



Protecting Livestock – Improving Human Lives

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

Cameroon Field Study Report

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In conjunction with Royal Veterinary College University of London and Mission Spéciale d'Éradication des Glossines, Minepia, Cameroon



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Registered Name: Global Alliance for Livestock Veterinary Medicines

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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 Cameroon, Burkina Faso, Ethiopia, Uganda 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 two regions in Northern Cameroon. The Adamawa region is the most important cattle rearing region in Cameroon and is heavily affected by AAT despite a number of control initiatives run by the Government since the 1960s. The North region is less dependent on livestock production, although cattle are important for draught power. There was little previous data available about AAT in this area. The study results will inform the refinement of existing decision support tools to aid evidence-based decisions on the use of novel drugs, diagnostics and vaccines (should they become available) as part of integrated trypanosome & tsetse control programs.

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 areas 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.

1.2 Background

Livestock in Cameroon

In 2006, the FAO estimated the livestock population to comprise 5.9 million head of cattle, 4.4 million goats and 3.8 million sheep. With livestock production thought to provide a source of revenue for more than 30% of the rural population. Cattle are the biggest contributor to total meat consumption per capita (54%), followed by sheep and goats (13%), poultry (17%) and pigs (15%). The livestock population –and hence meat production - has been increasing at a low rate and this is attributed to high prevalence of production diseases such as trypanosomosis, pasteurellosis and foot and mouth disease [4].

Ruminants in Cameroon are usually reared in traditional systems. Grazing systems are extensive and of three types:

- **Nomadism:** herders have no fixed home and move throughout the year, in search of water and forage for their animals
- **Transhumance:** herders have a permanent residence but move seasonally, following the rainfall, in search of better grassland and water availability
- **Sedentary stock rearing:** Herders are settled and keep their livestock near to their village. Although they sometimes entrust a transhumant herder with part of their flock during the dry season. The sedentary population is typically composed of mixed-farmers and livestock rearing is complementary to crop production.

[†]The study was selected because it was estimated to be a moderate risk area for AAT from a systematic review of AAT literature.

AAT limits the expansion of regions with potential for agricultural growth; in comparison to AAT free zones those regions affected tend to have lower calving rates, reduced milk production and higher calf mortality. In 2010, a report from the Cameroonian government estimated that in tsetse infected zones, milk and meat sales were reduced by up to 50% [5]. In addition, AAT negatively impacts crop farming by reducing draught power of infected cattle. Entire herds with Trypanosensitive cattle can be destroyed if they are suddenly exposed to moderate or high risk areas.

Tsetse species in the area are *Glossina morsitans submorsitans*, *Glossina fuscipes fuscipes* and *Glossina tachinoides*. *Glossina nashi* has also been imported into the area in the last two years; specifically the Faro et Déo administrative division, via uncontrolled livestock movement from Nigeria into Cameroon during transhumance (Rapport d'activité de la Division Tsé-Tsé Adamaoua, 2013). Cattle are most frequently infected with *Trypanosoma congolense*, followed by *T. brucei* and *T. vivax*.

Study area

This study was conducted in the Faro et Déo department of the Adamawa region and the Faro and Mayo Rey departments of the North region. In both regions, the climate is tropical and bi-modal. The dry season takes place from November to March and April marks the start of the rainy season. Average rainfall is 900 to 1500mm per year and decreases from south to north with average temperatures ranging between 22 and 25°C. Study areas were classified based on ecoregions; resulting in three study areas Faro & North Faro (Northern Congolian Forest-Savanna Mosaic), South Faro (Cameroon Highlands Forests) and Mayo Rey (East Sudanian Savanna).

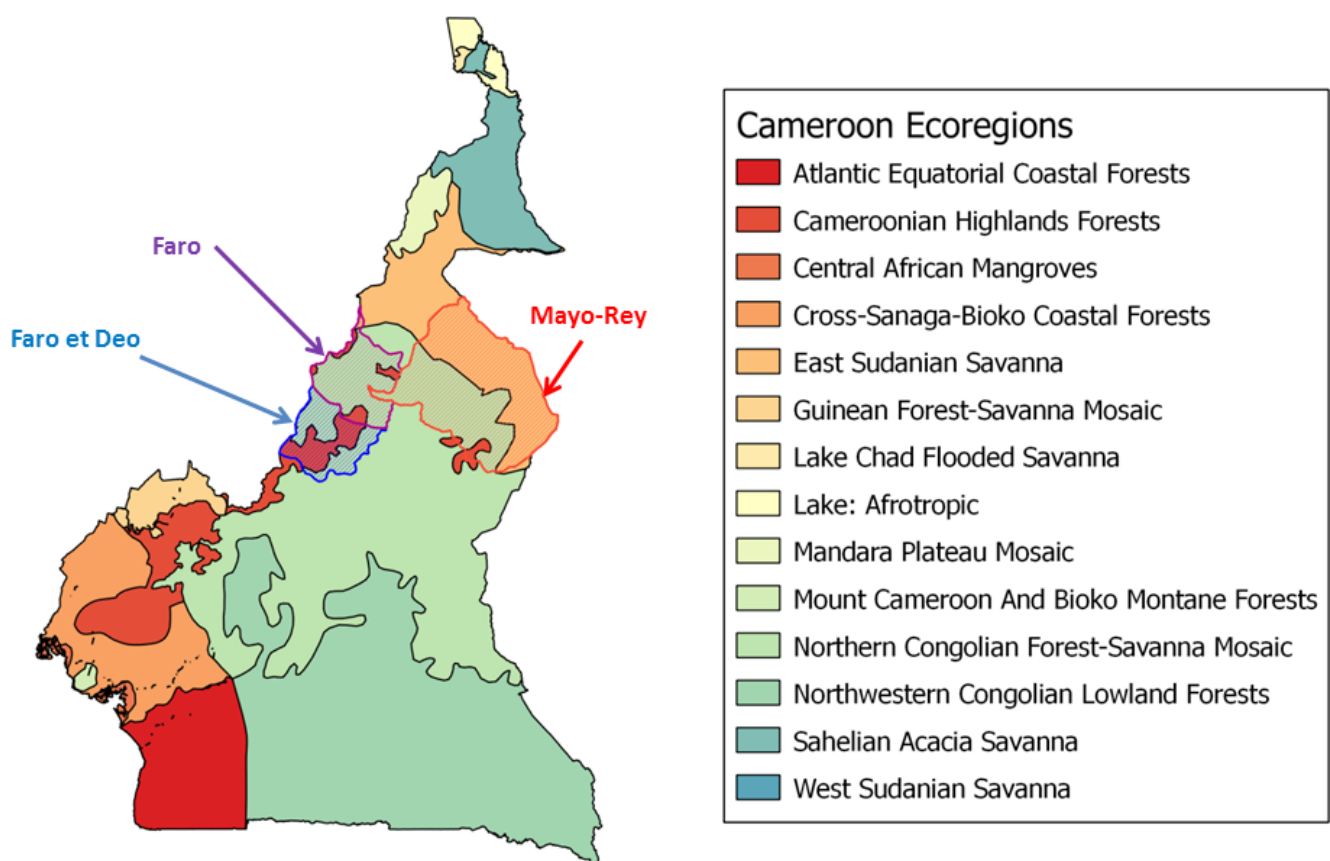


Figure 1: Map showing the ecoregions and study area in Cameroon.

Part of the study area is on the Adamawa plateau, which is a volcanic upland in west-central Africa that stretches from south-eastern Nigeria, through Cameroon and into the Central African Republic. The plateau is mostly located in the centre of North Cameroon and crosses both the Adamawa and the North region (Image 1). Its average altitude is 1100m and it is the main water dispersal centre of the country [4]. It has savannah-like vegetation making it great environment for livestock keeping and a desirable area for tsetse.



Image 1: Study area in Cameroon.

Many of the country's rivers such as the Faro and the Mayo Déo rise in the Adamawa region and fall into a tropical regime: rivers are high during the rainy season (flooding occasionally occurs), but dry up during the dry season and may completely disappear. Several crater lakes can also be found in the province and are the result of a long history of volcanism that has left many collapsed volcanoes filling with water. The grass cover is thick, rich and consistent. In terms of agriculture, millet is the mainstay; maize and cassava are also important. Crops of root vegetables such as taro are also important. Groundnuts are also grown, although in smaller quantities.

Over the years, the Cameroonian government has made many attempts to control AAT; from 1960 to 1975 a biannual trypanocidal treatment campaign was implemented in the Adamawa, north and east regions of Cameroon in an effort to eradicate. All cattle were preventively treated with isometamidium chloride before the transhumance and received a curative treatment with diminazene aceturate when returning for grazing after the dry season. Tsetse control was also carried out using habitat destruction however, a tsetse survey in 1988 showed tsetse re-infestation into previously cleared areas, which triggered the government to start a campaign of pyrethroids and organochlorides spraying. A lack of surveillance and maintenance of control in the cleared areas, as well as the movement of cattle between cleared and infested zones during the transhumance have limited the success of the program.

