Sustainable Control of Internal Parasites in Small Ruminant Production

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Geographic Applicability:

Humid or wet areas, including the tropical regions of North America and the eastern, midwestern, northwestern, and irrigated pastures of the United States.

Sheep and goat production is a viable enterprise, offering opportunities for marketing meat, fiber, milk, and solar grazing and other ecoservices. Their small size and low cost make them appealing for small farms with limited resources, and they are adaptable to many different production systems. Small ruminants (sheep and goats) can be raised with relatively few inputs, but they face huge production challenges. Control of internal parasites, especially gastrointestinal nematodes including *Haemonchus contortus* (barber pole worm, stomach worm), is a primary concern for many sheep and goat producers and is particularly challenging in warm, humid regions including summer months in much of the U.S. Grazing animals ingest infective larvae from grass and shorter forages. The larvae develop into adults in the abomasum (true stomach) of ruminants. The adult parasites feed on blood in the abomasum and lay their eggs, which are excreted in the ruminants' feces. The life cycle continues when the eggs hatch and larvae develop on pasture, where they can be ingested by the grazing ruminants. The eggs require warmth and moisture to hatch and to move onto the plant, which is why internal parasites are problematic, especially during the summer and in times of rainfall or irrigation.

Internal parasites have become more difficult to manage in small ruminants because of the parasites' increasing resistance to all available chemical dewormers. Parasite problems negatively impact the animals' health, reduce productivity and increase treatment costs. Pastures with heavy stocking rates in high-rainfall regions are especially vulnerable to the buildup of parasites. The cost of internal parasite infection includes treatment expense, reduced animal weight gains and performance, and even animal death.

In response, the American Consortium for Small Ruminant Parasite Control (ACSRPC) was formed. This group of researchers, veterinarians, and Extension educators has worked since 2001 to find practical, research-backed ways to manage internal parasites, improving viability of the sheep and goat industries as a result. The research group got its start thanks to a SARE Planning Grant and has greatly expanded over the years. Currently, the group offers the most current, science-based information and training housed at the website, womx.info. The Consortium has investigated several methods of sustainable gastrointestinal nematode parasite control, including smart drenching (including FAMACHA©), copper oxide wire particles (COWP), condensed tannin-containing plants, specifically sericea lespedeza (*Lespedeza cuneata*), genetic selection of parasite resistant animals, use of parasite-resistant breeds, providing nematode-trapping fungi, and other alternative methods. This fact sheet provides basic information on each approach and cites resources for training and further information. Much more information can be found at https://wormx.info and on the ATTRA site, https://attra.ncat.org.

Smart Drenching

Smart drenching is a method of parasite management that promotes selective use and improvement of the effectiveness of dewormers, most of which are drenches (liquid medications given by mouth). Chemical dewormer use builds resistance within parasite populations over time, so one of the primary goals of Smart Drenching is to balance production needs of the animal with the need to preserve the efficacy of available dewormers for as long as possible, if indeed they are still effective.

Dewormers should only be administered to animals that actually need treatment. Identifying these animals easily and correctly can be problematic, but the FAMACHA© system (see next section) can dramatically improve this process when *H. contortus* is the primary parasite. Because there are other parasites, diagnosis should include other methods in addition to the FAMACHA system. See discussion below of the Five Point Check.

The following Smart Drenching techniques should be used when administering dewormers:

- Identify which dewormers will work on your farm by performing a fecal egg count reduction test
  HOW to do a Fecal Egg Count Reduction Test: put this in a box with the instructions below: fecal egg count reduction tests can be performed by veterinarians or experienced producers. Briefly, pooled or individual fecal samples are collected before animals are treated with a dewormer and samples are taken again 12-14 days following the treatment. The fecal egg counts (a measure of infection) are

determined on the two sets of samples which are then compared. These can be submitted to a diagnostic lab (see www.wormx.info/lowcostfec or another veterinary diagnostic laboratory (more expensive) to determine fecal egg counts. At each collection, fresh fecal samples equally representing at least 10 animals should be placed in a plastic bag with air removed. Insulate with newspaper and ship with an ice pack overnight. It is okay to store the first fecal sample in the refrigerator – never frozen – and ship with the second sample. It is best to ship samples on a Monday so that they arrive in the lab well before the weekend and are not left in a warehouse over the weekend. If the samples get warm, the eggs will hatch and the counts will not be true.

