


**Why and How To Practice
Integrated Parasite Control For Sheep and Goats**

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The Problem

- Stomach and intestinal worms are the major health problem faced by producers east of the Rockies
- Subject of this presentation

Other Parasites Not Covered

- Coccidia
 - Protozoan (single cell) parasites
 - Common cause of diarrhea
 - Requires different control/treatment than GI worms
 - <http://www.sheepandgoat.com/> has lots of links

Other Parasites Not Covered

- Tapeworms (*Moniezia*)
 - Common, but little evidence of impact on health/production
 - Some dewormers effective
- Meningeal worm (*Parelaphostrongylus*)
 - Deer parasite, causes nervous system disease in sheep and goats
 - Complex treatment/control, treatment success varies

TODAY' S PROGRAM

- Worm biology
- Dewormers and resistance
- Techniques for integrated parasite control

What Should You Know About Worm Biology?

Stomach and Intestinal Worms

- Most important--barber pole worm, *Haemonchus contortus*
 - Abomasal (stomach) parasite
 - Exploits many environments, management practices

Haemonchus contortus--Barber Pole Worm (wireworm)

- Worms about an inch long
- White reproductive tract wraps around red intestine
 - looks like barber pole

Stomach and Intestinal Worms

- *Haemonchus contortus*
 - Blood sucking parasite
 - Large numbers can cause anemia (pale mucous membranes), weakness and bottle jaw
 - Decreased gains, growth
 - No diarrhea

Stomach and Intestinal Worms

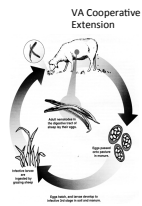
- Nematodes
 - Barber pole worm, *Haemonchus*, most important, but related worms add to problems and can cause diarrhea
 - Brown stomach worm (*Teladorsagia*)
 - *Trichostrongylus*
 - Others-- less important

Ruminant GI Neighborhood

<p>Abomasum <i>Haemonchus</i>, <i>Ostertagia</i>, <i>Trichostrongylus axei</i></p>	<p>Large Intestine <i>Oesophagostomum</i> <i>Chabertia</i></p>	
<p>Small Intestine Other <i>Trichostrongylus</i> <i>Nematodirus</i> <i>Cooperia</i></p>		

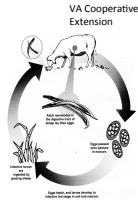
Life as a Worm

- All *Haemonchus* family have same life cycle
 - Eggs passed in manure
 - 200 female barber pole worms— one million eggs/day
 - Eggs develop, hatch
 - Larva molts to infective stage
 - Takes about 5-7 days minimum
 - The cooler it is, the longer it takes



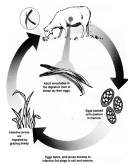
Life as a Worm

- All *Haemonchus* family have same life cycle
 - Larvae move onto forage
 - Sheep, goats infected when grazing
 - Adults start egg laying in about 3 weeks
- **ALL GRAZING ANIMALS HAVE WORMS**
- Generally these worms do not survive well in housing



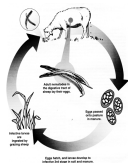
Life as a Worm

- Other useful information for designing control programs
 - How long do adult worms live?
 - How long can the infective larvae survive on pasture?
 - Can larvae survive winter weather?
 - When is it worm season?



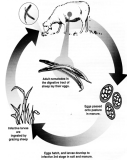
Life as a Worm

- Other useful information for designing control programs
 - How long do adult worms live?
 - Usually a few months



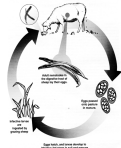
Life as a Worm

- How long can the infective larvae last on pasture?
 - Infective larvae can't eat
 - Once metabolic reserves used up, they die
 - Hotter it is, the faster they wiggle, the quicker they die
 - In cool, moist conditions they live for months



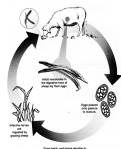
Life as a Worm

- Can larvae survive winter weather?
 - Some eggs and larvae survive winter weather better than others
 - Barber pole worm does not like freezing weather, eggs and larvae die



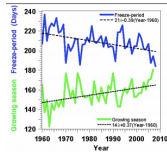
Life as a Worm

- Also another strategy for surviving winter
 - Larvae ingested in the fall enter stomach wall and become dormant (hypobiosis)
 - Wait to become adults till spring
 - While hypobiotic-- No disease, no eggs in manure



When is Worm Season?

