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Experiences of the one-health approach by the Uganda Trypanosomiasis Control Council and its secretariat in the control of zoonotic sleeping sickness in Uganda

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ABSTRACT

Elimination of sleeping sickness from endemic countries like Uganda is key if the affected communities are to exploit the potential of the available human and livestock resources (production and productivity). *Trypanosoma brucei rhodesiense*, the parasite that causes acute sleeping sickness in humans, is transmitted by tsetse flies and co-exists in non-human animal reservoirs. Uganda by Act of Parliament in 1992 decided to handle the complex approach to control of sleeping sickness and animal trypanosomiasis by establishing the Uganda Trypanosomiasis Control Council (UTCC) and its secretariat the Coordinating Office for the Control of Trypanosomiasis in Uganda (COCTU). The Institutional arrangement aimed to promote engagement with key stakeholders across nine key ministries and the community, all vital for control of zoonotic sleeping sickness, creating a One Health platform, long before such practice was common. From 2006, approaches by the Public Private Partnership, Stamp Out Sleeping Sickness (SOS) have required involvement of stakeholders in the promotion of insecticide treated cattle as live tsetse baits, targeting elimination of zoonotic sleeping sickness. Experiences in promoting sustainability of these interventions have been captured in this study as part of the Tackling Infections to Benefit Africa (TIBA) partnership. Meeting transcripts, focus group discussions and questionnaires were used to collect data from the different stakeholders involved in a rapid impact live bait study over 12 months from Dec 2017. The study provides unprecedented insights into the stakeholders involved in the application of a One health approach for control of zoonotic sleeping sickness across the most important active human African trypanosomiasis focus in East Africa. This unique study is fundamental in guiding multi-stakeholder engagement if the goal to eliminate zoonotic sleeping sickness is to be realised. A major challenge is timely feedback to the community as regards human and animal disease status; rapid diagnostic services that can be delivered from facilities established in close proximity to the affected communities and well equipped in-country reference laboratories are key to delivering effective control and best One Health Approach.

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1. Introduction

Trypanosomiasis significantly reduces productivity of millions of cattle, sheep and goats (Leigh et al., 2015; Nyimba et al., 2015). In Africa, many areas infested by the tsetse fly vector, also have trypanosomiasis affecting humans with Uganda as the only country affected by both acute (*Trypanosoma brucei rhodesiense*) and chronic (*Trypanosoma brucei gambiense*) types of sleeping sickness. A decade ago, Uganda represented a region of potential overlap, with the two focuses (the chronic type affecting the West Nile region and the acute type that affects the South East and Northern regions of Uganda) expanding towards each other (Picozzi et al., 2005). Moreover, the trypanosome species that causes acute *Trypanosoma brucei rhodesiense (Tbr)* sleeping sickness in humans co-exists in non-human hosts (tsetse, wildlife and domestic animals) with a number of other non-human infective pathogenic trypanosomes (Waiswa et al., 2003, 2006; Waiswa, 2005).

For Uganda, tsetse infestation and areas endemic for human and animal trypanosomiasis cover about 70% of the country (Albert et al., 2015), where millions of both livestock and human are exposed to the disease. *T. vivax, T. congolense* and *T. brucei sl* infections are common among cattle (Selby et al., 2013; Muhanguzi et al., 2014a). Among human infections, over 50% of reported *T. b. rhodesiense* cases in the whole of Africa between 2000 and 2009 were from Uganda (Simarro et al., 2010) and this emphasised the earlier suggested need for a strategy of an integrated disease control approach (Welburn et al., 2001).

Multi-stakeholder engagement and involvement in designing solutions for a disease that affects human, livestock and wildlife in Uganda has been a key function for the Uganda Trypanosomiasis Control Council (UTCC) and its Secretariat Coordinating Office for Control of Trypanosomiasis in Uganda (COCTU) since 1992 (UTCC Act, 1992). In addition, since 2006, several initiatives have been deployed especially treatment of diagnosed human sleeping sickness cases and use of live bait in cattle to control the zoonotic form of sleeping sickness (Kabasa, 2007; Waiswa and Rannalette, 2010; Waiswa and Kabasa, 2010). The Stamp Out Sleeping Sickness (SOS) intervention treated >500,000 cattle in seven districts in Northern Uganda over two phases since 2006. Following establishment of the private public partnership through the SOS consortium, trypanosome prevalence reduced by 75% through mass treatment alone, with reduction in human sleeping sickness cases by 90% (Welburn and Coleman, 2015). Published data concluded that the SOS intervention resulted in a significant decrease in the prevalence of *T. brucei s.l.* and human infective *T. b. rhodesiense* infection in village cattle and this is estimated to have saved between $150–400 million in human health care costs by avoiding the overlap of the two forms of Human African Trypanosomiasis (Welburn and Coleman, 2015). The Restricted Application of Insecticide using cattle as live bait for tsetse protocol (RAP) implemented through SOS has also generated increased productivity of $30 per head of cattle per year and mean annual income per household of $110 in poor communities (Muhanguzi et al., 2015; Okello, 2016. Given that approximately a million cattle are treated annually (Waiswa and Wangoola, 2019), this is $30 million per year in terms of increased productivity in impoverished communities of Uganda. This live bait approach continues to be used, in addition to both passive and active surveillance plus treatment of the human cases of sleeping sickness. Similarly, UTCC advocates for an integrated pest management (IPM) approach where other tools like awareness, use of tsetse fly traps and targets (Lehane et al., 2016) are also used in an engagement that requires participation of various stakeholder approach (Goodman and Thompson, 2017). By 2017, some of these tools had been adopted at community level, which resulted in significant reduction in the number of reported sleeping sickness and animal trypanosomiasis cases in Uganda (Waiswa and Wangoola, 2019). However various areas in Uganda have been recorded as having different levels of *T.brucei sl* infections among cattle (Unpublished Survey by University of Edinburgh and COCTU, 2015), with some being potentially human infective.

