An assessment of tick-borne diseases constraints to livestock production in a smallholder livestock production system in Machakos District, Kenya

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Abstract

The principle objective of the study was to determine the tick- borne diseases constraints to livestock production in Machakos District. The survey was carried out in eight randomly selected sub- locations spread across the district. Two hundred farmers were recruited into the study. All cattle from the selected farms were bled to determine the prevalence of tick- borne diseases. Clinical examination of sick animals was carried out during the survey. Questionnaires with questions designed to identify and rank various tick- borne disease production constraints, occurrence of tick- borne diseases, mortality and disease control strategies were administered. A total of 634 zebu and 15 cross- breed (Friesian-zebu crosses) cattle were sampled on the 200 farms for blood parasite infections (serology and direct parasite detection) and tick infestation.

From the farmers' perceptive, East Coast fever (ECF) and anaplasma were ranked as the main tick -borne diseases prevalent in the district. Although babesia was not ranked as one of the main tick-borne diseases in the district by the farmers, serological analysis did indicate a high prevalence of the disease. Tick challenge was high in seven of the eight sub-locations where the survey was carried out. The most common tick species were *Rhipicephalus appendiculatus, Amblyomma variegatum, Rhipicephalus evertsi, Rhipicephalus pulchellus* and *Boophilus decoloratus.*

Veterinary services in the district are inadequate with up to 92 % of the farmers in one of the sub-locations treating their sick animals without the assistance of qualified veterinary personnel.

Key words: anaplasma, animal production constraints, babesia, disease ranking, East Coast fever, prevalence, serological analysis, sub-location

Introduction

The major tick- borne diseases (TBDs) of cattle in Kenya as evaluated by the economic impact they exert on the farming communities where they occur include theileriosis, anaplasmosis, babesiosis and heartwater.

East Coast fever (ECF) is the most important tick-borne disease of cattle in Eastern, Central and Southern Africa (Young et al 1989, Norval at al 1992). It is caused by *Theleria parva* which is transmitted by the brown ear tick *Rhipicephalus appendiculatus*. Other less-important tick-borne diseases in cattle include benign theileriosis caused by *Theileria mutans*, babesiosis caused by *Babesia bigemina*, anaplasma caused by *Anaplasma marginale* and cowdriosis caused by *Erlichia ruminantium.* ECF is prevalent in large areas of East and Central Africa where it causes major economic losses through morbidity and mortality (Perry and Young 1995). The disease is an important constraint to the improvement of the livestock industry in large areas of East, Central and Southern Africa (Norval et al 1992).

Cowdriosis or heartwater is caused by rickettsial *Erlichia ruminantium* and transmitted by ticks of the genus *Amblyomma.* Heartwater is a disease of cattle, sheep, goats and wild ruminants. The disease is endemic in sub-Sahara Africa and is a major obstacle to upgrading local breeds of livestock using more productive susceptible exotic breeds (Uilenberg and Camus 1993).The disease is known to be endemic in various parts of Kenya (Ngumi et al 1997), though there is little information on the epidemiology of the disease in country.

Anaplasma marginale and *Anaplasma centrale* are the most important anaplasma parasites of cattle in Kenya (Ristic 1968). Although *Boophilus decoloratus* ticks are incriminated as the main vectors for anaplasmosis, mechanical transmission through repeated use of hypodermic needles as in vaccination campaigns is common (Maloo 1993).

Babesiosis is caused by babesia parasites which are intra-erythrocytic protozoa with world wide distribution. The main species of babesia that infect cattle in Kenya is *Babesia bigemina*. The main tick vector for *Babesia bigemina* is *Boophilus decoloratus.*

Relatively few studies on animal health and production have been carried out in Machakos district which has a significant livestock population of 783,400 of cattle and small ruminants (Mukhebi 1985; Kinuthia 2001). The only documented study on constraints to livestock productivity in the district, was a cross sectional survey undertaken by Mukhebi (1985). However, the study was very limited in scope and the data collected was largely qualitative based on a questionnaire.

The study was undertaken as a component of a broader study that was carried from mid 2007 to early 2009 to identify constraints to livestock production in the district and ultimately recommend appropriate interventions for the constraints (Wesonga in press).

