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HAEMATOPHAGOUS FLIES, HAEMOPARASITES AND ECOLOGICAL VARIABLES IMPINGING LIVESTOCK HEALTH IN THREE PRIVATE FARMS WITHIN SOUTHERN PARTS OF KANO STATE, NIGERIA

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ABSTRACT
A spot check for animal trypanosomosis was conducted in three farms; two from Kiru and one from Bunkure Local Government Areas of Kano State, within the Sudano-Sahelian Ecological Zone in North West of Nigeria. The study was sequel to suspected outbreak of trypanosomosis and biting flies menace in the farms. Severe emaciation and low grade mortalities (often sudden) among the herds were reported. Blood samples were collected from emaciated cattle (n=70) from the study population (n=241) and examined for presence of trypanosomes using the buffy coat technique. *Babesia* and *Anaplasma* were analyzed by microscopic examination of thin blood smear fixed in absolute methanol and stained with 10% Giemsa solution. Twenty two samples (30%) were found to have different species of haemoparasites; *Trypanosoma theileri* (n=2), *Anaplasma marginale* (n=13) and *Babesia bovis* (n=7). The mean packed cell volume (PCV) was 25±% with a range between 16-41%; Farm-1 in Kiru and Farm-3 in Bunkure had the lowest and highest values, respectively. It was obvious that ticks infestation posed health and livestock production challenges to the study farms. The likelihood that mechanical transmission of trypanosomosis can be facilitated stemmed from migrating nomadic herds interaction with farm cattle during grazing and presence of biting fly population. The huge negative economic impact of haemoparasites; babesiosis and anaplasmosis to livestock within tsetse free area remains a big challenge. Combining vector (biting flies), haemoparasites and ectoparasites (ticks) control strategy using berenil and chlortetracycline appeared to be highly cost effective and efficient when administered to all animals.

Keywords: Convective Flow, Dusty Viscous Fluid, MHD, Viscous Dissipation.

INTRODUCTION
Crop and or livestock farming are the backbone of the socio-economic system of most rural communities in the continent of Africa (El-Metanawey *et al*., 2009). There is paradigm shift of moving from old tradition that adopted pastoral nomadic to semi-pastoral way of living engaged in crop farming. These people owned approximately 50% of African livestock, equivalent to approximately 225 million animals (Kamuanga *et al*., 1997). As such, Animal disease constitutes a major constraint to development goals (Aluwang and Bello, 2010). Arthropod-borne haemoparasitic diseases, caused by *Trypanosoma*, *Babesia*, *Theileria*, and *Anplasma* occur throughout the world but are frequently of greatest importance in the tropics and subtropics where conditions are favourable to maintenance of the vector population (Kuttler and Kreier, 1986, Uilenberge, 1995, Matovu *et al*., 2020) especially tick-borne diseases. Anaplasmosis is bacterial vector-borne disease in domestic animal species (Ben Said *et al*., 2018). It is caused by the organism that belongs to *Anaplasma* genus (Rickettsiales: Anaplasmataceae) which is genetically diverse with six known species (Atif, 2016; Ben Said *et al*., 2018). Trypanosomes are unicellular protozoan that cause human and animal African trypanosomiasis (Hargrove *et al*., 2012) in Africa and South America (Kneeland *et al.,* 2012, WHO, 2013). The *Trypanosoma* genus comprises of various species of significant medical and veterinary importance (Grebaut *et al*., 2009). *Trypanosoma brucei gambiense* and *Trypanosoma brucei rhodesiense* infect human, causing Human African Trypanosomiasis (HAT) in Africa (WHO, 2013), while *Trypanosoma cruzi*; another form of human trypanosomiasis called chagas disease occur in Latin America (Maya *et al*., 2007). In animals, *T. brucei*, *T. congolense, T. vivax, T. evansi* and *T. simiae* cause animal African trypanosomiasis (AAT) in domestic and wild animals (Fajinmi *et al*., 2006). The tsetse vectors that cyclically transmit trypanosomosis are excluded from an area in the extreme north of Nigeria termed as tsetse free zone (TFZ).

Infection by one or more of these trypanosome species results in acute or chronic disease which is characterised by intermittent fever, emaciation, anaemia, loss of appetite, weakness, corneal opacity, occasional diarrhoea, parasitaemia, coma and death if not treated (Chaudhary and Iqbal, 2000). This disease usually leads to reduced reproduction and quality, low feed conversion ratio and possible death of animals, hence, affecting the farmer's overall profit (Fasanmi *et al.,* 2014).

