Evaluation of Bovine trypanosomosis intervention in Chunya District, Tanzania

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SUMMARY

A study was conducted in Chunya District, Tanzania during December 2013 to assess the impact of tsetse fly and trypanosomosis control programme based on use of targets and traps. The trypanosome prevalence was determined by microscopic examination of thick and thin blood smears from 229 cattle selected randomly from 33 households. Additionally a semi-structured questionnaire was administered to heads or representatives of selected households to collect information on cattle-keepers' knowledge on clinical features, transmission and control of trypanosomosis. Descriptive analysis of the data was done to establish proportions of different attributes and association between variables. Of 229 animals examined, six (2.6%) were positive for trypanosomes indicating significant decrease from baseline level of 13.8% found in 2010 at the beginning of the programme. Two trypanosome species, *Trypanosoma vivax* and *T. congolense* were identified in blood samples and vectors collected from the study area were identified as *Glossina* spp, *Tabanus* spp and *Haematopota* spp. Questionnaire results showed that burning of grasses (30.3%), theft of targets and traps (3.0%) and lack of follow up from the programme authority (6.1%) were major constraints that faced the programme. The study has shown a decline in prevalence of trypanosomosis which suggests that the application of traps and screens had a significantr impact on the disease and this warrants a recommendation of extending the trap and screen application technology to other similar tsetse infested areas of Tanzania.

Key words: Trypanosomosis, tsetse control, targets, traps, trypanocides

INTRODUCTION

Tsetse-borne animal trypanosomoses caused by species of salivarian trypanosomes namely *Trypanosoma congolense*, *T. simiae*, *T. vivax* and *T. brucei* singly or in combination are diseases of great socioeconomic importance in Africa. The vector tsetse flies are known to have occupied up to ten million square kilometers of Africa (Onditi *et al.,* 2007). The disease lowers productivity in livestock, reduces cattle density up to 70%, sale of meat and milk by 50%, calving rates by 20% and calf mortality by 20% (Malele *et al.,* 2011). It is estimated that trypanosomosis causes annual losses summing to $1340 million to livestock producers (Kristjanson *et al.,* 1999). The disease is often fatal to cattle and also causes severe losses in livestock production due to poor growth, weight loss, low milk yield, infertility, abortion, and reduced capacity for work by draught animals (Jordan, 1985).

Tanzania ranks third in Africa after Ethiopia and Sudan (before South Sudan independence) in terms of cattle numbers which are estimated to be 25.8 million (URT, 2016). Despite this large number of cattle, the contribution of the livestock industry to the economy of Tanzania is not as high as it should be, generating only 4.7% of national GDP and only 8.9% of agriculture GDP (NBS, 2011). The incongruence of contribution of the livestock industry to cattle population is partly explained by low productivity that is contributed to by, among other factors, diseases that are responsible for morbidity and mortality. Of all animal diseases having impact on livestock productivity in Tanzania, tsetse- transmitted trypanosomosis ranks second to tick-borne diseases of cattle in terms of mortalities (Daffa and Njau, 2003). Nevertheless, the situation has improved as pointed in a recent report by Daffa *et al*. (2013) that the area occupied by the tsetse has shrunk to one third. Tanzania hosts seven species of tsetse namely *Glossina morsitans*, *G. pallidipes*, *G. swynnertoni*, *G. austeni*, *G. fuscipes*, *G. longipennis* and *G. brevipalpis* (Moloo, 1985; Malele, 2011; Daffa *et al.*, 2013).

In Tanzania traps and targets, as means of tsetse fly control, have been in use since 1975 though on a small scale and sporadic programs being implemented in selected places in Tanzania (Malele, 2011). Tsetse transmitted trypanosomosis is a problem in Chunya due to the district being situated in a tsetse fly belt. In 2010, Chunya district in collaboration with Ministry of Livestock and Fisheries Development (MLFD) implemented a tsetse fly control programme at Kambikatoto village. We report here, findings from a study aimed at assessing the impact of the intervention, establishing species of trypanosomes prevailing in cattle and identifying factors which have impacted on the intervention.

MATERIALS AND METHODS

Study area

The study was conducted in Chunya district in Mbeya region, Tanzania. The district lies between latitudes 7˚S and 9˚S and between longitudes 32˚E and 34˚E bordering Singida (Manyoni district) and Tabora (Sikonge district) regions in the north, Iringa region and Mbarali district of Mbeya region in the east, Mbeya district in the south and Rukwa region, as well as Mbozi and Momba districts of Mbeya on the West.