In 1994, a tsetse fly barrier system - aiming at preventing tsetse reinvasion from the plains to the north of the Adamawa plateau into the cleared areas in the south- was constructed. Biconical traps were placed between rows of screens that had been impregnated with insecticide. Maintenance of cleared areas was successful until most of the barrier system was destroyed in bushfires.

2. Methods for data collection

2.1 Sampling of the study areas and households

For each district included in the study, the District Veterinary Officer (DVO) 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 fourth 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 and livestock diseases 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 completed 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.

Study results

3. Cameroon Profile

3.1 Results Summary

The Adamawa region is the most important cattle rearing region in Cameroon; white and red Fulani cattle are reared extensively with a system of communal herding. In addition Gudali (Sahelian Zebu) cattle also have an important role in livestock production in the region. In 1995, at the end of the tsetse eradication campaign initiated by the government, the Faro et Déo (Image 2) division of the Adamawa plateau was divided into three zones; infested, AAT free and a buffer zone; where all the cattle are treated with pyrethroids at regular intervals. These zones are regularly evolving to take into account uncontrolled movement during transhumance and borders have been moved up to 60km (Rapport annuel de la MSEG, 2013).

AAT prevalence in the infested area (valley: Faro & North Faro et Deo) is estimated as 35.1%, it is significantly lower in the buffer zone (5.3%) and plateau (4.3%) in South Faro et Deo. The high prevalence is partly attributed to the nearby game reserves where tsetse population density is high and wildlife hosts are abundant. Further, a study from 2007 showed that *T. congolense* had become resistant to isometamidium (57.5%) and diminazene (92.5%).

In the North region, many rivers run and water levels vary with the seasons; the Benoue River is the region's main waterway. It rises from the Adamawa plateau and flows west towards Nigeria. Along the way, it is enlarged by the Mayo-Rey, the Mayo Kebi and other small waterways. The valley of the Benoue River forms the main part of the Benoue depression, where the relief of the Adamawa plateau falls very abruptly.



Image 2: Faro et Déo study area.

The North is a land of savanna; The vegetation on the Adamawa plateau is wooded savanna, with a thick grass cover. North, this wooded savanna gradually gives way to savanna in the Benoue depression. In terms of agriculture, sorghum, millet and maize are the staple crop throughout most of the region; cassava is also important on the plateau. Other crops include taro and groundnuts. In the north region, the main tsetse vector is *Glossina morsitans submorsitans* [5] however, very little previous information is available regarding AAT prevalence, tsetse flies distribution or drug resistance in the area. Most previous research on AAT focuses on the Adamawa region.

Results Summary

An overall summary of the findings from each of the 3 study areas is presented in the table below. The report then goes into a comprehensive detail of the results in the sections that follow.

3.2 Study population characteristics

A total of 298 households were included in study and general household characteristics are presented in Table 1. Percentages for most tables are given with number of responses (excluding missing data), as the baseline. The study areas differ considerably with regard to the relative importance of livestock as a source of income with lower livestock dependency and more crop production in Mayo-Rey. Across all study areas most households (~90%) reported the use of communal land. In North Faro & Faro et Déo 13.1% of households practiced transhumance; three households in Mayo-Rey and two households in South Faro et Déo practiced transhumance.

Study areas	North Faro et Déo & Faro	Mayo-Rey	South Faro et Déo
Households studied	130	91	77
Household members Median (Q1 & Q3)	7 (3 & 17)	9 (7 & 12.5)	6 (3 & 9)
Primary source of income N (%):			
Crop farming	6 (4.7%)	36 (40%)	1 (1.3%)
Mixed farming	6 (4.7%)	12 (13.3%)	7 (9.3%)
Livestock farming	116 (90.6%)	39 (43.3%)	67 (89.3%)
Business	-	3 (3.3%)	-
Secondary source of income:			
Crop farming	45 (34.6%)	28 (31.1%)	48 (64%)
Mixed farming	1 (0.8%)	8 (8.9%)	-
Livestock farming	5 (3.9%)	39 (43.3%)	2 (2.7%)
Business	1 (0.8%)	6 (6.7%)	-

Table 1: Number of households studied, median (second quartile) household size with lower (first) quartile and upper (third) quartile (Q1 & Q3) and sources of household income by area (data from 298 households interviewed in Northern Cameroon in August 2013)².

² Quartiles are equal divisions of an ordered set of data values. The lower quartile (Q¹) is the midpoint between the smallest value and the median (lowest 25% of data). The upper quartile (Q³) is the midpoint between the median and highest value (highest 25% of data).

Ecological System and District

	North Faro & Faro et Déo	Mayo-Rey	South Faro et Déo
General livestock keeping data			
Primary source of income	Livestock farming (91%)	Livestock (43%) & crop farming (40%)	Livestock farming (89%)
Median no. of cattle (lower & upper quartile: Q1 & Q2)	60 (43 & 79)	16 (8 & 36)	16 (8 & 36)
Predominant cattle breed	White Fulani (71%) : trypanosensitive Gudali (22.8%): trypanotolerant	White Fulani (57%) & Zebu (40%): trypanosensitive	White Fulani (92%): trypanosensitive
Predominant cattle rearing system	Free-grazing	Free-grazing	Free-grazing
Other species livestock	Poultry (89%), Sheep (77%), Goats (33%)	Sheep (72%), Poultry (66%), Goats (46%)	Poultry (90%), Sheep (77%)
Impact of AAT			
Perceived AAT occurrence in herd/disease ranking	Constant (83%) Ranked no. 1	Constant (75%), Never (23%) Ranked no. 1	Constant (72%) Ranked no. 1
Perceived AAT impact on income	Moderate	Severe	Low
Main losses in livestock outputs due to AAT	Meat & Milk	Milk, meat, draught power	Meat & Milk
AAT treatment failure/perceived reason for failure	Moderate/ineffective drugs > fake drugs	Never-rare/resistance	Low/ineffective drugs
Current AAT control			
Treatment of AAT	Diminazene aceturate > isometamidium	Diminazene aceturate > isometamidium	Diminazene aceturate > isometamidium
Cost per AAT treatment	Farmers	Farmers	Farmers
Level of knowledge about AAT prophylactic measures	US \$0.5 (0.32 & 2)	US \$2 (1 & 3.3)	US \$0.77 (0.38 & 0.63)
Point of sale of veterinary products	Good	Moderate	Good
Control programmes for AAT/facilitators	General shop	Vet pharmacy	Travelling salesman
Future AAT control			
Awareness of AAT & knowledge of epidemiology	Governments (66%), None (19%), NGOs (14%)	Governments (47%), None (40%)	Government (58%), None (42%)
Willingness to use/pay higher price for new AAT drugs	Aware: 97%: Good knowledge	Aware: 91%: Good knowledge	Aware: 100%: Good knowledge
Willingness to use/pay for new AAT diagnostic	96%/79%	82%/86%	92%/58%
Willingness to use/pay for novel AAT vaccine	97%/67% - median: \$0.30	100%/74% - median: \$3.00	90%/51% - median: \$0.40
Problems with AAT treatments	92% /88% - median: \$0.30	88%/89% - median: \$0.20	97%/81% - median: \$0.20
Perception of fake AAT drug circulation	Preparing the drugs > fake drugs > clean water > correct dosing	Correct dosing > preparing drugs > affording drugs	Fake drugs > availability of drugs > preparing drugs
PRIORITY AREA FOR AAT CONTROL (based on farmers' perceptions)	Moderate	High	Low

Household amenities according to study area presented in Figure 2 show considerable differences in water access, sanitation and communication across study areas, with Mayo-Rey having better access to facilities. The dependency on livestock and the challenge of maintaining livestock health is reflected in the fact that most households mentioned “livestock health” as the main issue they faced (in addition to health of household members in Mayo-Rey) (Figure 3). In agreement with the relative importance of livestock vs. crops; health of livestock was mentioned in fewer households (50%) and health of crops mentioned more frequently (22%) in Mayo-Rey compared to other two study areas (Figure 3).

