Study of the population dynamics of gastrointestinal nematodes in organic sheep farms in Canada with an attempt to introduce sustainable parasite control measures

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Executive Summary

The hypothesis of this study is that the epidemiology of sheep gastrointestinal nematodes in Canada is sufficiently different to that described for other countries, and that effective control of gastro-intestinal parasitism of sheep can be accomplished without the use of, or with the reduced use of, chemical anthelmintics. To test this hypothesis it is first necessary to determine the prevalence and patterns of gastrointestinal nematode parasitic disease in untreated or minimally treated sheep flocks. These data will be gathered from organic and conventional flocks based in Ontario and Quebec over a three-year period. During this time, anthelmintics will only be used when animals become clinically diseased. Data will be gathered on factors influencing gastrointestinal nematode infection rates in the sheep. Pasture contamination and infectivity levels will be measured and analyzed. Climate data, as well as other farm level and individual sheep data will be gathered and analyzed. Based on the data collected, models of gastrointestinal parasite epidemiology will be developed. These models will allow future research in the proposition and evaluation of specific management practices that aid parasite control, with a view to eventually developing a sustainable parasite control system using integrated strategies, applicable to both organic and conventional sheep farming enterprises.

Benefit of the research

Internationally, the sheep industry faces an increasingly severe production-limiting problem with resistance of the major species of gastro-intestinal nematodes to all classes of anthelmintics. Because of this, in some regions sheep production has almost ceased. The traditional approach of developing new formulations of anthelmintics has only led to development of more anthelmintic resistance. Veterinarians and producers must adopt alternative control methods if sheep production is to remain sustainable. The FAMACHA system of parasite control, in which sheep are treated individually on the basis of the colour of the internal membrane around the eye, requires frequent examination of sheep and is designed for places where hematophagous nematodes are prevalent, thus its suitability under Canadian conditions needs to be examined. There is also a growing niche market for organically raised meats as consumers perceive that organic production is more sustainable and that the meat

may be healthier. The sheep industry has embraced organic production but experiences severe problems of disease due to gastrointestinal parasitism (GIP).

By studying the epidemiology of GIP under Canadian conditions, the factors that affect parasite survival and infectivity can be discerned and models can be developed that will help veterinarians and producers raise sheep with minimal or no anthelmintic use. Studies in other countries with a similar climate to Canada have shown that (for example), *Haemonchus contortus* can be eradicated with such programs. The benefit to the industry and society will be a reduced risk of development of anthelmintic resistance; reduced costs associated with sheep production from savings both on drugs and labour; improved productivity because of lower disease rates; improved welfare for the sheep by disease avoidance; and application of sound science to sustainable production of organic sheep. Producers will find no need to use unproven, likely ineffective and potentially toxic alternative compounds in an attempt to control parasitism. The development and widespread application of economically and environmentally sustainable practices in parasite control will demonstrate a strong commitment to public health and a healthy environment.

Results over this reporting period (May 2005 – April 2006)

