REFERENCES AND RECOMMENDED READING

BOOKS AND TECHNICAL MANUALS

Sheep Flock Health - a planned approach. Neil Sargison. Blackwell Publishing, Oxford UK. 2008.

Smart Drenching and FAMACHA©, Integrated Training for Sustainable Control of Gastrointestinal Nematodes in Small Ruminants. Southern Consortium for Small Ruminant Parasite Control.

Sustainable Worm Control Strategies for Sheep, a technical manual for veterinary surgeons and advisors 3rd edition. K.A. Abbott, M. Taylor, L.A. Stubbings editors. April 2009.

Veterinary Parasitology, 3rd edition.M.A. Taylor, R. L. Coop and R. L. Wall editors.Blackwell Publishing, Oxford UK. 2007.

SELECTED RESEARCH AND REVIEW PAPERS

Coles GC, Bauer C, Borgsteede FHM et al. World Association for the Advancement of Veterinary Parasitology (W.A.A.V.P.) methods for the detection of anthelmintic resistance in nematodes of veterinary importance. Vet Parasitol 1992;44:35-44

Eysker M, Bakker N, Kooyman FNJ et al. The possibilities and limitations of evasive grazing as a control measure for parasitic gastroenteritis in small ruminants in temperate climates. Vet Parasitol 2005;129:95-105.

Fleming SA, Craig T, Kaplan RM et al. Anthelmintic resistance of gastrointestinal parasites in small ruminants. J Vet Intern Med 2006;20:435–444

Guthrie AD, Learmont J, Van Leeuwen J et al. Evaluation of a British computer model to simulate gastrointestinal nematodes in sheep on Canadian farms. Vet Parasitol 2010;174:92-105.

Houdijk JGM, Kyriazakis I, Jackson F et al. Effects of protein supply and reproductive status on local and systemic immune responses to *Teladorsagiacircumcincta*in sheep. Vet Parasitol 2005;129:105–117.

Kenyon F, Greer AW, Coles GC et al. The role of targeted selective treatments in the development of refugia-based approaches to the control of gastrointestinal nematodes of small ruminants. Vet Parasitol 2009;164:3-11.

Langrová I, Makovcová K, Vadlejch J et al. Arrested development of sheep strongyles: onset and resumption under field conditions of Central Europe. Parasitol Res 2008;103:387–392

Larsen M. Biological control of nematode parasites in sheep. J AnimSci 2006;84(E. Suppl.):E133–E139

Learmount J, Taylor MA, Smith G et al.A computer model to simulate control of parasitic gastroenteritis in sheep on UK farms. Vet Parasitol 2006;142:312–329.

LeJambre LF, Windon RG, Smith WD. Vaccination against *Haemonchuscontortus*: performance of native parasite gut membrane glycoproteins in Merino lambs grazing contaminated pasture. Vet Parasitol 2008;153:302-312.

Louie K, Vlassoff A, Mackay AD. Gastrointestinal nematode parasites of sheep: A dynamic model for their effect on liveweight gain. Int J Parasitol 2007;37:233-241.

Marley CL, Fraser MD, Fychan R et al. Effect of forage legumes and anthelmintic treatment on the performance, nutritional status and nematode parasites of grazing lambs. Vet Parasitol 2005;131:267–282

Mederos A, Fernandez S, Vanleeuwen J et al. Prevalence and distribution of gastrointestinal nematodes on 32 organic and conventional sheep farms in Ontario and Quebec, Canada (2006-2008). Vet Parasitol 2010;170:244-252.

Miller JE, Horohov DW. Immunological aspects of nematode parasite control in sheep. J AnimSci 2006;84(E. Suppl.):E124–E132.

Min BR, Barry TN, Attwood GT et al. The effect of condensed tannins on the nutrition and health of ruminants fed fresh temperate forages: a review. Anim Feed Sci Tech. 2003;106:3-19.

Morgan ER, Cavill L, Curry GE et al. Effects of aggregation and sample size on composite faecal egg counts in sheep. Vet Parasitol 2005;131:79–87.

Morgan ER, Coles GC. Nematode control practices on sheep farms following an information campaign aiming to delay anthelmintic resistance. Vet Rec 2010;166:301-303.

O'Connor L, Walkden-Brown SW, Kahn LP. Ecology of the free-living stages of major trichostrongylid parasites of sheep. Vet Parasitol 2006;142:1-15.

Pasture Production. Ministry of Agriculture, Food and Rural Affairs. Order Publication 19, Agdex #130. http://www.omafra.gov.on.ca/english/crops/pub19/pub19toc.htm

Pollott GE, Karlsson LJE, Eady S et al. Genetic parameters for indicators of host resistance to parasites from weaning to hogget age in Merino sheep. J AnimSci 2004;82:2852–2864.

Taylor SM, Kenny J, Edgar HW et al. Efficacy of moxidectin, ivermectin and albendazole oral drenches for suppression of periparturient rise in ewe worm egg output and reduction of anthelmintic treatment for lambs. Vet Rec 2007;141:357-360.

vanWyk JA, Bath GF. The FAMACHA system for managing haemonchosis in sheep and goats by clinically identifying individual animals for treatment. Vet Res 2002;33:509–529.

vanWyk JA, Hoste H, Kaplan RM et al. Targeted selective treatment for worm management - How do we sell rational programs to farmers? Vet Parasitol 2006;139:336-346.

