COMPARATIVE STUDY OF TSETSE AND TRYPANOSOMOSIS CONTROL METHODS IN KASESE DISTRICT

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DECLARATION

I, Godfrey Kalule, declare that this work is original and has not been submitted any kind of award by any other institution.

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ACRONYMS AND ABBREVIATIONS

BTC	Belgium Technical Corporation
BVM	Bachelor of Veterinary Medicine
DDT	Dechloro Diphenyl Trichloroethane
DRC	Democratic Republic of Congo
EATRO	East Africa Trypenosomiasis Research Organisation
FAO	Food Agricultural Organisation
FDG	Focus Discussion Groups
FMD	Foot and Mouth Disease
FVM	Faculty of Veterinary Medicine
H/C	Head of Cattle
HPI	Heifer Project International
ILRAD	International Livestock Research for African Development
ILRI	International Livestock Research Institute
Km^2	Square Kilometers
KNP	Kibale National Park
MaK	Makerere University Kampala
MSC	Master of Science
NGOs	Non Governmental Organisations
NLPIP	National Livestock Productivity Improvement Project
OAU	Organisation of African Unity
OIE	Organisation of International Epizootics
PATTEC	Pan-African Tsetse and Trypanosomosis Eradication Campaign
PACE	Pan-African Control of Epizootics
PARC	Pan African Rinderpest Control
PRA	Participatory Rural Appraisal
QENP	Queen Elizabeth National Park
RMNP	Rwenzori Mountain National Park
SIT	Sterile Insect Technique
SNV	Netherlands Development Association

SRS	Simple Random Sampling
UBoS	Uganda Bureau of Statistics
UK	United Kingdom
US$	United States Dollars
UVA	Uganda Veterinary Association

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ABSTRACT

A study was done in Karusandara sub-county, Kasese District, Uganda to compare efficiency of proper control of tsetse flies and trypanosomosis with the common control practices found. Test studies were done in two parishes (Karusandara and Kibuga) and control studies done in two parishes of Kabukero and Kanamba. In test parishes cattle were sprayed with deltamethrin once a very two weeks, prophylactic treatment of cattle using Samorin® and deployment of tsetse traps were effected. Meanwhile in control parishes, cattle continued to be sprayed with deltamethrin. Before intervention all parishes, had a high prevalence of trypanosomosis (40.2±2.5% on average) due to *Trypanosome congolense* and *T. vivax* in cattle. Karusandara parish had highly significant (P>0.01, t=8.1) prevalence of trypanosomosis (46.2±1.1%) than those in Kanamba (37±1%) Kibuga (42.1±0.6%). There was no significant difference (P>0.05) in prevalence of trypanosomosis in cattle before intervention between Kanamba and Kabukero (37±0.2%). Also before intervention, there was high tsetse fly challenge (31.2 flies per trap per 72 hours catch effort), being 27.8 flies in Kibuga and 34.5 flies in Karusandara. The high prevalence of trypanosomosis and infestation of tsetse flies was attributed to poor tsetse control methods. Despite the fact that all of the farmers were aware of negative effects of trypanosomosis on their cattle only 46% were readily willing to participate in trypanosomosis control. With the combination of use of trypanocides, monthly spraying with Decatix® and deployment of traps in Kibuga and Karusandara parishes, there was steady reduction of tsetse fly infestation with 80% reduction achieved in the second month of application. Similarly, there was reduction of trypanosomosis prevalence in cattle in Kibuga and Karusandara with 80% reduction also observed in the second month of application. Meanwhile in control parishes (Kanamba and Kabukero) where traditional methods of control were practiced the prevalence of trypanosomosis among cattle remained the same. This means that a combination of use traps, with regular use of trypanocides (prophylactic treatment using Samorin® and treatment of clinical cases using Berenil® and spraying cattle bi-weekly using Decatix® could significantly reduce trypanosomosis in Kasese District. This could be improved further by community participation.

CHAPTER ONE: INTRODUCTION

1.1 Background

Livestock play a pivotal role in supporting livelihoods of communities in rural Africa. This means that factors affecting the health and productivity of livestock also severely constraint the development and wellbeing of such communities. Diseases transmitted by tsetse flies are important causes of mortality and morbidity of livestock. Animal trypanosomosis has been estimated to cost Africa US $ 4.5 billion a year (Codjia *et al.,* 1993).

The African trypanosomosis is a disease caused by a protozoan parasites belonging to the genus *Trypanosoma*. Trypanosomosis attacks nearly all vertebrates including man and his domestic animals. Wild animals especially bovidae and suidae, act as asymptomatic carriers. Trypanosomes are transmitted cyclically by the *Glossina* species (tsetse flies). These occur in a tsetse belt extending from 14^0 north and 29^0 south infesting 10 million Km^2 (Itty, 1992). Other biting Diptera flies namely of *Tabanus and Stomoxysis* can mechanically transmit the trypanosomes especially *Trypanosoma vivax* which can develop in the mouth parts of the tsetse flies (Kettle, 1995). Animal trypanosomosis is lethal if left untreated. It causes severe losses in livestock production as a result of poor growth, weight loss, low milk yield, decreased capacity to work, infertility and abortion even when it is in low levels of infection. Control of the disease therefore would increase production in endemic areas and also open up vast areas for livestock production. Uganda falls in the tsetse belt and Kasese district is one of the districts infested with tsetse flies.

Historically in Uganda research and control of tsetse borne diseases were under the auspices of Veterinary and Entomology Departments. Due to privatization which resulted in reduction of Government Veterinary and extension services, control of tsetse borne diseases has devolved from the level of Government agencies to that of individual farmers and livestock keepers. The need for integrated disease control rather than control of individual diseases should be recognized. This applies to prevention, control, diagnosis and therapy where potential synergies can be exploited through integration, increasing awareness and availability of technologies that impinge on diseases particularly pyrethyoid insecticides that are effective against tsetse and raising of genetically trypanotolerant cattle like Ndama.

The integrated approach to tsetse control shoud be considered by farmers because the government-funded veterinary health care is in decline. The private use of drugs to control trypanosomosis has increased whereas tsetse control using baits by farmers as individual or as a community has not increased without Government's and / or NGO's support between the two extremes, lies the use of pyrethroid treated cattle as moving targets, in which has seen some spontaneous and sustained adoption by individual farmers and communities. It is suggested that contrasting adoption reflects differences in private and public benefits. Use of drugs confers private benefits, which are immediately seen when a farmer treats a single cow. On the otherhand, the benefits of artificial baits for control of tsetse flies are largely public and only realized when farmers work as groups over a large area for a relatively long period. Treatment of cattle with pyrethroids has a mix of private and public benefits. Capitalizing on the perceived private and visible benefits of pyrethroid-treated cattle with improved adoption of bait technologies for tsetse control, it is recommended that appropriate means of promoting these practices to farmers and rural communities need to be developed.

Non-government Organisations (NGOs) play an increasing and important role in initiating and managing tsetse control strategies. Accordingly, they need to be provided with appropriate advice on various control methods and the possible dangers associated with tsetse control. Although the role of government in animal health provision is declining, it still has an important stake in guiding the control of trypanosomosis to avoid drug and insecticide resistance.

Methods available for control of trypanosomosis has been the use of trypanocides directed against the parasites. Measures against the vector employed were bush clearing, application of insecticides, avoiding grazing in national parks and bush burning.

Even after use of trypanocidal drugs and use of deltamenthrin and cypermethrin products by farmers in Kasese, there has been re-invasion of tsetse flies from the neighbouring national parks. Although there exist a number of methods of tsetse and trypanosomosis control, their effectiveness has not been evaluated in Kasese. The objective of the study was therefore to compare effectiveness of various methods of control of tsetse flies and trypanosomosis with the hope that the most appropriate methods of controlling trypanosomosis and tsetse flies would be identified.

1.2 Statement of the study problem

Karusandara Sub-county in Kasese district, which is the study area is situated in and around protected areas of Queen Elizabeth National Park, Kibale National Park and Rwenzori Mountain National Park. In these areas, tsetse fly challenge is very high hence a high incidence of trypanosomosis in livestock. For the last seventeen years, efforts have been made to control this disease chemically by prophylactic treatment using isometamedium chloride (Samorin®) every three months. Clinically sick animals are treated using diaminazene acceturate (Berenil®). The three months had been reduced to two months intervals. Despite practicing the above measures for control of tsetse flies and trypanosomosis, still a high prevalence of the disease was reported. For example in the village of Kyaranga, a herd of 250 heads of cattle of Friesian crosses were reported to have failed to breed, lost milk production, abortions were rampant, mortality rate was very high and eventually the whole herd perished due to trypanosomosis.

Further, the situation of using drugs for controlling trypanosomosis has been made worse by introduction of liberalized economy and privatization policies; drugs have become very expensive. It is therefore vital to try to find if other methods of trypanosomosis control could be integrated with the use of drugs. No such study had been done in Kasese district.

1.3 Significance, rationale and justification of the study

Trypanosomosis is one of the major constrains in the effective enhancement of livestock production in Kasese district. This is especially so in areas surrounding Queen Elizabeth National Park (QENP) where livestock keepers are relying on the use of trypanocides and spraying using fly repellants (deltamethrin and cypermethin products. These methods are expensive and in the process, farmers tend to under mix chemicals resulting into resistance. Sometimes high concentrations of these acaricides/insecticides lead to poisoning and drug residues in livestock products. This study will therefore identify cheaper control methods that can be integrated with chemical use thereby reducing adverse effects associated with over use of chemicals. The use of environmentally and economically friendly methods needed to be popularized.

1.4 Objectives of the study

The aim of the study was to identify a comprehensive and environmentally friendly tsetse and trypanosomosis control methods to enhance livestock production in Kasese district.
The specific objectives of the study were to:

1. Identify various approaches being used to control tsetse and trypanosomosis.
2. Identify factors that hinder effective control of tsetse flies and trypanosomosis.
3. Determine the effectiveness of the different types of tsetse and trypanosomosis control methods.

1.5 Research questions

1. What are the current existing methods of controlling trypanosomosis in Kasese?
2. What factors hinder the control of tsetse and trypanosomosis?
3. How effective are the current methods in controlling trypanosomosis and tsetse flies?

1.6 Scope of the study

This scope of the study determined the health status of livestock, apparent density of tsetse flies, environmental challenges and parasites in blood.

CHAPTER TWO: LITERATURE REVIEW

2.1 Importance of livestock

Livestock keeping among various communities is a source of livelihood, income, nutrition, traction, manure and pride. They are used for cultural purposes. Unlike crop, livestock can endure harsh conditions. Any factor that can lead to poor health or death of livestock is detrimental to the livestock industry. Therefore, diseases like trypanosomosis (nagana) is of a major economic importance, hence its control is vital (Uilenberg, G. 1996 and Alsop, 1994).

2.2 Impact of tsetse flies and trypanosomosis on livestock productivity

Livestock play a pivotal role in supporting livelihood of communities in rural Africa. This means that factors affecting the health and productivity of livestock also severely constraint the development and wellbeing of such communities in Sub-Sahara Africa. Diseases transmitted by tsetse flies are important causes of mortality and morbidity in livestock. Animal trypanosomosis has been estimated to cost Africa US $4.5 billion a year (Codjia *et al.*, 1993). Trypanosomosis is a massive constraint to development in vast areas of rural Sub-Saharan African. Every year some 25,000 cases of human trypanosomosis are reported and the World Health Organization (WHO) estimates that as many as 300,000 people may be infected in one year. Tsetse flies infect an area capable of carrying 140 million animals, yet farmers are forced away from productive grazing land because of cattle trypanosomosis (nagana).

Trypanosomosis control has been achieved using a variety of methods, old and new, often used in combination to increase their efficacy. Drugs have been for the direct treatment of trypanosomosis whilst arrange of measures have been introduced to provide control of the tsetse vector. Present day trypanocides and insecticides with their toxicity and potential to develop resistance require intensive investment to function. And trapping is heavily dependent on external funding. Political and economic difficulties throughout the region have combined with political problems over the years to further constraint the development of trypanosomosis control (Professor Ian Maudlin, 1999 University of Glas Gow UK).

Mr. John Kabayo, the head of Addis Ababa Coordination Office of the Pan-African Tsetse and Trypanosomosis Eradication Campaign (PATTEC), says that the most challenging problems facing Africa remains rural poverty, which is intrinsically linked to food insecurity. *"If you look at this disease",* he told Africa Recovery, "You see that nothing has been more significant in the way it shaped the continent of Africa. It is because of tsetse that there are few horses in Africa, that we get a separation of crop and animal production, that there is no mixed farming".

Some experts indicate that trypanosomosis helps create African "green deserts" 10 million square kilometers of otherwise lush and fertile land that is not in production because of the tsetse fly carrier. This includes land 32 of the world's poorest countries. "It is no accident that the concentration of the much of the world's most acute poverty is in regions of Sub-Saharan Africa infested with tsetse flies, "notes Mr. Quian Ji hui, deputy director-general of the International Atomic Energy Agency (IAEA), which is centrally involved in many of Africa's efforts to eradicate tsetse flies through radiation induced sterilization. "Allowing more African farmers to own livestock would have a profound impact on hunger and poverty in the continent," he says. But that can not be achieved without elimination of tsetse flies".

In launching PATTEC campaign in October 2001, African leaders concurred. "Africa's most viable contribution to its expanding population and to the rest of the world in the new millennium is increased agriculture production, "they said in a declaration.

The first step towards the development and realization this dream is the removal of trypanosomosis constraint.

2.3 Tsetse control methods

Knowledge of tsetse life cycle is important in tsetse control (Williams *et al.,* 1992). The adult stage is found in the environment, the larval stage occurs in the mother and the pupal stage in the ground (Thompson, 1987; Vale *et al.,* 1997). It has been known that each female tsetse fly to reproduce just two flies, must obtain nine blood meals (Eisler *et al.,* 2001). This frequent contact with hosts provides an important opportunity for controlling tsetse flies. However, because of the rapid movement of tsetse flies, the areas cleared of tsetse flies can be rapidly re-invaded from adjacent areas.

Two main strategies are generally used for controlling tsetse flies. One strategy aims at killing the flies as they emerge, before they manage to deposit a larva in the ground. This approach has been carried out using insecticide with persistent residual properties like dieldrin or synthetic pyrethroids. These are applied at the resting sites of tsetse flies. Also aerial application of non persistent insecticide such as endosulfan have been done (Vale, 1993).

The second strategy aims at applying sustained small reduction of tsetse fly population over a long period. This is usually carried out by attracting tsetse flies to lethal baits. The baits may either be artificial devices, such as traps or insecticides treated targets baited with synthetic host odours, or natural baits such as cattle treated with insecticides. The low reproductive rate of tsetse means that a deployment of low density, of targets for example: 4 targets per kilometer of evenly spaced artificial baits can eradicate tsetse populations within two years (Vale, 1993; Willemse, 1991; Dransjield *et al.*, 1991). Similarly, spraying cattle with insecticides or acaricides has controlled tsetse populations successfully in Zimbabwe (Thompson *et al.*, 1991), Zambia (Chizyuka and Liguru, 1986), Tanzania (Fox *et al.*, 1993), Kenya (Baylis and Stevenson, 1998), Burkina Faso (Bauer *et al.*, 1992, 1995) and Ethiopia (Leak *et al.*, 1995).

Over the past 20 years, there has been a wide spread shift from the use of ground and aerial spraying to bait methods of control, partly because, the latter methods are effective and cheaper. In the 1970s for instance, a typical tsetse control operation would have consisted of a large army of Government employed spray men who regularly applied a persistent insecticide, such as DDT, to the resting sites of tsetse flies. The operation would cover over several thousand square kilometers. They were funded, planned and implemented by a government agency. Such operations eradicated tsetse from large area of Nigeria, South Africa, Uganda and Zimbabwe (Jordan, 1986). Today, funding and Institutional capacity to undertake such operations have largely disappeared. There is growing opposition to use of these persistent insecticides in the environment.

