CHAPTER 4

RESULTS

4.1 Trial. 1 Natural tick infestation

Tick infestation

Amblyomma hebraeum

Counts of engorged female ticks suggest that the tick species were present throughout the year with marked peaks of abundance during March and November of both years (1998 and 1999). Higher numbers were encountered on all three breeds during the rainy season of each year (Fig. 4.1).

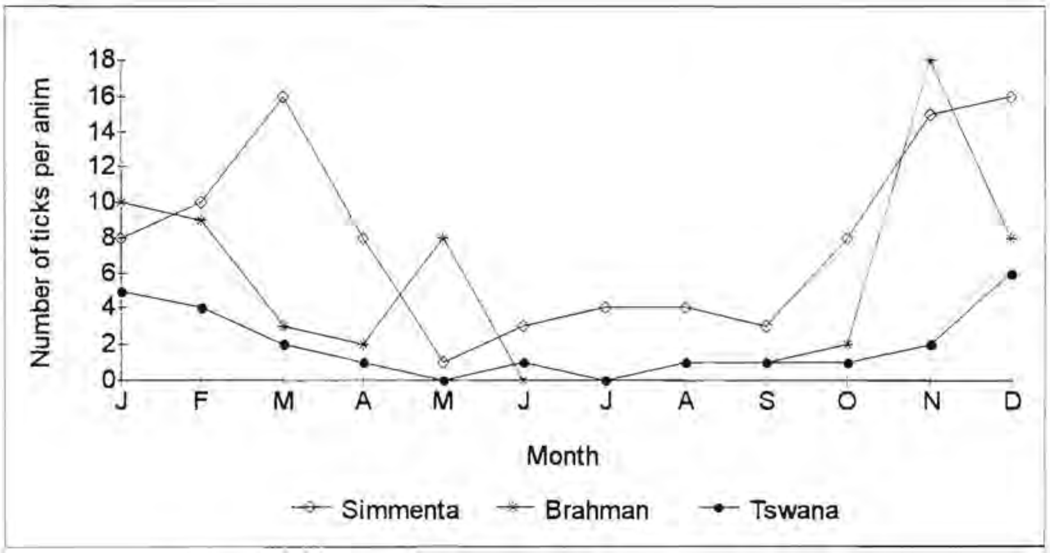

Fig. 4.1 Mean monthly number of engorged *A. hebraeum* females on three breeds of cattle during the trial period.

In general the results showed that mean tick population densities were significantly lower ($P<0.005$) in the experimental than control animals (Table 4.3)

Minor differences in the relative number of ticks on Simmental and Brahman cattle were evident during the first year of study (Figure 4.1). Both breeds were infested with significantly ($P<0.05$) higher numbers of ticks compared to Tswana cattle during the summer months.

During the summer months (February to April) of the experiment (Fig.4.1), tick counts on the Brahman were intermediate between the relatively high numbers found on the Simmental and lower numbers on the Tswana animals. A lower number of ticks were encountered on all three breeds during the dry and winter season of the year.

Rhipicephalus evertsi

Again mean tick population densities observed were lower in the neem treated than control animals ($P<0.05$, Table 4.13). Seasonal peaks of engorged females ticks were evident during the summer months of December 1998 and again in March and December 1999. The trend was similar in all three breeds of cattle (Fig.4.2).

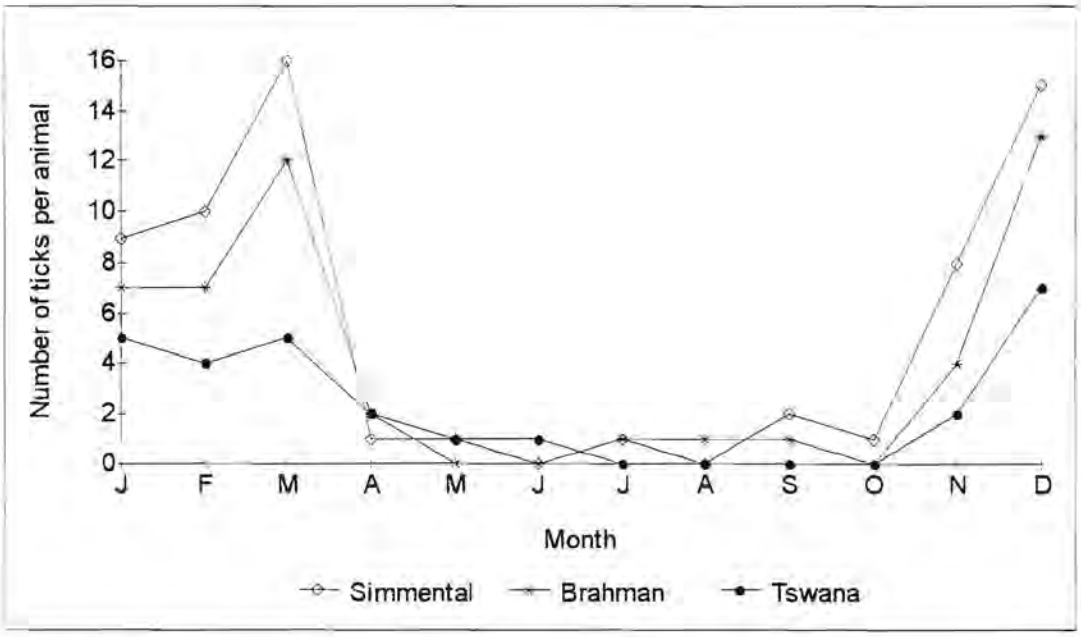

Fig 4.2 Mean monthly number of engorged *R. evetsi*

During both years the counts on Simmental and Brahman cattle were significantly (P = 0,05) higher compared to Tswana cattle in this trial.

Counts of engorged females during winter and spring suggest that *R. evertsi* were present at very low levels through these two seasons of the year. Lower tick counts were obtained during these seasons on all three breeds. (Fig.4.2)

Hyolomma truncutum infestation

Hyolomma truncatum were present although there was some difficulty in distinguishing *Hyolomma* species by means of the stereomicroscope and magnifying lens.

Peak numbers of engorged females ticks occurred during February and October of the 2nd year (1999) of the study (Fig.4.3). Simmental cattle carried significantly more engorged female ticks than Brahman and Tswana cattle during the February peak, but similar numbers were found on all three breeds during winter. There was a sharp increase in tick numbers between September and October, probably due to the abrupt change of weather associated with an increase on temperature and rainfall in the study area.

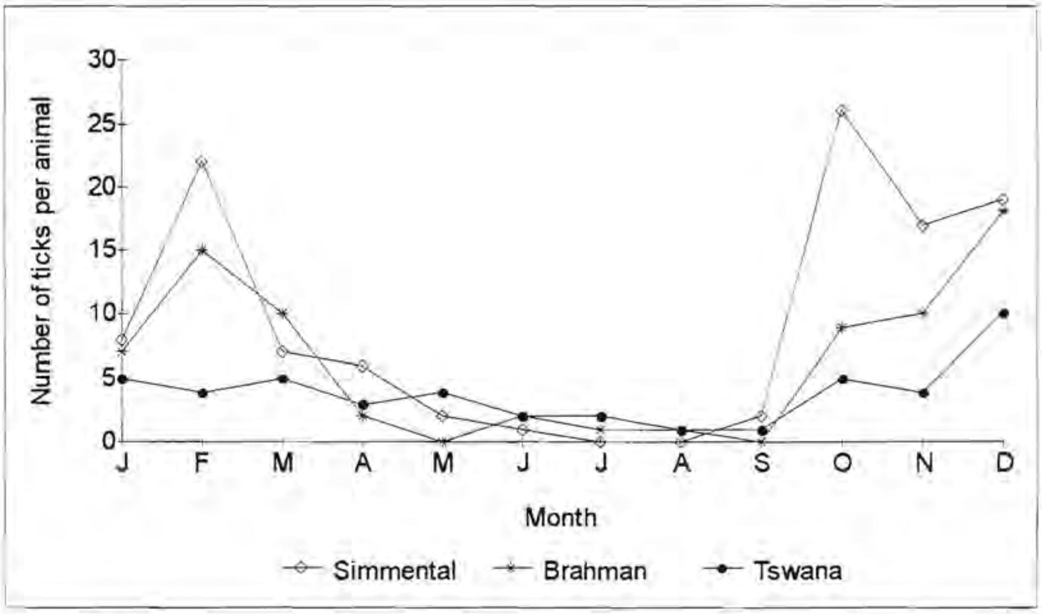

Fig 4.3 Mean monthly number of engorged female *H. truncatum*.

Boophilus decoloratus

Small differences were found between the numbers of engorged females tick on the Simmental and Brahman cattle (Fig.4.4). The ticks occurred throughout the year with peak numbers in March and September. Fewer engorged *B. decoloratus* females were encountered during the study period than any other species of ticks.

During the winter no significant difference was observed in tick counts between neem treated and control animals. This observation was similar for all breeds of cattle, Simmental, Brahman and Tswana.

