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Assessment of the Impacts of Tsetse and Trypanosomosis Control Activities in Dawuro Zone, Ethiopia

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Abstract

African Animal Trypanosomosis is the major constraint of livestock production in tsetse infested areas of Ethiopia and is the major challenge in Dawuro zone. Various interventions have been applied to control the disease in tsetse infested areas. However, there is a shortage of information on the impacts of these control methods. A cross-sectional study was conducted from November, 2017 to June, 2018 with the aims of assessing the apparent prevalence of the diseases and density of tsetse flies and the impacts of applied control interventions. The trap deployment and questionnaire survey were conducted. The apparent density of tsetse and Stomoxys were 5.37 FTD and 0.39 FTD respectively. The overall mean *vector density of pre-intervention was 0.17 ± 0.38 while post intervention was 5.50 ± 0.51 respectively. The findings of the questionnaire survey showed that livestock keepers were familiar with ruminant trypanosomosis, its vectors as well as the effect of the major control interventions applied in areas. There are continuous control interventions applied in the area but the results show that the disease prevalence and apparent density were increasing. Therefore, a comprehensive national wise evaluation of the impacts of control interventions should be undertaken.*

Keyword: Apparent Density, Control Interventions, Dawuro Zone, Ethiopia

Introduction

Ethiopia is one of the top-ranking countries in Africa and among the first ten in the world in terms of livestock resource (OIE, 2008), with an estimated 56.71 million cattle, 29.33 million sheep and 29.11 million goats as reported by Central Statistical Authority (CSA, 2017). Ethiopia has huge and diverse livestock population that plays important roles in the economy and livelihoods of farmers and pastoralists (Tegegne *et al*., 2013).

Despite the importance of livestock to the largest sector of the population and to the economy at large, the productivity of this livestock sector is lower than the potential level of the African production average (Belay *et al.*, 2012(b)). This is attributed to a multitude of problems including diseases, age-old traditional management system, inferior genetic make-up, food shortage in quality and quantity and absence of well-developed market infrastructure (Behnke, 2010; Belay *et al*., 2012a).

The tsetse fly (genus: *Glossina*) is the vector of trypanosomosis occurs only in sub-Saharan Africa. In other parts of the world, the transmission of pathogenic trypanosomes to animals is believed to be non-cyclical or mechanical and is effected mainly by blood sucking arthropods (Denbarga *et al*., 2012). Currently, about 220,000 Km^2 areas of the Western, South and South-western lowland regions are infested with five species of tsetse flies namely *G. Pallidipes*, *G. m. submorsitans*, *G. fuscipes*, *G. tachinoides* and *G. longipennis* as reported by National Institute for Control and Eradication of Tsetse and Trypanosomosis (NICETT, 2004). These fertile lands are excluded from agricultural activities. The most important trypanosome species affecting livestock in Ethiopia are *T. congolense*, *T. vivax* and *T. brucei* in cattle, sheep and goat, *T. evansi* in camel and *T. equiperdum* in horse (Getachew, 2005).

The direct and indirect impacts of African animal trypanosomosis on agriculture constitute a major constraint to the socio-economic development of tsetse fly

(Glossina) infested areas (Swallow, 1999*)*. According to Food and Agriculture Organization (FAO) estimation, Africa loses over 3 million cattle and other domestic livestock annually through deaths incurred by trypanosomosis (FAO, 2008). Approximately 35 million doses of trypanocidal drugs (worth about 35 million USD) is bought every year in futile efforts to maintain livestock free of the disease. The annual loss directly attributed to trypanosomosis, in terms of reduced meat and milk production and in terms of the costs related to treating the disease or controlling the vector, has recently been estimated at 1.2 billion USD (FAO, 2008). This figure rises to over 4.5 billion USD per year, if losses in potential crop and livestock production attributable to the disease are considered and excludes the losses attributable to the effects of sleeping sickness in humans (PATTEC, 2000).

