WAR OF THE WORMS

TODAY'S PROGRAM

- The problem
- The parasites; where we are and why
- Biology of important GI Parasites
- Dewormers – a quick review
- What can we do?
  - Integrated Parasite Control
  - Pasture management
  - Alternative anthelmintics

Vermont Historical Society

Worms are not a new problem!

In the 1920's drenches included carbon tetrachloride and copper sulfate/nicotine

Stomach and Intestinal Worms

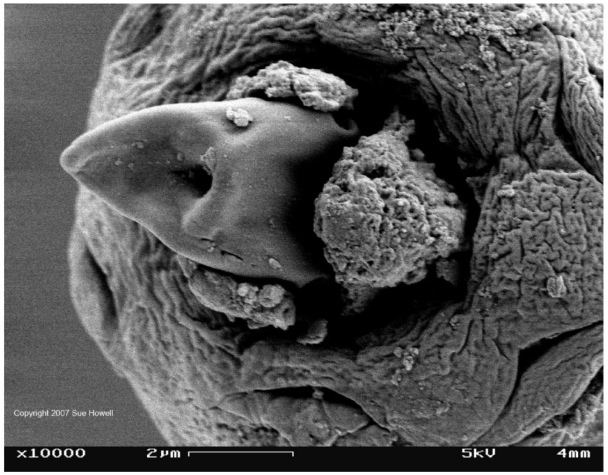
- GI nematodes biggest health problem east of the Rockies
- Most important--barber pole worm, *Haemonchus contortus*
  - Abomasal (stomach) parasite
  - Exploits many environments, management practices
    - Typically warm weather worm but survives everywhere with adequate moisture
    - In summer predominant even in Vermont

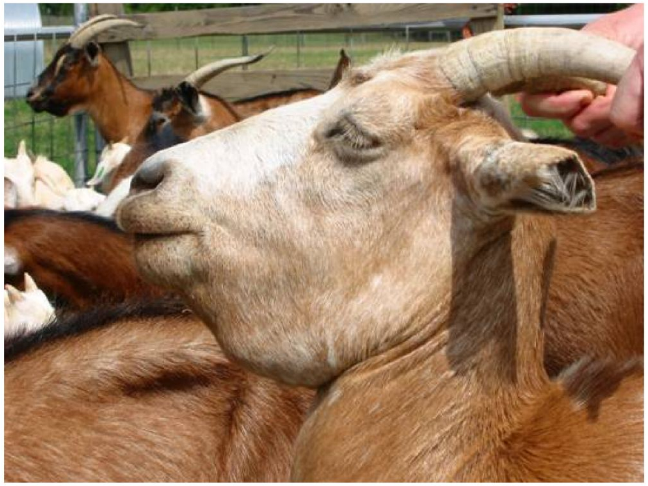
Stomach and Intestinal Worms

- Nematodes
  - ALL GRAZING ANIMALS HAVE WORMS!!!!!!!!!
  - Most important is barber pole worm, *Haemonchus contortus*
  - Related parasites also contribute to problems and can cause diarrhea
    - Brown stomach worm (*Ostertagia,Teladorsagia)*
    - *Trichostrongylus*
    - Others-- less important

Stomach and Intestinal Worms

- *Haemonchus contortus*
  - Blood sucking parasite
    - Heavy burden can result: anemia and bottle jaw, weakness
    - ½ cup or more of blood per day
    - Not diarrhea usually
    - Subclinical losses possible
      - Decreased gains, growth



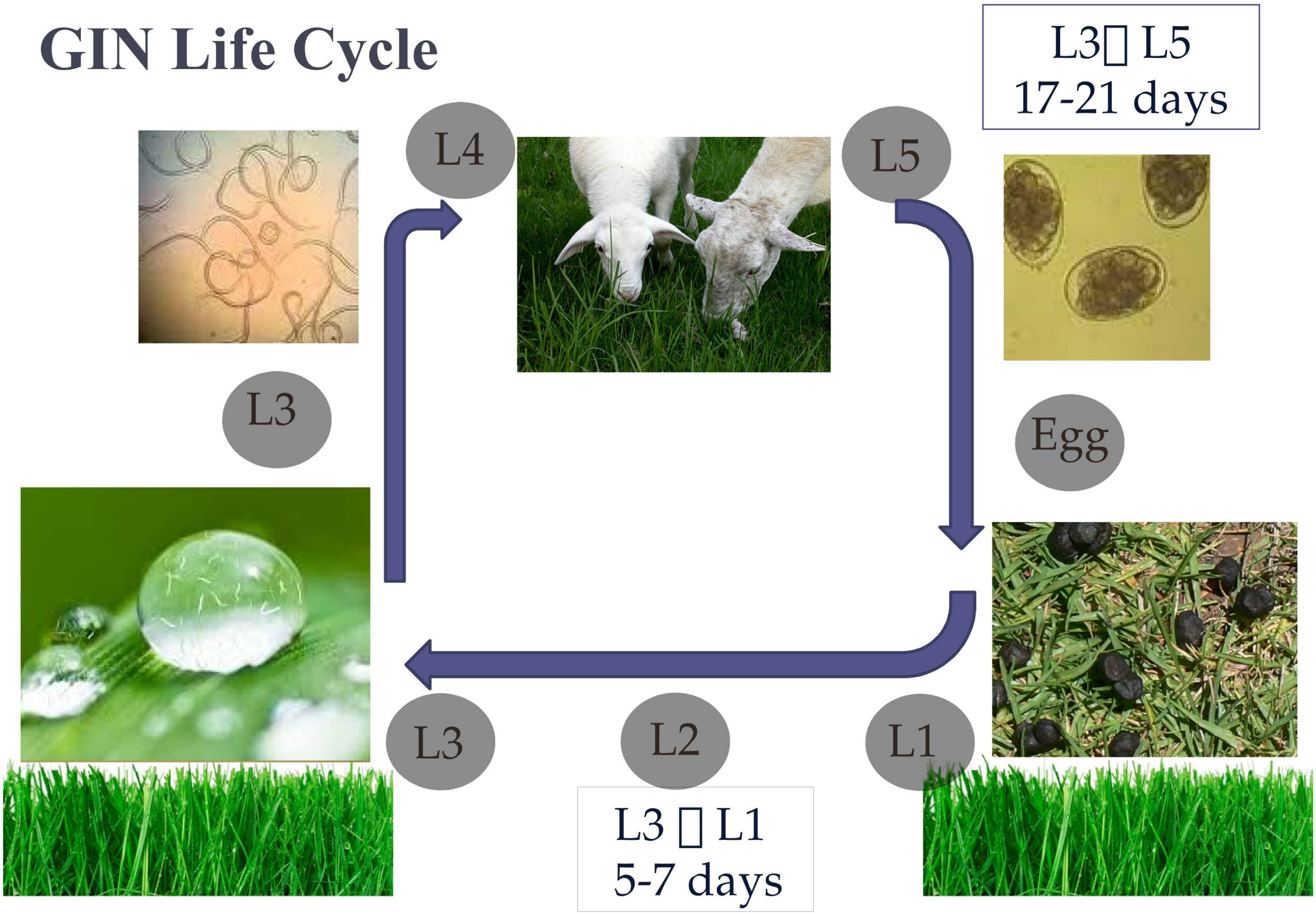


Haemonchus—heavy infection

Brown Stomach Worm (Ostertagia)

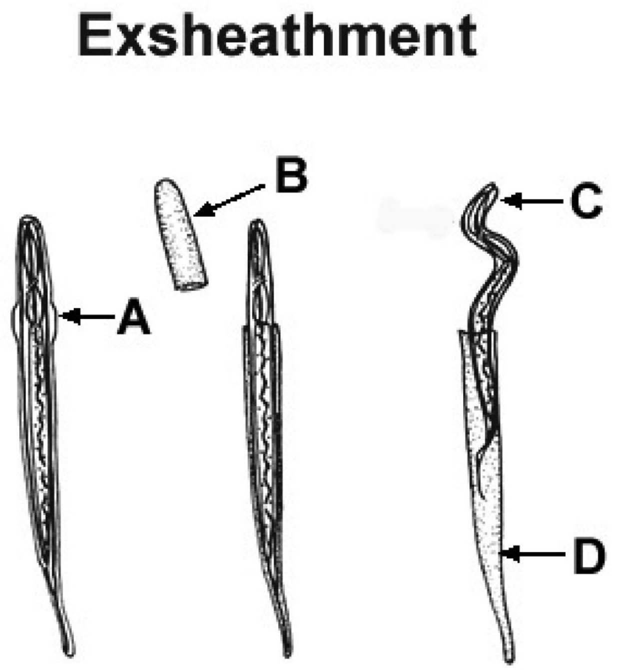
- Used to be considered most serious parasite of sheep in cool climates
- Worm develops in gastric glands of stomach (abomasum) and destroys the glands as they grow
- Affects appetite, digestion and nutrient utilization
- Clinical signs – diarrhea, reduced appetite, weight loss

GIN Life Cycle



Process of Exsheathment

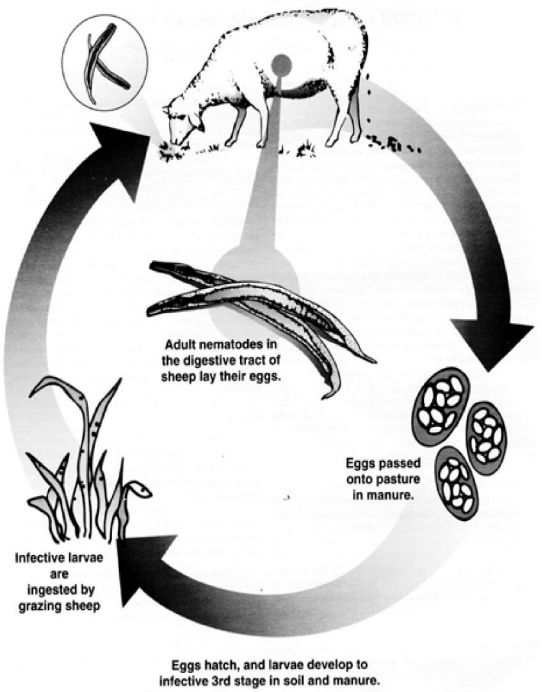
- Occurs in rumen
- CO_2 in rumen activates neurosecretory cells
- Neurosecretory cells take up H_2O activates crystallized enzymes
- Activated enzymes weaken cuticle cuticle breaks
- L3 fully infective



http://cal.vet.upenn.edu/projects/merial/nematodes/nems_7.htm

Life as a Worm

- How long can the infective larvae last on pasture?
  - They can’t eat once they reach the infective stage
  - Once metabolic reserves used up, they die
  - Hotter it is, the faster they wiggle, the quicker they die
  - Cool, moist conditions they live for months
  - Freezing kills some species
    - Includes *Haemonchus*



Life as a Worm

- How do worms survive the winter?
  - On pasture as eggs, larvae
    - Only some species can make it through the winter on pasture
  - As larvae in the host in a dormant state (arrested or hypobiotic)
    - No disease, no eggs in feces

Getting Rid of Parasites

- Goal is to manage the worms, not to eradicate the worms
- Goal is to keep worms at a level that doesn't have detrimental health effects

Stomach and Intestinal Worms

- What contributes to their success and increases losses?
  - Climate/weather
  - Management
  - Drug resistance

Stomach and Intestinal Worms

- Climate/Weather
  - Warm, wet grazing seasons perfect for *Haemonchus*
    - Short life cycle
      - About 3 weeks from infection to egg laying
  - Milder, shorter winters extend transmission season
    - Vermont worm season July-August
    - Virginia worm season June-October
    - Florida worm season all year

Stomach and Intestinal Worms

- Is barber pole worm important in the Northeast?
  - Past wisdom--other worms more important
  - Vet, producer experience say yes
  - Most numerous eggs found in project samples in New England
  - Has importance increased?
    - Resistant worms?
    - Changing grazing season?