Chunya district has an area of 29 219 km^2 with 30 wards and 73 villages. The main economic activities are mining, agriculture, harvesting forest products (such as timber), bee-keeping and fishing. The district has also two game reserves namely Lukwati and Piti. The Lukwati Game Reserve occupies 2,000 km^2 and borders Gua and Ngwala villages while Piti Game Reserve occupies 2,972.9 km^2 and borders Mafyeko, Bitimanyanga, Kambikatoto and Ngwala villages (Chunya District, 2013).

In 1988, tsetse fly control programme was designed and implemented at Kambikatoto village in Chunya District for three years between 1988 and 1991. It was funded by Food and Agriculture Organization (FAO) under supervision of Mbeya Regional Livestock Office. The programme showed a good result in trypanosomosis control but upon phasing out there was a resurgence of the tsetse fly population. After a significant increase in bovine mortality due to trypanosomosis, the District Council in collaboration with MLFD re-introduced tsetse fly control programme in 2010 at Kambikatoto village through deployment of targets and traps. The present study was conducted at Kambikatoto village located in Chunya district to evaluate the intervention efforts where targets and traps

were put in place. The village has total area of 128,826 hectares (ha) grazing land which is under land use plan.

Study animals

These were cattle of all ages and both sexes. At the time of the study, the village was estimated to have a cattle population of 17,560. Animals involved in the study were kept under extensive system of management in communal grazing areas.

Intervention description

The intervention to control trypanosomosis and tsetse flies population was done by placing pyrethroid impregnated traps and targets made of black and blue colour. Pyramidal, biconical, S3-trap, H-traps and targets made of blue and black clothing materials were placed at a distance of approximately 200 m from each other. A total of 40 targets were put in place and the targets were impregnated with pyrethroids to kill alighting flies.

Sample size and sampling procedure

In this study, cluster sampling design was used because the list of herds (clusters) was available and not a list of individual cattle. The number of clusters (C), which represented a herd or a household keeping cattle, was calculated by the formula $C= P(1-P)D/(SE^2)n$ (Bennett *et al.,* 1991), where $D= 1+\rho (n-1)$, $SE= d/Z_{\alpha}$, Z= Standard variate at 95% confidence interval, SE=Standard error, D=Design effect, d= precision of 5%, P= Prevalence of the disease before intervention of 13.7% (Mramba F. personal communication, 2013), ρ= Intra cluster correlation factor/rate of homogeneity of 0.115 (Majekodunmi *et al.,* 2013), and n= the average herd size of seven obtained in a preliminary survey in the study area. A total of 33 clusters required in this study contributed 229 cattle. The households keeping cattle were selected at random and in each household, cattle were selected proportionately.

Sample collection, processing and examination

Thin and thick blood smears were prepared in the field from the blood collected direct from the ear veins. The slides were air dried and fixed using absolute methanol. The blood smears were then transferred to Sokoine University of Agriculture laboratory where they were stained with Giemsa at 1:10 (dilution with buffered distilled water pH 7-7.2) for 30 minutes as described by Armour (1983) and examined under the microscope. In addition, microhaematocrit centrifugation buffy coat technique was applied to detect trypanosomes. To increase the chance of detecting *Trypanosoma brucei*, blood from cattle purposely selected from the selected population on the basis of clinical appearance was inoculated into mice. A total of 33 mice were used in screening for trypanosomes.

Questionnaire administration

Pre-tested semi-structured questionnaire was administered to livestock keepers in the selected clusters for purposes of assessing socio-demographic characteristics of the study population, cattle management practices and knowledge of diseases in general, knowledge on the vector transmitting trypanosomoses and tsetse fly control as well as prevention and the constraints hindering the intervention.

Data analysis

The raw data were entered in Microsoft excel and analysis was done by use of Epi info version 7 programme. Using Statcalc,

proportions of categorical variables were computed and further compared using the Chi-square test at a critical probability of $p < 0.05$. The strength of associations between dependent and independent variables were determined using 2 x 2 contingency tables.

RESULTS

Prevalence of trypanosomosis

Records show that the prevalence of trypanosomosis before intervention was 13.7% (n= 190 cattle) (Mramba F. personal communication, 2013). Our study showed that after intervention, the prevalence was 2.6% (n=229 cattle). The trypanosome species identified were *T. vivax* (2 samples) and *T. congolense* (4 samples) as shown in Figures 1 A & B.

