



Protecting Livestock – Improving Human Lives

Baseline study for the integration of novel treatments, vaccines and diagnostics into Animal African Trypanosomosis control programmes

Uganda Field Study Report

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Table of contents

Foreword	3
Study Aims and Methodology	3
1. Introduction	3
1.1 Aim of the study and approach	3
2. Methods for data collection	4
2.1 Sampling of the study areas and households	4
2.2 Data collection	5
Study Results	5
3. Uganda profile	5
3.1 Description of the study area and summary of the results	5
3.2 Study population characteristics	7
3.3 General livestock keeping data	8
4. Veterinary practises	10
4.1 Veterinary services	10
4.2 Veterinary practises	10
5. Perceived impacts of AAT in study areas	12
5.1 Perceptions of AAT occurrence	12
5.2 Perceptions of AAT economic impact	16
5.3 Attitudes and practises towards AAT diagnosis and treatment in cattle	17
5.4 Existing AAT control	20
6. Households' knowledge about AAT	21
7. Attitudes towards future AAT control	23
7.1 Population opinion about new control methods	23
Conclusions	29
References	29

Foreword

Animal African trypanosomosis (AAT) is an important constraint of livestock production and threat to food security in sub-Saharan Africa [1]. Of the 37 sub-Saharan African countries affected by trypanosomosis, 21 are among the world's 25 poorest [2]. Reduced productivity of cattle due to trypanosome infection has been estimated at approximately 10-20% across a range of parameters including mortality, calving rate, meat production, milk production and draft power. It also reduces the area which could potentially be used for livestock production, as cattle density is very low in areas with a high tsetse-trypanosome burden. In these areas farmers are often more reliant on crop farming however trypanosomosis reduces the availability of draught animals to plough fields and manure for fertiliser.

This is one of five country specific sub-Saharan African studies (conducted in Uganda, Burkina Faso, Cameroon, Ethiopia and Zambia) aimed at generating baseline information that could inform the integration of novel treatments, diagnostics and vaccines (should they become available) into control programs for AAT. A previous systematic review of recent and on-going Trypanosome & Tsetse control programs has been the basis for the geographic focus of the five ecopathological studies [3]. This report summarizes the results of the study which was carried out in Uganda (Southeast), where AAT is considered endemic. In this area cattle are the main reservoirs for *Trypanosoma brucei rhodesiense* (*T. b. rhodesiense*) which causes human African trypanosomosis (HAT) or 'sleeping sickness' in humans. There are also reports and evidence of the development of trypanocide resistance in the area [4]. Districts included in the study were Busia, Buyende, Kumi, Iganga, Pallisa and Tororo.

Study Aims and Methodology

1. Introduction

1.1 Aim of the study and approach

The aim of the study was to assess the current perceived impact of AAT in the selected study area and the scope for improving AAT control by introducing or integrating new control measures into future or existing AAT control programs.

The relative extent to which AAT constrains livestock production in the study areas was ascertained by comparing farmers' attitudes regarding AAT frequency and economic impact (mortality, loss of production and cost of treatment) with their attitudes towards general livestock diseases in their herds. Successful control of AAT is dependent on farmers' motivation to control the disease individually, and to cooperate with externally-led control programs. Data regarding existing control programs and consumer willingness to use and pay for new trypanocides, diagnostic tests and vaccines were collected to inform future control programs and assess the demand for, and likely uptake of novel AAT products.

The study was conducted in the Southeast region of Uganda as a previous systematic literature review of AAT indicated that this is one of the areas that had the highest tsetse population and trypanosome burden [3]. Trypanosomosis is considered endemic in Uganda; the 'tsetse belt' runs from Southeast to Northern Uganda and at least 70% of the entire country is thought to be infested with tsetse flies. *Glossina fuscipes fuscipes* is the main tsetse species present and *G. pallidipes* and *G. morsitans* are also inhabitants. *Trypanosoma vivax*, is the most prevalent species of trypanosome in Ugandan cattle and *T. congolense* and *T. b. rhodesiense* infections are also found [5, 6].

Following increases in human density, changes in land use and a reduction in the wildlife population Ugandan cattle are now considered the primary host of *T. b. rhodesiense* [7]. *T. b. rhodesiense* causes human African Trypanosomosis (HAT) or 'sleeping sickness' which is fatal if left untreated. The distribution of *T. b. rhodesiense* in Uganda has increased dramatically in the past 10 years; this is attributed to the restocking of infected cattle into naïve areas following military conflict in the late 1990's [8]. Over 50% of reported *T. b. rhodesiense* cases in the whole of Africa between 2000 and 2009 were from Uganda [9]. Seven districts were included in the study namely Busia, Buyende, Iganga, Kumi, Ngora, Pallisa and Tororo. Based on available data summarised in Table 1 the region was classified into four study areas according to ecoregion, agro-ecological zone and predominant farming system. These study areas are shown in Image 1 and were Lake Victoria basin (Tororo), Lake Kyoga basin (Buyende & Pallisa), East Sudanian Savanna (Kumi & Ngora) and Lake Victoria basin (intensive) (Busia & Iganga) (see Section 3.1 for a more detailed description of the study areas).

¹The study was selected because it was estimated to be a moderate risk area for AAT from a systematic review of AAT literature (Selby et al. in Preparation).

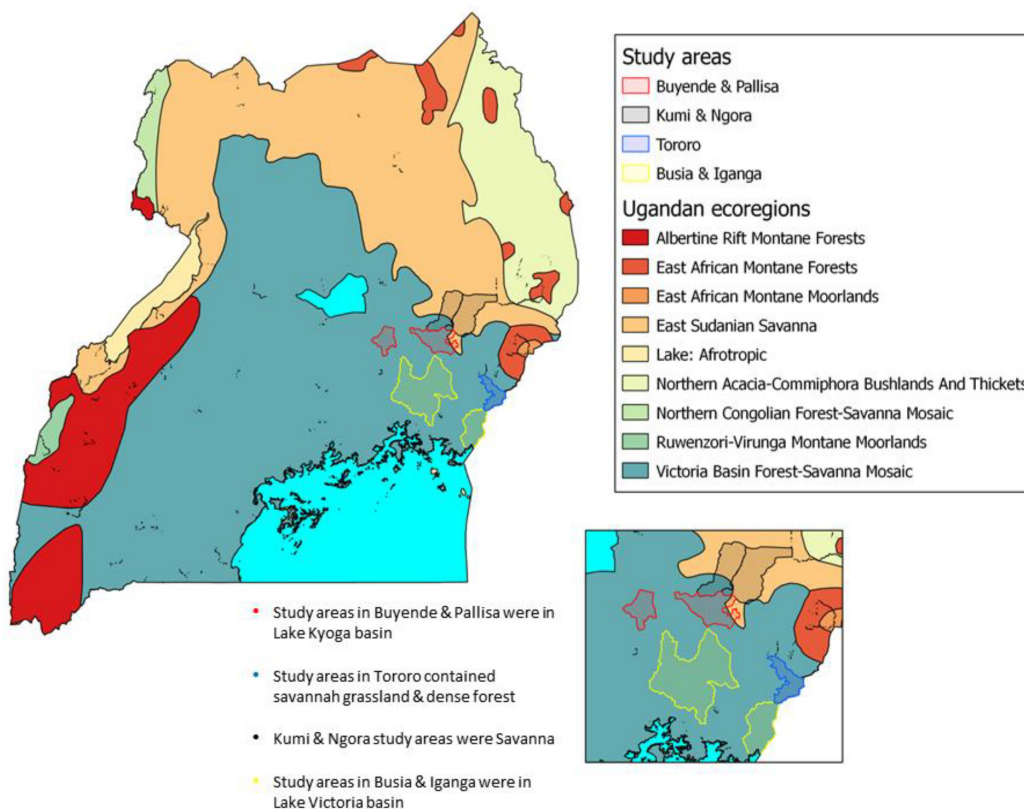


Image 1: Location of the study areas and their ecoregions

	Tororo	Buyende & Pallisa	Kumi & Ngora	Busia & Iganga
Ecoregion	Victoria basin Forest-Savanna Mosaic	Victoria basin Forest-Savanna Mosaic	East Sudanian Savanna	Victoria basin Forest-Savanna Mosaic
Agro-ecological zone	Lake Victoria Crescent & Mbale Farmlands	Southern and Eastern Lake Kyoga Basin	Southern and Eastern Lake Kyoga Basin	Lake Victoria Crescent & Mbale Farmlands
Farming system	Banana-millet-cotton	Banana-millet-cotton	Annual cropping and cattle Teso	Intensive banana-coffee lake shore

Table 1: Description of the study areas within Uganda [10-14].

2. Methods for data collection

2.1 Sampling of the study areas and households

The District Veterinary officer (DVO) for each district included in the study was contacted and a list of village names was obtained. Villages were selected for incorporation in the study using random sampling. The community leader(s) of each village were then contacted in order to gain permission to work in the village. The sampling unit was a household (or homestead); defined as a group of people who normally cooked, ate and lived together. Households were selected using systematic sampling from a central point in the village; a random direction was selected and every fifth household was approached for inclusion in the study. If the household selected did not own cattle, or the head of the household was not present, the next cattle-owning household was studied instead.

2.2 Data collection

The head of the household was contacted and asked if they would be willing to take part in a study which aimed to collect data on cattle health and production in the area. If the head of the household was unavailable then another household would be sampled and the house was re-visited once the member had returned. There were no refusals to participate in the study. Once sampling of the village was complete the enumerators would provide information, including public health risks regarding AAT and other livestock diseases to the community. They would also answer any questions the farmers had regarding livestock production and disease. Data from the study was entered into a Microsoft Access database and selected data were exported to Microsoft Excel for further data analysis.

Study results

3. Uganda Profile

3.1 Results Summary

An overall summary of the findings from each study area are presented in the Table on the following page. The report then goes into a comprehensive detail of the results in the sections that follow.

Area 1: Lake Victoria Crescent (Tororo)

Tororo vegetation mainly consists of savannah grassland and Lantana camara shrubs; dense forests and swamp lands are still found near rivers and streams which are a suitable habitat for *Glossina fuscipes fuscipes*. The region has regular rainfall and high humidity; this is driven by the close proximity of the mountains that lay along the Uganda-Kenya border. The majority of land is currently used for arable production with a high number of small fields throughout the area; crops produced in abundance include maize, wheat, sorghum and cassava. Most farming is subsistence (75%) and there is minimal mechanisation of agricultural processes. The landscape of this area is ideal for tsetse and previous research into AAT and sleeping sickness indicates that there is high risk of both in Tororo [15]. The proximity of tsetse population to water sources used by livestock means interaction rates with cattle can be high [10].

Farmers reported constant AAT challenge; with increasing occurrences in the rainy season. Farmers' perceived the impact of AAT to be severe with losses to draught power and some losses to meat and milk production. There were reports of treatment failure which was attributed to delayed treatment or resistance. Knowledge of the disease was high and knowledge of control was moderate; area was thought to have the highest priority for control.

Area 2: Lake Kyoga basin (Buyende and Pallisa)

Within the district of Kamuli (Buyende) and Pallisa (classified as Lake Kyoga Basin) the majority of land is currently used for arable production. The area has plenty of watering points within the landscape as it is in close proximity to Lake Kyoga and its water courses. These watering points are frequented for grazing, drinking, fishing, hunting and washing purposes and support tsetse populations. Farming occurs to a lesser extent than the other study areas; the area typically being small field plots interspersed by grazing pastures throughout. There is minimal mechanisation of arable processes with cattle draught being the means for ploughing. In addition, many households supplement their income by fishing. With the lower density of arable activity there is an abundance of shrub land where tsetse are found and this area is a high risk HAT and AAT area [8].

