



A New Approach to Parasite Management in Sheep

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The American Sheep Industry Association
Rebuild the Sheep Inventory Committee



A New Approach to Internal Parasite Management in Sheep

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Fort Valley State University
and

American Consortium for Small Ruminant
Parasite Control



Topics

- The problem
- The parasites; where we are and why
- Biology of important GI parasites
- Dewormers – a quick review
- What can we do?
 - Smart Drenching
 - Using the FAMACHA tool
 - Alternative controls



The Big Problem facing sheep producers in the more humid areas Worldwide

- Anthelmintic (dewormer) Resistance is considered a major threat to the current and future control of parasites of ruminants and horses.
 - Worldwide phenomena
 - The prevalence of multi-drug resistant worms is extremely high in many areas of the world.



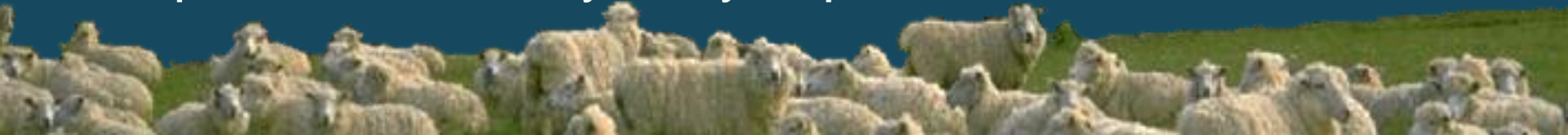
What is “Resistance”?

- The ability of certain worms in a population to survive drug treatments that are generally effective against the same worm species and stage of infection
 - Caused by changes in levels of “resistance” genes carried by worms in a population.
 - Result of drug treatment that produces genetic selection of resistant worms in a population of worms.

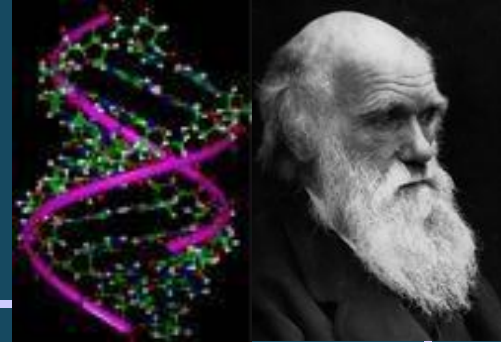


Dewormer Resistance History of the Problem

- Age of modern dewormers
 - Effective, broad-spectrum, cheap, safe
- Over-reliance on dewormers
 - Addiction to drugs, improper use of dewormers
 - Loss of common sense approaches
 - Belief there will always be a new drug
- No new drug classes introduced since 1981
 - We have what we have !!!!
- May be a new dewormer coming on line in future but expected to be very, very expensive.



Where Do Resistant Worms Come From ??



- Resistance is an inevitable consequence of using any particular drug to kill worms
 - “Resistant” worms – worms that can survive drug treatment, actually exist prior to the first use of a drug
 - Treatment eliminates worms whose genes render them susceptible to the drug
 - Parasites that are resistant survive and pass on their “resistant” genes to their offspring
 - Over time with continued treatment, more and more resistant worms build up in the population
 - High level of animal movement spreads resistant worms. Animals shipped from state to state or country to country carry their worm infections with them. Buying sheep = Buying parasites.



It's A Gene Frequency Thing

- Multiple genes; multiple loci. Many genes involved.
 - Each gene provides some level of resistance.
 - The effects are additive.
- Parasites that are genetically resistant to the effects of an anthelmintic have a high frequency of genes providing resistance.



Selection for Drug Resistance

Parents

Susceptible



Resistant

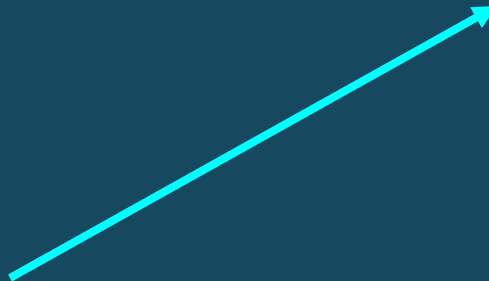
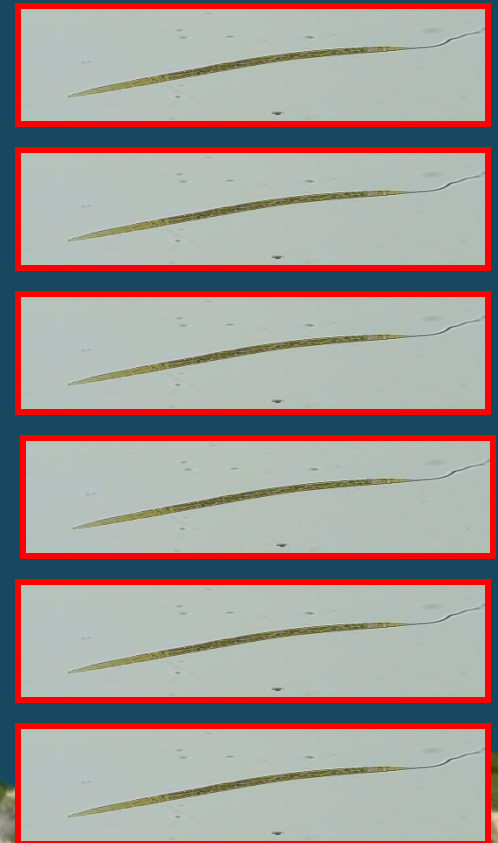


Drug Treatment

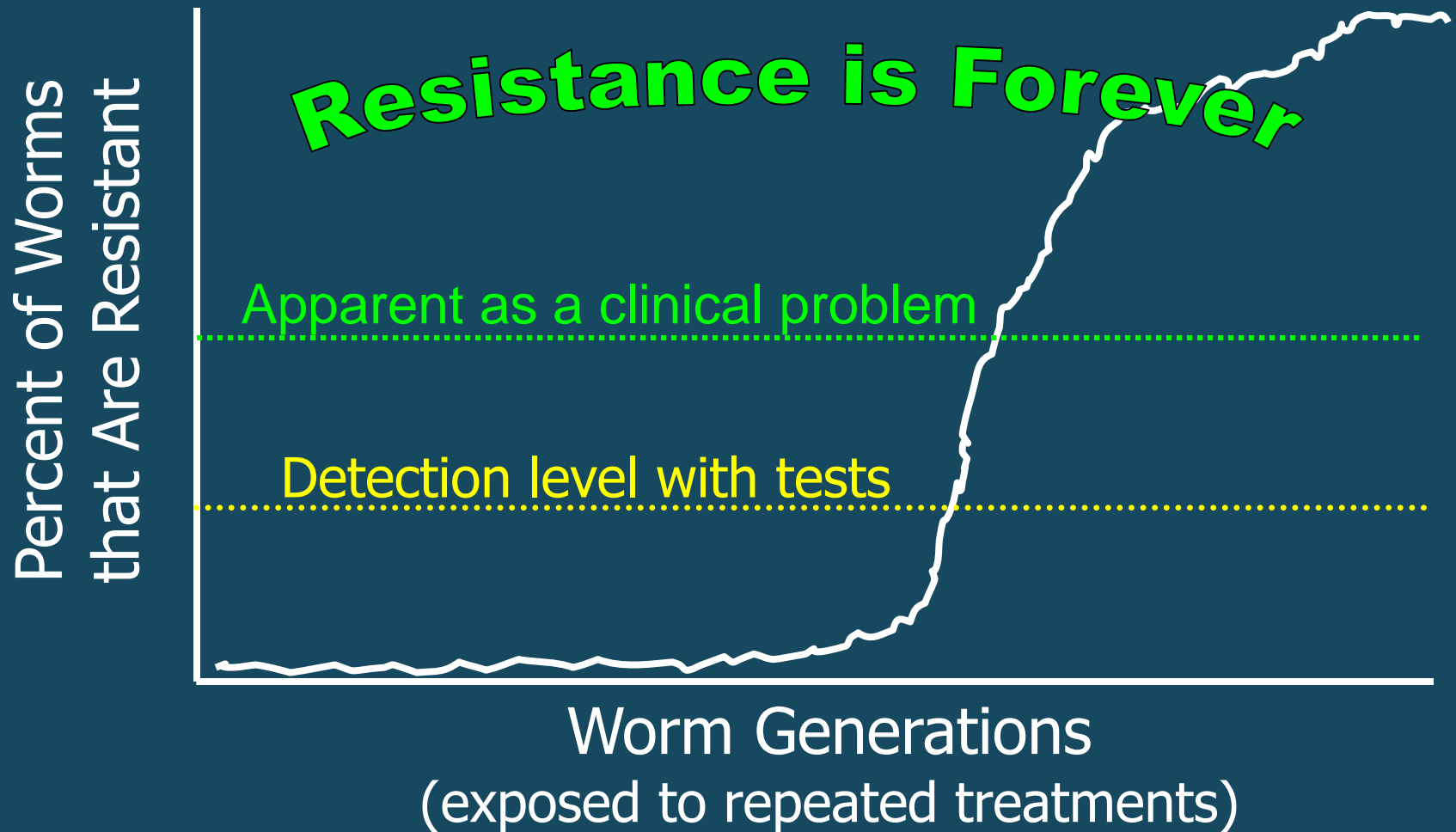


Next Generation

Resistant



Changes in “Resistance” Genes in Response to Drug Selection



American Consortium for Small Ruminant Parasite Control

Fort Valley State University (Georgia) – Lead
University of Georgia – College of Vet Med
Louisiana State University – College of Vet Med
Virginia Tech – College of Vet Med
Auburn University
University of Pretoria – South Africa
University of Maryland-Eastern Shore
University of Maryland-Western Station
Delaware State University
ARS – Booneville, Arkansas
ARS – Brooksville, Florida
Michigan State University
West Virginia University
NCAT/ATTRA – Fayetteville, AR
University of St. Croix
University of Puerto Rico
University of Florida
North Carolina State University
North Carolina A&T State University
Langston University (Oklahoma)
Texas A&M University
Tuskegee University (Alabama)

