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CONCURRENT TRYPANOSOMOSIS, THEILERIOSIS, ANAPLASMOSIS AND HELMINTHOSIS IN FRIESIAN, ZEBU AND SAHIWAL CATTLE IN UGANDA

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ABSTRACT

An epidemiological investigation was conducted on mixed farms in Tororo and Soroti districts of Uganda from January to February 2000 to determine the cause of reported persistent mortality of cattle. Blood and faecal examination of 98 cattle comprised of 33 Friesians, 58 Zebu and 7 Sahiwal was undertaken. Results revealed 7 (7.1%) cattle had trypanosome infection, mainly due to *Trypanosoma vivax* and *T. brucei*, 17 (17.3%) had *Fasciola* infection, 28 (28.6%) had gastrointestinal nematode infection, 33 (33.7%) had *Theileria parva* infection and 13 (13.3%) had *Anaplasma marginale* infection. Mixed infections were detected in 24.5%, 30%, 20.6% and 43% of all cattle, Friesians, Zebu and Sahiwal respectively. Anaemia (PCV<25) was detected in 21%, 24%, 19% and 14% of all cattle, Friesians, Zebu and Sahiwal respectively. Persistent mortality of Friesians, Zebu and Sahiwal cattle on these farms could have been due to either single or mixed parasitic infections probably exacerbated by malnutrition.

Key words: Anaemia; Friesian; Mixed-parasitic-infections; Sahiwa1; Uganda; Zebu

INTRODUCTION

Uganda has an estimated cattle population of 4.4 million (Anon., 1995). Cattle are the most economically important species of livestock. The majority of them are indigenous breeds consisting of Zebu and Sanga, while exotic high-yielding breeds constitute only 5% of the entire cattle population. Zebu and Sanga cattle are mainly kept under traditional management, but few are kept under improved management together with exotic breeds on either private or govern-

ment-owned mixed farms. Many such farms aim to increase milk production to satisfy the milk demand of the growing human population of the Uganda, now estimated at 20 million. However, livestock production in general is hampered by disease constraints, most important of which include trypanosomosis, tick-borne diseases and helminthosis that are endemic in Uganda and often occur together.

Existing reports in Uganda indicate the prevalence of trypanosomosis in cattle is 11.9% under, the intensive dairy system and 25% under the communal grazing systems (Okuna et a1., 1996). Reported prevalences of fasciolosis in cattle range from 29% to 36% (Magona et a1. 1999a) and of gastrointestinal nematode infections range from 22% to 61% (Magona and Musisi, 1998). Reported prevalences of theileriosis, anaplasmosis and babesiosis in cattle are 48%, 36% and 16% respectively (Anon, 1996). However, there are no published reports on the prevalence of mixed parasitic infections in both indigenous and exotic breeds of cattle on mixed farms in Uganda. This paper reveals the prevalence of anaemia, single and mixed parasitic infections in Friesian, Zebu and Sahiwal cattle, which were the cause of persistent mortality on mixed farms in Uganda.

MATENALS AND METHODS

Farms visited

Serere Agricultural and Animal Production Research Institute (SAARJ) farm in Soroti and Morukatipe Government Prison NGP) farm in Tororo, where persistent cattle mortality had been reported, were visited.

SAARI farm

SAARI farm is located 17 km Southwest of Soroti to& in Eastern Uganda. The vegetation in the area is Savannah grassland. Soroti district receives 1,000-1,500 mm of rainfall annually. The rainfall is bimoda1, with two wet seasons March to May and September to November) and -two dry seasons (December to February and June to August). Soroti district has a daily mean minimum temperature of 18 ^{o}C and mean maximum of 30 ^{o}C. Mixed farming is practiced on SAARI farm. Legumes, pastures, sunflower and cassava are grown. At the time of the visit, SAARI farm had 8 Friesian, 8 Sahiwal and over 500 Zebu cattle. Friesian and Sahiwal cattle