Fecal Culture Results from CT, MA, RI and VT

Culture Results (%)	**2010**	**2011**	**2012**	**Average**
Haemonchus	**83**	**69**	**79**	**77**
Trichostrongylus	**13**	**24**	**15**	**17**
***Teladorsagia:* (also called *Ostertagia*)**	**4**	**1**	**0**	**2**
Cooperia	**2**	**0**	**0**	**1**
Oesophagostomum/Chabertia	**10**	**6**	**5**	**7**

Stomach and Intestinal Worms

- What contributes to their success and increases losses?
  - Climate/weather
  - Management
  - Drug resistance

Management

- Most parasites part of an animal's natural world
- Usually become a primary problem because of our management practices
  - High density grazing on permanent pastures

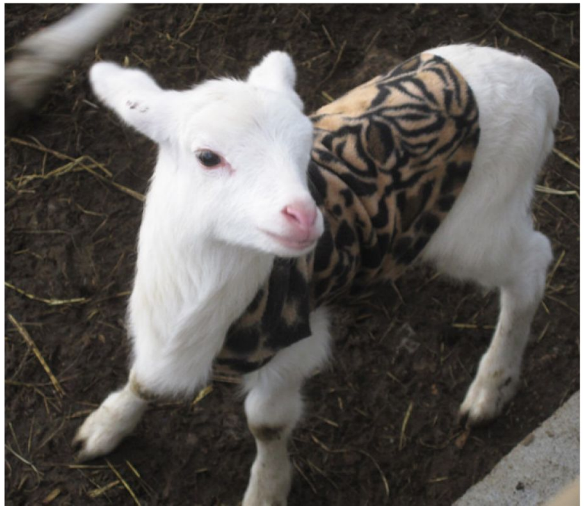
TRENDS in Ecology & Evolution

Stomach and Intestinal Worms

- What contributes to their success and increases losses?
  - Climate/weather
  - Management
  - Drug resistance

Dewormer Drugs

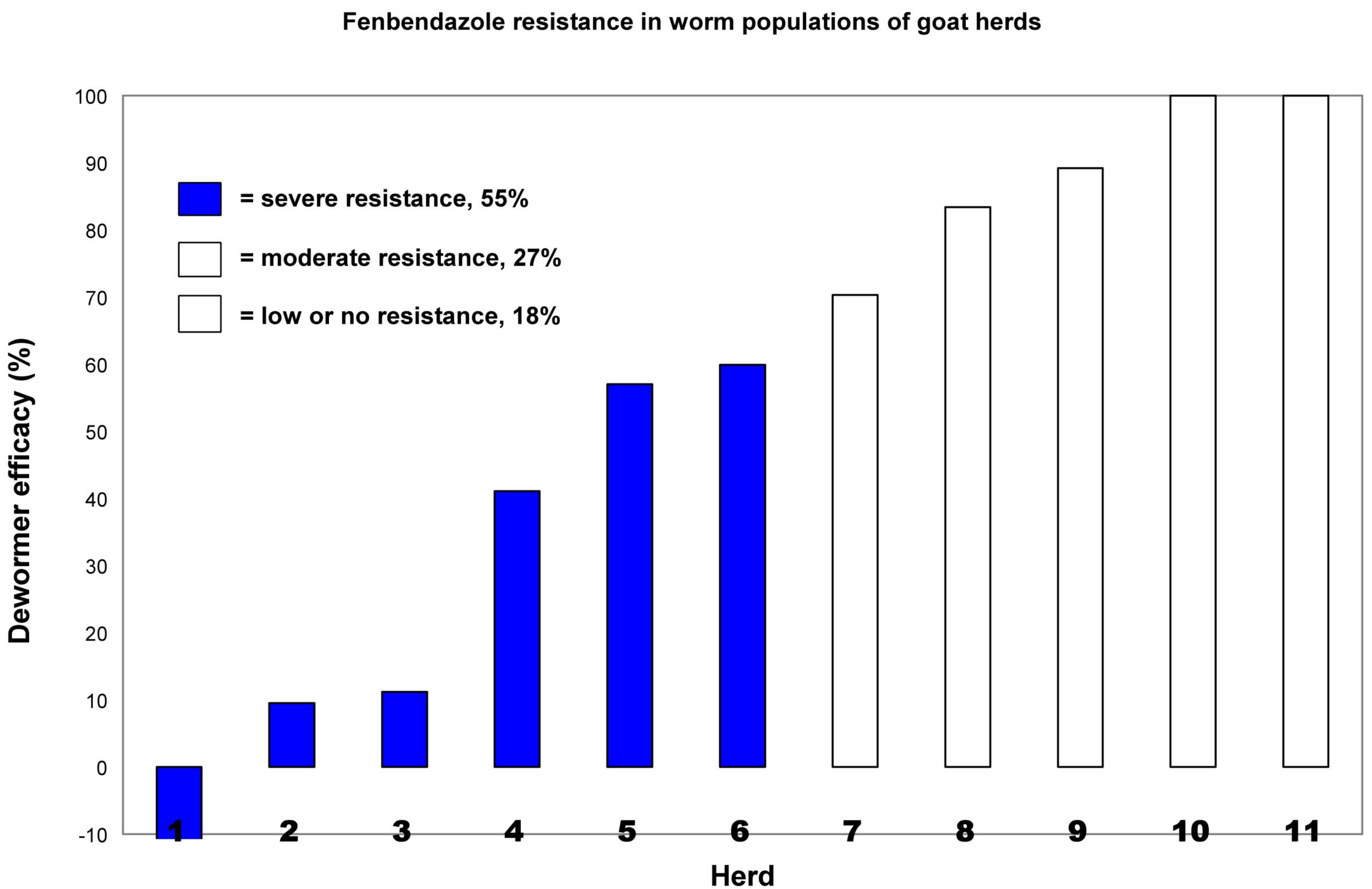
- Victory for Science!
- Since 1960’s have had fantastic drugs for treatment of sheep and goat GI nematodes
  - Highly effective against adults and larvae (>95%)
  - Safe
  - Nonprescription
  - CHEAP



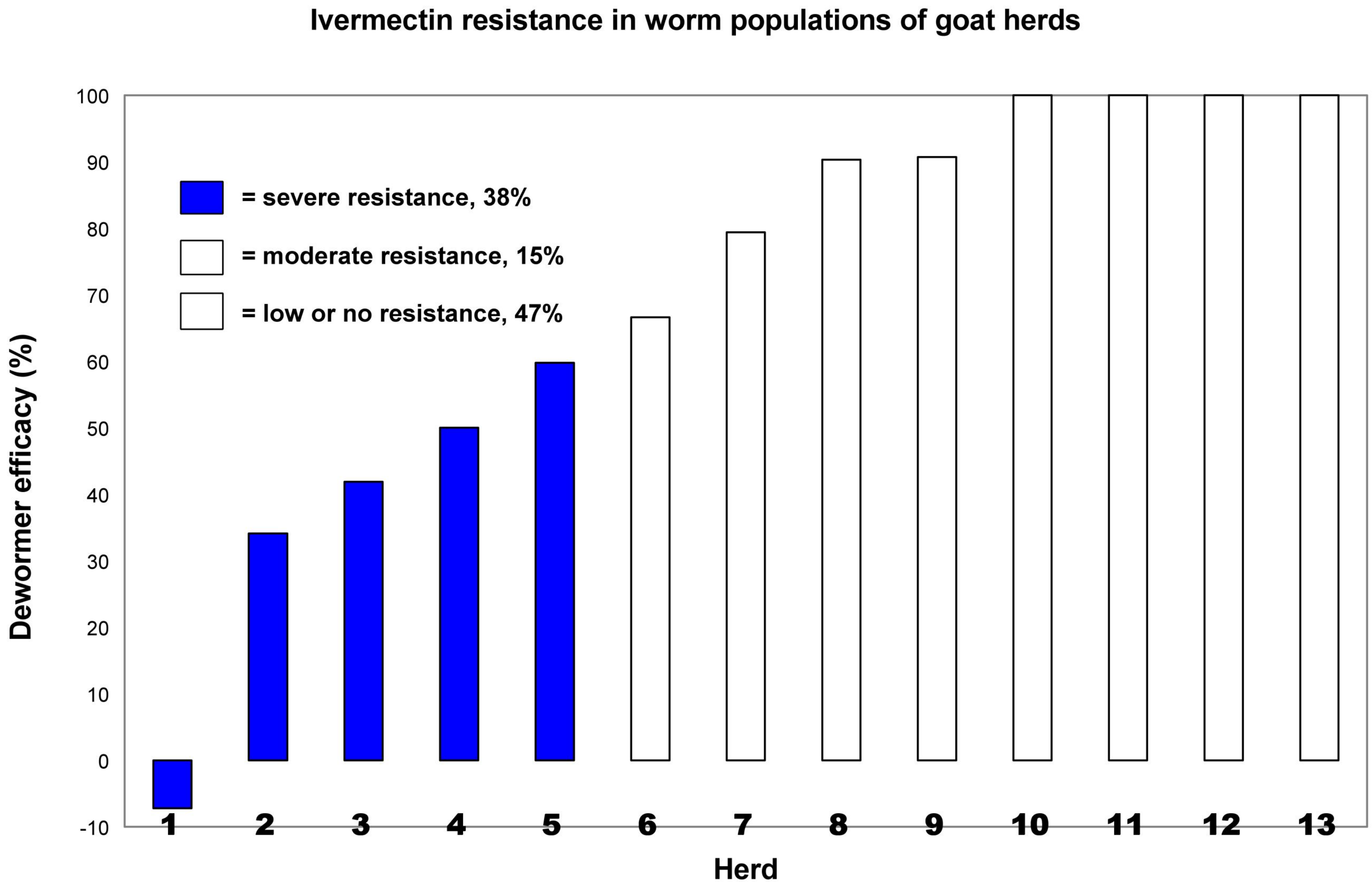
Drug Resistance

- Assumptions:
  - Some worms with a genetic ability to resist a drug always exist at low levels because of random gene mutation
  - When the drug not present, the resistant worms have no advantage
  - Use of a drug gives those worms an advantage
  - Gradually the number of resistant worms increases

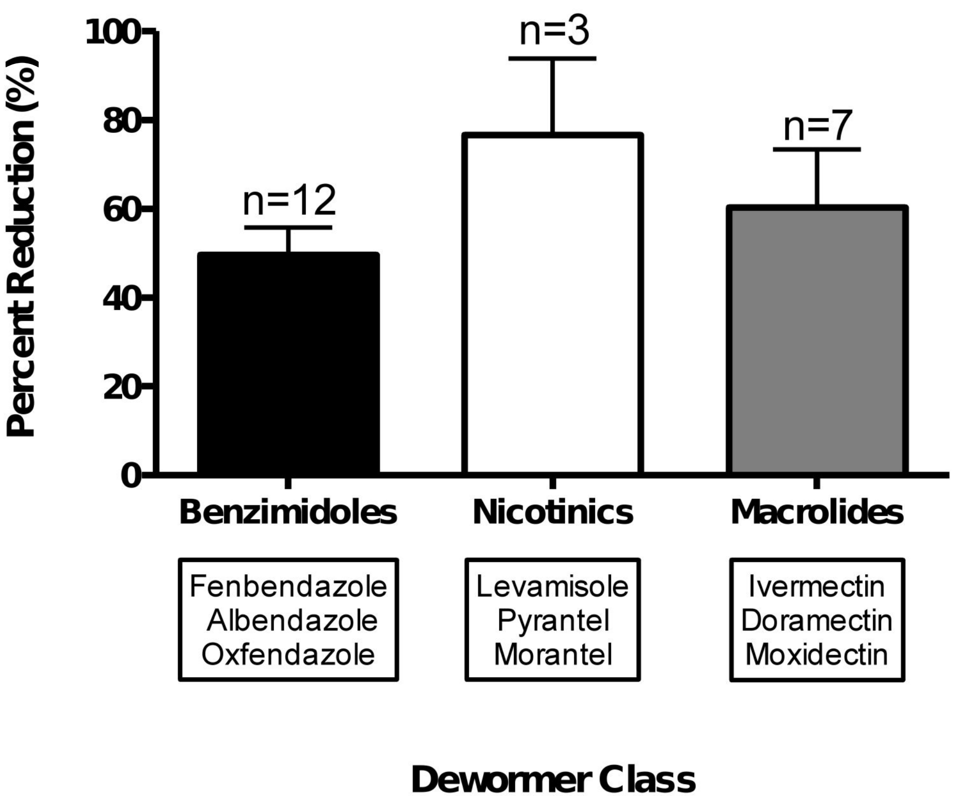
Comparison of fecal egg counts before and 7 to 10 days after deworming in NY and PA goat herds



Comparison of fecal egg counts before and 7 to 10 days after deworming in NY and PA goat herds



Fecal Egg Reduction Rate for Each Dewormer Class in a New England Study



Anthelmintic Resistance Simplified

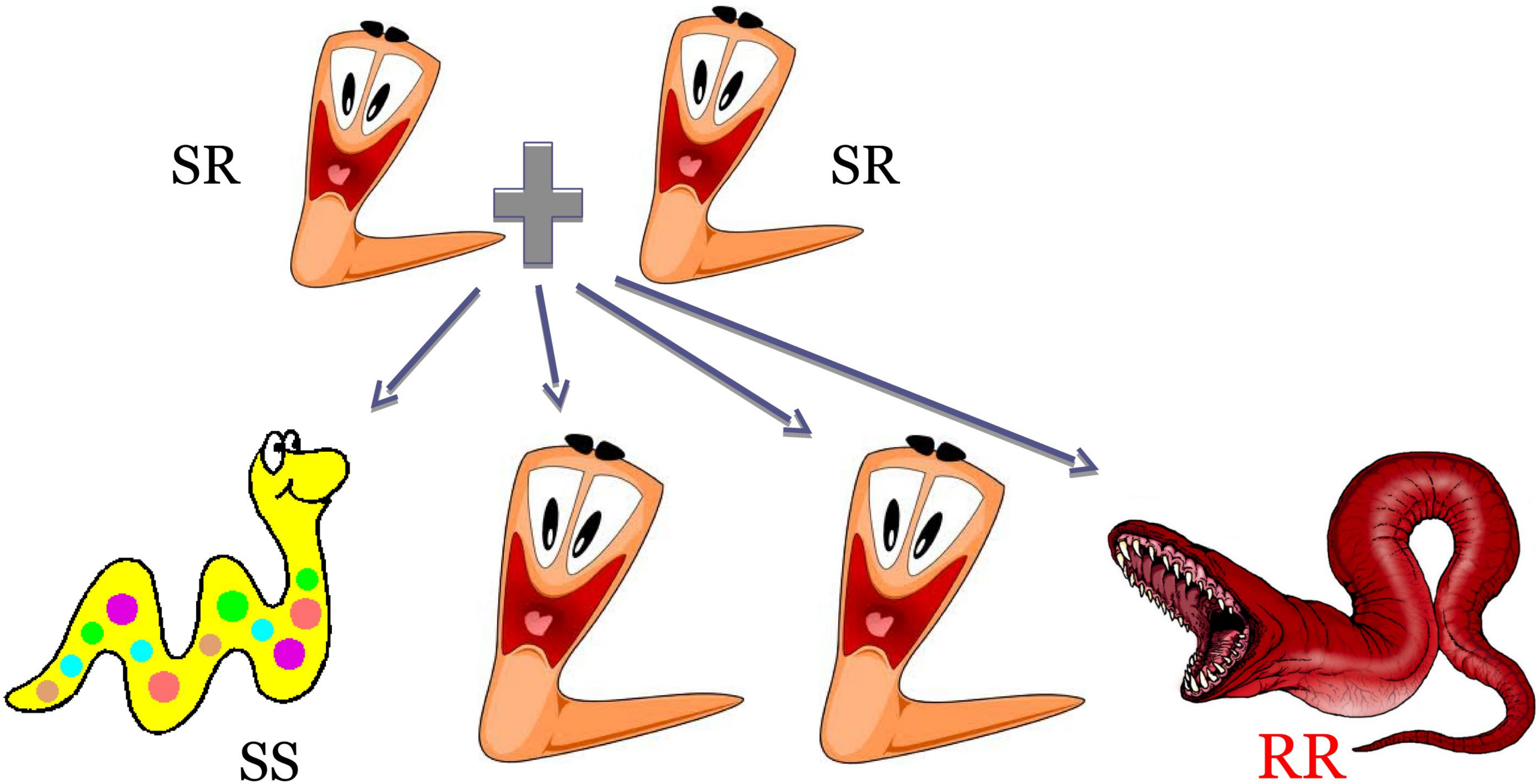
- Difficult to detect in early stages—WHY?
  - Each worm inherits genetic material from parents determining resistance (R) or susceptibility (S) to a drug
  - Random mutation gives rise to R alleles
  - Assume that an SR has some slight advantage (example: can survive if animals are underdosed)

