5 RESULTS

5.1 Cross-sectional study

5.1.1 Questionnaire survey

5.1.1.1 Household data

In Busia District, the household survey results showed that the average family size was 8.5 persons with most (81.4%) of the respondents having some formal education (primary school 24.2%, secondary school 45.1%, advance-level 2.2%, college 8.8% and artisan 1.1%) while 18.6% had no formal education. Most (87.9%) families were headed by men, although a few households (12.1%) were headed by women who were either widowed or single mothers.

5.1.1.2 Animal husbandry and management

In Busia District, cattle, poultry, pigs, sheep and goats in this order were perceived as the most important livestock. The average number of cattle per household was 4.5. In Budalang'i and Funyula divisions, the mean cattle herd sizes were reported to be 5.9 and 7.3 animals, respectively. Most farmers kept more than one species of livestock with the majority keeping poultry in addition to other animals. The proportion of respondents owning local breeds (East African Zebu) of cattle was 80.2%, exotic/crossbred cattle (Friesian, Jersey, Guernsey or Ayshire) 15.7% , sheep 45.1%, goats 41.8%, pigs 29.7% and 94.5% kept poultry. These animals were kept under a mixed crop/livestock subsistence farming system. Cattle in the district are reared under four main husbandry practices identified as free-grazing, tethering, stall-feeding and free-grazing/tethering (Table 4). Reasons advanced for keeping animals were traction, milk, manure, meat and as homestead "security" banks (Table 5).

Table 4. Animal husbandry practices in Busia District as expressed by respondents (n = 91), during the cross-sectional survey (2002)

Husbandry system	Perceived proportion (%)
Free-grazing	41.7
Tethering	27.5
Stall-feeding	7.7
Free-grazing/tethering	23.1

Free grazing: grazing animals on free range in communal or privately owned land

Tethering: Restraining animals with ropes as they graze

Stall-feeding/zero grazing: Feeding animals within an enclosure with fodder collected from the fields

Table 5. Ranking of the importance of livestock in Busia District as perceived by respondents (n = 91), during the cross-sectional survey (2002)

Animal use	Importance				
	Cattle	Sheep	Goats	Poultry	Pigs
Meat	+ + +	+ + +	+ + +	+ + +	+ + +
Milk	+ + +	- - -	- - -	NA	NA
Traction	+ + +	NA	NA	NA	NA
Manure	+ + +	+ +	+ +	+	+
Eggs	NA	NA	NA	+ + +	NA
Sale	+ + +	+ + +	+ + +	+ +	+ +

+ + + : Highly important; + + Moderately important; +: important; N/A: Not applicable; - -: Not considered

5.1.1.3 Management of animals trypanosomosis

Diseases perceived as important constraints to production were listed as trypanosomosis, ECF, anaplasmosis, babesiosis, cowdriosis, helminthosis, pneumonia, lumpy skin disease (in Nambale Division) and foot and mouth disease (Nambale, Butula, Budalang'i and Funyula divisions). Trypanosomosis, tick-borne diseases and helminthosis were ranked as the most important diseases in that order. However, these responses were not based on any conventional diagnostic procedures, hence the need for a comprehensive survey to verify these claims. The respondents reported that veterinary officers, animal health assistants (AHAs), quacks and farmers were the persons offering animal health services. Proportionally, (Figure 3), respondents indicated that diminazene aceturate (Veriben®, Sanofi Kenya Ltd; Berenil®, Hoechst Kenya Ltd), isometamidium chloride (Samorin®, Hoechst Kenya Ltd; Trypamidium®, Sanofi Kenya Ltd; Norotryp®, Skaj Kenya Ltd) and Homidium chloride (Novidium® Merial France) were the most preferred trypanocides used in the district, in that order (Figure 3). These drugs were mainly sourced from agrovet-shops, animal health assistants (AHAs) and/or quacks (Figure 4).

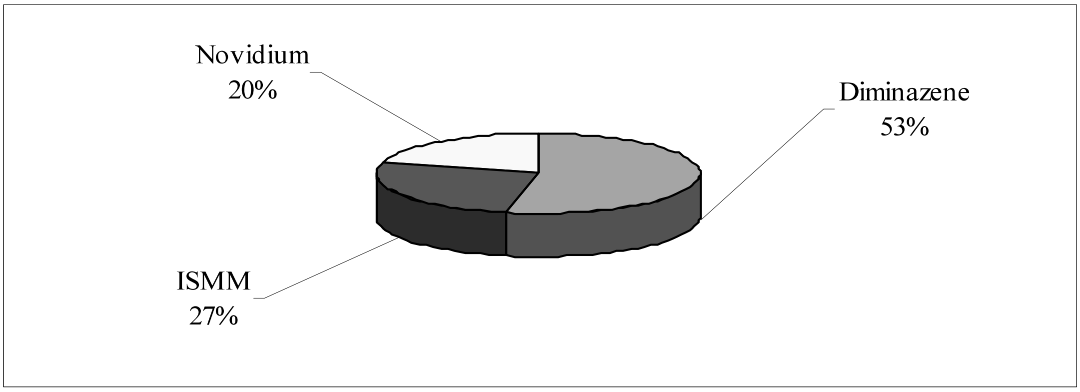

Figure 3. Proportions of trypanocides used in Busia District as reported by respondents (n = 91), during the cross-sectional survey (2002)

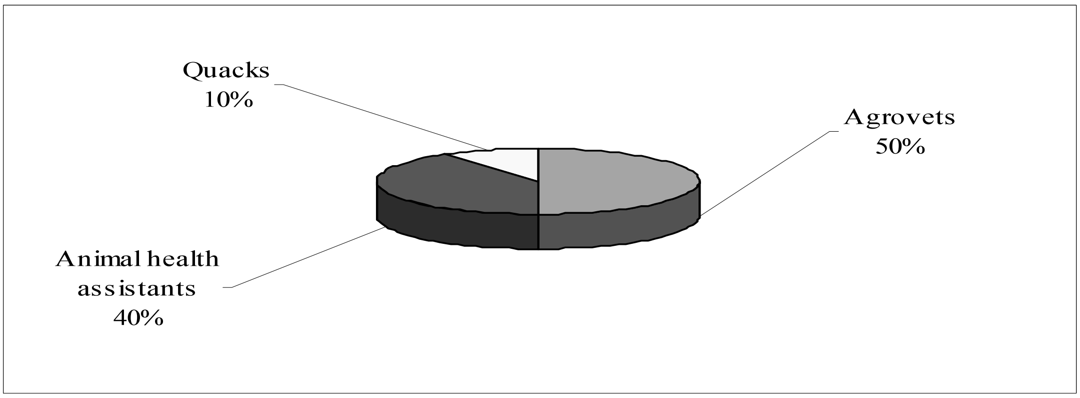

Figure 4. Sources of trypanocidal drugs in Busia District as indicated by respondents (n = 91), during the cross-sectional survey (2002)

The average number of trypanocidal treatments per year in cattle as indicated by the respondents was 3.1 (range: 1-6) (Figure 5). The average interval between these treatments was reported to be

3 months. The mean cost of trypanocidal treatments by each farmer per year was reported to be KSh. 416.60 (~ $US 5.2).

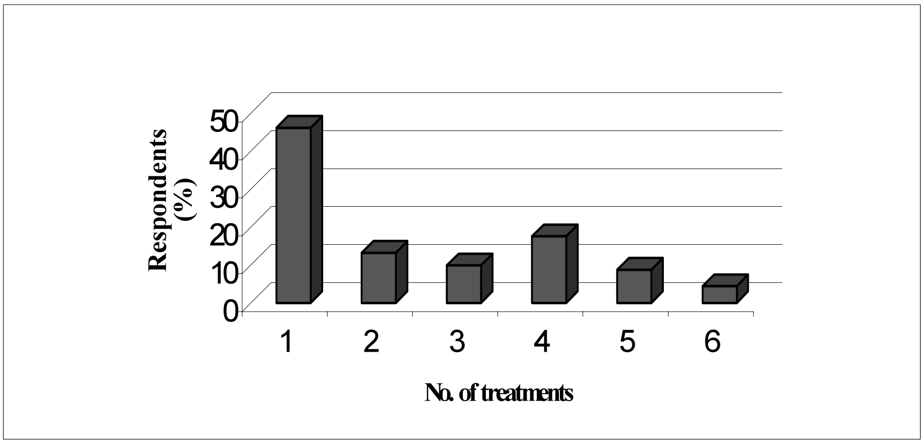

Figure 5. Number of trypanocidal treatments per year in cattle in Busia District as reported by the respondents (n = 91), during the cross-sectional survey (2002)

5.1.1.4 Control of helminths

The respondents indicated that helminthosis was a major constraint to animal production (especially calves and small stock). Up to 68% of the respondents recognized helminthosis as an important condition based on the observation of the hair-coat, potbelly and poor body condition. However, the mean number of antihelmintic treatments administered to calves and small stock by these 'knowledgeable' (those claiming to recognise signs of heavy worm infestation) farmers was only 0.8/year. This implied that some farmers did not deworm their animals at all within a given year.

5.1.1.5 Tick control

Tick control in all the divisions of Busia District is mainly undertaken through hand spraying. Most plunge dips have been neglected due to poor dip-management. Spraying is undertaken by farmers, farm-helps or by individuals (quacks) who visit the farmers with the acaricides and knapsacks. During the interviews, it was reported that 71.7% of the respondents were spraying their animals while 28.3% were not. The proportions of acaricides used in Busia District by farmers were reported as follows: amidines (Triatix®-Cooper Kenya Ltd-71.5% and Almatix®-Unga Kenya Ltd-3.2%), organophosphates (Steladone®-Norvatis East Africa-17.8%) pour-ons (8.5%) However, none of the respondents stated that they were aware of the required dilution levels for these acaricides. The scenario is worsened by the fact that when a farmer relies upon a farm-help or quack to use the acaricide appropriately, the results might be disappointing. The frequency of acaricide wash per month as reported by respondents was as follows: 4-washes/month (11.7%), 3-washes/month (16.5%), 2-washes/month (17.3%) and one-wash/month (26.2%) while 28.3% did not wash their cattle with an acaricide at all.

5.1.2 Results of cross-sectional disease survey (trypanosomosis and TBDs)

In the cross-sectional survey, the importance of risk factors (age, sex, husbandry practice and location) was investigated for both trypanosomosis and tick-borne diseases. Consequently, results for both trypanosomosis and tick-borne diseases are presented together.

Of the 2827 cattle sampled in Busia District, 1923 (68%) were females while 904 (38%) were males. The overall trypanosome prevalence in the six divisions of Busia District was 4.7% (95% CI = 4.0-5.6). Examination of Giemsa stained smears revealed four types of trypanosomes infections in cattle, namely: *T. vivax*, *T. congolense*, *T. brucei* and mixed infections. The proportions of trypanosome species infecting cattle in Busia District were calculated stratified by location. Specifically, out of the 133 infections detected, 54 (40.6%) were of *T. vivax* infections, 47 (35.3%) were of *T. congolense*, 26 (19.5%) were of *T. brucei* and 6 (4.5%) were of mixed infections. In all divisions, *T. vivax* infections were the most predominant followed by *T. congolense*, *T. brucei* and mixed infections, in that order. However, in Funyula Division, there were higher proportions of *T. congolense* than *T. vivax* infections (Table 6).

Table 6. Divisional-dependent proportions of trypanosome species infecting cattle in Busia District in 2002

Division	Proportions (%) of trypanosome species			
	T. vivax	*T. congolense*	*T. brucei*	Mixed
Budalang'i	36.8	34.2	23.7	5.3
Funyula	35.3	41.2	19.6	5.9
Butula	50.0	25.0	18.7	6.3
Nambale	46.1	38.5	15.4	0.0
Matayos	50.0	30.0	20.0	0.0
Township	75.0	25.0	0	0.0

Chi square comparison of divisional-specific trypanosome prevalence revealed a significant difference (χ^2 = 34.8, df = 5, $p < 0.05$) (Table 7).

Table 7. Comparative results of the Divisional trypanosome-specific prevalence in cattle in Busia District in 2002

Division	Trypanosome prevalence (%)	95% CI
Budalang'i	8.5^{a}	6.1-11.5
Funyula	6.4^{a}	4.8-8.3
Butula	4.0^{ab}	2.3-6.4
Nambale	2.4^{b}	1.3-4.0
Matayos	2.1^{b}	1.0-3.8
Township	3.0^{ab}	1.0-7.4

a, b: Values with different superscript letters are significantly ($p < 0.05$) different along the column of comparison

The overall prevalences of *Anaplasma*, *Babesia* and *Theileria* parasites in cattle in the six divisions of Busia District were16.4% (95% CI = 15.1-17.9), 4.8% (95% CI = 4.1-5.7) and 6.9% (95% CI = 6.0-7.9), respectively. The division-specific *Anaplasma* spp.-specific prevalence in cattle did not differ significantly amongst divisions (Table 8). In contrast, chi square statistics for comparison of division-specific *Babesia*- and *Theileria* spp. proportions in cattle revealed significant differences (χ^2 = 26.4, df = 4, $p < 0.05$) and (χ2 = 38.0, df = 5, $p < 0.05$), respectively (Table 9 and 10).

Table 8. Division-specific *Anaplasma* spp. prevalence for cattle in Busia District in 2002

Division	*Anaplasma* spp. prevalence (%)	95% CI
Budalang'i	18.1	14.6-22.0
Funyula	19.7	17.0-22.6
Butula	13.5	10.3-17.2
Nambale	17.6	14.5-21.0
Matayos	11.9	9.2-15.2
Township	12.6	7.5-19.4

Table 9. Division-specific *Babesia* spp. prevalences for cattle in Busia District in 2002

Division	*Babesia* spp. prevalence (%)	95% CI
Budalang'i	6.3^{ab}	4.2-8.9
Funyula	7.5^{a}	5.8-9.5
Butula	5.0^{abc}	3.1-7.6
Nambale	3.1^{bc}	1.8-4.9
Matayos	2.1^{c}	1.0-3.8
Township	0.0^{d}	-

a, b, c, d: Values with different superscript letters are significantly ($p < 0.05$) different along the column of comparison

Table 10. Division-specific *Theileria* spp. prevalences for cattle in Busia District in 2002

Division	*Theileria* spp. prevalence (%)	95% CI
Budalang'i	10.3^{a}	7.6-13.5
Funyula	9.6^{a}	7.7-11.8
Butula	7.5^{ab}	5.1-10.5
Nambale	3.8^{b}	2.4-5.8
Matayos	3.3^{b}	1.9-5.4
Township	3.0^{b}	1.0-7.4

a, b: Values with different superscript letters are significantly ($P < 0.05$) different along the column of comparison

Age–specific proportions of the haemoparasites were compared using chi square and results showed significant differences in trypanosome prevalence between adults, young stock and calves ($\chi^2 = 10.1$, df = 2, $p < 0.05$). The prevalence of *Anaplasma* spp. in adults and young stock significantly differed to that of calves ($\chi^2 = 11.4$, df = 2, $p < 0.05$). In addition, adult and young cattle had significantly higher prevalence of *Babesia* spp. than calves ($\chi^2 = 13.6$, df = 2, $p < 0.05$). In contrast, age was not a significantly important risk factor for *Theileria* spp. (Table 11).

Table 11. Distribution of age-specific prevalences for haemoparasitic infections in cattle in Busia District (2002)

Infection	Adults		Young ones		Calves	
	Prev. (%)	95% CI	Prev. (%)	95% CI	Prev. (%)	95% CI
Trypanosome	5.6^{a}	4.6-6.8	4.0^{ab}	2.6-5.8	2.1^{b}	1.0-4.0
Anaplasma	18.8^{a}	15.9-19.7	17.1^{a}	14.3-19.3	8.5^{b}	5.7-12.4
Babesia	7.1^{a}	5.0-8.8	6.7^{a}	4.9-7.5	2.3^{b}	1.3-3.8
Theileria	6.6	5.4-7.8	7.0	5.1-9.2	8.2	5.8-11.3

a, b: Values with different superscript letters are significantly ($P < 0.05$) different along rows of comparison; Prev: Prevalence

Sex was not a significant risk factor for trypanosome, *Anaplasma, Babesia* and *Theileria* spp. infections. However, male animals had apparently higher parasite-specific prevalences as compared to females (Table 12).

Table 12. Distribution of sex-specific prevalences for haemoparasitic infections in cattle in Busia District (2002)

Infection	Females		Males	
	Prevalence (%)	95% CI	Prevalence (%)	95% CI
Trypanosome	4.4	3.5-5.4	5.5	4.1-7.1
Anaplasma	16.2	14.6-17.9	17.1	14.7-19.8
Babesia	4.3	3.4-5.3	6.0	4.5-7.8
Theileria	6.8	5.7-8.0	7.1	5.5-9.0

There were significant differences ($\chi^2 = 11.4$, df = 2, $p < 0.05$) between trypanosome prevalence proportions in cattle raised under different husbandry practices. On the other hand, the overall prevalence of TBD-parasites (*Anaplasma*, *Babesia* and *Theileria* spp.) in Busia District did not differ significantly in the different husbandry systems (Table 13).

Table 13. Distribution of haemoparasitic-specific prevalences in cattle in Busia District (2002), by husbandry practices

Infection	Free grazing		Tethering		Free grazing/tethering	
	Prev (%)	95% CI	Prev (%)	95% CI	Prev (%)	95% CI
Trypanosome	5.5[a]	4.5-6.8	1.9[b]	1.0-3.4	5.1[a]	3.5-6.9
Anaplasma	17.0	15.2-19.0	15.1	12.1-18.4	16.4	13.8-19.3
Babesia	4.3	3.4-5.5	5.0	3.3-7.3	5.7	4.2-7.7
Theileria	6.6	5.4-7.9	6.8	4.8-9.3	7.8	6.0-10.0

a, b: Values with different superscript letters are significantly ($p < 0.05$) different along rows of comparison; Prev: Prevalence

The division-specific proportions of TBD-parasites did not differ significantly with regard to husbandry practices (Table 14, 15, 16, 17, 18 and 19). However, there was a significant difference in the trypanosome prevalence in cattle from Nambale and Township Divisions, with respect to husbandry practices (Table 17 and 19).