herds were confined in separate paddocks and managed by rotational grazing' whereby both herds shared pasties sequentially. Zebu cited were divided into different herds and managed by open grazing. They were grazed during the day and kept in paddocks at night. Hired herdsmen were allocated one or more herds to control daily. Water for paddocked animals was pumped from underground. In addition, a water reservoir was available on the farm, from which Zebu cattle were always watered and Friesian and Sahiwal cattle whenever the water pump broke down. Disease management was mainly by routine vaccinations against epidemic diseases such as rinderpest and contagious bovine pleuropneumonia (CBPP) and irregular tick control, which depended on availability of acaricides. Endemic diseases other than tick-borne diseases were managed by treating cases whenever they occur.

MGP farm

This farm is located about 10 km Northeast of Tororo town Close to the Uganda/Kenya border. The vegetation in the area is Savannah grassland. The area receives 1200 -1500 mm of rainfall annually. The rainfall is bimoda1, with two wet seasons march to May and September to November) and two dry seasons (December to February and June to August). Tororo district has a daily mean minimum temperature of 15 ^{o}C and mean maximum of 27 ^{o}C. MGP farm is a mixed farm and crops such as cotton and maize are grown. At the time of the visit, the farm had 25 Friesian cattle. Adult cattle were separated from calves. Calves were paddocked during the day and housed at night; while adult cattle were herded on the farm land during the day and kept in the calf paddocks during night time. Much of the land on which the animals grazed had broken fences and neighbouring village cattle-owners encroached on the farm land to graze their cattle. The main source of water for the animals on this farm was a stream. Disease management on the farm was by routine tick control through dipping. However, dipping was hampered by unavailability of sufficient funds for dip maintenance. Endemic diseases other than tick-borne diseases were managed by treatment of cases as they occurred. Vaccination against major epidemic diseases such as rinderpest and CBPP was carried out regularly.

Disease transmission potential

Soroto district, especially Serere county were SAARI farm is located is infested by tsetse flies, *Glossina fuscipes fuscipes* (Okuna et a1., 1999) which transmit *Trypanosoma brucei*, *T. congo-*

lense and *T. vivax* to cattle. Tororo district where MGP farm is located is likewise infested with tsetse flies, mainly *Glossina fuscipes fuscipes* and to a limited extent *G.. pallidipes* (Magona et a1. 1997). The major tick species of economic importance that are known to occur in the two areas visited include *Rhipicephalus appendiculatus, Rhipicephalus evertsi evertsi, Boophilus decoloratus* and *Amblyoma variegatum* (Okello-Omen et a1. 1999) which transmit *Theileria parva, Anaplasma marginale, Babesia bigemina* and *Cowdria ruminantium* to cattle.

Climatic conditions and presence of swamps and marsh land in both Soroti and Tororo districts are known to be suitable habitats for snails, *Lymnea natalensis* (Ogamba-Ongoma, 1972), intermediate hosts for *Fasciola gigantica* that is prevalent in cattle in these areas (Magona et a1., l999b). In addition, climatic conditions in the areas also favour continuous survival of helminth larvae on pasture.

Cattle sampling and examination

Cattle sampled were of all ages and of both sexes. All Friesians and Sahiwal cattle together with 10% of the Zebu (58) on SAARI farm and all Friesians on MGP farm were sampled. Disease history and general examination was carried out. Blood and faecal samples were collected.

Blood examination

Cattle were bled from the jugular vein and blood was examined for trypanosomes using the haematocrit centrifugation technique (Woo 1969). Giemsa stained thick and thin blood smears were examined for haemoparasitses and for morphological identification of trypanosomes. Packed cell volume (PCV) was measured using a microhaematocrit reader (Hawksley, London, UK) with blood samples subjected to haematocrit centrifugation technique.

Faecal examination

Faecal samples were obtained directly from the rectum and each sample was placed separately in a plastic bag labeled, transported on ice and dispatched to laboratory where samples were examined immediately. Faecal samples were examined for trematode eggs using the sedimentation technique and for nematode eggs using a modified McMaster method accurate t. 50 eggs per gram of faeces (Thienport et a1., 1979), with nematodes eggs classified as 'strongyle-type'.

