CURRENT CONCEPTS IN SHEEP PARASITE CONTROL

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INTRODUCTION

Internal parasites, or worms, cause economic and production losses to sheep producers where pasture conditions allow the worms to complete their life cycle. Sheep infected with parasites may become ill and even die. Infected sheep don't gain well or loose, weight, become lethargic and may have diarrhea. Sometimes losses occur which are undetected because the signs of parasitism are not obvious. The internal parasites responsible for the greatest losses to sheep in the mid-atlantic area are the ones that infect the abomasum, or true stomach, of the sheep. Every flock in the mid-atlantic area harbors some of these parasites. By far the most important of these is a parasite technically known as Haemonchus contortus, or the barberpole worm. Lung worms are rarely a problem in flocks. Since control programs for Haemonchus usually result in the control of intestinal worms, they will not be considered separately in this discussion.

LIFE CYCLE

An understanding of the Haemonchus life cycle is important to understanding effective control programs. The life cycle of Haemonchus is defined as direct. This means that it does not need any other animals in order to complete its cycle. Adult Haemonchus worms live in the abomasum and lay eggs in huge numbers that are then passed in the manure. Following passage onto the pasture in the manure, they must develop into infective larvae before they are capable of infecting the sheep. The period of time required for the hatching of the egg and development of the larvae is dependent on weather conditions, but it may be as little as five days or as long as several months. Larvae develop and survive best under warm, wet conditions. This explains why parasitism is a much greater problem in moist climates than in dry, arid climates. It also explains the seasonal occurrence of parasitic disease following periods of warm, moist weather.

After larvae have developed into the stage where they are infective, they must be eaten by the sheep in order to complete their life-cycle. The larvae have a limited ability to transport themselves from the manure onto the pasture plants. Therefore, continuation of the cycle depends on disintegration of manure during rains, which transports larvae in splashes and small currents to the surrounding grasses. When sheep are forced to graze pastures very closely, the number of larvae ingested usually increases because the concentration of larvae is higher in the lower parts of pasture plants. The fact that sheep naturally tend to graze selected areas of the pasture very closely, even when other pasture is available is one of the characteristics that makes them so susceptible to worms.

Once the larvae are eaten, they must continue the development process before becoming adults and being able to lay eggs. This requires a very specific time period; about 14 days in the case of Haemonchus contortus. For Ostertagia and Trichostrongylus, it takes approximately 21
days of development after being eaten before the mature worm is able to produce eggs. These specific periods of time become important when strategic parasite control programs are initiated.

Figure 1 depicts the cycle of a typical stomach worm.

A factor that has important implications in the parasite life cycle is the discovery that stomach worms have the ability to go through a stage of arrested development (hypobiosis). Hypobiosis means that some of the larvae consumed by the sheep go into a dormant state instead of continuing their development. This allows them to get through periods of adverse climatic conditions for larval development and survival in the environment. This occurs in our area in the winter. These hypobiotic larvae accumulate and may reach large numbers. They may also be protected from some dewormers that are not effective against this stage of the parasite. In the spring or at lambing, a sudden resumption of their development to adult worms may occur and result in an increase in egg shedding onto the pasture and occasional disease signs in the sheep.

The damage caused by the parasite in the sheep is related to two factors. The first way that damage occurs is specific to *Haemonchus*. *Haemonchus* is a ravenous blood-sucker and removes considerable quantities of blood from the sheep. Blood loss can rapidly become greater than the animal is able to replace, resulting in anemia (a low blood cell level). Anemia may become so severe that animals are unable to transport adequate oxygen to tissues, resulting in the death of the animal. Secondly, the developing larvae damage the gland cells of the stomach, which produces a disturbance of the digestive process.
SHEEP SUSCEPTIBILITY TO PARASITISM

Sheep, as a group, tend to very susceptible to parasites and their damage. Experts suggest that this is due to a combination of several factors including:

1. *Haemonchus* is often the major parasite of sheep and its blood sucking characteristic makes it very damaging.

