Tropical Animal Health and Production (2021) 53:309
https://doi.org/10.1007/s11250-021-02752-w

REGULAR ARTICLES

# Knowledge, attitudes and practices on bovine trypanosomosis control in pastoral and agro pastoral communities surrounding Murchison Falls National Park, Uganda

Daniel Kizza[1] · Michael Ocaido[2] · Anthony Mugisha[1] · Rose Azuba[1] · Sarah Nalule[2] · Howard Onyuth[2] · Simon Peter Musinguzi[3] · Sylvia Nalubwama[1] · Charles Waiswa[4]

Received: 10 February 2021 / Accepted: 2 May 2021


## Abstract

A mixed method survey was conducted among pastoral and agro pastoral communities surrounding Murchison Falls National Park, Uganda to assess knowledge, attitudes and practices about control of bovine trypanosomosis. A total of 96.8% ($n = 152$) of the participants had seen tsetse flies, and close to 91.7% ($n = 116$) of the participants had heard about bovine trypanosomosis. Bovine trypanosomosis was reported as a major disease in their area by about 73.9% ($n = 116$). There was a significant difference ($P < 0.05$) in the level of awareness and perception about tsetse and bovine trypanosomosis across the study sub counties. The majority of the farmers (60.5%) stated that grazing near national parks was the main cause of bovine trypanosomosis. A small proportion of farmers associated sharing grazing land and watering points with wildlife (19.1%) and grazing cattle in tsetse fly-infested areas (8.3%) as the causes of trypanosomosis. The communities in the study sub counties were aware of at least one or two clinical signs of bovine trypanosomosis. Spraying cattle with insecticide and avoiding grazing animals in tsetse-infested areas were the control practices. Curative trypanocides were mainly used to treat their cattle against trypanosomosis. Bush clearing, targets and traps as tsetse fly control measures were less practiced by the farmers. Treatment of cattle was based on observation of clinical signs due to absence of blood diagnostic facilities. Implementing regular tsetse fly population monitoring surveys and promotion of disease rapid diagnostic tools at farm level as long-term strategies are key for effective control of the disease.

**Keywords** Bovine trypanosomosis · Murchison Falls · Knowledge · Practices · Attitudes

✉ Daniel Kizza
danielkizza8@gmail.com; daniel.kizza@mak.ac.ug

Michael Ocaido
mocaido2@gmail.com; michael.ocaido@mak.ac.ug

Anthony Mugisha
anthony.mugisha@mak.ac.ug

Rose Azuba
roseazuba@gmail.com

Sarah Nalule
snalule@gmail.com

Howard Onyuth
onyuthhoward@gmail.com

Simon Peter Musinguzi
spmusinguzi@kab.ac.ug

Sylvia Nalubwama
drnalubwama@gmail.com

Charles Waiswa
charles.waiswa@mak.ac.ug; hhsltd@yahoo.com

1 Department of Livestock and Industrial Resources, College of Veterinary Medicine Animal Resources and Biosecurity, Makerere University, Kampala, Uganda

2 Department of Wildlife, Aquatic and Animal Resources, College of Veterinary Medicine Animal Resources and Biosecurity, Makerere University, Kampala, Uganda

3 Department of Animal Sciences, Faculty of Agriculture and Environmental Sciences, Kabale University, Kabale, Uganda

4 Department of Veterinary Pharmacy, Clinical and Comparative Medicine, College of Veterinary Medicine Animal Resources and Biosecurity, Makerere University, Kampala, Uganda

Published online: 07 May 2021

## Background of study

Animal trypanosomosis is a major limitation for cattle production causing a threat to household food security and livelihoods in pastoral and agro pastoral (PAP) regions. The disease causes huge economic losses to cattle industry by causing mortality, reduction in milk and weight gain, high control and treatment costs (Cox et al. 2010). Areas with high tsetse fly presence and bovine trypanosomosis (BT) prevalence limit cattle production, and farmers often survive by abandoning cattle rearing relying on only crop production (Holt et al. 2016). In addition, the disease also affects crop production due to reduced traction power and production of manure as fertilizers (Kristjanson et al. 1999).

In sub Saharan Africa, it is projected that US $4.75 billion is lost annually due to BT (Van den Bossche et al. 2010).

Uganda has been one of the worst hit countries in sub Saharan Africa with African trypanosomes accounting for over 50% of reported *Trypanosoma.brucei rhodesiense* cases between 2000 and 2009 (Simarro et al. 2010). Although *T.b. rhodesiense* affects humans, cattle play an important role as a reservoir host for the humans. According to the Coordinating Office for Control of Trypanosomiasis in Uganda (COCTU), about 70% of the whole country is estimated to be infested with tsetse flies (Albert et al. 2015). The “tsetse belt fly” stretches from the highlands in South-Western Uganda across Lake Kyoga through to North Eastern Uganda. Areas around Murchison Falls National Park occupied by pastoral communities are heavily infested by tsetse flies (Angwech et al. 2015) with high prevalence of trypanosomosis among their cattle. Hence, control of bovine trypanosomosis in this area has remained a challenge. It is against this background that this study was designed to understand cattle owners’ attitudes, knowledge, perceptions and practices in control of bovine trypanosomosis. This is critical in that locally sustainable adapted control programs can be designed for this area (Mwaseba and Kigoda 2017; World Health Organization 2008; Malulu et al. 2017).

## Methods

### Study area description

The study was conducted in Buliisa district located at 02 11 N 31 24 E neighboring Murchison Falls National Park (MFNP) (details were as shown in Fig. 1). Buliisa was purposively selected due to its location in the cattle corridor and its proximity to Murchison Falls National Park. It is also part of the Albertine Graben where oil and gas have been discovered and explorations are currently going on. The adverse environmental effect of oil and gas extraction is likely to affect cattle production as it can distort cattle grazing routes and reduction of grazing land in the district. The district is bordering Nebbi district in North West, Nwoya district in North East, Masindi district in East and Hoima district in the South and Lake Albert in the West. Bugungu wildlife reserve which is part of Murchison Falls National Park is located in Buliisa district. The socio-economic activities in the district include pastoralism, agro pastoralism, fishing and subsistence crop agriculture. The district experiences a bimodal type of climate with two rainy seasons (March to May and August to November), and the vegetation is classified into forest, savannah, grassland and swamp. The forest vegetation includes Budongo forest, while savannah vegetation comprises perennial grasses, scattered trees and shrubs. Murchison Falls National Park and Bugungu Game reserve contribute to grassland and woodland cover. According to the Uganda Bureau of Statistics (UBOS, 2014), the total human and cattle populations in Buliisa district were 113,161 and 34,800 respectively.

