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Managing Internal Parasitism in Sheep and Goats

Kate Hepworth, Animal Sciences Student; Mike Neary, Extension Sheep Specialist; Terry Hutchens, Extension Associate for Goat Production, University of Kentucky

Internal parasites are a significant threat facing today's small ruminant producer. Problems associated with parasites, particularly those of the gastrointestinal tract of sheep and goats can cause irreversible damage or even death to the animal, reduced performance and economic loss for the producer. Animals that are overburdened with parasites can be hindered in their reproductive performance, experience reduced growth rates, and become less productive overall, whether their purpose be meat, fiber, or milk. Prevention and control of the parasites that infect sheep and goats are becoming increasingly difficult due to generations of overuse and improper use of the available anthelmintic dewormers, which results in increasing resistance by parasites to common anthelmintics.

This paper will be used to give producers a general understanding of the parasites that affect their animals, how they live, and methods that can be used to lower their costs and losses due to parasite infestations.

Sheep and goats are affected for the most part by the same parasites. By far the most deadly internal parasite to small ruminants in the Midwestern United States is the gastrointestinal roundworm *Haemonchus contortus,* also known as the barber pole worm and a variety of other names. *Haemonchus contortus* is a blood sucking parasite that can cause severe anemia, protein loss and death in goats and sheep, and thus is the most important to control. Some other parasites that affect sheep and goats are those of the *Trichostrongylus* family, particularly *Teladorsagia circumcincta* and *Trichostrongylus axei,* and the protozoa coccidia. *Haemonchus contortus* is the most dangerous parasite to sheep and goats in many parts of the United States, although other parasites may be important in different regions outside the Midwest. However, by developing a parasite control plan aimed at *Haemonchus*, the majority of other dangerous parasites will be controlled as well.

Lifecycle

Sheep and goats are generally affected by the same parasites, although certain parasites may affect one species more severely than the other, and treatment methods may vary between sheep and goats. In order to know how best to prevent future problems with parasites and control current infestations, it is necessary to understand the general life cycle of the parasites most common to sheep and goats.

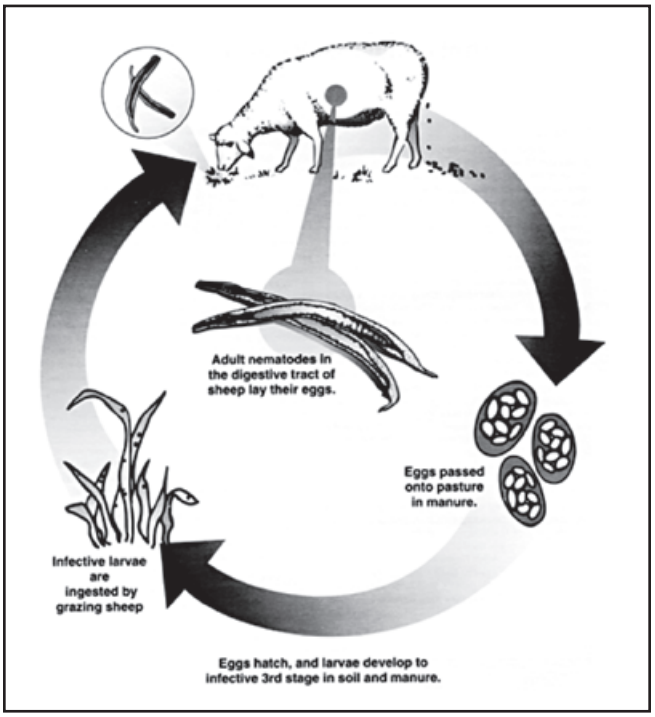

Figure 1: The lifecycle of a gastrointestinal parasite. This image is courtesy of Virginia Tech Cooperative Extension.

Haemonchus has a lifecycle that takes approximately 21 days to complete (see Figure 1). The cycle begins when the larvae in the infective L3 stage of development are ingested from the grass and travel to the abomasum, or true stomach, of the host. Once in the abomasum the larvae will follow one of two paths. They may proceed with further larval stages and the eventual development into adults, or they will go into hypobiosis. This is an inhibited, or arrested development state, that occurs when conditions are not conducive for the entire life cycle to be complete.