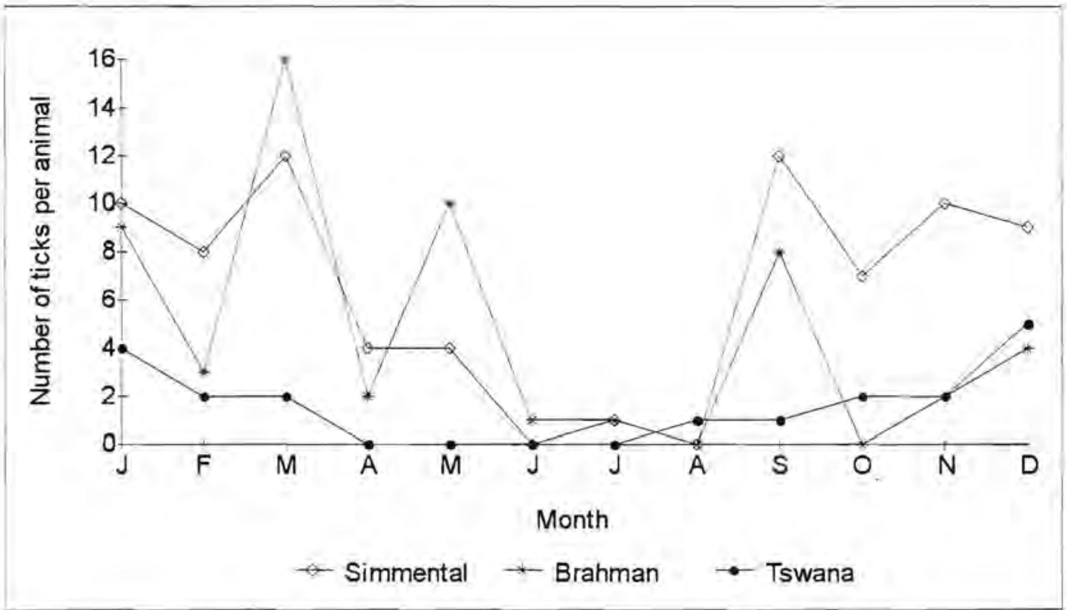

Fig 4.4 Mean monthly number of engorged *Boophilus decoloratus*

Table 4.1 Ticks collected during trial I from neem treated and control animals from all three breeds (pooled results)

	Neem treated Animals		Control Animals	
Date	Number of animals treated	Number of tick collected	Number control Animals	Number of ticks collected
January	9	28	9	59
February	9	36	9	60
March	9	36	9	50
April	9	19	9	18
May	9	18	9	26
June	9	5	9	11
July	9	42	9	15
August	9	24	9	11
September	9	98	9	30
October	9	17	8	26
November	9	30	8	54
December	9	34	7	90

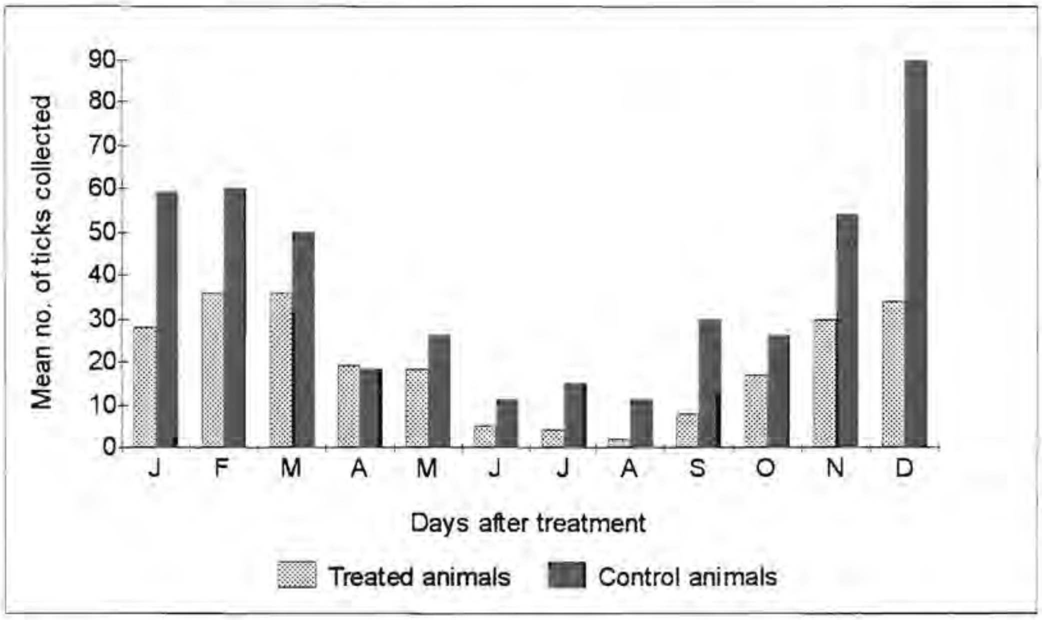

Fig 4.5 Mean monthly number of ticks collected on neem treated and control animals during trial 1.

Table 4.2 Total tick counts from various anatomical sites of neem treated and control animals of all three breeds (Pooled data).

NEEM TREATED GROUP					CONTROL GROUP			
	Ambyomma spp	*Boophilus spp*	*Hyollomma spp*	*R.evertsi*	*Ambyomma spp*	*Boophilus spp*	*Hyollomma spp*	*R.evertsi*
Belly	19	10	25	10	41	21	44	18
Ear	8	8	8	2	17	11	12	10
Perenial	19	14	19	10	35	26	28	11
Scrutum	7	6	5	3	7	10	6	4
Sternum	8	12	16	13	29	24	38	18
Udder	3	2	3	3	13	8	15	7

Incidence of Abscesses

Mean monthly numbers of ruptured abscesses per breed for the trial period are given in Fig 4.6, with most occurring between January, March and December. The Simmental had a significantly (P = 0,05) higher number of abscesses than either the Tswana or Brahman animals. The Brahman was intermediate in this respect while the Tswana had fewer abscesses. Most of the abscesses were encountered in control animal than *neem* treated animals. In other hand there were few number of ruptured abscesses during winter and spring period while most abscesses were present during the rainfall months corresponding with peak tick numbers. Abscesses were attributed mainly to *Hyalomma* and *Amblyomma* infestations, occurring in the regions like udder, root of the tail, vulva lips and on the scrotum in case of males.

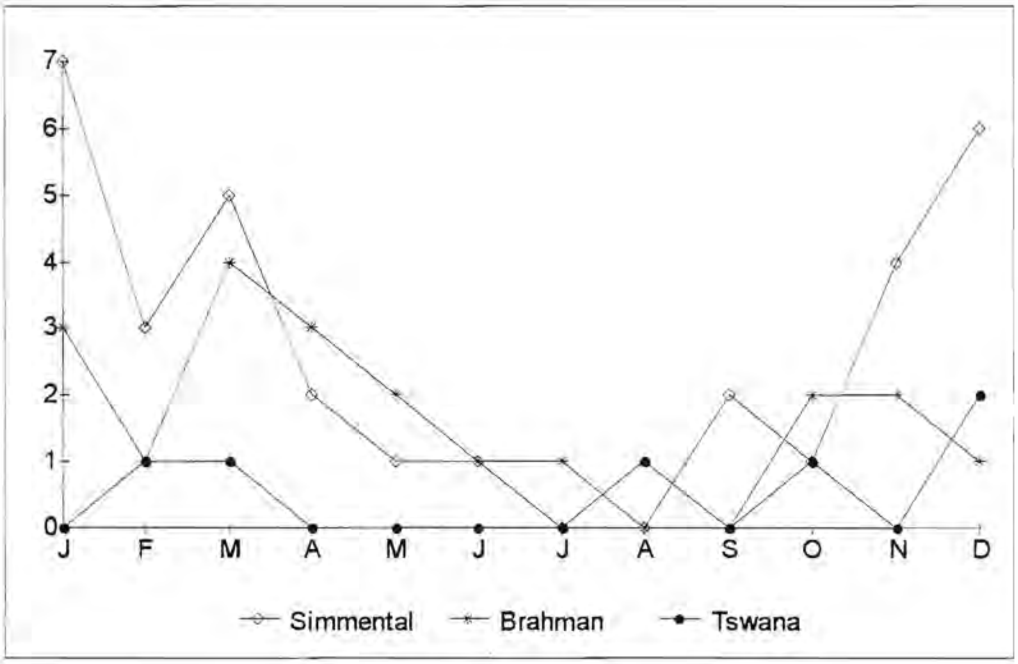

Fig.4.6 Mean Monthly number of ruptured abscesses per breed found on Simmental, Brahman and Tswana animals during the trial 1, 2 and 3.

Table 4.3 Mean total tick counts obtained from treated and control animals on the different anatomical sites.

