

Sustainable Management of Internal Parasites in Ruminants

Part 1

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Internal parasites are a part of most every livestock producer's farm. Regardless of whether they are pasture raised or in a confinement setting, livestock will be exposed to internal parasites at some time in their life. Animals raised on the dry and arid rangelands are much less likely to be infested. But if these animals are brought to the more humid climates east of the Rockies, worms will be a major problem for these animals. Small ruminants are more likely to have major disease problems with internal parasites but cattle can also be affected, especially calves.

Chemical dewormers are losing their effectiveness, with parasites developing resistance to them at an alarming rate. The situation is particularly serious in sheep and goats, but also occurs with cattle. There are some parts of the country where the internal parasites of sheep and goats have developed resistance to all commercially available dewormers. This resistance means that not all the worms are killed during deworming. The surviving worms pass that genetic resistance on to offspring.

Certified organic livestock producers face an additional challenge as they are limited to using only ivermectin and must justify why they are using it. Routine use is prohibited, and it also can never be used in animals raised for meat.

The growing concern about the resistance of internal parasites to all classes of dewormers has caused people to look for alternatives. This also helps the organic producer who is even more in need of alternative management strategies and products. As dewormers lose their effectiveness, the livestock community fears increasing economic losses from worms. Much attention both in the research community and on the farm is being devoted to discovering ways to prevent and treat internal parasites without relying on heavy doses of chemical dewormers. Many people claim this treatment or that control measure works, but there are more questions than answers. There is no simple alternative way of preventing or treating worms. By looking at the whole farm as an interrelated system, it becomes apparent that there are parts of the system that can be managed to decrease internal parasites and their effects. These management adjustments not only postpone the day when chemical controls no longer work, but they also may decrease costs and increase the overall health of the animal.

Nutrition

Nutrition plays a major role in how well animals are able to overcome the detrimental effects of internal parasites. In fact, the signs of parasitism can often be used as a symptom of some other problem, usually poor nutrition. In an article in the Journal of the American Veterinary Medical Association in 1943, researchers showed that sheep placed on a high plane of nutrition were able to reduce their worm burden significantly and many of the sheep were even able to cure themselves.

Pasture Management

Management of animals, pastures and any loafing areas is key to reducing the amount of internal parasite problems in livestock. An understanding of the life cycles of the different parasites within the whole soil-plant-animal system will help show the interrelationships between these three components. Managing internal parasites is just like managing fleas in dogs and cats. The major part of the parasite life cycle is outside of the animal. This point will help the producer to choose management strategies that reduce

parasite levels on his or her farm and decrease the usage of chemical dewormers. The same principle is used in integrated pest management for vegetables and other crops.

Many farmers closely monitor their animals but pay little attention to the plants and soil. Pasture contamination by infective larvae is the primary factor to deal with. If you start with an understanding of the interrelationship between the animal, the plants it eats and the soil on which those plants grow, then it becomes clearer how parasites infect the animal and how they can be managed so as not to cause as many problems. Everything a farmer does to his or her animals, including the grazing management, affects the manure, which affects the animal's environment.

For example, animals that continuously graze a pasture eat the grass into the ground, while contaminating the soil with so many parasites that nothing outside of regular deworming with chemicals will control them. By using controlled grazing methods that allow pastures to rest and soil life to function well, contamination can be reduced. This reduction occurs because soil organisms, including earthworms, dung beetles, and nematophagous fungi will destroy or keep a lot of the parasite eggs and larvae from developing. Keeping the grass in a more vegetative stage, and tall enough to provide the animal with adequate forage, will provide better nutrition to keep the animal healthier, strengthening the immune system to prevent the adult worms from producing eggs. Parasites do not cause as much harm to a healthy, well nourished animal. The parasites that are present will not deplete the host as much as in an animal that is malnourished. Parasite loads affecting wildlife generally do not cause the death of the host, because the parasites need the host to survive. The same principle applies to livestock.