### Study design and sampling

A cross-sectional survey was conducted from January to April 2020 using mixed study design through conducting focus group discussions and administration of structured questionnaires. Preliminary reconnaissance visit was done to the study area through the Coordinating Office of Trypanosomosis Control in Uganda (COCTU) to Buliisa District. The District Production Office (DPO) and District Veterinary Office (DVO) were contacted. During this visit, discussions were held with local government extension staff and relevant stakeholders about the study objectives. Acquaintance with study sites was made. The DVO contacted the sub county Veterinary and Animal Husbandry Extension staff who facilitated the identification of study sites. Sub counties of Biiso, Buliisa, Butiaba, Kigwera and Ngwedo were visited and study sites selected. Qualitative data was collected through focus group discussion (FGD) using a checklist of questions. Three FGDs were conducted with cattle farmers from the sub counties of Biiso, Ngwedo and Kigwera. Each FGD constituted 10–12 participants, both men and women. Participation in FGDs was voluntary, and responses were recorded anonymously. At the end of the three FGDs, data saturation was achieved. Key informant interviews were conducted with the District Veterinary Officer, District Entomologist, District Production Officer, Local Council leader and Sub County Veterinary officer. The discussions and interviews collected information on knowledge about trypanosomosis, attitudes towards importance of trypanosomosis in their community, presence of human and livestock cases of trypanosomosis, factors that contribute to persistence of trypanosomosis, the livestock species affected, the age and breed of livestock most susceptible, the clinical signs that livestock exhibit, drugs used and at what dose, control practices used at the farm and if there were human cases of trypanosomosis. The information collected from participatory methods was reinforced by administration of detailed structured questionnaire.

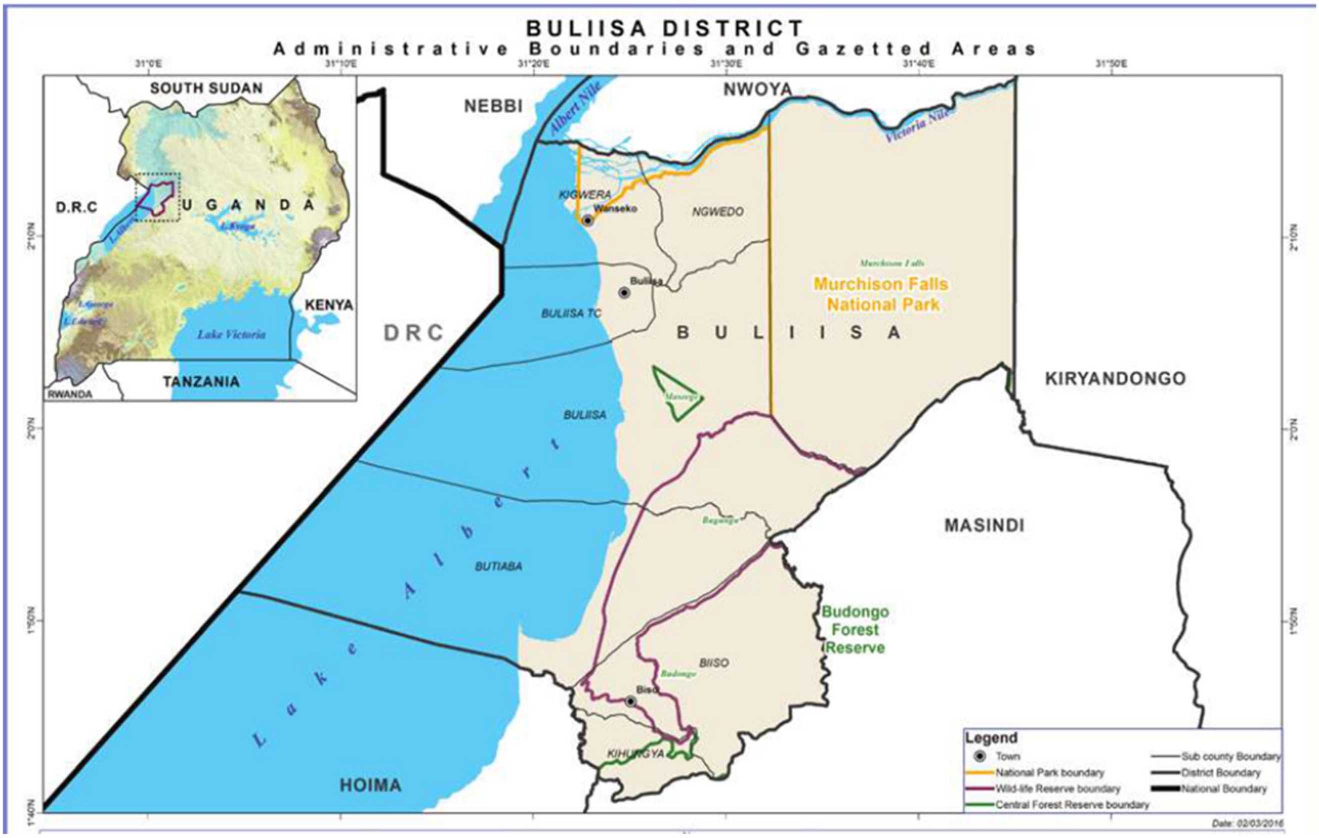


**Fig. 1** Map showing the location of the study area

The sample size was estimated using the following formula:

$$n = \frac{(Z)^2 pq}{e^2}$$

where $n$ = sample size, $Z$ = $Z$ value 1.97 at 95% confidence level, $e$ = desired level of precision (5%), $p$ = estimated proportion of an attribute that is present in the population − prevalence of 41% trypanosomosis in Nwoya and Amuru (Angwech et al. 2015) and $q = 100 - p$ (Israel 2012).