The farmers in the district traditionally practice mixed farming, rearing predominantly local breeds of cattle and small ruminants. However, due to the proximity of the district to major urban centers such as Nairobi and Machakos, there is potential of replacing the indigenous breeds with improved breeds of livestock as means of improving livestock production. Already a number of farmers particularly in Kangundo division of the district are keeping improved breeds of dairy cattle such as Friesians. The transition from rearing of indigenous to improved breeds of livestock is expected to result into an upsurge of tick borne- diseases since the improved livestock breeds are more susceptible to ticks and tick-borne diseases. The results of the survey will provide information on the risk of tick- borne diseases in the district particularly to exotic breeds of livestock. This in turn will be the basis for formulating appropriate control strategies for the tick-borne diseases in the district.

The study is the first of its kind to undertake a survey to determine the seroprevalence of tick-borne diseases in the district.

Materials and methods

Study site

The study was conducted in Machakos District, one of the districts in the eastern province of Kenya. It lies between latitudes 0.45’S and1.31’S and longitudes 36.45’E and 37.45’E and has a total area of 6,850 km^2. The location of the district is shown in Figure 1.

Figure 1. Map of Machakos district showing, the administrative divisions

The average annual rainfall in the district ranges from 500-1,300 mm.The mean temperature range is 18-25^{0}C. The district consists of small hills and plateaus varying in altitude from 1,800 to 2,100 metres above sea level.

Study population

The study population consisted of smallholder farms keeping both cattle and small ruminants. Zebu cattle and the small East African goat are the predominant domestic animal species raised in the district. Based on the information obtained from the local veterinary department office, questionnaires administered to the farmers, chiefs and assistant chiefs, there is an estimated population of 7,700, 6,100 and 3,300 cattle, goats and sheep respectively.

The farming system in the district is described as Dual Purpose Cattle Small Scale (DPCASS)/ Sheep and Goats Small Scale (SGSS) (Peeler and Omore 1997). The grazing system is predominantly traditional free grazing (Kinuthia 2001) but a few farmers practice zero grazing.

Cross sectional survey

Selection of farmers for the cross sectional study

A stratified random sampling method was used to select the study farms. Two levels of stratification were applied. First, four administrative divisions were randomly selected from a total of twelve. All sub locations in each division were listed. Then two sub-locations per division were selected using a random-number table.

At the second level, in each of the eight selected sub locations, a list of all livestock farmers was compiled with the assistance of the chiefs and the assistant chiefs. Using a random number table, twenty five farmers were selected from each sub-location. A total of 200 farms were selected for the study (Table 1).

Table 1. Summary of the farms selected for the cross- sectional surveys and the number of animals sampled

Selected Sub-location	Administrative division	Total number of farms in the division	Number of farms selected for the study	Number of cattle sampled
Kiatineni	Ndithini	107	25	104
Milani	Ndithini	101	25	72
Kalandini	Matungulu	375	25	52
Katine	Matungulu	200	25	66
Ndunduni	Kangundo	211	25	94
Kathome	Kangundo	333	25	105
Katani	Athi River	34	25	101
Ngelani	Athi River	39	25	97
Total		1,400	200	691

On selection of the study farms, the farmers were notified of the intended survey in writing. Each farm was then visited and the study objectives were explained to the farmers. The protocol, objectives and aims of the study were also discussed with veterinary personnel within the study area. The local chiefs and assistant chiefs were also informed.

Data collection

A study team comprising of one veterinarian, a livestock technologist, the local Animal Health Assistant (AHA) or livestock officer, two enumerators and animal attendants who were experienced in sampling were constituted. The technologist performed the initial processing of biological samples (blood and lymph node biopsies) within six hours of collection before they were dispatched to the lab.

Every study farm was then visited once within the study period. During the visit, questionnaires were administered and blood samples collected from cattle, sheep and goats on the farm.

Although blood samples were collected from all the three livestock species, the serological screening of blood samples for tick-borne diseases was only undertaken for samples collected from cattle. Blood samples from goats and sheep were not screened due to problems with the standardization of the ELISA kits used in the screening of Cowdria (*Erlichia ruminantium,*), the main tick-borne disease of small ruminants in Eastern Africa (Dolan 1991) at the Veterinary Research Centre (VRC), Muguga. The serum obtained from sheep and goats will be screened at a later date once the problem with the kits is resolved.