Pasture contamination can be reduced through management. Livestock will avoid manure piles and the grass surrounding them. This behavior also helps them avoid eating larvae. The height of the pasture sward can affect parasites. The majority of worm larvae crawl only one inch from the ground onto plants, so not allowing animals to graze below that point will cut down on a lot of infestation. This is one reason sheep tend to have more problems with internal parasites. They eat much lower to the ground than cattle do, picking up higher numbers of larvae. Therefore, it is important to monitor grazing sheep closely so they don't graze too low. Larvae migrate from the manure no more than 12 inches from the manure pile. If livestock are not forced to eat close to their own manure, they will eat fewer larvae.

With sheep and goats, the most important time to control pasture contamination is during the periparturient rise, which is the sudden release of infective larvae and eggs within the ewe's intestinal tract. This occurs right after lambing, and is due to the ewe and doe's immune system becoming temporarily less effective. By treating animals at this time, the exposure to newborn and young lambs (those most susceptible to parasites) is minimized.

Good grazing management includes the use of clean pasture to minimize re-infection. Clean pasture is pasture that has not been grazed by the host animal (in this case sheep and goats) for 12 months, and therefore is not contaminated with worm larvae. It may be new pasture, pasture grazed by livestock such as cattle or horses which do not share parasites with sheep (goats do share parasites with sheep), or pasture that has been hayed, renovated, or rotated with row crops. There is some killing of parasites on pasture during the winter due to freezing and thawing; however, snow cover insulates the larvae. Summer is the time in the Southern states when most larval kill will occur on pastures. Sunlight will kill them, and this occurrence can be used to determine which pastures can be used in the fall and into the winter. Grazing down to 2 inches from the ground allows more sunlight to get to those larvae and increases their chances of drying out and being killed.

Warmth, oxygen and moisture are the three most important things that increase the chances that larvae will survive on pasture. Knowing when your pastures are apt to be driest and coldest will help you manage them better for parasite control.

Cleanliness is a defense against parasites. Feed troughs and water sources located where they can be contaminated with feces will increase the chances of livestock infestation. This is only one reason not to water directly from ponds, or to allow animals continuous access to water sources. Feeders should be cleaned and elevated. Calving and lambing areas, as well as other holding areas, should be clean and dry. Prevent the transmission of infestations from new arrivals to the herd or flock by deworming them before arrival and again three weeks later.

By-pass Protein

Researchers around the world have been studying the effects of by-pass protein on parasitized sheep. They have found that by increasing the amount of protein that is not degraded or broken down in the rumen, animals lose less weight than those animals that were not fed the increased level of by-pass protein. These researchers used fish meal as their source of by-pass protein. However, there are forages that also have an increased level of by-pass protein because they contain tannins. These include birdsfoot trefoil and lespedeza. The protein in native warm season grasses also has a higher level of by-pass protein. This may be one of the most exciting areas of new research.

Immunity

While it is usually neither possible nor advisable to completely eliminate internal parasites in sheep or other livestock, reduction of parasite load can be achieved. Many people have found, and research has shown, that adult animals rarely need to be wormed. Most animals develop immunity against internal parasites, though not to the level that is developed against viruses and bacteria. This immunity keeps the parasites from reproducing but rarely kills them. An example of an effective parasite control program can be found in Tennessee. Dennis Onks, superintendent of the Highland Rim Experiment Station in Springfield, Tennessee, has not wormed the adult cattle on the farm in eight years. They are wormed at weaning, around 7 months of age, and then not again. They have never shown any signs of internal parasites and their condition is excellent. These animals are on a high plane of nutrition, have a low stress level, and are strictly culled on production. All these things work together to produce an animal that shows no signs of internal parasites.

It is the young animal whose immune system is not fully mature and the animal whose immune system is compromised by disease, inadequate nutrition, or other stress, that is most adversely affected by worms. Animals brought from western rangelands, for example, where the arid conditions keep parasites from surviving, have no immunity and can easily be overwhelmed by worms.

