SOUTHERN CONSORTIUM FOR SMALL RUMINANT PARASITE CONTROL (SCSRPC)

- Veterinarians
- Parasitologists
- Animal scientists
- Extension specialists
Internal Parasites
#1 health problem in sheep and goats in warm, moist climates

- Sheep and goats are the most susceptible livestock to internal parasites.
  - Close grazing
  - Graze near fecal pellets
  - Slow-to-develop immunity

- We can no longer rely on anthelmintic treatments alone to control parasites; a much more integrated approach is necessary.
  - Few anthelmintics are FDA-approved for sheep, even fewer for goats.
  - Anthelmintic resistance is real and increasing.
  - New drugs take a lot of time and money to develop and reach the market place (if ever).

anthelmintic = dewormer = anti-parasitic drug
Haemonchus contortus

The Barber Pole Worm
A blood-sucking parasite (roundworm) that pierces the mucosa of the abomasum (ruminant “stomach”) and causes blood plasma and protein loss to the sheep, goat, or camelid.

I want your blood!

0.05 ml blood per day
Barber Pole Worm

**Symptoms**
- Pale mucous membranes
- Edema (bottle jaw)
- **NOT** diarrhea (scours)
- Ill thrift
- Sudden DEATH

**Difficult to control**
- Short, direct life cycle
- Prolific egg producer
- Can go into “hypobiotic” (arrested) state during winter to survive.
- Can survive on pasture for a long time.
  → Adaptable

Rough hair coat
Weight loss, unthrifty
Bottle jaw
Pale membranes
Other gastro-intestinal (round) worms (*strongyle family*)

- Direct life cycles
- Burrow into the wall of the abomasum or intestines.
  - Usually secondary in importance.
  - Usually have an additive effect in mixed parasitic infections.
- Symptoms: scouring, weight loss, rough hair coat, ill thrift, poor appetite.

*Trichostrongylus Ostertagia (Teladorsagia) Oesophagostomum Nematodirus*
Fecal egg counts - Larvae ID
2009 Western Maryland Pasture-Based Meat Goat Performance Test
Tapeworms

Moniezia spp.

**Life Cycle**
- Worms live in the small intestines.
- Eggs pass out through feces.
- The egg is eaten by a pasture mite.
- The egg hatches.
- The mite is eaten by the sheep or goat.

- Is the only parasite we can see in the feces.

- Light loads of tapeworms tend not to be a problem, but severe infestations could cause GI problems.

- Tapeworms are generally considered to be non-pathogenic.

- Deworming for tapeworms has not been shown to increase performance in lambs.
Lungworms

- Indirect or direct life cycle.
- Transmitted in feces.
- Difficult to see in fecal sample.
- Severe infestations can result in coughing, fluid on lungs, pneumonia.
- Diagnosis is usually via necropsy.
- Most drugs which kill stomach worms kill lung worms.
Liver flukes

*Fasciola hepatica*

- Generally not considered to be a problem in Mid-Atlantic area.
  - Gulf states and Pacific Northwest.
- Requires open water and aquatic snails (wet conditions) to complete life cycle.
- Can kill adult liver flukes with Albendazole (Valbazen®) or Ivomec® Plus.)
Coccidia

*Eimeria* sp. (species-specific)

Normal inhabitant of ruminant’s GI system.

Single-cell protozoa that damage the lining of the small intestines.

- Causes diarrhea that may be smeared with blood and/or mucous.
- Signs of disease occur ~17 days after infection (ingestion of oocytes).
- Damage can be permanent!

Prevent with good sanitation and proper stocking.

Fecal samples may or may not be helpful in diagnosing disease.
Coccidia

*Eimeria sp.* (species-specific)

- Can use additives in feed, mineral, or water to prevent clinical disease in groups of animals:
  - Lasalocid (Bovatec®)\(^1\)
  - Monensin (Rumensin®)\(^2\)
  - Decoquinate (Deccox®)\(^3\)
  - Amprolium (Corid®) in water

- Treat (individual animals) with Amprolium or sulfa drugs.