The questionnaire

Farm level data was collected using a standard questionnaire. The questionnaires were administered to the head of the household or the person normally in charge of livestock.

The questionnaire were administered in Kiswahili or translated into in the local Kikamba where respondents had limited knowledge of Kiswahili. To maintain consistence, most of the questionnaires were designed in a closed format except for the introductory section. In cases where the set of expected responses was deemed not exhaustive, an option for “others: please specify” was provided. However, when a numerical response was expected, open –ended questions were used. Further verification of the responses was done by inspection of the farm especially where physical quantification of the farm variables was the sought response.

The questions were designed to identify and rank various livestock production constraints and the disease control strategies. Additional data was sought on household information and demographics, grazing management, delivery of animal health services, occurrence of diseases in (cattle, sheep and goats) and mortality (Table 2).

Table 2. Summary of the layout of farm questionnaire used in the cross-sectional study showing the division into sections and subsections with the information sought in each

Part	Section	Subject Covered in Questionnaire
1	A	Introduction: location of farm, farmer’s details
	B	Farming enterprise characteristic
	C	Livestock management
	D	House hold information

2	A	Livestock numbers and structure at the time of the visit
	B	Retrospective data on animal health
	C	Constraints to production
	D	Occurrence of disease and mortality
	E	Control Practices of ticks and TBDs
	G	Delivery of animal health services.

Although some of the farmers were literate and could provide English names of the main livestock diseases on their farms, the majority of the farmers were semi-literate. However, 173 of the selected farmers had 6 to 10 years experience of keeping livestock while the rest (27) had 1 to 5 years experience. Thus the majority of the farmers were very familiar with the common livestock diseases on their farms. During the administration of questionnaires, the farmers listed the diseases in the local Kikamba names. The names were then translated into English with the help of either the local AHA.or veterinarian who were fluent in the local Kikamba language. A compressing probing of the farmers on the symptoms, time of the year when disease is common and animal species or breeds affected by the diseases listed in Kikamba was undertaken before the final translation into the English names was undertaken. Local veterinary personnel at location or district level were present throughout the interviews to assist in the verification of disease translation and occurrence of the diseases mentioned in the locality. Details of the Kikamba names and their translation into English are indicated in Table 3.

Table 3. Disease translation

Disease	**Local Name**	**Direct translation**	**Interpretation**
Anaplasmosis	Kithatia/ Nthiana	*Kithatia* refers to hardened feaces often observed in the animals with anaplasmosis. *Nthiana* is generally used to refer to the disease by the community	Though this is not a pathognomic sign of the disease (hardened faeces), the field veterinary personnel who attended the interviews confirmed that in most instances cattle reported to have this as one of the key symptoms were often positive for anaplasmosis.
Anthrax	Ndulu	Something that kills very fast associated with oozing of blood from body orifices.	Translated directly to mean anthrax.
Black quarter	Ikene	A swelling	Swelling associated with disease areas such as upper parts of affected limbs, brisket and psoas muscle. Rapid onset and high mortality reported by the farmers.
Brucellosis	Kuvuna	Abortion	Abortion, a symptom associated with the disease in late pregnancy. Infertility was reported to follow the abortion. Local veterinarians verified that sporadic cases do occur.
ECF	Ngai	Lymph node	Term used in central Kenya and parts of eastern Kenya to refer to enlarged lymph nodes, one of the key signs of ECF. Normally the term directly refers to ECF.
Eye worm	Kiinyu Kya Yiitho	Worm of the eye	The term refers to infection of the eye whereby the farmers described a worm like organism in the eye.
Foot and Mouth	Muthingithu /	*Muthingithu* means	The wobbling or unsteady gait is as result of the

