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Research Article

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Survey on Apparent Density of Tsetse Fly and Biting Fly and Factors Affecting Its Distribution in Arba Minch Zuria Wereda, Southern Ethiopia

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Abstract

A cross-sectional study was carried out from November 2017 to April 2018 in Arbaminch zuria woreda of Gamo Gofa zone, south western Ethiopia. To determine the distribution and the apparent density of tsetse fly and other biting flies. 180 traps were deployed for 72 hr to collect tsetse fly and a total of 1784 tsetse flies, 610 Tabanus and 1162 other fly were caught from the seven selected kebeles during study period. Only one Glossina species (G.pallidipes) were captured in the study area with 499 (27.97%) male and 1233 (69.11%) female and 52 (2.92%) undetermined sex. The overall mean apparent density of tsetse fly and other biting flies in the study area was investigated as 3.30 f/t/d (flies per trap per day) and 3.28 f/t/d (flies per trap per day) respectively. With forest vegetation shows the highest mean apparent density of both tsetse fly and biting flies followed by wood grass land with 6.80 f/t/d and 3.88 f/t/d at forest vegetation and 4.79 and 3.80 at wood grass land of tsetse fly and biting fly respectively. But bush land had the lowest apparent density of 2.54. Similarly the mean apparent density of both tsetse fly and biting fly were higher in the altitude between1000-1200 mas which accounts 4.59f/t/d and 3.59 f/t/d respectively than the apparent density of the fly at altitude between 1200-1400 m a s which records as 1.54 f/t/d tsetse fly and 2.86 f/t/d of biting fly. This study showed a significant difference (p <0.05) of apparent density of tsetse fly among vegetation type and altitude. Based on kebeles, Kanchama records the highest mean apparent density of tsetse fly followed by Kola Shara with 10.94 f/t/d and 3.94 f/t/d respectively and Lante with the slowest mean apparent density of 0.03f/t/d, without statistically significant variation among kebeles during study period (P >0.05). Similarly, there was no statistically significant difference in apparent density of biting fly among altitude (p>0.05).

Keywords: Apparent Density, Biting Fly, Entomology, G. Pallidepes, Tsetse Flies

1. Introduction

Globally, livestock contribute about 40% of Agricultural gross domestic product (GDP) and also provide livelihood and income for at least 1.3 billion people. However, despite their economic importance, livestock receive just a small fraction of official development assistance to agriculture. With more investment, livestock production can be the economic driver for millions of people in low and middle-income country. Furthermore roughly 70 % or 50 million of the rural poor in sub Saharan Africa (SSA) are at least partially depends on livestock to sustain their livelihood. Moreover SSA has the largest area of permanent pasture of any continent and the largest number of pastoralists, hence livestock production currently contributes about 35 per cent of agricultural GDP in SSA.

However, African animal trypanosomiasis is one of the major animal health problems posing a significant negative effect on the settlement and socio economic development over large tsetse belt regions of the continent. In Sub-Saharan Africa, including East Africa, the vector of a disease is distributed over 10 million km2 of potential grazing lands in 37 countries, exposing the lives of around 55 million people and 160 million cattle to the risk of a disease. So that the overall economic loss (both direct and indirect) is estimated to be about 500 billion dollars a year in terms of mortality, production, abortion, reduced fertility, and ability to work as traction animals [1]. Similarly Ethiopia's economy is largely based on agriculture, which contributes 40-50% to the Agricultural sector domestic product (GDP) and 16.5 to country GDP. However an area of 1.1million km2 with 240,000 km2 of fertile land is under threat of trypanosomosis particularly the western and southern lowlands of Ethiopia [2].

Trypanosomiasis continues to remain a major constraint to livestock and agricultural production and consequently human health. The impact of animal trypanosomosis is mainly attributed to morbidity and mortality of livestock, treatment as well as control costs, and denied access to land resources and more importantly draught power to cultivate land for food crops. In addition, pregnant cows abort, oxen could not plough, equines could not be used for transportation, milking cows reduce milk production, and the death of animals that are not properly treated [3].

It's expected that five species of tsetse namely Glossina morsitans sub morsitans, G. Pallidipes, G. fuscipes fuscipes, G. tachinoides, and G. longipennis are known to exist in Ethiopia. These vectors cyclically transmit five species of animal and one of human type trypanosomes (Trypanosoma congolense, *T. vivax*, *T.brucei* and *T. simiae, T. godfreyi* of livestock and *T. rhodesiense* of human) [4].

