

Effect of insecticide treated nets fence in protecting cattle against tsetse and other biting flies in Arba Minch Zuria district, Southern Ethiopia

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Abstract

A field trial was carried out to assess the effect of insecticide treated net in protecting cattle from tsetse and other flies. A total of 35 pens were constructed, out of which 30 of them were fenced with insecticide treated net which served as treatment group and the remaining 5 pens were untreated controls. The fly populations around the pens were monthly monitored for five months using NGU traps deployed 5 m away from the cattle pens. The defensive movements of different body parts manifested by an animal for fly protections were observed for 5 minutes in each of the experimental and control groups. Additionally, other parameters such as packed cell volume, milk yield and body condition scores and buffy coat examination were investigated for both groups. Milk yield, body condition scores, packed cell volume (PCV) and data of defensive movements of animals were analyzed using linear model for longitudinal data or repeated measures by specifying time (monitoring cycles) and cattle as repeated variables. The result of this study showed that the overall proportion of fly catches was significantly lower in treated (38.3%) than control group (61.7%). Similarly, a significantly lower proportion of tsetse flies (28.4% versus 71.6%), biting flies (40.7% versus 59.3) and non-biting nuisance flies (39.7% versus 60.3%) compared to treatment. As a result, animals in treatment group had significantly lower average defensive movements of different body parts (7.84) compared to those in controls (16.37). All animals in both groups were negative for trypanosome infection and there was no significant difference in their mean PCV values. Significant variation was not observed in daily milk yield between cows in treatment (0.83 liter) and in controls (0.53 liter). Fly

densities had showed positive and negative relationships with defensive movements and PCV values over the monitoring time period, respectively. Body condition score of animals in the treatment group was also significantly higher ($p < 0.05$) than those in controls. In conclusion, deltamethrin treated netting was found to reduce the challenges of tsetse and other biting flies, and thus can contribute to improved performances of animals in treatment groups.

Keywords: Cattle; Fly protection; Insecticide treated net; Southern Ethiopia; Zero-grazing

Introduction

The lowlands of Ethiopia that constitute about 64% of the land mass of the country, and support about 12% of human and 30% of the livestock population of the country. The suitability of the lowland areas for agricultural activities is constrained by wide prevailing disease pathogens and their vectors which indeed hinders livestock production, and thus contributed to resource under utilization. Among the insect vectors, tsetse flies (*Glossina* species), which transmit the deadly livestock disease trypanosomosis, occupy large areas of lowlands of the country (Getachew Abebe, 2005; Reta Duguma *et al.*, 2015). In addition to challenges by tsetse flies, other biting flies can also be vector of diseases and cause irritation, stress and restlessness that compromise health status, body conditions and performances of the animals (Byford *et al.*, 1982; Baur *et al.*, 2011).

Tsetse flies invade vast areas of the fertile and well rain-fed lowlands of southwestern and northwestern regions of Ethiopia covering around 240, 000 km² with increasing invasion of new areas (Reta Duguma *et al.*, 2015). The low-lying of Ghibe and Omo watersheds are among the areas that are infested with tsetse and biting flies and remained underutilized for livestock production. So far, five species of *Glossina* (*G. m. submorsitans*, *G. pallidipes*, *G. tachinoides*, *G. f. fuscipes* and *G. longipennis*) have been recorded in Ethiopia and posing challenges to livestock production in the affected regions (Getachew Abebe, 2005). Alekaw Sinshaw *et al* (2006) reported various biting flies such as *Stomoxys*, *Tabanus*, *Chrysops*, *Haematopota* and *Atylotus*, and their potential role in the mechanical transmission of *Trypanosoma vivax*. However, unlike tsetse flies which were well studied, information regarding the population dynamics and adverse effects of other biting and nuisance flies on livestock production is rarely available for Ethiopia. In general, biting and nuisance flies can be

quite abundant in the warm lowland areas of the country causing considerable economic losses resulted from decreased milk production, decreased feed efficiency, reduced weight gains, and vector born related morbidity and mortality (Byford *et al.*, 1982).