Disease	Kuvu	wobbling movement/unsteady gait. *Kuvu* means rot between toes	lameness caused by the vesicles on feet (in the cleft) and painful swelling of the coronet. Farmers were also able to describe other symptoms such lesions in the mouth and abundant salivation. Outbreaks invariably confirmed by vet department whenever disease outbreak is suspected. Disease known for the quarantine measures put in place following confirmation
Heartwater	Muthyuuku	Move in circles (circling)	Name associated with circling; one of the main symptoms of heartwater. Circumstantial evidence provided by description of excess "water" in the thorax and in a sac around the heart (Hydrothorax / hydropericardium)
Lumpy Skin Disease (LSD)	Nthunthua wa Kikonde	Skin or hide lumps	Multiple nodules on the skin, one of the key symptoms of LSD. Rapid spread described as a feature of the disease.
Mastitis	Uwau wa Mikami or Uwau wa nondo	Disease of udder or teats	Inflammation of the mammary gland irrespective of the cause.
Mites	Mbanguule		Translated directly to mean mites.
Pneumonia	Mavui	Lungs	Disease affecting lungs. Reported to be associated with difficulty in breathing, coughing and most common during the cold months. Occurrence confirmed by local vet personnel
Rabies	Mung'ethya	Open mouth in readiness to bite or snarl	A symptom of rabies whereby infected animal bite objects. Farmers reported other key symptoms like aggressiveness. Disease is known to be endemic in the district.
Trypanosomiasis	Uwau wa matungua (or Kisiko)	Disease caused by tsetse flies	Disease transmitted by tsetse flies.
Worms	Minyoo	Swahili word for helminths	Universally used word referring to helminth infection in livestock

The questionnaires were pre- tested on ten farms. This was part of the refresher training of the technician who assisted in the administration of the questionnaires. The field veterinarians were also present to give their opinion and suggestions after which a consensus on questionnaire administration style was agreed upon. All necessary corrections to the questionnaire were made at this stage.

Diseases as constraints to livestock production were ranked using the pair ranking technique. The technique involved farmers listing the key diseases that limit livestock production in their respective sublocations. The list of the diseases was then entered into the first row of a table. Using the same sequence in which the diseases were listed in the first row, the list of the diseases was entered into the first column of the table. Diseases were then compared in pairs across the table from the left to the right side of the table. For every comparison between two diseases, the disease that was perceived to be of more importance in terms of economic losses resulting from mortality, quarantine measures or cost of treatment was entered into the table. The diseases were then ranked based on the frequency with which they appeared in the table.

Participants from neighbouring sub-locations undertook the ranking jointly. Using the results from the farmers' ranking of diseases, each disease ranking was given scores as follows.

1st Disease = 6 points
2nd Disease = 5 points
3rd Disease = 4 points
4th Disease = 3 points
5th Disease = 2 points
6th Disease = 1 point.

Only the first six diseases were ranked (Table 4).

Table 4. Disease constraint identification and ranking as perceived by farmers in the seven sub-locations

Disease	Ranking by farmer groups in the eight sub-locations				
	Kiatineni/Milani	Kalandini /Katine	Kathome/ Ndunduni	Katani/Ngelani	Overall score
Pneumonia	1	3	1	1	22
Anaplasma	6	6	5	3	7
ECF	2	1	3	2	20
Mastitis	8		4	9	3
Heartwater	7	7		8	0
Helminths	5		6		3
Rabies	4			5	3
Trypanosomiasis	3	4			7
Lumpy Skin Disease		5		6	3
Mange				4	3
Eye worm				11	0
Black Quarter		2			5
FMD		9		7	0
Brucellosis				10	0
Anthrax			2		5

Selection and sampling of animals

All animals on the selected farms were recruited into the study. A total of 634 zebu and 15 cross-breed (Friesian-zebu crosses) cattle were sampled. Each animal was ear- tagged and given a number containing an area, farm number and individual animal number codes. The following parameters were recorded for each animal; age category (whether calf, yearling or adult), sex, breed, live weight (estimated by heart girth measurements using weigh band, tick infestation and any disease manifestation at the time of sampling.

ELISA Test for Tick Borne-Diseases (TBDs)

All animals present on the farms recruited for the study were bled for serum. The animals were bled from the jugular vein into vacutainer tubes (10 ml without anticoagulant; Becton Dickinson). Each sample was labeled with the individual animal code and kept at room temperature. Every effort was made to transport the samples (on ice) to the VRC laboratories at Muguga within 48 hours. The samples were separated and stored at -20 ^{0}C. The serum samples from cattle were screened for TBDs using the ELISA for ECF, anaplasma and babesiosis. Samples were not screened for Cowdria (*Erlichia ruminantium*) due to problems with the standardization of the ELISA kits used in the screening *Erlichia ruminantium* at VRC, Muguga.