2. Material and Methods

2.1. *Study Area*

This survey was conducted in seven kebels of Arbaminch zuria wereda, Gamo Gofa Zone, SNNPR which is located 500 km south of Addis Ababa in the Southern Nations, Nationalities and Peoples Region. The total area of Arbaminch zuria is 1,638.3 square kilometer with mean annual temperature of 15.1-250 c and mean annual rain fall of 801-1600 in millimeter. The elevation of an area ranged from 1001-1400 meters above the sea level (m a s) and found on latitude of 5.74921 – 6.15015 and 37.42836 –37.67510 longitude. In the study area livestock population are estimated to 100,000 cattle [5].

2.2. *Study Population*

The livestock populations that are found in the study area are estimated to 100,000 cattle, 12,466 sheep, 14,586 goat and 6,955 equine and 48,853 poultry. They are kept under traditional extensive husbandry system with communal herding during the day and return to their owner's farmstead in the evening. They are managed under the same agro-ecology without any additional supplementary feedings.

2.3. *Study Design and Sampling Techniques*

The study area was selected purposely based on the extent of the existing problems of Trypanosomiasis from veterinarian and coworker, the complaints of farmers and the level of medium to high tsetse challenge in the area. A cross-sectional study design was employed and seven kebeles (Wezeka, Kanchama, Lante, Chano dorka Kola Shara Chano Mile and Chano Chalba) were selected and the apparent density was determined based on the mean catches of flies in traps deployed and expressed as the number of fly catch per trap per day.

2.4. *Entomological Survey*

The tsetse survey was conducted through deployment of NGU (Nguruman) traps. The traps were deployed at altitudinal range of 1000-1400 meters above sea level (m a s) and baited with Phenol and octanol filled in open bottle placed on the ground as attractant, all odors were placed on the ground about 30cm up wind of the trap. Traps were positioned at approximate intervals of 200-250 m .The coordinates of each trap position were recorded with a Global Positioning System (GPS) and found in the range between 1000 to 1400 meters above sea level and remained deployed for about 72 hours. After 72 hours trapped flies were identified, sexed, counted and recorded. The apparent density was determined based on the mean catches of flies in traps deployed and expressed as the number of fly catch/trap/day [2].

A total of 180 traps were deployed in seven kebeles of Arba Minch zuria weredas (30 in Wezeka, 30 in Kanchama, 12 in Lant, 39 in Chano Dorka, 59 in Kola Shara 5 in Chano Mile and 5 in Chano Chalba) were deployed in the morning and in position for 72 hr.

The species of tsetse fly was identified based on morphological characteristics while other biting flies according to morphological characteristics such as size, color, wing venation and proboscis at the genus level. Sexing was done for tsetse fly just by observing the posterior end of the ventral aspect of abdomen by hand lens as a result male flies easily identified by enlarged hypogeum. The matrix- assisted laser desorption/ ionization Time of flight mass spectrometry (MALDI TOF MS) technique already standardized for microbial identification [6].

The NGU traps have an equilateral triangle from above. NGU trap is the most effective model and the best – identified trap in most vegetation type in the region. The rear two sides are blue; the shelf is black and slopes down in to the trap from the top. The black target basis attached half way along the base of the two sides and its top is fixed to the upper rear corner. The pyramidal net cone is not recessed and a hole in its apex admits flies to the cage. A large polyphenol cage in the form of modified tetrahedron is used to avoid overcrowding. The cage and trap are supported externally by poles; the cone is supported internally by a center pole with three nails in its end [7].

Figure 1: Figure Shows NGU Trap and how it can Deployed

2.5. *Statistical Analysis*

Microsoft Excel was used to store all the data and IBM© SPSS® statistics 21 ANOVAs were used to analyze the entomological data. The association with in different variables and among the variable like vegetation types and altitude were evaluated, in all cases differences between parameters was tested for significance at probability levels of 0.05 or less. The mean apparent density of tsetse fly were calculated by dividing total number of flies caught by total number of traps deployed and period of deployment, and expressed as flies per trap per day (flies/ traps/day).