Different control options that target parasite and vector controls or of innate resistance of the host have been in place for several decades. A vector control campaign has been launched since 1991 using a synthetic pyrethroid 'pour-on' insecticide applied monthly to cattle, which has subsequently, resulted in reduction of tsetse and other biting flies (Rowlands *et al.*, 1999). Thereafter, other methods such as traps and insecticide impregnated targets, and sterile insect techniques have been applied in battling against tsetse and trypanosomes. More importantly, the pyrethroid treated netting (Zero Fly livestock fence) has been recently introduced and being regarded as affordable by poor farmers, easy to transport and relatively safe for the user and the environment. Thus it can be used as an alternative tool to combat against fly challenges and vector born livestock diseases (Baur *et al.*, 2011; Maia *et al.*, 2012; Peck *et al.*, 2014).

Due to the prevailing shortage of grazing land and tsetse challenges, small holder livestock management in the study area is increasingly shifting from free ranging to zero grazing system. This scenario would help farmers to keep their livestock healthy and productive, and hence, protected against diseases that spread from contacts with affected animals. This also may pave way to use insecticide treated netting around cattle pen as an innovative option to reduce challenges from tsetse and other flies. Besides knocking down the flies that come in contact, the technology may also provide physical protection to the animals. It would eliminate tsetse, biting and other nuisance flies, and create conducive environment for small holder livestock farming under zero grazing system (Baur *et al.*, 2011; Maia *et al.*, 2012). Therefore, the aim of this study was to assess the protection of this technology and its applicability as an alternative method in combating against tsetse, biting and others nuisance flies, and hence, improving productivity.

Materials and Methods

Study area

The trial was conducted from November 2014 to April 2015 at Arba Minch Zuria district, Gamo Gofa Zone, Southern Ethiopia (Figure 1). The area has bimodal rainfall pattern, the short rain falls from March to April, and the long

rain from June to September. The annual rainfall is ranging from 800 to 1200 mm, and the mean annual temperature is 26.3°C. The district bordered by two rift valley lakes namely Lake Abaya and Lake Chamo. The district altitude is ranging from 1000 to 2500 m.a.s.l. (AZWDA, 2007). The study area has infestation with *Glossina pallidipes*, and biting flies like *Tabanus* and *Stomoxys* (Geja Gechere et al., 2012). Tsetse control is also being carried out in some Kebeles of the district by the Southern Tsetse Eradication Project.



Figure 1. Map of Ethiopia showing the study area (Study site indicated with star)

Study animals, study design and sampling procedure

The study animals were local zebu cattle above one year selected from extensive management system. A total of 35 households having cattle were recruited for field experiment, and 30 of them were assigned to treatment and the remaining five were considered as control groups. It worth noting that unbalanced groups were used as the control groups were reduced to minimum acceptable size for cost reason. Herds in treatment groups had a total of 78 animals while those in controls were 15 animals. The animals composed of 46 male and 47 female animals, of which 29 were lactating cows (i.e. 24 lactating

cows in treatment and five in controls). Herd selection was purposive, depending on the economic capacity of the farmers to keep their animals in zero grazing condition and their willingness to participate in the study. Name of owner, animal name and its characteristics such as sex, age, breed and coat colors were recorded at the beginning.

Field trials and data collection

Following the guideline of the company (Vestergaard Frandsen), a total of 35 identical cattle pens of 4m by 4m (16 m²) size with at least 2 animals holding capacity was constructed for the study. Those 30 pens allocated for experimental animals were fenced with 1 m-high net treated with insecticide (Deltamethrin), while the pen for the control group was left unfenced with net. Then each selected farmers were allowed to keep their animals in the prepared pens either in treatment or control groups. But calves were kept separately by the owners and not part of the treatment. The animals were monitored monthly for five repeated monitoring cycles during which defensive movements, blood sample collection for packed cell volume (PCV) and buffy coat test, milk yield and body condition score measurements were recorded.

