ADDIS ABABA UNIVERSITY

FACULTY OF VETERINARY MEDICINE

ASSESSMENT OF THE IMPACT OF TSETSE CHALLENGE ON HERD COMPOSITION, MILK YIELD AND REPRODUCTIVE PERFORMANCE OF CATTLE IN DAWRO ZONE OF SOUTHERN NATION, NATIONALITY AND PEOPLE REGIONA STATE, ETHIOPIA

BY

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DEBRE ZEIT, ETHIOPIA

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A Thesis Submitted to the School of Graduate Studies of Addis Ababa University, Faculty of Veterinary Medicine in Partial Fulfillment of the Requirements for the Degree of Master of Science in Tropical Animal Health and Production

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DEDICATION

This thesis paper is dedicated to almighty God, who helps me always in all corner of my life.

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TABLE OF CONTENTS

PAGE

LIST OF TABLES

PAGE

LIST OF FIGURES

PAGE

LIST OF ANNEX

PAGE

LIST OF ABBREVIATIONS

DFID	Department for International Development
DVM	Doctor of Veterinary Medicine
ERGO	Environmental Research Group Oxford
FAO	Food and Agricultural Organization of the United Nation
I CPVE	Integrated Control of Pathogenic Trypanosomes and their Vector
ILCA	International Livestock Center for Africa
ILRAD	International Laboratory for Researches in Animal Diseases
MSc	Master of Science
OIE	Official for International Epizootics
PAAT	Programme Against Africa Trypanosome
TALA	Trypanosomosis and Land Use in Africa
WHO	World Health Organization
DZAO	Dawro Zone Agricultural Office
MDAO	Mareka District Agricultural Office

ABSTRACT

This study was conducted in the Dawuro Zone of the Southern Nations, Nationalities and People Region. The specific study sites were Mareka and Tocha districts which were randomly selected from the Zone. The objective of the study were to determine the impacts of bovine trypanosomosis on cattle herd size and composition, milk yield and reproductive performances of cattle. Known tsetse infested areas, Tercha and Lala Kebeles were selected from Mareka and Tocha districts, respectively. As a control, known tsetse free area, Docha Kebele, was selected slected from Mareka District. A total of 52 households were selected randomly from each Kebele that made a total sample size of 156 households. A structured questionnaire was prepared and one visit interview was carried out to collect data about on socio-economic characteristics, farming system characteristics, cattle herd size and composition, milk yield and reproductive performances of cattle, major cattle health problems and mortalities. In addition, a total of 30 pre-partum cows were selected (10 from each Kebele) for a postpartum follow-up study, which lasted for about six months (October 2006-March 2007), to collect data on daily milk yield and the occurrence of first postpartum observable heat. Data collected were analyzed using descriptive statistics and independent t-test. The results showed that the most important cattle health problem identified were trypanosomosis and blackleg in tsetse challenged and free areas, respectively. Cattle herd size did not different significantly ($p>0.05$) between tsetse challenged and free areas. However, the average number of lactating pregnant ($p<0.05$) and dry pregnant cows ($p<0.001$) was significantly higher in tsetse free area than tsetse challenged areas. On the other hand the number of dry non-pregnant cows was significantly higher in tsetse challenged area than free area ($p<0.01$). The average daily milk yield was in general low in both tsetse challenged and free areas. The differences in milk yield at three stages of lactation in the two areas were significant ($p<0.001$). Cows in tsetse affected areas were able to give only 52.14, 47.73 and 29.63% of the daily milk yield of those in tsetse free area during the beginning, middle and end of lactation, respectively. In addition, cows in tsetse free areas had an average lactation length longer by 4.35 months than those in challenged areas. Cows in tsetse free areas gave their first calf earlier by an average of 5.64 months, had an average calving interval shorter by 2.41 months and required lesser number of services per conception by 0.35 ($p<0.001$). The results of the follow-up study showed that the average daily milk yield of cows in challenged areas was lower by 37 to 46.5%

than those in free areas throughout the lactation period. Only 1 cow was detected in heat (5%) (on day 122 postpartum) in tsetse challenged area while 50% of the cows were in heat on day 107.8 on average in tsetse free area. The number of cattle died in one year time was significantly higher in tsetse challenged area (26.73 times) than tsetse free area ($p<0.001$). It can be concluded that tsetse infestation is seriously affecting the cattle herd composition and the performances of animals in the challenged area.

Key words: cattle, herd composition, Ethiopia, milk yield, mortality, postpartum, reproductive performance, tsetse challenge

1. INTRODUCTION

African continent is faced with challenge of satisfying a dramatic increase in demand for livestock products, in particular for milk and meat. This is mainly due to the failure of the livestock production to fulfill the dramatic increase in the demand of livestock products. A number of factors are contributing to the low level of livestock production in Africa among which animal disease caused by parasites, bacteria, viruses and fungi are major constraints to animal production and trypanosomosis is arguably the most important of these. Jahnke *et al* (1988) considered that a total increase in cattle 33 million heads might be possible and would lead to an additional production of 495,000 metric tones of meat per year (assuming productivity of 15kg/head/year) and an increase in milk production of 1.26 million tones per year (using estimates of 38.3kg milk/head/year), if eradication or sustainable control of trypanosomosis is considered for 40 countries in Africa affected by this disease.

Tsetse transmitted trypanosomosis is an important constraint to agricultural development in Sub-Saharan Africa. Tsetse flies infest an area of about 10 million km^2 stretching across 40 countries in the region. The disease affects both livestock and human. It is currently estimated that about 50 million people (Kuzoe, 1991) and 48 million cattle (Kristijanson *et al.*1999) are at risk of contracting trypanosomosis. On individual basis, untreated animal or human trypanosomosis will lead at best to chronic debilitating condition and at worst to death. At the herd level, it is estimated that the incidence of trypanosomosis decreases meat yield by 5-31% and milk off-take by 9-38% and the work performance of oxen by 33%. The risk of trypanosomosis also shapes farmers choices about livestock purchases, sales and overall herd size. The evidence from a small number of field studies suggests that farmers in areas of high trypanosomosis risk keep 25-60% as many cattle as farmers in nearby areas of low risk (Swallow, 1997b).

Pathogenic species of trypanosomes are prevalent throughout vast areas of Africa, Asia, Latin America and Middle East and these cause disease in cattle, sheep, goat, water buffalo, pigs, equines, camels, wildlife and man (Murray and Trail. 1990; Murray *et al.*, 1991). In Africa, the major pathogenic trypanosome species for livestock are transmitted by tsetse fly (genus glossina) and include *Trypanosoma conglense*, *Trypanosoma vivax*, *Trypanosoma brucei brucei* and

Trypanosoma simiae. None-tsetse transmitted form of trypanosomosis also occur in Africa. The most important pathogen under these circumstances is *Trypanosoma evansi*. This parasite can cause severe losses in production and performance in cattle and water buffalo (D'Iteren *et al.*, 1998). The sub species of *T. brucie*, *T. brucie rhodesiense* and *T. brucei gambiense,* cause sleeping sickness in man. The fact that domestic animals and wildlife also act as reservoir hosts for human pathogens is an important health constraint to rural development in large areas of Africa (D'Iteren *et al.*, 1998).

In tsetse infested region of Ethiopia, the problem of trypanosomes is the main cause of decline in the number of cattle and particularly draught oxen Abebe and Jobre (1996). As a result, draught oxen cannot be used for cultivation and other purpose and thus the situation forces farmers to cultivate land manually as the majority of peasant farmers cannot afford costly machinery. The end result is that only a small fraction of potential agricultural land is cultivated for crop production.

The current study area, the Dawuro Zone of the Southern Nations Nationalities and People State is located within the tsetse belt and is found sandwiched between Gojab and Omo rivers. It is thus one of the areas, which are seriously affected by trypanosomosis. However, limited work has been done to determine the status of trypanosomosis in the area and no work has been done to assess impacts of the disease on cattle production.

The objectives of this study are therefore:

- To determine the impacts of tsetse challenge on cattle herd size and composition;
- To determine the effects of tsetse challenge on milk yield and reproductive performances of cattle.

2. LITERATURE REVIEW

2.1 The status of animal trypanosomosis in Africa

2.1.1. Distribution of animal trypanosomosis in Africa

African animal trypanosomosis is a disease complex caused by tsetse fly transmitted *T. congolense, T. vivax* or *T. brucei brucei* or simultaneous infection with one or more of these trypanosomes. The disease complex is most important in cattle but can cause serious losses in pigs, camels, goats and sheep (Table 1). In Southern Africa, the disease is widely known as Nagana which is derived from Zulu term meaning "to be low or depressed spirit". Vast humid and sub humid areas of Africa are held captive by tsetse flies infestation and trypanosomes, which it transmits (Figure 1).