Trypanosomiasis is transmitted via bites by different species of *Glossina* and mechanically, by biting flies (Oluwafemi *et al*., 2007). Transmission takes place mostly in rural areas where agricultural activities expose people to the bite of tsetse fly (Muturi *et al*., 2011; Okoh *et al*., 2012). The tsetse fly-transmitted trypanosomes; *Trypanosoma brucei, T. congolense* and *T. vivax* are limited to Africa where they have been responsible for barring livestock production from large areas of land, which are possibly capable of supporting cattle and other ruminants (Alfredo, 2004; Jay, 2008). Livestock productivity in sub Saharan Africa suffers from high prevalence of trypanosomiasis with projected annual loses due to the direct and indirect consequences of the disease running into billions of dollars with disproportionate adverse effect in rural areas (Fajinmi *et al*., 2006). It creates the utmost constraint to livestock and crop production thus directly influencing hunger, poverty, protein malnutrition and suffering to entire communities in Africa (PATTEC 2002). Animal trypanosomiasis therefore, is an important livestock disease in Africa and is considered as a threat to the on-going effort on poverty alleviation in the continent (Wint *et al*., 2010). Control of tick-borne disease and animal African trypanosomosis is regarded as private good and the farmer is expected to foot the bill for the treatment (Bardosh *et al*., 2013).

Studies on trypanosome infection rate and its impact on livestock production have revealed that they vary with sex, age, species of trypanosomes and the tsetse fly, locality, season and also depend largely on the level of interaction between tsetse flies, domestic and game animals (Mohammed-Ahmed, 1993, de Dekens, 2002, Ahmed, 2007, van de Bossche). Livestock are the background of socioeconomic system of most of the rural communities in Africa. This can be noted more clearly with those who are adopting the pastoral and semi-pastoral ways of living (El-Mentanawey *et al.* 2009). The economic impact imposed by the disease directly affects the milk and meat productivity of animals reduced birth rate and increased abortion as well as mortality rate. All of these affect the herd size and herd composition (Basaznew, *et al.,* 2012). These three farms under study, therefore represent the paradigm shift from the traditional longstanding extensive to semi-intensive livestock management system.

A spot check, intervention and follow up were conducted after reports of suspected outbreak of trypanosomosis and biting flies menace in three livestock farms in southern parts of Kano State. The aim of the study was to determine the cause and effect of environmental factors on tsetse and biting population dynamics. The first objective is to use clinical features and standard parasitological methods to detect trypanosomosis and any other haemoparasite infections of animals in the study herds. Secondly, to appraise how existing herd management system in operation could impact on the disease transmission and on their health status

MATERIALS AND METHOD

Study Area

The study was carried out at three private farms with Farm-1 and Farm-2 at Kiru Local Government Area (LGA) and Farm-3 at Bunkure LGA of Kano State, Nigeria. Bunkure LGA is located around latitudes 10°33' N to 12º03' N and longitudes 7º34' E to 8º32' E. Kiru LGA point location of Farm-1 and Farm-2 situate at coordinates Lat. 11˚25´N and 11˚39´270" and Long. 08˚1´ E and 008˚33´218"E. They have elevation of 609 and 543 meters above sea level, respectively. Kiru LGA has an area of 927km^2 and a population of 264,781 while Bunkure Local Government Area has an area of 487km^2 and population of 170,891 at the 2006 census (NPC, 2006).

Study Population and Herd Management

The three livestock breeding farms have 243 heads of cattle comprising female (n=233) and males (n=10). A few sheep were kept at the Kirun Farm-1 while sheep and goat were kept in Farm-2. Only cattle were kept in Farm-3 at Bunkure. Cows below one year (≤ 12 months) were considered as calves, and those over one year were regarded as adults. The animals were made up mostly of Sokoto Gudali, Azawak and few Friesian breeds. There were 25 Yankassa breed of sheep and rams, and 50 brown Sokoto goats. Pedigree of the animals showed they were purchased from Katsina State.

Entomological Sampling

Biconical traps were used in the pre-survey to assess the presence of tsetse and other biting flies within the farm and grazing areas. Five traps were mounted at three different locations for twenty four hours as follows; Huntu Dam area (n=2), Farm-1 in Kiru Local Government Area (LGA) (n=2), Farm-2 (n=2) and Farm-3 (n=1) at Zango Buhari in Bunkure LGA. Temperature and relative humidity of each trap point was recorded using whirling hygrometer and the coordinates were obtained using the Garmin 75 map handheld GPS. Flies caught were sorted and identified according to Desquesnes *et al*. (2005) manual for biting flies.