Table 14. Distribution of haemoparasitic-specific prevalences in cattle in Budalang'i Division, Busia District (2002), by husbandry practices

Disease	Free grazing		Tethering		Free grazing/tethering	
	Prev (%)	95% CI	Prev (%)	95% CI	Prev (%)	95% CI
Trypanosome	10.8	7.1-15.7	4.3	1.0-14.5	6.8	3.6-11.6
Anaplasma	17.6	12.8-23.2	17.0	7.6-30.8	18.2	12.8-24.7
Babesia	5.9	3.2-9.8	10.6	3.5-23.1	5.7	2.8-10.2
Theileria	11.7	7.8-16.7	6.4	1.3-17.5	9.7	5.7-15.0

Table 15. Distribution of haemoparasitic-specific prevalences in cattle in Funyula Division, Busia District (2002), by husbandry practices

Infection	Free grazing		Tethering		Free grazing/tethering	
	Prev (%)	95% CI	Prev (%)	95% CI	Prev (%)	95% CI
Trypanosome	6.9	4.7-9.6	4.3	1.6-9.0	6.9	3.9-11.2
Anaplasma	20.7	17.0-24.7	18.4	12.4-25.8	18.5	13.6-24.4
Babesia	7.3	5.1-10.1	7.1	3.5-12.7	8.3	5.0-12.9
Theileria	7.6	5.3-10.4	9.9	5.5-16.1	13.9	9.6-19.2

Table 16. Distribution of haemoparasitic-specific prevalences in cattle in Butula Division, Busia District (2002), by husbandry practices

Infection	Free grazing		Tethering		Free grazing/tethering	
	Prev (%)	95% CI	Prev (%)	95% CI	Prev (%)	95% CI
Trypanosome	5.0	2.5-8.7	1.0	0.0-4.5	7.0	1.9-17.0
Anaplasma	11.8	7.8-16.8	14.8	9.0-22.3	17.5	8.7-30.0
Babesia	3.2	1.3-6.4	6.6	2.9-12.5	8.8	2.9-19.3
Theileria	7.7	4.5-12	7.4	3.4-13.5	7.0	1.9-17.0

The trypanosome prevalences of free grazed and free grazed/tethered cattle in Nambale Division were 3.3% and 1.4%, respectively. However, no trypanosome infection was detected in tethered cattle. The proportions of TBD-parasites under different husbandry practices did not differ significantly ($p > 0.05$) although tethered animals had lower values in all instances (Table 17).

Table 17. Distribution of haemoparasitic-specific prevalences in cattle in Nambale Division, Busia District (2002), by husbandry practices

Infection	Free grazing		Tethering		Free grazing/tethering	
	Prev (%)	95% CI	Prev (%)	95% CI	Prev (%)	95% CI
Trypanosome	3.3[a]	1.7-5.8	0[b]	-	1.4[a]	0.1-4.9
Anaplasma	18.8	14.8-23.4	17.6	9.5-28.8	14.6	9.3-21.4
Babesia	3.0	1.4-5.4	1.5	0.0-7.9	4.2	1.5-8.8
Theileria	4.2	2.3-6.9	2.9	0.4-10.2	3.5	1.1-7.9

a, b: Values with different superscript letters are significantly ($p < 0.05$) different along rows of comparison

Table 18. Distribution of haemoparasitic-specific prevalences in cattle in Matayos Division, Busia District (2002), by husbandry practices

Infection	Free grazing		Tethering		Free grazing/tethering	
	Prev (%)	95% CI	Prev (%)	95% CI	Prev (%)	95% CI
Trypanosome	3.1	1.4-6.1	1.0	0.0-5.1	1.0	0.0-5.2
Anaplasma	13.3	9.4-18.1	9.3	4.6-16.5	12.5	6.8-20.4
Babesia	1.6	0.4-4.0	1.9	0.2-6.6	2.9	0.6-8.2
Theileria	3.1	1.4-6.1	5.6	2.1-11.8	1.0	0.0-5.2

The trypanosome prevalence proportions in free grazed and free grazed/tethered cattle in Township Division were 1.5% and 8.8%, respectively. No trypanosome infection was detected in tethered cattle. In this Division, no *Babesia* parasites were detected in cattle. The prevalence of *Theileria* spp. in free grazed and tethered cattle was 4.5% and 3.0%, respectively, which did not differ significantly. In addition, the prevalence of *Anaplasma* parasites in cattle in the different husbandry practices did not differ significantly ($P > 0.05$) (Table 19).

Table 19. Distribution of haemoparasitic-specific prevalences in cattle in Township Division, Busia District (2002), by husbandry practices

Infection	Free grazing		Tethering		Free grazing/tethering	
	Prev (%)	95% CI	Prev (%)	95% CI	Prev (%)	95% CI
Trypanosome	1.5[a]	0.0-8.0	0[b]	-	8.8[a]	1.9-23.7
Anaplasma	13.4	6.3-24.0	12.1	3.4-28.2	11.8	3.3-27.5
Babesia	0	-	0	-	0	-
Theileria	4.5[a]	1.0-12.5	3.0[a]	0.1-15.8	0[b]	-

a, b: Values with different superscript letters are significantly ($p < 0.05$) different along rows of comparison

5.1.3 PCV profiles

The overall mean PCV% for cattle in Busia District was 25.4%± 0.7. The mean PCV% for trypanosome-aparasitaemic cattle in Busia district was 26.9%±0.1 while that of the trypanosome infected cattle was 23.8%± 0.5. Comparison of mean PCV% values of parasitaemic and aparasitaemic cattle using the student t-test indicated that the PCV% of parasitaemic animals was significantly lower than that of aparasitaemic ones (Table 20).

Table 20. Mean PCV% of trypanosome-aparasitaemic and trypanosome infected cattle in Busia District (2002)

Division	Aparasitaemic cattle		Parasitaemic cattle	
	Mean PCV%	95% CI	Mean PCV%	95% CI
Butula	27.4[a]	26.9 – 27.8	23.9[b]	21.4 – 26.4
Funyula	27.2[a]	26.9 – 27.6	22.8[b]	21.1 – 24.6
Budalang'i	25.4[a]	25.1 – 25.7	22.1[b]	20.8 – 23.4
Nambale	27.0[a]	26.6 – 27.4	23.3[b]	22.9 – 25.6
Matayos	27.3[a]	26.9 – 27.6	23.8[b]	21.6 – 26.1

a, b: Values with different superscript letters are significantly ($p < 0.05$) different along rows of comparison

5.1.4 Entomological survey

Two tsetse fly species (*Glossina pallidipes* and *G. fuscipes*) were caught in Busia District during the survey. *Glossina pallidipes* (Savannah group) was caught mainly in isolated thickets and in overgrown bushes from idle land away from stream/rivers (water systems). On the other hand, *G. fuscipes* (Riverine group) were found in riverine thickets located along River Sio, River Nzioa, seasonal streams and around the shores of Lake Victoria. The overall mean apparent tsetse densities within four divisions (Budalang'i, Funyula, Nambale and Matayos) of the District were low, especially for *G. pallidipes* (0.32 flies/trap/day). However, the apparent density for *G. fuscipes* was 4.9 flies/trap/day, which was significantly higher (χ^2 = 33.2 df = 1 $p < 0.05$) than that of *G. pallidipes*. The mean trypanosome infection rate of *G. pallidipes* in Budalang'i (7.0%, 95% CI = 4.5-10.3) was significantly higher than that of *G. fuscipes* (1.5%, 95% CI = 0.7-2.9). The mean trypanosome infection rate of *G. pallidipes* in Funyula (7.3%; 95% CI = 5.1-10.3) was also significantly higher than the mean trypanosome infection rate of *G. fuscipes* (2.2%, 95% CI = 1.2-3.8) (Table 21). The tsetse survey was not carried out in Butula and Township Divisions due to logistical problems.

Table 21. Division-specific mean apparent tsetse densities and trypanosome infection rates of flies from Budalang'i, Funyula, Nambale and Matayos divisions in Busia District (2002)

Division	Species	Number of flies	Mean FTD	IR (%)	Proportion (%)	
					T. congolense	*T. vivax*
Budalang'i	*G. pallidipes*	40	0.73	7.0	100	0
	G. fuscipes	911	16.6	1.5	42.9	57.1
Funyula	*G. pallidipes*	29	0.53	7.3	66.7	33.3
	G. fuscipes	138	2.51	2.2	0	100
Nambale	*G. pallidipes*	0	0	N/A	N/A	N/A
	G. fuscipes	16	0.53	3.8	33.3	66.7
Matayos	*G. pallidipes*	1	0.033	0	N/A	N/A
	G. fuscipes	14	0.47	0	N/A	N/A

FTD: flies/trap/day; IR (%): infection rate (%)

Results of linear regression analysis indicated that there was a positive significant correlation ($p < 0.05$, R = 0.78) between trypanosome prevalence in cattle and mean apparent tsetse densities for Budalang'i, Funyula, Nambale and Matayos divisions. The risk for trypanosomosis was therefore positively associated with tsetse apparent density (Table 22).

Table 22. Division-specific mean apparent tsetse densities and trypanosome prevalences in cattle from Budalang'i, Funyula, Nambale and Matayos divisions, Busia district (2002)

Division	Mean FTD	Trypanosome prevalence (%)
Budalang'i	8.7	8.5
Funyula	1.5	6.4
Nambale	0.3	2.4
Matayos	0.3	2.1

FTD: flies/trap/day

5.1.5 Tick infestation

The species of ticks infesting cattle were recorded following examination of animals on "half-body basis". Abundance of tick infestation was stratified on a four-point scale (0 = none, low = < 20, moderate = 20-50 and high = >50 ticks). Obtained results indicated that there were three main tick species in the District. These were *Rhipicephalus appendiculatus*, *Amblyomma variegatum* and *Boophilus decoloratus* (Figure 6).

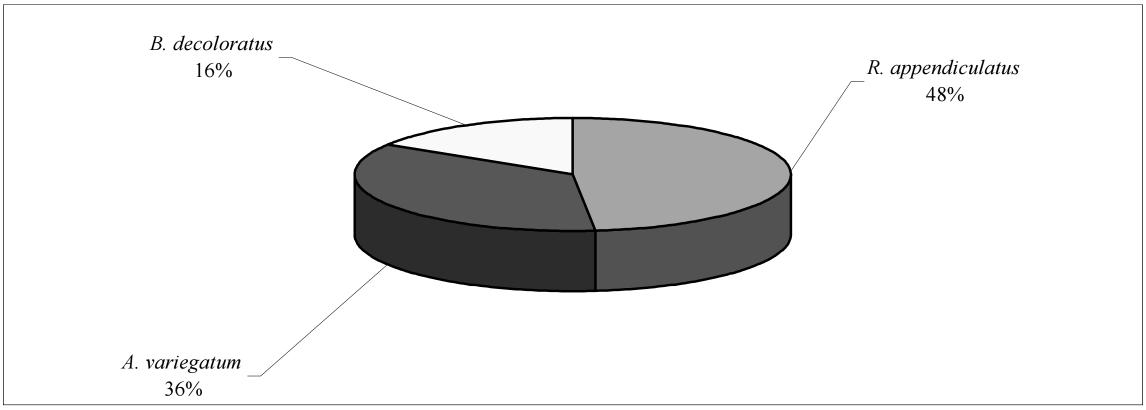

Figure 6. Proportions of tick species infesting cattle in Busia District (2002)

Most animals (72.5%) were infested with more than one tick spp. Adult cattle had significantly higher tick infestation than young animals and calves, while young animals had significantly higher infestation than calves (*$p < 0.05$*). It was therefore evident that tick infestation was age dependent. In contrast, there was no significant difference in tick infestation between males and females (Table 23).

Table 23. Stratification of tick infestation in cattle from the six Divisions of Busia District in 2002 with respect to age and sex

Stratum	Sample size	Levels of tick infestation (%)			
		None	Low	Moderate	High
Adult cattle	1752	10.3^{a}	18.1^{a}	41.6^{a}	30.0^{a}
Young stock	647	19.7^{a}	23.3^{a}	38.4^{a}	18.6^{b}
Calves	425	37.5^{c}	34.8^{c}	19.1^{c}	8.6^{c}
Males	1923	17.2	22.7	38.3	24.5
Females	899	17.9	21.5	39.1	25.5
Overall	2827	17.4	22.3	38.5	24.8

a, b, c: Values with different superscript letters are significantly (*$p < 0.05$*) different along columns of comparison

5.1.6 Helminthosis in calves

Results indicated that calves had FEC which ranged between 0-9 000 epg with a mean FEC was 1160 epg. The majority of the eggs were strongyle and a relatively small number of were derived from ascarids. For purposes of interpretation, calves with FEC of more than 500 epg were considered as heavily infected and those with less than 500 epg as having light to moderate infection (Table 24). There were significantly higher (χ^2 = 12.7, df = 1, p <0.05) numbers of heavily infected calves as compared to light infection. However, no significant difference between male and female calves was observed.

Table 24. Stratification of helminth faecal egg counts recorded in calves from Busia District (2002), by division, sex and levels of FEC

Division	Sex	No. Sampled	Level of FEC shedding (%)	
			Moderate	Heavy
Budalang'i	Males	45	6.5	43.5
	Females	62	9.7	40.2
Funyula	Males	56	15.9	38.1
	Females	68	17.7	28.3
Butula	Males	29	14.1	34.0
	Females	37	20.4	31.5
Nambale	Males	28	11.9	21.4
	Females	34	21.4	45.2
Matayos	Males	22	15.2	30.8
	Females	29	17.9	36.1
Township	Males	8	13.3	33.3
	Females	17	16.7	36.7

Moderate: FEC ≤ 500 per gram of faeces; Heavy: FEC > 500 per gram of faeces

5.2 Longitudinal (prospective) study

5.2.1 Trypanosome incidence

The trypanosome incidence was initially calculated and expressed as a mean hazard rate (MHR) and stratified by trial groups and location (Table 25). Later, the MHR was expressed as the number of cases of trypanosome infections per 100 animals within 52 animal-weeks at risk.

In Budalang'i Division, the MHR for cattle in the untreated control group was 0.066 while that of ISMM-treated animals was 0.016. Cattle that were treated with albendazole (Group III) had a

MHR of 0.039 while those treated with both albendazole/ISMM (Group IV) had a mean MHR of 0.011. The mean hazard ratio (reciprocal of the ratio of MHR in treated compared to control animals) of new infections indicated that the controls animals were 4.13 (0.066/0.016) times at a higher risk of getting new infections than the ISMM treated animals. In addition, the controls were 1.69 (0.066/0.039) times more at risk of new trypanosome infections than the albendazole-treated animals. Finally, the risk of new infections in the control animals was 6 (0.066/0.011) times higher than that of animals under the combined albendazole and ISMM treatments.

In Funyula, control animals had a mean MHR of 0.052 while the ISMM-treated cattle had a mean MHR of 0.012. Albendazole-treated cattle had a mean MHR of 0.030 and Group IV animals had a rate of 0.009. Consequently, the risk of new trypanosome infections in control animals was 4.33 (0.052/0.012) times as high as that of ISMM-treated ones. The risk of new infections in the controls was 1.73 (0.052/0.030) times higher than that of the albendazole-treated animals. In addition, the control animals were at 5.78 (0.052/0.009) times at a higher risk of new trypanosome infections as compared to the combined albendazole- and ISMM-treated animals.

In order to describe the mean hazard rates to the level of each variable, stratified hazard rates were calculated with respect to Division, treatment group, age and breed. The hazard ratios are therefore calculable from tables presented in the annex (Annexes 2 and 3).

Table 25. Mean Hazard rates and the number of trypanosome infections per 100 animals under 52 animal-weeks at risk in Budalang'i and Funyula divisions, Busia District (2003)

Divisions	Trial group	Number of subjects	Number of failures	Number of censored subjects	Weeks at risk	Mean hazard (weeks)	Cases per 100 animal years at risk
Budalang'i	G I	50	100	10	1510	0.066	343
	G II	50	28	4	1716	0.016	83
	G III	50	63	5	1620	0.039	203
	G IV	50	19	4	1714	0.011	57
Funyula	G I	50	81	7	1552	0.052	270
	G II	50	21	2	1726	0.012	62
	G III	50	49	5	1660	0.030	156
	G IV	50	16	3	1750	0.009	47

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM
Censored subjects: Animals removed from the study through death, sale or culling.

5.2.2 Survival analysis for trypanosomosis: multiple failure-time data analysis

Since some animals experienced re-infections with trypanosomes during the 36 weeks follow-up period, it was not possible to analyse the data using simple survival analysis. Therefore, multiple failure-time data for new trypanosome infections in cattle were analysed using the marginal risk set model (Wei *et al.,* 1989). A 'case' of trypanosomosis was defined as "positive detection of trypanosomes (*T. vivax, T. congolense, T. brucei* or a mixed infection) in a buffy-coat smear using the BCT. The model was run initially for the two Divisions (Budalang'i and Funyula Divisions) combined and later for each Division separately.