A total of 157 respondents were sampled from 5 sub counties of Buliisa district. The number of cattle keeping households that participated from sub counties was distributed as shown in Table 1.

The participating households were purposively selected. The selection criteria of study participants considered being a cattle farmer and voluntarily consenting to participate in the study. The respondents were drawn from the list of cattle keepers provided by local leaders and veterinary extension staff in each sub county. The questionnaire administered to respondents was translated from English to Runyoro by Makerere University Centre for Languages and Communication Services.

Data was collected and collated from the questionnaire. Descriptive statistics were generated, and the chi- square test was used across the sub counties to identify both the most significant positive and negative aspects of knowledge, attitudes and practices towards bovine trypanosomosis using Microsoft Excel and Statistical Package for Social Scientist (SPSS) IBM version 20. The difference in socio-demographic characteristics was analyzed across the overall percentages. Qualitative information from both focus group discussions and interviews was analyzed using QDA Miner lite version 2.0.8 and organized into codes and themes.

**Table 1** Distribution of participants interviewed per sub county of study

| Sub county | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo |
|---|---|---|---|---|---|
| Number | 22 | 51 | 26 | 29 | 29 |

## Results

### Socio-demographic characteristics of participants

The percentage of socio-demographic characteristics of participants are shown in Table 2.

**Table 2** Socio-demographic characteristics of participants

| Variables | Sub counties | | | | | Overall | $\chi^2$ value *P* value |
|---|---|---|---|---|---|---|---|
| | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo | | |
| Gender | | | | | | | |
| Female | 27.3 | 5.9 | 15.4 | 0.0 | 6.9 | 9.6 | $\chi^2 = 103$ |
| Male | 72.7 | 94.1 | 84.6 | 100 | 93.1 | 90.4 | $P < 0.05$* |
| Education level | | | | | | | |
| Primary | 36.4 | 56.9 | 42.3 | 41.4 | 62.1 | 49.7 | $\chi^2 = 114$ |
| O-level | 40.9 | 23.5 | 34.6 | 31 | 20.7 | 28.7 | $P < 0.05$* |
| A-level | 9.1 | 3.9 | 15.4 | 20.7 | 3.4 | 9.6 | |
| Tertiary | 9.1 | 5.9 | 7.7 | 6.9 | 6.9 | 7 | |
| No formal education | 4.5 | 9.8 | 0.0 | 0.0 | 6.9 | 5.1 | |
| Land tenure | | | | | | | |
| Customary | 4.5 | 3.9 | 57.7 | 0.0 | 58.6 | 22.3 | $\chi^2 = 193$ |
| Rented | 13.6 | 2.0 | 3.8 | 0.0 | 3.4 | 3.8 | $P < 0.05$* |
| Leased | 9.1 | 2.0 | 3.8 | 0.0 | 0.0 | 2.5 | |
| Private/bought | 13.6 | 0.0 | 3.8 | 0.0 | 37.9 | 9.6 | |
| Institutional | 13.6 | 0.0 | 3.8 | 3.4 | 0.0 | 3.2 | |
| Communal | 45.5 | 92.2 | 26.9 | 96.6 | 0.0 | 58.6 | |
| Record keeping | 22.7 | 31.4 | 38.5 | 75.9 | 55.2 | 43.9 | $\chi^2 = 2.29$ |
| | | | | | | | $P = 0.127$ |

*Denotes statistical significance at the 5% level

The majority of the participants in the study were males. The education level of respondents was mainly primary education followed by secondary education. Communal and customary were the major land tenure systems found in the study area. Record keeping was practiced by a fair proportion of the participants (Table 2). The percentage households (H/h) age category distribution was as shown in Table 3. The average cattle and goat herd sizes were 34 ± 3.4 and 14 ± 1.6 respectively. The household land holding in acres was found to be 24 ± 4.42.

The participants of the FDGs were residents of Kigwera, Ngwendo and Biiso sub counties, and the males were 58%. They were aged between 30 and 65 years with about 80% aged less than 50 years.

The household age category constituted more children and teenagers combined (65%) compared to adults (35%).

**Table 3** The percentage household age category distribution

| Age category | Percentage |
|---|---|
| Male children < 7 years | 16.8 |
| Male teenager 8–18 years | 17.7 |
| Male adults | 17.2 |
| Female children < 7 years | 15.7 |
| Female teenagers 8–17 years | 14.9 |
| Female adults > 18 years | 17.8 |

The percentage of communities' awareness and perception (attitude) towards tsetse flies and BT are shown in Table 4.

The results showed that most farmers had ever seen or heard of tsetse flies, knew bovine trypanosomosis and sleeping sickness were transmitted by tsetse flies and had heard of Bovine trypanosomosis. Furthermore, the majority of cattle keepers were aware about the presence of tsetse flies, bovine trypanosomosis as a major disease in cattle and human sleeping sickness caused by tsetse flies. Bovine trypanosomosis was a major livestock disease (Table 4). There were significant differences ($P < 0.05$) in the level of awareness and perception about tsetse and bovine trypanosomosis across the sub counties.

The FDG participants mentioned tick-borne diseases and bovine trypanosomosis as the two most important animal diseases in the study area.

The risky areas where cattle could encounter tsetse flies were reported by 33.1% ($n = 52$) of the households as grazing near national park, along rivers by 23.6% ($n = 37$), in bushes and forests by 33.8% ($n = 53$) and in savannah bushes and shrubs by 9.6% ($n = 15$). There was a significant difference ($P < 0.05$) in farmers' perception on the risky areas, and the difference can be associated to the variation in the environment which *Glossina* species inhabit. *Glossina* species are grouped into three main groups based on the environment they live in: riverine (*palpalis*), savannah (*morsitans*) or forest-dwelling tsetse (*fusca*).