3. Result

3.1. *Result of Entomological Survey*

A total of 1784 tsetse flies were caught from the study area with Wezeka 68, Kanchama 985, Lante 1, Chano Dorga 29, Kola Shara 697, Chano Mile 2, Chano Chalba 2. Out of which 499 (27.97%) were male, 1233 (69.11%) were female and 52(2.91%) were unknown sex all of which were G. pallidipes. 610 Tabanus and 1162 other fly were recorded in the study area. Vegetation type and altitude were observed as the factor for variation in distribution and apparent density of fly. Among these vegetation types and altitude showed significant difference in apparent density of tsetse fly. That is there is significant difference among vegetation type and within vegetation types ($p < 0.05$) and 95% confidence interval.

The total mean apparent density of tsetse flies in this survey was investigated as 3.30 f/t/d (flies per trap per day). While the mean apparent density of mechanical vectors, tabanids and other flies were recorded to be 3.28 f/t/d. Species wise all of the 1784 tsetse flies caught were Glossina pallidepes.

3.2. *Separation of Tsetse from other Blood Sucking Flies*

Tsetse are similar to other large flies, such as the housefly, but can be distinguished by various characteristics of their anatomy either with the aid of naked eye or with the microscope. The species of tsetse and other biting flies were identified based on morphological characteristics such as size, color, wing venation and proboscis at the genus level. Tsetse folds their wings completely when they are resting so that one wing rests directly on top of the other over their abdomens, Aristae of the antenna has branched hairs on its upper surface, they also have a long proboscis, which extends directly forward and is attached by a distinct bulb to the bottom of their heads and have an hatchet cell on the wings. But, other blood sucking flies (mechanical transmitters) have proboscis which angled at its base and has no bulb, arista has un-branched hairs on its upper surface, they have no hatchet cell on the wing and their wings are held out at an angle of the abdomen at rest.

Also it needs clarification to distinguish tsetse flies among themselves. For instance, Glossina *morsitans* has a dark ring on the 4^{th} tarsal segment of the front leg and the dark last two tarsal segments of the hind leg. Glossina *pallidipes* has the pale 4th tarsal segment of the front leg, the dark last two tarsal segments of the hind leg and the long median scutellar bristles. Glossina *fuscipes* has the dark color of most of the tarsal segments of the hind leg and it has a very narrow pale area which crosses each abdominal segments. But, in case of Glossina *tachinoides* there is dark color of most of the tarsal segments of the hind leg (Figure.1, 2 and 3).

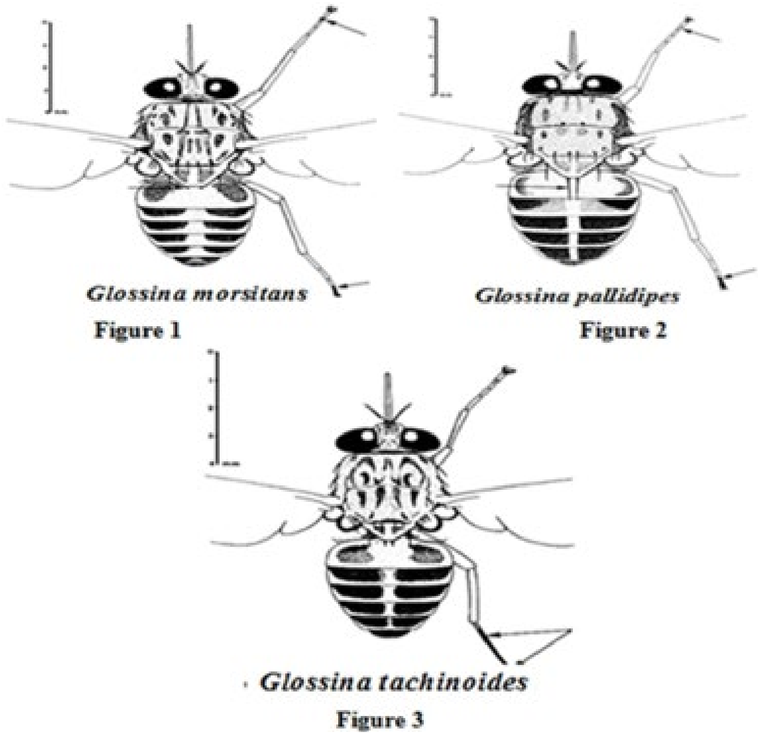

Figure 2: Figure Show How Different Species of Glossina Differentiated
Source [8].

Sexes of the tsetse flies were done just by observing or palpating the posterior end of the ventral spect of the abdomen by microscopic lenses as a result male flies were easily identified by enlarged hypophgeum in the posterior ventral part of the abdomen.