Table 1. Distribution of tsetse transmitted animal trypanosomes

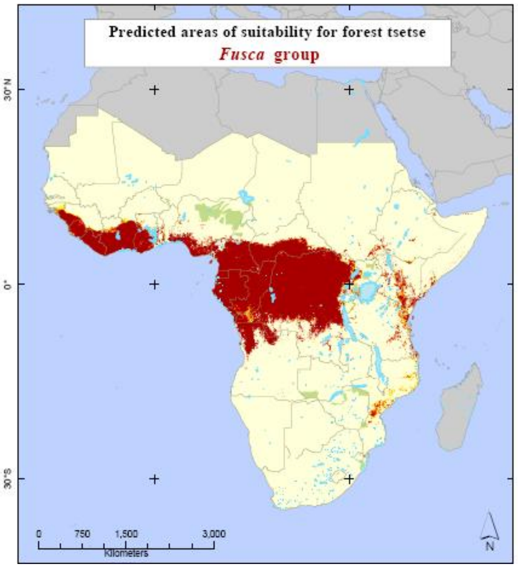
Trypanosome species	Animals mainly affected	Major geographic distributions
T. congolense	Cattle, sheep, goats, dogs, pigs, camels, horses, most wild animals	Tsetse region of Africa
T. vivax	Cattle, sheep, goats, camels, horses, various wild animals	Africa, Central and South America, West Indies*
T. brucei brucei	All domestic and various wild animals; most severe in dogs, horses, cats	Tsetse region of Africa
T. simiae	Domestic and wild pigs, camels	Tsetse region of Africa

* In non-tsetse areas transmitted by biting flies

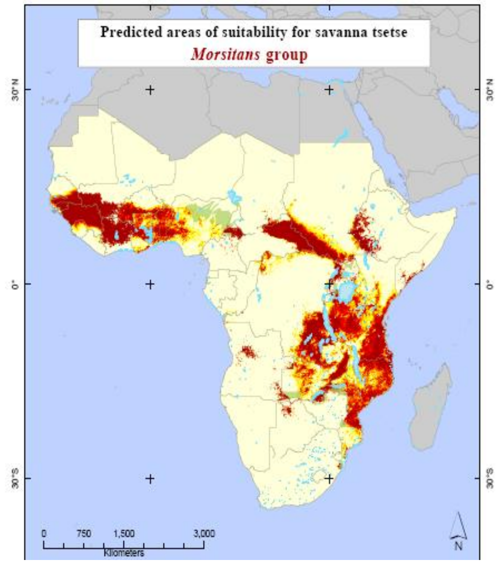
Source: Holmes (2006)

In addition to the tsetse transmitted trypanosomes, there is another species called *T. evansi,* which is the most widely distributed of the pathogenic animal trypanosomes transmitted by haematophagous flies, affecting domestic livestock in Asia, Africa and Central and South

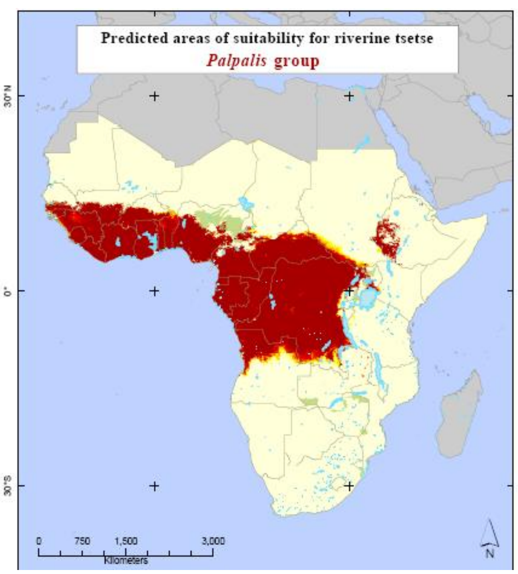
America. In Africa, camels are the most important hosts of *T. evansi* and cause the disease called Sura (Luckins, 1999).



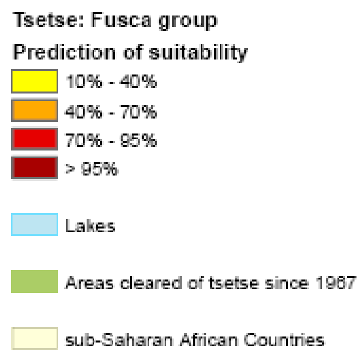
Fusca group



Morsitants group



Palpalis group



Source: ERGO and TALA (1999)

Figure 1. Predicted distribution of different groups of tsetse in Africa

Another disease of livestock caused by trypanasoma species is dourine which is a venereal disease of horses caused by *T. equiperdum* and transmitted during coitus. The disease is recognized on the Mediterranean coast of Africa, in the Middle East, South Africa and South America (Holmes, 2006) and recently in Ethiopia (Hagos, 2005).

2.1.2. Impact of animal trypanosomosis on livestock production in Africa

Tsetse flies infest 10 million square kilometer of Africa much of which is watered and fertile and also suitable for grazing. This area of land represents 37% of the continent or about half of habitable land affecting 37 countries (Maclennon, 1980; FAO-WHO-OIE, 1982). It was estimated that 70% of this area could otherwise be suitable for livestock and mixed agriculture. It is conservatively estimated that this area could support more than 140 million cattle plus at least equivalent number of sheep and goats (ILCA, 1985). The size of land infested with tsetse is even larger when it is calculated for Sub-Saharan Africa. Approximately, 70% of the humid and sub humid zone of Sub-Saharan Africa, which is infested with tsetse, is devoid of cattle farming and if cattle are present, it is only through continued chemotherapy and tsetse control programs. In these areas agricultural communities are denied the benefit of keeping draught animals (Swallow, 1997). The opportunity cost of land and other resources currently not used for livestock production amounts to be about 5 billion USD in Sub-Saharan Africa (Budd, 1999). According to some reports, there appears to a direct link between the incidence of tsetse-transmitted trypanosomosis and the extent to which mixed crop-livestock farming system can be developed in the region. In highly tsetse infested areas, trypanosomosis susceptible breeds of livestock may not survive without heavy use of trypanocidal drugs and, therefore, mixed farming possibilities are limited in these areas (Sones, 1999; Kristjanson *et al.*, 1999).

The presence of tsetse flies not only exclude domestic livestock from a considerable area but also causes direct and indirect economic impacts on livestock production. The direct impact is associated with the loss of milk and meat production in addition to mortality. It has been reported that trypanosomosis kill 3 million animals each year and reduces productivity of sick animas (Erkelense *et al*., 2000). Regassa (2004) reported that 99% of farmers in a tsetse infested area put trypanosomosis as the first most important disease causing mortality while only 52% did so in tsetse controlled area. In a special case at Yale Pastoral Zone in Burkina-Faso, where an outbreak hit recently settled herders very hard, over 60% of calves died of trypanosomes (Kumuanga *et al*., 2001a).

Adult cattle undergo weight loss and young animals have reduced growth rate. Their reproductive system is frequently affected and 'abortions' and infertility is common in herds found in areas of trypanosomosis challenge (Ikede *et al*., 1988). Testicular damage occurs affecting sperm viability thus fertility. A number of studies have been carried out to evaluate the herd level effects of trypanosomosis using simulation models. Brandl (1988) conducted an ex-ante assessment of benefits and costs associated with Sterile Insect Techniques in Southern Burkina-Faso and predicted that the cattle population in the Study area would increase about 0.9 percent per year without tsetse control and between 2 and 5% per year with control. It was estimated that the improvement in herd growth without control practices reduces milk off take by 9 to 38 per cent and meat yield 5 to 31 percent. Swallows (1997) assessed the benefits of tsetse control by pour-on at Ghibe valley of Ethiopia and showed that the cattle herd would increase at an average annual rate of 8.7% per year without tsetse control and 14% per year with tsetse control.

Trypanosomosis has also a negative impact on the traction power of animals (Swallow, 1997). Swallow (2000) reported that oxen in a high-risk area were 38% less efficient than oxen in a low -risk area in Ethiopia. In addition, the disease also affects the decision of farmers regarding the total number, species and breeds of livestock kept and the way animals grazed. Trypanosomosis also has direct effects on farmers choice of where, when and how to establish their homestead (Swallow, 1997). Kamuanga *et al*. (2001b) reported that the numbers of draught oxen increased ten fold in Burkina Faso due to tsetse control. In another study, in this particular area, the proportion of house holds with draught cattle increased from 64% to 93% after tsetse control (Kamuanga et al; 2001c).

A socio-economic survey conducted by Getachew (2000) showed that an average milk production per cow before tsetse fly suppression was 4.10 liters. However, after suppression of tsetse flies population, there was a significant improvement to 8.71 liters during the survey time.

Furthermore, the manure provided by livestock is essential for the production of both food crops and cash crops and a source of energy in the form of biogas (ILCA, 1985).