According to the systematic review performed by Meyer *et al*., (2016) on past and ongoing tsetse and animal trypanosomosis control operations in five African countries including Ethiopia, indicated that there is lack of evaluation of the impacts of control programmes; as well as a lack of a standardized methodology to conduct such evaluations. Even though, there were extensive and long-standing tsetse and trypanosomosis control programmes that have been running in Ethiopia for several years, African animal trypanosomosis is still remained as major constraint of livestock production in tsetse infested areas of the country in general (NICETT, 2012 unpublished) and the higher ranking constraints to livestock production in the study areas in particular which is reported by Wolaita Sodo trypanosomosis and tsetse investigation and control station (WSTTICS, 2017 unpublished). The four common trypanosomosis control interventions that have been applied in Tarcha and Tocha areas of Dawuro zone were spot-on techniques, chemical impregnated targets and traps, chemoprophylaxis and chemotherapy of specifically known diseased animals (Dawuro Zone Livestock and Fishery Development Department (DZLFDD, 2017 unpublished). These interventions have been applied in the studied areas for several years but no sign of improvement was seen on the disease prevalence and tsetse fly density (WSTTICS, 2017 unpublished). There is limited information on the impacts of the current control interventions of trypanosomosis and tsetse fly in the two selected study areas of Dawuro zone. Hence, assessment of the effects of existing trypanosomosis control interventions should be conducted to look for alternative disease control options (Meyer *et al*., 2016). Therefore, this study was conducted to assess the impacts of some of the applied tsetse and trypanosomosis control interventions & to assess the perception of the farmers on the impacts of control interventions.

Materials and Methods

Description of the Study Area

This study was conducted from November, 2017 to June, 2018 in Dawuro zone which is one of the 14 zones in Southern Nations, Nationalities and Peoples Regional State (SNNPR). The zone is located at about 497 km far from Addis Ababa, capital city of Ethiopia and 319 km South West of Hawassa, the capital city of the SNNP regional state. Geographically, it is roughly lies between $6^o59'$-$7^o35'$ North Latitude and $36^o6'$-$37^o53'$ East Longitude and the altitude is between 1300-3500 masl. (CSA, 2016). It is bordered with Oromiya region in the North West, Kembata Tembaro Zone in the North East, Wolaita Zone in the East, Gamo Zone in the South, and Konta special Woreda in the West. The total area of the zone is estimated to be 4,436 square kilometers and it shares 4.07% of the total area of the region. The mean annual rain falls and the temperature of Dawuro Zone ranges from 1201-1800mm and 15.1-34.5°c, respectively. Among many rivers, Omo (Gilgel Gibe III hydroelectric power project is currently under operation) is one of the region’s biggest drainage basins which flows and surrounded the zone. River Omo is the longest rivers bordering Dawuro zones and other river basins within the zone which create suitable agro-ecology for the tsetse fly include Gojeb and Manisa river basins as reported by Dawuro Zone Finance and Economy Development Department (DZFEDD, 2017 unpublished).

Sample Collection

Retrospective data collection

At the beginning of this study, retrospective data was collected from Wolaita Sodo Tsetse and Trypanosomosis Investigation and Control station (WSTTICS, unpublished), which is the only center assigned to perform local trypanosomosis control and follow up the situation in the study area. Baseline data concerning, the apparent density and species of *Glossina* circulating in the study area, frequencies and efficacy of the control interventions that have been applied in the study areas were gathered.

Entomological Sample Collection

The retrospective pre-intervention entomological data was collected from WSTTICS of the region while the post intervention data was gathered by deploying traps in the six selected kebeles according to Okoth *et al*. (1999). The general geographic information of all the kebeles under study were recorded using GPS (Garmin 48 type). A total of 30 Nguruman (NGU) traps (five traps per kebele) were deployed at approximate distance of 200-250 meters’ intervals. During deployments of the traps in each kebele, the forest coverage, trap type, starts date and start time were also registered. After 72 hours of deployment, the end date and end time were registered. Acetone and commercial grease were used to attract tsetse flies and prevent tsetse fly predators, respectively.. Then the traps were collected, tsetse and other fly species were harvested and their species and sexes were identified based on sex organs on male tsetse (Okoth *et al*., 1999). Communities were participated in trap keeping from thief and fire exposure.