- When do temperature and moisture best support transmission and multiplication of barber pole worm
 - Vermont worm season July-August
 - Virginia worm season June-October
 - Florida worm season almost all year
- “Climate is what you expect; weather is what you get.”
--Robert Heinlein



Climate change in Vermont, Allen K. Betts, 2011. Vermont Agency of Natural Resources

Getting Rid of Worms

- Barber pole worm family part of sheep/goat world
- Usually a primary problem because of our management practices
 - High density grazing on permanent pastures

Dewormers and Resistance: A Quick Review

Why Is it Harder To Control Worms Now Than It Was 30 Years Ago?

Dewormers

- So many ruminant dewormer choices at the feed store!
 - Effective
 - Safe
 - Nonprescription
 - CHEAP



Dewormers (Anthelmintics)

- Modern available dewormers fall into in 3 groups

Benzimidazoles	Macrolides A-ivermectin M-milbemycin	Nicotinics
fenbendazole (Safeguard®, Panacur®)	ivermectin-A (Ivomec®, Noromectin®, Agrimectin® etc.)	levamisole (Prohibit®, LevaMed®)
albendazole (Valbazen®)	doramectin-A (Dectomax®)	pyrantel(Strongid®)
oxfendazole (Synanthic®)	eprinomectin-A (Eprinex®)	morantel (Rumatel®, Goat Care®, Positive Pellet®, DuMore®)
oxibendazole (Anthelcide®)	moxidectin-M (Cydectin®)	

Why Do You Need to Know About the 3 Groups?

- If a worm population is resistant to 1 drug in a group, resistant to all in group
- Ivermectin and moxidectin in same group but different subgroup

Benzimidazoles	Macrolides A-ivermectin M-milbemycin	Nicotinics
Fenbendazole (Safeguard Pancur)	ivermectin-A (Ivomec etc.)	levamisole (Prohibit)
albendazole (Valbazen)	eprinomectin-A (Eprinex)	Pyrantel(Strongid)
Oxfendazole (Synanthic)	doramectin-A (Dectomax)	morantel (Rumatel, Goat Care, Positive Pellet)
Oxibenda-zole (Anthelcide)	moxidectin-M (Cydectin)	

Georgia Goat Farms– 2001
Mortenson et al. 2003. JAVMA 223:495-500

- More than 90% of farms had evidence of *Haemonchus* resistant to ivermectin and albendazole
- Cydectin (moxidectin) introduced about that time
 - No resistance detected in 2001
 - 2003, about 40% of farms using mostly moxidectin showed resistance
- But that's Georgia (*Haemonchus* paradise!)
 - Results of our Northeast SARE project LNE10-300
 - Half of testable herds/flocks showed some level of resistance to drug currently in use

Drug Resistance--What happened?

- Resistance—Inherited change in a parasite population produced by drug use so that the drug no longer works as well as it did
 1. Some worms with a genetic ability to resist a drug always exist at low levels because of random gene mutation
 2. Use of a drug gives those worms an advantage
 3. Gradually the number of resistant worms increases

Dewormer Resistance Simplified

- Difficult to detect in early stages—WHY?
 - Each worm inherits genes from its parents determining resistance (R) or susceptibility (S) to a drug
 - Assume need 2 R's to be fully resistant to a drug

SS—fully susceptible SR—not fully resistant, but maybe can survive low drug doses RR—fully resistant

Dewormer Resistance

- What does it look like as it develops? (fictional example—could develop faster or slower)

Year 1
98% effective Year 4
88% effective Year 5
70% effective Year 6
50% effective Year 7
30% effective Year 8
15% effective

Usually by the time resistance to a drug is detected, so many worms are resistant that even if drug use stops the worm population will stay resistant to that drug for years

What management practices would speed up development of resistance?

What management practices would speed up development of drug resistance?

- Frequent treatments
- Treating all the animals at once
- Underdosing
- Treating and moving to clean pastures
- Treating when there aren't many worms on pasture (drought, end of winter)
- All these decrease the REFUGIA on your farm

Refugia

- Portion of parasite population not exposed (=unselected) when a drug is administered
 - Worms on pasture
 - Worms in untreated animals
- Refugia is good—keeps susceptible worms around

Refugia—why does it matter?

