Effects of anthelmintic treatment and feed supplementation on grazing Tuli weaner steers naturally infected with gastrointestinal nematodes

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ABSTRACT

A study was carried out to determine the epidemiology of gastrointestinal nematodes in indigenous Tuli cattle and the effect of dietary protein supplementation and anthelmintic treatment on productivity in young growing cattle. Forty steers with an average age of 18 months were divided into 4 groups; 1) fenbendazole (slow release bolus) and cottonseed meal (FCSM group), 2) fenbendazole (FBZ group), 3) cottonseed meal (CSM group) and 4) control (no cottonseed meal and no fenbendazole) (control group). Performance parameters measured included worm eggs per gram of faeces (EPG), packed cell volume (PCV), albumin and live-weight gain. Results showed that faecal worm egg counts were lower and PCV was higher in the FCSM and FBZ groups than in the CSM and control groups ($P < 0.01$). Weight gains were higher in the CSM and FCSM groups than in the FBZ and control groups ($P < 0.05$). The cost benefits of anthelmintic treatment and dietary supplementation were apparent in this study. The improved growth performance of the FCSM, FBZ and CSM groups reflected a financial gain over the controls on termination of the study. The dominant genera of gastrointestinal nematodes on faecal culture, pasture larval counts and necropsy were *Cooperia* and *Haemonchus.* The incidences of *Trichostrongylus, Oesophagostomum* and *Bunostomum* were low.

Key words: anthelmintic treatment, epidemiology, gastrointestinal nematodes, indigenous cattle, productivity, protein supplementation.

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INTRODUCTION

Gastrointestinal helminthoses play a major role in decreasing livestock productivity in sub-Saharan Africa, particularly in young and growing animals. In Zimbabwe, parasites of the genera *Haemonchus, Cooperia, Oesophagostomum, Trichostrongylus, Bunostomum, Strongyloides* and *Toxocara vitulorum* have been reported in cattle[29,31,33]. *Ostertagia ostertagi* has also been reported on 1 irrigated farm in the highveld of Zimbabwe[28].

Traditionally, anthelmintics have been the most popular and widely-used means of controlling helminth parasites. Cases of resistance to benzimidazoles by populations of *Trichostrongylus axei, O. ostertagi* and *Cooperia oncophora* have been reported in cattle in Australia[10] and New Zealand[19,20,27]. These data show that a potential risk of selection for drug resistance in bovine gastrointestinal nematodes exists, and, added to the high cost of anthelmintic drugs and the growing public concern over the presence of chemical residues in meat and meat products[25], research into alternative control strategies is necessary. Possible alternatives include selective breeding of resistant animals[35], development of vaccines[11] and better nutrition[6].

There is evidence that the level of dietary protein intake significantly boosts the immune response of the host to helminth infection[6]. In Zimbabwe's communal areas, the pastures are generally of poor quality and low nutritive value, especially during the dry season[31], and there is therefore a need for supplementary feeding of cattle during this season. Animals are, however, not provided with supplementary feed because resource-poor farmers cannot afford to buy commercial feeds. The availability of low-cost potential sources of protein supplement for use by the communal farmer like manually pressed sunflower cake[22] and cottonseed meal[7] enhances the nutritional resources that can be provided to the animals during the dry season, and reduces the detrimental effects of gastrointestinal parasites on the animals, resulting in substantial increases in productivity.

This on-station study was therefore carried out to determine the epidemiology of gastrointestinal nematodes in indigenous Tuli cattle and the effect of anthelmintic treatment and protein supplementation, during the dry season, on productivity of the animals.

MATERIALS AND METHODS

Study site

The study was conducted at Grasslands Research Station which lies on the highveld of Zimbabwe, 75 km east of Harare, (18°30′S, 31°30′E). The soils are predominantly medium-grained sandy loams of low pH (4.5–5.1) on a $CaCl_2$ scale. Since the site is a research station, the pastures are well managed and not overgrazed. The major grass species on the pastures were *Hyperrhenia filipendula, Eriosema nutans, Brachiaria brizantha* and *Sporobolus pyramidalis,* supplemented with stargrass (*Cynodon aethiopicus*). All climatic data for the study site were collected from the Meteorological Office (Belvedere, Harare). These included the mean monthly temperatures (minimum and maximum) and mean monthly rainfall from June 1997 to May 1998 (Fig. 1).

