the study, out of isometamidium chloride treated animals 17 (26.56%), 2 (4.26%), 22 (48.9%) and 3 (13.04%) were parsitaemic, respectively. With in 30 days 19 (30%) trypanosome infections were detected and *T. congolense* contributed for 89.5% of infections. With in 60 days 41 (64.06%) trypanosome infections were detected and *T. congolense* contributed for 78% of infections. Totally, 44 (68.75%) trypanosome infections were detected during 90 days period and *T. congolense* contributed for 79.5% of all infections (Table 17). All animals detected parasitaemic post-treatment with isometamidium chloride were later treated with diminazene aceturate at 7.0 mg/kg bw consequently.

Table 17. Drug sensitivity of trypanosomes in Zebu cattle naturally infected in the field and treated with isometamidium chloride (1mg/kg bw)

Parameters	Days after treatment					Total detected
	0	15	30	60	90	

Number of cattle	64	64	47	45	23	-
Infection (%)	100	26.56	4.26	48.9	13.04	68.75
T. congolense	39	15	2	15	3	35
T. vivax	24	2		7		9
Mixed (*Tc* & *Tv*) infections	1	-	-	-	-	-
Number of cattle parasitaemic	64	17	2	22	3	44
95% CI		16.3, 39	0.5, 14.5	33.7, 64.2	2.8, 33.7	55.9, 79.8

4.7.2. PCV findings

There was a significant increase in the average PCV readings of all cattle examined after 15 (23.14%) (95% confidence interval = 12.8, 33.4) and 30 days (25.79%) (95% confidence interval = 24.55, 38.3) of treatment. However, after 30 days post isometamidium chloride block treatment the haematocrit value of examined cattle have decreased due to development of infections (Table 18).

Table 18. The mean PCV value of isometamidum chloride treated animals

Days after treatment	Number of examined cattle	Mean PCV (%)	95% CI
0	64	20.19	10.4, 30
15	64	23.14	12.8, 33.4
30	47	25.79	24.55, 38.3
60	45	23.91	22.65, 36.4
90	23	24.82	7.2, 42.4

5. DISCUSSION

In order to improve the welfare and security of rural communities in Africa, rapid method for assessing risk and diagnosing urgent problems are needed for the control of both human and animal diseases (Vlassoff, 1991). Therefore questionnaires to collect information from

community respondents, rapid survey of tsetse abundance, the prevalence of trypanosome infections in village livestock (Snow and Rawlings, 1999) and study on curative and prophylactic actions of isometamidium chloride gave complementary results and led to discussions and conclusions about the severity of tsetse and trypanosomosis problems in the study area.

The result of questionnaire revealed that the disease was known in the area for about 40 yeas, and still now considered as a priority disease. Since then trypanosomosis hampered animal production and productivity and resulted a considerable socio economic loss through mortality and morbidity of draught power in particular and other animals in general. As a result of that, currently despite the high abundance of animal feeds in the area, the average herd size per household lowered to 3.36. Therefore, the present result is in agreement with report of d'Ieteren *et al*. (1988) in which he indicated that trypanosomosis is the major constraint on animal production in the areas of Africa. Moreover, it was stated that trypanosomosis is the main cause of decline in the number of cattle and particularly draught oxen (Abebe and Jobre, 1996).

The present results also revealed that the common trypanocidal drug sources for both PAs are smugglers. According to questionnaire 97.5% of sick animals were treated by owners and smugglers. This result is similar to the situation of the Kola Shara PA of of Arbaminch zuria where each peasant was armed with his own syringes and needles to treat his cattle with trypanocidal drugs (Woldyes and Aboset, 1997). Habtewold (1993) reported that one of the most important factors that cause the failure in the efficacy of the trypanocidal drugs used in wolayita was extensive drug smuggling practices. The respondents mentioned that the treatment delay time after recognizing the clinical sign of disease in cattle was 2-3 days from end of late wet season up to late dry season (September - February) and 7-15 days from early wet up to late wet (March to August)season. The reason for the treatment deliance time is that from end of late wet up to dry seasons they get money easily by selling cash crops and secondly during these seasons due to shortage of animal feeds parasitaemic cattle rapidly loose their body conditions and this situation makes them to treat their cattle on time (with in three days interval). Whereas during wet season (March to August) they can't generate income and secondly animals during this season due to availability of feeds gradually loose their body condition and because of that they make treatment delay time up to 7 and even 15 days and more. In the study area the average frequency of treatment per year was about 6 times per year per cattle and it was higher than the result of Muturi (1999) at Merab Abaya, South Ethiopia (2.9 times) and Afework (1998) at Pawe, North west Ethiopia (3.1 times).