		CONTROL GROUP		NEEM TREATED GROUP	
Anatomical sites	Tick	Mean	Std. Deviation	Mean	Std. Deviation
Belly	Amblyomma	2.28	1.74	1.06	0.87
(n = 18)	Boophilus	1.11	1.13	0.56	0.70
	Hyollomma	2.44	1.62	1.39	1.20
	R.evertsi	1.00	0.69	0.56	0.51
	Total	1.71	1.49	0.89	0.91
Ear	Amblyomma	0.94	1.00	0.44	0.62
(n = 18)	Boophilus	0.61	0.85	0.44	0.62
	Hyollomma	0.67	1.29	0.44	0.62
	R.evertsi	0.56	1.20	0.11	0.32
	Total	0.69	1.02	0.36	0.56
Perineal	Amblyomma	1.94	1.47	1.06	1.00
(n = 18)	Boophilus	1.44	1.38	0.78	0.88
	Hyollomma	1.56	1.54	1.06	0.73
	R.evertsi	0.61	0.78	0.56	0.62
	Total	1.39	1.39	0.86	0.83
Scrotum	Amblyomma	0.78	0.97	0.67	0.71
(n = 9)	Boophilus	1.11	1.27	0.67	0.87
	Hyollomma	0.67	0.71	0.63	0.74
	R.evertsi	0.44	0.53	0.33	0.50
	Total	0.75	0.91	0.57	0.70
Sternum	Amblyomma	1.44	0.98	0.44	0.62
(n = 18)	Boophilus	1.33	0.69	0.67	0.59
	Hyollomma	2.11	1.53	0.89	0.96
	R.evertsi	1.00	0.77	0.72	0.67
	Total	1.47	1.10	0.68	0.73
Udder	Amblyomma	1.22	1.20	0.33	0.50
(n = 9)	Boophilus	0.89	0.60	0.22	0.44
	Hyollomma	1.67	1.12	0.78	0.67
	R.evertsi	0.78	0.97	0.33	0.71
	Total	1.14	1.02	0.42	0.60
Total	Amblyomma	1.52	1.37	0.70	0.80
(n = 90)	Boophilus	1.10	1.05	0.58	0.70
	Hyollomma	1.59	1.49	0.90	0.91
	R.evertsi	0.76	0.87	0.46	0.58
	Total	1.24	1.26	0.66	0.77

Table 4.4 Mean tick counts obtained from control and treated Simmental cattle

		CONTROL GROUP		NEEM TREATED GROUP	
Anatomical sites	Tick	Mean	Std. Deviation	Mean	Std. Deviation
Belly	Amblyomma	3.33	2.16	1.33	1.03
Ear		1.50	1.38	0.67	0.52
Perineal		2.67	0.82	1.50	0.82
Scortum		1.33	1.53	1.00	1.05
Sternum		2.17	1.17	0.50	1.00
Udder		1.00	0.00	0.67	0.55
Total		2.17	1.51	0.97	0.85
Belly	Boophilus	2.00	1.26	0.83	0.75
(n = 6)	Hyollomma	3.67	1.63	2.00	1.41
	R.evertsi	1.33	0.82	0.50	0.55
	Total	2.33	1.57	1.11	1.13
Ear	Boophilus	1.17	0.98	0.67	0.82
(n = 6)	Hyollomma	1.33	1.37	0.67	0.82
	R.evertsi	1.00	2.00	0.00	0.00
	Total	1.17	1.42	0.44	0.70
Perineal	Boophilus	2.33	1.21	1.33	1.03
(n = 6)	Hyollomma	1.83	1.94	1.00	0.89
	R.evertsi	1.00	0.89	0.83	0.75
	Total	1.72	1.45	1.06	0.87
Scrotum	Boophilus	2.00	2.00	0.67	1.15
(n = 3)	Hyollomma	1.00	1.00	0.67	1.15
	R.evertsi	1.00	0.00	0.67	0.58
	Total	1.33	1.22	0.67	0.87
Sternum	Boophilus	1.50	0.55	0.83	0.75
(n = 6)	Hyollomma	3.50	1.38	1.33	1.03
	R.evertsi	1.17	0.98	0.83	0.41
	Total	2.06	1.43	1.00	0.77
Udder	Boophilus	1.00	0.00	0.67	0.58
(n = 3)	Hyollomma	2.67	1.53	1.33	0.58
	R.evertsi	1.33	1.53	0.67	1.15
	Total	1.67	1.32	0.89	0.78
Total	Boophilus	1.70	1.12	0.87	0.82
	Hyollomma	2.43	1.76	1.20	1.06
	R.evertsi	1.13	1.14	0.57	0.63
	Total	1.76	1.46	0.88	0.88

Table 4.5 Mean tick counts obtained from control and treated Tswana cattle

		CONTROL GROUP		NEEM TREATED GROUP	
Anatomica sites	Tick	Mean	Std. Deviation	Mean	Std. Deviation
Belly	Amblyomma	1.00	0.63	0.33	0.52
(n = 6)	Boophilus	0.33	0.52	0.17	0.41
	Hyollomma	1.67	1.03	0.50	0.55
	R.evertsi	0.83	0.41	0.33	0.52
	Total	0.96	0.81	0.33	0.48
Ear	Amblyomma	0.33	0.52	0.00	0.00
(n = 6)	Boophilus	0.17	0.41	0.00	0.00
	Hyollomma	0.00	0.00	0.17	0.41
	R.evertsi	0.60	0.55	0.17	0.41
	Total	0.25	0.44	0.28	0.28
Perineal	Amblyomma	1.17	0.98	0.67	0.82
(n = 6)	Boophilus	0.50	0.55	0.17	0.41
	Hyollomma	0.67	1.03	1.00	0.63
	R.evertsi	0.17	0.41	0.33	0.52
	Total	0.63	0.82	0.33	0.66
Scrotum	Amblyomma	0.67	0.58	0.00	0.00
(n = 3)	Boophilus	0.67	0.58	0.00	0.00
	Hyollomma	0.33	0.58	0.50	0.71
	R.evertsi	0.00	0.00	0.00	0.00
	Total	0.42	0.51	0.09	0.30
Sternum	Amblyomma	0.83	0.75	0.00	0.00
(n = 6)	Boophilus	0.67	0.52	0.67	0.41
	Hyollomma	0.83	0.75	0.33	'0.52
	R.evertsi	0.67	0.52	0.17	0.41
	Total	0.75	0.61	0.17	0.38
Udder	Amblyomma	0.67	1.15	0.00	0.00
(n = 3)	Boophilus	0.67	0.58	0.00	0.00
	Hyollomma	1.00	0.00	0.33	0.58
	R.evertsi	0.67	0.58	0.33	0.58
	Total	0.75	0.62	0.17	0.39
Total	Amblyomma	0.80	0.76	0.20	0.48
	Boophilus	0.47	0.51	0.10	0.31
	Hyollomma	0.77	0.90	0.48	0.57
	R.evertsi	0.50	0.51	0.23	0.43
	Total	0.63	0.70	0.25	0.47

Table 4.6 Mean tick counts obtained from control and treated Brahman cattle

		CONTROL GROUP		NEEM TREATED GROUP	
Anatomical sites	Tick	Mean	Std. Deviation	Mean	Std. Deviation
Belly (n = 6)	Amblyomma	2.50	1.38	1.50	0.55
	Boophilus	1.00	0.89	0.67	0.82
	Hyollomma	2.00	1.55	1.67	1.03
	R.evertsi	0.83	0.75	0.83	0.41
	Total	1.58	1.32	1.17	0.82
Ear (n = 6)	Amblyomma	1.00	0.63	0.67	0.82
	Boophilus	0.50	0.84	0.67	0.52
	Hyollomma	0.67	0.82	0.50	0.41
	R.evertsi	0.17	0.41	0.17	0.41
	Total	0.58	0.72	0.50	0.59
Perineal (n = 6)	Amblyomma	2.00	2.10	1.00	1.10
	Boophilus	1.50	1.64	0.83	0.75
	Hyollomma	2.17	1.33	1.17	0.75
	R.evertsi	0.67	0.82	0.50	0.55
	Total	1.58	1.56	0.88	0.80
Scrotum (n = 3)	Amblyomma	0.33	0.58	1.00	0.00
	Boophilus	0.67	0.58	1.33	0.58
	Hyollomma	0.67	0.58	0.67	0.58
	R.evertsi	0.33	0.58	0.33	0.58
	Total	0.50	0.52	0.83	0.58
Sternum (n = 6)	Amblyomma	1.33	0.52	0.83	0.75
	Boophilus	1.83	0.41	1.00	0.00
	Hyollomma	2.00	1.10	1.00	1.10
	R.evertsi	1.17	0.75	1.17	0.75
	Total	1.58	0.78	1.00	0.72
Udder (n = 3)	Amblyomma	2.00	1.73	0.33	0.58
	Boophilus	1.00	1.00	0.00	0.00
	Hyollomma	1.33	0.58	0.67	0.58
	R.evertsi	0.33	0.58	0.00	0.00
	Total	1.17	1.11	0.25	0.45
Total (n = 30)	Amblyomma	1.60	1.38	0.93	0.78
	Boophilus	1.13	1.04	0.77	0.63
	Hyollomma	1.57	1.22	1.00	0.87
	R.evertsi	0.63	0.72	0.57	0.63
	Total	1.23	1.17	0.82	0.74

Table 4.7 Tick counts at different anatomical location on the various cattle breeds of during the trial 1 (Pooled data)

Anatomic site	Tick	Mean	Std.Deviation
Belly (n = 36)	Amblyomma	1.67	1.49
	Boophilus	0.83	0.97
	Hyollomma	1.92	1.50
	R.evertsi	0.78	0.64
	Total	1.30	1.30
Ear (n = 36)	Amblyomma	0.69	0.86
	Boophilus	0.53	0.74
	Hyollomma	0.56	0.84
	R.evertsi	0.33	0.89
	Total	0.53	0.84
Perineal (n = 36)	Amblyomma	1.50	1.32
	Boophilus	1.11	1.19
	Hyollomma	1.31	1.21
	R.evertsi	0.58	0.69
	Total	1.13	1.17
Scrotum (n = 18)	Amblyomma	0.72	0.83
	Boophilus	0.89	1.08
	Hyollomma	0.65	0.70
	R.evertsi	0.39	0.50
	Total	0.66	0.81
Sternum (n = 36)	Amblyomma	0.94	0.95
	Boophilus	1.00	0.72
	Hyollomma	1.50	1.40
	R.evertsi	0.86	0.72
	Total	1.08	1.01
Udder (n = 18)	Amblyomma	0.78	1.00
	Boophilus	0.56	0.62
	Hyollomma	1.22	1.00
	R.evertsi	0.56	0.86
	Total	0.78	0.91
Total	Amblyomma	1.11	1.19
	Boophilus	0.84	0.93
	Hyollomma	1.24	1.28
	R.evertsi	0.61	0.75
	Total	0.95	1.08