**Table 4** Percentage of participants' awareness and perception about tsetse and bovine trypanosomosis

| Variables | Sub counties | | | | | Overall | $\chi^2$ value<br>*P* value |
|---|---|---|---|---|---|---|---|
| | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo | | |
| Ever seen or heard of tsetse flies | 100 | 98 | 92.3 | 96.6 | 96.6 | 96.8 | $\chi^2 = 17$<br>$P = 0.002$* |
| BT transmitted by tsetse flies | 100 | 86.3 | 88.5 | 96.6 | 96.6 | 92.4 | $\chi^2 = 11$<br>$P = 0.029$* |
| Human sleeping sickness transmitted by tsetse flies | 90.9 | 74.5 | 80.8 | 55.2 | 75.9 | 74.5 | $\chi^2 = 13$<br>$P = 0.015$* |
| Ever heard about BT | 90.9 | 92.2 | 88.5 | 89.7 | 96.6 | 91.7 | $\chi^2 = 16$<br>$P = 0.004$* |
| BT is a major livestock disease | 81.8 | 90.2 | 80.8 | 27.6 | 79.3 | 73.9 | $\chi^2 = 34$<br>$P < 0.05$* |

*Denotes statistical significance at the 5% level

During the FGD, participants reported that the presence of tsetse flies was a major risk of infection expressed by participants. Most farmers reported that grazing their animals close to the national park pre-disposed their cattle to trypanosomosis infection. Asked to further explain the disease pattern, the farmers said that during the dry season there is scarcity of pastures and animals are grazed in distant places from their households where the animals got exposed to the disease vectors and infections.

## Communities' knowledge about causes of BT

Communities' knowledge (%) about causes of bovine trypanosomosis are presented in Table 5.

It is apparent from Table 5 that the majority of farmers were aware that grazing near the park was the major cause of infection of bovine trypanosomosis. Very few farmers reported that not controlling tsetse flies, sharing water and grazing areas with wildlife, grazing in tsetse-infested areas and keeping trypano-susceptible cattle (0.6%) were additional causes of bovine trypanosomosis infection.

The FGD participants stated that most participants said adult cattle were most susceptible to trypanosomosis infection compared to calves. Another participant mentioned the reason why adult cattle were more susceptible compared to young cattle was the fact that adult cattle grazed at distant places and were exposed to high risk while calves grazed around households that are less risky areas.

The percentage of communities' knowledge about transmission of bovine trypanosomosis are shown in Table 6.

The results (Table 6) revealed that the majority of the farmer did not know that bovine trypanosomosis could be transmitted by tsetse flies biting cattle (infectivity of tsetse flies), failure of the cattle immune system and grazing in tsetse fly-infested areas.

The percentage of communities' knowledge about signs and symptoms of bovine trypanosomosis are presented in Table 7.

**Table 5** Percentage of communities' knowledge on the causes of BT

| Causes of trypanosomosis | Sub counties | | | | | | $\chi^2$ value<br>*P* value |
|---|---|---|---|---|---|---|---|
| | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo | Overall | |
| Grazing near the national park | 59.1 | 58.8 | 57.7 | 48.3 | 79.3 | 60.5 | $\chi^2 = 11$<br>$P = 0.023$* |
| Not controlling the tsetse flies | 4.5 | 2 | 15.4 | 24.1 | 17.2 | 11.5 | $\chi^2 = 7$<br>$P = 0.109$ |
| Sharing grazing land and watering points with wildlife | 36.4 | 21.6 | 15.4 | 20.7 | 3.4 | 19.1 | $\chi^2 = 10$<br>$P = 0.046$* |
| Grazing in tsetse-infested areas | 0 | 17.6 | 11.5 | 3.4 | 0 | 8.3 | $\chi^2 = 19$<br>$P = 0.000$* |
| Keeping trypano-susceptible breeds of cattle | 0 | 0 | 0 | 3.4 | 0 | 0.6 | $\chi^2 = 4$<br>$P = 0.406$ |

*Denotes statistical significance at the 5% level

**Table 6** Communities' knowledge (%) about transmission of BT

| Variable | Sub counties | | | | | | $\chi^2$ value *P* value |
|---|---|---|---|---|---|---|---|
| | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo | Overall | |
| Cattle fed on by tsetse flies | 22.7 | 21.6 | 19.2 | 44.8 | 51.7 | 31.2 | $\chi^2 = 9$ $P = 0.07$ |
| Cattle fed on by tsetse flies with disease pathogens | 40.9 | 41.2 | 19.2 | 6.9 | 34.5 | 29.9 | $\chi^2 = 22$ $P = 0.00$* |
| Failure of cattle immune system | 9.1 | 9.8 | 7.7 | 13.8 | 0 | 8.3 | $\chi^2 = 6$ $P = 0.211$ |
| Grazing in tsetse fly-infested area | 27.3 | 27.5 | 53.8 | 34.5 | 13.8 | 30.6 | $\chi^2 = 9$ $P = 0.069$ |

*Denotes statistical significance at the 5% level

The results (Table 7) suggested that generally the communities were ignorant of the clinical signs and symptoms of bovine trypanosomosis. However, interestingly, the majority of farmers in Biiso were aware of intermittent fevers, farmers in Ngwedo were aware of emaciation and farmers in Buliisa were aware of rough coat as major signs and symptoms of the disease.

In contrast, participants in the FGDs reported weight loss, decreased appetite, progressive loss of condition and progressive emaciation as signs of the disease. One farmer mentioned that "when my animal gets infected with trypanosomosis, it lacks energy and enthusiasm".

The percentage of households that use different control practices of bovine trypanosomosis are presented in Table 8.

In Table 8, it was clear that the majority of farmers knew that spraying cattle with insecticide could control bovine trypanosomosis except in Butiaba sub county. The results also showed most farmers in Butiaba Sub county thought avoiding grazing areas in tsetse-infested areas was a control strategy for bovine trypanosomosis. The results indicated that majority of the farmers did not practice bush clearing, use insecticide impregnated traps and targets and keep trypano-tolerant cattle breeds as control practices of bovine trypanosomosis.