When the L3 stage larvae enter the abomasum, provided that environmental conditions are favorable, they will molt into the L4 stage of larval development and will then molt once more into adults. Factors that induce the molting of the L4 larvae into adults include: greening of grass, a rise in environmental temperature, rain following a drought period, increased estrogen levels in the host, and possible even a photoperiod stimuli. Once the molt into an adult form is complete adults then begin to lay eggs in the abomasum.

In the case of *Haemonchus* and *Ostertagia*, the L4 larvae can go into arrested development, or hypobiosis. Hypobiosis is a period of dormancy that occurs when the environment is not conducive to the lifecycle of these parasites. Larvae in different regions may go into hypobiosis in different times during the year, depending on the environment. For example, in the Midwestern states, Haemonchus larvae will likely become dormant during harsh winters. In southern parts of the country, hypobiosis may occur when the weather is too hot or dry for larvae to survive.

During hypobiosis the L4 larvae hibernate in glands in the abomasum without developing further or causing problems for the host. They remain metabolically inactive until they receive signals that indicate it is time for them to resume development and then begin to lay eggs. The signals that spur the L4 larvae to come out of hypobiosis are the same signals mentioned above that indicate to them to develop in the first place. Once larvae leave hypobiosis, they resume the normal lifecycle and begin to lay eggs.

Haemonchus adults require about 14 days to begin laying eggs (see Figure 2) in the stomach after reaching adulthood. The *Haemonchus* adult female can lay up to 5,000 eggs per day, yet another reason why *Haemonchus* is so difficult to control and so dangerous to sheep and goats. Females that have gone through hypobiosis over the winter generally resume development two to four weeks prior to lambing or

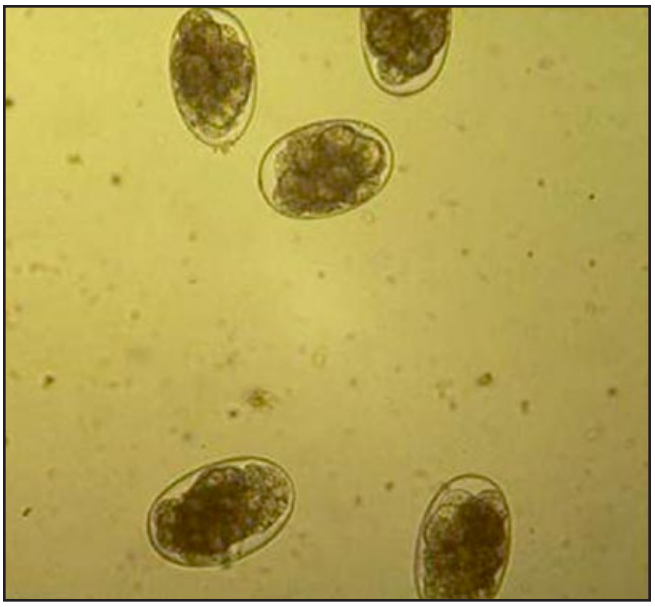

Figure 2: This image shows magnified eggs of Haemonchus Contortus.

kidding and begin to produce eggs. This phenomenon is called the "periparturient rise" in fecal egg counts (will be discussed later). The eggs laid in the abomasum are expelled from the body via the feces.