Animal Sampling and Diagnosis

A systematic biased (only animals with gross clinical signs of trypanosomiasis) were sampled. Blood samples were obtained from 70 cattle of different ages, sexes and breeds. Two milliliters of blood were taken from the jugular vein of each animal was put into specimen bottles containing ethylene diamine tetra acetic acid (EDTA) dispensed as one milligram powder per milliliter of blood. Blood samples were conveyed to the field laboratory for analysis inside a cold box containing ice pack. The samples were analyzed for trypanosomes using the buffy coat technique (Murray *et al,* 1977) after centrifugation capillary tubes containing blood samples in a haematocrit centrifuge. Both *Babesia* and *Anaplasma* were analyzed from thin blood smear immediately fixed in absolute methanol and stained with 10% Giemsa solution. The packed cell volume (PCV) values were measured as described by Marcotty *et al.* (2008).

Herd Treatment Intervention

One month after, the treatment of all cows in the 3 farms were undertaken using Topline® pour-on (Merial, France) for biting and suckling lice and tick ectoparasites, and Trypadim® (diminazene diaceturate) intra muscularly for trypanosomiasis and babesial infections in the herds. Treatments were administered using the bodyweight measuring tape to determine the dosage for each animal. The herds were followed up for six months to observe their gross clinical conditions. Cost of treatment consists of all expenses incurred in the diagnoses and treatment of only clinically affected cattle suffering from symptoms of the nagana disease (Okello *et al*., (2007). Of importance is the early institution and implementation of combined disease and vector intervention measures before high number of animals infected in the herds become seriously devastating.

RESULTS

The point location of Rahama and Zango Buhari cattle farms are on coordinates Lat. 11˚25´ N and 11˚39´270" Long. 08˚11´E and 008˚33´218", with an elevation of 609 and 543 meters above sea level, respectively. These geospatial coordinates were obtained using handheld GPS (Garmin 75 map). The farms fall within the Sudano sahel-savannah ecological zone (SSEZ) of the country

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with few sparsely distributed shrubs and stunted natural trees characterizing the vegetation type. The two LGAs are devoid of continuous vegetation cover, absence of rivers and streams, and no forest galleries suitable for tsetse fly breeding. The vegetation cover from satellite imagery and geospatial location of the study LGAs are shown on the map (Figure 1) as shown on the satellite imagery on Fig. 1 vide supra. More importantly, the area around the dams where many herds including those belonging to the livestock farms go for drinking water and grazing have very sparse stunted tree growth within adjacent surroundings.

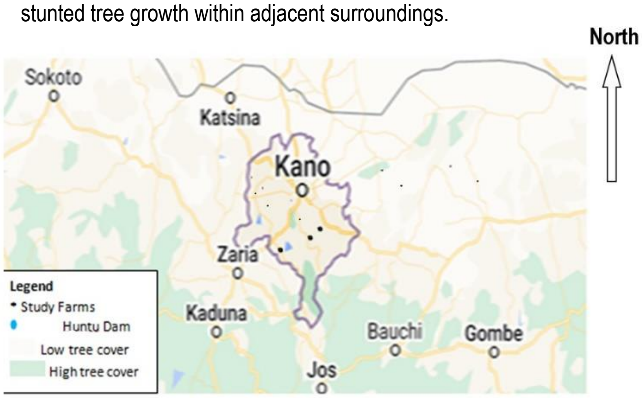

Figure 1: Satellite image of vegetation cover of northern Nigeria with insert map of Kano State showing study farms and dam sites.

Economic and ecological factors were identified to interplay in the health and well-ness of the livestock. There is a small earth dam at both local government areas that provide ready source of drinking water all-year round. The irrigation channels runs along the area where Farm 3 was located. Extensive crop farming in grains like maize, rice, sorghum or millet and onions, water melon, and sweet potatoes are cultivated by farmers. Over 65% of the land is cultivated during wet season, and in dry season farming was carried out along the irrigation area in Bunkure LGA.