Every farm is different. The parasite load of the animal depends on many variables —such as stocking density, time of year, the reproductive state of the animal, etc. Good nutrition plays a big part in how well the animal's immune system mounts the proper defenses, and in the animal's overall ability to tolerate the presence of some worms. Healthy and well-nourished animals will be able to develop resistance and resilience to worms and other parasites much better than thin animals that do not have good availability of quality feed. Resistance is the ability of an animal to prevent the establishment and maintenance of a parasite population within the gastrointestinal tract. Some individuals and some breeds show more resistance to parasitic infection than others. Research to identify characteristics in such individuals is a hot area.

Culling susceptible animals can take advantage of this. While this is not done as frequently with organic animals, it still needs to be considered in some cases. Resilience is the ability of an animal to reduce production loss during a parasite infestation. Both of these traits are being looked at as ways of selecting animals that will be less susceptible to parasite effects. Animals that possess some genetic resistance or

resilience can still be infected with worms. Therefore, you must keep in mind that this is just one more measure that will help control worm problems, not a cure by itself.

Soil Organisms

There are several soil organisms that can have an impact on parasites. Managing pastures to favor populations of beneficial soil organisms will decrease parasite levels on pastures. Oxygen is the primary requirement for worm eggs and larvae to survive and develop. Earthworms have been shown to ingest worm eggs and larvae, either killing them or carrying them far enough below ground to keep them from maturing. Dung beetles ingest and disperse manure, taking it to their burrows, thus keeping eggs and larvae from developing. There are also nematophagous fungi that produce "traps" that engulf and kill parasitic larvae. These fungi are more delicate than other fungi, so there are rarely great numbers of them in the soil. If the soil is depleted or out of balance, other, more dominant microorganisms will replace these fungi. Research at Louisiana State University shows that fungi fed to sheep completely destroy all the nematode eggs in the sheep's manure. The amount of time that feces remain on the pasture has an effect on the number of parasite larvae that survive and mature. Anything that hastens the breakdown of the feces will lessen the number of larvae. This can include the soil organisms mentioned above, mechanical dragging of pastures, poultry or other animal disturbance and the consistency of the feces themselves.

Strategic Deworming

There will be times when chemical dewormers are the best treatment. But for organic dairy producers, these times will need to be kept to an absolute minimum.

It does little good to deworm livestock and return them to the same infected area. Do not deworm and immediately move animals to a clean pasture. All the dead worms, with very viable eggs in them, will be passed to contaminate the pasture. Instead, deworm, hold animals in their same location for 12-24 hours, and then move them to a clean pasture. Appropriate management minimizes re-infection. Strategies include calving or lambing on clean pasture, weaning calves and lambs to clean pasture (with cows and ewes grazing the infested pastures in the fall), and pasture rotation between cattle and sheep.

There are several ways to utilize multiple animal species to control the worm population. One technique that appears to work well is dividing your farm in half, with cattle on one half and sheep on the other half. Midway through the grazing season, switch halves of the farm. Having one species of livestock follow another one will have a benefit. Sheep and goats are infested by the same species of worms. Cattle are mainly infested by other species. The cattle parasite of most concern is *Ostertagia ostertagi*, the brown stomach worm. The barber pole worm, *Haemonchus contortus*, is a stomach worm that can severely affect sheep and goats. Horses and poultry each have their own species also. Mixing different species of livestock is one method of parasite control, by interrupting the parasite life cycle of each livestock species. The different livestock species will break up manure of other species and will not avoid those areas of pastures. This will break the life cycles of the parasites because their natural host will not be present.

Animals and worms have developed together. Getting rid of all worms all the time is not essential for the health of the animal, is rarely cost effective and can actually be detrimental since the immune system of the animal is an important defense mechanism in managing parasite effects. For sheep and goat producers the population of susceptible larvae, called refugia, may be the most important aspect when determining their parasite control program.

Managing the length of time animals remain on a pasture is also important to remember. This is just one other item that has to be figured in when doing pasture planning for a season. Don't let those pastures be grazed too short!