After running the model for the two Divisions combined, Cox proportional hazard model coefficients indicated that 3 predictor-variables out of 5 were significantly associated with multiple failure-time for trypanosome infection in cattle. These were treatment trial groups, husbandry practices and ages of the animals. However, there was no significant difference ($p > 0.05$) in the rate of recurrent trypanosomosis between cattle from Budalang'i and Funyula divisions. Breed was also not significantly ($p > 0.05$) associated with recurrence of trypanosome infection in cattle. Treatment of cattle with ISMM (Group II and IV) significantly ($p < 0.05$) reduced the probability of occurrence of multiple failures with trypanosomosis. The untreated control (Group I) and albendazole-treated animals (Group III) had significantly ($p < 0.05$) higher rates of recurrence of trypanosome infections than animals in treatment Group III and IV. Free grazed and free grazed/tethered animals experienced significantly ($p < 0.05$) higher probability of repeat infections with trypanosomosis as compared to stall-fed and tethered animals. The probability of recurrence of trypanosome infection also increased with age, where adult cows and heifers experienced significantly ($p < 0.05$) higher recurrent trypanosome infections as compared to calves. The effect estimates (coefficients), robust standard errors for the coefficients, p-values and 95% CIs for the estimates are presented in Table 26.

Table 26. Coefficients, robust standard errors (SE) and 95% CI from a Cox proportional hazards model (Wei, Lin and Weissfeld-model) of factors associated with multiple failure-time for trypanosome infection in cattle from Budalang'i and Funyula Divisions, Busia District (April-December 2003)

Variable	Levels	Coeff.	Robust SE*	Z-value	*p* > Z	95% CI
Division	Budalang'i	0.25	0.09	2.83	0.42	0.08-0.43
	Funyula	0.17	0.06	2.16	0.26	0.03-0.36
Trial group	G I	-0.46	0.04	-10.82	0.00	-(0.54-0.37)
	G II	0.07	0.11	0.29	0.42	-0.06-0.15
	G III	-0.73	0.09	-13.19	0.00	-(0.24-0.08)
	G IV	0.02	0.07	0.82	1.20	-0.15-0.37
Husbandry	F-grazing	-0.45	0.01	-15.60	0.00	-(0.91-0.55)
	Tethering	0.00	0.00	-0.66	0.41	-0.03-0.01
	S-feeding	-0.05	0.04	-1.22	0.29	-0.14-0.03
	F/tethering	-0.31	0.01	-17.33	0.01	-(0.85-0.42)
Age category	Calves	0.00	0.00	0.68	0.47	-0.01-0.00
	Heifers	-0.13	0.05	-2.53	0.01	-(0.23-0.03)
	Adults	-0.39	0.01	-1.30	0.00	-(0.98-0.40)
Breed	Exotic	0.06	0.10	0.64	0.52	-0.13-0.25
	Local	-0.01	0.01	-0.62	0.54	-0.39-0.04

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM
No. of subjects in the final model = 400; multiple failures = 377; total time at risk = 13 248 weeks
*Robust standard errors adjusted for clustering on animal id; Coeff: Coefficient
Log pseudo-likelihood = -2177.19; Wald χ^2 (15) = 145.45; p > χ^2 = 0.00 (results based on Cox regression-Efron method for ties)

In Budalang'i Division, the Cox regression coefficients showed that the trial groups, husbandry practices and ages of the animals were significantly ($p < 0.05$) associated with multiple failure-time for trypanosome infection in cattle. Breed in contrast was not significantly ($p > 0.05$) associated with multiple trypanosome infection in cattle over time (Table 27). Isometamidium-treated animals had significantly ($p < 0.05$) lower rates of recurrence than the untreated control and albendazole treated animals. Stall feeding and tethering of animals significantly reduced the probability of multiple recurrences with trypanosomosis as compared to free grazing and free grazing/tethering. In addition, the probability of multiple recurrences significantly increased with the age of an animal.

Table 27. Coefficients, robust standard errors (SE) and 95% CI from a Cox proportional hazards model (Wei, Lin and Weissfeld-model) of factors associated with multiple failure-time for trypanosome infection in cattle from Budalang'i Division, Busia District (April-December 2003)

Variable	Levels	Coeff.	Robust SE*	Z-value	*p* > Z	95% CI
Trial group	G I	-0.45	0.05	-8.69	0.00	-(0.55-0.35)
	G II	0.05	0.08	0.32	0.64	-0.04-0.21
	G III	-0.29	0.02	-6.43	0.02	-(0.62-0.39)
	G IV	0.04	0.09	0.55	0.94	-0.22-0.01
Husbandry	F-grazing	-0.32	0.02	-12.45	0.00	-(0.72-0.41)
	Tethering	0.03	0.01	-0.38	0.26	-0.07-0.05
	S-feeding	-0.01	0.05	-0.26	0.80	-0.12-0.10
	F/tethering	-0.38	0.01	-14.10	0.02	-(0.66-0.39)
Age category	Calves	-0.40	0.01	-0.12	0.29	-(0.67-0.43)
	Heifers	-0.09	0.01	-1.15	0.04	-0.05-0.13
	Adults	-0.13	0.06	-2.20	0.03	-(0.25-0.01)
Breed	Exotic	0.19	0.11	1.67	0.10	-0.03-0.41
	Local	0.24	0.05	1.88	0.69	-0.09-0.37

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM
No. of subjects in the final model = 200; multiple failures = 210; total time at risk = 6 560 weeks
*Robust standard errors adjusted for clustering on animal id; Coeff: Coefficient
Log pseudo-likelihood = -1067.13; Wald χ^2 (13) = 87.46; p > χ^2 = 0.00 (results based on Cox regression-Efron method for ties)

Results from Funyula Division were similar to those observed in Budalang'i Division. Treatment trial groups, husbandry and ages of animals were significantly associated with multiple failure-time for trypanosome infection in cattle but not breed. Treatment of animals with ISMM significantly reduced the recurrence of trypanosome infection. Conversely, free grazing and free grazing/tethering significantly increased the recurrence of trypanosome infection in cattle. In addition, adult cows and heifers were significantly associated with multiple recurrence of trypanosome infection as compared to calves (Table 28).

Table 28. Coefficients, robust standard errors (SE) and 95% CI from a Cox proportional hazards model (Wei, Lin and Weissfeld-model) of factors associated with multiple failure-time for trypanosome infection in cattle from Budalang'i Division, Busia District (April-December 2003)

Variable	Levels	Coeff.	Robust SE*	Z-value	$p > Z$	95% CI
Trial group	G I	-0.46	0.07	-6.82	0.00	-(0.55-0.35)
	G II	0.08	0.05	0.26	0.37	-0.05-0.29
	G III	-0.51	0.04	-5.18	0.01	-(0.70-0.44)
	G IV	0.06	0.08	0.36	0.62	-0.13-0.09
Husbandry	F-grazing	-0.27	0.01	-9.53	0.01	-(0.64-0.29)
	Tethering	0.01	0.00	-0.25	0.08	-0.04-0.06
	S-feeding	-0.11	0.07	-1.42	0.16	-0.12-0.10
	F/tethering	-0.34	0.01	-10.51	0.03	-(0.81-0.42)
Age category	Calves	-0.12	0.09	-1.44	0.15	-(0.25-0.01)
	Heifers	-0.18	0.03	-2.01	0.03	-(0.43-0.19)
	Adults	-0.36	0.01	-4.35	0.00	-(0.62-0.38)
Breed	Exotic	0.08	0.06	-0.33	0.09	-0.12-0.28
	Local	0.10	0.18	-0.55	0.58	-0.02-0.44

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM
No. of subjects in the final model = 200; multiple failures = 167; total time at risk = 6 688 weeks
*Robust standard errors adjusted for clustering on animal id; Coeff: Coefficient
Log pseudo-likelihood = -850.20; Wald χ^2 (13) = 65.96; p > χ^2 = 0.00 (results based on Cox regression-Efron method for ties)

5.2.3 Entomological survey

5.2.3.1 Apparent tsetse density

Two tsetse species were detected in Budalang'i and Funyula Divisions; *Glossina fuscipes* and *G. pallidipes*. The predominant tsetse species in both Budalang'i and Funyula divisions was *G. fuscipes*. In Budalang'i Division, the overall mean apparent density of *G. fuscipes* was 10.1 flies/trap/day while that of *G. pallidipes* was 4.2 flies/trap/day (Figure 7). In Funyula, the mean apparent density of *G. fuscipes* was 9.2 flies/trap/day while that of *G. pallidipes* was 5.8

flies/trap/day (Figure 8). Results of the graphical correlation between the apparent densities and monthly rainfall data showed gradual increases in the apparent densities for *G. fuscipes*, between April and May (after the onset of the long rains) and peaked in early June (after the end of long rains). Consequently, the apparent densities decreased through July, August and September and then rose again from October (towards the end of the short rains). For *G. fuscipes*, there was a time-lag between the peak of the rains and the peak of the apparent tsetse densities. On the other hand, the apparent densities of *G. pallidipes* seemed to increase and decrease concurrent with rains.

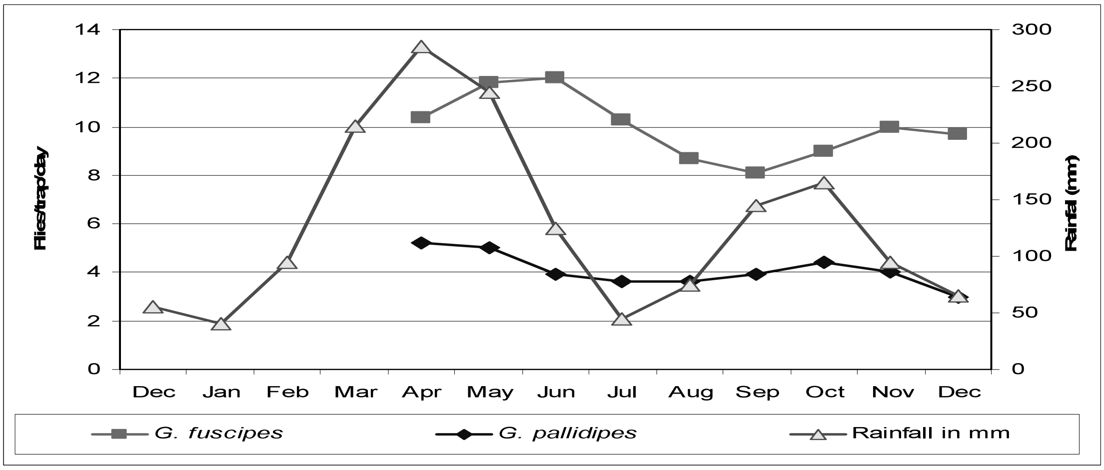

Figure 7. Correlation between mean monthly apparent densities of *G. fuscipes* and *G. pallidipes* (April-December 2003) and mean monthly rainfall (December 2002-December 2003) in Budalang'i Division, Busia District

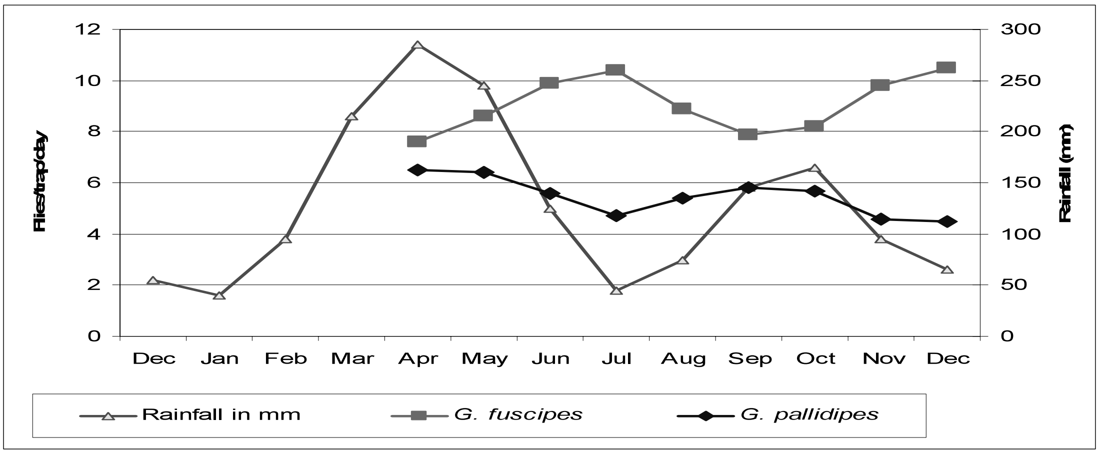

Figure 8. Correlation between mean monthly apparent densities of *G. fuscipes* and *G. pallidipes* (April-December 2003) and mean monthly rainfall (December 2002-December 2003) in Funyula Division, Busia District

5.2.3.2 Trypanosome species and infection rates in tsetse flies

Results of trypanosome species and infection rates in tsetse flies in Budalang'i and Funyula divisions are summarised in Tables 29 and 30. In Budalang'i Division, the overall mean mature trypanosome infection rate in *G. fuscipes* was 1.8% while that in *G. pallidipes* was 3.3%. In Funyula Division, the mean infection rate was 1.5% in *G. fuscipes* and 3.8% in *G. pallidipes*.

Table 29. Mature trypanosome infection rates in *G. fuscipes* and *G. pallidipes* in Budalang'i Division (April-December) 2003

Month	*G. fuscipes* Number dissected	Number infected	Infected (%)	*G. pallidipes* Number dissected	Number infected	Infected (%)
April	115	3	2.6	51	2	3.9
May	97	1	1.0	49	1	2.0
June	124	4	3.2	54	2	3.7
July	102	3	2.9	37	1	2.7
August	88	1	1.1	22	0	0
September	79	0	0.0	27	1	3.7
October	100	2	2.0	35	1	2.9
November	106	1	0.9	56	2	3.6
December	119	2	1.7	58	3	5.2
Overall	930	17	1.8	389	13	3.3

Table 30. Mature trypanosome infection rates in *G. fuscipes* and *G. pallidipes* in Funyula Division (April-December 2003)

Month	*G. fuscipes* Number dissected	Number infected	(%) infected	G. pallidipes Number dissected	Number infected	(%) infected
April	91	1	1.1	65	1	1.5
May	84	2	2.4	70	3	4.3
June	70	2	2.9	54	1	1.9
July	115	2	1.7	49	2	4.1
August	80	1	1.3	37	1	2.7
September	97	1	1.0	45	2	4.4
October	65	0	0	40	2	5.0
November	88	2	2.3	54	3	5.6
December	90	1	1.1	60	3	5.0
Overall	780	15	1.5	474	18	3.8

Three groups of trypanosomes were observed in infected tsetse flies, namely: *Vivax*-, *Congolense*- and *Brucei*-group (Table 31 and 32). In both Divisions, *G. fuscipes* apparently harboured more *Vivax*-type infections as compared to the *Congolense*-type. Whereas, *G. pallidipes* had apparently higher *Congolense*-type infections as compared to the *Vivax*-type. However, there were no significant differences in the proportions of the *Vivax*-type compared to *Congolense*-type infections. Only 5 positive salivary gland infections (2 in *G. fuscipes* and 3 in *G. pallidipes*) were detected in the two divisions.

Table 31. Proportion and type of trypanosome infection of *G. fuscipes* and *G. pallidipes* from Budalang'i Division (April-December 2003)

		Vivax-group			*Congolense*-group			*Brucei*-group		
			(%) infected[a]			(%) infected[a]			(%) infected[a]	
Species	n	Positive	(1)	(2)	Positive	1	2	Positive	1	2
G. fuscipes	930	10	1.1	58.8	6	0.6	35.3	1	0.1	5.9
G. pallidipes	389	5	1.3	38.5	7	1.8	53.8	1	0.3	7.7

[a](1) Infection rate (%) of the total sample; [a](2) Proportion (%) of the trypanosome species infecting the flies

Table 32. Proportion and type of trypanosome infection of *G. fuscipes* and *G. pallidipes* from Funyula Division (April-December 2003)

		Vivax-group			*Congolense*-group			*Brucei*-group		
			(%) infected[a]			(%) infected[a]			(%) infected[a]	
Species	N	Positive	(1)	(2)	Positive	1	2	Positive	1	2
G. fuscipes	780	8	1.0	53.3	6	0.8	40.0	1	0.1	6.7
G. pallidipes	474	6	1.3	33.3	10	2.1	55.6	2	0.4	11.1

[a](1) Infection rate (%) of the total sample; [a](2) Proportion (%) of the trypanosome species infecting the flies

5.2.3.3 Results of bloodmeal identification

Out of 84 bloodmeal samples collected from Budalang'i Division, 60 (71.4%) were from *G. fuscipes* while 24 (28.6%) were from *G. pallidipes*. Of the 60 *G. fuscipes* bloodmeal samples, 35 (58.3%) were identified and 12 (50.0%) out of 24 *G. pallidipes* bloodmeal samples were identified. In total, 47 (56.0%) bloodmeal samples were identifiable (Table 33).

In Funyula Division, a total 93 bloodmeal samples were collected, of which 67 (72.0%) were from *G. fuscipes* while, 26 (28.0%) were from *G. pallidipes*. The bloodmeal ELISA was able to identify 46 (68.7%) bloodmeal samples from *G. fuscipes* and 17 (65.4%) of bloodmeal samples from *G. pallidipes*. Consequently, 63 (67.7%) out of 93 bloodmeal samples from both the two fly-species were identifiable (Table 33).