Farmers reported frequent AAT challenge; with increasing occurrences in the rainy season. Farmers' perceived the impact of AAT to be low with minor losses to draught power, meat and milk production. Farmers reported low treatment failure which was attributed to delayed treatment or misdiagnosis. Knowledge of the disease and its control were good and this area was thought to be a low priority for control.

Area 3: East Sudanian Savanna (Kumi and Ngora)

Within the districts of Kumi and Ngora (classified as East Sudanian Savanna) most of the dry areas are farmed or used for livestock grazing. A large area of the landscape remains savannah as the population density has not increased as dramatically in this region. There are plenty of watering points during the rainy seasons, however, many of these dry up entirely during the dry season; watering points and grazing areas (during both wet and dry seasons) are favourable habitats for supporting tsetse populations.

Ecological System and District

	Lake Victoria Crescent (Tororo)	Lake Kyogo Basin (Buyende and Pallisa)	East Sudanian Savanna (Kumi and Ngora)	Lake Victoria Crescent (Intensive) (Busia, Iganga)
General livestock keeping data				
Primary source of income	Mixed farming	Mixed farming	Mixed farming	Mixed farming
Median no. of cattle (Q1 & Q2)	5 (3 & 8)	5 (4 & 9)	8 (5.5 & 13)	4 (3 & 6)
Predominant cattle breed	Zebu (Trypanosensitive)	Zebu (Trypanosensitive)	Zebu (Trypanosensitive)	Zebu (Trypanosensitive)
Predominant cattle rearing system	Free-grazing - tethered	Free-grazing > tethered	Free-grazing > tethered	Tethered > Free-grazing
Other important species livestock	Poultry (82%), Goats (78%), Pigs (55%)	Goats (92%), Poultry (92%), Pigs (62%)	Poultry (93%), Goats (85%), Pigs (60%)	Sheep (78%), Poultry (76%), Goats (54%)
Impact of AAT				
Perceived AAT occurrence in herd/disease ranking	Constant/Ranked no. 1	Frequent/Ranked no. 1	Frequent/Ranked no. 1	Frequent/Ranked no. 1
Seasonality	Some seasonality (> rainy)	Some seasonality (> rainy)	Seasonal (rainy)	Seasonal (rainy)
Perceived AAT impact on income	Severe	Low	Moderate	Low
Main losses in livestock outputs due to AAT	Draught power > meat > milk	Draught power > meat > milk	Draught power > meat > milk	Draught power > meat > milk
AAT treatment failure/perceived reason	Moderate Delayed treatment > resistance	Low Delayed treatment - misdiagnosis	Moderate Delayed treatment > resistance	Low Delayed treatment - misdiagnosis
Current AAT control				
Trypanocides kept in household	Isometamidium > diminazene	Diminazene > isometamidium	Few households keep trypanocides	Diminazene > isometamidium
Treatment of AAT	Vet > AHW	Vet	AHW	Vet > Farmers
Cost per AAT treatment: Median (Q1& Q2)	\$3.8 (2.7 & 5.5)	\$4.4 (3.3 & 5.5)	\$4.4 (2.7 & 8.0)	\$2.7 (1.7 & 5.5)
Level of knowledge of AAT control/disease	Moderate/high	Moderate-high/high	Low/moderate	Moderate/high
Point/location of sale of veterinary products	Vet pharmacy Nearby town - village	Vet pharmacy > general shop Local market > nearby town	Vet pharmacy Local - village - nearby town	Vet pharmacy Nearby town
Existing AAT control/facilitators	Low	Moderate	Low	Moderate
Future AAT control				
Willingness to use/pay higher price for new AAT drugs	97%/89%	96%/95%	99%/94%	100%/87%
Willingness to use/pay for new AAT diagnostic	94%/91% - median: \$1.09	99%/98% - median: \$0.80	97%/92% - median: \$1.19	97%/99% - median: \$0.80
Willingness to use/pay for novel AAT vaccine	91%/91% - median: \$1.19	97%/95% - median: \$0.80	100%/96% - median: \$0.80	95%/97% - median: \$0.80
Problems with AAT treatments	Efficacy > shelf life > safety > availability	Efficacy > shelf life > safety > availability	Efficacy > shelf life > storage temperature > availability > safety	Efficacy > shelf life > safety > availability
Perception of fake AAT drug circulation	Low/moderate	Moderate	Low/moderate	Moderate
PRIORITY AREA FOR AAT CONTROL (based on farmers' perceptions)	High priority High risk, high impact, some treatment failure	Moderate priority High risk, low impact, low treatment failure	Moderate-high priority Moderate risk, moderate impact, treatment failure	Low-moderate priority Moderate risk, low impact, low treatment failure
Likely eco-epidemiological cycle	ENDEMIC AAT			

The majority of crops grown here are for home consumption or local sale, whereas other areas tend to produce crops for sale in larger cities such as Kampala. Agriculture is small scale with small field plots interspersed by grazing pasture throughout the area. The proximity of the majority of Kumi and Ngora to wetlands and water courses connected to Lake Kyoga means that much of the rural community supplement their income through fishing activities. The majority of land area in Kumi and Ngora is suitable, or in close proximity to an area that is suitable, for tsetse populations. Previous research into AAT and sleeping sickness does show that there is high risk of both AAT and HAT within the district [16].

Farmers reported frequent and seasonal AAT challenge and the perceived impact on income was moderate with some losses to draught power, meat and milk production. There were some reports of treatment failure which was attributed to delayed treatment or resistance. Knowledge of the disease and its control were low and moderate, respectively and this area was thought to be a moderate-high priority for control.

Area 4: Lake Victoria Crescent (Intensive) (Busia, Iganga)

Within the district of Iganga and Busia (Lake Victoria Crescent) there has been a great increase in the human population over recent years. However, a large section of Iganga is owned by the Kakira sugar plantation, this entire area is unpopulated by human and cattle. Private farmers also grow sugar cane which is then sold to the Kakira refinery. Iganga and Busia also produce maize, wheat, sorghum, rice and cassava; much of the crops grown here are for sale in larger cities such as Kampala, but home consumption is still common.

Water courses flow into the district from the Lake and are used as watering points. The unfarmed areas close to the Lake are used for grazing and are favourable habitats for supporting tsetse populations. However due to the density of population and the high coverage of fields in Iganga much of the shrubland/woodland has been cleared and the landscape is dominated by fields. Farmers reported frequent and seasonal AAT challenge and the perceived impact on income was low with minor losses to draught power, meat and milk production. Treatment failure was thought to be low and attributed to delayed treatment or resistance. Knowledge of the disease and its control were moderate and high, respectively and this area was thought to be a low-moderate priority for control.

3.2 Study population characteristics

A total of 374 households were included in the study; the number of households studied and median household size according to study area is presented in Table 2. Of households interviewed 91.2% were primarily mixed (livestock and crop) farmers and 98% had permanent access to land. Only 4% of households moved seasonally in order to find better grazing areas for livestock.

Study areas	Households studied	Median household size (Q1 & Q2)
Lake Victoria basin (Tororo)	139	11 (7.5 & 14.5)
Lake Kyoga basin (Buyende, Pallisa)	78	13 (9 & 17.8)
East Sudanian Savanna (Kumi, Ngora)	83	9 (7 & 13)
Lake Victoria basin (intensive) (Busia, Iganga)	74	10 (7 & 13)

Table 2: Number of households studied and median household size and lower (Q1) and upper (Q3) quartiles (data from 374 households interviewed in East Uganda in May/June 2013).

Most households did not have water or electricity in the home, however, most did have water in the community and most had toilets in the community and household (>90% for all study areas). Walking distances from households to the nearest water point is presented in Table 3; households in the East Sudanian Savanna (Kumi, Ngora) area had the furthest walking distance to water points. This study area was furthest away from the Lakes (Victoria/Kyoga). Many households in the study population had mobile phones and bicycles, which appeared to be the main mode of transport owned by households.

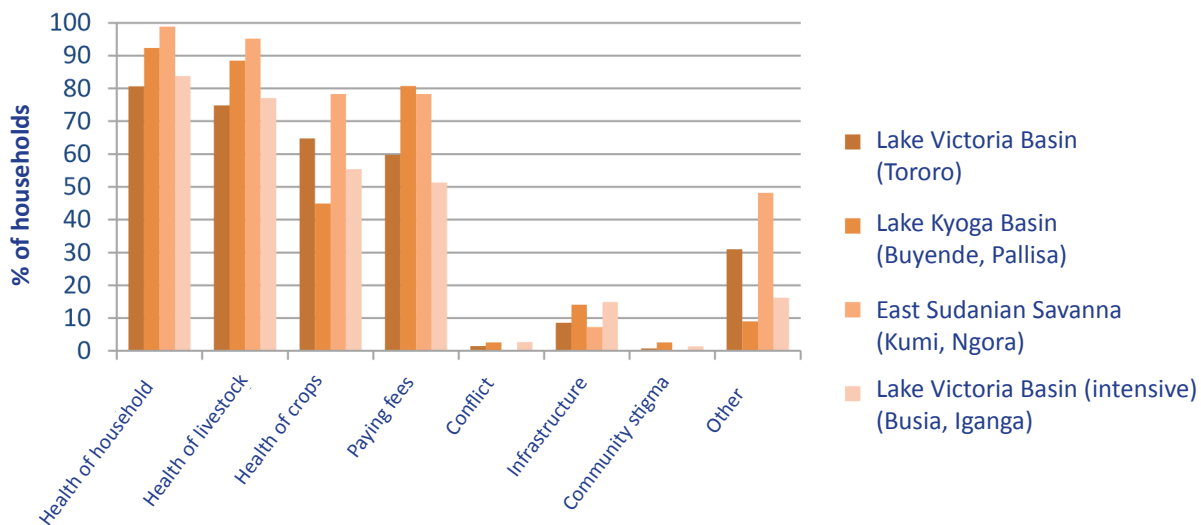


Figure 2: Main issues faced by households, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

3.3 General livestock keeping data

The East Sudanian Savanna study area (Kumi & Ngora) tended to have larger herds and more households owned cattle (Table 4). This is predominantly due to the availability of open grassland for the grazing of cattle. In the other study areas households kept fewer cattle and they were more likely to be tethered (or a combination of tethered and free-grazing); particularly in Busia & Iganga (63.5%). In this area high population density and intensive farming reduces availability of livestock grazing areas also, cattle are often tethered during the wet season and driven to open grasslands near swampy areas during the dry season. In addition to cattle (which was a prerequisite for enrolment in the study) households owned sheep, goats pigs and poultry.

Households kept Zebu; a trypanosensitive cattle breed. Reasons given for keeping this breed were mainly traditional preference in all study areas (40 to 50%), improved traction, particularly in Lake Victoria basin (Tororo: 30.7%) and East Sudanian Savanna (Kumi, Ngora: 35.2%) and disease resistance (~25%) (Table 5).