Waller PJ, Rudby-Martin L, Ljungstrom BL et al. The epidemiology of abomasal nematodes of sheep in Sweden, with particular reference to over-winter survival strategies. Vet Parasitol 2004;122:207–220.

Zajac AM. Gastrointestinal nematodes of small ruminants: life cycle, anthelmintics, and diagnosis. Vet Clin Food Anim. 2006;22:529-541.

APPENDICES

1. PROTOCOL FOR COLLECTING FAECAL SAMPLES FOR FAECAL EGG COUNTS

EQUIPMENT AND SUPPLIES:

- Ziploc or sealable sandwich bags
- Ice packs and styrofoam cooler if need to ship to lab
- Disposable gloves and lubricant (if taking samples from the rectum)
- Sharpie black pen (for identifying samples)
- Form on which to record: date samples collected; from which group of animals; from which pasture; age of animals samples; total number of individual samples collected

SAMPLE COLLECTION

- Collect 8-10g fecal samples (for lambs or kids 10 to 15 fecal pellets and from adults, 6 to 8 fecal pellets) from each of 10 to 15 different animals that are representative of their group (e.g. nursing lambs; weaned kids; pregnant ewes) or pasture.
- Don't mix samples from different groups or pastures.
- The simplest way to collect samples is from the ground. Close the animals in a clean pen or crowd into a clean corner of the pasture, leave them for 15 minutes, release the group and then collect the feces from the ground.

- You can also purposely collect from specific animals. The best way is to put on a glove, use a small amount of lube and using 1 finger in the rectum, tease out the faecal pellets.
- To be sure samples from the ground are fresh; they should be warm and moist. Old samples will give a false negative result as the eggs may have hatched and so won't be visible under the microscope.
- You do not need to keep track of who shed the feces, but if you are interested in individual egg counts, you may do so.

SAMPLE SUBMISSION

Once you have collected the samples in separate Ziploc bags, place them in the Styrofoam boxes, put in the ice-packs, and fill in the records. Deliver the samples to your veterinary clinic while still chilled. If kept cool, the samples are good for a few days but room temperature will allow the eggs to hatch. The samples can be processed either by your veterinarian or they may be sent to the Animal Health Laboratory, University of Guelph (Ontario producers) for analysis via courier through your veterinarian. Although individual samples are collected, request that samples be "pooled" for analysis. One pooled result per group of animals (e.g. production group, pasture etc).

2. MCMASTER COUNTING TECHNIQUE

PRINCIPLE:

The McMaster counting technique is a quantitative technique to determine the number of eggs present per gram of feces (epg). A flotation fluid is used to separate eggs from fecal material in a counting chamber (McMaster) with two compartments. The technique described below will detect 50 or more epg of feces.

APPLICATION:

This technique can be used to provide a quantitative estimate of egg output for nematodes, cestodes and coccidia.

EQUIPMENT:

- Beakers or plastic containers
- Balance
- A tea strainer or cheesecloth
- Measuring cylinder
- Stirring device (tongue depressor)
- Pasteur pipettes and (rubber) teats
- Flotation fluid (e.g. salt/sugar solution: 400 g NaCl + 1000 ml water + 500 g sugar (fluid specific gravity = 1.280)
- McMaster counting chamber
- Microscope

PROCEDURE:

- Weigh 4 g of feces and place into Container 1.
- Add 56 ml of flotation fluid.
- Mix (stir) the contents thoroughly with a stirring device (tongue depressor).
- Filter the fecal suspension through a tea strainer or a double layer of cheesecloth into Container 2.
- While stirring the filtrate in Container 2, take a sub-sample with a Pasteur pipette.
- Fill both sides of the McMaster counting chamber with the sub-sample.
- Allow the counting chamber to stand for 5 minutes (this is important).
- Examine the sub-sample of the filtrate under a microscope at 10 x 10 magnification.
- Count all eggs and coccidia oocysts within the engraved area of both chambers.
- The number of eggs per gram of feces can be calculated as follows: Add the egg counts of the two chambers together. Multiply the total by 50 to give the epg of feces. (Example: 12 eggs seen in chamber 1 and 15 eggs seen in chamber 2 = (12 + 15) x 50 = 1350 epg).

Source: Hansen, J. and Perry, B (1994) The epidemiology, diagnosis and control of helminth parasites of ruminants. International Laboratory for Research on Animal Diseases, P.O. Box 30709, Nairobi, Kenya, pp. 171.

5 STAR WORM PLAN PASTURE USE PLANNING SHEET - 20_____

Use this form to track pasture use, results of parasite management of animals. This form is to help you plan pasture use in order to minimize contamination of the pasture with parasite eggs and exposure of livestock to infective parasite larvae.

Pasture	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FEC												
FAMACHA												
DRENCH												

Record Grazing Details: e.g. species (e.g. sheep, goats, cattle etc), age of animals, number of animals, production stage

Record Pasture Management Details: e.g. resting (no livestock); hay making; seeding; spreading manure; strip grazing

Adapted from A Handbook of Sustainable Worm Management for Livestock Farms

4. RECORD FOR FAECAL EGG COUNT MONITORING

5 STAR WORM PLAN
FAECAL EGG COUNT RECORD

Date Sampled	Pasture History	Species / Class	Age / Weight	Date Last Dewormed	RESULTS			Comments
					GIN epg Mean (range)	Coccida opg Mean (range)	Other	