Instead, typical contemporary tsetse control operations are being conducted aimed at reducing the tsetse population, rather than eradicating them. These are funded and carried out partly or wholly by local livestock owners and employ some from bait technology (Barrett and Okali, 1998; Bright Well *et al.,* 2001). The distribution of cattle is largely dictated by livestock production systems by factors such as adequate water, pastures for grazing and protection from theft and predators. The patchy distribution of financial resources means that the use of pyrethroid treated cattle becomes patchy in their spatial and temporal distribution, hence comprising their efficacy as baits (Hargrove *et al.,* 2002). The cost of using pyrethroid-treated cattle is still prohibitively high for poorer livestock owners and sustained adoption of the technology, without subsides from either government or NGOs is rare. Tsetse fly control operations have problems associated with initiating and sustaining it over an area which is sufficiently large.

Another problem facing tsetse fly control is the farmer's perception towards tsetse control. Some farmers with poor cash flow may respond by buying costly drugs but unwilling to pay for cheaper preventive strategies. At times farmers may not know the connection between tsetse flies and trypanosomosis (Kamara and Kettle, 1995; Machila, *et al.,* 2000). On the otherhand, farmers treating their cattle at the edge of tsetse control belt will not detect any great improvement in their cattle if adjacent areas are still infested with tsetse flies. While farmers at the centre of an operation will be less affected by invading flies and they are more likely to see an initial rapid improvement of their cattle (Bright Well *et al.,* 2001).

2.4. Trypanosomosis control

2.4.1 Use of trypanocidal drugs

Trypanocidal drugs remain the only widely available control method for trypanosomosis. Currently available trypanocidal drugs for use in cattle are limited to the salts of three compounds:

a. Diminazene aceturate (Berenil®, Hoechest®, Veriben®, Sanofi, and various other generic formulations).
b. Homidium bromide (Ethidium®, Laprovet), Homidiumchloride (Novidium®, Merial).
c. Isometamedium chroride Samorin®/Trypamidium®, Merial: Veridum®. Sanofi).

There are two main strategies used when using trypanocidal drugs for controlling bovine trypanosomosis. Drugs may be used for the therapy of existing trypanosome infections, in which case they are termed as chemotherapeutic drugs. Alternatively, the drugs with a prolonged period of biological activity may be administered as suitable intervals to cattle at risk of becoming infected, in which case they are termed chemoprophylactic drugs. Some of the drugs can be used for either purposes, although dose rates and routes of administration may be adjusted for the particular circumstances. Isometamedium chloride is the most widely used drug. It is the most efficacious chemoprophylactic drug, but also has good chemotherapeutic activity (Leach *et al.,* 1980). Homidium salts are used mainly for chemotherapy, but also do have some prophylactic activity. Meanwhile diminazine acceturate is the most widely used chemotherapeutic agent, but has almost no prophylactic activity (Leach and Roberts, 1981).

In many parts of Africa, farmers control trypanosomosis by constant treatment of the sick animals with commercial trypanocides, that can easily be obtained from veterinarians or private drug shops (Geets *et al.,* 2001). Doran (2000) reported that this was the most common strategy practiced by farmers in the tsetse fly belt in Zambia, Malawi, and Mozambique. They considered it the most sustainable method. Barret (1997) however, suggests that a detailed analysis of the true economic benefits of using this method would show that this strategy is more expensive than thought. A preliminary study of farmers in Konso, Southern Ethiopia by Morton (2002) found that there was considerable losses associated with cattle mortality and draught animal power loss. However, in (Uganda, Ocaido *et al.,* 2004) showed that the use of cattle sprayed with deltamthrin as mobile was cost effective in controlling trypanosomosis as compared to the use of drugs. Geerts and Holmes (1997), Eisler *et al.,* (2001) and Geets *et al.,* (2001) demonstrated high levels of trypanosome drug resistance in numerous locations studied in Kenya, Tanzania and Zambia. The degree of resistance was related to the historical drug usage in each area. Resistance to more than one trypanocide was recorded in some areas, notably in the coastal regions of Kenya and Tanzania. Multiple resistance to all trypanocidal drugs commonly used in cattle was demonstrated with *Trypanosoma congolense* at the clonal level in South Western Ethiopia (Codjia *et al.,* 1993). This was shown to have been persistent over a number of years (Mulugeta *et al.,* 1997).

In summary, although trypanocidal drugs continue to be of use among the poor, there is a danger of multiple drug resistance. This would render trypanosomosis control strategy useless (Geets *et al.,* 2001). This concern should be taken most seriously, because of the slow livelihood development and marketing of new trypanocides in the near future (Geerts *et al.*, 2001).

2.4.2 Vaccination

Despite extraordinary research efforts directed at the development of vaccines against trypanosomes (Authie *et al.*, 2001) no vaccine has so far been developed. The one area where there has been some progress has been in the development of an anti-disease vaccine. Here efforts had been directed towards preventing the pathogenic effects of the parasite rather than infection itself (Authie *et al.,* 2001).

2.4.3 Use of trypanotolerant livestock

In recent years, increasing interest has been paid to exploitation of trypanotolerant traits in a number of cattle breeds, particularly the taurine breeds of West Africa such as the Ndama (Murray *et al.,* 1979). However, the trypanotolerant trait is not absolute solution to trypanosomosis because trypanotolerant cattle have been known to succumb to the effects of trypanosomosis under circumstances of stress, poor nutrition, over work, inter current diseases or under heavy tsetse fly challenge. Roelant (1986) analyzed data from a number of experimental studies that compared the survival of Zebu and trypanotolerant cattle under conditions of different levels of natural tsetse challenge. Under conditions of light tsetse fly natural challenge, 75% of zebu cattle died and 98% of Ndama cattle survived. However, under heavy natural tsetse challenge overall motaliry among zebu cattle rose to 94%, and 31% for the trypanotolerant Ndama, Muturu and Baoule breeds. The use of trypanotolerant livestock is thus often supplemented by the use of trypanocodal drugs in areas of heavy tsetse fly challenges (Roelants, 1986; Otesile and Akpokodjl, 1981).

Trypanotolerant cattle also appear to have higher levels of resistance to ticks, helminths and dermatophilosis. It should also be noted that while classically considered trypanosuceptible in comparison to Ndama and other similar West African taurine breeds, the Zebu and Sanga cattle of East and Southern African are undoubtedly less susceptible to the disease than the many breeds of exotic cattle that have been imported into tsetse infested countries. The Orma Boran cattle of Kenya has been studied in details for their trypanotolerant (Doran and Van den Bossche, 1998).

2.4.4 Bush clearing

There are certain types of vegetation that enable micro-climate establishment of both temperature and humidity that makes habits suitable for certain types of tsetse flies. Clearing of such vegetation therefore causes the tsetse species concerned to disappear (Finelle, 1974). This method of trypanosomosis control is labour intensive, can lead to soil erosion, and needs slashing of regenerated vegetation.

2.4.5 Traps and Targets

Traps can be used unbaited (Dransfield *et al.,* 1991); Okoth, 1986; Okoth, 1991) or baited using cow urine and cow breath (Alsop, 1994) and may also use synthetic odour (Dransfield *et al.,* 1990; Vale *et al.,* 1999). Baits are various natural or synthetic compounds that act as olfactory attractants to tsetse flies in the field and when applied on to traps and targets, results in significantly increased catches of tsetse flies (Brusel *et al.,* 185). Tsetse control by use of traps offers some of the best realistic approaches for control of many *Glossina* species. Traps can be made from local materials for example cone traps made from old vehicle tyres or biconical tsetse traps made from barkcloth with the upper cone made from palm reed netting.

Biconical tsetse fly trap is effective in Uganda (Okoth, 1986). Community participation ensures effective planning, designing and implementation of tsetse control using traps, thus eliminating the disadvantages of a top-down approach (Okoth, *et al.,* 1999). The community can make cheap traps themselves and take responsibility for their viability and sustainability.

The government and researchers aid in creating awareness about community participation of the use of traps in controlling trypanosomosis. Communities are encouraged to elect their own leaders. Together with officials and scientists they draw up trapping programmes.

Since the community members own land, they know where the tsetse flourish. Tsetse fly trapping activities becomes an integral part of their normal routine agricultural work.

Low cost monoscreens for the control of *G.fuscipes fuscipes* in Kapyanga area of Busoga have been successful (Okoth *et al.,* 1991). In Kenya, the Nguruman project used traps by Local people without use of insecticide and within eight (8) months in the suppression zone, fly catches had fallen by 99% and trypanocidal drug use reduced by 50% (Dransfield *et al.,* 1991). The use of traps have a number of advantages in that they are cheap, technologically simple, environmentally friendly and largely target specific. They are very good for small scale operation against *G. palpalis* and *G. morsitans,* involve low initial capital investments, have no risk of resistance and incorporate community participation (Aslop, 1994).

2.4.6 Sterile insect technique (SIT)

This involves production of large sterilized male tsetse flies which are released to the wild. It is a cumbersome venture, involving use of skilled manpower (Jordan, 1995 and Alsop, 1994). With this method of tsetse fly control there is a need to have regional effort. However, in an event of eradication tsetse flies, SIT can be used for mopping up low density foci of tsetse flies remaining (Jordan, 1998 and Alsop, 1994).

2.5 Impact of tsetse and trypanosomosis control

Eradication of the tsetse hence trypanosomosis, and prevention of re-invastion of tsetse flies will lead to improved productivity of livestock and therefore improved wellbeing and development of livestock keepers and the community (Vale., 1999). In order to determine how much progress has been achieved in the past or can be achieved in minimizing the impact of tsetse- trypanosomosis on livestock, human and wildlife and rural economies in general, the concepts of "control" and "eradication" must be elaborated and applied appropriately to the vector, the disease-causing organism *(trypanosomes)* the disease (trypanosomosis) reservoirs (wild and domestic animals and to host (Budd, 1999) Budd (1999) adopted the term "trypanosomosis control" for those drug-based strategies that eliminate parasite organisms in the host or for the use of innate resistance in host animals to combat the effect of the parasite. The indirect control of trypanosomes through attacking the tsetse fly is referred to as "tsetse control". Where a complete removal of the vector from a given or defined area is the objective, the strategy is referred to as eradication.

Tsetse-transmitted trypanosomosis is the major constraint to livestock development in the humid and sub-humid zones of Sub-Saharan Africa. Sustainable control of trypanosomosis requires strategies that integrate vector and parasite management. Further more, sustainable control strategies need to be based on a thorough assessment of critical aspects of control as they influence livestock production, the environment and the welfare of African farmer (Robinson, *et al.*, (1997).

2.6 Future directions in tsetse control in Africa

2.6.1 Attributes desirable in future technologies

The preceding section makes it clear that the challenges is to develop an integrated tsetse fly management system inorder to kill tsetse cost-effectively, avoid killing beneficial species and reduce direct costs caused by damage by external parasites. The current knowledge of tsetse biology suggests that there are several opportunities to modify current tsetse control practices. Specific opportunities relate to adjusting the timing, extent and /or placement of insecticide (Vale *et al.*, 1999).

2.6.2 Timing

Vale *et al.* (1999) showed that the pyrethroid formulations were effective against tsetse for 5-55 days. Thus to achieve continuous high levels of control, 21 applications/year are required. However, may small-scale users of the technology apply the insecticide at monthly intervals on the legs to reduce the operational costs. Reducing the frequency application could reduce the impact on tsetse populations. To examine the trade-off between frequency of insecticide treatment and tsetse control, a simulation model based approach could be used (Williams *et al.,* 1992; Hargrove 2000 and 2002; and Hagrove *et al.,* 2002). Here tsetse population movement and growth are modeled (Williams *et al.,* 1992*)*. The rise in tsetse populations observed when cattle are not treated is due to growth in the tsetse population in the operational area and re-invasion of tsetse from adjacent infested areas. Similarly, isolated low population of tsetse flies cannot recover due to the intrinsically low reproductive rate of tsetse flies. Due to high rate of movement of tsetse flies (~1km/day for savanna species such as *G. pallidipes)* means that tsetse flies can rapidly reinvade if not controlled.

2.6.3 Selective treatment of cattle

Tsetse flies attracted to a herd of cattle show a feeding bias towards older and larger animals. Torr *et al.* (2001) showed that in a herd comprising of a mixture of 2 oxen, 4 cows/steers and 2 calves, about 8% of meals were got from the two largest animals within the herd and only 3% were from calves. There is a strong correlation between the live weight of an animal and the percentage of feeds got from that animal. This therefore provides a good rule of the thumb of judge which animals to treat. The benefits of this approach would be influenced by the cattle management practices of the owners. For instance, some communities, in tsetse infested areas (Torr *et al.,* 2000) graze the adult cattle separately from calves and small stock.

2.6.4 Selective application of tsetse feeding sites

Several studies done in Zimbabwe (Thompson, 1987, and Vale *et al.,* 1999) have shown that about 80% of *G. pallidipes* land on the legs of cattle. By Spraying Decatix® on the legs, it was found that it was effective as treating the whole animals. But had no significant impact on non-target species and reduced the use of insecticide by 90%. However, this approach may not be suitable for all cases. For instance, Vale *et al.* (1999) found that only 30% of *G. morstans* fed on the legs of cattle compared to 70% of *G.pallidipes.* Most (70%) of *G. morsitans* fed on the torso of the host whereas only 30% of *G. pallidipes* fed here.

2.6.5 Low-technology approaches to tsetse control

Farmers employ various strategies to reduce the number of tsetse biting their cattle. In principal, zero-grazed cattle provide such control strategy. A survey of farmers in Pongani District in Tanzania revealed that virtually all farmers used wood smoke to reduce the number of flies, including tsetse flies (Torr *et al.,* 2000). Many farmers treat their cattle with insecticide which they believed repelled tsetse. Few farmers have also filled their Kraals with netting to prevent tsetse from biting their cattle. Farmers reported that tsetse traps placed adjacent to cattle could be used as protection.

2.6.6 Environment impact of pyrethroid-treated cattle

While assessing the susceptibility of various pyrethroids, Vale *et al.* (1999) noticed dead beetles in the vicinity of dung produced by treated cattle. It was confirmed that insecticide was detectable at concentration of up to 0.15pmm for 12 days post-treatment.

2.6.7 Policy issues and information provision for tsetse and trypanosomosis control

Governments generally assume a significant role in the management of contagious animal diseases such as foot and mouth disease (FMD), contagious bovine pleuropneumonia (CBPP) and rinderpest (Finelle *et al.,* 1974). In such a case, national regulations, regarding livestock movement, disease reporting and sales, are combined with government sponsored interventions to control spread of epizootics. Moreover, livestock movement can affect transmission of such diseases hence they are subjected to international agreements and are concern of various international organizations like OIE, PARC, and PACE. In contrast when a disease is not contagious such regulation is less necessary since livestock production is less likely to affect disease transmission (Itty, 1992).

In the absence of tsetse flies, trypanosomosis is not contagious. Trypanosomosis is generally regarded as one of many constraints on livestock production. Consequently, governments currently tend to expect livestock keepers to decide on how to manage trypanosomosis and to bear associated costs involved. The decline in institutional support and low financial capacities in Africa mean that few Governments are not able to undertake large scale operations themselves. It is therefore desirable that the development and adoption of bait methods of tsetse control by local communities should be developed. This encourages small scale operations aimed at controlling, rather than eradicating tsetse flies and trypanosomosis (Itty and Swallow, 1993).

2.6.8 Non-generational organizations

In practice NGOs and community based organizations are assuming an increasingly important role in the local promotion and management of operations to control tsetse. In the absence of a national government policy and appropriate technical information, there is a risk that NGOs could encourage interventions that will, for instance, lead to acaricide resistance hence ineffective tsetse control. Such organizations are however receptive to guidance and can play an important role in the dissemination of knowledge and best practice to local communities and livestock owners (Stevesion *et al.*, 1993).

2.6.9 Knowledge attitudes and practice of farmers towards tsetse and trypanosomosis

The apparent lack of knowledge results in misuse of drugs, which is uneconomic, environmentally unsound and may lead to drug resistance or any other problem of toxicity (Greerts and Holmes, 1997; Stevenson *et al.*, 1993 and Eister *et al.*, 1997).

2.6.10 Management of trypanosomosis

Farmers' attempts to manage the disease range from the use of curative treatments (both tradition and modern) to use of preventive measures were not beneficial. A study on trypanosomosis by Doran (1988) showed that the choice between use of therapeutic drugs and prophylactic drugs was made on the basis of cost per dose, without a clear understanding by farmers of the advantages of prophylactic drugs used in appropriate circumstances. A similar study in Uganda by Olila (1999) indicated that trypanocidal drug treatments were not given appropriately. Major sources of drugs and advise were from local agro-veterinary drug traders (Machila *et al.*, 2000). Most local agro-veterinary drug traders have no training in animal health care.

