Best Management Practices for Internal Parasite Control in Small Ruminants

TARGETED SELECTIVE TREATMENT (TST)

Long term use (and sometimes misuse) of anthelmintics (dewormers) has resulted in worm populations that have become increasingly resistant to treatment. In the US, dewormer resistance tends to be highest among benzimidazoles (Valbazen®, SafeGuard®) and avermectins (Ivomec®, Eprinomectin®, Dectomax®), but is also common with levamisole (Prohibit®, Leva-Med®) and moxidectin (Cydectin®), depending upon climate and individual farm.

Targeted selective treatment (TST) is considered to be an important strategy for combating dewormer resistance. TST involves deworming only those animals that require treatment or would benefit most from treatment. It differs from previous recommendations which involved whole-flock and/or calendar-based treatments.

Refugia

TST slows anthelmintic resistance by reducing the number of treatments, which increases refugia. Refugia are worms that have not been exposed to dewormers; thus, the overall worm population remains susceptible to anthelmintic treatment. The goal is to dilute the resistant worms (on a farm) so that a sufficient proportion of the worm population remains susceptible to the drugs. This maintains the high efficacy of treatments, even though some resistant worms are present. Refugia are needed to slow down the development of resistant worms.

TST also helps to identify animals which are more resistant and resilient (and conversely more susceptible) to parasitic infection. There are several tools which small ruminant producers can use to identify which animals require or would benefit from deworming. These include the FAMACHA© eye anemia system, body condition score (BCS), and the Five Point Check©. Performance indicators, including the Happy Factor®, are other options for implementing TST.

Some animals are more susceptible to internal parasitism. *Image by Susan Schoenian*

The FAMACHA© System

The FAMACHA© eye anemia system was developed almost 30 years ago by South African researchers in response to growing dewormer resistance. FAMACHA© was introduced to the US (and other countries) in 2002, where it was validated (and modified) for sheep, goats, and camelids (llamas and alpacas).

FAMACHA© is a color eye chart that estimates the level of anemia (blood loss) in the animal. Anemia is the primary symptom of barber pole worm infection. The

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barber pole worm (*Haemonchus contortus)* is a highly pathogenic roundworm that thrives in warm, moist climates and/or during periods of seasonal rainfall. It is the primary parasite of small ruminants in many parts of the US. Anemia is measured by packed cell volume (PCV) or blood hematocrit: the proportion (%) of red blood cells in blood. While there can be other causes of anemia, the barber pole worm is the most common cause in the US.

Anemia is also a symptom of liver fluke disease (fascioliasis). Other causes of anemia can be undernourishment or diseases, such as paratuberculosis (Johne's disease), caseous lymphadenitis (CL), and protozoan parasites, such as coccidia and trypanosome. To find out if worms are the cause of anemia, the fecal egg counts of animals with FAMACHA© scores of 4 or 5 can be examined. If most pale animals have high fecal egg count, then FAMACHA© can be used as the primary deworming criteria.

A FAMACHA© card displays five color and treatment categories. Each corresponds to a PCV value or range. A FAMACHA© score of 1 (red) is indicative of an animal with a healthy or "high" PCV (>28%). At the other end of the scale is a FAMACHA© score of 5 (white) which is indicative of a very low or "deadly" PCV (<12%).

Category	Color	Treatment Recommendation
1	Red	No
2	Pinkish-red	No
3	Pink	Maybe
4	Pinkish White	Yes
5	White	Yes

Treatment recommendations

It is recommended that sheep, goats, and camelids with FAMACHA© scores of 4 or 5 always be dewormed with effective drugs, whereas those with FAMACHA© scores of 1 or 2 generally do not need dewormed, unless other signs of parasitism are present. It is usually advisable to treat periparturient females with FAMACHA© scores of ≥ 3, especially if they are young and/or nursing multiple offspring. Because they have comparatively small blood volumes and can progress rapidly from moderate to severe anemia, consideration should be given to

It is usually not necessary to deworm the entire flock.
Image by Susan Schoenian

deworming lambs and kids with FAMACHA© scores of ≥ 3. It is not uncommon to deworm any goat with a FAMACHA© score of 3 or greater, since goats tend to have lower PCVs than sheep.