Also, rapid changes in human behaviour, resource utilization, and other extrinsic environmental factors continue to threaten the current distribution of several endemic and historically neglected zoonoses in many developing regions worldwide (Okello and Welburn, 2014), with examples of some circulating within relatively localized geographical areas for some time. Therefore, the persistence of *T.brucei sl* infection among cattle and continued registration of sleeping sickness in Uganda despite the effort by the Stamp Out Sleeping Sickness (SOS) that involved treatment of the cattle reservoir since 2006 (Kabasa, 2007; Waiswa and Rannalette, 2010; Waiswa and Kabasa, 2010; Hamill et al., 2017) has demanded in-depth examination of the engagements by different stakeholders. The Rapid Impact and Making a Difference projects of Tackling Infections to Benefit Africa (TIBA) Uganda interventions offered opportunity of capturing experiences of the multi-stakeholder engagements. The one health model platform in the name of UTCC, that was put in place in 1992 to handle all issues of tsetse and trypanosomiasis control in Uganda provided a unique opportunity to the investigation. This manuscript captures observations and notes recorded as different stakeholders came together to implement TIBA projects in Uganda.

2. Materials and methods

2.1. Stakeholder analysis

Stakeholder analysis was undertaken based on the identified tasks that needed to be accomplished in relation to the Uganda Rapid Impact (RI) Tackling Infections to Benefit Africa (TIBA) one-health project. Elimination of zoonotic sleeping sickness needed expertise in handling the ethical, technical, political and social aspects of the target communities affected by the zoonotic sleeping sickness in the endemic focus of Northern Uganda. The target area was purposively chosen and covered three districts of Lira, Alebtong and Kole that had been persistently experiencing sleeping sickness outbreaks and yet were part of the Stamp Out Sleeping Sickness than began in 2006 (Waiswa and Kabasa, 2010; Waiswa and Rannalette, 2010). The UTCC (multi-stakeholder Institution with veterinary, medical, agriculture, environment, wildlife, lands and political science as key disciplines), vector

control division of Ministry of Health (with medical specialist and host of Manager of the Uganda National sleeping sickness control program), leaders in district and sub-counties (technical; veterinary, medical, entomology, social work disciplines and politicians) plus community were purposively selected for engagement.

2.2. Research and ethical approval for TIBA Uganda

All projects under TIBA-Uganda were submitted to The Uganda National Council for Science and Technology through the Vector Control Division ethical committee. The committee received, evaluated the TIBA project that was eventually given clearance (Ref: H5 2316) by the Uganda National Council for Science and Technology.

2.3. Stakeholder engagements

2.3.1. Uganda trypanosomiasis control council (UTCC)

Stakeholders to engage are well defined in the law (UTCC Act, 1992, CAP 211 http://coctu.go.ug/UTCC_ACT) that put in place the Uganda Trypnaosomiasis Control Council (UTCC) and its Secretariat, Coordinating Office for Control of Trypanosomiasis in Uganda (COCTU) that handles daily management and administration of the UTCC as an institution. The UTCC multi-stakeholder composition provided a perfect opportunity for discussions related to the approach of TIBA projects in Uganda at two of their Statutory meetings in 2018. The Chairperson of the UTCC scheduled the meetings on agreed dates with members before invitation letters were sent. Policy implications of introducing new tools in surveillance and handling suspect cases especially humans found positive for trypanosome DNA with these tools formed the major issues during the discussions. The usefulness of pyrethroid based acaricide in controlling the vector for trypanosomiasis was also discussed in line with the one health approach that needed to be sensitive to the tick resistance threat to the pyrethroid based acaricides in Uganda.

2.3.2. Local government leaders

For all the target areas, letters about the TIBA project were written to the chief administrative officers (CAOs) of Alebtong, Kole and Lira districts with a request for a meeting with the technical staff (veterinary, medical, entomology, social workers) plus political leaders. Telephone conversations were also held to reconfirm or agree on the suitable dates for the meetings. At every district meeting, discussions on dates for the community entry meetings were made and the technical staff took the responsibility of mobilisation via telephone and visitation to the different village chairpersons. The village chairpersons took the responsibility of informing and inviting the community to the meetings. Community entry meetings were held to introduce the project and seek permission to start work that involved seeking consent of participants. This manuscript has captured experiences and engagements from Alebtong, Kole and Lira districts (Fig. 1) as these were the sites for the implementation of the Rapid Impact Project that was undertaken for 12 months starting December 2017.

2.3.3. Deepening awareness through community meetings

Meetings involving village and opinion leaders plus residents were held in each village to let them know about the project, their roles and the outcome anticipated from the interventions. After discussions with the village gate keepers (political and opinion leaders) and getting their permission, a day was set aside to hold the community meeting and consent engagements. The local government technical staff and leaders plus the TIBA-Uganda team explained the approach and answered any questions that arose. Terms of reference for the different stakeholders and modalities of engagement were outlined and agreed on before any start of activities. All meetings were also used to verify the estimate of the human and livestock population in the villages since movement and migrations could affect numbers.

2.3.4. Cattle study

Cattle were targeted in the study as previous survey results indicated high prevalence of *T. brucei sl.* (COCTU Records 2016 unpublished) with evidence of the human infective *T.b. rhodesiense* among the recorded infections. For this investigation, the aim was to screen, treat and spray cattle kept within and around the selected villages based on an estimate of about 200 cattle within and immediate neighbourhood (as per verbal information received early in 2018 from the respective district veterinary officers of Kole, Lira and Alebtong districts).

2.3.5. Cattle sample size determination for prevalence and stability studies

This was determined using the following formula by Daniel (1999)

$$n = \frac{Z^2 * P(1-P)}{d^2}$$

Where: n = required sample size.
Z = Z statistic for a level of confidence
P = expected prevalence
d = desired absolute precision