Entomological monitoring was monthly conducted to investigate the presence and densities of tsetse and other flies using NGU trap. Acetone baited traps were deployed for 72 hours at a distance of five meters far from pens. Fly counts were recorded from each trap after 72 hours of deployment, and then their sex and genus (e.g. *Glossina*, *Tabanus*, *Stomoxys*, *Chrysops*, and non-biting *Musca*) were identified as described by Uilenberg (1998) and Pollock (1982). Since our focus was on flies, mosquitoes were not considered and recorded in this study. As flies land on animals, they cause biting, irritation and nuisance to animals in response of which defensive movements are produced. Then the defensive movements displayed by animals to protect themselves from flies were observed for 5 minutes on each of the animals in both treatment and control groups from 9:00 to 10:00 AM. The defensive movements were closely observed and recorded on selected body parts including head and ear movements, tail switching, skin ripples and leg kicks counts were recorded for each body parts. Accordingly, a repeated monthly data on defensive movements have been collected for five cycles.

Packed cell volume, milk yield and body condition scores were regarded as proxy indicators of performances of animals in both treatment and control

groups. Blood samples were collected to examine presence of trypanosomes and to determine Packed Cell Volume (PCV). Blood samples were aseptically collected by puncturing on the top margin of ear vein. Pair of capillary tubes were filled three fourth of their length. The capillary tubes were sealed by using crystal seal at one end. The blood in the capillary tube was centrifuged at 12,000 revolutions per minute (rpm) for five minutes. Subsequently, the PCV of each sample was determined by using a microhaematocrite reader and PCV less than 25% was designated as anemic (Murray *et al.*, 1977). The capillary tube was cut below the buffy coat intersection and then transferred on to a clean microscope slide for parasite examination.

Similarly, milk production of 29 lactating cows and body condition scores of all cattle in both treatment and control groups were recorded. The body condition score of the animals were assessed in each monitoring cycle based on the criteria described in Nicholson and Butterworth (1986). Accordingly, animals were considered as poor when they show marked emaciation, transverse process project prominent, spines appear sharply, individual dorsal spines are pointed to the touch, hips, tail, head and ribs are prominent. Whereas animals categorized under good body condition score were animals with smooth, well covered and heavy deposits of fat, which is clearly visible on tail, head, brisket, dorsal spines, ribs and hooks and as medium when they are found between the two. None of the animal was missed to follow throughout the monitoring cycles.

Data analysis

All collected data were entered into Microsoft Excel spread sheet, and then summarized by using descriptive statistics. Entomological data and body condition score were analyzed using Poisson regression test for longitudinal data (repeated measures). Milk yield, body condition scores, PCV and data of defensive movements of animals were analyzed using linear model for longitudinal data or repeated measures by specifying time (monitoring cycles) and cattle as repeated variables. Linear relationships between number of flies caught per traps and PCV as well as defensive movements of animals in pens adjacent to traps were plotted by graph. All data analyzes were performed using STATA version 11 software.

Results

Table 1 presents comparative entomological data between treatment and control groups. The Table presented the number of flies caught throughout the study averaged by number of traps for comparison between treatment and control groups. The study showed that control groups had higher average number (68 vs. 27) and proportions of tsetse flies (71.6% versus 28.4%), biting flies such as Tabanus and Stable fly (59.3 versus 40.7%) and non-biting nuisance flies (60.3% versus 39.7%) compared to treatment. Similarly, the average and total fly caught per trap, and each fly types caught in treatment were significantly lower than that of control group ($p < 0.05$).

Table 1. Poisson regression of longitudinal data of fly caught near treatment and control fences

Fly Groups	Treated	Control	Coef	P-value
	Average (%)	Average (%)		
Tsetse flies	27 (28.4)	68 (71.6)	1.68	0.000
Biting flies	44 (40.7)	64 (59.3)	1.07	0.006
Non-biting flies	202 (39.7)	307 (60.3)	1.11	0.000
Total flies	273 (38.3)	439 (61.7)	1.12	0.000

Trends of the fly data in the treated groups over the monitoring cycles showed that except for tsetse flies, the number of biting and other flies caught showed a gradual decrease during subsequent monitoring cycles and finally dropped in the 5th monitoring cycles (Figure 2). In contrast, the catches in control groups have showed no much change or slight increase for non-biting flies during the subsequent monitoring cycles. Similarly, the defensive movements of different body parts in response to fly challenges showed that animals in treatment group had displayed lower (7.84) overall movements than those in control group (16.37). In general, the movements displayed by each body parts in treated groups have progressively decreased during the successive monitoring cycles while increased trends have been observed over the monitoring cycles for control groups similar to trends in fly population. Since all animals in both treatment and control groups were negative for trypanosome infection on buffy coat examination, thus results were not presented.