The ELISA tests for ECF, anaplasma and babesiosis were carried out as described by and Nielsen et al (1996) and Katende et al (1998). Briefly the specific antigens (the polymorphic immunodominant antigen for *Theileria parva*, p32 kilo Dalton antigen for *Anaplasma marginale* and p200 kilo Dalton antigen for *Babesia bigemina*) was used to coat Starwell polysorp micro-ELISA plates (Polysorp, Nunc, Denmark). Casein 0.25% was used as the blocking agent. The test sera was diluted 1: 200 for *Theileria parva* and 1: 100 for both *Babesia bigemina* and *Anaplasma marginale* in Dulbeco's phosphate buffered saline (DPBS) (pH 7.4), containing 0.1% Tween 20 and 5% skimmed milk. The presence of antibodies to specific parasites antigens was tested by addition of test sera into wells in two replicates. The plates were incubated for 25 min at 25^{0}C to allow antibodies to bind to specific antigens

and unbound antigens washed off using DPBS. To ensure that the antigen –antibody reaction had taken place, anti-bovine IgG or IgM monoclonal antibodies conjugated to Horse-Radish Peroxidase (HRP) was added. The reaction was visualised by addition of 1% hydrogen peroxide as substrate and 40nM 2, 2'-amino-bis (3-ethylbenz-thiazoleline-6-sulphuric acid), diammonium salt (ABTS) as chromogen in sodium citrate buffer pH 4.0. The plates were then incubated in the dark for one hour for colour development.

The intensity of the colour developed (optical density; OD) was determined using an ELISA reader. Using the OD reading from highly positive reference sera (C++) included in the ELISA, the percentage positivity (PP) of the test sera was then computed. For *Theileria parva*, a sample was considered positive if the percent positivity value was 20 or above; for *Babesia bigemina* and *Anaplasma marginale*, the cut- off PP value was 15.

Tick infestation

Due to the amount of data that was collected from each farm both for this study and the broader study, it was not possible to undertake tick counts on each and every animal recruited into the study. Using a technique designed by Muraguri (1996), tick challenge was assessed by observing tick infestation on at least ten randomly selected cattle, sheep or goats in each sub-location. Tick challenge was categorised as follows:

High= Ticks found on most animals sampled (for ticks) at the time of the visit.
Medium= Ticks found on some animals at the time of the visit.
Low= Ticks of any species rarely found.
None= No ticks of any species seen.

Tick samples on the animals were taken to theVRC at Muguga for identification up to species level.

Tick control methods and tick- borne disease management

Using a questionnaire farmers, on all the recruited farms were asked to provide information on occurrence of tick- borne diseases and mortality on their farms. The farmers were asked to describe the symptoms of suspected tick-borne diseases as a way of verifying the information provided. Additional data was sought on delivery of animal health services, tick control and grazing management.

Lymph node and blood smears were made from any animal found to have a body temperature of more than 39.5^0C during the course of the study. Smears were made for examination for TBD parasites (schizonts for *Theileria parva* or piroplasms for anaplasma and babesia). The smears were fixed in methanol and stained with Giemsa on site but were examined for haemoparasites at VRC-Muguga.

However, animals suspected to be infected with any of the TBDs were treated immediately free of charge as an incentive to the farmers.

Tick control practices were categorized as follows.

Regular= acaricide (dip, spray or pour- on) applied according to manufacturers' instructions at 1-2 weeks interval.
Irregular= acaricide (dip, spray or pour- on) applied according to manufacturers' instructions at times of high tick challenge.
None= no tick control measures used.

Statistical analysis

Comparison of the sero-prevalence between sites was done using the Chi-square (χ^2) test. A probability value of less than 5% was used to denote a significant difference.

Results

Of the two hundred farmers initially recruited for the study, only one declined to take part in the study, demonstrating a high level of enthusiasm for the study by farmers. However, the farmer was immediately replaced from the list provided by the chiefs.

