International Journal of Agricultural and Environmental Sciences
2019; 4(2): 21-29
http://www.openscienceonline.com/journal/ijaes

Factors Affecting Farmers' Choice of Tsetse and Trypanosomiasis Control Methods in Lamu County, Kenya

Seth Ooko Onyango[1, *], Sabina Mukoya-Wangia[2], Josiah Mwivandi Kinama[3], Pamela Akinyi Olet[1]

[1]Kenya Tsetse and Trypanosomiasis Eradication Council (KENTTEC), Nairobi, Kenya

[2]Department of Agricultural Economics, University of Nairobi, Nairobi, Kenya

[3]Department of Plant Science and Crop Protection, University of Nairobi, Nairobi, Kenya

Email address

sethooko@yahoo.com (S. O. Onyango), sm.wangia@gmail.com (S. Mukoya-Wangia), josikinama@yahoo.com (J. M. Kinama), pamaolet@yahoo.com (P. A. Olet)

*Corresponding author

To cite this article

Seth Ooko Onyango, Sabina Mukoya-Wangia, Josiah Mwivandi Kinama, Pamela Akinyi Olet. Factors Affecting Farmers' Choice of Tsetse and Trypanosomiasis Control Methods in Lamu County, Kenya. *International Journal of Agricultural and Environmental Sciences*. Vol. 4, No. 2, 2019, pp. 21-29.

Received: March 18, 2019; **Accepted**: May 7, 2019; **Published**: May 19, 2019

Abstract

Tsetse flies and trypanosomiasis affects 37 sub-Saharan African countries impacting lives of about 60 million people and 48 million cattle. It is one of the greatest constraints to agricultural development in the sub-humid and humid zones of Africa that needs to be removed if the Sustainable Development Goals and Kenya's Vision 2030 goals of poverty reduction and food security is to be achieved. This study assessed the factors influencing farmers' choice of Integrated Methods (IM), Moving Targets (MT), Insecticide Treated Targets (ITT) and Trypanocidal Drugs/Ethno-veterinary practices (TD) as methods used to control tsetse and trypanosomiasis in Lamu County, Kenya. A structured questionnaire was used to collect Social and economic data from a random sample of 536 farm households. Multinomial Logit regression results showed that the odds of a household choosing IM over TD increased 1.046 times (Sig. =0.002) when the Tropical Livestock Units in the household increased by one unit. When the household's distance from dips, crush pens or insecticide treated target screens increased by 1 kilometre, the odds of choosing IM over TD decreased 0.861 times (Sig.= 0.000), that of choosing MT over TD decreased 0.908 times (Sig. = 0.007) and that of choosing ITT over TD decreased 0.684 times (Sig = 0.000). A one year increase in level of education of the head of household led to 1.075 folds increase in the odds of choosing IM over TD (Sig.= 0.027). When a household was headed by a female, the odds of choosing IM over TD increased 18.672 times (Sig. = 0.000) compared to 9.952 times when household head was male. The odds of choosing IM over TD decreased 0.119 times (Sig. = 0.003) when IM was not available and when the cost was low; the odds of choosing the IM method over TD increased 2.54 times (Sig. = 0.012) and that of choosing ITT increased 3.178 times (Sig. = 0.031)). When IM was not effective, the odds of choosing the method over TD decreased 0.342 times (Sig=0.001) and when extension service was not available, the odds of choosing IM over TD decreased 0.41 times (Sig. = 0.011). The study recommends that National Government, County governments and development agencies to consider household characteristics, technological factors and institutional factors when introducing new technologies to farmers. The County Governments to formulate policies that encourage Small and Micro-Enterprises to establish input shops to increase farmers' accessibility to the tsetse control technologies.

Keywords

Factors, Tsetse, Trypanosomiasis, Control, Methods, Technologies, Choice

1. Background

Tsetse flies (*Glossina spp*) transmit a fatal zoonotic disease called trypanosomiasis. The disease is known as sleeping sickness in humans and *nagana* in livestock. The vector and the disease that it transmits affects 37 sub-Saharan African countries impacting lives of about 60 million people and 48 million cattle [1]. It is one of the greatest constraints to agricultural development in the sub-humid and humid zones of Africa that needs to be removed if the Sustainable Development Goals (SDG) and Kenya's Vision 2030 goals of poverty reduction and food security is to be achieved.

The area of Kenya infested by tsetse flies is estimated to be 138,000 km^2 covering 38 out of 47 counties [2]. In 2010, the Government of Kenya through the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) piloted tsetse and trypanosomiasis control activities in the 62 km^2 area of Pate Island of Lamu County in the Northern Coast of Kenya [3]. The project promoted use of different methods of tsetse and trypanosomiasis control which include deployment of Insecticide Treated Targets (ITT) to kill the flies in the farmlands and in conservation areas, use of Moving Targets (MT) which entailed application of insecticides on livestock by spraying, dipping or use of pour-ons and use of Trypanocidal Drugs (TD) to treat livestock [4].

