Managing Haemonchosis in Sheep and Goats

Eva M. Wray, Ph.D.
Post Doctoral Fellow

Chris Tucker, Ph.D.
Program Associate – Animal Science

Dr. Jeremy Powell
Professor – Animal Science

Introduction

Internal parasites are arguably the biggest consideration when raising small ruminants (sheep and goats) and can lead to huge economic losses. Small ruminants are readily infected by several different parasitic worms, but far and away the biggest concern is the blood-eating nematode, *Haemonchus contortus* (barber pole worm). *Haemonchus* infections can cause severe anemia and protein loss, which can lead to economic losses such as lowered milk production, poor weight gains, substandard wool quality, and sudden death in animals of all production stages. The general failure of dewormers (anthelmintics) against *Haemonchus* should be forefront in a producer's mind when choosing a chemical control, and an integrated management approach should be used for parasite control. Fecal egg counts should be conducted on a regular basis to determine both parasite burden levels and dewormer effectiveness. Intensive pasture and grazing management strategies should be implemented to curb parasite pressure from pastures. Culling animals that carry consistently heavy parasite burdens and exhibit clinical signs is recommended. The methods used to control internal parasites in small ruminants should be tailored to individual production situations as each operation is unique regarding burden severity and anthelmintic resistance status. Parasite control begins with understanding the life cycle of target parasites, identifying key parasitic behaviors (such as seasonal life cycle changes), and implementing targeted management controls.

Haemonchus contortus

Haemonchus contortus is a voracious, blood-eating nematode (parasitic roundworm) that affects small ruminants and is found in the abomasum. The abomasum, also called the 'true stomach', is an important site for protein digestion. *Haemonchus* is extremely reproductive, with females laying up to 5,000 eggs in a single day, which can lead to pastures quickly becoming heavily parasitized. A severe infection can result in significant and rapid blood loss, often leading to animals becoming severely compromised and anemic within a few days. This is especially true if animals are not closely monitored, as initial signs may not be easily recognized by the casual observer. Pathological damage sustained by the animals is unseen by the producer; therefore, frequent health assessments of animals should be established for functional control of haemonchosis. The clinical (visual) signs of haemonchosis include swelling of the lower jaw (bottle jaw), pale mucus membranes (eyelids, gums), weight loss, poor milk yields, pot-belly appearance in lambs, poor body condition, poor hair coat, generally reduced thriftiness and activity, poor appetite, significantly

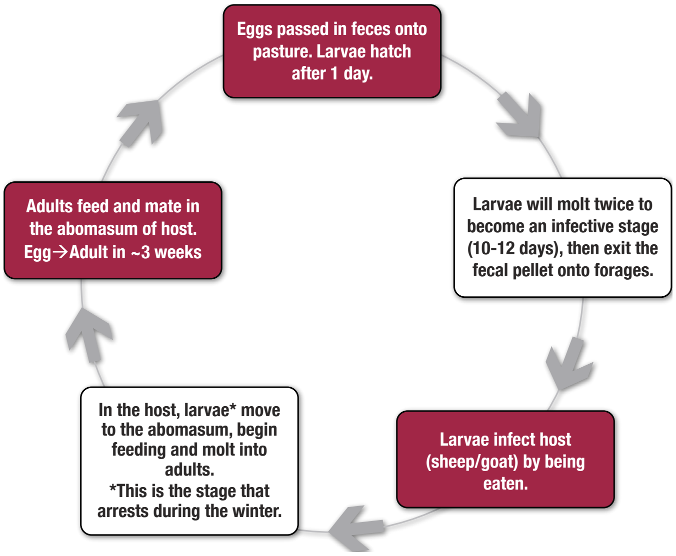


Figure 1. Generalized life cycle of ***Haemonchus contortus.***

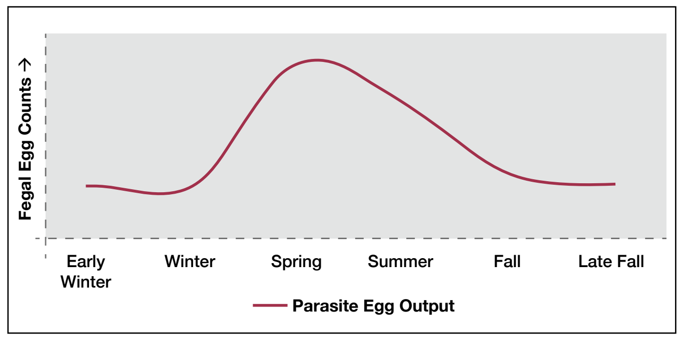
reduced growth in lambs and sudden death. Lambs and lactating females are most susceptible to acute infections, but *Haemonchus* readily causes injury and loss to all ages of small ruminants.