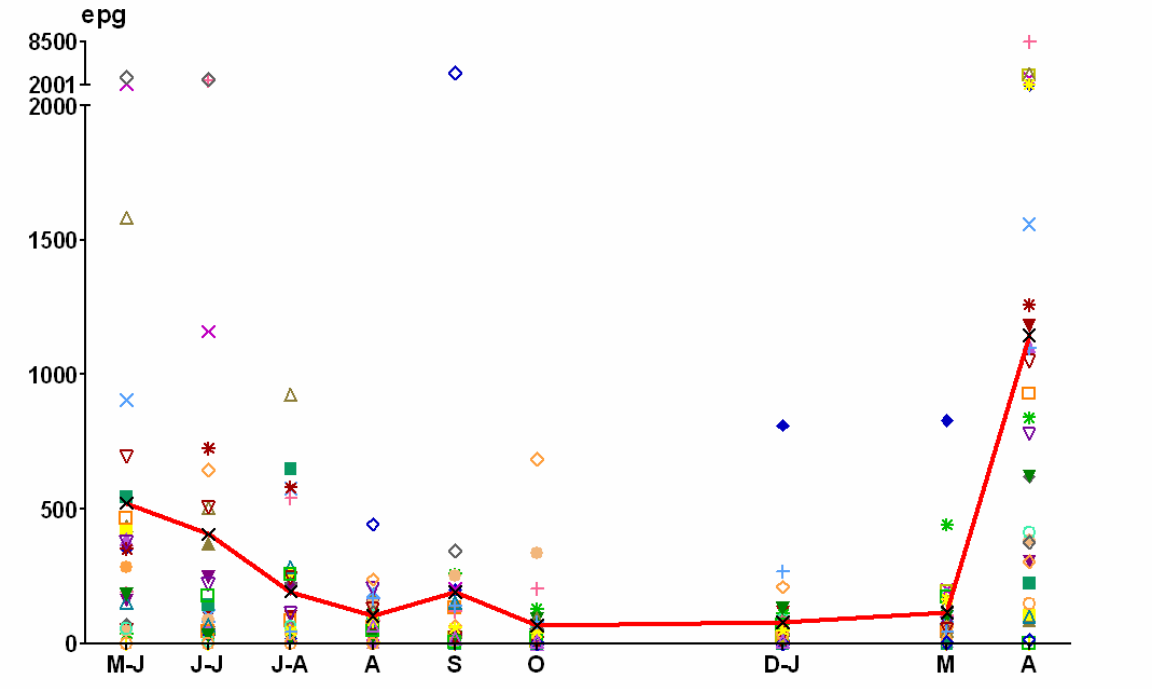
Epidemiological study, 1st year – A total of thirty-two organic and conventional sheep farms in Ontario (n=23) and Quebec (n=9) were recruited to participate in this study. The organic farms comply with the draft of the National Standard for Organic Agriculture (June 2004), that states as organic "a method of production including any subsequent processing, storage and transportation, conforming to this standard that which may or may not be attested by a certification body. This definition applies to the terms organically grown, organically raised, organically produced, biodynamic and the translation in any official language of these words which may be used in lieu of organic." Participating farms (conventional and organic) agreed to not use anthelmintics of any kind (conventional or alternative) during the study period unless animal health was jeopardized. The purpose of selecting such farms was to – as much as possible – observe true patterns of gastro-intestinal parasite development and infection rates. Farms were restricted to Ontario and Quebec for the following reasons: most Canadian sheep production occurs in these two provinces; both provinces are noted for warm, wet summers which favour parasite development and thus a high risk of clinical disease; and resources exist in these provinces to perform the study. Since no previous studies have been carried out in Canada to obtain estimates of gastro-intestinal nematode (GIN) disease, or prevalence of factors related to disease, we selected a farm "n" of 30 (actual: 32) to assure that adequate power existed for examination of multiple flock-level factors. Organic farms were selected from a list of approved organic producers that pasture their sheep; conventional farms were selected from a list provided by the Ontario and Quebec provincial sheep associations. A random sample of producers that fit the following criteria was solicited for participation in the study: sheep are pastured during the summer; the owner is willing to have the sheep gathered monthly for sampling and has adequate handling facilities; the owner is willing to not treat the sheep for gastrointestinal parasites with any class of anthelmintic, conventional or alternative, unless clinical disease develops or if test results indicate dangerously high parasite loads.

As indicated above, 23 sheep farms in Ontario and 9 sheep farms in Quebec participated in the first year of the study. All farms were visited monthly during the grazing season - May to

October - and then again in December-January and March. At each visit, fecal samples were collected from ten randomly selected grazing animals from each of two age cohorts, adult and lambs. In addition, pasture samples were collected (May-October). Body condition score, dag score, and fecal consistency scores of all experimental animals were monitored at each visit. Twice during the summer, blood samples were taken to determine levels of anaemia. In the fall, 2 untreated lambs from 7 study farms in Ontario were necropsied to investigate the actual worm burden that had established over the grazing period. The criteria used to select these 7 farms were based on the pattern of nematode infection in the lambs on each farm during the grazing season.