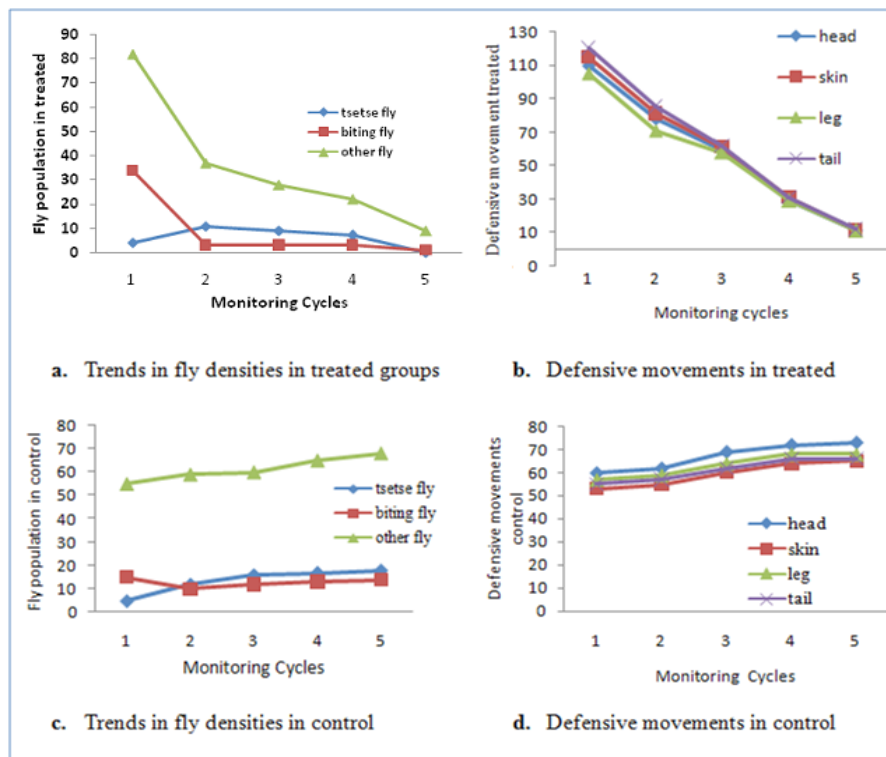


Figure 2. Trends in fly densities in (a) treated and (c) control groups, versus cattle defensive movements over monitoring cycles in (b) treated and (d) control groups

PCV values of animals in study groups were surprisingly lower than expected and did not differ significantly between treatments (25.9%) and control (25.4%) animals (Table 2). In particular, lower average PCV was observed during the first round of the study for the treatment groups, which might have affected the overall outcome. Similarly, milk yield recorded on small number animals also did not show difference between the groups when compared using t-test. Two variables that showed significant difference between treatment and control groups were body condition score and body movements shown by the animals. Accordingly, BCS of treatment groups were found to be better than untreated group. Similarly, animals in treatment groups displayed significantly lower average body movements compared to those in control groups.

Table 2. Comparative analysis of milk yield, packed cell volume (PCV), body condition score (BCS), defensive movements (DM) of various body parts between treatment and control groups

Defensive movements ^a	Treated		Control		Coefficient	P-Value
	Mean	Sd	Mean	Sd		
Milk yield	0.83	0.40	0.53	0.40	1.43	0.082
PCV	25.94	4.43	25.36	4.43	-0.56	0.457
BCS**	2	1 – 3	3	1 – 3	-7.898	0.000
Defensive movements						
Head and ear	1.91	1.75	4.48	0.89	0.86	0.000
Skin	1.99	1.64	3.96	1.41	0.69	0.000
Legs	1.83	1.68	4.21	1.21	0.84	0.000
Tail	2.07	1.66	4.08	1.10	0.68	0.000
Total DM	7.84	5.54	16.37	3.76	0.73	0.000

^aDefensive movement is the number (count) of a respective body movements per minute displayed by animals in response to fly landing on animal or biting.