The life cycle for *Haemonchus* is show in Figure 1. In short, the eggs are expelled from the host into the environment encased in the fecal pellets. After about a day, a larva hatches from the egg, then undergoes two molts to become infective (10-14 days); this all occurs within the fecal pellet. Once infective, the nematode larva exits the fecal pellet onto the grass, migrating up and down the blade with the dew until it is consumed by the sheep or goat during grazing. It then moves to the abomasum and begins feeding on the animal; it then molts to become an adult. Both larval and adult stages of the parasite consume blood. This whole process generally takes about 21 days for completion, though this period can be altered by environmental conditions (moisture, temperature).

Figure 2. Inhibited *Haemonchus contortus* larvae in abomasum of sheep.

Haemonchus is most prevalent in regions with a hot, humid environment, though it is increasingly found in cooler areas. *Haemonchus* undergoes a seasonal life cycle arrestment (a physiological state similar to hibernation) during the harsh winter months. When the environmental conditions become adverse in the winter, *Haemonchus* larvae will penetrate the wall of the abomasum and enter a hypobiotic, arrested state (Figure 2). Here, they will remain until weather becomes favorable in the early spring, at which time the encysted larvae emerge from the abomasum wall. The exiting larvae create lesions and begin to eat blood; animals then have higher protein and other nutritional requirements to compensate for both blood loss and tissue healing. This larval emergence in the spring, called 'Spring Rise,' occurs in both male and female small ruminants (Figure 3).

Figure 3. Spring rise exhibited by *Haemonchus contortus* in small ruminants.



There is an additional emergence of arrested *Haemonchus* from the abomasum wall that occurs in pregnant females and coincides with birthing season. This emergence, called 'Periparturient Rise', restarts the halted life cycle when new hosts become available. The output of *Haemonchus* eggs is directly correlated with the number of offspring a dam delivers; dams that birth multiple offspring have higher egg counts than dams that birth single or stillborn offspring (Figure 4). Spring Rise and Periparturient Rise occur simultaneously in lactating females (Figure 5), resulting in not only a physiologically taxing situation for the animals, but also it leads to pastures becoming heavily contaminated in a relatively short period of time. Heavy parasite burdens are also common in the late summer since pasture contamination continues to increase as the worm burdens in the animals increase.

Haemonchus contortus has exhibited resistance to anthelmintics on a worldwide scale, and every drug class available met with resistance. Therefore, drugs must not be the sole method used to control haemonchosis. Implementing an integrated approach to managing haemonchosis is key to a successful small ruminant operation.

Figure 4. Periparturient rise exhibited by *Haemonchus contortus* in small ruminants.

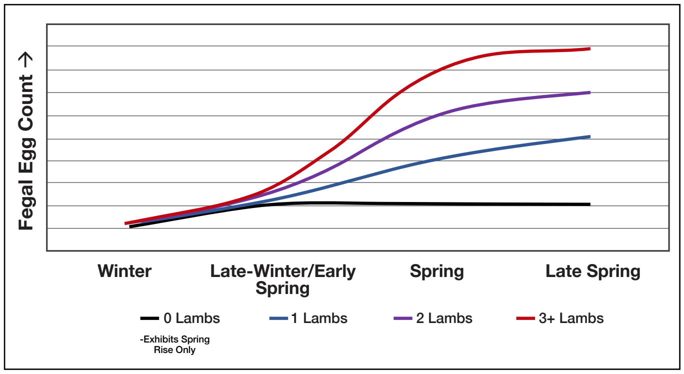
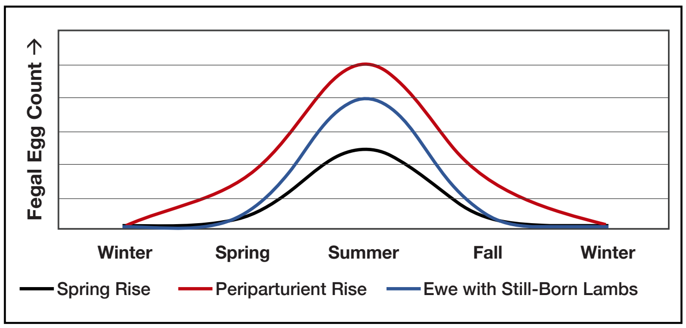


Figure 5. Spring rise and periparturient rise exhibited by *Haemonchus contortus* in small ruminants.