Eggs in the feces generally remain inactive for a few days in the environment, until the environment and temperature become favorable for the development of these eggs into larvae. The larvae hatch from the egg and then emerge from the pellets and move through larval stages L1, L2 and L3 of development. Once the larvae reach the L3 stage, the infective stage, they emerge from the fecal pellet and climb up onto blades of grass (see Figure 3) where they wait to be ingested by a grazing animal, thus completing the lifecycle. In

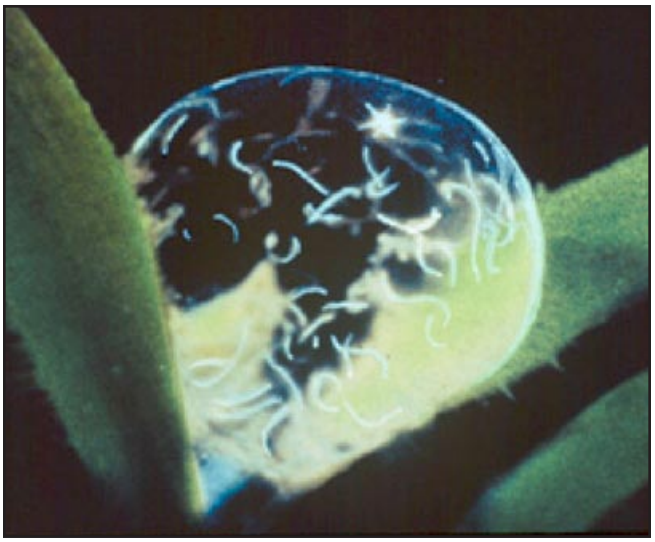

Figure 3: This image depicts larvae inside a droplet of water on a blade of grass.

order for the larvae to emerge from the fecal pellet in which it was expelled from the body, the environment has to be in a condition that keeps the pellet moist and pliable. Optimal conditions for the L3 larvae to emerge from the pellet are warm, wet conditions, like those that usually occur in the early spring.

An important characteristic of these larvae that must be taken into account when designing a parasite control plan is that the L3 larvae can survive on pasture for extended periods of time, making pasture management a key component in the prevention and control of parasite infection. The L3 larvae can survive on pasture for up to 90 days in the summer, and up to 180 days in the fall or winter. The *Haemonchus* larvae thrive in temperatures ranging from 70° to 80° Fahrenheit where there is an average of approximately 2 inches of rainfall per month. Extremely hot or dry environments will cause egg laying to stop, but the larvae can survive temperatures below 32° F. *Ostertagia* larvae prefer cooler temperatures, with their optimum temperature for development being around 40° Fahrenheit. These larvae are very resistant to adverse winter conditions, and can over-winter on pasture.

Animal Susceptibility

Individual goats and sheep vary in their degree of susceptibility to *Haemonchus* and other parasites. Some animals, by means of their genetics, are much more resistant or resilient to parasitic infections, and can survive parasite levels without showing any symptoms while another animal may be killed by that level of infestation. This genetic resistance can be used when selecting breeding stock, since a herd that exhibits more innate resistance to parasites will cost less to maintain and will ultimately be more profitable to the producer.

Animal age and stage of development also have a significant impact on the susceptibility to parasites. As animals age, they are exposed to more and more parasites and develop some immunity to infection. This is more likely with sheep than with goats. Resistance describes an animal's ability to resist infection from parasites, while resilience describes the animal's ability to withstand infection from parasites once it has occurred.

Young animals that are growing and are on continuous permanent pasture are the most susceptible to parasites. These animals have very low levels of immunity, and are extremely susceptible to infection from parasites on pasture. They are also exposed to many eggs at a young age due to the periparturient egg rise of the ewe or doe. The lambs and kids will begin to develop some immunity to parasites around six to eight weeks of age, provided that they do not reach pathogenic levels of parasites in their system before this time. Lactating ewes and does on pasture follow the lambs and kids with slightly increased resistance to infection. Lactating animals are often in a negative energy balance, and therefore are weaker and less able to resist the effects of parasites on their body. Goats at any reproductive stage are more susceptible to parasitic infection than sheep.

Ewes or does in late gestation, and for a short period after parturition lose much of their resistance to parasites due to hormonal and photoperiod effects. During this period, the ewe or doe is no longer able to resist worm development or egg production. This phenomenon is termed the "periparturient egg rise," and is a critical time in the parasite control plan. It is particularly important because it coincides with a time when the number of susceptible animals (kids or lambs) increases significantly. Finally, mature dry ewes are the least susceptible to parasitic infections. These animals have some immunity due to their age, and are under no real stress to their system that could lower their body's ability to resist parasitic infections. Goats of any age have little natural resistance or resilience to parasitic infection.