Transhumant management was practiced; the Farm-1 in Kiru has three sown pasture paddocks, and animals were grazed within the ranch areas. The second farm has a large expanse of farm lands undergoing pasture development. In the Farm-3 locations, had natural bush outgrowth used for grazing with the movements of nomadic herds visible around the vicinity. The available fodder and natural forage areas at the farms were inadequate to meet the feed needs of the herds. Hence, animals were moved outside the ranch to other locations as far as 10km away for grazing to compensate for pasture shortfall particularly during the long period of dry season. During this critical period, the farms depend on supplementation with groundnut hay, maize and guinea corn offal to some extent. There was no evidence of supplementary feeding with commercial feed concentrate. The study area has huge output of fodder, straw and plant residues been a bastion of small scale agro processing and milling clusters that generate huge farm by-products. It was only in Farm-1 site there was evidence of salt lick been adequately provided.

The parasitological examination indicated that 2 out of the 30 samples analyzed from Farm-1 in Kiru LGA were positive with *Trypanosoma theileri* (a non-pathogenic trypanosome), 7 showed *Anaplasma marginale* and 5 had *Babesia bovis.* Of the 20 samples from Farm-2 had 3 (15%) cases of *A. marginale* and 2 (10%) of *B. bovis*. At Bunkure LGA only 3 (15%) of *A. marginale* was detected among 20 samples from Farm-3 (Table 1).

The overall mean and standard deviation (STDEV) from the study population mean PCV was 25±5.7% with a range of 16-41%. The lowest mean PCV of 21% was at Farm 1 (RIF), while the highest (41%) was at Farm 2. Corollaries to the Farm 1 with the lowest mean PCV had the highest tick infestation of 32% followed by Farm 2 with 24%. While the animals in Farm 1 provided with salt-lick had better body condition and no case of *Babesia* parasite was detected.

Table 1: Mean Packed Cell Volume and Prevalence of Haemoparasites

Parameters	**Number of Cases (%)***			
Study site	**Farm 1**	**Farm 2**	**Farm 3**	**Total**
Sample size	30 (27.8)	20 (31.7)	20 (27.4)	70 (28.8)
Mean PCV (%)	21±3.4	24±1.0	32±9.0	25±5.7
Haemoparasites				
Trypanosoma species	2 (6.7)	0	0	2 (2.86)
Anaplasma species	7 (23.3)	3 (15.0)	3 (15.0)	13 (18.57)
Babesia species	5 (16.7)	2 (10.0)	0	7 (10.0)
Overall haemoparasites	**14 (46.67)**	**5 (25.0)**	**3 (15)**	**22 (31.4)**

Percentage in parenthesis (%), pack cell volume, PCV

Entomological studies found total number of five biting flies consisting of four *Tabanus* and one *Hymenoptera* flies were caught with Biconical traps at Bunkure Farm 3 and at other locations (Table 2). Many *Tabanus taeniola* flies (n=10) and *Hymenoptera* spp. were caught around the operational areas of Farm 3 than the farm 2 at Kiru LGA. The mean temperature and relative humidity were 27.7°C and 79.2%, respectively. The geographic coordinate of each trap points are shown in Table 2. The presences of these biting flies were conspicuously visible in the 3 farm sites particularly within the animal housing facilities.

Table 2: Geographic Coordinates of Temperature, Elevation and Humidity of Trap Points

Trap Points	**Location**	**X Coord.**	**Y Coord.**	**Elevation (Metres)**	**Temp (°C)**	**RH (%)**
1.	Huntu Dam	11°27´224"	008°11´574"	617	25.5	87
2.	Huntu Dam	11°25´497"	008°11´092"	610	27.5	89
3.	Farm-1	11°25´510"	008°11´097"	609	28.5	81
4.	Farm-2	11°27´158"	008°11´497"	619	27	74
5.	Farm-3	11°39´270"	008°33´218"	543	30	65

Atmospheric relative humidity (RH) in percentage (%) and temperature, °C in degree Celsius, X and Y coordinates

Data on herd productivity and health status of animals prior to intervention control showed that the calving rates were n=108, 25/83 (30.12%), n=63, 13/50 (26.0% and n=71, 16/55 (29.1%) in Kiru, Farm 1 and 2 and Farm 3 at Bukunre, respectively. The condition of some of the animals had deteriorated with visible signs of weight lost, lacrimation, swollen lymph nodes and a case of onchocercal skin nodules in one cow at Kiru farm. Overall, moderate cases of dermatophilosis were 23 (9.54%) in the study

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population (n=241): with 2 (6.7%), 15 (75%) and 3 (15%) in farms 1-3, respectively. Five deaths (2.07%) mortality rate were reported to have occurred within a month in Farm 3 and the animal with the lowest mean PCV was at Farm 2.