3.3. *Result of Entomological Survey Based on Kebeles*

A total of 3556 flies were caught at the time of the study; out of these 1784 belong to tsetse of the genus *Glossina and species of G. pallidepes* but the remaining 1772 were shared by other genera (biting flies), namely *Tabanus* and *other flies* with score of 610 and 1162 respectively.

The mean apparent density of tsetse fly and other biting flies in the study area was investigated as 3.30 f/t/d (flies per trap per day) and 3.28 f/t/d (flies per trap per day) respectively. With Kanchama records the highest apparent density of tsetse fly followed by Kola Shara with 10.94f/t/d and 3.94 f/t/d respectively and Lante with the slowest apparent density of 0.03 f/t/d .Similarly Wezeka shows the highest apparent density of other bitting flies followed by Kanchama which accounts 5.70 f/t/d and 3.71 f't/d respectively, but Lante and Chano Chalba had the lowest mean apparent density of 0.44 f/t/d and 0.50 f/t/d respectively. There is no statistical difference among all kebeles (p >0) but only Kanchama have significant difference with all the rest of the kebeles (p< 0) as indicated in the (Table: 1).

G.pallidipes caught								Bitingfly				
		Sex										
Kebele	No. Tra	M	F	U.sex	Total	App.d		Tab.	Oth. F	Total	Ap.d	
						f/t/d	%				f/t/d	%
Wezeka,	30	27	41	0	68	0.76	3.82	97	417	514	5.71	29.01
Kanchama	30	276	697	12	985	10.94	55.22	91	239	330	3.70	18.62
Lante	12	0	1	0	1	0.03	0.001	16	0	16	0.44	0.44
Chano Dorga	39	8	18	3	29	0.25	1.63	104	279	383	3.27	21.61
Kola Shara	59	188	472	37	697	3.94	39.10	279	227	506	2.85	28.56
Chano Mile	5	0	2	0	2	0.13	0.11	16	0	16	1.10	0.9
Chano	5	0	2	0	2	0.13	0.11	7	0	7	0.50	0.40

Chalba											
Total	180	499	1233	52	1784	3.30	100	610	1162	1772	3.28	100

G.*pallidipes*- Glossina *pallidepes*, No Tra.- number of trap M- male, F- female, U. sex-unknown sex, App.d- apparent density, Tab.-tabanus, Oth.F -Other flies, f/t/d- flies per trap perday.

Table 1: Table Shows Apparent Density of Tsetse Flies and other Bitting Flies in Different Kebeles of Arbaminch Zuria Wereda

3.4. *Result of Entomological Survey Based on Vegetation Types and Altitude*

A total of 3556 flies were caught at the time of the study; out of these 1784 belong to tsetse of the genus *Glossina and species of G.pallidipes,* but the remaining 1772 was shared by other genera (biting flies), namely Tabanus and other flies with score of 610 and 1162 respectively.

The overall mean apparent density of tsetse fly and other biting flies in the study area was investigated as 3.30 f/t/d (flies per trap per day) and 3.28f/t/d (flies per trap per day) respectively. With forest vegetation shows the highest apparent density of both tsetse fly and biting flies followed by wood grass land with 6.80 f/t/d and 4.79 f/t/d tsetse fly and 3.88 and 3.80 biting fly of forest vegetation and wood grass land respectively. But bush land had the lowest apparent density of 2.54 fly/trap/day of tsetse fly. With bush land has statistical difference of apparent density with the rest of the vegetation types ($p < 0.05$).

On the other hand the mean apparent density of both tsetse fly and biting fly were higher in the altitude between 1000-1200 m a s which accounts 4.59 f/t/d and 3.59 f/t/d respectively than the apparent density of the fly of altitude between 1200-1400 m a s which records as 1.54f/t/d tsetse fly and 2.86 f/t/d of biting fly. This results in 80.33% of tsetse fly and 63.15% of biting fly in altitude between 1000-1200 m a s. On the other hand 19.67%of tsetse fly and 36.85% of biting fly were recorded in altitude between 1200-1400 m a s. The two altitude range has statistically significant different mean apparent density of tsetse fly ($p < 0.05$) as summarized in (table: 2).

