Little anthelmintic drenching required for lambs finished over winter and spring on annually re-established irrigated pasture on the Highveld of Gauteng province, South Africa

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ABSTRACT

As part of a trial to test the profitability of finishing weaner lambs over winter and spring on the Highveld of Gauteng province, an investigation was carried out over 4 consecutive years as to whether or not worm control was necessary while the lambs were on irrigated, improved pastures. Pastures that had not been grazed by sheep or other livestock for at least 5 years were planted to annual ryegrass (*Lolium multiflora*) that was ploughed under and replanted annually. Weaner lambs were randomly divided into either 2 (A and B) or 3 (A, B and C) groups and finished from April/May to November/December on a separate pasture per group. While Group A lambs were dewormed before being placed on pasture, those in Groups B and C were not. Faecal egg counts were performed at irregular intervals, and when the lambs were sold at the conclusion of each year's trial, the gastrointestinal tracts of 4–5 lambs per trial group were processed for worm recovery. *Haemonchus contortus* was the dominant worm species, while *Trichostrongylus colubriformis, Ostertagia circumcincta* and *Trichuris* spp. were encountered sporadically. From the results obtained it seems unlikely that there is appreciable 'carry-over' of the various worm species from year to year on pastures that are ploughed and replanted annually; thus it is improbable that there will be a build-up of anthelmintic-resistant worms. While on pasture, no drenching was required for the Group A lambs (dewormed before placing on the pasture), nor in 2 of the 4 years in Groups B or B+C that were not drenched and were lightly infected at the start. In the remaining 2 years Groups B or B+C were drenched once only during the course of each trial. Thus, under the conditions as in this study, little worm control is necessary, provided faecal worm egg counts are done to gauge the levels of infection before the lambs are placed on pasture, and to guard against the possibility of an increase in worm burdens thereafter in some years. Also, because of the apparent lack of carry-over between years, anthelmintic treatment at the time of introduction of the lambs or during the period of finishing should be safe as regards progressive selection for anthelmintic resistance. It is also likely to be cost-effective, considering the low cost of anthelmintics in relation to the price of lambs, to counter the possibility of a loss in production if lambs were to harbour relatively heavy worm burdens when introduced.

Key words: annually replanted pasture, anthelmintic drenching requirement, anthelmintic resistance, *Haemonchus contortus*, lamb finishing, *Ostertagia circumcincta*, sheep, South Africa, *Trichostrongylus colubriformis, Trichuris* spp., winter/spring pasture.

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INTRODUCTION

Farmers in South Africa are inclined to drench lambs monthly while being finished on improved pasture, especially if irrigated (J A van Wyk, pers. obs.), in order to control internal parasites. Thus there is a strong likelihood that selection of worm populations for anthelmintic resistance will be severe, since the intervals between drenches are close to the prepatent periods of the common gastrointestinal worm species.

Resistance of worms to anthelmintics has escalated to such an extent in South Africa[11–15], as in numerous other countries, that Van Wyk *et al.*[12] titled a recent article 'Rampant anthelmintic resistance in sheep in South Africa – what are the options?'. Furthermore, these authors[12] described a strain of *Haemonchus contortus* with resistance to 8 of 10 anthelmintics tested, and surveys of resistance carried out mainly in Mpumalanga and KwaZulu-Natal provinces showed that such resistance was present on all of the 52 farms investigated[15] in these provinces.

The opportunity arose to investigate worm infections in a trial aimed at testing the profitability of finishing lambs during winter and spring on irrigated pastures that are ploughed under and re-established annually.

MATERIALS AND METHODS

Four-month-old Mutton Merino-type lambs with a mass of 20–23 kg were purchased annually from various sources for the trials (75 for Years 1 and 4 and approximately 125 for each of the remaining 2 years). On arrival on the farm the lambs were divided at random into either 2 or 3 groups, according to the number bought annually – Groups A and B, or Groups A, B and C. Group A lambs were drenched before being placed on pasture, while those in Groups B and C were not. The reason why Groups B and C were separated despite being treated similarly in the trial in Years 2 and 3, was to obtain similar grazing pressure for each group, to that of Group A, when relatively large numbers of lambs were used in the investigations.