	Tororo	Buyende & Pallisa	Kumi & Ngora	Busia & Iganga
Total number of cattle: Median (Q1 & Q2)	5 (3 & 8)	5 (4 & 9)	8 (5.5 & 13)	4 (3 & 6)
Adult Female cattle: % households owning at least 1 Median (Q1 & Q2)	89.9% 2 (1 & 4)	91% 2 (1.25 & 4)	98.8% 3 (2 & 4)	97.3% 3 (2 & 3.8)
Adult Male cattle: % households owning at least 1 Median (Q1 & Q2)	84.9% 2 (1 & 3)	87.2% 2 (2 & 3)	95.2% 2 (2 & 4)	67.6% 1 (0 & 2)
Calves: % households owning at least 1 Median (Q1 & Q2)	61.2% 1 (0 & 2)	69.2% 1 (0 & 2)	88% 2 (1 & 3)	59.5% 1 (0 & 2)
Cattle rearing system:				
Free grazing	48.9%	50%	70.7%	36.5%
Tethered	32.4%	31.6%	19.5%	44.6%
Penned	1.4%	1.3%	0%	0%
Free grazing & tethered	17.3%	15.8%	9.8%	18.9%
Free grazing & penned	0%	1.3%	0%	0%
Other species:				
Sheep	23.7%	21.6%	31.5%	9.9%
Goats	77.7%	91.9%	84.7%	80.3%
Pigs	54.7%	62.2%	59.7%	26.8%
Poultry	82.7%	91.9%	92.7%	91.6%

Table 4: Cattle herd composition of each type of cattle, according to study area (data from 151 households interviewed in April/ May 2013).

Variables associated with breed choices	% of households
Households mentioning traditional preference	
Lake Victoria basin (Tororo)	44.6%
Lake Kyoga basin (Buyende, Pallisa)	43.2%
East Sudanian Savanna (Kumi, Ngora)	54.4%
Lake Victoria basin (intensive) (Busia, Iganga)	49.3%
Households mentioning improvement in traction	
Lake Victoria basin (Tororo)	30.7%
Lake Kyoga basin (Buyende, Pallisa)	16.2%
East Sudanian Savanna (Kumi, Ngora)	35.2%
Lake Victoria basin (intensive) (Busia, Iganga)	7.0%
Households mentioning disease resistance	
Lake Victoria basin (Tororo)	25%
Lake Kyoga basin (Buyende, Pallisa)	21.6%
East Sudanian Savanna (Kumi, Ngora)	26.4%
Lake Victoria basin (intensive) (Busia, Iganga)	28.2%

Table 5: Reasons for selecting particular breeds, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

4. Veterinary practises

4.1 Veterinary services

Veterinary services were decentralised to reduce public expenditure during the late 1980s and early 1990s [17]. This resulted in privatisation of clinical and breeding services, which caused a great range in the quality of activities. Vaccination and tsetse control were still the responsibility of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) [17]. There are a number of actors involved in the delivery of veterinary services in Uganda. A recent study found the community animal health workers (CAHWs) and NGOs/development agencies tend to be involved in curative and preventive services for pastoral systems [17]. CAHWs tend to have three months of training in animal health management; some paraprofessionals which work with intensive producers have one to two years formal training. Government veterinarians tend to work with the National Agricultural Advisory Services (NAADS) programme and often do not have time for clinical services. The NAADS act aims at transforming extension services to a private-sector demand-driven approach, see Ilukor et al. (2014) for more information on provision of veterinary services in Uganda. Trypanidium®).

4.2 Veterinary practises

Around 87% of households reported consulting a veterinarian or similar when their livestock were sick. Participants were asked to present drugs that were currently in the household's possession; they were then asked about any other drugs they regularly use which were not currently in the household. Results according to study area are presented in Table 6; most trypanocides kept by studied households were diminazene diacetate or isometamidium chloride.

	Tororo	Buyende & Pallisa	Kumi & Ngora	Busia & Iganga
Trypanocides				
Diminazene	9.4%	11.5%	7.2%	17.6%
Isometamidium chloride	10.8%	3.8%	1.2%	12.2%
Homidium chloride	0%	0%	0%	4.1%
Acaracide	29.7%	8.1%	54.1%	13.5%
Acaracide (general)	5.8%	6.4%	6%	1.4%
Suitable for tsetse	2.9%	5.1%	4.8%	0%
Anthelmintics	10.1%	28.2%	12%	21.6%
Multi-vitamins	0%	5.1%	1.2%	2.7%
Antibiotics				
Oxytetracyclin	18%	25.6%	10.8%	23%
Penicillin	1.4%	6.4%	2.4%	5.4%
Other	3.6%	5.1%	0%	4.1%

Table 6: Main livestock drugs kept in the house, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

The main point-of-sale households' used for livestock treatment in each study area are presented in Figure 3 and Figure 4. Most households bought livestock treatment from a vet pharmacy located either in the local market (Lake Kyoga basin) or a nearby town (Lake Victoria basin (intensive)).

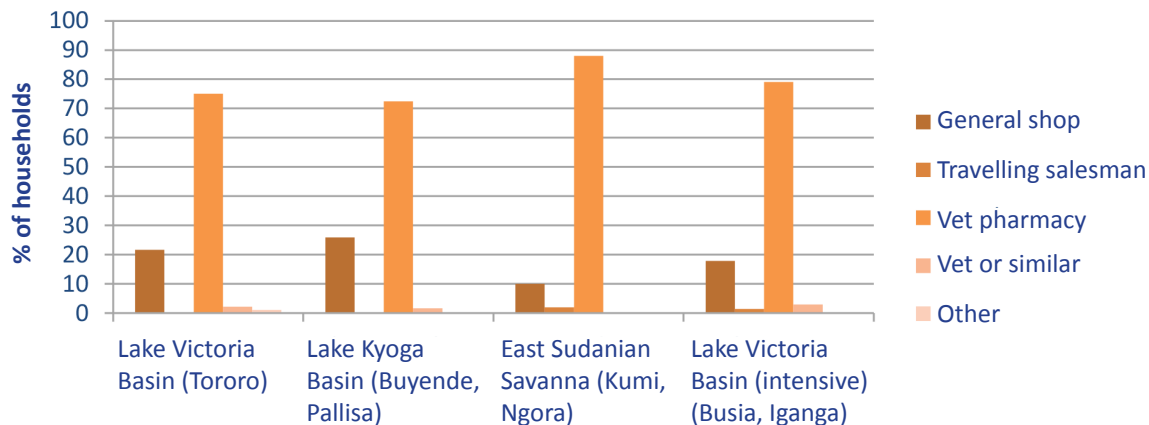


Figure 3: Point-of-sale of veterinary drugs and products, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

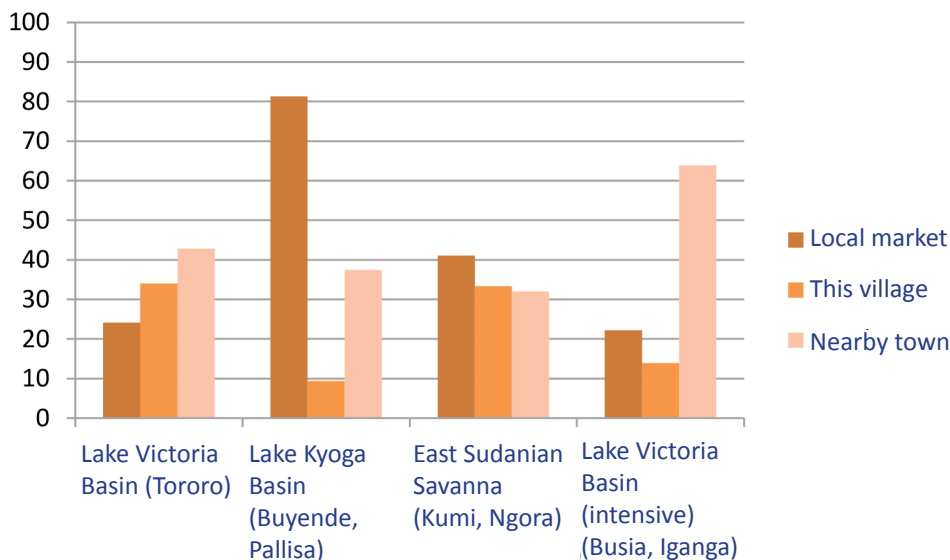


Figure 6: Location of drug point-of-sale, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

Around a third of households reported vaccinating their cattle; however, in the Lake Kyoga basin study area (Buyenda & Pallisa) 78.4% of households reported vaccinating their animals. Households which vaccinated generally did so when an official programme was active (31.6%), however households in Iganga and Busia would also vaccinate individually (22.5%). Households mainly vaccinated against East Coast fever (ECF) using the Infection-treatment method (ITM). Some households reported vaccinating against AAT, despite there being no AAT vaccine currently available. Prophylactic treatment and mass vaccination is the same in the local language, therefore follow up questions revealed this was due to trypanocide prophylaxis.

	Vaccinate cattle (%)	Official Programme (%)	Individually (%)
Lake Victoria basin (Tororo)	37.4%	32.4%	7.9%
Lake Kyoga basin (Buyende, Pallisa)	78.4%	70.3%	10.8%
East Sudanian Savanna (Kumi, Ngora)	23.6%	22.8%	1.6%
Lake Victoria basin (intensive) (Busia, Iganga)	39.4%	25.4%	22.5%
Whole country	37.2%	31.6%	8.8%

Table 7: Proportion of livestock vaccination and vaccination context, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

5. Perceived impacts of AAT in study areas

5.1 Perceptions of AAT occurrence

The following results were obtained when interviewees were asked non-specific questions regarding livestock diseases in the area, with no mention of AAT. Figure 5 displays the top 10 livestock diseases in the study areas; ranked in accordance with the percentage of households reporting them as important livestock diseases (in terms of monetary losses). AAT was ranked the highest overall and was the most important disease in all study areas; especially East Sudanian Savanna (Kumi & Ngora: 89.2%). Most households in this study area also mentioned East Coast Fever (ECF) (88.0%). Tsetse were mentioned as causing a problem to livestock especially in the Lake Kyoga basin (Buyende & Pallisa: 67%) and Lake Victoria basin (intensive) (Busia & Iganga: 61%).

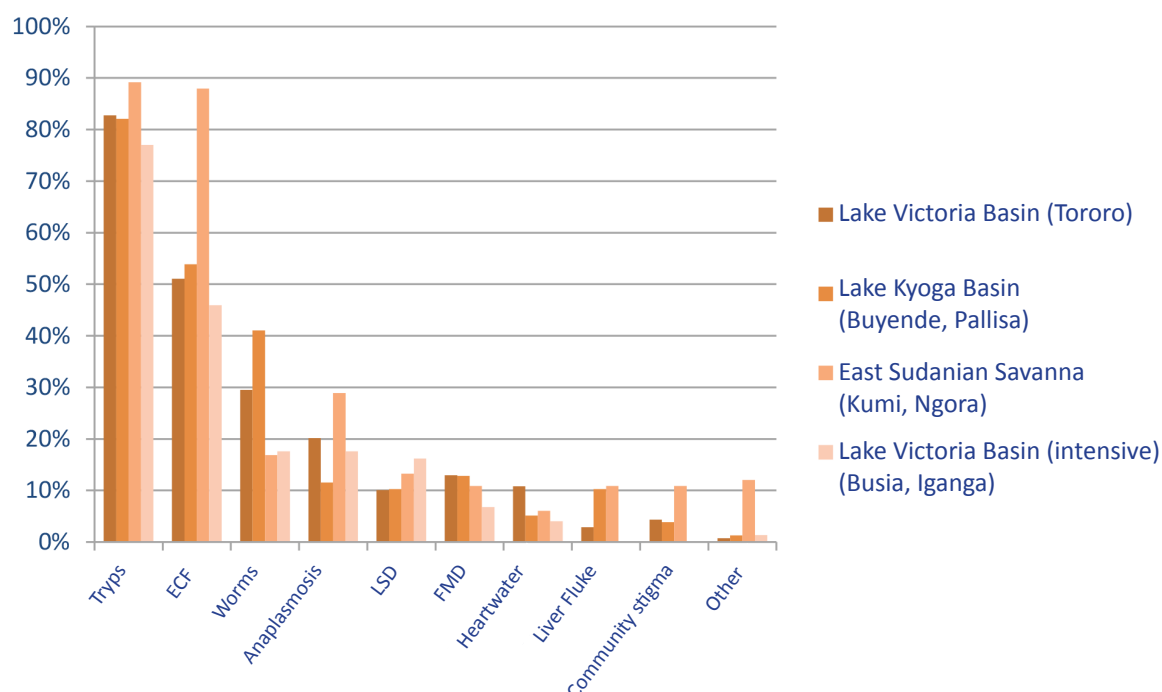


Figure 5: Top 10 diseases, according to the percentage of households mentioning them as 'important livestock diseases in terms of monetary losses' (data from 374 households interviewed in East Uganda in May/June 2013).