The participants from the FGDs mentioned that tsetse flies were controlled through spraying using insecticides like Duodip, Norotraz, Almatix, Vectocid and Amitraz. Participants reported that there was no animal diagnostic laboratory within the study area, and diagnosis was mainly based on observable clinical signs.

The control practices mentioned by the participants during the FGDs included spraying their animals using insecticide and avoiding grazing their animals in high-risk areas like close to forests and near the national park. Farmers stated that areas close to forests had a high tsetse fly population compared to areas away from forests. One female participant mentioned that "I am keeping indigenous breed of cattle because they

**Table 7** Communities' knowledge about signs and symptoms of bovine trypanosomosis

| Signs of trypanosomosis | Sub counties | | | | | | $\chi^2$ value *P* value |
|---|---|---|---|---|---|---|---|
| | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo | Overall | |
| Emaciation | 9.1 | 11.8 | 57.7 | 37.9 | 62.1 | 33.1 | $\chi^2 = 16$ $P = 0.002$* |
| Intermittent fevers | 81.8 | 15.7 | 11.5 | 17.2 | 6.9 | 22.9 | $\chi^2 = 23$ $P = 0.000$* |
| Rough coat | 4.5 | 52.9 | 15.4 | 31.0 | 27.6 | 31.2 | $\chi^2 = 42$ $P < 0.05$* |
| Diarrhea | 4.5 | 19.6 | 3.8 | 3.4 | 3.4 | 8.9 | $\chi^2 = 23$ $P = 0.000$* |
| Anemia | 0 | 0 | 11.5 | 3.4 | 0 | 2.5 | $\chi^2 = 9$ $P = 0.074$ |
| Circling movement | 0 | 0 | 0 | 6.9 | 0 | 1.3 | $\chi^2 = 8$ $P = 0.091$ |

*Denotes statistical significance at the 5% level

**Table 8** Percentage of households using different control practices of bovine trypanosomosis

| Control practices | Sub counties | | | | | | $\chi^2$ value $P$ value |
|---|---|---|---|---|---|---|---|
| | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo | Overall | |
| Bush burning/clearing | 4.5 | 5.9 | 15.4 | 6.9 | 13.8 | 8.9 | $\chi^2 = 2.4$ $P = 0.657$ |
| Spraying cattle with insecticide | 59.1 | 74.5 | 11.5 | 75.9 | 55.2 | 58.6 | $\chi^2 = 36$ $P < 0.05$* |
| Not grazing in areas infested with tsetse | 36.4 | 9.8 | 65.4 | 13.8 | 17.2 | 24.8 | $\chi^2 = 15$ $P = 0.005$* |
| Keeping trypano-tolerant cattle breeds | 0 | 3.9 | 7.7 | 3.4 | 3.4 | 3.8 | $\chi^2 = 2.3$ $P = 0.675$ |
| Using insecticide impregnated traps/targets | 0 | 5.9 | 0 | 0 | 10.3 | 3.8 | $\chi^2 = 9$ $P = 0.061$ |

*Denotes statistical significance at the 5% level

can tolerate the trypanosomosis infection compared to exotic or cross bred cattle". When asked how tsetse flies could be controlled before biting their animals and transmitting infection, one farmer said "I have heard that there are traps that are used to attract and trap tsetse flies but in this area these traps are not available and I don't know where farmers can get them".

Participants during the FGDs described that the use of trypanocides in combination with antibiotics and insecticide was the major approach used to control trypanosomosis within their herds. The most common trypanocides used were Diaminazine Aceturate and Isometamidium Chloride (Veridium), while Tetracycline® and Penicillin and Streptomycin ® were the most common antibiotics used. Trypanocides and antibiotics were commonly administered by animal owners or their family members.

The percentage of households using treatment and preventive methods for controlling bovine trypanosomosis are shown in Table 9.

As Table 9 shows, most farmers stated using curative trypanocides to treat their cattle against trypanosomosis. There was minimal use of veterinarians to administer treatment to susceptible sick animals, and a small proportion of farmers used prophylactic trypanocides as a preventative approach.

Results from FGD revealed that participants mention Samorin, Veridium and Trypamidium as the common drugs in treatment of bovine trypanosomosis. These drugs were purchased from local veterinary drug shops, constituted and administered by the farmers themselves. The dosage administered to animals was estimated based on the age and body weight. The estimated dosage ranged from 0.25–1 to 0.5–1 mg/kg.

The percentage of communities' information source before administering treatment are shown in Table 10.

In Table 10, the majority of farmers in Biiso, Buliisa and Ngwedo relied on clinical sign for diagnosis of bovine trypanosomosis infection. In contrast, few farmers relied on

**Table 9** Percentage of households using treatment and preventive methods of cattle

| Variable | Sub counties | | | | | | $\chi^2$ value $P$ value |
|---|---|---|---|---|---|---|---|
| Treatment | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo | Overall | |
| No treatment | 0 | 2 | 7.7 | 0 | 6.9 | 3.2 | $\chi^2 = 4$ $P = 0.406$ |
| Local indigenous herbs | 0 | 3.9 | 15.4 | 20.7 | 0 | 7.6 | $\chi^2 = 11$ $P = 0.023$* |
| Curative trypanocides | 72.7 | 72.5 | 57.7 | 65.5 | 72.4 | 68.8 | $\chi^2 = 15$ $P = 0.002$* |
| Prophylactic trypanocides | 13.6 | 21.6 | 11.5 | 13.8 | 13.8 | 15.9 | $\chi^2 = 9$ $P = 0.056$ |
| Use of veterinarians | 13.6 | 0 | 7.7 | 0 | 6.9 | 4.5 | $\chi^2 = 5$ $P = 0.273$ |

*Denotes statistical significance at the 5% level

**Table 10** Communities' information sources (%) before administering treatment

| Information source | Sub counties | | | | | | $\chi^2$ value $P$ value |
|---|---|---|---|---|---|---|---|
| | Biiso | Buliisa | Butiaba | Kigwera | Ngwedo | Overall | |
| Farmers' observation of clinical signs | 77.3 | 92.2 | 57.7 | 58.6 | 82.8 | 76.4 | $\chi^2 = 30$ $P < 0.05$* |
| Blood diagnosis | 13.6 | 2 | 11.5 | 6.9 | 3.4 | 6.4 | $\chi^2 = 2$ $P = 0.735$ |
| Veterinarians' observation of clinical signs | 4.5 | 0 | 30.8 | 31 | 13.8 | 14 | $\chi^2 = 15$ $P = 0.005$* |
| Tsetse flies on animal's body | 4.5 | 5.9 | 0 | 3.4 | 0 | 3.2 | $\chi^2 = 6$ $P = 0.199$ |

*Denotes statistical significance at the 5% level

blood diagnosis before treatment probably due to absence of diagnostic facilities in the study area. The use of veterinarians' observation of clinical signs was reported by few farmers, and there was no tsetse fly surveillance and monitoring system in the study area.