Surveillance and Diagnosis

Haemonchosis is diagnosed by either conducting fecal egg counts (FEC) or a postmortem examination. The postmortem examination is typically conducted only after an animal dies naturally. FEC give a standardized estimation of intestinal parasite burden intensity relative to egg output. In short, intestinal parasite eggs are identified using a microscope and the results are expressed as 'number of parasite **e**ggs **p**er one **g**ram of feces' (epg). Though an estimation, this process remains one of the most efficient and affordable methods to diagnose intestinal parasitisms in small ruminants. On a typical operation, 20% of a flock/herd will harbor 80% of the total parasite population, and FEC can help producers identify that 20% for treatment or culling. Individual FEC will provide the most accurate information; however, collecting fecal samples from 10-20% of a group that is housed or managed together will also allow producers to surveil parasite burdens based on the entire group. Group FEC are less accurate than at the individual level, but still produce valuable information that can be utilized by the producer.

FEC are also a valuable tool to help producers save money on dewormers that are no longer effective on their operations. The common failure of dewormers against *Haemonchus* creates a situation where producers can no longer be confident that a drug is still effective on their operation in the absence of parasitic surveillance. Every time a dewormer is administered, its effectiveness should be measured using FEC. Testing dewormer effectiveness, called a Fecal Egg Count Reduction Test (FECRT), can save producers money and help identify anthelmintic resistance. The instructions for a FECRT are below:

1. Collect fecal sample just before dewormer is administered. Conduct FEC on fecal sample (day 0).
2. 14 days after treatment, collect another fecal sample from the same animal(s) dewormed on day 0. Conduct FEC on fecal sample (day 14).
3. Calculate the %FECR:

$$\frac{(\text{Day 0 FEC})-(\text{Day 14 FEC})}{\text{Day 0 FEC}} \; x \; 100\%$$

FEC for small ruminants can be conducted in the lab or on site using the Modified McMaster Fecal Egg Counting technique. The producer, rather than a laboratory technician, can use a McMaster slide to conduct FEC on site, reducing the timeframe for results and the overall costs for internal parasite evaluations. It is important to use the same individual or lab for both pre- and post-treatment samples when conducting a FECRT to ensure uniformity in data.

Chemical Controls

The common failure of anthelmintics makes protecting the effectiveness of dewormers in small ruminants essential to a sustainable parasite control program. The level of drug resistance on an operation is unique and dependent on many things, such as frequency of dewormer usage, product selection, climate and certain management factors. Every time a dewormer is used on an operation, resistance increases, making targeted selective treatments fundamentally important. Targeted treatments can be implemented by conducting FEC to identify individual animals that might require treatment. Confirmation of parasite burdens using FEC, as well as FAMACHA scores, body condition scores and overall production status, should always precede giving a dewormer. This treatment check point system will help prolong the effectiveness of the few drugs available to producers.

Targeted, selective treatments also promote a wide refugia. Refugia is the population of parasites both in the animals and the environment that have not been exposed to a particular dewormer. When an animal is given a dewormer, all the internal parasites that survive the treatment are resistant to that dewormer and distribute resistant eggs onto the pasture, increasing drug resistance on that operation. Having a wide refugia results in a large proportion of parasites that might be susceptible to said dewormer, meaning the dewormer is more likely to be effective for future deworming strategies. Maintaining a wide refugia can help delay the development of drug resistance on an operation.

The three main classes of anthelmintics used in Arkansas small ruminants are listed in Table 1. Benzimidazoles, called "white wormers", include the chemicals fenbendazole and albendazole. Though these drugs are indicated for nematodes, *Haemonchus* has shown significant resistance to this class of dewormer. These products should be used in accordance to the manufacturer's recommendations. Macrocyclic lactones consist of two subclasses: avermectin and milbemycin. Avermectin includes the chemical ivermectin and has had significant resistance displayed against it by *Haemonchus*. Milbemycin consists of the drug moxidectin and has been shown to be more effective against *Haemonchus* due to its higher potency and persistent effects. However, producers should be aware that moxidectin will kill ivermectin-resistant *Haemonchus* only for a short time, as side resistance will develop within as few as two grazing seasons if used indiscriminately. The third class, imidazothiazole, includes the chemical levamisole. Though levamisole has shown to be effective against *Haemonchus*, use of this chemical should be limited due to the increasing rate of resistance being exhibited. It should also be noted that levamisole given at too high a dosage can result in toxicity and even death. Producers should always weigh animals (either with scales or weight tape) to acquire the proper dosage before administering a dewormer. It is strongly recommended that only oral dewormers should be used in small ruminants. Not all available dewormers are labeled for both sheep and goats, so extra-label usage might be required, resulting in a need for producers to consult with their veterinarian. Dewormers should not be used indiscriminately in the absence of treatment confirmations using a comprehensive check point system (FEC, FAMACHA scores, body condition, overall performance, clinical signs).