Recognizing Parasitic Infections

When animals are heavily burdened with parasites, there are a variety of symptoms that can be used to identify if an animal is infected with parasites, and which parasites are causing the problem. Some general symptoms typical of parasite infections are diarrhea, weight loss or reduced weight gain, unthriftiness, loss of appetite, and reduced reproductive capacity and performance.

In the case of *Haemonchus*, anemia and edema, or swelling, are key symptoms. The *Haemonchus* parasite can consume up to $1/10^{th}$ of an animal's total blood volume in a day. Anemia is most easily identified in small ruminants by the color of the mucous membranes, particularly those in the lower eyelid. A normal animal will have healthy, red mucous membranes, while one heavily burdened with *Haemonchus* will exhibit light pink or white membranes. Edema may also occur in animals heavily burdened with *Haemonchus*. This accumulation of fluid will be most obvious as a swelling in the lower jaw, a condition known as "bottle jaw" (see Figure 4). Diarrhea is not a common

Figure 4: This picture shows a goat with bottle jaw, a main symptom of parasitic infection. This picture is courtesy of Dr. Ray Kaplan, DVM, University of Georgia.

symptom of *Haemonchus* infection, although it has been known to occur in some cases.

In order to make a definitive diagnosis of the parasite burden of your herd, it may be necessary to enlist the help of a veterinarian or a laboratory. Fecal egg counts can be done to measure the number of eggs shed in the feces of a random sample of animals in the herd. Fecal egg counts are mainly useful in determining the level of contamination on the pasture, since these numbers vary significantly from herd to herd and animal to animal. Some herds may be quite resistant to parasites, and will have large fecal egg counts with no significant health problems. Other herds may be very susceptible to parasites and a low egg count can still be indicative of some problem. Fecal samples can also be used to determine which species of parasite is infecting the herd in question. In some cases blood tests can also be used as a diagnostic tool for parasitic infection.

Control

The main goal in attempting to control *Haemonchus* and other internal parasites is to break the life cycle, which can be done in a variety of ways. The three methods that will be discussed in this publication are use of anthelmintics, animal management, and pasture management. Using a combination of these three will usually give the best results, and the best chance of breaking the life cycle of *Haemonchus* in your herd.

Pasture Management

Pasture management is a key aspect in breaking the lifecycle of internal parasites. As mentioned in the previous section, infective larvae can survive for long periods of time on pasture. The grazing habits of sheep and goats make them much more susceptible to parasites than other species. Sheep tend to graze much closer to the ground than other animals, and also show little aversion to grazing in areas with high fecal contamination. These two characteristics drastically increase the numbers of larvae that sheep are exposed to and also the number that they are likely to ingest. Although parasite problems cannot be entirely eliminated by good pasture management, using good rotational grazing techniques combined with an efficient anthelmintic program should significantly lower the parasite problem in the herd.

As was described in a previous section, the infective L3 larvae of *Haemonchus* can survive on pasture for extended periods of time. The goal of pasture management is to allow the pastures enough time to rest so that lower numbers of larvae are infective and will not be a problem to the grazing animals. There are varying ideas of what a "safe" pasture consists of, but a general rule is that a pasture is considered relatively free from Haemonchus if it has been tilled or burned since the last time that sheep and/or goats grazed the land. The land would also be considered safe if it has been grazed by other species of animals (especially cattle or horses), or if three months have passed since it was last grazed during the spring or summer and if six months have passed since it was last grazed over the winter. Pasture that has had a crop of hay removed is also considered safe.