The ITT technique is considered to be conferring a public benefit to livestock in the entire area of interventions in addition to protection of individual farms [5]. The use of the technique to protect individual cattle compounds or Zero Grazing Units has been documented to have an impact on tsetse populations and on the prevalence of trypanosomiasis in animals [6]. In the tsetse and trypanosomiasis controlled areas of Busoga in Uganda, it was observed that use of ITT technique in the control of the vector and the disease that it spreads was successful [7].

The adoption of MT technique on the other hand has been shown to control tsetse flies, ticks, nuisance insects and other vectors and is recommended to farmers for integration into existing vector control regimes [8-9]. The PATTEC project for example promoted the technique in Pate Island where members of the community constructed crush pens for spraying livestock, application of pour-ons or dipping of the animals to serve as live baits for killing tsetse flies while grazing out in the fields [4].

In a study on chemotherapy of animal trypanosomiasis, it was shown that TDs are most often used for prophylaxis and curative purposes [10]. This agrees with the baseline surveys conducted by the PATTEC project in Pate Island which indicated that trypanocidal drugs were used either for treatment or prophylactic purposes [4]. It is estimated that on average 1.9 doses of TD are given in dairy herds per head per annum and in other cattle populations it is likely to be between 1 and 2 doses [11].

Individual households in Lamu County adopted one or more of the above methods of tsetse and trypanosomiasis control. For the purposes of this study, instances where households adopted more than one method was referred to as Integrated Methods (IM).

The achievements of tsetse and trypanosomiasis control in the PATTEC project areas of Kenya include reduced tsetse population from 46 to 0 Flies per Trap per Day (FTD) and reduced African Animal Trypanosomiasis prevalence from 20 percent to below 5 percent making it possible for the communities to keep livestock profitably [4, 12].

This study assessed factors that influenced farmers' choice of the tsetse and trypanosomiasis control methods in Lamu County and isolates key factors for consideration by government and development agencies to aid successful adoption of agricultural technologies by farmers in the tsetse infested areas of Africa. Figure 1 shows the map of the study area.

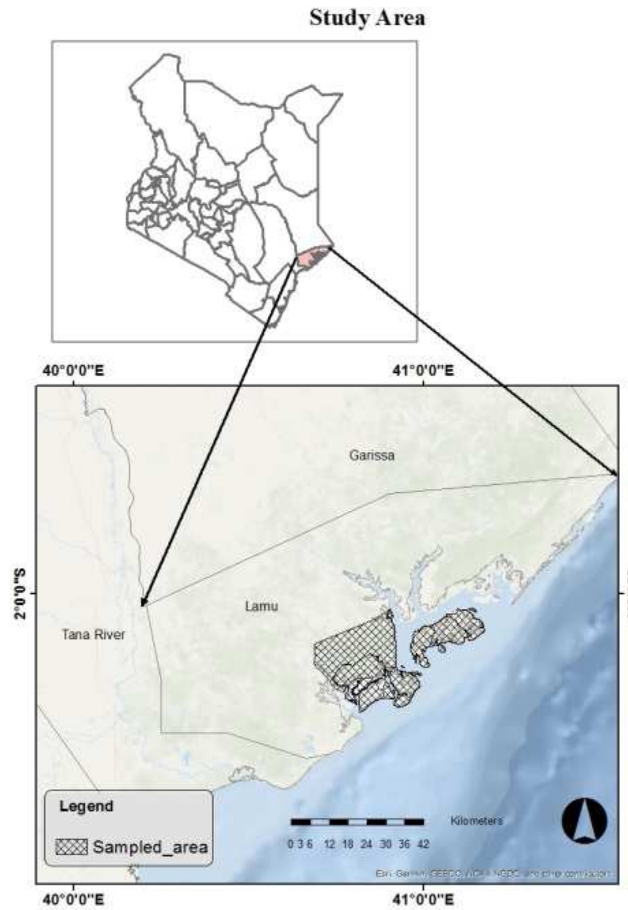

Figure 1. *A Map showing the study area covering Pate Island, Amu Island and Hindi division of Lamu County, Kenya*

2. Research Methodology

A sample of 536 households was drawn from Lamu County situated at latitude 1*°40, 20° 30 S and longitude 40° 15 and 40° 35 East* in the Northern Coast of Kenya [3]. The study area covered eight administrative sub-locations in the PATTEC project area namely Kwatini, Kwatongani, Pate, Siyu, Shanga, Tchundwa, Kizingitini and Myabogi all in Pate Island; and seven non-project sub-locations namely Hindi, Bargoni, Mokowe and Kilimani in Hindi division and Matondoni, Kipungani and Manda in Amu divisions of Lamu

County. Systematic proportional random samples were drawn along transects cutting across each village. The first household was randomly selected along each transect after which every 5th household owning livestock was identified and interviewed.