Questionnaire Survey

Semi-structured Questionnaires were used to assess the farmers perception towards the general understanding of ` trypanosomosis affecting domestic ruminants, the type, frequencies and the efficacy of tsetse and trypanosomosis control interventions applied so far in the study areas. Representative sample size of the questionnaire survey was determined by using the formula which was used by Yamane (1967);

$$n = \frac{N}{1+N(e)^2}$$

Where, n is sample size; N is target population and *e* is level of precision. Based on this formula, by assuming level of precision 9% and the number of total human population 142,861; the required sample size for the questionnaire survey was estimated to be 123.

But for the ease of sampling and to give equal opportunity to the farmers in the kebeles under study, equal numbers of respondents were selected. Therefore, 132 respondents (22 respondents from 6 kebeles) were selected for the study. The questionnaires were pre-tested and administered to famers who owned livestock and lived for at least for two years in the area.

Data Management and Analysis

Data was categorized, filtered, coded and entered in to MS Excel and was transferred to Statistical Package for Social Sciences (SPSS) Software version 20 (by Jim Dalrymple, Macworld Software Company, USA.). The relative abundance (apparent density) of tsetse and other flies were calculated as the average number of flies (males and females) caught per trap per day (FTD). The relative abundance of mean tsetse fly population and the prevalence of ruminant trypanosomosis in pre-intervention and post-intervention of some of the control intervention strategies applied so far in the study areas were assessed by using descriptive statistics. The Paired sample t-test was used to estimate the mean changes of the apparent tsetse density and prevalence of trypanosomosis in ruminants before and after application of different control intervention strategies in the study areas for assessment of the effects of the control strategies. In all analysis, confidence level and absolute precision were held at 95% and 5% respectively and $P \leq 0.05$ was taken for significance.

The Ethical Consideration

The study was reviewed and approved by Jimma University College of Agriculture and veterinary medicine ethical and research review board. The objectives were well explained to all participating farmers and oral consents were obtained prior to the study. Questionnaires were administered to farmers who were willing to participate in the survey.

Results and Discussion

Entomological Study Findings

A total of 1,022 flies (483 tsetse flies, 35 *Stomoxys* and 504 non-biting flies) were caught during the study period. The only species of tsetse that was identified in this study was *Glossina pallidipes*. The apparent density of tsetse, *Stomoxys* and other non-biting flies was 5.37 FTD, 0.39 FTD and 5.60 FTD, respectively. From all the study sites, the highest (5.93 FTD) and lowest (4.60 FTD) tsetse fly densities were recorded in Wara Wory and Tarcha Zuria kebele, respectively. From total tsetse fly trapped, 259 (53.62%) flies were females which occupied larger proportion and the rest 186 (38.50%) flies were males while the remained 38 (7.86%) were unknown sex because of distortion of body structure of dead flies (Table 1).

Table 1. The tsetse, other biting and non-biting flies caught from Dawuro zone, Ethiopia

Kebele	Trap type	Forest coverage	Flies caught in traps						
			G. pallidipes					*Stomoxys*	
			M	F	Unidentified	Total	Density	No	Density
Tarcha	NGU	RFF,WGL	27	37	5	69	4.60	0	0
Lala	NGU	RFF,WGL	32	46	9	87	5.80	8	0.53
Wara	NGU	RFF,WGL	35	44	10	89	5.93	8	0.53
Abba	NGU	WGL,Cul.L	24	48	6	78	5.20	10	0.67
Gorika	NGU	RFF,Cul.L	34	32	8	74	4.93	9	0.6
Waruma	NGU	RFF,WGL	34	52	0	86	5.73	0	0
Total			186	259	38	483		35	
	Apparent density		2.06	2.88	0.42	5.37	5.37		0.39