By comparing the fecal egg counts prior to and following treatment of the animals, producers can see how effective the deworming treatment was. An effective treatment should reduce the fecal egg count by 95%.

- Resources to assist producers with fecal egg count reduction and smart drenching or use of dewormers:
    - Smart Drenching and FAMACHA© manual https://www.fvsu.edu/content/userfiles/files/2023/02/SCSRPC_Manual.pdf
    - Proper use of Dewormers: go to https://wormx.info and click on "Resources" and then "Best Management Practices" and select "12. Proper use of dewormers"
    - Dewormer resistance (or how to know if you have dewormer resistance): go to https://wormx.iinfo and click on "Topics" and then "Drug resistance", under Factsheets, select "Managing Dewormer Resistance".
- Deliver the proper dose of dewormer to each animal. This will require knowing each animal's weight. It is important to note that sheep and goats require different dosages of dewormers. Goats need 1.5 to 2 times the dose recommended for sheep depending on the dewormer used. Consult your veterinarian and ACSRPC recommendations for more specifics: go to https://wormx.info and click on "Topics" and then "Deworming" to find handy dewormer charts for sheep, goats, and camelids. Withhold feed (except for late pregnant/lactating ewes/does and young lambs or very sick animals) 12 to 24 hours prior to drenching with benzimidazoles (white dewormers such as fenbendazole and albendazole), ivermectin, doramectin and moxidectin. Benzimidazole efficacy may be enhanced by repeating the drench 12 hours after the first dose. Consult your veterinarian or the package label for more specifics regarding proper dosage.
- Deliver the dewormer over the tongue in the back of the throat with a drench tip or drench gun.

- Drench only the animals that need treatment, as described in the FAMACHA© section below. This reduces dewormer use and cost. Most importantly, untreated animals harbor worms that will stay more vulnerable to dewormers, prolonging dewormers' effectiveness.

Smart drenching also includes recommendations for stopping the parasite life cycle through pasture management, a vital component of an animal management system designed to reduce parasite problems. To ensure good pasture management:

- Maintain forage height of at least 4 inches. Most parasite larvae migrate in water droplets on grass, but usually to heights no greater than 3 inches. When grazing cool-season forages, such as fescue or orchardgrass, move animals to a new paddock or section when the forage stubble height reaches 3 to 4 inches. This promotes faster regrowth. Also, maintaining grass at a greater height will provide forage above the infected zone, and thereby reduce the number of parasite larvae ingested by grazing animals. Contact your nearest Cooperative Extension office or Natural Resources Conservation Service (NRCS) office for advice on grazing management.
- Move sheep or goats off the pasture before the eggs can hatch and become infective larvae to avoid increasing the infection load in the animal. In the summer, this can happen as quickly as four days. A study in Arkansas showed that rotating once or twice a week and returning to same pasture 28 to 35 days later was enough to reduce the amount of deworming required in lambs compared with continuous grazing.
- Remove small ruminants from pastures for 3 to 6 months to allow worm larvae on pasture to die off. This recommendation may not be feasible or practical under certain circumstances and will have to be balanced against available resources and forage quality.
- Cut grass for hay on heavily contaminated pastures to reduce the parasite population in the pasture. The hay will be safe to feed because the larvae will not survive the haying process.
- Plant winter and summer annual forages in a prepared (tilled or disked) seedbed to break the worm cycle and drastically reduce the worms' population on the pasture.
- Alternate or co-graze pastures with horses or adult cattle, as these may not be affected by sheep and goat parasites. They may serve as dead-end hosts for the parasites, lowering the parasite population on the pasture.
- Maintain appropriate stocking rates for the pasture. High stocking rates will ultimately increase parasite loads on the pasture.

- Avoid over-grazing, which forces animals to feed close to the soil, where worm larvae live.
- Allow goats to browse upright plants rather than grasses, as goats are especially vulnerable to re-infection through close-to-the-ground grazing.
- Consider use of a nematode-trapping fungus fed to highly susceptible animals (pregnant/lactating or young lambs/kids) to reduce infective larvae on pasture as described below.