*A Fresh Approach Was
Needed!*

*A Fresh Approach Was
Developed!*

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ACSRPC Projects

www.scsrpc.org

- FAMACHA validation and evaluation
- Copper-oxide wire particle bolus
- Condensed tannin containing forage
- Integrated management approaches
- Host (sheep) resistance studies
- Nematophagous fungi
- Vaccines



Gastrointestinal Nematodes (Worms) of Sheep (and goats)

Most Important Species:

1. *Haemonchus contortus* ***
 - Barberpole worm
2. *Teladorsagia (Ostertagia) circumcincta*
 - Brown stomach worm
3. *Trichostrongylus colubriformis*
 - Bankrupt worm
4. +/- *Nematodirus*

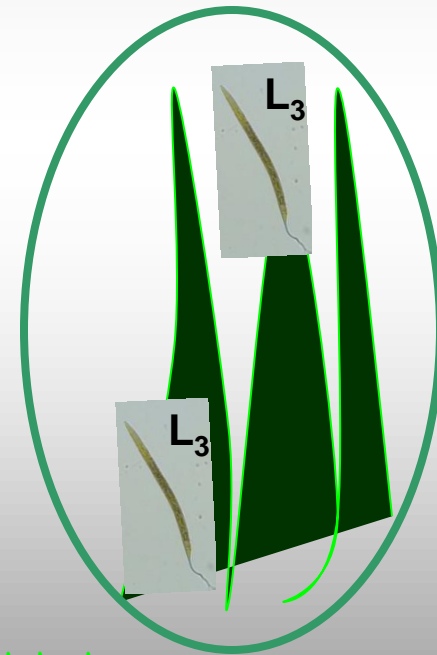
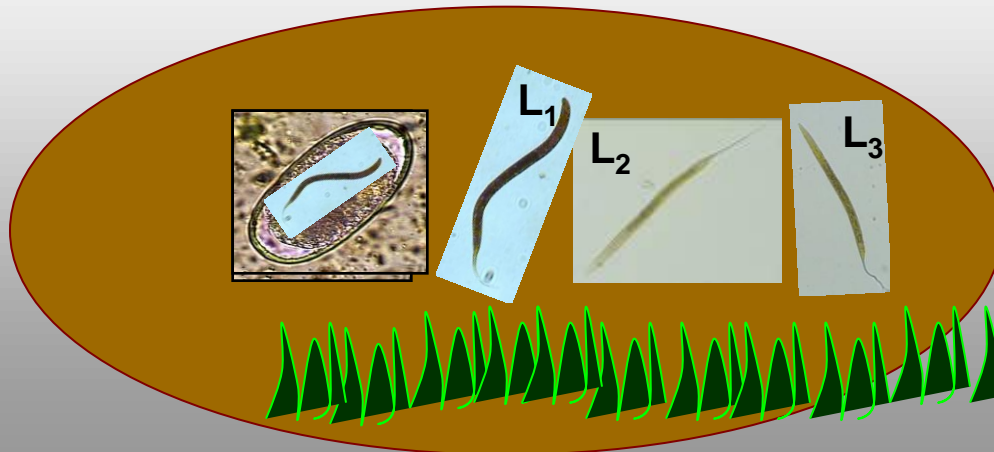


Haemonchus contortus **(Barber Pole Worm)**

- **PUBLIC ENEMY NUMBER ONE** for sheep
 - Literally a blood sucking worm
 - Very prolific – one adult female can produce 5000 eggs per day
 - Short life cycle – about 3 weeks from time of infection until eggs are produced
 - Preys on the weak, young, pregnant, or lactating animal
 - Developing resistance to all classes of dewormers

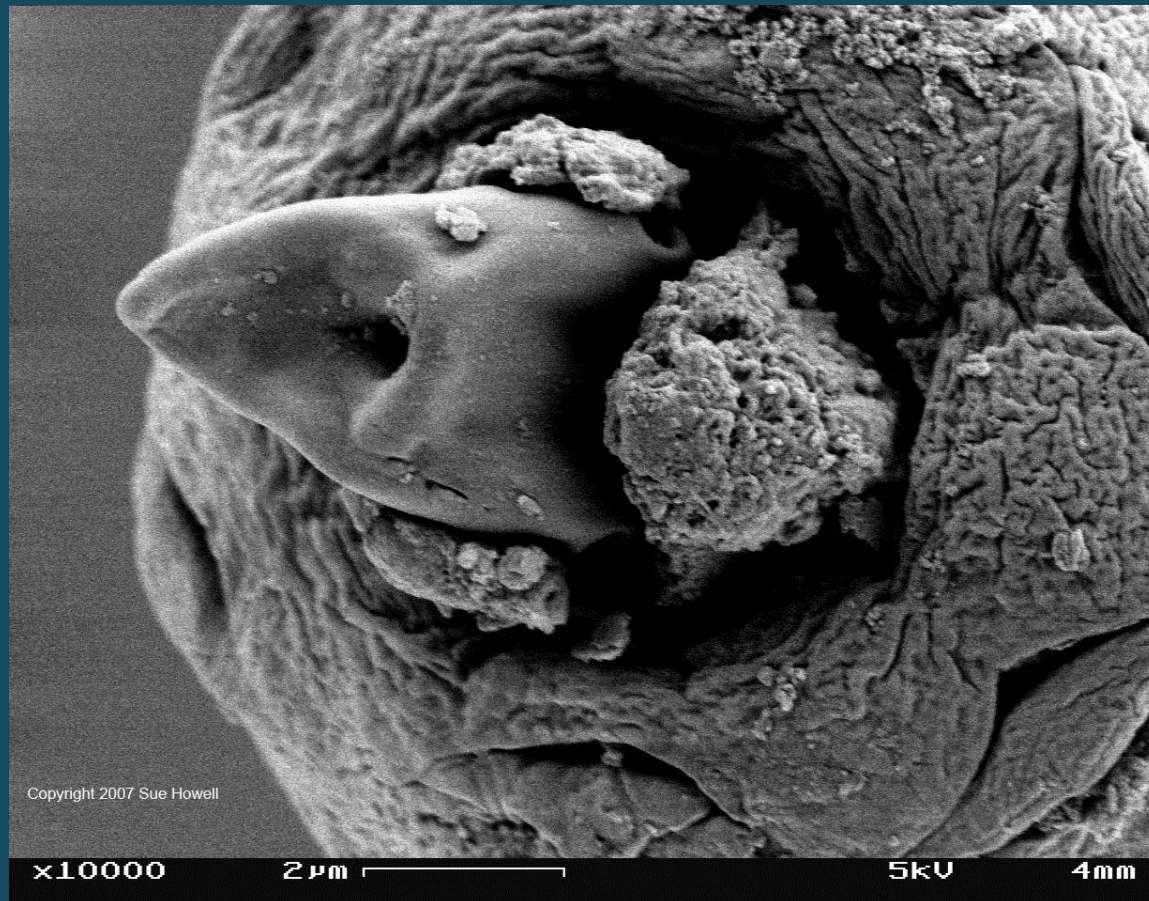


Life Cycle of GI Worms





Haemonchus contortus





Anemia



Bottle Jaw

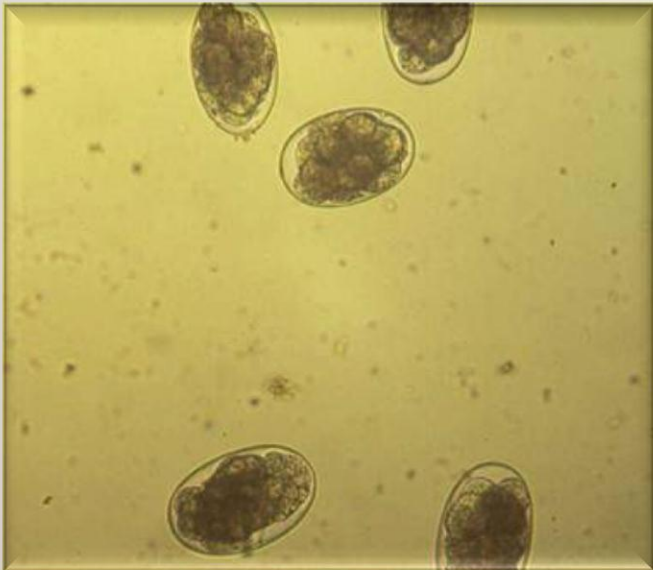
Why is *H. contortus* Such a Problem ???