SS

SR

Anthelmintic Resistance

- Need 2 Rs to be fully resistant → SEX



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 the parasite population not exposed (=unselected) when a drug is administered
  - Worms on pasture
  - Worms in untreated animals
  - Keeps susceptible worms in the population

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

Drugs

- Goals of rational drug use are to prevent disease/loss and minimize rate of development of resistance
  - Reduce treatments
  - Maintain refugia
- Drug use in goats
  - Sheep and goats metabolize drugs differently
  - Effective dose in goats is two times the sheep dose except
    - Levamisole (1.5x)
    - Moxidectin injectable—don't use it

Drugs

- Other ways to increase refugia
  - Don’t deworm and immediately move animals to safe/clean pasture
    - Only resistant worms will go to new pasture
    - Put back on old pasture for awhile to pick up susceptible worms or just treat some animals before move
  - Don’t deworm all animals at the same time

Other Antiparasitic Compounds

- New drugs
  - Amino acetonitrile
    - Monepantel—Zolvix
  - Different class of drugs but will select for resistant worms just as quickly

Alternatives to Commercial Dewormers

- Herbal dewormers
  - Several products commercially available containing variety of plants
  - Not regulated by the FDA
  - No requirement for studies to support efficacy or safety
  - No guarantee of consistency from bag to bag

Drugs

- Dewormer use in organic sheep operations
  - Ivermectin, moxidectin and fenbendazole (prescription only) currently allowed for limited use
    - Prohibited in slaughter stock sold as organic
    - Allowed for emergency treatment of dairy and breeder stock when all else fails
    - Milk or milk products cannot be labeled organic for 90 days following treatment
    - If offspring to be sold as organic meat, cannot be used in last 1/3 of gestation or during lactation
    - Must treat in humane situation

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

Immunity of the Host

- Sheep and goats develop immunity to GI worms
  - Controls parasites, does not eliminate them
    - Immune animals will have eggs in manure
  - Immunity in place at maturity
  - Goats more susceptible than sheep

Immunity of the Host

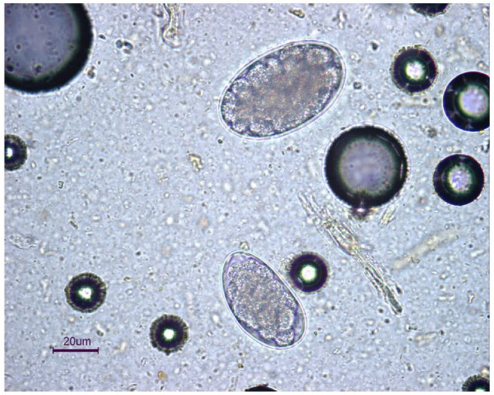
- Which animals have the most worm problems?
  - Animals with temporary high susceptibility to parasites
    - Young--before immunity develops
    - Lactation
      - Sheep at time of lambing especially susceptible
    - Poor health or nutrition
  - Animals with INHERITED high susceptibility to parasites

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

- Selective breeding!
  - Cull highly susceptible animals (FAMACHA good for this)
  - 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 selective breeding



Immunity of the Host

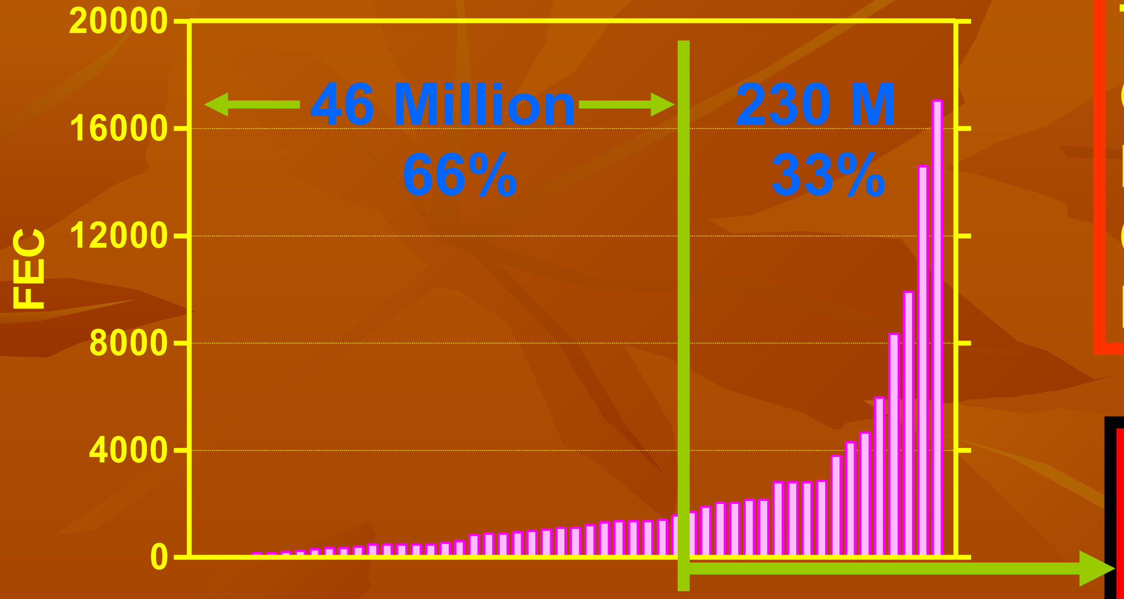
- Breeds with higher levels of resistance to parasites
  - St. Croix
  - Katahdin
  - Gulf Coast/Florida Native
- Have to keep selecting for parasite resistance even in more resistant breeds
- Less research on variation in resistance in goat breeds

Provided by Katahdin Hair Sheep International

Immunity of the Host

- How can you use immunity?
  - Selective deworming programs
    - Concentrates dewormer use on animals that need it the most
      - Use less dewormer
      - Slow development of resistance to dewormers

Distribution of FEC in Goat Herds



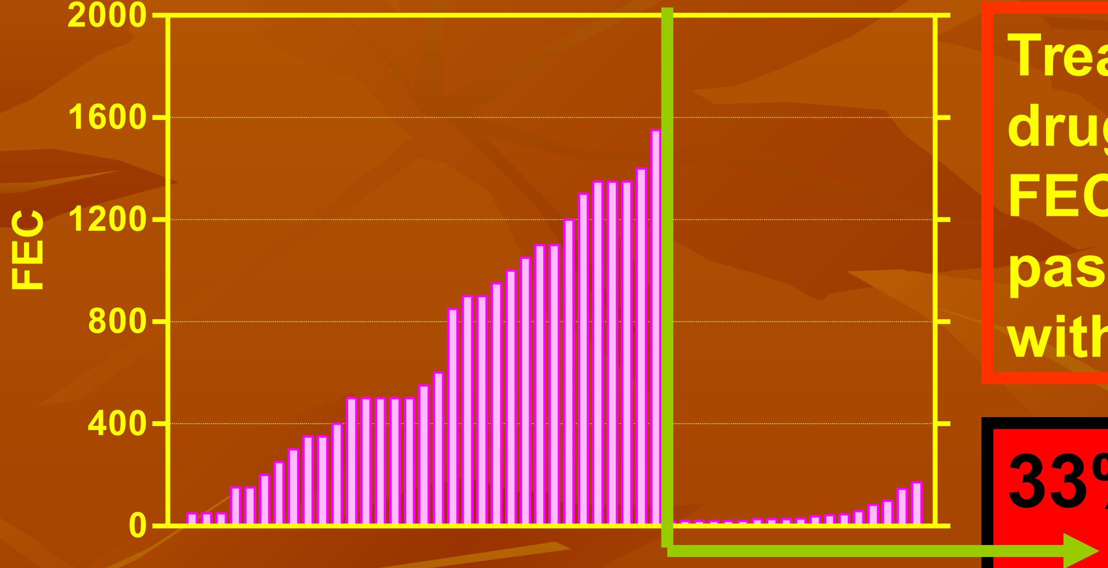
Treating high 33% Greatly Reduces Daily Pasture Contamination With Eggs

33% of Goats

80% of Eggs

Treating 1/3 of herd gives just as good control as treating the entire herd

What Happens If We Treat Only the High 33% ???



Treating high 33% with a drug that causes a 99% FECR reduces daily pasture contamination with eggs by 80%

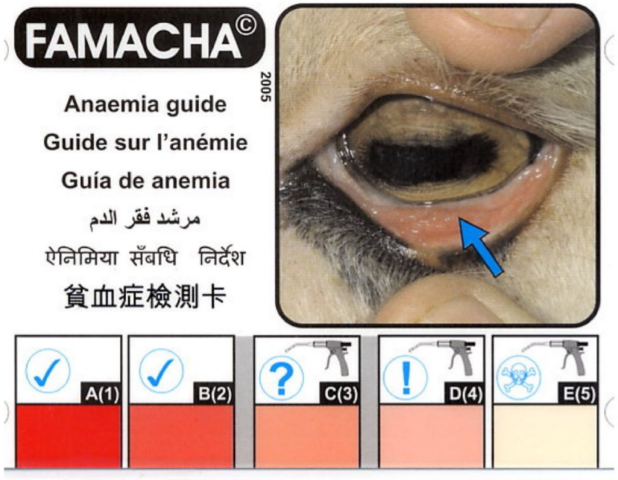
33% of Goats

< 5% of Eggs

Following treatment
> 95% of eggs are being shed by untreated goats
= REFUGIA

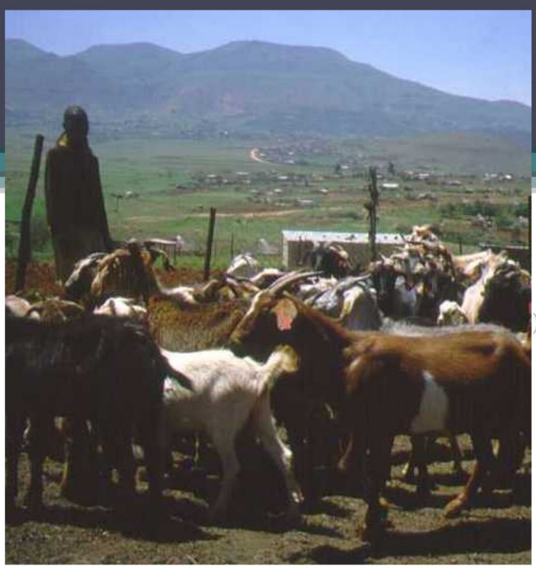
Immunity of the Host

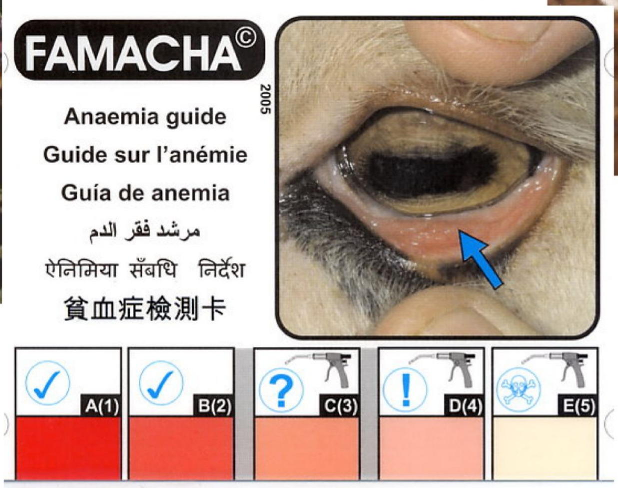
- FAMACHA a popular targeted (selective) deworming program
  - Matches color of sheep or goat ocular mucous membrane to chart
  - Identifies which ones to treat
  - ONLY WORKS FOR BARBER POLE WORM



Use of the FAMACHA Selective Deworming System in Parasite Control

American Consortium on Small Ruminant Parasite Control (ACSRPC)
www.acsrpc.org has lots of information





What is selective deworming?

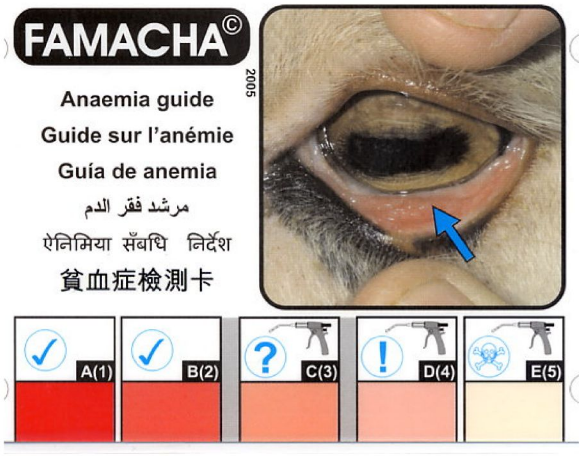
- Treat only most parasitized animals
- Worms are not evenly distributed in the host population
  - 20-30% of the animals have most of the worms and deposit 80% of the eggs

Who Do You Treat in a Selective Deworming System?

