Long-time sheep and goat producers can readily list all the standard parasite control measures they have been taught over the years:

- Deworm when fecal examinations are positive
- Deworm all animals at the same time
- Place animals onto a clean pasture after deworming
- Deworm regularly
- Rotate dewormers

Unfortunately, these practices and other factors have contributed to the development of parasite resistance to dewormers. Indeed, in some areas of the south, producers have no effective dewormers and cannot raise sheep and goats without extreme losses to parasites; the common name for a major intestinal parasite—“the bankrupt worm”—has become all too true for them.

**Small Ruminant Public Enemy #1**

*Haemonchus contortus*, commonly known as the barber pole worm, is responsible for most losses from small ruminant nematode (roundworm) parasitism. Other common nematodes of sheep and goats are listed in Table 1. Figure 1 depicts the life cycle of *H. contortus*. Note that eggs are shed in fecal pellets and several larval molts are required before the parasite reaches the infective L-3 stage. Photo 1 illustrated L-3 larvae suspended in dew on a blade of grass, awaiting ingestion by a host.

**Table 1. Common nematodes (roundworms) of sheep and goats.**

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemonchus contortus</td>
<td>Barber pole worm</td>
<td>Abomasum</td>
</tr>
<tr>
<td>Marshallagia marshalli</td>
<td>-</td>
<td>Abomasum</td>
</tr>
<tr>
<td>Ostertagia spp (species)</td>
<td>Brown stomach worm</td>
<td>Abomasum</td>
</tr>
<tr>
<td>Trichostrongylus axei and spp</td>
<td>Small stomach worm/stomach hairworm</td>
<td>Abomasum</td>
</tr>
<tr>
<td>Bunostomum trigonochephalum</td>
<td>Hookworm</td>
<td>Small intestine</td>
</tr>
<tr>
<td>Capillaria spp.</td>
<td>-</td>
<td>Small intestine</td>
</tr>
<tr>
<td>Cooperia spp.</td>
<td>Intestinal worm</td>
<td>Small intestine</td>
</tr>
<tr>
<td>Nematodirus spp.</td>
<td>Thread-necked worm</td>
<td>Small intestine</td>
</tr>
<tr>
<td>Strongyloides papillosus</td>
<td>Intestinal threadworm</td>
<td>Small intestine</td>
</tr>
<tr>
<td>Trichostrongylus colubriformis</td>
<td>Bankrupt worm / black scour worm</td>
<td>Small intestine</td>
</tr>
<tr>
<td>Ascaris suum</td>
<td>Hog roundworm</td>
<td>Bile ducts</td>
</tr>
<tr>
<td>Chabertia ovina</td>
<td>-</td>
<td>Large intestine</td>
</tr>
<tr>
<td>Skrabinema ovis</td>
<td>Pinworm</td>
<td>Large intestine</td>
</tr>
<tr>
<td>Oesophagostomum venulosum</td>
<td>-</td>
<td>Large intestine</td>
</tr>
<tr>
<td>Trichuris spp.</td>
<td>Whipworm</td>
<td>Large intestine</td>
</tr>
</tbody>
</table>
An organization called the American Consortium for Small Ruminant Parasite Control (ACSRPC) is devoted to addressing the problem of parasite resistance to dewormers. Their research with copper particles and certain condensed tannin-containing plants shows promise as potential non-chemical parasite control measures. Nevertheless, producers still rely heavily on anthelmintics (dewormers). Dr. Des Hennessy of Australia coined the term “Smart Drenching” (deworming) to describe selective treatment of certain animals and the ACSRPC advocates this approach.

The goal of Smart Drenching is to maintain animal health and production while decreasing the rate of development of parasite resistance to anthelmintics. Smart Drenching encourages producers to used dewormers selectively, judiciously and effectively.