2. The *Haemonchus* worm is a very prolific egg layer so that worm numbers can build up very rapidly.

3. The short life cycle of the *Haemonchus* worm allows rapid, even explosive build-ups in worm numbers.

4. The small fecal pellets of sheep disintegrate very easily thus releasing the worm larvae onto pastures.

5. The ability and tendency of sheep to graze close to the ground where larvae numbers are higher increases drastically their exposure to parasites.

6. Sheep, different from many other animals, have very little aversion to grazing areas of high fecal contamination.

7. Sheep have a flocking instinct that encourages them to graze close together where worm exposure and pasture contamination becomes greater.

8. The inability of even older sheep to develop immunity that controls the parasite life cycle.

9. Increasingly there is resistance to deworming treatments by the parasites thus making their control more difficult.

SYMPTOMS AND DIAGNOSIS

Stomach worms cause the loss of large quantities of blood and protein, which results in weakness and anemia. Anemia is characterized by paleness of the gums and the linings of the eyelids. When there is a rapid build-up in the number of parasites, sheep may die suddenly due to excessive blood loss, even if they are in good body condition and appear healthy. When the build-up is slower, sheep lose weight, become anemic, and their wool becomes brittle and may fall out. Weak animals may go down, develop pneumonia, and eventually die. A condition known as "bottle jaw" (where fluid accumulates under the skin of the lower jaw) may develop as a symptom of low protein levels.

Diarrhea may or may not occur as a result of parasitism. Diarrhea results from intestinal irritation and from disturbed digestion of food. Infections with *Haemonchus* very rarely result in diarrhea. The other worm species are more likely to cause diarrhea.
By the time symptoms appear, significant damage has already occurred, and prompt action is necessary to prevent further loss. Many of the symptoms mentioned are also symptoms of other diseases. Therefore, it is wise to consult a veterinarian in order to arrive at an accurate diagnosis. Only after an accurate diagnosis is made can an effective treatment and control program be undertaken.

In general diagnosis of parasitism can be made from clinical signs. Examination of feces for worm eggs may help to understand the entire picture but it must be remembered most normal sheep will shed some parasite eggs in their feces. In addition to the examination of feces for parasite eggs, pasture grass may be examined to determine approximate levels of pasture contamination, and total parasite counts can be obtained from an autopsy.

PARASITE LARVAE NUMBERS ON PASTURES

Research in recent years has increased our understanding of when and why build-ups of parasites occur. An understanding of seasonal changes in pasture larva numbers is inherent to a successful control program. In the past, parasite larvae were considered to be relatively fragile and able to survive on pastures for only short periods. Recent research indicates that the larvae survive for considerably longer periods of time than once thought. In fact, many larvae survive on pastures through the winter or even longer.

As the lush grass growth of spring proceeds and grazing begins, the over wintered larvae are picked up by grazing animals. The number of over wintered larvae on grass tends to decrease during the spring season due to increased temperature and sunlight, which kill larvae. If sunny, dry conditions prevail, larvae numbers may decline dramatically. Larvae eaten by sheep as they begin the grazing season go through the two-week development and begin to produce eggs. Since one larva can result in an adult that produces thousands and thousands of eggs, a multiplication in parasite numbers occurs. This is particularly true if moist, warm weather conditions are favorable to the development of larvae from eggs.

From mid-summer on, if weather conditions are appropriate, a large number of larvae accumulate on the pasture. This is referred to as the "midsummer explosion" in larval numbers. Depending on weather conditions, these larval numbers may remain high on pastures for the balance of the grazing season. If hot, dry weather conditions prevail, larval numbers will decrease due to the killing effect of drying. Figure 2 is a graph of typical numbers of larvae on the pasture during grazing season.