Alternative Dewormers

Most alternative dewormers have not been shown by scientific research to have any effect on numbers of worms. Diatomaceous earth (DE) has been promoted by some for controlling internal and external parasites in livestock. Almost pure silica, DE is the finely ground fossilized remains of diatoms, tiny sea organisms that accumulate on the sea floor and can be mined from deposits. The diatom remains have microscopic cutting edges that are said to pierce the outer protective layer of parasitic worms and insects, causing dehydration and death. There is little scientific data on the effectiveness of DE for internal parasites, but researchers have seen a decrease in flies on animals when using DE. One study at Iowa State showed no benefit from using the DE. I have talked to Dan Morrill, Sheep Extension Specialist at Iowa State, who worked on the study. He told me that they had a hard time even getting the lambs infested with worms, which was necessary to test the effectiveness of DE. I bring up this point to make you aware that farmers must know if their animals even have worms in order to know whether control measures are needed, are effective, or how to effectively change them.

Many producers have claimed that they have had good results with DE, but their management is usually very good. They may be giving credit to the DE when they should be giving it to themselves. Although I have nothing to back me up, I've often wondered if it isn't the minerals in the DE that provide the benefit. Worm egg count also naturally falls at the end of summer and the beginning of fall. People who are doing fecal egg counts (FEC) may be thinking the DE is lowering the egg counts, instead of realizing that it is the natural cycle. I haven't talked to any producer who uses DE without significantly changing and then watching their management.

Using DE is not just a simple substitute for a chemical dewormer. This is another problem with the scientific research that has been done on DE. Researchers have simply substituted DE for their conventional wormer and done everything else exactly the same. This is component research, whereas to really prove that DE has an effect, systems research needs to be done, using the same or similar management techniques that producers use. This type of research is much more difficult to do. If you still want to use DE, one dosage that I've seen used is ten to twenty pounds per ton of mineral supplement. Every animal must be fed a dose every day to be effective. Deworming alternatives exist in herbal and folk medicine used for centuries in other cultures.

Herbs such as garlic work not by killing the worms, but by making the intestinal tract healthier. Since worms and other intestinal parasites have evolved to thrive in the unhealthy digestive tract, anything that will make that environment healthier will be detrimental to their survival. Herbal research is beginning in the U.S., looking at pasture plants as well as herbal medications that can be given to animals. There are also some herbal remedies on the market that may have potential for helping reduce the effects of worms. Herbal remedies will also not directly kill the worms, so must be part of an overall management program.

Conditions with Signs Similar to Parasitism

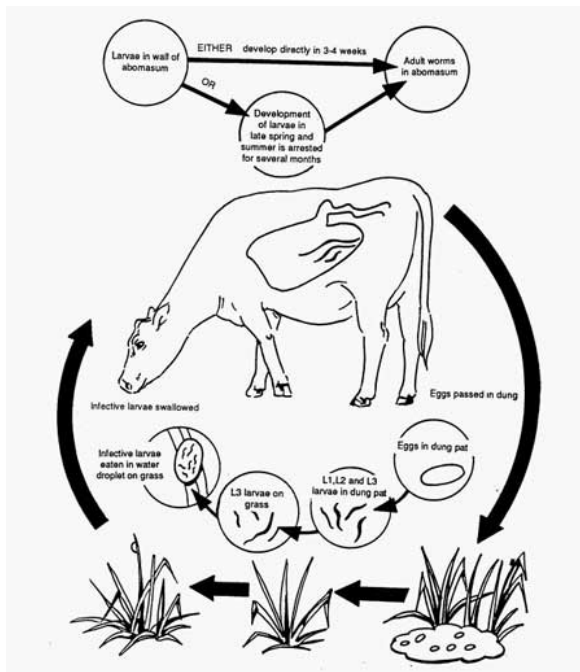
Keep in mind that there are other conditions that can mimic the signs of parasites. It is easy to assume that any unthrifty or thin animal with a rough hair coat or diarrhea is wormy. Internal parasites may be present, but the clinical signs are secondary or a symptom of some other, more insidious disease or condition. Any stressful condition, such as a weather extreme, can cause borderline clinical parasitism to become severe. If animals do not have enough forage or other feed in the fall so that they go into winter in good condition, this lack of condition will cause additional stress on the animal in other ways. This

animal will be more apt to show extreme clinical signs of parasitism, including blood loss and death, than an animal which might have some internal parasites but is in good physical condition and is on a high plane of nutrition. In this case, poor nutrition is the cause of the animal's disease and worms are the symptom.