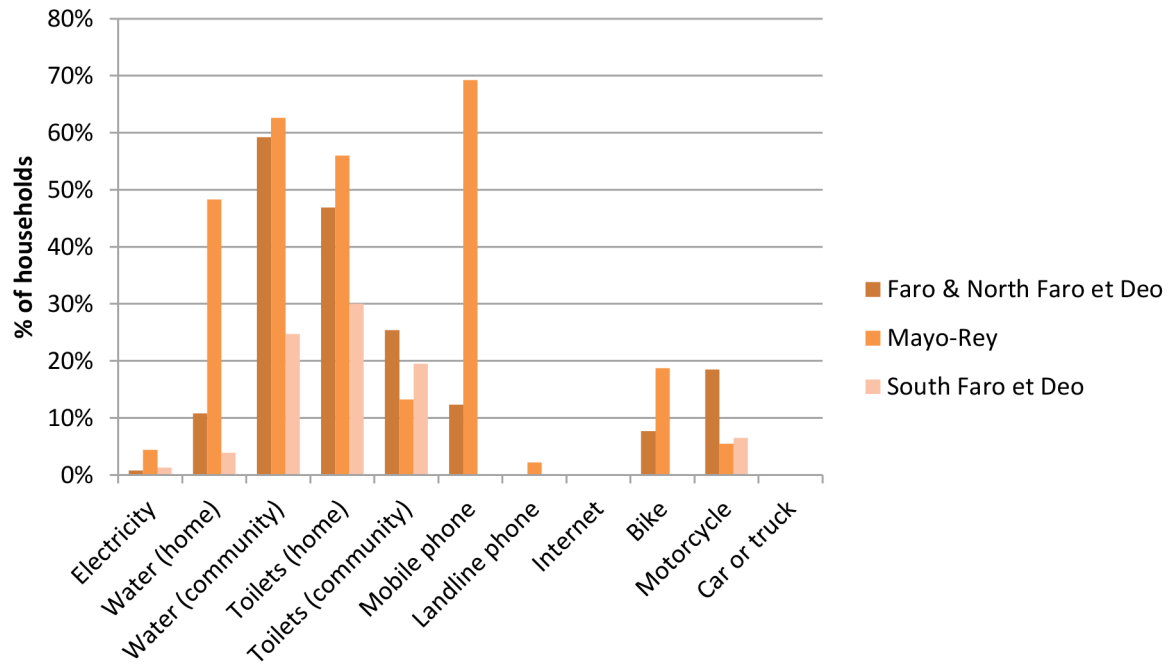


Figure 2: Percentage of households reporting to have specific amenities (data from 298 households interviewed in Northern Cameroon in August 2013).

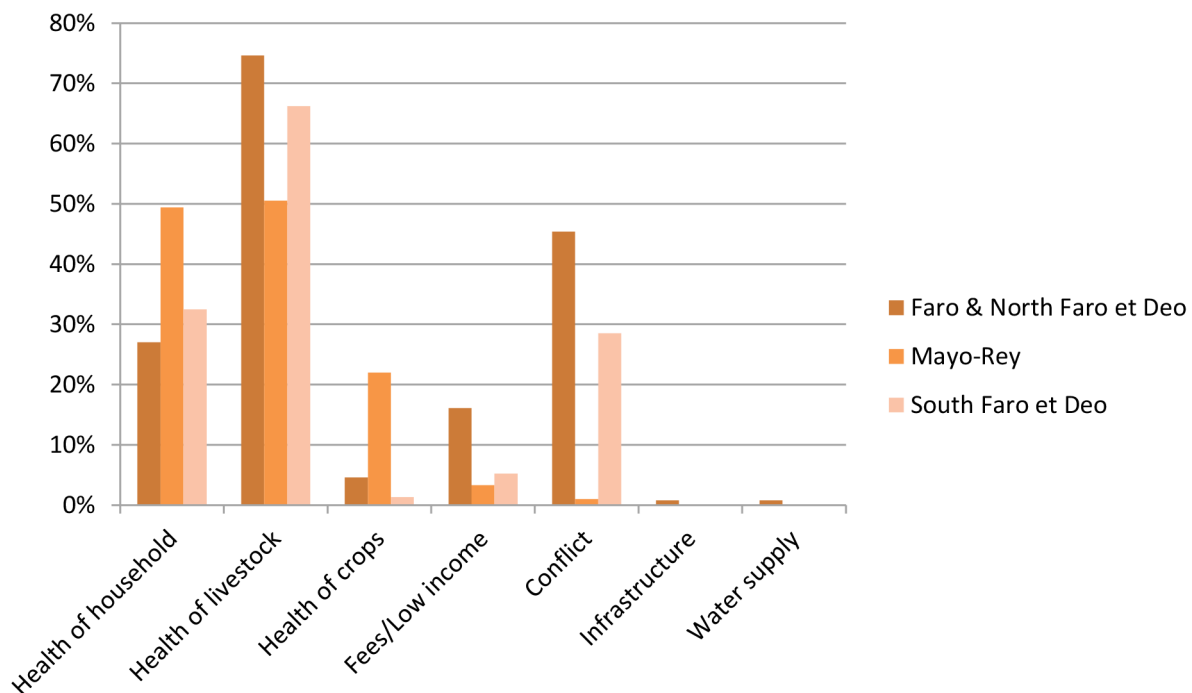


Figure 3: Percentage of households mentioning each major issue, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

3.3 General livestock keeping data

In the study areas, cattle and ruminants were mostly free grazed. Data on the size and composition of cattle herds are presented in Table 2. Some households (one in four for North Faro) refused to provide information on the total number of animals they own and have been excluded from these calculations.

	Faro & North Faro et Déo	Mayo-Rey	South Faro et Déo
Total number of cattle:			
Median (Q1 & Q2)	60 (42.75 & 79)	16 (7.5 & 36)	16 (7.5 & 36)
Adult female cattle:			
% households owning at least 1	100%	96.7%	92.4%
Median (Q1 & Q2)	29 (22.75 & 45)	8 (3 & 21)	30 (20 & 78.75)
Adult male uncastrated cattle:			
% households owning at least 1	96.8%	94.5%	94%
Median (Q1 & Q2)	7 (2.75 & 15)	2 (1.5 & 4)	9.5 (4 & 12.75)
Adult male castrated cattle:			
% households owning at least 1	65.3%	25.27%	47.7%
Median (Q1 & Q2)	3 (4.5 & 15)	0 (0 & 0.5)	0 (0 & 2)
Calves:			
% households owning at least 1	100%	90.1%	84.9%
Median (Q1 & Q2)	-	5 (1 & 10)	10 (5 & 20)
Cattle rearing system:			
Free grazing	100%	100%	100%
Tethered	-	-	-
Penned	-	-	-
Cattle breed:			
Red Fulani	13.4%	8.9%	10.5%
White Fulani	70.9%	57.1%	92.1%
Zebu	-	39.8%	-
Gudali (trypanotolerant)	22.8%	5.4%	-
Crossbreed	-	14.3%	-
Other species:			
Sheep	76.9%	71.6%	77.4%
Goats	33.0%	46.3%	12.9%
Pigs	1.1%	3.2%	4.8%
Poultry	89.0%	66.3%	90.3%

Table 2: Household herd composition according to cattle type and other livestock species (data from 298 households interviewed in Northern Cameroon in August 2013).



Image 3: White Fulani Cattle of Cameroon.

4. Veterinary practises

Each department (Faro et Déo, Faro, Mayo Rey) has a designated chief veterinarian who is assisted by at least five livestock technicians and five veterinary assistants (VA). At district level there is a chief VA assisted by several VA's and technicians. As these people are not necessarily trained in AAT and its control a special mission for the eradication of *Glossina spp.* (Mission Spéciale d'Éradication des Glossines (MSEG; www.mseg.cm) was created to support livestock producers and technicians in the field and works with the groupements d'initiative commune (GIC).

Household practices regarding the point-of-sale for livestock products are presented in Figure 4. Households in Mayo-Rey were most likely to get livestock drugs from a vet pharmacy (83.9%), whereas households in South Faro et Déo were more likely to source their veterinary products from a travelling salesman (71.2%) and households in North Faro et Déo & Faro were most likely to get their drugs from a general shop (74.1%) (Figure 4).

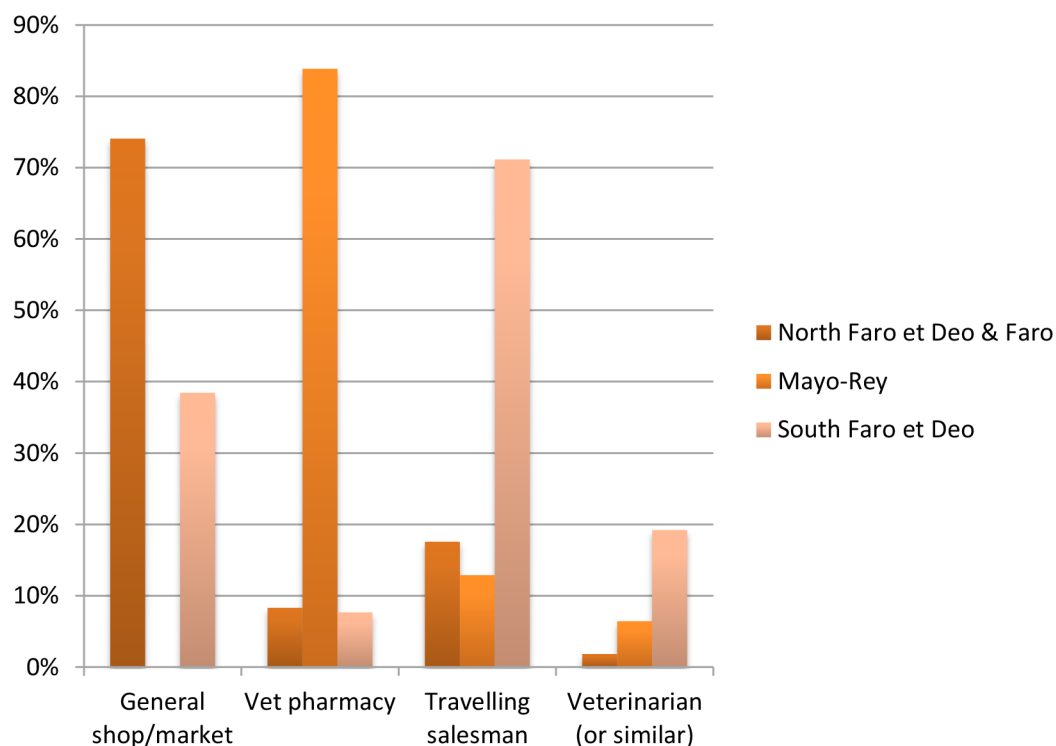


Figure 4: Point of sale of livestock veterinary products (data from 298 households interviewed in Northern Cameroon in August 2013).