Copper Oxide Wire Particle Bolus

With the widespread anthelmintic resistance displayed by *Haemonchus*, producers must look to non-chemical means of control. Copper oxide wire particles (COWP) are small pieces of copper oxide that can be mixed in the feed or put into a gelatin capsule and have shown to be effective against *Haemonchus*. However, COWP are only effective against the parasites that are in the abomasum at the time of administration, and they do not produce a lingering protection against incoming larvae. COWP can be used in place of, or in conjunction with, a chemical dewormer, though precautions must

Table 1. Anthelmintics indicated for small ruminants available in Arkansas.

Chemical Class	Active Ingredient	Trade Name	Formulation	Species Indication	Meat Withdrawal*	Milk Withdrawal*
BNZ	Fenbendazole	Safe-Guard®	Paste Suspension Feed Block Mineral Pellets	Goats	16 days (suspension only)	4 days (suspension only)
BNZ	Albendazole	Valbazen®	Paste Suspension	Sheep Goats	Sheep: 7 days Goats: 9 days	7 days
ML/AVM	Ivermectin	Ivomec®	Oral Drench	Sheep	Sheep: 11 days Goats: 14 days	8 days
ML/MLB	Moxidectin	Cydectin®	Oral Drench	Sheep	Sheep: 14 days Goats: 17 days	8 days
IMD	Levamisole	Prohibit®	Soluble Drench Powder	Sheep	Sheep: 3 days Goats: 4 days	3 days

*Withdrawal periods are indicated for the labeled dosages. If a product is used at a different dosage than listed on the label, a veterinarian should be consulted, and withdrawal times must be adjusted.

BNZ= Benzimidazole ML/AVM= Macrocyclic Lactone, Avermectin ML/MLB= Macrocyclic Lactone, Milbemycin IMD= Imidazothiazole be taken. Although copper oxide is less bioavailable than copper sulfate, sheep are copper-sensitive animals, and too high and too frequent doses of COWP could possibly lead to copper toxicity. Low doses of COWP are recommended: lambs/kids under 8 months old can receive 0.5-gram boluses, and adult sheep/goats can receive 1- to 2-gram boluses, administered every 6 weeks.

FAMACHA Scoring

FAMACHA (Faffa-Malan Chart) is a diagnostic anemia-ranking system that was developed to assess the blood loss caused by *Haemonchus* using the conjunctiva of the eye. FAMACHA scoring can be a very valuable tool in a parasite control program if used frequently and consistently. However, because other medical conditions can lead to anemia, producers should apply the treatment check point system and compare FEC, FAMACHA scores, body condition scores and overall production assessments (milking, growth rate, etc.) before determining the validity of a deworming treatment.

Treatment Parameters and Considerations

The decision to administer a deworming treatment to a sheep or goat should involve a comprehensive assessment of the animal, utilizing every tool available. The FEC economic threshold does not have a definitive range due to the variation between individual animals, though an epg of 1,000+ should be an indication that the animal should be closely monitored. Animals with a high FEC should be thoroughly evaluated by conducting FAMACHA and body condition scores, assessing the overall production output exhibited (weight gains, milk production, etc.) and examining the general appearance of the animal. A comprehensive assessment to determine a deworming treatment is essential, as some breeds and individuals can routinely carry heavy parasite burdens but have the physiological capability to demonstrate proper growth and production.