Many other pasture management techniques can be used to reduce parasite problems. For more information see https://www.wormx.info/pasturemanagement. And see the Best Management Practices series (https://www.wormx.info/bmps) for titles on management, nutrition, and grazing management, as well as the ATTRA publication, "Grazing to Avoid Parasites".

FAMACHA©

FAMACHA© was developed in South Africa as a method of identifying sheep and goats heavily infected with *Haemonchus contortus* (barberpole worm), a blood feeder that causes anemia. FAMACHA© involves examining the color of the inside of the lower eyelid, which can indicate anemia and thus the presence of *H. contortus*.

FAMACHA© uses a color chart that shows five consecutive grades of goat or sheep eyelid pallor, ranging from 1 (red color; not anemic) to 5 (very pale; anemic). The eyelid is compared with the chart, and the animal is scored. Only animals in the palest categories are treated with dewormers.

Only animals that are anemic should be dewormed. Records should be kept to identify chronically wormy animals, which should be culled from the herd. Research has shown that 80 percent of a herd's parasites are carried by 20 percent of the animals. Culling the heavily infested 20 percent will greatly reduce a herd's parasite problem.

Use of FAMACHA© requires training but ultimately decreases the use of dewormers by as much as 90% and allows the producer to identify animals that need frequent deworming. The FAMACHA© system can even be used to select rams or offspring that are parasite resistant and/or resilient, which in turn produce offspring who are also more resistant and resilient.

Tens of thousands of FAMACHA© kits have been distributed to date. FAMACHA© kits are sold to producers only through veterinarians and other trained animal health specialists. Sheep and goat producers may obtain a card when they attend formal FAMACHA© training

workshops, in person or virtual. For more information see “Topics”, select “FAMACHA©” on wormx.info and scroll to “Useful information”.

Using FAMACHA© and culling problem animals:

- strengthens the flock/herd through selection of the most infection-resistant animals for breeding;
- reduces parasite levels on the pasture by culling heavily infected animals;
- slows development of resistance to dewormers by reducing the number of internal parasites exposed to dewormers;
- and saves money by reducing drug expenditures.

The Five Point Check

Because there are other internal parasites that may impact the health of small ruminants (see https://www.wormx.info/otherworms), FAMACHA cannot stand alone. The same researchers who developed the FAMACHA system recognized that fact and have developed additional screening procedures, collectively called the “Five Point Check”, that can be used to quickly decide which animals need to be dewormed. These “Five Points” include:

- the nose, checking for mucus which could indicate nose bots;
- FAMACHA eyes;
- Jaw, looking for presence of an accumulation of fluid called “bottle jaw”, which indicates anemia;
- Body Condition Score (BCS), because thinner animals may be parasitized, or will be less able to battle parasites if their condition is too thin;
- Tail; looking for presence of diarrhea, because some parasites cause loose stools.

Another valuable indicator is the condition of the coat. These indicators, used together, may also tell the producer about the adequacy of nutrition for the flock or herd. For a fuller discussion, see the Consortium publication “Targeted Selective Treatment”, part of the Best Management Practices series on the wormx.info website under “Resources”. Reading the 16 currently available publications in this series will give you a well-rounded view of the problem and how to tackle it; see https://www.wormx.info/bmps.

Copper Oxide Wire Particles

The ACSRPC has investigated the use of low dose (less than 2 grams) copper oxide wire particles (COWP) as a deworming agent for barber pole worm or *Haemonchus contortus*. The goats and sheep on many U.S. farms have experienced complete resistance to other

chemical dewormers, and COWP offers an alternative control method. Another benefit is cost savings—COWP can cost 20 percent or less if using low doses than chemical dewormers. In addition, there may be less fecal egg contamination on pasture. COWP acts like a short-acting dewormer and can be administered alongside a dewormer to increase the efficacy of both products including when a mixed population of worms are present (other worm species in addition to *H. contortus*).

Administration of COWP in small ruminants requires preparation of copper boluses in smaller doses than are currently commercially available. Copper boluses (Copasure® or Ultra Cruz®) are currently sold for use in cattle, goats and sheep by veterinary and animal health suppliers in 2, 4, 12.5-gram and 25-gram doses. Sheep and goats should be given 0.5 or 1 grams if less than one year of age, and 1 to 2 grams for adults. The Copasure® cattle bolus was recently reformulated to a solid mass that can be broken up and placed into gel capsules. Multiple doses of COWP can be given in 4 to 6-week intervals when pasture contamination is high. Animals should receive no more than four (if doses of 0.5 grams or 1 gram are used) or two (if doses of 2 grams are given) COWP boluses in the summer worm season only if no other sources of copper are available to sheep. COWP should be selectively administered similar to a dewormer to minimize development of resistance by the worms.