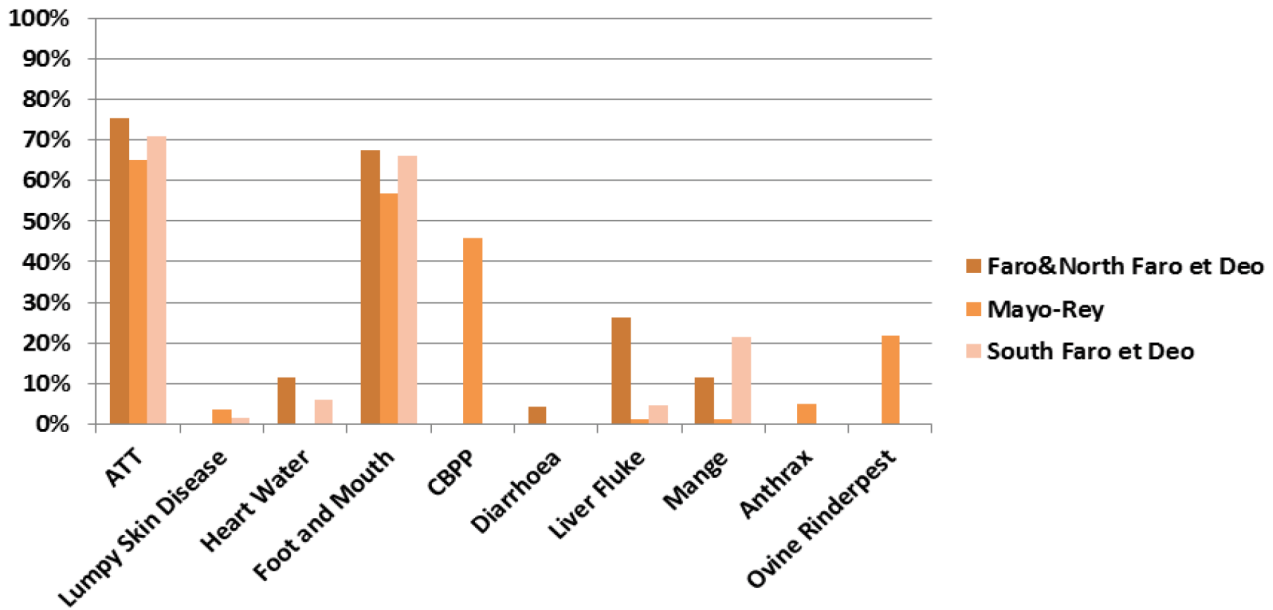
5. Perceived impacts of AAT in the study areas

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 percentage of households mentioning specific livestock diseases as “important in terms of monetary losses”. AAT was ranked highest in the study areas; followed by FMD, which was mentioned by a similar number of farmers as AAT. With the exception of CBPP in Mayo-Rey, the importance of all other diseases was marginal when compared to AAT and FMD (Figure 5).

Around 42% and 58% of interviewees mentioned ticks and tsetse flies as the major insects causing problem to their livestock, respectively. Tsetse flies were a major problem in Mayo-Rey where almost all households who responded to this question mentioned them (Figure 6). The situation was similar in South Faro et Déo but different in Faro & North Faro et Déo, where ticks were considered to be a more important insect in terms of livestock production (66%).

Households were shown a picture of cow suffering from AAT (Figure 7), although the clinical signs exhibited by the cow were nonspecific. This information was used as an indication of the relative importance of AAT in 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.



Disease	Rankings
AAT	1
FMD	2
Mange	3
CBPP	4
Liverfluke	5
Heartwater	6
Ovine Rinderpest	7
LSD	8
Anthrax	9
Diarrhoea	10

Figure 5: Top 10 diseases, according the percentage of households mentioning them as “important livestock diseases in terms of monetary losses” (data from 298 households interviewed in Northern Cameroon in August 2013).

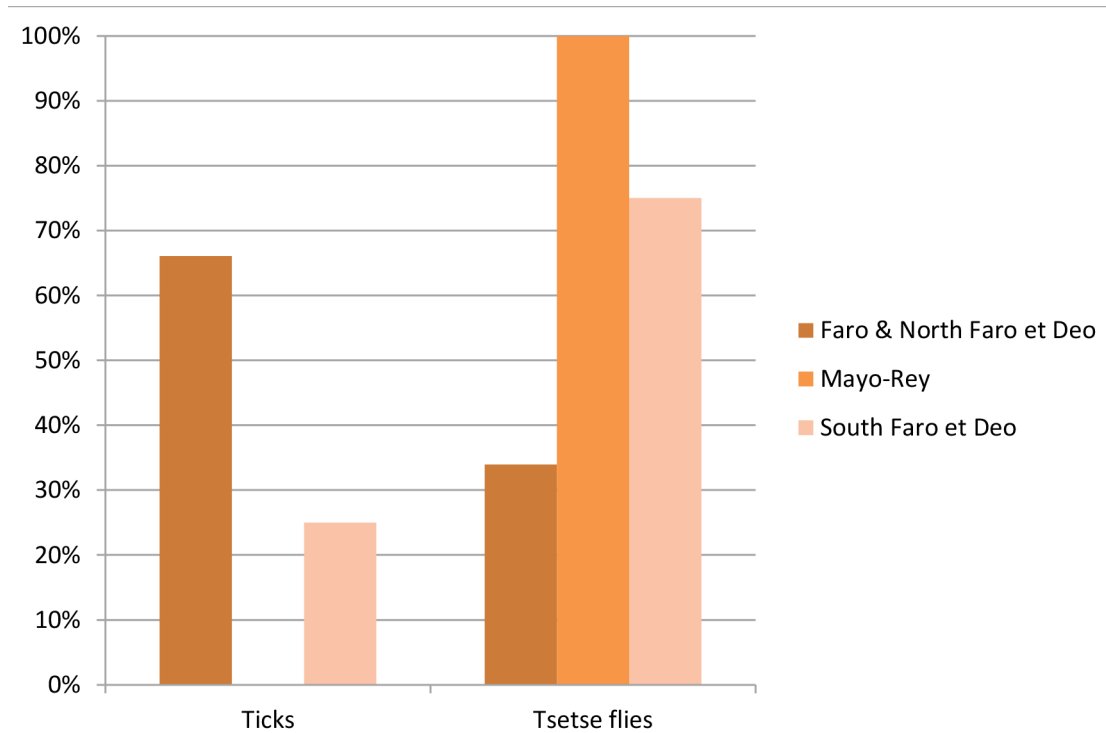


Figure 6: Insects affecting livestock production in Cameroon, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).



Image 7: AAT infected cow showing typical wasting signs, interviewees were asked to suggest what was wrong with the cow (shown to 298 households interviewed in Northern Cameroon in August 2013).

Overall almost 67% of the households suggested that the cow was infected with AAT. A higher number of households in Mayo-Rey (71%) identified the disease as AAT compared to Faro & North Faro et Déo (70%) and South Faro et Déo (54%) as shown in the table below. Other diseases that were mentioned, but much less frequently, were malnutrition, liver fluke, Tuberculosis (Table 3).

	Faro & North Faro et Déo	Mayo-Rey	South Faro et Déo
AAT	70.4%	71.1%	54.3%
Malnutrition	11.3%	0.0%	18.6%
TB	0.0%	3.3%	0.0%
AAT/other diseases	16.5%	5.6%	27.2%
Anthrax	-	7.8%	-
Fluke	-	2.2%	-
FMD	-	8.9%	-
Hepatitis	-	3.3%	-

Table 3: Disease suggestions when shown a picture of a cow with clinical signs compatible with AAT, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

After non-specific questions were posed to interviewees, the interviewer asked whether they had heard of AAT. Those that had heard of AAT were then asked a series of specific questions to acquire further information on the relative impact of AAT in the areas. Most interviewees said they knew of it; 96.9%, 91.2% and 96.1% in Faro & North Faro et Déo, Mayo-Rey and South Faro et Déo respectively. The majority of livestock keepers in all 3 study areas considered AAT as a constant problem. Although 22.9% households from Mayo-Rey said it never occurred there (Figure 8). Around a third of farmers in South Faro et Deo did not provide an answer when asked to assign a qualitative frequency of the presence of AAT in the area.