- The higher the refugia, the greater the chance that there will be susceptible worms around to reduce the chances of 2 resistant worms mating

Techniques For Integrated Parasite Control

Parasite Control in Sustainable Systems

- Parasite losses are a management disease
- We have ways of controlling parasites
- Each producer has to decide which control methods work best for him/her
- Must have integrated parasite control program

GI Worm Control in Sustainable Systems

- Goal is not to eradicate the worms
- Goal is to keep worms at a level that doesn't have detrimental health effects
- TOOLS
 - Reduce parasite exposure on pasture
 - Immunity of the host
 - Dewormers

Reduce Parasite Exposure on Pasture

Immunity of the host
Dewormers

- Limited or no pasture exposure
 - No grass means few worms
 - Small amounts of grass can be enough
- Reduce stocking density
 - Watch out for “Barnyard effect”—areas of high transmission where animals spend lots of time

Reduce Parasite Exposure on Pasture

- Diversification is good for parasite control
 - Alternate or mixed grazing
 - Sheep/goats/camelids ≠ cattle ≠ horses for GI worms
 - Each host is a vacuum cleaner for the parasite larvae of other hosts
 - Few exceptions, usually not practically important
 - Poultry may be helpful
 - Pick apart feces

Reduce Parasite Exposure on Pasture

- After grazing pasture, harvest regrowth for hay
 - Process kills larvae
 - More detrimental to parasites than just letting pasture sit unused

Reduce Parasite Exposure on Pasture

- Pasture rest and rotation
 - Benefits
 - Death of larvae over time
 - Longer forage
 - Most larvae won't migrate higher than 4-6"

Reduce Parasite Exposure on Pasture

- Length of pasture rest is critical
 - May not coincide with optimal forage use
 - How long to leave pasture ungrazed?
 - 60 days minimum, often need longer
 - Hotter it is, faster larvae die
- Try combining methods--alternate sheep and cattle in rotation for example

Reduce Parasite Exposure on Pasture

- Let goats browse if possible
 - Heads are up
 - Antiparasitic compounds in some browse

Reduce Parasite Exposure on Pasture

- Whatever other methods are used, the pasture with the fewest larvae should be used for the most vulnerable animals
 - Lactating does/ewes
 - Growing lambs/kids
 - Stressed animals

Reduce Parasite Exposure on Pasture
Immunity of the Host
Dewormers

- Sheep and goats develop immunity to GI worms
 - Controls parasites, doesn't eliminate them
 - Immune animals will have eggs in manure
 - Goats more susceptible than sheep

Immunity of the Host

- Immunity not developed till maturity and beyond
 - First lactation animals still more vulnerable
- Reproductive cycle could be timed to avoid high exposure till animals are older
- Dry, non pregnant ewes/does most immune
 - Can actually help clean up pasture
 - At weaning, move young to safer pasture, leave adults

Immunity of the Host

- Which animals have the most worm problems when exposed to lots of worms?
 - Sheep and goats without a good immune response
 - Temporary factors
 - Age—young animals before immunity develops
 - Lactation
 - Poor health or nutrition
 - Inherited susceptibility

Immunity of the Host

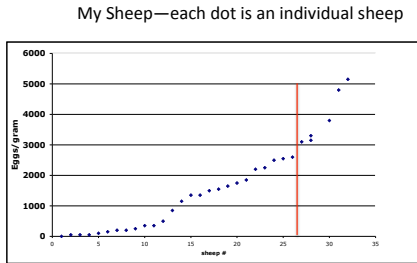
- All animals develop immunity, but some do a better job than others
- Much of an individual animal's susceptibility is inherited
- All other things equal, **~30% of the animals have ~80% of the worms**

Immunity of the Host

My Sheep—each dot is an individual sheep

sheep #	Eggs/g ram
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	50
12	100
13	150
14	200
15	300
16	400
17	500
18	600
19	700
20	800
21	1000
22	1200
23	1500
24	1800
25	2200
26	2500
27	2800
28	3200
29	3500
30	4000
31	4500
32	5000
33	5500
34	6000
35	6500