Pasture Management

Pasture management is a fundamental aspect in breaking the life cycle of parasites, as parasite larvae can survive on pasture for extended periods of time. Infective *Haemonchus* larvae can migrate up to 6 inches on forages with the dew, with the bottom 3 inches containing the highest concentrations. Grazing at heights above 4 inches will help to reduce reinfections from pastures. Some pasture management strategies, such as rotational grazing, can reduce the parasite pressure from pastures (re: reduce reinfection rates). Rotational grazing allows producers to control grazing height and consistency by blocking off smaller sections of a large pasture, then rotating grazing animals on a schedule. Grazing different species together (mixed grazing or co-species grazing) can also help to reduce parasite pressure from pasture; each of these species acts as a dead-end host for the other species' parasites. Alternatively, dry lotting an animal will reduce the reinfection rate of *Haemonchus*, though producers must be mindful of keeping the ground clean of soiled hay and grain.

Implementing tannin-rich legume forages can also be a means of parasite management. Tannins have been shown to help suppress internal parasites, though it must be continuously fed to be effective. Some tannin-rich forages include Sericea lespedeza, birdsfoot trefoil, sainfoin and purple prairie clover.

Rainfall and heavy dew can also influence the parasite pressure from pastures. High moisture content will allow the infective parasite larvae to travel much greater distances in all directions than in dry conditions, resulting in a larger area of contaminated pasture. Spring and fall forage growth is typically associated with heavy dew in Arkansas, and typically this is when high reinfection rates will occur. However, it is not uncommon to have heavily contaminated pastures during the summer months, so proper year-round pasture management is essential for a functional parasite control program.

Additionally, Bioworma (*Duddingtonia flagrans*), a nematode-eating fungus, can be fed daily by top-dressing grain or corn. The fungal spores are consumed by the animal and passed on pasture with feces. Inside the fecal pellet, the fungus consumes the nematode larvae before it can reach the infective stage. Over time, if fed properly and consistently, the overall infective larvae on an operation can be greatly reduced. It should be noted that Bioworma does nothing to the worm populations inside the host animal; it affects only the populations on pasture.

Developing a Parasite-Tolerant Flock/Herd

A producer can develop a parasite-tolerant flock/herd with strategic and planned management. One strategy is using breeds known to have a genetic tolerance to parasites. Sheep breeds such as Katahdin, Barbados Blackbelly, St. Croix and Gulf Coast Native, and goat breeds such as Spanish, Kiki and Myotonic, as well as some of their composite or crossbreeds, have been shown to improve parasite tolerance. However, just as there are breed differences in the way that small ruminants handle parasite burdens, there are also individual differences. As previously mentioned, 20% of the population will harbor 80% of the intestinal parasites (the 20:80 rule). Again, identifying and culling these animals with the heaviest parasite burdens through FEC will offload much of the worm problem. Culling the animals that consistently carry high FEC and exhibit clinical signs can also lead to parasite-tolerant genetics in flocks and herds, as the remaining animals will be able to physiologically manage *Haemonchus*, further leading to a parasite-tolerant flock/herd.

Nutrition and stress also play a large role in immune competency and the tolerance of parasites in small ruminants. Having proper nutrition—adequate energy, protein, minerals and fresh water—promotes a healthy immune system, which can lead to lower parasite burdens. Stressed animals will have a suppressed immune system and will carry heavier parasite loads than animals not exposed to stressful situations.

Developing an Effective Parasite Control Program

When developing a successful parasite control program, small ruminant producers should use every tool and management practice applicable to their own, unique operation. The implementation of FEC will allow producers to see what is going on inside of the animal, assess the effectiveness of dewormers and identify animals that carry heavy, clinical parasite burdens. FEC can also help identify parasite-tolerant gene pools and keep replacement ewes/does whose parents have exhibited a physical tolerance for their parasite burdens. Using different grazing strategies and applying intensive pasture management will help to reduce the parasitic pressure received from pastures. Deworming treatments targeted at specific, individual animals will delay the resistance-status of an operation and prolong the life of the dewormers. Limiting new animal introductions, especially animals acquired without a known deworming history, will help producers manage the parasite populations without an influx of new populations of parasites. Another important part of a successful parasite control program is a close association with your local veterinarian and/or cooperative extension agent, who can offer more information about what methods work most effectively on individual operations. It is vital for sheep and goat producers to utilize multiple strategies for the control of *Haemonchus*.

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EVA M. WRAY is a post doctoral fellow with the Dale Bumpers College of Agricultural, Food and Life Sciences. **CHRISTOPHER TUCKER** is a program associate - animal science the University of Arkansas System Division of Agriculture Cooperative Extension. **JEREMY POWELL** is a professor - animal science with the University of Arkansas System Division of Agriculture Cooperative Extension.

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