2.2. The status of human trypanosomosis in Africa

2.2.1. Distribution and occurrence of human trypanosomosis

Trypanosomosis was fist demonstrated as a cause of human sleeping sickness in 1902 and was proved experimentally in 1909 (Laveran and Mesnil, 1912). The name 'sleeping sickness' is descriptive of the later stage of the disease. Human Africa trypanosomosis or sleeping sickness is a zoonosis caused by flagellated protozoa *T. brucie rhodesiense* in East Africa and *T. brucie gambiense* in West and Central Africa (Ford, 1971).

Although it is difficult to estimate accurate disease prevalence, there are about 100,000 new cases reported per year with many more cases probably remaining undetected. In tsetse fly infested areas in 36 countries, 60 million people live at risk of infection. The disease caused by *T. brucei rhodesiense* has been detected variously distributed in Botswana, Mozambique, Zambia and Tanzania while that caused by *T. brucei gambiense was reported in* Democratic Congo and almost the whole area of countries located west of Nigeria (Ady, 1965; Ormerod, 1967). Balis and Bergion (1968) reported the first cases of the disease (*T. brucei rhodesiense*) in western Ethiopia.

Tsetse is usually absent from towns, villages and other areas populated by man, and hence, sleeping sickness in West Africa and the Congo basin is essentially a disease affecting rural populations. Men are more often infected than women because of their agricultural activities and work away from the village; but women may also become infected when they enter the habitat of the fly to draw water, bathe or gather firewood. Villages situated in a loop of a river or stream are particularly vulnerable because they may be attacked by the fly from all sides (Balis and Bergion, 1968).

2.2.2. Impact of human trypanosomosis

Human trypanosomosis is one of the most devastating diseases in Sub-Saharan Africa, killing 80% of infected victims (FAO, 2002). Generally, its first indications are merely accentuation of debility and languor. There is a disinclination to exertion, slow shuffling gait, morose, mask-like expression, relaxation of feature, hanging of lower lip, puffiness and dropping of the eye lids, tendency to lapse in to sleep or a condition simulating sleep, somnolence or 'near coma' contrasting with restlessness at night; slowness in answering question and shrinking of the days task. Later, there may be twitching of muscles, especially of tongue and tremor centers. The speech of the patient will be difficult to follow, become indistinct and staccato. As time goes on, the patient begins to lose flesh and tremor of hands and tongue becomes more marked and convulsive or chroeic movements may occur in the limbs or in limited muscular areas. Some times, too rigidity of the cervical muscles and retraction of the head occur. There are usually intolerable pruritis of the skin, bedsores tend to form, the lips become swollen and saliva dribbles from the mouth. Generally the lethargy deepens, the body wastes, the bedsores extend; the sphincters relax; and finally the patient dies comatose or sinks from slowly advancing asthenia (Manson-Bahr, 1966).

2.3. The status of trypanosomosis in Ethiopia

2.3.1. Distribution of tsetse and trypanosomosis in Ethiopia

In Ethiopia, areas in western and southwestern parts are infested with tsetse flies and trypanosomosis. It was indicated that tsetse flies are confined between 33^{o} east longitude and 5^{o} south and 12^{o} north latitude in the country (Langridge**,** 1976). However, tsetse flies have progressively invaded more productive agricultural areas and consequently the size of infested areas has been increased to about 220,000 km^{2} (Slingebergh, 1992). Main rivers like Omo, Gojob, Boro-Akobo, Didessa and Abay River and their main tributaries are highly infested with tsetse flies.

Five species of glossina have been identified in Ethiopia including *G. morsitans*, *G. pallidipes*, *G. fuscipes*, *G. longipennis* and *G. tachinoides* (Langride, 1976) (Figure 2). The species of trypanosomes reported from the various tsetse-infested areas of Ethiopia in order of importance are *T. congolese*, *T. vivax* and *T. brucei.* Abebe and Jobre (1996) reported an overall prevalence of 17.7% and 8.71% bovine trypanosomosis in tsetse infested and tsetse free areas, respectively. The detail is presented in Table 2.

Table 2. Prevalence of two species of trypanosome in tsetse infested and free areas in Ethiopia

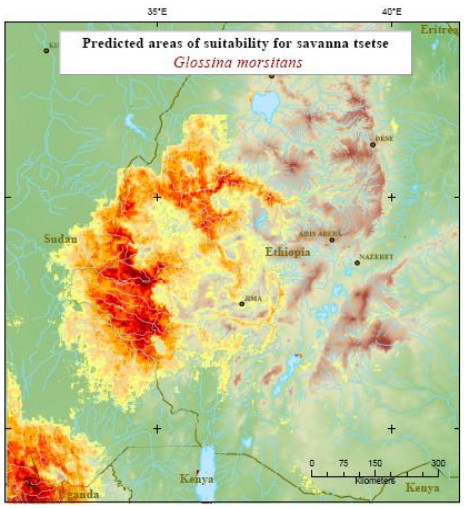
Categories	Number of animal infected	Prevalence
Tsetse infested area	1698	17.67%
T. congolense	993	58.50%
T. brucei	540	31.80%
Tsetse free area	423	8.71%
T. vivax	419	99.01%
Total	2121	13.19%

Number of observations = 14,193

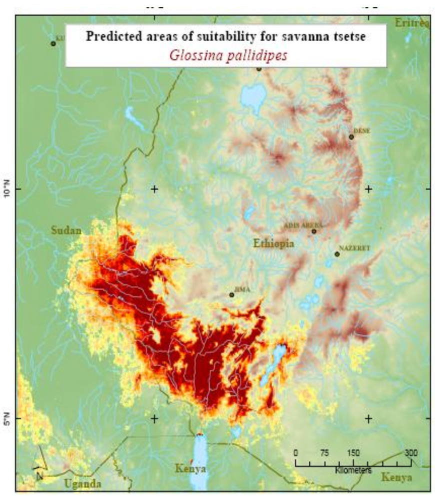
Source: Abebe and Jobre (1996)

The seasonal dynamics of *T. vivax* and *T. evansi* in camel population in Borena Zone of Oromia Regional State was worked out by Getahun (1998). According to the report, the prevalence of *T. vavix* and *T. envansi* was 3% and 97% in the wet season, respectively. On the other hand, prevalence rates of 13% and 87% were recorded for *T. vivax* and *T. envansi* in the dry season, respectively. In addition, a work depicting seasonal dynamics was reported by Shimelis (2004), who showed that the prevalence of trypanosomosis in general in different areas in the Northwest Ethiopia was 17.07% and 12.35% in the late rainy and dry seasons, respectively.

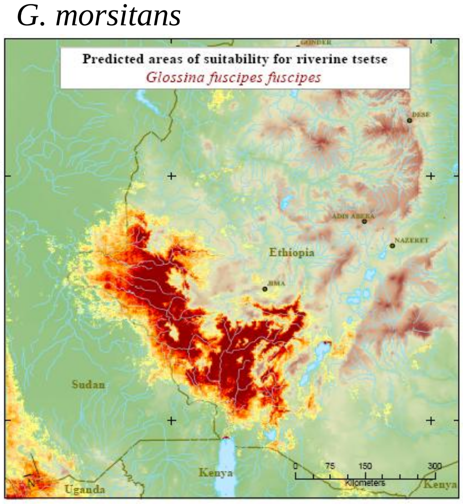
Ermias and Getachew (2001) reported a prevalence rate of 4% for *T. vivax*, 9% for *T. brucei*, 66% for *T. congolense* and 21% for mixed species in equines in north Omo Zone of the Southern Nations Nationalities and People Regional State. The summary of reports of the prevalence of trypanosomosis in different areas in Ethiopia is presented in Table 3.



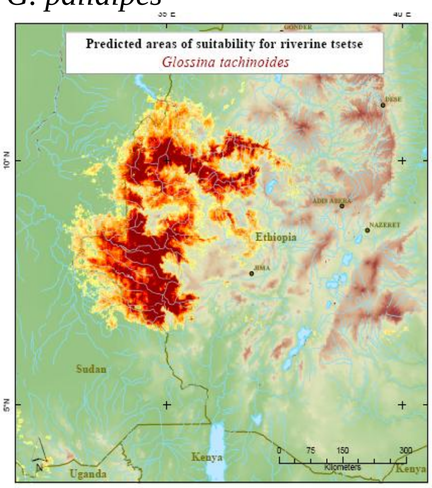
G. morsitans



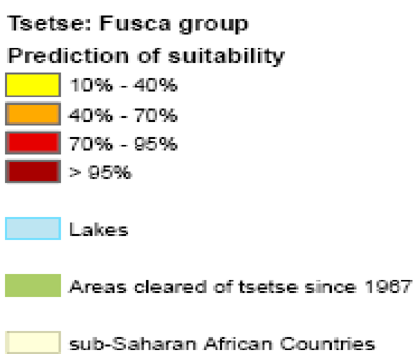
G. palidipes



G. fuscipes fuscipes



G. tachinoides



Source: Ergo and Tala (1999)