2.1. Data Collection

A structured questionnaire was used to collect data on household characteristics which included the age (years) of household head, gender of household head, distance (Km) of household from animal health service provision facilities, years of education of household head, number of household members; data on ownership of different types of livestock namely cattle, sheep, goats, donkeys and poultry; data on availability, cost and effectiveness of the technology or method applied to control tsetse and trypanosomiasis; data on institutional services available to farmers including extension services, access to credit and membership to community groups; and data on different methods applied by households to control tsetse and trypanosomiasis in the County.

2.2. Theoretical Framework

The study applied the Random Utility Model or the Choice model where an individual is faced by a set of unordered multiple choices and does not reveal their preferences for the choices they make. In this study the choices to be made by farmers were contained in a set of tsetse control methods which the farmer could adopt to reduce or eliminate the problem of tsetse flies and the disease it transmits. Unordered choice models can be motivated by a random utility model [13]. For the i^{th} individual faced with J choices, suppose that the utility of choice j is

$$U_{ij} = Z_{ij}^{'}\theta + \varepsilon_{ij} \tag{1}$$

Where

U_{ij} is utility of choice j for individual i

Z_{ij} includes aspects specific to individual i as well as the choice j that the individual makes.

If the individual makes choice j, then it is assumed that U_{ij} is the maximum among the J utilities. The following equation captures the statistical model and is driven by the probability that choice j is made [13].

$$\text{Prob } (U_{ij} > U_{ik}) \text{ for all other } k \neq j \tag{2}$$

A Multinomial Logit (MNL) model is therefore more applicable in a scenario where a choice has to be made from a set of multiple choices. Theoretically presented, let Y_i be a random variable that indicates the choice made by individual i. According to equation 1 above, utility depends on z_{ij}, which can be partitioned as $z_{ij} = [x_{ij}, w_i]$ and θ partitioned into [β', α']. The components of x_{ij} are called the attributes of the choices while the w_i contains the characteristics of the individual. It is further noted that the multinomial logit model which allows individual specific effects can be presented as follows [13]:

$$\text{Prob } (Y_i = j \mid w_i) = P_{ij} = \frac{\exp(w'_i\alpha_j)}{1+\sum_{k=1}^{J}\exp(w'_i\alpha_k)}, j = 0,1,.........., J. \tag{3}$$

Where

Y_i is a random variable that indicates the choice made by individual i

P_{ij} is a set of probabilities for the J+1 choices for an individual making the decision

j is the choice made by individual i from among J choices

J is the number of choices facing individual i

w_i is a set of characteristics of individual i (the decision maker)

Equation 3 simply captures the probability that individual i makes choice j given a set of characteristics, w, of that individual.

2.3. Empirical Framework

The following MNL model was applied to the responses given by livestock farmers in Lamu County to assess the factors influencing the choice of tsetse control methods applied by the households:

$$Y_i = \beta_0 + \beta_1 AGE_i + \beta_2 TLU_i + \beta_3 GEND_i + \beta_4 DISTDIP_i + \beta_5 EDUCYRS_i + \beta_6 HHSIZE_i + \beta_7 TECAVAIL_i + \beta_8 TECOST_i + \beta_9 TECEFF_i + \beta_{10} CREDIT_i + \beta_{11} EXTNAV_i + \beta_{12} GRPMEM_i \tag{4}$$

Where:

Y_i is the probability of the i^{th} household choosing a particular method of tsetse and trypanosomiasis control from a set of methods categorized as follows:

1 = "Integrated Methods (IM)" (i.e. combination of any two or more of the following: moving targets, insecticide treated targets or trypanocides/ethno-veterinary practices).

2 = "Moving Targets (MT)" (dipping, spraying or use of pour-on on livestock killing tsetse flies on contact).

3 = "Insecticide Treated Targets (ITT)" (i.e livestock are protected using gadgets made of metal frames and insecticide treated clothes. These gadgets are deployed in the thickets and farmlands killing the tsetse flies on contact).

4 = "Trypanocidal Drugs/Ethno-veterinary practices (TD)" (i.e livestock are treated using trypanocidal drugs/ethno-veterinary practices either for prophylaxis or curative purposes).

AGE_i is the age of head of the i^{th} household in years

(Continuous);

TLU_i is the Tropical Livestock Units (cattle, sheep; goats, donkeys, poultry) owned by the i^{th} household in 2016 (Continuous);

$GEND_i$ is Gender of head of the i^{th} household (Dummy: 1 = Male and 0 otherwise);

$DISTDIP_i$ is the Distance (Km) of the i^{th} household from animal health care facilities such as dips, crush pens for spraying or insecticide treated targets (Continuous);

$EDUCYRS_i$ is the Number of years of education of head of the i^{th} household (Continuous);

$HHSIZE_i$ is the number of members in the i^{th} household (Continuous);

$TECAVAIL_i$ is the availability of the technology to the i^{th} household (Dummy: 1 = Available and 0 otherwise);

$TECOST_i$ is the cost of the method applied by the i^{th} household (Dummy: 1 = High and 0 otherwise);

$TECEFF_i$ is the Household's perception about effectiveness or performance of the method used (Dummy: 1 = Effective and 0 otherwise);

CREDITi is the accessibility to credit facilities by i^{th} household (Dummy: 1 = Accessible and 0 otherwise);

$EXTNAV_i$ is the availability of extension services to the i^{th} household (Dummy: 1 = Available and 0 otherwise); and

$GRPMEM_i$ is the membership of the i^{th} household to a community group (Dummy 1 = Member and 0 if otherwise).