Allowing pasture to rest stops the land from having any more parasites deposited on it, and it also allows for new growth, which lowers the risk that sheep and goats will ingest the larvae present in the pasture. When pasture is overgrazed, sheep, which tend to graze close to the ground anyway, are exposed to even more of the larvae that live low down on blades of grass. When done properly, pasture management can reduce the number of parasites that sheep and goats are exposed to. The best way to avoid pasture related parasite problems is to avoid overgrazing areas of pasture, and to implement a rotational grazing system. Rotational grazing implies that once a pasture has been grazed, animals are rotated to another paddock and the pasture is allowed a rest period. If cattle or horses grazing can be incorporated into the grazing system, parasite contamination can be reduced even further. Safe pastures can also be created by planting or utilizing summer annual forage crops. Examples of these would be sorghum x sudan hybrid forages. These forages grow quite tall and animals graze at shoulder or higher height (see Figure 5). This reduces the

Figure 5: This picture shows a goat that is browsing, or grazing at shoulder-height.

opportunity to ingest larvae. Also, goats are natural browsers, and browsing forages or brush well above ground level has the same effect.

Anthelmintics

Anthelmintics (see Figure 6) are drugs that either kill egg laying adults, or kill larvae before they become adults and become capable of laying eggs. While some anthelmintics are effective in killing *Haemonchus*, there are two major problems that arise when using anthelmintics. The first problem that affects mainly sheep and goat producers is that there are very few anthelmintics that are actually approved by the FDA for use in small ruminants. The second problem is the resistance that parasites have developed to many anthelmintics. Resistance occurs when a drug is overused and the parasites develop a tolerance to the drug, making it no longer effective in killing them. Resistance makes it very difficult to effectively control *Haemonchus* because it lowers the number of options available to treat the parasite, especially since resistance to one drug often means that a parasite will be resistant to all drugs in that compound class. Resistance will be discussed in more depth in a later section.

Figure 6: This picture shows a variety of different anthelmintics. This picture is courtesy of Dr. Lisa Williamson.

Anthelmintics can be used in conjunction with rotational grazing and proper pasture management (discussed in a later section) to lower the number of parasites that the herd is exposed to. It used to be a recommendation to deworm animals and then rotate to a new pasture. More current thinking is this practice allows eggs from resistant parasites to have a competitive advantage on the pasture rotated on, thus enhancing resistance development. After treating animals for parasites they should be left in original pasture for a couple of days before rotating. Under some circumstances, it is recommended to keep animals on a dry lot for 12 to 24 hours after deworming. This ensures that the eggs and larvae that survived the anthelmintics are not deposited on safe pasture. The decision whether or not to dry lot animals after treating with anthelmintics should be based on the season, the type of anthelmintics used, and the diet of the animals. It is usually more important in goats than sheep, since goats tend to metabolize anthelmintics faster than sheep and have a faster passage rate through the intestinal tract.

Ewes and does should also be dewormed prior to breeding and approximately two weeks prior to and one week after lambing or kidding to help combat the pre-parturient egg rise. There may also be a need for treatments throughout the grazing season, depending on the specific situation and condition of your herd. The suggestions described in this section are up to the discretion of the producer and veterinarian. There are a variety of methods that can be used to monitor the parasite levels in one's herd, and also to lower the chance of developing drug resistant parasites in your herd.

There are three main classes of drugs that are currently used as anthelmintics in sheep and goats. These three are avermectins, benzimidazoles, and imidothiazoles. These classes contain all of the

anthelmintics that are used in controlling and treating parasites in goats and sheep.

Benzimidazoles

Benzimidazoles contain the anthelmintics albendazole, fenbendazole, mebendazole, oxfendazole, and oxibendazole. Fenbendazole is approved for use in goats, and albendazole is approved for use in sheep. This class of anthelmintics is also known as the white drenches. While benzimadoles have a high margin of safety (meaning that it can safely be given at double or triple the labeled dose) and are effective against many species of intestinal parasites, their efficacy against *Haemonchus* is fairly low. The other problem with benzimidazoles, which is more pronounced in this class of drugs than in others, is that if a parasite is resistant to one of the benzimidazoles, the resistance is most likely wide spread among all of the drugs in this class.

