SHEEP PARASITES: PROBLEMS, RESISTANCE, NEW PRODUCTS AND PRACTICES FOR PARASITE CONTROL

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Parasites are Normal
Disease is an Imbalance

- Parasitic disease occurs when the number of parasites is in excess of what the sheep can tolerate
- The number of parasites is a function of exposure, and resistance to the parasite
- Exposure varies with climate and management
- Resistance (immunity) varies with age, exposure, reproductive status and management of sheep
The Where, What and How Questions

1. Where you are geographically?
2. What classes of livestock you are raising?
3. How do you manage the feeding, reproduction and protection of the sheep?
4. Where did you buy your parasites from?

Because of differences among producers there is no answer that fits all. But there are things to think about and see where you fit.
Parasites of Sheep in North America: worms, coccidia, ectoparasites

- Worms aren’t simple: worms reproduce exponentially, worms adversely affect some sheep, worms give parasitologists interesting jobs, worms provide profits for pharmaceutical companies

- Gastrointestinal nematodes (roundworms) will be considered today
Gastrointestinal Nematodes

- Life cycle of most species, similar outside of host
- Each parasite species makes its living inside the host in a different way
- Different worms are of primary concern in different climates
- Immunity can be established but takes repeated exposure and will wane
- Immunity relaxes at time of parturition
- Nematodes arrest development in host to evade unfavorable conditions
L3 larvae ingested during grazing

thin shelled segmented eggs

L1 & L2 feeding on bacteria

infective L3 larvae
Nematode Larvae in Pasture

- Important worms are transmitted when larvae ascend vegetation in rain water, dew etc. where they are grazed.
- Larvae are actively wiggling in water to move but this expends energy.
- They do not move vigorously in the dry fecal pellet, under snow or ice.
- They die because it’s too dry, too long or they had too many wiggles.
- Life span: 1 month warm wet summer, >8 months cool or dry season.
Infection

- Larvae ingested during grazing
- Develop to adults and begin laying eggs (21-28 days) or arrest development for 1 to 5 months
- Arrested larvae are inactive do not feed or reproduce but evade unfavorable conditions in the environment or resistant host
- Larvae in arrested development resume activity with depressed immunity (lambing) or season change i.e. spring, rains
**Haemonchus contortus**

- Barber pole, stomach or candy cane worm
- Most important parasite of small ruminants in much of North America
- Death losses; due to blood sucking, not weight loss, most important aspect of infection
- Acquired immunity is not manifest until young are 4 to 6 months of age
- Immunity wanes at parturition which coincides with reactivation of arrested larvae
Haemonchus contortus
*Trichostrongylus colubriformis*

- Black scour or bankrupt worm
- Small intestine of small ruminants between villi in small intestine
- Interfere with absorption of Ca, P, Vit A
- Ricketts, abdominal pain and diarrhea
Teladorsaiga circumcincta

- Brown stomach worm of sheep
- Common parasite in some areas, rare else where
- Affects digestion, especially protein; weight loss, diarrhea, bottle jaw but not anemia
- Often seen with *Trichostrongylus colubriformis* causing diarrhea, poor doing animals; this combination is extremely important in northern Europe, southern South America, Australia, New Zealand and is resistant to anthelmintics in these areas
Oesophagostomum spp.

Nodular Worm

- Adults cecum
- Larvae in nodules in mucosa emerge in 7 – 10 days susceptible host
- Larvae remain in nodules for up to a year in host with resistance to the worm
- Bacteria in nodule may adversely affect host
- Economic loss of intestines, lowered reproductive potential
To control parasites determine

- which parasites are present
- when they are being transmitted
- how they survive (host /environment)
- which anthelmintics are effective
- when is the most appropriate time to administer anthelmintics
- what dose is required for host species
Control of Helminths with Anthelmintics

- Anthelmintics are drugs labeled to kill worms
- Mainstay of parasite control for past 60 years
- Some worms no longer economically important
- Higher stocking density of livestock
- Less reliance on avoiding parasites more on killing them
Livestock Anthelmintics in United States