Table 1. Mean packed cell volume and prevalence of different diseases in Friesian, Zebu, and Sahiwal on mixed farms in Uganda, January-February, 2000

Breed	Farm	Age group (n)	Mean PCV	No. of cattle infected with (%)					
				Trypano-some	Gastroin-testinal nematode	*Fasciola*	*T. parva*	*A. marge-inale*	Mixed
Frie-sian	SAARI	Calves (2)	21.5±6.8	0 (0)	0 (0)	0 (0)	2 (100)	0 (0)	0 (0)
		Adults (6)	23.0±4.4	1 (16.6)	0 (0)	0 (0)	3 (50)	3 (50)	2 (33)
		Total (8)	22.6±3.5	2 (25)	0 (0)	0 (0)	5 (62.5)	3 (37.5)	2 (25)
Frie-sian	MGP	Calves (5)	27.8±2.3	0 (0)	2 (40)	1 (20)	1 (20)	0 (0)	1 (20)
		Adults (20)	27.6±1.7	1 (5)	2 (10)	4 (20)	4 (20)	5 (25)	7 (35)
		Total (25)	27.6±1.4	1 (4)	4 (16)	5 (20)	5 (20)	5 (20)	8 (32)
Frie-sian	SAARI +MGP	Calves (7)	26.0±3.1	0 (0)	2 (28)	1 (14)	3 (43)	1 (14)	1 (14)
		Adults (26)	26.5±1.8	2 (8)	6 (23)	6 (23)	6 (23)	7 (27)	9 (35)
		Total (33)	26.4±1.5	2 (6)	8 (24)	7 (21)	9 (27)	8 (24)	10 (30)
Zebu	SAARI	Calves (27)	29.6±1.7	2 (7)	10 (37)	3 (11)	14 (52)	0 (0)	8 (30)
		Adults (31)	27.4±1.4	2 (6)	9 (29)	4 (13)	5 (16)	5 (16)	4 (13)
		Total (58)	28.4±1.1	4 (7)	19 (33)	7 (12)	19 (33)	5 (9)	12 (21)
Sahi-wal	SAARI	Adults (7)	29.6±3.0	1 (14)	0 (0)	3 (43)	5 (71)	0 (0)	3 (43)
All	SAARI +MGP	Calves (34)	28.8±1.5	2 (5.8)	12 (35.3)	4 (11.8)	17 (50.0)	1 (2.9)	9 (26.5)
		Adults (64)	27.3±1.0	5 (7.8)	15 (23.4)	13 (20.3)	16 (25)	12 (13.3)	12 (23.4)
		Total (98)	27.8±0.8	7 (7.1)	27 (27.6)	17 (17.3)	33 (33.6)	13 (13.3)	24 (24.5)

Calves=<1 year; Adults=>1 year;

* No. (%)

RESULTS

Disease history

For 2 consecutive months before the visit to SAARI farm, 4 (33%) Friesian cattle had died while a large number of the Zebu cattle had been progressively wasting. On MGP farm, 6 (20%) cattle had died within two months preceding the visit.

General body condition of cattle

All cattle (Friesian) on MGP farm were in a fair to good body condition. Whereas on SAARI farm, all Sahiwal cattle were in a good body condition, but 33% of the Friesian cattle, 75% of the Zebu adult and 33% of the calves were in a poor body condition. Apparent shortage of pasture was observed on both farms due to the dry season.