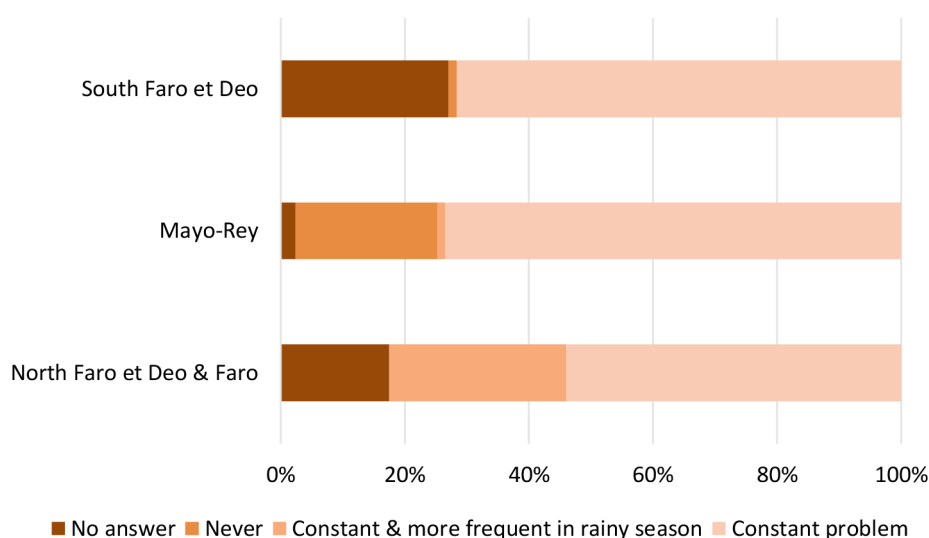


Figure 8: Reported frequency of AAT in livestock, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

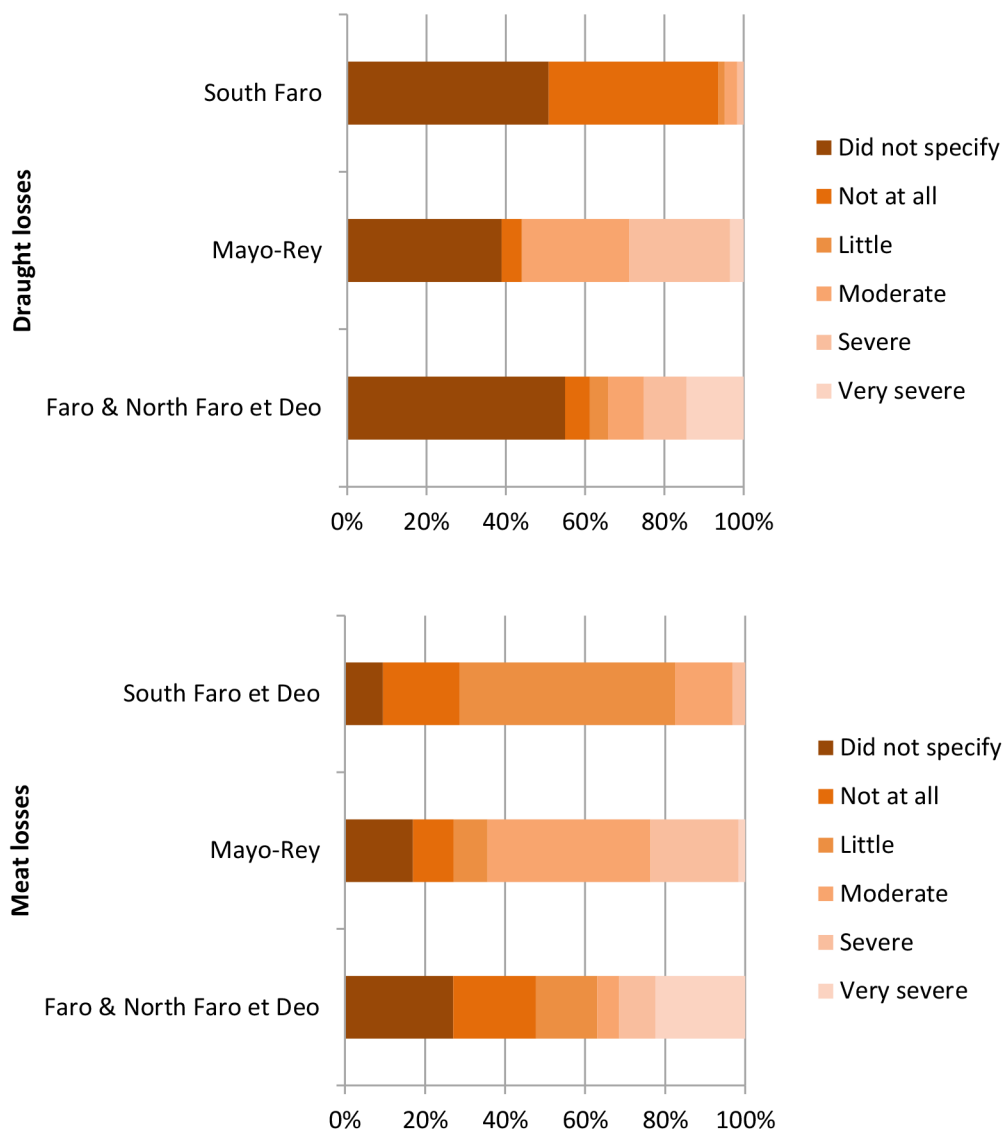
5.2 Perceptions of AAT economic impact

The perceived impact of AAT on household income is summarized in Table 4. Households in Mayo Rey or Faro & North Faro et Déo were more likely to report severe or very severe impact, compared to South Faro et Déo. Although, 28.9% of households in Mayo-Rey were unsure of the impact.

Impact	Faro & North Faro et Déo	Mayo-Rey	South Faro et Déo
Little	12.7%	6.0%	27.0%
Moderate	7.9%	9.6%	13.5%
Not at all	31.0%	13.3%	37.8%
Severe	7.1%	31.3%	5.4%
Very severe	26.2%	10.8%	-
No answer	15.1%	28.9%	16.2%

Table 4: Perception of the economic impact of AAT on household income, by study area (data from 298 households interviewed in Northern Cameroon in August 2013).

AAT-associated losses were mainly related to reduced milk production in South Faro et Déo, losses in meat in Mayo-Rey milk and draught power appeared to be of equal importance, and around a quarter of households in Faro & North Faro et Déo considered losses to meat, milk, draught, manure, wool and leather to be severe or very severe (Figure 9).



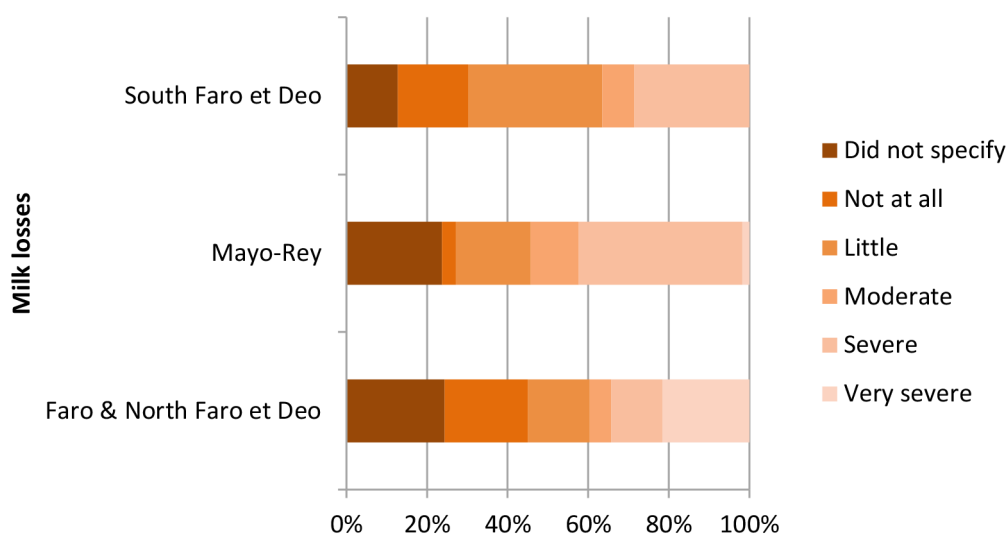


Figure 9: Production losses due to AAT, according to study area and livestock output (data from 298 households interviewed in Northern Cameroon in August 2013).

	Faro & North Faro et Déo	Mayo-Rey	South Faro et Déo
Cost (US\$) per individual AAT treatment: Median (lower & upper quartiles)	US \$0.50 (0.32 & 2)	US \$2 (1 to 3.3)	US \$0.77 (0.38 to 0.63)
Cattle deaths AAT % households > 0 Median (quartiles)	44.4% 4(2 to 8)	56.6% 7 (4 to 10.5)	23.4% 3 (2 to 5)
Cattle deaths (all disease) % households > 0 Median (quartiles)	92.5% 4 (2 to 10)	75.3% 5.5 (4 to 10.25)	61.8% 3 (2 to 5)

Table 5: Direct losses from AAT and other livestock diseases in terms of treatment costs in US dollars and mortality (data from 298 households interviewed in Northern Cameroon in August 2013).