The Smart Drenching System
1. Identify which dewormers are effective on your farm. This is done by pre- and post-treatment fecal egg counts (see Reference #6 below for the procedure) or submitting fecal samples to Dr. Ray Kaplan’s laboratory at the University of Georgia’s College of Veterinary Medicine for “DrenchRite” laboratory diagnosis of resistance. Resistance is defined as less than 95% reduction in fecal egg counts post-treatment.
2. Weigh each animal to be treated and administer the correct amount of dewormer to each animal. Be sure to administer the entire dose over the animal's tongue and to the back of its throat. Consult with your veterinarian when treating goats because extra-label dosages are usually recommended.

3. Use dewormers from two different classes if resistance is suspected on the farm. See Table 2 for a list of dewormer classes.

4. Hold animals to be wormed off feed for 12-24 hours before treating with benzimidazoles (Fenbendazole and Albendazole). This slows the digestive processes, allowing the dewormer to remain in the animal's body longer for increased effectiveness. Do NOT hold pregnant ewes or does off feed in late gestation. Benzimidazole effectiveness will be greatly enhanced if the animal is re-dosed in 12 hours.

5. ONLY DEWORM ANIMALS THAT NEED TREATMENT. Use the FAMACHA® system (described below) to assess animals with clinical anemia due to Haemonchus contortus. For other parasites, base treatment on body condition, age (parasitism is a larger concern in younger animals), fecal egg count, performance/production, pregnancy/lactation status (these dams are under higher stress and have reduced immunity), signs of illness and short-term weight gain.

The benefits of Smart Drenching are threefold: fewer animals are dewormed, so costs are reduced; there is less pressure on parasites to develop resistance; and more parasites in the “refugia” remain susceptible to dewormers. Refugia is the portion of the parasite population not subjected to dewormers and therefore not under pressure to develop resistance; it includes parasites in untreated animals as well as eggs and larvae on pasture. According to Dr. Kaplan, the refugia provides a pool of sensitive genes that dilutes resistant genes selected for by deworming. Figure 2 is a graphic depiction of the selection for drug resistance.

The FAMACHA® System

The FAMACHA® System originated in South Africa. It is a method of identifying individual sheep and goats that are heavily parasitized, based on physical evidence of anemia caused by Haemonchus contortus. A colored chart (see Figure 3) is placed next to an animal's conjunctiva (pinkish tissue inside the lower eyelid) to assess each animal's level of anemia. A scale of one to five is used; a score of one is the reddest and healthiest and a score of five is palest and most anemic. Animals with scores of four and five should be treated or culled; those with scores of one or two do not need treatment; various factors will help a producer decide whether or not to treat those with a score of three.

This system helps producers identify the parasites equivalents of “Typhoid Mary” in their herds: 20% of animals harbor 80% of the herd's worms and are responsible for the majority of environmental contamination with worm eggs. The FAMACHA® System helps identify heavily-parasitized individuals so producers can make appropriate management decisions (treat or cull). From an animal welfare standpoint, animals in need of treatment should be treated, but then owners should decide whether or not to retain and continue breeding these less resilient animals. Retaining only animals that
require no or rare treatment should greatly decrease the need to deworm individuals in this herd in the future.

**Parasite Control through Management**

Non-chemical parasite control measures will become even more important as resistance to dewormers grows; it is also essential for organic livestock enterprises. Here are some key practices that can help producers reduce the need for chemical deworming:

1. Never graze pastures below three inches. Infective parasitic larvae live in water droplets on pasture plants and 90% are found in the lower three inches of forage. The only way sheep and goats increase their load of intestinal nematodes is to eat infective larvae on pasture, so reduce this risk.
2. For similar reasons, try not to let animals graze on wet pastures.
3. Rotate pastures and allow as much rest time as possible between re-grazing—at least six weeks; six months is much more effective in ensuring larval death.
4. If possible, practice multi-species grazing. Only a few parasites are transmissible between species, so following sheep or goats with horses, for example, will help reduce the number of small ruminant parasites on pastures.
5. Do not overstock animals—never graze more that six to eight small ruminants per acre of irrigated pasture. Overstocking increases the likelihood that animals will overgraze and encounter infective larvae; it also stresses them and reduces immunity.
6. Select for animals that are healthy and resilient despite parasite infections; cull individuals that require repeated deworming to survive. Even better: select for resistant animals—those that are healthy and productive despite exposure to parasites (resilient) and have low fecal egg counts (resistant).
7. Do not feed animals directly on the ground.
8. Protect feed troughs, water sources and trace-mineral salt feeders from manure contamination.
9. Provide as much browse as possible for goats.
10. Support animals’ immune systems by minimizing stress and providing excellent nutrition, including trace minerals. A diet that provides 120% of recommended daily protein requirements can help animals be more resilient to the effects of parasitism.