Table 4.8 Factors included in multifactorial analysis of variance (ANOVA) analysis"with type III sum of squares (Trial 1)

		N
Treatment	C	360
	T	359
Breed	BRAHMAN	240
	SIM	240
	TSWANA	239
Tick	Ambyomm:	180
	Boophilus	180
	Hyolomma	179
	R.evertsi	180
Anatomical sites	Belly	144
	Ear	144
	Perineal	144
	Scortum	71
	Sternum	144
	Udder	72
Sex	Female	360
	Male	359

Table 4.9 Effects of treatment, breed and season on tick counts based on GLM-repeated measures analysis (Pooled data)

	PR>F
Treatment	< 0.0001
Breed	< 0.0001
Trt*breed	0.4856
Season	< 0.0001
Season*trt	0.8256
Season*breed	0.9258
Season*trt*breed	0.6198

The results of the GLM-repeated measures procedure on the pooled data suggest that treatment (P<0.0001), breed (P<0.0001) and season (P<0.0001) significantly influenced the tick counts on cattle in trial 1. No statistically significant interactions were observed. These results will be discussed in more detail by referring to the GLM-repeated measures procedures for the various tick species in the following sections (Table 4.9)

Table 4.10 Effect of treatment, breed and season on the number of Amblyomma ticks based on GLM repeated measures analysis.

	PR>F
Treatment	< 0.0001
Breed	< 0.0001
Trt*breed	0.4553
Season	< 0.0001
Season*trt	0.0846
Season*breed	0.1529
Season*trt*breed	0.9296
Difference between seasons	
Spring	
Trt	0.0347
Breed	0.0320
Trt*breed	0.8445
Summer	
Trt	0.1265
Breed	0.7397
Trt*breed	0.7785

Treatment (P<0.0001), breed (P<0.0001) and season (P<0.0001) significantly affect the number of engoged female *Amblyomma* ticks on the cattle. It is important to note that the differences in the *Amblyomma* ticks treatment (P<0.034 and breeds (P<0.032) were only significantin spring. In summer most of these differences ere not significant (Table 4.10). This means that the effect of the 5% NSK treatment in reducing the number of *Amblyomma* tick was was particularly significant in spring while the effect was less obvious in summer when the number of ticks started to decline. A similar trend was observed for the effect of breed on tick counts. In spring it was quite clear that Tswana cattle harboured significantly less (P<0.0320 ticks compared to Brahman and Simmental cattle. This typically coincides with times of peak tick abundance. When the tick count start to decline (e.g. in winter), the differences between the various breeds of cattle tend to be less important. No significantly interaction were observed between these factors for *Amblyomma* ticks (Table 4.10).

Table 4.11 Effect of treatment, breed and season on the number of Boophilus ticks based on GLM repeated measures analysis.

	PR>F
Treatment	< 0.0001
Breed	< 0.0001
Trt*breed	0.4825
Season	< 0.0001
Season*trt	0.0796
Season*breed	0.4896
Season*trt*breed	0.4975
Difference between seasons	
Spring	
Trt	0.7795
Breed	0.4226
Trt*breed	0.4009
Summer	
Trt	0.0541
Breed	0.6463
Trt*breed	0.6055

Treatment (P<0.0001), breed (P<0.0001) and season (P<0.0001) significantly influenced the number of engorged female *Boophilus* ticks. No statistically significant interactions were observed. Treatment significantly reduced (P<0.0001) the number of *Boophilus* ticks on all breeds. Tswana cattle carried significantly less (P<0.0001) *Boophilus* ticks compared to Brahman and Simmental cattle. Minor differences were found between the numbers of engorged female *Boophilus* ticks on Simmental and Brahman cattle (Table 4.11).

Table 4.12 Effect of treatment, breed and season on the number of Hyolomma ticks based on GLM repeated measures analysis.

	PR>F
Treatment	< 0.0082
Breed	< 0.0002
Trt*breed	0.7031
Season	< 0.0001
Season*trt	0.9032
Season*breed	0.0099
Season*trt*breed	0.2982
Difference between seasons	
Spring	
Trt	0.6748
Breed	0.0632
Trt*breed	0.4006
Summer	
Trt	0.7490
Breed	0.0143
Trt*breed	0.3861

Treatment (P<0.001), breed (P<0.001) and season (P<0.0001) significantly influence the tick number of engorged female *Hyolomma* ticks (Table 4.12). The interactions between season and breeds tended toward significance (P<0.05). Simmental cattle carried significantly (P<0.05) more engorged *Hyolomma* female ticks than Brahman and Tswana cattle during the February peak, but similar numbers were found on all three breeds during winter months. The effect of breed of cattle on the number of *Hyolomma* ticks was particularly evident in summer (P<0.0143), while a tendency toward significance was also noted in spring (P<0.0632). This suggest that the differences between breeds in terms of the numbers of ticks harboured are more significant during times of higher tick infestations. This agrees with the observations of the number of *Amblyomma* ticks in the trial.

Table 4.13 Effect of treatment, breed and season on the number of R. evertsi ticks based on GLM repeated measures analysis.

	PR>F
Treatment	< 0.0249
Breed	0.0056
Trt*breed	0.3320
Season	< 0.0001
Season*trt	0.7271
Season*breed	0.2145
Season*trt*breed	0.2116
Difference in season	
Spring	
Trt	0.4680
Breed	0.1621
Trt*breed	0.4788
Summer	
Trt	0.5775
Breed	0.1478
Trt*breed	0.1440

Treatment ($P<0.05$), breed ($P<0.05$) and season ($P<0.0001$) significantly affected the number of engorged female *R. evertsi* ticks on the cattle. These results are similar to the main effects reported in section 4.1.1 for *R. evertsi* ticks. No significant interaction was observed between these factors for *Amblyomma* ticks (Table 4.13).

4.2 TRIAL 2 RESULTS (Naturally tick infestation)

4.2.1 Tick counts

The effect of 2% NSKS treatment on the number of ticks on cattle was not significant ($P<0.701$; $F=0.148$). It is evident that at least 5% NSKS should be used for effective tick treatment in Simmental, Brahman and Tswana cattle like in trial 1 (Table 4.20). Peak numbers of engorged female ticks were evident during the summer months of March and December 1999. The situation was similar in all three breeds of cattle. Tick counts on Simmental and Brahman cattle were significantly ($P = 0.05$, Table 4.19. and 4.21) higher than on Tswana cattle. After 12 months of treatment it was found that the numbers of ticks infesting animals were less as compared to the initial number at the first treatment. It is evident from these observations that the nymphs that hatched later were also affected by the treatment.

Results from trial 1 and 2 with 5% and 2% concentrations of NSKE respectively resulted in very similar reductions in tick counts on the treated animals. Counts of engorged female ticks during dry seasons suggest that ticks were present at very low levels during winter and spring. During dry seasons no significant difference was observed in tick counts between neem treated and control animals. This observation was nearly similar for all breeds of cattle, Simmental, Brahman and Tswana. Small differences were found between the numbers of engorged female ticks on the Simmental and Brahman cattle.

4.2.2.Effects of season on tick counts.

The highest number of engorged female ticks was observed during the summer (Table 4.22). There were only minor differences between tick counts in the winter and spring.

Table 4.18 Number of various treatment groups naturally infested with ticks during trial 2.

Between-Subjects Factors		
		N
Treatment	C	30
	NT	30
Breed	BRA	20
	SIM	20
	TSW	20
Sex	F	30
	M	30

Table 4.19 Mean tick counts obtained from natural infested animals during trial 2

			Control group			Neem treated group	
	Breed	**Sex**	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**
Belly	**BRA**	**F**	23.4000	7.1624	5	6.0000	4.3589
		M	24.6000	6.2690	5	2.4000	2.0736
		Total	24.0000	6.3770	10	4.2000	3.7357
	SIM	**F**	24.8000	5.8907	5	12.4000	3.9115
		M	24.8000	8.7579	5	11.4000	3.7815
		Total	24.8000	7.0364	10	11.9000	3.6652
	TSW	**F**	12.0000	6.2048	5	4.6000	1.5166
		M	8.4000	4.3359	5	5.0000	1.5811
		Total	10.2000	5.3914	10	4.8000	1.4757
	Total	**F**	20.0667	8.4131	15	7.6667	4.7759
		M	19.2667	10.0887	15	6.2667	4.6209
		Total	19.6667	9.1363	30	6.9667	4.6719
Ear	**BRA**	**F**	6.0000	2.9155	5	4.6000	3.3615
		M	2.6000	3.7815	5	2.4000	2.0736
		Total	4.3000	3.6530	10	3.5000	2.8771
	SIM	**F**	5.8000	2.2804	5	4.8000	1.7889
		M	5.6000	3.2863	5	4.4000	2.9665
		Total	5.7000	2.6687	10	4.6000	2.3190
	TSW	**F**	2.4000	2.3022	5	1.6000	1.5166
		M	4.0000	1.5811	5	1.0000	1.2247
		Total	3.2000	2.0440	10	1.3000	1.3375
	Total	**F**	4.7333	2.8900	15	3.6667	2.6637
		M	4.0667	3.0814	15	2.6000	2.5014
		Total	4.4000	2.9548	30	3.1333	2.5962