Figure 2. Predicted distribution of four species of Glossina in Ethiopia

Table 3 . The prevalence of trypanosomosis in different areas in Ethiopia

Study area	Species	N	Prevalence	Source
Metekel and the surrounding	Cattle	484	17.20%	Afework (1998)
Bahir Dar and the surrounding	Cattle	739	16.10%	Mihert (1995)
Arba Minch and the surrounding	Cattle	813	12.79%	Sertese (1994)
Upper Didessa valley	Cattle	992	24.38%	Dagninet (1993)
Upper Didessa valley	Cattle	484	24.40%	Nuru (1993)
Areas bordering Lake Tana	Cattle	1509	6.10%	Alekaw (2004)
Areas bordering Lake Tana	Small ruminants	798	0.20%	Alekaw (2004)
Areas bordering Lake Tana	Equines	749	0.00%	Alekaw (2004)
Northwest Ethiopia	Cattle	2462	12.35-17.07%	Shimelis (2004)
Southern Rift Valley	Cattle	323	23%	Jemere (2004)
Southern Nation	Cattle	1509	15.77%	Terzu (2004)

N= number of animals examined

2.4. The impact of trypanosomosis in livestock production in Ethiopia

Trypanosomosis is a very important disease in Ethiopia that has severe impacts on crop production, livestock production and ecological balances in areas where it is endemic. Slingebergh (1992) indicated that about 220,000-km2 lands in Ethiopia, most of which is fertile and suitable for cultivation, is infested with tsetse. In the early 1980's, severity of trypanosomosis increased strongly causing rapid contraction in farmland size (30% decrease over 5 years) and decrease in human population due to migration and also a significant reduction in livestock production in the areas (Reid *et al.*1997; Wilson *et al.*, 1997). Roder *et al*. (1984) reported the occurrence of the highly pathogenic form of *T. vivax* in Ethiopia that killed 1,200 heads of cattle before it was brought under control by chemotherapy. In the late 1980's, changes in settlement policy in Ethiopia drove farmers back in to Ghibe Valley, expanding settlement and cropping (Reid *et al.*1997; Wilson *et al.*, 1997). Initially, this expansion of cultivation took place in wooded grasslands and later on expanded into the biological gallery forest that caused a serious impact on the ecology. When farmers remove vegetation in gallery forest for settlements, they are removing ideal tsetse habitat, which meanwhile decreases tsetse populations. However, deforestation results in the loss of rich biological resources and hence access of farmers to plant species traditionally used for medicine, fuel wood and construction materials (Reid *et al.* 1997 and Wilson *et al.,* 1998).

A recent work by Regassa (2004) quantified the effects of trypanosomosis on productivity, reproductive performance, mortality, animal traction and veterinary medical expenses in the upper Didessa Valley. The report indicated that calving rate increased by 35%, mortality was reduced by 72%, average daily milk yield increased by 80%, lactation yield increased by 120%, the work efficiency of draught oxen increased by 31-40% and treatment rate reduced from 7.16 to 0.19 times in the tsetse controlled areas.

3. MATERIAL AND METHODS

3.1. Study area

The Dawuro Zone of the Southern Nations, Nationalities and People Region was the study area, which is recently established and located in southwestern part of Ethiopia about 500 km from Addis Ababa. Its total area coverage is about 466,082ha. It is bounded at south by Gamagofa, at East by Wolita, at North West by Jimma and at North by Kambata and Hydiya Zones. The Zone is within the tsetse belt, bounded by big rivers and tributaries (Omo, Ghibe, Gojab, etc). This has been thus a hazard for livestock production in the area for a long period of time. Due to the shortage of veterinary infrastructure, still there are no sufficient control and intervention activities against trypanosomosis (DZOA, 2004).

The study areas elevations ranges from 1300 to1750 masl in tsetse challenged areas of Mareka and Tocha Districts (Tercha and Lala Kebele) and from 1400 to1800 masl in tsetse free area of Mareka District (Dochi Kebele). The average annual rainfall in tsetse challenged and free areas are 1409.5 and 1554 mm, respectively. The average daily temperatures ranges from 16.9 to 29.4^0C and from14.5 to 26^0C in tsetse challenged and free areas, respectively (DZOA, 2003).

The predominant farming system in the areas is mixed crop-livestock system. People in these areas have long history of rearing animals for traction power and as a source of income, food and manure. The main annual crops grown in the area are maize, teff, tarro and sorghum. Enset is the most important perennial crop grown and used as a staple food in the Zone (DZOA, 2004). The vegetation types in the areas include grasses and forest comprising different species of Acacia. The area is also enriched with different species of wild animals and, thus, there is one nationally recognized park called Chebera-Churichura.

The big challenge of the study area is animal health problem including tsetse transmitted trypanosomosis and other diseases caused by bacteria, viruses, endoparasites and ectoparasites. Tsetse challenge in the study areas rapidly increased starting from the end of 1995 (E.C.) following the invasion of all cultivable and fertile lands of the area. The veterinary service in the area is not yet well organized and not responsive to the huge livestock population in the Zone (MDOA, 2006).

3.2. Study population

The cattle population in tsetse challenged and tsetse free areas of Mareka and Tocha Districts of Dawuro Zone of the Southern Nations, Nationalities and Peoples Regional State were the study population.

3.3. Study design

Cross-sectional and longitudinal types of studies were undertaken from September 2006 to April 2007 to collect data by questionnaire survey and follow-up of animals for about six months. Questionnaire survey was used to collect data on socioeconomic and farming system characteristics; cattle herd size and composition and performance parameters. The follow-up study was used to collect data on milk yield and reproductive performances of cattle.

3.4. Sampling procedure and sample size determination

Two Districts, Mareka and Tocha, were randomly selected from the list of Districts found in the Dawuro Zone. Then one Kebele which is known to be tsetse challenged was selected purposely from each District. Accordingly, Tercha Kebele was selected from Mareka District while Lala Kebele was selected from Tocha District. As a control, Docha Kebele, which is considered as tsetse free, was again selected purposely from Mareka District.

The total number of households to be sampled was determined by the formula recommended for survey studies by Arsham 2006:

$$N = 0.25/SE^2$$

With an assumption of a 5% standard error, a total sample size of 100 households is required. Based on these 52 households were selected using a simple random sampling method from each Kebele.

For the longitudinal (follow-up) study, a total of 30 pre-partum cows, 10 from each Kebele, were selected. Pre-partum cow in the study area, which were conveniently located for the follow-up study, were included.

3.5. Data collection

3.5.1 Questionnaire survey

A structured questionnaire was prepared and tested for appropriateness of questions and amendments were made when deemed necessary. Then a one visit interview was carried out to all heads of selected households to collect data on socio-economic characteristics, farming system characteristics, cattle herd size and composition, milk yield and reproductive performances of cattle, major cattle health problems and mortalities (Annex 1). A total 104 and 52 households were interviewed from tsetse challenged and free areas, respectively.

3.5.2. Follow up study

A total of 30 pre-partum cows, 10 from each Kebele, were followed for a total of about 5.5 months (22 weeks) to collect data on daily milk yield and postpartum reproductive performance. Data was collected every two weeks from October of 2006 to March 2007. During data collection daily milk yields were recorded for each cow and animals were observed and owners interviewed about the occurrence of the first postpartum heat. In addition, the tsetse challenge of the study Kebeles was recorder every two weeks for the same period of time in both tsetse challenged and tsetse free areas. A total of 36 biconical traps were set in the three study Kebeles (12 in each Kebele) to collect tsetse for the estimation of tsetse challenge (Challier and Lavessier, 1973).

3.6. Data analysis

Data collected was stored in MS-Excel spread sheet (Microsoft excel 2003). Descriptive statistics was used to summarize data independent t-test were used to compare means of different parameters for tsetse challenged and free areas. Descriptive statistics and comparison of means was carried out using SPSS (Release 11.05, 2002).

4. RESULTS

4.1. Socio-economic and farming system characteristics

The average family size, land holding pattern and livestock herd size and composition in the tsetse challenged and free areas are presented in Table 4. The average family size in tsetse challenged (7.07 persons) and free areas (6.88 persons) was comparable. The total land holding in the tsetse challenged area (3.48ha) was higher than in tsetse free area (1.85ha). There was smaller land allocated for cropping in the tsetse free area (1.09ha) while the reverse was true for crop land size.