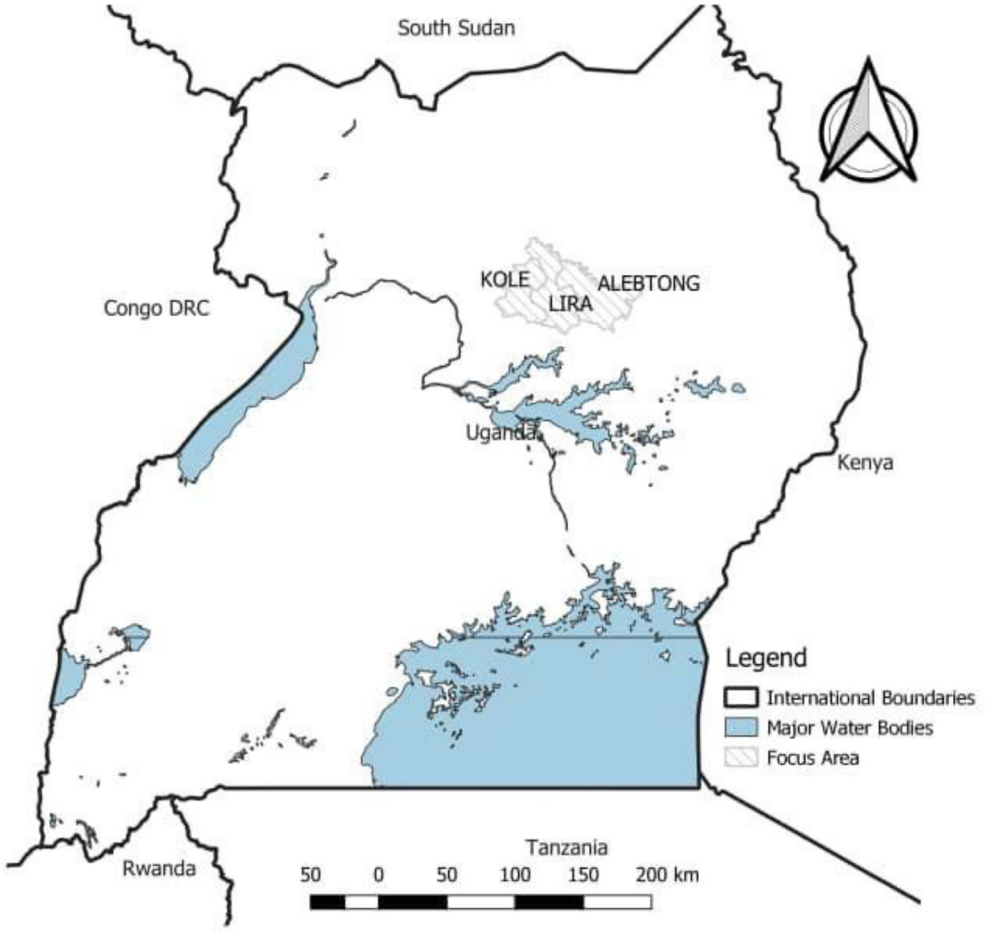

Fig. 1. Map of Uganda showing location of the three districts of Kole, Lira and Alebtong where the study villages were selected for the TIBA Rapid Impact Project study.

Using a known average prevalence of 35% recorded during the survey conducted by Welburn & Waiswa (COCTU Records, 2014 unpublished) and a precision of 5% at 95% CI; $P = 0.35$, $d = 0.05$ and Z Statistic as 1.96.

Therefore;

$$n = \frac{(1.96)^2 * 0.35(1-0.35)}{(0.05)^2}$$

$$n = \frac{0.873964}{0.0025}$$

$n = 349.5856$.

A minimum sample size of approximately **350** cattle was needed for the study to determine the exact prevalence of African Animal Trypanosomiasis (AAT) and stability of trypanosomes in cattle in the 20 villages. These samples were proportionally allocated to each village and a minimum of 350/20 = 17.5 or 18 cattle were needed from each of the 20 villages. However, since all owners of domestic animals in the village were mobilized, a target of 80–100 cattle per village was set as this could additionally give more elaborate information on the status of trypanosomiasis in each village. After consent of the owners or their representatives, cattle were randomly selected and bled to get blood samples. The recurrent ear vein was pricked using a lancet, blood drawn using two hematocrit tubes and immediately spotted on FTA cards. The FTA cards with blood spots were air dried and thereafter stored under room temperature as they awaited future analysis for presence of trypanosome DNA using Polymerase Chain Reaction (PCR). The blood screening test would give the prevalence of trypanosomiasis in general and enable estimation of the potentially human infective (*T.brucei rhodesiense).*

2.4. Treatment of cattle presented during the study

Since cattle in the study area had earlier been reported to carry *T.brucei rhodesiense* in all the target villages, *Diminazene aceturate* was used to treat all animal kept in the 20 study villages. Similarly, all animals presented during the investigation were sprayed with deltamethrin insecticide/acaricide (Vectocid® CEVA *Sante Animale, Libourne, France*) to promote live bait approach to control the tsetse vector as advocated by the Stamp Out Sleeping Sickness consortium since 2006 (Kabasa, 2007; Waiswa and Rannalette, 2010; Waiswa and Kabasa, 2010). Live bait has overtime been recorded as a more community friendly and sustainable approach to controlling sleeping sickness (Waiswa and Wangoola, 2019). At the same time, livestock farmers were encouraged to spray their animals monthly to kill the tsetse vector while getting the benefits of tick control since this was the theory of change that was expected in the community to help reduce the tsetse fly density in the area, subsequently reducing any possible transmission of animal and human trypanosomiasis.

2.5. Study of human subjects

Samples size determination for evaluating factors related to the human subjects was calculated using Yamane (1967) formula as given below

$$n = \frac{N}{1 + Ne^2}$$

Let N be the population size.
e denotes margin of error.
According to UBOS census report (2014) Area Specific Profiles

- Kole district has a population of 239,327
- Alebtong district has a population of 227,541
- Lira district has a population of 408,043

All this makes a total population of 874,911.
N is 874,911.
e is 0.0036 (6%)

$$n = \frac{874911}{1 + 874911 * 0.0036^2}$$

n= 277.6896– 278 as the sample size.

Therefore, a minimum of 278 subjects were needed to be interviewed and briefed about the study to enable them give their consent to participate.

However, all residents in the target 20 high risk villages in the three districts (Kole, Alebtong and Lira) were mobilized to attend the screening and each was given an opportunity to voluntarily consent to the screening and blood sampling. Experts in social work and community development were engaged to explain and enhance understanding, acceptability and participation in the project.

The head of the Sleeping Sickness Control Program in Uganda set up a team to work with staff at COCTU, colleagues from the University of Edinburgh and Local Government. A total of 5000 people were targeted to be examined for evidence of clinical signs for *T.brucei rhodesiense* human African Trypanosomiasis (rHAT) in all the three districts. In each of the 20 villages, at least 250 individuals were selected randomly from the those that accepted to come for the screening and their blood taken and screened for trypanosomiasis using microscopic examination. After examination by microscopy, blood was also spotted on FTA cards and stored awaiting further molecular analysis for evidence of trypanosome DNA.