These variables all represent a vector of household characteristics, attributes of technology or method used and institutional factors hypothesized to be determining choice of tsetse and trypanosomiasis control method. The $\beta_{0...}\beta_{12}$ are known parameters to be estimated.

3. Results and Discussions

The study cross-tabulated project and non-project households by the choice of tsetse and trypanosomiasis control methods that they made during the year 2016. The results showed that 62.7% of households applied Integrated Methods (IM) to control tsetse flies and the disease the flies spread, 8.6% of the households used Moving Targets (MT), 6.9% of the households relied on the Insecticide Treated Targets (ITT) and 21.5% of the sampled households used Trypanocidal Drugs/Ethno-veterinary practices (TD) either for prophylaxis or treatment. It was apparent that the highest proportion of Lamu farmers used integrated methods and were mainly from project areas probably because the PATTEC project promoted appropriate technologies among the farmers. This was followed by farmers using trypanocidal drugs or ethno-veterinary practices who were predominantly from non-project areas. It implies that farmers in non-project areas could not easily access the tsetse control technologies and mainly treated their livestock when the animals were already infected. Table 1 presents these results.

Table 1. *Methods of tsetse control applied by households in Lamu County in 2016.*

Tsetse and trypanosomiasis control method applied by household	Number of households		Total
	Non-project household	Project household	
Integrated Methods (IM)	132 (46.8)	205 (80.7)	337 (62.7)
Moving Targets (MT)	35 (12.4)	12 (4.7)	47 (8.6)
Insecticide Treated Targets (ITT)	0 (0)	37 (14.6)	37 (6.9)
Trypanocidal Drugs/Ethno-veterinary practices (TD)	115 (40.8)	0 (0)	115 (21.5)
Total	282 (100)	254 (100)	536 (100)

NB: The numbers in parentheses are percentages.
Source: Author: Tsetse control methods survey report 2016.

The factors affecting farmers' choice of tsetse and trypanosomiasis control methods in Lamu County were examined using a Multinomial Logit (MNL) regression model where use of Trypanocidal Drugs/Ethno-veterinary practices (TD) was taken as the reference category. Factors considered in this study were categorized into household characteristics, attributes of the method or technology used and institutional factors as documented by different scholars [14-17].

3.1. Household Characteristics

A review of literature showed that household characteristics affecting adoption of agricultural technologies include gender of the household head, distance of household from tsetse and trypanosomiasis control facilities, level of education of household head, size of household, age of the household head and the number of livestock owned by the household [18-24]. The study analyzed whether household characteristics affect choice of tsetse and trypanosomiasis control methods in Lamu County.

3.1.1. Tropical Livestock Units (TLU) Owned by Household

It was found that when the Tropical Livestock Units (TLU) in the household increased by one unit, the odds of a household choosing Integrated Methods (IM) over use of Trypanocidal Drugs/ethno-veterinary practices (TD) increased 1.046 times (Sig.= 0.002. This means that households that had more livestock were more likely to spray their animals as well as ensure grazing the livestock in protected thickets. It implies that households with more livestock units found it more risky and potentially costly in the event that the animals got infected hence opting to control other than treat or loose a large stock to *nagana*. This result is consistent with the finding that herd size affected the adoption of Artificial Insemination (AI) as a technology in Uganda and also the finding that ownership of livestock directly affected adoption of a new technology for processing waste from rice straws and cattle droppings in

Indonesia [25-26].

3.1.2 Distance from Livestock Health Facilities

The study also investigated how distance of household from where the farmers accessed the tsetse and trypanosomiasis control services affected the choice of the method adopted. It was found that when the household's distance from dips, crush pens or sites where insecticide treated target screens were deployed increased by 1 kilometre, the odds of choosing Integrated Methods (IM) over use of Trypanocidal Drugs/Ethno-veterinary practices (TD) decreased 0.861 times (Sig. = 0.000), the odds of choosing MT over TD decreased 0.908 times (Sig. = 0.007) and that of choosing ITT over TD decreased 0.684 times (Sig=0.000). These findings are consistent with the available literature that distance is inversely related to adoption of technologies [19]. The finding may be explained by the fact that the farmers found it difficult to take their livestock for spraying when crush pens were located far away from their homes. On the other hand, the insecticide treated targets (ITT) were mainly deployed in the thickets which were far from some households limiting access.