\(^1\)FDA-approved for sheep
\(^2\)FDA-approved for goats
\(^3\)TOXIC to EQUINES!!!!!!
Meningeal worm (deer, brain worm)  
*Parelaphostrongylus tenuis*

- Parasite of **White Tail Deer**
- Small ruminants are abnormal hosts.  
  - sheep, goats, llama, alpaca, horse
- Parasite has **indirect** life cycle  
  - Snails and slugs needed for infection.
- Once ingested, larva travel from intestinal tract to spinal cord to brain, causing progressively worse symptoms . . .
  - Lameness
  - Gait abnormality
  - Hind quarter weakness
  - Paralysis
  - DEATH
  - Animals maintain appetite

Cannot diagnose in a living sheep/goat (necropsy or spinal fluid)
Meningeal worm

Treatment
- High doses of anthelmintics
  - Ivermectin
  - Fenbendazole
- Anti-inflammatory drugs
- Some recover on their own.
- Cannot repair damaged tissue.

Prevention
- Restrict access to certain areas of pasture.
  - Fence off wet areas
  - Areas with lots of debris
- Control deer population
- Control snail/slug population
- Monthly deworming
  - Only if problem is severe!

Fencing to exclude deer is not usually practical.
How do you know what kind of worms your sheep or goats have?
Parasite identification

1) Fecal flotation or egg count

✔ Can differentiate between strongyle (stomach), tapeworm, and coccidia eggs.
❌ Can’t differentiate between most strongyle (stomach) worm eggs. eggs (except Nematodirus)
✔ Meningeal worm does not pass eggs

✔ Do-it-yourself
  • Public lab
  • Diagnostic lab
  • Private lab
  • Veterinarian

Moniezia spp.
Eimeria spp.
Stomach worm identification

2) Fecal coproculture / larvae ID
   - Differentiate between **strongyle** (stomach) worms (*H. contortus*, *Teladorsagia*, and trichostrongyles)
     - University of Georgia
       (Dr. Ray Kaplan’s lab)
   - Can take test one step further to determine anthelmintic resistance -- larval development assay (LDA) or DrenchRite® test.

3) Lectin-staining test (new)
   - Determine percent of *Haemonchus contortus* eggs in sample.
     - Oregon State University
     - University of Georgia
How do sheep and goats get infected with parasites?

sheep/goats + grazing (pasture) = worm infection

L3’s infective larvae ingested → L4’s and adults suck blood
Life Cycle of Stomach Worms

Worm problems vary by location, farm, year, and season.

Eggs require warmth (60°F) and humidity to hatch to first stage larvae.
Integrated Parasite Management (IPM)

Goal is not to create parasite-free animals. It is normal for sheep and goats to have parasites. Goal is to prevent clinical disease and production losses.
Consider host resistance

**Most susceptible**
- Weaned lambs and kids
- Orphan lambs and kids
- Yearlings
- High producing females
- Late-born lambs and kids
- Geriatric animals
- Goats
- Unadapted breeds

**Less susceptible**
- Mature animals
- Males
- Dry ewes
- Pets
- Mature wethers
- Sheep
Parasite control begins with good management and common sense

- Good sanitation.
- Use of feeders which prevent wastage and contamination.
- Clean water, free from fecal matter and other debris.
- Avoid overstocking pens and pastures.
- Isolate and deworm new additions to the farm.

The primary cause of internal parasitism is overstocking.
Use of “clean or safe” pastures

- New pasture
- A pasture that has been renovated with tillage.
- A pasture that has not been grazed by sheep or goats for the past 6 to 12 months.
- A pasture that has been grazed by horses and/or cattle for the past 6 to 12 months.
- A pasture in which a hay or silage crop has been removed.
- A pasture that has been rotated with row crops.
- Pasture that has been burned
- Severely overgrazed pasture

Cleaner, safer pastures are a more realistic goal for most producers.
Graze multiple species

Sheep and goats share the same internal parasites, but they are different from the parasites that affect cattle and horses.
- Except barber pole worm in young calves.

Producers who graze multiple species of livestock report fewer parasite problems.

Cattle and horses “vacuum” sheep/goat pastures of infective worm larvae.

There are other benefits to mixed species grazing, such as complimentary grazing habits.
Pasture rotation is a recommended strategy for controlling internal parasites because it allows the use of safe or safer pastures.

BUT, intensive rotational grazing generally may not help to reduce parasitism unless rest periods are long enough.