Group A lambs were initially dewormed with a 'battery' of anthelmintics (Table 1) before each trial commenced, in order to determine whether it was possible to completely exclude worms as a reason for under-performance under such conditions. It was also intended that this group would act as a production control for Group B and C lambs, to ensure as far as possible that the latter 2 groups would have no production disadvantage by not being drenched at the outset, and if given the minimum number of drenches during the course of being finished on pasture. Ten to 14 days after the deworming mentioned, pooled 5 g samples of faeces from the lambs in Group A were exam-

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Table 1: **Drenching schedule of Group A lambs at the start of the trial in each year.**

Trade name	Active ingredient	Dosage per day (mg/kg)	Days drenched[a]	Manufacturer
Ripercol-l	Levamisole	15	1–5	Janssen
Ivomec	Ivermectin	0.4	2	MSD[b]
Lambazen	Albendazole + niclosamide	3.8 + 50	3–5	SmithKline-Beecham[c]

[a]The lambs were drenched daily over 5 days with various combinations of anthelmintics.
[b]Now Merial; product distributed by Logos Agvet.
[c]Subsequently acquired by Pfizer.

ined by total flotation[16] to test whether the treatment had been practically fully effective. Individuals that were still passing worm ova were retreated, whereupon no ova were encountered when they were retested by the same method.

While the lambs ran on the pasture, they were drenched (using ivermectin and levamisole, Table 1) only when the group mean faecal worm egg counts (FECs) were at a level of, or close to 1000 eggs per gram of faeces, or, alternatively, had risen by more than 400 FEC within a period of about a month. In Years 2 and 3, when there were 2 groups of sheep that were undrenched initially (B and C), it was decided that both of these groups would be treated if only 1 of them qualified for treatment according to the criteria mentioned.

The trials were conducted during 1992–1995 (Years 1–4, respectively) at the Roodeplaat Experimental Farm (25°30′S, 28°17′E, altitude: ~1200 m) of the ARC-Range and Forage Institute, Gauteng. The mean minimum temperature for June/July (the coldest months of the year) over the 4 years of the trials was 0.8 °C and for December/January 16.4 °C. The corresponding mean maximum temperatures were 20.8 °C and 29.6 °C. Climatic data were obtained from a weather station on the farm.

The soils on which the pastures were established are predominantly of the Wasbank type, with a clay content of 15–35 % in the uppermost 20–30 cm, and in addition, a relatively small component of the Hutton type. Although steenbok (*Raphicerus campestris*) was noticed infrequently, the land on which the pastures were established had not been grazed by sheep or other domestic ruminants for more than 5 years. During December 1991 and January 1992 the land was cleared of trees and prepared by conventional agricultural practices for the establishment of a pasture consisting of the annual Midmar cultivar of rye grass (*Lolium multiflora*), as described below. When the grass was ready for grazing, the lambs were introduced and kept there until they reached market mass.

During the course of the experiment the fields were ploughed annually in March and fertilised with superphosphate (to a final concentration of 15 ppm P, based on soil analysis). Thereafter they were irrigated, ploughed again with a disc-plough at the end of March and, after planting the rye grass seeds, they were rolled. Potassium ammonium nitrate (KAN) was applied as a surface fertiliser (40 kg/ha) as soon as the seedlings had reached the 3-leaf stage, and then monthly until October. Each year, after withdrawal of the lambs, the pasture was ploughed under and the surface was turned with a disc-plough for weed control. The fields were not used for grazing other farm animals between the finishing trials.

The pasture was bisected by a road with edgings approximately 10 m wide, with the pasture of Group A on one side, and the pastures of Groups B and C on the other. Each pasture was individually fenced and had a separate animal handling facility. Each of the groups was invariably handled separately in its own handling facility. The annual grazing pressure was similar for all groups (about 36 lambs/ha).

During the colder months of the year (May–August) the pasture was irrigated at a rate of 15 mm per week, and after September/October with 20 mm per week, except after rainfall of at least 15 mm per week.

With the exception of Year 1, during which a 4-paddock rotational grazing system was followed (with each pasture being divided into 4 portions by wire fencing, every portion being occupied for a week at a time), a set-stocked system was used. The lambs started grazing the pastures annually in April or May, but the 1st faecal egg counts after they had been placed on pasture were done in June or July. Lambs were marketed when they reached a predetermined mass of 42–45 kg (determined by regular weighing) in November to December.