The results of the tsetse survey indicated that all of the survey areas were infested with tsetse flies. Three species of tsetse fly were detected during study period: *G. pallidipes, G. m. submorsitans* and *G. fuscipes.* The first species and the last two species were detected at Gadala and Badaye PAs respectively. The previous surveys indicated the presence of *G. pallidipes* and *G. fuscipes* at Badaye PA of Boloso Sore wereda (Birhanu, 1995; SRVL, 1996). However, the present survey revealed that *G. pallidipes* was replaced by *G. m. submorsitans* at Badaye PA. Similar results were obtained in Ghibe valley (Peregrine *et al*., 1994). Three species of tsetse fly (*G. pallidipes, G. fuscipes* and *G. m. submorsitans*) were detected in the valley between March 1986 and November 1992. *G. pallidipes* was the predominant tsetse species detected there. During the study period only *G. pallidipes* was caught at Gadala PA. Whereas during the previous surveys both *G. pallidipes* and *G.* fuscipes were reported there (Birhanu, 1995; SRVL, 1996). During late wet season (October), 0.36 flies /trap/day was registered. Whereas the earlier survey in the same month (October) revealed 0.06 flies/trap/day (SRVL, 1996), which was lower than the present survey. The reason for increased apparent density in the present survey may be due to restriction of bush fire by zonal administration in the last 2-3 years around Ajora falls below grazing area of Gadala PA. Annual bush fire was practiced in the area during previous years and damaged suitable vegetations, which were determing factor for tsetse distributions (Leak, 1999). In general higher catches of *G. pallidipes* were registered during late wet (October) and early dry (December) seasons than late dry (February) and early wet (April) seasons. These results are in agreement with the result of Leak *et al*. (1993). It was stated that the tsetse apparent density was increased from September up to December during survey conducted from 1986-1990 at Ghibe valley, which is upper part of Omo valley.

At present study G. *m. submorsitans* was considered an important vector of animal trypanosomosis at Badye PA. However, no catches and very low catches were registered during early dry season (December) and other study seasons (late wet season (October), early wet season (April), and late dry season (February)), respectively. Because of the low catches, it was not analysed. Leak, (1999) also did not consider *G. m. submorsitans* in his result because of the low number of flies caught.

At present study during late dry season (February) after bush fire *G. m. submorsitans* caught at vegetation of homestead area. Slingenbergh *et al*. (1992) also indicated that *G. m. submorsitans* occupies the woodland on the floor and sides of the valley and only during the short dry season,

after the bush fires, does this species seek the shelters of vegetation on the drainage lines. During early wet season (April), it was caught at a long distance from homestead area (upper part of valley) and in this period, starting from the middle of March, animals were taken for search of lush grasses reappeared after bush fire and thereby make contact with *G. m. susmorsitans*.

On the other hand, during late dry season no catches of *G. pallidipes* was registered at AJacho village and incontrary there were catches at Lower Samine of Gadala PA. The reason for the first case could be that the flies have migrated from light bushes of grazing area to ticker and cooler vegetations of the gorge below grazing area. The reason for the second case could be the flies were caught at thicker vegetations nearer to the river basins and at vicinity of river by the traps positioned for *G. fuscipes*. Therefore it is in agreement with Williams *et al*. (1992) in which he indicated when temperature is very hot and dry the flies will tend to retreat into thicker and cooler vegetation. Moreover, Leak (1999) indicated that during the hot dry season, tsetse tends to move into the gallery forest area close to the Ghibe river. During early wet season the reapearance of *G. pallidipes* at grazing areas of Gadala PA is because of dropped temperature around grazing area. Williams *et al*. (1992) stated as temperature drops the flies would tend to spread out into more open areas. Leak (1999) also indicated that during rainy seasons as the vegetation grows and a more suitable habitat is formed the flies start to disperse to other parts of valley.

The over all trypanosome infections prevalence rate in cattle was 15.77%. This result was almost similar with the result of Tewelde (2001) at village one and Keto settlement area of South western Ethiopia (15%). The present result was higher than the findings of Habtewold (1993) and (1995) at Humbo Larena of Wolayita zone (9.3%) and at Konso wereda (11.5%), which were infested only with *G. pallidipes* respectively. On the other hand, ths result was slightly lower than the findings of Afework (1998) at Pawe, North west Ethiopia (17.2%), Abebe and Jobre (1996) for the tsetse infested areas of Ethiopia (17.67%).