					95%							
P<0.05 G. *Pallidipes*					Confidence interval			Other				
	sex							Bitting flies				
Vegitation	No. Tra	M	F	U.sex	Total	Ap.d	%	Tab	Oth.F	Total	Ap.d	%
Types						f/t/d					f/t/d	
WGL	76	319	757	17	1093	4.79	61.3	216	650	866	3.8	48.87
BUL	76	31	86	3	120	0.53	6.73	176	404	580	2.54	32.73
FV	28	149	390	32	571	6.80	32	218	108	326	3.88	18.4
Total	180	499	1233	52	1784	3.30	100	610	1162	1772	3.28	100
Altitude m a s 1000-1200	104	403	985	45	1433	4.59	80.3	424	695	1119	3.59	63.15
1200-1400	76	96	248	7	351	1.54	19.7	186	467	653	2.86	36.85
Total	180	499	1233	52	1784	3.30	100	610	1162	1772	3.28	100

WGL.- wood grass land, BUL.- bushe land, FV.- forest vegetation, G. *pallidipes*- Glossina *pallidepes*, No Tra.- number of trap, M- male, F- female, U.sex- unknown sex, App.d - apparent density, Tab.- tabanus , Oth.F- Other flies, f/t/d- flies per trap per day.

Table 2: Table Shows Apparent Density of Tsetse Fly and other Bitting Fly in Different Vegetation Types and Altitudes

4. Discussion

The study was conducted from November 2017 to April 2018 in seven kebeles of Arbaminch zuria woreda (Wezeka, Kanchama, Lante, Chano Dorga, Kola Shara, chano Mile, Chano Chalba) Gamo gofa zone, Southern, Nation, Nationality and people Regional state to assess the distribution and apparent density of tsetse and other blood sucking flies in the study area. In the study, an entomological survey was conducted by deploying traps in different positions at approximate intervals of 200-250 m for 72 hours in watering and grazing points of forest vegetation, wood grass land and bush land, in which the fly and vector are believed to have frequent contacts. Tsetse flies and other flies were collected from selected kebeles of the study area. The altitude levels, kebeles, numbers of traps, tsetse species caught, other biting flies, days and vegetation types were recorded during the sampling period.

As the result, a total of 1784 tsetse flies with a total mean apparent density of 3.30 flies per trap per day were caught from the seven selected kebeles during the study period. Additionally, about 1772 other blood sucking flies or mechanical transmitters (610 Tabanus and 1162 other bitting fly) were caught. From the total of tsetse flies collected (69.11 %) of them were females, (27.97) of them are male and 52 (2.91%) were un known sex of G. pallidepes. un known sex is due to death, fragile due to drying, loss of normal architecture, eaten by predators like ants, As tsetse fly after 72 hour of trap deployment which makes sex differentiation difficult. Females accounted for 69.11% catch during this study which is 1 male to 2.47 female ratios. This result is somewhat approached to the report of Bekele where he indicated about 1:1.7 male to female ratio [9]. Also this result is found to be highly consistent with previous study in which they reported female (69.63%) tsetse flies was caught than males (30.36%) G. pallidipes [10]. Associated higher catches of female G .pallidipes to be attributable due to their longer life span (average of 8 weeks) than males living about 4 weeks, so that more catch of females could appear, male more susceptible for insect cide and female are more attracted to the trap [2].

This result is less than the study of who reported 11.46f/t/d (flies per trap per day) of apparent density of tsetse fly and the mean apparent density of mechanical vectors, tabanids was recorded to be 4.54 f/t/d. but higher than the study of who reported the overall apparent density of tsetse and biting fly obtained in the study area was 0.194 and 0.069 fly/trap/day respectively [11, 12]. Adramatic reduction of mean apparent density of the tsetse flies at the study area (3.30 f/t/d) when compared to that of at NechSar National Park, Southern Ethiopia which is 11.46 f/t/d is because of the presence of considerable suppression of flies population by the use of 1% deltameterin insecticide impregnated targets, ground spraying, trap and insecticide-treated livestock (pour on) under taken in the area by Southern Tsetse fly eradication project (STEP) [11]. Effort has been made to conduct an entomological survey based on different kebeles. In Wezeka there were 68, 97 and 417 of tsetse fly, tabanus and other biting fly respectively. In Kanchama 985 tsetse fly, 91 tabanus, 239 bitting fly, in Lant 1 tsetse fly, 16 tabanus, no other fly, in Chano Dorga 29 tsetse, 104 tabanus, 279 other fly, in Kola Shara 697 tsetse, 279 tabanus, 227 other fly, in Chano Mile 2 tsetse, 16 tabanus, no other fly, in Chano Chalba 2 tsetse, 7 tabanus, no other fly were observed.