2.6.11 Public and private benefit and collective action

Control of tsetse in small area like over $10km^2$, will have no discernable effect on tsetse numbers and hence trypanosomosis. Control must be applied over a large area to have effect. The use of pyrethoid-treated cattle for tsetse control in African smallholder, and agro-pastoral systems require collective action (Ocaido *et al.*, 2004). This may be collective action by individuals to use pyrethoid for tsetse fly control. Ocaido *et al* (2004) used community participatory approach to control tsetse and trypanosomosis in agropastotal areas of Soroti successfully. It is important to note that while tsetse are killed by deltamethrin, they are not prevented from infecting cattle with trypanosomes before dying. Consequently, in terms of tsetse and trypanosomosis control, there is virtually no benefit to a cattle-owner of treating his/her cattle with insecticide if their neighbours are not doing so (Machila *et al.*, 2000).

From what has been cited above it becomes apparent that the importance of livestock, the impact of tsetse flies and trypanosomosis on livestock productivity and the types of tsetse and trypanosomosis control methods available dictate the type of integrated sustainable approach adopted by communities for controlling trypanosomosis in Sub-Saharan Africa.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study area description

Kasese district is located in the Western region of Uganda, astride the equator and directly to the North Channel, Lakes Edward and George, which it shares with Bushenyi District in the South. It lies between latitude 0^o12 S and 0^o26 N, longitude 29^o4E and 30^o18 E. Kasese also shares borders with Kamwenge in the East, Bundibungyo and Kabarole in the North and North East. To the West lies the Democratic Republic of Congo (DRC). The total surface area of Kasese is 3,389.8 square kilometers (The Biomass land use/cover stratification study, 1995). The study was conducted in the Sub-county of Karusandara with livestock population of 3700 heads of cattle (H/C), 900 goats, 200 sheep and 1800 pigs.

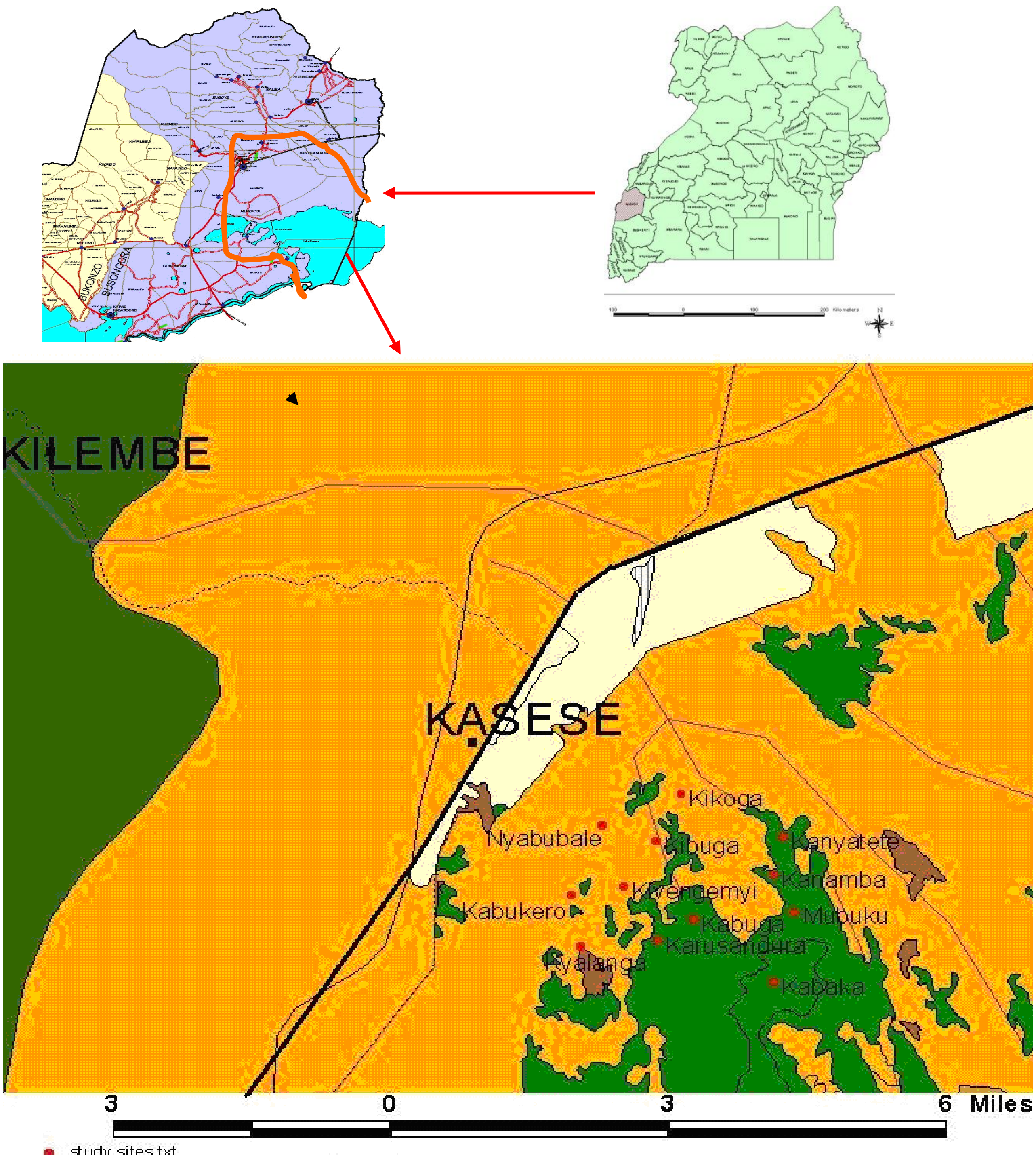
Livestock is managed on communal basis. However, few fenced farms do exist. The Sub-county is located in the Western side of the district, bordering Queen Elizabeth National Park and Kibale National Park. Details of the location on the study area are as depicted in Fig. 1 and appendix I.

3.2 Study design and sampling criteria

The study was cross-sectional in nature. The efficiency of various methods in controlling tsetse flies and trypanosomosis like use of trypanocides to treat the sick animals and for prophylaxis, spraying of livestock with pyrethroids and use of treated traps were compared. The study was carried out in Karusandara Sub-county, in parishes of Kanamba, Kibuga, Karusandara and Kabukero. Karusandara Sub-county was chosen because it had a high tsetse and trypanosomosis challenge, compared to other areas in the District. The selection of the parishes was also purposively done. However selection of households was done by simple random sampling (SRS).

A survey consisted of the use of participatory methods (focus group discussions) administration of questionnaires and testing different tsetse and trypanosomosis control methods. Secondary data was collected to supplement data collected.

Figure 1. Location of Kasese and study sites



(Give a legend for the map, eg.. What the different coloured areas represent?)

For participatory methods 5 services providers and 4 focus discussion groups (FGDs) were conducted. One FGD per parish consisting of 20 members was carried out. Questionnaire was administered to 100 respondents. The sample size was determined using the equations given by Dohoo *et al* (2003) and Thrusfield (2007) where by:

$$n = \frac{Z^2.PQ}{e^2}$$

Where

Q = 1-P

Z = 1.96

E = Confidence level = 0.05; P = Prevalence of about 93%.

Twenty farmers in each parish were sampled.

3.3 Methodology

Focus group discussions with aid of check list of questions (see Appendix II) were held with five service providers and a group of 20 farmers in each parish.

Hundred questionnaires (see Appendix IV) were administered to individual livestock farmers.

From focus group discussion and questionnaires administered the information regarding the following were obtained:-

i) Importance of trypanosomosis and tsetse flies in the area.
ii) Various approaches being used to control tsetse flies and trypanosomosis.
iii) Appropriate strategies that were environmentally friendly and cost effective.
iv) Factors that hinder effective control of tsetse flies and trypanosomosis.
v) The coping mechanisms adopted by the farmers.

To determine the cost effective method of controlling tsetse flies and trypanosomosis, two parishes were subjected to two different treatments (use of traps and trypanocides). For all parishes, from January to February, they were controlling tsetse flies and trypanosomosis using targets sprayed with delatmethrin® products. From March to June, 2009 Kibuga and Karusandara Parishes were subjected to massive treatment of cattle using trypanocides and use of traps. Meanwhile Kanamba and Kabukero Parishes continued with spraying of cattle as the control method for tsetse flies and trypanosomosis. Details were as shown in table 1.

Table 1. Different tsetse and trypanosomosis control methods deployed in each parish

Month 2009	Kanamba Parish			Kibuga Parish			Karusandara Parish			Kabukero Parish		
	TRY	TAR	TT	TRY	TAR	TT	TRY	TAR	TT	TRY	TAR	TT
JAN	-	+	-	-	+	-	-	+	-	-	+	-
FEB	-	+	-	-	+	-	-	+	-	-	+	-
MARCH	+	+	-	+	+	-	+	+	-	+	+	-
APRIL	+	+	-	+	+	+	+	+	+	+	+	-
MAY	+	+	-	+	+	+	+	+	+	-	+	-
JUNE	-	-	-	+	+	+	+	+	+	-	-	-

KEY

TRY – Trypanocides

TAR – Targets

TT – Treated traps

The prevalence of trypanosomosis was monitored in parish every week from January-June by taking blood from cattle. The numbers of cattle sampled from January to June 2009 were as shown in Table 2.

Table 2. Number of cattle sampled from January to June 2009

Parish	**January**	**February**	**March**	**April**	**May**	**June**
Kanamba	86	68	97	75	70	92
Kibuga	101	64	110	90	80	110
Karusandara	120	102	125	100	90	140
Kabukero	52	57	60	48	35	60
Total	359	291	295	313	275	402

Identification of trypanosomoses by species: this was done using three methods: the first involved wet mount of blood slide smears and the second thick blood films stained with Giemsa and examined using a light micro-scope for trypanosomes. The third method used was examination of smears of buffy coat obtained by micro-hematocrit centrifuge for trypanosomes. *T. congolense,* were seen active and exhibiting marked but non progressive

movements although the undulating membrane was uncospicious. *T. vivax* was very motile in fresh blood, moving rapidly across the field pushing cells aside.
Identification of Tsetse flies by species was determined by ecological zones for example, the riverline types along rivers and the forest type in the forest zone.

Determination of the infestation of the tsetse was carried out by counting the trapped insects within the treated traps which were put in various places from April 2009 to June 2009. Twenty biconical treated traps with insecticides were put in parishes of Kibuga and Karusandara in Karusandara Sub-county. The densities of tsetse flies were monitored in Kibuga and Karusandara parishes every week from April-June.

The various costs of control of trypanosomes were taken to include costs of the present prices of treat of cattle with synthetic pyrethroids, use of traps and use of trypanocides. Different approaches for control of trypanosomosis and tsetse flies were compared in the project area. A recommended strategy with cost effective, environmentally friendly involving active participation of the local community to ensure sustainability was adopted.

CHAPTER FOUR: RESULTS

4.1 Household characteristics

Average number of cattle kept per households, number of years livestock keepers have been in the locality and the number of years they have been keeping livestock were as shown in Table 3. Overall there were 31.2±1 per household.

Table 3. Average number of cattle kept per households, number of years livestock keepers have been in the locality and the number of years they have been keeping livestock

Parish	Cattle	Years keeping cattle	Years in locality
Kibuga	29.2± 1.4	9.9± 1.1	24.7± 2.3
Kanamba	29.7± 1.1	14.4± 1.8	19.1± 2.9
Karusandara	33± 3.6	14.3± 2.4	27.8± 2.3
Kabukero	32.7± 1.07	13.9± 1.7	21.9± 3.4

Apart from cattle, the other types of animals kept were goat, 72% of the farmers, sheep (63%) and pigs (26%). The major problems facing livestock keeping were diseases (100%), biting flies (97%) and insufficient pasture (60%). Environmental problems faced by the community in Karusandara Sub-county were as shown in Fig 2.

4.2 Perception of tsetse flies and trypanosomosis as a problem to livestock production

Almost all (99%) of the farmers had a case of trypanosomosis in their herds. The problem which trypanosomosis caused to livestock as perceived by the cattle keepers were as shown in Fig 3. Although all farmers noticed negative changes on their livestock when attacked by tsetse flies only 46% felt a need to control tsetse flies. The changes noticed by farmers when tsetse flies attack animals were as shown in Table 3.

Figure 2. Environmental problems faced by communities in Karusandara Sub-county in Kasese district

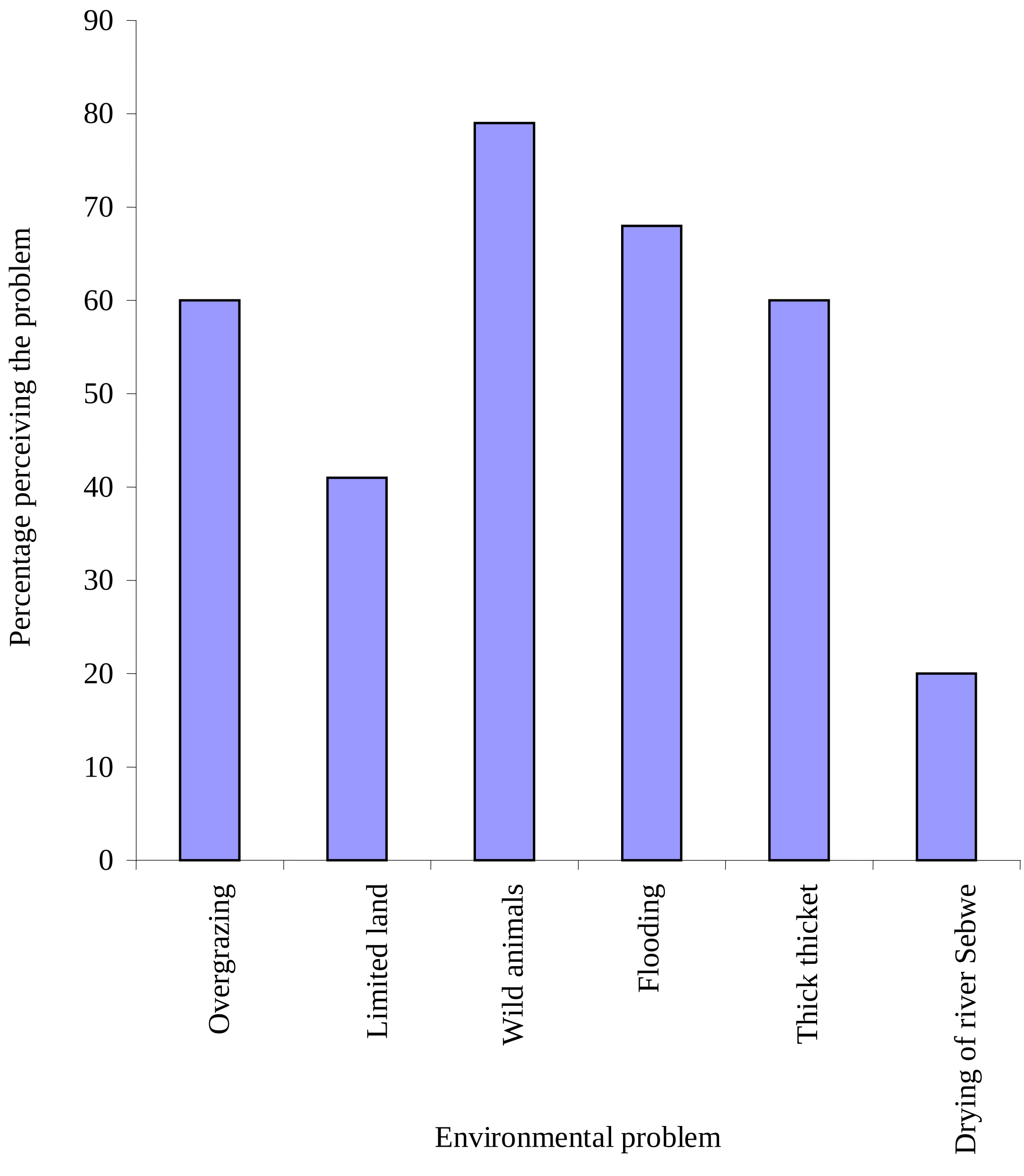


Figure 3. Problem trypanosomosis caused to livestock as perceived by the cattle keepers