Study animals

Forty-five weaner steers were selected for the study. In the communal areas of Zimbabwe cattle are weaned at 1.5–2.0 years. All were of the indigenous Tuli breed, which is characterised by a compact body conformation, fine bone structure and small size. Live weight of a mature male ranges from 363 to 635 kg. The animals were subjected to a regular dipping programme (once a month during the dry season and fortnightly during the rainy season). At the start of the experiment the average age and body weight of the steers were 18 months and 260 kg, respectively.

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Feed supplement

In addition to the pastures, the weaners received cottonseed meal (Olivine Industries, Zimbabwe). The supplement consisted of the residue remaining after oil extraction from the oilseed. The extraction of the oil from the oilseed was done using the solvent method[26]. Proximate analysis was done to determine the dry matter, ash, crude protein, crude fibre and ether extract of the feed. The procedure outlined by Macdonald *et al.*[26] was followed. The chemical composition of the feed is shown in Table 1.

Anthelmintic

The Panacur slow-release bolus (Hoechst) was used in the study. The bolus contains as active ingredient fenbendazole, which is released at approximately 80 mg per day continuously over a period of up to 5 months. An applicator supplied by the manufacturer was used to administer the bolus. Fenbendazole is effective against gastrointestinal nematodes, lungworms and cestodes of ruminants, horses, pigs, dogs and cats.

Experimental design

Forty steers were divided, according to live weight, into 4 groups of 10 animals each. Five steers were used as tracers. The treatment groups were designated FBZ (each animal received the Panacur (SR) bolus in July and December), CSM (each animal was fed 70 g of cottonseed meal per day from July 1997 to January 1998), CSM+FBZ (each animal received the Panacur (SR) bolus in July 1997 and December 1997, and was fed 700 g of cottonseed meal per day from July 1997 to January 1998) and the control (animals were neither given the cottonseed meal nor the Panacur (SR) bolus). Animals from all groups were grazed on the same paddock for the duration of the study. All tracer animals were treated with levamisole twice before to grazing in September, October and November. On removal from pasture, the tracers were confined on concrete floors before parasite recovery. The nematode infections at time of necropsy were therefore reflective of pasture infectivity during grazing.

Table 1: **Nutritional composition of the cotton-seed meal determined by proximate analysis.**

Component	Percent composition
Dry matter	93.97
Ash	5.51
Crude protein	33.14
Ether extract	1.1
Crude fibre	23.44

Parasitological procedures

Faecal worm egg counts and cultures: rectal faecal samples were collected from each animal at the start of the study and monthly thereafter, from June 1997 to May 1998. The modified McMaster technique[1] was used for the determination of worm egg counts per gram of faeces. To determine the genera of nematodes affecting the study animals, monthly group faecal samples were pooled in glass jars for culture. Standard procedures for the preparation of faecal cultures were followed[1]. One hundred larvae from each group were differentiated[1].

Pasture larval counts: herbage samples were collected from September 1997 to December 1997 and processed to determine pasture infectivity. Larval counts and identification to genus level were carried out following standard procedures[16].

Necropsy

Necropsies were performed on 5 tracer animals during September, October and November 1997. Necropsy and worm counts were done according to the method of Hansen and Perry[16]. One hundred male worms and larvae per animal were identified to genus/species level using the keys in MAFF[1].

Productivity parameters

Blood parameters: EDTA and whole blood samples were collected monthly from the jugular vein of each animal to determine packed cell volume (PCV) and albumin, respectively. The procedure described by Henry *et al.*[17] was followed to determine albumin and a Coulter counter (Coulter, T890) was used to determine PCV. Animals were examined for any signs of disease at each sampling.

Live weight: before the study commenced individual body weights for all study animals were recorded using a scale and then fortnightly until the termination of the study.

Economic analysis: the cost, in United States dollars, of the cottonseed meal and the anthelmintic was determined. The cost of the Panacur (SR) bolus was substituted with that of 2 doses of fenbendazole per animal. The assumption was that the 2 doses of fenbendazole would result in weight gains similar to those achieved with the bolus. The value of the live-weight gain for each group was calculated by multiplying the mean live-weight gain for the group by the return per kg live weight of beef. Subtraction of the cost from the return gave the benefit.