Some additional recommendations for FAMACHA© scores of 3 are 1) treat 3s if FAMACHA© scores are trending higher since the last time the animals were checked; 2) treat 3s if more than 10 percent of the group has FAMACHA© scores of ≥ 4; 3) treat 3s if you will not be able to check the animals in a timely fashion; and 4) treat 3s if nutrition is sub-optimal or the risk of reinfection is high.

For all species, FAMACHA© scoring is most sensitive when categories 3, 4 and 5 are treated. However, based on research, 3s are only rarely anemic, and treating all 3s will greatly increase the total number of treatments. However, by treating FAMACHA© category 3, you are reducing the probability of missing an anemic (clinically parasitized) animal. In contrast, when only categories 4 and 5 are treated, the probability of deworming an animal that doesn't require treatment decreases. Some producers choose to err on the side of caution and deworm any animal that has a FAMACHA© score of 3 or greater.

Proper FAMACHA© technique is essential.
Image by Cristina Sotomaior

Performance can be a criteria for deworming.
Image by Susan Schoenian

Using the FAMACHA© system

Proper training is required before using the FAMACHA© system. In fact, producers must take an approved training course in order to get a FAMACHA© card. Veterinarians may purchase FAMACHA© cards without completing a training, though training is still recommended. Louisiana State University is the sole North American distributor of FAMACHA© cards. FAMACHA© workshops are conducted throughout the United States. Online certification is also available at https://www.wormx.info/online-famacha-certification.

Proper FAMACHA© technique is essential and the main reason why training is mandatory. The phrase "Cover, Push, Pull, Pop" has been adopted to teach proper technique; 1) cover the top eyelid; 2) push down on the eyelid (gently); 3) pull down the bottom eyelid; and 4) the mucous membranes will "pop" into view. You should not try to expose the membranes simply by pulling down on the eyelid. It is important not to score the inner surface of the lower eyelid, but rather to score the bed of mucous membranes. Both eyes should be scored, since they can be different. You should always use the higher score and err on the side of caution. Half scores are not used. The higher score should always be used. A FAMACHA© card (not memory) should always be used to assign FAMACHA© scores.

A handling system with a head gate is convenient for doing FAMACHA© scoring. FAMACHA© scoring can also be done chute-side, by leaning over the raceway panel. Producers who don't have handling equipment can crowd their animals into a pen or have someone else hold the animal for inspection. Camelids are more challenging to score than sheep and goats. Smaller and more docile camelids may be manually restrained, whereas larger and more spirited camelids may require a chute for safety purposes.

FAMACHA© scoring can be done at the same time as other activities, such as weighing, sorting, body condition scoring, or vaccinating. It should always be done in full daylight, not indoors or in the shade. Care should also be taken not to shade the eye when scoring. The FAMACHA© card should be stored in a dark place when it is not being used (to prevent fading). It should be replaced after several years of use. The length of time is dependent on the extent of use and how the card is stored. A suggested approach is to have two cards: one is used and one is stored in the dark. Every few months, compare the cards and when the in-use card looks faded as compared to the storage-card it is time to replace it. Under no circumstances should someone try to make their own card by copying the colors of the FAMACHA© card.

One of the challenges of the FAMACHA© system is that it can be labor-intensive. Animals need to be checked frequently (every 1 to 3 weeks) during the peak *H. contortus* transmission season. Outside the months of peak transmission, animals can be checked with less frequency. Depending upon

climate, it may not be necessary to check animals during the winter months. The exception to this would be pregnant females, which suffer a temporary reduction in immunity around the time of parturition.