Disease prevalence

The prevalence of different parasitic infections, mixed infections and mean PCV of calves and adult cattle of the different breeds are shown in Table 1. *Theileria parva,* gastrointestinal nematode, *Fasciola, A. marginale* and trypanosome infections were detected in 33.6%, 27.6%, 17.3%, 13.3% and in 7.1% of all cattle respectively. All Friesian calves on SAARI farm had only T parva infection, while Friesian calves on MGP farm had gastrointestinal nematode infections, *Fasciola* infection and a low prevalence of *T. parva* infections (20%) of which 20% were mixed infections. Friesian adult cattle on SAARI farm had *T. parva, A. marginale* and trypanosome infections of which 32% were mixed infections. Friesian adult cattle on MGP farm had infections of *A. marginale, T. parva, Fasciola* sp., gastrointestinal nematodes and *Trypanosoma* sp. Generally, Friesian adult cattle had a higher -prevalence of *Trypanosoma* sp., *Fasciola* sp. and *A. marginale* infections than the calves.

Infections of *T. parva,* gastrointestinal nematodes, *Fasciola* sp. and *Trypanosoma* sp. were the major diseases in Zebu calves with 30% of the infection being mixed. While single or mixed infection of gastrointestinal nematodes, *T. parva, Fasciola* sp. and *Trypanosoma* sp. were the major diseases prevalent in Zebu adult cattle. One Sahiwal had mixed infection of *Fasciola* sp. with *T. parva.* Friesian cattle had the lowest mean PCV, followed by Zebu and Sahiwa1. Overall, 24.5% of all cattle had mixed infection, with 43% of the Sahiwal, 30% of the Friesians and 20.6% of the Zebu. Friesian and Zebu calves had higher prevalence of infections of gastrointestinal nematodes and *T. parv*a than the older cattle. Single or mixed infection of gastrointestinal nematodes, *Fasciola* sp. and *Trypanosoma* sp. were found in Zebu adult cattle.

Mixed infections

Of all cattle, 24.5% had mixed infections. The Sahiwal cattle had the highest prevalence of mixed infection (43%), followed by Friesian (30%) and Zebu cattle (19%). The prevalence of mixed infections was higher in older Friesian cattle (35%) than in calves (14%). The reverse was true

for Zebu cattle as calves had a prevalence of mixed infections (30%) than older cattle (10%).

Table 2 shows the prevalence of different disease combinations that constituted mixed infections in Friesians, Zebu and Sahiwa1. Mixed infection of *Fasciola* with *T. parva* was the predominant type in Friesian and Sahiwal cattle, while mixed infection of gastrointestinal nematodes with *T. parva* was the predominant type in Zebu cattle. Sahiwal cattle had only mixed infections with two types of parasites, while Friesians and Zebu had mixed infection with two or three types of parasites. The ratio of mixed infections with two types of parasites to those with three types of parasites was 7:3 in Friesian and 2:1 in Zebu cattle.

Prevalence of anaemia

Table 3 shows the percentage of Friesians, Zebu and Sahiwal that had anaemia. Friesian cattle had the highest prevalence of anaemia, followed by Zebu and Sahiwal cited.

Figure 1 illustrates the proportion of anaemic and non-anaemic Friesian, Zebu and Sahiwal cattle that had various parasitic infections. Anaemic Friesian cattle had mixed infections of *Fasciola* sp. with either *A. marginale* or *T. parva*. Many of the non-anaemic Friesian cattle (48%) were free Of infection, but 52% of them had subclinical infections of gastrointesdna1 nematodes, *T. parva, A. marginale* and mixed infections of *Fasciola* sp. with either *T. parva* or *A. marginale* and *Trypanosoma* sp. with *A. marginale*.

The proportion of anaemic Zebu cattle with gastrointestinal nematode and *T. parva* infections was greater than that of non-anaemic ones. However, it was noteworthy that 36% of the anaemic Zebu cattle did not harbor any detectable parasitic infections. Anaemic Zebu cattle had mixed infection of *Trypanosoma* sp. with *T. parva* and gastrointestinal nematodes. Whereas, 42% of the non-anaemic Zebu cattle were free of infections, 56% of them had subclinical infection of gastrointestinal nematodes, *Fasciola* sp., *T. parva, A. marginale* and *Trypanosoma* sp.