The most cattle age group most affected by trypanosomosis were adults (83%) with the sub adult (9%) and calves (8%) reported by the households.

All the participants during focus group discussion confirmed that in their households and in their immediate neighborhood, they had not experienced or heard of cases of human trypanosomosis in the last 6 months.

## Discussion

From this study (Table 4), it was clearly evident that majority of the farmers had ever seen tsetse flies and had ever heard about bovine trypanosomosis within their area with significant differences among the sub counties. These results suggested that the sub counties were experiencing different magnitude of bovine trypanosomosis burden within the agro pastoral and pastoral communities around MFNP. The majority of study participants had seen tsetse and heard about bovine trypanosomosis. These results are consistent with the work of Magona et al. (2004) from a study conducted in Eastern Uganda in Tororo and Busia Districts. The location of Buliisa in the cattle corridor, vegetation type, bordering a national park, having a wildlife reserve and proximity to a water body could have been plausible reasons for the presence of tsetse flies which enhance trypanosomosis being a major cattle disease in this area. In addition, wild animals especially wild ruminants, elephants and wild suidae act as maintenance hosts of *Glossina* species; the anthropod vector that transmits trypanosomosis can be associated with the presence of tsetse and bovine trypanosomosis (Bengis et al. 2002). The vegetation type and climate in the study area provide a very suitable habitat for the different tsetse fly species. Glossina *Palpalis* and G. *Fusca* tsetse fly species are known to survive well in moist conditions surrounded by woody vegetation, while the *moristan* species thrive well in hot, dry conditions, and during the wet season they migrate into savanna woodland (Vreysen et al. 2013). In the dry season, G. *moristan* species live in vegetation near water bodies. Furthermore, seasonal change modifies the relative humidity, vegetation, temperature and light radiance which influence the development and multiplication of the tsetse flies (Sow 2013). The majority of farmers stated that grazing near the national parks was the main cause of bovine trypanosomosis (Table 5). A significant difference ($P < 0.05$) was observed in the sub counties between grazing near the national park, sharing grazing land and watering points with wildlife and grazing cattle in infested areas. The difference was probably caused by the variation in available grazing land and proximity to the national park. In geographical locations close to national parks, farmers could easily associate prevalence of trypanosomosis to grazing animals near the national parks (Mechtilda et al. 2016). Contrary to our findings, a study done in Kenya (Machila et al. 2003) found out that about 44.1% of the respondents reported that tsetse flies were the main cause of trypanosomosis and 54% of the respondents did not know the cause of trypanosomosis. The responses on the causes of trypanosomosis suggested by the cattle keepers were in agreement with the acceptable scientific cause of the disease. This finding suggests that the farmers in the study sub counties were aware about the causes and risk factors for trypanosomosis, which factor is likely to support the pastoral communities and their cattle herds' need to be resilient and survive in that environment. A study in Nwoya, a district neighboring the same high-risk protected area, found a prevalence rate of 41% (Angwech et al. 2015) which is likely to be similar with the disease burden in Buliisa district. It is therefore necessary to determine the prevalence of bovine trypanosomosis in Buliisa district.

The participants' knowledge on transmission routes of bovine trypanosomosis (Table 6) were found to be all scientifically correct. Such results reflected the level of awareness of livestock farmers in the study area in correctly knowing how the disease was transmitted in their herds. This finding is contrary to a study in Ethiopia by Chanie et al. (2013) that revealed 80% of the respondents thought bovine trypanosomosis was caused and transmitted via the environment.

Farmers were generally ignorant about the major signs of trypanosomosis (Table 7) except in Biiso where farmers were aware of intermittent fevers, in Ngwedo where they were aware of emaciation and in Buliisa where they were aware of rough coat as major signs and symptoms of the disease. The high awareness in Biiso, Ngwedo and Buliisa sub counties could be attributed to their proximity to Budongo forest reserve and Murchision Falls National Parks respectively, which probably shows a higher disease burden compared to Kigwera and Butiaba sub counties.

The clinical signs identified by the farmers focused mainly on the impaired animals' physiological processes and not on economic losses. Farmers, however, did not link the signs of trypanosomosis to loss in milk production, mortality and other productivity indicators like decreased offtake and reduced calving rate as reported in several studies (Swallow 2000; Muhanguzi et al. 2014). The reason for lack of connection between productivity indices as critical clinical signs may be attributed to the multiple functions of cattle in pastoral communities which are beyond production of milk and beef. The significant difference ($P < 0.05$) among the sub counties in interpreting disease signs except anemia and circling movement could be as a result of the fact that farmers could at least associate one peculiar sign to the presence of the disease in their herds especially in Biiso, Butiaba and Ngwedo sub counties.

The ability and precision to identify these visual signs depend on the experience of the farmers. Although there are other diseases that can present similar signs, with long periods of practice, farmers developed comparable understanding of the important signs of the disease in their herds (Ayenalem et al. 2017). The lack of precise knowledge of pastoral communities about the other major signs and symptoms of trypanosomosis could also have been contributed by existence of several other diseases that present similar signs as bovine trypanosomosis.