SHEEP FACTORS

Sheep have the ability to develop some immunity to parasites. As sheep get older, they are less susceptible to the negative effects of parasites. Also, if sheep have been exposed to parasites, they will, to a certain degree, be able to inhibit parasite development and egg laying. However, this resistance is not complete and may break down during times when sheep are challenged with high numbers of infective larvae of Haemonchus. Treatment of mature ewes is, therefore, important in an attempt to prevent infection of young animals. Sheep imported from areas where parasite exposure is considerably lower may have less resistance to parasites than sheep produced locally.
A phenomena called the periparturient (meaning around lambing time) egg rise must also be considered in parasite control programs. Beginning about two weeks before lambing, and continuing up to eight weeks after lambing, the ewe has a reduced ability to deal with worms. This process occurs regardless of when during the year lambing takes place and results in decreased ability to prevent development of incoming larvae, expel worms, and inhibit egg production by parasites already present in the stomach. These parasites produce large numbers of eggs that are shed in the manure. This is evidently a mechanism by which the parasite ensures the infection of the new generation of sheep about to be born. Effective parasite control programs must prevent this contamination of the surroundings into which very susceptible lambs will be born.

PARASITE CONTROL PROGRAMS

Control programs are based on understanding the above-discussed principles. The most effective programs require the use of dewormers to some extent. However, well planned programs will provide for a minimal amount of dewormer usage. This provides a number of benefits, including 1) decreased cost due to less dewormer usage, 2) decreased parasite resistance caused by indiscriminate use of dewormers, and 3) decreased production losses due to parasitism since dewormers are used to prevent rather than treat disease.

Many control programs used in the past, although well intentioned, resulted in the sheep having only a few days without worms before the process of reinfection began. Sheep quickly returned to worm burdens of essentially pretreatment levels. This resulted because the treatment programs did not stop the pasture contamination build-up; and therefore, sheep were dewormed and returned to very heavily contaminated pastures. Effective control programs should, therefore, combine the preventive use of dewormers with appropriate grazing management.

The management on the farm will determine the required intensity of a parasite control program. The two biggest management factors affecting this are stocking density and season of lambing. With low stocking rates, much less control is needed. If lambing and weaning occur such that young lambs are not grazing from midsummer on, then the intensity of the parasite control program may be greatly decreased.

LEVEL OF PASTURE CONTAMINATION

A very useful concept in parasite control involves considering the level of contamination on pastures. Almost never can a pasture be considered to be free of worm larvae but in some cases the number of worms may be low. Pastures that have been harvested for hay, silage, or small grain crops can generally be considered to have low levels of contamination. Pastures that have been grazed by cattle, horses, or other species for a grazing season or longer are considered low because only a small amount of cross-infection between species occurs. Contrary to previous belief, a pasture that has not been grazed for a few weeks can not be considered safe. In fact, a year or more without grazing is required for ungrazed pastures to become safe. Most rotational grazing systems currently practiced do not aid in parasite control and, in fact, usually provide for an increased parasite challenge because sheep densities are higher on pastures!
If a flock is moved to a safe pasture after treatment, it may enjoy several weeks of low worm burdens rather than only two or three days as the result of treatment alone. A safe pasture should not be grazed by infected sheep; they should be treated before being allowed to graze. This treatment serves two purposes: 1) it removes the potentially harmful worm burden in the sheep, and 2) it protects the safe pasture from new contamination.

**TREATMENT FOR PARASITES WHEN GRAZING PERMANENT PASTURES**

To completely control parasites that are grazing permanent pasture deworming would have to be administered every two weeks. This frequent treatment is both expensive and labor intensive. However, early in the season 2-week treatments may be justified to prevent large pasture build-ups. Dewormers with persistent activity are marketed for cattle but are not currently approved for sheep. These dewormers stay in the animals’ body for days or weeks after treatment and kill incoming larvae different from the approved products that kill only the adult and larval worms that are in the sheep at the time of deworming. The use of products with persistent activity would allow deworming intervals to be extended.