The anaemic Sahiwal cow had mixed infection of *Fasciola* sp. with *T. parva*. Only 17% of the non-anaemic Sahiwal cattle were free of infection. Many non-anaemic Sahiwal cattle (83%) had subclinical infections of *T. parva* and mixed infections of *Fasciola* sp. with either *Trypanosoma* sp. or *T. parva*.

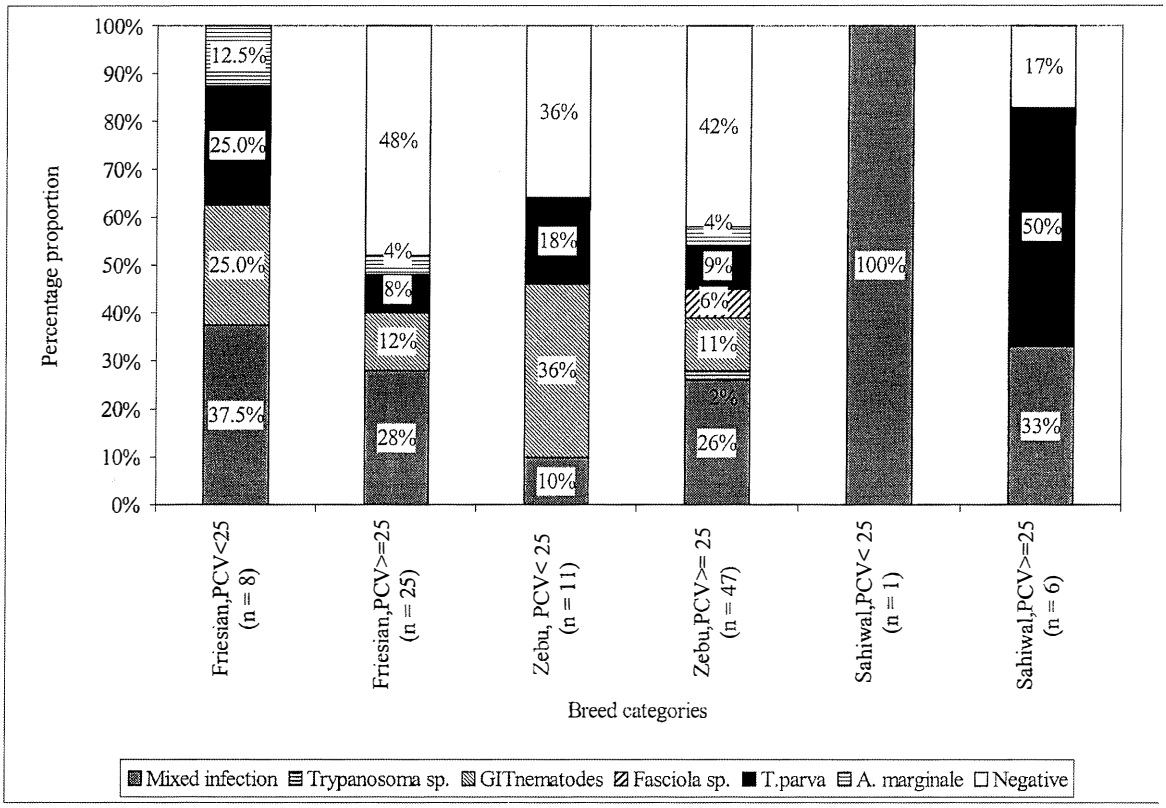

Figure 1. Percentage proportion of Friesian, Zebu, and Sahiwal cattle with or without anemia that had warious parasitic infections on mixed farms I Uganda, January-February, 2000.

DISCUSSION

This investigation was undertaken to determine the probable cause of persistent mortality and chronic wasting of cattle on mixed farms in Uganda. It was found that on MGP farm, the general condition of animals was fair to good, which was reflected by a rather high mean PCV (27.8), but the mortality rate (20%) was high. On SAARI farm with Friesians, Zebu and Sahiwal cattle, though Sahiwal cattle were in good condition, also reflected by the high mean PCV (29.6), Friesian cattle were in a poor condition, had a low mean PCV (22.6) and an alarmingly high mortality rate (33%). Zebu cattle experienced chronic wasting, but had a high mean PCV (28.4). Anaemia was detected in 21%, 24%, 19% and 14% of all cattle, Friesians, Zebu and Sahiwal respectively. Cattle mortality on the two farms occurred mainly during the dry season.