Statistical analysis

Data were analysed using the Statistix computer programme (version 1.0). Worm egg counts were transformed to logarithm (count + 1) to calculate the geometric mean. Comparisons of faecal egg counts and productivity parameters between groups were done by 1-way analysis of variance. The 5 % significance level was used to determine whether there were significant differences between the parameters measured between the treatment groups.

RESULTS

Meteorological data

Figure 1 summarises the mean monthly rainfall and mean monthly temperatures (minimum and maximum) during the study. The distribution of rainfall and the range of monthly temperatures (minimum and maximum) were normal for the area except that in February there was a significant decrease in the amount of rainfall recorded.

Faecal worm egg counts

The monthly geometric mean strongylid eggs per gram of faeces (EPG) for the 4 groups are given in Fig. 2. The control and CSM groups had high EPGs during the period of the study, with peaks occurring in October and January. The EPGs declined only towards the end of the rainy season. There was no significant difference in EPGs between CSM and control although the mean EPG for CSM was lower (48.5) than that of the control (94.5). The 2 groups that received the Panacur (SR) bolus (FBZ and FBZ+CSM) had virtually zero egg counts throughout the study period, with a slight rise in April and May 1998. A pairwise comparison among the 4 groups revealed a significant difference ($P < 0.01$) between the anthel-

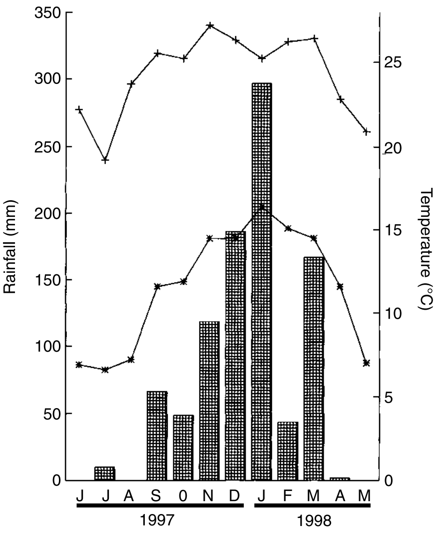

Fig. 1: **Mean monthly rainfall** (histogram) **and temperature** (+ = maximum, ✶ = minimum) **at the Grassland Research Station during the study** (June 1997 to May 1998)**.**

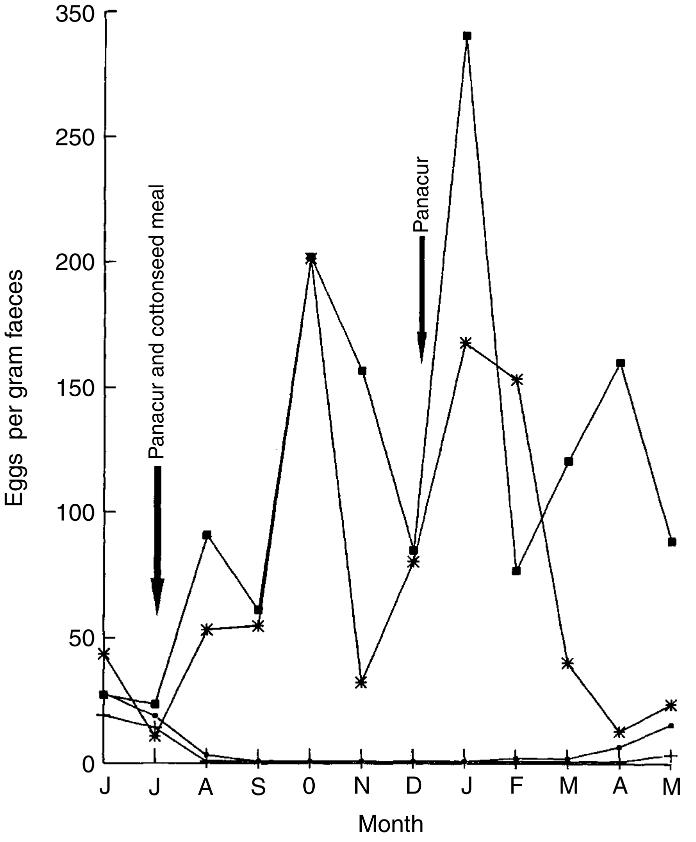

Fig. 2: **Geometric mean faecal worm egg count of animals in 4 groups during the study;** ▪ = anthelmintic only; + = anthelmintic and CSM; ✶ = CSM; ■ = control.

mintic-treated groups and the non-treated groups. There was no significant difference in EPG between FBZ+CSM and FBZ groups. These comparisons are summarised in Table 2.