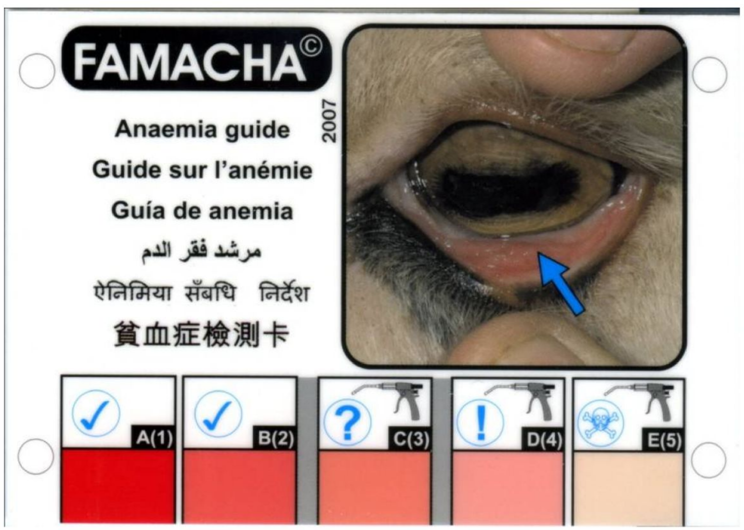
- Identify wormiest animals by
  - Fecal Egg Counts
  - The FAMACHA© system
    - Technique for the assessment of *Haemonchus contortus* and need for treatment
    - Estimates level of anemia
      - a reduction below normal in the number or volume of red blood cells in the blood

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



Relationship of Eye Score to Anemia



FAMACHA score	Color class	Hematocrit (% Red Blood Cells)
1	Red	≥ 28
2	Red-pink	23-27
3	Pink	18-22
4	Pink-white	13-17
5	White	≤12

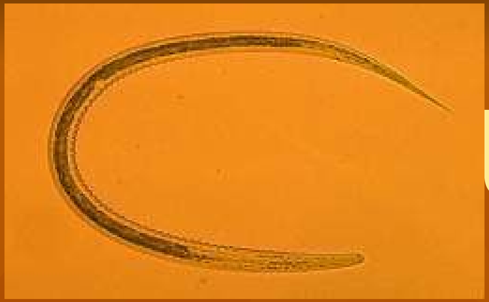
Why use FAMACHA

- Animals treated that really need it
- Increases "Refugia"
  - Reduces rate of development of drug resistance
- Saves money
- Identifies animals that need more frequent deworming -- cull
- Helps identify animals that need less frequent deworming -- keep for breeding

Questions?

Photographer: E. Lamperelli

Basics of Pasture Management to Help Control Internal Parasites



ture -

- Eggs in feces, fall from animal to ground
- Requires warmth (may be as cool as 50+F but lots of response by 60 F) and humidity to hatch into first stage larvae, L-1. Occurs in 1-6 days.
- L-1 eats bacteria in feces and grows, molts (sheds skin like a snake) and becomes L-2
- L-2 also eats bacteria in feces and then molts

On Pasture -

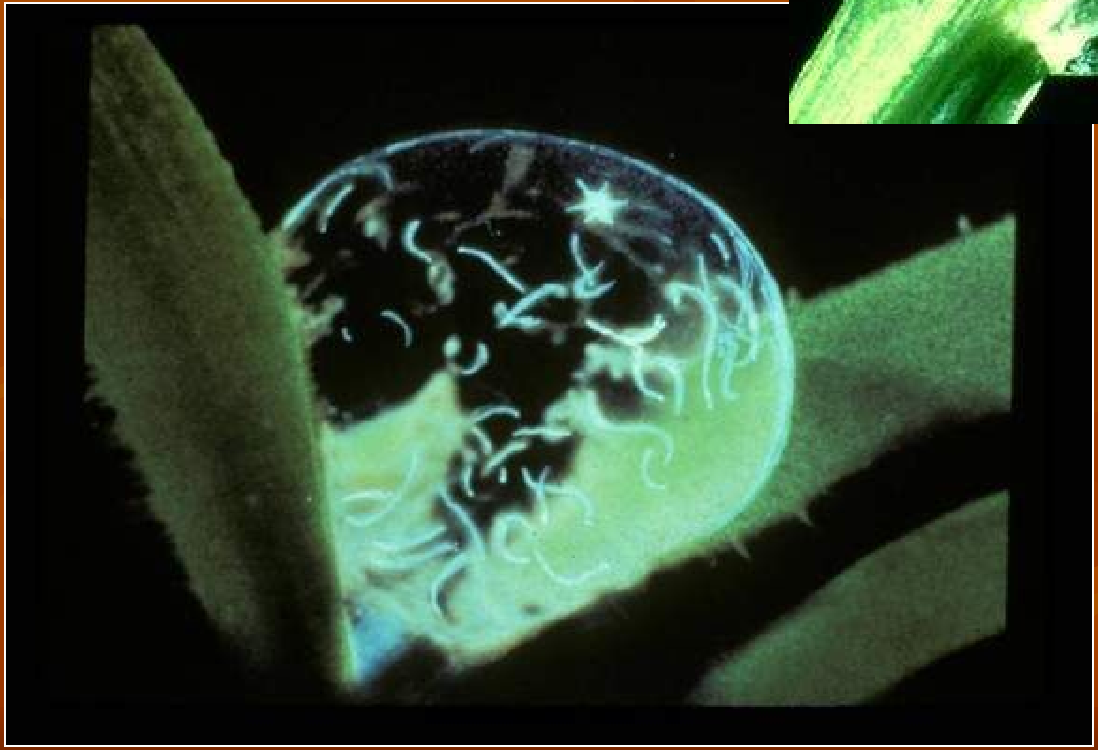
- Direct sunlight can heat fecal pellet to 155 F and sterilize pellet – This is an excellent time to mow a pasture short to aid in drying the fecal pellet
- Shade trees and tall, dense grass increase humidity and protect fecal pellets from the sun increase problem

Infectious Larvae on Pasture – L3

- L-2 molts to L-3. However, the cuticle (skin) is not shed, so the L-3 has 2 layers of cuticle. This makes the L-3 much more resistant to drying out.
- However, the L-3 cannot eat, because his mouth is covered. He must live off his stored reserves.
- Since he is cold-blooded, his metabolism speeds up when it is hot. He can only live about 30-60 days in hot weather or 120-240 days in cool weather. He can not survive freezing.

L3 - Takes about
5 -14 days from fresh fecal pellet to L-3

Pasture becomes infective at this time



Most L3s do not get more than about 2 inches high on grass blade.

L3 – on pasture

- The L-3 must escape from the fecal pellet to infect an animal
- The L-3 can only live about a week or two inside a fecal pellet if it is hot and dry.
- Pellet must be broken up by rain (2 inches in a month’s time) then the larvae scoots on a film of water (from rain or dew) and gets under fallen leaves or other debris OR scoots on a film of water 2-3 inches up onto fresh forage .

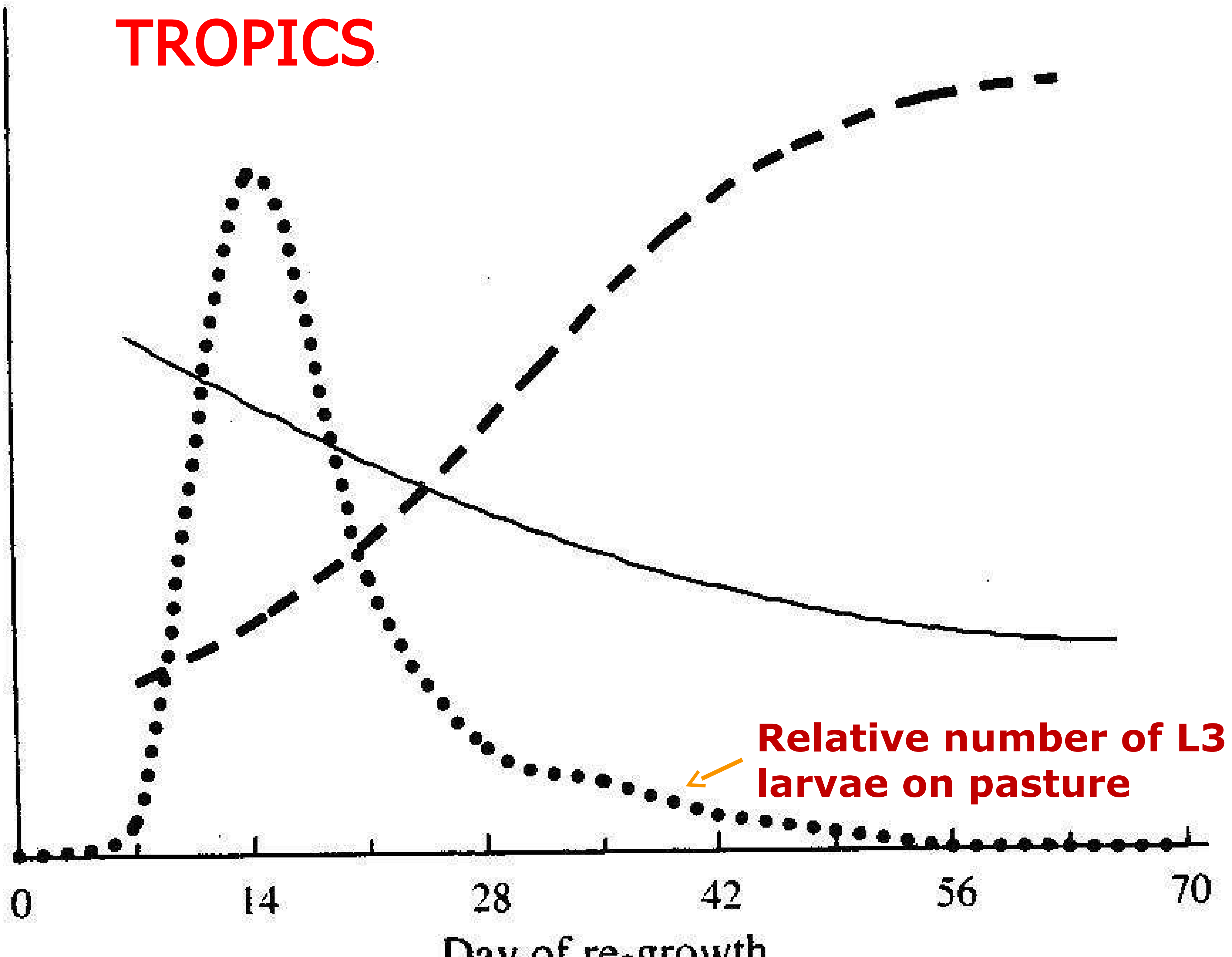
L3 continued (barber pole worm life cycle)

- Maybe only 2-10% of eggs end up as L-3 larvae on forage.
- L-3 must be eaten by a goat or sheep to continue development - Cattle and horses can “vacuum up” L3 larvae from goat pastures and stop its life cycle

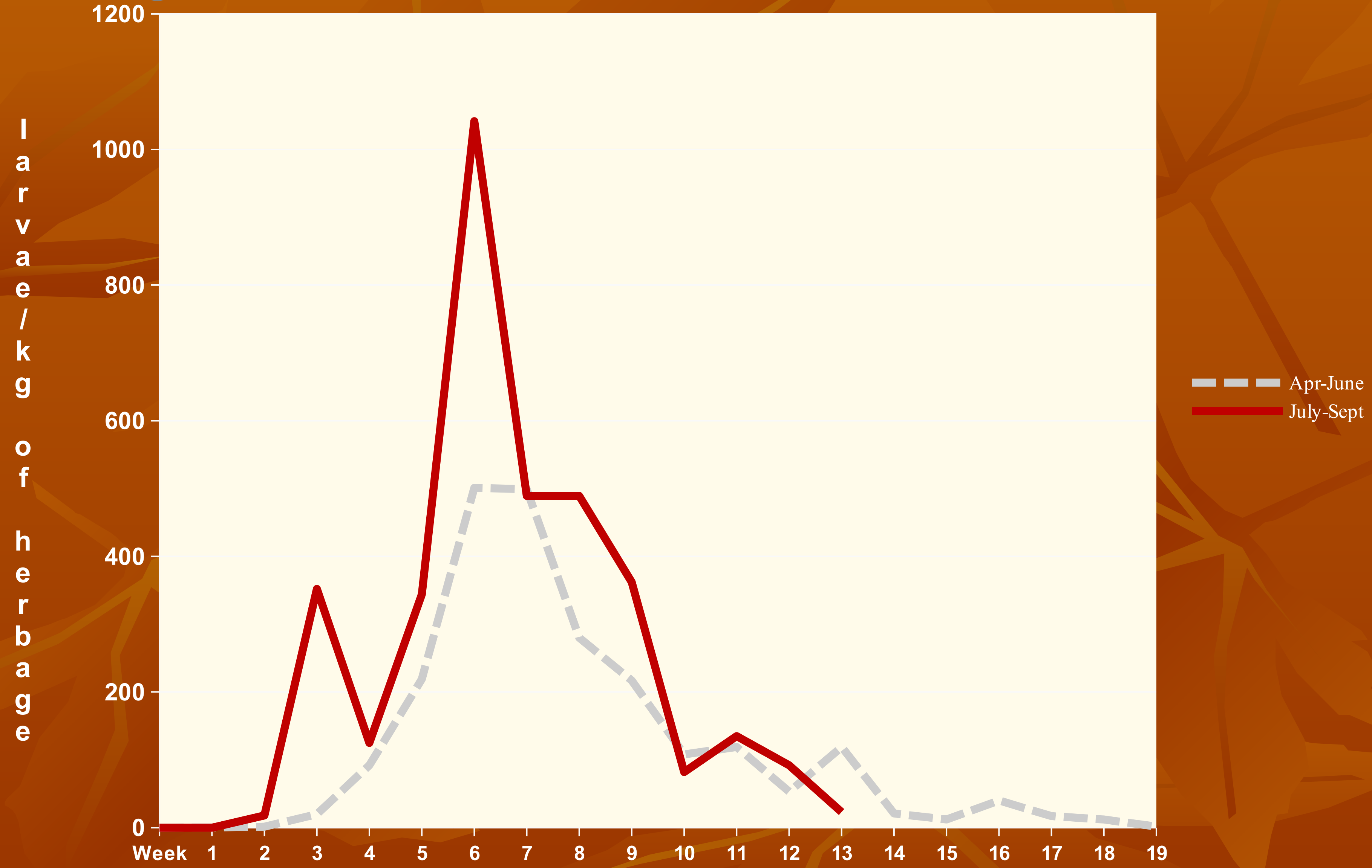
Pasture Management to reduce barber pole worm problems