For producers with large flocks or herds, a random sample of animals can be selected for FAMACHA© scoring. If the combined percentage of 1s and 2s exceeds 80 to 90 percent, and there are no category 4 or 5 animals in the selected group, it is unlikely there is danger in not checking the whole flock. Another check could be done in a few weeks. However, if there are some 4s or 5s, then the entire group should be checked or even treated, leaving some animals untreated to maintain refugia. Another option is to sort off the animals that lag behind (thus, are more likely to be parasitized) and subject them to scoring. In large flocks and herds, FAMACHA© can be used to select male and female replacements.

BODY CONDITION SCORE (BCS)

Body condition score (BCS) is a measure of the relative fatness of an animal. Low body condition scores (≤ 2) are indicative of a nutrition issue, and these animals are more prone to parasitic infection. Moreover, animals with low BCS and/or on a poor plane of nutrition are less able to cope with the effects of a parasitic burden.

Various studies have shown BCS to be a reliable indicator of internal parasitism in adult animals. In the tropics, research has shown that hair sheep ewes with a BCS of 3 or greater can be maintained without anthelmintic treatment during the production year. Similar results have been obtained in Australia. Leaving ewes with higher BCS untreated helps to maintain refugia. Research has shown that camelids in optimal to overweight categories harbor fewer parasites. Body condition scoring is probably less effective as a tool for young growing animals.

Sheep, goats, and camelids are typically assigned body condition scores using a scale from 1 to 5, with 1 representing emaciated, 3 being average, and 5 being obese. Half scores are used. Visual assessment of body condition can be misleading because fleece (and even pregnancy) can hide the true status of an animal. It is necessary to touch the animal to assess body condition, and it is recommended to use a body condition scoring card (or fact sheet or video) as a reference.

BCS can be a reliable indicator of parasitism in adults. *Image by Lisa Williamson*

Body condition scoring involves feeling for fat and muscle over the spine, loin, and ribs. Prominent bones are an indication of less fat cover, whereas bones that are difficult to detect can be an indication of over-condition. Better conditioned animals also feel fuller in the loin. Body condition scoring is different in goats (and some hair sheep), as they carry more fat in their abdomen and less on their backs. It is normal for goats to carry less condition than sheep,

THE FIVE POINT CHECK©

The Five Point Check© was developed by the same South African researchers to address the limitations of the FAMACHA© system, which only assesses damage caused by blood feeding parasites, primary *H. contortus*. The Five Point Check® is a simple extension of the FAMACHA© system. It utilizes five check points (on the animal's body) to make deworming decisions. These five check points provide the criteria necessary for evaluating the

Goat with "bottle jaw" *Image by Susan Schoenian*

impact of other parasites that can affect small ruminants, including those that cause digestive disturbances and infect the nasal passages (nasal bots). The Five Point Check© exemplifies the importance of considering multiple criteria when making deworming decisions.

The five check points are eye, jaw, back, tail, and nose. (1) The eye is examined to determine FAMACHA© score. (2) The jaw is examined to check for the presence (or absence) of bottle jaw (submandibular edema). (3) The back is felt to assess body condition score. (4) The tail is observed to determine the extent of fecal soiling. (5) The nose is observed for signs of a nasal discharge.

Bottle jaw

Submandibular edema is an accumulation of fluid under the jaw of the animal. It is commonly called "bottle jaw." The edema is caused by disruption of the normal balance of pressure and/or proteins between the blood and the spaces between cells located outside the blood vessels. All animals with bottle jaw, whether they appear anemic or not should be dewormed. On the other hand, bottle jaw does not develop in the majority of animals that are clinically parasitized. It is seen primarily when anemia is severe.

While there can be other causes of bottle jaw in small ruminants, the barber pole worm is the most common cause. However, it is important not to confuse bottle jaw with milk goiter (neck), which is a (lower) throat-swelling, common to well-nourished goats and hair sheep lambs. Tooth abscess, periodontal disease, and "lumpy" jaw (caused by bacteria) can also look similar to bottle jaw.