Health and laboratory workers in the Government health facilities were trained to build their capacity in screening and treatment for zoonotic sleeping sickness. There after they participated in active surveillance for sleeping sickness. In all places affected with zoonotic sleeping sickness, there is routine case detection done through regular active and passive screening of populations, treatment of positive cases and community mobilisation and sensitization. During the Rapid Impact TIBA Uganda project, staff in laboratories in the approved treatment centres were trained by a team from the sleeping sickness control program (Ministry of Health, Uganda) to increase their sleeping sickness suspicion index. Capacity building was also undertaken in laboratory technical skills and thereafter staff were provided with supplies to undertake the screenings as this particular stakeholder is very key and must be well equipped to be able to confirm presence of infection in communities during sleeping sickness outbreaks in the focus areas.

3. Results

3.1. Ethical clearance and approval

The studies were reviewed, approved and registered with reference numbers (Ref: HS 2316) and the process from first submission to approval took 60 days.

3.2. Multi-stakeholder project implementation committee

The various engagements necessitated a committee to oversee implementation of activities. Its composition had to reflect the desires of a one-health approach in line with the UTCC Act, 1992. The composition of the implementation committee is given in Table 1.

The committee sat every 3 months to review progress and guide the implementation.

Additionally, the technical team involving veterinary/animal production staff, Animal Resource Key Persons (ARK) (Waiswa and Wangoola, 2019), District Veterinary/Health technical staff, UTCC/COCTU staff, Makerere University and University of Edinburgh were in charge of the implementation and routinely met to review the standard operating procedures.

3.2.1. Engagements with the Uganda Trypanosomiasis Control Council (UTCC)

TIBA Uganda project components fell within the constitutional mandate of the UTCC and this made it easy to implement the one health approach under this platform. After endorsement of the project, UTCC directed its Technical Committee, that was also established under the Act of 1992, to oversee and participate monitoring and evaluation of activities during TIBA project implementation in addition to guiding the actors and help achievement of the envisaged theory of change.

UTCC has nine key stakeholder ministries that are represented by one officer not below the rank of undersecretary, appointed by each of the following the stakeholder Ministries:

(i) the Ministry responsible for animal health.
(ii) the Ministry responsible for health.
(iii) the Ministry responsible for agriculture.
(iv) the Ministry responsible for local government.
(v) the Ministry responsible for environment protection.
(vi) the Ministry responsible for tourism and wildlife.
(vii) the Ministry responsible for finance, planning and economic development.
(viii) the Ministry responsible for lands.
(ix) the Ministry responsible for foreign affairs.

Plus, three other members appointed by the Minister (Ministry of Agriculture Animal Industry and Fisheries) from the wider public.

3.2.1.1. Key issues captured that were considered critical. UTCC provided a perfect opportunity for quick handling of any outcomes from the study that needed urgent policy guidance and was routinely provided with Information Papers on the progress of TIBA Uganda projects.

A Policy Brief was provided at the end of the Rapid Impact project and it mainly focused on three critical issues:

- Some ten human samples gave signals for trypanosome DNA after testing the blood with PCR. These samples have been sent for further characterisation to establish presence or absence of T. brucei rhodesiense (Tbr) or T. brucei gambiense (Tbg).
- People whose samples had signals of Tbr or Tbg were reported as suspects to the Manager of the sleeping sickness control program in Uganda for follow up, confirmation of infection or more health/scientific evaluations.

Table 1
Multi-stakeholder project implementation committee.

Category	Number	Specialisations
Principle Investigator and Co-Investigators	3	PI (Veterinarian) Co-PI (Medical) Co-PI (Molecular Biology)
Secretariat staff	5	Veterinarian Medical Communication and Data Finance Manager Administrative Assistant
Representatives of Academic/Research Institutions	4	Medical Molecular Biology Laboratory Technology (x2)
Total	12	

Table 2
Key Local Government Leaders and their Roles in the 3 study districts.

Category	No	Role
Resident District Commissioner	3	Represents President's office at the district and overseas all Government projects.
LC 5 Chairman	3	Elected district political head and vital in mobilisation of communities
Chief Administrative Officer	3	Chief Executive of the district and in charge of the technical human resource
District production and marketing officer	3	Head of production department and overseas the Agriculture sector
District health officer	3	In charge of the health sector and provided the health workers for the activities
District veterinary officer	3	In charge of the veterinary services in the and provided the needed staff for the activities
Senior administrative secretaries and their assistants	20	In charge of sub counties (lower local Government) and the 20 villages where the TIBA projects are being implemented
Total	38	Total of key stakeholders involved as gate keepers for the community, mobilisation and awareness plus technical support

- Use of synthetic pyrethroid based insecticides/acaricides in the promotion of live bait as a valuable tool to reduce transmission of zoonotic sleeping had to continue as this would enable continued contribution of livestock owners to the sleeping sickness control activities since presence of trypanosome DNA in some human samples was of big concern.

3.2.2. Engagements with local governments

Local governments leadership are the research gate keepers at the district and lower local government levels. They played key roles in community mobilisation and acceptance of the study. Similarly, they supervised the technical teams and keenly followed up the approach during implementation of activities. The composition and roles of Local Government leaders is detailed in Table 2.

Since the Rapid Impact TIBA Uganda project involved a 'One Health Approach' on studies related to zoonotic sleeping sickness, the district medical and veterinary officers took technical lead in each district.

3.2.2.1. Major issues highlighted by the local government stakeholders.

- Control of the tsetse vector, passive surveillance of sleeping sickness, diagnosis and treatment of the animal disease are key aspects that need support of various stakeholders as they are pillars for sustaining good practices. However, the less sensitive clinical signs and microscopy are the major tools available for diagnosis in all the target three districts.
- Awareness and community guidance based on risks identified is a key role for the technical officers in local governments. Therefore, they need better tools to enable accurate and timely information for dissemination

3.2.3. Engagement of community as key stakeholders

Community meetings were organised for all the selected 20 villages and explanation on roles, interventions and any benefits were done in each of the target areas. Dates and venues for the animal and human screening plus sampling were discussed and set. In total, 40 community entry meetings (20 for livestock owners and 20 for human) were held and the number per district is outlined in Table 3. *All communities welcomed the investigations and expressed willingness to participate.* However, some stakeholders at this level were greatly concerned with delays related to quick feedback and immediate benefits. This has been highlighted as one of the major/key issues in Table 3.