Disease	Rankings
AAT	1
East Coast Fever (ECF)	2
Worms	3
Anaplasmosis	4
Lumpy Skin Disease (LSD)	5
Foot and mouth disease (FMD)	6
Heartwater	7
Liver fluke	8
African Swine Fever (ASF)	9
Contagious bovine pleuropneumonia (CBPP)	10

Figure 5 (continued): Top 10 diseases, according to the percentage of households mentioning them as 'important livestock diseases in terms of monetary losses' (data from 374 households interviewed in East Uganda in May/June 2013).

Households were shown a picture of a cow suffering from AAT, although the clinical signs exhibited by the cow were non-specific (Image 2). This information was used as an indication of the relative importance of AAT in the different areas i.e. in areas where AAT was a major problem a household would be more likely to suggest the cow was suffering from AAT. When shown the picture, most households said that the cow was suffering from AAT (>50%) for all study areas (Table 7).



Image 2: AAT infected cow showing typical wasting signs, interviewees were asked to suggest what was wrong with the cow.

	Lake Victoria basin	Lake Kyoga basin	East Sudanian Savanna	Lake Victoria basin (intensive)
AAT	61.2%	62.8%	51.8%	66.2%
Malnutrition	4.3%	7.7%	3.6%	5.4%
Liver flukes	5.8%	3.8%	-	1.4%
Worms	7.2%	17.9%	10.8%	4.1%
Other	2.8%	-	5%	-
No answer given	18.7%	7.8%	28.8%	22.9%

Table 8: Disease suggestions when shown a picture of a cow with clinical signs compatible with AAT, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

After non-specific disease questions were posed to interviewees; the interviewer then asked whether they had heard of AAT, those that had (96.3% overall: 97.1% Lake Victoria basin, 91.0% Lake Kyoga basin, 97.6% East Sudanian Savanna and 98.7% Lake Victoria basin) were then asked a series of specific questions to acquire further information on the relative impact of AAT in the areas. The Lake Victoria basin (Tororo) area appeared to have the most frequent outbreaks of AAT with 55.9% of households reporting AAT occurrence to be constant. In the other study areas around a third of households reported constant or frequent AAT occurrences; with households in the Lake Victoria basin (intensive) (Busia & Iganga) study area more likely to report that AAT rarely occurs in the area (20.6%).

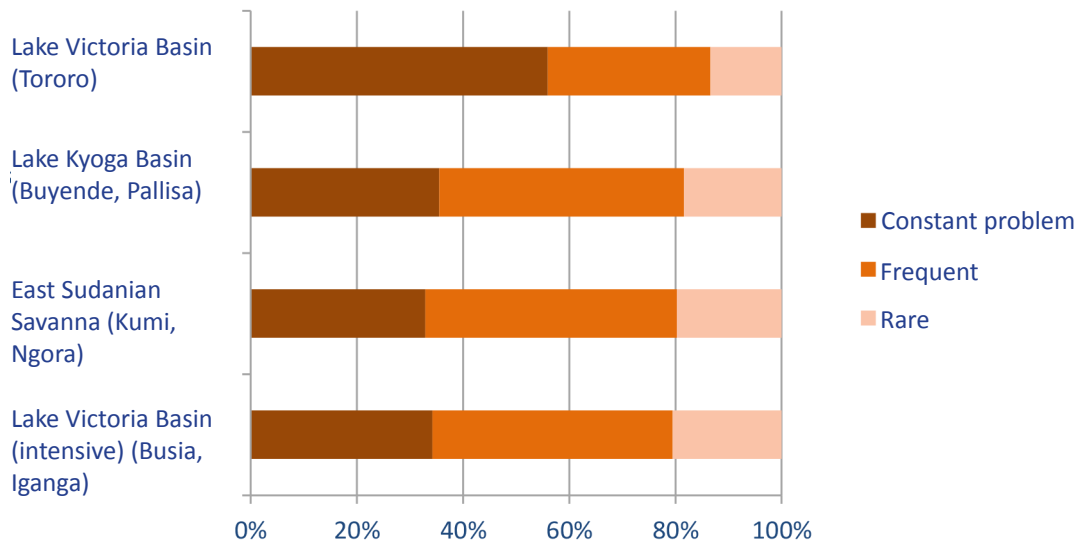


Figure 7: Frequency of AAT in livestock, according to study area (data from 374 households interviewed in East Uganda May/June 2013).

Households were least likely to report a seasonal pattern to AAT occurrence in Lake Kyoga basin (Buyende and Pallisa). Around half of farmers in this study area said disease occurrence was sporadic. Households reporting seasonality mostly said that AAT is more frequent in the rainy season (>80% for all study areas).

	Lake Victoria basin	Lake Kyoga basin	East Sudanian Savanna	Lake Victoria basin (intensive)
AAT seasonal	36.5%	17.4%	30.9%	34.3%
Some seasonality	15.9%	2.9%	14.8%	8.6%
Present throughout the year	30.3%	27.5%	9.9%	25.7%
Sporadic	27.3%	52.2%	44.4%	31.4%

Table 9: Seasonality of AAT (data from 374 households interviewed in East Uganda in May/June 2013).

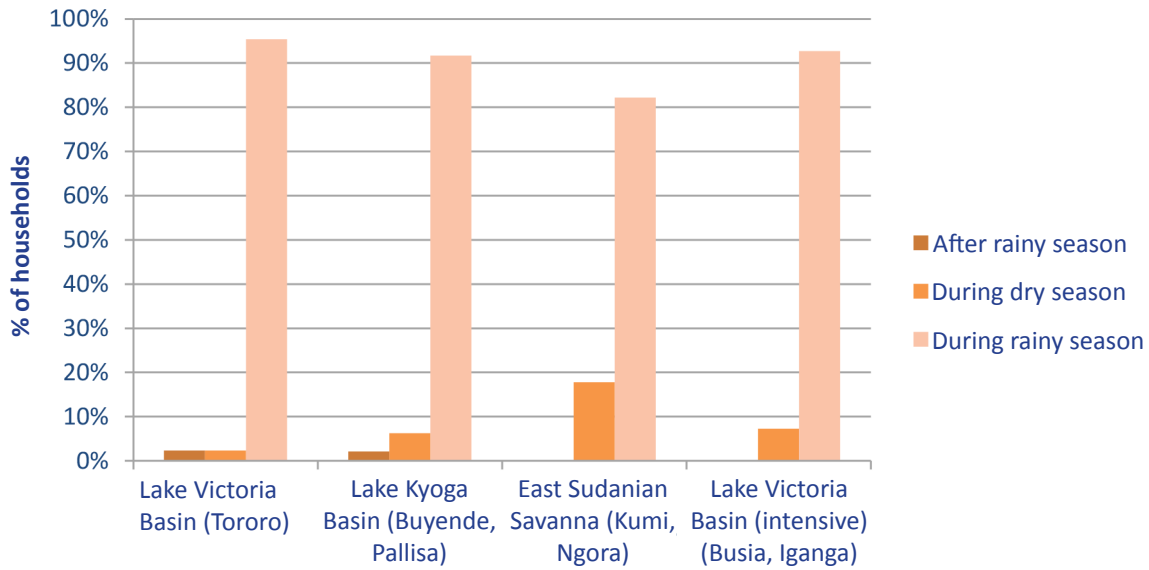


Figure 8: Period of higher AAT occurrence according to households reporting seasonality, (data from 374 households interviewed in East Uganda in May/June 2013).

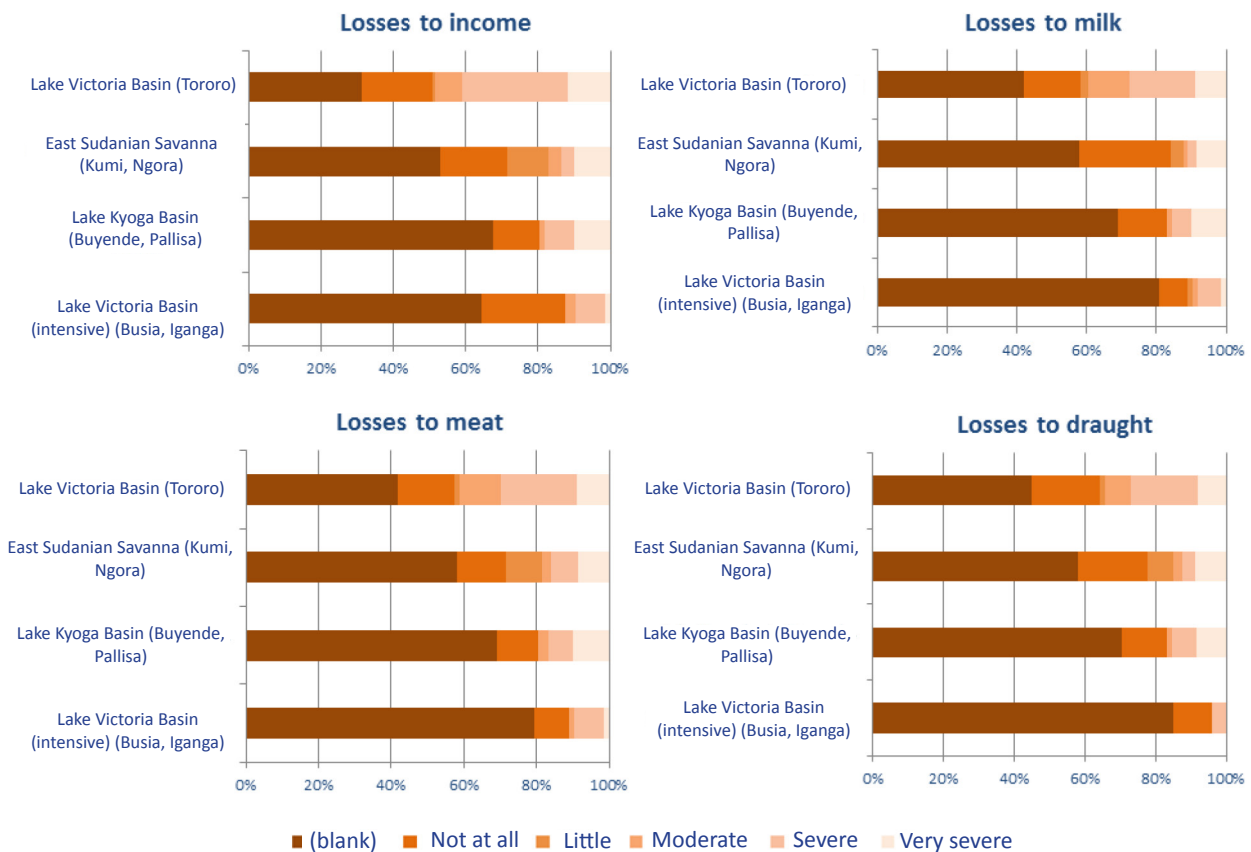


Figure 9: Production losses due to AAT, according to study area and livestock outputs (data from 374 households interviewed in East Uganda in May/ June 2013).