- Evolved in tropics
 - thrives in warm/wet climates
- Long transmission season in southern states
- Short life cycle
- Immunity is slow to develop in sheep
 - Lambs are highly susceptible
 - Ewe immunity wanes around time of lambing



Why is *H. contortus* Such a Problem ???

- Very prolific — each female worms produces
 - 500 worms → ~ 5,000 eggs per day (epd)
 - 50 sheep → 2.5 million epd per animal
 - 1 billion eggs per week



Teladorsagia (Ostertagia) circumcincta **(Brown stomach worm)**

- Most important parasite of sheep/goats in cool climates.
- Tiny worms develop in gastric glands of stomach (abomasum)
 - as worms grow they destroy the glands
 - affects appetite, digestion and nutrient utilization
- Clinical symptoms
 - diarrhea, reduced appetite, weight loss



Overview of Anthelmintics

- Commonly called de-wormers/drenches
- Only three actual classes or families of anthelmintics exist.
 - Drugs within a class (or family) are very similar in chemistry and activity.
- Sold under many different trade names.
- Selection can be very confusing



Classes of Anthelmintics

(Currently Available Approved Dewormers for Sheep)

1. Benzimidazoles (BZ)

- fenbendazole (FBZ; Panacur, Safeguard)
- albendazole (ABZ; Valbazen)



Classes of Dewormers

2. Avermectin / Milbemycins

- ivermectin (IVM; Ivomec)
- moxidectin (MOX; Cydectin)



Classes of Anthelmintics (Dewormers)

3. Imidazothiazoles / Tetrahydropyrimidines

- (Membrane depolarizers)
- levamisole (LEV); Tramisole, Levasole, Prohibit)
- morantel tartrate & pyrantel tartrate; Rumatel



Note: Levamisole Problems - Concerns

- Narrow margin of safety
- Weigh animals
- Do not withhold feed
- Do not use in debilitated or dehydrated animals



What About?

- Diatomaceous Earth
- Herbal Dewormers
- No scientific evidence that these have any benefit for worm control.
- Some research work continues.

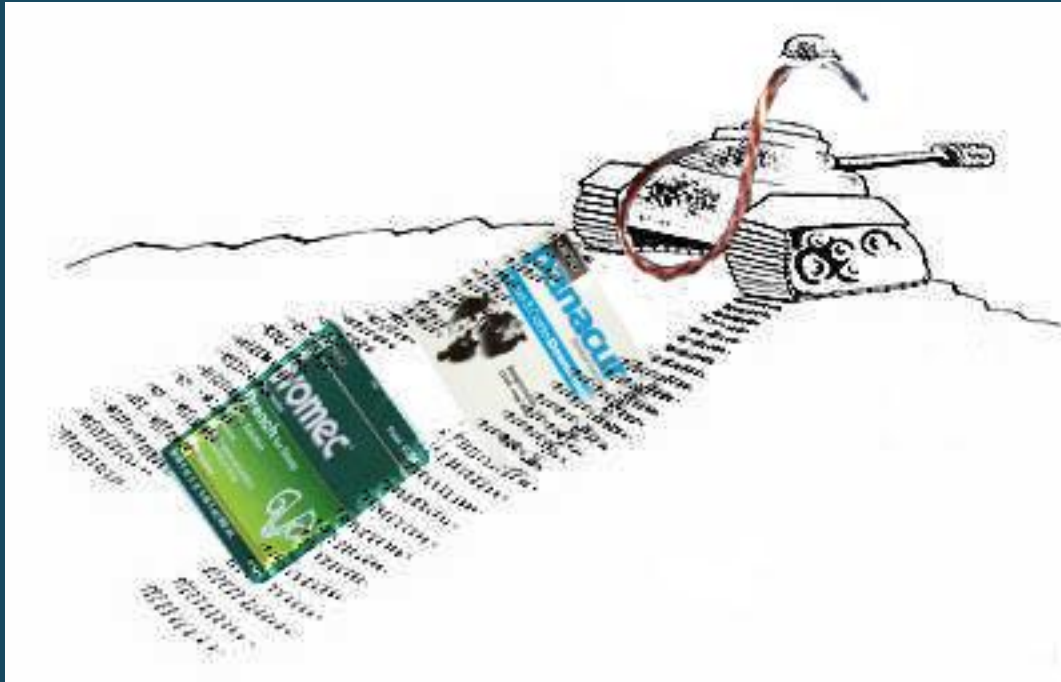


So, How did we get here?

- By doing what we thought was right, based on what we knew.
- What was recommended by the experts.

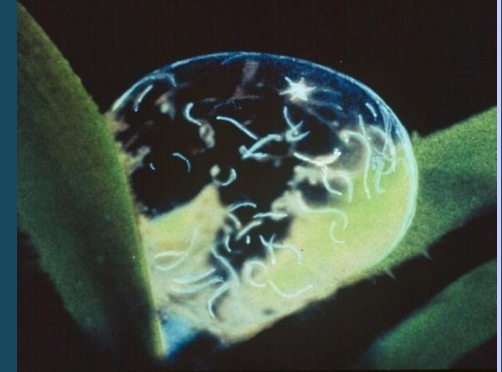


Resistance Revisited



The Traditional Approach to Parasite Management

- Treated entire herd
- Dewormed by the calendar
- Rotated wormers regularly
- Used only one pasture – may be only option
- Over crowding/over grazing
- Dewormed at move to new pasture
- Unknowingly purchased resistant worms



What Causes Resistance To Dewormers ???

- **Lack of Refugia**

- Refugia = the proportion of the worm population that is not selected by drug treatment

- Worms in untreated animals
 - Eggs and larvae on pasture

- Refugia provides pool of sensitive genes.

- Dilutes frequency of resistant genes

- Considered the **most important factor in the development of drug resistance**



What Causes Resistance To Dewormers ???

Treatment strategies that ↓ refugia

- Treating and moving to clean pasture
- Treating when few larvae are on the pasture (drought)
- Treating all animals at same time

Frequent treatments

- ≥ 3 treatments per year

Under dosing (Weigh)



If Resistance is Inevitable

What Can We Do ???

- Resistance is a natural biological consequence of drug treatment.
- Rate of development of resistance is within our control and can be greatly reduced.
- Goal is to preserve drug efficacy for as long as possible.
 - Increase refugia
 - Selective treatment



Resistance Occurs Within Classes of Anthelmintics

- Resistance to one drug in a class confers resistance to all others
 - same mechanism of action
- **Exceptions** to this are due to differences in potency and **are only temporary.**



Total Anthelmintic Failure

- A near-term possibility on many sheep farms and in many geographic areas
 - Many farms are down to their last drug
- First case TAF in USA diagnosed by Dr. Kaplan's UGA laboratory in 2005.
 - Recent study -- TAF on 17% of farms in SE
 - Future viability of SR industries is threatened.
 - 2010 NAMS-Sheep study confirms problem.



What Does This Mean For The Sheep Industry ???

- Dewormers can no longer be thought of as a cheap input to maximize productivity.
 - Extremely valuable and limited resources.
 - Requires a medically-based approach to treatment of the population.



What Does this Mean for the Sheep Industry?

- Control of *Haemonchus* must be practiced with an eye to the future.
 - Reality = long-term control of *Haemonchus* will only be possible if dewormers are used intelligently with prevention of resistance as a goal
 - Reduced-chemical and increased non-chemical approaches are needed.



Slowing down “Resistance”

- Given that “resistance” is inevitable and “resistance” is forever, how do we slow it down?
 - Reduce genetic selection pressure for resistance.
 - Maintaining a pool of sensitive genes –
REFUGIA
 - Treat individuals, not herds



Concept of Smart Drenching or Integrated Parasite Management

- Using what we have learned to develop deworming strategies that maximize the effectiveness of treatments while at the same time decreasing the rate at which we create drug resistance



Components of a Smart Drenching Program (IPM)

- Know the resistance status of the flock.
- Appropriate pasture management.
- Keep resistant worms off the farm
- Administer the proper dose
- Utilize host physiology
- Selective treatment – FAMACHA as a tool



Know the Resistance Status of the Flock

- Perform FECRT or DrenchRite©
 - What is this? Next slide
- Repeat every 2 years
- When resistance is recognized in early stages
 - Drug can still be used
 - Must be managed appropriately



FECRT?

- Fecal Egg Count Reduction Test
 - Take random fecal sample from ~10 animals.
 - Deworm with currently-used product.
 - Take fecal sample from same 10 animals in 7 to 10 days.
 - Determine the level of decrease in FEC.
 - Should reduce by 90% to 95% if working as claimed.
- Can be done on farm facilities.
- DrenchRite is a laboratory procedure.



Recommendations For Pasture Management

- Use appropriate stocking rates
- Build temporary or permanent fences to provide “safe” pastures
- Use dilution strategies
 - Mix 2 or more livestock species on same pasture (e.g. sheep with cattle or horses)
 - Rotate pastures between different species.
 - Combining sheep with goats does not work as they share the same parasites.