3.3. Cattle reservoir interventions

Livestock owners took great interest in the study/interventions and information leaked to the neighbouring villages who brought their animals for screening as well. The numbers from outside the study villages formed the majority (2465/4222 = 58.4%) of cattle brought to the agreed sites (see Table 4). This was encouraging as it indicated that these stakeholders had taken interest in the research and shared the potential benefits with the neighbours. Animals from outside the target villages were not bled or treated with *Diminazene aceturate* but were all sprayed with deltamethrin as a promotion of use of live bait for the control of the tsetse vector. It was also recorded as a finding by the research team that:

- The private sector led supply chain for deltamethrin based acaricide/insecticide that can be used for spray is not consistent and yet this is needed to sustainably enable farmers contribute to the control of the tsetse vectors. The livestock owners requested for interim Government intervention

Table 3
Number of Community Meetings and Key Issues.

District	Number of Meetings	Key Issues that need attention
Alebtong	12	• *After taking of blood from animals and human, feedback on results takes too long and sometimes earlier groups of researchers never came back.*
Lira	6	
Kole	22	• *Need for incentives especially in the longitudinal part of the study necessitating monthly sampling of livestock*
Total	40	

Table 4
Taking Cattle Blood Samples, Treatment with *Diminazine aceturate* plus Spray with Deltamethrin based insecticide in the different villages.

District	Number of target villages	Number Brought for Screening and Treatment	Number from outside the target villages	Number Sampled
Alebtong	12	480	173	307
Lira	6	1163	686	477
Kole	22	2579	1606	973
Total	40	4222	2465	1757

3.4. Human study: Screening for signs of sleeping sickness, taking blood samples and examination using parasitological techniques

As sleeping sickness control moves towards the elimination phase in Uganda, explanations to the community and justification for them to turn up for screening in the absence of reported cases is needed. Interestingly, the '*one-health*' approach adopted by the Rapid Impact Uganda TIBA project attracted a lot of community interest since earlier investigations had indicated presence of potentially human infective *T.b. rhodesiense* among cattle kept in the selected villages, thus highlighting the potential risk of transmission of the disease to the human population in these areas. Table 5 gives the number of individuals screened per village.

- The community quickly understood the veterinary and medical team explanation. The turn up per site was good and sometimes beyond expectation, including allowing children in schools a few hours break to participate in the exercise, adding school head teachers and staff plus management committees as key stakeholders.
- Sharing the right information with the community is critical in stimulating the appropriate action.
- There were no sleeping sickness cases detected using microscopy. A total 5409 blood samples were submitted to laboratories for trypanosome DNA screening. 10 of these samples had positive signals for trypanosome DNA and this matter was reported to the UTCC in a policy brief for guidance.

4. Discussion

Multi-stakeholder engagement in Uganda to control sleeping sickness is an approach that started during the 1976–1983 epidemic in the Busoga Region where 10,414 male and 9560 female patients were detected with the acute zoonotic sleeping sickness (Abaru, 1985). Establishment of an inter-ministerial committee to help handle the sleeping sickness epidemic was among the key strategies used to control the disease. This later resulted into the formation of the Coordinating Office for Control of Trypanosomiasis in Uganda (COCTU records, 1987, unpublished). COCTU was subsequently institutionalised to become the Secretariat of the Uganda Trypanosomiasis Control Council (UTCC) through an Act of Parliament (UTCC Act, 1992, Cap 211). In line with the earlier approach, current zoonotic sleeping sickness elimination agenda must be participatory and needs a multi-stakeholder arrangement given the wide range of animal reservoir host that live in different ecological settings. According to Vandersmissen and Welburn (2014), working together in a One Health movement, which addresses risks, including zoonoses, at the human-animal- environment interface requires the development of innovative partnerships at the political, institutional and technical levels and it is a sustainable and rational option although it demands long-term financial investment.

Table 5
Number of households, people and blood samples taken for parasitology examination.

Location targeted	Estimated population	House holds	Persons screened
Barropok	280	103	57
Acankwo A	268	116	104
Acungkena A	655	425	145
Akwete	318	63	108
Ogora	256	109	99
Abongwawobe	700	136	224
Amonomito	318	123	109
Oluro	225	58	264
Ilupe	400	83	295
Amia bil	280	75	331
Otyang	667	110	259
Alilo	708	417	360
Akaidebe	130	80	485
Bar Nyang	470	92	275
Bar dyel	300	120	359
Bung cell	396	130	240
Obele	698	141	341
Abur ward	600	200	538
Bar- dyang	1072	117	549
Acung apenyi	272	134	267
Total	8439	2067	5409

The UTCC Institutional arrangement has nine stakeholder ministries represented at the council by people at the level of Under Secretary, Director or Commissioner heading the Department responsible for control of trypanosomiasis (http://www.coctu.go.ug/About_COCTU.html). These join three appointed eminent citizens to constitute the UTCC that guides the country on issues of trypanosomiasis control (http://www.coctu.go.ug/About_COCTU.html). The UTCC Act similarly provides for the Technical Committee (TC) whose composition is made up of technical officers responsible for issues related to tsetse and trypanosomiasis in the stakeholder Ministries. After more than 28 years of its establishment, the multi-stakeholder approach and information sharing has brought Uganda towards elimination of sleeping sickness (Waiswa and Wangoola, 2019). As earlier stated by some scholars, projections of growth in the demand for livestock production and consumption in Asia and Africa also call for effective One Health responses (Vandersmissen and Welburn, 2014). The Coordinating Office for Trypanosomiasis Control in Uganda is one example of Consolidating the One Health approach in the Global Network (Vandersmissen and Welburn, 2014; Okello et al., 2014; Welburn et al., 2015) and highlights the importance of interfacing with key policy issues in preventing the emergence and re-emergence of zoonotic disease using HAT in Uganda as an example. The COCTU approach has turned rhetoric into reality and action in integrating Global Health Governance with National Priorities that enables putting theory into practice of integrated health approaches (Okello et al., 2011; Okello and Welburn, 2014).