Defensive movements of different body parts of the animals have reflected the trends in fly population around the animal fences. There was also a strong positive relationship between the total mean defensive movements and fly population of pooled data of treated and control group (Figure 3). But a negative linear relationship was observed between fly catches by adjacent to traps and PCV of study cattle in respective pens.

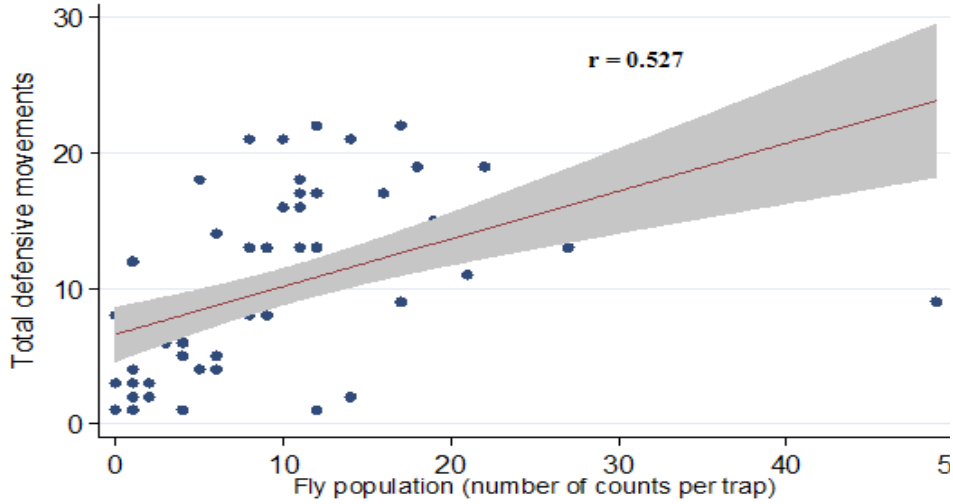


Figure 3. A positive linear relationship between fly catches and cattle defensive movements in pens adjacent to traps (pooled data).

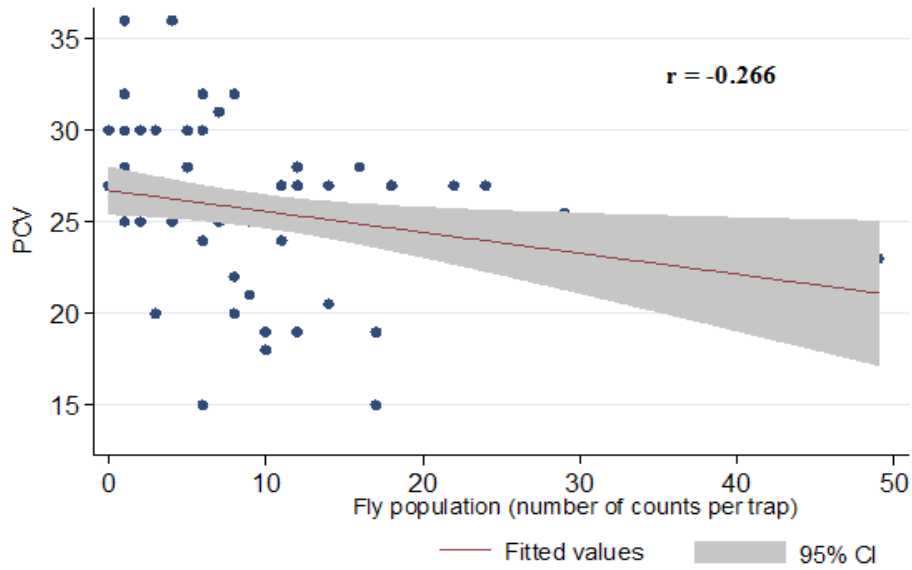


Figure 4. A negative linear relationship of fly catches with PCV of study cattle in pens adjacent to traps using pooled data.