Smart Pasture Management

– Stocking Rate Issues

- Avoid overstocking.
- Stocking rate versus stocking intensity.
- 5-8 sheep = animal unit. .5 to 1 AU per acre.
- Fewer is often better; reduces exposure.



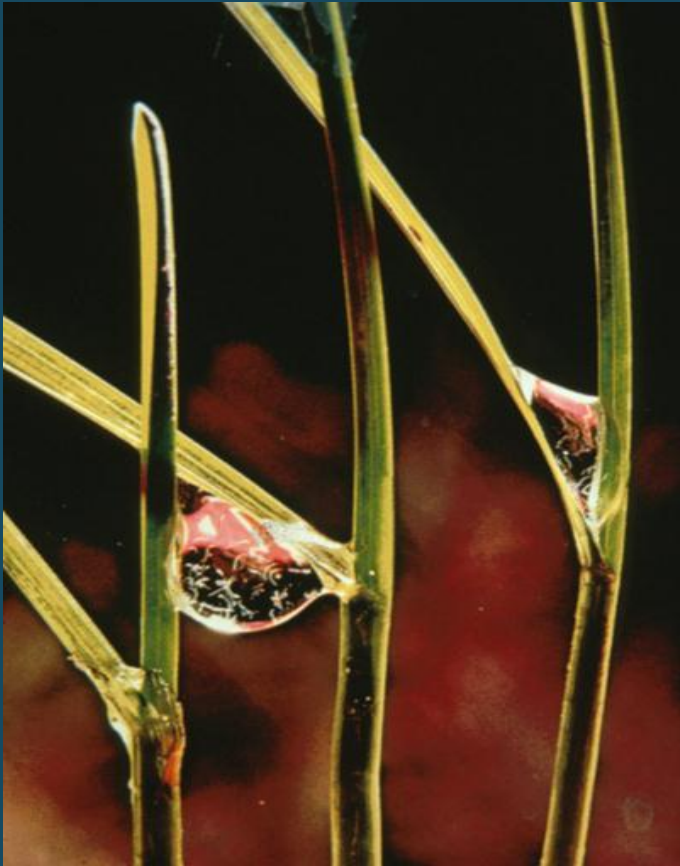
Browse Rather than Graze



- Reduces exposure to worm larvae.
- Provides diversity in diet.
- May be limited energy.
- Protein level can be high.



Pasture Rotation



Risky Areas in Pastures

- Where animals congregate
 - Increased fecal (worm egg) contamination
 - Increases “relative” stocking rates



Do Not Buy Resistant Worms

- All new additions to the flock should be quarantined and aggressively dewormed upon arrival.
- Deworm with three anthelmintics from different drug classes
 - moxidectin, levamisole, and albendazole upon arrival
- Should remain in quarantine for 10 - 14 days
 - Perform FEC to confirm that no eggs are shed
- Place animal onto contaminated pasture.



Use Proper Technique

- Ensure proper dose is delivered
- Proper technique when drenching sheep (and goats) is very important
 - drench should be delivered over the back of the tongue
 - critical that full dose lodges in the rumen
- drench delivered to the mouth may stimulate esophageal groove to close
 - significant drench bypasses the rumen
 - efficacy is reduced

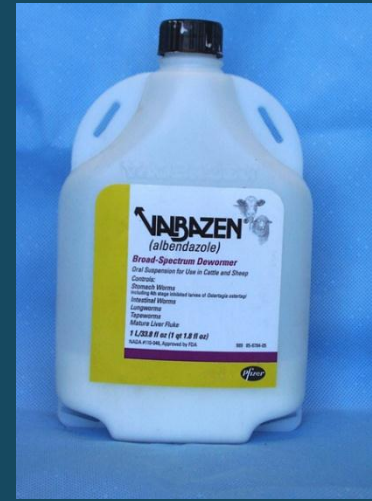


Images courtesy of
premier1supplies.com



Dewormer Savvy

Give the *Right* Dose



- Know the weight of animals being treated.
- In a common group treat according to heaviest weight.



Dose According to Weight

- Weigh scales
- Weight tapes
 - Sheep = OK
 - Dairy goats = OK
 - Meat goats = ??



Utilize Host Physiology to Maximize Drug Efficacy

- Restrict feed intake for 24 hours prior to treatment (BZ and ivermectin)
 - Withholding feed decreases digesta flow rate leading to an increase in drug efficacy
 - BUT, Never in late pregnancy
- Repeat dose in 12 hours (BZ)
- These simple measures can substantially improve efficacy when resistance is present and can help to delay resistance if not yet present



Genetic Impact

- **Resilience**
 - The ability to cope with a worm challenge.
- **Resistance**
 - The ability to limit the establishment of a worm infection.
- **Sire and breed influence**



Good Nutrition = Health



Importance of Nutrition as related to Genetics and Performance

- Good nutrition is key to overall animal health and growth rate
 - True whether your interested in meat, milk or fiber
 - Key to overall thrift and health of immune system
- Multiple studies show that sheep provided with adequate protein and energy-protein ratio stand a better chance of fighting off parasites.



Appropriate Nutrition

- Good nutrition plays major factor in resistance and resilience
 - Even a “resistant breed”, if it is on a poor diet, will lose the battle in the face of a major parasite challenge.
 - Susceptible breeds on a good diet will stand a better chance because of overall better health and immune system functionality.



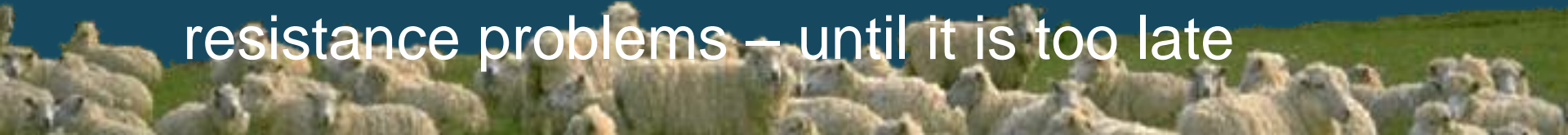
Rotation of Dewormers Is This a Good Idea ???

- Idea has been promoted for many years.
- Recommended for many years but new arguments against using drug rotation
 - Rotation is NOT a replacement for proper resistance prevention measures
- On many farms, rotation is not possible because of resistance.
- Use what works until it quits working.



Rotation of Dewormers Is A Bad Idea

- Creates false presumption among veterinarians and livestock owners that they have bona-fide resistance prevention program
- Rotation will mask resistance
 - Resistance develops slowly to all drugs simultaneously
 - One effective drug will “cover” for another
 - Few livestock owners realize they have resistance problems – until it is too late



Drug Combinations

- Use of combinations of drugs simultaneously have been shown to
 - Decrease rate with which resistance develops
 - Increase the effectiveness of treatment
 - Drugs not useful on their own can achieve reasonable therapeutic results if combined
- BUT – very dangerous if:
 - Do not build refugia into system
 - Do not do efficacy testing to monitor resistance situation



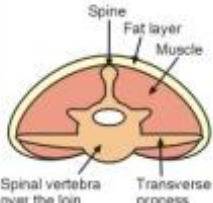





Selective Treatment

- FAMACHA[©]
 - For *H. contortus* only
- For other GI worms
 - FEC
 - Age
 - Body condition
 - Production level
 - Symptoms
 - Short term weight gain



Body Condition Scores

Condition Scoring in Sheep

Spines	Individually clearly felt, sharp, obvious	Form a smooth line with deep undulations	Only slightly detectable undulations	Only detectable with firm pressure	Not detectable
Transverse processes	Fingers easily pass underneath	Smooth round edges	Well covered. Have to push firmly to get fingers underneath	Cannot be felt at all	
Muscle	Very little. Concave	Concave	Not concave. Not convex	Maximally developed. Convex	
Fat layer	No	Very thin	Moderate	Thick	Very thick to form a dip along top midline
					
Condition score	1	2	3	4	5

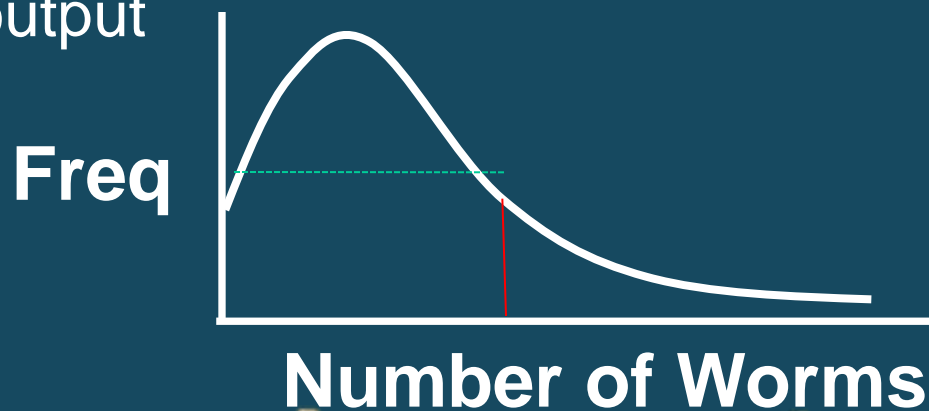
Description:

- The condition scoring is performed over the lower back area.
- Cases which do not fit these categories properly ie. fall between whole numbers, can be assigned half scores eg. 1.5, 2.5 etc.
- This scheme may be used in goats, but half a score is added to the score, since goats preferentially store fat intra-abdominally and not over the lower back.