The UTCC model as adopted and Institutionalised by Uganda in 1992 provides an effective platform to give immediate response as over time, for the past 28 years, there has been evidence of the socio-economic value that the One Health approach has led to the reduction of sleeping sickness in the human population (Franco et al., 2018) and areas that were not able to keep high grade cattle like South Eastern Uganda can now benefit from them if they adopt appropriate recommendations on cost benefit analysis of the different control options (Shaw et al., 2013, 2017). Relatedly, research around SOS and COCTU one-health approach that was supported by ICONZ (Okello et al., 2015a, 2015b, 2015c) raised the profile of Neglected Zoonotic Diseases through three complementary European Commission-funded projects that aimed to streamline research, build capacity and advocate for their control. This research also showed that only 25% of cattle need to be treated with RAP to cost effectively control HAT (Muhanguzi et al., 2014b) and that this treatment has a large impact on household income (Muhanguzi et al., 2015; Okello et al., 2015a, 2015b, 2015c). The long-term success of SOS is the fact that activities are now embedded within COCTU policy and practice. Treatments have been sustained by farmers in HAT at risk zones of Uganda as evidenced by the high turn up of cattle owners and their livestock from within and beyond the 20 study villages. During this investigation/study, more cattle were brought from neighbouring none target villages ($2465/4222 = 58.4\%$) and this interest is one of the reasons why this stakeholder has significantly contributed to rHAT control in Uganda since over 1 million cattle are now treated annually (Waiswa and Wangoola, 2019). With the rise of COVOD-19, it is more important than ever to deliver One-Health in practice to address emerging zoonoses (Mazet et al., 2009) and it is very crucial to develop one health diagnostic facilities that can deliver rapid results to the populations that need them for rapid interventions to take place and to avoid pandemic panic and anxiety in the developing countries as is seen now (Iceland et al., 2020).

TIBA projects in Uganda have emphasised involvement of leadership especially at National and local governments levels as their support, good governance and effective policies and networks are needed as building blocks for the sustainability of the One Health approach adopted by Uganda since the beginning of the 1976 to 1980s sleeping sickness outbreak. The high turn-up for the human and animal interventions plus active involvement by all stakeholders was as planned. Engagements were even easier when the risk was explained as feedback of earlier findings in 2015 by COCTU and the University of Edinburgh that partnered and designed a survey that took samples from cattle in 250 clusters (villages) across Uganda and completed PCR analysis to determine the overall prevalence of *T. brucei* s.l. and *T.b. rhodesiense*. That study provided unprecedented insights into the spatial distribution of the *T. brucei* s.l. and *T. b. rhodesiense* human infective parasites across the full geographic extent of the most important active zoonotic HAT focus in East Africa (COCTU records, 2016 unpublished). This data set was shared with the different stakeholders at the inception and was a good tool used during the engagements and mobilisation of stakeholders to participate in the rapid impact (RI) Tackling Infections to benefit Africa (TIBA) Uganda project. Consequently, this addressed the key issue of delayed feedback and the turn up of human and animals for the studies was as planned and the desired number of animals and human were screened in each of the 20 villages. However, definite answers on timing of feedback are still needed as the time between taking blood samples and getting results after analysis with the more sensitive molecular tools that target detection of trypanosome DNA is still the unacceptable many months especially in the face of potential disease outbreak. This became very urgent in the human screening where the microscopic based parasitological screening gave negative results for all people screened and yet the team could not give a definite answer as to whether the community can be declared free from sleeping sickness.

Like for COVID-19 we need rapid point of care diagnostics for use in the community to feed into a COCTU reference centre. The diagnostics need to come to the community as the stakeholders have highlighted the importance of having these tools domesticated in Uganda for quick public access and feedback. For trypanosomiasis control, engagement of community-based networks during activities as was for Stamp Out Sleeping sickness (Waiswa and Rannalette, 2010; Waiswa and Kabasa, 2010) where students and spray persons were mentored and continue to be used as a sustainable approach (Waiswa and Wangoola, 2019) seems necessary. Mentoring these networks in interventions and using them for surveillance is a major focus for the proposed setup of the Uganda Tsetse and Trypanosomiasis Resource Centre (UTTRC, unpublished) that has already received support from the UTCC to help address the quick feedback and linkage to the community. However, the real solution to the challenge is for the stakeholders to access tools that can be used in the field and generate results on site and be able to share them quickly with stakeholders. For One Health to be realised, and with the emergence of zoonotic infections that can rapidly spill into large populations, rapid diagnostics that share a common platform are essential to enable serve both rural and growing city

populations. What various actors have learned from old diseases, such as sleeping sickness and new diseases such as COVID-19 is that timely diagnosis is key and laboratories need to be established for notifiable zoonotic diseases in-country like for Uganda to enable routine screening for Human African Trypanosomiasis (HAT). More especially now that HAT cases are declining, it has never been more important to find cases quickly to continue the path to elimination. The TIBA projects in Uganda are putting a lot of effort in that direction, with need for different stakeholders both local and international to come together with the needed support be it political, technical, financial or others to address the quick feedback issue that is currently of major concern.

For the animal interventions to reduce on the animal reservoir and promotion of live bait to suppress the tsetse fly vector population using the approach of restricted application to tap into the less is more (Torr et al., 2007), the community had concern on the inconsistent supply of the chemicals by the private sector, an issue that had already been noted in earlier studies (Waiswa and Wangoola, 2019). Strengthening of the supply chain of chemicals that benefit both tsetse and tick control should be undertaken if communities are to actively engage with the theory of change that is desired to sustain interventions and eliminate sleeping sickness. Relatedly, affirmative action by UTCC is needed during this period when Uganda is faced with challenges related to tick resistance to some of the products on the market.

5. Conclusion

Multi-stakeholder engagements similar to the UTCC approach in Uganda are very efficient as demonstrated on the way trypanosomiasis control in Uganda has been handled. However, like any other team, after winning several engagements especially in controlling sleeping sickness in Uganda during different outbreaks in the last three decades, the elimination point comes with issues on the captain to lift the trophy. This study has shown that every stakeholder needs to play their role and take interest plus allowing new stakeholders to cover the spaces that must be bridged to enable sleeping sickness elimination. As people may behave differently and impact on the control of a disease like sleeping sickness, future studies will need to look at the attitude, perception and behaviour of different stakeholders as factors that affect quick achievement of elimination of sleeping sickness in Uganda. The UTCC secretariat COCTU has been in the best position to observe different key stakeholders and each one of them has been a major factor in the success registered to date and all deserve the space to place their hands on the trophy for winning the battle targeted at eliminating sleeping sickness from Uganda.