Avermectins

The main drugs in this class are ivermectin and moxidectin. Both drugs are effective against Haemonchus in normal situations, but they are only approved by the FDA for use in sheep, and requires extra-label use in goats. Extra-label use requires that the producer work with a veterinarian to get a prescription for the desired drug, as well as the proper doses and withdrawal times when using the anthelmintics. Sheep should be given the sheep drench form of ivermectin and moxidectin, and goats should receive a higher dose.

Imidothiazoles

The most important drug for sheep and goats in this class is levamisole. Levamisole is approved for use in sheep and is also shown to be very effective against Haemonchus. There is less of a resistance problem to levamisole than there is to benzimidazoles.

Extra Label Use of Anthelmintics

Many drugs that are not approved for use in sheep and goats are perfectly safe to use, they remain unapproved however because of the expense associated with getting FDA approval for drugs. The small ruminant industry is not prominent enough in this country to warrant the government or the drug companies expending the money necessary to do the research and approve the drug. The goat industry suffers even more than the sheep industry from this perspective, because there are even fewer anthelmintics approved for use in goats. However, although some drugs are not approved for use in a particular species, they can still be used to treat parasite infections through extra-label use.

As mentioned previously, extra-label use requires the producer to work closely with a veterinarian to get a prescription for the desired drug, as well as the proper doses and withdrawal times when using the anthelmintics. Through extra-label use, goats can be treated with ivermectin, doramectin, levamisole, and moxidectin. There are more anthelmintics approved for use in sheep, so there is less necessity for extra-label use than with goats.

Administration of Anthelmintics

Anthelmintics can be administered to animals by varying means, with the most common being in the form of oral drenches. Oral drenches are thick liquid suspensions of the anthelmintics that are deposited into the back of the animal's mouth (see Figure 7).

Some anthelmintics are available in the injectable form, but these are not generally recommended for use in small ruminants. It is particularly important when

Figure 7: This picture shows an oral drench being administered to a goat.

using drugs not labeled for use in sheep and goats that the concentration of the active substance be considered when determining the appropriate dose for the animals. It is also necessary to realize that sheep and goats metabolize many anthelmintics at different rates, with goats usually metabolizing the drugs faster and often requiring a larger dose.

When using products that are not approved for sheep and goats, it is imperative that the amount being given is in fact the recommended dose for sheep or goats, not the species for which the formula is marketed. Some products may be marketed for cattle as injectable or pour on, but will be ineffective if administered to sheep or goats in this manner. Pour-on anthelmintics are formulated to be absorbed through the skin of cattle, but do not absorb in therapeutic amounts

through sheep and goat skin due to the wool and hair of these species. It is also important that drenches are mixed in the proper way and administered while they are still effective. If drenches are not mixed properly, they may settle out, and the animal will not receive the effective amount of the anthelmintics. It should also be common practice to check the expiration date of a product before administration.

Parasite Resistance to Anthelmintics

Resistance is one of the main reasons why parasites, *Haemonchus contortus* in particular, are such a huge problem for small ruminant producers. Producers may find one method or anthelmintic that appears to effectively control parasites in their herd, but the efficacy of anthelmintics can be significantly lowered when resistance develops. Resistance is very difficult to overcome because it reduces the number of anthelmintics available to treat the herd and may last for years.

Resistance to anthelmintics has developed as a result of years of overuse and improper dosing with available anthelmintics. When producers continuously deworm their herd with the same anthelmintics, fewer and fewer parasites are killed with every treatment, and genetic selection for resistant parasites occurs. This resistance occurs mostly when animals are under-dosed, meaning that the amount of anthelmintics administered to the animal is not enough to kill a significant number of parasites. The parasites that are resistant to the drug then begin to reproduce and the number of resistant parasites in the animal continues to multiply until that particular drug is no longer effective at all.

Checking your herd for resistance

If a producer suspects that resistance may be present in his herd, there are a few things that need to be considered. Anthelmintics can be ineffective for a variety of reasons, which should be ruled out before resistance is determined as the root of the problem. Improper dosing is a major reason for the reduced or total lack of efficacy in anthelmintics. Before administering the dewormer, it is important to make sure that the dosing gun is calibrated properly and that the proper dose is being delivered to the animal.