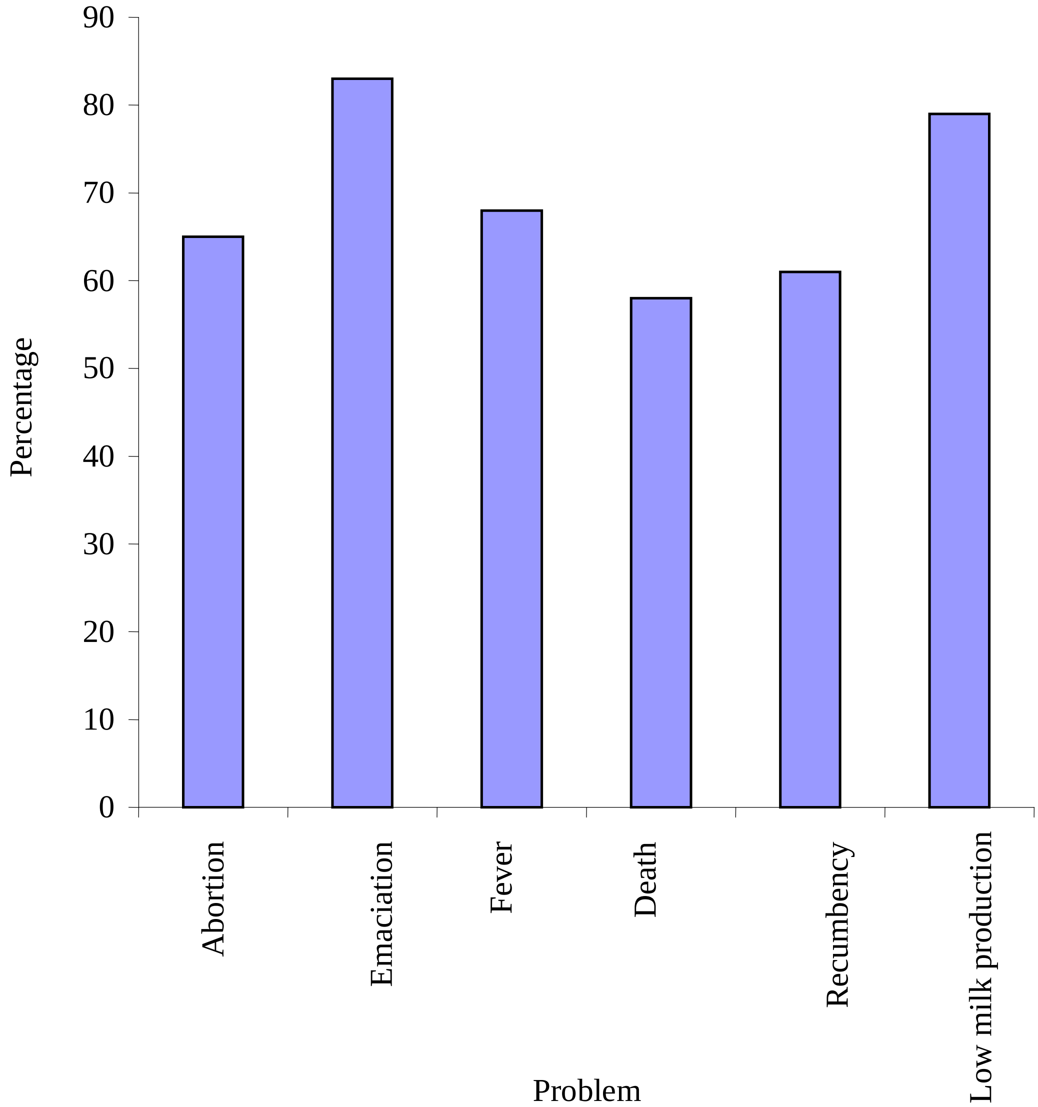


Table 4: The changes that farmers notice with animals when attacked by tsetse flies

Changes in livestock	Percentage
Emaciation	100
Fever	98
Starring coat	100
Recumbency	100
Abortion	97
Low milk production	99
Diarrhoea	100

4.3 Control practices or tsetse flies and trypanosomosis

Control measures being practiced by farmers for controlling trypanosomosis were as shown in Table 5. They felt that control methods shown in Table 5 were effective in controlling trypanosomosis.

Tale 5: Control measures being practiced by farmers for controlling trypanosomosis

Control measures put in place	Percentage
Prophylaxis by Samorin®	91
Treatment by Berenil®	89
Dipping/spraying by deltamethrin	89
Avoiding grazing in the park	15
Migrating	6
Bush clearing	14
Bush burning	13
Digging trenches around the farm	3

Table 6: Effective methods of controlling trypanosomosis as perceived by the farmers

Effective method	Percentage of farmers practising
Spraying using Decatix® weekly	25
Using Samorin® every three months	19
Avoiding grazing in the park	8
Bush burning	7
Bush clearing	4

Sixty six percent of the respondents received a form of training on how to control tsetse flies and trypanosomosis. Almost all the farmers (93%) received training while on their farms. The frequency of on farm visits by service providers were as shown in Table 7. Tsetse flies were controlled by spraying with Decatix® which was done weekly by 43% of farmers and monthly by 57% of the farmers. The most effective measure of controlling tsetse flies and trypanosomosis as perceived by livestock keepers were as shown in Table 6. The impact of tsetse and trypanosomosis control method on cattle spraying against tsetse flies to the environment and cattle as perceived by the farmers were as show in Table 9.

Table 7: The frequency of on farm visits by service providers

Frequency of visits	Percentage
Monthly	29
Every two months	10
Every three months	18
Every four months	7
Every six months	20
Every one year	16

Table 8: The most effective measure of controlling both tsetse flies and trypanosomosis as perceived by livestock keepers

Effective measure	Percentage
Spraying with Decatix® between 1-2 weeks because of its long residual effects	39
Treatment with Samorin® every 3 months because of its prophylactic effects	19
Treating with Berenil® because of its therapeutic effects	4
Avoiding the park because of inaccessibility to the vector	7
Bush clearing to reduce hiding places for the flies	2
Bush burning destroys the flies	4

Table 9: Effect of tsetse and trypanosomosis control method on the environment and cattle as perceived by the farmers

Effect	Percentage
Spraying reduce fly population	7
Bush clearing reduce hiding places for the flies	8
Bush burning reduce fly population and destroys vegetation cover	4
Avoiding grazing in the park improves on the vegetation	2
Samorin® causes swelling and roughening of the injection site	12

The challenges met by the communities when controlling tsetse lies and trypanosomosis were as shown in Table 10. The coping mechanisms by the communities to tsetse flies and trypanosomosis were as shown in Table 11. The farmers gave various strategies which should be adopted by communities so that a burden of trypanosomosis in the area can be overcome. Details were as shown in Table 12.

Table 10. The challenges met by the communities when controlling tsetse flies and trypanosomosis

Challenge faced	**Percentage**
Drugs are expensive	91
Re – infection after treatment	57
Poor drug administration	23
Poor extension services	22
High tsetse challenge	75
Grazing with wildlife	37
Communal grazing	12
Poor synchronization during control	11

Table 11: Coping mechanisms employed by communities to overcome tsetse fly and trypanosomosis challenge

Coping mechanism	**Percentage**
Seek professional advice	43
Prophylaxis by Samorin®	69
Treat the sick with Berenil®	47
Clear the bush	15
Avoiding grazing in the park	11
Consultation with fellow farmers on control measures	10
Divide the herds	5
Migrate	3

Table 12: The strategies which should be adopted by communities so that a burden overcoming the trypanosomosis problem in the area

Strategy to be adopted	Percentage
Introduce other control methods	40
Introduce on market efficacious drugs	4
Making community to work as a team	4
Introduce entomology department	4
Avail more extension services	15
Introduce bye-laws	21
Avail loan scheme to help buy drugs	8
Introduce trypanotolerant breeds	3

4.4 Cost effectiveness of different tsetse fly and trypanosomosis control methods

There was high tsetse fly challenge of 31.2 flies per trap per 72 hours catch effort, being 27.8 in Kibuga and 34.5 in Karusandara. The weekly total variation of tsetse fly and biting flies counts caught in both Kibuga and Karusandara parishes were as shown in Fig. 4. The prevalence of tsetse flies in Kibuga and Karusandara parishes were as shown in Fig. 5. The percentage decay of tsetse flies in Kibuga and Karusandara parishes were as shown in Fig. 6. And in both Kibuga and Karusandara Fig.7. During the study tsetse fly in Karusandara and Kibuga parishes had a very highly positive correlation ($p<0.001$, $r=984$). However, Karusandara had a high tsetse fly challenge than Kibuga ($p<0.001$, $t=5.6$).

Initially, there was high prevalence of trypanosomosis being on average 40.2±2.5% being highest in Karusandara 46.7% and Kibuga 41.5%. Before intervention (January to march) cattle in Karusandara parish had highly significant ($p<0.01$, $t=8.1$) higher prevalence of trypanosomosis (46.2±1.1%) than those in Kanamba (37±1%) and also with those of Kibuga (42.1±0.6%). There was no significant difference ($p>0.05$) between prevalence of trypanosomosis in cattle before intervention between Kanamba and Kabukero (37±0.2%). *Trypanosome Congolese* and *T. vivax*. The variation of prevalence of trypanosomosis per parish from January to June 2009 were as shown in Figure 8. Percentage decrease of trypanosomosis in each parish under different method tsetse and trypanosomosis control were as shown in Figure 9.

Fig. 4. Weekly total variation of counts of tsetse fly and other biting flies
Caught in both in Kibuga and Karusandara

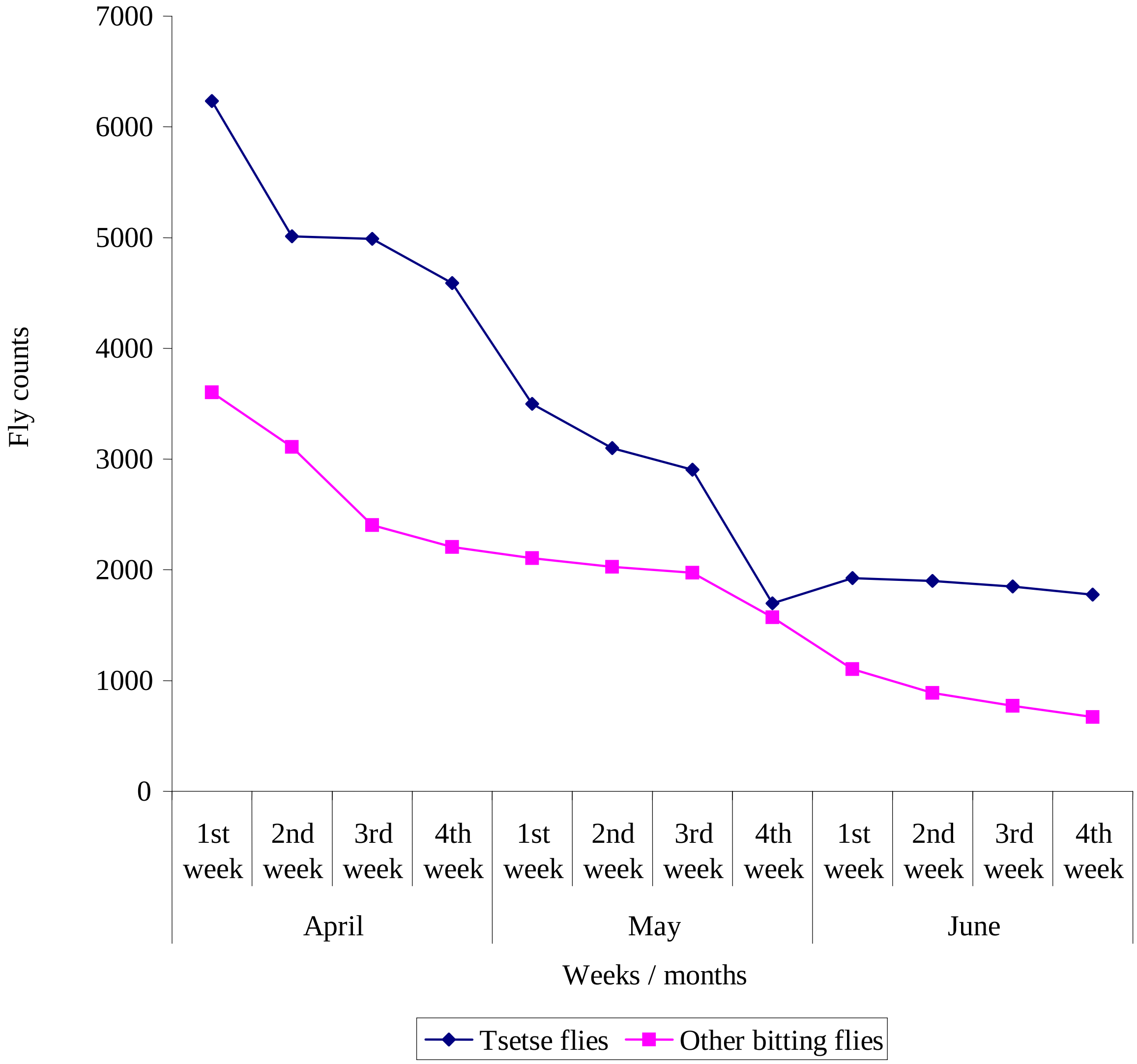


Fig. 5. Variation of tsetse fly counts in Kibuga and Karusandara

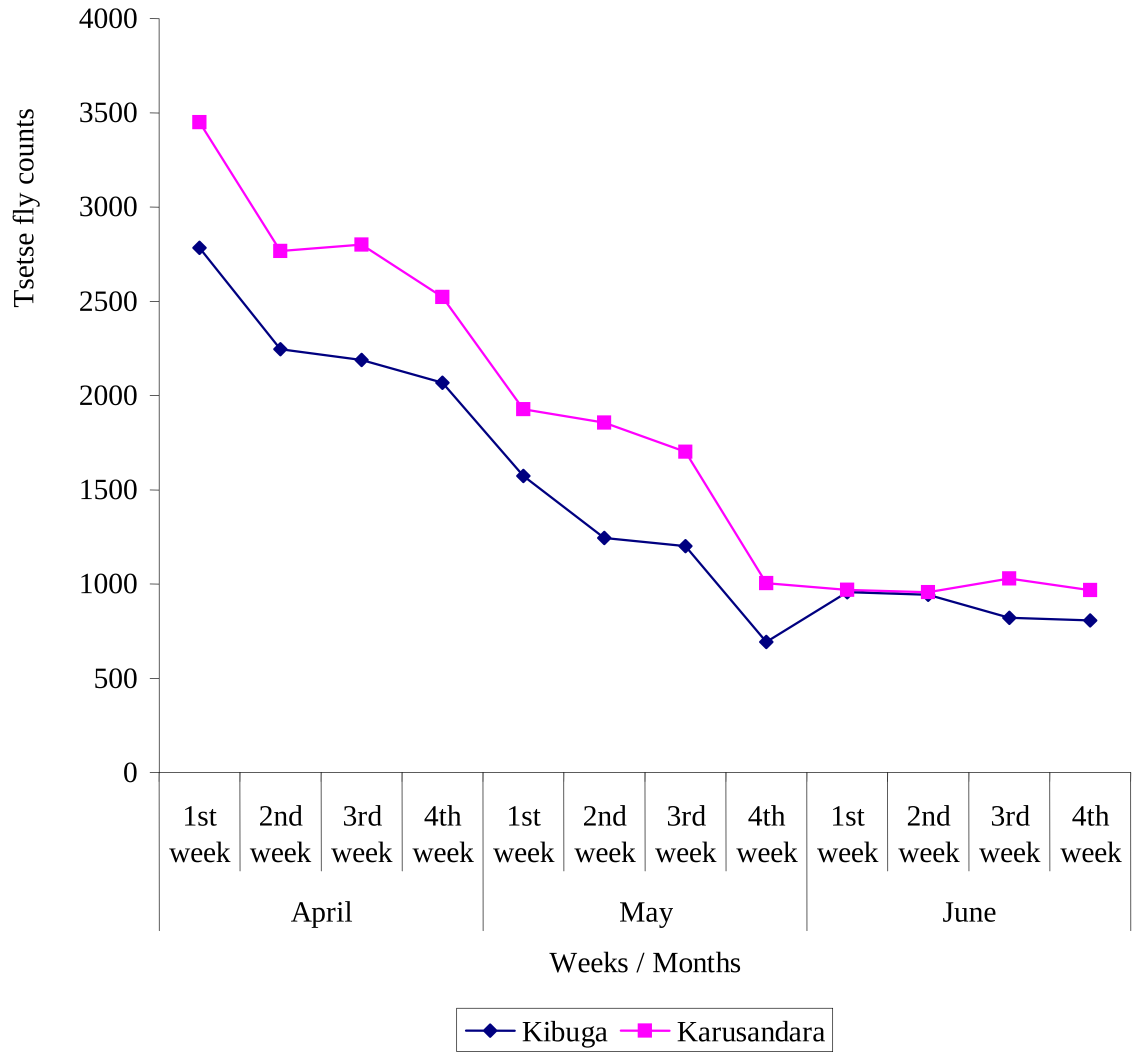


Fig. 6 . Percentage decay of tsetse fly catches in Kibuga and Karusandara parishes