Table 33. Number of bloodmeal samples identified from tsetse flies caught in Budalang'i and Funyula Divisions, Busia District (April-December 2003)

Division	Glossina species	Number of samples	Identified samples	% identified
Budalang'i	*G. fuscipes*	60	35	58.3
	G. pallidipes	24	12	50.0
	Overall	**84**	**47**	**56.0**
Funyula	*G. fuscipes*	67	46	68.7
	G. pallidipes	26	17	65.4
	Overall	**93**	**63**	**67.7**

5.2.3.4 Feeding patterns

In Budalang'i Division, the main source of bloodmeals for *Glossina* was ruminants (primarily cattle, sheep and goats). In the case of *G. fuscipes*, 48.6% of their bloodmeals were derived from ruminants while for *G. pallidipes* they accounted for 41.7%. In addition, 40.0% and 33.3% of bloodmeal for *G. fuscipes* and *G. pallidipes* were respectively derived from reptiles (crocodile). Other sources of bloodmeals for tsetse in Budalang'i were Homidae (2.9% for *G. fuscipes*), Suidae (5.7% for *G. fuscipes*; 8.3% for *G. pallidipes*) and mixed bloodmeals (2.9% for *G. fuscipes* and 16.7 for *G. pallidipes*) (Figure 9A and 9B). Mixed samples were a combination of either ruminant/Suidae or ruminant/reptile.

In Funyula Division, the results revealed that tsetse flies also fed mainly on blood from ruminants (cattle, sheep and goats). *Glossina fuscipes* had 87.0% of their bloodmeals taken from ruminants while, for *G. pallidipes*, it was 70.6%. Reptiles (crocodiles and monitor lizards) were not as common a source of bloodmeals as was in Budalang'i Division. Crocodiles contributed

4.3% of the bloodmeal for *G. fuscipes* and none for *G. pallidipes*. Other sources of bloodmeals for the flies were Homidae (4.3% for *G. fuscipes*), Suidae (5.9% for *G. pallidipes*), monitor lizards (11.8% for *G. pallidipes*) and mixed bloodmeals (4.3% for *G. fuscipes*; 11.8% for *G. pallidipes*) (Figure 9C and 9D).

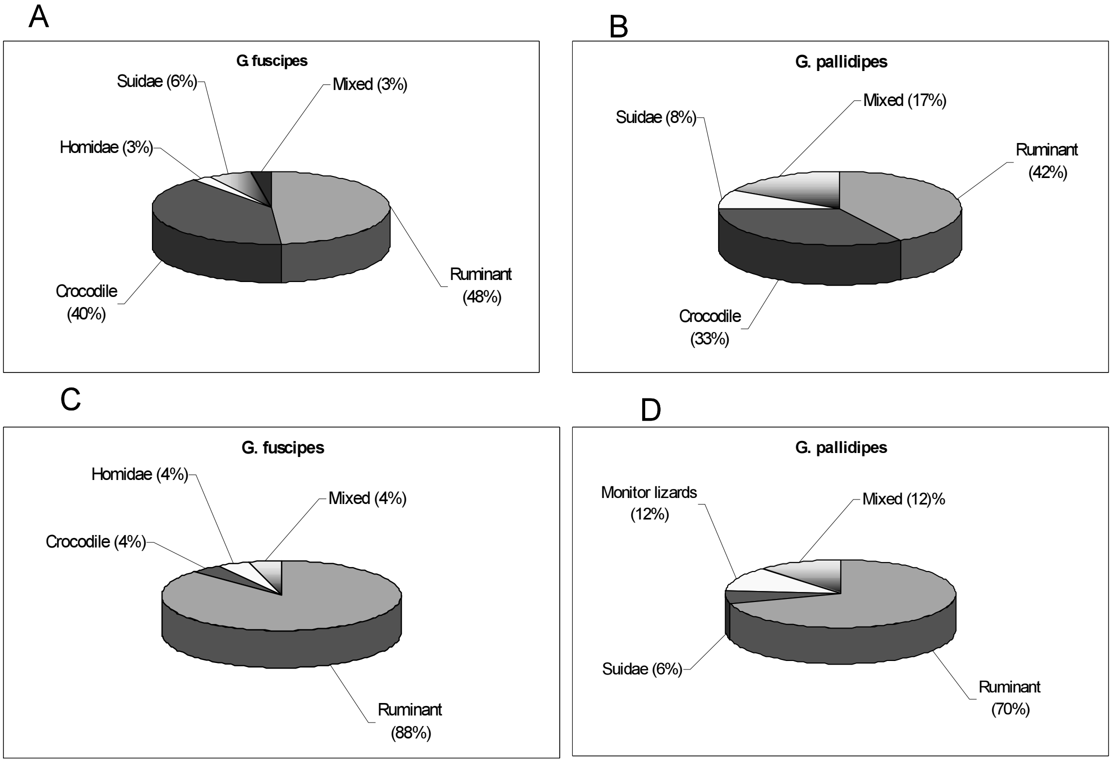

Figure 9. Feeding patterns (rounded to nearest whole number) of tsetse flies from two divisions of Busia District (April-December 2003). A: *Glossina fuscipes* (n = 35) from Budalang'i Division. B: *Glossina pallidipes* (n = 12) from Budalang'i Division. C: *Glossina fuscipes* (n = 46) from Funyula Division. D: *Glossina pallidipes* (n = 17) from Funyula Division

5.2.3.5 Tsetse challenge

The risk index in Budalang'i Division was estimated to be 1455 and that in Funyula was 2757. The main factor that seemed to influence the observed difference was the proportion of bloodmeals taken from ruminants whereby, in Funyula, the proportion almost doubled that in Budalang'i Division. In return there was twice as high a risk index in Funyula Division as that of Budalang'i Division (Table 34).

Table 34. Estimates of tsetse challenge for domestic ruminants in Budalang'i and Funyula divisions (April-December 2003)

Division	Species	Apparent density	Infection rate (%)	Ruminant bloodmeal (%)	Risk index	Total risk*
	G. fuscipes	10.1	1.8	48	873	
Budalang'i	*G. pallidipes*	4.2	3.3	42	582	1455
	G. fuscipes	9.2	1.5	88	1214	
Funyula	*G. pallidipes*	5.8	3.8	70	1543	2757

*Total risk results from the summation of the risk indices from *G. fuscipes* and *G. pallidipes* per Division

5.2.4 Tick-borne diseases

The association between various risk factors and tick-borne diseases in cattle were estimated using logistic regression (Table 35). Each of the three TBD-parasites (*Anaplasma*, *Babesia* and *Theileria*) was separately dichotomised and used as a response variable in the model. While, location (division), trial group, husbandry practices, ages, breeds and time (investigation week) were used as predictor variables. Since no treatment/control against tick-borne diseases was undertaken during the study (as compared to trypanosome and helminth infection), detection of the parasites was considered as a background infection and was monitored to establish whether control of trypanosomosis and helminthosis had a significant effect on the outcome of TBD-parasites.

Trial group, ages and breeds of the animals were significantly associated with the level of detected *Anaplasma*-parasites. Combined treatment with albendazole/ISMM every three months significantly reduced the odds of detection of *Anaplasma*-parasites in cattle. Conversely, control animals, ISMM -(Group II) and albendazole -(Group III) treated animals were all at significantly higher risks of infection as compared to the albendazole/ISMM-treated (Group IV) animals. The risk of infection with *Anaplasma*-parasites also increased with the age of the animals. Adults and heifers were significantly at a higher risk of infection as compared to calves. In addition, the odds of contracting *Anaplasma*-parasites were significantly higher for exotic cattle. Location, husbandry system and investigation week were not significantly associated with detection of the parasite (Table 35).

Table 35. Odds ratios, robust standard errors (SE) and 95% CI from a logistic regression analysis of factors associated with detection of *Anaplasma*-parasites in cattle from Budalang'i and Funyula divisions, Busia District (April-December 2003)

Variable	Levels	Odds ratio	Robust SE*	Z-value	$p > Z$	95% CI
Division	Budalang'i	5.38	9.96	0.91	0.36	0.14-202.83
	Funyula	3.21	6.55	0.82	0.51	0.25-190.83
Trial group	G I	2.12	0.09	-2.54	0.01**	1.62-4.61
	G II	1.60	0.13	-1.95	0.03**	1.25-4.22
	G III	1.26	0.12	0.08	0.05**	0.68-3.16
	G IV	1.10	0.72	0.84	0.40	0.59-3.82
Husbandry	F-grazing	0.92	0.08	-0.91	0.35	0.77-1.10
	Tethering	0.53	0.07	-0.96	0.51	0.32-0.95
	S-feeding	0.77	0.11	-0.83	0.47	0.58-1.01
	F/tethering	0.48	0.09	-0.79	0.62	0.29-0.83
Age category	Adults	1.40	0.08	0.06	0.03**	1.21-1.85
	Heifers	1.31	0.06	0.02	0.05**	1.10-1.52
	Calves	0.65	0.20	0.13	0.97	0.42-0.99
Breed	Local	1.11	0.09	0.22	0.07	0.09-2.76
	Exotic	2.27	0.15	-2.43	0.02**	1.18-4.35
Time (week)	--	0.99	0.01	-1.05	0.29	0.98-1.01

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM
*Robust standard errors adjusted for clustering on animal id
Log pseudo-likelihood = -1029.36; Wald χ^2 (df; 7) = 29.76; $P > \chi^2 = 0.00$
**Odds ratios significantly different from 1 with $p < 0.05$
F-grazing: Free grazing, S-feeding: Stall feeding, F/tethering: Free grazing/tethering

The risk of detecting *Babesia*-parasites in cattle increased with the age of the animals. Adults and heifers were at a significantly ($p < 0.05$) higher risk of infection as compared to calves. All the other predictor variables were not significantly associated with the risk of infection with *Babesia*-parasites in cattle in the two divisions (Table 36).

Table 36. Odds ratios, robust standard errors (SE) and 95% CI from a logistic regression analysis of factors associated with detection of *Babesia*-parasites in cattle from Budalang'i and Funyula divisions, Busia District (April-December 2003)

Variable	Levels	Odds ratio	Robust SE*	Z-value	$p > Z$	95% CI
Division	Budalang'i	1.25	1.83	-0.10	0.92	0.01-71.09
	Funyula	1.48	1.67	-1.32	0.63	0.07-58.24
Trial group	G I	1.15	0.42	0.36	0.38	0.75-4.63
	G II	0.81	0.76	0.80	0.66	0.48-5.21
	G III	0.99	0.36	0.72	0.64	0.53-4.29
	G IV	0.94	0.55	-0.10	0.92	0.30-2.96
Husbandry	F-grazing	1.02	0.27	0.09	0.24	0.69-2.51
	Tethering	1.14	0.16	-0.72	0.90	0.87-2.09
	S-feeding	0.93	0.31	-1.35	0.46	0.59-1.00
	F/tethering	1.06	0.10	0.62	0.54	0.88-1.27
Age category	Adults	1.41	0.05	-2.01	0.04**	1.19-2.08
	Heifers	1.30	0.08	-1.10	0.05**	1.05-1.68
	Calves	0.94	0.13	-0.46	0.64	0.71-1.23
Breed	Local	0.52	0.33	-1.31	0.62	0.24-0.93
	Exotic	0.74	0.26	-0.87	0.39	0.38-1.46
Time (week)	--	1.01	0.01	1.18	0.24	0.99-1.03

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM
*Robust standard errors adjusted for clustering on animal id
Log pseudo-likelihood = -615.84; Wald χ^2 (df; 7) = 3.80; $p > \chi^2 = 0.05$
**Odds ratios significantly different from 1 with $p < 0.05$
F-grazing: Free grazing, S-feeding: Stall feeding, F/tethering: Free grazing/tethering

For *Theileria* spp., breed was a significant predictor of the level of theileriosis in cattle in both Divisions. The odds of exotic/crossbred animals contracting *Theileria*-parasites were significantly higher than that of the local Zebus. Location, treatment group, husbandry, age and investigation week were not significantly associated with the risk of infection with *Theileria*-parasites in cattle (Table 37).

Table 37. Odds ratios, robust standard errors (SE) and 95% CI from a logistic regression analysis of factors associated with detection of theilerial-parasites in cattle from Budalang'i and Funyula divisions, Busia District (April-December 2003)

Variable	Levels	Odds ratio	Robust SE*	Z-value	$p > Z$	95% CI
Division	Budalang'i	1.78	2.34	0.44	0.66	0.13-23.27
	Funyula	1.95	3.27	0.82	0.51	0.25-28.51
Trial group	G I	1.82	0.06	-1.32	0.92	0.94-3.34
	G II	1.55	0.11	-2.21	0.12	0.79-4.00
	G III	1.26	0.09	-1.56	0.45	0.86-3.64
	G IV	0.83	0.91	0.47	0.72	0.43-3.29
Husbandry	F-grazing	1.00	0.16	-0.27	0.45	0.58-1.92
	Tethering	0.89	0.09	-0.94	0.39	0.67-1.13
	S-feeding	0.63	0.18	-1.02	0.75	0.44-0.96
	F/tethering	0.97	0.60	-0.43	0.67	0.86-1.10
Age category	Adults	1.19	0.07	0.28	0.06	0.94-1.73
	Heifers	0.68	0.15	0.07	0.09	0.37-0.91
	Calves	0.99	0.18	0.09	0.27	0.73-1.28
Breed	Local	0.85	0.11	0.26	0.39	0.55-1.16
	Exotic	3.51	0.09	-3.45	0.01**	2.26-5.61
Time (week)	--	0.99	0.01	-0.18	0.86	0.98-1.01

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM
*Robust standard errors adjusted for clustering on animal id
Log pseudo-likelihood = -721.18; Wald χ^2 (df; 16) = 73.94; $p > \chi^2 = 0.02$
**Odds ratios significantly different from 1 with $p < 0.05$
F-grazing: Free grazing, S-feeding: Stall feeding, F/tethering: Free grazing/tethering

5.2.5 Faecal egg counts (FEC)

5.2.5.1 Descriptive statistics

A graphical distribution was fitted to the FEC data to determine the type of analysis to be applied. The data were heavily skewed to the right with many animals having zero and low counts while few animals had high counts (Figure 10). Log transformation failed to normalize the distribution. After transformation, the data still exhibited an over-dispersed Poisson distribution (Figure 11).

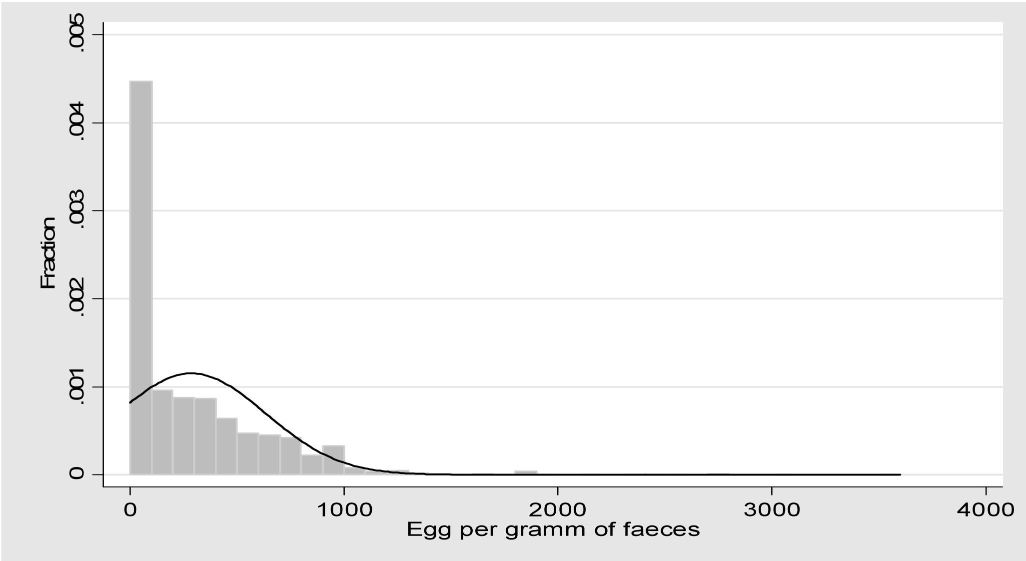

Figure 10. Distribution of FEC of cattle from Budalang'i and Funyula divisions, Busia District (April-December 2003)

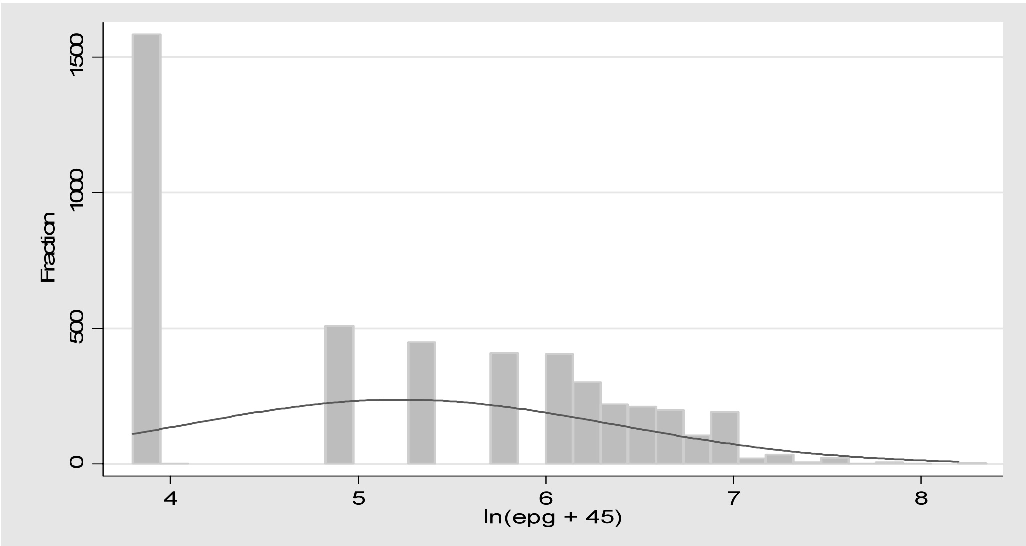

Figure 11. Distribution of FEC of cattle from Budalang'i and Funyula divisions, Busia District (April-December 2003) after ln(epg + 45) transformation

The mean, median and the range of FEC of cattle with respect to treatment group in each Division are presented in Tables 38 and 39. In general, the FEC of adult cattle ranged from 0 to 1800, for heifers from 0 to 2250 and for calves from 0 to 6570 eggs per gram of faeces.

