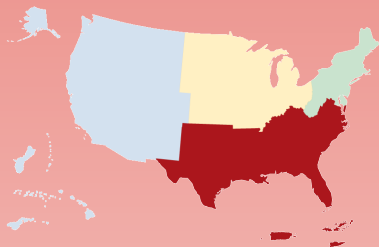


# FACT SHEET

Peer-reviewed research findings and practical strategies for advancing sustainable agricultural systems



## SARE FUNDING ON THIS TOPIC

See the section “SARE Research Synopsis” on page 2 for a list of SARE-funded projects related to this topic.

### Authors

Margo Hale and Linda Coffey,  
National Center for Appropriate  
Technology/The National Sustainable  
Agriculture Information Service  
(ATTRA) and American Consortium  
for Small Ruminant Parasite Control

Updated in 2026 by Joan Burke,  
USDA, Agricultural Research Service,  
Booneville, Ark.



[www.sare.org](http://www.sare.org)



Photo by Joan Burke

## Sustainable Control of Internal Parasites in Small Ruminant Production

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

### Introduction

Sheep and goat production is a viable enterprise, offering opportunities for marketing meat, fiber, and milk, plus grazing services for public agencies, solar farms, and others. Their small size and low cost make them appealing for small farms, including ones 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 the control of internal parasites, especially gastrointestinal nematodes including *Haemonchus contortus* (barber pole worm, stomach worm), is often a huge production challenge. Parasite control is particularly challenging in warm, humid regions, including the summer months in much of the United States. Grazing animals ingest infective larvae from grass and shorter forages. The larvae develop into adults in the “true” stomach (abomasum) 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 forage plants, 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

their increasing resistance to all available chemical dewormers. Pastures with heavy stocking rates in high-rainfall regions are especially vulnerable to parasite buildup. The costs of internal parasite infection include treatment expenses, reduced animal weight gains and performance, and even death.

In response, the American Consortium for Small Ruminant Parasite Control (ACSRPC, referred to in this fact sheet as “the consortium”) 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 the viability of sheep and goat production as a result. The consortium got its start thanks to two SARE Research and Education grants ([LS01-124](#) and [LS02-143](#)), and has greatly expanded over the years. Currently, the consortium offers the most current, science-based information and training on their website, [www.wormx.info](http://www.wormx.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 on [the consortium’s website](#) and the [ATTRA website](#).

### 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, the USDA Capacity Building program, and the USDA Organic Research Initiative. For more in-depth information on the consortium’s SARE-funded work, see the following 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 [LS22-363](#).

## Smart Drenching

Most dewormers are drenches, or liquid medications given by mouth. Smart drenching is a method of parasite management that seeks to improve their effectiveness through selective use. Parasite populations build resistance to chemical dewormers 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



Dewormers can be administered with a drench gun. Photo courtesy of Jean-Marie Luginbuhl, North Carolina State University

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 (see the text box). By comparing the fecal egg counts prior to and following treatment of animals, you can see how effective the deworming treatment was. An effective treatment should reduce the fecal egg count by 95%.
- Give the proper dose of dewormer to each animal. This will require knowing each animal’s weight. It’s important to note that sheep and goats require different dosages of dewormers. Goats need a dose that’s 1.5–2 more than what is recommended for sheep, depending on the dewormer used. The <https://wormx.info> website has handy dewormer charts for [camelids](#), [goats](#), and [sheep](#). Withhold feed (except for late pregnant/lactating animals, young lambs or very sick animals) 12–24 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, [the consortium](#) or the package label for more specifics regarding proper dosage.
- Give the dewormer over the tongue and 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 higher 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 3–4 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.
- To avoid increasing the infection load in the animal, move sheep or goats off the pasture before the eggs can hatch and become infective larvae. 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 the same pasture 28–35 days later was enough to reduce the amount of deworming required in lambs compared with continuous grazing.
- Remove small ruminants from pastures for 3–6 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.



Goats on pasture in a rotational grazing system. Photo courtesy Robert Braun, Pigeon River Farm

### How to Do a Fecal Egg Count Reduction Test

Fecal egg count reduction tests can be performed by veterinarians or experienced producers. Individual or pooled 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 the consortium's [website for low-cost lab options for determining fecal egg counts](#), or contact another veterinary diagnostic laboratory. At each collection, fresh fecal samples equally representing at least 10 animals should be placed in a plastic bag with the air removed. Insulate these bags with newspaper and ship them with an ice pack overnight. It's okay to store the first fecal sample in the refrigerator—never frozen—and ship it with the second sample. It's best to ship samples on a Monday so that they arrive in the lab well before the weekend and aren't left in a warehouse over the weekend. If the samples get warm, the eggs will hatch and the counts won't be true.