5.2 Perceptions of AAT occurrence

The perceived impact of AAT on household income is presented in Figure 9. Most households did not define the losses due to AAT. In some cases this was because they did not feel the losses were severe or cattle were not of major importance to the income of the household. Households in Lake Victoria basin (Tororo) reported the biggest losses in income due to AAT with 41.0% of households reporting severe or very severe losses. In this study area, 69.2% of households experiencing cattle deaths had experienced cattle deaths due to AAT (Figure 10). Within households which owned goats, sheep and pigs in this area 22.8% had experienced goat or sheep deaths which they attributed to AAT and 13.2% had pig mortalities which they believed were due from AAT. However, it cannot be confirmed that the deaths were due to AAT.

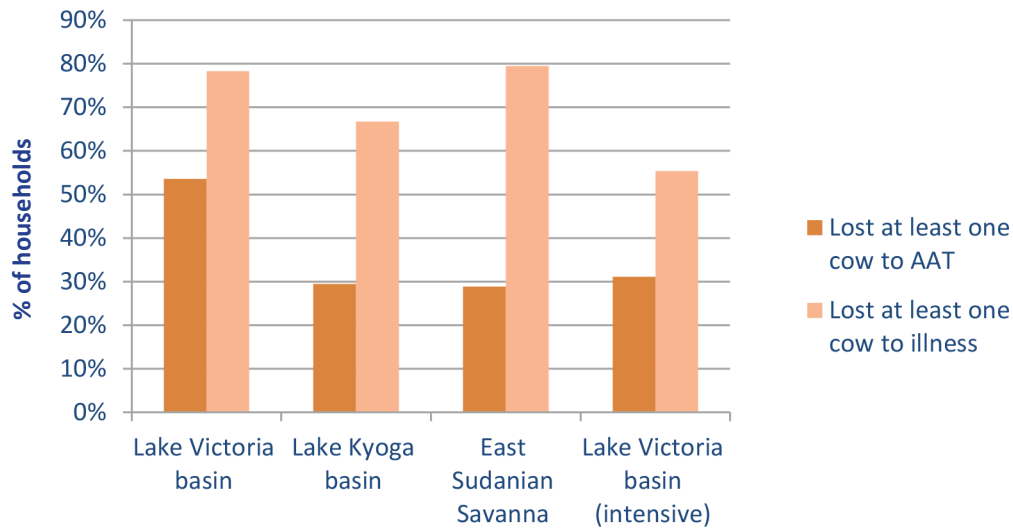


Figure 10: Percentage of cattle died in that past two years according to study area (data from 374 households interviewed in East Uganda in May/ June 2013).

Information on total costs of treatment and mortality for all diseases in general, and specifically AAT, are presented in Table 10. Total cost of treating and diagnosing AAT tended to be highest in Lake Victoria basin (Tororo), followed by Lake Kyoga basin (Buyende & Pallisa). Mortality questions were asked over a two year period.

The study was conducted in May/June 2013 and at this time the exchange rate of the Ugandan shilling (UGX) to the United States Dollar (USD) according to www.xe.com was 2591.9 UGX = 1USD.

³ The study was selected because it was estimated to be a moderate risk area for AAT from a systematic review of AAT literature (Selby et al. in Preparation).

	Lake Victoria basin	Lake Kyoga basin	East Sudanian Savanna	Lake Victoria basin (intensive)
Cost per individual AAT treatment (US\$): Median (Q1 & Q3)	3.8 (2.7 & 5.5)	4.4 (3.3 & 5.5)	4.4 (2.7 & 8.0)	2.7 (1.7 & 5.5)
Total cost (US\$) AAT diagnosis & treatment: % households > 0 Median (Q1 & Q3)	71.9% 27.4 (11 & 82.3)	46.2% 16.5 (3.3 & 43.9)	68.7% 11.0 (3.3 & 24.7)	44.6% 11.0 (2.7 & 41.1)
Total cost (US\$) disease diagnosis & treatment: % households > 0 Median (Q1 & Q3)	71.2% 90 (30.2 & 219.4)	43.6% 43.9 (25.4 & 94.6)	47.0% 131.7 (74.0 & 238.6)	39.2% 27.4 (11.0 & 16.3)
Cattle deaths AAT: % households > 0 Median (Q1 & Q3)	31 2.5 (1 & 7)	21 2 (2 & 10)	27.1% 1 (1 & 3.25)	31.1% 2 (1 & .5)
Cattle deaths (all disease): % households > 0 Median (Q1 & Q3)	41.4 2 (1 & 3)	59 4 (2 & 6.3)	79.5% 3 (2 & 5)	55.4% 2 (1 & 3)
Goat/sheep deaths (AAT) : % households > 0 Median (Q1 & Q2)	21 3 (2.25 & 6.8)	11.5 5 (3 & 5.5)	12.5% 3 (2 & 4)	11.7% 3 (2 & 4.5)
Goat/sheep deaths (all disease): % households > 0 Median (Q1 & Q2)	29.2 4 (3 & 10)	59 3.5(1.75 & 6)	47.2% 3 (2 & 5)	51.7% 2 (1 & 4)
Pig deaths (AAT) : % households > 0	29.2	59	2.0%	4.8%
Pig deaths (all disease) : % households > 0	29.2	59	1.9%	2.8%

Table 10: Direct losses from AAT and other livestock diseases in terms of treatment costs in US dollars and mortality ; null values are excluded from the calculation of medians and quartiles (data from 374 households interviewed in East Uganda in May/June 2013).

5.3 Attitudes and practises towards AAT diagnosis and treatment in cattle

Diagnosing and treating AAT

The majority of people reported consulting a veterinarian or similar if they suspected their animal had AAT (Figure 11) although households in East Sudanian Savanna (Kumi & Ngora) were more likely to consult an animal health worker (86.4%). However, it is not known whether interviewees distinguished between veterinarians and animal health workers correctly.

Regarding drug administering, most households were more likely to use animal health workers or veterinarians to treat livestock (Figure 12). However, around a third of households in the Lake Victoria basin (intensive) (Busia & Iganga) study area reported treating AAT themselves; all these farmers, except three, measured the animals' weight 'by-eye' i.e. decided on the dosage based on the visual size of the animal. Main inconveniences with current AAT treatment are presented in Figure 13. Most households cited acquiring consumables, affording the drugs and preparing them. Buying genuine drugs was mentioned by some households particularly Lake Victoria basin (Tororo) and East Sudanian Savanna (Kumi & Ngora).

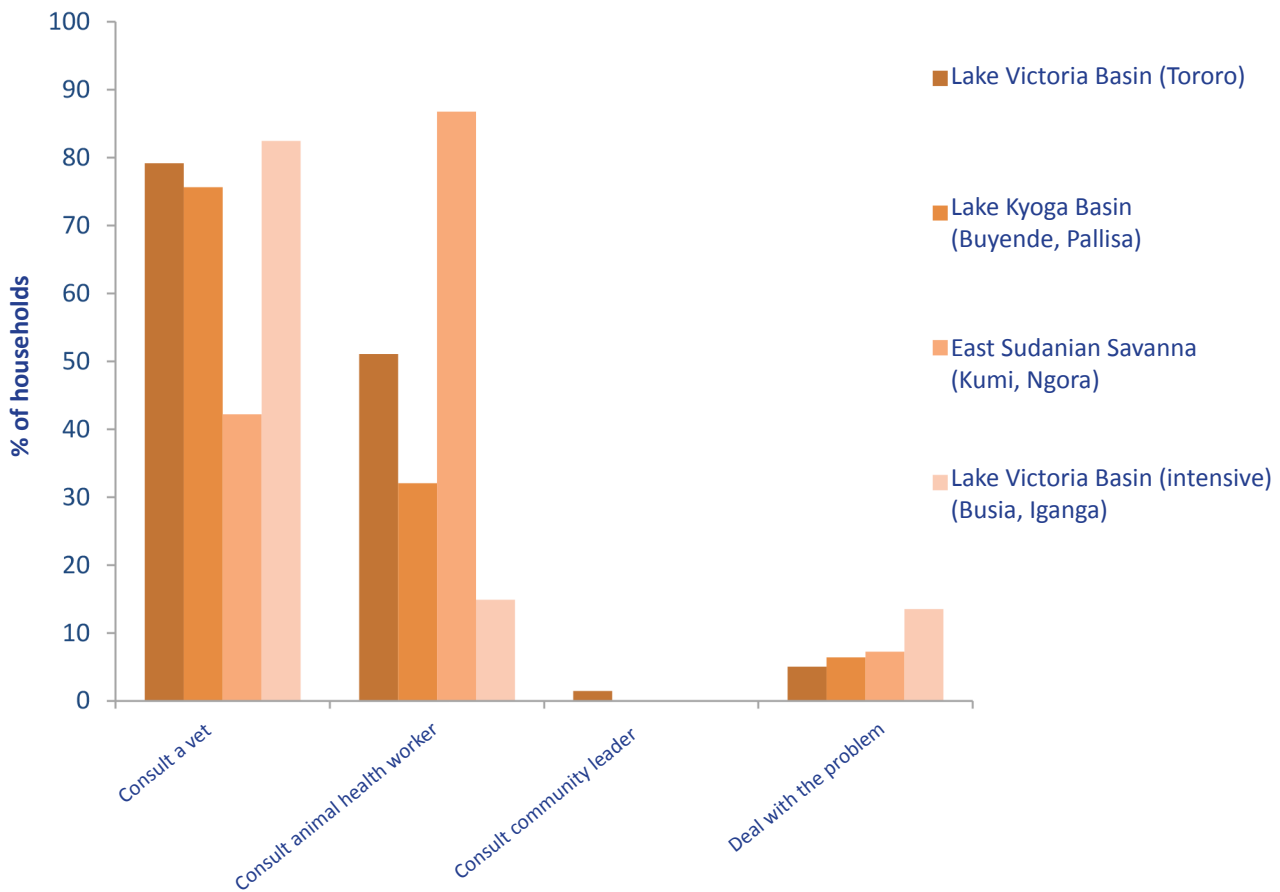


Figure 11: Household action in case of AAT suspicion, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

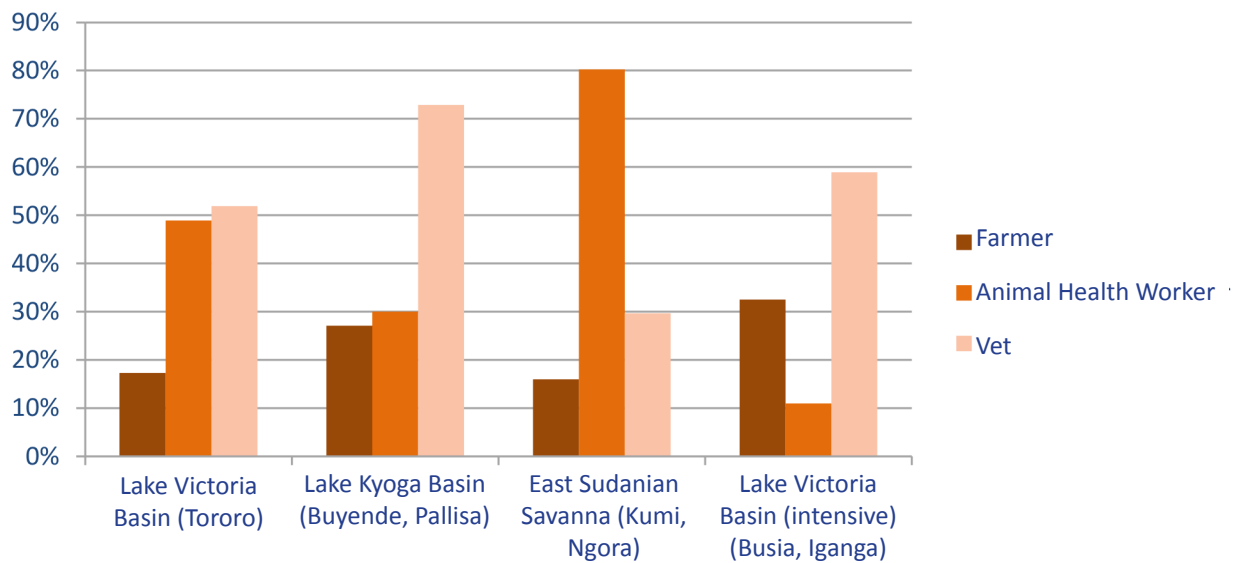


Figure 12: Who carries out AAT treatment, according to study area (data from 374 households interviewed in East Uganda in May/June 2013). Households could give multiple answers.