When all of these possibilities for ineffectiveness of a dewormer can be ruled out, a Fecal Egg Count Reduction Test may be necessary in order to determine the efficacy of the anthelmintics. This test, more commonly called FECR test, involves taking fecal samples from a random group of animals within the herd. Samples should be taken at the time of deworming and then again 10 to 14 days from the same animals after treating with an anthelmintic. In order for an anthelmintic to be considered effective, there should be at least a 95 percent reduction in the number of eggs between the two samples. If the test shows a reduction of less than 95 percent between the two samples, it is probably time to rotate to a new class of drugs (see Figure 8).

Figure 8: This picture shows people in a lab reading the results of a Fecal Egg Count Reduction test.

Avoiding Resistance

First and foremost, resistance can be prevented by making certain that herds are all dosed for the heaviest animal in the class, with does, bucks, and kids each making up a separate class within the herd. Most anthelmintics (except levamisole) have a wide safety margin, so it is not dangerous to give the smaller animals a dose higher than the recommended amount. If lambs or kids are included in the herd, all of the lambs or kids should be dosed according to the weight of the heaviest lamb or kid in the herd. It is imperative that the equipment being used to administer anthelmintic medication to animals is calibrated properly, and that the compound itself is effective, not out of date, improperly stored or ineffective due to resistance.

Producers can avoid resistance in their herd by not purchasing animals that already show signs of having resistant parasites. If these animals must be purchased, they should be aggressively treated for parasites, and quarantined from the rest of the herd for 21 to 30 days. They should be treated with anthelmintics from three different classes in order to avoid leaving any worms present that may be resistant to one of the classes of anthelmintics. Using three different drug classes

should kill all of the worms present in the animal. Following deworming, the animal should remain separate from the herd in a dry lot for 21 days, and a fecal egg count should be performed in order to ensure that the deworming achieved the desired results.

Rotation of dewormers is also a common practice in attempting to avoid resistance. Past recommendations advocated that producers switch between different classes of anthelmintics with every deworming. However, this practice has now been shown to increase resistance by selecting for worms that are resistant to different drug classes at the same time. With most anthelmintics, if worms are resistant to one member of that drug class, they will be resistant to all of the members of that class. The current recommendation is that anthelmintic dewormers be rotated on an annual basis, or until the current drug loses its effectiveness. By using the anthelmintic for a longer period of time, the development of resistance is slowed.

It is becoming a common practice to deworm only some of the animals in the herd. This practice is based on the knowledge that in most herds 20 percent of the animals carry approximately 70 to 80 percent of the parasite burden. By only deworming a small portion of the herd, there is a population of worms left in refugia. Refugia refers to the population of worms that are left untreated, and therefore are still susceptible to anthelmintics. By maintaining this sensitive worm population, the anthelmintic resistant genes are diluted among the population, and resistance is slowed down. A system called the FAMACHA system was developed in South Africa based on the refugia concept. It is used as a way to combat resistance and lower the cost to sheep and goat producers of *Haemonchus* loss, treatment, and control.

FAMACHA

As was mentioned in the previous section, FAMACHA is a system that was developed in South Africa to aid farmers in combating the problems of parasite resistance and high treatment costs in sheep. The goal of the FAMACHA system is to decrease and delay resistance by only selectively treating the animals in the herd that are showing symptoms of parasite infection.