Due to increased stocking rates, management intensive grazing may increase internal parasite problems in sheep and goats.

In a rotational grazing system, ideally, sheep/goats should not be returned to the same pasture for 2 to 3 months.
Alternative forages

- Livestock that browse have fewer parasite problems.

- Livestock grazing tall-growing forages will have less parasite problems.
  - 80% of parasites live in the first 2 inches of the vegetation.

- Grazing tanniferous may reduce the effects of parasitism.
Chicory, birdsfoot trefoil, and Sericea Lespedeza have all been shown to reduce fecal egg counts and/or inhibit larval development.
Sericea lespedeza

Lespedeza cuneata (high tannin variety)

- Warm season legume that grows in acidic soils with low fertility and tolerates drought well.
- Fed as . . .
  - Fresh forage
  - Loose or ground hay
  - Pelleted supplement
- Goats readily eat.
- Sheep will eat.
- For control of barber pole worm only

Images from scsrpc.org
Nutritional Management

- Animals on a high plane of nutrition and in better body condition are better able to withstand worm burdens.
- Nutrition in early pregnancy (fat stores) can affect the immune response to internal parasites.
- Sheep receiving higher levels of protein prior to lambing have lower fecal egg counts.
- Supplementing grazing lambs with protein has been shown to reduce fecal egg counts.

*Nutritional supplementation is most likely to be beneficial when pregnant females and young animals are below optimal body condition at a time when pasture quality and/or quantity is limited.*
“Zero” grazing
bedded pens, dry lot with no green vegetation, slatted floors

- Sheep/goats raised in confinement or dry lot (zero grazing) tend to have fewer worm problems.
- Sheep/goats put in confinement or dry lot do not usually get re-infected with worms.
- Coccidiosis could still be a problem, if preventative measures are not taken.
  - Good sanitation
  - Proper feeders
  - Coccidiostats
Genetics and worms
Two important traits: resistance and resilience

**Resistance**
- Ability of host to limit infection
- Assessed by fecal egg counts (FEC)

**Resilience**
- Ability of host to withstand challenge and/or infection, and thus maintain health and productivity.
- Assessed by blood hematocrit or packed cell volume (PCV) and estimated by FAMACHA© eye anemia score.

Parasite traits are moderately heritable – 20-40 percent
“Resistant” Breeds

Some sheep and goat breeds are more resistant to worms.

**Sheep**
- Gulf Coast Native
- Hair sheep
  - St. Croix
  - Barbados Blackbelly
  - Katahdin

**Goats**
- Spanish/Brush
- Myotonic/
  - Tennessee Fainting goat
- Kiko

**NOT**
- Traditional wooled breeds

**Maybe**
- Dorper
- Royal white
- Other breeds?

**NOT**
- Boer goats
- Dairy goats
- Angora goats

? 
- Pygmy
- Savannah
"Resistant" animals

There is as much difference within breeds as between breeds.

- The 80-20 rule
  - Approximately 20 percent of the flock sheds most (~80 percent) of the parasite eggs.

- Focusing deworming on susceptible animals will significantly reduce pasture contamination.

- Culling worm-susceptible animals will increase flock resistance and reduce pasture contamination.
Heritability of FEC and PCV

<table>
<thead>
<tr>
<th></th>
<th>FEC (resistance)</th>
<th>PCV (resilience)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewes</td>
<td>0.31</td>
<td>0.15</td>
</tr>
<tr>
<td>Lambs</td>
<td>0.10</td>
<td>0.39</td>
</tr>
</tbody>
</table>

2004, Vanimisetti, Andrew, Zazac, Notter

Selection for parasite resistance is possible and will not adversely affect growth of lambs and fertility of ewes.
Comparison of Genetic and Non-genetic Control Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Reduction in FEC’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic Selection</td>
<td>69%</td>
</tr>
<tr>
<td>Protein supplementation</td>
<td>35%</td>
</tr>
<tr>
<td>Strategic deworming</td>
<td>28%</td>
</tr>
<tr>
<td>Experimental vaccine</td>
<td>0%</td>
</tr>
</tbody>
</table>

Australia, 2002

- Monitor sheep, run in the plots after the end of the experiment had lower FEC’s when run in the plots previously grazed by supplemented sheep (35%) or selected sheep (46%).