Table 38. Summary statistics for FEC of cattle from Budalang'i division, Busia District (April-December 2003) with respect to treatment trial group

Age category	Trial group	n	Mean	Median	Range	SD
Adults	G I	234	390	360	0-1800	303
	G II	240	323	270	0-1080	263
	G III	235	134	0	0-1260	219
	G IV	234	127	0	0-1080	226
Heifers	G I	173	447	360	0-2250	390
	G II	180	375	360	0-2070	311
	G III	180	192	90	0-1800	248
	G IV	176	158	90	0-2160	230
Calves	G I	166	990	630	0-6300	590
	G II	171	617	450	0-6120	560
	G III	169	186	90	0-6570	371
	G IV	176	169	90	0-6480	351

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

Table 39. Summary statistics for FEC of cattle from Funyula Division, Busia District (April-December 2003) with respect to treatment trial group

Age category	Trial group	n	Mean	Median	Range	SD
Adults	G I	236	302	270	0-1620	252
	G II	240	250	180	0-1170	216
	G III	233	119	0	0-1530	185
	G IV	240	90	0	1350	173
Heifers	G I	180	388	360	0-1800	274
	G II	180	362	360	0-1260	284
	G III	180	184	0	0-1530	265
	G IV	180	159	0	0-1620	221
Calves	G I	159	869	540	0-5490	484
	G II	171	703	450	0-5310	323
	G III	174	175	90	0-5760	281
	G IV	174	155	45	0-5580	304

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

During examination, two main types of helminth eggs were detected in calves, namely, strongyle and ascarid eggs. In comparison, in adults and heifers, strongyle eggs dominated the counts. Results indicated that in the control group, the shedding of ascarid eggs declined over time to undetectable levels by the time calves were 6-8 months of age. In contrast, the shedding of strongyle eggs in the control group continued to show periodic changes but remained well over 500 epg throughout the period. In the treatment groups, there was a major reduction in FEC of both strongyle and ascarid eggs two weeks post treatment with albendazole or with albendazole/ISMM. Low levels were maintained throughout the follow-up period except for slight increases in the last four weeks preceding treatment. The trends of shedding of helminth eggs in the control and treatment groups for adults, heifers and calves over time were also investigated to establish the effect of treatment on the rate of excretion of eggs. Animals within the treatment groups maintained significantly lower levels of FEC than those in control groups in both Budalang'i and Funyula divisions. The following series of figures (Figure 12-19) show the trends of shedding of strongyle and ascarid eggs by calves and the comparison of the rate of helminth egg-excretion in the control and treatment groups in adults, heifers and calves in Budalang'i and Funyula divisions.

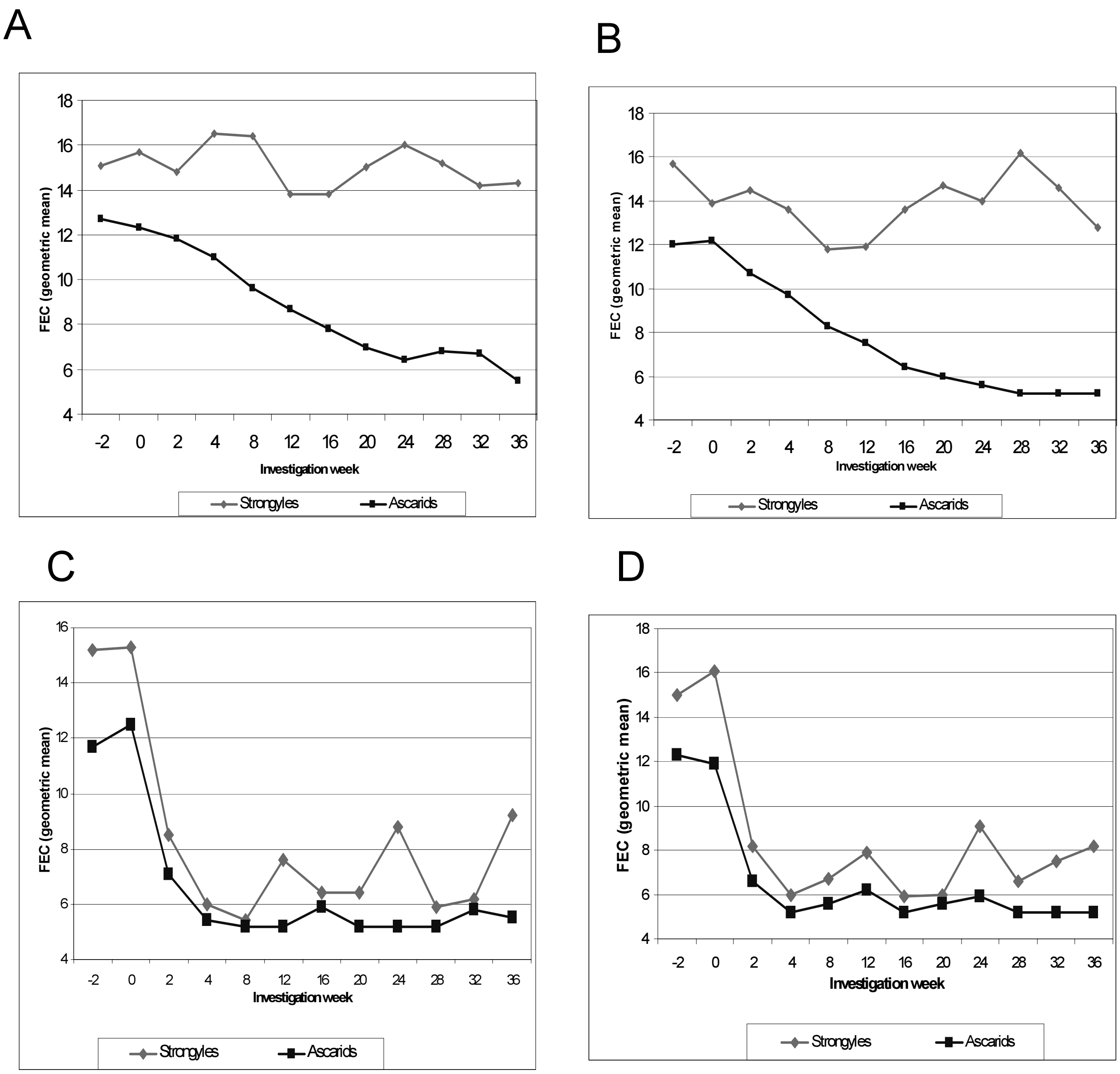

Figure 12. Patterns of shedding of FEC in calves from Budalang'i Division, Busia District (April-December 2003). A: Untreated control (group I); B: ISMM treatment (group II); C: Albendazole treatment (group III); D: Albendazole and ISMM treatment (group IV)

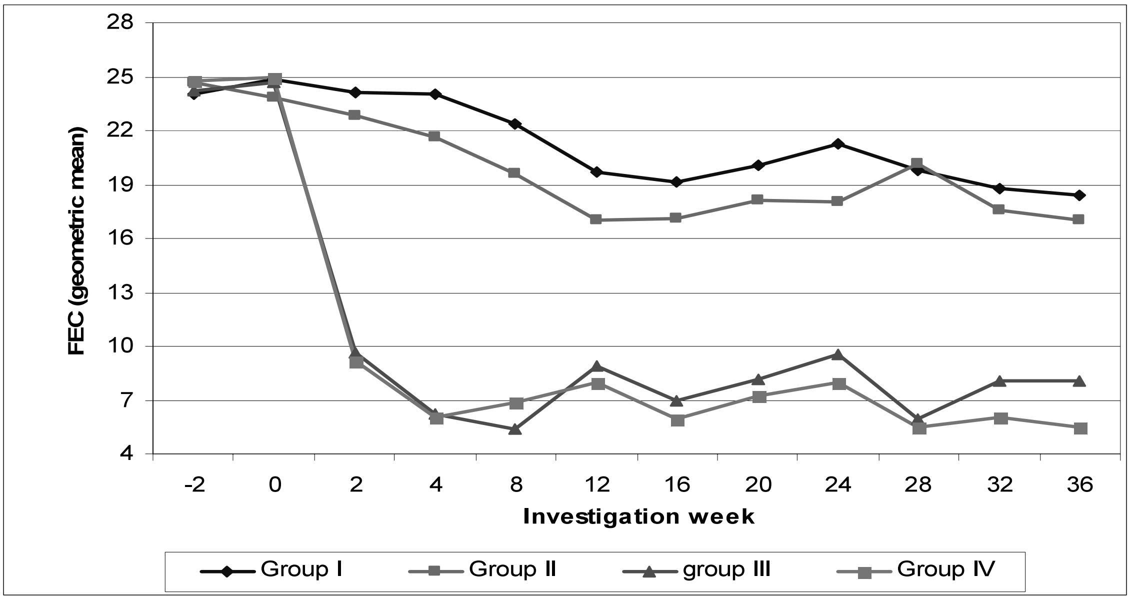

Figure 13. Overall trends of FEC shedding in treated and control calves from Budalang'i Division, Busia District (April-December 2003)

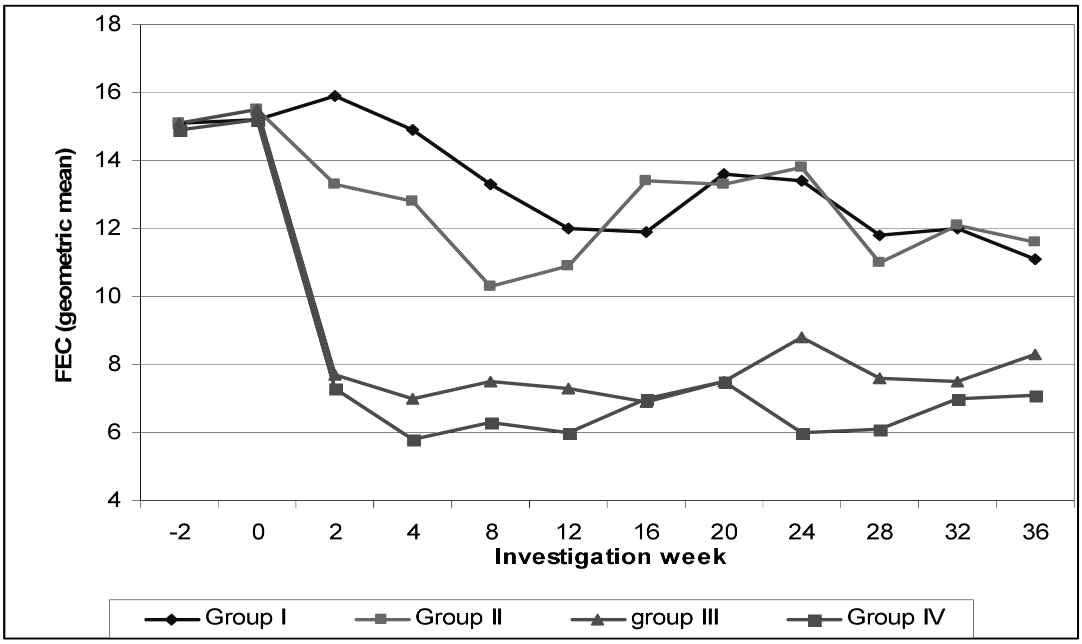

Figure 14. Overall trends of FEC shedding in treated and control heifers from Budalang'i Division, Busia District (April-December 2003)

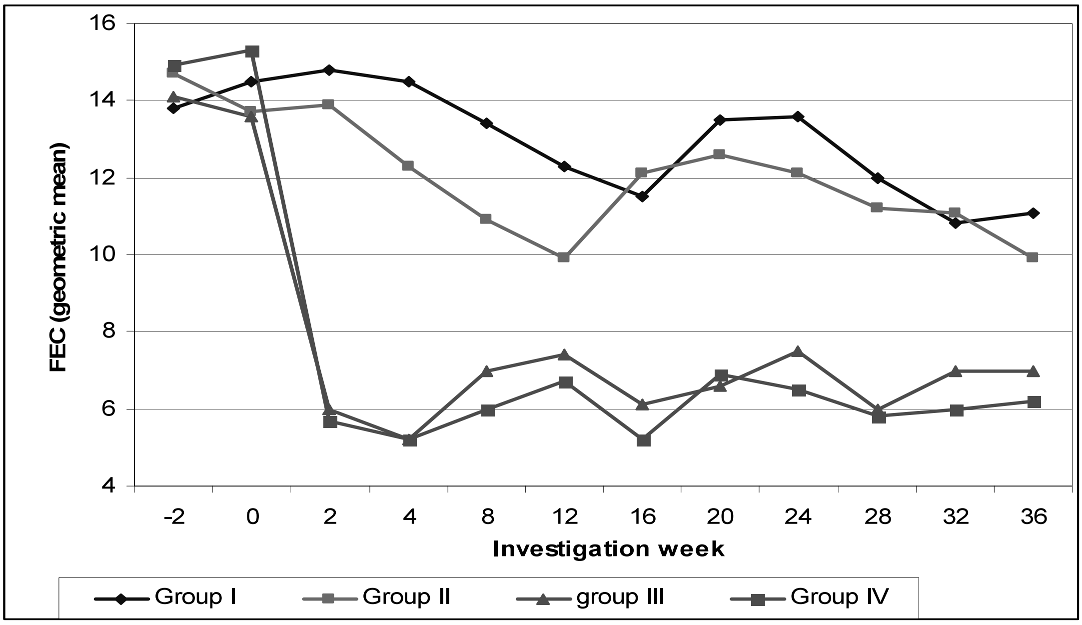

Figure 15. Overall trends of FEC shedding in treated and control adult cattle from Budalang'i Division, Busia District (April-December 2003)

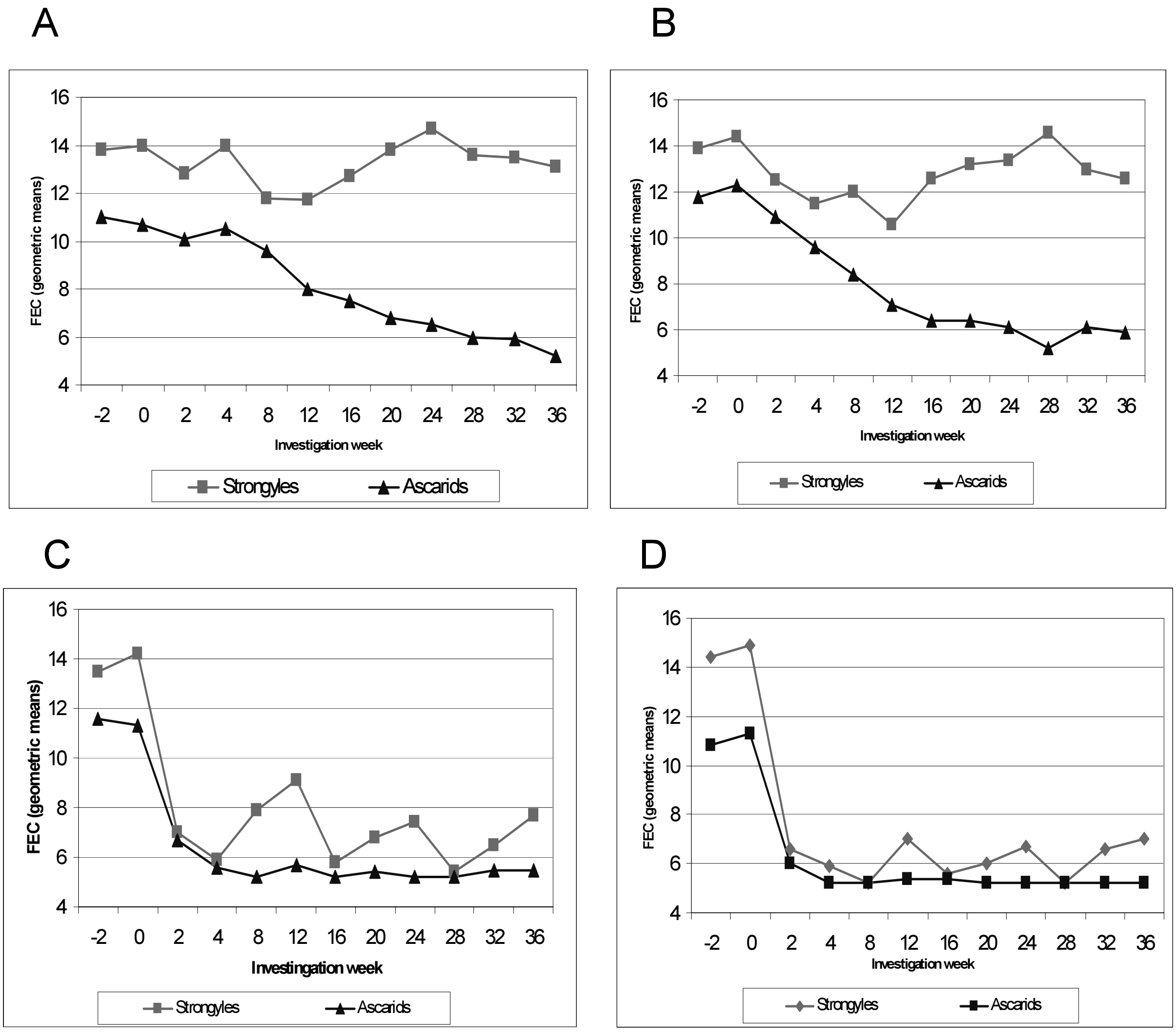

Figure 16. Patterns of shedding of FEC in calves from Funyula Division, Busia District (April-December 2003). A: Untreated control (group I); B: ISMM treatment (group II); C: Albendazole treatment (group III); D: Albendazole and ISMM treatment (group IV)