The higher prevalence of trypanosome infection was registered during late wet and early dry seasons. The reason was that the apparent density of tsetse flies has increased during those seasons. Moreover, the high prevalence of early dry season (December) might be influenced by the high abundance of tsetse flies during late wet season. This result agrees with the result of Leak *et al*. (1993) in which he indicated that both the apparent density of *G. pallidipes* and prevalence of trypanosome infections had repeatedly increased in different years from September

up to December from year 1986-1989. The present prevalence of trypanosome infection (20.9%) of late wet season (October) was higher than the previous survey result (19.02 %) conducted by SRVL (1996) in the same month and area. The apparent density of *G. pallidipes* was also lower (0.06flies/trap/day) than the present result (0.36flies/trap/day).

The result of trypanosome infection rate in cattle during late wet season (October) was lower than the result of Tilahun *et al*. (1997) at Pawe in the same month (22%). Moreover, the finding of prevalence rate of trypanosome infection during early wet season (April) was lower than the result of Muturi (1999) at Merab Abaya, South Ethiopia (14.2 %) in the same month.

The present result revealed that majorities of infections were due to *T. congolense* (63.4%). Similar result was reported by Muturi (1999) at Merab Abaya, South Ethiopia (66.1%), Afework (2001) at Pawe, North west Ethiopia (60.9%) and Abebe and Jobre (1996) for the tsetse infested area of Ethiopia (58.5%). Moreover the results of Tewelde (2004) at Kone (75%) and village I (93%) settlement area of West Ethiopia, Woldeyes and Aboset (1997) at Arba minch zuria wereda (85.2 %) and Rawlands *et al*., (1993) in the Ghibe valley, South west Ethiopia (84%) had shown higher results than the present findings.

The result of trypanosome infection rate during late dry season at Badaye was 8.6 % and out of this result *T. vivax* constitute higher proportion than *T. congolense* and mixed infections. The reason for higher proportion of *T. vivax* in cattle of Badaye was may be due to contact with reverine species (*G. fuscipes*) at mechancho river which is the only watering point used during late dry season (January and February) where 0.75 flies /trap/day was registered in February, 2004. A high vivax- ratio in cattle is expected where the palpalis group of flies (especially *G. fuscipes*) are the main or sole vectors (Leak, 1999). The higher ratio of *T. vivax* was registered in cattle less than or equal to three years in all seasons. Muturi (1999) obtained similar results. This could be young cattle yet not developed immunity to vivax. On the other hand, The higher ratio of *T. congolense* was registered in cattle greater than three years in all seasons and this result agrees with the findings of McDermott and Coleman (1999); Muturi (1999) at Merab Abaya, South Ethiopia. The reason for the higher ratio of *T. congolense* to *T. vivax* in older cattle could be cattle may more readily develop immunity to *T. vivax* than *T. congolense* (Maclennan, 1970; d'Ieteren *et al*., 1988; Leak *et al*., 1993).

During early wet season, higher prevalence was registered at Badaye PA (15.38%) than at Gadala PA (8.51%). The reason for this could be that cattle at Badaye were taken a long distance near to valley starting from middle of March for search of lush grasses, which were reappeared after bush fire and there by make contact with *G. m. submorsitans*.

During study period cattle with PCV value less than 26% were considered anaemic (Tewelde, 2004; Rawlands, 2000), which is said to be the principal sign for trypanosomosis in the live stock (Ilemobade *et al*., 1979; Gardiner, 1989). In the present study, 85.3% of parasitaemic cattle had PCV value less than 26%. Similar results were reported by Afework (1998) at Pawe, North west Ethiopia (90%), Muturi (1999) at Merab Abaya, South Ethiopia (88.9%).

Trypanosome infection and mean PCV values obtained in the present study of parasitaemic and aparasitaemic cattle were negatively correlated and this result was in agreement with the result obtained by Rowlands *et al*. (2001) at Ghibe valley in the South western Ethiopia, in which he indicated that as the proportion of samples detected parasitaemic increased PCV value decreased. Therefore the difference between mean PCV of parasitaemic and aparasitaemic indicates that trypanosomosis is involved in adversely by lowering the PCV value of infected animals.On the other hand, the appearance of negative animals with PCV values of less than 26% may be due to the inadequacy of detection method used (Murray *et al.,* 1977) or delayed recovery of anaemic situation after recent treatment with trypanocidal drugs or may be due to compound effects of poor nutrition and haematophagus helminth infections such as haemonchosis and bunostomiasis (Afework, 1998). However, PCV value can be affected by many factors other than trypanosomosis, but these factors are likely to affect both trypanosomosis positive and negative animals (Van den Bossche and Rowlands, 2001).