- Use clean or safe pastures – wise management decisions about pasture height, grazing duration and pasture rest - easy to say, difficult to implement for entire grazing cycle

- Give priority to recently weaned young stock -> lactating does/ewes -> dry animals


TROPICS
Relative number of L3
larvae on pasture
0
14
28
42
56
70
Day of re-growth

Barber pole worm population in pastures grazed 2 to 4 weeks



Evasive Grazing

- Move animals fast enough to prevent infection from feces deposited during current grazing period (autoinfection). **Takes 3-5 days to hatch at 77-79˚F, 15-30 days to hatch at 50–52˚F.** Often ~5 to 14 days from egg to L3.
- Play it safe with 4 day (wet, warm) to 7 day (cooler, drier) grazing duration. Move earlier if pasture getting too short – i.e. 3 inches.
- Allow a long enough rest period that there is substantial L3 die off before animals return to graze. (60 – 105 days)

Problem

- Pasture rest periods to control barber pole worm need to be longer than normal recommendations for either pasture health or nutritional value

Keep pastures from getting too mature

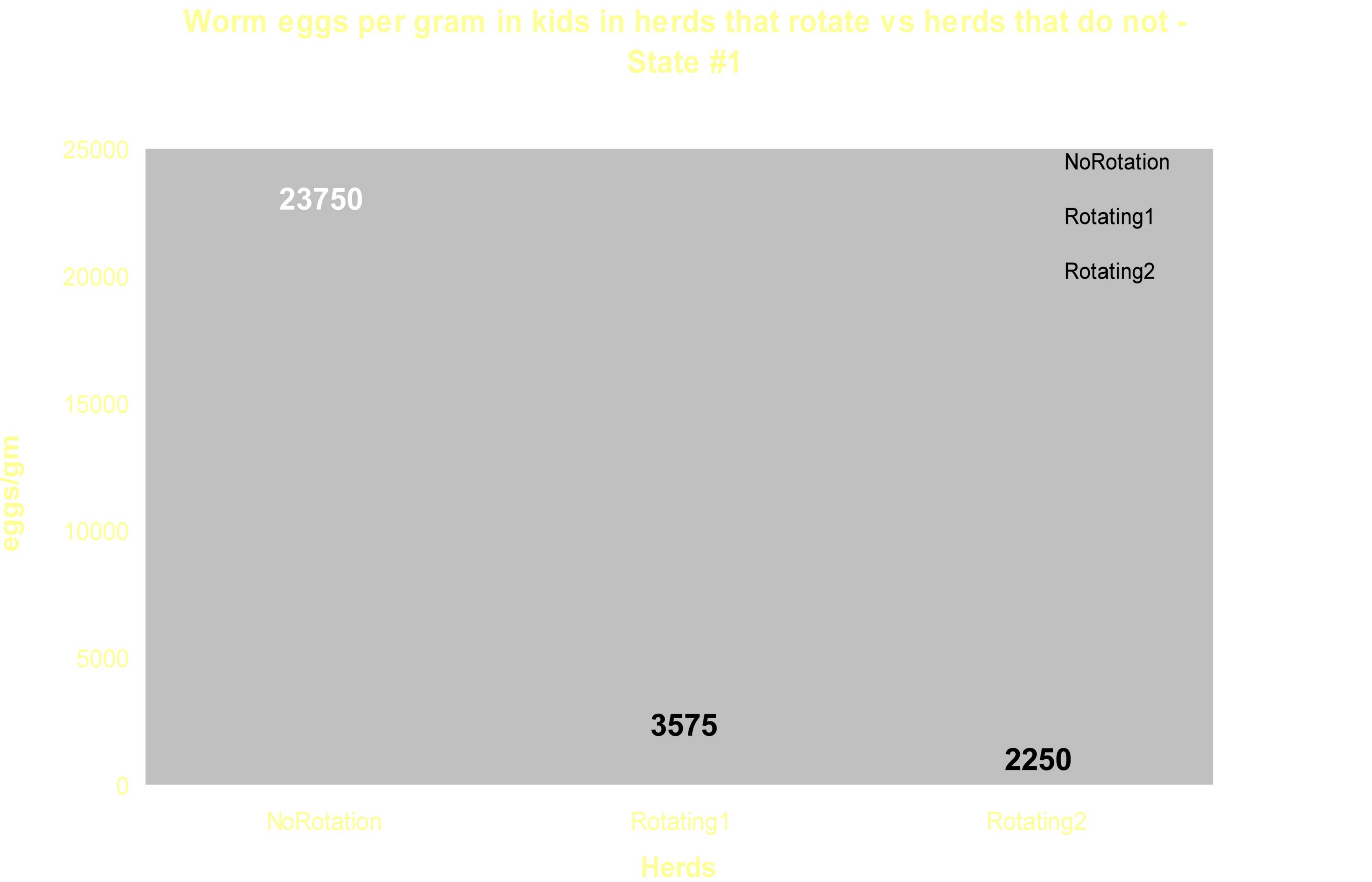
- Graze cattle or horses in between
- Clip pasture
- Harvest hay crop

Rotational grazing in the spring appears to reduce the “barnyard effect” and delay the onset of summer parasite problems

Barnyard Effect

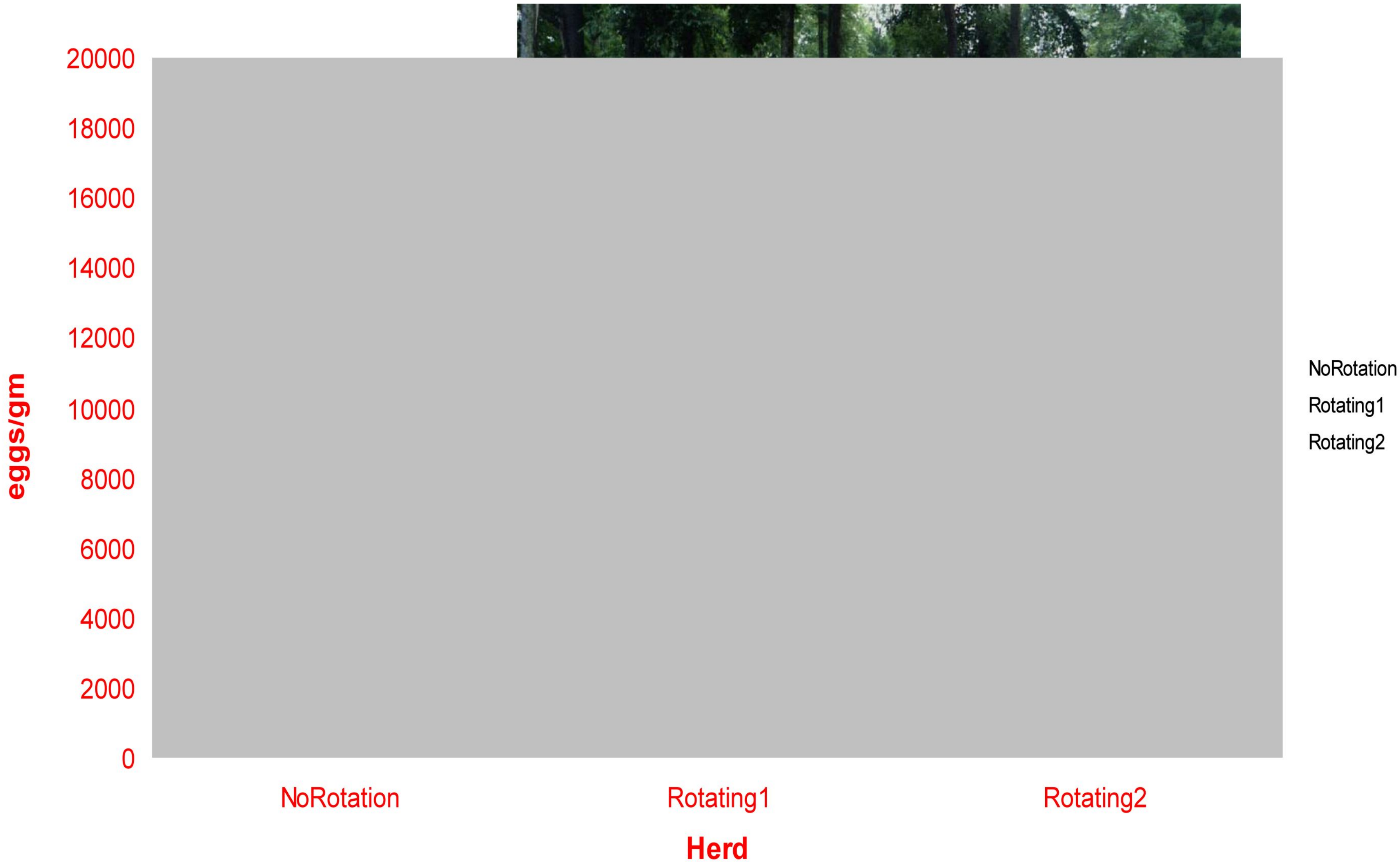
- Barnyards with grass or other good forage
- Lead to high concentration of manure and internal parasites in grazing material
- Can contribute greatly to herd contamination with internal parasites
- May have a “barnyard effect” in pastures that border barn and are not rotated

Manure pile right in yard – kids born late April – barn situated in very large pasture but kids and does tend to graze right by barn where manure concentration (and worm contamination) is highest. By late July kid loss to worms and coccidia


Worm eggs per gram in kids in herds that rotate vs herds that do not - State #1
25000
20000
15000
10000
5000
0
eggs/gm
23750
3575
2250
NoRotation
Rotating1
Rotating2
NoRotation
Rotating1
Rotating2
Herds

Goats free range on woodlands during the day and locked in very large compound 5 pm to 8 am →compound seeded to pasture in 2004→herdsman noticed in Spring 2005 that kids did not go to woods with dams, instead stayed & grazed at compound → kid loss by mid July to worms and coccidia.

Worm eggs per gram in kids in herds that rotate vs herds that do not - State #2



Central graining and watering areas can also have a barnyard effect

Some options to help reduce barnyard effect –

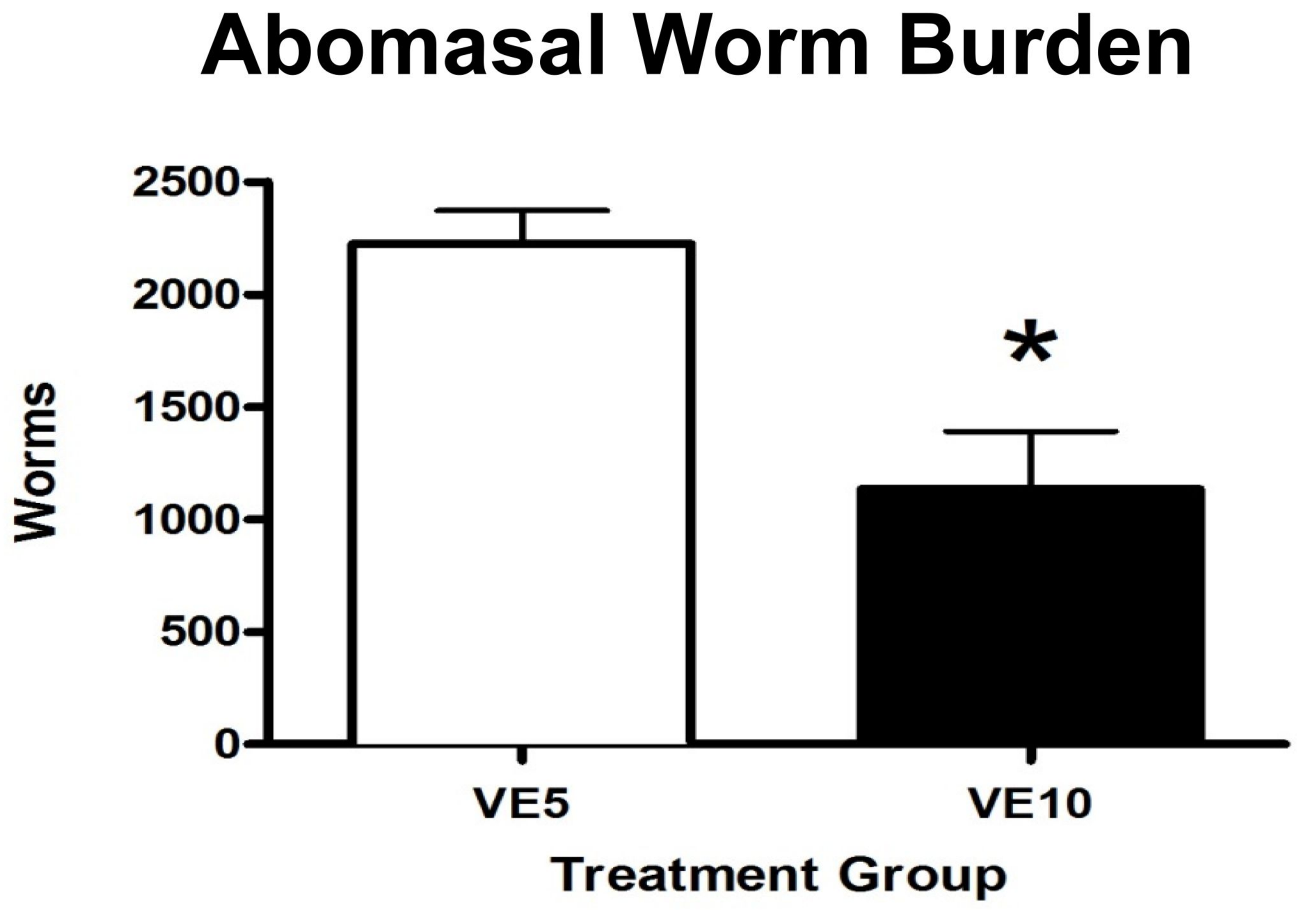
Can you implement any of them?

