# Seasonal variations of nematode infection in Small East African goats and their crosses with Boer and Saanen reared under extensive and semi-intensive systems

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# Seasonal variations of nematode infection in Small East African goats and their crosses with Boer and Saanen reared under extensive and semi-intensive systems

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## SUMMARY

A study was conducted in Turiani (sub-humid environment) and Mlali (semi-arid environment) to assess the seasonal variation of nematode infection in Small East African (SEA) goats and $F_1$ crosses of SAE with Saanen and Boer. The SEA goats were kept under extensive system while the crossbreds were kept under semi-intensive system. In Mlali 37 SEA goats and 30 SEA x Boer crosses while in Turiani 30 SEA goats and 33 SEA x Saanen crosses were included in the study. Worm burden was assessed using faecal egg count (FEC) and packed cell volume (PCV) as indicator traits. Faecal and blood samples were collected at the end of dry season, mid and end of rain season. The dominant worm species were identified by faecal culture. The results indicated that fewer animals (30 – 66.7%) were infected at the end of the dry season than at the mid and end of the rain season (69.7 – 100%). The FEC values differed significantly between periods of the year ($P< 0.001$) and between locations ($P<0.05$). The geometric mean faecal egg count (GFEC) ranged from 71.3 to 200.9, 185.8 to 516.4 and 273.5 to 924.7 eggs per gram (epg) at the end of dry season, mid and end of rain season, respectively. The GFEC values of SEA goats reared under extensive system were slightly higher (80.5 – 924.7 epg) than those of crossbred goats (71.3 – 690.2 epg) reared under semi-intensive system. The PCV values differed significantly ($P<0.001$) between locations, periods of the year and breeds. In Mlali, the PCV values ranged from 18 to 45% while in Turiani, the values ranged from 10 to 43%. The dominant parasite in the study areas was *Haemonchus spp* and accounted for 47.5 and 48.9% of total worms in Turiani and Mlali, respectively. This was followed by *Trichostrongylus spp (*21.3 and 19.8% in Mlali and Turiani, respectively) and *Oesophagostomum spp* (18.2 and 20.7% in Turiani and Mlali, respectively). The proportions of *Strongyloides spp* (6%), *Bunostomum spp* (4%) and *Cooperia spp* (3%) were small in all periods and locations. It is concluded that the level of nematode infection is highest at the end of the rain season and low during the dry season. The crossbred goats kept under semi-intensive grazing system had lower level of nematode infection than the local goats kept under the free-range grazing system.

**(Keywords**: Dry and wet seasons, feacal egg count, nematode spp, packed cell volume)

## INTRODUCTION

The population of goats in Tanzania is 13.1 million, of which 98% are indigenous goats (MLDF, 2008) belonging to the Small East African breed (SEA). These goats play an important role in providing animal protein and income generation, especially to resource poor farmers in rural areas. They are particularly important for rural poor people who cannot afford to keep cattle and they are more readily sold than cattle when only a small amount of cash is needed (Winrock International, 1983). The value of indigenous goats in social and cultural functions is vital in traditional societies.

These include dowry payments and slaughtering for traditional feasts or religious ceremonies. However, the productivity of SEA goats under village production system is low due their low genetic potential for milk and meat production.

Since independence, Tanzania has been importing dairy breeds from Europe (i.e. Toggenburg, Saanen, Anglo-Nubian, Norwegian, etc) and dual-purpose breeds (i.e. Boer) from South Africa for crossbreeding with indigenous goats to improve milk and meat production. Non-governmental organizations (NGOs) such as Heifer Project International – Tanzania, Farm-Africa and various church organizations have been assisting rural poor farmers to acquire exotic breeds and crossbred goats. However, the performance of both the pure exotic breeds and their crosses under traditional management system has not been encouraging. Gastrointestinal nematode infection is the biggest challenge against the full exploitation of pure exotic breeds and their crosses to meet human needs for meat and milk in Tanzania (Kassuku and Ngomuo, 1997). Gastrointestinal nematode infections have been reported to cause considerable economic losses in rural areas (Mboera and Kitalyi, 1994). These occur through mortalities, reduced weight gain and milk yield, increased susceptibility to viral, protozoan and bacterial diseases, and direct cost associated with preventive and curative measures. In addition, losses occur due to condemnation of carcasses or specific organs at slaughter (Maingi and Gichigi, 1999).