Faecal and Pasture larval differentiations

Figures 3A–D show the frequency of infective larvae (L$_3$) by genera from faecal cultures of the control group and the CSM group. No larvae were recovered from cultures of the anthelmintic-treated groups (FBZ and FBZ+CSM) until March. *Cooperia* and *Haemonchus* were the most prevalent genera (Fig. 3A, B). *Trichostrongylus* and *Oesophagostomum* were found in low percentages (Fig. 3C, D). There was no significant difference in the generic composition of the larvae from the supplemented (CSM) and the non-supplemented (control) groups. On pasture, *Cooperia* and *Haemonchus* were the dominant larval types found (Table 3) and *Trichostrongylus* and *Oesophagostomum* were found in low percentages.

Tracer animal worm counts

Table 4 shows the differential worm counts from the necropsies performed on 5 tracer animals in September, October and November 1997. The data indicate that *C. pectinata* and *Haemonchus* sp. were the most prevalent nematodes. A relatively high proportion of the *Haemonchus* sp. populations consisted of inhibited early 4th stage larvae (EL$_4$). Abomasa were not processed for recovery of EL$_4$ in November.

Live weight

Figure 4 shows the mean monthly live weight of the animals for the duration of the study. At the start of the study there was no difference in the mean weights among all 4 groups. All animals lost weight during the dry season and gained during the rainy season. When dietary supplementation began in July, the 2 supplemented groups (CSM and FBZ+CSM) began to gain more weight than the non-supplemented groups (FBZ and control). Between November 1997 and May 1998, the slopes ($y = mx + b$) of the growth curves were similar, indicating that the growth rates were similar among all 4 groups. At the termination of the study the CSM group and the FBZ+CSM group had gained significantly more weight than the control group ($P < 0.05$), (see Table 2). The final rank order of live weights of the groups was CSM > FBZ+CSM > FBZ > control.

Blood parameters

Mean monthly values for packed cell volume (PCV) and albumin are shown in Table 2.

At the beginning of the study there were no significant differences in PCV and albumin values among the 4 groups. At the end of the study the supplemented and the anthelmintic-treated groups had higher albumin values than the controls (FBZ > CSM > FBZ+CSM > conttrol). However, these differences were not statistically significant. PCV, on the other hand, was significantly higher ($P < 0.01$) in the FBZ+CSM group than in the CSM and the control groups (Table 2).

Table 2: **Comparison of mean ± standard error of eggs per gram of faeces, live weight, packed cell volume and albumin between the 4 groups** (values in brackets depict the range).

Group	*n*	EPG (g)	Mean weight (kg)	Mean PCV (%)	Mean albumin (g/ℓ)
FBZ	10	2.9^{a} ± 1.22 (0–160)	$290.14^{a,b}$ ± 4.63 (213–420)	$31.914^{a,b}$ ± 0.38 (20–40)	30.301^{a} ± 0.54 (9.6–48.8)
FBZ & CSM	10	1.7^{a} ± 1.15 (0–301)	299.26^{a} ± 4.80 (214–445)	33.159^{a} ± 0.35 (20–43)	29.816^{a} ± 0.50 (18.5–46.8)
CSM	10	48.5^{b} ± 1.24 (0–750)	300.77^{a} ± 4.59 (195–415)	31.686^{b} ± 0.31 (22–38)	30.068^{a} ± 0.52 (16.8–50.5)
Control	10	94.5^{b} ± 1.23 (0–1050)	282.04^{b} ± 4.04 (205–400)	31.000^{b} ± 0.29 (26–37)	28.461^{a} ± 0.49 (15.7–43)

Values without a common superscript letter within a column are significantly different ($P < 0.05$).