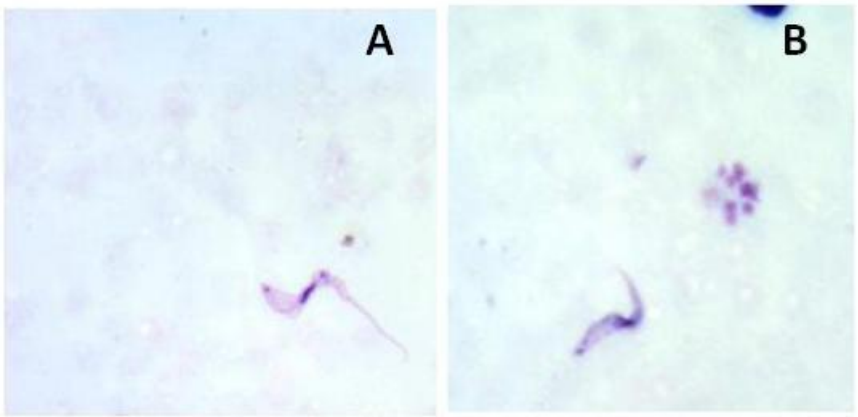

Figure 1. *Trypanosoma vivax* (A) and *Trypanosoma congolense* (B) recovered from cattle in Chunya District

The socio-demographic characteristics of the respondents are shown in Table 1. Heads of households constituted 72.7% of respondents while the second in-charge represented 9.1%. Majority of the respondents (90.9%) were males. Out of 33 respondents 14 (42.4%) all of whom were adults did not divulge their ages. The intimated ages of the remaining 19 (57.6%) were between 21 and 70 years. On education, only 45.5% had formal (primary) education.

Knowledge of respondents on diseases and disease control

Respondents reported reported the most common diseases in Chunya district. Trypanosomosis was mentioned by 97.0% of respondents and 45.5% reported that the disease occurs throughout the year and 84.9% specified that all age groups of animals are affected (Table 2). Less dense forest was mentioned as the habitat for the tsetse fly by the majority (72.7%) of respondents. When asked about other stubborn flies, the majority of respondents (51.6%) did not know the features of these other flies while 21.2% were able to mention that these flies had dark bands on their wings and also had pointed proboscis (Table 2).

Table 1. Socio-demographic characteristics of respondents (n=33)

Variable	Category	Frequency	Percentage
Position in the household	Head of the family	24	72.7
	Second in charge	3	9.1
	Others	6	18.2
Sex	Male	30	90.9
	Female	3	9.1
Age of respondents	21-40 years	12	36.4
	41-70 years	7	21.2
	Unknown age (adult)	14	42.4
Education	None-formal	18	54.6
	Primary	15	45.5

On control of the trypanosomosis and vectors, majority of respondents (78.8%) said this can be achieved by spraying animals with acaricides and treating them with trypanocides while 57.6% mentioned use of traps and targets as methods for control (Table 2).

About two fifths (42.4%) of respondents were of the opinion that there has been a decrease in tsetse population and cases of trypanosomosis (Table 3). The acaricides used by cattle keepers were in pyrethroid group specifically "Cybadip®", Paranex® and Alfanex®. Livestock keepers mentioned different factors affecting trypanosomosis control programme in Chunya District. These included fire, trap theft and lack of government follow-up on deployed traps. However, 42.4% of respondents did not mention these factors (Table 3).

DISCUSSION

The study conducted at Kambikatoto village to assess the impact of the intervention carried out for control of bovine trypanosomosis through the use of targets and traps showed a decrease in prevalence of trypanosomosis from 13.7% to 2.6%. Also *T. vivax* and *T. congolense* were identified and trypanosome transmitting vectors (*Glossina morsitans*, *Tabanus* spp. and *Haematopota* spp.) were identified. The identified trypanosome species seem to be more prevalent in Tanzania as also reported in a research done in Monduli district by Swai and Kaaya (2012).

A research done by Mramba (Personal communication, 2013) showed the disease prevalence to be high before intervention. Also according to the reports from extension officer of Kambikatoto village, out of 650 cattle in Kambikatoto ward before intervention, 43 cattle were diagnosed with trypanosomosis and out of them five died in one month alone. This is a very huge number of cases to occur within one month (Mramba F. Personal communication, 2013).