Control of gastrointestinal nematode infection in Tanzania relies on anthelmintic treatments of the entire flock at three months intervals. However, this scheme for anthelmintic treatment is prohibitively costly to most smallholder goat keepers in rural areas. In order to reduce the treatment costs, alternative strategic treatment schemes have been suggested that aim at maintaining low level infections (Torres-Acosta and Hoste, 2008). In areas with well-defined wet and dry season, it has been recommended to apply two anthelmintic treatments per year, one administered at the beginning of the rain season to avoid the build-up of infection in the rain season and the second at the end of rain season to reduce the chance of infection passing to the next wet season (Tembely *et al.*, 1994). Some authors have recommended treating animals with anthelmintic drugs once in the dry season (Torres-Acosta and Hoste, 2008). These strategic treatment schemes seem to be suitable under smallholder conditions as they may reduce the cost of helminth control. Moreover, the strategic treatment schemes allow some worm infection to enable the expression of host resistance to nematodes (Vercruysse and Claerebout, 2001). However, the strategic anthelmintic treatment scheme requires good epidemiological information in order to define the period when animals will need treatments. Currently there is little information in Tanzania on the seasonal variation of the intensity of nematode infection in goats kept under agro-pastoral and mixed farming systems. Moreover, specific information on peak periods of worm burden in different agro-ecological zones is scanty. Therefore, the objective of this study was to assess the seasonal variability of nematode infection in goats reared under sub-humid and semi-arid agro-ecological zones. In addition, the study was intended to compare the level of infection in local goats kept under extensive system and crossbred goats kept under semi-intensive system.

## MATERIALS AND METHODS

### Study area

The study was carried out in Turiani division, Mvomero district, Morogoro region and in Mlali division, Kongwa district, Dodoma region. Turiani division is located in a sub-humid agro-ecological zone. The division lies at longitudes 37$^{o}$36´ - 38$^{o}$ E and latitudes 5 $^{o}$ – 7 $^{o}$ S. The division is located at an altitude that ranges from 300 to 520 m above sea level, has an average annual rainfall of 1000 – 2000 mm and temperature that range between 15 and 29$^{o}$C. The rainfall pattern experienced in the division is bimodal, with long rains received from end of February to early May and the short rain period is between November and December. The dry period is from June to October. Mlali division is located in a semi-arid agro-ecological zone and lies at an altitude of 1000 to 1600 m above sea level. Mlali division receives unimodal rainfall which falls between December and April, with 75% falling between March and April. The average annual rainfall ranges from 600 to 800 mm. The division experiences a long dry season between late April and early December. The temperature varies between 19 and 20 $^{o}$C during the coldest months (May-July) and 25 – 32 $^{o}$C during the hot period (August – December). The characteristic vegetation is of bush or thicket type.

In each division two villages were selected after consultation with the District Livestock Office. In Mvomero district the villages selected were Mkindo and Hembeti while in Kongwa district the villages were Mlali Iyegu and Mlali Bondeni. These villages were selected because of ease accessibility throughout the year and the availability of both local goats and crossbred goats which were the interest of this study.

**Animals and their management**

The animals used in this study were the local goats of the SEA breed and their $F_1$ crosses with Saanen and Boer. In Mlali division, the crossbred goats were SEA x Boer crosses while in Turiani were SEA x Saanen crosses. Goats of both sexes and aging between six and 12 months at the start of the experiment were used. The animals were ear tagged for ease identification of individual animals. The local goats were kept under extensive system whereby the animals were grazed in communal grasslands and fallow lands during the day and at night they were kept in kraals (bomas) or goat houses of ground floor type made of mud. The crossbred goats were kept under semi-intensive system whereby the animals were zero grazed in the morning and in the afternoon they were restricted grazed around the homesteads. The crossbred goats were kept in slated goat houses made of wood and roofed with either iron sheets or grasses.