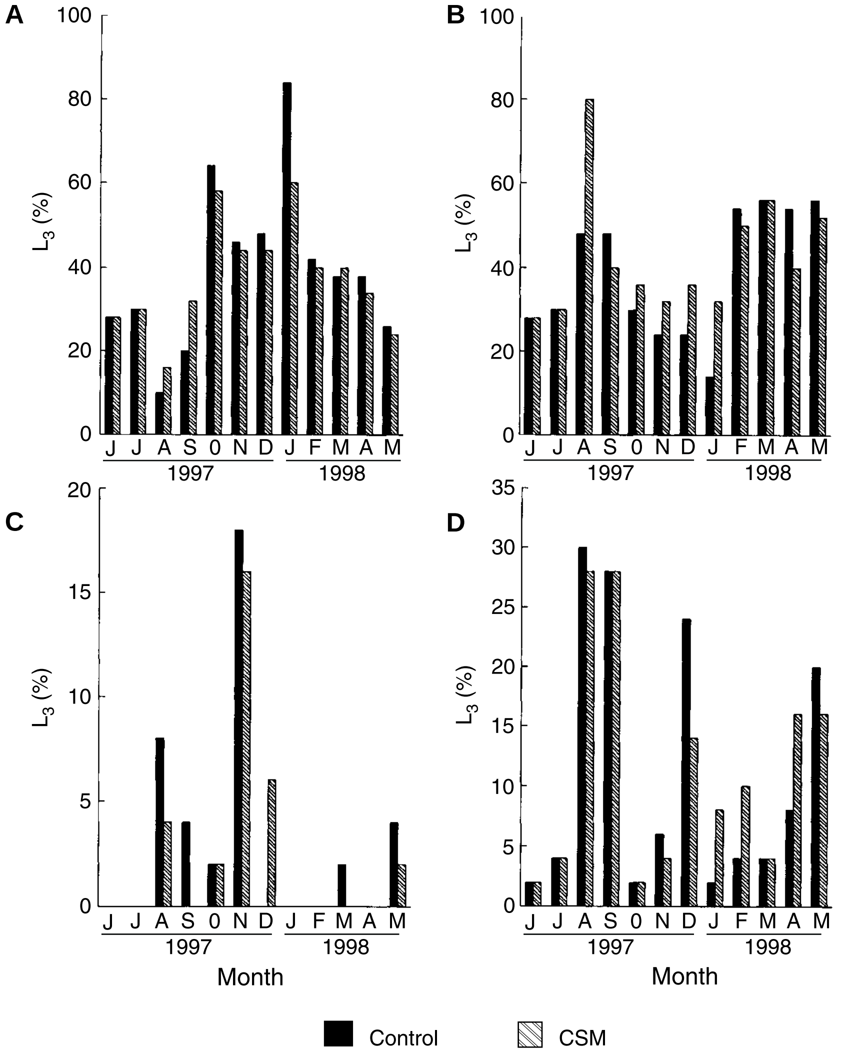

Fig. 3: **Frequency of L$_3$s on faecal cultures of the CSM and control groups** (**A** = *Haemonchus* sp.; **B** = *Cooperia* sp.; **C** = *Trichostrongylus* sp.; **D** = *Oesophagostomum* sp.).

Table 3: **Pasture larval counts at the Grasslands Research Station from September to December 1997.**

Nematode genera	September	October	November	December
Haemonchus (%)	26	34	36	56
Cooperia (%)	56	50	30	28
Trichostrongylus (%)	12	6	22	0
Oesophagostomum (%)	6	10	12	16
Total infective L$_3$/kg DM	157	162	143	182

Economic evaluations

A summary of the cost-benefit analysis of anthelmintic treatment and feed supplementation is presented in Table 5. All monetary values are expressed in United States dollars. The value of live-weight gain over the trial period (live weight gain × return per kg) was highest in the CSM group. Each intervention resulted in some financial gain over the controls. After subtracting the cost of the intervention, the highest benefit came from giving 2 doses of fenbendazole during the study.