Concept Behind Selective Treatment

- Parasites are not equally distributed among all animals in a sheep flock.
 - Overdispersed / aggregated distributions
 - 20-30 % of animals harbor most of worms
 - Few animals are responsible for most of egg output



**So, how do we easily
determine who to treat
if we are working to
manage *H. contortus*
(Barberpole)??**





FAMACHA[©]

Fafa Malan's Chart

The FAMACHA[®] System



- Eye color chart with five color categories
- Compare chart with color of mucous membranes of sheep or goat
- Classification into one of five color categories:
 - 1 – not anemic
 - 5 -- severely anemic



How Does FAMACHA Work ??

- Since the primary impact of *H. contortus* is anemia, one can indirectly measure parasite burden (and need for treatment) by measuring anemia
- Only useful where *H. contortus* is the primary parasite species



Anemia

- Definition – a reduction below normal in the number or volume of red blood cells in the blood
- Symptoms depend on degree/severity
 - Sub-mandibular Edema (Bottle Jaw)
 - Unthrifty Condition
 - Poor BCS
 - Broken fleece
 - Exercise and Heat intolerance
 - Pale mucus membranes



Severe Anemia

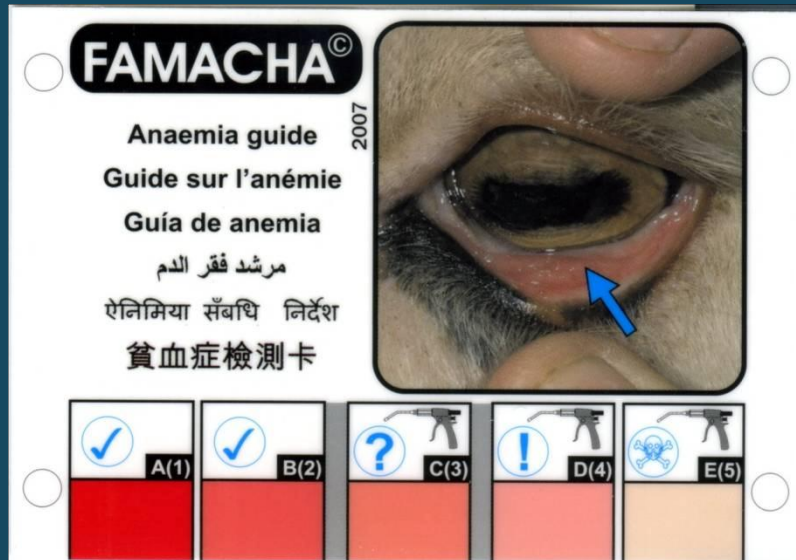


Haemonchus contortus

- Heavy burden can result in the loss of $\frac{1}{2}$ cup or more of blood per day.
- The total blood volume makes up approximately $\frac{1}{12}^{\text{th}}$ total body weight.
 - Can be as much as 50% blood loss in 37 days.



Conjunctiva color relationship to Anemia



Clinical Category	Color Classification	Hematocrit Range (%)
1	Red	≥ 28
2	Red-pink	23 -27
3	Pink	18 -22
4	Pink-white	13 - 17
5	White	≤ 12



1) Place gentle downward pressure on eye with upper thumb

3) Read color of eye on mucous membranes of lower eyelid

2) Pull down lower eyelid with other thumb



Some Words of Caution:

- FAMACHA® is only applicable where *Haemonchus* is the main worm causing clinical disease.
- Conjunctival redness can be caused by eye disease, environmental irritants, and systemic disease.

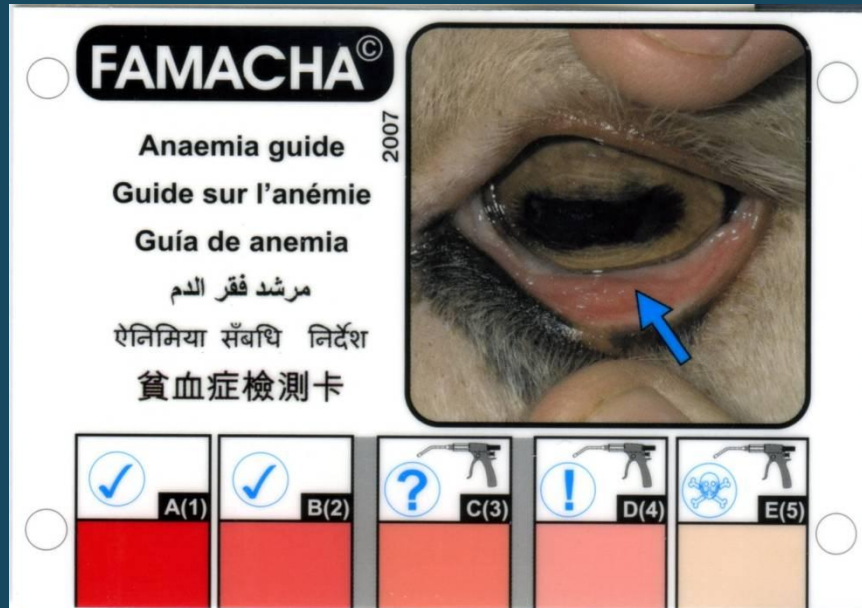


More Precautions....

- **Don't use FAMACHA as a sole criteria for whether or not to drench.**
 - If you see other symptoms such as bottle jaw, you know you need to drench.
 - Look at all available signs
 - Body condition score
 - Coat condition
 - Consistency of feces
 - Heat/exertion intolerance



The Famacha Card

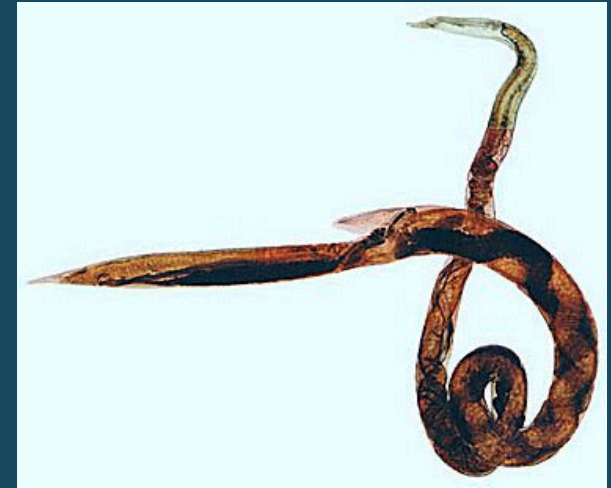


- Available following training.
- Store in dark place when not in use.
- Replace card after 12 months' use.
- Keep a spare card in a light protected place



Why use IPM and the FAMACHA tool?

- Decreased worm burdens
- Creates “Refugia”
 - Decreased development of resistance.
- Saves money .
- Identifies animals that need less frequent deworming -- keep for breeding!
- Identifies animals that need more frequent deworming -- cull!