Perineal	**BRA**	**F**	17.4000	3.4351	5	7.6000	3.6469
		M	17.8000	3.7683	5	11.0000	4.8477
		Total	17.6000	3.4059	10	9.3000	4.4234
	SIM	**F**	17.0000	4.5826	5	9.0000	2.7386
		M	17.4000	4.2190	5	8.6000	4.0373
		Total	17.2000	4.1580	10	8.8000	3.2592
	TSW	**F**	9.4000	2.4083	5	4.4000	1.5166
		M	9.4000	5.4129	5	3.8000	1.0954
		Total	9.4000	3.9497	10	4.1000	1.2867
	Total	**F**	14.6000	5.0540	15	7.0000	3.2514
		M	14.8667	5.7924	15	7.8000	4.6167
		Total	14.7333	5.3430	30	7.4000	3.9444
Scrotum	**BRA**	**F**	.0000	.0000	5	.0000	.0000
		M	4.0000	3.6742	5	1.4000	1.1402
		Total	2.0000	3.2318	10	.7000	1.0593
	SIM	**F**	.0000	.0000	5	.0000	.0000
		M	3.4000	3.0496	5	3.2000	.8367
		Total	1.7000	2.7101	10	1.6000	1.7764
	TSW	**F**	.0000	.0000	5	.0000	.0000
		M	1.0000	1.2247	5	2.0000	.7071
		Total	.5000	.9718	10	1.0000	1.1547
	Total	**F**	.0000	.0000	15	.0000	.0000
		M	2.8000	2.9568	15	2.2000	1.1464
		Total	1.4000	2.4997	30	1.1000	1.3734
Sternum	**BRA**	**F**	10.8000	5.3572	5	3.4000	1.3416
		M	4.8000	1.9235	5	4.0000	2.3452
		Total	7.8000	4.9396	10	3.7000	1.8288
	SIM	**F**	15.2000	6.1400	5	4.6000	1.5166
		M	18.0000	3.9370	5	3.2000	1.4832

		Total	16.6000	5.0816	10	3.9000	1.5951
	TSW	**F**	4.4000	1.8166	5	2.6000	.5477
		M	6.6000	2.1909	5	3.0000	2.5495
		Total	5.5000	2.2236	10	2.8000	1.7512
	Total	**F**	10.1333	6.4016	15	3.5333	1.4075
		M	9.8000	6.5922	15	3.4000	2.0633
		Total	9.9667	6.3869	30	3.4667	1.7367
Udder	**BRA**	**F**	5.4000	3.7148	5	3.6000	2.5100
		M	.0000	.0000	5	.0000	.0000
		Total	2.7000	3.7727	10	1.8000	2.5298
	SIM	**F**	5.2000	3.1145	5	3.0000	1.8708
		M	.0000	.0000	5	.0000	.0000
		Total	2.6000	3.4383	10	1.5000	2.0138
	TSW	**F**	3.8000	3.4205	5	2.0000	1.4142
		M	.0000	.0000	5	.0000	.0000
		Total	1.9000	3.0350	10	1.0000	1.4142
	Total	**F**	4.8000	3.2558	15	2.8667	1.9591
		M	.0000	.0000	15	.0000	.0000
		Total	2.4000	3.3280	30	1.4333	1.9945

Table 4.20. GLM-repeated measures analysis results on the effect of treatment, breed, sex and season on tick counts obtained from different breeds of cattle during trial 2.

Source	**PR<F.**
TREATMEN	0.701
BREED	0.000
SEX_	0.181
SEASON	0.000
BREED * SEASON	0.058

In general treatment did not significantly affect the tick counts on cattle in trial 2 (Table 4.20). This result is in contrast with the findings in the first trial. This could be partly due to the fact that the cattle were older and or better adapted to the tick infestation; or that the tick burden was reduced by the previous treatment (carry-over effects). It is also possible that the concentration of NSKE in trial 2 was too low to effectively reduce the tick numbers. However, significant differences in tick counts were observed between breeds and between seasons, which agrees with the findings in trial 1.

Table 4.21. GLM-repeated measures analysis results of the effect of treatment, breed and sex on tick counts on cattle.

Source	Dependent Variable	PR<F.
TREATMEN	Belly	.000
	Ear	.060
	Perineal	.000
	Scrotum	.441
	Sternum	.000
	Udder	.065
BREED	Belly	.000
	Ear	.003
	Perineal	.000
	Scrotum	.164
	Sternum	.000
	Udder	.419
SEX_	Belly	.411
	Ear	.194
	Perineal	.579
	Scrotum	.000
	Sternum	.769
	Udder	.000
	Sternum	.769
	Udder	.000

Table 4.22. Mean tick counts obtained in different seasons from Control and neem treated animals during trial 2.

			Control group			Neem treated group	
Breed	**Sex**	**Season**	**Mean**	**Std. Dev**	**N**	**Mean**	**Std. Dev**
BRA	F	spring	17.0000	7.4833	5	17.0000	7.4833
		summer	30.6000	6.6933	5	30.6000	6.6933
		winter	15.4000	6.6182	5	15.4000	6.6182
		Total	21.0000	9.5469	15	21.0000	9.5469
	M	spring	15.6000	4.3932	5	15.6000	4.3932
		summer	27.2000	4.4385	5	27.2000	4.4385
		winter	11.0000	3.4641	5	11.0000	3.4641
		Total	17.9333	8.0220	15	17.9333	8.0220
	Total	spring	16.3000	5.8319	10	16.3000	5.8319
		summer	28.9000	5.6460	10	28.9000	5.6460
		winter	13.2000	5.4934	10	13.2000	5.4934
		Total	19.4667	8.8033	30	19.4667	8.8033
SIM	F	spring	18.0000	4.7434	5	14.4000	8.3247
		summer	32.2000	4.0249	5	32.2000	4.0249
		winter	17.8000	5.4955	5	17.8000	5.4955
		Total	22.6667	8.2693	15	21.4667	9.8406
	M	spring	20.0000	4.4159	5	20.0000	4.4159
		summer	32.6000	6.3087	5	32.6000	6.3087
		winter	16.6000	9.0443	5	14.6000	5.8992
		Total	23.0667	9.5429	15	22.4000	9.3717
	Total	spring	19.0000	4.4472	10	17.2000	6.9410
		summer	32.4000	4.9933	10	32.4000	4.9933
		winter	17.2000	7.0836	10	16.2000	5.6332
		Total	22.8667	8.7759	30	21.9333	9.4538

TSW	F	spring	6.8000	2.8636	5	6.8000	2.8636
		summer	19.4000	6.6558	5	19.4000	6.6558
		winter	5.8000	3.9623	5	5.8000	3.9623
		Total	10.6667	7.7797	15	10.6667	7.7797
	M	spring	6.4000	2.6077	5	6.4000	2.6077
		summer	14.2000	6.0581	5	14.2000	6.0581
		winter	8.8000	3.6332	5	8.8000	3.6332
		Total	9.8000	5.2536	15	9.8000	5.2536
	Total	spring	6.6000	2.5906	10	6.6000	2.5906
		summer	16.8000	6.5963	10	16.8000	6.5963
		winter	7.3000	3.9172	10	7.3000	3.9172
		Total	10.2333	6.5373	30	10.2333	6.5373
Total	F	spring	13.9333	7.2256	15	12.7333	7.6295
		summer	27.4000	8.0516	15	27.4000	8.0516
		winter	13.0000	7.3776	15	13.0000	7.3776
		Total	18.1111	9.9412	45	17.7111	10.2217
	M	spring	14.0000	6.8868	15	14.0000	6.8868
		summer	24.6667	9.5593	15	24.6667	9.5593
		winter	12.1333	6.4903	15	11.4667	4.8236
		Total	16.9333	9.4205	45	16.7111	9.2211
	Total	spring	13.9667	6.9356	30	13.3667	7.1703
		summer	26.0333	8.7945	30	26.0333	8.7945
		winter	12.5667	6.8415	30	12.2333	6.1738
		Total	17.5222	9.6480	90	17.2111	9.6925

TRIAL 3 RESULTS (Artificial tick infestation)

Amblyomma hebraeum

The results suggest that the mean tick population densities were significantly lower in the neem treated than control animals (Table 4.25 and Table 4.27). The tick counts indicate that the various tick species were present throughout the year with marked peaks of abundance during the summer of both years (1998 and 1999).

Higher numbers of *Ambyomma hebraeum* were encountered on all three breeds during the rainy season of each year. Counts of *Ambyomma hebraeum* on the Brahman were intermediate between the relatively high numbers found on the Simmental and lower numbers on the Tswana animals. During winter months (April, May and June) there were minor differences in tick counts on Simmental and Brahman cattle. On the other hand Brahman and Simmental breeds were infested with significantly (P=0.05) higher numbers of ticks compared to Tswana cattle during the summer months of the experiment. Similar results were obtained in the first trial, where the tick counts were lower on all three breeds during the dry season of the year.

Boophilus decoloratus

The effect of treatment on tick counts tended toward significance (P=0.06; Table 4.25 and 4.27). A large number of ticks was observed on Simmental cattle followed by Brahman and Tswana cattle.

The ticks occurred throughout the year with peak numbers in February and November 1999. The general observation was that *B. decoloratus* tick counts from neem treated and control animals during the trial were low compared to that of *Amblyomma* spp. During the dry season no significant difference was observed in tick counts between animals.

Table 4.23 Number of various treatment groups artificially infested with ticks.