Table 4. Mean and standard errors of livestock herd size and composition, land holding and family size per household

Socio-economic characteristics	Tsetse-challenged area			Tsetse free area		
	N	Mean	SE	N	Mean	SE
Family size	104	7.07	0.27	52	6.88	0.40
Total land	104	3.48	0.21	52	1.85	0.12
Crop land (ha)	104	1.50	0.09	52	1.09	0.07
Pasture land (ha)	104	0.56	0.08	52	0.75	0.10
Fallow land (ha)	104	1.45	0.18	52	0.01	0.01
Livestock herd composition						
Cattle	104	5.77	3.84	52	6.17	3.84
Sheep	104	1.18	1.56	52	2.90	2.06
Goats	104	0.96	1.47	52	0.12	0.43
Donkey	104	0.37	0.71	52	0.13	0.35
Horse	104	0.00	0.00	52	0.37	0.63
Mule	104	0.90	0.32	52	0.35	0.48
Total livestock herd size (heads)	104	9.18		52	10.04	
Chicken	104	2.63	0.31	52	1.83	0.35

N= number of observations, SE=standard error

The values of total livestock holding in tsetse free (9.18 heads) and challenged (10.04 heads) areas were very close. The same thing held true for cattle herd size. The sheep flock size in tsetse free area (2.90 heads per household) was more than double of the value of tsetse challenged area (1.18 heads per household). The goat flock size was higher in the tsetse challenged (96 heads per 100 households) area than the tsetse free area (12 heads per 100 households).

The type of crops produced in tsetse challenged and free areas are presented in Table 5. The most important crops produced in tsetse challenged areas were maize (100%), tarro (96.2%), enset (86.5%), sorghum (82.5%) and banana (51.0%). In tsetse free areas, the major crops produced include enset (100%), bean (98.1%), pea (92.5%), maize (71.7%), barley (64.2%) and wheat (54.7%).

Table 5. Proportions of households producing major crops in tsetse challenged and free areas

Parameters	Tsetse challenged area			Tsetse free area		
	N	Frequency	Percentage	N	Frequency	Percentage
Enset	104	90	86.5%	52	52	100.0%
Banana	104	53	51.0%	52	1	1.9%
Maize	104	104	100.0%	52	38	71.7%
Teff	104	94	90.4%	52	1	1.9%
Wheat	104	0	0.0%	52	29	54.7%
Barley	104	0	0.0%	52	34	64.2%
Sorghum	104	85	82.5%	52	15	28.3%
Tarro	104	100	96.2%	52	1	1.9%
Bean	104	0	0.0%	52	51	98.1%
Pea	104	0	0.0%	52	48	92.5%

The major cattle diseases recognized as important in the study areas by selected farm households are presented in Table 6. In tsetse challenged areas trypanosomosis was mentioned by all respondents (100%) as an important disease. The second most important disease in the tsetse challenged areas was blackleg (97.1%) followed by ectoparasites (72.1%), endoparasites (61.5%), anthrax (54.8%) and pasteurellosis (52.9%).

In tsetse free areas, the first most important disease mentioned by all the respondents (100%) was blackleg followed by pasteurellosis (82.7%), endoparasites (65.4%), anthrax (57.7%) and ectoparasites (50%).

Table 6. Cattle diseases mentioned as important by selected households in the tsetse challenged and free areas

Parameters	Tsetse-challenged area			Tsetse-free area		
	N	Frequency	Percentage	N	Frequency	Percentage
Trypanosomosis	104	104	100.0	52	3	5.8
Blackleg	104	101	97.1	52	52	100.0
Ectoparasites	104	75	72.1	52	26	50.0
Endoparasites	104	64	61.5	52	34	65.4
Anthrax	104	57	54.8	52	30	57.7
Pasteurellosis	104	55	52.9	52	43	82.7

4.2. Cattle herd size and composition in tsetse challenged and free areas

The results of independent t-test showed (Table 7) that there was no significant difference between tsetse challenged and free areas in cattle herd size and number of pregnant non-lactating cows, lactating cows, heifers, male calves, bulls and steers ($p>0.05$). However, there was significant difference between the two areas in the number of lactating cows ($p<0.05$), dry pregnant cows ($p<0.001$), dry non-pregnant cows ($p<0.01$) and female calves ($p<0.05$). The number of lactating pregnant and dry pregnant cows was higher in tsetse free areas (29 cows in 100 households for lactating pregnant group and 71 cows in 100 households for dry pregnant group) than tsetse challenged areas (11 cows in 100 households for lactating pregnant group and 28 in 100 households for dry pregnant group). The same trend was observed in the case of the number of female calves. Their number was higher in tsetse free area (63 calves in 100 households) than tsetse challenged areas (34 calves in 100 households). The reverse was true for the number of dry non-pregnant cows. Their number was higher in tsetse challenged areas.

Table 7. Comparison of cattle herd size and composition per household in tsetse challenged and free areas

Herd composition	Tsetse challenged area			Tsetse free area				
	N	Mean	SE	N	Mean	SE	t-value	p-value
Pregnant non-lactating cow	104	0.78	0.10	52	0.48	0.13	1.85	0.067
Lactating non pregnant	104	0.70	0.09	52	0.92	0.12	-1.48	0.141
Lactating pregnant	104	0.11	0.03	52	0.29	0.09	-2.21	0.029
Dry pregnant	104	0.28	0.57	52	0.71	0.11	-3.79	0.000
Dry non-pregnant	104	0.69	0.01	52	0.23	0.09	2.29	0.004
Heifers	104	0.97	0.11	52	1.19	0.16	-1.17	0.244
Male calves	104	0.61	0.08	52	0.58	0.10	0.21	0.835
Female calves	104	0.34	0.06	52	0.63	0.10	-2.58	0.011
Bull	104	0.79	0.08	52	0.58	0.11	1.52	0.132
Steer	104	0.58	0.08	52	0.58	0.11	0.00	1.000
Total cattle	104	5.88	0.38	52	6.19	0.11	-0.47	0.628

N= number of observations

4.3. Milk yield and reproductive performance of cattle in tsetse challenged and free areas

The results of independent t-test to compare milk yield and reproductive performance parameters in tsetse challenged and free areas are depicted in Table 8. The average daily milk yield was in general low in both tsetse challenged and free areas. The differences in milk yield at three stages of lactation in the two areas were significant ($p<0.001$). At all stages of lactation, the average daily milk yield of cows was higher in tsetse free areas. Cows in tsetse affected areas were able to give only 52.14, 47.73 and 29.63% of the daily milk yield of those in tsetse free area during the beginning, middle and end of lactation, respectively. In addition, cows in tsetse free areas had an average lactation length longer by 4.35 months than those in challenge areas.

There were also significant differences in age at first calving, calving interval and number of services per conception ($p<0.001$). In general cows in tsetse free areas had better reproductive performance than those in tsetse challenged areas. Cows in tsetse free areas gave their first calf earlier by an average of 5.64 months, had an average calving interval shorter by 2.41 months and required lesser number of services per conception by 0.35.

Table 8. Mean and standard errors of milk yield and reproductive performances of cattle in tsetse challenged and free areas

Parameters	Tsetse challenged area			Tsetse free area			t-value	p-value
	N	Mean	SE	N	Mean	SE		
Milk yield at BL (l)	104	0.73	0.02	52	1.40	0.06	-12.42	0.000
Milk yield at ML (l)	104	0.42	0.01	52	0.88	0.05	-11.54	0.000
Milk yield at EL (l)	104	0.16	0.01	52	0.54	0.04	-11.00	0.000
Lactation length (months)	104	5.52	0.11	52	9.87	0.31	-16.08	0.000
Age at first calving (year)	104	5.44	0.07	52	4.97	0.08	4.28	0.000
Calving interval (months)	104	21.49	0.36	52	19.08	0.40	4.12	0.000
NSPC	104	1.62	0.05	52	1.27	0.06	4.18	0.000

N= number of observations, NSPC= number of services per conception, BL= beginning of lactation, ML= middle of lactation, EL= end of lactation

The results of the follow-up study to determine the lactation curve of cows in tsetse challenged and free areas together with the trend of tsetse challenge during the study period (October 2006 to April 2007) is illustrated in Figure 3. The daily milk yield of cows in challenged areas was lower by 37 to 46.5% than those in free areas throughout the lactation period. On the other hand the tsetse challenge in terms of count of individual tsetse trapped during the study period was dropping steadily from the first to the last week of sampling in the tsetse infested area (from 240-250 in October to 13-19 in March). On the contrary, there was no tsetse trapped in the tsetse free areas throughout the study period.

The results on reproductive performance showed that only 5% (1 cow) was detected (on day 122 postpartum) in heat in tsetse challenged area while 50% of the cows were in heat on day 107.8 on average.