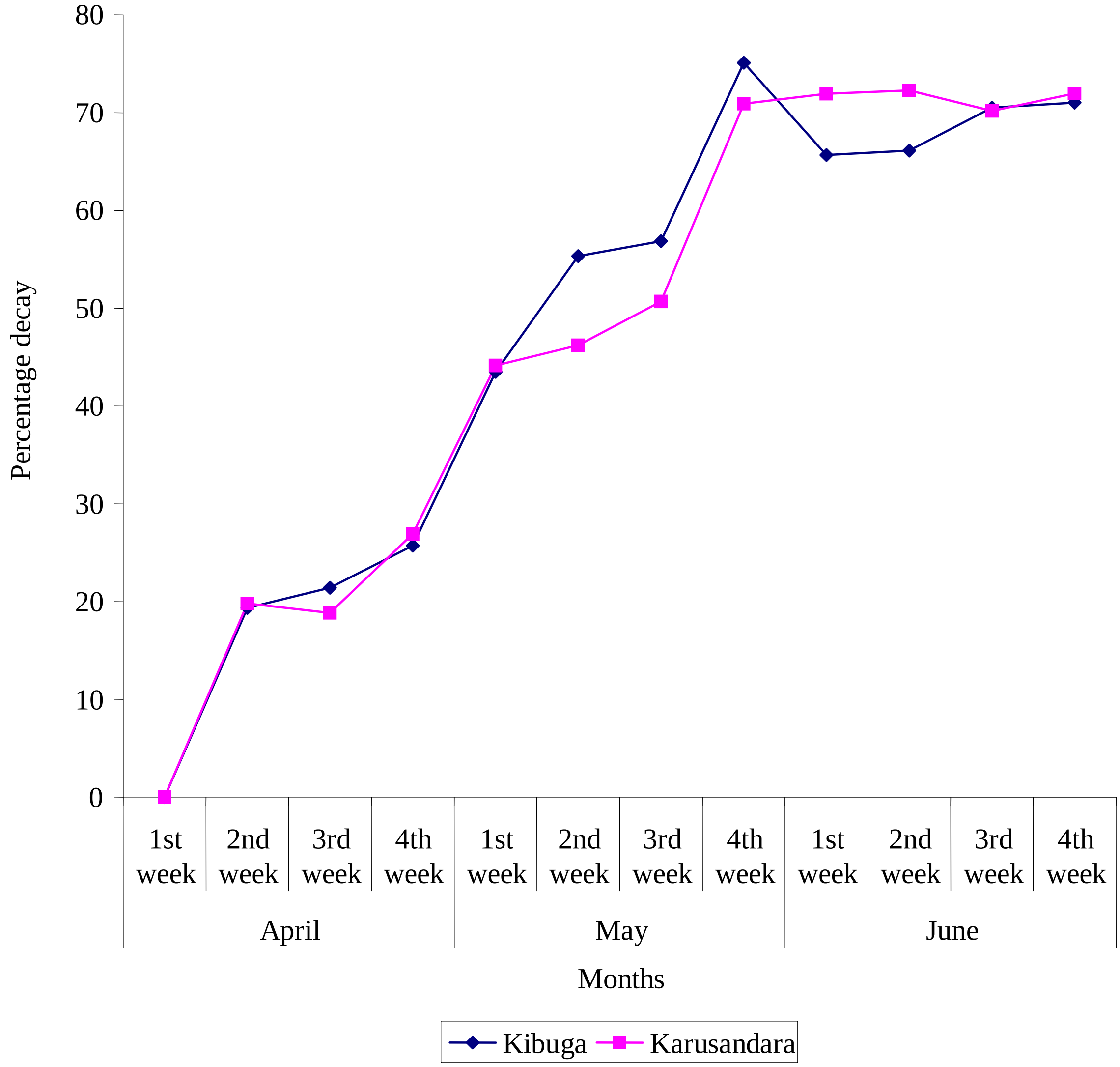


Fig. 7. Weekly percentage decay flies in the Kibuga and Karusandara parishes where they introduced tsetse traps on top moving targets

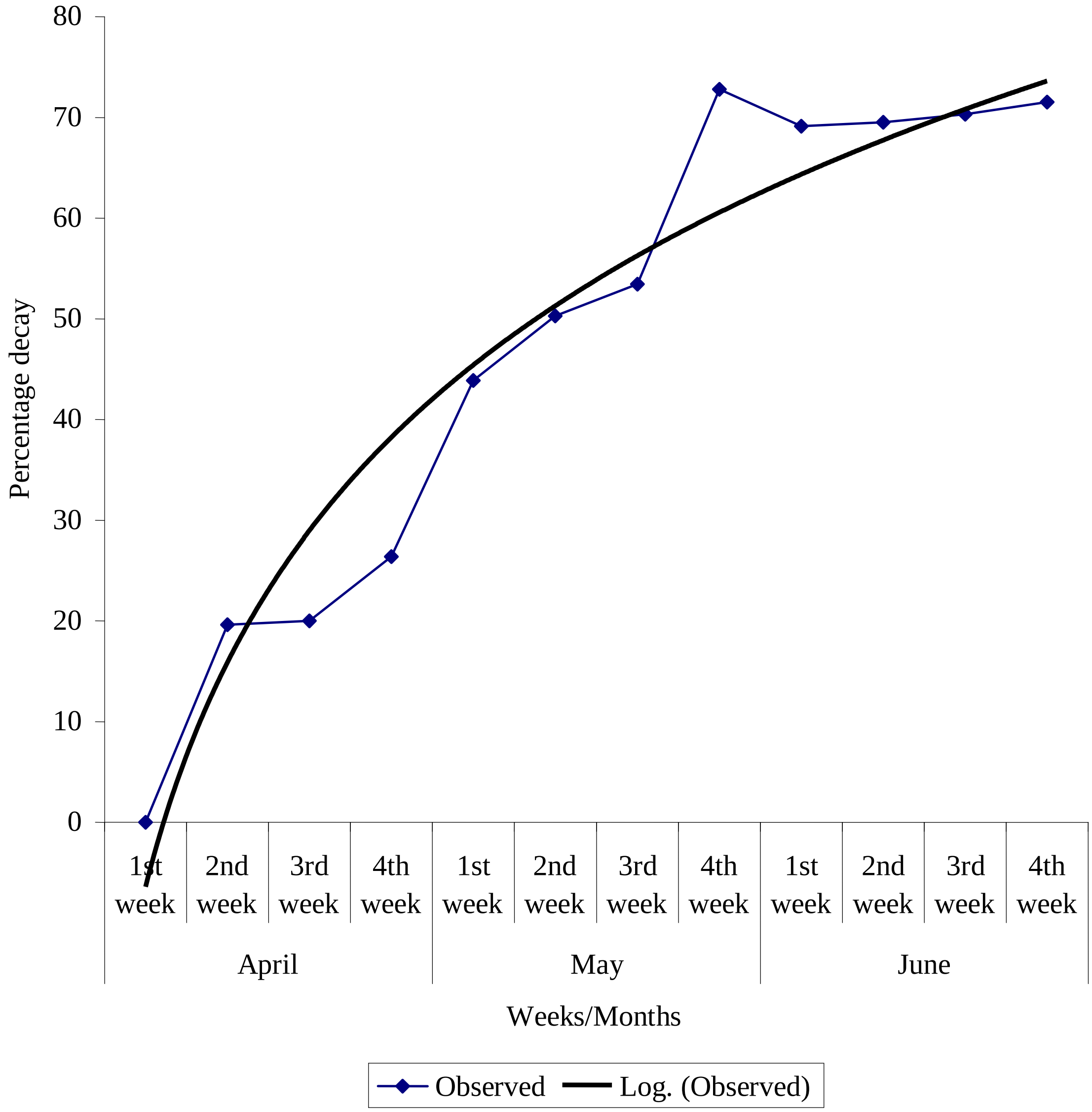


Fig. 8 . Variation of monthly percentage prevalence of trypanosomosis in cattle

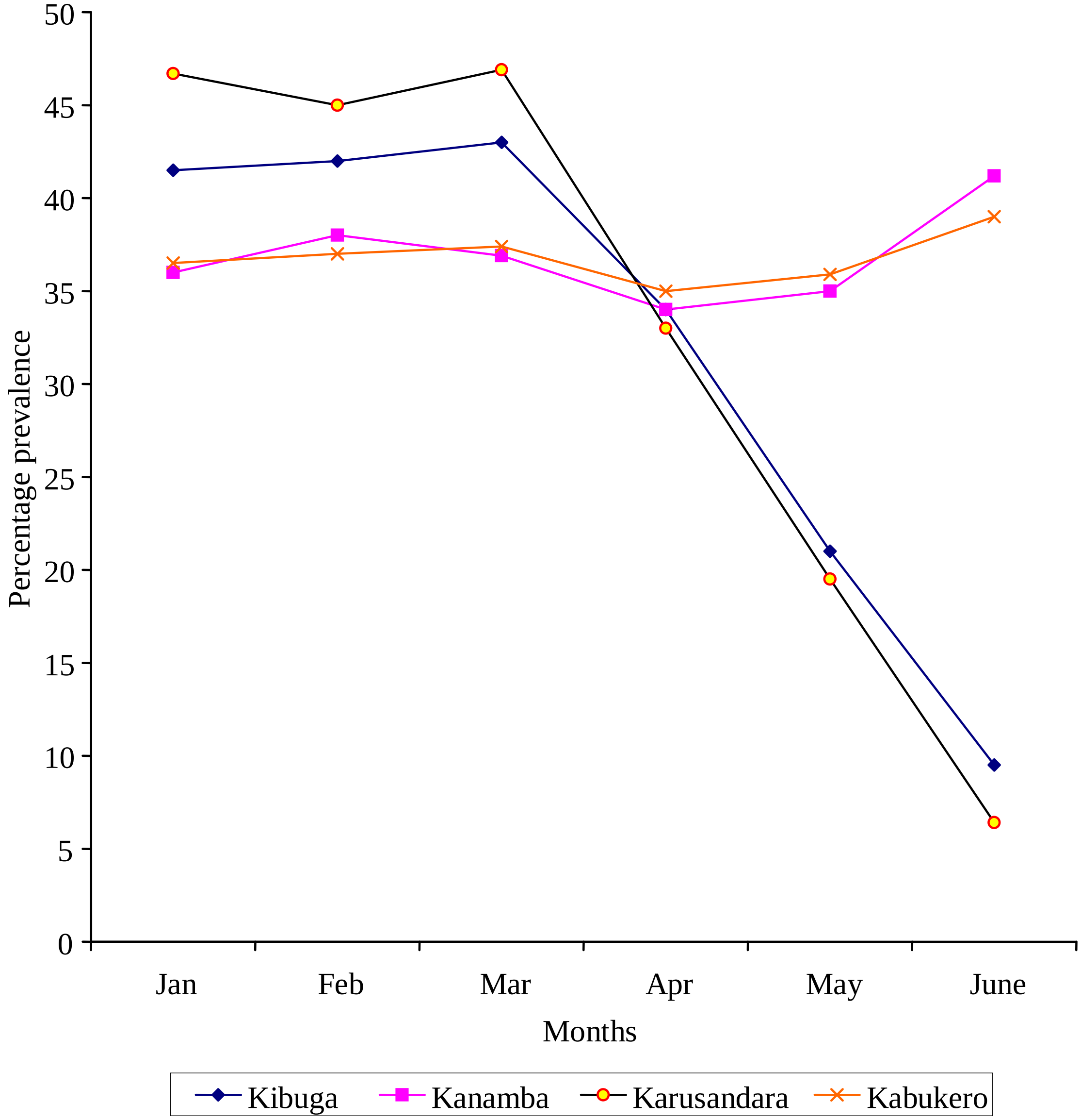
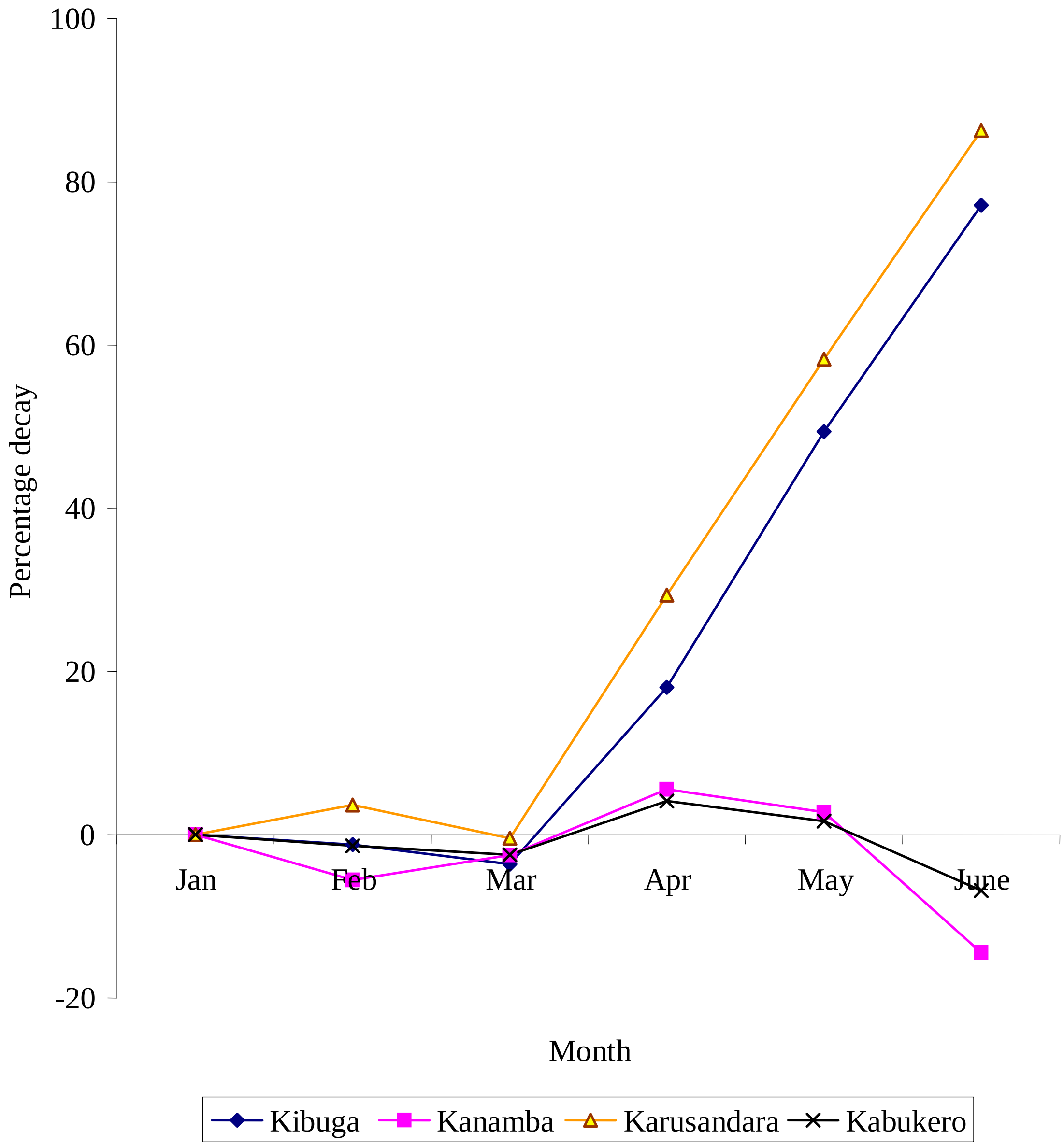


Fig. 9. Percentage decay of prevalence of trypanosomosis with various methods of intervention



4.5 Annual costs of controlling of trypanosomosis and tsetse flies

Average annual costs for controlling trypanosomosis and tsetse flies per household were as shown in Table 13.