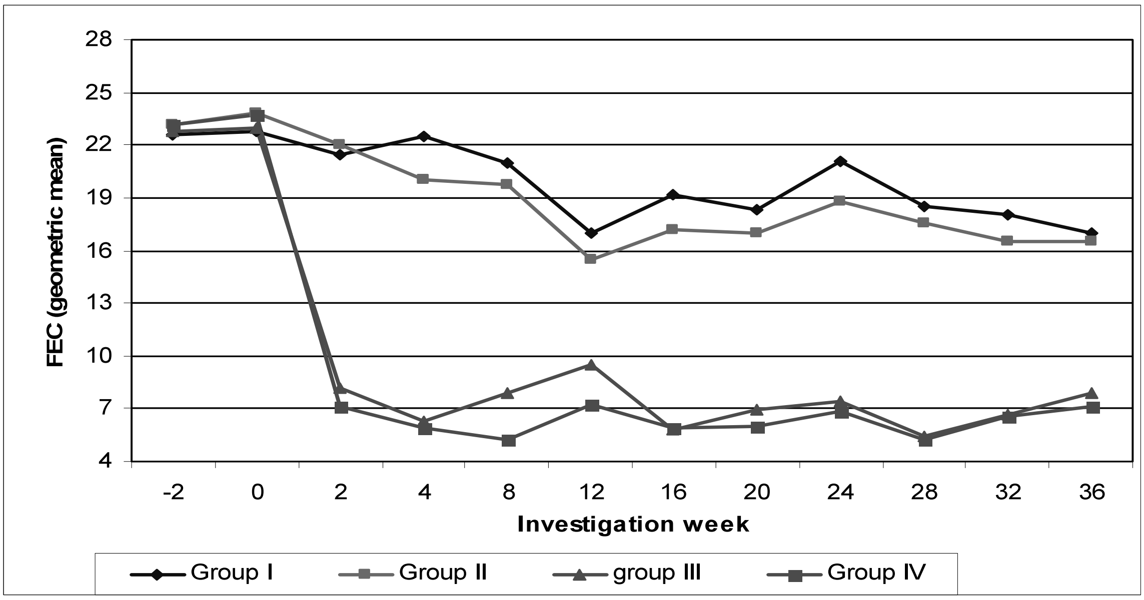

Figure 17. Overall trends of FEC shedding in treated and control calves from Funyula Division, Busia District (April-December 2003)

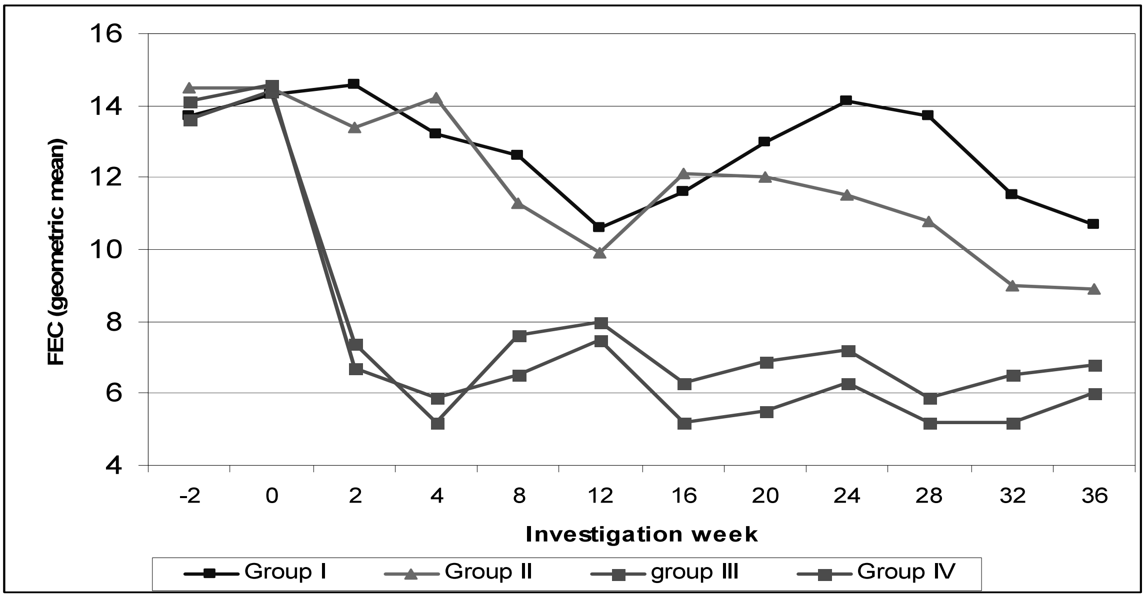

Figure 18. Overall trends of FEC shedding in treated and control heifers from Funyula Division, Busia District (April-December 2003)

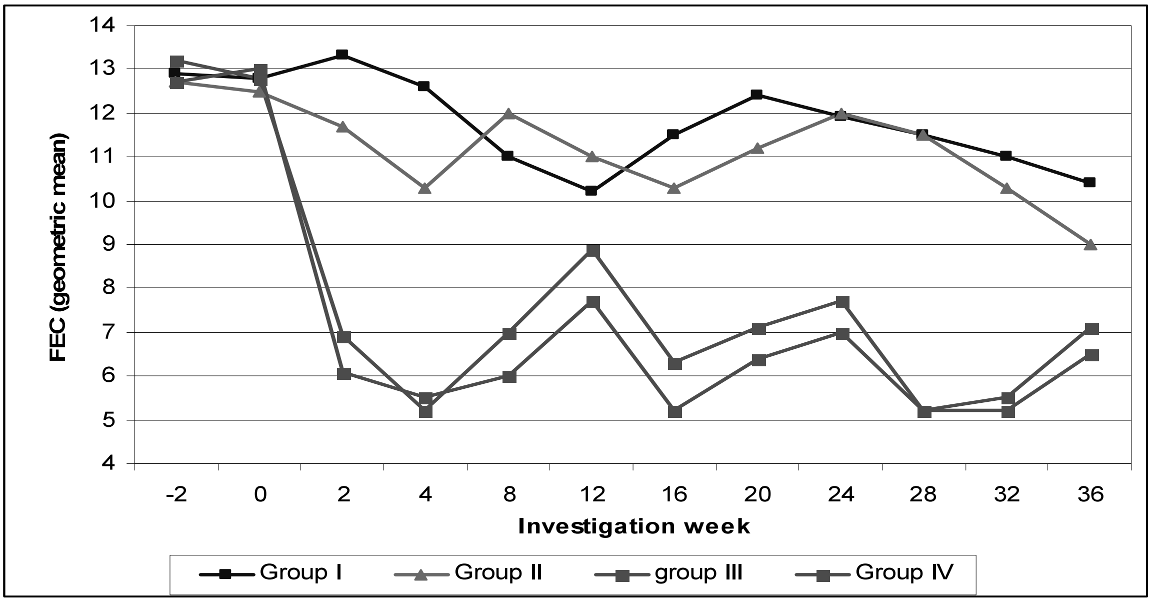

Figure 19. Overall trends of FEC shedding in treated and control adult cattle from Funyula Division, Busia District (April-December 2003)

5.2.5.2 Faecal egg count reduction (FECR %)

Faecal egg count reduction (FECR %) was calculated to evaluate the effectiveness of the anthelmintic (Gardal®, Intervet East Africa Ltd) in reducing FEC in cattle. Results indicated that the percentage FECR in albendazole treated animals (group III and IV) was more than 95% in both Divisions, irrespective of age. This indicated that albendazole is still potent against nematodes in Budalang'i and Funyula Divisions. However, the percentage FECR in ISMM treated animals (group II) was less than 13% in the three age strata, indicating that ISMM treatment did not significantly influence shedding of FEC (Table 40).

Table 40. Faecal egg count reduction (FECR %) two weeks after treatment of cattle from Budalang'i and Funyula divisions, Busia District (2003)

Division	Age category	FECR %		
		Group II	Group III	Group IV
Budalang'i	Adults	10.90	95.70	96.40
	Heifers	9.50	96.30	96.70
	Calves	11.20	97.10	97.80
Funyula	Adults	11.50	95.40	97.10
	Heifers	10.80	96.20	96.50
	Calves	12.60	95.70	97.90

G II: ISMM; G III: ALB; G IV: ALB/ISMM

5.2.5.3 Results of negative binomial regression analysis

The overall variance of the un-transformed FEC data was 119939.03 with a mean of 286.50. After $\ln(n + 45)$ transformation, the overall variance was more than twice the mean (variance = 27.36; mean = 10.91). The Poisson distribution could have been the correct one to fit the count data. But, it was considered inappropriate since it assumes that its values of mean and the variance be the same (mean = variance = λ). Hence, a negative binomial error distribution in a generalized linear model was used in order to deal with the lack of normality in the data.

Obtained coefficients for the various variables are presented in Table 41. Treatment trial group, husbandry practice, age and time (investigation week) were important predictors of shedding of helminth eggs by cattle. The FEC of animals in both divisions in total did not differ significantly. Control -(Group I) and ISMM -(Group II) treated animals had significantly higher FEC than albendazole -(Group III) and combined albendazole/ISMM -(Group IV) treated animals. Stall-fed animals had significantly lower FEC than animals under any other husbandry (free grazed, tethered, free grazed/tethered) system. The coefficients and their corresponding *p*-values for adults and heifers indicated that older animals had significantly lower FEC than calves. In addition, increase in the time (week of investigation) was significantly associated with a reduction in shedding of faecal eggs. In contrast, no significant differences in FEC of animals were determined with regard to breed.

Table 41. Coefficients, robust standard errors and 95% CI estimated in a negative binomial model of factors associated with FEC in cattle from Budalang'i and Funyula divisions, Busia District (April-December 2003)

Variable	Levels	Coeff.	Robust SE*	Z-value	$p > Z$	95% CI
Division	Budalang'i	Baseline	-	-	-	-
	Funyula	0.07	0.01	5.4	0.07	0.04-0.09
Trial group	G I	Baseline	-	-	-	-
	G II	0.02	0.03	-0.26	0.79	-0.07-0.05
	G III	-0.13	0.00	-11.19	0.00	-(0.01-0.0006)
	G IV	-0.18	0.01	-32.27	0.00	-(0.19-0.17)
Husbandry	F-grazing	Baseline	-	-	-	-
	Tethering	0.00	0.00	-0.66	0.51	-0.02-0.01
	S-feeding	-0.46	0.01	-78.69	0.00	-(0.47-0.45)
	F/tethering	-0.01	0.03	-0.36	0.72	-0.06-0.04
Age category	Calves	Baseline	-	-	-	-
	Heifers	-0.28	0.01	7.47	0.00	0.06-0.10
	Adults	-0.36	0.01	11.30	0.00	0.07-0.10
Breed	Exotic	Baseline	-	-	-	-
	Local	-0.01	0.02	-0.55	0.59	-0.49-0.03
Time (week)	-	-0.01	0.00	-17.14	0.00	-(0.09-0.07)
Intercept	-	3.06	0.05	67.35	0.00	2.97-3.14
ln-alpha	-	-2.43	0.04	-	-	-(2.51-2.34)
Alpha	-	0.09	0.00	-	-	0.08-0.10

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM
Log likelihood = -13525.92; Likelihood ratio χ^2 (df; 17) = 4787.69; $p > \chi^2 = 0.00$
Likelihood-ratio test of alpha = 0: Chibar^2 (χ^2) (df; 1) = 1323.80; $p > \chi^2$= 0.00
*Robust standard errors adjusted for clustering on animal id.: Coeff. = Coefficients
F-grazing: Free grazing, S-feeding: Stall feeding, F/tethering: Free grazing/tethering

5.2.5.4 Shedding of trematode eggs

At the onset of the study, the proportion of adult Zebu cattle shedding trematode eggs in Budalang'i Division was 22.3% (95% CI = 18.2-26.8), while that of adult exotic/crossbred was 5.6% (95% CI = 2.4-9.2). During the same time, the proportion of local Zebu heifers shedding trematode eggs was 7.7% (95% CI = 3.1-12.4), while that of exotic/crossbred heifers was 1.3% (95% CI = 0.4-2.2). In Funyula Division, the proportion of adult Zebu cattle shedding trematode eggs was 10.5% (95% CI = 7.8-14.3) while that of exotic/crossbred cattle was 3.4% (95% CI = 1.1-6.0). The proportion of local Zebu heifers shedding trematode eggs at that time was 3.9% (95% CI = 1.8-6.5), while that of exotic/crossbred heifers was 0.6% (95% CI = 0-1.4). There were significant differences between the proportions of adult cows shedding trematode eggs and that of heifers in both Divisions, with respect to breed. In addition, the proportion of adult cattle shedding trematode eggs was significantly higher in Budalang'i as compared to Funyula Division. There were initially significantly more local Zebus than exotic/crossbred cattle shedding trematode eggs, in the respective age strata (adults and heifers). At the beginning of the study, no calves were detected to have trematode eggs. However, by the end of the study, three calves (two from Budalang'i Division and one from Funyula Division) had started shedding trematode eggs. All belonged to the untreated control animals.

The proportion of control animals shedding trematode eggs remained consistently high for adults with minimal variations. For control heifers, there was a gradual increase in the proportions of animals shedding trematode eggs over time. In both divisions, ISMM treatment of animals every three months gradually reduced the proportion of animals shedding trematode eggs. By the end of the end of 36 weeks, there was a significant difference between the proportions of control- and ISMM-treated animals shedding trematode eggs. In addition, the proportions of albendazole- and albendazole/ISMM-treated animals shedding trematode eggs declined significantly for both adults and heifers. By 12th-20th weeks of treatment, the proportions of adults and heifers shedding eggs had decreased to zero. Thereafter, the proportion of animals shedding trematode eggs remained below 2%. Figures 20-23 indicate the proportions of adult cows and heifers from Budalang'i and Funyula divisions shedding trematode eggs over the 9-month follow-up period.

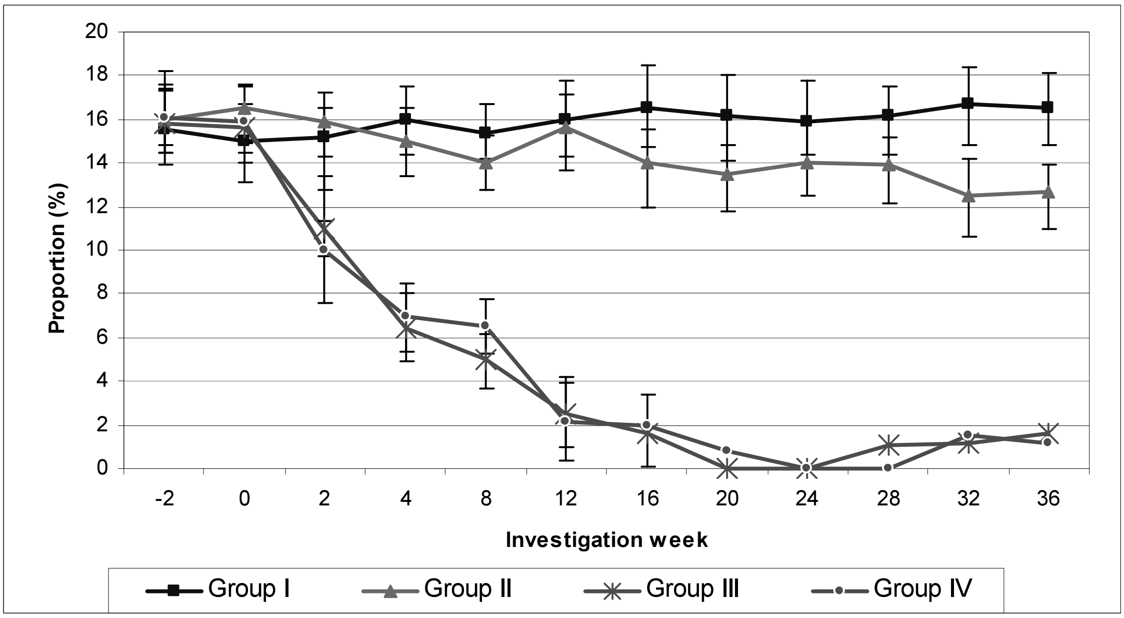

Figure 20. Proportions of adult cattle shedding trematode eggs in Budalang'i Division, Busia (District April-December 2003), by trial groups

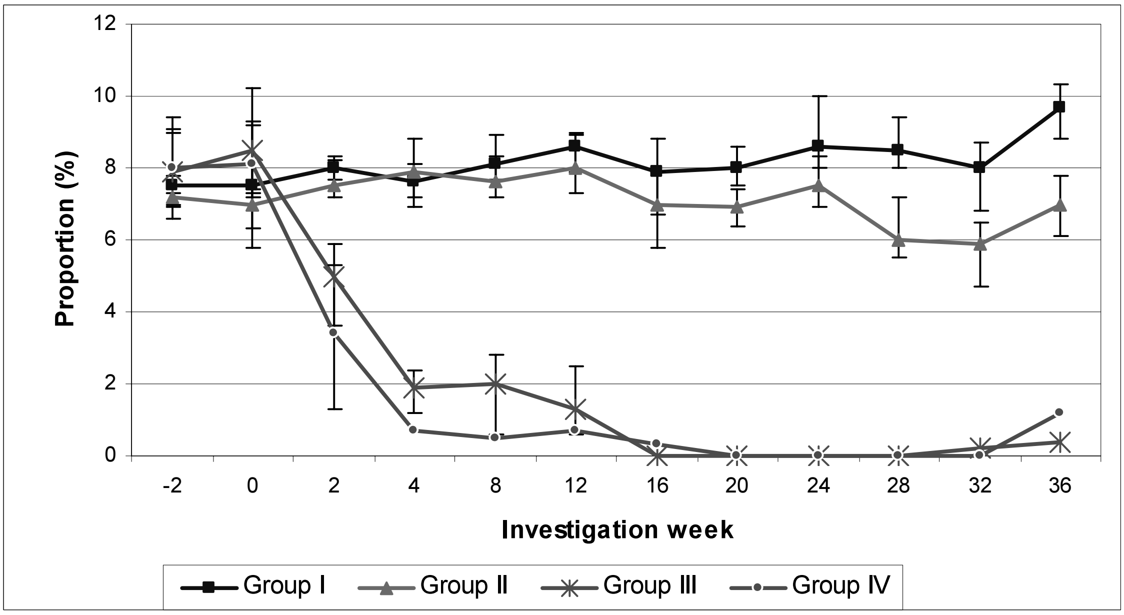

Figure 21. Proportions of heifers shedding trematode eggs in Budalang'i Division, Busia District (April-December 2003), by trial groups