3.1.3. Years of Education of Household Head

To answer the research question on how education level of the household head affected the choice of tsetse and trypanosomiasis control method applied by households, the MNL regression results showed that a one year increase in level of education of the head of household led to 1.075 folds increase in the odds of choosing integrated methods (IM) of tsetse control over the application of Trypanocidal Drugs/Ethno-veterinary practices (Sig. = 0.027). The finding agrees with the results of a study on adoption of new technologies by fish farmers which showed that the level of education had a positive and significant influence on adoption of the technology [27]. This may be explained by the fact that education level of a farmer increases his ability to obtain, process and use information relevant for the adoption of a new technology [21, 28].

3.1.4. Gender of Household Head

The study investigated how gender of the household head affected the choice of tsetse and trypanosomiasis control method used by livestock keeping households of Lamu County. The results indicated that when a household was headed by a female, the odds of choosing Integrated Methods (IM) over treatment of livestock with Trypanocidal Drugs/Ethno-veterinary practices (TD) increased 18.672 times (Sig.= 0.000) compared to 9.952 times when household head was male. This is in line with the observation that in Pate Island it was women who made decisions concerning livestock husbandry. Where livestock rearing activities proved to be more labor intensive, for example restraining of animals during spraying and application of pour-on, walking the animals to the dips and taking livestock out to graze far away in the tsetse controlled thickets, a group of households mainly female headed, hired herdsmen at a cost. Elsewhere in Nigeria, a study on adoption of technology found that gender of the farmer had a significant and positive influence on adoption of improved cassava production [29]. In yet another study in Mekong Delta of Vietnam, it was found that men were applying technologies for rice, fruit and fish production while women used technology for pig and chicken production further defining the variation of adoption of agricultural technology by gender [18].

3.2. Characteristics of Technology or Method

The characteristics of the method or technology used that this study examined include availability of the technology, cost of the technology and farmers' perception about the effectiveness or performance of the technology as documented in literature [21, 24, 30-32].

3.2.1. Availability of the Technology or Method

The results indicated that when integrated tsetse and trypanosomiasis control method was not available, the odds of choosing integrated methods (IM) over treatment of livestock with trypanocides/ethno-veterinary practices (TD) decreased 0.119 times (Sig. = 0.003). The finding is consistent with that of a study of factors affecting adoption of Integrated Crop Management Farmer Field School (ICM-FFS) in swampy areas of Indonesia which indicated that adoption of production input by farmers could be explained by the input availability [33]. A study on determinants of fertilizer and manure use in maize production in Kiambu County, Kenya reported unavailability of demanded packages as one of the main constraints to fertilizer adoption [24].

3.2.2. Cost of the Technology or Method

On examining how the cost of the method applied by farmers affected the choice made, the MNL regression results showed that when the cost of integrating methods (IM) was low, the odds of choosing the method over treatment of livestock with Trypanocidal Drugs/Ethno-veterinary practices (TD) increased 2.54 times (Sig. = 0.012) and that of choosing ITT over TD increased 3.178 times (Sig. =0.031)). This findings are in line with the literature that the elimination of subsidies on prices of seed and fertilizers since the 1990s due to the structural adjustment programs in sub-Saharan Africa has increased the costs hence affecting fertilizer adoption [31]. On the other hand a study on determinants of fertilizer and manure use in maize production in Kiambu county of Kenya reported high cost of labor and other inputs as one of the main constraints to fertilizer adoption [24]. The cost of hired labor was also reported as one among other factors constraining adoption of fertilizer and hybrid seed in Embu county Kenya [34].

3.2.3. Effectiveness of the Technology or Method

Looking at effectiveness or performance of the method used, it was found that when farmers said Integrated Method (IM) was not effective, the odds of choosing the method over choice of Trypanocidal Drugs (TD) decreased 0.342 times

(Sig = 0.001). Farmers determined the effectiveness of the method of controlling tsetse flies by assessing the presence or absence of tsetse flies and the disease after application of the preferred method. It implies that when fewer tsetse fly catches and fewer cases of trypanosomiasis were reported upon use of the control method, farmers preferred to use the IM more than use Trypanocidal Drugs/Ethno-veterinary practices (TD) alone as an option which could be applied only when the animal fell sick or when there was government mass treatment campaign against trypanosomiasis. A study of rice farmers in Sierra Leone showed that farmers' perception of the characteristics of modern rice variety significantly influenced their decision to adopt it [32]. In studying determinants of adopting Imazapyr-Resistant maize (IRM) technology in Western Kenya, it was found that the characteristics of the technology played a critical role in adoption decision process [21]. The study argued that farmers who perceive the technology as being consistent with their needs and compatible to their environment are likely to adopt since they find it as a positive investment.