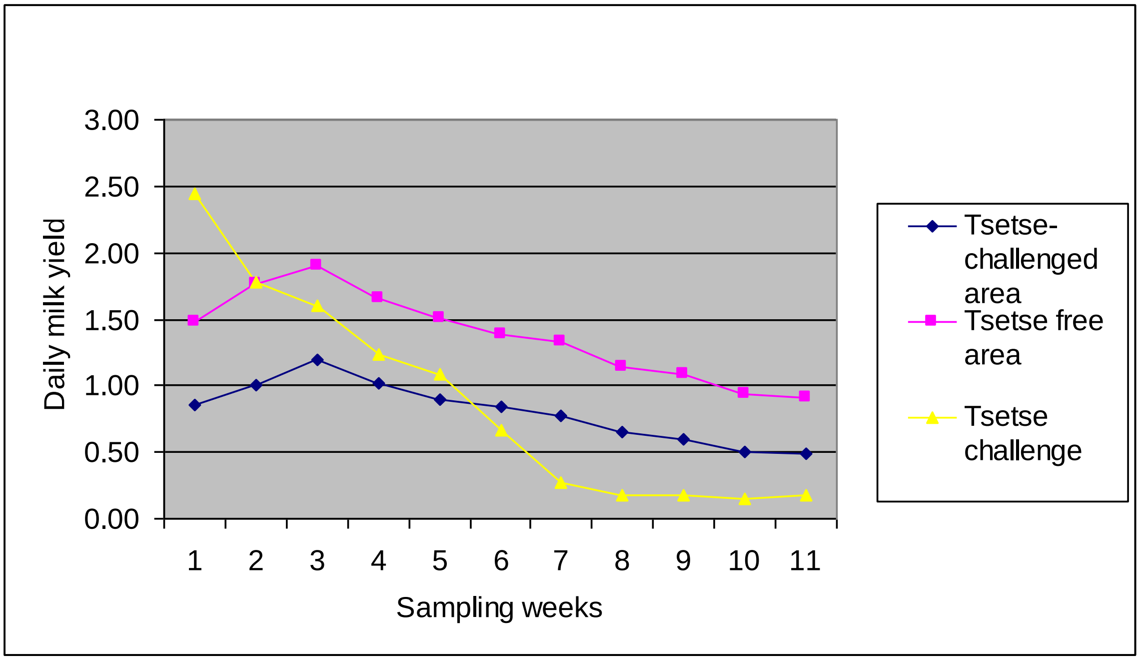


Figure 3 . Lactation curves of cows in tsetse challenged and free areas

4.4. Mortality of cattle in tsetse challenged and free areas

The average numbers of cattle died in 1998 E.C. in the study areas are presented in Table 9. The number of cattle died in one year time was significantly different for total number of cattle and all groups of cattle ($p<0.001$). The total number of cattle died in one year time in tsetse challenged areas was about 26.73 times higher than the value for tsetse free area. In terms of the different groups of cattle, the mortality was higher by 50.75 folds for male calves, 32.67 folds for bulls, 26.65 folds for cows, 21.2 folds for heifers and 13.38 folds for female calves in tsetse challenged areas.

Table 9. Average number of cattle mortality during 1998 E.C

Parameters	TT-challenged area			TT-free area			t-value	p-value
	N	Mean	SE	N	Mean	SE		
Cow	104	6.13	0.83	52	0.23	0.08	5.03	0.000
Heifer	104	2.12	0.28	52	0.10	0.05	5.09	0.000
Male calves	104	2.03	0.18	52	0.04	0.03	7.42	0.000
Female calves	104	1.74	0.19	52	0.13	0.06	2.67	0.000
Bulls	104	1.96	0.51	52	0.06	0.03	5.19	0.000
Steer	104	2.06	0.27	52	0.04	0.03	6.07	0.000
Total	104	16.04	1.73	52	0.60	0.10	6.30	0.000

N= number of observations

5. DISCUSSION

Swallow (2000) indicated that oxen in high risk areas were 38% less efficient than oxen in a low-risk area in their traction performance. Slingebergh (1992) estimated that about The average holding per household in tsetse challenged and free areas were 3.48 and 1.85ha, respectively. This indicates that land is relatively more abundant in tsetse challenged areas since people do not feel confident to settle and use cattle for crop cultivation in tsetse challenged areas. Reid *et al*. (1999) suggested that the presence of trypanosomosis can prevent the expansion of agriculture because farmers have little access to healthy draft oxen. Slingebergh (1992) 220,000-km^2 land in Ethiopia, most of which is fertile and suitable for cultivation, is infested with tsetse and hence can not be used properly.

The livestock herd size and cattle herd size in this study were comparable in tsetse challenged and free areas. This was not because cattle were not challenged by tsetse in tsetse-infested area rather due to the fact that there is a high turnover of cattle herd size because of mortalities and replacements. People tend to replace their cattle every time they loss due to mortality. This is evidenced by the very high number of mortality encountered during the previous year (1998 E.C.). Each household lost an average of about 16.04 heads of cattle, which was in most of the cases over 100% of the current cattle herd size in each household. Another result of this study showed that the goat flock size (goat are believed to be less susceptible) was higher in tsetse challenged area, which is an indication of one of the risk minimization strategies of farmers in the tsetse challenge areas. However, the report of Swallow (1997b) is in disagreement with our finding regarding the cattle herd size. He reported that farmers in areas of high trypanosomosis risk kept 25-60% as many cattle as the farmers in near by low risk areas.

In this study, trypanosomosis was ranked as the first most important disease by farmers in the study areas (100%). This result is in line with the reports of Perry *et al*. (2002) in a global context and Regass (2004), who reported that about 99% of farmers in tsetse challenged area ranked trypanosomosis as the most important cattle health problem.

The number of lactating pregnant cows, dry pregnant cows and female calves was significantly lower in tsetse challenged areas than in tsetse free areas in this study. This is an indication that tsetse challenge and trypanosomosis exerted additional stress on the animals, thus their lactation and pregnancy performance is seriously compromised. Feron *et al.* (1988) reported that the calving percentage of N'Dama cattle in Zaire, which are considered to be trypanotolerant, was less by 15.8% in an area, where there is trypanosomosis risk than where there is no risk. The report of Kamuanga *et al.* (2001) also supported our finding in that the proportion of live births increased to 57.6% due to application of tsetse control. In an experimental study on Boran cattle in Kenya, three out of six infected susceptible Galana Borans aborted whilst one had stillbirth. On other hand in the same study, none of the trypanotolerant Orma Boarn cattle aborted (Okech *et al*., 1996). A recent report by Regass (2004) showed that calving rate was increased by 35% in Didessa Valley in Ethiopia due to tsetse control. Regarding the low number of lactating animals found in this study, a similar finding was reported by Mugunieri and Matete (2005) that the density of dairy cows decreased by 53% in trypanosomosis risk areas than in no-risk areas.

In addition, it was found in this study that cattle in tsetse challenged area had significantly higher age at first calving and calving interval than those in tsetse free areas. Depressed performance in terms of age at first calving was also found by Clifford (1986) in that age at first calving of 40 and 60 moths were reported for cattle in low and high tsetse challenge areas, respectively. Regarding calving interval, the same finding was reported by Feron *et al*., for N'Dama cattle in Zaire that the calving interval of N'Dama cattle was better by 15.8% in non-risk area than in risk area for trypanosomosis. Another report by Defly *et al*. (1988) also stressed that trypanosome infection in cows significantly delayed subsequent calving in Togo. In a more recent report, Mugunieri and Matete (2005) found a calving interval, which was higher by 11 months in risk areas than non-risk areas for trypanosomosis in western Kenya. The mechanisms leading to disruption of reproduction functions could involve a number of factors including anemia, weight loss and post-infection decline of plasma progesterone levels (Okech *et al*., 1996).

Cattle in tsetse challenged area had lower performance in daily milk yield at the beginning, middle and end of lactation in this study. This was also confirmed by the follow-up study; cows in tsetse challenged area were by 37 to 46.5% lower in performance through out the lactation period than those in tsetse free areas. Similar report from Gambia by Swallow (1997a) indicated that milk yield performance of cows was depressed by 10-26% due to the exposure to trypanosomosis. Another report by Agymang *et al*. (1990) showed that trypanosome infection caused a reduction in milk yield production for 6months following infection. In addition, Kamuanga *et al*., (2001) reported an improvement of daily milk yield from 0.2 to 2 liters due to trypanosomosis control. In Ethiopia, a recent work by Regassa (2004) in Didessa Valley revealed that daily milk yield increased by 80% due to tsetse control measures.

In this study, there was in general a very significant difference in number of mortality in cattle in general and the different groups in particular. The number of animals died in the 1998 E.C. in tsetse challenged area was by far higher than the case in tsetse free area. The extent of morality found in this study is in agreement with the report of Kumuanga *et al*. (2001) in Burkina Faso where over 60% of calves died due to trypanosomosis. Swallow (2000) estimated an annual cattle mortality rate due to trypanosomosis ranging from 0-20%. Although, it was not possible calculate the mortality rate in our case, our result seems to be much higher than this range. In Ethiopia, the report of Reggassa (2004) indicated that mortality of cattle was reduced by about 72% in areas where tsetse control measures were applied. The importance of trypanosomosis in causing cattle mortality was also emphasized by many authors (Roder *et al*., 1984; Reid *et al.*, 1997; Wilson *et al*., 1997).