- lay down gravel, concrete, or herbicides
- close off access to barnyard or provide hay in barn at night when animals come in from pasture to cut down on night grazing in the barnyard
- Make barn yards small so that no grazing occurs
- Put in lanes or leave animals out 24/7

The Effect of Vitamin E Supplementation on an Experimental *Haemonchus Contortus* Infection in Lambs

Evaluate the effects of vitamin E supplementation (10 IU/kg BW/day) on lambs experimentally infected with *Haemonchus contortus*

Results


Abomasal Worm Burden
Worms
2500
2000
1500
1000
500
0
*
VE5
VE10
Treatment Group

Conclusions

- Elevated levels of vitamin E supplementation had a beneficial effect on the abomasal worm burden
- VE 10 lambs tended to have
  - Lower mean FEC
  - Higher eosinophil and globule leukocyte counts
- No treatment effect on PCV, male: female worms
- Future studies will examine mechanistic effect of VE supplementation on GIN infections in lambs including direct effects on parasitic defense mechanism

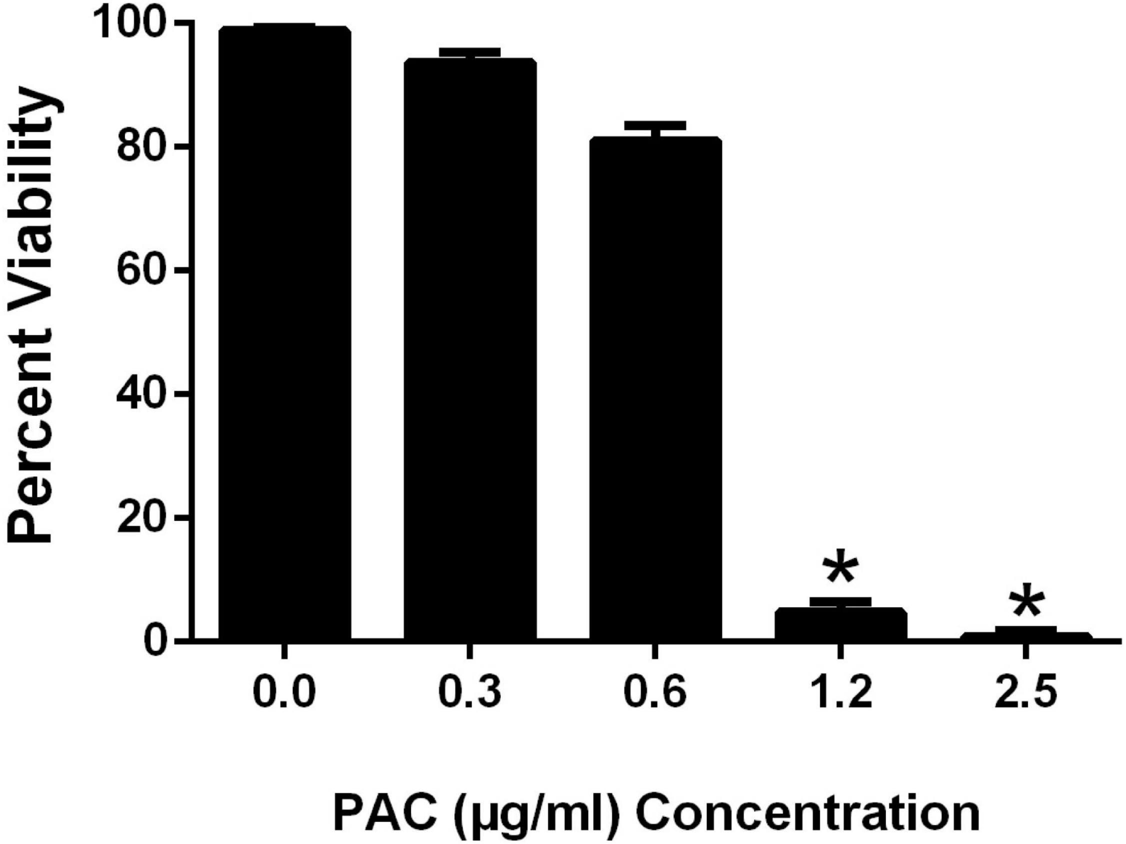
Anthelmintic effect of cranberry leaf powder and cranberry leaf proanthocyanidin extract on ovine *Haemonchus contortus*

Cranberry Leaf Proanthocyanidin (PAC)

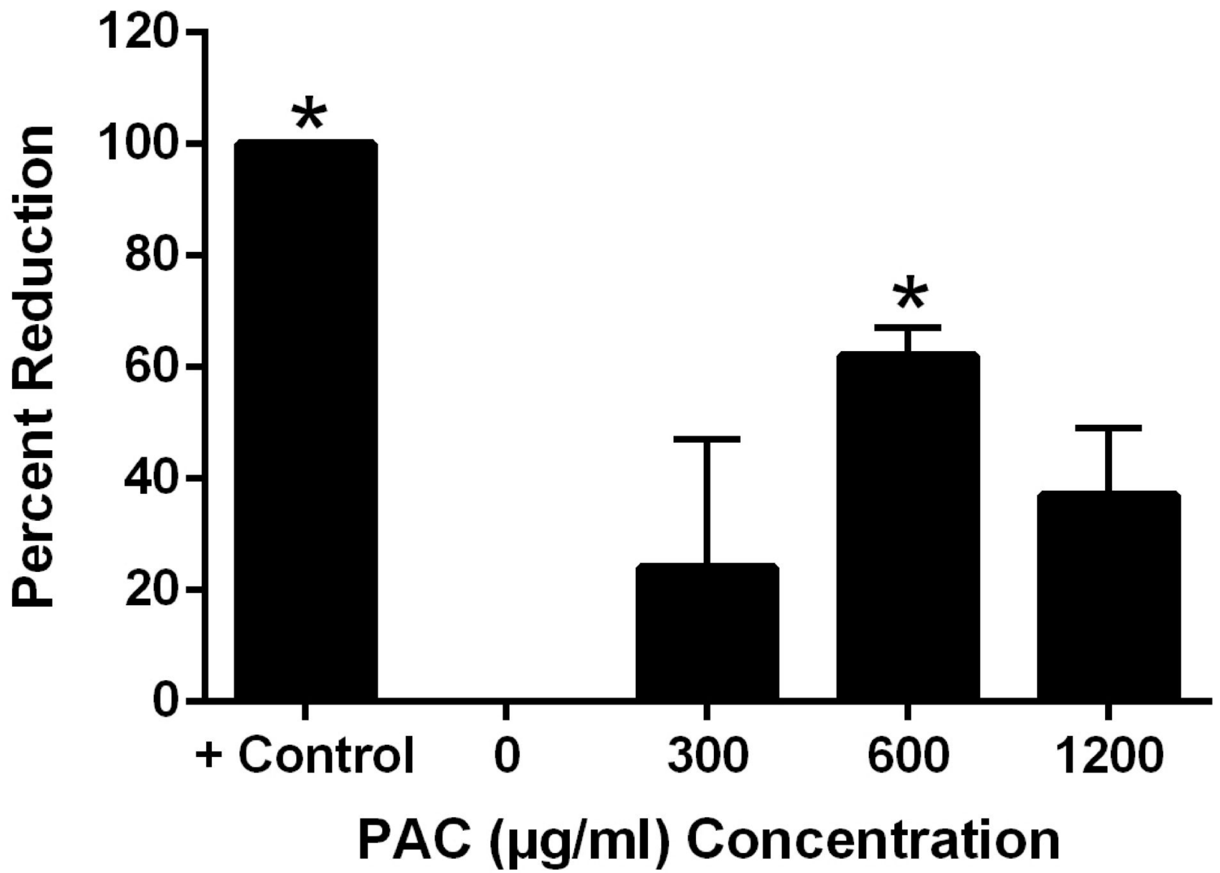
- Cranberry leaves contains high levels of Proanthocyanidin condensed tannin
- Leaves are by-product of harvest
- Wisconsin and Massachusetts

http://viewfromthe14thfloor.com/?p=967

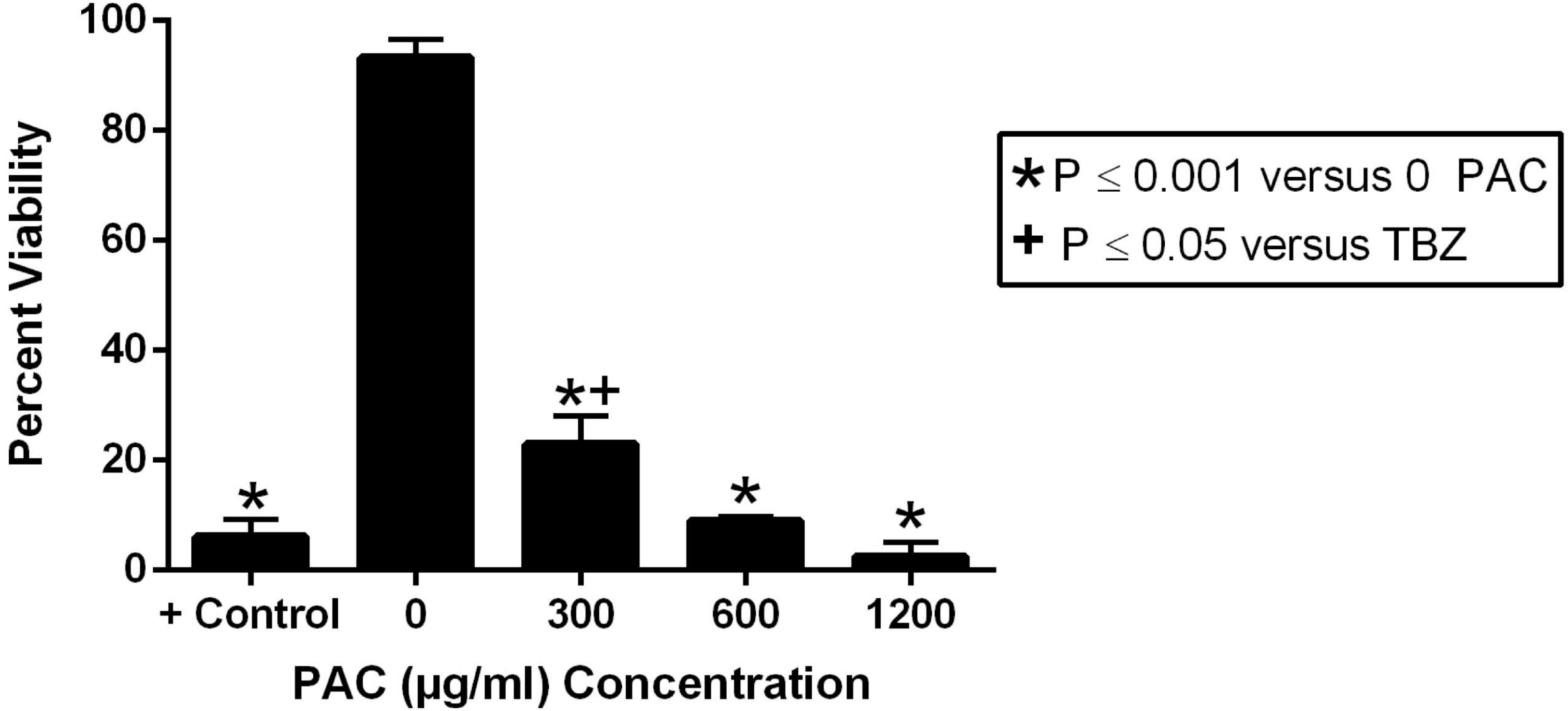
Effect of Cranberry PAC on *H. contortus* L1/L2