- The largest and most persistent effect on FEC’s and worm contamination of pasture was achieved by genetic selection.
Drugs
(anthelmintics)

A valuable, limited resource that must be managed properly.
Three drug families

Drugs kill parasites by starving them or paralyzing them.

1) Benzimidazoles
   Chemical name ends in '..dazole
   Fenbendazole, Albendazole, Oxybendazole

2) Nicotinics
   Levamisole, Morantel, Pyrantel

3) Macrolytic lactones
   a) Avermectins
      Ivermectin, Doramectin
   b) Milbemycins
      Moxidectin
Benzimidazoles
The “white drenches”

1. Fenbendazole
   SafeGuard®, Panacur®
2. Albendazole
   Valbazen®
3. Oxyfendazole
   Synantic ®

- First class of modern anthelmintics.
- Most broad spectrum:
  - adult and L4 larvae
  - hypobiotic larvae
  - Tapeworms
  - liver flukes
- Wide margin of safety
- High level of resistance across industry.
Albendazole  
Valbazen® drench

- FDA-approved for sheep (7 day slaughter withdrawal).

- Labeled for control of liver flukes in non-lactating goats (7 day slaughter withdrawal).

- For control of...
  1. Adult and 4th stage larvae of GI worms
  2. Varying levels of activity against hypobiotic larvae.
  3. Adult and larval forms of lungworms
  4. Heads and segments of tapeworms
  5. Adult liver flukes

- Safe, but use restricted during pregnancy (1st 30 days).

- Widespread resistance across industry.

- Fast animals to improve efficacy.
Fenbendazole
SafeGuard®, Panacur® drench

- FDA-approved for goats (6 day slaughter withdrawal).
- Labeled dosage should be doubled (per Intervet).
- For control of adult GI worms and L4 larvae.
- Widespread resistance across industry.
- Fast animals to improve efficacy.
- Double dosage will kill heads and segments of tapeworms.
- One of the preferred drugs for treating meningeal worm.
Nicotinics

- **Levamisole** (clear drench)
  Tramisol ®, Levasole®, Prohibit®

- **Morantel**
  Rumatel®, Positive Pellet, Goat Care-2X

- **Pyrantel**
  Strongid®
Levamisole

Prohibit®, Levasole®, Tramisol® drench or oblets

- FDA-approved for sheep (3 days slaughter withdrawal)
- For control of
  - Adult and L4 larvae stages of GI worms
  - Hypobiotic larvae (?)
  - Adult and larvae forms of lungworm

→ Probably the most effective anthelmintic.

- Lowest margin of safety
  - Treat based on accurate weights
  - Administer orally.
  - Goats – 1.5x sheep dose

Back on the market, but in limited supply.
Rumatel
Morantel tartrate

- Medicated feed.
- Best to feed goats individually.
- FDA-approved for all classes of goats.
- For control of mature worms only.
- 30-day slaughter withdrawal.
- Not much is known about its efficacy or resistance.
Macrolides
(Macrolytic lactones, ML’s)

1) Avermectins
   Ivermectin
     Ivomec®, Zimecterin®, Eprinex®, Promectin®
   Doramectin
     Dectomax®

2) Milbemycins
   Moxidectin
     Cydectin®, Quest®

- Newest
- Broad spectrum
  - Adult and L4 larvae GI worms
  - Hypobiotic larvae
  - Adults and larvae stages of lungworm
  - External parasites (biting)
- Wide margin of safety
- Persistent activity
Avermectins: Ivermectin
Ivomec® drench

- Introduced in the 1980’s.
- Drug of choice for meningeal worm.
- For control of . . .
  - Adult and L4 larvae GI worms
  - Hypobiotic larvae
  - Adult and larvae lungworms
  - Larval stages of nosebot
- 11-day slaughter withdrawal
- High levels of resistance in industry.
- Fast animals to improve efficacy
Moxidectin
Cydectin® drench

- For control of mature and L4 larval stages of GI worms.
- 7-day slaughter withdrawal
- Similar to ivermectin, but disrupts different chemical neurotransmitter.
- May kill ivermectin-resistant worms.
- Due to similarity to Ivermectin, resistance will develop rapidly if it is overused.
Extra-label Drug Use

- Only Fenbendazole (SafeGuard®) and Morantel (Rumatel®) are FDA-approved for goats.