3.3. Institutional Factors

The institutional factors that were analyzed include household's access to credit, availability of extension services and household membership to a farmers group [26, 35-36]. Of all the institutional factors hypothesized to be affecting the choice of integrated tsetse control methods (IM) in Lamu over the choice of Trypanocidal Drugs/Ethno-veterinary practices (TD), only availability of extension services was found to be significant (Sig=0.020). The results indicated that when extension services were not available, the odds of choosing Integrated Methods (IM) of tsetse and trypanosomiasis control over choice of Trypanocidal Drugs/Ethno-veterinary practices (TD) decreased 0.41 times (Sig.= 0.011) and that of choosing ITT over TD decreased 0.151 times (Sig.= 0.000). This finding is in tandem with other studies which have documented direct relationship between extension services and adoption of technology; for example a study of the integrated farming systems of rice and beef in Indonesia found that availability of extension services directly affected adoption of the technology to enhance the capacity of farmers to process wastes from rice straw and droppings from cattle [26]. Other authors have reported a positive relationship between availability of extension services and technology adoption as in the case of adoption of Imazapyr-Resistant Maize Technologies (IRM) in Western Kenya, adoption of agricultural technologies in Mozambique; adoption of improved maize and land management in Uganda and adoption of modern agricultural technologies in Ghana [21, 36-38]. The results of the MNL regression are presented in Table 2.

Table 2. *Factors affecting farmers' choice of tsetse and trypanosomiasis control methods in Lamu County.*

Tsetse and Trypanosomiasis control method applied by households	Variable	Parameter	Std. Error	Sig.	Odds
Integrated Methods (IM)	Household characteristics				
	Age of household head	0.009	0.01	0.396	1.009
	Tropical Livestock Units (TLU) owned by household*	0.045	0.014	0.002	1.046
	Distance from livestock health facilities*	-0.15	0.026	0.000	0.861
	Years of education of household head*	0.073	0.033	0.027	1.075
	Size of household	-0.018	0.04	0.651	0.982
	Female household head*	2.927	0.706	0.000	18.672
	Male household head*	2.298	0.711	0.001	9.952
	Technological factors				
	Technology is not available*	-2.131	0.71	0.003	0.119
	Technology is available	0^b	.	.	.
	Cost of the technology is low *	0.932	0.37	0.012	2.54
	Cost of the technology is high	0^b	.	.	.
	Technology is not effective*	-1.073	0.311	0.001	0.342
	Technology is effective	0^b	.	.	.
	Institutional factors				
	Credit not accessible	-0.2	0.374	0.592	0.818
	Credit accessible	0^b	.	.	.
	Extension services not available*	-0.891	0.352	0.011	0.41
	Extension services available	0^b	.	.	.
	Not member of community group	-0.096	0.334	0.774	0.909
	Member of community	0^b	.	.	.
Moving Targets (MT)	Household characteristics				
	Age of household head	.008	.014	.543	1.008
	Tropical Livestock Units (TLU) owned by household	.013	.019	.490	1.013
	Distance from livestock health facilities*	-.096	.035	.007	.908
	Years of education of household head	-.015	.046	.740	.985
	Size of household	-.062	.062	.317	.940
	Female household head	-.636	1.079	.556	.530
	Male household head	-.696	1.093	.524	.498
	Technological factors				
	Technology is not available	-.828	.624	.185	.437

Tsetse and Trypanosomiasis control method applied by households	Variable	Parameter	Std. Error	Sig.	Odds
	Technology is available	0^b	.	.	.
	Cost of the technology is low	-1.188	.793	.134	.305
	Cost of the technology is high	0^b	.	.	.
	Technology is not effective	.367	.415	.377	1.443
	Technology is effective	0^b	.	.	.
	Institutional factors				
	Credit not accessible	-.411	.528	.436	.663
	Credit accessible	0^b	.	.	.
	Extension services not available	.773	.614	.208	2.165
	Extension services available	0^b	.	.	.
	Not member of community group	.489	.524	.351	1.630
	Member of community	0^b	.	.	.
Insecticide Treated Targets (ITT)	Household characteristics				
	Age of household head	-.009	.018	.625	.991
	Tropical Livestock Units (TLU) owned by household	-.036	.056	.523	.965
	Distance from livestock health facilities*	-.380	.098	.000	.684
	Years of education of household head	.026	.052	.618	1.026
	Size of household	.052	.069	.453	1.053
	Female household head	1.795	1.236	.147	6.017
	Male household head	.926	1.341	.490	2.525
	Technological factors				
	Technology is not available	.744	1.091	.495	2.105
	Technology is available	0^b	.	.	.
	Cost of the technology is low*	1.156	.535	.031	3.178
	Cost of the technology is high	0^b	.	.	.
	Technology is not effective	-.842	.835	.314	.431
	Technology is effective	0^b	.	.	.
	Institutional factors				
	Credit not accessible	1.090	.766	.155	2.975
	Credit accessible	0^b	.	.	.
	Extension services not available*	-1.891	.540	.000	.151
	Extension services available	0^b	.	.	.
	Not member of community group	-.202	.522	.699	.817
	Member of community	0^b	.	.	.

NB: [a]Use of Trypanocidal Drugs/Ethno-veterinary (TD) practices was taken to be the reference category. [b]This parameter was set to zero because it was redundant. *Significant at 0.05 level

Source: Author (2016).