The present study revealed that when the age of cattle increased the prevalence rate also increased and this finding agrees with the result of Muturi (1999) at Merab Abaya, South Ethiopia. In the present study, there was a significant difference in the prevalence of trypanosome infection in different age groups. Moreover,odds ratio revealed that the risk of trypanosomosis in different age groups during early wet (April), late wet (October) and early dry (December) seasons was 1.46, 1.11 and 1.13 times higher than the late dry season, respectively.

In order to asses the curative/prophylactic effect of isometamidium chloride at Badaye and Gadala PAs 64 positive cattle were screened and treated at day 0. Then after, at day 15, 17/64

(26.6%) relapse/break through infections in the field with prophylactic dose (1mg/kg bw) of isometamidium chloride was demonstrated. At day 30, 4/47 (4.26%) relapse/break through infections were identified. Totally, 19/64 (29.7%) relapse/break through infections were demonstrated with in 30 days after treatment and most cases of the relapsed/break through infections were due to *T. congolense* (89.5%). Works done before 10 years around Wolayita by Habtewold (1993) revealed 8.3% and 21.9% recurrent parasitaemia ten and twenty days after treatment with trypamidium (0.5 mg/kg bw). Cherinet (1996) reported 22.2% recurrent parasitaemia on 12 days after curative dose (0.5mg/kg bw) of trypamidium. Both results were lower than the present result of 26.6% after 15 days treatment with prophylactic dose of isometamidium chloride.

The present finding of 29.7% recurrent parasitaemia and 89.5% of *T. congolense* infections with in 30 days of treatment was higher than the findings of Afework (2001) at Pawe, North west Ethiopia in which he demonstrated 13 % relapse/break through infections and *T. congolense* contributed 80% of infection with in 30 days of treatment with prophylactic dose of isometamidium chloride. Muturi (1999) revealed 30% of recurrent parasitaemia with in 4 weeks time after treatment with prophylactic dose of isometamidium chloride, which is almost similar result with the present finding.

During 60 days post isometamidium chloride block treatment 64.1% of trypanosome infections were demonstrated and *T. congolense* contributed 78% of infections. Lower trypanosome infections results were reported by Afework (2001) at Pawe, North west Ethiopia (36%), and Tewolde (2001) at Chelelektu (4.51%), Kolu (5.72%) and Burka (10.08%), South west Ethiopia with in 60 days period post isometamidium block treatment in comparison with the present finding.

At present study with in 90 days period of post isometamidium block treatment 68.75% trypanosome infections were detected and this result was higher than the result reported by Afework (1998) at Pawe, North west Ethiopia (50%). However, *T. congolense* contributed 79.5% of infections in this study and this result was almost similar with the result of Afework (2001) at Pawe, North west Ethiopia (80%). Similar works carried out in the South west Ethiopia (Codjia *et al*., 1993; Leak *et al*., 1993; Rowlands *et al*., 1993), also indicated that *T. congolense* is the most prevalent drug resistant trypanosome species in the region.

Moreover, recent field observations in Ethiopia based in cloned populations showed that the drug resistant phenotype of *T. congolense* had not altered over a period of 4 years (Mulugeta *et al.*, 1997), and transmission by tsetse flies doesnt appear to affect the drug sensitivity of trypanosomes and drug resistant strains remain resistant after passage through tsetse flies (Moloo and Kutuza, 1990).

The present study revealed higher proportion of *T. congolense* infection post-isometamidium block treatment. Therefore, the emerging drug resistant trypanosomes especially *T. congolense* despite the right dose of trypanocidal drugs used by most community members of the study area could be due to providing treatment of animals with out proper diagnosis, prolonged and frequent use of trypanocides even when well applied, is likely to select for resistance as well (Clausen *et al*., 1992; Geerts and Holmes, 1998). Therefore, treatment deliance situations and loss of virulence of drug resistant trypanosomes (Whiteside, 1962) can make favourable conditions for tsetse flies to pick drug resistant trypanosomes and as the result can aggravate the situation of animal trypanosomosis in the area.