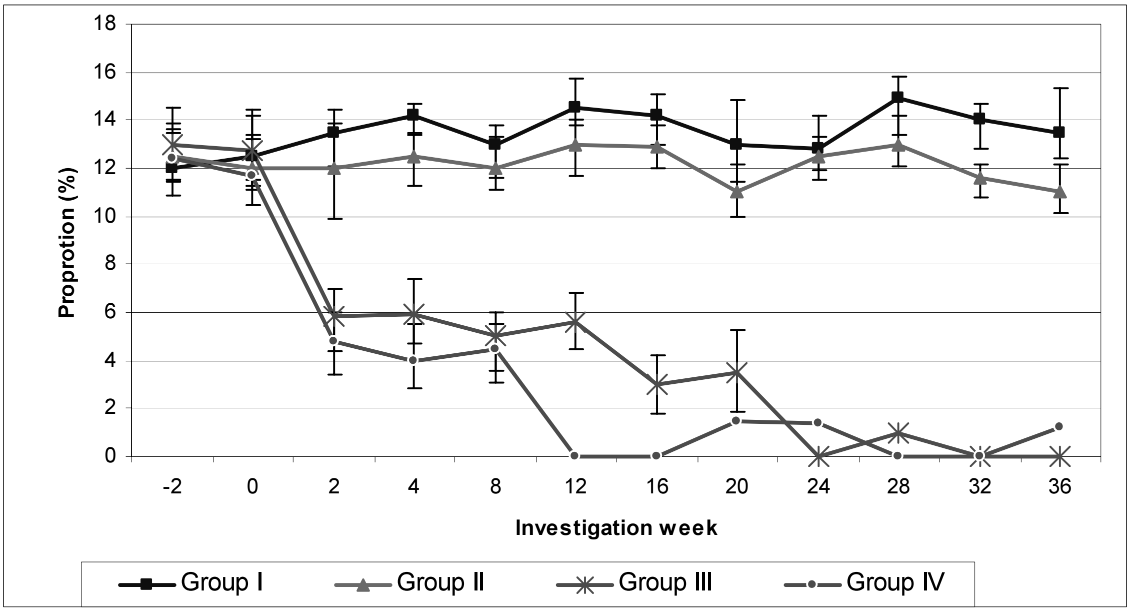

Figure 22. Proportions of adult cattle shedding trematode eggs in Funyula Division, Busia District (April-December 2003), by trial groups

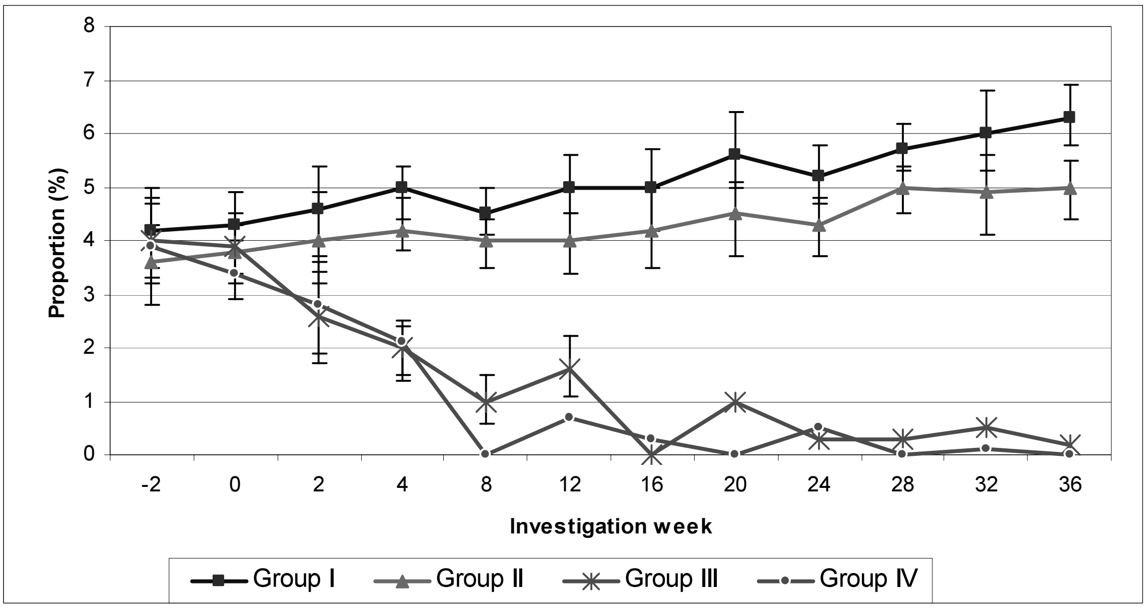

Figure 23. Proportions of heifers shedding trematode eggs in Funyula Division, Busia District (April-December 2003), by trial groups

5.2.6 Packed cell volume (PCV %) profiles

At the onset of the study (week -2), the mean PCV% of cattle in the four trial groups in Budalang'i Division ranged between 25.4-25.7%. Two weeks later (week 0), the mean PCV% increased from 26.4 to 26.8%. Nevertheless, the change was not significant. As from week 0, the PCV% of animals in groups II, III and IV gradually rose. And, by week 8 of investigation, animals in group IV had significantly higher PCV% values than those in the other trial groups. The mean PCV% of cattle in groups II and III were however not significantly different but their values remained visually apparently than those of animals in Group I. At the 12th week, mean PCV% of animals in groups II, III and IV declined slightly, but maintained the initial trends, with the exception of Group I animals which experienced a slight increase. After treatment was repeated at week 12, there was an increase in mean PCV% of animals in groups II, III and IV. This trend was maintained but declined at the 24th week. Treatment was again undertaken at that week and the mean PCV% in the treated animals increased up to the 32nd week of treatment when the PCV% values began to drop. This continued until the 36th week when the study was terminated (Figure 24).

Figure 25 shows the trends of mean PCV% values for cattle in Funyula Division during the follow-up study period. Initially, all the animals had a mean PCV% of between 26.5-26.9%. However, from the 4th week, the mean PCV% values for cattle in Group IV remained significantly higher than that of other animals while, the weekly mean PCV% values of cattle in groups II and III increased but were not significantly different. The ISMM-treated animals had slightly higher values than the albendazole-treated animals. The mean PCV% of the control animals remained significantly lower than that of other all animals from the 2nd week. These patterns were similar to those observed in Budalang'i Division.

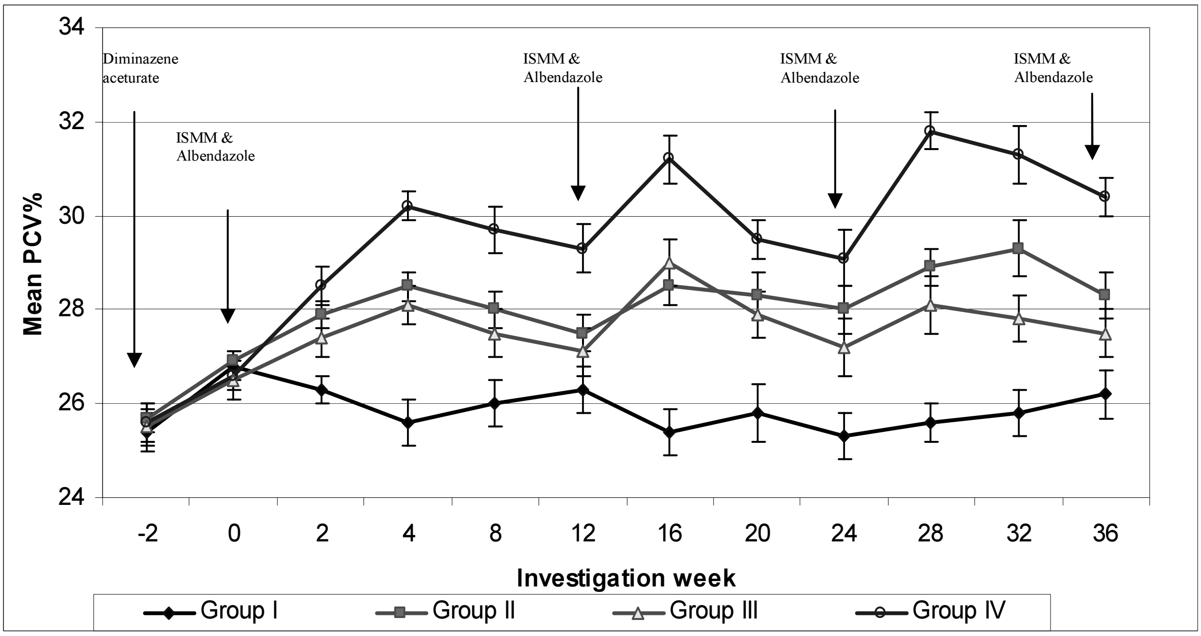

Figure 24. Mean PCV% and 95% CIs of cattle in Budalang'i Division, Busia District (2003), during the 9-month follow-up study period

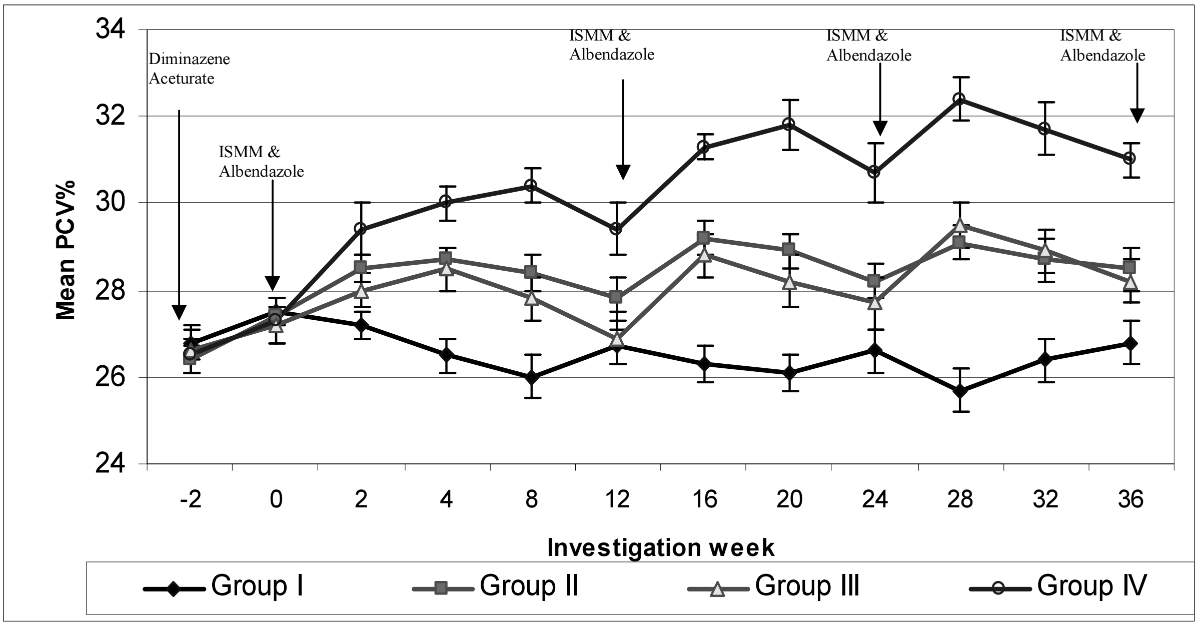

Figure 25. Mean PCV% and 95% CIs of cattle in Funyula Division, Busia District (2003), during the 9-month follow-up study period

Table 42 describes the overall mean PCV% and 95% CI for cattle in Budalang'i and Funyula divisions during the 9-month follow-up study period, with respect to age and breed. In

Budalang'i Division, the mean PCV% values for Zebu calves were significantly higher than those of exotic calves in the control trial group. However, the within-group comparison of mean PCV% profiles for animals in treatment groups II, III and IV revealed no significant differences with regard to age and breed

Comparison of mean PCV% of cattle in Funyula Division revealed that, in the control group, the mean PCV of local Zebu cattle did not differ significantly. However, the mean PCV% of adult exotic cattle was significantly higher than that of calves. In addition, the mean PCV% of adult exotic cattle was significantly higher than that of local Zebus. Furthermore, the mean PCV% of Zebu calves was higher than that of exotic calves in the control group. The Within-group comparison of the mean PCV% profiles of cattle in groups II, III and IV revealed no significant differences with regard to age and breed (Table 42).

Table 42. Overall mean PCV% and 95% CI for cattle in Budalang'i and Funyula divisions during the 9-month follow-up study period with respect to age and standardized for breed

Division	Trial group	Breed	Adults		Heifers		Calves	
			PCV%	95% CI	PCV%	95% CI	PCV%	95% CI
Budalang'i	G I	Local	26.1	25.7-26.5	26.4	25.9-26.9	25.6	25.3-25.9
		Exotic	26.1	25.9-26.3	25.5	24.9-26.1	24.8	24.4-25.2
	G II	Local	28.5	28.1-28.9	28.2	27.8-28.6	27.7	27.2-28.2
		Exotic	28.3	27.8-28.8	27.7	27.2-28.2	26.9	26.4-27.4
	G III	Local	27.2	26.8-27.6	27.6	27.2-28.0	27.5	26.9-28.1
		Exotic	27.4	27.0-27.8	27.1	26.8-27.3	27.6	27.2-28.0
	G IV	Local	29.1	28.6-29.6	29.7	29.2-30.2	29.3	28.7-29.9
		Exotic	29.1	28.5-29.7	29.5	28.9-30.1	30.1	29.6-30.1
Funyula	G I	Local	26.2	25.9-26.5	26.6	26.1-27.1	26.7	26.2-27.2
		Exotic	27.7	27.3-28.1	27.1	26.7-27.5	25.5	25.1-25.9
	G II	Local	28.3	28.0-28.6	28.4	28.0-28.8	27.9	27.4-28.4
		Exotic	28.5	28.2-28.8	28.4	28.1-28.7	28.5	28.2-28.8
	G III	Local	28.0	27.5-28.5	27.4	26.9-27.9	27.7	27.1-28.3
		Exotic	28.1	27.7-28.5	28.4	27.8-29.0	28.6	28.1-29.1
	G IV	Local	29.9	29.6-30.2	30.0	29.5-30.5	30.6	30.2-31.0
		Exotic	31.1	30.7-31.5	29.8	29.4-30.2	30.0	29.5-30.5

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

The overall change in mean PCV% over the 9-month follow-up study period revealed that significant increases in mean PCV of animals in each treatment group occurred in Budalang'i and Funyula divisions. Conversely, there was no significant change in mean PCV of control animals over the same 9-month-period (Table 43).

Table 43. Overall changes in mean PCV of cattle from Budalang'i and Funyula divisions, Busia District (April-December 2003), by trial groups

		Mean PCV%		
Division	Trial group	Start of study	End of study	Overall change
Budalang'i	G I	25.4	25.8	1.6
	G II	25.7	28.5	10.9
	G III	25.5	27.8	9.0
	G IV	25.6	30.1	17.6
Funyula	G I	26.8	26.6	-0.7
	G II	26.4	29.3	11.0
	G III	26.6	28.0	5.3
	G IV	26.5	31.3	18.1

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

Within-treatment group comparison of mean PCV% of trypanosome negative and trypanosome infected cattle over the 9-month follow-up study period revealed that aparasitaemic cattle had significantly ($p < 0.05$) higher mean PCV% than aparasitaemic ones. The difference in mean PCV% was highest in Group IV animals and lowest in Group I animals in both divisions (Table 44).

Table 44. Comparison of division-specific mean PCV% of aparasitaemic and parasitaemic cattle during the 9-month follow-up study period

Division	Trial group	Aparasitaemic animals		Parasitaemic animals	
		PCV%	95% CI	PCV%	95% CI
Budalang'i	G I	26.5[a]	26.4-26.6	23.0[b]	22.7-23.6
	G II	28.2[a]	27.8-28.6	24.5[b]	24.1-24.9
	G III	27.9[a]	27.7-28.1	23.9[b]	23.6-24.2
	G IV	29.6[a]	29.4-29.8	25.5[b]	23.8-25.2
Funyula	G I	27.1[a]	27.0-27.2	23.3[b]	23.0-23.6
	G II	28.5[a]	28.3-28.7	24.0[b]	23.4-24.6
	G III	28.3[a]	28.2-28.4	23.7[b]	23.3-24.1
	G IV	30.4[a]	30.1-30.7	23.3[b]	22.8-23.8

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

a, b: Values with different superscript letter are significantly different along rows of comparison ($P < 0.05$)

5.2.7 Weight changes in calves

The weight changes in Zebu and exotic/crossbred calves from Budalang'i and Funyula divisions during the 9-month- follow-up study are shown in Figure 26. The absolute changes in body weights and the 95% CI were plotted to aid in comparing these changes. Between week 2 and week 4, the calves exhibited similar weight changes. As from week 8, the slopes of the curves started to diverge and their separation became evident. By week 16, calves in Group IV had significantly ($p < 0.05$) higher body weights than calves in groups I and II. By the end of 32nd week, Group IV calves had significantly ($p < 0.05$) higher body weights than those in Group III. Similarly, Group III calves gained significantly ($p < 0.05$) higher weights than calves in Group I and Group II. In general, calves in the control group (Group I) maintained significantly ($p <0.05$) lower body weights than the rest of the study calves.