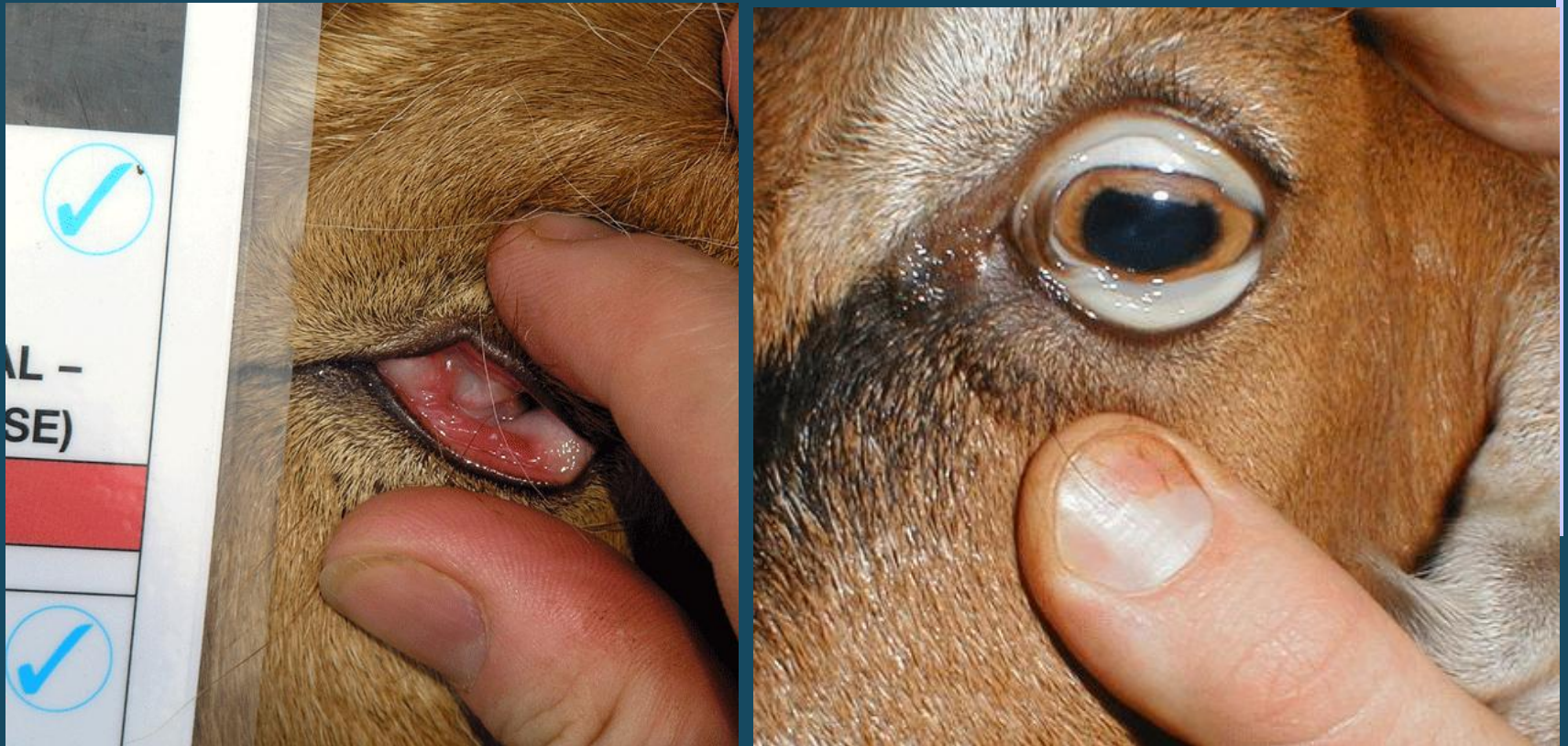


Remember Refugia (“In Refuge”)

- Untreated animals harbor susceptible worms.
- Dilutional (genetic) effect on resistant worms when worms mate.
- Resistance develops more slowly.
- Try to keep a “flock” of susceptible worms.



Keep Herd and Individual Records!!!! For Decisions.



Example Herd Anemia Record

FAMACHA ANEMIA RECORD

Group ID: _____

Category	Totals				
	1	2	3	4	5
Date: 5/1 Treatment:					
Date: 5/15 Treatment:					
Date: 6/1 Treatment:					
Date: Treatment:					
Date: Treatment:					

● Counted

✓ Counted and Treated

✕ Bottle Jaw - Treated



Alternative and Newer Methods for Worm Control



Breeding Sheep for Resistance

- Select resistant individuals and cull susceptible animals based on FAMACHA.
- Use more resistant breeds for crossbreeding in commercial flocks.
 - Crossbreds will demonstrate intermediate resistance, on the average.
- Long term process, but will be rewarding.



Copper-oxide Wire Particles

- *Haemonchus* only
- Marketed for use in cattle (Copasure) where copper deficiency is common.
- Appears to work better in sheep but potentially toxic effects through accumulation.
- Effect more variable in goats
- Selective treatment for individuals (FAMACHA)
- Copper oxide administered as small bolus. Copper sulfate added to feed is not the same
 - Does not appear to work



Condensed Tannin Containing Plants

- Sericea lespedeza
 - Forage that grows relatively well in SE US
 - Establishment as pasture may fit some operations
 - Hay, ground hay, pellets, etc. may be suited for many other operations
 - Has effect on *Haemonchus*
- Plant extracts
 - Drench or in pelleted feed





© James H. Miller



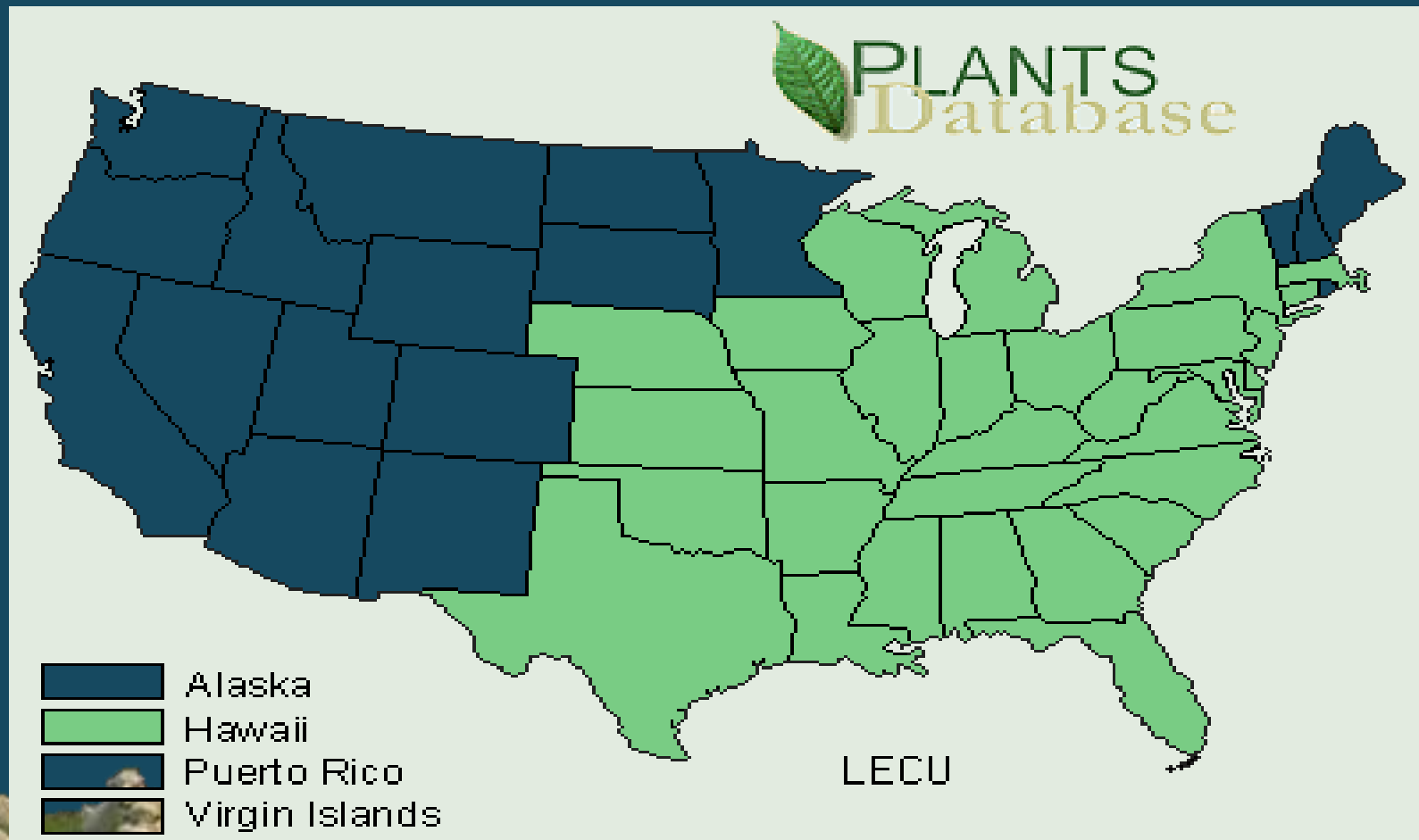
Sericea lespedeza

- Perennial warm-season legume
- High in condensed tannins
- Tolerant to low pH (4.5)
- Grows well on infertile soils