The decrease in prevalence of infection might be attributed to interventions employed in the tsetse fly infested area. Targets and traps have been used widely in controlling tsetse flies and trypanosomosis in Tanzania. Traps have been effective in controlling tsetse flies as pointed out by a study conducted by Malele *et al.* (2011) to determine the efficiency of available traps for catching tsetse flies infesting the area, their infection rates and *Trypanosoma* species circulating in the new farming area of Rufiji district, Tanzania. In spite of differences in efficacy between traps and targets as pointed out by Mramba *et al*. (2013), they also contribute significantly in tsetse fly control. As a result, the traps and

targets (pyramidal, epsilon traps) deployed at Chunya district have contributed to the decrease in tsetse flies population and the prevalence of bovine trypanosomosis. However, there are also other factors which may have contributed to the decline in tsetse-borne trypanosomosis prevalence at Kambikatoto Chunya. These include widespread use of pyrethroid acaricides which are insecticidal/repellent on tsetse flies and also trypanocidal drugs application and grass burning as pointed out in the household questionnaire conducted.

Table 2. Knowledge of respondents on livestock diseases and disease control (n=33)

Domain	Variable	Category	Frequency (%)
Diseases in Chunya district	Troublesome diseases in the area	Trypanosomosis only	10 (30.3)
		Trypanosomosis and other diseases	22 (66.7)
		Other diseases excluding trypanosomosis	1 (3)
Knowledge on trypanosomosis	Season of trypanosomosis occurrence	Rain season	4 (12.1)
		Dry season	5 (15.2)
		Throughout the year	15 (45.5)
		End of rain to start of dry season	6 (18.2)
		I do not know	3 (9.1)
	Age group affected	Calves	2 (6.1)
		Adults	1 (3)
		All age groups	28 (84.9)
		I do not know	2 (6.1)
Knowledge on tsetse fly vectors	Habitat of vector	Anywhere where hosts can be found	3 (9.1)
		Clear and open areas	1 (3)
		Less dense forest	24 (72.7)
		I do not know	5 (15.2)
Knowledge on features of other stubborn flies	Troublesome flies	(a) Big head fitted with thorax, with big eyes	3 (9.1)
		(b) Dark bands in wings, pointed proboscis	7 (21.2)
		Small body size and pointed proboscis	1 (3)
		I do not know	19 (57.6)
		Both (a) and (b) above	3 (9.1)
Knowledge on the control of the disease and vectors	Protect animals from tsetse fly and bovine trypanosomosis disease	Spraying using acaricides	2 (6.1)
		Prophylactic treatment	3 (9.1)
		Doing nothing	2 (6.1)
		Spraying and using prophylaxis	26 (78.8)
	Control of tsetse flies	Traps and targets	19 (57.6)
		I do not know	13 (39.4)
		Burning grasses	1 (3)

Table 3. Status, acaricides use and factors affecting trypanosomosis control (n=33)

Variable	Category	Frequency (%)
Status of trypanosomosis and tsetse fly in the area	Decrease in tsetse population and cases of disease	14 (42.4)
	Increase in tsetse population and cases of disease	1 (3)
	No changes from previous situation	6 (18.2)
	I do not	12 (36.4)
Drivers for the decrease in tsetse fly population and bovine trypanosomosis	Use of acaricides only	1 (3)
	Traps and targets only	1 (3)
	I don't know	18 (54.6)
	Both trapping and use of acaricides	1 (3)
	Acaricides, trapping and trypanocides	7 (21.2)
	Acaricides, traps, trypanocides, burning grasses	1 (3)
	Bush clearing, acaricides, traps, trypanocides	1 (3)
	Acaricides, traps, burning grasses	1 (3)
	Acaricides and trypanocides	2 (6.1)
Acaricides used in tsetse fly control	Cybadip®	13 (39.4)
	Alfanex®	2 (6.1)
	Do nothing	4 (12.1)
	Paranex® and Cybadip®	4)12.1)
	Paranex®, Cybadip® and Alfanex®	10 (30.3)
Knowledge on factors affecting the programme	Burning fire	10 (30.3)
	Theft	1 (3)
	I do not know	14 (42.4)
	No follow up from government	2 (6.1)
	Burning with fire and theft	5 (15.2)