- **BENZIMIDAZOLES**
  - Albendazole (Valbazen)
  - Fenbendazole (Safe-Guard, Panacur)
  - Oxfendazole (Synanthic)

- **LEVAMISOLE / MORANTEL**
  - Totalon, Levasole, Prohibit / Rumatel

- **MACROLIDES**
  - Ivermectin (Ivomec and many other names)
  - Doramectin (Dectomax)
  - Moxidectin (Cydectin)
  - Eprinomectin (Eprinex)
Approaches to use anthelmintics to control gastrointestinal nematodes

- Opportunistic
- Suppressive
- Strategic
- Tactical
- Targeted or Selective
- Salvage
Opportunistic Treatment

- Treat when sheep, money and labor are available and you think about it.

- You feel better having done something but are unlikely to have affected parasite populations for more than a few weeks.
Suppressive Administration

- Try to eradicate worms
- Treat all the animals in the flock
- Treat at short intervals i.e. 3 to 4 weeks
- Treat when entering parasite free permanent pasture
- Looks good early but?
- **Powerful selection process for resistant worms**
Strategic Control

- Treatment when the highest proportion of the worm population is in the host not on the pasture
- Near parturition when arrested larvae are activated but not producing many eggs
- Moving animals onto pastures with few larvae
- Helps provide safe pastures but selects for resistance
Transmission of nematodes in west central Texas

Treat ewes in Jan Feb
Tactical Control

- Treatment when the potential for parasitic disease is increasing but no disease
  - Treat two to three weeks after rainfall which exposes hosts to worm larvae before the newly acquired worms reproduce
  - Treat when the average worm number is increasing but not yet critical in sheep >1000 eggs/gram or 40% of flock anemic
  - Treat when moving to safe pastures

- Lower pasture contamination and removed worms which could cause problems
Targeted treatment

- Treat those individuals in the flock which contribute the greatest contamination to the pasture
- 20% of flock has 80% of worms

Selective treatment

- Base on egg counts or level of anemia
- Risk factors: young, multiple offspring
Evaluation of Worm Numbers; fecal egg counts

- Direct relationship between level of infection by adult worms and egg count
- Some species produce more eggs than others i.e. *Haemonchus* 5,000 *Trichostrongylus* 50
- Aid in deciding when to tactically treat
- Determine efficacy of anthelmintics on each individual farm
- Evaluate management schemes
Evaluation of Worm Numbers; Anemia

- Associated with numbers and persistence of infection with *Haemonchus*
- Proportion of erythrocytes (red blood cells) in blood
- Color of mucous membranes: pink or white
  FAMACHA color chart
The FAMACHA© System

- Compare chart with color of mucous membranes
- Classification into one of five color categories:
  - 1 - not anemic
  - 5 - severely anemic
Salvage Treatment

- Save lives
- Will have to be repeated if management is not changed
- Does not select for anthelmintic resistance
Anthelmintic Resistance

- *Haemonchus contortus* predominant resistant worm in North America,
- *Trichostrongylus / Teladorsaiga* elsewhere
- *Haemonchus* and *Trichostrongylus* populations resistant to all classes of anthelmintics in small ruminants in North America
How did we get anthelmintic resistance?

- We removed susceptible worms and left the resistant ones.
- Under dosing; dosing for the average weight in flock
- Injecting anthelmintics with residual effect
- Suppressive deworming practices
- Buying them in a dewormed sheep
Avoid Resistance by Rotation of Anthelmintics; **Wrong!**

- **RAPID ROTATION**
  - Rotation within a grazing season; selects for resistance to all anthelmintics in the rotation

- **SLOW ROTATION**
  - Rotation between years with **different classes** of drugs; may slow the onset of resistance

- **NO ROTATION**
  - Use drug until it no longer works then change; similar to slow rotation
Evasion of Resistance

- Treat only heavily parasitized animals
- Remove susceptible hosts from population
- Use combinations 2 or more drugs from different classes simultaneously
- Allow susceptible worms from refugia (a population of worms not exposed to anthelmintics) to mate with resistant worms
- Management of pastures and livestock
Use of anthelmintic combinations

- Widely used in some countries has been used in US to some success
- Problem in Australia now use combination of ivermectin, albendazole and levamisole
- Will fail unless 100% effective; We have succeeded in producing super Super worms on some farms in US
- Super worms are more widely available than refugia worms
What’s new in anthelmintics in North America?