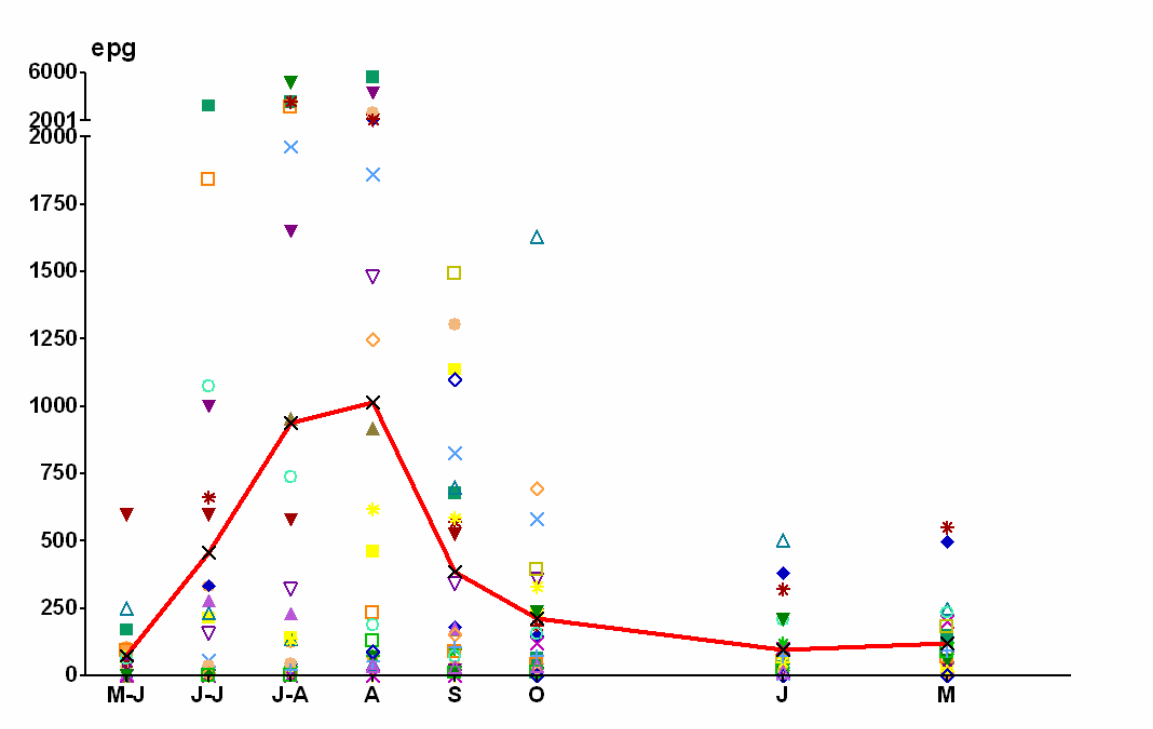
***Fecal egg counts (FEC)*:** These data indirectly inferred the parasite worm burdens in the animals, and at the same time revealed the seasonal pattern of contamination of pastures with nematode eggs during the grazing months. At the farm level, the average (arithmetic mean) FEC - expressed as 'eggs per gram of feces', i.e. epg - from adult ewes (Fig. 1) was lower than 1500 epg throughout the grazing season on all except 6 farms. On all farms, the value dropped below 500 epg in the winter months of December-January and March, and increased sharply again in April (range in farm-level average = 0-8456 epg) coinciding with the lambing season - known as the "peri-parturient rise phenomenon (PPR)".

Figure 1. Farm-level mean fecal egg counts for adult ewe groups throughout the first year of sampling. Red line shows the mean season trend for all farms. (M-J = May-June; J-J = June-July; J-A = July-August; A = August; S = September; O = October; D-J = December-January; M = March; A = April)



Fecal egg counts in grazing lambs were much higher than those recorded for the adult groups, showing the highest FEC during the summer months - late June to late August. The highest peaks in mean egg output, at the individual farm level, for these months were 3245 in June, 3564 in July, and 5610 in August. The number of lambs sampled in 9/32 farms decreased towards the fall and winter as individual animals were sold and replacements were not available.