Investigations revealed occurrence of multiple parasitic infections including trypanosome infection, mainly due to *Trypanosoma vivax* and *T. brucei*, *Fasciola* infection, gastrointestinal nematode infection, *T. parva* infection and *A. marginale* infection in Friesian, Zebu and Sahiwal cattle. Some of the infections were mixed.

The low mean PCV and associated high mortality of Friesian cattle on SAARI farm was probably due to the high prevalence of single or mixed infections of *T. parva*, *A. marginale* and trypanosomosis. However, the relatively lower prevalence of single or mixed infections of *T. parva*, *A. marginale* and trypanosomosis together with gastrointestinal nematodes seemed to have had less impact on the health conditions of Friesian cattle on MGP farm in terms of reducing the mean PCV, but caused a substantially high mortality. All Friesian calves on SAARI farm had only *T. parva* infection, which led to a low mean PCV (21.5). Friesian calves on MGP farm had gastrointestinal nematode infections, *Fasciola* infections and a low prevalence of *T. parva* infections (20%) with 20% of the infection being mixed, but these infections seemed to have had less impact on the mean PCV (27.8). Parasitic gastroenteritis caused by gastrointestinal nematodes results in ill-thrift, poor growth and diarrhoea in young cattle, but profound anaemia is associated with haemonchosis. Haemonchosis, fasciolosis, anaplasmosis, and trypanosomosis affect the haematocrit of affected animals (Urquhart et a1., 1987). Generally, trypanosomosis and anaplosmosis cause substantial mortality (Kalu 1996), but *Theileria parva* infection is associated with high mortality of exotic breeds of cattle such as the Friesians (Gitau et a1. 2000).

Infections of *T. parva*, gastrointestinal nematodes, *Fasciola* sp. and trypanosomosis were the major diseases in Zebu calves with 30% of the infection being mixed. Theileriosis has been reported to cause 13.5% cumulative annual mortality in indigenous calves (Zebu) in Uganda (okello-Onen et a1. 1996). Sauvage and colleagues (1974) similarly found 19.8 to 47.9% of indigenous calves up to 1 year secreting strongyle-type eggs in Ankole district in Uganda, but the animals were found to be in good condition. Thus gastrointestinal nematode infection leads mainly to reduction in growth rather than overt parasitic gastroenteritis in indigenous calves. Trypanosomosis due to *T. vivax* found in the Zebu calves too causes retarded growth. Single or mixed infection of gastrointestinal nematodes, fasciolosis and trypanosomosis that were found in the Zebu adult cattle cause chronic wasting which was observed on SAARI farm. Zebu adult cat-

tle exposed to *T. parva* infection normally develop endemic stability, but usually succumb to A. marginale infection, which is often peracute, or fatal in older cattle (Jain, 1993) in which it is characterised by pyrexia, progressive anaemia and icterus. The low PCV (23) observed in one Sahiwal cow was due to mixed infection of *Fasciola* sp. and *T. parva*.

Anaemia of varying degrees of severity was detected in Friesian, Zebu and Sahiwal cattle on the mixed farms. Anaemia is a cardinal sign of most vector-borne diseases such as trypanosomosis and anaplasmosis and helminth diseases such as fasciolosis and parasitic gastroenteritis. It was more severe in Friesian cattle than in Zebu and Sahiwal cattle. These differences in the severity of anaemia probably reflected existing variations in innate resistance to parasitic diseases among Friesian, Zebu and Sahiwal breeds of cattle.