Therefore apparent densities of tsetse flies and other biting fly were recorded in seven corresponding kebeles or PAs (in Wezeka 0.76 and 5.71 f/t/d, in Kanchama10.94 and 3.70 f/t/d, in Lant 0.03 and 0.44f/t/d, in Chano Dorga 0.25 and 3.27 f/t/d , in Kola Shara 3.94 and 2.85 f/t/d, in Chano Mile 0.13and 1.10 f/t/d and in Chano Chalba 0.13 and 0.50 f/t/d of tsetse fly and other biting fly) were caught respectively. The study revealed that Kanchama have high tsetse apparent density (10.94f/t/d) followed by Kola Shara (3.94 f/t/d) and wezeka have high biting fly apparent density (5.71f/t/d).

Regarding the distribution of tsetse fly and other biting fly based on vegetation types and altitude levels, in wood grass land 1093 tsetse fly, 216 tabanus and 650 other fly, in bush land 120 tsetsefly, 404 tabanus and 580 other fly, in forest vegetation 571 tsetses, 108 tabanus and 326 other fly. Its corresponding mean apparent density will be 4.79 of tsetse fly and 3.80 of biting fly f/t/d, 0.53 tsetse fly and 2.54 of biting fly f/t/d and 6.80of tsetse fly and 3.88 of biting fly f/t/d of wood grass land, bush land and forest vegetation respectively. This result indicates forest vegetation inhabits both high tsetse and biting fly distribution and density (6.80 of tsetse fly and 3.88 f/t/d of biting fly) followed by wood grass land (4.79 of tsetse fly and 3.80 of biting fly f/t/d). But William and Krinsky, stated that Glossina pallidepes was wide spread in Savanna land. The morsitans group of savanna species, which includes G. morsitans, G. pallidipes, G. longpalpalpis, G. swynnertoni and G. austien, is primarily centeral and south eastern Africa in distribution. The reduction of fly density in bush land is due to suppression technique used in the areas by southern tsetse fly eradication project before the survey.

On the bases of altitude the distribution of tsetse fly between altitude of 1000-1200 m a s were 1433 tsetse fly and 1119 biting fly with mean apparent density of 4.59 and 3.59 f/t/d of tsetse fly and biting fly respectively. Between altitude of 1200-1400 m a s 351 of tsetse fly and 653 of biting fly with mean apparent density of 1.54 and 2.86 of tsetse fly and biting fly respectively. This indicates the apparent density of both tsetse fly and biting fly decrease as altitude increase. This is in agreement with who reported the geographical distributions of the tsetse flies were concentrated in the low land area as climatic conditions are more favorable and most of the tsetse were caught in the low land areas and the apparent density decreases as altitude increases [13].

5. Summary

The results of apparent density of tsetse survey in the study area indicated that, an overall apparent density of 3.30 flies per trap per day and 3.28 flies per trap of biting flies in which moderate to high density of tsetse flies was recorded. During this entomological survey, only one species of tsetse flies (G. pallidipes) were identified along with other biting flies. These flies are responsible in transmitting trypanosomosis to the animals in the kebeles either biologically or mechanically. As more prevalence of the disease was found in place where highest tsetse fly density is present. This result is in agreement with previous result obtained by who conclude that both the apparent density and prevalence of trypanosomes are positively correlated [14]. Therefore trypanosomosis can still remain major constraint in the area and pose enormous economic loss through poor weight gain, reduced reproductive performance , reduced meat and milk production, reduce working capacity of oxen and productivity, treatment cost and death of affected animals, although different control measures were applied by National Tsetse and Trypanosomosis Investigation and Control Center (NTTICC). Situation is getting worse as the control and prevention of trypanosomosis is facing a challenge due to limitation of vector control activities and drug resistance taking in to account the above mentioned points, the following recommendations were forwarded:

- To generate complete data set on epidemiology of trypanosome infections, their economic loss and ecology of tsetse flies, further detailed studies need to be conducted in different seasons with the possibly larger sample size at study area.
- Designing and implementation of appropriate and feasible control strategies of trypanosomosis focusing integrated approach (vector control and chemotherapy) should be continuing in the studied areas.
- Veterinary clinics should be expanded with trained veterinarian and supply of appropriate prophylactic and therapeutic drugs to control trypanosomosis.
- Extension service implemented should have to incorporate participatory packages on public awareness creation in the control of tsetse flies and trypanosomosis and the burdens of both tsetse and biting fly should be further investigated at the area [15-24].

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