Smaller gel capsules can be purchased at a local pharmacy, health food store or veterinary supply house, and repackaged to make boluses with the proper dose for your goats or sheep. The prepared boluses can be administered to the animals with a pill gun or the copper particles to individuals mixed in sticky feed (such as when milking goats).

Sheep are particularly susceptible to copper toxicity and misuse, or overdosing may lead to sudden death. Safety of the COWP method is dependent on the amount of copper already in the animals' diet and on the presence of other elements that can increase or decrease the effect of copper. The type of copper used in COWP boluses is poorly absorbed reducing the risk of copper toxicity, especially when using low doses (0.5 to 2 grams), but one must account for other copper sources. Cattle minerals used to supplement diets contain copper, for example. And higher concentrations of copper can be found in some legumes, especially in the midwestern United States and where soil is molybdenum deficient, or when poultry litter is applied to pastures. Check with your local Cooperative Extension office for information on copper levels in your area.

As a rule of thumb, sheep may suffer toxicity at levels above 25 ppm copper in the diet; but the interactions of other minerals will influence this. Goats, on the other hand, require copper levels ranging from 15 to 25 ppm, depending on the class of goat. In addition, goats can safely have access to a free-choice loose mineral containing 1,000 ppm copper. For

more information on using COWP, see https://www.wormx.info/copper-oxide-wire-particles.

With regards to copper administration, the ACSRPC found:

- Low doses of COWP (0.5 grams and 1 gram) are effective treatments in lambs or kids.
- COWP is safe to use in late-pregnant and lactating ewes. A 1 to 2 gram dose is recommended. The dose is not weight dependent.
- Multiple low doses of COWP can be given to lambs in a summer worm season but will increase their level of copper
- The new cattle formulation of solid COWP used at low doses can still reduce fecal egg counts associated with barber pole worms.
- Worms may develop resistance to COWP, so use selectively (described above).

Results have varied across studies, and researchers believe that a disturbance in rumen function somehow interferes with the COWP action. COWP is not always effective, perhaps because problems with digestion interfere with its action as indicated by the fact that COWP works against abomasal barber pole, but not intestinal worms. Research results in this area have varied and COWP action is not fully understood.

Nematode-trapping Fungus

Nematode-trapping fungi have been shown to be efficient against the worm larvae in livestock feces. These fungi are found naturally in environments that are rich in organic matter where they produce a variety of mycelial (vegetative part of the fungus) structures that trap, destroy, and feed on non-parasitic soil worms. A commercial source of these fungi, specifically *Duddingtonia flagrans*, are sold in the U.S. as BioWorma® or Livamol® with BioWorma® currently sold through Premier1 Supplies. Spores of *D. flagrans* spores are fed to livestock, pass through the ruminant gastrointestinal tract intact and deposited in the feces on pasture. Then, *D. flagrans* spores germinate. The mycelia grow rapidly into sticky, sophisticated traps/loops that trap and digest the developing worm larvae. These larvae emerge from worm eggs within the fecal pat alongside the fungus, but because they are trapped and killed by the fungus, they remain in the fecal pat (do not escape to the environment).

The fungus **does not** have any activity on existing worms in the animal or reduce fecal egg counts or improve anemia. Instead, **it reduces the number of infective larvae on pasture**. Improvements may be seen after long-term feeding of the fungus and concomitant control of worms in the animal using other methods described. The fungus does not naturalize and persist in the environment; it must be supplied continuously,

though only during warm, humid conditions, during late pregnancy/early lactation, and when susceptible lambs or kids are grazing.

The fungus can be fed in the feed or mixed in a trace mineral mix for flocks/herds that do not provide grain supplement. The fungus can safely be mixed with coccidiostats for control of pasture worms and coccidia in the animal. For more information see https://www.wormx.info/_files/ugd/6ef604_835b05c3fd0e4df59e9cacf71b1bac50.pdf or under www.wormx.info/bmps select "Worm Killing Fungus".