Immunity of the Host



Immunity of the Host

- Selective breeding!
 - Cull highly susceptible animals (FAMACHA® good for identifying them)
 - Select more parasite resistant breeding stock
 - Ask breeders if they have info
 - Use fecal egg counts to assess
 - You can make any group of any breed more parasite resistant with selection

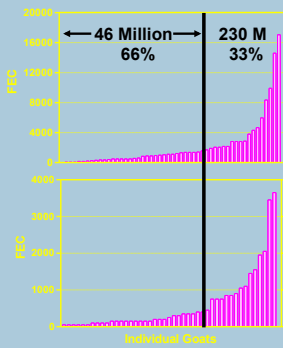
Immunity of the Host

- Breeds with higher levels of resistance to parasites
 - St. Croix
 - Katahdin
 - Gulf Coast/Florida Native
- Have to keep selecting for parasite resistance even in more resistant breeds
- Less research on variation in resistance in goat breeds

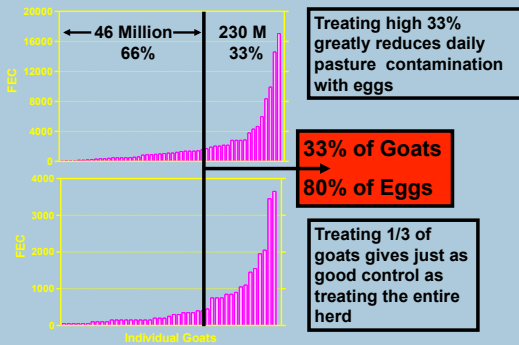
Immunity of the Host

- Targeted selective deworming programs
 - Concentrates dewormer use on animals that need it the most
 - Uses immunity because many animals don't need to be dewormed—they are immune
 - Benefits
 - Use less dewormer
 - **Increases refugia, slows rate of development of resistance to dewormers**

Distribution of FEC in Goat Herds



Distribution of FEC in Goat Herds



Immunity of the Host

- For selective deworming, FAMACHA® best for small ruminants in eastern, midwestern US
 - Direct assessment of effects of parasite
 - ONLY WORKS FOR BARBER POLE WORM



Immunity of the Host

- FAMACHA® best but.....
- Fecal egg counts also can be used for selective deworming
 - More labor intensive
 - Not directly linked to parasite effects
- FAMACHA® plus egg counts best for breeding selection

Immunity of the Host

- Individual targeted deworming has greatest impact on resistance because results in treatment of fewest animals
- Group targeted deworming has less impact but better than treating all animals
 - Lambs/kids treated but not adults
 - Lactating ewes/does treated but not dry ewes/does

Immunity of the Host

- Good nutrition CRITICAL to effective immunity
 - Consider increasing protein levels in young or lactating animals
 - Immune response develops faster
 - No hard and fast rules (18% mentioned)
 - Benefit depends on circumstances
 - Also need adequate minerals, vitamins

Reduce Parasite Exposure on Pasture
Immunity of the Host

Dewormers

- Dewormers are third element in control
 - Use to help prevent disease/loss and to minimize development of dewormer resistance
- Involve your vet in dewormer selection
- Use the correct dose
 - Sheep and goats metabolize drugs differently
 - Effective dose in goats is two times the sheep dose except:
 - Levamisole (1.5 times)
 - Goat dose on the Safeguard® label too low
- Know correct withdrawal times

Reduce Parasite Exposure on Pasture
Immunity of the Host

Dewormers

- Use dewormers in integrated control
 - Don't underestimate weight
 - Dose for heaviest animal in group
- Give dewormers by mouth only
 - Injectables speed up drug resistance

Dewormers

- Place in back of mouth
 - Harder to spit out
 - Prevents esophageal groove closure
 - Pastes hard to dose accurately, easier to spit out
- Remember supportive care for clinically affected animals
 - Take off infected pasture
 - Good food
 - Reduce risk of reinfection

Dewormers

- If you think dewormer is not fully effective and want to keep using it
 - Increase the dose
 - Maximize Absorption
 - Multiple treatments
- All short term fixes—will work for awhile
- Any time drugs used in a manner not consistent with the label use it is an off label use
- Changing dose and administration affects withdrawal periods