**Assessment of worm burden**

The study assessed the extent of worm infection at the end of dry season, mid of rain season and end of rain season in order to know the peak periods of worm burden. In Mlali division samples were collected from 37 local goats and 30 crossbred goats while in Turiani division the number of local goats and crossbred goats were 30 and 33, respectively. The crossbred goats were sampled from five to seven farmers per villages while the local goats were randomly sampled from six farmers per village. The number of goats sampled was based on the number of crossbred goats available in each village. Samples were collected in October, 2006, (end of dry season), February 2007 (mid of rain season) and May 2007 (end of rain season). The levels of infection were assessed using faecal egg counts and packed cell volume as indicators.

## Determination of faecal egg counts

Faecal samples were collected into plastic containers from the rectum of each animal and each sample was labeled and put into a cool box containing ice packs. After sampling the samples were transported to the laboratory at Sokoine University of Agriculture within 12 hours and kept at $4^oC$ in a refrigerator until analyzed. Faecal egg counts (FEC) were determined as number of eggs per gram (epg) using a Modified McMaster technique (MAFF 1986) as described by Max et al (2006). The values for epg were used as an indirect way of estimating total worm burden.

## Determination of packed cell volume

Blood samples were collected at the same time with faecal samples. Blood samples were obtained from each animal by jugular vein puncture using vacutainer tubes with ethylene diamine tetraacetic acid (EDTA). The blood samples were used for determination of packed cell volume (PCV) to evaluate the degree of anaemia. The PCV was analysed using haematocrit centrifuge technique as described by MacLeod et al (1981).

## Faecal culture

The faecal samples were bulked by location. Representative samples were cultured at room temperature for seven days to allow hatching of larvae from the worm eggs. After seven days the larvae were harvested. The larvae were identified under microscope to genus level using identification keys (Hansen and Perry, 1994).

## Data analysis

The prevalence of worm infection was calculated as a percentage of animals infected with nematode (i.e. found with 100 epg and above). The chi-square test was used to assess the significance of differences of prevalence between months, breeds and locations. Faecal egg count and PCV data were analysed using the general linear model option of SAS (2000) statistical software. A nested design was used and the model fitted included the fixed effects of location (Turiani vs Mlali) and periods of the year (end of dry season, mid of rain season and end of rain season) and the interaction of locations and periods. Breed was nested within location. The FEC data were analysed after a logarithmic transformation of $\log_{10}$ (FEC + 50) to normalise the distribution. The results were back transformed by taking antilogarithms of means and then subtracting 50. The results were presented as geometric mean faecal egg count (GFEC).

## RESULTS

Figure 1 shows the proportions of animals that were found with 100 epg or more. The graph indicates that fewer animals (30 – 66.7%) were infected with nematode at the end of the dry season (October, 2006) while the greatest proportions of infected animals (69.7 – 100%) were observed at the end of the rain season (May, 2006). The $\chi^2$- test indicated that the proportion of infected animals differed significantly between periods ($P< 0.001$), but not between breeds and locations. Although not statistically significant, the proportion of crossbred goats that were infected was less than that of local goats. Furthermore, the figure shows that during the dry season more goats were infected in Turiani than in Mlali while during the rain season it was vice versa (i.e. more goats were infected in Mlali than in Turiani).