Faecal worm egg counts were performed by a modified McMaster method[7] and were done at irregular intervals on approximately 20 % of the lambs in each group. At the end of each trial the gastrointestinal tracts of 4 to 5 lambs per group were processed for worm counts (Table 2). The worms in 10 % of the ingesta of the abomasum and small and large intestines were counted under a stereomicroscope. In addition, the mucous

Table 2: **Mean worm burdens of lambs per trial group in Years 1–4.**

Groups[a]/years[b]:	Year 1		Year 2				Year 3				Year 4	
	A	B	A	B	C	B+C	A	B	C	B+C	A	B
H. contortus (L4)	Nil	8	5	23	13	18	nr	nr	nr	nr	Nil	Nil
Total	20	94	324	340	16	179	30	2155	1868	2011	10	640
T. colubriformis (adults)	Nil	Nil	732	606	209	408	Nil	132	Nil	66	Nil	1850
O. circumcincta (adults)	Nil	Nil	Nil	Nil	Nil	Nil	10	2747	1514	2131	Nil	Nil
Trichuris spp. (adults)	Nil	Nil	Nil	Nil	Nil	Nil	10	70	20	45	Nil	Nil
Lambs examined[c]	4	5	4	4	4	n/a	5	5	5	n/a	5	5

[a]Lambs drenched at start of trial; B+C: not drenched initially; nr: not recorded separately; n/a: not applicable.
[b]In Year 2, Groups B+C were drenched on pasture in October, and in Year 4, Group B was drenched in July.
[c]Number of lambs processed for worm recovery.

membranes of these organs were scraped off separately and digested in a pepsin/HCl solution[7]. Total worm counts were done on the resultant digests[7]. In every sample the 1st 25 worms encountered were identified using a compound microscope, and if fewer than 25 worms were found, all were identified.

RESULTS

The FECs of the trial groups in the 4 years of the experiment are depicted graphically in Figs 1–4. In Year 2 the Group B and C lambs (undrenched initially) were drenched in October, shortly before the termination of the trial. By contrast, in Year 4 the corresponding group was drenched in July, when there was a sudden increase in FECs and it was considered likely that the worm burdens may have caused losses in production before the end of the trial, had the animals not been drenched at the time. Group A lambs did not require anthelmintic treatment in any of the years, while on pasture, and while low levels of FECs were detected in their faeces in Years 1 and 2, no eggs were detected in Years 3 and 4 by the modified McMaster method[7].

The intensity and nature of the worm burdens are summarised in Table 2. According to the guidelines of Gardiner & Craig[2] and Gordon[3], *H. contortus* was the dominant species in each of the trial years with regard to pathogenicity. No *Trichostrongylus colubriformis* was recovered in Year 1, but in Years 2–4 the ranges of this worm species per group were 209–732, 0–132 and 0–1850, respectively. *Ostertagia circumcincta* was recovered only in Year 3, with mean burdens of 10, 1514 and 2747 in the 3 trial groups. Mean burdens of 10–70 *Trichuris* spp. per group were recovered in Year 3, in contrast to the fact that none were recovered in the other years.

The average daily gain (ADG) in mass (g) in the various groups varied from 151–302 in the 1st half of each annual trial (a period of ~3 months) and from 128–263 in the 2nd half. The differences in ADG between the lambs in Group A (*i.e.* those drenched at the commencement of each trial) for each half of the finishing period on pasture and the corresponding values for those in Groups B or B and C (not predrenched), were never significant ($P > 0.05$).