6. CONCLUSIONS AND RECOMMENDATIONS

The result of the present study demonstrated that trypanosomosis is a major constraint to livestock development at Badaye and Gadala PAs of SNNPRS.

According to questionnaire 97.5% of sick animals were treated by owners and smugglers with high frequency and there by aggravate drug resistance problem in the study area.

Three species of tsetse flies namely, *G. m. submorsitans*, *G. fuscipes* and *G. pallidipes* were identified at Badaye and Gadala PAs, respectively. Higher catches of *G. pallidipes* were registered during late wet (October) and early dry (December) seasons in comparison with late dry (February) and early wet (April) seasons. There was a significant difference in mean catches of *G. pallidipes* between seasons**.** Despite the high prevalence of trypanosome infection at Badaye PA very low catches of *G. m. submorsitans* was registered. *G. fuscipes* was caught only during late dry season (February).

The over all trypanosome infection prevalence in cattle of both PAs was 15.77%. The prevalence of trypanosome infection during late wet (October) and early dry (December) was significantly higher than that of late dry (February) and early wet (April) seasons. During early wet season, significantly higher prevalence was registered at village of Badaye PA (15.38%) than villages of Gadala PA (8.51%). Giemsa stained blood smear examination revealed the presence of *T. congolense* and *T. vivax* in the study area. *T. congolense* accounted for 63.4% in overall infections. The prevalence of trypanosome infection was positively correlated with apparent density of *G. pallidipes.*

The general health status of cattle was poor and this was confirmed by low mean PCV value (24.02%) of cattle because of parasitaemia. The mean PCV values of different seasons are negatively correlated with the prevalence of trypanosomosis of corresponding seasons. There was a statistically significant difference between mean PCV values of parasitaemic and aparasitaemic cattle tested during different seasons**.**

T. congolense and *T. vivax* contributed higher infections in adult cattle (greater than three years) and young cattle (less than or equal to three years), respectively. There was a significant difference in trypanosome infection between different age groups of cattle.

The field study has shown that curative/prophylactic effect of isometamidium chloride (1mg/kg/ bw) in cattle against *T. congolense* infection was very low and it is not economically advisable for use in the study area. *T. congolense* was accounted for 79.5% of the over all infections. However, despite a significant percentage of relapse/break through infection in the field, treatment with 1mg/kg bw of isometamidium chloride has shown a significant increase of mean PCV up to the first month.

The study was not exhaustive and did not cover the whole wet season. However, taking into consideration the above conclusions the following remarks are recommended for immediate attention:

If all positive and negative cattle with low PCV value would be treated with effective trypanocides during every dry season where no or very low tsetse flies are present, the transmission of pathogenic trypanosomes to wet season can be tackled and thereby the prevalence of disease can be decreased in the study area.

The prevalence of trypanosome infection can be decreased during early wet season (April) at Badaye PA if the cattle would not be taken near to valley (tsetse habitat) to feed lush grasses.

Moreover, to alleviate poverty of study area priority should be given to control trypanosomosis through integrated disease management strategy, targeting vector and parasite.

Further to alleviate drug resistance problem in the study area, detailed study on the epidemiological aspects and development of drug resistance in pathogenic trypanosomes is required.

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8. ANNEX

Annex 1. Questionnaire format used to interview cattle owners

Name…….....

Date……

PA……..

Livestock management

1. How many animals do you have?

a. Cattle……. d. Donkeys……

b. Sheep……. e. Horses……

c. Goats ……. . f. Mules……..

2. How do you manage your cattle in different seasons?

a. free grazing…….. c. Stall feed…….

b. Tether…….. d. free grazing and tether……

3. Where do cattle graze in different seasons and how far is it?

Month …….. Site …….……. Distance……

Month ……. Site .....…… Distance……

Month……. Site …… Distance……

4. Where are animals watering points in different seasons and how long are these?

Month …….. Site …….…….. Distance……

Month ……. Site .....…… Distance ……..

Month……. Site …….. Distance……

5. What about feed abundance in different seasons?

(high, medium or low)

Month …….....

Month …….

Month……. ……

6. Which type of wild animals are available and where are they found in different seasons?

Months ……

Months ……

Month……

Livestock disease

1. What are the most common diseases affecting your animals?

(descending order)

a.……d. ……

b. …… e.…… …….

c. …… … f. ……..……

2. When had trypanosomosis been introduced to your area?.....

3. When had trypanocidal drugs been introduced to your area?..... .....

4. Is there drug resistance problem in your area?.....

5. If yes, when had it begun?..... .....

6. Which species of animal is affected by trypanosomosis?

(descending order)

a. …….. c. …… ……..

b. ……. d. …… …….