- 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.

Resources to assist producers with fecal egg count reduction and smart drenching or use of dewormers:

- [Smart Drenching and FAMACHA®](#) (manual)
- [Proper Use of Dewormers](#) (fact sheet)
- [Managing Dewormer Resistance](#) (fact sheet)

Many other pasture management techniques can be used to reduce parasite problems. For more information see the consortium's [pasture management page](#). And see the consortium's [Best Management Practices series](#) for titles on management, nutrition, and grazing management, as well as the ATTRA publication [Grazing to Control Parasites](#).

### FAMACHA®

FAMACHA® was developed in South Africa as a method of identifying sheep and goats heavily infected with *Haemonchus contortus* (barber pole 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. Keep records to identify chronically wormy animals, which should be culled from the herd. Research has shown that 80% of a herd's parasites are carried by 20% of the animals. Culling the heavily infested 20% will greatly reduce a herd's parasite problem.

The use of FAMACHA® requires training, but ultimately it 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, see the "Useful information" section on [this FAMACHA® resources page](#).

Using FAMACHA® and culling problem animals will:

- strengthen the flock or herd through selection of the most infection-resistant animals for breeding
- reduce parasite levels on the pasture by culling heavily infected animals
- slow development of resistance to dewormers by reducing the number of internal parasites exposed to dewormers
- save money by reducing drug expenditures

### The Five Point Check

Because there are other internal parasites that may impact the health of small ruminants (see [The "Other Worms" That Infect Small Ruminants](#)), FAMACHA® cannot stand alone. The same researchers who developed the FAMACHA® system recognized that



This animal's inner eyelid is being compared with the FAMACHA® color chart to assess its level of anemia. Photo courtesy of Margo Hale, NCAT

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:

1. The nose, checking for mucus which could indicate the presence of nose bots
2. FAMACHA® eyes
3. The jaw, looking for the presence of an accumulation of fluid called "bottle jaw," which indicates anemia
4. The body condition score (BCS), because thinner animals may be parasitized, or will be less able to battle parasites if they are too thin
5. The tail, looking for the 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 whether nutrition is adequate for the flock or herd. For a fuller discussion, see the Consortium publication [Targeted Selective Treatment](#), part of [the Best Management Practices series](#) on their website. Reading the 16 currently available publications in this series will give you a well-rounded view of the problem and how to tackle it.

## Copper Oxide Wire Particles

The consortium has investigated the use of a low dose (less than 2 grams) of copper oxide wire particles (COWP) as a deworming



Signs of heavy parasitism include bottle jaw (top), poor body condition (bottom), and a rough coat (bottom). Photos courtesy of Jean-Marie Luginbuhl, North Carolina State University

agent for barber pole worms, 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 80% 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 other worm species in addition to *H. contortus* are present.

Administration of COWP in small ruminants requires preparation of copper boluses in smaller doses than are currently commercially available. Copper boluses (such as 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-, 25-gram doses. Sheep and goats should be given 0.5 gram or 1 gram if less than one year of age, and 1–2 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 gram or 1 gram are used) or two (if doses of 2 grams are given) COWP boluses in the summer worm season, and only if no other sources of copper are available to sheep. COWP should be selectively administered, similarly to a dewormer, to minimize development of resistance by the worms.

You can purchase smaller gel capsules at a local pharmacy, health food store or veterinary supply house, and repackage them to make boluses with the proper dose for your goats or sheep. Administer prepared boluses to the animals with a pill gun, or mix copper particles in sticky feed for individuals (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 (0.5–2 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 of copper in the diet; but the interactions of other minerals will influence this. Goats, on the other hand, require copper levels in the range of 15–25 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, see the resources on the consortium's [Copper Oxide Wire Particles page](#).

With regards to copper administration, the consortium found:

- Low doses of COWP (0.5 gram and 1 gram) are effective treatments in lambs or kids.
- COWP is safe to use in late-pregnancy and lactating ewes. A 1–2 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



Gelatin capsules, size 3 and size 1, are filled with 0.5 g (500 mg) of copper oxide wire particles. Photo courtesy of Joan Burke, USDA Agricultural Research Service

worms.

- Worms may develop resistance to COWP, so use it selectively (as 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 worms, but not intestinal worms. Research results in this area have varied and COWP action is not fully understood.