Between-Subjects Factors		
		N
Treatment	**C**	18
	NT	18
Breed	**BRA**	12
	SIM	12
	TSW	12
Sex	**F**	18
	M	18

Table 4.24. Effect of anatomical location on the tick counts of artificial infested animals

			Control group			Neem treated group	
Anatomic site	**Breed**	**Sex**	**Mean**	Std.Dev	**N**	**Mean**	**Std.Dev**
Belly	**BRA**	**F**	10.3333	6.1101	3	6.6667	2.3094
		M	11.0000	7.9373	3	4.6667	1.5275
		Total	10.6667	6.3456	6	5.6667	2.0656
	SIM	**F**	15.0000	8.0000	3	7.6667	1.1547
		M	14.6667	12.4231	3	5.0000	1.0000
		Total	14.8333	9.3470	6	6.3333	1.7512
	TSW	**F**	6.0000	1.0000	3	2.3333	.5774
		M	5.3333	1.5275	3	3.6667	1.5275
		Total	5.6667	1.2111	6	3.0000	1.2649
	Total	**F**	10.4444	6.3857	9	5.5556	2.7889
		M	10.3333	8.4558	9	4.4444	1.3333
		Total	10.3889	7.2691	18	5.0000	2.1963
Ear	**BRA**	**F**	2.6667	2.0817	3	.6667	1.1547
		M	2.0000	3.4641	3	1.3333	.5774
		Total	2.3333	2.5820	6	1.0000	.8944
	SIM	**F**	2.6667	1.5275	3	1.3333	1.1547
		M	2.0000	1.0000	3	1.0000	.0000
		Total	2.3333	1.2111	6	1.1667	.7528
	TSW	**F**	2.3333	.5774	3	.6667	.5774
		M	2.3333	1.5275	3	.6667	.5774
		Total	2.3333	1.0328	6	.6667	.5164
	Total	**F**	2.5556	1.3333	9	.8889	.9280
		M	2.1111	1.9650	9	1.0000	.5000
		Total	2.3333	1.6450	18	.9444	.7254

Perineal	**BRA**	**F**	9.0000	5.1962	3	6.6667	3.7859
		M	4.3333	1.5275	3	4.3333	2.5166
		Total	6.6667	4.2740	6	5.5000	3.1464
	SIM	**F**	9.6667	2.5166	3	5.0000	1.0000
		M	13.6667	4.0415	3	7.6667	2.5166
		Total	11.6667	3.7238	6	6.3333	2.2509
	TSW	**F**	1.3333	.5774	3	1.3333	1.5275
		M	2.0000	1.0000	3	.6667	.5774
		Total	1.6667	.8165	6	1.0000	1.0954
	Total	**F**	6.6667	4.9497	9	4.3333	3.1623
		M	6.6667	5.7879	9	4.2222	3.5277
		Total	6.6667	5.2244	18	4.2778	3.2504
Scrotum	**BRA**	**F**	.0000	.0000	3	.0000	.0000
		M	1.6667	2.0817	3	1.6667	1.5275
		Total	.8333	1.6021	6	.8333	1.3292
	SIM	**F**	.0000	.0000	3	.0000	.0000
		M	1.6667	1.5275	3	2.0000	1.7321
		Total	.8333	1.3292	6	1.0000	1.5492
	TSW	**F**	.0000	.0000	3	.0000	.0000
		M	1.3333	1.5275	3	1.0000	1.0000
		Total	.6667	1.2111	6	.5000	.8367
	Total	**F**	.0000	.0000	9	.0000	.0000
		M	1.5556	1.5092	9	1.5556	1.3333
		Total	.7778	1.3086	18	.7778	1.2154
Sternum	**BRA**	**F**	4.0000	2.0000	3	5.0000	2.6458
		M	5.6667	4.1633	3	3.6667	4.6188
		Total	4.8333	3.0605	6	4.3333	3.4448
	SIM	**F**	10.0000	5.1962	3	3.0000	1.0000
		M	8.3333	1.5275	3	5.0000	2.6458

		Total	9.1667	3.5449	6	4.0000	2.0976
	TSW	**F**	2.6667	1.5275	3	1.6667	1.1547
		M	2.0000	.0000	3	2.0000	1.0000
		Total	2.3333	1.0328	6	1.8333	.9832
	Total	**F**	5.5556	4.4472	9	3.2222	2.1082
		M	5.3333	3.5355	9	3.5556	3.0046
		Total	5.4444	3.8991	18	3.3889	2.5237
Udder	**BRA**	**F**	2.0000	.0000	3	1.0000	1.0000
		M	.0000	.0000	3	.0000	.0000
		Total	1.0000	1.0954	6	.5000	.8367
	SIM	**F**	3.3333	2.5166	3	1.6667	.5774
		M	.0000	.0000	3	.0000	.0000
		Total	1.6667	2.4221	6	.8333	.9832
	TSW	**F**	1.3333	1.1547	3	1.0000	1.0000
		M	.0000	.0000	3	.3333	.5774
		Total	.6667	1.0328	6	.6667	.8165
	Total	**F**	2.2222	1.6415	9	1.2222	.8333
		M	.0000	.0000	9	.1111	.3333
		Total	1.1111	1.6047	18	.6667	.8402

Table 4.25 GLM-repeated measures analysis results of the effect of treatment, breed and sex on tick counts on artificially infested cattle.

Source	**Dependent variable**	PR<F
TREATMEN	Belly	.005
	Ear	.009
	Perineal	.012
	Scrotum	1.000
	Sternum	.035
	Udder	.164
BREED	Belly	.026
	Ear	.914
	Perineal	.000
	Scrotum	.756
	Sternum	.002
	Udder	.269
SEX_	Belly	.731
	Ear	.737
	Perineal	.950
	Scrotum	.000
	Sternum	.952
	Udder	.000

Table 4.26. Effect of treatment on tick counts of artificial infested animals with *Amblyomma* and *Boophilus spp.*

CONTROL GROUP					NEEM TREATED		
	Breed	**Sex**	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**
Amb	**BRA**	**F**	13.3333	2.8868	3	12.0000	2.6458
		M	14.6667	8.0208	3	7.6667	6.0277
		Total	14.0000	5.4406	6	9.8333	4.7924
	SIM	**F**	24.0000	6.0828	3	9.0000	4.5826
		M	22.3333	15.5027	3	11.6667	3.0551
		Total	23.1667	10.5720	6	10.3333	3.7771
	TSW	**F**	7.6667	1.1547	3	2.3333	1.1547
		M	7.3333	2.5166	3	4.0000	2.0000
		Total	7.5000	1.7607	6	3.1667	1.7224
	Total	**F**	15.0000	7.9530	9	7.7778	5.0690
		M	14.7778	10.9519	9	7.7778	4.8419
		Total	14.8889	9.2856	18	7.7778	4.8088
Boop	**BRA**	**F**	9.3333	3.7859	3	9.6667	3.2146
		M	10.0000	6.0828	3	7.6667	4.6188
		Total	9.6667	4.5461	6	8.6667	3.7238
	SIM	**F**	16.6667	4.6188	3	9.6667	1.1547
		M	18.0000	2.6458	3	9.0000	3.4641
		Total	17.3333	3.4448	6	9.3333	2.3381
	TSW	**F**	5.6667	1.5275	3	4.6667	1.5275
		M	5.6667	1.5275	3	4.3333	1.5275
		Total	5.6667	1.3663	6	4.5000	1.3784
	Total	**F**	10.5556	5.7470	9	8.0000	3.1225

		M	11.2222	6.3988	9	7.0000	3.6401
		Total	10.8889	5.9100	18	7.5000	3.3299

Table 4.27. GLM-repeated measures analysis results of the effect of treatment, and breed on the tick counts of artificial infested animals with *Ambyomma* and *Boophilus spp*

Source	Dependent Variable	PR<F
TREATMEN	**Amblyomma spp**	.002
	Boophilus spp	.006
BREED	**Amblyomma spp**	.000
	Boophilus spp	.000

In the cattle artificially infested with *Amblyomma* and *Boophilus* larvae the treatment significantly affected the number of engoged female *Boophilus* (P<0.002) and *Ambyomma* (P<0.006) ticks (Table 4.27). Significant differences in the number of *Amblyomma* and *Boophilus* ticks were also observed on Simmental, Brahman and Twana cattle regardless of the artificial infestations of cattle with similar amounts of larvae.

CHAPTER FIVE

5.0 DISCUSION

5.1 TRIAL 1

5.1.1 Effects of treatment on tick counts.

Neem treatment (5% NSKE) significantly reduced the tick counts ($P<0.0001$, Table 4.9) of cattle in trial 1. Average tick counts were 37.5±12.75 for control animals and 19.75±12.75 for treated animals (Table 3.3). The fact that all cattle grazed together and were equally exposed to a highly infested shelter suggests that all breeds of cattle had equal chances of being infested by ectoparasites. The observation was that the population densities of ticks were significantly lower on neem treated (5% NSKE) than control animals during the experimental period (summer, winter and spring) in trial1. This can be attributed, partly, to the lethal or repellent effects of the Neem Seed Kernels Extracts, (NSKE) on the various tick species. These results agree with that of Jotwarni and Sirca, (1965) and Butterworth et al., (1971). It appears that, Neem extracts have insect repelling properties, reduce infestation and digestion of feed and cause poor development and growth of insects. These results are also in agreement with that of Rembold et al., (1986) and Saxena, (1993). The extracts cause a disruption in mating, oviposition and inhibit eggs hatchability and exposed insects fail to moult.