Dewormers

- If you think dewormer is not fully effective and want to keep using it
 - Increase the dose
 - Consult with vet
 - Maximize Absorption
 - Multiple treatments

Dewormers

- If you think dewormer is not fully effective and want to keep using it
 - Increase the dose
 - Maximize absorption—benzimidazoles and macrolides
 - Restrict food for 12 hours before treatment
 - Slows gut movement and movement of drug through GI tract
 - Don't restrict food in late pregnancy
 - Multiple treatments

Dewormers

- If you think dewormer is not fully effective and want to keep using it
 - Increase the dose
 - Maximize absorption—benzimidazoles and macrolides
 - Multiple treatments
 - Second dose 12 hours after first with benzimidazoles and macrolides
 - Several treatments over consecutive days

Dewormers

- Combination treatment
 - 2 or 3 drugs from different groups given at the regular dose at the same time
 - Recommended for
 - new animals, should also be quarantined
 - clinically affected animals where drug efficacy questionable
 - in a targeted (selective) treatment program, like FAMACHA[®], if individual drugs don't work
- Don't use in old-fashioned program (treating all the animals at regular intervals)
 - May lose all drugs faster

Dewormers

- Should I rotate drugs?
 - No longer recommended
 - Selective deworming more important, reduces need for drug rotation
- Should I treat before moving to clean pasture?
 - No--Only resistant worms will go to new pasture
 - Selective deworming before move
- Don't deworm all animals at the same time

Dewormer Alternatives

- Some products available with limited research showing effect against parasites
- Effects aren't consistent
- Don't work for everyone

Dewormer Alternatives

- Copper bolus
 - Similar to a moderately effective commercial dewormer
 - Copper oxide wire particles have specific effect on *Haemonchus*
 - Other forms of copper not effective
 - Effect not consistent
 - Too much copper causes disease
 - Sheep more susceptible
 - Copper levels in animals influenced by soil levels, diet

Dewormer Alternatives

- Copper oxide wire particles (COWP)
 - Available as a copper supplement for sheep and goats deficient in copper
 - Bolus contains more COWP than needed for anti-parasitic activity
 - Check with veterinarian/extension for appropriate dose before using



Do not administer to lambs or kids of unknown copper status or those supplemented with other sources of copper. Veterinary advice should be sought before treating breeds such as North Ronaldsay, Texels or Lleyns known to be copper sensitive.

Sericea lespedeza

- Introduced for road stabilization
- Considered noxious weed in some midwestern states
- Grows well in southeast, less well as move north
- All the parasite work has been done with Auburn Grazer cultivar

Sericea lespedeza

- SL pellets (>85% SL leaf meal, remainder molasses/lignin binder) available from Sims Brothers (wholesale) Countryside Organic, Faithway Feed Co.
- [simsbrothers.com/ourProducts.htm - parasitecontrol](http://simsbrothers.com/ourProducts.htm-parasitecontrol)
 - Seeds and pellets

Unproven Commercially Available Dewormers

- Herbal dewormers
 - Plants do produce compounds that can affect parasites, however:
 - No mandated testing for efficacy or safety
 - Lot to lot consistency not guaranteed
 - No basis for recommending them
- Diatomaceous earth
 - No experimental evidence that it works

Other Antiparasitic Compounds

- New drug
 - Amino acetonitrile
 - Monepantel—Zolvix
 - Different class but use will select for resistance
- Nematophagous fungi
 - Eats nematode larvae in manure
 - Add to feed, maybe 2 years?
- *Haemonchus contortus* vaccine
 - Not available in U.S.

GI Worm Control in Sustainable Systems

- Work with your veterinarian to design the program best for you
- Internet resources
 - National Sustainable Agriculture Information Service
 - attra.ncat.org/
 - University of Rhode Island Small Ruminant Parasite Control
 - web.uri.edu/sheepngoat/
 - American Consortium for Small Ruminant Parasite Control
 - www.acsrpc.org/
 - University of Maryland small ruminant website
 - www.sheepandgoat.com/



GI Worm Control in Sustainable Systems

- Goal is not to eradicate the worms
- Goal is to keep worms at a level that doesn't have detrimental health effects (cost you money)

- TOOLS
 - Reduce parasite exposure on pasture
 - Immunity of the host
 - Dewormers