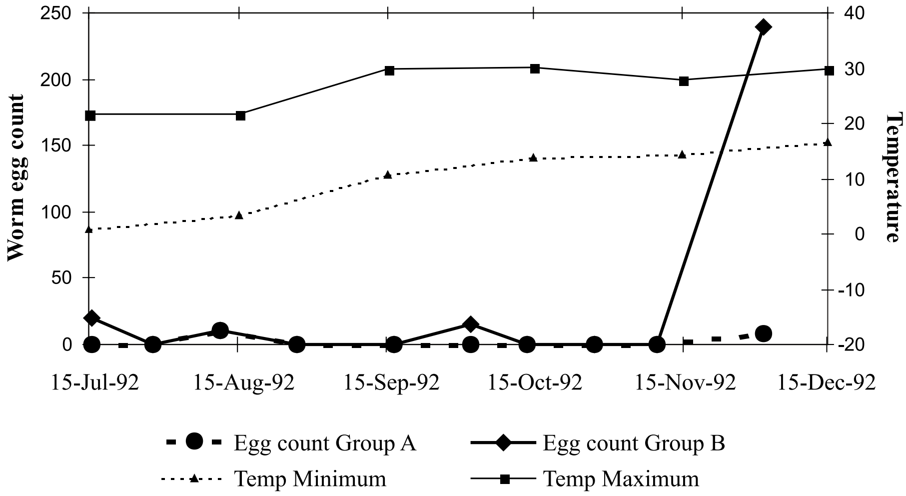

Fig. 1: **Mean faecal worm egg counts and minimum and maximum temperatures in Year 1 (1992).**

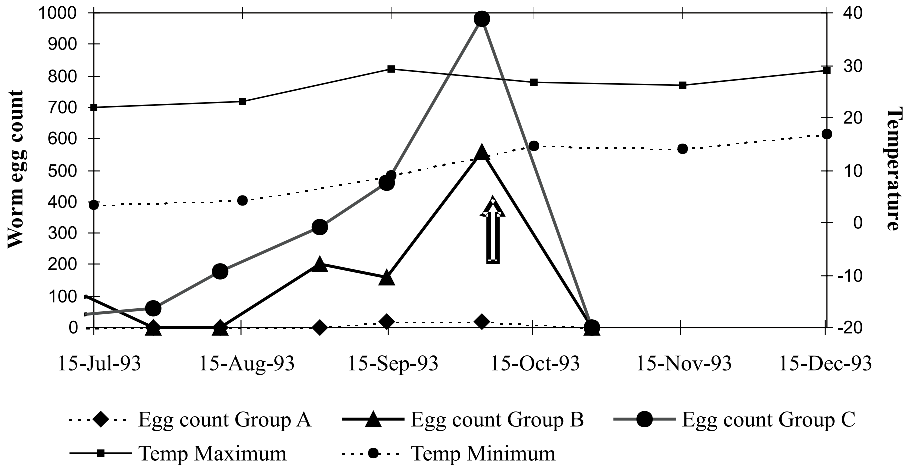

Fig. 2: **Mean faecal worm egg counts and minimum and maximum temperatures in Year 2 (1993). The arrow indicates anthelmintic treatment of Groups B and C.**

DISCUSSION

In Years 2 and 3, when larger numbers of lambs were purchased, additional pasture had to be established adjacent to the former Group B pasture, and the lambs that were not predrenched were allocated to 2 separate pastures (Groups B and C), in order to obtain uniform grazing pressures for all 3 groups. Group A lambs were intended to serve as practically uninfected production controls for the other groups, in which worm infections were expected to develop. These lambs were separated by a road from the other groups to prevent worm eggs or larvae from being carried over between pastures. With the intensive predrenching schedule (Table 1) and careful testing for worm eggs in the faeces thereafter[16], it was attempted completely to prevent any worm infection of this pasture that should have been free from ovine worm species as it had not been grazed by sheep or other livestock for more than 5 years. It is obvious from the results, however, that this was unsuccessful in 2 of the 4 years.

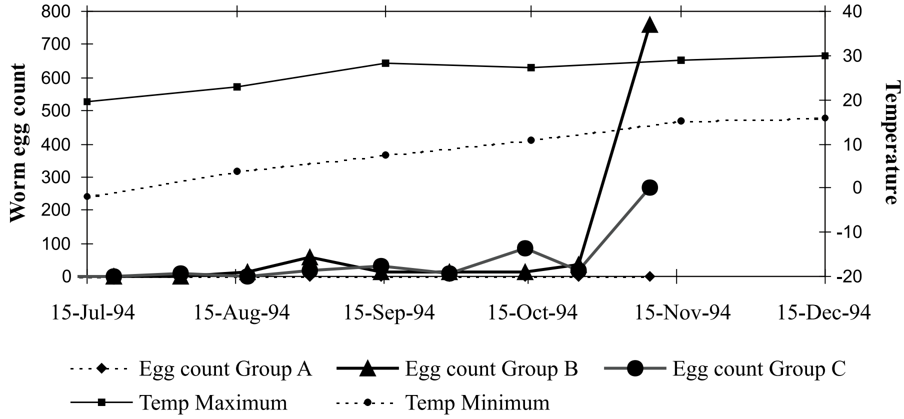

Fig. 3: **Mean faecal worm egg counts and minimum and maximum temperatures in Year 3 (1994).**