Table 13: Average annual costs for controlling trypanosomosis and tsetse flies per household per parish

Parish	**Costs (Ug Shs)**
Kanamba	455,520 ± 36,858
Kibuga	530,800± 42,508
Karusandara	667,400± 151,088
Kabukero	326,000± 24,358

The economic implications and challenges were enormous due to high prices of veterinary inputs and also due to low milk yield, death and low growth rate caused by the disease transmitted by tsetse flies.

CHAPTER FIVE: DISCUSSION

5.1 Perceptions of farmers to tsetse fly and trypanosomosis challenge as a problem

The farmers were mainly cattle keeping communities with mean holding of 31.2±1 cattle, similar with the number for agro-pastoral communities in Soroti and Kayunga (Ocaido *et al.*, 2005; Ocaido *et al.,* 2009b). This cattle holding per household were lower than for pastoral households in Kiruhura (Ocaido *et al.,* 2009a; Ocaido *et al.,* 2009b) and Sembabule (Otim *et al.*, 2004). The major constraints to livestock keeping were diseases, biting flies and inadequate pasture especially during dry season. The major environmental problems in the locality were wild animals, flooding, overgrazing and thick thicket (Fig. 2).

All the farmers sampled had at least case of trypanosomosis in their herds. The problem trypanosomosis caused to livestock as perceived by the cattle keepers were emaciation, low milk production, abortions, fever, recumbency and death (Fig. 3). Although farmers noticed negative changes on their livestock when attacked by tsetse flies only 64% felt a need to control tsetse flies. The farmers recognized the common clinical signs of trypanosomosis (Table 3). More than 54% of the farmers did not feel the need to control tsetse flies, due to reinvasion from the neighbouring QENP.

5.2 Tsetse fly and trypanosomosis control

The major control measures for trypanosomosis being practiced were: prophylactic treatment using Samorin®, treatment of clinical cases by use of Berenil® and dipping/ spraying with deltamethrin® (Table 4). No control measure was reported to be effective alone. Few farmers were seen to be practicing the correct regime of controlling trypanosomosis. Only 25% were spraying their cattle weekly using Decatix® and 19% were prophylactically treating their cattle using Samorin® every three months. This could explain why there was high prevalence (40.2±2.5%) of trypanosomosis among cattle (Fig.8) and high infestation rate of tsetse flies observed in the study area at inception of the study (Fig 4 and 5).

Some of the farmers (15%) understood that the park was a source of tsetse flies and trypanosomosis, hence they avoided grazing their livestock in Queen Elizabeth National Park.

Bush clearing as control method was being practiced by the farmers (1%). During the colonial times bush clearing was a method used to get area rid of tsetse flies like around Lake Mburo National Park, Uganda (Ocaido *et al.,* 1996). Little migrations (1%) to other areas was seen in the area due to tsetse and trypanosomosis challenge. Basongora pastoral communities with big cattle herds of about 500 heads tended to divide the herds into 5 herds each containing 100 cattle and moved to various villages and even to neighbouring districts.

Only 3% of the farmers tried to dig trenches around their farms to prevent wild pigs from entering their land from the national park. They were aware that wild pigs were reservoirs of trypanosomosis.

The main constraints met by the communities when controlling tsetse flies and trypanosomosis control were: expensive drugs, high tsetse challenge and re-infection after treatment (Table 9). Other constraints were grazing in the national park, poor drug administration regimes, poor extension services, communal grazing and poor synchronization during control in that descending order of importance.

However the main coping mechanisms employed by communities to overcome trypanosomosis challenge was phrophylactic treatment of cattle with Samorin® and treatment of the sick cattle with Berenil® (Table 10). The participating farmers were few. The main strategies therefore advocated by the local communities for overcoming constraint to trypanosomosis control would be introduction of other control methods and introduction of bye-laws to enforce trypanosomosis control measures being introduced (Table 11). Other less popular remedies suggested were provision of adequate extension workers, provision of farmers with loans to buy drugs, farmers working together as a team and introduction of trypano-tolerant breeds of cattle. Elsewhere community participation in controlling trypanosomosis has proved effective (Ocaido *et al.,* 2005).

5.3 Tsetse fly and trypanosomosis risks

The study area had high tsetse fly infestation (Fig. 4 and 5). This could be due to failure of the farmers to institute robust cost-effective control measures due to reasons already discussed. In addition, the study area borders Queen Elizabeth National Park, river Mubuku and river Ssebwe. Also the area has been invaded by heavy thickets of *Lantana camara* which offers a best habitant for tsetse flies and other biting flies. **(**Other biting flies caught were of the *genus Tabanus, Stomoxysis, Haematopotas, Chrysops* and *Pangonia*.

There was a high tsetse fly challenge, average catch of 31.2 flies per trap per 72 hour effort, being 27.8 in Kibuga and 34.5 in Karusandara. This challenge was far higher than tsetse fly infestation reported to e 17.4 in Kateeta in Soroti district (Ocaido *et al.,* 2005). This calls for an integrated approach in controlling tsetse flies in this area.

Initially (January, 2009), there was high prevalence of trypanosomosis being on average 40.2±2.5% being highest in Karusandara 46.7% and Kibuga 41.5%. The control (Kanamba and Kabukero) parishes had significantly lower initial prevalence of trypanosomes than the test parishes (Karusandara and Kibuga). The common trypanosomes recovered were *Trypanosoma congelense* and *Trypanosoma vivax.* This prevalence of trypanosomosis in cattle was more than double with what was reported in Kateeta of 16.5 (Ocaido *et al.,* 2005). This is in agreement with the perception of the farmers. With the current light erratic control measures being enforced in the area, cattle re-infection become rampant hence frustrating individual farmer efforts in controlling trypanosomosis. Community integrated approach should therefore be promoted in this area.

Before intervention (January to April) cattle in Karusandara parish had significantly ($p<0.01$) higher prevalence of trypanosomosis (46.2±1.1%) than those in Kanamba (37±1%) and also with those of Kibuga (42.1±0.6%). There was no significant difference ($p>0.05$) between prevalence of trypanosomosis in cattle before intervention between Kanamba and Kabukero (37±0.2%).

Karusandara parish had a higher prevalence of the disease trypanosomosis compared to the rest of the three parishes in the study area. This was due to the fact that the parish is separated from Queen Elizabeth National Park by Kampala-Kasese Railway line. There was re-invasion of tsetse flies from the protected areas.

Some communities have the tendency of grazing in the National Park especially in the dry season although it is practically illegal. However when various methods of tsetse and trypanosomosis were employed from January-June, 2009 the prevalence reduced from 46.7% to 6.4%.

Kibuga had higher prevalence than Kanamba. Kibuga parish is in between the 2 tributaries of River Mubuku, with plenty of water reeds and Lantana camara thicket which offer the best habitat for the tsetse flies. While Kanamba farmers are trying to fence off their farms with cross breed. Bush clearing is occasionally practiced in Kanamba, however still some few farmers sneak to the protected areas where the tsetse challenge is high. Like in Karusandara, Kibuga where various control practices where compared, prevalence of trypanosomosis reduced from 41.5% to 9.5% and Kanamba remained with the average prevalence 37%.

In Kanamba and Kabukero, the prevalence of trypanosomosis remained almost the same. This was brought about by the control mechanisms for the trypanosomosis and tsetse flies which was similar; January-February, 2009 both parishes never applied trypanocides. This being a dry season with poor pastures, farmers believe that trypanocides are stressful to their livestock. However both parishes continued with spraying with fly repellants (decatix®. Treated traps were not introduced in the two parishes.

5.4 Cost effectiveness of different tsetse fly and trypanosomosis control methods

With the combination of use of trypanocides, monthly spraying with Decatix® and deployment of traps in Kibuga and Karusandara parishes, there was steady decrease of tsetse fly infestation (Fig. 4, 5 and 6) with 80% reduction achieved in the second month of application (Fig. 6) Similarly, there was decrease of trypanosomosis prevalence in cattle in Kibuga and Karusandara (Fig. 8) with 80% reduction observed in the second month of application. Meanwhile in control parishes (Kanamba and Kabukero) where traditional methods of control were practiced the prevalence of trypanosomosis among cattle remained the same. This means that a combination of use traps, with regular use of trypanocides (prophylactic treatment using

Samorin® and treatment of clinical cases using Berenil® and spraying cattle bi-weekly using Decatix® could significantly reduce trypanosomosis in Kasese district. This could be improved further by community participation. Through community participation it was possible to reduce the tsetse fly by 95.1% after 6 months by spraying of cattle with Decatix® in Kateeta, Soroti district, Uganda. Meanwhile no cases of trypanosomosis was reported after six months of spraying in Kateeta. Integrated approach using three technologies through community participation opens door to control of trypanosomosis in Kasese.

This shows clearly that tsetse fly life cycle is important in tsetse control (Williams *et al.*, 1993) because the adult stages found in the environment, the larval stages found in the mother and the pupal stages in the ground (Thompson, 1987; Vale *et al.*, 1999). The slow rate of tsetse fly reproduction can enhance their eradication (Holmes *et al.*, 1987) since the female tsetse fly produces two flies after nine blood meals (Eisler *et al.*, 2001). This frequent contact with the host provides an important opportunity for controlling tsetse flies using deltamethrin sprayed cattle as mobile targets. Because of the rapid movement of the tsetse flies, there is rapid re-invasion from the adjacent (Vale *et al.*, 1993). Spraying cattle with insecticide acaracides (mobile target) can eradicate tsetse fly population within two years (Vale, 1999). However, the cost of spraying is prohibitively high for a poor live stocker owner (Hargoves *et al.*, 2002). For trypanosomosis control, diminazine acceturate (Bereni® obtained from private veterinary drug stores have been used (Geets *et al.*, 2000). However, Barret *et al.*, (1997), suggested that a more wide range analysis of the economic benefits of the smallholder cattle of controlling trypanosomosis show that a trypanocidal strategy to be expensive than originally thought.

The findings of this study agrees with earlier observation made by Brusel *et al.* (1985) that use of treated traps significantly increased catches of tsetse flies. According to Okoth (1986) tsetse fly control by use of treated traps is one of the best realistic approaches for control of tsetse flies. The community can make cheap traps themselves and take responsibility for their viability and sustainability (Okoth *et al.*, 1991).

The control of trypanosomosis has economic implications due to high prices of drugs and traps. The average annual costs for controlling trypanosomosis and tsetse flies per household per parish were as follows: Kabukero parish Ug Shs 326,000±24358, Ug Shs Karusandara parish 667,400±151,088, Ug. Shs Kibuga parish 530,800±42,508 and Kanamba parish Ug. Shs 455,520±36,858. These costs could further be reduced through community approach. Here farmers will enjoy economies of scale when purchasing inputs. With control of the trypanosomosis the costs of control would fall because there would be no cases to be treated and outputs from the farm would increase tremendously.

5.5 Community participation in control of trypanosomosis

The establishment of tsetse control through collective action will require some degree of institution-building, institutional strengthening or "community development" in the project area. Many of the issues are the same as those that arise for "pure" tsetse control strategies based on traps or targets. Some of the important principles are as follows; the free-rider problem is a theoretical one that in practice works itself out very differently depending on culture, "social capital" and the institutions existing with in a community. Barret and Okali (1998) considered that "voluntary collective action for improving people's wellbeing" is a reality in the context of vector control. Therefore pubic goods tsetse control technologies such as the use of traps and targets are very important. The participation of communities should be profound. Cattle owners should be involved in the most important levels of project decision-making and from the beginning of design (Barret and Okali, 1998).

Communities should not be expected to pay for benefits experienced outside their own boundaries. Communities that live in areas treated as barriers, to prevent re-infection of tsetse free areas elsewhere, should not be subject to full cost, which is likely to be higher than that of the degree of suppression the community itself would choose. Technical consideration influence the participatory nature of control strategies. Inequalities are inherent in the practice of control for several reasons. First, farmers in areas of low cattle density, wildlife area, and /or subject to high levels tsetse invasion may need to treat proportionally more cattle and /or use artificial baits. Secondly, different livestock production systems will have inherently different effects on tsetse populations, derive different benefits will differ in their ability to invest in tsetse control. Compare for instance traditional pastoralists owning large mobile herds of indigenous cattle with small-scale owners of zero grazed diary cattle. The former group would be more effective at controlling tsetse but the latter might expect better improvements in livestock production from tsetse control (Torr *et al.*, 2001). Thirdly, there are strong temporal inequalities. At the start of any tsetse control initiative, owners have to pay for tsetse control while still sustaining the costs of trypanocides. Thus in the first few months of any operation three is an increase in cost with no discernible benefit. Overtime, owners at the centre of an operation will benefit more than those at the periphery. These inequalities are obstacles to the adoption and sustainability of community-based tsetse control and call for some form of equalization. NGOs government and donors have attempted to take some of these inequalities through the use of subsides, but these have no generally been sustainable (Brightwell *et al.*, 2001).

Local institutions must be understood. PRA methods will also be of use in understanding local institutions, considered in the broadest sense, and including both “traditional” and modern institutions. It will depend greatly on local circumstances whether existing institutions are used for tsetse control or whether new institutions, such as tsetse control committees, will be needed.

There is need to establish a communication highway between farmers and between them and extension workers. Communication of information on disease, vectors and control to farmers, as well as building institutions for collective action needs to be done. It is essential to invest in ‘human capital’ through education and training of farmers, as well as their social capital through institutional strengthening for successful tsetse control. An understanding of the farmers’ motivation factor to learn is a key to whether or not they will attend a training/awareness campaign or accept/adopt the extension messages. Adults are voluntary learners who perform best when they have decided to attend a training/awareness campaign for a particular reason. There is a need to know why a topic is important to them. Anon-formal education set-up would be a suitable form of systematic teaching outside the formal system for farmers. In view of this information transfer to farmers should be based on teaching through discussion, practical demonstration and participation of farmers with experience would help each other to learn. Sharing of experiences should be encouraged.

An understanding of farmers' information networks is required when attempting to form linkages between them and extension workers (FAO, 2000). Farmer Field Schools (FAO), Farmer Field Days, Group extension, school-based campaigns, community meetings, community-based organizations, clinics, health centres and religious organizations all offer strategic opportunities for information dissemination in the study area. Because a large proportion of farmers are illiterate or semi-literate, appropriate communication techniques and channels need to be employed to transfer information on tsetse control. Benefits of control measures flexibly be communicated to farmers. If there is a possibility of switching to improved new methods, these should be done.

5.6 Communication with farmers

The discussion highlighted the need for communicating information on disease, vectors and control to farmers, as well as building institutions for collective action. It is essential to invest in 'human capital' through education and training of farmers, as well as their social capital through institutional strengthening for successful tsetse control. An understanding of the farmers' motivation factor to learn is a key to whether or not they will attend a training/awareness campaign or accept/adopt the extension messages. They need to know why a topic is important to them. A non-formal education set-up would be a suitable form of systematic teaching outside the formal system for farmers. In view of this information transfer to farmers should be based on teaching through discussion, practical demonstration and participation farmers have experience and can help each other to learn, and this sharing of experienced should be encouraged.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

1. Although all farmers had trypanosomosis in their herds and were aware of negative impacts of trypanosomosis only 46% were readily willing to participate in trypanosomosis control.

2. According to the community the challenges facing them in controlling tsetse flies and trypanosomosis were high prices of drugs and deltamethrin products coupled with high tsetse fly challenge hence leading re-infection after treatment.