Discussion

Fly catches showed that the total number of flies (tsetse, biting and other nuisance flies) in treated group had progressively reduced over the monitoring cycles compared to that of control group. As a result, treatment has significantly lowered the number of fly caught (i.e. by 60% for tsetse, 32% for biting and 34% for other nuisance flies) over the monitoring period. This reveals the effects of insecticide treated net fence in reducing fly population and their challenges near the protected fence. This finding is also in line with the works of Maia *et al* (2010) and Bauer *et al* (2006) who reported similar effects from Ghana and Kenya, respectively. Lower total counts of defensive movements of different body parts among animals in treatment (7.8) compared to those in control groups (16.4) reflected a reduction of fly population and their challenges in the treatment groups. This was further substantiated by a strong positive linear relationship between number of flies caught by traps adjacent to pens and total defensive movements of body parts. Accordingly, animal disturbances and restlessness have been decreased over the monitoring periods in treatment groups and vice versa for controls. Similarly, Maia *et al* (2010) reported reduction of the average defensive movement in treated group by 81% compared to those animals in untreated group. The same authors also observed fewer disturbances of feed uptake and resting among animals in treatment than animals in control groups. This suggests that animals in treatment group remained safe, stable and less disturbed compared to those animals in controls.

The observed low PCV, which is close to anemia in both treatment and control groups and negative result for trypanosome in control groups, is surprising and unclear. Low PCV could be brought about by the prevailing feed shortage in the study area coupled with the effects of other helminth parasites. There could be possibility of undetected trypanosomosis given the suboptimal sensitivity of the buffy coat, or reduced chances of infection of animals which are none free ranging and kept in enclosures around home stead. This finding could be influenced by the impacts of treatment practices by livestock owners themselves as well as the tsetse control practices being carried out by STEP. There was no significant variation in the mean PCV values between treatment (25.94%) and controls (25.36%). Unlike our findings, Geja Gechere *et al* (2012) observed a significant difference in PCV between tsetse controlled (30.5) and uncontrolled areas (28.4) in Arba Minch Zuria district. The same authors also reported trypanosomes in calves from uncontrolled areas, but they did not detect trypanosomes in tsetse-controlled areas.

In the present study, existence of a negative linear relationship between mean PCV values and outside catches indirectly suggests the adverse effects of flies on PCV. Bauer *et al* (2011) reported a significantly lower incidence of trypanosome infections and thus higher PCV in animals protected by Zero fly fences than in controls. Apart from their role in transmission of Trypanosomes, tsetse and other biting flies can cause high level of annoyance and blood loss, and affect feeding patterns of animals, thus resulting in reduced weight gain, decreased milk production, and animal performances (Byford *et al.*, 1982; Mullens *et al.*, 2006). Likewise, the result of body condition scores indicate that median value of body condition score of animals in treatment is significantly better than that of unprotected animals similar to the findings of Catangui *et al* (1993). Findings of this study confirmed that the use of insecticide treated net increases protection against biting flies and thereby improves the body conditions and overall production performances of the animals.

In a study by Taylor *et al* (2012) the annual production losses per animal were estimated to be 139 kg of milk for cows, and 6, 26, and 9 kg body weight loss for preweaning calves, pastured stockers, and feeder cattle, respectively. Similarly, this study found a slight increment of milk yield by 56% in treatments compared to controls. But this was not significant due to small number of animals included in the study. Mullens *et al.* (2006) have also reported prevention of milk loss through controlling nuisance flies.

In conclusion, tsetse and biting flies have been contributing to reduced production and productivity of the livestock sector in Ethiopia. Thus, various vector and parasite control efforts have been made over the last several decades and resulted in some success histories. Use of insecticide treated netting therefore adds up on those efforts in combating against tsetse and other biting flies. Results of this study revealed that use of insecticide treated net around livestock fence has showed better protection of cattle against biting flies, thus reduced animal disturbances and contributed to improved body conditions of the animals. This technology also suits the local condition of land shortage where few animals are kept with zero grazing system or tethering. Further study on economic feasibility and the long term effects of this technology on production and reproduction parameters should be carried out for further promotion of this technology.

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