Fecal soiling (or dag score)

Parasites which cause mild to severe diarrhea (scours) are more significant than the barber pole worm in some locations and parts of the world. The accumulation of feces on the backside of a sheep can predispose it to fly strike. The tail (or hindquarters) of the animal should be examined to determine if diarrhea is present. Fecal soiling is usually assessed using a scale of 0 to 5, with 0 representing no fecal soiling and 5 representing very severe diarrhea, extending to the hocks. Treatment (or action) is usually considered at score 3 (moderate soiling, dag formation). As with most of the other checkpoints, there can be other causes of diarrhea besides worms.

Nasal discharge

A clear or even purulent nasal discharge can be indicative of nasal bots. Nasal bots are a parasite of sheep and goats. While usually only a minor annoyance, they can cause serious problems in some instances. Female flies (*Oestrus ovis*) deposit their larvae in and around the nostrils of their host, causing sneezing and a snotty nose.

In goats, the nose check point is sometimes changed to coat condition. A poor or rough hair coat can be indicative of parasitic infection. Researchers have found coat condition to be a reliable indicator of welfare in dairy goats. Like other parameters, a poor hair coat can have other causes including poor nutrition and/or other disease conditions, and it is important to consider additional check points or criteria when making deworming decisions.

Fecal soiling and dag formation can be a sign of parasitism. *Image by Susan Schoenian*

Check point	Observation	Possibilities
1. Eye	Anemia 1-5 FAMACHA© card	Barber pole worm Liver fluke Other diseases Undernourishment
2. Jaw	Soft swelling "bottle jaw"	Barber pole worm Liver fluke Other diseases
3. Back	Body condition score 1-5 BCS card	Brown stomach worm Bankrupt worm Nodular worm Other worms Other diseases Undernourishment
4. Tail	Soiling (0-5) Dag score card	Bankrupt worm Brown stomach worm Nodular worm Other worms Other diseases
5. Nose	Discharge 0-1	Nasal bots Lungworms Pneumonia Other diseases

Adapted from Bath and Van Wyk, 2009

In addition to assessing the damage caused by worms other than blood feeders, the Five Point Check® is useful for making deworming decisions for animals with FAMACHA© scores of 3. For example, a small ruminant with a FAMACHA© score of 3 should be dewormed if it has bottle jaw, poor body condition, and/or moderate to severe diarrhea.

PERFORMANCE INDICATORS

Weight (or more precisely gain) has also been used to implement TST, mostly in climates where the barber pole worm is not the primary parasite. The Happy Factor™ was developed by New Zealand researchers. It is a model that predicts a target weight for a growing lamb. If the lamb fails to achieve the predicted level of performance, it is dewormed; otherwise, it is left untreated. Similar to FAMACHA©, the Happy Factor™ results in fewer treatments being given; thereby, increasing refugia, while maintaining productivity.

Brazilian researchers determined that TST that combined weight gain with FAMACHA© produced the best performance in lambs. In fact, they recommend against using FAMACHA© as the sole criteria when making deworming decisions, even in situations where the barber pole worm is the primary parasite. Similar experience in tropical areas of Latin America has shown that properly nourished lambs can be maintained without anthelmintic treatment, so long as they meet a standard of performance (e.g. $\geq$ 100 g per day or 0.22 lb. per day).

In Europe, milk production has been used as a criterion to deworm dairy goats, with goats in their first lactation and with the highest level of production being targeted for treatment. British researchers have applied different deworming protocol (and nutrition) to ewes carrying single, twin, and triplet fetuses.

Fecal egg count (FEC) is frequently used to make deworming decisions. When flock size is too large for individual assessment, whole flock treatments are administered when certain FEC thresholds are achieved. Leaving some animals untreated (at least 10%, preferably 15 to 20% or more) helps to maintain refugia. The FEC that triggers treatment varies. As a deworming criterion, FEC is most effective when it is combined with the other criteria.