Incidence of Abscesses and neem treatment

The heavy tick infestations of control animals were at least partly responsible for the higher incidence of abscesses during the three trial I, II and III. Fewer abscesses due to tick bites were observed in the Tswana cattle as compared to Brahman and Simmental (Figure 4.6). Most abscesses were present during the summer months (December and March) corresponding with peak tick numbers. More abscesses were encountered in control animals (72%) than Neem treated (28%) animals. The incidence of abscesses was attributed particularly to Hyalomma and Amblyomma infestations, occurring in specific anatomical areas like the udder, root of the tail, vulva lips and on the scrotum. These results are in agreement with report from the Department of Animal Health and Production, Serowe that during the rainy season animals some animals are subjected to screw worm due to abscesses occurring in the region of clumping of the former species and at the isolated attachment sites of the latter species, especially on the udder, scrotum axillae and at the tail root.

5.1.2 Effect of Breeds on tick counts

There was a large variation in tick counts among breeds ($P<0.0001$; Table 4.9). Counts of engorged female ticks on naturally infested cattle over a one-year period, showed that indigenous Tswana cattle harboured significantly fewer ticks during periods of peak abundance than either Brahman or Simmental cattle. The results suggest that Tswana cattle were infested with fewer ticks as compared to Brahman and Simmental. These results are in agreement with that of Norval et al, 1998a and Scholtz, 1989) that the use of indigenous breeds that possess a very high resistance to tick infestation may be a solution to the dilemma of tick infestation and frequent dipping in the undeveloped parts of Africa.

5.1.3 Effect of the interaction between treatment and anatomical sites on tick counts

Neem treatment significantly reduced the number of ticks on different anatomical sites of treated animals ($P < 0.05$). In all treated and control animals, ticks were found at nearly all anatomical sites (Table 4.2). Most of the Amblyomma species were found on the Belly area followed by the perineal area. On the other hand most of the other tick species were observed on the anatomical sites with longer hair. Simmental cattle had the highest tick counts and therefore the assumption that longer hair is conducive to tick infestations is true as far as tick selection of cattle for resistance is concerned. No significant correlation between hair length of different anatomical sites and tick counts could be demonstrated between the sexes within each of the three breeds.

5.1.4 Interaction between treatment and sex on tick counts

There was no significant difference among different sexes. Treatment did not affect the tick counts in either sex, although some Tswana bulls had lower tick count compared to the females counterparts.

5.1.5 Effect of breed on tick counts.

Breed significantly influenced the tick counts ($P<0.001$; Table 4.9). The average values obtained from tick counts among the different breeds were as follows; Tswana cattle (0.4435±0.6251); Brahman cattle (1.0250±1.0018); Simmental cattle (1.3167±1.2793). The consistently large percentage of Tswana cattle showing low tick counts indicates a higher level of natural resistance in this breed. Tick counts of individuals, which could indicate a high or low resistance, suggest that there are differences among breeds and even individual animals. These results suggest that there is a potential for the selection for tick resistance within all three breeds.

5.1.6 Effect of the interactions between breed and anatomical sites on tick counts

There was no significant interaction between anatomical sites of different breeds on tick counts. No significant interaction was observed between breeds and anatomical sites for the different tick species.

5.1.7 Effect of the interaction between breed and sex on tick counts

The effect of the interaction between breed and sex on tick counts tended toward significance (P=0.088). Males of some breeds exhibited lower tick counts compared to those of other breeds. The interaction effects for specific tick species were not significant namely: Ambyomma P=0.1795, Boophilus P=0.0781; Hyolomma P=0.149; R. evertsi P=0.6163.

5.1.8 Effects of season on tick counts.

Season significantly affected the tick counts on cattle (P<0.01; Table 4.9). The results show that the highest number of engorged female ticks was observed during the summer season. Higher tick counts were obtained during summer probably because ticks breed during the rainy season when the ambient temperature is also high. There was no significant difference between tick counts in the winter and spring. This is in agreement with that of Chavunduka et al, (1990), that, during summer tick populations build up more rapidly resulting in an upsurge of tick infestations on cattle. It is also in agreement with the information I got from the Department of Animal Health, Serowe that tick burden depend on the weather condition, the eggs hatch out more rapidly if the weather is warm and moist than cold dry winter months.

5.1.9 The effect of the interactions between season, breed and sex on tick counts

No significant interaction between breed, seasons and sex on tick counts was observed (P>0.05; Table 4.9)

5.1.10 Effect of anatomical sites on tick counts.

The anatomical sites significantly affected the number of ticks counted on the experimental animals (P < 0.01). Ticks were found at all anatomical sites (Table 4.3 to 4.7) regardless of the breed of cattle or sex. More ticks were found on the belly, perineal and sternum while fewer tick were found on the udder and scrotum. On the other hand more ticks were observed at the anatomical areas covered with longer hair because the longer hair provides an ideal site for tick breeding. This result is in agreement with Chavunduka at al., (1990) that different species have different predilection sites and that the length of the animalsí coat tends to affect the degree of tick infestation. He further noted that the level of tick infestation might differ markedly in two animals of the same breed and on the same pastures.

5.1.11 Effect of the interaction between anatomical sites and treatment on tick counts.

Generally there was a significant interaction between treatment and anatomical sites on the numbers of ticks (P= 0.031).

The treatment generally affected the tick counts at different anatomical sites of experimental animals of both sexes. The belly had the highest tick counts while the lowest tick counts were observed on the udder and scrotum. The various anatomical sites and predominant tick species are as follows; Belly (Hyolomma spp), Ear (Amblyomma spp), Perineal (Ambyomma spp), Scrotum (Boophilus spp), Sternum (Hyolomma spp) and udder (Hyolomma spp), (Table 4.2).

5.1.12 Effect of the interaction between anatomical sites and sex on tick counts

Significant interaction effects between anatomical sites and sex were observed for specific tick species. There were more ticks on the udder (1.139±1.02) of the control animals compared to the number of ticks collected from the scrotum (0.75±0.906) of the same group of animals. Therefore sex affected the tick counts at specific anatomical sites. The opposite is true in the case of treated animals, where more ticks were collected from the

5.2 DISCUSSION OF TRIAL 2

5.2.1 Effects of treatment on tick counts.

The effect of 2% NSKE treatment on the number of ticks on cattle was not significant ($P<0.701$; $F=0.148$). It is evident that at least 5% NSKS should be used for effective tick treatment in Simmental, Brahman and Tswana cattle like in trial 1 (Table 4.20). Peaks of engorged female ticks were evident during the summer months of March and December 1999.

The situation was similar in all three breeds of cattle. Tick counts on Simmental and Brahman cattle were significantly ($P = 0.05$, Table 4.19. and 4.21) higher than on the Tswana breed. After 12 months of treatment it was found that the numbers of ticks infesting animals were less as compared to the initial number at the first treatment. It is evident from these observations that the nymphs that hatched later were also affected by the treatment.

Results from trial 1 and 2 with 5% and 2% concentrations of NSKE respectively resulted in very similar reductions in tick counts on the treated animals. These results are in agreement with that of Schmutterer, (1990) that, temperature, ultraviolet light, rainfall, and other environmental factors may exert a negative effect on the active principles of *Azadirachta indica* when low dosage is used.

The neem-based insecticides are safe, non-toxic but due to its short LC_{50}, insect pests can develop resistance when low dosage is used at short interval.

5.2.2 Effect of Breeds on tick counts

There was a large variation in tick counts among breeds (P<0.005; Table 4.21). Indigenous Tswana cattle harboured significantly fewer` ticks during periods of peak abundance than Brahman and Simmental cattle. These results are the same as trial 1 as discussed in section 5.1.2.

5.2.3 Effect of the interaction between treatment and anatomical sites on tick counts

Neem treatment significantly reduced the number of ticks on different anatomical sites of treated animals (P < 0.05, Table 4.21). In all treated and control animals, ticks were found nearly at all anatomical sites. Except in scrotum the neem treatment did not reduce the tick counts (P=0.441; Table 4.21).

5.2.4 Effect of sex on tick counts

There was no significant difference among different sexes (P>0.05)

Table 4.21) except on the other anatomical locations named scrotum (P<0.01; F=41.978; Table 4.21) and udder (P<0.01;F=56.277, Table 4.21). Treatment did not affect the tick counts in either sex.

5.2.5 Effects of season on tick counts.

Season significantly affected the tick counts on cattle (P<0.001; Table 4.20). The highest number of engorged female ticks was observed during the summer. There were little differences between tick counts in the winter and spring. Higher tick counts were obtained during summer probably because ticks breed during the rainy season when the ambient temperature is also high. The effect of season in trial 2 is similar to that of trial 1 discussed in section 5.1.8 of this chapter.

5.2.6 The effect of the interactions between breed and season

The effect of the interaction between breed and season on tick counts tended toward significance (P=0.058; F=2.339; Table 4.20). High tick counts was observed on Simmental cattle followed by Brahman and Tswana cattle the least.

5.3 DISCUSSION OF TRIAL 3 (ARTIFICIAL TICK INFESTATION)

5.3.1 Effects of treatment on tick counts.

Neem treatment with 3% NSKE on artificially infested animals significantly reduced the tick counts of *Amblyomma spp* ($P<0.01$; $F=12.507$, Table 4.27) and *Boophilus spp* ($P<0.01$; $F=9.256$, Table 4.27). Animals on trial were all infested with *Amblyomma* and *Boophilus spp* ticks artificially and grazed together, and therefore ticks had equal chances of infesting all the animals equally, however the population densities of ticks were significantly lower on neem treated than control animals during the trial period. This can be attributed, partly, to the lethal or repellent effects of the Neem Seed Kennels Extracts, (SKE) on the various tick species. These results agree with that of Rembold et al., (1986) and Saxena, (1993). The extracts cause a disruption in mating, oviposition and inhibit egg hatchebility and exposed insects fail to moult.