Haemonchus has already been described as a blood sucking parasite that causes severe anemia in its hosts. FAMACHA utilizes the color of the mucous membranes in the lower eyelid to determine the level of anemia that the animal is experiencing. The FAMACHA chart (see Figure 9) assigns a number from 1 to 5 to each level of color in the eyelid. A normal eyelid of a healthy sheep or goat is dark red, indicating that no anemia is present and the animal is presumed to be free of dangerous levels of parasites. The range of colors used in the FAMACHA system goes from Red, to reddish pink, to pink, to pinkish white, to white. The numbers 1 to 5 are assigned to each of these values, respectively. Although some dispute remains as to where the cut off for treatment should be, producers generally treat animals with a score of a 4 or a 5, and in some cases a 3. Since goats are affected more seriously by internal parasites than sheep, the cut offs for treatment in goats may be lower than in sheep to prevent serious loss from occurring. Treatment also depends on class of animal and the relative susceptibility of that class of animal (i.e. buck, doe, kid, lamb). Producers can be trained and certified to

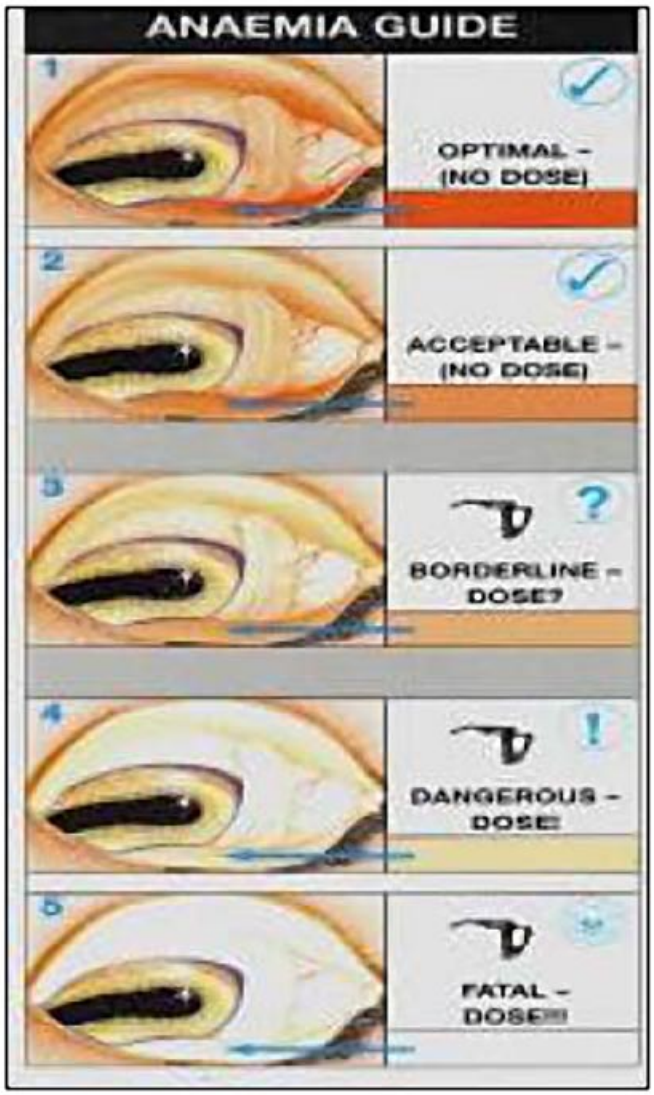

Figure 9: This image is the FAMACHA chart that depicts the eyelid color associated with each level of anemia and each FAMACHA score.

Figure 10: This picture shows a goat having the color of its eyelid checked against the FAMACHA chart.

use the FAMACHA system (see Figure 10). The FAMACHA system can be a valuable tool in helping to delay resistance issues in sheep and goat herds.

Recommendations for Effective Management of Internal Parasites

- Remember that effective management of internal parasites cannot be accomplished by using only one management factor, it is a combination of factors that will produce the most effective defense against internal parasites.
- Anthelmintics should be used only to treat animals when necessary, and should be thought of as a limited resource to be used sparingly.
- Rotation between different classes of anthelmintics can slow the development of resistance.
- Remember, if a parasite becomes resistant to one drug in a class, it is probably resistant to all drugs in that class.
- The FAMACHA system can be used to identify which animals are in need of anthelmintic treatment.
- Proper pasture and animal management is a key component to managing internal parasites in sheep and goat operations.

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