Effect of Cranberry PAC on Larval Development



Effect of Cranberry PAC on Adult *H. contortus*



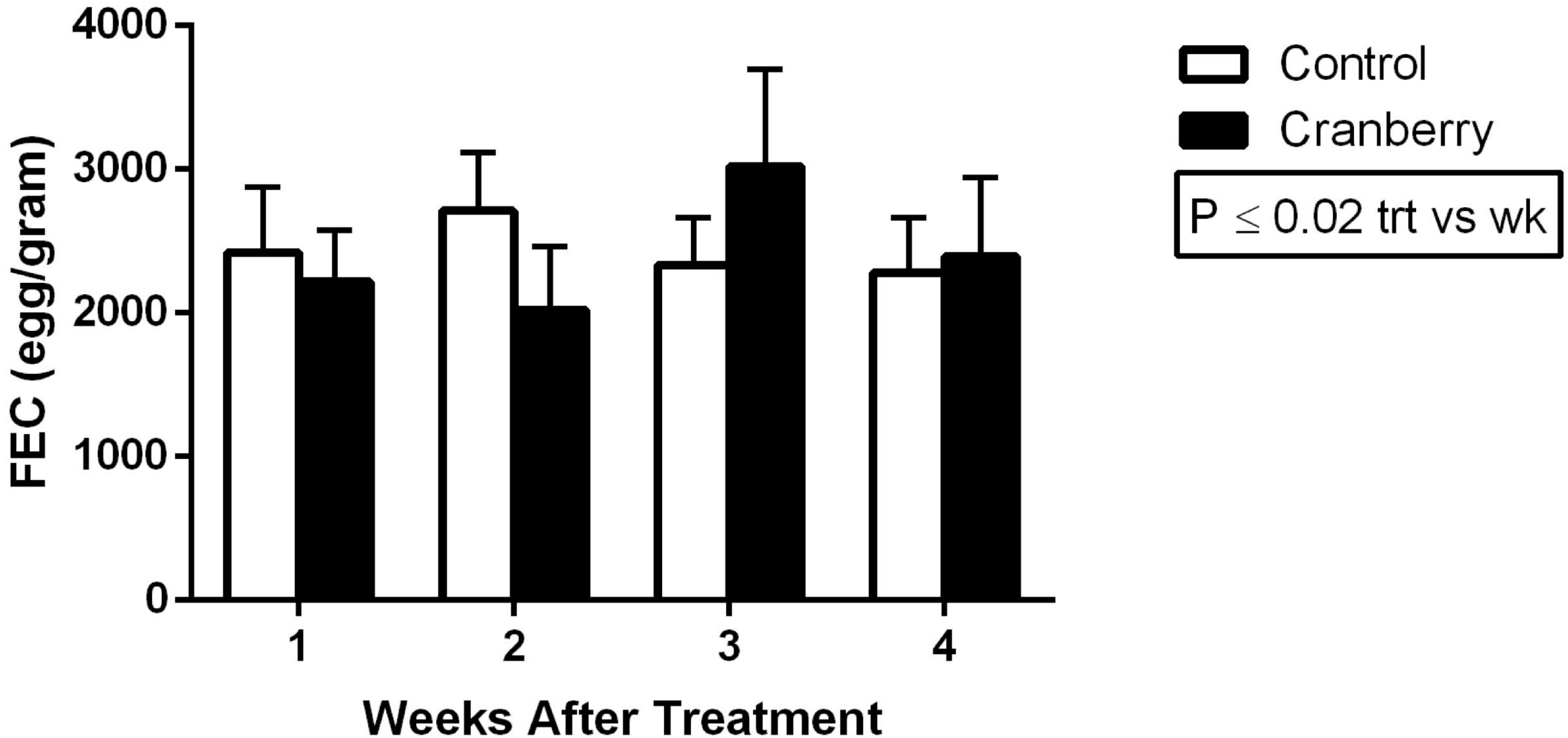
Effect of cranberry leaf powder on *H. contortus* fecal egg count reduction

- Two groups of 9 lambs were infected with *H. contortus* L3 larvae.
- One group was treated with 75 µg/mL cranberry leaf powder and one group was not treated.
- Fecal egg counts were processed weekly.

Photographer: E. Lamperelli

Photographer: C. Barone

Effect of cranberry leaf powder on *H. contortus* fecal egg count reduction



Conclusions

- Cranberry leaf powder PAC exhibited anthelmintic activity against:
  - L1/L2 *H. contortus* after 48 hour incubation at a concentration of 1.25 µg/mL
  - larval development at a concentration of 600 µg/mL
  - adult *H. contortus* after 48 hour incubation at a concentration of 1200 µg/mL
- Cranberry leaf powder showed anthelmintic efficacy through fecal egg reduction at weeks 1 and 2 post treatment at a concentration of 75 µg/mL

USDA OREI
Forage-based Parasite Control in Sheep and Goats in the Northeast U.S.

West Virginia University
Cornell University
University of Rhode Island
University of Wisconsin
Virginia Tech

Project Objectives

- Evaluation of birdsfoot trefoil (BFT) cultivars – URI tested 7 conventional varieties. Also studied 51 high tannin varieties with limited seed availability (kept 20 most promising for multiplication of seed).

- Analysis of the condensed tannin profiles
- Assess the anthelmintic effect of BFT cultivars
- Assess the effect of BFT on immune function

- Evaluate herd health and economic outcomes of BFT pasture mixes for GIN suppression

Birdsfoot Trefoil at URI –

planted Sept 2012 in nurse crop of oats, mowed (some reps grazed) repeatedly to suppress weeds

Variety	BFT plants/m^2	% BFT in stand	Yield (bales)
Empire	20.5	23	8
Bull	19.9	21	7
New York	16.7	18	6
Bruce	18.0	17	3
Norcen	20.1	31	6
Pardee	17.9	20	4.5
Leo	18.3	21	4.5

Stand data are averages across 10 randomly placed 1 m^2 quadrats per plot; data were collected in July. Yield is standard square bales per ¼ acre plot; hay was cut in mid-August.

On-Farm BFT Studies

- Coordinate on-farm studies with participating farmers who will investigate how to best utilize BFT in the field. Want to work on-farm starting spring and fall 2014. Let tatiana know if interested!
- Are there practical ways to incorporate BFT into grazing systems and control parasites?
  - Variety differences in terms of effectiveness and suitability?
  - Amount needed? Sustainability?

Copper Oxide Wire Particles for Barber Pole Worm Control in Goats and Sheep

Slides by Drs. Dwight Bowman, Steve Hart and tatiana Stanton

Copper toxicity in sheep

- Sheep are ten times more susceptible to copper toxicity than cattle.
- When consumed over a long period of time, excess copper is stored in the liver.
  - No damage occurs until a toxic level is reached hemolytic crisis with destruction of red blood cells.
  - Copper is closely related to molybdenum, and copper toxicity occurs when the dietary ratio of copper to molybdenum increases about 6-10:1.
  - Affected animals suddenly go off feed and become weak. Mucous membranes and white skin turn yellowish brown color. Urine red-brown color due to hemoglobin in the urine.

Copper Oxide Wire Particles

- Copper oxide wire particles (COWP) were developed as a slow release source of copper for cattle on copper deficient soils.

- COWP particles are retained in the abomasum long enough to permit acid solubilization of the copper.

- Results in gradual release of copper which reduces risk of copper toxicity.

Copper Oxide Wire Particles

- COWP boluses (Copasure©) available commercially and already approved by organic certification associations because of their role in copper supplementation.

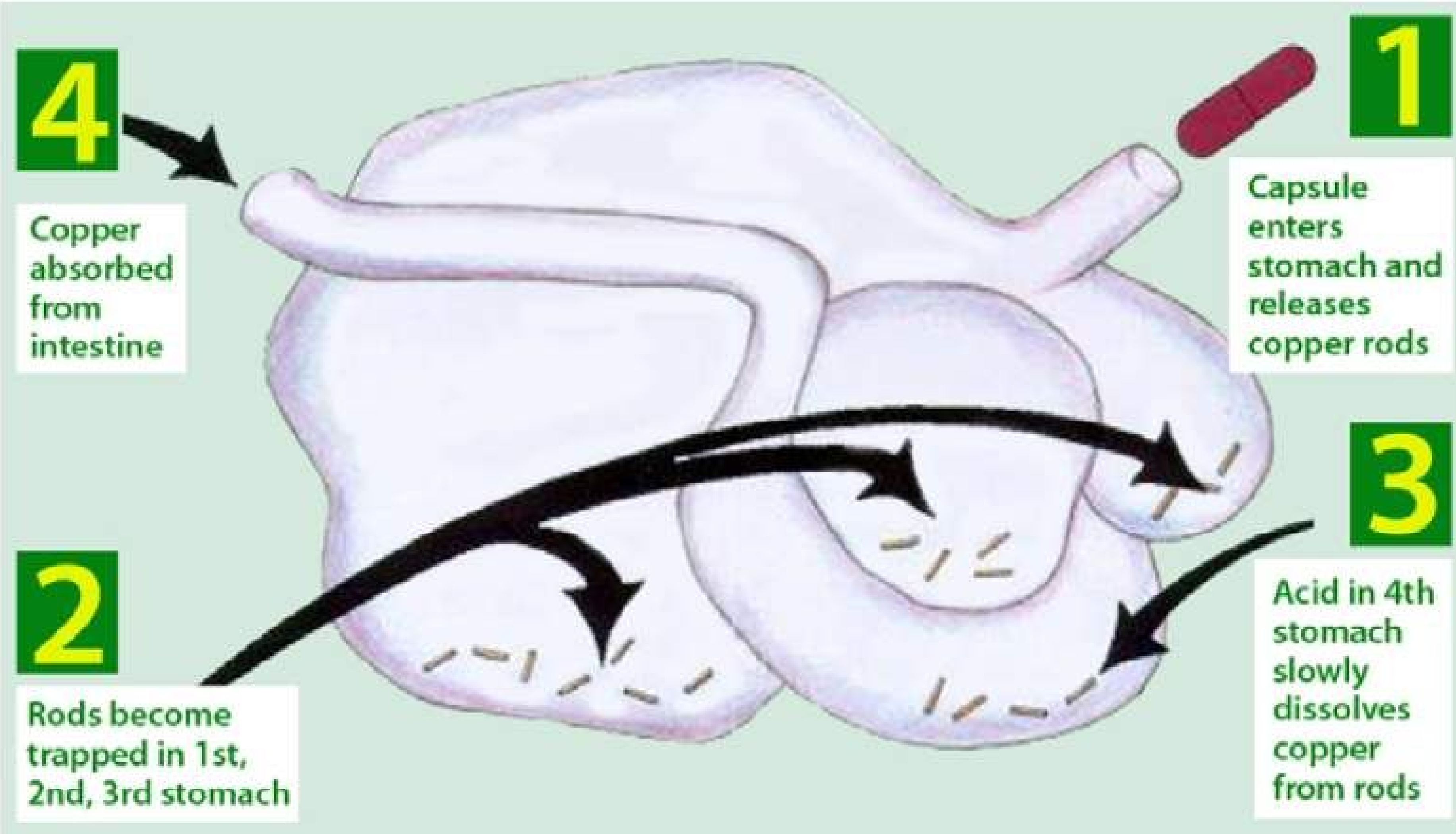
- 12.5 and 25 gram boluses for calves and cows need to be repackaged into far smaller doses suitable for growing sheep and goats!

Copper Oxide Wire Particles

- Effective against Barber pole worm (*Haemonchus contortus*) and not thought to be effective against arrested worms. What time of year best to give?
- Not effective against Brown stomach worm (WHY?), not effective against tapeworms.
- .5-2 g dose for lamb or kid and 1-4 gram dose for ewe or doe. The lower dosages may be repeated a few times a year depending on soil and diet levels of Cu and Mo.
- Studies in SE US focus on looking for lowest dosages that can be used in combination with FAMACHA – give COWP to your vulnerable “3s” (lambs, kids, lactating or late pregnant females) rather than giving a commercial dewormer.

Copper Oxide Wire Particles

- Mechanism is unknown
- Seems to work poorly in animals that are stressed or run down
- Not effective in just weaned kids or lambs
- When it works □ Quite effective, killing 75-95% of Barber pole worms
- Cornell has a grant to develop guidelines on the use of Copper Oxide Wire Particles in the Northeast US



Illustrates the fate of COWP boluses in the animal. (adapted from www.animax-vet.com)



Photos by Adriana Stimola,
courtesy of Stone Barns Center for Food & Agriculture

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courtesy of Stone Barns Center for Food & Agriculture

NEW YORK
1 Goat Dairy

- Treatments consisted of
  - 1 gram COWP/head,
  - 2 gram COWP/head, or
  - 1 gram COWP/22 lb. live weight
- 15 to 16 lactating does per treatment

Looked for signs of copper problems

- Sampled milk on Day 0 (immediately before) COWP dosing, Day 14 and Day 42 to analyze for Cu content using plasma-atomic emission spectroscopy
- Cheese maker reported no changes in time to set curd and consistency of curd for 4 different cheeses made first week immediately following COWP treatments
- Blood samples taken on Day 42 and the plasma then analyzed for AST enzyme activity (indicator of copper toxicity)

Changes in Cu Level in Milk after COWP Treatment –

The increase was significantly more for 1 g/22 lb. LW

BUT no significant differences in actual level of CU in milk between the treatments

Treatment	Day 0 – Immediately before treatment	Day 14	Increase
1 gram/22 lb livewt.	0.105 ppm (0.042 – 0.33)	0.171 ppm (0.083 – 0.322)	0.066 ppm
2 gram/head	0.135 ppm (0.056 – 0.398)	0.161 ppm (0.103 – 0.282)	0.026 ppm
1 gram/head	0.153 ppm (0.043 - 0.551)	0.191 ppm (0.121 – 0.358)	0.039 ppm

AST Enzyme Levels in Plasma after COWP Treatment – no significant differences between treatments

Treatment	DAY 42
1 gram/22 lb livewt.	117.9 (89 – 221)
2 gram/head	120.6 (76 – 203)
1 gram/head	112.9 (86 – 138)

Copper toxicity elicits enzyme activity values > 300 - 400 units. Only two goats had values > 200 units.

Effect of copper oxide wire particles (COWP) on the change in fecal egg counts after 14 days.

