Know your enemy! Control *Haemonchus contortus* by manipulating its winter ecology

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Many sheep producers in northern New England have lost animals due to internal parasitism. Arguably the most damaging of these parasites is *Haemonchus contortus*, the Barber Pole worm. Haemonchus makes a living by feeding on blood within the sheep's fourth stomach. It matures quickly, and then lays thousands of eggs each day, leading to rapid contamination of pastures with infective larvae. The rainy 2013 grazing season in Maine created ideal conditions for multiplication of Haemonchus on pastures. Our sheep and lambs suffered from high rates of anemia and death, and our producers struggled to control these parasites with dewormers that are becoming less and less effective.

Haemonchus has historically been categorized as a parasite of the southern United States, not New England. With increased interstate movement of brood stock during the last few decades, Haemonchus has become an entrenched parasite of New England sheep, despite its inability to survive on pastures through our prolonged winters. Haemonchus has adapted to life in northern latitudes by changing the strategy it uses to survive from one grazing season to the next. While sheep grazing southern pastures continuously re-infect themselves throughout the year with Haemonchus due to year-long exposure to larval stages on pastures, larvae in the North are stimulated by decreasing photoperiod to enter a "winter hypobiosis" or hibernation within the sheep's gut until the next spring. This strategy has allowed Haemonchus to survive from one grazing season to the next in a warm, hospitable host despite the winter kill of virtually 100% of its eggs and larvae on northern pastures.

Thanks to the Internet, a variety of resources are now available that teach parasite management strategies to sheep producers. This information is based on research completed in regions with mild winters where producers have been dealing with Haemonchus for decades. How applicable are these southern management strategies to New England producers? FAMACHA and fecal egg counts are universally applicable tools that reduce the development of dewormer resistance and help us identify at-risk animals, and should be used by all sheep producers. However, current Haemonchus control programs do not take advantage of northern winter kill, even though the seasonal patterns of pasture contamination are very different in Georgia versus Maine,. For example, most of us concentrate our deworming on anemic animals during the grazing season, and then pay little attention to Haemonchus during the non-grazing season. This may be a missed opportunity.

While sheep producers in southern regions of the U.S. must deal with Haemonchus populations that can produce new larvae virtually all year, producers in northern latitudes experience a much shorter season (one to two generations from late May through July) where Haemonchus can increase exponentially in number on pasture. This difference is due partially to our cooler temperatures, but primarily because Haemonchus switches from egg-laying to the production of hypobiotic larvae after early summer. Similarly, northern sheep do not re-infect themselves with Haemonchus during the six months of the year when grazing is not possible, and all of the surviving Haemonchus individuals overwintering on a farm are located in one easily accessible area – the sheep stomach! Contrast this with the plight of sheep producers in a state like Georgia, where pastures are a PERMANENT reservoir of Haemonchus that can't be effectively controlled.

Maine's cold, prolonged winters, by interrupting the egg-laying process and reducing pasture contamination, can be used as a tool to control the spread of Haemonchus, especially if producers manage pastures to minimize egg contamination early in the season. Maine producers should take advantage of the fact that they are fighting a parasite at the **northern limit of its range**. In our climate, strategies that incrementally decrease Haemonchus' success early in the grazing season will substantially reduce subsequent losses and treatment of sick animals. Successfully implementation of these strategies can be based on;

1) understanding how Haemonchus survives through a year in Maine.

2) taking advantage of "weak links" in its life cycle.

3) intervening at critical points to reduce Haemonchus contamination of pastures.

A Year in the Life…

Let's start by reviewing the life cycle of Haemonchus. Infected sheep drop Haemonchus eggs on pasture, on roads and alleyways, on dry lots, on bedded packs in barns, and in water buckets and feed troughs! If the environment is moist and the average daily temperature exceeds 55 degrees F, the eggs will develop in stages to a long lived "infective larvae" in ten days to three weeks. Infective larvae can persist on pastures for weeks to months under optimal conditions. Infective larvae that are eaten by sheep will develop to adults in an additional ten days. Haemonchus adults will then feed on blood within the lining of the fourth stomach and lay eggs for about 4 to 6 weeks before dying.

After the summer solstice in northern latitudes, Haemonchus larvae are stimulated by rapidly decreasing day length to arrest in development before they become adults. Arrested larvae burrow into the wall of the fourth stomach and hibernate until spring, a process called hypobiosis. While these arrested larvae are curled up in a nice warm sheep, virtually 100% of eggs and larvae remaining on pastures from the previous grazing season are killed by the cold of an extended Maine winter. Another cycle of egg laying begins when cues related to lambing and increasing spring photoperiod stimulate the maturation of hibernating larvae into adults, an event called "Spring Rise."

What happens to these early spring eggs? Many of the eggs laid during the spring probably survive "mud season" but do not actually develop into infective larvae until the first extended warm spell in late May or early June. At that time, all the surviving eggs from the previous weeks to months are stimulated to mature to infective larvae. This spells disaster for sheep and lambs grazing on these heavily contaminated pastures, as huge numbers of larvae synchronously develop to blood-feeding adults. If the environment at the base of the grass blades remains moist during early summer due to frequent rains, cool weather and a thick grass cover, this first generation of larvae and their offspring could continue to re-infect grazing sheep through much of the remaining grazing season. Once infective larvae reach a dangerous level on summer pastures, producers are forced to follow a cycle of deworming, reinfection and retreatment until the grazing season ends.