DISCUSSION

Faecal egg output showed a clear seasonal pattern as reflected in the non-treated groups. During the rainy season (December to March), environmental conditions were ideal for the development and translation of infective larvae on herbage. It is during this period that faecal egg counts began to rise, reaching their highest peaks between March and May. The faecal egg counts declined from June, reaching their lowest levels in July. This decline may be attributed mainly to the dry conditions prevailing and the low temperatures, which are unsuitable for the development of the free-living stages. These findings concur with the seasonal patterns reported earlier for gastrointestinal nematodes of cattle in Zimbabwe[13,29,31,38]. The rise in faecal egg count observed in October may have been due to the unseasonal rains that fell in September. These resulted in enough moisture to stimulate the development and translation of infective larvae on the herbage and hence increased pasture infectivity.

No faecal worm eggs were observed in the FBZ and FCSM groups during the greater part of the experiment. The results are in agreement with reported data showing that that the Panacur SR bolus, when given to naturally-infected animals, is able to reduce worm egg output by up to 99.9 %[9,26] (Pfeiffer H, 1991, unpublished report, Hoechst, Germany). During the dry season and part of the rainy season

Table 4: **Composition of gastrointestinal nematode species recovered from 5 tracer animals necropsied in September, October and November 1997.**

Month		**Worm count**							
		***Haemonchus* sp.** (%)	**EL$_4$** (%)	***Trichostrongylus axei*** (%)	***Cooperia pectinata*** (%)	***Cooperia punctata*** (%)	***Cooperia spatulata*** (%)	***Oesophagostomum radiatum*** (%)	**Total**
Sept.	T1	84 (72)	17 (15)	10 (9)	0	4 (3.2)	0	1 (0.8)	116
Oct.	T2	194 (32)	45 (7)	58 (9.5)	290 (48)	15 (5)	0	5 (1)	607
	T3	218 (29)	56 (7)	89 (12)	334 (44)	45 (12)	0	21(2.5)	763
Nov.	T4	608 (19)	ND	68 (2)	1697 (54)	590 (19)	172 (6)	0	3135
	T5	224 (9.5)	ND	30 (1.5)	1518 (65)	437 (19)	125 (5)	0	2334

ND = not done.

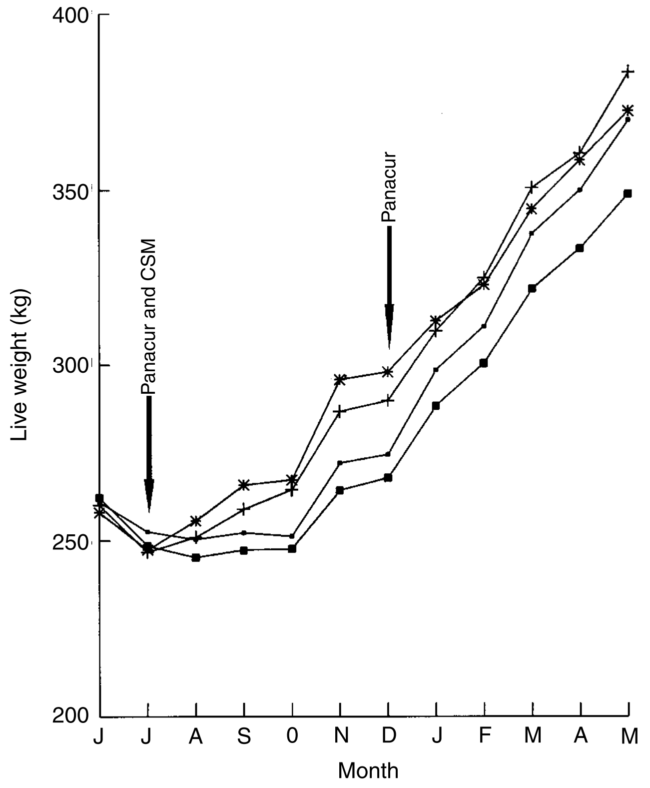

Fig. 4: **Mean monthly weights of animals in 4 groups from June 1997 to May 1998.**
▪ = anthelmintic only; + = anthelmintic and CSM; ✶ = CSM; ■ = control.

(August to January) the faecal egg count in the bolus-treated groups was virtually zero, and only started to increase slowly in February. This may have been due to grazing together of treated and untreated animals. In other field trials where treated and untreated animals grazed together on pasture, faecal worm egg output of the treated cattle was found to increase as early as the 12th week of grazing compared to 22 to 27 weeks in separately grazed animals[3].