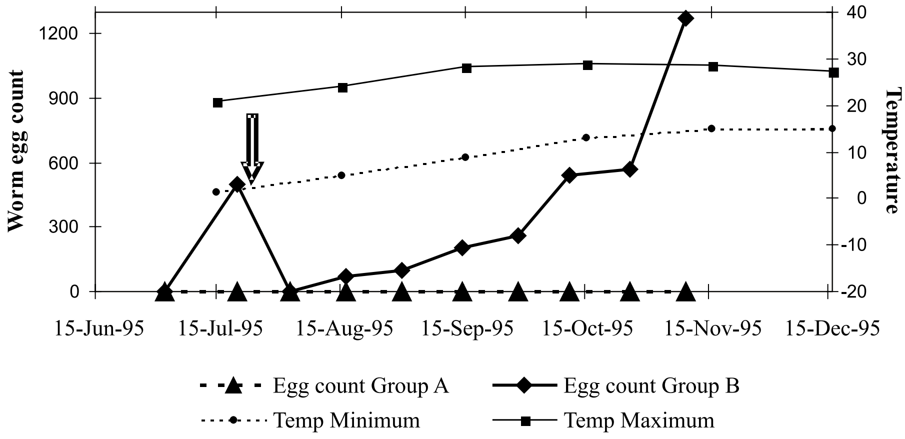

Fig. 4: **Mean faecal worm egg counts and minimum and maximum temperatures in Year 4 (1995). The arrow indicates anthelmintic treatment of Group B.**

As discussed by Van Wyk[10], not even intensive drenching is to be recommended for preventing introduction of anthelmintic resistant worm populations on farms that are restocked after not having been grazed by domestic ruminants for such long periods that the pastures are free from the principal gastrointestinal helminths. If the present pastures had not been ploughed and re-planted annually, it seems likely that the 'Group A worms' surviving the 'battery' of drenches would have been able to fully repopulate the terrain with a population that was likely to be extremely resistant. Even if the intervention is initially successful, it is likely that worms (that will most probably be resistant in the case of many sheep-producing countries like South Africa) will be introduced by various means thereafter[10].

Drenching with anthelmintics as intensively as for Group A at the commencement of each year's trial (Table 1) is not recommended as a general practice by farmers when initiating similar management systems for finishing lambs for the market. In these trials it was necessitated by the fact that, given the high prevalence of anthelmintic resistance in South Africa and that the lambs were purchased from elsewhere, the lambs were expected to harbour resistant worms. They also had to be used in the trial soon after having been bought, thus allowing insufficient time to treat conventionally with anthelmintics and test until no worm eggs were detected. It seemed highly unlikely that a single drench with any drug alone or in combination with any other available at the time would render the lambs virtually worm free. The drenching schedule was nevertheless resorted to in order to ensure that the lambs of Group A were cleared as far as possible of nematodes.

The production trials were conducted (by J M) to investigate whether it is profitable to finish fat lambs on annually established winter/spring pastures. The season in which worm burdens are at their maximum is from November/December to April/May in the summer rainfall region of South Africa, and the main purpose of the worm investigations was to determine whether it was necessary to drench lambs on the Highveld of Gauteng province (and thus most probably also on the Highveld of Mpumalanga province) when they are grazed on such pastures only during the season of the year when worm infections are at their minimum. The reasoning was that, because the pastures are largely helminthologically uninfective in winter and spring on the Highveld of Gauteng and Mpumalanga[4], no drenches would be needed. In no instance was there a statistically significant difference in production between the Group A lambs and those in the groups that were left undrenched at the start of the trials, although it was necessary, according to the criteria selected, to drench the lambs of the latter groups on 2 occasions over the 4 years of the trials. Furthermore, it should be noted that, as can be seen from the FECs of Groups B and C (Figs 1–4), the lambs were relatively lightly infected at the start of the trials, despite not having been drenched after arrival on the farm. The results could be expected to differ markedly in the case of heavy initial worm burdens, thus emphasising the importance of FECs in such production systems (see below).