Bigger Bang for the Buck…

The ideal in veterinary care of animals is the prevention of disease. While producers often treat with dewormers to reduce the loss of parasitized sheep, most would prefer a situation where deworming was not needed because the sheep were not exposed to Haemonchus in the first place.. In the case of grazing sheep and Haemonchus, successful management means keeping parasite exposure low enough

to cause insignificant decreases in animal productivity. Producers can reduce exposure of their sheep to Haemonchus by recognizing two key opportunities that are related to Haemonchus' adaptation to cold winters:

1) by mid-winter, virtually all of the Haemonchus on a farm are in the form of hypobiotic larvae in the sheep gut, so winter is the only opportunity all year for producers to treat all of the Haemonchus individuals on a farm. Use of effective wormers at this time will drastically reduce the number of parasites that survive to infect pastures during the next grazing season;

2) Spring Rise, when overwintering larvae synchronously mature into adults, begins a race between Haemonchus' brief egg-laying period and the start of the grazing season. If this first generation of adults dies of old age before they have an opportunity to infect pastures that will be grazed all summer, widespread contamination will be delayed and parasitism will be less severe during the rest of that grazing season. Remember that Haemonchus shifts from egg production to larval hypobiosis after the summer solstice, so its window of opportunity for contaminating pasture is actually limited to a few months. Once hypobiosis starts, parasite management is limited to controlling the exposure of sheep to a dwindling supply of surviving larvae.

Four Interventions…

Following are a number of actions that are likely to reduce the severity of Haemonchus parasitism on your farm. Some producers may not be able to implement all of these suggestions because of conflicts with maintaining an organic certification, complying with laws regulating drug use in food-producing animals, timing lambing for a particular ethnic market, or simply because of physical limitations in the layout of their barns, paddocks and fields. I urge you to consider these management changes by weighing the cost against the potential benefit of each recommendation on your own farm.

1. Deworm sheep during the winter to kill hypobiotic larvae. This action is easier said than done, because not all chemical classes of dewormers are effective on hypobiotic larvae, and parasites on your farm, including hypobiotic larvae, may have already developed resistance to one or more of them. Some parasite experts are now recommending sequential dewormings with two different chemical classes of drugs. Ideally, work with your veterinarian to identify treatment protocols that will work on your farm, and that are safe for your sheep.

2. Provide an alternative to using good pastures as loafing areas during mud season. This may be as simple as identifying and fencing in a patch of open woods, or using a pasture that will be hayed once the grass starts growing. Be careful about micro-environments such as manure piles, runways and dry lots that may be heavily contaminated with Haemonchus eggs. If any grass grows in these "hot spots", even if just around the fence lines, grazing sheep may receive extremely high doses of infective larvae. Spreading gravel or herbicides on these patches will decrease the odds that sheep will become infected.

3. Consider lambing earlier. Since Spring Rise is stimulated by changes associated with birth, moving lambing back to February will stimulate the development of Haemonchus adults that are less likely to survive the longer interval until grazing season - remember that this first Haemonchus generation will not be replaced by its offspring until the weather becomes warm enough to hatch its eggs in early June. Early lambing also shifts egg-laying back in time, resulting in a higher proportion of Haemonchus eggs being killed by late winter cold snaps. Lambs born earlier in the spring can be weaned and separated from their dams, then placed on "clean" pastures that have not yet been

grazed and contaminated by adults. In contrast, late spring lambs may still need to be nursing their dams during pasture season, leading to increased transfer of Haemonchus from ewes to their lambs.

4. Rotate fields often, then rest them. Excellent pasture management will decrease the numbers of infective larvae on a piece of pasture that survive from one grazing session to the next. While we can't control environmental factors such as summer temperature or rainfall that might increase larval survival on pastures, we can let pastures rest long enough to dramatically decrease the number of infective larvae on them when sheep are returned for another grazing session. Allowing sufficient rest periods is much easier when pasture available is more than adequate to feed all of our sheep! Many sheep producers in Maine graze their sheep at densities that are too high to allow effective rotational management. If that is your situation, consider feeding stored forage to your sheep rather than returning them to pastures that have not had time to regrow or decrease the levels of infective larvae.

Conclusion

Even with excellent winter management for Haemonchus, some parasitism will probably still occur each grazing season. Frequent monitoring of your sheep for parasitism will prevent "surprise" outbreaks from happening, and will allow you to selectively deworm before you lose any animals. If you have limited funds to do diagnostics, concentrate your monitoring on lambs during the first few months of the grazing season when Haemonchus populations can quickly get out of control. Fecal egg counts, FAMACHA scores and dewormer treatments can be used to identify and select individual sheep that don't seem to get sick in the face of a Haemonchus outbreak. Since parasite resistance seems to have a genetic component, these animals should be preserved as breeding stock in your flock.

Although we can improve our parasite management by understanding how Haemonchus has adapted to northern climates, many questions about its winter ecology remain unanswered. Our group at the University of Maine is interested in learning more about how to control Haemonchus, and we plan to contact local producers to participate in field studies of Haemonchus management in 2014 and 2015, if we can find funding.