5.3 Attitudes and practices towards AAT diagnosis and treatment in cattle

Diagnosing and treating AAT

Variables associated with AAT treatment practices are presented in Figures 10, 11 and 12. In Mayo-Rey most people would consult a veterinarian if they suspected their animal had AAT; whilst in the other study areas the vast majority of those interviewed reported dealing with the problem themselves. Although it cannot be certain that the farmers distinguished between veterinarians and animal health workers. Overall, 57.2% of households reported always treating livestock themselves.

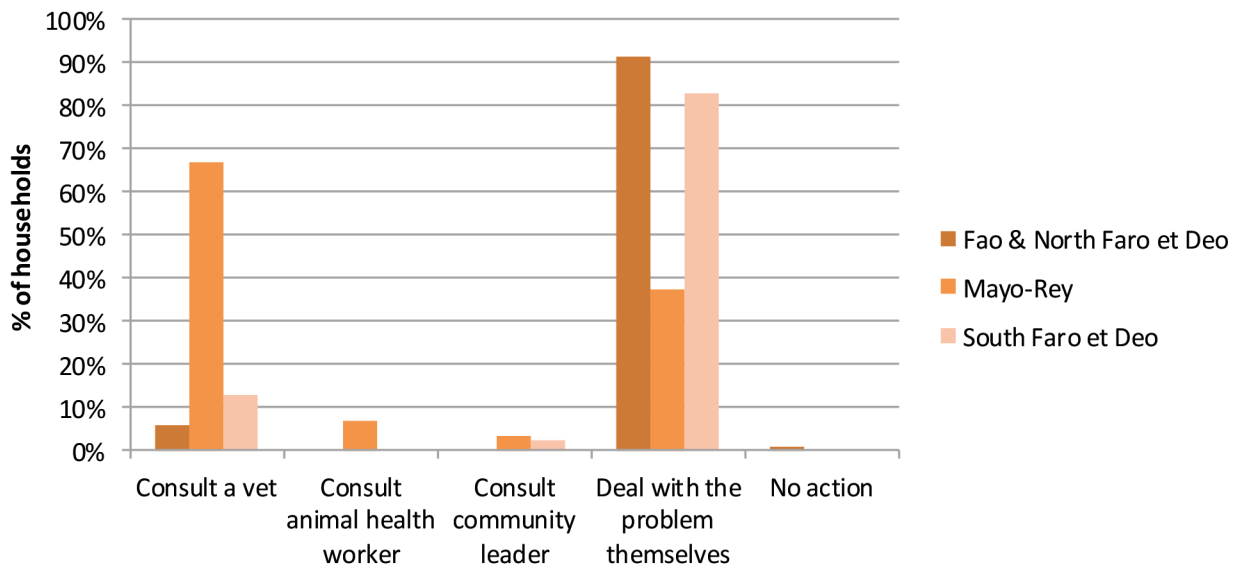


Figure 10: Household action in case of AAT suspicion, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

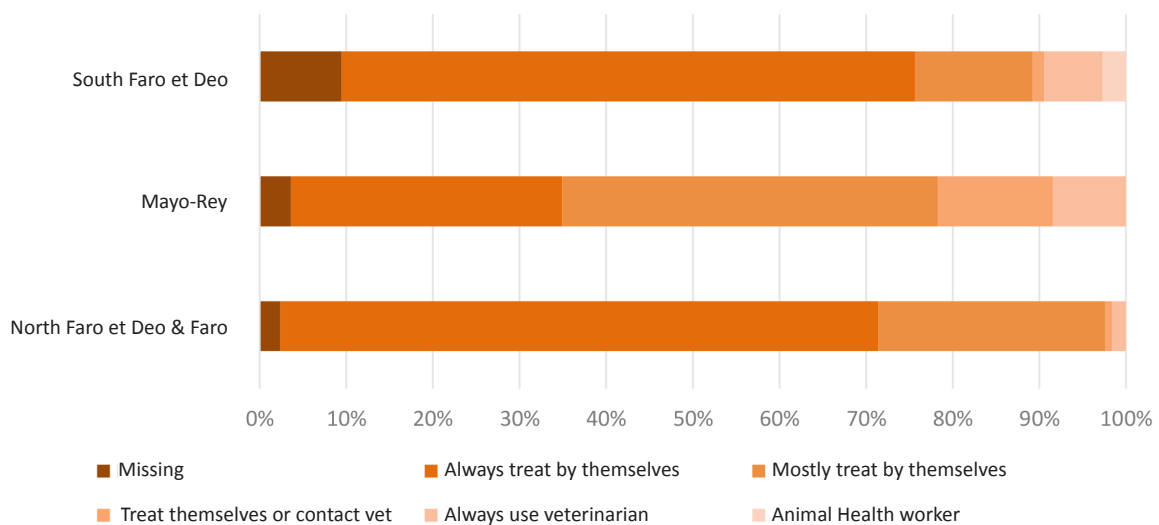


Figure 11: Who treats cattle against AAT, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

With regards to the main problems associated with current AAT treatment, drug preparation, affordability and correct dosing were the main problems in Mayo-Rey. Drug preparation and correct dosing were also identified as problems in Faro & North Faro et Déo and at South Faro. Additional limitations were access to sterile or clean water in (Faro & North Faro et Déo) and access to genuine drugs (Faro & North Faro et Déo and South Faro).

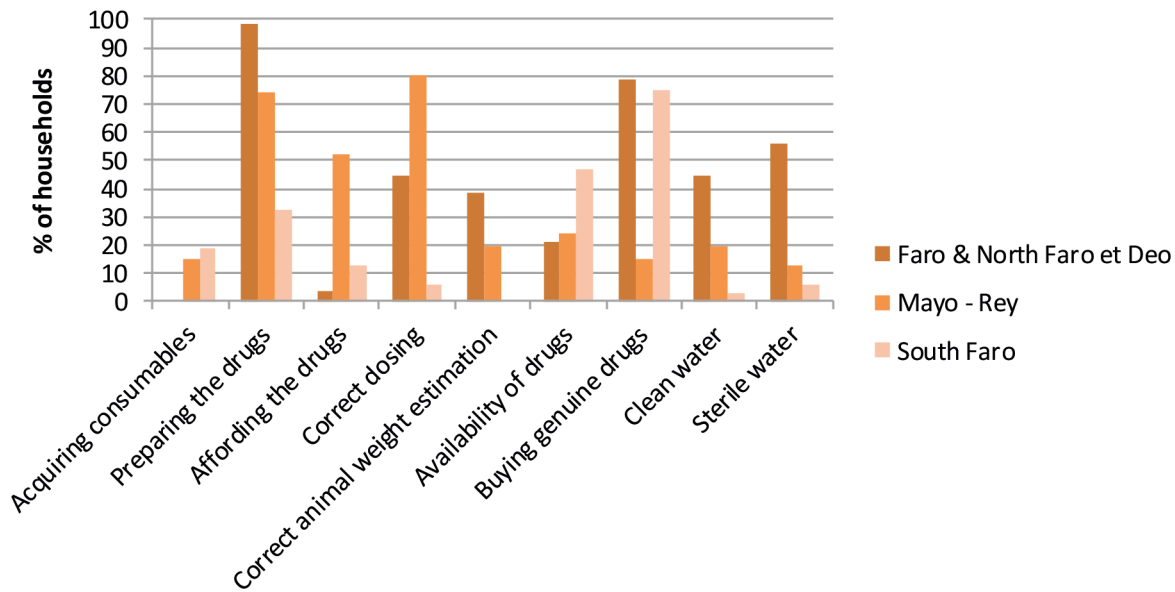


Figure 12: Main inconveniences with current AAT treatment, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

Treatment failure

Treatment failure occurred most regularly in South Faro et Déo and Faro & North Faro et Déo. In North Faro et Déo & Faro and South Faro et Déo using the ‘wrong drug’ or buying ‘fake drugs’ were the main reasons attributed to treatment failure. In Mayo-Rey resistance was mentioned as the main reason for treatment failure (46.2%).

WTP (\$)	Faro & North Faro et Déo	Mayo-Rey	South Faro et Déo
<0.25	100.0%	100.0%	100.0%
0.25	85.1%	100.0%	87.5%
≥0.5	42.5%	74.6%	40.0%
≥0.75	39.1%	71.6%	15.0%
≥1	39.1%	71.6%	12.5%
≥1.25	2.3%	64.2%	5.0%
≥1.5	2.3%	64.2%	5.0%
≥1.75	2.3%	64.2%	5.0%
≥2	2.3%	64.2%	5.0%
≥2.5	-	58.2%	2.5%
≥3	-	56.7%	2.5%
≥3.5	-	40.3%	2.5%
≥4	-	40.3%	2.5%
≥4.5	-	14.9%	2.5%
≥5	Never Rare	Frequently 14.9%	Always Most times 2.5%

Figure 12: Main inconveniences with current AAT treatment, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

	Faro & North Faro et Deo	Mayo-Rey	South Faro et Deo
AAT was not the cause of sickness	4.9%	23.1%	18.9%
Did not inject enough of the drug	3.6%	15.4%	13.5%
The disease has become resistant	9.7%	46.2%	2.7%
The drug bought was wrong and ineffective	56.6%	26.3%	35.1%
The drugs used were probably fake	36.9%	3.8%	2.7%
Did not specify/Did not know	32.9%	11.5%	29.7%

Table 6: Reasons attributed to AAT treatment failure (data from 298 households interviewed in Northern Cameroon in August 2013).