Ranking of disease constraints to livestock production

Pneumonia, ECF, anaplasma, trypanosomiasis, blackquarter and anthrax were ranked by farmers as the most important disease constraints to the rearing of cattle in the district with respective scores of 22, 20, 7,7, 5 and 5 respectively (Table 3). From the ranking, ECF and anaplasma were perceived by the farmers to be the most important tick-borne diseases of cattle in the district. Though heartwater was listed, it was not ranked as it was not among the first six disease constraints in any of the sub-locations.

Prevalence of tick borne- diseases

A total of 649, 547 and 563 serum samples were screened for *Theleria parva*, anaplasma and babesia respectively. From the results of the serological analysis *Theleria parva*, anaplasma and babesia are prevalent in the district with prevalences of 66%, 50% and 38 % respectively (Table 5).

Table 5. Prevalence of antibodies against *Theileria parva* (ECF), anaplasma and babesia

Disease sublocation	ECF			Anaplasma			Babesia		
	Total No. of samples	Total No. Positive	% Positive	Total No. of samples	Total No. Positive	% Positive	Total No of samples	Total No. Positive	% Positive
Kiatineni	85	51	60	85	48	56	85	33	39
Milani	67	30	45	57	57	85	36	10	28
Kalandini	57	47	82	63	28	44	72	38	53
Katine	70	36	51	48	14	29	86	34	40
Ndunduni	96	54	56	88	22	25	105	26	25
Kathome	104	57	55	73	17	23	40	13	33
Katani	88	75	88	67	40	43	68	31	46
Ngelani	82	78	95	66	47	71	71	30	42
Total	649	428	66	547	273	50	563	215	38

Overall, the prevalence of ECF was significantly higher than that of babesia and anaplasma ($p < 0.05$). However, overall there was no significant difference between the prevalences of anaplasma and babesia in district.

At sub-location level, the prevalence rate for *Theileria parva* ranged from 45 % to 95% (Table 5).The sero prevalence of *Theileria parva* in Ngelani and Katani were significantly higher ($p < 0.05$) than in the other sub-locations. There was no significant difference ($p > 0.05$) in the sero prevalence of *Theileria parva* between the two sub-locations.

The sero prevalence of anaplasma ranged from 23% to 71% and was significantly higher in Ngelani and Milani ($p<0.05$) than in all other sub-locations (Table 6). However, there was no significant difference ($p<0.05$) in the prevalence of the disease between the two sub-locations.

Table 6. Disease diagnosed during the course of the survey

Sub-location	No of sick animals	TBDs	Other Diseases
Kiatineni	2	ECF (1 case)	Bacterial infection (1 case)
Milani	9	0	Trypanosomiasis (5 cases) Bacterial infection (4 cases)
Athi River	1	0	Bacterial infection (1 case)
Ngelani	2	0	Bacterial infection (2 cases)

The sero prevalence for babesia ranged from 25% to 53% and was highest in Kalandini (Table 5) where also *Boophilus decoloratu*s, the tick vector, was found to be very common on cattle.

Ndunduni where most of the farmers practice zero grazing had significantly lower prevalences ($p<0.05$) for all the three tick-borne diseases than most of the other sub-locations (Tables 5).

Tick and tick-borne disease control practices in the district

The tick challenge was high in all sub-locations except in Ndunduni where most of the farmers who participated in the study practice zero-grazing. *Rhipicephalus appendiculatus* was the commonest tick species found on cattle, sheep and goats in all the sub-location (Table 7).

Table 7. Summary of tick challenge on farms in the eight sub-locations

Sub location	No. of animals sampled			No. of animals with ticks			Tick challenge	Prevalent tick species
	Cattle	Goats	Sheep	Cattle	Goats	Sheep		
Kiatineni	26	4	0	22	0	0	High	*Rhipicephalus appendiculatus Amblyomma variegatum, Boophilus decoloratus*
Milani	19	5	4	16	3	3	High	*Rhipicephalus appendiculatus, Amblyomma.variegatum, Rhipicephalus evertsi Boophilus decoloratus*
Kalandini	22	5	3	15	5	2	High	*Rhipicephalus appendiculatus Amblyomma variegatum, Boophilus decoloratus*
Katine	11	4	8	9	0	7	High	*Rhipicephalus appendiculatus. Boophilus decoloratus*
Ndunduni	14	3	2	2	1	0	Low	*Rhipicephalus appendiculatus Rhipicephalus evertsi*
Kathome	17	4	0	15	4	0	High	*Rhipicephalus appendiculatus Boophilus decoloratus*
Katani	16	8	5	15	4	2	High	*Rhipicephalus appendiculatus, A.variegatum, Rhipicephalus evertsi Boophilus decoloratus/ Rhipicephalus .pulchellus*
Ngelani	30	3	8	30	3	8	High	*Rhipicephalus appendiculatus, Boophilus decoloratus / Rhipicephalus pulchellus*