5.3.2 Effect of Breeds on tick counts

As it was the case for the first trial a large variation in tick counts among breeds were observed in this trial for *Amblyomma spp* ($P<0.01$; $F=10.830$, Table 4.27) and *Boophilus spp* ($P<0.01$; $F=18.286$, Table 4.27). Tick counts on artificially infested cattle over a year, indicate that Tswana cattle harboured significantly fewer ticks than either Brahman or Simmental cattle. These results obtained in trial 1 suggest that the use of indigenous breeds that possess a very high resistance to tick infestation may be a solution to the dilemma of tick infestation in the some parts of Africa (Norval et al., 1998a).

5.3.3 Effects of treatment and anatomical location on tick counts.

Neem treatment significantly reduced the tick counts ($P<0.05$, Table 4.25) on different anatomical sites with the exception of the udder, belly ($P=0.005$; $F=9.372$), ear ($P=0.009$; $F=013$), perineal area ($P=0.012$; $F=7.337$), scrotum ($P=0.001$; $F=0.00$), sternum ($P=0.035$; $F=4.978$), and udder ($P=0.164$; $F=2.065$). Average total tick counts were as follows; belly (5.000±2.1963) for neem treated and (10.3889±7.2692) for control, ear (0.9444±0.7264) for neem treated and (2.3333±1.6450) for control, perineal (4.2778±3.2504) for neem treated and (6.6667±5.2244) for control, scrotum (0.7778±1.2154) for neem treated and 37.5±12.75 for control, sternum (3.3889±2.5237) for neem treated and (5.4444±3.8991) for control, and udder (0.6667±0.8402) for neem treated and (1.111±1.6047) for control.

5.3.4 Interaction between breed, anatomical sites on tick counts

In some anatomical locations there was a variation in tick counts among breeds for example belly, perineal and sternum (P<0.05, Table 4.25). But it was not the case for the other anatomical sites like ear, udder and scrotum where (P>0.05).

5.3.5 Effect of the interaction between treatment and breed on tick counts..

Neem treatment significantly reduced the number of *Boophilus* ticks on of treated animals (P < 0.05; F=4.286; Table 4.27). There was no significant difference between treatment and breeds in *Amblyomma* species.

5.4 Effect of the geographical locations on neem seed oil concentration

It has already been shown that the concentrations of the azadirachtin vary with geographical location and the time when the seeds was harvested i.e. seeds harvested a considerable time ago tend to be more concentrated than newly harvested seeds. It follows that the preparation of the formulations/dosage forms in the different parts of the country will depend on the chemical content of these constituents.

The terms inhibition, suppression and anti-feeding activity however provide a good description of the phenomenon (Butterworth and Morgan, 1971). Both the water extract and ether extract of the kernels contain active feeding inhibitors. The studies conducted on filter paper impregnated with Neem seed fraction and sucrose has shown that locust was not able to feed on filter papers (Butterworth and Morgan, 1971). These results were obtained from laboratory-based studies, which agree with the field observations in the present study.

In general there was a marked difference in tick counts between those animals treated and the control. Some live ticks were collected from treated animals. The presence of live ticks on animals treated with neem extracts can be explained as follows;

- Firstly the simple spray machine, which was used, was not efficient due to the low pressure and leakage of the chemicals.

- Secondly the small sized nozzle of the sprayer effected the application of the extracts, so that neem extract probably did not penetrate well through the hair to the skin.

- Thirdly the concentration of the neem extract use could have been lower than that required, so it failed to maximize its efficacy on ticks.

- Absence of a crush makes the restraining of animals during application so difficult, that a large proportion of the chemical was lost.

As neem is an insect repellent the plant extract tends to repel insect, cockroaches and mosquitoes. It has further been shown that the crushed neem leaves and seeds can inhibit the life cycles of mosquitoes in ponds and stagnant water in the breeding places.

Although the cake is not considered as a true concentrate due to its higher fibre content, Neem seed cake may be used as anthelmintic for animal production. Further investigation is required to determine the level at which neem seed cake can be incorporated in the feed without causing toxicity to animals.

The use of the Modern hand sprayer proved to be very efficient due to the fact that the drug penetrates well to the skin due to the large sized nozzle hence high pressure. The drug also showed high efficacy because even those animals sprayed by simple hand killed a large number of ticks.

Further investigations however should be pursued to determine the actual nature of the effects of NSKE on ticks, the active ingredients affecting ticks, concentration in the carrier or any solvent with subsequent effects on the efficacy and optimum treatment period and interval in beef cattle.

CHAPTER SIX

CONCLUSSION AND RECOMMENDATIONS

Neem is a cheap natural source of insecticide that can play a significant role in reducing the indiscriminate use of synthetic chemicals which are potentially dangerous to man and the ecosystem i.e. toxicity to non-target organisms, development of insecticide resistance and consequent pest resurgence, environmental pollution, health hazards to those who cannot afford protective clothing and hazard due to pesticide residues.

Neem trees also provide a good shade around homes and high quality building and fencing poles, which withstand the attack of termites.

Neem is used as a pesticide and it disrupts metamorphosis in many insect larvae. Moulting is inhibited and hence larvae die. Neem repels insects, a property which is important in crop protection during pre- and post-harvest periods.

It was concluded that, the Tswana breed is more tick resistant than Simmental or Brahman cattle. Simmental cattle appeared to be the most susceptible to tick infestation. The use of local breeds (i e Tswana) that possess a high resistance to tick infestation may be a solution to the dilemma of infestation and frequent dipping in the undeveloped parts of Africa, as pointed out by Norval et al, (1988a). This may be combined with strategic dipping e.g. dipping every three weeks during the wet season and only when necessary in the dry season. This strategy will to a large extent prevent the loss of endemic stability.

Frequent dipping is essential to avoid drastic losses in productivity when exotic breeds, with a high susceptibility to tick infestation, are utilised in farming areas with a high tick incidence.

It is recommended that the choice of acaricides and the dosage form should be based on epidemiological studies. It is further recommended that acaricides control programs be initiated in villages.

Improvement in the health of animals should result in enhanced meat and milk production for domestic use as well as for sale. In the commercial sector appropriate management practices in conjunction with strategic tick spraying and dipping should be adopted to reduce the prevalence of ticks and tick borne diseases.

Further studies are needed to determine the efficacy of Neem seed, leaf and bark extracts/powders against gastrointestinal parasites of cattle and other animals when administered in feed or water at various concentrations.

From the prevalence study it was established that Hyolomma truncutus is the most prevalent species of ticks on Serowe village animals, followed by Ambyomma hebraeum. In the study it was also possible to determine which season has the highest tick burden. The prevalence of ticks was highest in the summer, thus it is recommended that further studies be carried out to establish the following: -

The species of ticks that is mostly affected after neem treatment and the species of ticks that shows neem extract resistance.

To establish the persistent effect (residual effect) of neem seed extracts. The findings from this study will be of importance in epidemiological based strategic dipping and spraying with the aim to reduce the frequency of treatment and therefore slow the evolution of acaricides resistance.

However, as far as animal production is concerned I also recommend the following: -

- The minimum use of effective acaricide,
- Integration of chemotherapy and pasture management,
- Avoid under dosing during spray or dipping of the animals,
- Adequate nutrition,
- Monitoring of the tick burden and insecticide efficacy,

Introduction of a proper insecticide treatment regime and recommended dosage rates by the manufacturer. These will reduce the rate of development of insecticide resistance and maintain the efficacy of the drugs (chemicals).

Farmers and livestock keepers should be;

Sensitised on production, preparation, quality control, formulation and dispensing of the neem extracts as ticks, fleas, lice and mites etc transmit some of the most important diseases of livestock in the country.

Advised to use an efficient spraying machine for effective tick control when acaricides are used.

Provided with a modern hand sprayer (perhaps on loan bases) for effective tick control.

Educated through extension officers about the economic losses attributed to tick borne diseases.

In view of the present observations and easy availability and preparation of neem products, consideration of its inclusion in the programmes for tick management on livestock in developing areas of southern Africa (Botswana) is recommended.

Botswana should develop enough data on the number of Neem trees available, the content of active constituents and efficacy of these constituents in different formulations against the huge variety of pests in agriculture and livestock production.

On the other hand Neem needs to be grown on large scale in Botswana as a cash crop to supply oil for the commercial industry. The cake obtained after extraction of oil could be used as a supplemental feed in animals.

Botswana being among the livestock based economies, stands to benefit from the available trees in insect/pest control to increase livestock production, while at the same time reducing the use of synthetic insecticides/acaricides in the long term. The country will save millions of Pula spent on importing acaricides. Botswana, should benefit from home-made crude neem extracts as a source of safe agricultural chemicals, by just preparing extracts using locally available facilities such as wooden mortars and pestles squeezing out the juice/extract and spraying on animals after mixing with water. Brooms can be used in small-scale production systems. This would be the most practical way to prepare dosage forms of extracts from seeds, leaves and bark of neem tree for use against ectoparasites and pests of livestock.

It is justifiable that the plant could be effectively used for controlling ectoparasites on cattle in many parts of Africa especially dry areas where most animal farming is also a major activity.

Farmers who already have neem trees will benefit from this because they can be advised on how to best feed their animals on neem seed cake after oil extraction (Home based or industrial).