Among the chemotherapeutic treatment intervention were given to the 22 (31.4%) cases of haemoparasites including 2 cases of trypanosomes suspected to be non-pathogenic, 13 (18.57%), anaplasmosis and 7 (10.0%) babesiosis. All the animals that appeared positive or have the symptoms of infection by haemoparasite were treated accordingly (Babesiosis with Trypadim® and Anaplasmosis with Tetracycline). Chlortetracycline also known as CTC can reduce the risk of anaplasmosis, and a consistent intake of the correct amount of mineral is crucial to anaplasmosis prevention programme.

A benefit-cost analysis of treatment intervention based on gross physical examination of the animals for up to six months post-treatment with therapeutic and prophylactic drugs and insecticide application. There was remarkable improvement in animal health and no death was recorded among the herds within the period. Cost benefit ratio (CBR) of the intervention control (IC) included the cost of drugs, diagnostics materials, insecticides applied, personnel allowances, logistics are shown in a breakdown below (Table 3). It was compared with the avoidable projected number of animals' loss (AL) or dead (n=5) due to the diseases, the 20 animals infected with haemoparasites and the total animals in the 3 herds (n=241) using prevailing market price. These represented the minimum, medium and maximum projected impact and benefits. Other financial rates of return (FRR) benefits included more calves due to low calf mortality and increased milk and meat production were not calculated.

Table 3: The breakdown of cost of controlling haematophagous flies and haemoparasites

Item	Quantity	Unit Price (₦)	Amount (₦)
Trypadim®	2 packs	11,000.00	22,000.00
Topline® pour	10 jars	17,000/1ltr Jar	170,000.00
Diagnosis	71 samples	1000	71,000.00
Per diem	2 days/5 staff		134,000.00
Total			**397,000.00**

The window price estimated values of the animals; adults and calves was N50, 950,000.00 those of the 3 farms are shown on Table 3. The cost of 5 dead animal was N1.25 million and those sampled and treated (n=71) were N5.0 million. The distribution of the cost intervention among the farms is shown on Table 3. The overall cost of intervention was N397,000.00 which translated to the BCRs of 3.2 and 20 and 243 or ratio 6:1, 24:1 and 230:1 one year post intervention. The value of milk was discounted to zero because the farms only breed for meat.

Table 4: The distribution of intervention benefit cost ratio per farm

Herd size (n)	Herd size (n)		Cost of animals (000'₦)		Revenue (000'₦)	Sample (000'₦)	Drug Tx per animal @₦310.0	Insecticide spray per animal @ ₦699.6	Cost of intervention per animal @₦5591.55	BCR of Intervention
Farm	Adult	Calves	Adult	Calves	Sub-total					
RIF1(108)	83	25	20,750	2,000	22,750	30 (N7,500)	9,300.00	72,058.8	167,746.5	44.5
RIF2 (63)	50	13	12,500	1,040	13,540	20 (N5,000)	6,200.00	44,074.8	111,831.0	44.7
Farm3 (70)	54	16	13,500	1,200	13,700	21 (N5,250)	6,510.00	48,972	117,422.5	55.4
Total (241)	187	54	46,750	4,240	50,950	71 (N17,750)	22,010.00	168,603.8	397,000.0	42.9
Average (80)	62	18	15,583	1,440	17,023	24 (N6,000)	7,440.00	59,968	134,197.2	44.7

It is evident from the figures above that the benefit of the treatment intervention outweighed the cost because BCR of each farm was far less than the cost of avoidable death of cattle that was averted, since there was no death recorded six (6) months and one year after the intervention. In addition, the farms reported remarkable improvement in the body conditions of the animals.

DISCUSSION

Various factors like climate, vegetation, availability of host animals to feed upon, soil for breeding among others play key role in the distribution and density of tsetse fly population. The vegetation of the farm sites are such that would not support the existence of tsetse flies as over 60 of the areas are largely under crop farming, with only few shrubs and trees that are sparsely distributed or distant apart. The study area comprising Kiru and Bunkure LGAs lies between 8° 11' and 11°39' is outside the 15° limit of the northern fringes designated as tsetse free zone (Onyia, 1983; 1995). Vegetation of the study location runs contrary to observation by Yelwa *et al*. (2020) that the pockets of probable habitats of tsetse flies mostly located around forest islands characterized by dry woodland and savannah, and in some cases around gallery forests and few lowland and riverine areas. Besides, the soils are mashed with pockets of floods; this is particularly unsuitable for tsetse fly breeding. However, other biting flies like *Tabanus* and *Hymenoptera* that were thriving in the Zango Buhari area may facilitate mechanical transmission of parasites. These flies have been implicated in disease transmission especially African trypanosomiasis even in areas outside the tsetse belt (Selmi *et al*., 2019). The reported cases of *Trypanosoma* spp., *Anaplasma* spp. and *Babesia* spp. in camels', blood and also among sheep and horses in Tunisia is recent case in point.