## Nematode-Trapping Fungus

Research has shown that nematode-trapping fungi are effective 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 structures (the vegetative part of the fungus) that trap, destroy, and feed on non-parasitic soil worms. A commercial source of these fungi, specifically *Duddingtonia flagrans*, are sold in the United States as BioWorma® or Livamol® with BioWorma® currently sold through Premier 1 Supplies. Spores of *D. flagrans* are fed to livestock, pass through the ruminant gastrointestinal tract intact and are 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 effect on existing worms in the

animal, reduce fecal egg counts, or improve anemia. Instead, **it reduces the number of infective larvae on pasture**. You may see improvements after long-term feeding of the fungus while also using other methods described here to control worms in the animals. 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 the fact sheet [Worm-Trapping 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 consortium 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. Feeding sericea lespedeza for the long term 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 Great Plains. Sheep and goats need to adjust to grazing sericea but will quickly learn to feed on this forage. Plant sericea 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.



This goat is grazing on sericea lespedeza. Photo courtesy of Jean-Marie Luginbuhl, North Carolina State University

The consortium found that:

- Grazing sericea lespedeza and feeding sericea hay effectively reduced fecal egg counts (for barber pole worm only) and oocyst counts in goats and sheep, most likely due to the condensed-tannin content of the plant.
- Loose and pelletized sericea hay were effective in reducing fecal egg counts in goats and sheep in some, but not all, studies.
- Grazing kids or lambs on sericea decreased fecal egg counts, which stayed lower while they were grazing sericea and increased when sericea lespedeza was removed from their 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 rather combine it with other methods.

For more information on using sericea lespedeza see the consortium's [Sericea Lespedeza webpage](#) or ATTRA's publication, [Tools for Managing Internal Parasites in Small Ruminants: Sericea Lespedeza](#).

## Genetic Selection or Resistant Breeds for Parasite Control

A long-term solution to worm parasites is the selection of resistant animals. When you determine that individuals within a flock or herd have low fecal egg counts compared with others in its group, select them as replacements. This is especially important when choosing rams and bucks, because they contribute half the

genes to their offspring, 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 shown 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. However, do not assume that all animals in a resistant breed will be a good choice for your flock or herd. Animals within the breed should have good body structure, feet, legs, and mouth. They should also perform at least better than average within their farm group, in terms of growth, reproduction, and fecal egg counts.

The [National Sheep Improvement Program](#) offers a program to select parasite resistant individuals within a breed population, with the aim of improving overall resistance within herds and flocks. This program is based on fecal egg counts and body weight data collected at weaning and post-weaning. Selection for parasite resistance will lead to less frequent deworming and 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, a measure of anemia, is also a heritable trait that can be passed to the offspring. In an on-farm study (SARE grant [LS22-363](#)) 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 (they are less anemic).

For more information, see these publications available through the consortium's [Best Management Practices series](#):

- [Genetic Selection: Using Crossbreeding and Estimated Breeding Values](#)
- [On-Farm Selection for Resistance to Parasites](#)

Also, the consortium's [Genetic Control of Internal Parasites page](#) lists 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 consortium 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 didn't successfully control internal parasites.



The St. Croix and Katahdin breeds of sheep are resistant to infection by internal parasites. Photo courtesy of Joan Burke, USDA Agricultural Research Service

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 (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 didn't 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 didn't influence the number of animals that required deworming. Similarly, birdsfoot trefoil didn't reduce fecal egg counts in lambs.
- Quebracho tannin powder wasn't effective in controlling

worm parasites but reduced fecal oocyst counts from coccidia.

While the consortium hasn't conducted research on the following methods, they are also useful for reducing parasitism in sheep and goats:

- **Zero grazing:** Put the animals in a dry lot and provide them with cut forage, such as hay or other harvested forage. This gives the pasture rest and prevents the animals from both 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 0.25 lb. 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 bottom line for any farm operation. Preliminary economic analyses suggest that producers implementing FAMACHA® reduce their drug costs by 70% or more while slowing resistance to dewormers. Exact dollar amounts are difficult to assess because costs of chemical dewormers vary widely. In addition, it's difficult to assess loss of production and death losses due to parasites, and perceived benefits to alternatives are difficult to assign a value to.

For more information, see:

- **The American Consortium for Small Ruminant Parasite Control**, [www.wormx.info](http://www.wormx.info)
- **ATTRA, National Center for Appropriate Technology**, [www.attra.org](http://www.attra.org)

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