Steers supplemented with cottonseed meal (FCSM and CSM) showed no significant difference in resistance to infection with gastrointestinal nematodes compared to those that did not receive supplement (FBZ and control) as assessed by faecal egg counts. Improved nutrition, particularly of protein, has been shown to enhance resistance and resilience of sheep to gastrointestinal nematode infection[23,36,39,40]. The daily maintenance levels of protein given to each animal in this study may not have been enough to cause a significant effect on the gastrointestinal nematode infection. Although the differences observed were not significant, the supplemented animals had lower mean egg counts than the controls (see Table 2). Possibly if increased amounts of metabolisable protein had been given to the animals, significant differences could have been observed.

The results of larval differentiations indicated that *Cooperia* sp. and *Haemonchus* sp. were the dominant nematode species. Other nematodes recovered include *Trichostrongylus* sp., *Oesophagostomum* sp. and *Bunostomum* sp. These observations agree with earlier studies on cattle in the highveld of Zimbabwe[29,31] (J P le Stang , unpublished report, Hoechst, Germany), in eastern Nigeria[4] and the Gambia[24].

Conditions are favourable for the development of the free-living stages of *Cooperia* sp. and *Haemonchus* sp. when mean maximum temperatures exceed 18 °C[8] and mean monthly rainfall exceeds 50 mm[14]. These conditions prevail in most parts of Zimbabwe between November and April.

No L_3s were recovered from faecal cultures of the FBZ and FCSM treatment groups until March 1998, when a few *Cooperia* sp. larvae were recovered from the FBZ group. This may have been due to the treated and untreated animals grazing together, with the former becoming infected by the contaminated pasture. There was no significant difference in the species composition of larvae from faecal cultures between CSM and control groups, which confirms that supplementing animals with cottonseed meal at maintenance levels had no effect on the establishment of gastrointestinal nematodes in the study animals.

The 5 tracer animals slaughtered in the last 3 months of the dry season of 1997 and the pasture larval counts over the same period showed that, although pasture infectivity declined during the dry period, there were still infective larvae surviving on the pastures.

C. pectinata, C. punctata and *Haemonchus* sp. were the dominant species in the tracer animals at slaughter. The same *Cooperia* species were found in sheep at this research station[15] and on commercial farms and communal areas on the highveld of Zimbabwe[28]. Results from the tracer animals also confirm that *Haemonchus* sp. survives the dry season as inhibited early 4th stage larvae as well as adults, whereas other species particularly *Cooperia* spp., survive the dry season mainly as adults, and this is in agreement with previous results elsewhere[13,24,28].

Animals in all groups lost weight between June and July because the pasture was very dry, unpalatable and of low nutritive value. Unexpectedly, the animals that had the benefit of both the anthelmintic and the cottonseed meal did not gain as much weight as those that received cottonseed meal alone (Table 2). This is possibly due to the depressive

Table 5: **Cost-benefit analysis of the 3 treated groups with reference to the control group.**

Group	Mean total weight gain per animal (kg)	Market value/kg[a] (US$)[b]	Value of gain (US$)	Cost of intervention per animal (US$)	Net value of gain per animal (US$)	Net benefit over controls (US$)
CSM	114.4	0.70	80.38	14.97	65.41	4.49
FBZ	108.8	0.70	76.45	0.36[c]	76.09	15.17
FBZ and CSM	123.3	0.70	86.64	15.33	60.92	10.39
Control	86.7	0.70	60.92	Nil	71.31	Nil

[a] Cold Storage Commission sales, July 1998.
[b] US$1 was equivalent to Z$18.5 in July 1998.
[c] Cost of 2 doses of Fenbendazole.

effects of fenbendazole on rumen digestion. Benzimidazole compounds including fenbendazole have been shown to adversely affect rumen fermentation by suppressing cellulolytic and carbohydrate dependent microorganisms[18,21]. Administration of fenbendazole every 2 weeks at the therapeutic dose has been shown to result in depressed performance in calves[12]. This aspect should be considered when developing anthelmintic slow-release devices[33]. Under the experimental conditions described in this study, the overall effects of fenbendazole did not outweigh the benefits of its use as an anthelmintic.