This study has shown that trypanosomiasis is not endemic in the 3 farms, even though 2 samples were positive with *Trypanosoma theileri*, which is commonly regarded as a non-pathogenic trypanosome parasite transmitted primarily by Tabanid fly. However, the prevalence of anaplasmosis (18.6%) and babesiosis (10%) are significantly high considering the number of animals sampled. It is not surprising that tick-borne diseases (anaplasmosis and babesiosis) are endemic in 2 of the farms because the tick vector was detected in all the herds examined (Uilenberg, 1995, Jongejan and Uilenberge, 2004). These 2 major haemoparasites (*Anaplasma* and *Babesia*) may have caused gross emaciation observed in cattle because they are known to attack erythrocytes (red cells) component of the blood (Jing *et al.,* 2009), which can as well be the main reason for the low PCV observed in the herds. The highest PCV of 41% was recorded at Bunkure, Farm-3 while the lowest 16% was at RIF.

Observed direct BCR of 3.15 derived from the intervention control assessed based on the death of animals (n=5) averted worth N1,250,000 over the N397,000 expended had to a large extent impressed the farmers. In addition to other impact of the intervention control were the increased calving rate, kilograms of bodyweight gained and milk quantity and quality produced. From the outcome of this study, the intervention control aligned with the suggestion that farmers will benefit if they invest in control and treatment of the disease (Salifu *et al*., 2010). The livestock farmers had recognized the challenge and the threat tsetse and other biting flies pose to cattle health and productivity may likely be responsible for loss of cattle earlier recorded.

Taking the economic outlay of the three farms and totality of its value of livestock on Table 4 into consideration, it is seemingly clear that the intervention was highly cost effective. The BCR based on the numbers of animals effectively protected from death and loss of body condition due to the diseases, etc. The control strategy has translated to outstanding net benefits and FRR and had allowed the farmers generate a good return on investment (RoI) above the assumed opportunity cost of capital (Salifu *et al*., 2010). A further increase in the cost of the intervention even by 100% will not lead to increasing production cost up to 10% acceptable margin. On the contrary, Meyer *et al*. (2018) suggested that an increase in intervention costs (by 25%, 50% and 75% of RAP, respectively) could lead to a reduction in the technical intervention efficiency (final AAT incidence of 10%) leading to price reduction of commodities. Therefore, with more investment in additional control inputs should be continued to the point where the incremental investment is yielding positive net benefit given BCR greater than one.

This study has further demonstrated that prompt therapeutic and insecticide treatment interventions were viable and had a positive impact on the overall health and productivity of cattle at the farms. These will translate to a significant increase in earnings/income derivable from animal sales in quality and quantity of meat and milk products. It will be more cost saving to combine the insecticidal control of vectors (biting flies) and ectoparasites with the treatment control of haemoparasites using trypanocides and cyclotetracycline along with regular screening of haemoparasites on a sustainable basis.

Conclusions and Recommendations

Following the control strategy instituted using impregnated screens and targets had helped to curb the biting menace of these flies within farm operational areas. It is of utmost expedient to forestall the potential exposure of the herds to mechanical transmissible *Trypanosoma* species and possibly other haemoparasites that can be contracted from nomadic and or transhumant infected livestock. Also treatment of the animals against tick infestation and the control of ticks were accorded priority consideration to help boost the wellbeing of the animals. The infestation of the herd by ecto-parasites should be controlled by using the appropriate acaricide (Topline pour-on or Amitix spray were administered) to stop further transmission of the two major haemoparasites detected in the herds.

The farm managers were advised on how to spray the animals with commercially available synthetic pyrethroid insecticides, which should be done consistently on a fortnightly basis to ensure tick re-infestation doesn't occur. To regularly carry out routine screening of the herds for haemoparasites and control of both vectors and parasites. The procurement of veterinary drugs, acaricides and insecticides from reputable sources so as to avoid buying fake and or adulterated products was canvassed. The managements were advised to ensure judicious application of veterinary drugs be applied by competent personnel. We advocated for insecticide treated net used to screen round one of the animal housing facility should be extended to the other two farms.

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