RFF = Riverine Forest, WGL = Wooded Grass Land, Cul.L = Cultivated Land

The study of entomological survey was showed only *Glossina pallidipes* and *Stomoxys* in Tocha and Tarcha areas of Dawuro zone. The apparent density of tsetse was 4.60 FTD in Tarcha and the apparent density of tsetse and *Stomoxys* were 5.52 FTD and 0.39 FTD respectively in Tocha district. The overall apparent density of tsetse and *Stomoxys* were relatively high in the study areas. The apparent density findings of tsetse was higher than the study findings of Girma *et al.*, (2014), they determined 3.88 FTD of tsetse but the apparent density of *Stomoxys* is lower than their findings of 1.38 FTD *Stomoxys* in and Around Arba Minch, Gamo Gofa zone, South Ethiopia. But the overall apparent density of tsetse and *Stomoxys* were lower than the findings of Habte *et al.* (2015), the study spatial distribution of tsetse fly and prevalence of bovine trypanosomosis and other risk factors in Darimu District, Ilu Aba Bora Zone, Western Ethiopia, they determined overall apparent density of 6.87 FTD and 1.05 FTD for tsetse fly and *Stomoxys* respectively. Out of total tsetse fly harvested, females occupied larger proportion that creates suitable conditions for population density of tsetse species. These higher vector densities were directly related to the disease prevalence of domestic ruminants` trypanosomosis. The higher vector density might be due to the lower frequency, less sustainability and inability of the tsetse control interventions to cover wider areas in the study areas.

Effect of the Control Interventions

The finding of the current study showed higher post-intervention disease prevalence in cattle, sheep and goats compared to the prevalence recorded before the intervention. The mean prevalence of the trypanosomosis in cattle, sheep and goats before the control intervention was lower than after the application of control interventions in the areas. The mean apparent density of the tsetse fly before the application of the control intervention strategies was also lower than mean apparent density of tsetse after the application of control interventions. The overall results show that there is no progressive reduction in both the apparent density of the tsetse fly and prevalence of trypanosomosis (Table 2). The findings of the current assessment is inline with Meyer *et al.* (2016), who conducted a systematic review on trypanosomosis control operations (some results of impact assessment) in five African countries (Ethiopia, Burkina Faso, Zambia, Cameroon and Uganda) and stated that there was a lack of evaluation of the impacts of control programmes, as well as a lack of a standardized methodology to conduct such evaluations.

For more comparison of the current study findings on evaluation of the impacts of intervention strategies applied in the study areas to control tsetse and trypanosomosis, the study has faced shortage of standard methods and evaluations that have been done before to compare and conclude whether the intervention methods were effectual or not based on the disease status and tsetse populations.

Table 2. The prevalence of trypanosomosis in pre and post control intervention period

Animal species	Mean prevalence before control	Mean prevalence after control
Cattle	13.50±6.54	23.83±6.43
Sheep	0.04±0.62	4.00±7.62
Goats	0.03±0.41	4.67±7.47
Overall	4.50±7.44	10.83±11.63
Apparent density	0.17±0.383	5.50±0.51

However, these results were in disagreement with the findings of Bekele *et al*., (2010), on the evaluation of the impacts of deltamethrin applications in the control of tsetse and trypanosomosis in the Southern Rift Valley areas of Ethiopia, where they have found reduction of post-intervention disease prevalence (10.75% to 1.8%) and apparent fly density (1.35 FTD to 0.005 FTD). This may be due to the intensive tsetse and trypanosomosis suppression program in the southern rift valley areas of Ethiopia.

Findings from this study were not in line with the study conducted by Percoma *et al*., (2018). Their findings showed that in the intervention areas the apparent density of tsetse flies declined from 10.73 FTD to 0.43 FTD. At the end of the campaign, an 83% reduction of apparent density of tsetse was observed for *Glossina palpalis* gambiense and a 92% reduction for *G. tachinoides*. Based on findings, they concluded and suggested that tsetse flies could be suppressed efficiently but their elimination in the target deployment areas may require the use of integrated methods including the sterile insect technique. The challenge will remain the sustainability of the achievement. This may be due to the inconsistency of the intervention methods in this current study.