The control practices of trypanosomosis carried out focused mainly on controlling tsetse flies from getting into contact with animals through spraying cattle with insecticides and not grazing cattle in areas infested with tsetse flies except in Butiaba sub county (Table 8). A significant difference ($P < 0.05$) was observed using insecticides to control tsetse flies and avoiding grazing cattle in infested areas with tsetse flies across the sub counties. The plausible reason why few farmers in Butiaba reported spraying cattle with insecticide as a control practice could be that Butiaba sub county was close to Lake Albert and probably with less tsetse fly population due to less tsetse fly hiding and breeding places compared to other sub counties. The control practices that targeted controlling the tsetse fly population in their habitat (bush clearing, targets and traps) were less practiced by the farmers. Although there are several control strategies of the trypanosomosis in Uganda including strategies targeting the disease vector such as stationary baits, mobile baits (insecticide treated cattle) and aerial spraying, their success, technical efficiency and the affordability by the farmers are at different stages at both farm and community levels (Muhanguzi et al. 2015). Farmers in choosing from the available control options are driven by the cost, and usually the insecticide-treated cattle option seems widely used in Uganda (Waiswa and Wangoola 2018) and cheapest as stated in a study by Shaw et al. (2013). The insecticide-treated cattle strategy is a widely used approach by farmers probably because of the dual benefits of controlling tsetse flies and ticks, the vectors for trypanosomosis and tick-borne diseases respectively. These findings are in agreement with a study in Tanzania (Mwaseba and Kigoda 2017) which found that dipping was the major control method of trypanosomosis. Avoiding grazing cattle in risky areas can be rather a challenging strategy in pastoral setting especially where the land tenure system is communal. In the dry spell, pastures and watering points are limited thereby forcing herders to graze and water their animals in the same location shared by the wildlife. During the dry season, tsetse flies especially the *moristans* species live in vegetation close to water points targeting both domestic and wild ruminants for blood meals (Hargrove 2004).

There was a minimal use of insecticide-impregnated traps and targets and bush clearing as control practices of the tsetse fly vector. With limited use and promotion of traps and targets, the tsetse population changes in time and space and therefore cannot effectively be monitored, and disease management strategy based on tsetse fly population is difficult to implement with no surveillance and monitoring system of the tsetse fly population dynamics.

The overdependence of farmers on using insecticide-treated cattle as a major control strategy of bovine trypanosomosis could be attributed to a breakdown in the livestock extension and entomology community intervention programs that control the vector (tsetse fly) population that transmits the disease.

The most common treatment method (Table 9) of trypanosomosis was using curative trypanocides followed by the use of preventive trypanocides. The results revealed a significant difference in using curative trypanocides and local indigenous herbs. The difference could be attributed to the rate of uptake of crossbreeding strategies adopted by the farmers. Farmers with crossbred animals tend to rely so much on curative trypanocides, while farmers with mainly indigenous animals use local herbs. Although both curative and prophylactic trypanocides are effective in treating and preventing trypanosomosis infection respectively, the choice to use mostly curative trypanocides to treat suspected infected cattle can be attributed to the fact that fatality cases from trypanosomosis are not immediate. In addition, using prophylactic trypanocides can be expensive to the farmers since it involves treating the entire herd of about 34 animals on average. Treating only suspected sick animals that have shown signs of the disease is a cheaper option in the shorter term for farmers. However, the over reliance of farmers on curative trypanocides in treatment of trypanosomosis in cattle can contribute to abuse and misuse of trypanocides especially if treatment is administered by the farmers themselves (Tekle et al. 2018).

The farmers' decision to administer treatment to their cattle was based on observation of clinical signs (Table 10). A significant difference was observed among the study sub counties on information based on before administering treatment using farmers and veterinarians' observation of clinical signs. The difference could be as a result of the years of experience in cattle keeping and herd sizes. In smaller herd sizes, farmers can easily use clinical signs correctly compared to larger herd sizes. The longer the experience in cattle keeping the higher the chances of using clinical signs correctly as these are among the many factors that can contribute to control or persistence of animal trypanosomosis in a community as evidenced by Wangoola et al. (2019) in a recent study covering the Lango sub region of Uganda. The practice of using clinical signs before treatment further suggests that many seemingly healthy animals are left untreated. With no proper diagnosis of animals, it may result in treating a wrong disease condition since there are other diseases that can present similar signs as bovine trypanosomosis .The use of clinical signs may be attributed to lack of animal diagnostic facilities leading to failure in getting results in real time by the farmers, the costs and expertise involved in collecting the blood samples from the animals and the long distances from the study areas to places where laboratory services can be found. In addition, although rapid diagnostic tool is available, the tool is still not widely used by livestock farmers probably due to cost or unavailability of the technology in the study area. The practice of administering treatment of cattle against trypanosomosis without proper diagnosis can lead to misuse and abuse of trypanocides and cause resistance of trypanosome against the drugs.

**Funding** Acknowledgement to the Government of Uganda support, Uganda Trypanosomiasis Control Council (UTCC) through the Coordinating Office for the Control of Trypanosomosis in Uganda (COCTU) and World Bank supported African Centre of Excellence in Agro Ecology and Livelihood Systems (ACALISE) for funding this study.

**Availability of data and materials** The dataset(s) supporting the conclusions of this article is (are) available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate** The study protocol was approved by Makerere University School of Veterinary Medicine Animal Resources (SVAR) higher degrees, SVAR research and ethics committees (SVAREC /19/2018). Study participants signed a voluntary consent to participate in the study.

**Consent for publication** All the authors have approved the manuscript for submission.

**Competing interests** The authors declare no competing interests.

## References

Albert, M., et al . (2015). Tsetse Fly (G.f. fuscipes) Distribution in the Lake Victoria Basin of Uganda. PLoS Neglected Tropical Diseases, 9(4), 1–14. https://doi.org/10.1371/journal.pntd.0003705

Angwech, H., et al. (2015). Heterogeneity in the prevalence and intensity of bovine trypanosomiasis in the districts of Amuru and Nwoya, Northern Uganda. BMC Veterinary Research, 11(1), 1–8. https://doi.org/10.1186/s12917-015-0567-6

Ayenalem, D., Mossie, T., & Ababa, A. (2017). Prevalence of Bovine Trypanosomosis and Farmers ' Perception of the Disease and Its Management in Guangua and Dangila Districts 7(7), 1–10.