The other common tick species were *Rhipicephalus evertsi, Boophilus decoloratus, Rhipicephalus.evertsi, Rhipicephalus pulchellus and Amblyomma variegatum.*

During the survey, 14 cattle were clinically sick with elevated temperatures of greater than 39.5^{o}C. Five of the animals were found to be infected with *Trypanosoma vivax,* one animal was infected with ECF while the other 8 animals were infected with what was suspected to be bacterial infections. The bacterial infections were confirmed on basis of response to antibiotic treatment. Response to the treatment was confirmed by the farmers, three to four days after the treatment (Table 5).

Most of the farmers (64% to 84%) stated that they practiced tick control regularly (Table 8) though this was not consistent with the high tick challenge (Table 6 7) observed and the high sero- prevalence of the tick-borne diseases.

Table 8. Summary of tick control practices on farms in the eight sub-locations

Sub-location	Regular	Irregular	No tick control
Kiatineni	84%	4%	12%
Milani	68%	32%	0
Kalandini	76%	12%	12%
Katine	64%	6%	20%
Ndunduni	76%	8%	16%
Kathome	72%	20%	8%
Katani	80%	12%	8%
Ngelani	80%	4 %	16%

Animal health delivery was generally inadequate (Table 9).

Table 9. Animal Health Delivery

Sub-location	Type of personnel that undertakes treatments when animals are sick					
	Family member	Animal Health Assistant	Private Vet	Government Vet	Livestock officer	Witch doctor
Kiatineni	4%	84%	8%	4%	0%	0%
Milani	48%	44%	8%	0%	0%	0%
Kalandini	8%	56%	4%	20%	12%	0%
Katine	8%	24%	0%	8%	60%	0%
Ndunduni	0%	56%	16%	28%	0%	0%
Kathome	0%	28%	44%	28%	0%	0%
Katani	64%	28%	0%	8%	0%	0%
Ngelani	92%	0%	0%	0%	4%	4%

In all sub-locations very few farmers had access to qualified veterinarians and largely relied on para veterinary personnel or family members to treat sick animals. In one instance, a farmer indicated that he relied on services of a witch doctor to treat his animals.

Conclusions and discussion

The high enthusiasm by the farmers in the district was evident from the fact that only one farmer declined to take part in survey. This was explained by the fact that farmers in the district hardly get any veterinary services from either the government or private veterinary practitioners. This provided the opportunity for the farmers to present animal health problems they have to deal without any professional charges.

The use of qualitative means (questionnaires and ranking) to identify disease constraints to livestock production was useful in providing an insight into the most important diseases in the district from the farmers' perceptive. The farmers were able to accurately identify the main diseases prevalent in the district. The presence of diseases such as the TBDs and trypanosomiasis were confirmed by the serological surveys and laboratory examination .

However qualitative techniques should not be entirely relied on and should be in combination with quantitative epidemiological methodologies such as serological surveys. This is because, important diseases or problems could be missed out due to lack of appropriate technical information to diagnose particular diseases. In the study for instance, none of the farmers ranked babesia as a major disease constraint, yet there is a high sero prevalence of the disease in the district.

Results of the serological survey do indicate a high prevalence of antibodies to *Theileria parva*, anaplasma and babesia. This was not surprising as the tick challenge is high in nearly all the sub-locations. The ELISA tests for *Theileria parva*, *Anaplasma marginale* and

Babesia bigemina have sensitivities of 99%, 90% and 97% respectively while the respective specificities for the parasites are 99%, 90 and 98% (Katende et a1, 1998, Morzaria et al 1999). In absence of re-challenge, it has been demonstrated that. antibodies to *Theileria parva* decline by six months (Lawrence et al 2004) after infection. The high prevalence of antibodies to the tick-borne diseases based on the results of the ELISA test which has a high specificity, especially for the *Theileria parva* and *Babesia bigemina*, does suggest recent or continuous challenge by the parasites.