Treatment failure

Households were most likely to report frequent treatment failure in Lake Victoria basin (Tororo: 58.9%) and Lake Victoria (intensive) (Busia & Iganga: 35.6%) study areas (Figure 14).

When asked what they thought the reasons for treatment failure were, 161 (48.2%) of households provided an answer. Delayed treatment was most commonly mentioned (30.4%) with some adding that they could not afford the drugs in order to treat in time (Table 10). Resistance was mentioned by 21.1% of households. Households in Lake Kyoga basin (Buyende & Pallisa) were more likely to attribute treatment failure to misdiagnosis (21.4%), this may be because AAT occurs less frequently in this study area. Fake drugs were also mentioned by some households.

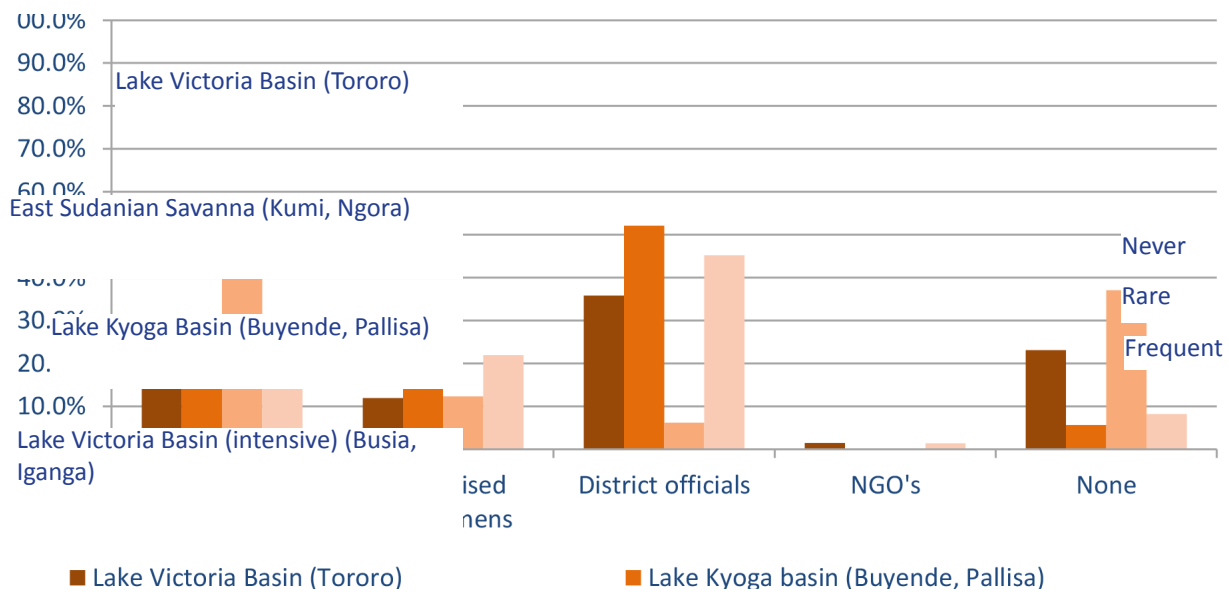


Figure 13: Perceived frequency of treatment failure experienced by households (data from 374 households interviewed in East Uganda in May/June 2013).

Variables associated with treatment failure (% out of those who experienced failure)	% of households
Misdiagnosis (not AAT)	
Lake Victoria basin (Tororo)	4%
Lake Kyoga basin (Buyende, Pallisa)	21.4%
East Sudanian Savanna (Kumi, Ngora)	2.8%
Lake Victoria basin (intensive) (Busia, Iganga)	13.6%
Under-dosing	
Lake Victoria basin (Tororo)	12%
Lake Kyoga basin (Buyende, Pallisa)	14.3%
East Sudanian Savanna (Kumi, Ngora)	5.6%
Lake Victoria basin (intensive) (Busia, Iganga)	-
Resistance	
Lake Victoria basin (Tororo)	24%
Lake Kyoga basin (Buyende, Pallisa)	14.3%
East Sudanian Savanna (Kumi, Ngora)	22.2%
Lake Victoria basin (intensive) (Busia, Iganga)	18.1%
Fake drugs	
Lake Victoria basin (Tororo)	16.9%
Lake Kyoga basin (Buyende, Pallisa)	14.3%
East Sudanian Savanna (Kumi, Ngora)	8.3%
Lake Victoria basin (intensive) (Busia, Iganga)	4.6%
Wrong/ineffective drug	
Lake Victoria basin (Tororo)	10.7%
Lake Kyoga basin (Buyende, Pallisa)	14.3%
East Sudanian Savanna (Kumi, Ngora)	19.4%
Lake Victoria basin (intensive) (Busia,	36.4%
Delayed treatment	
Lake Victoria basin (Tororo)	30.7%
Lake Kyoga basin (Buyende, Pallisa)	21.4%
East Sudanian Savanna (Kumi, Ngora)	41.7%
Lake Victoria basin (intensive) (Busia, Iganga)	27.3%

Table 11: Reports of AAT treatment failure, disease resistance and fake drugs, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

5.4 Existing AAT control

Households which were located in Lake Kyoga basin (Buyende & Pallisa: 50.7%) and Lake Victoria basin (intensive) (Busia & Iganga: 48.0%) were the most likely to report existing AAT control in the area. However, not all these households specified what these controls were (Table 11). Facilitators of control were mainly district officials (Lake Victoria basin: 35.8%, Lake Kyoga basin: 52.1% and Lake Victoria basin (intensive): 45.2%) and individuals (Lake Victoria basin: 29.8% and East Sudanian Savanna: 44.4%). Quite a few households in Lake Victoria basin (Tororo: 23.1%) and East Sudanian Savanna (Kumi & Ngora: 37.0%) said that there were no facilitators of control in the area (Figure 14). In addition one person in Tororo said it was conducted by communities acting together.

	Lake Victoria basin	Lake Kyoga basin	East Sudanian Savanna	Lake Victoria basin (intensive)
Existing control measures in the community	33.6%	50.7%	19.8%	48%
Control measures mentioned (if control reported)				
Tsetse traps	22.2%	2.8%	12.5%	5.7%
ITC	-	2.8%	31.2%	-
Prophylaxis cattle	8.9%	5.6%	-	14.3%

Table 12: Existing AAT control measures in the community (data from 374 households interviewed in East Uganda in May/June 2013).

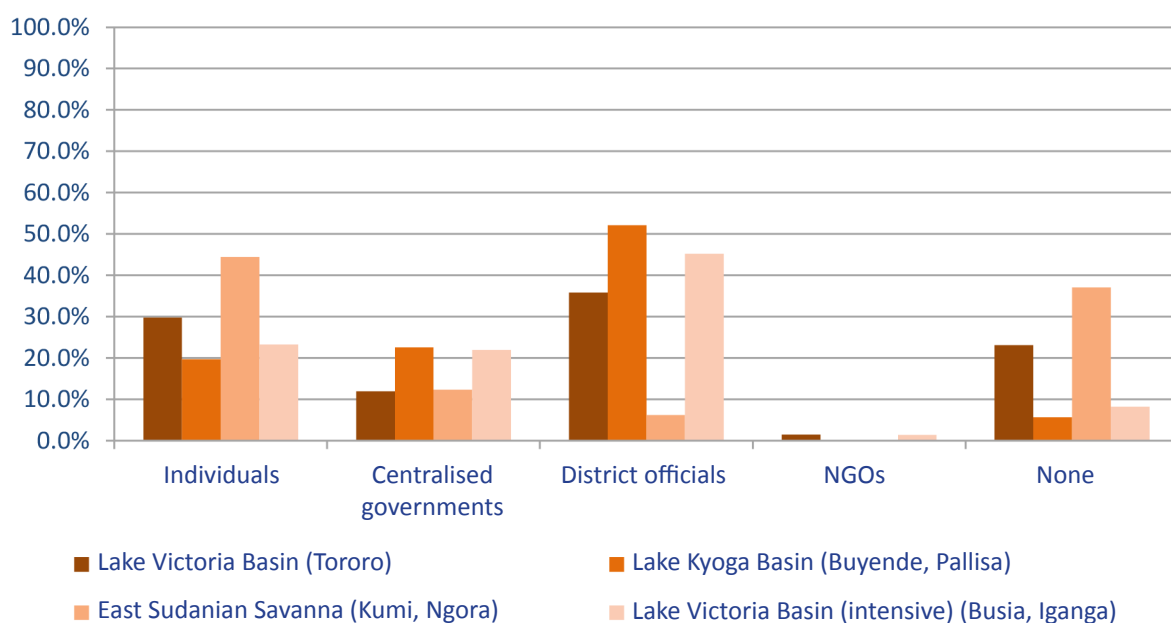


Figure 14: Facilitators of AAT control according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

6. Households knowledge of AAT

The ability of the interviewees to give accurate information regarding the current AAT situation in the area is dependent on their awareness and knowledge of the disease. Therefore, knowledge of AAT transmission, clinical signs and control was assessed. Poor knowledge of the disease and control measures could be hindering AAT control in the area. Although, knowledge is likely to be highly correlated with incidence i.e. the more disease incidents the more aware farmers are and the better their knowledge of the disease, and vice versa. Households which were “aware” of AAT were asked a series of questions regarding the disease and control of the disease.