Bengis, R. G., Kock, R. A., & Fischer, J. (2002). Infectious animal diseases: the wildlife/livestock interface. Revue Scientifique et Technique (International Office of Epizootics), 21(1), 53–65.

Chanie, M., Adula, D., & Bogale, B. (2013). Socio-Economic Assessment of the Impacts of Trypanosomiasis on Cattle in Girja District, Southern Oromia Region, Southern Ethiopia. Acta Parasitologica Globalis, 4(3), 80–85. https://doi.org/10.5829/idosi.apg.2013.4.3.7523

Cox, A. P., et al. (2010). Constraints to estimating the prevalence of trypanosome infections in East African zebu cattle. Parasites and Vectors, 3(1), 1–8. https://doi.org/10.1186/1756-3305-3-82

Hargrove, J. W. (2004). Tsetse population dynamics. In I. P. H. H. and M. A. M. Maudlin (Ed.), The Trypanosomiases. CABI Publishing.

Holt, H. R..,et al.(2016). Assessment of animal African trypanosomiasis (AAT) vulnerability in cattle-owning communities of sub-Saharan Africa. Parasites & Vectors, 9(1), 53. https://doi.org/10.1186/s13071-016-1336-5

Israel, G. D. (2012). Determining Sample Size (PEOD6). Agricultural Education and Communication Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. http://edis.ifas.ufl.edu.

Kristjanson, P., et al, (1999). Measuring the costs of African Animal Trypanosomiasis: the potential benefits of control and returns to research. The Agriculture Systems, 59, 79–98. https://doi.org/10.1016/S0308-521X(98)00086-9

Machila, N., et al. (2003). Cattle owners' perceptions of African bovine trypanosomiasis and its control in Busia and Kwale Districts of Kenya. Acta Tropica, 86(1), 25–34. https://doi.org/10.1016/S0001-706X(02)00288-7

Magona, J. W., Walubengo, J., & Olaho-Mukani, W. (2004). Knowledge and attitudes of cattle owners regarding trypanosomosis control in tsetse-infested areas of Uganda. Journal of the South African Veterinary Association, 75(4), 173–176. https://doi.org/10.4102/jsava.v75i4.478

Malulu, D. J., et al. (2017). Assessment of community knowledge, attitude and practices for sustainable control of tsetse and tsetse-borne trypanosomosis in Meatu district, Tanzania. Livestock Research for

Rural Development, 29(5). http://www.lrrd.org/lrrd29/5/malu29096.html

Mechtilda, B., Gamba, N., & Sebastian, M. (2016). Evaluation of knowledge, attitude and practices of agro-pastoralists on tsetse fly(Glossina sp.) in Western Serengeti Tanzania. Journal of Veterinary Medicine and Animal Health, 8(11), 169–175. https://doi.org/10.5897/JVMAH2016.0496

Muhanguzi, D., et al. (2014). The burden and spatial distribution of bovine African trypanosomes in small holder croplivestock production systems in Tororo District, south-eastern Uganda. Parasites and Vectors, 7(1), 1–10. https://doi.org/10.1186/s13071-014-0603-6

Muhanguzi, D., et al. (2015). Cost analysis of options for management of African Animal Trypanosomiasis using interventions targeted at cattle in Tororo District; South-eastern Uganda. Parasites and Vectors, 8(1), 1–9. https://doi.org/10.1186/s13071-015-0998-8

Mwaseba, D. L., & Kigoda, K. J. (2017). Knowledge, attitude, and practices about tsetse control among communities neighbouring Serengeti National Park, Tanzania. Heliyon, 3(6), e00324. https://doi.org/10.1016/j.heliyon.2017.e00324

Shaw, A. P. M.., et al. (2013). Estimating the costs of tsetse control options: An example for Uganda. Preventive Veterinary Medicine, 110(3–4), 290–303. https://doi.org/10.1016/j.prevetmed.2012.12.014

Simarro, P. P., et al. (2010). The Atlas of human African trypanosomiasis: A contribution to global mapping of neglected tropical diseases. International Journal of Health Geographics, 9, 1–18. https://doi.org/10.1186/1476-072X-9-57

Sow, A. (2013). Trypanosomosis risk factors and impact assessment of a tsetse and trypanosomosis eradication campaign in Burkina Faso. PhD Thesis Ghent University.

Swallow, B. M. (2000). Impact of trypanosomiasis on African agriculture. PAAT Technical and Scientific Series 2. FAO (Food and Agriculture Organization of the United Nations),.

Tekle, T., et al. (2018). Aberrant use and poor quality of trypanocides: A risk for drug resistance in south western Ethiopia. BMC Veterinary Research, 14(1), 1–8. https://doi.org/10.1186/s12917-017-1327-6

Van den Bossche, P., et al. (2010). A changing environment and the epidemiology of tsetse-transmitted livestock trypanosomiasis. Trends in Parasitology, 26(5), 236–243. https://doi.org/10.1016/j.pt.2010.02.010

Vreysen, M. J. B., et al. (2013). Tsetse flies: Their biology and control using area-wide integrated pest management approaches. Journal of Invertebrate Pathology, 112(SUPPL.1), S15–S25. https://doi.org/10.1016/j.jip.2012.07.026

Waiswa, C., & Wangoola, M. R. (2018). Sustaining Efforts of Controlling Zoonotic Sleeping Sickness in Uganda Using Trypanocidal Treatment and Spray of Cattle with Deltamethrin. XX(Xx), 1–6. https://doi.org/10.1089/vbz.2018.2382

Wangoola, R. M., et al. (2019). Factors associated with persistence of African animal trypanosomiasis in Lango subregion, northern Uganda. Tropical Animal Health and Production, 51(7), 2011–2018. https://doi.org/10.1007/s11250-019-01900-7

World Health Organization. (2008). Advocacy, communication and social mobilization for T.B control. A guide to developing knowledge,attitude and practice surveys. Geneva ISBN 978 92 4 159617 6 http://apps.who.int/iris/bitstream/10665/43790/1/9789241596176_eng.pdf