Fescue toxicosis is often blamed when animals are actually wormy. These two conditions can also work together, and it can be hard to determine which one is the main culprit. Fescue toxicosis is especially blamed when bringing animals from the western states. While that indeed may be a problem, the farmer needs to look at the time of year the animals have been placed on fescue, what their overall body condition is, and also check for the presence of worm eggs in the feces.

Parasite control with minimal or no chemical dewormer use requires a combination of extremely good management techniques and possibly some alternative therapies. Organic producers must be aware of the incidence of parasites in their animals. Cattle will be easier to manage than sheep or goats and older animals will be easier to manage than younger animals. Observation, testing and monitoring animals will be crucial to determining progress and success. Alternative parasite control is an area that is receiving a lot of interest and attention. Programs and research will continue in the pursuit of parasite control, using alternative and more management-intensive methods.

For organic dairy cattle producers, the parasite of most concern is *Ostertagia ostertagi*, the brown stomach worm. Type 1 disease occurs in calves and causes green diarrhea, bottle jaw, weight loss, unthriftiness and low vitality. Type 2 disease occurs when arrested larvae in the abomasal lining descend due to weather conditions conducive to survival. This form will affect adults primarily. The life cycle of the *Ostertagia* is shown.



Determination of parasites

The producer needs to figure out if internal parasites or worms are actually a problem. If they are a problem, then using those signs as a symptom of something else wrong, what can be changed about the farm to make these parasites less of a problem?

Worms become a problem when calves are raised on the same ground year after year. This is due to the survival of overwintering larvae from the previous year. Immunity to the worms starts at weaning and may take up to two years for *Ostertagia*. This immune response can be enhanced by good nutrition. Fecal egg counts (FECs) can be run to see if the levels are indicative of parasitic disease. Keep in mind though, that due to that immune response and to genetic resilience, that some calves may have high egg counts and show no signs of parasites. Calves with FECs of 300-600 are usually going to show other signs of parasites.

If worms are a problem, the first thing to do is to move calves to a different area. Letting a piece of ground rest for one year will make it safe again for calves. The goal is to limit exposure to the worm larvae when calves are young before their immune system can handle the worm burden. In addition, high levels of nutrition, controlled rotational grazing, certain pasture plants and possibly certain herbal products will lessen the problem of worms in calves.

Poor nutrition will mimic parasite problems. Good nutrition will prevent parasite disease even if animals have parasites. Poor sanitation will worsen parasite problems. Changing basic animal management will often take care of what was thought to be parasites. High stock density in an area will increase the chances of harmful levels of larvae.

Healthy adult cattle should have enough immunity that parasites won't be a problem. If they are a problem, then the worms should be used as a symptom that something else is wrong in the farming system. Other diseases, poor nutrition, poor weather or some other management mistake needs to be considered.

Grazing Management

It has been stated that goat producers who don't rotationally graze their goats will end up with insurmountable worm problems. Ten years ago, Dr. Louis Gasbarre received a SARE grant to study the impact of parasites in dairy cattle that were being intensively grazed (McBride, 1998). Research in both the U. S and internationally shows that controlled rotational grazing is the best defense against internal parasites in cattle. It's important to put calves on ground that hasn't had cattle on it for at least six months. Rotating them through pastures so they aren't overexposed to larvae, keeps infestation to a minimum. Having pasture heights in the 6-10 inch range, removing them when grass is no shorter than 2 inches and not forcing the calves to graze close to manure piles will also prevent infestation.