Figure 2. Farm-level mean fecal egg counts for lamb groups throughout the first year of sampling. Red line shows the mean season trend for all farms. (M-J = May-June; J-J = June-July; J-A = July-August; A = August; S = September; O = October; J = January; M = March)



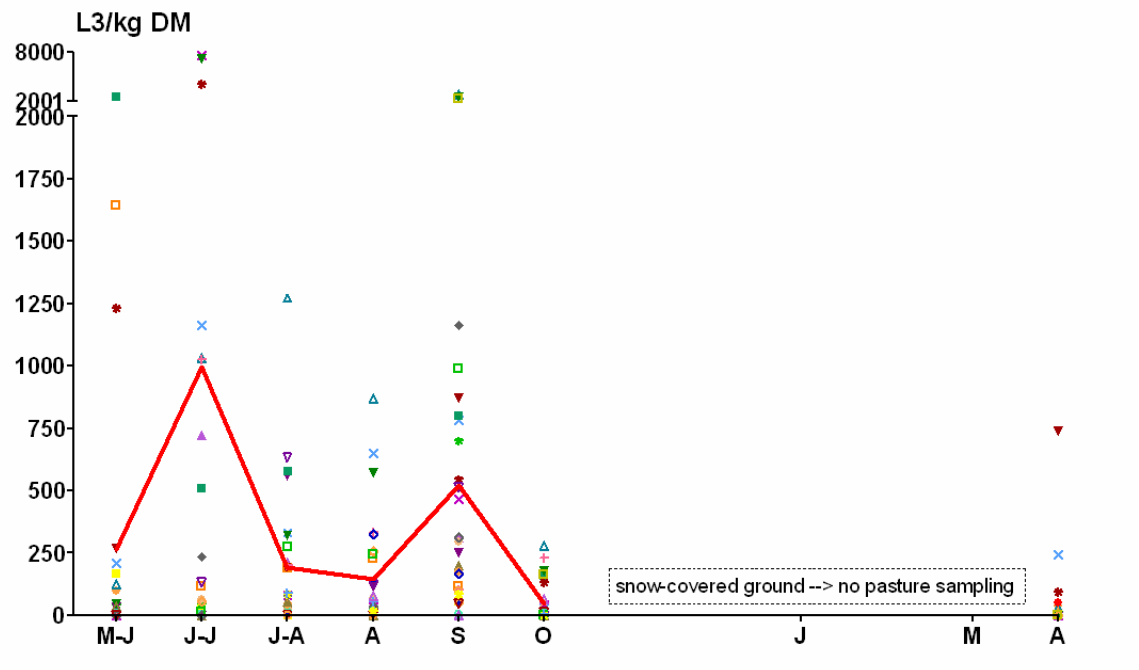
Of the 4 farms that reared lambs exclusively indoors (i.e. with no access to pasture at any time), 3 farms had lambs that typically had very low FEC (epg<20), while the lambs at the fourth farm experienced acute clinical parasitosis due to GIN in mid-Aug (average epg 1240) and needed to be treated. None of these 4 farms are shown in Fig. 2 as their lambs did not contribute to infecting the pastures grazed by the rest of the respective flocks.

As a direct result of the flock monitoring through fecal tests, 14 individual farmers were advised to treat their flocks against gastrointestinal nematodes. However, the final decision regarding treatment (whether or not to treat, and what kind of anthelmintic to use) was made by the producers and/or their veterinarians. Anaemia scores were lower than normal in most animals in 3/32 farms for lambs in August, and in 1/32 farms for ewes in the same month. Of these 4 farms, 3 were amongst the group of 14 that were advised to treat.