Figures 2-7 are results of trials conducted at the Southwest Agricultural Research and Extension Center in Glade Spring, Virginia on grazing ram and ewe lambs. They were conducted to evaluate the effectiveness of deworming programs using dewormers containing a deworming product called milbemycin which has persistent activity. Two commercial preparations that contain this dewormer are Quest®, a paste horse dewormer and Cydectin®, a pour-on cattle dewormer. When cattle and horses are treated with these products the active ingredient stays in the animal for several weeks after treatment and continues to kill incoming larvae so that the animals stay free of worms for several weeks after treatment. In 1999 lambs were treated at 6-week intervals with these products, applied by the same route and at the same doses as recommended for horses and cattle. In 2000 the Cydectin® was given orally at the same dose as for cattle pour-on and the interval between treatments was extended to 8 weeks. In 2001 the dose for Cydectin was increased to 7.5 ml of Cydectin given orally at 8-week intervals.

Figure 2. Fecals worm eggs passed with three deworming strategies in 1999.
Figure 3. Red blood cell levels in grazing ram lambs with three deworming strategies in 1999.

Figure 4. Fecals worm eggs passed with three deworming strategies in 2000.
Figure 5. Red blood cell levels in grazing ram lambs with three deworming strategies in 2000.

![Graph showing packed cell volume for ram lambs during different deworming strategies.]

Figure 6. Plasma protein levels in grazing ram lambs with three deworming strategies in 2000.

![Graph showing total plasma protein for ram lambs during different deworming strategies.]

60
Figure 7. Fecals worm eggs passed with three deworming strategies in 2001.

Programs must be worked out on a per-farm basis that will balance the expense and labor of frequent treatments with the risk of losses due to heavy infections of worms. The ability to put sheep on less infected pastures and decreasing the frequency of deworming during periods when pastures are to dry to support survival of larvae will help reduce the frequency of deworming. In general pastures in Virginia will support the survival of Haemonchus larvae from late April through the beginning of October. Cooler temperatures during the late fall and winter do not support larval development so grazing sheep would not be expected to acquire large parasite loads. Larvae during these months are also more likely to be programmed for hypobiosis so that they do not develop into blood sucking adults during these months.

For treatment programs to be effective, it is essential to include all sheep. Mature ewes, any lambs over a few weeks of age, rams, and replacements must all be dewormed. Leaving a few untreated sheep mixed with sheep on a program may allow for enough parasite build-up over a period of weeks and months to destroy earlier efforts.

An alternative program used by many producers involves monthly treatments throughout the grazing season. This program will probably fail in severe parasite years because of the long interval between treatment allowing reinfection and egg laying by the worms.

Pre-lambing treatment is critical in a parasite control program and should be administered approximately two weeks before ewes lamb, thus preventing the contamination from the periparturient egg rise from occurring. This can conveniently be done when ewes are bagged prior to lambing or coupled with vaccination or crutching procedures. Waiting until lambing has occurred, or until ewes are turned out of the lambing barn with their lambs, results in considerable contamination of the environment prior to the treatment. If prelambing deworming
is not possible, ewes can be dewormed at lambing and moved to safe pastures. It is important that animals be treated with a dewormer that is effective against hypobiotic larvae. Levamisole and ivermectin are approved products which have that ability. Thiabendazole does not remove hypobiotic larvae at high rates when given at approved dosages.

Sheep kept in dry lots do not pick up larvae from grazing and need only be dewormed when introduced to lots from pastures.

OTHER DEWORMING PROGRAMS

Continuous feeding of a dewormer in the salt or mineral is sometimes used for parasite control. While this provides some parasite control, problems may develop because the dewormers available in these forms are not highly effective against all stages of parasites. Parasitism may, therefore, continue to cause production losses even though severe signs of parasitism are not seen. The low-level feeding of these dewormers also encourages the development of parasites that are resistant to the dewormer; consequently, the effectiveness of these programs decreases with time.