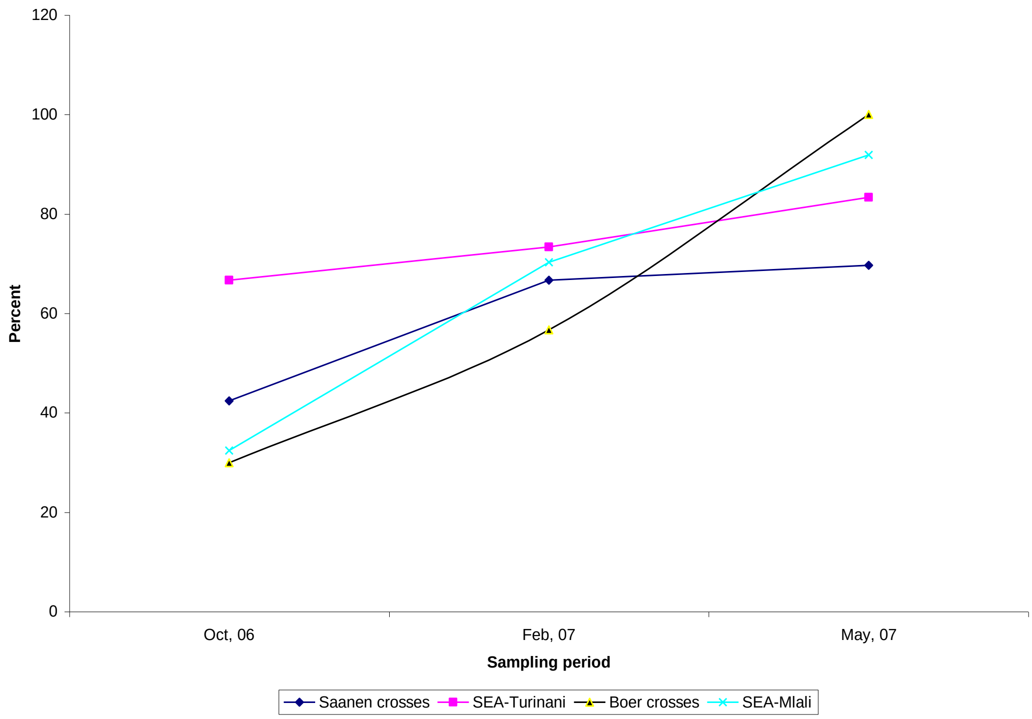


**Figure 1:** Proportions of animals infected with worms at different periods of the year

The geometric means for faecal egg count (GFEC) observed in local and crossbred goats in the two divisions are shown in Table 1. Generally, the local goats had significantly (P<0.05) higher GFEC values than the crossbred goats in both locations. Moreover, the values differed significantly between periods (P< 0.001) and between locations (P<0.05). In Turiani division the epg values ranged from 0 – 1400 at the end of dry season, 0 - 5800 at the mid of the rain season and 0 – 9900 at the end of the rain season for Saanen crosses. For the SEA goats the epg values ranged from 0 – 1800, 0 – 4700 and 0 – 7200 for the same periods. In Mlali division the range of epg values were 0 – 200 (end of dry season), 0 – 2900 (mid of the rain season) and 100 – 3400 (end of the rain season) in Boer crosses. In SEA goats, the ranges were 0 – 600 (end of dry season), 0 – 3800 (mid of the rain season) and 0 – 10,000 (end of the rain season).

**Table 1:** Geometric means (± se) of faecal egg counts in SEA and crossbred goats

| | Mlali | | Turiani | |
|---|---|---|---|---|
| **Sampling Period** | **F1 Boer crosses** | **SEA** | **F1 Saanen crosses** | **SEA** |
| October 2006 | 71.28 ± 1.24a | 80.54 ± 1.21 a | 104.71 ± 1.23 a | 200.90 ± 1.26b |
| February 2007 | 206.54 ± 1.26a | 516.42 ± 1.26b | 228.56 ± 1.26a | 185.78± 1.26a |
| May 2007 | 690.24 ± 1.29b | 924.70 ± 1.22b | 273.53± 1.26a | 306.90 ±1.23a |

ab Means with different superscript within a row differ significantly ( P≤ 0.05)