Declaration of Competing Interest

None.

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References

Abaru, D.E., 1985. Sleeping sickness in Busoga. Uganda 1976–1983.
Albert, M., Wardrop, N.A., Atkinson, P.M., Torr, S.J., Welburn, S.C., 2015. Tsetse fly (*G. f. forcipes*) distribution in the Lake Victoria basin of Uganda. PLoS Negl. Trop. Dis. 9 (4), e0003705. https://doi.org/10.1371/journal.pntd.0003705 Apr 15.
Daniel, W.W., 1999. Biostatistics: A Foundation for Analysis in the Health Sciences. 7th edition. John Wiley & Sons, New York.
Franco, J.R., Cecchi, G., Priotto, G., Paone, M., Diarra, A., Grout, L., Simarro, P.P., Zhao, W., Argaw, D., 2018. Monitoring the elimination of human African trypanosomiasis: update to 2016. PLoS Negl. Trop. Dis. 12 (12), e0006890. https://doi.org/10.1371/journal.pntd.0006890. eCollection 2018 Dec 6.
Goodman, M.S., Thompson, V.L.S., 2017. The science of stakeholder engagement in research: classification, implementation, and evaluation. Transl. Behav. Med. 7, 486–491.
Hamill, L., Picozzi, K., Fyfe, J., von Wissmann, B., Wastling, S., Wardrop, N., Selby, R., Acup, C.A., Bardosh, K.L., Muhanguzi, D., Kabasa, J.D., Waiswa, C., Welburn, S.C., 2017. Evaluating the impact of targeting livestock for the prevention of human and animal trypanosomiasis, at village level, in districts newly affected with *T. b. rhodesiense* in Uganda. Infect. Dis. Poverty. 6 (1), 16. https://doi.org/10.1186/s40249-016-0224-8 2017 Feb 6.
Iceland, K.K., Mujinya, R., Bogere, P., Ekou, J., Zirintunda, G., Ahimbisibwe, S., Matama, K., Ninsiima, H.I., Echoru, I., Ayikobua, E.T., Ssimbwa, G., Musinguzi, S.P., Muyinda, R., Ssempijja, F., Matovu, H., MacLeod, E., Anderson, E.N., Welburn, S.C., 14 Apr 2020. Pandemic panic and anxiety in developing countries. Embracing One Health offers practical strategies in management of COVID-19 for Africa. Pan African Med. J. 35 (2), 3. https://doi.org/10.11604/pamj.supp.2020.35.2.22637. https://www.panafrican-med-journal.com/content/series/35/2/3/full/.
Kabasa, J.D., 2007. Public-private partnership works to stamp out sleeping sickness in Uganda. Trends Parasitol. 23, 191–192.
Lehane, M., Alfaroukh, I., Bucheton, B., Camara, M., Harris, A., Kaba, D., Lumbala, C., Peka, M., Rayaisse, J.B., Waiswa, C., Solano, P., Torr, S., 2016. Tsetse control and the elimination of Gambian sleeping sickness. PLoS Negl. Trop. Dis. 10 (4), e0004437. https://doi.org/10.1371/journal.pntd.0004437.
Leigh, O.O., Emikpe, B.O., Ogunsola, J.O., 2015. Histopathological chnages in some reproductive and endocrine organs of Trypanosoma brucei infected West African Dwarf goat Does. 1, 31–39. https://doi.org/10.15547/bjvm.83.
Mazet, J.A.K., Clifford, D.L., Coppolillo, P.B., Deolalikar, A.B., Erickson, J.D., Kazwala, R.R., 2009. A "one health" approach to address emerging zoonoses: the HALI project in Tanzania. PLoS Med. https://doi.org/10.1371/journal.pmed.1000190.
Muhanguzi, D., Picozzi, K., Hattendorf, J., Thrusfield, M., Kabasa, J.D., Waiswa, C., Welburn, S.C., 2014a. The burden and spatial distribution of bovine African trypanosomes in small holder crop- livestock production systems in Tororo District. , pp. 1–10 https://doi.org/10.1186/s13071-014-0603-6.
Muhanguzi, D., Picozzi, K., Hattendorf, J., Thrusfield, M., Welburn, S.C., Kabasa, J.D., Waiswa, C., 2014b. Improvements on restricted insecticide application protocol for control of human and animal African trypanosomiasis in Eastern Uganda. PLoS Negl. Trop. Dis. 8 e3284. [3.9].