The high tick challenge can largely be attributed to a break down in tick control services formerly supported by the government not only in the district, but in the rest of the country. The history of tick control in Kenya has been reviewed by Keating (1983). Despite the enactment of the Cattle Cleansing Act (GOK 1976) which led to the initiation of a national tick control programme, adequate control of ticks and TBDs is still far from being achieved. The escalating costs of acaricides, relevant infrastructure and monitoring services for the intensive tick control strategies advocated by the Cattle Cleansing Act led to the inability of the government services to sustain the programme. Just like in other parts of the country, poor management of dips by local committees in the district virtually led to the collapse of the tick control facilities. As result virtually all the farmers depend on hand sprays to apply acaricides on the animals.

It was evident from discussion with farmers that although most of the farmers applied acaricides on livestock on a regular basis, the tick loads on the animals on most of the farms were high. This was so even in instances where farmers had indicated that they applied acaricides on the animals a few days prior to the visit. It was clear that the farmers applied under strength concentration of acaricides either due to inability to follow instructions or due to financial difficulties.

The problem was clearly demonstrated in Ngelani which had a significantly higher prevalence of TBDs compared to most of the other sub-locations in the district. This is directly attributed to the fact that the sub-location has the poorest access to veterinary services. Most of the treatments are undertaken by farmers (92%) many of whom are either illiterate or semi illiterate. Although most of the farmers (84%) indicated that they undertook tick control on a regular basis it was evident few of the farmers applied the acarides as recommended as ticks could still be found attached on animals that had been sprayed as late as a day or two prior to the visit.

Improper application of acarides especially use of under strength acaricides could result in ticks developing widespread resistance to the acarides in the district and this needs to be investigated

Veterinary extension services are necessary to assist farmers to effectively apply the hand spray technique of tick control as it is not as reliable as dips. Farmers need to be trained on how to prepare the correct dilution of the acaricides and the predilection sites of the ticks where the spraying should be focused on the body of animals. Currently, there are inadequate veterinary extension services in the district to provide the farmers with the required technical information on tick control. This is especially so in sublocations that are relatively far from urban centres, such as Milani and Ngelani. Although, it is recognized that AHA or Para veterinary staff have an important role to play in the provision of veterinary services in the country, their scope of training requires intervention of services of qualified veterinarians on certain technical and policy issues.

Recent studies by Umali et al (1994), Otieno- Oruko (2000) and Mugunieri et al (2004) do indicate that Para veterinary staff and Community Based Animal Health Workers (CBAHW) can play a significant role in animal health delivery if appropriate policies are put in place to strengthen their activities. The studies found that Para veterinary staff and CABHW who were provided with basic training in animal health and entrepreneurial skills were successful in delivering animal health services particularly in marginal areas.

The relatively lower prevalence of babesia and anaplasma compared to ECF could be attributed to the higher abundance of the *Rhipicephalus appendiculatus*, the vector of *Theileria parva,* in all the sub-locations. Nevertheless, there appears to be endemic stability (Gitau 1998, Rubaire-Akiki et al 2004) for all the three TBDs. This is evident from the fact that only one clinical case of ECF was confirmed during the visits to the two hundred farms.

Besides in most of the sub-locations there appears to be continuous high tick challenge of the tick vectors through the year. Thus most of the young zebu calves on the farms are likely to be exposed to the TBDs and become immune to the TBDs by six months of age.

Endemic stability could explain why the farmers did not rank babesia as a constraint to livestock production yet the prevalence in half of the sub-locations where the survey was undertaken was 40% or more. The other explanation could be that the disease could not be diagnosed accurately due to lack of qualified veterinary personnel in most of the sub-locations.

From the results of the study, introduction of exotic breeds, which are highly susceptible to TBD, should be undertaken with caution. Farmers need to be made aware that introduction of exotic needs to be accompanied by intensive tick control to minimize the risk of the animals contracting TBDs.

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