7. What is the magnitude of occurrence of trypanosomosis in different seasons?

(high, medium or low)

1. Season…… 3. Season…… ……..

2. Season ……. 4. Season…… ……. ……

8. Is the trend of trypanosomosis is increasing or decreasing?

Increasing ……. Decreasing……..The same…… ……..

9. Which category of animal is more affected by trypanosomosis in different seasons?

(descending order)

a.……c…….……

b.……d…….……

10. Do you know tsetse flies?

(yes or no)……...

11. Do you know that tsetse flies transmit trypanosomosis?

(yes or no)…….

12. Where do you get tsetse flies in different seasons?

(yes or no)……..

Month …… Grazing area …….....Around watering point..……

Month …….Grazing area …… Around watering point……..

Month……Grazing area …… Around watering point……..

13. If no where can you get it?.....

14. If yes, when you compare with other seasons is it high, medium or low?

Month …….....

Month …….

Treatment

1. where are the common trypanocidal drug sources?

a. Veterinary clinic……. b. Smugglers……

2. Who is applying treatment?

a. Your self…… ……. c. Drug smugglers……

b. Veterinary personnel…….. …… d. Others (neighbour)……

3. Which trypanocidals do you use commonly to treat your animals?

a. ……. ……c. ……

b. …… d. ……

4. What quantity of trypanocidals do you use to treat your cattle?

Type of drug: …… ….. Dosage: cow/oxen……

…….. cow/oxen……

……. heifers/bullcalf……

…… heifers/bullcalf……

5. How many times do you treat each animal in a year?

cow/oxen ……..…

heifers/bullcalf……..……

calves……

6. For how long do you delay to treat your animal after observing clinical symptoms indifferent seasons?

Month ……. Delay time …….....

Month …… Delay time ……

Month……. …… Delay time ……

7. what about availability of money to purchase trypanocidals in different seasons? (high, medium or low)

Month ……. Availability…… ……

Month …… Availability …… … ……

Name of interviewer……. Signature …… …….

Annex 2. Study animals of isometamidium chloride block treatment

No.	Owner's name	Name of cattle	Sex	Age	Day 0 PCV	Day 0 lab. result	Day 15 PCV	Day 15 lab. result	Day 30 PCV	Day 30 lab. result	Day 60 PCV	Day 60 lab. result	Day 90 PCV	Day 90 lab. result
1	Chinasho Mota	Wosole	F	6	16	*Tc*	13	*Tc*						
2	Galato Ganebo	Wodonte	F	10	20	*Tc*	24	*Tc*						
3	Dima Kumalo	Woysho	M	6	22	*Tc*	26		24		25		26	
4	Tefera Salgedo	Maldo	M	3	24	*Tv*	23	*Tv*						
5	Tolka Ambicho	Adom	M	4	18	*Tc*	21	*Tc*						
6	Tolka Ambico	Dulte	F	3	19	*Tc*	23		28		25	*Tc*		
7	Mekno Tilkya	Wosde	F	11	23	*Tc*	20		22		17	*Tc*		
8	Bekele Badebo	Wogone	M	6	26	*Tc*	27	*Tc*						
9	Mekno Tilkya	Wadeo	M	6	22	*Tc*	21	*Tc*						
10	Utalo Tilkaya	Bulicha	M	7	23	*Tc*	25		27		26	*Tc*		
11	Asrat Geta	Woysho	M	8	14	*Tc*	17	*Tc*						
12	Lema Tase	Dirbo	M	4	16	*Tc*	19	*Tc*						
13	Mengestu Milkias	Dubane	F	6	19	*Tc*	20	*Tc*						
14	Abrahm Adamu	Damsa	M	7	19	*Tc*	21		22		23		25	
15	Manjura Mastdebo	Wontesa	F	3	18	*Tc*	21	*Tc*						
16	Darcha Washla	Woysha	M	6	18	*Tc*	23	*Tc*						