Sericea Lespedeza

Sericea lespedeza (*Lespedeza cuneata*) is a perennial summer legume with a relatively high condensed-tannin content that can be used as part of an integrated parasite control system. The ACSRPC has investigated several forms of the forage, including sericea hay, ground hay and pelletized sericea hay. Including these in the diet of sheep and goats reduces parasite loads, specifically *H. contortus*, through the action of specific condensed tannins that change the outer cuticle of the adult worm. The same results were observed with grazed sericea lespedeza. Sericea lespedeza can also be effective as a treatment or preventative of coccidiosis. Long-term feeding of sericea lespedeza can slow growth rates of lambs and kids, and can bind essential trace minerals. Not all varieties of dried sericea lespedeza are effective at barber pole worm control.

Sericea is listed as a noxious weed in some states, and can be unwanted in some ecosystems, such as native grasslands in the Plains States. Sheep and goats need to adjust to grazing sericea but will quickly learn to feed on this forage. Sericea should be planted in the spring after the last frost date. Contact your local Cooperative Extension office to ensure sericea is not listed as a noxious weed in your state and for assistance with selecting the best variety for your purposes and area, seed sources and advice on cultivation.

The ACSRPC found that:

- Grazing sericea lespedeza and feeding sericea hay effectively reduced fecal egg (barber pole worm only) and oocyst counts (FEC and FOC) in goats and sheep, most likely due to the condensed-tannin content of the plant.
- Loose and pelletized sericea hay were effective in reducing FEC in goats and sheep in some, but not all, studies.
- Grazing kids or lambs on sericea caused a decrease in FEC, which stayed lower while grazing sericea and increased when removed from sericea lespedeza feeding.
- In animals consuming sericea, the percentage of parasite eggs developing into larvae was reduced, as was the overall number of adult worms.

Farmers should not use sericea as their only method for controlling internal parasites but combine it with other methods.

For more information on using sericea lespedeza see https://www.wormx.info/sl or Tools for Managing Internal Parasites in Small Ruminants: Sericea Lespedeza (https://attra.ncat.org/wp-content/uploads/2022/10/sericea_lespedeza.pdf).

Genetic Selection or Resistant Breeds for Parasite Control

A long-term solution to worm parasites is the selection of resistant animals. Individuals within a flock or herd determined to have low fecal egg counts compared with others in its contemporary group can be selected as replacements. This is especially important when choosing rams and bucks, because they contribute half the genes to their progeny, impacting generations to come. In addition to selecting the most resistant animals in your flock, you may consider including some resistant breeds in your operation. Sheep breeds that have demonstrated some level of resistance to internal parasite infection include St. Croix, Barbados Blackbelly, Gulf Coast or Florida Native, and Katahdin. Less is known about resistant goat breeds, though research indicates Spanish, Kiko and Myotonic breeds may offer some genetic resistance to parasite infections, while Boer goats tend to be more susceptible. Bear in mind that animals must be selected on their own merits, and do not assume that all animals in a resistant breed will be good choices for your flock or herd.

The National Sheep Improvement Program (www.nsip.org) offers a program to select parasite resistant individuals within a breed population. This program is based on fecal egg counts and body weight data collected at weaning and post-weaning with the aim of improving overall resistance within herds and flocks. Selection for parasite resistance will lead to less frequent deworming, lower production costs and reduce parasites' resistance to dewormers. There is generally more variation within any given breed than between breeds. Every breed can be improved by culling the animals that require an excessive number of deworming treatments or have high fecal egg counts, and breeding those animals that produce well with the least amount of drenching.

It has also been found that FAMACHA scores (or the more accurate packed cell volume), a measure of anemia, is also a heritable trait that can be passed to the offspring. In an on-farm study (SARE LS22-063) over a three-year period with 10 sires, there were significant differences among the average FAMACHA scores of the sires' offspring, which will translate to less need for deworming for those with lower scores (less anemic).

For more information see: https://www.wormx.info/bmps, Best Management Practices Factsheet Series 1) Genetic Selection, 2) On-Farm Selection for Resistance to Parasites. Also, https://www.wormx.info/genetics, there are a number of articles of interest.