- Nothing yet!!
- Monepantel (Zolvix) a drug now used in Europe and Australia and New Zealand under review in US for use in sheep! Appears to be effective against worms resistant to other classes of anthelmintics. Will probably get approval for use in sheep in the U.S. by 2014?
- Derquantel combined with abamectin (Startect) Australia and N.Z.
What management procedures can be used to stop, or reduce resistance on a specific farm?

- Strategic treatment with effective anthelmintic in winter (lambing)
- Use dry lots, annual pastures, crop (hay) aftermath for susceptible animals
- Have resistant animals harvest pastures after susceptible animals, do not treat these animals as the survivor worms will become the refugia
What should we learn about nematode resistance?

- Helminths are a part of the natural ecosystem and eradication will fail if the worms are important.
- The more we rely on anthelmintics the less reliable they are.
- The *Haemonchus* genome is large and the reproduction rate prodigious and they use us to insure that they mate with other high achievers.
Anthelmintic of choice
THE ONE THAT WORKS!

- Each farm/ranch is an ecosystem it has its own population of hosts and parasites as well as its unique biota, soil, weather and management.
- Anthelmintics are as effective as the worm population to which they are exposed are susceptible.
- Anthelmintics must be evaluated at the farm level.
- University professors, drug company sales reps, feed store managers, county agents, neighboring ranchers or internet blogs don’t have a clue!
If not drugs what?

- Increased protein intake increases immune responsiveness: this may be expensive or difficult to ensure consumption by the at risk animals at the critical time.
- Plants containing polyphenolic compounds, lowers worm egg production and may improve nutritional status (bypass protein) Quebracho, Sainfoin, Chicory, Sericea lespedeza (hay or pellets).
- Red berry juniper terpenes, effect of plant and behavior? Lowers parasite establishment.
- Other botanical anthelmintics may be locally effective, or ineffective; safe or unsafe.
Other aids to worm control?

- Copper oxide wires; kills *Haemonchus*, also sheep if extreme care is not used
- Diatomaceous earths in feed may lessen survival of larvae in the environment if humidity low and temperature hot
- Nematophagous fungi; destroy larval nematodes in feces: must be consumed daily
- Dung beetles bury feces and worms, removes large percentage of worms from soil surface but some live longer in protected environment
Pasture rotation

- Moving animals on to rested pastures lowers the exposure to parasites. When? 30 days in wet summer conditions with rapidly growing forage
- Tilled wheat pasture; no worms, over seeded rye grass or dormant bermudagrass; worms survive at least 8 months
- Short duration pasture rest will result in high quality palatable forage but will result in greater exposure to nematode larvae
Pasture management

- Shared grazing; Each species of grazing animal has its own preferred forage more pounds of livestock can share a pasture without putting undue pressure on the environment and dilute the exposure to parasites.

- Rotate between classes of livestock: Leader follower systems; Susceptible animals graze followed by resistant animals harvesting larvae from pasture; fewer larvae available when susceptible animals return to pasture.

- Prescribed burning of pastures will expose worms to drying, lowering parasite numbers.
Selective use of forage may increase nutrition and lessen worm problems.

Browsing keeps away from worms.

A worm free pasture.
Manage to tolerate infection

- Allow exposure to moderate numbers of worms to stimulate protective immunity
- **Selection of individual animals with the genetic capacity to tolerate or lessen establishment of worms**
- Genetic selection for the environment in which sheep live not for maximum productivity under ideal conditions
- Strategic, tactical or selective deworming