3. There was high tsetse fly challenge of 31.2 flies per trap per 72 hours catch effort, being 27.8 flies in Kibuga an 34.5 flies in Karusandara.

4. There was high prevalence of trypanosomosis, on average 40.2±2.5% being highest in Karusandara 46.7% and Kibuga 41.5%.

5. No single method of control is effective when employed alone. Spraying of cattle as a moving target with deltamethrin products being practiced in the area could not alone control trypanosomosis nor reduce tsetse fly populations.

6. Introduction of insecticide treated traps a long the two rivers and along Kasese Kampala railway line which separates the National parks with the Sub-county coupled with treatment of sick cattle with trypanocides and existing control systems like spraying with decatix, bush clearing and avoiding trespassing in the National parks greatly reduced tsetse fly populations and prevalence of trypanosomosis.

6.2 Recommendations

1. Farmers should be encouraged to integrate the existing control methods with cheaper ones like popularizing and sensitizing the importance of insecticide treated traps.

2. There is a need to address the roles of livestock-wildlife interface in the epidemiology of trypanosomosis in the area. Uganda Wildlife Authority should work hand in hand with

the local communities and local governments to address problems of vectors and diseases emanating from the protected areas. "One world one health concept".

3. The Veterinary office should be equipped with the necessary logistics to monitor the Tsetse fly population, Tsetse fly species, species of trypanasomoses and proper use of drugs and chemicals.

4. There is need for a concerted inter district co-operation of the three neighbouring districts; Kabarole, Bushenyi and Kamwenge in the fight against tsetse flies and trypanosomosis.

5. Regional co-operation of the Government of the Republic of Congo and Uganda is vital in the war against tsetse flies since tsetse flies regard no political boundary.

6. Donor agencies in the District who are involved with restocking especially Belgium Technical Co-operation (BTC), Netherlands Development Association (SNV) and Heifer project International (HPI) should play a great role in promoting productive breeds of livestock. This will motivate livestock keepers to adhere to extension advice and follow the required control measures.

7. The community should work together to achieve total control of flies and eventually the disease (trypanosomosis).

REFERENCES

1. Alsop, N, J. 1994. A review of recent approaches to sustainable control analysis of the potential of modern techniques for large scale use in: *A systematic approach to tsetse and trypanosomosis control*. Proceeding of the FAO panel of experts, Rome 1-3 December 1993. FAO of United Nations, Rome.

2. Authié, E., Boulange, A., Muteti, D., Lalmanach, G., Gauthier, F. and Musoke, A. J. (2001). Immunisation of cattle with cysteine proteinases of *Trypanosoma congolense*, targeting the disease rather than the parasite. *International Journal for Parasitology*, **31**, 1429-1433

3. Barrett (1997). Economic issues in trypanosomiasis control. *NRI Bulletin* **75**, Natural Resource Institute, Chatham, UK

4. Barrett, K. and Okali, C. (1998). Partnership for tsetse control – community participation and other options. *World Animal Review*, **90**, 39 – 46.

5. Bauer, B., Kabore, I., Liebisch, A., Meyer, F. and Petrich-Bauer, J. (1992) Simultaneous control of ticks and tsetse flies in Satiri, Burkina Faso, by the use of flumethrin pour-on for cattle. *Tropical medicine and Parasotology* **42**, 41 – 46.

6. Bauer, B. Amsler-Delafosse, S., Clausen, P-H, Kabore, I. And Petrich-Bauer, J. (1995). Successful application of deltamethrin pour on to cattle in a campaign against tsetse flies (Glosiina species) in pastoral zone of Samorogouan, Burkina Faso. *Tropical Medicine and Parasitology*, **46**, 183-189.

7. Baylis, M. and Stevenson, P. (1998) Trypanosomosis and tsetse control with insecticidal pour-ons – fact ad fiction. *Parasitology Today*, **14**, 77-82.

8. Brightwell, B., Dransfield, B., Maudlin, I., Stevenson, P. and Shaw, A. (2001). Reality vs. Rhetoric – a survey and evaluation on tsetse control in East Africa. *Agriculture and Human Values*, **18**, 219-233.

9. Brusel, (1985). Baits and natural or synthetic compounds that act as olfactory attractants to tsetse flies.

10. Chizyuka, H.G.B, and Liguru, S.M.K. (1986) Dipping to control vectors of cattle parasites. *Parsitology Today* **2**,123.

11. Codjia, V., Mulatu, W., Majiwa, P.A.O., Leak, S.G.A., Rowlands, G.J. and Authié, E. (1993). Southwest Ethiopia Part 3. Occurrence of populations of *T. congolense* resistant to diminazene, isometamidium and homidium. Acta Tropica, 53,151-163.

12. Dohoo, I., Martin, W. and Stryhn, H., 2003. Veterinary Epidemiologic Research. Charlottetown, Prince Edward Island, Canada: AVC Inc.

13. Doran, M.H. and Van den Bossche, P. (1988). Socio economic survey of tsetse free and tsetse infested areas of Eastern province, Zambia, 1997. Regional tsetse and trypanosomosis Control Programme (RTTCP), Harare, Zimbabwe.

14. Doran, M. (2000). Socio-economics of trypanosomosis: Implications for control strategies with the common fly-belt of Malawi, Mozambique, Zambia and Zimbabwe.

15. Dransfield, R. D., Williams, D. G. and Bright Well, R. (1991). Control of trypanosomosis: Myth or reality. *Parastology Today*, **7 (10)**, 287-291

16. Eisler, M.C., Stevenson, P., Munga, L. AND Smyth, J.B.A. (1997). Concentrations of isometadium chloride (Samorin) in sera of sebu cattle which showed evidence of hepatotoxicity following trypanocidal treatments. *Veterinary Pharmacology and Therepeautics*, **20**, 173-180.

17. Eisler, M.C., Brandt, J.M Bauer, B. and Geerts, S. (2001). Standardised tests in mice and cattle for the detection of drug resistance in tsetse transmitted trypanosomes of African domestic cattle. *Veterinary Parasitology*, **97**,171 -183

18. Finelle, P, (1974). African animal trypanosomosis in: *World Animal Review* **No. 9** part III control of vectors, 39-43

19. Fox, R. R. Mbando, S. O, Fox M.S and Wilson A. (1993): Effect on herd health and productivity of controlling tsetse and trypanosomosis by applying detamethrine to cattle. Tropical Animal Health and Production **25**, 203-214.

20. Geerts, S. and Holmes, P.H. (1997). Drug management and parasite resistance in animal trypanosomosis in Africa. PAAT Position Paper, FAO/WHO/IAEA/IBAR

21. Geerts, S., Holmes, P.H., Dial, O. and Eisler, M.C. (2001). African animal trypanosomiasis: The problem of drug resistance. *Trends in Paristology*, **17**, 25-28.

22. Hargrove, J. W. (2000). A theoretical study of the invasion of cleared areas by tsetse flies (Diptera: Glossinidae). *Bulletin of Entomological Research*, **90**, 201-209.

23. Hagroove, J.W. (2002). Optimised simulation of control of tsetse flies *Glosinna palllides* and *G. mortisan mortisans* using odour baited targets in Zimbabwe. *Bulletin of Entomological Research.*

24. Hargroove, J.W. Torr, S.J. and Kindness, H.M. (2002). Factors affecting efficacy of using insecticide treated cattle to control tsetse. *Bulletin of Entomology Research*.

25. Holmes, P.H. (1997). New approaches to integrated control of trypanosomosis. *Veterinary Parasitology*, **71**, 121-135.

26. Itty, P. (1992). *Economics of village cattle production in tsetse affected areas of Africa*, A study of trypanosomosis control using trypanotorelant cattle and chemotherapy in Ethiopia, Kenya, Cote De Ivory, The Gambia, Zaire And Togo, Hurtong, Correvertag, Iconstanz (Germany).

27. Itty, P. and Swallow, B. 1993. The economics of trypanotolerant cattle production in regions of origin and areas of introduction. *Paper presented at the ILRAD workshop: Towards increased utilisation and adoption of trypanotolerance - current status of research and future directions*. Nairobi, Kenya, 26-29 April 1993. Nairobi, ILRAD.

28. Jordan, A.M. (1986). Trypanosomosis Control and African Rural Development. Longman, London and New York.

29. Kamara, D. and Kettle (1995). Assessment of the socio-economic factors affecting implementation of community-based tsetse control in Busia, Kenya. International Scientific Council for Trypanosomosis Research and Control. OAU/Scientific, Technical and Research Commission (OAU/STRC). Nairobi Kenya: 1993, Publ. 1995. No. 117,293-301.

30. Kettle, D.S. (1995). Tabanidae (Horseflies, Deer flies, Clegs). En: Cab International (Eds.) Medical and Veterinary Entomology. 2nd Edition. 211-224.

31. Leach, T.M. and Roberts, CJ. (1981). Present status of chemotherapy and chemoprophylaxis of animal trypanosomosis in the Easten hemisphere. *Pharmacology and Therapeutics*, **13**, 91-147.

32. Leak, S.G.A, Woudyalew, M., Rowlands and DTeteren, G.D.M. (1995). A trial of cypermetherin pouron to control *Glossina pallidipes*, G. fuscipes, and *G. mortisan submortisan* (Diptera Glosiinedae) in south-west Ethiopia. *Bulletin of Entomological Research*, **85**, 241-251.

33. Machila, N. Eisler, M.C., Wanyangu, S.W. , McDermot, J.J., Welburn, S.C. and Maudlin, I. (2000). Cattle owners perceptions of African Boveine tryapnosomosis and its control in Busia and Kwale districts of Kenya. 9th ISVEE Symposium, Breckenridge, Colorado, USA, August 2000.

34. Morton, J.F. (2002). Livestock management and socio-economic factors affecting the feasibility of trypanosomosis and malaria control in Konso Special Woreda, Ethiopia: report of preliminary survey.

35. Mulungeta, W., Wilkes, J., Mulatu, W., Majiwa, P.A. Masake, R., and Peregrine A.S. (1997). Longterm occurrence of *Trypanasoma congelense* to diaminazene, isometamidium and homodium in caattle at Ghibe, Etipia. Acta Tropica, 64, 205-217.

36. Murray, M. Morrison, W.I., Murray P.K., (1979) Trypanolerance a review. *World Animal Review* **31**,2-12.

37. Ocaido, M., Siefert, L. and Baranga, J. (1996). Disease surveillance in mixed livestock and game areas around Lake Mburo National Park in Uganda. *South African Journal of Wildlife Research*,**26(4)**: 133-135.

38. Ocaido, M., Otim, C.P., Okuna, N.M., Ssekito, C., Kakaire, D., Erume, J., Wafula, R.Z.O., Walubego, J. , Musisi, G., Okello-Bwangamoi, Okure, S, Ebiaru, W. and Monrad, G. (2005). Dual control of ticks and tsetse flies using deltamethrin through community participatory methods. *Uganda Journal of Agricultural Sciences*, **9(1)**: 672-679.

39. Ocaido, M., Otim, C.P., Okuna,N.M., Erume J, Ssekitto, C., Wafula R.Z.O., Kakaire, D., Walubengo, J. and Monrad, J. (2005) . Socio-economic and livestock disease survey of agro-pastoral communities in Serere County, Soroti District, Uganda. Livestock Research for Rural Development ***17 (8)***. **http://www.cipav.org.co/lrrd/lrrd17/8/ocai17093.htm**

40. Ocaido M, Muwazi, R.T. and Opuda-Asibo, J. (2009a). Financial analysis of livestock production systems around Lake Mburo National Park, in South Western Uganda. *Livestock Research for Rural Development. Volume 21, Article # 70.* Retrieved April 16, 2009, from *http://www.lrrd.org/lrrd21/5/ocai21070.htm*

41. Ocaido,M., Otim C.P. and Kakaire, D. (2009b). Impact of major diseases and vectors in smallholder cattle production systems in different agro-ecological zones and farming systems in Uganda. *Livestock Research for Rural Development. Volume 21, Article #155.* Http://www.lrrd.org/lrrd21/9/ocai21155.htm=

42. Okoth, J.O. (1986) Community participation in tsetse control. *Parasitology Today*, **2(3)** 88.

43. Okoth JO. 1991. Description of a mono-screen trap for *Glossina fuscipes fuscipes* Newstead in Uganda. *Annuals of Tropical Medicine and Parasitology* 85: 309-314.

44. Okoth, J.O., 1999. Natural hosts *of Glossina fuscipes fuscipes* and epidemiological implications for sleeping sickness outbreak in S.E. Uganda. *In: Proceedings of the 25th Meeting of the International Scientific Council for Trypanosomiasis Research/Organisation of African Unity, ISCTRC/OAU 120*:239-253.

45. Olila, D. (1999). Pharmacological and epidemiological studies on drug sensitivity of trypanosomes isolated from peri-urban dairy systems in Uganda. University of Nairobi, PhD thesis, 311pp.

46. Otesile, E.B. and Akpokodje, J.U. (1991) performance of a herd of Ndama cattle during and after cessation of chemoprophylaxis for trypanosomosis. *Tropical Veterinarian*, **9**, 51-54.

47. Otim, C.P., Ocaido, M., Okuna, N. M., Erume, J., Ssekitto, C., Wafula, R.Z.O., Kakaire, D., Walubengo, J., Okello, A., Mugisha, A. and Monrad, J. 2004: Disease and vector constraints affecting cattle production in pastoral communities of *Ssembabule district, Uganda*. Livestock Research for Rural Development. Vol. 16, Art. #35. *Retrieved June 2, 2004* http://www.cipav.org.co/lrrd/irrd16/5/otim16035.htm

48. Robinson, T.R., Rogers D.R. and Williams B. (1997). Mapping tsetse habitat suitability in the common fly belt of Southern Africa using multivariate analysis of climate and remotely sensed vegetation data. *Medical and veterinary entomology* **11**, *235-45*

49. Roelants, G.E. (1986). Natural resistance to Africa trypanosomosis. *Parasite Immunology*, **8**,1-10.

50. Stevesion, P, Munga, L. (1993). Knowledge and best practices to local communities in controlling tsetse flies. And the detrimental effects of frequent treatment with trypanocidal drugs

51. Stevesion, P, Murunga, L. and Dolan, R.B. (1993). Detrimental effects of frequent treatment with trypanocidal drugs. In: *Proceedings of the 22nd Meeting of the International Scientific for Trypanosomisis Research and control, Kampala, Uganda 25th -29th October, 1993*. Ed. K.R. Sones, 130-135. OAU/STRC, Nairobi.

52. Thompson, J.W. (1987). Low technology approach to tsetse control and a review of developments in tsetse fly (*Glossina species*) control by application of insecticide to cattle.

53. Thompson, J.W., Mithchell, M., Rees, R.B., Sheren W., Schoefeld, A.H. and Wilson, A. (1991). Studies on efficacy of deltamethrin applied to cattle for

control of tsetse flies (*Glossina* species) in Southern Africa. *Tropical Animal Health and Production*, **23**, 221-226.

54. Torr, S.J., Wilson, P.J., Schofeld, S. Mangwiro I.N.C., Akber, S. and White, B.N. (2001). Improving control of tsetse: the use of DNA profiling to establish the feeding responses of tsetse to cattle. Final technical Report (Project R 7364). DFID Animal Health Programme.

55. Thrusfield, M., 2007. Veterinary Epidemiology, 3rd Edition. London: Blackwell Science

56. Uilenberg, G. (1996). Integrated control of tropical animal parastoses. *Tropical animal health and production (1996).* **28** 257-265

57. Vale, G,A. (1993). Movements of tsetse flies and re-invasion of tsetse flies. Buttletin of Entomology Research, **84**, 567 – 577.