The least square means for PCV of the crossbred and local goats in the two locations are shown in Table 2. The PCV values differed significantly (P<0.001) between locations, periods of sampling and breeds within a location. In Mlali division, the PCV values ranged from 20 to 45% and 18 to 37% during the dry season and rain season, respectively. In Turiani division, the PCV values ranged from 14 to 35% during the dry season and from 10 to 43% during the wet season. On average, the animals in Turiani had higher PCV values (28.5%) than the animals in Mlali (26.3%). In both locations the lowest PCV values (10 – 19%) were observed at the end of the rain season (May 2007). When the breeds were compared within a location, the crossbred goats had higher PCV values than the local goats.

**Table 2:** Least square means (± se) of PCV (%) in SEA and crossbred goats

| | Mlali | | Turiani | |
|---|---|---|---|---|
| **Sampling period** | **$F_1$ Boer crosses** | **SEA** | **$F_1$ Saanen crosses** | **SEA** |
| October 2006 | 30.25 ± 0.88[a] | 27.95 ± 0.77[b] | 27.09 ± 0.81[b] | 25.00 ± 0.92[c] |
| February 2007 | 27.65 ± 0.92[b] | 24.12 ± 0.94[a] | 37.65 ± 0.92[d] | 33.42 ± 0.92[c] |
| May 2007 | 25.14 ± 1.02[b] | 22.29 ± 0.80[a] | 24.62 ± 0.92[b] | 24.63 ± 0.83[b] |

[abc] Means with different superscript within a row differ significantly ( $P \leq 0.05$)

Figures 2a and 2b show the proportion of nematode species in positive faecal samples. The results indicate that *Haemonchus spp* comprised the largest proportion (47%) of worm burden in the study areas, followed by *Trichostrongylus spp* (21%) and *Oesophagostomum spp* (19%). *Haemonchus spp* accounted for 42, 57.5 and 43% in Turiani while in Mlali the species accounted for 56, 43.8 and 47% of all worms at the end of the dry season, mid and end of the rain season, respectively. *Trichostrongylus spp* accounted for 19, 19.7 and 23% of total worm burden at the end of the dry season, mid and end of the rain season, respectively. *Oesophagostomum spp* was the third predominant species and its proportion ranged from 18.8% at the mid of the rain season to 20.5% at the end of the rain season. In both locations *Strongyloides spp* and *Bunostomum spp* were the least and their proportion did not exceed 8% in all periods. *Cooperia spp* was observed only in May 2007 in both locations and was found to comprise 8% of the worm species.

## DISCUSSION

The present study revealed that the period of the year significantly influenced the proportion of animals infected with nematode. On average 43, 67 and 86% of the animals sampled were found to be infected with nematode at the end of dry season, mid of the rain season and end of the rain season, respectively. Similarly the low FEC values were observed during the dry season while the highest values were observed at the end of the rain season. This is because of the high level of humidity during the rain season which favourably supports the development of nematode larvae. These observations agree with the findings of Tembely et al (1992), Magona and Musisi (2002) and Nwosu et al (2007) who reported that the level of nematode infection and worm-egg output are higher in the wet season than in the dry season.

The development of nematode larvae is affected with the adverse conditions of the dry season as the larvae are susceptible to desiccation due to dryness and high temperatures (Waruiru et al 1993).