5.4 Existing AAT control

Few control measures were listed by participants as being used in the community (Table 7). Most households mentioned centralised governments as being the main facilitator of AAT control.

	Faro & North Faro	Mayo-Rey	South Faro
Control measures mentioned (community)			
Tsetse traps	0.8%	-	2.7%
Insecticide treated cattle	1.6%	-	5.4%
Select resistant breeds	-	-	2.7%
Treat sick cattle	-	-	2.7%
Treat all cattle	0.8%	-	2.7%
Facilitators of control			
None mentioned	19.1%	39.8%	41.9%
Communities acting	0.8%	1.2%	-
Centralised government	65.9%	46.6%	58.1%
Independent individuals	-	7.2%	-
District Officials	-	4.8%	-
Facilitated by NGOs	14.3%	12.0%	-
Facilitated by churches	-	4.4%	-

Table 10: Existing AAT control measures in the community (data from 374 households interviewed in East Cameroon in May/June 2013).

6. Knowledge of AAT

When interviewees were asked to describe AAT they mentioned classic signs of weight loss, malaise and loss of tail brush. Households in Mayo Rey mentioned that it was vector-borne and that tsetse flies were the vector. The data in the table also shows which species the interviewees thought can be affected by AAT. All the households mentioned that cattle are affected and some households correctly identified small ruminants as being susceptible to AAT. But this awareness was lower in Mayo Rey where more households mentioned donkeys than small ruminants. This may also reflect the importance of these species. This may also reflect the importance of these species.

AAT knowledge	% of households		
Aware of AAT			
Faro & North Faro et Déo	96.9%		
Mayo-Rey	91.2%		
South Faro et Déo	96.1%		
Mentioned that it is spread by vector			
Faro & North Faro et Déo	58.7%		
Mayo-Rey	88.7%		
South Faro et Déo	62.2%		
Mentioned that it is spread by tsetse			
Faro & North Faro et Déo	33.9%		
Mayo-Rey			
South Faro et Déo			
Mentioned that it affects other species	Sheep & goat	Donkey	Pigs
Faro & North Faro et Déo	94.4%	94.4%	94.4%
Mayo-Rey	57.3%	57.3%	57.3%
South Faro et Déo	70.7%	70.7%	70.7%
Think that AAT is zoonotic			
Faro & North Faro et Déo	14.3%		
Mayo-Rey	55.4%		
South Faro et Déo	4.1%		

Table 8: General knowledge about AAT, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

	Faro & North Faro	Mayo-Rey	South Faro
Said they knew how to control AAT			
% households	8.7%	14.5%	24.3%
Could identify a picture of tsetse trap			
% households	91.3%	72.3%	83.8%
Control measures mentioned (awareness)			
Tsetse traps	6.4%	10.8%	16.2%
Insecticide treated cattle	7.9%	10.8%	20.8%
Select resistant breeds	0.8%	7.2%	0%
Treat sick cattle	4.0%	12.1%	9.5%
Treat all cattle	0.8%	9.6%	6.8%

Table 9: Awareness of the existence of AAT control measures, according to study area (data from (data from 298 households interviewed in Northern Cameroon in August 2013).

7. Attitudes towards future AAT control

7.1 Population opinion about new control methods

Consumer willingness to use and pay for new diagnostic tests

Most households in the study area felt there was a need for new drugs and were ready to pay a higher price than current AAT treatment, providing it was more effective (Table 8). The willingness to pay was slightly lower in valley. During informal discussions most households said they needed more choice of drug or that the disease was still prevalent so better control is needed.

	Think there is a need for new AAT treatments	Would be willing to pay for a new treatment
Faro & North Faro et Deo	96.2%	79.2 %
Mayo-Rey	82.4%	85.7%
South Faro	92.2%	58.4%

Table 10: Proportion of farmers who think there is a need for new AAT drugs and would be ready to pay a higher price for it, according to study area (data from 210 households interviewed in Lundazi and Mambwe districts of Zambia in June 2013).

Consumer willingness to use and pay for new diagnostic tests

Most households interviewed would use a new diagnostic test but the proportion of households willing to pay for it was lower with around half of interviewees (51%) ready to pay for it in South Faro et Déo. The median price those interviewed where ready to pay was similar in Faro & North Faro et Déo (Median=0.3USD) and South Faro et Déo (Median= 0.4USD) (Table 11).

	Want diagnostic	Willing to pay >0	Median cost (IQR) in US\$ ³
Faro & North Faro et Deo	98.2%	67%	\$0.30 (0.20 & 1.00)
Plateau (Lundazi)	95.4%	74%	\$0.30 (0.20 & 0.70)
Valley (Mambwe)	89.2%	51%	\$0.40 (0.30 & 0.60)

Table 11: Proportion of farmers who would use new AAT diagnostics, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

Table 12 and Figure 13 show the price people are willing to pay for the new diagnostic test. Households in Mayo-Rey were consistently willing to pay higher price compared to other study areas. Proportion of households willing to pay more than one dollar was quite low in South Faro et Déo and Faro & North Faro et Déo.

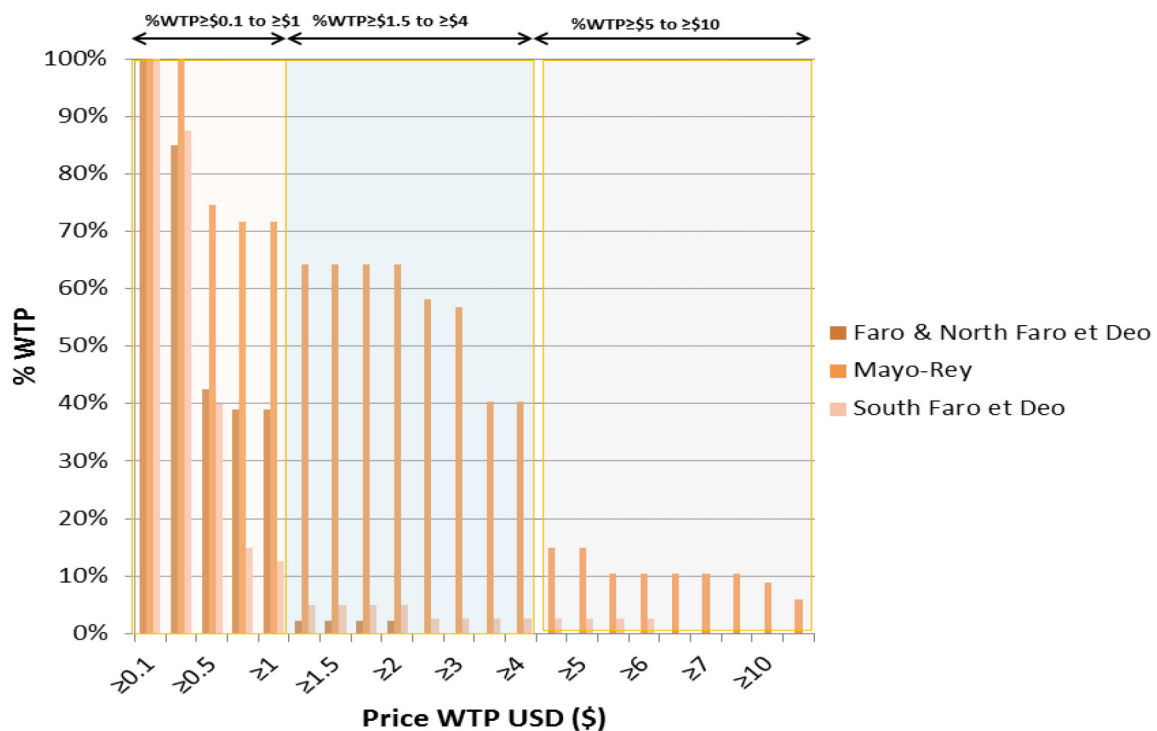


Figure 13: Cost (in USD) households would be willing to pay for an individual AAT diagnostic test (data from 298 households interviewed in Northern Cameroon in August 2013).

³ The study was conducted in June 2013 and at this time the exchange rate of the Central African CFA France (XAF) to the United States Dollar (USD) according to www.xe.com was 491.59 XAF = 1USD.