In Budalang'i Division, Zebu calves in the control group had attained a mean weight of 80 kg (95% CI: 76.1-83.9), while the treated calves had gained mean weights as follows: Group II 109.1 kg (95% CI, 106.0-112.2), Group III 117.8 kg (95% CI: 114.8-120.8) and Group IV 131.2

kg (95% CI: 127.8-134.6), respectively, at the end of the study period. On the other hand, exotic/crossbred calves in the control group had attained a mean of 93 kg (95% CI: 89.2-96.8), Group II 116 kg (95% CI: 111.9-120.1), Group III 128.5 kg (95% CI: 125.0-132.0) and Group IV had 143.6 kg (95% CI: 139.9-147.3), respectively.

In Funyula Division, Zebu calves in the control group had attained a mean weight of 87 kg (95% CI: 82.5-91.5), Group II 112 kg (95% CI: 107.2-116.8), Group III 126 kg (95% CI: 121.4-130.6) and Group IV 137.7 kg (95% CI: 133.6-141.8), respectively, at the end of the study period. In return, exotic/crossbred calves in the control group had attained a mean of 99.4 kg (95% CI: 95.9-102.9), Group II 119 kg (95% CI: 115.2-122.8), Group III 131.4 kg (95% CI: 127.5-135.3) and Group IV 143.9 kg (95% CI: 139.9-147.9), respectively.

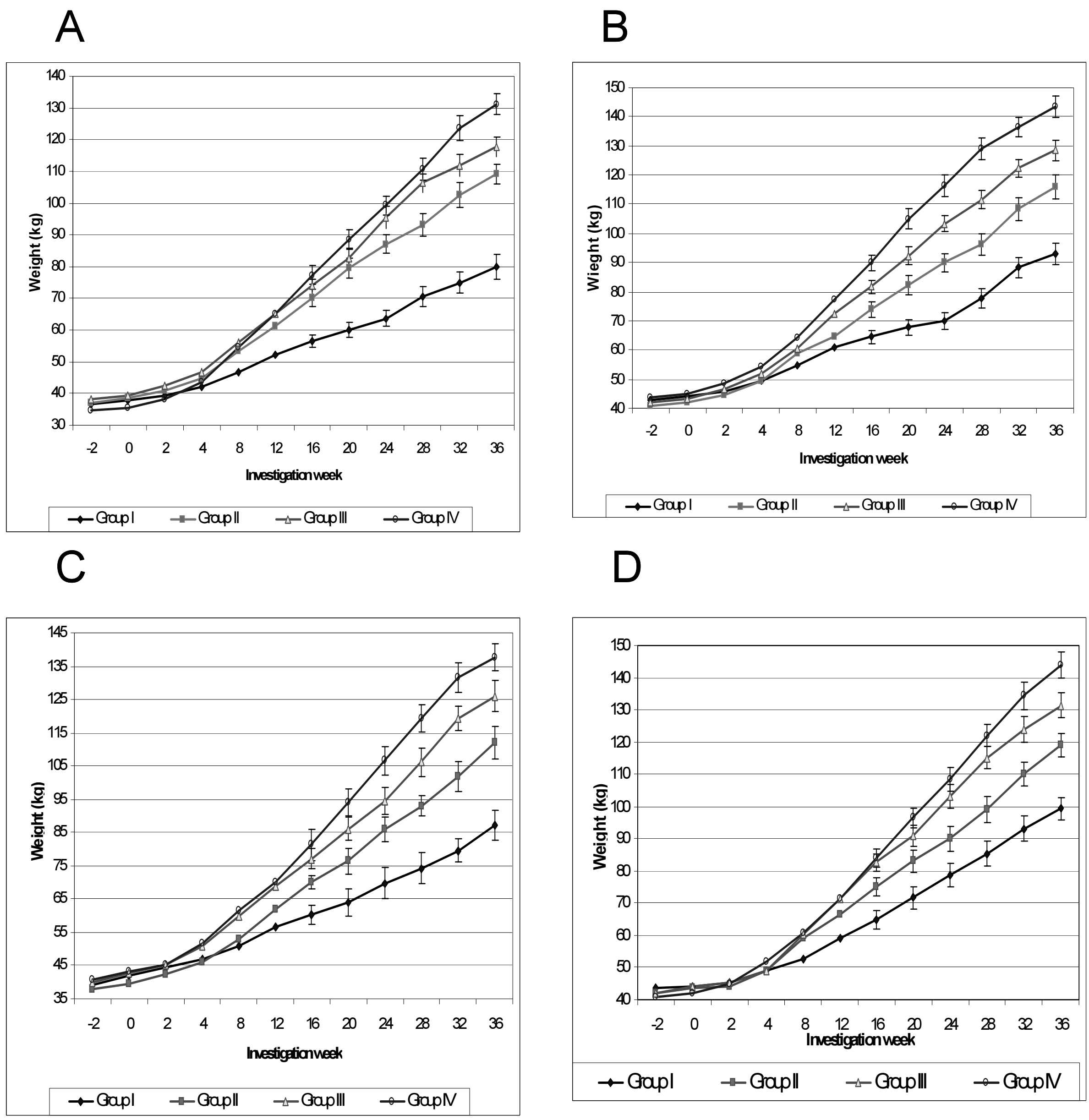

Figure 26 (A-D). Weight changes of calves in the four trial groups (GI: Control, GII: ISMM, GIII: Albendazole, GIV: Albendazole and ISMM) in Budalang'i and Funyula divisions of Busia District during the 9-month-period, 2003. A: Local Zebu calves in Budalang'i Division, B: exotic/crossbred calves in Budalang'i Division, C: local Zebu calves in Funyula Division and D: exotic/crossbred calves in Funyula Division

The overall mean weight changes for calves in Budalang'i and Funyula divisions during the 9-months follow-up study period revealed that treated calves had significant weight gains than the control calves. Among the treated calves, the albendazole/ISMM group in both divisions significantly gained more weight than calves in either the albendazole- or ISMM-treated groups. In return the albendazole treated calves in both divisions had gained significantly more weight than the ISMM treated ones, at the end of the study period (Table 45and 46).

Table 45. Distribution of overall changes in mean weight of calves from Budalang'i Division, Busia District (April-December 2003), by breed and trial groups

		Weight (kg)		
Breed	Trial group	Start of study	End of study	Overall change
Zebu calves	G I	37.7	80.0	42.3
	G II	37.3	109.1	71.8
	G III	38.1	117.8	79.7
	G IV	37.5	131.2	93.7
Exotic/crossbred calves	G I	43	93.0	50.0
	G II	41	116.0	75.0
	G III	42.2	128.5	86.3
	G IV	43.8	142.6	98.8

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

Table 46. Distribution of overall changes in mean weight of calves from Funyula Division, Busia District (April-December 2003) by breed and trial groups

		eight (kg)		
Breed	Trial group	Start of study	End of study	Overall change
Zebu calves	G I	39.2	97.0	47.8
	G II	37.9	112.0	74.1
	G III	39.9	126.0	86.1
	G IV	39.0	137.7	98.7
Exotic/crossbred calves	G I	43.6	94.4	50.8
	G II	42.2	119.0	76.8
	G III	42.0	131.4	89.4
	G IV	42.7	143.9	101.2

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

5.2.8 Conception rate

The majority of the cows in both divisions were either pregnant or became pregnant at one point or the other, during the 9-month follow-up study period. In addition, some heifers also conceived, but only towards the end of the follow-up. Pregnant cows and in-calf heifers were monitored monthly until they delivered, aborted, or had stillbirths. However, some of the animals were still within the gestation period by the time the study was terminated. At the end of the study, all the in-calf heifers were in the first trimester. The proportions of cows and heifers that became pregnant during the 9-month-study period are shown in Table 47.

Table 47. Distribution of cows and heifers that conceived in Budalang'i and Funyula divisions, Busia District (April-December 2003), by trial group and breed

Division	Category	Trial group	No. Pregnant (Zebu)	(%) Pregnant	No. Pregnant (Exotic)	(%) Pregnant
Budalang'i	Adult cows	I	8	53.3	3	60.0
		II	12	80.0	3	60.0
		III	10	66.7	3	60.0
		IV	13	86.7	4	80.0
	Heifers	I	1	6.7	0	0
		II	2	13.3	1	20.0
		III	1	6.7	0	0
		IV	3	20.0	1	20.0
Funyula	Adult cows	I	9	60.0	3	60.0
		II	10	66.7	4	80.0
		III	12	80.0	3	60.0
		IV	12	80.0	5	100.0
	Heifers	I	1	6.7	0	0
		II	3	20.0	1	20.0
		III	2	13.3	1	20.0
		IV	4	26.7	2	40.0

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

5.2.9 Calving rate

The number of live births was recorded in both divisions during the study period. The proportion of cows that had calved down by the end of the period was calculated as the number of live calves divided by the number of in-calf animals. They were stratified by breed and trial group (Table 48).

Table 48. Numbers and proportions of live births by cows in Budalang'i and Funyula divisions, Busia District (April-December 2003) by trial group and breed

Division	Trial group	No. of live births (Zebus)	% Calving rate	No. of live births (Exotic)	% Calving rate
Budalang'i	I	3	37.5	1	33.3
	II	6	50.0	2	66.7
	III	5	50.0	1	33.3
	IV	7	53.6	3	75.0
Funyula	I	4	44.4	2	66.7
	II	7	70.0	3	75.0
	III	6	50.0	2	66.7
	IV	8	66.7	4	80.0

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

5.2.10 Abortions and stillbirths

A total of 8 (14.2%; 95% CI = 6.3-26.2) cows aborted in Budalang'i Division. Out of the 8 abortions, 5 (45.5%; 95% CI = 16.7-76.6) were by animals from the untreated control group and the remaining 3 (23.1%; 95% CI = 5.0-53.8) were from albendazole (Group III) treated animals. No abortions were recorded in cows from the ISMM (Group II) and the combined ISMM and albendazole (Group IV) treated cows. In the control group, 3 (37.5%; 95% CI = 8.5-75.5) abortions were from local Zebus while 2 (66.7%; 95% CI = 9.4-99.2) were from the exotic/crossbred cows (Table 49). Out of the 3 abortions recorded in the albendazole treated animals, 2 (20%, 95% CI = 2.5-55.6) were from local Zebus while 1 (33.3%, 95% CI = 0.8-90.6) was from the exotic/crossbred cows. During the same period, two stillbirths were reported from local Zebu cows (one from the control group and one from the albendazole treated cows).

In Funyula Division, a total of 6 (10.3%; 95% CI = 3.9-21.2) abortions were recorded. Four (33.3%; 95% CI = 9.9-65.1) of these were in the untreated control cows and 2 (13.3%; 95% CI = 1.7-40.5) from the albendazole treated animals. Again, no abortions were reported from cows in treatment groups II and IV. From the untreated control cows, 3 (33.3% 95% CI = 7.5-70.1) of the abortions were from Zebus while, 1 (33.3% 95% CI = 0.8-90.6) was from exotic cows. In the albendazole treated animals, there was one abortion from a Zebu (8.3%; 95% CI = 0.2-38.5) and one exotic (33.3%; 95% CI = 0.8-90.6) cow each (Table 49). Two cases of stillbirths were reported from the local Zebus cows (one from the untreated control group and one from the albendazole treatment group) during the same period.

Table 49. Divisional-, treatment group- and breed-dependent abortion rates for cows in Budalang'i and Funyula Divisions, Busia District (April-December 2003)

Division	Treatment group	Abortion rate (%)					
		Zebu	95% CI	Exotic	95% CI	Overall	95% CI
Budalang'i	I	37.5	8.5-75.5	66.7	9.4-99.2	45.5	16.7-76.6
	III	20.0	2.5-55.6	33.3	0.8-90.6	23.1	5.0-53.8
Funyula	I	33.3	7.5-70.1	33.3	0.8-90.6	33.3	9.9-65.1
	III	8.3	0.2-38.5	33.3	0.8-90.6	13.3	1.7-40.5

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

5.2.11 Mortality

The overall mortality rate in adult cattle in Budalang'i Division was 1.3% (95% CI = 0.03-6.8), in heifers it was 1.7 (95% CI = 0.04-8.9) and in calves 11.7 (95% CI = 4.8-22.6) over the 9 months of follow-up. In both adults and heifers, only one death was registered per age stratum and both the dead animals were local Zebus from the untreated control group. However, more deaths were reported from calves (7/60: 11.7%; 95% CI = 4.8-22.6) with the majority of dead animals (4/15; 26.7%; 95% CI = 7.8-55.1) being from the untreated control group. No death was reported in calves from the combined albendazole/ISMM treatment group (group IV) (Table 50).

Table 50. Treatment group-, age- and breed-dependent mortality rates for cattle in Budalang'i Division, Busia District (April-December 2003)

Age	Treatment group	Mortality rate (%)					
		Zebu	95% CI	Exotic	95% CI	Overall	95% CI
Adults	I	6.7	0.2-31.9	0	0	5	0.1-24.9
	II	0	0	0	0	0	0
	III	0	0	0	0	0	0
	IV	0	0	0	0	0	0
Heifers	I	10.0	0.3-44.5	0	0	6.7	0.2-31.9
	II	0	0	0	0	0	0
	III	0	0	0	0	0	0
	IV	0	0	0	0	0	0
Calves	I	20.0	2.5-55.6	40.0	5.3-85.3	26.7	7.8-55.1
	II	10.0	0.3-44.5	20.0	0.5-71.6	13.3	1.7-40.5
	III	10.0	0.3-44.5	0	0	6.7	0.2-31.9
	IV	0	0	0	0	0	0

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

In Funyula Division, the scenario was similar to that observed in Budalang'i. Out of the 80 cows, only one death (1.3%; 95% CI = 0.03-6.8) was reported in adult cattle whereas no death was reported in heifers. The dead cow also was from the untreated control group (group I). Six deaths (10.0%; 95% CI = 3.8-20.5) were reported in calves and again the untreated control group had 4 (26.7%; 95% CI = 7.8-55.1) deaths out of the 60 calves (Table 51).

Table 51. Treatment group-, age- and breed-dependent mortality rates for cattle in Funyula Division, Busia District (April-December 2003)

Age	Treatment group	Mortality rate (%)					
		Zebu	95% CI	Exotic	95% CI	Overall	95% CI
Adults	I	13.3	1.7-40.5	0	0	10.0	1.2-31.7
	II	0	0	0	0	0	0
	III	0	0	0	0	0	0
	IV	0	0	0	0	0	0
Calves	I	20.0	2.5-55.6	40.0	5.3-85.3	26.7	7.8-55.1
	II	10.0	0.3-44.5	0	0	6.7	0.2-31.9
	III	0	0	20.0	0.5-71.6	6.7	0.2-31.9
	IV	0	0	0	0	0	0

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

Heifers excluded from the table since no deaths were reported in this group of animals

5.2.12 Milk production

Out of the 60 local Zebu cattle in Budalang'i Division, 40 (66.7%) were being milked and 17 (85%) out of 20 exotic/crossbred were also being milked. In Funyula, 44 (73.3%) out of 60 Zebus were milking while 18 out of 20 (90%) exotics/crossbreds were milking (Table 52).

Table 52. The number and proportions of milking cows in Budalang'i and Funyula Divisions, Busia District (April-December 2003) with regard to treatment and breed

Division	Treatment group	Number and proportion of milking cows			
		Local	%	Exotic	%
Budalang'i	I	8	53.5	3	60
	II	10	66.7	4	80
	III	10	66.7	5	100
	IV	12	80	5	100
Funyula	I	9	80	4	80
	II	12	80	5	100
	III	11	73.3	4	80
	IV	13	86.7	5	100

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM

The distribution of the mean daily milk yields from both local Zebu and exotic/crossbred cattle in Budalang'i and Funyula divisions is summarized in Table 53. In all cases, exotic/crossbred cattle had significantly higher yields than the local Zebus. However, between-treatment group comparison of milk yields from animals of the same breed did not reveal significant differences. In both divisions, cows that received combined albendazole/ISMM treatment maintained higher milk production than the other groups, although that difference was not significantly. The untreated control cows in most instances had lower milk yields than cows of other treatment groups.

Table 53. Mean daily milk yields from local Zebu and exotic/crossbred cattle from Budalang'i and Funyula Divisions, Busia District (April-December 2003), with regard to treatment

Division	Treatment group	Mean daily milk production (litres)/cow			
		Local Zebu		Exotic/crossbred	
		Mean	95% CI	Mean	95% CI
Budalang'i	I	1.5	1.2-1.8	6.7	5.3-8.1
	II	1.7	1.5-1.9	6.6	4.8-8.4
	III	1.7	1.3-2.1	6.9	5.2-8.6
	IV	2.0	1.5-2.5	7.1	5.8-8.4
Funyula	I	2.1	1.7-2.5	7.5	5.4-9.6
	II	2.0	1.8-2.2	7.8	5.9-9.7
	III	2.2	1.9-2.5	7.6	5.3-9.9
	IV	2.5	2.1-2.9	8.7	7.0-10.4

G I: Control group; G II: ISMM; G III: ALB; G IV: ALB/ISMM