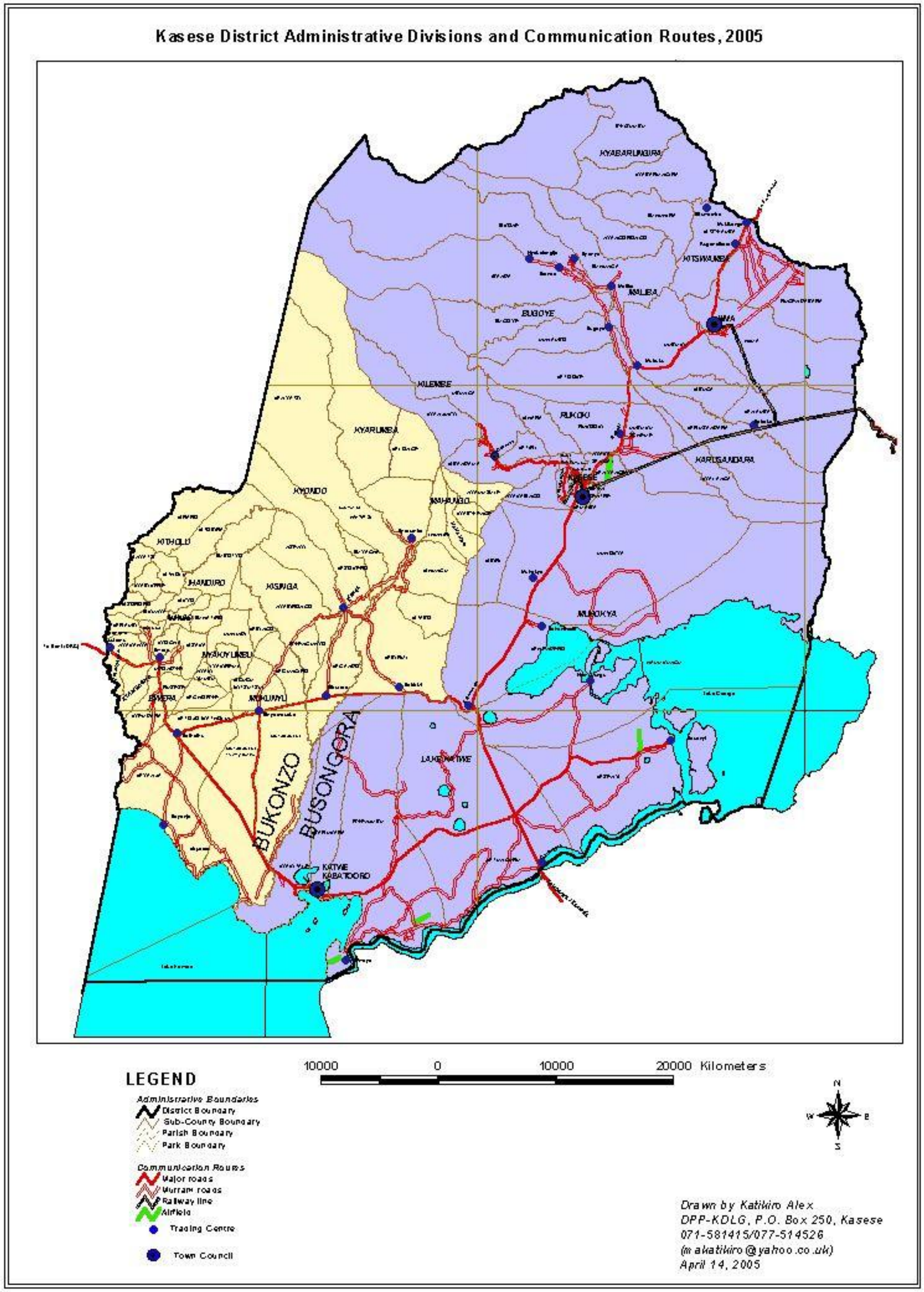
58. Vale, G.A., Mutika, G. and Lovemore, D.F. (1999) Insecticide treated cattle for controlling tsetse (Diptera: Glossinidae). *Bulletin of Entomological Research*, **89**, 567-577.

59. Vale, G,A. (1985). Journal on trypanosomosis control and insecticide treated cattle for controlling tsetse flies

60. Willemse, (1991). Effective treatment of trypanosomosis and trials of a dour-baited targets to control the tsetse fly. (*Glossina Morsitans centralis)*. (Diptera Glossinidae) in West Zambia. *Bulletin of Entomological Research,* **81**, 651-657.

61. Williams, B., Dransfield, R. and Brightwell, R. (1992). The control of tsetse flies in relation to fly movement and trapping efficiency. *Journal on Applied Ecology*, **29**, 163-179.78.

APPENDIX I



APPENDIX II: COMMUNITY OF FOCUS GROUP DISCUSSION GUIDELINES

COMPARATIVE STUDY WITH VARIOUS CONTROL METHODS FOR TSETSE FLIES AND TRYPANOSOMOSIS

A. Introduction to a group discussion

The FGD will be facilitated by the researcher, who will be able brief the group members the objectives of the research topic as follows:

a. To identify various approaches being used to control tsetse flies and trypanosomosis.
b. To establish on appropriate strategy that is environmentally friendly and cost effective method.
c. To identify factors that hinder effective control of tsetse flies and trypanosomosis.

In the process of the introduction of the subject, the facilitator will explain briefly the importance of the vector and the disease transmitted by the vector, and a need for the development of on integrated control strategy.

B. Questions for discussion in the FDGS

The following probing or checklist question have been development for discussion. However, to achieve the objectives indicated above the facilitator may need to add any other relative question as if may be deemed necessary.

Question 1

As livestock farmers, what major problem do you encounter with your livestock?

Question 2

How do you cope up with the problem?

Question 3

Is trypanosomosis and tsetse flies a problem in this area?

Question 4

How do you cope up with tsetse flies and trypanosomosis?

Question 5

What are the economic implications/challenges of tsetse flies and trypanosomosis?

Question 6

Have you ever heard about any control mechanism for tsetse and trypanosomosis no/yes if yes from where?

Question 7

What control methods are effective in this area in terms of

i) Costs?

ii) Environment?

Question 8

What gaps are missing and need to be filled?

C. Structure of the focus groups

There will be a total of four groups selected from the participating parishes. It is estimated that each group will be composed of 20 members preferably one from each household of the participating area. The members of the main FGD will be broken into smaller groups of 5-10 members. It is the smaller group which will discuss the lead questions above and present the findings in the plenary of all the 20 participants.

The groups will consist of any of the members of the household in the area where the questionnaires were administered.

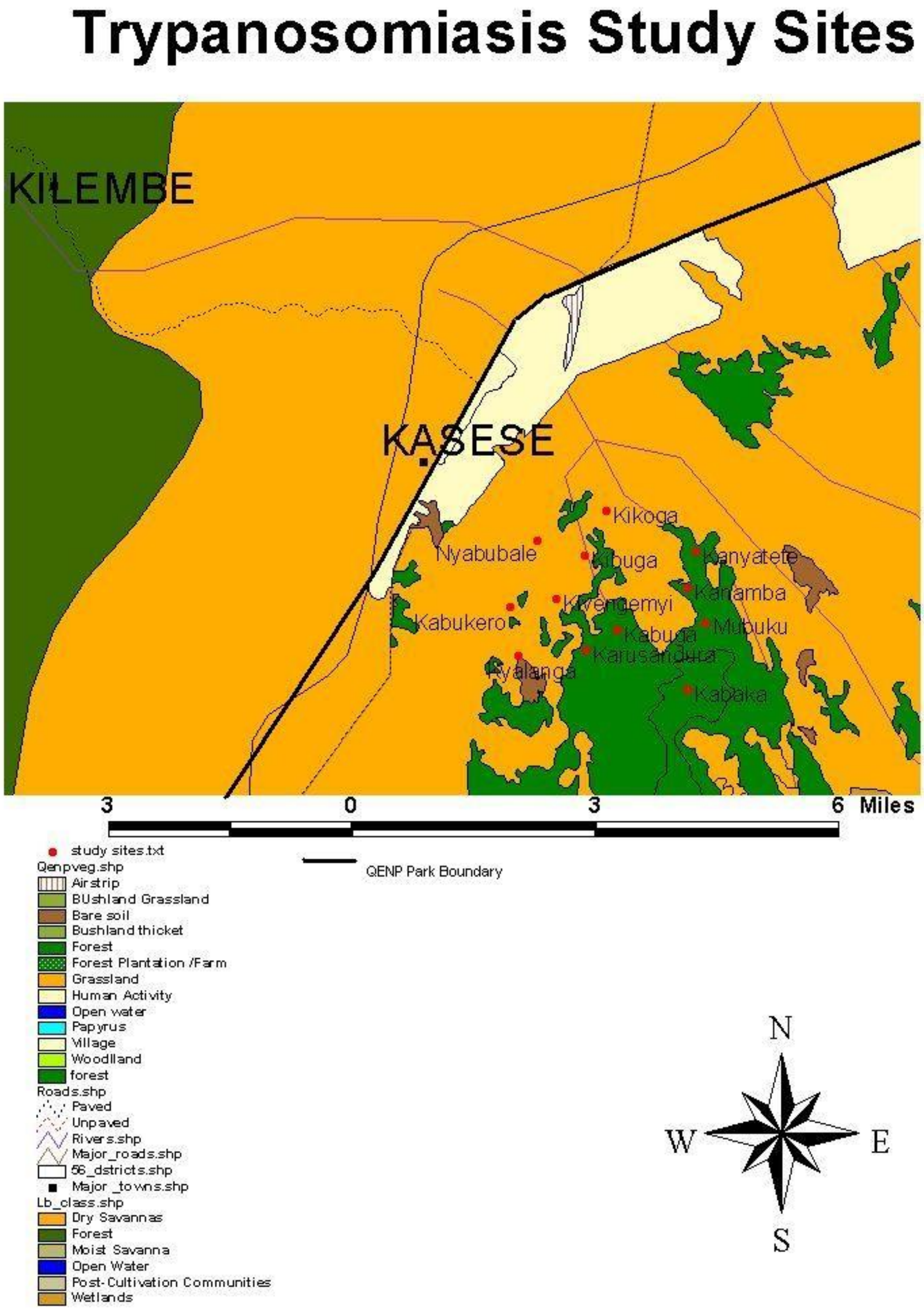
However, families or households which filled the questionnaires will not be targeted and will be discouraged from participating in the FGDs to allow introduction of new diseases.

There will be general discussion, resolutions, suggestions and away forward from the members of the focus groups concerning study of various control methods for tsetse flies and trypanosomosis.

D. Conclusion

The facilitator will be able to capture any other emerging issues related to the subject. Also the facilitator will be able to assure the participants that the information provided neither be attributed to any individual in the groups nor be used to their detriment. It will remain generalized in nature for the benefit of the entire Kasese District livestock industry. The facilitator will finally thank the participants for their contributions, time and resources committed to have the fruitful discussions.

APPENDIX III



APPENDIX IV: INDIVIDUAL QUESTIONNAIRES ON COMPARATIVE STUDY WITH VARIOUS CONTROL METHODS FOR TRYPANOSOMOSIS AND TSETSE FLIES IN KASESE DISTRICT

Preamble this questionnaire is intended to gather data and information that will assist to develop on various control methods for trypanosomosis and tsetse flies in Kasese District.

Instructions for filling the questionnaire

i. Fill in the information required in the space provided.
ii. Inhere it is provided, tick the appropriate box.
iii. You can provide and incorporate any other relevant information in the questionnaire.

INTRODUCTION

1. Name of respondent……………………………… Sex…………….. Age..........……
2. Village.……………………… Parish………………… Sub-county………………..…
3. County……………………………………………………………………………..
4. How many health centres do you have?
5. For how long have you been keeping livestock?
6. Apart from cattle, what other animals do you keep?
7. How long have you been in this locally?
8. What major problems do you face with your livestock?
9. What environmental problems have you met in this locality?
   i. ……………………………………………………………………………………
   ii. ……………………………………………………………………………………
   iii. ……………………………………………………………………………………
10. Have you had problems with tsetse flies? Yes or No
11. If yes, list the major problems.
   i. ……………………………………………………………………………………
   ii. ……………………………………………………………………………………
   iii. …………………………………………………………………………………….

12. How do you feel when these flies attack livestock?

iv. ……………………………………………………………………………………

v. ……………………………………………………………………………………

vi. ……………………………………………………………………………………

13. What changes do you notice with your animals when attacked by tsetse?

i. ……………………………………………………………………………………

ii. ……………………………………………………………………………………

iii. ……………………………………………………………………………………

iv. ……………………………………………………………………………………

14. What measure have you put in place to cope up with the problem?

i. ……………………………………………………………………………………

ii. ……………………………………………………………………………………

iii. ……………………………………………………………………………………

iv. ……………………………………………………………………………………

v. ……………………………………………………………………………………..

15. How effective or what is the most effective measure?

16. Have you ever got any form of training from anywhere? Yes or No

17. If Yes, where?

18. How often do you receive service providers?

19. How often do you attend or access control sensitization programmes?

20. How often do you control or put measures to control tsetse flies?

21. What are the effects of the methods you use on the environment and cattle?

22. Amongst the measures what do you think is more effective? Give reasons.

i. ……………………………………………………………………………………

ii. ……………………………………………………………………………………

iii. ……………………………………………………………………………………

iv. ……………………………………………………………………………………

23. What costs do you always incur while using the se methods?

i. ……………………………………………………………………………………

ii. ……………………………………………………………………………………

iii. ……………………………………………………………………………………

iv. ……………………………………………………………………………………

24. What challenges do you meet while controlling tsetse flies?

i. ……………………………………………………………………………………

ii. ……………………………………………………………………………………

iii. ……………………………………………………………………………………

iv. ……………………………………………………………………………………

25. How do you cope up with these challenges?

iv. ……………………………………………………………………………………

v. ……………………………………………………………………………………

vi. ……………………………………………………………………………………

26. What do you feel is still missing and needs to be filled?

i. ……………………………………………………………………………………

ii. ……………………………………………………………………………………

iii. ……………………………………………………………………………………

APPENDIX V: QUESTIONNAIRES FOR THE DISTRICT VETERINARY SERVICE PROVIDERS

QUESTIONNAIRES FOR THE FIELD VETERINARY SERVICE PROVIDERS ON A COMPARATIVE STUDY WITH VARIOUS CONTROL METHODS FOR THE TSETSE AND TRYPANOSOMOSIS IN KASESE DISTRICT

Preamble: This questionnaire is intended to gather data and information that will assist to develop on various control methods for tsetse flies and trypanosomosis in the district of Kasese.

Instructions for filling the questionnaires

i. Fill in the information required in the space provided
ii. Where it is provided, tick the appropriate box.
iii. You can provide and incorporate any other relevant information in the questionnaire.

INTRODUCTION

1. Name …………………………………………………………………………………
2. Department ………………………………………………………………………...
3. Area of operation ……………………………………………………………………….
4. What are the common diseases in livestock in your area of operation?

i. ………………………………………………………………………………………
ii. ………………………………………………………………………………………
iii. ………………………………………………………………………………………
iv. ………………………………………………………………………………………
v. ………………………………………………………………………………………
vi. ………………………………………………………………………………………

5. Are you identified trypanosomosis as a threat to livestock yes or no?

6. If yes, give reasons.
   i. ……………………………………………………………………………………
   ii. ……………………………………………………………………………………
   iii. ……………………………………………………………………………………

7. What have you done to cope up with this threat?
   i. ……………………………………………………………………………………
   ii. ……………………………………………………………………………………
   iii. ……………………………………………………………………………………

8. How effective are the measures you have established?

9. What impact do the measures established have on the environment?
   i. ……………………………………………………………………………………
   ii. ……………………………………………………………………………………
   iii. ……………………………………………………………………………………

10. How often do you control tsetse flies and trypanosomosis in your area?

11. What are the most effective measures do you think of? Give reasons.
   i. ……………………………………………………………………………………
   ii. ……………………………………………………………………………………
   iii. ……………………………………………………………………………………
   iv. ……………………………………………………………………………………

12. What challenges do you always meet while controlling tsetse and trypanosomosis in your area of operation?
   i. ……………………………………………………………………………………
   ii. ……………………………………………………………………………………
   iii. ……………………………………………………………………………………
   iv. ……………………………………………………………………………………

13. How do you cope up with these challenges?

i. ……………………………………………………………………………………

ii. ……………………………………………………………………………………

iii. ……………………………………………………………………………………

iv. ……………………………………………………………………………………

14. What are the gaps missing that you feel should be tackled immediately?

v. ……………………………………………………………………………………

vi. ……………………………………………………………………………………

vii. ……………………………………………………………………………………

viii. ……………………………………………………………………………………