WTP (\$)	Faro & North Faro et Déo	Mayo-Rey	South Faro et Déo
≥0.10	100.0%	100.0%	100.0%
≥0.25	85.1%	100.0%	87.5%
≥0.5	42.5%	74.6%	40.0%
≥0.75	39.1%	71.6%	15.0%
≥1	39.1%	71.6%	12.5%
≥1.25	2.3%	64.2%	5.0%
≥1.5	2.3%	64.2%	5.0%
≥1.75	2.3%	64.2%	5.0%
≥2	2.3%	64.2%	5.0%
≥2.5	-	58.2%	2.5%
≥3	-	56.7%	2.5%
≥3.5	-	40.3%	2.5%
≥4	-	40.3%	2.5%
≥4.5	-	14.9%	2.5%
≥5	-	14.9%	2.5%
≥10	-	9.0%	-

Table 12: Cost (in USD) households would be willing to pay for an individual AAT diagnostic test (data from 298 households interviewed in Northern Cameroon in August 2013).

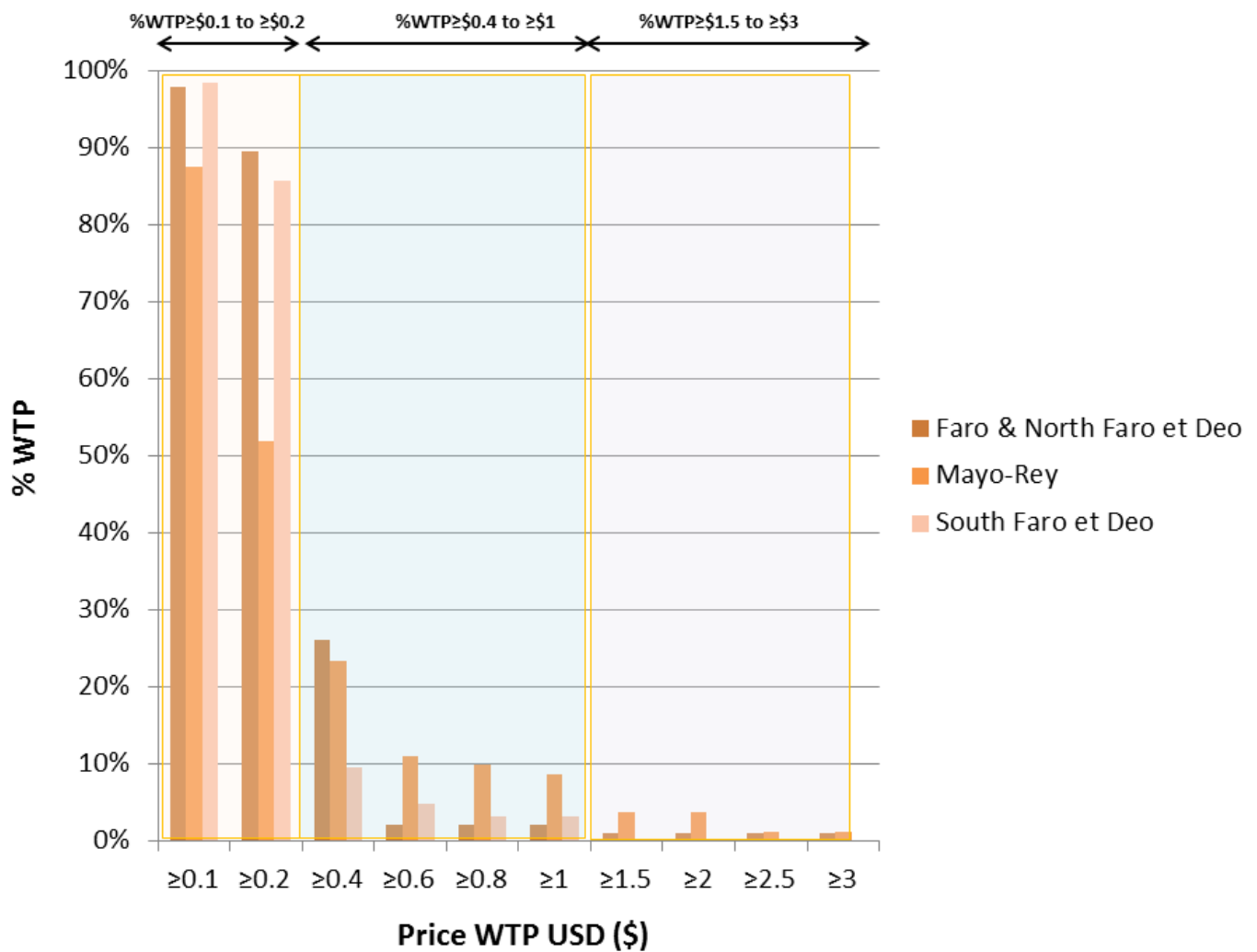
Consumer willingness to use and pay for new diagnostic tests

Almost all the households reported there is a need for a vaccine and they would vaccinate their animals should one become available. Most interviewees would be willing to pay for a novel vaccine: 74% in Faro & North Faro et Déo, 89% in Mayo–Rey and 81% in South Faro et Déo. Some also said they would vaccinate animals other than cattle such as sheep (45%), goats (28%), pigs, camel and equines. Households from Faro & North Faro et Déo were willing to pay slightly higher price. Most of the households were willing to pay anything less than or equal to 20 cents in all the study areas.

	Faro & North Faro et Déo	Mayo - Rey	South Faro
Would vaccinate	91.5%	94.0%	97.4%
Willing to pay > 0	74%	89%	81.3%
Median cost (IQR) in US\$ ⁴	\$0.30 (0.20 & 0.40)	\$0.20 (\$0.10 & 0.20)	\$0.20 (0.20 & 0.30)
Additional species they would vaccinate:			
Sheep	27.7%	74.7%	38%
Goat	16.2%	60.4%	7.8%
Pigs	0%	5.5%	0%
Camel	0%	16.5%	0%
Donkey	3.1%	16.5%	1.3%
Horses	0%	33%	1.3%

Table 13: Proportion of farmers who would vaccinate their animals against AAT if a vaccine was available, according to study area (data from 298 households interviewed in Northern Cameroon in August 2013).

⁴ The study was conducted in June 2013 and at this time the exchange rate of the Central African CFA France(XAF) to the United States Dollar (USD) according to www.xe.com was 491.59 XAF = 1USD.



WTP (\$)	Faro & North Faro et Déo	Mayo-Rey	South Faro et Déo
≥ 0.1	97.9%	87.7%	98.4%
≥ 0.2	89.6%	51.9%	85.7%
≥ 0.4	26.0%	23.5%	9.5%
≥ 0.6	2.1%	11.1%	4.8%
≥ 0.8	2.1%	9.9%	3.2%
≥ 1	2.1%	8.6%	3.2%
≥ 1.5	1.0%	3.7%	-
≥ 2	1.0%	3.7%	-
≥ 2.5	1.0%	1.2%	-
≥ 3	1.0%	1.2%	-

Figure 14 and Table 14: Cost (in USD) households would be willing to pay for an individual AAT vaccine (data from 298 households interviewed in Northern Cameroon in August 2013).

Conclusions

The primary source of income for cattle owners was livestock production in North Faro & Faro et Déo, however, farmers in Mayo-Rey were also likely to mention crop production (40%). Free-grazing was practiced in all areas. Some farmers in North Faro and Faro et Déo owned Guldali; a trypanotolerant cattle breed, in addition to White Fulani and Zebu.

AAT was the most frequent disease mentioned by farmers as ‘important’ in terms of monetary losses. Although some farmers in Mayo Rey (24%) said AAT was never a problem for them; when it did occur it appeared to have the highest perceived impact and losses to milk, meat and draught power were reported. Most farmers (91.5%) had lost at least one cattle to AAT in the past two years in Faro & North Faro et Déo. With around two-thirds in Mayo-Rey and one-third in South Faro et Déo reporting AAT mortalities.

Knowledge of the disease and its control were best in North Faro & Faro et Déo and in South Faro et Déo study area.

Treatment failure appeared frequent in all study areas and livestock owners attributed this failure to ineffective or fake drugs and resistance. Livestock owners reported treating AAT themselves. They mentioned preparing the drugs, correct dosing, buying genuine drugs, availability of the drugs, affording the drugs and obtaining clean/sterile water as the main inconvenience with current treatments.

Most farmers were willing to use novel treatments and diagnostics; willingness to pay was lowest in South Faro et Déo and highest in Mayo-Rey.

North Faro et Déo appeared to have the highest AAT burden. Although, when the disease did occur in Mayo-Rey impacts are high; particularly as cattle are very important for draught power in this area.

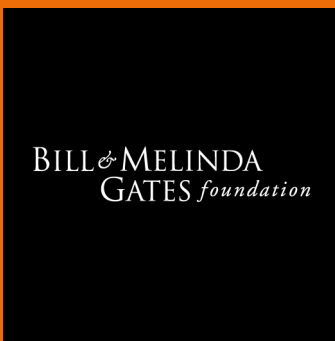
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This material has been funded by UK aid from the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

This publication is based on research funded in part by the Bill & Melinda Gates Foundation. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the Bill & Melinda Gates Foundation.

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