Pasture infectivity (Fig. 3): The seasonal pattern of pasture infectivity (i.e. presence of infective larvae on pasture) showed that pastures were infective on 54% of the farms sampled at the time the study commenced in late-May 2006, with larval counts ranging from 6 to 2456 L3/KgDM (infective larvae per kilogram of dry matter). Over-wintering parasitism was confirmed in 3 farms (one of which dropped out from the project shortly after), with counts of 33, 40, and 558 L3/KgDM on each farm at that time. Identification of these larvae is shown in Fig 5. Whether larval over-wintering in 2005/2006 occurred in any of the other farms could not be determined as the parasitized flocks were already grazing and contaminating the pastures by the time of the first sampling.

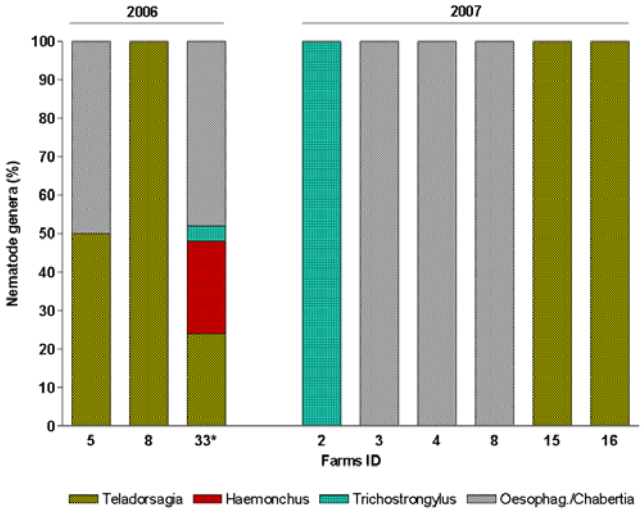
Overall, there were two peaks of pasture infectivity in 2006: late-June (range = 0-7611 L3/KgDM) and late-September (range = 0-2724 L3/KgDM). At the pasture sampling in late October the pasture infectivity dropped drastically (range = 0-278 L3/KgDM), with 44% of the samples being negative for the presence of gastrointestinal nematodes. There was no pasture sampling during the winter due to snow covering the fields.

Figure 3. Pasture infectivity during the 2006 grazing season and first sampling of the 2007 season. Red line shows the mean season trend. (M-J = May-June; J-J = June-July; J-A = July-August; A = August; S = September; O = October; J = January; M = March; A = April)



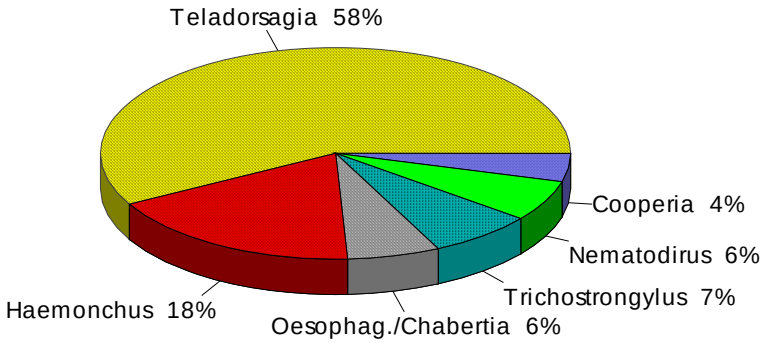
The first sampling at the beginning of the grazing season in April 2007 revealed that larval over-wintering occurred in 26% of the sampled farms (6/23), with a farm-level range of pasture infectivity of 27-741 L3/KgDM. The identification of the over-wintered larvae is shown in Fig. 4.

Figure 4. Genera of infective larvae that overwintered on pasture in 2006 and 2007.
(*) Farm 33 dropped out from the project.