These results should be viewed against the background of investigations on a number of sheep farms on which as many as 6 drenches were routinely administered to lambs maintained under similar rounding-off circumstances on winter/spring grazing (J A van Wyk, pers. obs.). In this experiment the burdens of *H. contortus* in Year 3, when no drenches were given to the lambs, were as high as 2155 per lamb – a burden that, had it been present for long, could have been expected to be pathogenic and thus to reduce production of the lambs[3]. The relatively low FECs at the beginning of November (Fig. 3) in Year 3 indicate that the bulk of the *H. contortus* infection was most probably contracted by the lambs shortly before the end of the trial.

The fact that relatively large worm burdens did accumulate in some of the lambs indicates that determinations of FECs, followed if necessary by appropriate treatment, are essential to ensure that undosed lambs are not overwhelmed by worm infections. If such determinations are not done, particularly in a relatively warm spring, either a routine drench should be considered in August or September, or lambs should be dewormed before placement on pasture. To reduce costs, composite (pooled) FECs, instead of individual counts, should suffice[1,6].

The slow accumulation of worms that occurred in the lambs in all groups and years can probably be explained by nil or low infectivity of pastures at the beginning of each year (see below), and the so-called 'concertina effect' of development of the free-living stages of parasitic worms on pasture in spring. At the beginning of spring, when environmental temperatures are still low, eggs passed in the faeces of an infected sheep take a relatively long time to hatch and for the emerging larvae to reach the infective L3 stage[5]. However, rising temperature causes a reciprocal decrease in the latent period, so that progressively larger numbers of infective larvae become available over shorter periods[8].

In many instances lambs for finishing on winter pastures are purchased from several sources and, considering the widespread resistance of *H. contortus* to anthelmintics[15], may be infected with such worms. It is thus of cardinal importance to determine whether free-living stages of the common gastrointestinal helminths can live sufficiently long on pasture to survive and remain viable from year to year and cause problems as regards anthelmintic insusceptibility. It would seem possible from the intensity of worm burdens in the initially undrenched groups of lambs in these trials that the numbers of *H. contortus* could have increased progressively over the 3-year period, and may therefore have been carried over from year to year (Table 2). This is exemplified by the fact that there seemed to be a sharp increase in worm burden from Years 2 to 3. However, this was probably a false impression resulting from the fact that the lambs of Groups B and C (undrenched at the start of the trial) were drenched shortly before they were slaughtered in October of Year 2 (Fig. 2).

H. contortus is so common in the summer rainfall region that deductions from the present data as to a possibility of survival from year to year on the annually re-established pastures are almost impossible. Considering the burdens of the other species, however, it seems unlikely that much, if any, such 'carry-over' occurs. For instance, after mean burdens of 732, 606 and 209 on the different pastures in Year 2, no *Trichostrongylus* spp. were recovered in Year 3 from 2 of the 3 pastures, with a mean of only 132 from the 3rd. Similarly, no *Ostertagia* spp. were recovered from the Group B lambs in Year 4, despite a mean burden of 2747 from lambs that grazed the same paddock in Year 3.

The indications are therefore that there is little danger of long-term build-up of resistant worms introduced with lambs purchased from elsewhere for finishing over winter and spring on pastures that are ploughed under annually in early summer and lie fallow until replanted in autumn. However, this will only hold true if none of the lambs are retained on the farm on other pastures at the end of the period of finishing. In addition, to prevent the establishment of resistant worm strains originating from lambs introduced for finishing on pasture, farmers will have to ensure that no other livestock on the farm are placed on the pastures on which the lambs are being finished, or in the facilities in which the latter are handled.

Trichuris spp. are a potential threat under conditions of intensive grazing, since their ova can remain infective for considerably more than a year[9]. Fortunately, these ova do not hatch outside the host which becomes infected by ingesting the ova and not, as in many other parasitic nematodes, by ingesting the infective L3 stage. Consequently, as supported by the present results, the annual ploughing in preparation for establishing a pasture will bury the majority of these ova, which will thus not be available to grazing animals. After low *Trichuris* FECs in spring in the lambs of Year 2, mean numbers of 10–70 worms were recovered from the various groups of lambs in Year 3. But in Year 4 there were neither positive FECs nor adult or subadult *Trichuris* spp. in any of the lambs slaughtered at the end of the trial.

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