A better way of grazing these pastures, and one that will also allow more utilization of forage is to have the young calves graze through, followed by older cows whose immune systems are fully developed. Calves will be more selective than older cows, grazing the most nutritious and most palatable forage. Older cows will still get excellent nutrition but will eat more of the available forage. The rest period will allow forages to regrow and soil organisms to degrade and remove manure. Calves under the age of 5 months should not regraze those pastures that year.

This management strategy has been used successfully on organic farms in Switzerland (Hertzberg, 2002). These farms grazed different age groups separately and moved them among different pastures. Those farms unable to carry out this grazing strategy had high FECs in their calves and the calves showed unthriftiness.

Besides the University of Tennessee cattle system, which doesn't deworm any calves after the age of 7 months, grazing dairies in southwest Missouri rarely deworm calves more than once a year and several don't deworm at all (Rickard, personal communication). North Carolina State University carried out a study on dairy steers in 2004. Calves born in fall of 2003 haven't been dewormed at all and showed no rise in FECs compared with a control group of calves which were given a dose of Ivermectin in the spring. These calves were pastured starting at birth, but on pasture that had not had any cattle on it from March to mid-September (Washburn, personal communication).

Calves raised on Bermuda grass pastures in Georgia have had their FECs kept at 3 eggs per gram (epg) with once yearly deworming for 5 years (Stuedemann, 2004). These pastures had had no livestock on them before this research was begun.

The significance is that these places in the South have warm humid conditions for many months which is when larval and worm activity is high. Farther north, worms are dormant which lessens the risk of exposure for young calves.

Herbal leys

Herbal leys are pastures that have a combination of grasses, legumes and forbs, plants most of us know as weeds. The concept was developed in the early 1900s in Clifton Park. Although all the plants are important for nutritional purposes, it's the forbs and some of the legumes which is the focus for those of us looking for alternatives for chemical dewormers.

Most of the plant research has been aimed at sheep and goats, as they are the animals most severely affected by worms. But the concepts will fit all ruminants. There are a number of plants that have been researched, but I will discuss the ones most apt to have application in the northeast U.S.

These plants contain either condensed tannins, or sesquiterpenes as the compounds showing anti-worming activities. The plant which research shows has the most definitive effect on worms is sericea lespedeza. Goats grazing sericea had FECs drop to extremely low levels in two days time (Min, 2004). Within two weeks after the goats were removed from the sericea, the FECs had climbed back to pregrazing levels. Sericea has high levels of condensed tannins. Now sericea is a noxious weed in the central U.S. In the eastern U.S., it's hard to establish and hard to maintain stands. However, birdsfoot trefoil, which can be grown in the northern U.S., appears to have the same effect. The condensed tannins prevent the adult worms from laying eggs. There is some preliminary evidence that they also have an effect on the vigor of the worms, but that has not been substantiated. Chicory is another pasture plant that has been shown to have a negative effect on internal parasites (Marley, 2003). Puna chicory is a forage variety that can be grown in the U.S.

These plants can be planted within pastures or hedgerows or most preferably in an herbal pasture that animals have access to periodically. Many of the herbal forbs are highly palatable, have a longer rest period than the grasses, and can be more easily overgrazed. By having an herbal "medicinal" pasture, the animals can be offered it for a short period of time, and rested otherwise.

Animal Selection

Research for all ruminant species is showing that 80% of parasite problems occur in only 20% of a particular herd or flock. While it can be difficult to cull an organic animal based on its parasite status, doing so may benefit the farm by improving the overall health of the herd, increase the amount of milk produced and sold and decreasing contamination of pastures for newborn calves.

Keep records of animals with high FECs. If an animal does need to be dewormed with ivermectin, seriously consider culling that animal and any offspring or siblings. Do not overlook the genetics of the bulls. If one calf crop has more problems with worms, consider the possibility it is due to the bull used that year.

Producers who add parasite susceptibility to their list of culling factors find that in 2-3 years they have greatly decreased the incidence of parasite problems in their herds or flocks.