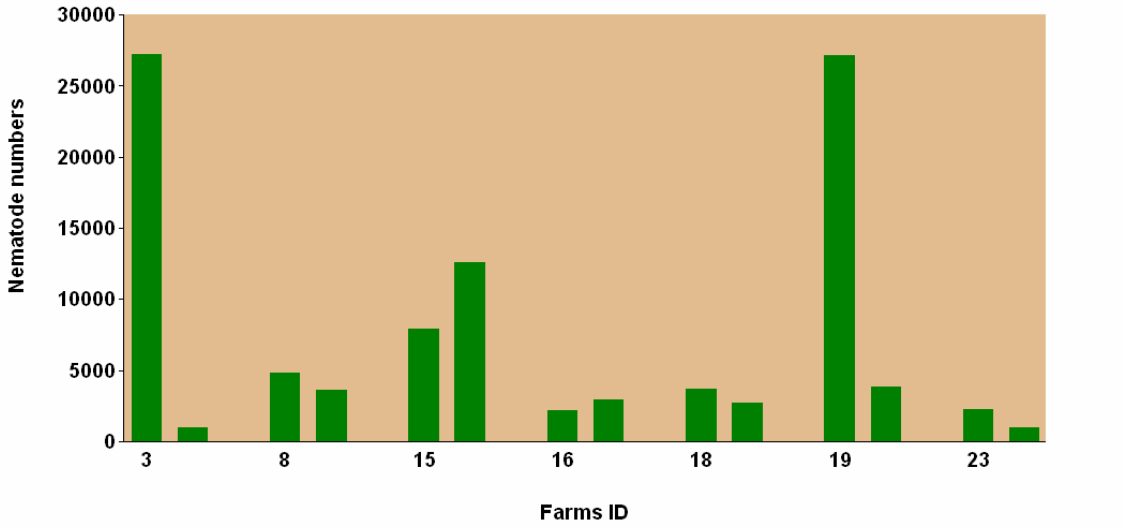
Larval genera identification: Gastrointestinal nematode genera identified from both fecal cultures and pasture samples showed that, although prevalence figures varied from farm to farm, *Teladorsagia* was the most common genera found throughout the first year, followed by *Haemonchus*, *Trichostrongylus*, *Nematodirus*, *Oesophagostomum/Chabertia*, and *Cooperia* (Fig. 5). *Haemonchus* was more predominant in June (29% of all nematode larvae identified) and August (25%), *Trichostrongylus* in May (14%) and June (11%), *Nematodirus* in June (14%), *Oesophagostomum*/*Chabertia* in May (16%) and October (17%), and *Cooperia* in July (9%), compared to other months. *Nematodirus* was detected only in the lamb groups.

Figure 5. Overall prevalence of nematode genera during 2006.



Necropsy of lambs from 7 of the studied farms: The total numbers of adult nematodes found in 14 lambs from 7 farms (n = 2/farm) can be seen in Fig. 6.

Figure 6. Total gastrointestinal nematode counts per lamb in 7 farms



Overall, the proportions of nematode genera were: *Trichostrongylus* (in both abomasum and small intestine), 74%; *Haemonchus*, 6%; *Teladorsagia*, 6%; *Nematodirus*, 7%; *Cooperia*, 2.5%; *Strongyloides*, 3%. Additionally, there was a very small percentage (<0.5%) of *Oesophagostomum*, *Chabertia*, and *Trichuris*. The nematode species identified in the different gastrointestinal organs were as follows: Abomasum: *Haemonchus contortus, Trichostrongylus axei, T. colubriformis,* and *Teladorsagia circumcincta*; Small intestine: *T. colubriformis, T. vitrinus, Cooperia Mcmasteri, C. curticei, Nematodirus filicollis,* and *Strongyloides papillosus*; Large intestine: *Oesophagostomum* spp., *Chabertia ovina,* and *Trichuris ovis.*

The overall results from the first year of the epidemiological study revealed that there was a wide range of parasitism levels amongst the sheep flocks, i.e. from zero parasite nematodes to farms with high parasite burdens and clinical parasitism. Lambs were the age group most affected; in only a few flocks were gastrointestinal parasites shown to be a problem in adult ewes.

The following two years of the project are currently under way.

An OACC Technical Bulletin is available for the above research project.