Control of trypanosomosis and tsetse fly population showed association with the use of both acaricides and trypanocidal drugs in control of the disease and vectors. This shows that apart from the programme instituted in the study area, the use of acaricides and trypanocidal drugs has contributed to the control of the disease and hence the decrease in disease status and tsetse fly population. Hargrove *et al*. (2012) citing studies in Uganda pointed out that the control of trypanosomosis using trypanocides or insecticides in Uganda showed that the two methods reduced trypanosome prevalence in cattle. Therefore, the use of trypanocides and pyrethroid acaricides on livestock may also have contributed to decline of trypanosomosis in the study area. This was also reported by Van den Bossche *et al.* (2000) who observed that in the tsetse-infested area the treatment of clinically sick animals significantly reduced the trypanosomosis-related mortality but was insufficient to boost reproduction in cows. Since 2006 there has been an increase in

dipping/spraying of animals for the control of ticks and troublesome flies due to increase in acaricides subsidies and new dip tanks (Chunya District Council, 2013). The study conducted by Kalule (2010) showed that use of acaricides and trypanocides alone cannot bring huge decrease in disease prevalence as seen Chunya District.

Reports from Chunya District Council, (2013) show that in 2012 the trypanosomosis cases were 17 and 69 in intervened and non-intervened areas respectively. This decrease in disease status in a tsetse fly intervened area is incomparable to the non-tsetse fly intervened area and accounts to the effectiveness of use of traps and targets in the intervened area. The use of traps and targets have been supported with the use of acaricides and trypanocides to control tsetse flies, other disease transmitting vectors and the disease.

Livestock keepers being knowledgeable on bovine trypanosomosis and vectors transmitting disease, trypanosomosis was ranked the most significant cattle disease in the study area and hence actions have been taken to control the disease through the use of acaricides and trypanocides which contributed to reducing disease prevalence. In spite of effectiveness shown by the programme, it was constrained by some factors as pointed out by respondents during interview. Mice inoculated with blood from trypanosomosis suspect cattle did not reveal any growth of trypanosomes signifying nil or low prevalence of the usually sub-patent trypanosome species *T. brucei*. The heavy use of trypanocides may have contributed to the low prevalence of trypanosomes.

In the study area, animal treatment is done by farmers themselves. Similar situation in other pastoral communities was observed in Eastern province of Zambia by Van den Bossche *et al*. (2000) and Rufiji district Tanzania by Magwisha *et al*. (2013). This may result in misuse of drugs. The questionnaire study revealed considerable misuse of drugs in that farmers often mixed two or more different trypanocidal drugs to inject at the same time and site (Matugandama, personal communication, 2013). Chunya district is in wildlife livestock interface. Six out of 229 sampled animals were found positive for trypanosomes (two with *T. vivax* and four with *T. congolense*). There are minimal interactions with wild animals running away from the hunting corridors. Hence the reduced interactions with wild animals may have contributed to the decrease in tsetse fly population and disease transmission to domestic animals.

It can be argued that deployment of traps and/or targets that destroy a proportion of the tsetse population will lead to a reduction in trypanosomosis transmission (Kuzoe and Schofield, 2004) and this has partly accounted for a decrease in disease prevalence from 13.7% to 2.6% in Chunya district. The programme has been supported by the use of trypanocidal drugs and use of acaricides that also are insecticidal against tsetse. Furthermore, the study has confirmed the high knowledge possessed by livestock keepers on disease and vectors transmitting the disease. The study established presence of the *morsitans* group of tsetse flies and *T. vivax* as well as *T. congolense* circulating in the study area.

Though it is possible that factors other than the tsetse control interventions are likely to have contributed to the observed decline in trypanosomoses, it is being recommended that this method should also be extended to other tsetse fly infected areas which are potential for livestock keeping.

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REFERENCES

Africa Development Fund. Multinational Eradication of tsetse and trypanosomiasis in Sub-Saharan Africa. Summary of the environmental and social impact assessment study, pp.19, 2004.

Armour J. Internal parasites. In: *A manual of Laboratory Technique.* (Edited by Hawken ML). British Small Animal Veterinary Association, Cheltenham, pp.85-86, 1983.

Bennett S, Woods T, Liyanage WM, Smith DL. A simplified general method for cluster-sample surveys of health in developing countries. *World Health Stat Q*, 44:98–106, 1991.

Chunya District Council. Chunya district livestock database, Mbeya region, Tanzania, 2013. (Unpublished).