Sericea lespedeza

- Distribution

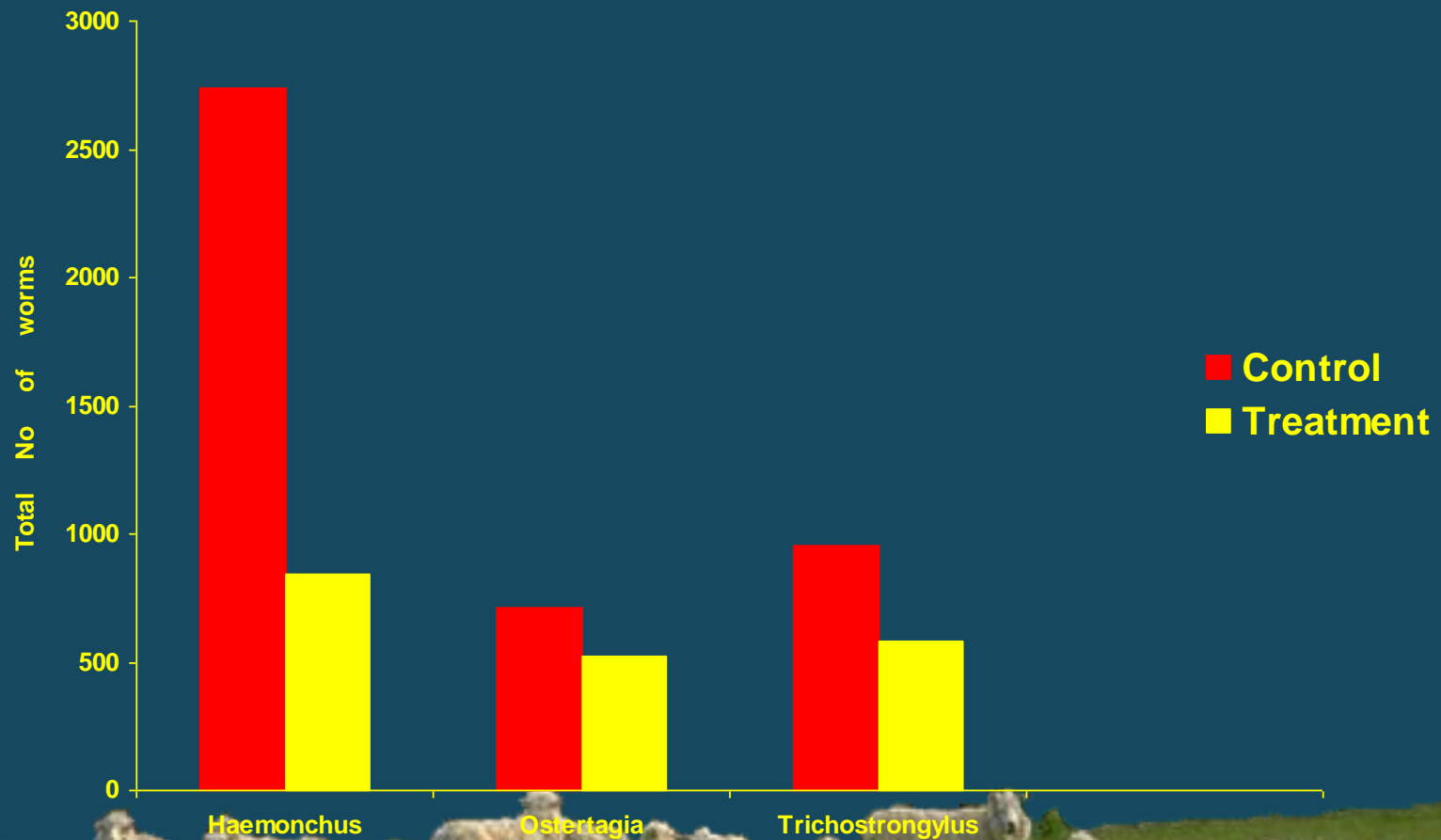


Different forms of sericea

- Unground hay
- Ground hay
- Leaf meal
- pellets



Effects on Adult Worm Species



Sericea lespedeza (SL)

research results

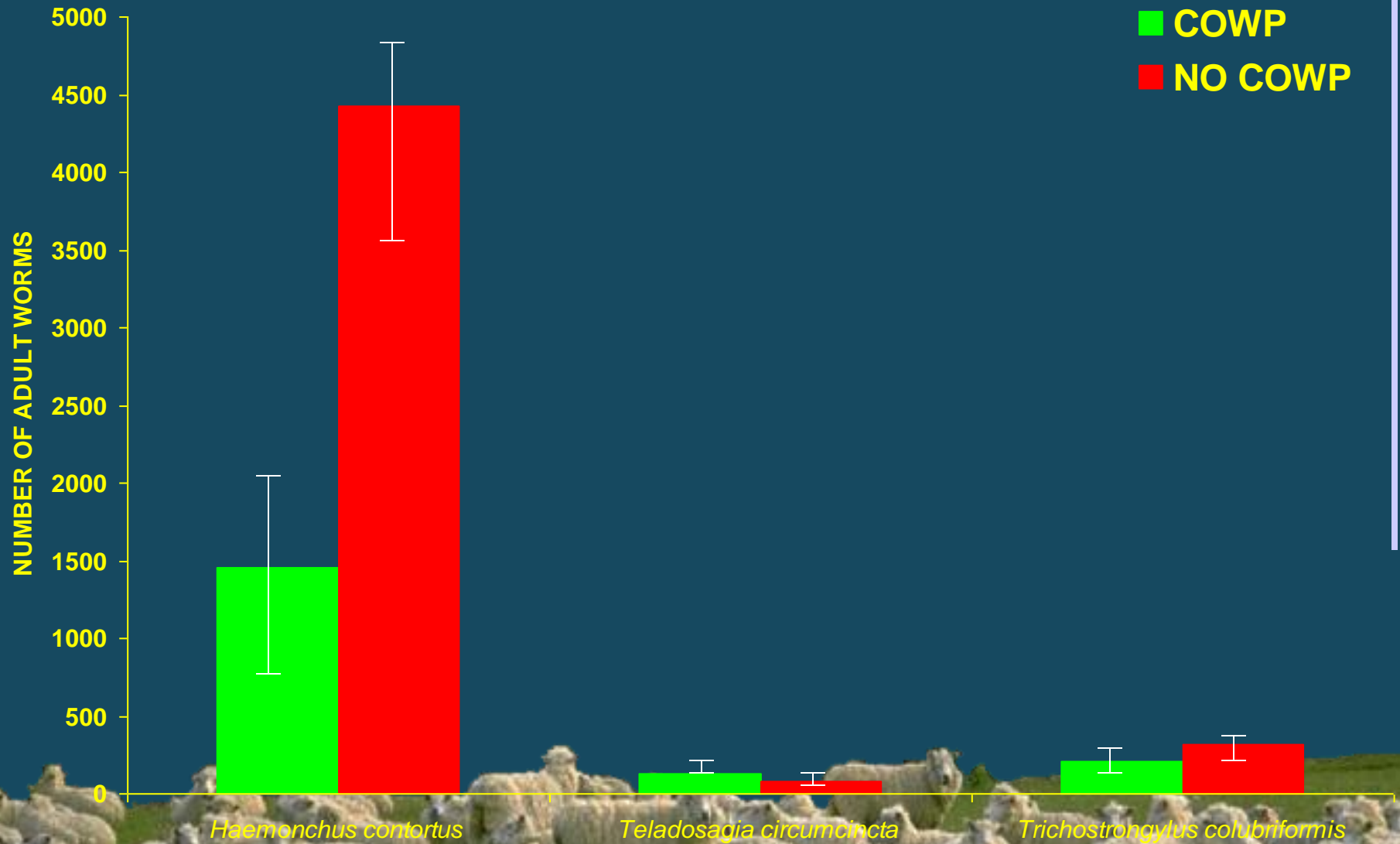
- Optimum dietary level of SL hay for reducing effects of GIN in goats and sheep 50-75%.
- Pelleting does not reduce the efficacy of sericea lespedeza hay against parasitic nematodes
- Sericea lespedeza hay reduced parasitic infection levels and increased animal performance (ADG) of growing goats



Copper oxide wire particles (COWP)



ADULT WORM DATA - SHEEP



COWP – Producer adoption



Integrated GIN control - research

- COWP + FAMACHA + SL pellet supplementation on pasture

(Burke et al., 2010)