When fall or winter lambing is practiced so that young lambs never graze, less strenuous control programs may be practiced. This is because all grazers have greater age and acquired immunity. Pre-lambing deworming should still be practiced. Remember that young replacements must be grazed separately and given an effective parasite control program. Sheep imported from arid areas will usually be quite susceptible to parasites and require an intensive control program.

DRUGS OF CHOICE

Drug resistance, the situation where parasites survive deworming, represents a major problem for the sheep industry. Several studies have reported resistance in the major parasite species against several drugs. Essentially no drug group exists to which some resistance has not been reported.

Four techniques have been suggested for reducing the development of resistance: 1) Use a full dose of dewormer whenever treatment is done. 2) Reduce dosing frequency by decreasing stocking rates or use of pasture management. 3) Treat all new introductions with the best products available and perhaps with a double dose. 4) Avoid alternating dewormers during the grazing season. Alternating dewormers between seasons may be advisable.

Table 1 contains a list of dewormer products approved for use in sheep. The table provides information concerning trade names, manufacturers, dosage forms, and effectiveness of dewormers against the various important sheep parasites.
Table 1. Deworming products approved for use in sheep

<table>
<thead>
<tr>
<th>Generic Names</th>
<th>Levamisole</th>
<th>Ivermectin</th>
<th>Albendazole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Names</td>
<td>Levasole, Tramisol, Prohibit</td>
<td>Ivomec Sheep Drench</td>
<td>Valbazen</td>
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<tr>
<td>Manufacturer</td>
<td>Schering-Plough, AgriLabs</td>
<td>Merial</td>
<td>Pfizer</td>
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<td>Dosage Forms</td>
<td>Drench, bolus</td>
<td>Drench (injectable not FDA approved)</td>
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<tr>
<td>Parasites</td>
<td>Control</td>
<td>Control</td>
<td>Control</td>
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<td><em>Haemonchus</em></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young (immature)</td>
<td>all</td>
<td>all</td>
<td>all</td>
</tr>
<tr>
<td>Young (immature)</td>
<td>most</td>
<td>all</td>
<td>all</td>
</tr>
<tr>
<td><em>Ostertagia</em></td>
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<td></td>
<td></td>
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<tr>
<td>Adults</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young (immature)</td>
<td>all</td>
<td>all</td>
<td>all</td>
</tr>
<tr>
<td>Young (immature)</td>
<td>some</td>
<td>all</td>
<td>all</td>
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<tr>
<td><em>T. Colubri</em></td>
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<td>formis</td>
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<tr>
<td>Adults</td>
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<tr>
<td>Young (immature)</td>
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</tr>
<tr>
<td>Lung worms</td>
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</tr>
<tr>
<td>Tapeworms</td>
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<td>none</td>
<td>all</td>
</tr>
<tr>
<td>Comments</td>
<td>Some documented resistance in the U.S.</td>
<td>Effective against nasal bots. Some external parasite control (sucking, lice, ticks, keds)</td>
<td>Resistance may be a problem due to relationship to long-used thiabendazole</td>
</tr>
</tbody>
</table>

**TAPEWORMS**

The tapeworm of sheep (*Moniezia*) lives in the small intestine and is transmitted to sheep by a small non-parasite mite that lives on pasture. Sheep are infected when they ingest the infected mites on grass. Although tapeworms are often accused of causing weight loss and/or diarrhea, they rarely cause much damage. The effective drug is albendazole.
SUMMARY

Internal parasites continue to be a threat to sheep health and productivity. Increased understanding of the role and actions of internal parasites provides the basis for control programs with considerable increases in effectiveness. Treatment programs should be based on the seasonal infectivity level of pastures. Preventive or move-and-dose systems, along with other management procedures, will allow for decreased use of dewormers and result in less loss from parasitism. The emphasis for these programs is on prevention rather than treatment. The two-week maturation period of Haemonchus after ingestion, the development of hypobiotic larvae, and the periparturient egg rise must all be considered in the implementation of effective parasite control programs.