Knowledge of the disease

When asked to describe AAT, households mentioned classic symptoms of disease including weight loss, malaise and loss of tail brush. Households in the East Sudanian Savanna study area (Kumi & Ngora) were less likely identify clinical signs in cattle (53.1%) and fewer said that the disease was spread by tsetse flies (75.3%), compared to >90% in all other study areas (Table 12). Figure 14 shows what species interviewees thought can be affected by AAT. Most households could correctly identify cattle as being susceptible to AAT. However, fewer households mentioned AAT in small ruminants and pigs; probably because these households

AAT knowledge	% of households			
Aware of AAT				
Lake Victoria basin (Tororo)	97.1%			
Lake Kyoga basin (Buyende, Pallisa)	91%			
East Sudanian Savanna (Kumi, Ngora)	97.6%			
Lake Victoria basin (intensive) (Busia, Iganga)	98.7%			
Know that it is spread by tsetse flies				
Lake Victoria basin (Tororo)	94.8%			
Lake Kyoga basin (Buyende, Pallisa)	90.1%			
East Sudanian Savanna (Kumi, Ngora)	75.3%			
Lake Victoria basin (intensive) (Busia, Iganga)	97.3%			
Can identify clinical signs in cattle				
Lake Victoria basin (Tororo)	64.4%			
Lake Kyoga basin (Buyende, Pallisa)	69%			
East Sudanian Savanna (Kumi, Ngora)	53.1%			
Lake Victoria basin (intensive) (Busia, Iganga)	67.1%			
Know the susceptible species	Cattle	Small ruminants	Pigs	Other
Lake Victoria basin (Tororo)	99.2%	50%	16.7%	2.4%
Lake Kyoga basin (Buyende, Pallisa)	100%	39.1%	10.1%	4.4%
East Sudanian Savanna (Kumi, Ngora)	100%	58.6%	10%	2.9%
Lake Victoria basin (intensive) (Busia, Iganga)	100%	35.4%	6.2%	9.2%
Know AAT is related to HAT				
Lake Victoria basin (Tororo)	90.4%			
Lake Kyoga basin (Buyende, Pallisa)	87.3%			
East Sudanian Savanna (Kumi, Ngora)	86.4%			
Lake Victoria basin (intensive) (Busia, Iganga)	91.8%			

Table 13: General knowledge about AAT, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

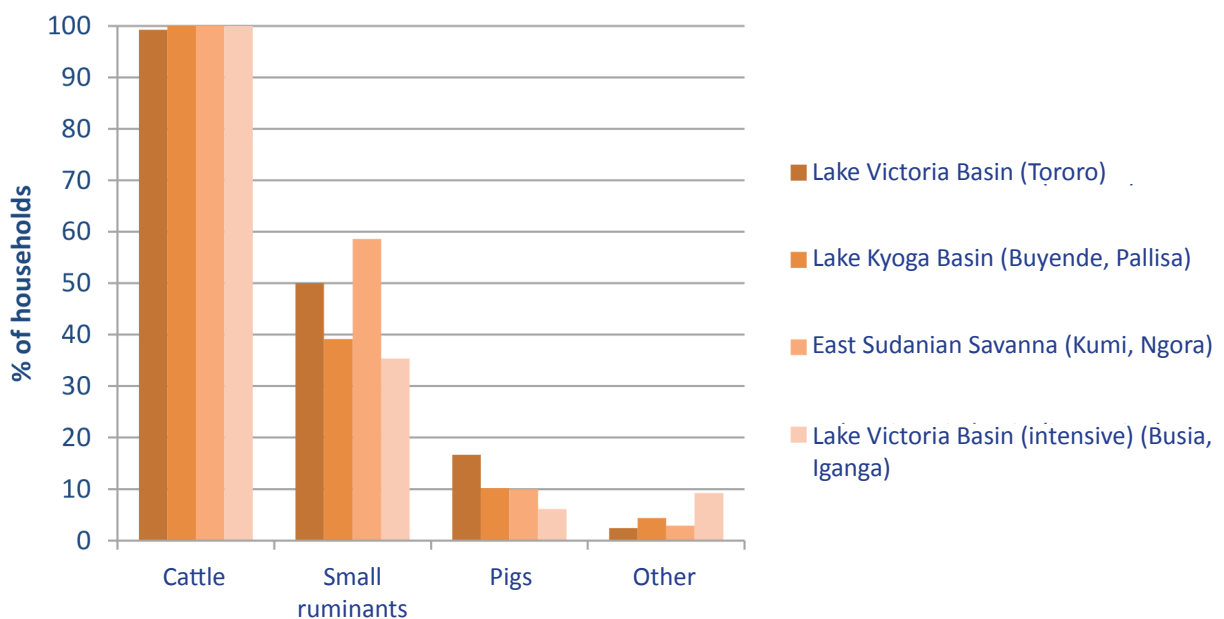


Figure 15: Species households mentioned as being susceptible to AAT (data from 374 households interviewed in East Uganda in May/June 2013).

Knowledge of AAT control

Knowledge of AAT control appeared to be lowest in the East Sudanian Savanna (Kumi & Ngora) study area; only a third of households said that they knew how to control AAT compared to >50% in the other study areas and 70.4% identified a picture of a tsetse trap compared to >90% in the other study areas. (Table 13)

	Lake Victoria basin	Lake Kyoga basin	East Sudanian Savanna	Lake Victoria basin (intensive)
Said they knew how to control AAT: % households	56%	62%	33.3%	58.9%
Could identify a picture of tsetse trap: % households	94.4%	94.4%	70.4%	91.8%
Control measures mentioned (awareness) (% of households)				
Tsetse control	46.5%	46.5%	17.3%	39.7%
Tsetse traps	45.1%	45.1%	25.9%	43.8%
ITC	46.5%	46.5%	25.9%	38.4%
Destroy tsetse habitats	42.3%	42.3%	23.5%	35.6%
Prophylaxis cattle	9.9%	9.9%	-	6.9%

Table 14: Knowledge of AAT control, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

7. Attitudes towards future AAT control

Finally, households were asked their opinions about the need for new AAT control measures in the area and whether they would be willing to use, and pay for these new measures. They were also asked about the difficulties with current AAT treatment.

7.1 Population opinion about new control methods

Consumer willingness to use and pay for new diagnostic tests

Most households interviewed would use a new AAT diagnostic test (Table 15) and would be willing to pay for it. Households in East Sudanian Savanna (Kumi & Ngora) appeared to be willing to pay the highest price for a diagnostic test (Median: \$1.19). Figure 16 and Table 16 show the willingness to pay at each price interval (% households willing to pay each price, or higher).

	Want new AAT treatments	WTP > current treatment costs
Lake Victoria basin (Tororo)	89.4%	89.2%
Lake Kyoga basin (Buyende, Pallisa)	98.4%	94.9%
East Sudanian Savanna (Kumi, Ngora)	90.2%	94%
Lake Victoria basin (intensive) (Busia, Iganga)	90.2%	86.5%

Table 15: Percentage of farmers who think there is a need for new AAT treatments and would be willing to pay (WTP) a higher price for it (data from 374 households interviewed in East Uganda in May/June 2013).

	Want diagnostic	Willing to pay >0	Median cost (Q1 & Q2) in US\$ ⁴
Lake Victoria basin	93.5%	90.9%	\$1.09 (0.40 to 1.99)
Lake Kyoga basin	98.7%	96.2%	\$0.80 (0.40 to 1.99)
East Sudanian Savanna	97.6%	91.6%	\$1.19 (0.40 to 2.34)
Lake Victoria basin	97.6%	98.6%	\$0.80 (0.40 to 1.99)

Table 16: Willingness of farmers to use and pay for a novel field diagnostic, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

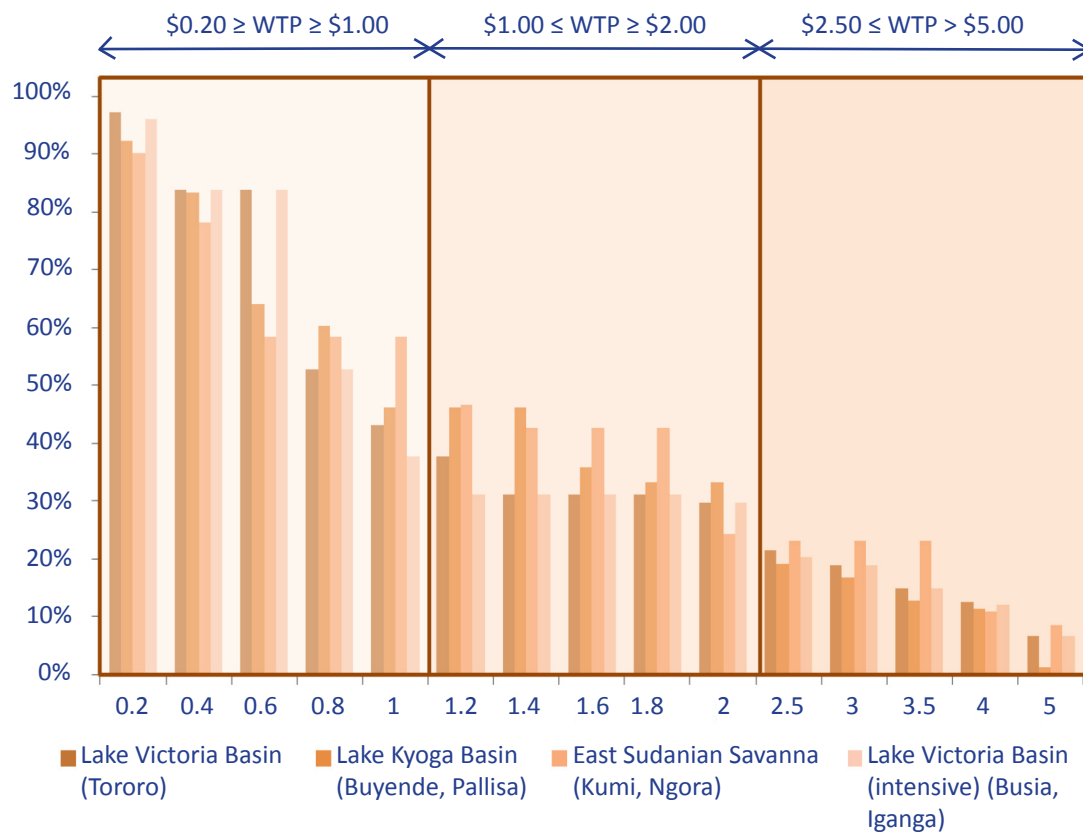


Figure 16: Distribution of the cost (in USD) households would be willing to pay for an individual AAT diagnostic test, according to study area.

⁴ The study was conducted in May/June 2013 and at this time the exchange rate of the Ugandan shilling (UGX) to the United States Dollar (USD) according to www.xe.com was 2591.9 UGX = 1USD.

WTP US\$	Lake Victoria basin	Lake Kyoga basin	East Sudanian Savanna	Victoria basin intensive
≥\$0.20	97.3%	92.3%	90.2%	96.0%
≥\$0.40	83.8%	83.3%	78.1%	83.8%
≥\$0.60	83.8%	64.1%	58.5%	83.8%
≥\$0.80	52.7%	60.3%	58.5%	52.7%
≥\$1.00	43.2%	46.2%	58.5%	37.8%
≥\$1.20	37.8%	46.2%	46.6%	31.1%
≥\$1.40	31.1%	46.2%	42.7%	31.1%
≥\$1.60	31.1%	35.9%	42.7%	31.1%
≥\$1.80	31.1%	33.3%	42.7%	31.1%
≥\$2.00	29.7%	33.3%	24.4%	29.7%
≥\$2.5	21.6%	19.2%	23.2%	20.3%
≥\$3.00	18.9%	16.7%	23.2%	18.9%
≥\$3.50	14.9%	12.8%	23.2%	14.9%
≥\$4.00	12.6%	11.5%	11.0%	12.2%
>\$5.00	6.7%	1.3%	8.5%	6.8%

Table 17: Distribution of the cost (in USD) households would be willing to pay for an individual AAT diagnostic test, according to study area.