- Albendazole (Valbazen®), Ivomec® drench, Cydectin drench, and Levamisole (drench and bolus) are FDA-approved for sheep.

- Use of a product that is different from its label constitutes extra-label drug use and requires a veterinary prescription and valid veterinarian-patient-client relationship.
Withdrawal for extra-label drugs

Use longer withdrawals for extra-label drugs.

- Meat withdrawal for Cydectin® drench is 23 days when administered to goats at double the dosage as compared to 7 days for sheep. (source: farad.org)

- Meat withdrawal is 120-130 days for Cydectin® 1% injectable when administered to goats as compared to 21 days for cattle. (source: farad.org)

Keep records of anthelmintic use.
Zolvix® (monepantel)

- New drug class
- Amino-acetonitrile derivative (ADD)
- Unique mode of action
- First new anthelmintic class in 25 years
- Kills worms that are resistant to other anthelmintics

Currently only registered for use in New Zealand, Great Britain, and Uruguay.

- When/will will it be available in the U.S.?
- Will it be approved for sheep and goats?
- Overuse will cause worms to develop resistance to it just like the other drugs.
Non-chemical “anthelmintics”

- Diatomaceous earth
- Pumpkin seed
- Garlic
- Papaya
- Tobacco
- Wormwood
- Others

So far, efficacy of natural “anthelmintics” has not been proven under controlled, scientific experimentation. Experiments are continuing.
Copper oxide wire particles (COWP)

- Made from Copasure®, a copper bolus marketed for copper deficiency in cattle.
- Repackage into doses suitable for sheep and goats.
- In research trials, the minimum dose that has demonstrated control is 0.5 g, but as much as 2-4 g may be necessary.
- Use FAMACHA© system to determine who gets a copper COWP bolus.
- For barber pole worm only.

RISK - Copper toxicity in sheep!
Anthelmintic resistance

How to measure
- Fecal Egg Count Reduction Test (FECRT)
  - Conduct fecal egg count before deworming
  - Fecal egg count 7-10 days after deworming
  - Control group to confirm resistance/efficacy.
- DrenchRite® (Univ. of GA)
  - Larval development assay (LDA)

Drug resistance
- < 95 % egg reduction
- Severe Resistance
- < 60 % egg reduction

** Caused by overuse and misuse of drugs. **
Anthelmintic resistance

SafeGuard® & Valbazen®
Widespread resistance

Levamisole
Still Effective in many places
( newly back on market)

Ivermectin
Widespread resistance

Moxidectin
Mostly effective

** Caused by overuse and misuse of drugs. **
Slowing Down Drug Resistance

- **DO NOT** overuse drugs, especially Levamisole and Moxidectin.

- **DO NOT** introduce resistant-worms to your farm
  - Isolate new animals and deworm them with anthelmintics from two different chemical classes.

- **DO NOT** underdose
  - Weigh animals or dose for heaviest animals in group.

- **DO NOT** rotate dewormers after each treatment
  - Rotate dewormers annually
  - Rotate among drug families
  - Use specific dewormers for specific situations.

- **DO NOT** treat everybody
  - Leave some animals untreated
“Refugia”
In refuge from the drug

What is refugia?
- Worms not exposed to drug; therefore still susceptible to treatment.

The goal
- Increase the population of susceptible worms.

How?
- Selective treatment – leave some animals untreated.
- After deworming, do not move animals to a clean pasture.

You do not have to deworm every animal.
How We Select for Drug resistance

Parents

Susceptible

Drug Treatment

Next Generation

Resistant

Resistant
Maximize the effect of a single treatment

- Give proper dose; do not underdose.
- Dose orally.
- Deposit anthelmintic in esophagus (not mouth) to prevent drug from by-passing rumen.
- Fast animals to increase efficacy of some drugs.
- Use higher dose for goats than listed on label. Goats usually require 1.5-2X the sheep/cattle dose.
  - Consult with veterinarian for proper dose for goats.
- Use drugs from two different chemical classes.
**Routes of administration**