Other Combined TST

Similar to the Five Point Check©, other combined TST strategies have been developed around the world. In tropical areas, many animals struggle with undernourishment. Sometimes, they have poor BCS and/or FAMACHA©, but low worm burdens. In these situations, Mexican researchers suggest fecal sampling animals with poor BCS $\leq$ 2.5) and/or FAMACHA© (4,5). If fecal egg count reaches certain thresholds, the animals are dewormed. Otherwise, treatment is withheld, but the skinny, pale animals are given improved nutrition.

Researchers in Ontario, Canada compared whole flock treatments (pre-lambing) of periparturient ewes with a TST strategy that used four criteria to determine deworming need. Ewes were only dewormed if they met at least one of the four criteria: 1) last grazing season was first grazing season; 2) BCS $\leq$ 2; 3) FAMACHA© score $\geq$ 4; and/or 4) nursing three or more lambs. Similar to other studies, their research demonstrated that TST can be effective, so long as accurate indicators are used to identify animals that need treatment.

COMBINATION TREATMENTS

The effectiveness of TST as a treatment strategy depends on the use of effective dewormers. An effective deworming treatment reduces fecal egg count by 95 percent or more. Dewormer resistance can be determined by comparing before and after fecal egg counts from 10 or more treated animals that have sufficiently high fecal egg counts (250 epg or higher).

It is now recommended that clinically parasitized small ruminants be given combination treatments. A combination treatment is when you give more than one drug to kill the same worm species. Combination treatments have an additive effect on the worm population. The purpose of combination treatments is to kill as many resistant worms as possible; worms that survive one drug can be killed by the second (or third). Of course, combination treatments will not be effective if none of the drugs used in the combination have enough efficacy. To be beneficial, each drug in the combination treatment should reduce fecal egg count by at least 60 percent.

In non-US countries, combination drenches may be commercially available. In the US, it is necessary to purchase and administer each drug separately. The most effective drug from each class should be given. In the US, this is usually albendazole (Valbazen®) + moxidectin (Cydectin®) + levamisole (Prohibit®, Leva-Med®). A full dose of each drug (based on an accurate weight) should be given. Drugs should not be mixed. Optimally, a different dosing syringe should be used for each drug, with treatments being given sequentially. The withdrawal period for the drug with the longest withdrawal (usually Cydectin®) should be followed.

Veterinary approval (valid veterinarian-client-patient relationship; VCPR) is required to administer combination treatments to goats and camelids, as non-FDA-approved drugs are usually recommended. For sheep, there is an FDA-approved drug in each dewormer class. When administering combination treatments, it is essential to follow TST guidelines to prevent resistance from developing to all drugs and classes simultaneously. When combination treatments are used in conjunction with other “best management practices,” the susceptibility of the worms to individual drugs may improve. However, if combination treatments are administered without maintaining refugia, multiple-drug resistance could occur quite rapidly.

SELECTING FOR RESISTANCE

Targeted selective treatment (TST) can be used to identify small ruminants that are more resistant and especially more resilient to internal parasites. Resistant animals are more immune to parasitic infection. Resistance (fecal egg count) is a moderately heritable trait (20 to 40%). Resilient animals maintain good health and performance while harboring a parasite load. Resilience tends to be less heritable than resistance. Both traits are important.

It goes without saying that animals that require frequent deworming should be culled (sent to slaughter, not sold for breeding. The frequency standard will depend upon the level of parasite challenge and the success of other parasite control measures. The culling standard should be applied more stringently to stud males, as they contribute the majority of genetics to the flock or herd, especially if they are bred to a lot of females and/or used in multiple breeding seasons.

The downside to using TST to select for parasite resistance is that resilient animals, i.e., those not

requiring deworming, may still be shedding a lot of worm eggs onto the pasture. Genetic correlations between FEC and FAMACHA© score are variable, but generally only low to moderate. The same is true of other clinical parameters. Fecal egg counts are still the best measure of parasite resistance and are recommended to producers who want to make more rapid genetic improvement.

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