No.	Owner's name	Name of cattle	Sex	Age	Day 0 PCV	Day 0 lab. result	Day 15 PCV	Day 15 lab. result	Day 30 PCV	Day 30 lab. result	Day 60 PCV	Day 60 lab. result	Day 90 PCV	Day 90 lab. result
17	Sata Teramo	Gime	F	7	25	*Tc*	22	*Tc*						
18	Chinasho Sadamo	Mddo	M	3	13	*Tv*	14		15		22		22	
19	Temesgen Silalo	Kayto	M	7	22	*Tc*	21	*Tc*						
20	Meskele Shanka	Maldo	M	5	18	*Tv*	24		23		24		24	
21	Abiyo Shata	Shadu	M	4	32	*Tv*	32		35		28	*Tv*		
22	Samuel Pinta	Muldo	M	4	25	*Tc*	28		32		33		31	
23	Donu Handaye	Wogsha	M	4	25	*Tc & Tv*	25		25		27		30	
24	Samuel Sadamo	Bukicha	M	3	23	*Tv*	28		27		28		26	
25	Temesgen Silalo	Dulke	F	8	26	*Tv*	28		30		25		23	
26	Silola Gadore	Sonda	M	7	21	*Tc*	22		20	Tc				
27	Esias Tonja	Woyaha	M	5	29	*Tv*	19	*Tv*						
28	Bata Mune	Boloko	M	5	22	*Tv*	20		25		25		24	
29	Bata Mune	Wosde	F	10	15	*Tc*	22	*Tc*						
30	Belayneh Banca	Wosde	F	7	16	*Tv*	20		22		23	*Tc*		
31	Kedru Kantushe	Wosde	F	3	18	*Tv*	21		27		30		31	
32	Adisu Gana	Gazgate	F	3	11	*Tc*	13	*Tc*						
33	Chumomo Figa	Gazgate	F	5	20	*Tc*	19		20		23	*Tc*		
34	Terfe Fola	Wosole	F	10	15	*Tc*	18		19		16	*Tc*		
35	Mengistu Mena	Woysho	M	8	18	*Tc*	18	*Tc*						
36	Bezabih one	Gersho	M	3	29	*Tv*	29		30		29		31	

No.	Owner's name	Name of cattle	Sex	Age	Day 0 PCV	Day 0 lab. result	Day 15 PCV	Day 15 lab. result	Day 30 PCV	Day 30 lab. result	Day 60 PCV	Day 60 lab. result	Day 90 PCV	Day 90 lab. result
37	Bezabih One	Wadwo	M	3	19	*Tv*	26		21		23		15	
38	Bezabih One	Wosole	F	4	24	*Tc*	31		29		26		29	
39	Lema Chemiso	Gozate	F	8	16	*Tc*	22		18	*Tc*				
40	Goa Langana	Lalo	M	3	21	*Tv*	23		31		25		25	
41	Yasin Yckob	Bulaha	M	8	20	*Tc*	27		31		25	*Tc*		
42	Mida Kaha	Bulaha	M	4	20	*Tv*	26		26		26	*Tv*		
43	Esyas Bolanko	Dego	M	3	18	*Tv*	22		28		27	*Tv*		
44	Mitike Herana	Panuke	F	8	28	*Tc*	25		24		16	*Tc*		
45	Mitike Herana	Bmolda	M	6	16	*Tv*	21		21		21	*Tv*		
46	Mitike Herana	Bulula	M	4	18	*Tc*	24		25		24	*Tc*		
47	Markos Masna	Moldo	M	6	13	*Tv*	28		30		26		26	
48	Tesfaye Zerhun	Gazate	F	8	21	*Tc*	25		27		20	*Tc*		
49	Dana Dubasha	Worso	M	2	12	*Tv*	13		24		26		26	
50	Tamiru Borbo	Gersho	M	6	15	*Tc*	21		17		20	*Tc*		
51	Yohan Endrias	Wego	M	4	15	*Tc*	27		30		26		26	
52	Teferi Takele	Bulicho	M	5	18	*Tc*	30		33		28		28	*Tc*
53	Ermias Molana	Woysho	M	6	20	*Tv*	23		25		25	*Tv*		
54	Mandefro Mongo	Woysho	M	3	15	*Tc*	25		30		20		18	*Tc*
55	Yasin Chila	Telkaye	M	4	17	*Tc*	24		18		19		19	
56	Zawga Didana	Wona	M	3	22	*Tv*	23		22		21	*Tv*		
57	Wolebo Wolde	Woroe	F	4	26	*Tv*	32		33		23		22	