6. CONCLUSIONS AND RECOMMENDATIONS

Based on our findings and previous reports the following can be concluded. The cattle herd size and composition was seriously affected by tsetse challenge. Tsetse challenge reduced the number of lactating cows, pregnant cows and female calves in the cattle herd. It has been proved both by the questionnaire survey and the follow-up study that the milk yield, lactation length and reproductive performance of cows were very much depressed in the tsetse challenged areas. The level of cattle mortality was very high in tsetse challenged areas and hinders the agricultural activity in the area.

Based on these conclusions, the following recommendations are forwarded:

- The use of integrated control measures specially on the vector is highly recommended to reduce the impact of tsetse challenge and trypanosomosis on cattle production;
- The veterinary service should be promoted to match the livestock population and the serious livestock health problem prevailing in the area;
- In long term it is essential to consider the use of indigenous trypanotolerant breeds of cattle in tsetse infested areas;
- Appropriate attention should be given to tsetse infested areas by research and development institutions and policy makers. Research and development projects, which are relevant to these areas, should encouraged and given priority;
- Further study should be carried out to investigate in detail the socio-economic impacts of tsetse challenge and trypanosomosis in the area.

7. REFERENCES

Abebe, G. and Jobre Y. (1996): Trypanosomosis threat to cattle production on Ethiopia. *Rev. Med. Vet.* **147** (12): 897-902.

Adane, M. (1995): Survey on the Prevalence of Bovine Trypanosomosis in and Around Bahir Dar. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Ady, P. H. (1965): Regional Economy Atlas: Africa. Oxford University Press, London, U.K.

Agyemang, K., Dwinger, R. H., Grieve, A. S., Bah, M. L., Little, D. A. (1990): Biological and economic impact of trypanosome infections on milk production in N"Dama cattle managed under village conditions in the Gambia. *Animal Production*, **50**: 383-389.

Alekaw, S. (2004): Epidemiological Investigation of Mechanically Transmitted Trypanosomosis (*Trypanosoma vivax*) of Domestic Animals in Three Districts Bordering Lake Tana. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Anwar, N. (1993): Prevalence Rate of Bovine Trypanosomiasis on Tsetse Protected and Uncontrolled (Galle) Areas. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Arsham, H. (2006): Questionnaire Design and Surveys Sampling. 8^{th} ed., http:/home.vbalt.edu/utsbarsh/ stat data / Surveys.htm # rsss.

Balis, J. and Bergeon, P. (1968): Etudedela repartition de glossines en ethiopoia. *Bull. Ent. Res*., **58**: 537.

Brandl, E. E. (1998): Economics of Trypanosomosis Control in Cattle. Wissenschafts Verlage, Kiel, Germany.

Budd, L. T. (1999): Funded Tsetse and Trypanosome Research in Development Since 1980. Volume 2. Economical Analysis. DFID, London, U.K.

Challier, A., Lavisher, C. (1973): Un niveau piege pour la captured glossines, Descriptionsur le terrain.Cha.Orstom ser. *Ent.Med.Parasitol*., **11:** 251-262.

Clifford, D. J. (1986): Reproductive performance of N'Dama cattle in Gambia. In: Proceedings of Second International Trypanotolerance Center Council Meeting, February 1986. The Gambia.

D'Iteren, G. D. M., Authice, E., Missoq, N. and Murray' M. (1998): Trypanotorecance and Option for Justifiable Livestock Production in Areas at Risk for Trypanosomes. ILRI, Nairabi, Kenya.

Dagninet, Y. (1993): Socio- economic Data Collection Cost Benefit Analysis of Tsetse Control (Limu-Shay) and Uncontrolled (Galle) areas. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Dawuro Zone Agricultural Office (2003): Annual Reports. P3, Tercha, Ethiopia

Dawuro Zone Agricultural Office (2004): Report Based on Base Line Data, Tercha, Ethiopia.

Defly, A. and Handlo, S. M. (1982): Introduction des Petites Ruminants dans lees Villages. CREAT (Centre de recherché et d'elevage, Avetonou, Togo), Togo.

Eramyas A., and Getachew A. (2001): Drug resistant to *T. congolense* in naturally infected donkeys in Northern Omo Zone, *Parasitology,* **99**:261-271.

ERGO and TALA (1999): Predicted Areas of Suitability for Tsetse. Maps Produced for FAO, Department of Zoology, University of Oxford, U. K.

Erkelense, A. M., Dwinger, R. D, Bedane, B., Slingenbergh, J. H. W. and Wint, W. (2000): Selection of priority areas for tsetse control in Didessa Valley, Ethiopia; a pilot study. In: Animal Trypanosomiasis, Diagnosis and Epidemiology, International Atomic Energy Agency, Vienna, Austria, Pp213-229.

FAO (2002): Human trypanosomiasis. *Tsetse and Trypanosomiasis Information Quarterly*, Volume **25**: 109-116.

FAO-WHO-OIE (1982): The economic losses caused by animal disease. In: Animal Health Year Book, FAO, Rome, Pp 284-313.

Feyessa, R. (2004): Current Epidemiological Situation of Bovine Trypanosomosis in Limu Shay Tsetse Controlled Area of Upper Didessa Valley. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Feron, A., G. d'Ieteren, D. M., Durkin, J., Itty, P., Kakaiese, D., Maehe, J. H. H., Mulungo, Nagda, S. M., Paling, R. W., Pelo, M., Rariya, J. M., Sheria, M., Thorope W., and M. Trail, J. C. (1988): Productivity of ranch N'Dama cattle under trypanosomosis risk. In: Livestock Production in Tsetse Affected Areas of Africa. International Laboratory for Research on Animal Disease/International Livestock Centre for Africa, Nairobi, Pp 246-250.

Ford, J. (1971): The Role of Trypanosomiasis and Tsetse Flies in African Ecology: A Study of the Tsetse Fly Problems. Clarendo Press, Oxford, UK.

Getachew T. (2000): Community driven sustainable tsetse and trypanosomes management in the Southern Ethiopia, in the context of holistic development. In: Proceedings of 25th Meeting of the International Scientific Council for Trypanosomes Research and Control, 25 September to 1 October1999, Mombassa, Kenya.

Getahun D. (1998): The Prevalence of Camel Trypanosomosis and Factors Associated with the Disease Occurrence in Leben District of Borena Zone, Oromia Region, Ethiopia. MSc Thesis, Addis Ababa University-Free University of Berlin, Faculties of Veterinary Medicine, Berlin, Germany.

Hagos, A. (2005): Serological and Parasitological Survey of Dourine (*Trypanasoma equiperdum*) in selected sites of Ethiopia. MSc Thesis, Addis Faculty of Veterinary Medicine, Ababa University, Ethiopia.

Holmes, P. H. (2006): Tsetse transmitted trypanosomosis. In: Merck Veterinary Manual, 9th Edition, Merck and Co., Whitehouse Station, NJ, USA.

Ikede, B. O., Elhasan, E.and Atap-Alapvie, S. O. (1988): Reproductive disorders and African trypanosomosis: a review. *Actatropica,* **45**:5-10.

ILCA (1985): Productivity of Boran Cattle Maintained by Chemoprophylaxis Under Trypanosomiasis Risk. Report No. 9. ILCA, Addis Ababa, Ethiopia.

Janke, H. E., Keil, P. and Rojat, D. (1988): Livestock Production in Tropical Africa, with Special Reference to the Tsetse Affected Zone. In: Livestock Production in Tsetse Affected Areas of Africa. ILCA/ILRAD, Nairobi, Kenya. Pp 430 – 432.

Jemere B. (2004): Control of Tsetse and Trypanosomosis in the Southern Rift Valley (Step area): Evaluation of Deltamethrin Application. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Kumuanga M., Antoine, C., Brasselle, A. S., Swallow B., d'Ieteren, G. and Barler, B. (2001): Impact of tsetse control on migration livestock production, cropping practices and farmer herder conflicts in the Mouhoun valley of southern Burkina-Faso. In: Proceedings of the 25th Meeting of the International Scientific Council for Trypanosomes Research and

Control (ISCTRC), Mombassa, 1999. Publication # 120 of Organization of Africa Unity (OAU), Scientific, Technical and Research Commission (STRC), Nairobi, Pp 239 –25.

Kumuanga, M., Sigue, H. Bauer, B. Swallow, B. and d'Ieteren, G. (2001): Farmer's perceptions of the impact of tsetse and trypanosomes and control on livestock production; evidence from the southern Burkina-Faso. *Tropical Animal Health and* Production, **33:**41-153.

Kristjason, P. M., Swallow, B. M., Rowlands, G. J., Kruska, R. L. and Deleeuw, P. N. (1999): Measuring the costs of African animals trypanosomosis, the potential benefits of control and returns to research. *Agric. Systems*, **59**:79 –98.

Kuzoe, F. A. S. (1991): Perspective in research and control of African trypanosomosis. *Annals of Tropical Medicine and Parasitology* **85**(1): 33-41.

Langridge, W. (1976): Tsetse and trypanosomiasis survey of Ethiopia. British Ministry of Oversea Development and Ministry of Agriculture of Ethiopia, Addis Ababa, Ethiopia. Pp 1-98.