Integrated GIN control – on-farm

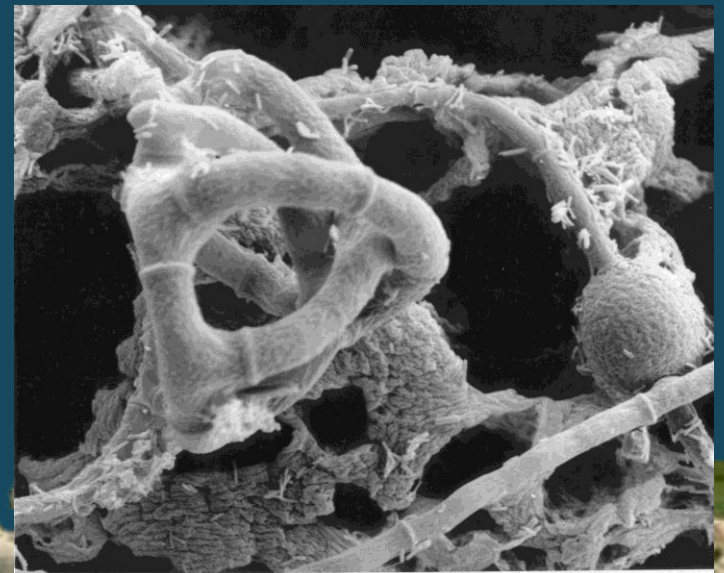
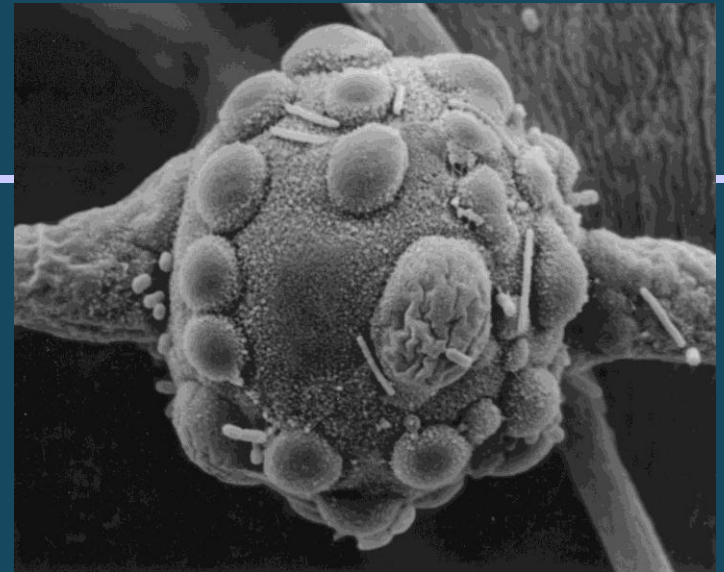
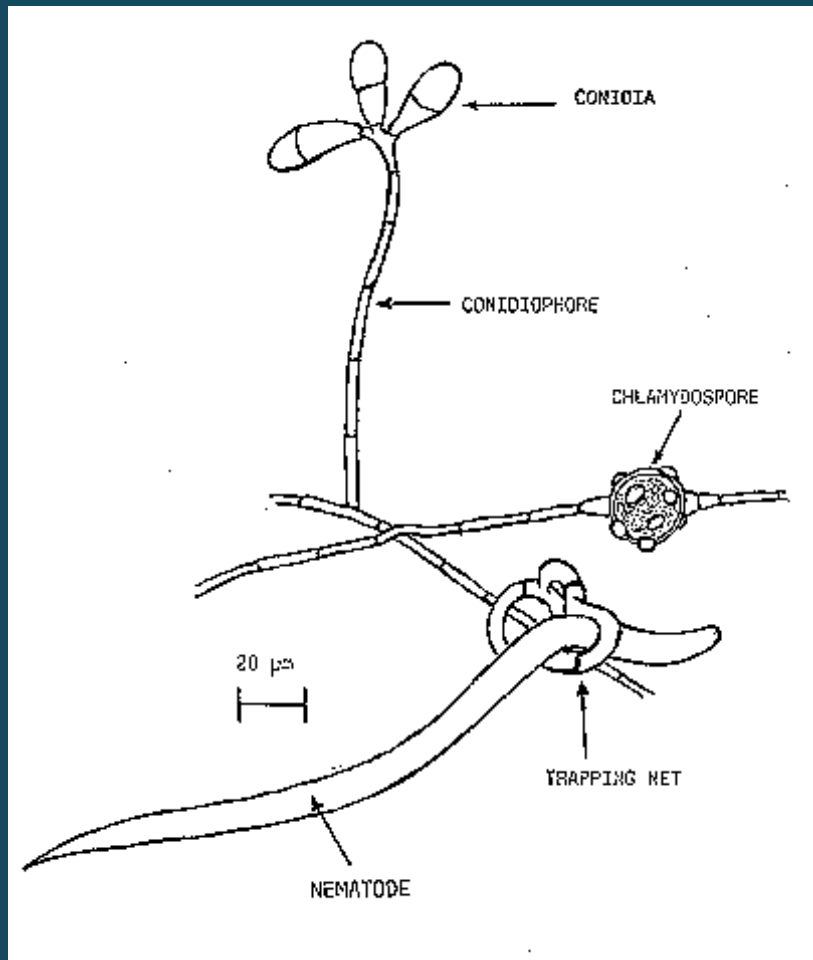
- FAMACHA + COWP
James Morgan, Arkansas sheep breeder
- FAMACHA + rotational grazing of browse, supplemental SL hay
An Peichal, Tennessee goat producer
- FAMACHA + genetic selection + rotational grazing to maintain refugia
Kathy Bielek, Ohio sheep breeder

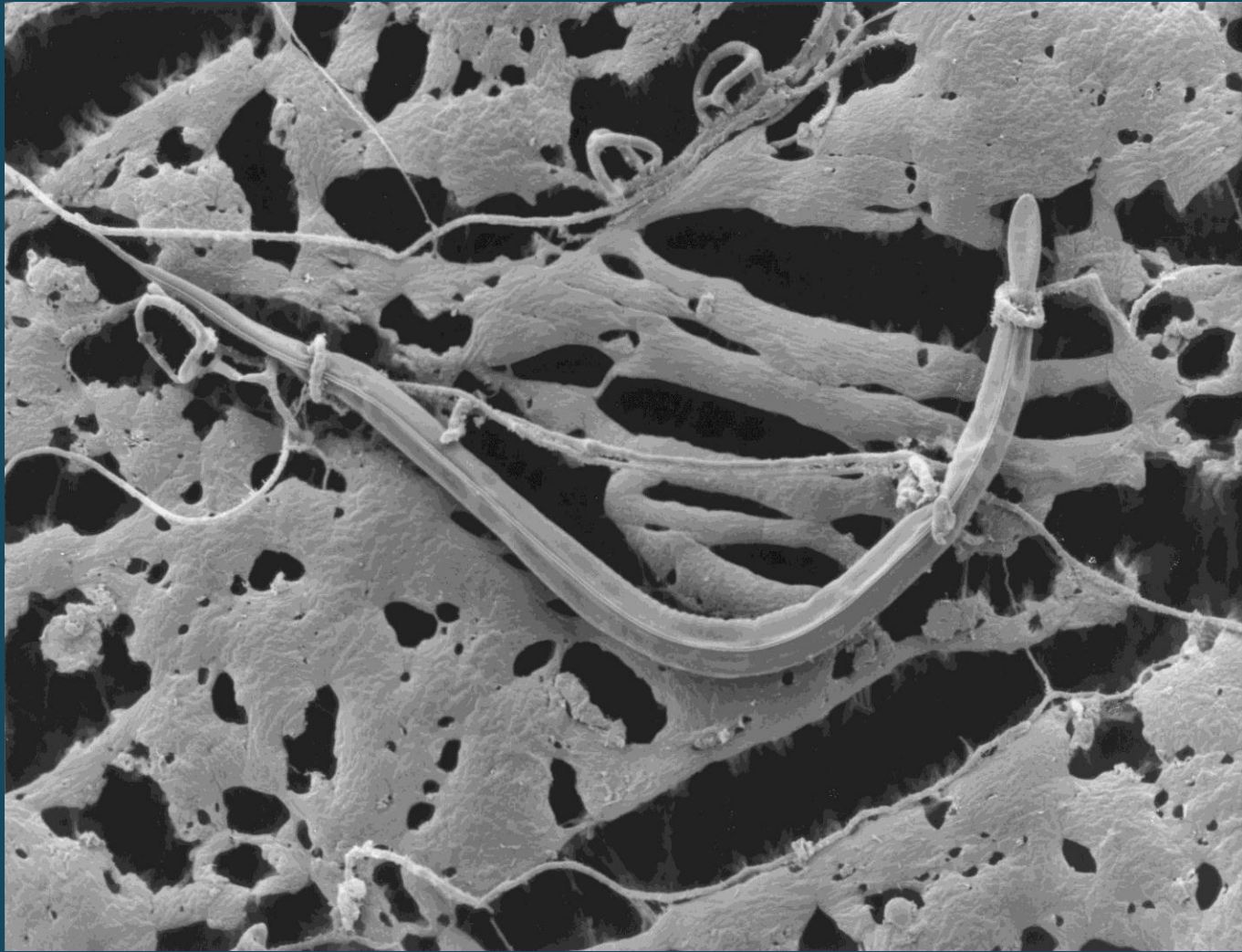


Worm-trapping Fungi

- *Duddingtonia flagrans*
 - Affects all worm larvae in feces
 - Feed daily with supplement
 - Primary objective is to clean up pasture
 - Long term results (?, maybe 2-3 years)







Vaccine

- Promising for *Haemonchus*
 - Works well in sheep and goats
 - Drawback is that vaccination has to be done frequently because protection is not complete
 - Expensive to produce now
 - Genetically engineered product is under development
 - Cost will be acceptable if successful



Pasture Rotation

- Short duration pasture rest
 - Results in high quality palatable forage
 - Results in greater exposure to nematode larvae for short time.
- In humid tropics
 - 30 days pasture rest may be sufficient to kill off many larvae
- In cool moist areas
 - 6-8 months or more is required for larval death



Pasture Rotation

- Rotate between **classes of livestock**
 - **Leader follower** systems
 - Susceptible animals followed by resistant animals harvesting larvae from pasture
 - Fewer larvae available when susceptible animals return to pasture
- **Shared grazing**
 - Each species of grazing animal has its own preferred forage and parasite fauna
 - More pounds of livestock can share a pasture without putting undue pressure on the environment and dilute the exposure to parasites



Control Internal Parasites by Determining:

- Which parasites are present
- When they are being transmitted
- How they survive
- Which anthelmintics are effective
 - What dose is required for host species
- When is the most appropriate time to administer anthelmintics or use other alternative control methods



An Integrated Strategy

- Use **FAMACHA** for monitoring infection level
 - **Cull** high infection individuals – resistance selection
 - **Deworm individuals** as necessary
 - Effective drug – smart drenching
 - Copper oxide wire particles
 - Sericea lespedeza
- **Management**
 - Stocking rate, mixed species grazing, dry lot, pasture spelling, and the like.
- In the Future (??)
 - Worm-trapping fungus, vaccine



Summary Statement

- Internal parasite management in sheep is now more effective and sustainable because it is based on a better understanding of the worm and it's host .
- Additional information and updates are maintained at www.acsrpc.org as well as at www.eXtension.org/sheep





A New Approach to Parasite Management in Sheep

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