The findings of the impacts might have indicated that the low frequency of control intervention strategies applied for tsetse and trypanosomosis per year, higher level of vector-host contact, illegal use of treatment in suspected animals by owners, the dose of treatment chemicals for suspected animals and spot-on chemicals would be inappropriate, lower attentions given to control the mechanical vectors of the disease, less sustainability of the control interventions, the control strategies were unable cover wider areas, the higher distribution of the vectors, the impacts of Gilgel Gibe III hydroelectric power dam construction and not practicing of new methods of tsetse and trypanosomosis control interventions in the areas such as Sterile Insect Techniques (SIT), ground spray or air spray in wider areas and might be the use of lower numbers of impregnated targets and traps that were deployed in the studied each kebele before the time to estimate the tsetse density with the ongoing parasite and vector control programmes applied by National Tsetse and Trypanosomosis Investigation and Control Center.

The Pearson Correlation of +1 which indicates strong positive correlation of disease prevalence and apparent vector density. Both prevalence of trypanosomosis and apparent vector density indicated strong positive correlation in one direction so that when the vector density increases, then the disease prevalence also increases and vice versa. The disease prevalence on domestic ruminants and apparent density of vectors before the application of control methods refers to the retrospective data while after control methods belong to the current study data. The descriptive prevalence and apparent density before and after application of control interventions were indicated in tabulated (Table 3).

Table 3. The descriptive data of prevalence and apparent density before and after application of control interventions

Kebele	Animals species	Disease prevalence (%)		Apparent density (FTD)	
		Before control	After Control	Before control	After control
Tarcha Zuria	Bovine	14.50	23.4	0.843	4.60
	Ovine	0.04	19	0.047	4.60
	Caprine	0.03	0	0.00	4.60
Lala Genji	Bovine	8.926	23.5	0.743	5.80
	Ovine	0.03	0	0.044	5.80
	Caprine	0.05	11.1	0.00	5.80
Wara Wory	Bovine	16.00	33.3	0.142	5.93
	Ovine	0.020	4.8	0.00	5.93
	Caprine	0.10	16.7	0.410	5.93
Waruma Galcha	Bovine	10	29.4	0.054	5.73
	Ovine	0.03	0	0.005	5.73
	Caprine	0.030	0	0.0547	5.73
Gorika Bersa	Bovine	25	15.7	0.333	4.93
	Ovine	0.062	0	0.041	4.93
	Caprine	0.041	0	0.684	4.93
Abba Dahi	Bovine	7.140	17.6	0.397	5.20
	Ovine	0.082	0	0.00	5.20
	Caprine	0.140	0	0.410	5.20

The Questionnaire Study

The perception levels of farmers were evaluated during the questionnaire survey. The result indicated that about one hundred respondents (75.80%) have lived more than fifteen years in the study areas which indicated that they have good information about the status of the disease and its control methods that have been in application in the areas. About eighty-eight respondents (66.70%) replied that tethering was considered to be the management tool to reduce the exposure of their animals to the vector. In addition, eighty-nine respondents (67.40%) answered that the sources of trypanosomosis for their animals were believed to be both grazing land and watering points but twenty-two (16.70%) of the respondents reported that only grazing area was found to be the disease source for their animals while twenty-one (15.90%) of them replied that the source of disease was only watering points. The higher proportions of the respondents (76.50%) replied that the most common disease that affect their domestic ruminants were trypanosomosis and anthrax. These responses in relation to the disease trypanosomosis were in line with Seyoum *et al*. (2013), which was studied on farmers' perception of impacts of bovine trypanosomosis and tsetse fly in the selected districts in Baro-Akobo and Gojeb river basins, southwestern Ethiopia. Based on their results 94.1% of the respondents considered bovine trypanosomosis as an economically important cattle disease which accounted for 64.6% of the total annual deaths.