Laveran, A. and Mesnil, F. (1912): Trypanosomes et Trypanosomiasis. Masson, Paris. Pp 555-591.

Luckins, A. G. (1999): Epidemiology of non-tsetse transmitted trypanosomosis-*Trypanosoma evansi* in perspective. ICPTV Newsletter, No.1, September 1999, University of Glasgow, UK.

Maclennan, K. J. R. (1980): Tsetse transmitted trypanosomosis in relation to the rural economy in Africa. 1. Tsetse infestation. *World Animal Review*, **36**:2-17.

Manson-Bahr, P. H. (1966): Manoson's Tropical Diseases. 16th Edition, Bailliere, Tindall and Cassell, London, UK.

Mareka District Agricultural Office (2006). Report to Dawuro Zone Agricultural Office in Case of Animal Disease, Pp3-5.

Mugunieri G. L. and Matete G. O. (2005): Association of trypanosomosis risk with dairy cattle production in Kenya. http://www.mendscape.com/medline/abstract/16562730 prt:true.

Murray, M. and Trail, J. C. M. (1990): Trypanotolerance in cattle and prospects for the control of trypanosmosis by selective breeding. *Review Sci. Tech.*, **9**(2), 369 –380.

Murray, M., Stear, M. J., Trial, J. C. M, D'Iteeren, G. D. M, Agyemang, K. D., Winger R. H. (1991): Trypanosomosis in cattle: prospects for control. In: Oxford, R. F. E. and Owen, J. B. (eds), Breeding for Disease in Farm Animals. CAB International, Walligford. Pp 203-233.

Okech, G., Luckins, A. G., Watson, E. D., Makawiti, D. W., (1996). Suspected in utero infection in a Boran heifer experimentally infected with trypanosomosis vivax. *Br.Vet.J. 152*, 105-107.

Ormerod, W. E. (1967): Cell inclusion and the epidemiology of Rhodesiense sleeping sickness. *Trans. R. Soc. trop. Med. Hyg***. 54**,299.

Perry, B. D., Randolph, T. F., McDermott, J. J., Sones, K. R., Thoronton, P. K. (2002). Investing in Animal Health Research to Alleviate Poverty. ILRI, Nairobi, Kenya, Pp148.

Reid, R. S., Wilson, C. J., Kruska, R. L. and Woudyalew Mulatu (1997): Impacts of tsetse control and land use on vegetative structure and tree species composition in south western Ethiopia**.** *Journal of Applied Ecology*, **34**(3): 731-747.

Reid, R. S., Kruska, R. L., Muttui, N., Taye, A., Wotton S., Wilson, C. J., Woudyalew, M. (1999): Land use and land-cover dynamics in response to changes in climatic, biological and socio-political forces: methods developed and a test case in southwestern Ethiopia.

Roder, P. L., Scott, J. M. and Pegram, R. G. (1984): Acute *Trypanosoma evansi* infection of Ethiopian cattle in the apparent absence of tsetse. *Trop. Anim. Hlth. Prod.*, **16**:141-147.

Shimelis, D. (2004): Epidemiology of Bovine Trypanosomosis in the Abbay Basin Areas of Northwestern Ethiopia. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Slingergh, J. H. W. (1992): Tsetse control and agricultural development in Ethiopia. *World Animal Review*, **70**: 30-36.

Sones, K. (1999): Pharmaceutical companies: Partners or Enemies. In: Proceedings of 2nd ICPTVE Workshop on Drug Delivery in the Contest of Integrated Disease Management, Nairobi, Kenya.

SPSS (2002): SPSS11.5 for windows, standewel Version, SPSS.INC, http://www.spss.com

Swallow, B. M. (1997): Impact of trypanosomosis on Africa agriculture. In: Proceedings of the 24th Meeting of International Scientific Council for Trypanosomosis Research and Control, Sept. 24-October 4, 1997, Maputo, Mozambique.

Swallon, B. M. (1997): Impacts of African animal trypanosomosis on human migration, livestock and crop production. In: Proceedings of the 24th Meeting of the International Scientific Council for Trypanosomosis Research and Control, Sept. 24-October 4, 1997, Maputo, Mozambique.

Swallow, B. M. (2000): Impact of Trypanosomes on Africa on Agriculture. PAAT Technical and Scientific Series 2, Food and Agricultural Organization. (FAO), Rome, Italy Pp 52.

Tefera, S. (1994): Prevalence of Bovine Trypanosomosis in Arba-Minch District. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia

Terzu, D. (2004): Seasonal Dynamics of Tsetse and Trypanosomosis in Selected Sites of Southern Nations Nationalities and People Regional State, Ethiopia. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.

Wilson, C. J., Reid, R. S., Stanton, N. L. and Perry B. D. (1997): Ecological consequences of controlling the tsetse fly in Southwestern Ethiopia: effects of land use on bird species diversity. *Conservation Biology*, **11**:435- 447.

Yohannes, A. (1998): Field Investigation on the Appearance of Drug Resistant Populations of Trypanosomes in the Metekel District, Notrhwest Ethiopia. MSc thesis, Addis Ababa University-Free University of Berlin, Faculties of Veterinary Medicine, Berlin.

8. ANNEX

Annex 1 . Questionnaires on impact of testse challenge in Dawro zone

I Survey site (location)

Region________Zone_______Woreda________Kebele________

Altitude (masl)

II Socio-economic and farming system characteristics

1. Name of farm owner______________
2. Age of farm owner________________
3. Sex of farm owner________________
4. Educational status__________________
5. Family size________________________
6. Land holding (ha) _________________

   Crop_____, Pasture________, Fallow, forest_____, Others_______.

7. Livestock herd size and composition.

Livestock species	Herd size	What is trend in the last ten years (decrease or decrease)	Reasons for the change in the trend
Cattle			
Sheep			
Goats			
Donkey			
Horse			
Mule			
Camel			
Poultry			

8.Cattle herd size and composition

Cattle type	Statues	Total
Cattle/cow	Pregnant non- lactating	
	Lactating non-pregnant	
	Lactating pregnant	
	Dry pregnant	
	Dry non-pregnant	
Heifers		
Bulls		
Male calves		
Female calves		
Steers		
Total		

9. What are the objectives cattle keeping?
10. When did you start keeping dairy animals in your farm?

11. Are you producing crop too? If yes specify the types of crops produced

List types of crops with priority	Area coverage	Changing pattern of production	Reasons for changing pattern
Annual crops			
1 2 3. 4.			
Perennials			
1. 2. 3. 4.			
Plantation			
1. 2. 3. 4.			
Others			
1. 2. 3. 4.			

III. Cattle breeding

1. What was your source of establishing the cattle herd?
2. How long have you used the current cattle herd?
3. How long are you intending to use the herd in future?
4. What is your primary objective of keeping cattle in your farm?

IV. Cattle health

1. What are the major health problems of cattle that are of economic importance in the area? List in the order of importance.
2. Is trypanosomosis a major cattle health problem in your area? A/ Yes; b/No
3. What are the most important signs of trypanosomosis?
4. Which species of livestock are mainly affected by trypanosomosis?
5. What are the major impacts of trypanosomosis in cattle in your area?

6. Was there any mortality of animals in your farm last year (1998 E.C)

Cattle	Number of animals died last year due to trypanosomosis
Cattle/ cow	
Cattle/heifers	
Cattle/ male caves	
Cattle/ female caves	
Cattle/ bulls	
Cattle/ steer	
Other species	

7. Was there any control practice against trypanosomosis by any body (governmental and /or non- governmental institutions) recently?
8. If Q 7 yes,
   A/ What type of control measure was taken/
   B/ Who did the control measure?
   C/ When was control measure taken?
   D/ How do you evaluate the effect of the control measure?
9. Which months of the year are highly affected by tsetse challenge?
10. Which months of the year are less affected by tsetse challenge?
11. How do you mange cattle health problems?

V. Reproductive performance

1. What was the age of your cows when they gave their first calf?
2. When did your cows give their recent birth? When did your cows give before the recent birth?

Cow ID/Name	Date/month/year of recent calving	Date/month/yearofpreviouscalvin g

3. How many times did you take your cow for service before it got pregnant?

Cow ID/Name	Types of mating (AI, Bull or both**)**	Numbers of services per conception

4. What is the average daily milk yield of your cows at the beginning, middle and end of lactation? And how long do you milk your cows?

Cow ID/Name	Daily milk yield			Lactation length (months)
	Beginning	Middle	End	

VI. Constraints

1. What are the major constraints of cattle production in your locality
2. What are your suggestions to alleviate the above-mentioned constraints?

9. SIGNED DECLARATION

The thesis, my original work, has not been presented for a degree in any other university and that All sources of material used for the thesis have been duly acknowledged.

Name Tizazu Tigicho

Signature ____________

Date of submission _____________

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

Dr. Kelay Belihu ________________

Dr. Marga Bekana _________________