4. Conclusions and Recommendations

4.1. Conclusions

The household characteristics that influenced the choice of tsetse and trypanosomiasis control methods significantly include Tropical Livestock Units (TLU) in the household, gender of the household head, distance of the household from sites of tsetse control technology application and level of education of the household head. The Technological factors that significantly influenced the choice of tsetse control methods include availability, cost and the farmers' perception on the effectiveness of the method. The only institutional factor that significantly influenced the choice of tsetse control methods among livestock farmers was availability of extension services.

4.2. Recommendations

For success in adoption of agricultural technologies by farmers, government and development agencies should consider household characteristics including the amount of Tropical Livestock Units (TLU) owned by the household, gender of the household head, distance of household to the site of tsetse control technology application and level of education of the household head.

The County Governments to make it easy for the Small and Micro-Enterprises (SMEs) to establish input shops to increase farmers' accessibility to the tsetse control technologies. Only then will the technologies be available locally and at a low cost.

In the wake of privatization of extension services in Kenya, the services became demand driven hence the National Government and the County Governments to intensify awareness campaigns urging farming communities to seek the services from both government and private sector as and when need srises.

The institutions of Government charged with ensuring efficacy of farm inputs to ensure that the insecticides and insecticide treated targets accessed by livestock farmers are effective in the control of tsetse and trypanosomiasis.

Trypanosomiasis being one of the Neglected Tropical Diseases (NTDs) requires heavy investments and should be handled by government as a public good. This will subsidize the heavy cost of control and increase affordability by the farmers.

Acknowledgements

We wish to acknowledge the invaluable contributions made to this study by a number of institutions and people. Our gratitude go to the Kenya Tsetse and Trypanosomiasis Eradication Council (KENTTEC) and the National Research Fund (NRF) that supported the research work by providing the funds. We also acknowledge the cooperation received from all KENTTEC staff both at the headquarters in Nairobi and at the Coastal operational region of the Council. Much thanks also go to the local leaders in the study area who assisted during community mobilization and to the Agriculture and Livestock Extension Staff of the County Government of Lamu who provided information and technical support. We thank the livestock keepers in Lamu for the cooperation they gave to the team during the data collection exercise in the field. Thanks to all who made a contribution to this work in one way or the other.

References

[1] WHO (World Health Organization) (2001). Report on Global Surveillance of Epidemic-Prone InfectiousDiseases– Africantrypanosomiasis. http://www.who.int/emc-documents/surveillance/docs/whocdscsrisr2001.html/African_ Trypanosomiasis/ A_Trypanosomiasis.htm.

[2] KENTTEC (Kenya Tsetse and Trypanosomiasis Eradication Council) 2011. Strategy for Tsetse and Trypanosomiasis Eradication in Kenya-2011-2021

[3] GoK (Government of Kenya) (2013). Lamu County Integrated Development Plan 2013-2017.

[4] KENTTEC (Kenya Tsetse and Trypanosomiasis Eradication Council) (2009, 2010, 2011, 2012, 2013, 2014). Assorted reports.

[5] Swallow, B. M., Mulatu, W., Leak, S. G. A., 1995. Potential demand for a mixed public-private animal health input: evaluation of a pour-on insecticide for controlling tsetse-transmitted trypanosomiasis in Ethiopia. Prev. Vet. Med. 24, 265–275.

[6] Bauer, B., Gitau, D., Oloo, F. P., Karanja, S. M., (2006). Evaluation of a preliminary trial to protect zero-grazed dairy cattle with insecticide treated mosquito netting in Western Kenya. Trop. Anim. Health Prod. 38, 29–34.

[7] Okoth, J. O., Kirumira, E. J. K., Kapaata, R. (1991). A new approach to community participation in tsetse control in the Busoga sleeping sickness focus, Uganda – a preliminary-report. Ann. Trop. Med. Parasitol. 85, 315–322.

[8] Vale, G., Torr, S., (2004). Development of bait technology to control tsetse. In: Maudlin, I., Holmes, P., Miles, M. (Eds.), The Trypanosomiases. CABI Publishing, Wallingford, pp. 509–523.

[9] Van den Bossche, P., De Deken, R., (2004). The application of bait technology to control tsetse. In: Maudlin, I., Holmes, P., Miles, M. (Eds.), The Trypanosomiases. CABI Publishing, Wallingford, pp. 525–532.

[10] Holmes, P. H., Eisler, M. C., Geerts, S. (2004). Current chemotherapy of animal trypanosomiasis. In: Maudlin, I., Holmes, P., Miles, M. (Eds.), The Trypanosomiases. CABI Publishing, Wallingford, pp. 431–444.

[11] Laker, C. D. (1998). Assessment of the economic impact of bovine trypanosomosis and its control in dairy cattle in Mukono County, Uganda. Ph. D. Thesis, Makerere University, Kampala.

[12] AfDB (2011). Completion Report of Project P-Z1-AZ0-005: Creation of Sustainable Tsetse Free Areas in East and West Africa-Appraisal Report.

[13] Greene, W. H. (2012). Econometric Analysis; Pearson Education Limited 2012, Edinburgh Gate, Harlow, Essex CM20 2JE, England.