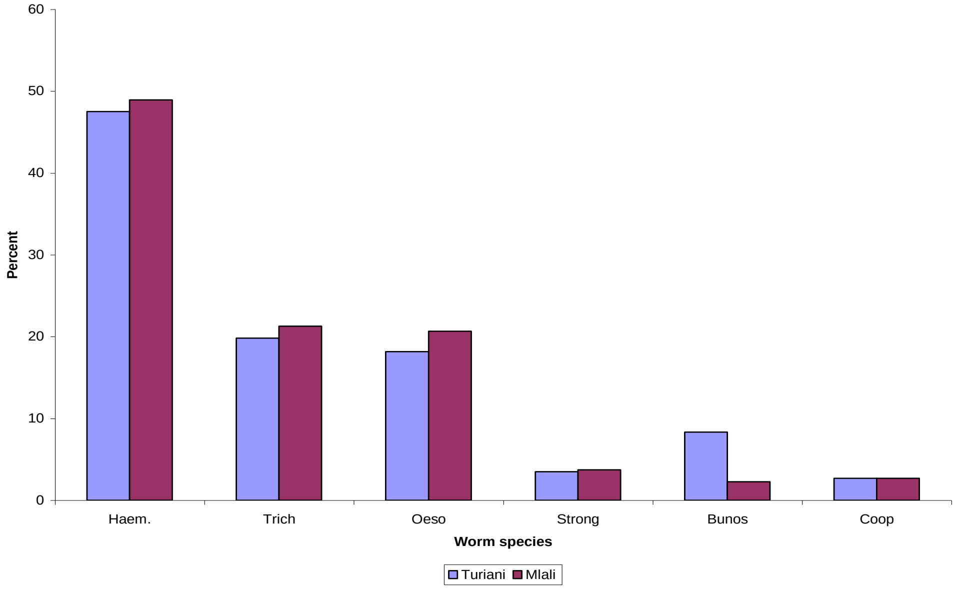


**Figure 2a**: Proportions of different nematode species in positive faecal samples obtained from Turiani and Mlali divisions. Haem - *Haemonchus* spp, Trich - *Trichostrongylus* spp, Oeso - *Oesophagostomum* spp, Strong - *Strongyloides* spp, Bunos - *Bunostomum* spp, Coop - *Cooperia* spp

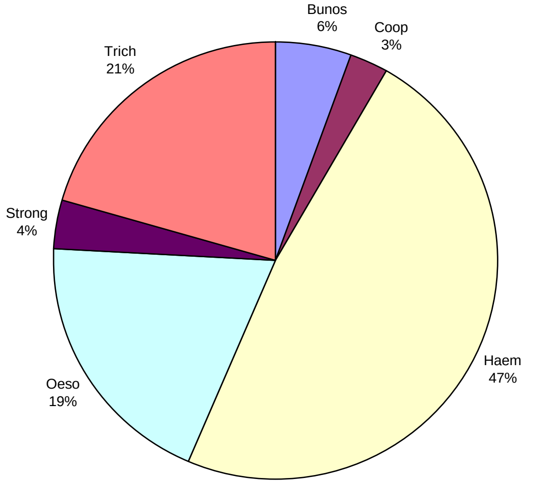


**Figure 2b**: Overall proportions of different nematode species in positive faecal samples. Haem - *Haemonchus* spp, Trich - *Trichostrongylus* spp, Oeso - *Oesophagostomum* spp, Strong - *Strongyloides* spp, Bunos - *Bunostomum* spp, Coop - *Cooperia* spp

The geometric means for FEC ranged from 71 to 201 and 274 to 925 epg at the end of the dry season and end of rain season, respectively. Generally, the FEC values observed in this study were low indicating light level of infection in both local and crossbred goats. According to Hansen and Perry (1994) the degree of infection is considered as light if the epg values are between 300 and 800 and treatment may not be necessary in adult goats. However, some authors have suggested deworming of animals when the average FEC of 100 - 200 epg is reached to prevent worm build-up in pastures (Torres-Acosta and Hoste, 2008). Since high levels of FEC in this study were observed only during the rain season, treatment with broad spectrum anthelmintic can only be done at the start and end of the rain season to control nematode infection in the study areas.

When the two locations are compared it is seen that worm burden was higher in Turiani division than in Mlali division during the dry season. During the rain season the worm burden was higher in Mlali than in Turiani. This is due to differences in climate, Mlali division falls under semi-arid environment while Turiani is under sub-humid environment. According to Waruiru *et al* (1993), the humid condition is an important predisposing factor for haemonchosis. This explains why the highest level of infection and EFC were observed in Turiani division during the dry season. The prevalence of helminth parasites and the severity of infection have been shown to vary considerably between locations due to differences in environmental conditions such as humidity, temperature, rainfall and management practices (Regassa *et al*., 2006). According to Magona and Musisi (2002) differences in agro-climatic zone have a significant influence on both the risk of infection and the worm-egg output of goats.