A substantial proportion of Zebu cattle manifested anaemia but no parasitic infections were detected. Such cases of anaemia could have been probably due to other causes of anaemia such as malnutrition bearing in mind this was dry season, when shortage of pasture usually occurs in this part of Africa. Malnutrition due to iron deficiency is known to cause anaemia by impairment of erythropoiesis (Jain, 1993). However, these could have been also cases of undetected chronic trypanosomosis occurring subclinically causing the 'Thin Cow Sydrome' (Dowler et a1. 1989), which was visually observed in Zebu cattle and by the packed cell volumes.

It was noteworthy that differences in the prevalence of *T. parva* and *A. marginale* infections on the two farms seemed to concur with the level of tick control. The MGP farm with routine dipping had a lower prevalence of tick-borne diseases than the SAARI farm that had an inefficient tick control programme.

Zebu cattle (small) had a lower prevalence of *Fasciola* infection than Friesian (exotic) and Sahiwal cattle (large Zebu). This finding concurred with observation made by Bitakaramire (1973) in Kenya in which indigenous small Zebu cattle had a lower prevalence of fascioliasis than European exotic and large Zebu breeds, a fact that was attributed to genetic resistance. Older Friesian and Zebu cattle had higher prevalence of trypanosomosis, fasciolosis and anaplasmosis than calves. Older cattle have been observed in other studies to have higher prevalence of trypanosomosis (Magona et a1. 1999a) and fasciolosis (Magona et a1. 1999b) than calves

Subclinical gastrointestinal nematode infections observed in Friesian and Zebu cattle

probably did not increase the risk of mortality per se. However, such infections are a detrimental effect to productivity through decreased weight as evidenced by progressive wasting of Zebu cattle or decreased milk and fertility of older cattle (Eysker and Pleoger 2000). Mild or subclinical *Fasciola* infection observed in the Friesians, Zebu and Sahiwal is usually associated with ill-thrift (Urquhart et a1. 1987), but heavy liverfluke infection in cattle clinically manifests in form of weight loss, ventral oedema due to hypoalbuminaemia and anaemia.

Persistent mortality of cattle occurred on the farms during the dry season starting from the end of the rainy season. The highest prevalences of vector borne diseases such as trypanosomosis and helminthosis usually occur during this season. This is also the period when the plane of nutrition is very low due to reduced pasture. Poor nutrition, especially low protein intake is known to exacerbate both trypanosomosis and helminthosis in livestock (Holmes et a1. 2000).

Mixed infections were detected in Friesian, Zebu and Sahiwal cattle. Occurrence of mixed infections involving parasitic diseases probably exacerbated the conditions of the affected cattle, either through incremental anaemia caused as a result of presence of trypanosomosis, fasciolosis, parasitic gastroenteritis and anaplasmosis or through synergistic effects due to interaction among various combinations of these diseases. The *T. vivax* and *T. brucei* detected in the infected cattle usually cause less severe anaemia than *T. congolense* not detected, but in cases of mixed infections, the ability of *T. brucei* to cause immunosuppression in the host could led to increased virulence of gastrointestinal nematode (Dwinger 1994). Stress resulting from chronic subclinical trypanosomosis due to *T. vivax* or *T. congolense* has been reported to cause patent parasitaemia and clinical anaplasmosis to emerge in premune carrier animals and as well as other diseases in general (Fox et a1. 1993).

Open grazing systems allow for more characteristic cycles of *T. parva* transmission to occur, both from carrier and clinically affected cattle (Gitau et a1. 2000). Mixing of susceptible Friesian with potentially infected carrier Sahiwal cattle in a sequential rotational grazing system was an important predisposing factor to *T. parva* infection (Gitau et a1. 2000). Similarly, sharing of grazing land between susceptible Friesian cattle and *T. parva* carrier village cattle was a predisposing factor to infection, since village cattle brought themselves with infected ticks to infest the farm land.

In conclusion, persistent mortality of Friesians, Zebu and Sahiwal cattle on mixed farms in Uganda could have been due to multiple parasitic infections including trypanosomosis, theileriosis, anaplasmosis, fasciolosis and gastrointestinal nematode infections that occurred either as single or mixed infections, which were probably exacerbated by malnutrition.

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