Muhanguzi, D., Okello, W.O., Kabasa, J.D., Waiswa, C., Welburn, S.C., Shaw, A.P.M., 2015. Cost analysis of options for management of African animal trypanosomiasis using interventions targeted at cattle in Tororo District; South-Eastern Uganda. Parasit. Vectors 8, e387. https://doi.org/10.1186/s13071-015-0998-8.
National Population and Housing Census, 2014. https://www.ubos.org/wp-content/uploads/publications/03_20182014_National_Census_Main_Report.pdf.
Nyimba, P.H., Komba, E.V., Sugimoto, C., N. B., 2015. Prevalence and species distribution of caprine trypanosomiasis in sinazongwe and kalomo districts of Zambia. Vet. Parasitol. 210 (3–4), 125–130.
Okello, W., 2016. Socioeconomics of animal and human Trypanosomiasis in Uganda. PhD Thesis. The University of Edinburgh.
Okello, A.L., Welburn, S.C., 2014. The importance of veterinary policy in preventing the emergence and re-emergence of zoonotic disease: examining the case of human African Trypanosomiasis in Uganda. Front. Public Health 2, 218. https://doi.org/10.3389/fpubh.2014.00218. eCollection 2014 Nov 3.
Okello, A.L., Gibbs, E.P., Vandersmissen, A., Welburn, S.C., 2011 Sep 10. 2011. One health and the neglected zoonoses: turning rhetoric into reality. Vet. Rec. 169 (11), 281–285.
Okello, A., Welburn, S.C., Smith, J., 2014. Crossing institutional boundaries: Mapping the policy process for the control of neglected zoonotic diseases in Sub-Saharan Africa. Health Policy Plan. https://doi.org/10.1093/heapol/czu059.
Okello, A.L., Beange, I., Shaw, A., Moriyón, I., Bardosh, K., Gabriel, S., Saarnak, C., Vang Johanssen, M., Mukaratirwa, S., Berkvens, D., Welburn, S.C., 2015a. Raising the profile of neglected zoonotic diseases: three complementary European Commission-funded projects to streamline research, build capacity and advocate for control. PLoS Negl. Trop. Dis. 9 (3). https://doi.org/10.1371/journal.pntd.0003505 03/2015.
Okello, W.O., Muhanguzi, D., MacLeod, E., Welburn, S.C., Waiswa, C., Shaw, A.P., 2015b. Contribution of draft cattle to rural livelihoods in a district of south eastern Uganda endemic for bovine parasitic diseases: an economic evaluation. Parasit. Vectors 8, 571. https://doi.org/10.1186/s13071-015-1191-9 11/2015.
Okello, A., Vandersmissen, A., Welburn, S.C., 2015c. One health into action: integrating global health governance with National Priorities in a globalized world. In: Zinsstag, Jakob (Ed.), One Health: The Theory and Practice of Integrated Health Approaches. Marcel Tanner, Esther Schelling, Maxine Whittaker ISBN: 9781780643410.
Picozzi, K., Fèvre, E.M., Odiit, M., Carrington, M., Eisler, M.C., Maudlin, I., Welburn, S.C., 2005. Sleeping sickness in Uganda: a thin line between two fatal diseases. BMJ. 331 (7527), 1238–1241 2005 Nov 26.
Selby, R., Bardosh, K., Picozzi, K., Waiswa, C., Welburn, S.C., 2013. Cattle movements and trypanosomes: restocking efforts and the spread of Rhodesian sleeping sickness in post-conflict Uganda. Parasites Vect. 6, 281.
Shaw, A.P.M., Torr, S.J., Waiswa, C., Cecchi, G., Wint, G.R.W., Mattioli, R.C., Robinson, T.P., 2013. Estimating the costs of tsetse control options : an example for Uganda ☆. Prevent. Vet. Med. 110 (3–4), 290–303. https://doi.org/10.1016/j.prevetmed.2012.12.014.
Shaw, A.P.M., Wint, William, Cecchi, Giuliano, Torr, Stephen, Waiswa, Charles, Alemu, Temesgen, Eregae, Michael, Abdi, Abdullatif, Muchina, Solomon, Mugasi, Samuel, Mattioli, Raffaele, Robinson, Timothy, 2017. Intervening against bovine trypanosomiasis in eastern Africa: Mapping the costs and benefit. Programme against African Trypanosomiasis. Food and Agriculture Organisation of the United Nations ISBN: ISBN 978-92-5-109781-6.
Simarro, P., Cecchi, G., Paone, M., Franco, J., Diarra, A., et al., 2010. The atlas of human african trypanosomiasis: a contribution to global mapping of neglected tropical diseases. Int. J. Health Geogr. 9, 57.
Torr, S.J., Maudlin, I., Vale, G.A., 2007. Less is more: restricted application of insecticide to cattle to iprove the cost and efficacy of tsetse control. Med. Vet. Entomol. 21 (1), 53–64.
Uganda Trypanosomiasis Control Council Act, 1992. http://www.coctu.go.ug/UTCC_ACT.pdf.
Vandersmissen, A., Welburn, S.C., 2014. Current initiatives in One Health: consolidating the One Health Global Network. Rev. Sci. Tech. 33 (2), 421–432 2014 Aug.
Waiswa, C., 2005. Porcine trypanosomiasis in southeastern Uganda: prevalence and assessment of therapeutic effectiveness. Bulgarian J. Vet. Med. 8 (1), 59–68.
Waiswa, C., Kabasa, J.D., 2010. Experiences with an in-training community service model in the control of zoonotic sleeping sickness in Uganda. J. Vet. Med. Educ. 37, 276–281.
Waiswa, C., Rannalette, A., 2010. Entrepreneurship initiatives in the control of sleeping sickness: experiences of the stamp out sleeping sickness in Uganda. J. Small Bus. Entrep. 23 555–464.
Waiswa, C., Wangoola, M.R., 2019. Sustaining efforts of controlling zoonotic sleeping sickness in Uganda using Trypanocidal treatment and spray of cattle with Deltamethrin. Vector Borne Zoo. Dis. https://doi.org/10.1089/vbz.2018.2382 2019 Jan 14.
Waiswa, C., Olaho-Mukani, W., Katunguka-Rwakishaya, E., 2003. Domestic animals as reservoirs for sleeping sickness in three endemic foci in South-Eastern Uganda. Ann. Trop. Med. Parasitol. 97, 149–155.
Waiswa, C., Picizzi, K., Katunguka-Rwakishaya, E., Olaho-Mukani, R.A., Welburn, S.C., 2006. *Glosssina fuscipes fuscipes* in the trypanosomiasis endemic areas of south eastern Uganda: apparent density, trypanosome infection rates and host feeding preferences. Acta Trop. 99, 23–29.
Welburn, S.C., Coleman, P., 2015. Human and animal African Trypanosomiasis. In: Zinsstag, Jakob (Ed.), One Health: The Theory and Practice of Integrated Health Approaches. Marcel Tanner, Esther Schelling, Maxine Whittaker ISBN: 9781780643410.
Welburn, S.C., Picozzi, K., Fèvre, E.M., Coleman, P.G., Odiit, M., Carrington, M., Maudlin, I., 2001. Identification of human infective trypanosomes in animal reservoir of sleeping sickness in Uganda by means of serum-resistance-associated (*SRA*) gene. Lancet 358, 2017–2019.
Welburn, S.C., Beange, I., Ducrotoy, M.J., Okello, A.L., 2015. The neglected zoonoses–the case for integrated control and advocacy. Clin. Microbiol. Infect. 5, 433–443. https://doi.org/10.1016/j.cmi.2015.04.011.
Yamane, Taro, 1967. Statistics, An Introductory Analysis. 2nd Ed. Harper and Row, New York.