In the current study ninety-seven respondents (73.50%) answered that they know the disease trypanosomosis is transmitted by the vector tsetse fly, while twenty respondents (15.20%) reflected that the transmitter of trypanosomosis is tick. According to the respondents, the source of the tsetse flies were areas close to river and watering points (12.10%), grass lands and areas close to watering points (25%), grass lands and forests (30.30%), cultivated land and areas close to river and watering points (7.60%). The majority of farmers in the community reflected blood meal in resting time. Majority (57.60%) of the respondents replied the period in which tsetse heavily invading their animals was from June to August, December to February & April to May. These responses were in agreement with Kamuanga *et al.*, (2001) based on farmers responses the authors explained and concluded that the seasonality of the disease and its vectors in which the disease and vectors were in their peak risk months in May and June.

Table 4. The results of the questionnaire survey

No	Questions asked	No. of Respo-ndents	Responses	Percent (%)
1	Perception of owners of the animals about Trypanosomosis and its interventions	100	Knows well	75.80%
2	The management tools used locally by the owner to reduce the exposure of animals to Trypanosomosis	88	Tethering	66.70%
3	The Sources of Trypanosomosis for the animals under study	89	Grazing land and watering points	67.40%
4	The most common disease suffering the domestic ruminants	101	Trypanosomosis and anthrax	76.50%
5	The vector transmitting trypanosomosis	97	Tsetse fly	73.50%
6	Knowledge owners about the control interventions applied in the study areas	115	One or more	87.10%
7	The period on which tsetse heavily invading the animals	76	Months/ Seasons	57.60%
8	The common control interventions applied in the study area	99	Spot-on and treatment	75%
9	Evaluations of the control methods applied in the area	65	Greatly improved	49.24%

About 45.50% reflected that the major intervention methods familiar to the study areas were impregnated targets and traps, spot-on techniques, chemoprophylaxis and treating diseased animals and about 18.20% replied that only chemoprophylaxis and treating diseased animals are major intervention strategies common till up to date in practice. These findings were in agreement to Seyoum *et al.*, (2013), they concluded based on their findings that chemotherapy is the major method for combating the problem, mean frequency of treatment being 5.7 times per animal per year but the frequency of treatment of chemoprophylaxis was reported to be lower in this study.

For the evaluations of the impacts of the control intervention methods, sixty five respondents (49.24%) answered that the methods applied in their areas so far greatly decreased the disease prevalence and vector density while sixty one respondents (46.21%) replied that the methods applied in their area have no clear achievements. The results of the questionnaire surveys were in line with

Kamuanga *et al*., (2001) and Seyoum *et al.* (2013), they all based on the farmers' perception of impacts of bovine trypanosomosis and tsetse fly in selected districts in Ethiopia and Burkina Faso respectively indicated and concluded that the perception of farmers were increased to higher levels and there is a need to work together with famers to reduce the disease prevalence.

Conclusion and Recommendation

The present study showed the apparent density of tsetse and *Stomoxys* was found to be slightly high and has showed positive correlation to the higher disease prevalence. Despite the long-standing trypanosomosis control interventions in Dawuro zone, current study indicated that the trypanosomosis prevalence and its vector density are increasing. The findings of the questionnaire survey showed that livestock keepers were familiar with ruminant trypanosomosis, its vectors as well as the effect of the major control interventions applied in areas. Based on this conclusion, the following recommendations are forwarded. Appropriate control measure with better efficacy, air and ground sprays are needed to take in place. The control interventions of trypanosomosis that will be applied in the area should have to consider the potential risk factors of the disease before application. Standards should be set and sustainability of vector control interventions to avoid reinvasion by responsible professionals and a comprehensive nation wise evaluation of the impacts of applied trypanosomosis control interventions is strongly needed. The perceptions of farmers in the communities should be improved and an integrated approach with farmers should be followed for the application of trypanosomosis control interventions in the areas.

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