Chunya District Office. Chunya district profile. Chunya district, Mbeya region Tanzania, 24 pp, 2013. (unpublished).

Connor RJ. Halliwell RW. Bovine trypanosomiasis in Southern Tanzania: Parasitological and serological survey of prevalence. *Trop Anim Health Prod* 19: 165-172, 1987.

Daffa J, Byamungu M, Nsengwa G, Mwambembe E, Mleche W. Tsetse distribution in Tanzania: 2012 status**.** *Tanz Vet J*, (28), 2013.

Daffa JWS, Njau PZ. National strategy for integrated management of tsetse and trypanosomosis control in Tanzania. In: Proceedings of the 21st TVA scientific conference of Tanzania Veterinary Association, ed Kazwala RR, Kimera SI. Arusha, Tanzania, pp. 209-221, 2003.

Hargrove JW, Ouifki R, Kajunguri D, Vale GA, Torr SJ. Modeling the control of trypanosomiasis using trypanocides or insecticides treated livestock. *PloS Negl Trop Dis*, 6(5): 1615, 2012.

Jordan AM. Tsetse eradication plans for southern Africa. *Parasitol Today*, 1(1):5121–5123, 1985.

Kalule G. Comparative study of Tsetse and Trypanosomosis Control Methods in Kasese District. Makerere University. Pp 67, 2010.

Kristjanson PM, Swallow BM, Kruska RL, de Leeuw PN. Measuring the costs of African animal trypanosomosis, the potential benefits of control and returns to research. *Agric Syst*, 59(1):79-98, 1999.

Kuzoe FA, Schofield CJ. Strategic review of traps and targets for tsetse and African Trypanosomiasis control, Report of Special Programme for Research and Training in Tropical Disease (TDR) TDR/IDE/TRY/051. Geneva, Switzerland: World Health Organisation, 2004.

Magwisha HB, Malele II, Nyingilili HS, *et al*. Knowledge, Attitude and Control Practices of Tsetse Flies and Trypanosomiasis among Agro-Pastoralists in Rufiji Valley, Tanzania. *Commonwealth Vet J*, 29(1):10, 2013.

Majekodunmi AO, Fajinmi A, Dongkum C, Picozzi K, Thrusfield VM, Welbum SC. A longitudinal survey of African animal trypanosomiasis in domestic cattle on the Jos Plateau, Nigeria: prevalence, distribution and risk factors. *Parasit Vect*, 6: 239, 2013.

Malele II, Magwisha HB, Nyingilili HS, *et al*. Multiple *Trypanosoma* infections are common amongst *Glossina* species in the new farming areas of Rufiji district, Tanzania. *Parasit Vectors*, 4:217, 2011.

Malele II. Fifty years of tsetse control in Tanzania: challenges and prospects for the future. *Tanz J Health Res*, 13(1):1-7, 2011.

Moloo, SK (1985). Distribution of Glossina species in Africa. *Acta Tropica*, 42: 275-281.

Mramba F, Oloo F, Byamungu M, Kröbe T, McMullin A, Mihok S, Patrick M. Guerin P.M. Standardizing Visual Control Devices for Tsetse Flies: East African Species Glossina swynnertoni. *PloS Negl Trop Dis* 7(2):e206, 2013.

Onditi SJ, Silayo RS, Kimera SI, Kimbita EN, Mbilu TJNK. Preliminary studies on prevalence and importance of goat trypanosomosis in selected farms in Morogoro District, Tanzania. Livestock Research for Rural Development, 19(5), 2007.

Swai ES, Kaaya JE. A parasitological survey for bovine trypanosomosis in the

livestock/wildlife ecozone of Northern Tanzania. *Vet World* 5(8):459-464, 2012.

Tanzania National Bureau of Statistics. National Sample Census of Agriculture 2007/2008: small holder agriculture. Livestock sector, (3) pp10, 2012.

Tanzania National Bureau of Statistics. National Sample Census of Agriculture 2007/2008: small holder agriculture. Technical and operation report, (1) pp1, 2011.

URT (United Republic of Tanzania). *Budget Speech 2016/17*, 2016. Viewed on 12 May 2016, from http://www.mifugouvuvi.go.tz/budget-speech-2016/16.

Van den Bossche P, Doran M, Connor RJ. An analysis of trypanocidal drug use in the Eastern Province of Zambia. *Acta Trop*, 75(2):247-58, 2000.