The GFEC values of local goats were slightly higher (80.5 – 924.7 epg) than that of crossbred goats (71.3 – 690.2 epg). This is because, the crossbred goats were reared under semi-intensive system (i.e. a combination of zero grazing and restricted grazing) while the local goats were freely grazed on communal lands. Under the extensive system, a large number of animals are grazed together and are herded continuously in the same area during the dry and wet seasons. This increases the degree of pasture contamination, thus resulting into higher prevalence rate of worm infection. Similar observation has been made by Magona and Musisi (2002) that goats under semi-intensive grazing system have fewer worm-egg counts than those kept under the free-range grazing system. Moreover, the low level of infection in crossbred goats compared to that of local goats may be due to the fact that farmers pay more attention to crossbred goats than local goats. The crossbred goats were kept in wooden barn with raised floor that were cleaned regularly while the local goats were kept in kraal, which were not regularly cleaned.

The PCV values of crossbred and local goats were relatively high as the overall average values were 27.62, 30.78 and 24.02% at the end of the dry season, mid of the rain season and end of the rain season, respectively. These values are far above the recommended threshold value of 20%. In both locations, the crossbred goats had slightly higher PCV values compared to the local goats. This is a reflection of higher degree of worm infection in local goats than in crossbred goats. It has been shown that as worm infestation increases, the PCV values decrease and that heavy infestations lead to low PCV that range between eight and 22%, with an average value of 15% (Newsholme and Start, 1976). Between the two locations, goats in Mlali had slightly higher PCV values than those in Turiani during the dry season, but during the rain season animals in Mlali showed lower values than those in Turiani. This is in accordance to the observation made for FEC that goats in Mlali had low level of worm infection compared to those in Turiani during the dry season, but during the rain season it was vise versa.

The results for assessment of the proportion of worm species in positive faecal samples indicate that *Haemonchus spp* comprised the largest percentage, followed by *Trichostrongylus spp*, *Oesophagostomum spp*, *Strongyloides spp*, *Bunostomum spp* and *Cooperia spp*. The observation in the present study concurs with previous findings that the most important and widely prevalent nematodes of goats are *Haemonchus, Trichostrongylus, Cooperia, Oesophagostomum and Bunostomum.* Among these, *Haemonchosis* has been shown to be the most wide spread type of helminthosis in goats (Githigia *et al*., 1998; Keyyu *et al*., 2001). According to these authors, *Haemonchus spp* contributes 67.9% to the total worm count. In Kenya *Haemonchus spp* has been shown to account for over 90% of all gastrointestinal nematodes identified in goats and the species contributes about 80% of the worm burden (Gatongi *et al*., 1998). However, in Nigeria the most prevalent genera of nematodes are *Strongyloides*, *Trichostrongylus*, *Haemonchus*, *Trichuris*, *Cooperia*, *Oesophagostomum* and *Bunostomum* (Nwosu *et al.*, 2007). It seems that *Haemonchus* is a dominant nematode genus in East Africa while in West Africa *Strongyloides* is the most abundant nematode species.

In conclusion, this study has revealed that the level of nematode infection is highest at the end of the rain season and low during the dry season. During the dry season worm burden is higher in sub-humid areas than in semi-arid areas. The crossbred goats kept under semi-intensive grazing system (zero grazing combined with restricted grazing) showed lower level of nematode infection than the local goats kept under the free-range grazing system. *Haemonchus spp*, is the major contributor to goat helminthiasis in Turiani and Mlali divisions, followed by *Trichostrongylus spp*, *Oesophagostomum spp* and *Strongyloides spp*.

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