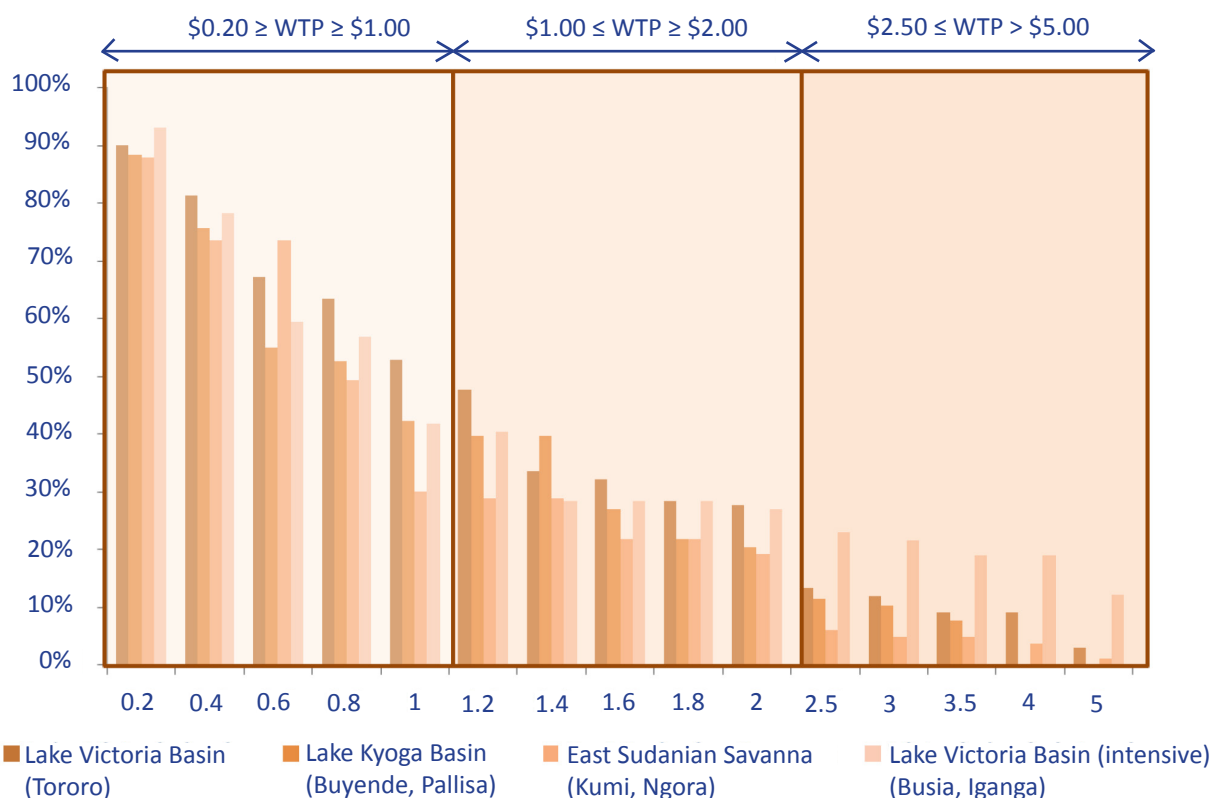
Consumer willingness to use and pay for new diagnostic tests

Most households interviewed would use a new AAT diagnostic test (Table 15) and would be willing to pay for it. Households in East Sudanian Savanna (Kumi & Ngora) appeared to be willing to pay the highest price for a diagnostic test (Median: \$1.19). Figure 16 and Table 16 show the willingness to pay at each price interval (% households willing to pay each price, or higher).

	Would vaccinate	WTP > 0	Median cost (Q1 & Q2) in US\$ ^a
Lake Victoria basin (Tororo)	90.6%	90.6%	\$1.19 (0.40 to 1.99)
Lake Kyoga basin (Buyende, Pallisa)	97.4%	94.9%	\$0.80 (0.40 to 1.60)
East Sudanian Savanna (Kumi, Ngora)	100%	96.4%	\$0.80 (0.40 to 1.19)
Lake Victoria basin (intensive) (Busia, Iganga)	94.6%	97.3%	\$0.80 (0.40 to 1.99)

Table 18: Willingness of farmers to use and pay for a novel field vaccine, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

^aThe study was conducted in May/June 2013 and at this time the exchange rate of the Ugandan shilling (UGX) to the United States Dollar (USD) according to www.xe.com was 2591.9 UGX = 1USD.



WTP US\$	Lake Victoria basin	Lake Kyoga basin	East Sudanian Savanna	Victoria basin intensive
≥\$0.20	90.0%	88.5%	88.0%	93.2%
≥\$0.40	81.3%	75.6%	73.5%	78.4%
≥\$0.60	67.2%	55.1%	73.5%	59.5%
≥\$0.80	63.4%	52.6%	49.4%	56.8%
≥\$1.00	53.0%	42.3%	30.1%	41.9%
≥\$1.20	47.8%	39.7%	28.9%	40.5%
≥\$1.40	33.6%	39.7%	28.9%	28.4%
≥\$1.60	32.1%	26.9%	21.7%	28.4%
≥\$1.80	28.4%	21.8%	21.7%	28.4%
≥\$2.00	27.6%	20.5%	19.3%	27.0%
≥\$2.5	13.4%	11.5%	6.0%	23.0%
≥\$3.00	11.9%	10.3%	4.8%	21.6%
≥\$3.50	9.0%	7.7%	4.8%	18.9%
≥\$4.00	9.0%	-	3.6%	18.9%
>\$5.00	3%	-	1.2%	12.2%

Figure 17 and Table 19: Distribution of the cost (in USD) households would be willing to pay for an individual AAT diagnostic test, according to study area.

Important factors to take into account for new drugs development

Farmers were also asked about the factors that are most important to them in a new veterinary product. Most households mentioned efficacy and shelf life. Those households which did not supply an answer said that the vet/animal health worker chooses the drugs for them.

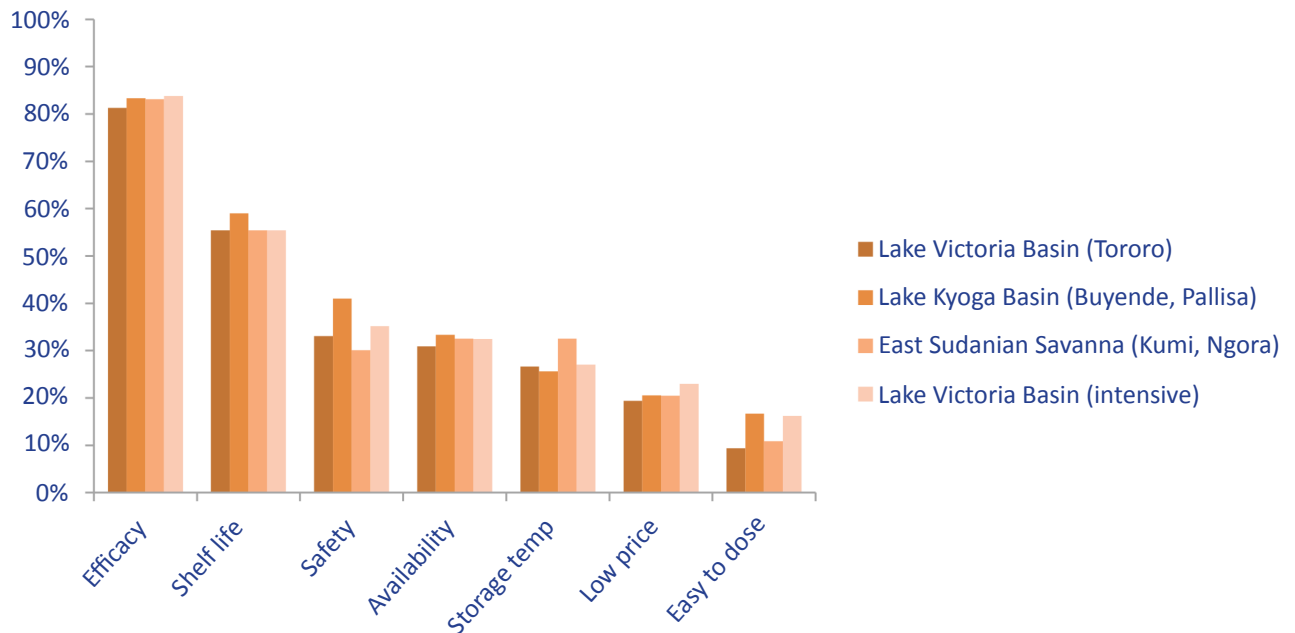


Figure 18: Important aspects for vet medicines, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).

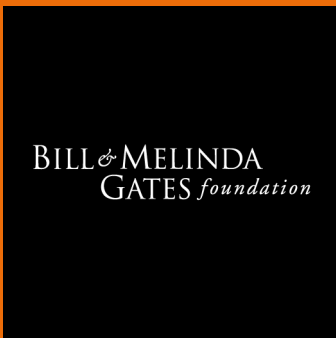
Drug factors	Lake Victoria basin	Lake Kyoga basin	East Sudanian Savanna	Lake Victoria basin (intensive)
Low price				
Important	19%	20.5%	20.5%	23%
Low importance	17%	17.9%	24.1%	20.3%
Not mentioned	63.3%	61.5%	55.4%	56.8%
Easy to dose				
Important	9.4%	16.7%	10.8%	16.2%
Low importance	0%	3.8%	0%	2.7%
Not mentioned	90.6%	79.5%	89.2%	81.1%
Availability				
Important	30.9%	33.3%	32.5%	32.4%
Low importance	2.2%	1.3%	7.2%	1.4%
Not mentioned	66.9%	65.4%	60.2%	66.2%
Efficacy				
Important	81.3%	83.3%	83.1%	83.8%
Low importance	2.2%	0%	0%	0%
Not mentioned	16.5%	16.7%	16.9%	16.2%
Safety				
Important	33.1%	41%	30.1%	35.1%
Low importance	2.2%	2.6%	12%	0%
Not mentioned	16.5%	56.4%	57.8%	64.9%
Suitable humans				
Important	33.1%	1.3%	1.2%	2.7%
Low importance	2.2%	43.6%	42.2%	16.2%
Not mentioned	64.7%	55.1%	56.6%	81.1%
Storage temperature				
Important	33.1%	25.6%	32.5%	27%
Low importance	2.2%	11.5%	7.2%	9.5%
Not mentioned	64.7%	62.8%	60.2%	63.5%
Shelf life				
Important	0.7%	59%	55.4%	55.4%
Low importance	38.8%	6.4%	1.2%	4.1%
Not mentioned	60.4%	34.6%	43.4%	40.5%

Table 20: Cost (in dollars) households would be willing to pay for an individual AAT vaccine, according to study area (data from 374 households interviewed in East Uganda in May/June 2013).



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8. Conclusions

AAT was considered the most important livestock disease in all study areas, in Kumi and Ngora (East Sudanian Savanna) ECF was of almost equal importance.

In Tororo (Lake Victoria Crescent) there is a constant AAT challenge with highest incidence in the rainy season. Perceived impact was high and there were reports of treatment failure and some concern regarding counterfeit drugs (and in Buyende & Pallisa). More than half of households in this study area had lost at least one cattle to AAT in the previous two years. Therefore this area was considered the highest priority for control. In Buyende and Pallisa (Lake Kyoga basin) perceived impact and treatment failure were low and the area was considered low priority for control.

In Kumi and Ngora (East Sudanian Savanna) cattle were mostly free grazed, which may increase the rate of biting by tsetse. AAT was reportedly seasonal in this study area and losses were moderate, there were some reports of treatment failure, one of the main reasons attributed to this was not being able to afford the drugs to treat the animal immediately. This area had the lowest knowledge of the disease and was deemed a moderate to high priority for control.

In Busia and Iganga (Lake Victoria Crescent) much of this area has been cleared for agriculture therefore the tsetse density is lower than other districts. Both impact and treatment failure were perceived to be low, therefore the area is a lower priority for control. Cattle were free grazed and tethered.

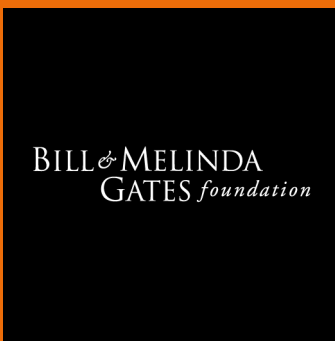
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