<table>
<thead>
<tr>
<th>Oral Drench/oblets</th>
<th>Medicated Pellet</th>
<th>Injectable</th>
<th>Pour-On</th>
</tr>
</thead>
<tbody>
<tr>
<td>✰ FDA-approved</td>
<td>✰ FDA-approved</td>
<td>✰ Not FDA-approved</td>
<td>✰ Not FDA-approved</td>
</tr>
<tr>
<td>✰ Most effective?</td>
<td>✰ Easy to administer</td>
<td>✰ Stays in system longer, accelerating drug resistance</td>
<td>✰ Not formulated for sheep and goats</td>
</tr>
<tr>
<td>✰ Shorter withdrawal</td>
<td>✰ Sick animal won’t eat</td>
<td>✰ Longer withdrawal</td>
<td>✰ Accelerates drug resistance.</td>
</tr>
<tr>
<td>✰ Easier to administer</td>
<td>✰ Accurate dosage??</td>
<td>✰ Potential for abscesses</td>
<td>✰</td>
</tr>
<tr>
<td>✰ Safer</td>
<td></td>
<td>✰ Less expensive</td>
<td></td>
</tr>
</tbody>
</table>

**Oral Paste/Gel**
- ✰ Not FDA-approved
- ✰ Hard to calibrate
- ✰ Hard to administer over tongue
- ✰ Most expensive
- ✰ Don’t have to buy as much

**Choose . . .**
1- Sheep Products
2- Cattle Products
3- Horse Products
Periparturient egg rise

- Temporary loss of immunity to parasites at the time of parturition. Egg counts ↑
- Often coincides with hypobiotic larvae resuming their life cycles in the spring.
- Dams are the primary source of infection to their offspring.

- Consider deworming with an anthelmintic that is effective against hypobiotic larvae.
- Increase protein in late gestation ration to counter egg rise.
When should you deworm sheep and goats?

- When they need it

- Use fecal egg counts and FAMACHA© to help determine the need for deworming.
Fecal Egg Analysis

Qualitative vs. Quantitative
Fecal Egg Counting

Qualitative Analysis
- Shows presence or absence of eggs
- Identify egg types
- Shows general trends in egg numbers.

Quantitative Analysis
- Shows specific number of eggs per gram of feces (epg)
- Uses known quantity of feces and flotation solution.
Fecal Egg Counting

What you need

- Microscope (min. 100x)
- Flotation solution
- Mixing vial
  - Mixing vial and strainer for qualitative analysis
  - Calibrated mixing vial and syringe for quantitative analysis
- Slides
  - Regular slides and cover slips for qualitative analysis.
  - McMaster egg counting slide for quantitative analysis
What do fecal egg counts tell you?

- Potential pasture contamination.
- Fecal egg counts are not mathematically correlated to worm numbers or the severity of parasitic disease.
- Monitor and maintain low egg counts; deworm when appropriate to keep contamination of pasture low.

**Determine the efficacy of anthelmintic treatment by comparing paired samples from the same animals (treatment and control group).**
When to deworm based on FEC’s

Example recommendations

> 1,000 epg in spring, summer
> 2,000 epg in fall, winter (TN)

> 500 epg or when there is dramatic increase (Microbus, HI)

> 1,000 epg for goats (OK)
   (> 500 for susceptible animals)

> 500 epg for goats (Australia)

✓ Depends on worm species, time of year, susceptibility of animals, as well as method of fecal analysis.
Guide to Internal Parasites of Ruminants

Sponsored by Intervet—providers of Panacur®/Safe-Guard® to the livestock industry.

- **Ostertagia** (brown stomach worm)
- **Cooperia** (small intestinal worm)
- **Moniezia** (tapeworm - sheep)
- **Moniezia** (tapeworm - cattle)
- **Bunostomum** (hookworm)
- **Haemonchus** (barberpole worm)
- **Nematodirus** (threadneck worm)
- **Trichostrongylus** (bankrupt worm)
- **Oesophagostomum** (nodular worm)
- **Trichuris** (whipworm)
- **Strongyloides** (threadworm)
- **Coccidia** (a protozoan that causes coccidiosis)
- **Dictyocaulus** (lungworm)
- **Mite Egg** - 1/4 actual size (contaminant - often mistaken for worm eggs)
Questions?

www.sheepandgoat.com

www.wormx.org