COWP	Haemonchus	Strongyles
1 g/22 lb. BW	-1153	-1185
2 g/doe	-1226	-1191
1 g/doe	107	75
SE	484.6	477.9
P-value for 1 g/head vs average of 1 g/22 lb. and 2 g/head	0.034	0.036
P-value for 1 g/22 lb. vs 2 g/head	0.914	0.993

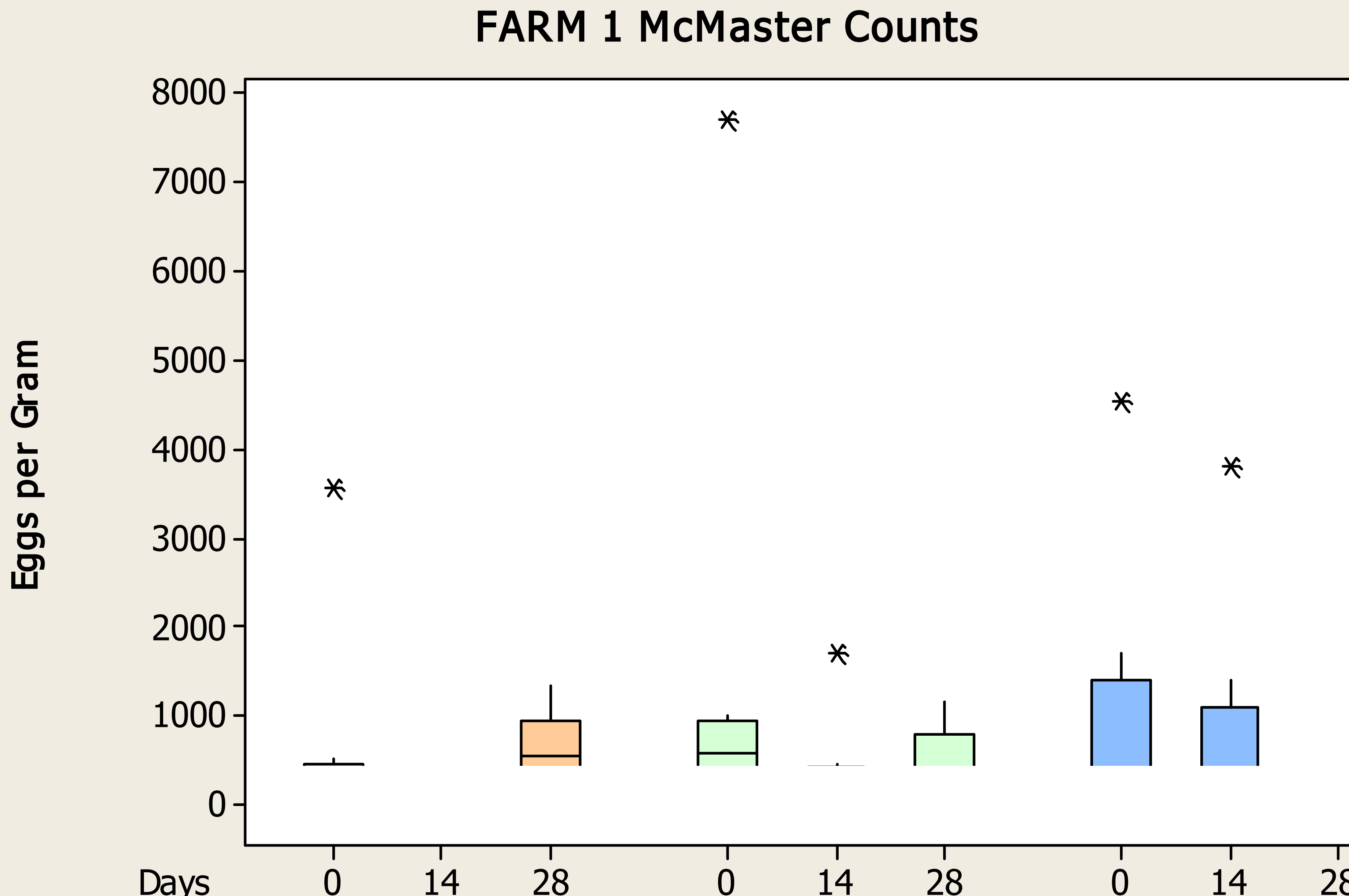
Conclusions

- Not as effective as a dewormer (assuming there is no resistance to the dewormer)
- No discarding of milk necessary
- 2 grams per head appeared to work as well as 1 gram per 22 lb. live weight and did not significantly increase the copper levels in milk

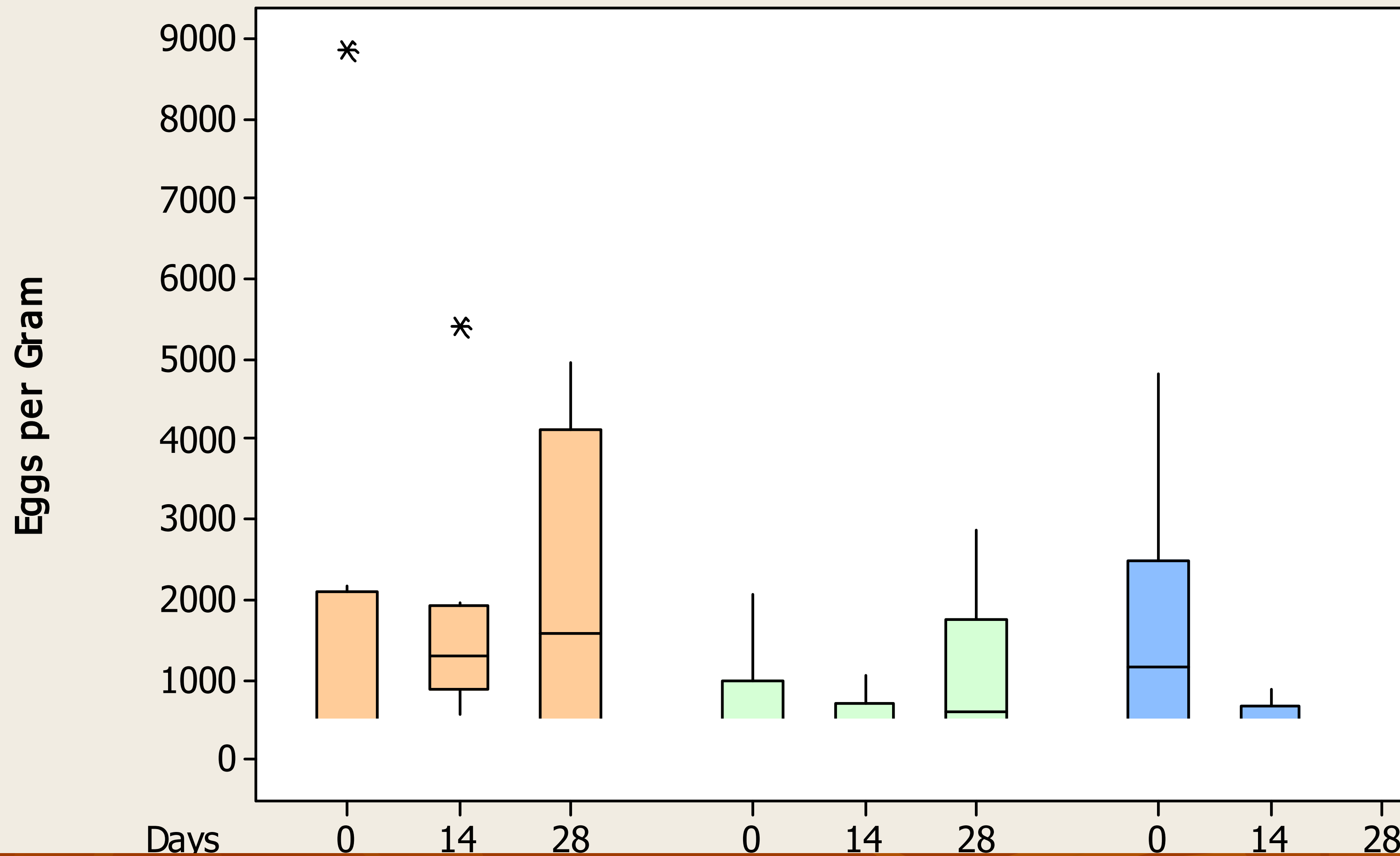
NEW YORK
3 Sheep Farms

FARM 1 & 2

- Lambs weaned 2 to 5 weeks previously
- LAMBS TREATED ON DAY 0
- (0 g, .5 g, 1 g of COWP) -15 lambs per treatment
- WEIGHED (Day 0 and 28)
- FAMACHA scored (Day 0, 14 and 28)
- FECAL EPG taken from 8 lambs per treatment(Day 0, Day 14, Day 28)


FARM 1 McMaster Counts
Eggs per Gram
8000
7000
6000
5000
4000
3000
2000
1000
0
Days
0
14
28
0
14
28
0
14
28

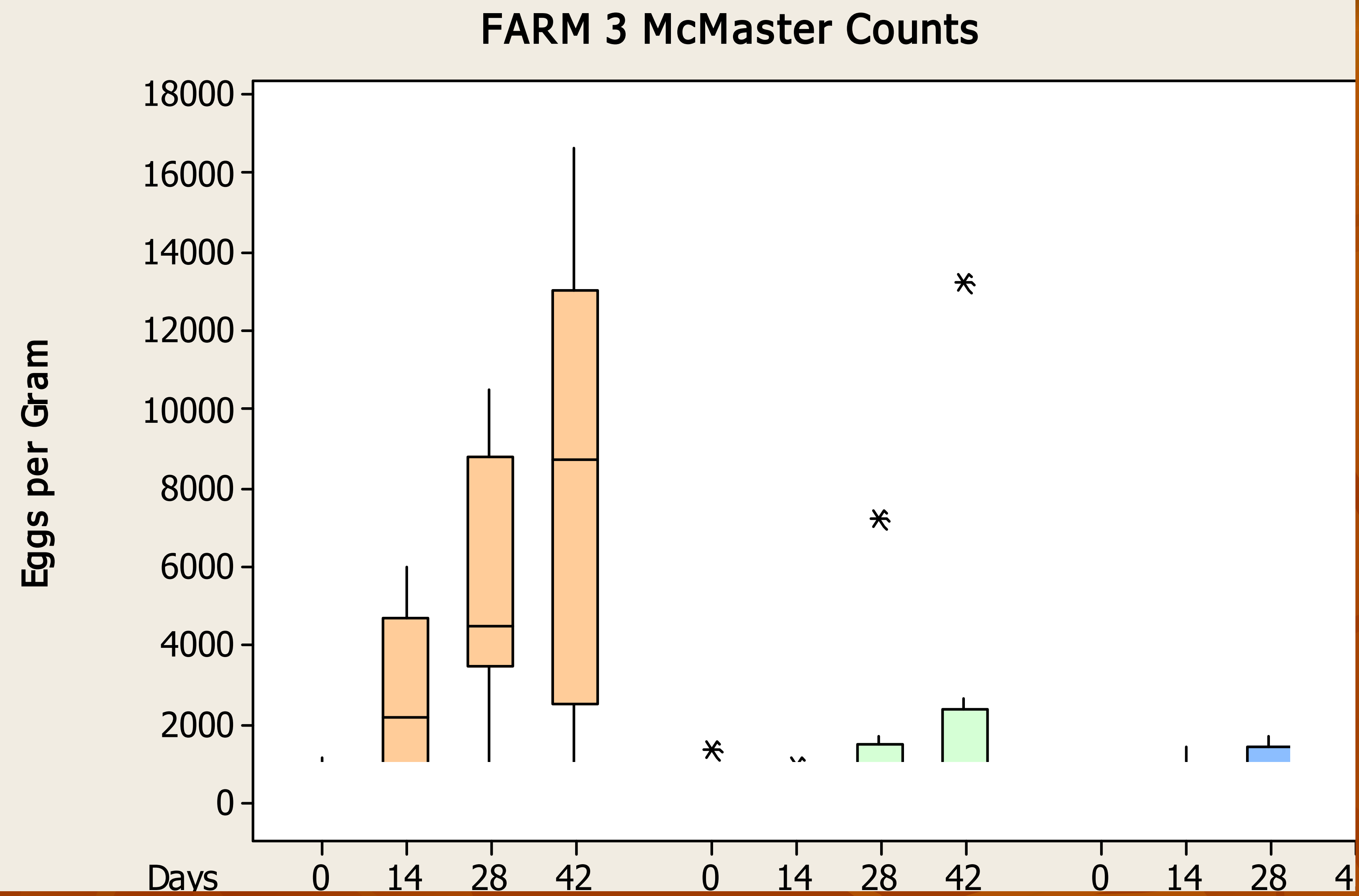
FARM 2 McMaster Counts



FARM 3

- Nursing lambs had been dewormed 34 days prior

- COWP TREATED ON DAY 0 - (0 g, .5 g, 1 g of COWP – 15 lambs per treatment)
- Lambs weaned on DAY 14
- WEIGHED (Day 0 , 14, and 42)
- FAMACHA scored (Day 0, 14, 28 and 42)
- FECAL EPG taken from 8 lambs per treatment(Day 0, 14, 28 and 42)


FARM 3 McMaster Counts
Eggs per Gram
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Days
0
14
28
42
0
14
28
42
0
14
28
4

Stats for Farm 3

Table Analyzed		Two-way ANOVA with RM by columns			
Two-way RM ANOVA	Matching: Stacked				
Alpha	0.05				
Source of Variation	% of total variation	P value	P value summary	Significant?	
Interaction	9.746	0.0122	*	Yes	
time	12.39	0.0002	***	Yes	
group	21.26	0.0009	***	Yes	
Subjects (matching)	22.45	0.0202	*	Yes	
ANOVA table	SS	DF	MS	F (DFn, DFd)	P value
Interaction	11.50	6	1.917	F (6, 63) = 2.996	P = 0.0122
time	14.62	3	4.873	F (3, 63) = 7.617	P = 0.0002
group	25.09	2	12.55	F (2, 21) = 9.944	P = 0.0009
Subjects (matching)	26.49	21	1.262	F (21, 63) = 1.972	P = 0.0202
Residual	40.30	63	0.6397		
Number of missing values	0				

Effect of Farm, level of copper oxide wire particle administration (COWP), and sex on average daily gain of pasture-reared lambs.

Effect	Average daily gain, g/day
Farm	
Farm1	67
Farm2	217
Farm3	269
SE	8.7
P-value	<0.001
COWP	
Control	173
0.5 g	186
1 g	194
SE	8.6
Control vs COWP P-value	0.096
0.5 g vs 1 g P-value	0.471
Sex	
Male	203
Ewe	166
SE	7.1
P-value	<0.001

Conclusions

- FEC decreased at all farms after giving either .5 to 1 gram per head.
- Results were short term at two farms but lasted at least 42 days at the third farm.
- On lambs, .5 gram per head dosages appeared to be as effective as 1 gram per head dosages.
- Need more studies to identify why the effect at the three farms differed.

How do suckling lambs differ from weaned lambs?

- Acidity of abomasum?
- Less solids in diet so easier for the wire particles to get lodged in the abomasum rather than the rumen?
- Difference in how they react to dosing gun?
- Need to do more research


QUESTIONS?