Herbal Deworming Products

There are several herbal deworming products, besides diatomaceous earth, which may have some potential. There has been on farm studies of several of these (Allen, 1998, Drazenovich, 2003, Murphy, 2001). All have been carried out on sheep farms. Grazing management, with clean pastures at the beginning of the season, has been one of the primary strategies seen to be effective. However, there is some indication that some of these products may have a beneficial effect. The effect may be due to something other than direct effect on the worms.

Most of these products have wormwood (*Artemisia absinthium*) as the main ingredient, which should be used with caution, if at all, on pregnant animals. Some also require a tonic to be given on weeks when the deworming treatment is not given. For producers with many animals, using these products may be prohibitive. However, dairy producers who are handling their animals individually every day will have an easier time of administering these products.

The latest product to be tested on sheep for deworming is a garlic product called Garlic Barrier (Noon, 2003). Garlic has known antibacterial effects, which may be the effect responsible for its success as a deworming product. Bacterial enteritis often accompanies parasitic disease. This study showed that egg counts went down after sheep were treated with the garlic product.

While I have not tried any of these products, I am working with a farm in central Arkansas for the second year that is interested in transitioning their sheep flock to organic production. Parasites are their biggest concern. Last year we managed the sheep flock strictly with rotational grazing and mixed grazing with beef cattle. This year we will be adding in an herbal dewormer plus seeding some pasture area to sericea lespedeza this spring and puna chicory this fall. I also want to try planting *Artemisia absinthium* and allow the sheep access to it to see if they will willingly graze it.

Ivermectin Resistance

The reason that management strategies, pasture plant research and alternative dewormers are such hot topics for the sheep and goat industry is that parasite resistance to all the currently available chemical dewormers has reached a crisis point. There are farms around the world, including the U.S., which no longer have a single chemical dewormer that is effective. Under NOP, ivermectin is to be used only in an emergency situation and never routinely. Couple that with the fact that cattle have more body capacity than sheep and goats, and resistance should be less of an issue. But since ivermectin is the only available dewormer to legally use at this time, resistance by the worms has to be considered as a possible occurrence over time.

Keep in mind that ivermectin will kill the dung beetle larvae, although for a short period of time. Manure from animals treated with ivermectin is slower to degrade.

Conclusion

There are a number of steps to take when evaluating the impact of parasites on your farm and then determining a management plan.

- Determine if parasites are problem
 - Fecal egg counts
 - Overall physical condition
 - Body condition scores
- Change location of calves
 - Keep area dry and clean
- Divide pastures to rest more
 - 6 months between calf crops
- Don't graze older cattle with calves
- Rotate pastures
 - Observe manure degrading soil organisms
- Plant forages with deworming activity
- Try herbal dewormers

It is essential to first determine if parasites are actually your problem. Fecal egg counts, physical and body condition and nutritional status will help you decide. Second, figure out if something simple like changing the location of calves will eliminate the problem. If changing the location is impossible, such as in a barn, make sure that the area is as dry and clean as possible. If a pasture is grazed and can't be rested for at least 6 months, divide it in half so that half can rest for a longer period of time. Keep older cattle off the pastures used for calves. Divide calves into smaller age groups and don't mix the groups until they are over five months of age. Rotate pastures as much as possible. Observe the presence of dung beetles and earthworms which degrade manure. Notice how quickly manure disappears from pasture. Explore the possibility of planting some of the listed plants as a way of decreasing the number of eggs and larvae contaminating the pasture. Lastly, try some of the herbal dewormers available.

There is still a great need for more research in the areas of forage plants and herbal deworming products. If herbal pastures can be developed that are effective in keeping pasture contamination and parasite numbers to a manageable level, this would be an effective and more applicable deworming strategy. The herbal deworming products are often dry material, require weekly or even daily treatments, and can be difficult to administer if animals are all fed together. If farmers try any of these products, they need to keep careful records to ensure that credit goes to the correct thing. As one farmer told, his calf disease problems went away when he just increased the tender loving care he was giving his calves. Many producers unconsciously change their management when they start using a different product, yet still give the credit to the product.

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