No.	Owner's name	Name of cattle	Sex	Age	Day 0 PCV	Day 0 lab. result	Day 15 PCV	Day 15 lab. result	Day 30 PCV	Day 30 lab. result	Day 60 PCV	Day 60 lab. result	Day 90 PCV	Day 90 lab. result
58	Baza Dubusho	Worga	F	3	29	*Tv*	29		33		22	*Tc*		
59	Amarch Abda	Bula	F	8	17	*Tc*	23		21		22		20	*Tc*
60	Amarch Abda	Dulkde	F	3	29	*Tv*	31		26		25	*Tc*		
61	Tadese Dimo	Alute	M	4	17	*Tc*	20		33		24	*Tc*		
62	Alemayhu Belay	Bulidho	M	5	23	*Tc*	25		29		22	*Tv*		
63	Girma Zeuga	Bulidho	M	6	21	*Tc*	22		24		24		24	
64	Fasika Bulte	Lade	F	6	22	*Tv*	26		30		21	*Tc*		

M: male, F: female, *Tc*: *T. congolense*, *Tv*: *T. vivax*

Annex 3. A cow with recurrent parasitaemia of *T. congolense* infection at Badaye PA

Annex 4. Biconical trap positioned at woodland savannah of Badaye PA

9. CURRICULUM VITAE

1. Personal identification

Name: Terzu Daya

Birth place: Wolayita, SNNPRS

Birth Date/Month/ Year: October, 1962

Sex: Male

Nationality: Ethiopian

Marital status: Married

Profession: Veterinarian

Occupation: Head, Regional Veterinary laboratory

Contact address: Wolayita Sodo Regional Veterinary Laboratory

P.O. Box 82

Wolayita Sodo

2. Educational back ground

1967 -1972: Dubo Catholic Elementary School, Wolayita, SNNPRS

1973 -1974: Junior Secondary School, Wolayita Sodo

1975 -1980: Comprhensve High School, Wolayita Sodo

Achievement - Ethiopian school leaving certificate

1979 -1980: Debre Zeit Animal Health College

Achievement – Diploma

1982 -1987: Kishnov Agricultural Institute, Moldovia

Achievement – Doctor of Veterinary Medicine (DVM degree)

3. Work experience

1981-1982: MOA, Kambata and Hadiya Awraja, Shoa

Assistant Veterinarian of Kambata and Hadiya Awraja

1988 -1989: MOA, Shire and Adigrat, Tigray

Field Veterinarian of Shire and Adigrat Awraja

1990 -1991: Tana Beles Project (Italian Project)

Junior Veterinarian in tsetse control activity

1992-1993: MOA, Damot Woyde and Damot Gale wereda

Field Veterinarian of Damot Woyde and Damot Gale wereda

1993 -1994: MOA, North Omo zone

Head, North Omo zone Agriculture Bureau

1995 -1996: Sodo Regional Veterinary Laboratory

Research officer of parasitology department

1997 -1998: Sodo Regional Veterinary Laboratory

Head, parasitology department

1899- 2002: Sodo Regional Veterinary Laboratory

Head, Sodo Regional Veterinary Laboratory

4. Language skills

Wolayita Language: writing, reading and speaking

Amharic: writing, reading and speaking

English: writing, reading and speaking

Russian: writing, reading and speaking

French: poor writing, reading and speaking

5. Training

Cattle Production and Health, Arab Republic of Egypt, Ministry of Agriculture and Land Reclamation.The Egyptian International Center for Agriculture and the Egyptian fund for technical cooperation with Africa in collaboration with Japan International Cooperation Agency (JICA). 1/10/2000- 30/11/2000 Kairo, Egypt.

Achievement - Certificate

International group training course on Tsetse Management, Monitoring and Control, 1-30 November, 1995 ICIPE, Nairobi and Mombasa.

Achievement - Certificate

IAE / FAO Regional Training course on the Sterile Insect Technique as a component for integrated area wide tsetse and trypanosomosis management. Tanga, United republic of Tanzania 20th March – 14th April, 2002

– Certificate

6. Technical papers

Daya, T. (1997): Community based tsetse and trypanosomosis control pilot program at Damot woyde wereda, SNNPRS. Un published

Daya, T. (2000): Tsetse and trypanosomosis survey at Hamer and Tambaro wereda, SNNPRS. Un published

Daya, T. (2003): The distribution of tsetse flies and trypanosomosis in Southern region of Ethiopia. a paper presented for the course, seminar on current topics. AAU, FVM, Debre Zeit

SIGNED DECLARATION SHEET

I, the undersigned, declare that the thesis is my original work and has not been presented for a degree in any university.

Name _____

Signature _____

Date of submission _____

The thesis has been submitted for examination with my approval as university advisor.

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