[14] Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture, 46, 1407-1424. http://dx.doi.org/10.1071/EA05037

[15] Loevinsohn, M, Sumberg J. Diagne A. (2013). Under what circumstances and conditions does adoption of technology result in increased agricultural productivity? Protocol. London: EPPI Centre, Social Science Research Unit, Institute of Education, University of London.

[16] Ani, A. O., Ogunnika, O., & Ifah, S. S. (2004). Relationship between socio-economic characteristics of rural women farmers and their adoption of farm technologies in Southern Ebonyi State, Nigeria. International Journal of Agriculture & Biology, 6 (5), 802–805.

[17] Rogers, E. M. (1995). Diffusion of innovations (Fourth Edition). New York: Free Press.

[18] Truong T. N. and Ryuichi Y. (2002). Factors affecting farmers' adoption of technologies in farming system: A case study in OMon district, Can Tho province, Mekong Delta.

[19] Rogers, E. M. (2003). Diffusion of Innovations. 5th ed. New York: The Free Press.

[20] Prokopy, L. S., Floress, K., Klotthor-Weinkauf, & Baumgart-Getz. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. Journal of Soil and Water Conservation, 63, 5, 300-311. http://dx.doi.org/10.2489/jswc.63.5.300.

[21] Mignouna, B., Manyong, M., Rusike, J., Mutabazi, S., & Senkondo, M. (2011). Determinants of Adopting Imazapyr-Resistant Maize Technology and its Impact on Household Income in Western Kenya:

[22] Bonabana-Wabbi J. (2002). Assessing Factors Affecting Adoption of Agricultural Technologies: The Case of Integrated Pest Management (IPM) in Kumi District, Msc. Thesis Eastern Uganda.

[23] Howley P., Donoghue C. O. and Heanue K. (2012). Factors Affecting Farmers' Adoption of Agricultural Innovations: A Panel Data Analysis of the Use of Artificial Insemination among Dairy Farmers in Ireland. Journal of Agricultural Science; Vol. 4, No. 6; 2012.

[24] Makokha, S., Kimani, S., Mwangi, W., Verkuijl, H., Musembi, F. (2001). Determinants of Fertilizer and Manure Use for Maize Production in Kiambu District, Kenya. CIMMYT (International Maize and Wheat Improvement Center) Mexico.

[25] Kaaya, H., Bashaasha, B., & Mutetikka, D. (2005). Determinants of utilisation of artificial insemination (AI) services among Ugandan dairy farmers, African Crop Science Conference Proceedings, Vol. 7. pp. 561-567.

[26] Abdullah A., Syamsu, J. A. and Hikmah M. A. (2014). Factors Affecting Farmer's Adoption of Technology for Processing Beef Cattle Waste on Integrated Farming Systems.

[27] Okunlola, O., Oludare, O., Akinwalere, B. (2011). Adoption of new technologies by fish farmers in Akure, Ondo state, Nigeria Journal of Agricultural Technology 7(6): 1539-1548.

[28] Lavison, R. (2013). Factors Influencing the Adoption of Organic Fertilizers in Vegetable Production in Accra, Msc Thesis, Accra Ghana.

[29] Obisesan, A. (2014). Gender Differences in Technology Adoption and Welfare Impact among Nigerian Farming Households, MPRA Paper No. 58920.

[30] Wekesa, E., Mwangi, W., Verkuijl, H., Danda, K., De Groote, H. (2003). Adoption of Maize Technologies in the Coastal Lowlands of Kenya. CIMMYT, Mexico, D. F.

[31] Muzari, W. Gatsi, W & Muvhunzi, S. (2013). The Impacts of Technology Adoption on Smallholder Agricultural Productivity in Sub-Saharan Africa: A Review, Journal of Sustainable Development; 5 (8).

[32] Adesina, A., & Zinnah, M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: a Tobit model analysis in Sierra Leone. Agricultural Economics.

[33] Kariyasa, K., Dewi, A. (2011). Analysis of Factors Affecting Adoption of Integrated Crop Management Farmer Field School (Icm-Ffs) in Swampy Areas. International Journal of Food and Agricultural Economics 1 (2): pp 29-38.

[34] Ouma, J., Murithi, F., Mwangi, W., Verkuijl, H., Gethi M, De Groote, H. (2002). Adoption of Maize Seed and Fertilizer Technologies in Embu District, Kenya. CIMMYT (International Maize and Wheat Improvement Center), Mexico, D. F.

[35] Mohamed, K. and Temu, A. (2008). Access to credit and its effect on the adoption of agricultural technologies: The case of Zanzibar. African Review of Money Finance and Banking: pp. 45-89.

[36] Uaiene, R., Arndt, C., Masters, W. (2009) Determinants of Agricultural Technology Adoption in Mozambique. Discussion papers No. 67E.

[37] Sserunkuuma, D. (2005). The adoption and impact of improved maize and land management technologies in Uganda.

[38] Akudugu, M., Guo, E., Dadzie, S. (2012). Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence their Decisions? Journal of Biology, Agriculture and Healthcare 2 (3).