Other Methods

Organic farms and farms with worms resistant to chemical dewormers must rely on alternatives to chemical dewormers. The ACSRPC has investigated other methods, such as commercially available non-drug treatments and traditional remedies. For example, some plants with high tannin content other than sericea traditionally have been useful in treating internal parasites. However, at this date and under the conditions of our experiments, the methods researched did not successfully control internal parasites. Research studies showed that:

- *Bacillus thuringiensis* (Bt) crystal proteins offered nematocidal activity against barber pole and other worm parasites of sheep similar to or greater than dewormers. The technology needs to clear FDA approval, which could take years.
- Diatomaceous earth or DE is popular among farmers for worm control, but research studies in sheep and cattle failed to show any reduction in fecal egg counts.
- Garlic (fresh juice, bulbs, and Garlic Barrier®—a commercial insecticide prepared from liquid garlic extract) used as a drench was not effective in control of gastrointestinal parasites.
- Herbal dewormers of various commercial formulations did not reduce fecal egg counts or incidence of anemia in goats or lambs.
- Other plants traditionally thought to be useful, including black locust, curly dock, and chicory, failed to control barber pole worm but provided improved nutrition for goats, compared with goats feeding only on grass pastures.
- High-tannin grain sorghum was not consistently effective in reducing internal parasite fecal egg counts in goats and did not influence the number of animals that required deworming. Similarly, birdsfoot trefoil did not reduce fecal egg counts in lambs.
- Quebracho tannin powder was not effective in controlling worm parasites but reduced fecal oocyst counts from coccidia.

While the ACSRPC has not conducted research on the following methods, they are also useful for reducing parasitism in sheep and goats:

- Zero grazing: Put the animals in dry lot and provide cut forage for them, such as hay or other harvested forage. This gives the pasture rest and prevents the animals from infecting it and re-infecting themselves by ingesting larvae.
- Protein supplementation: Research has shown that increasing dietary protein and body condition scores helps animals resist parasites. For example, when pasture is low in protein, feeding one-quarter pound of soybean meal per lamb per day

improved resistance (Ross, 1989). Other forms of protein can also help increase tolerance to parasites.

Final Words

Decreasing the negative impacts of internal parasites on flocks and herds will improve the economic bottom line for any farm operation. Preliminary economic analyses suggest that producers implementing FAMACHA© reduce their drug costs by 70 percent or more while slowing resistance to dewormers. Exact dollar amounts are difficult to assess because costs of chemical dewormers vary widely. In addition, it is difficult to assess loss of production and death losses due to parasites, and perceived benefits to alternatives are difficult to assign a value to.

SARE Research Synopsis

Consortium members conducted numerous research projects focusing on sustainable control methods for internal parasites. These projects have been supported by grants including ones from SARE, USDA Capacity Building, and the USDA Organic Research Initiative. For more in-depth information on the SARE-funded projects, search the SARE Project Database www.sare.org for projects LS01-124, LS02-143, LS04-164, GS05-047, LS05-175, LS05-177, LNE05-232, ES06-084, GS07-059, LS08-204, LS08-212, LNE08-269, OS09-045, OS19-124, and LS22-063.

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About The American Consortium for Small Ruminant Parasite Control (ACSRPC)

The ACSRPC was formed in 1999 to address the internal parasite (anthelmintic) resistance problem facing grazed small ruminants, especially in the southeastern United States. This research group got its start thanks to a SARE Planning Grant and has greatly expanded over the years. The Consortium's mission is development of new methods of sustainable control of internal parasites in sheep and goats, and education of people involved in the small ruminant industry. The Consortium now includes researchers, veterinarians, and extension educators from many states, territories, and South Africa. The group has generated a Web site to disseminate research information (http://www.wormx.info).

Further Resources

The American Consortium for Small Ruminant Parasite Control, www.wormx.info. The ACSRPC website contains research articles, recommendations for producers, presentations, list of events, and contact information for Consortium members. The website is updated when new information and research results become available.

ATTRA-The National Sustainable Agriculture Information Service: www.attra.org . ATTRA has information on a variety of agricultural topics, including small ruminant parasite management. It is suggested to use a search engine with the phrase "ATTRA: internal parasites" which will bring up Managing Internal Parasites in Sheep and Goats. For additional articles, use the ATTRA search bar (enter "parasite" or desired terms).