**If You Must Deworm**

Clinically-affected animals must be treated or euthanized for humanitarian reasons. These animals must be treated, but they don’t have to be kept, especially for breeding. Wait for the meat and milk withholding period to pass and make a decision to sell, cull, or eat this animal (the latter would be best for the benefit of the species). If animals need to be dewormed more than once a year, do not keep them or their offspring. By selecting for resistant and resilient animals, you will create a herd that should only need occasional deworming of individual animals. Frequent monitoring of all animals for signs of parasitism will always be required, however.

Know what dewormers are effective in your herd or flock (see Step 1 of Smart Drenching above). Another recommendation is to confine and deworm herd/flock
additions with a dewormer from each of the three major classes simultaneously; drylot these new animals on dirt, gravel or concrete and conduct a fecal egg count 10 to 14 days after deworming. Do not allow access to pastures and the rest of the herd/flock unless fecal egg counts are zero. Better yet: keep a closed herd and avoid importing problems. The objective here is to avoid importing dewormer resistance when bringing in new animals to the herd.

Some dewormer resistance already exists in the Pacific Northwest. Use dewormers sparingly and intelligently to prolong their effectiveness on your farm. Practice the non-chemical means of parasite control mentioned above to increase the sustainability of your small ruminant flock or herd. Limiting the widespread and routine use of dewormers will reduce the likelihood of complete dewormer failure, keep dewormers effective in herds when they are needed and make small ruminant farms more likely to survive in the long run.

For More Information
1. www.acsrpc.org
2. https://attra.ncat.org/publication.html#livestock:
   - Integrated Parasite Management for Livestock - IP150
   - Managing Internal Parasites in Sheep and Goats - IP293
   - Tools for Managing Internal Parasites in Small Ruminants: Animal Selection - IP400
   - Tools for Managing Internal Parasites in Small Ruminants: Copper Wire Particles -
   - Tools for Managing Internal Parasites in Small Ruminants: Pasture Management -
   - Tools for Managing Internal Parasites in Small Ruminants: Sericea Lespedeza - IP316
6. www.aces.edu/pubs/docs/U/UNP-0006/
7. www.aces.edu/pubs/docs/U/UNP-0078/UNP-0078.pdf?PHPSESSID=0caa21459f41703df80919f2f8c46f71
8. www.sheepandgoat.com (University of Maryland Extension)

Figure 2. Depiction of selection for resistant parasites. Graphic by Dr. Ray Kaplan.
### Anthelmintic (Dewormer) Classes for Nematodes (Roundworms)

<table>
<thead>
<tr>
<th>Class</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzimidazoles</td>
<td>fenbendazole, oxibendazole, albendazole, mebendazole</td>
</tr>
<tr>
<td>Avermectin / Milbemycins</td>
<td>ivermectin, eprinomectin, doramectin, moxidectin, others</td>
</tr>
<tr>
<td>Imidazothiazoles / Tetrahydropyrimidines</td>
<td>levamisole, pyrantel, morantel, others</td>
</tr>
</tbody>
</table>

Table 2. Classes of nematode dewormers.

### Signs of Parasitism

Animals affected by internal parasites can display any or all of these signs:

- Pot belly
- Failure to thrive
- Rough coat
- Diarrhea
- Bottle jaw
- Weakness
- Poor appetite
- Coughing (lungworms)
- Lack of stamina
- Poor production or performance
- Pale mucous membranes
- Death

Figure 3. FAMACHA® chart.