After the rains the pasture improved and all the animals began to gain weight. Compensatory growth was observed in the control group. Under certain circumstances compensatory gain in untreated[5] and unsupplemented[2] cattle may reduce or negate earlier weight gain advantages of anthelmintic treatment or dietary supplementation. In this study, however, the gains were maintained. Supplementary feeding of CSM and FCSM continued until January, but there was no measurable beneficial effect after October (Fig. 4). It can therefore be assumed that terminating the supplementary feeding in October would have produced the same weight gains at a lower cost, as less feed would have been used.

Notably, the CSM group out-performed both the control group, FCSM group and the FBZ group with reference to liveweight gain. This implies that dietary protein supplementation does improve productivity of cattle on pastures with subclinical gastrointestinal nematode infection, as measured by weight gain. This is in agreement with findings in sheep by Van Houtert *et al.*[37], where supplementary feeding with sunflower meal was more effective in increasing liveweight gain than treatment with a 100-day albendazole controlled-release capsule.

Albumin values were not significantly different among the 4 groups. This may be because the infections were not severe enough to cause significant protein losses in the untreated animals. PCV was significantly higher in the anthelmintic-treated groups than in the non-treated groups. Protein supplementation of young sheep infected with gastrointestinal nematodes has been shown to limit the decline in PCV[34]. It is possible, therefore, that increasing the amount of protein supplemented would have resulted in a significant difference.

A cost-benefit analysis showed the greatest financial benefit from the FBZ group (Table 5). This option gave the highest net financial benefit due to the relatively low cost of fenbendazole compared to that of cottonseed meal. The CSM group had the highest weight gains at the end of the study but, because of the relatively high cost of the commercially prepared cottonseed meal the financial benefit was eroded. Economic studies are intended to provide information for decision-making, but the expected financial return is not the only criterion on which decisions should be made. In communal areas where cattle are kept for draught power rather than for sale, the aspect of work output would be more important. Animals with the higher weight gain (CSM) would be the ones able to perform better[29]. It has been shown in Zimbabwe that dietary supplementation of oxen during the dry season improved their total work output[29].

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Book review — Boekresensie

Veterinary helminthology

Tibor Kassai

1999. Butterworth Heinemann, Oxford, 260 pp., soft cover. £35.00. ISBN 0 7506 3563 0.

"Veterinary Helminthology" is intended for veterinary practitioners, laboratory workers, researchers, instructors, graduate and advanced students of veterinary and biomedical sciences. It is a practical text and includes the important flukes, tapeworms and roundworms of domestic, game and companion animals as well as humans.

Part I includes helminth disease agents giving a review of the flukes, tapeworms and roundworms according to their taxonomic hierarchy. With this classification the reader is also given the helminth diseases of the various hosts and together these make the text more versatile. The roundworms are the most numerous in veterinary helminthology and compile a third of the book. Part II deals with anthelmintic therapy and control. This includes the treatment decision, diagnoses, selection of the appropriate anthelmintics, drug resistance and testing compounds for anthelmintic efficacy. Non-chemotherapeutic control alternatives and planning of integrated control strategies are included in this chapter together with chemotherapy. This reflects our current understanding of how all of these components form an 'integrated parasite toolbox' that can be used in the control of helminth parasites.

Part III is diagnostic helminthology and includes examination of faeces, urine and blood, *post mortem* worm count techniques and examination of muscles and skin. A section on molecular biological techniques updates the reader on the current status of this field. Part IV includes summary charts of the common helminth eggs for each of the important host species.

Several sections add value to the practical nature of this book. These are: a glossary with terms and definitions related to helminths, a classification of parasitic helminths, disease nomenclature and a multilingual dictionary of major helminths in six languages (*i.e.* English, German, French, Italian, Spanish and Portuguese).

This book is well-illustrated and well-photographed. The author's use of key words and bullet points makes the text easy to read and lifts out the main points in a specific section for the reader.

This book provides a complete and working guide to veterinary helminthology and when it does not contain the required information, provides the reader with additional relevant references. Although this book emphasises the important helminths of the Northern Hemisphere, it includes sufficient information to make it useful to those working in the Southern Hemisphere. Many texts overlook the applications needed for preventing helminth disease in developing community situations. However, this volume includes recommendations relevant for both the developed and developing countries in which the tools of this book can be applied.

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