



# Parasites, Their Resistances and Alternate Methods

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# Topics For Presentation

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- Biology of GI nematodes
- Understanding drug resistance
- “Smart Drenching”
  - concepts and practice



# Gastrointestinal Nematodes of Sheep

## Major pathogens:

*Haemonchus contortus*

*Ostertagia (Teladorsagia) circumcincta*

*Trichostrongylus colubriformis*

+/- *Nematodirus*

## Less important worms:

*Trichostrongylus axei*

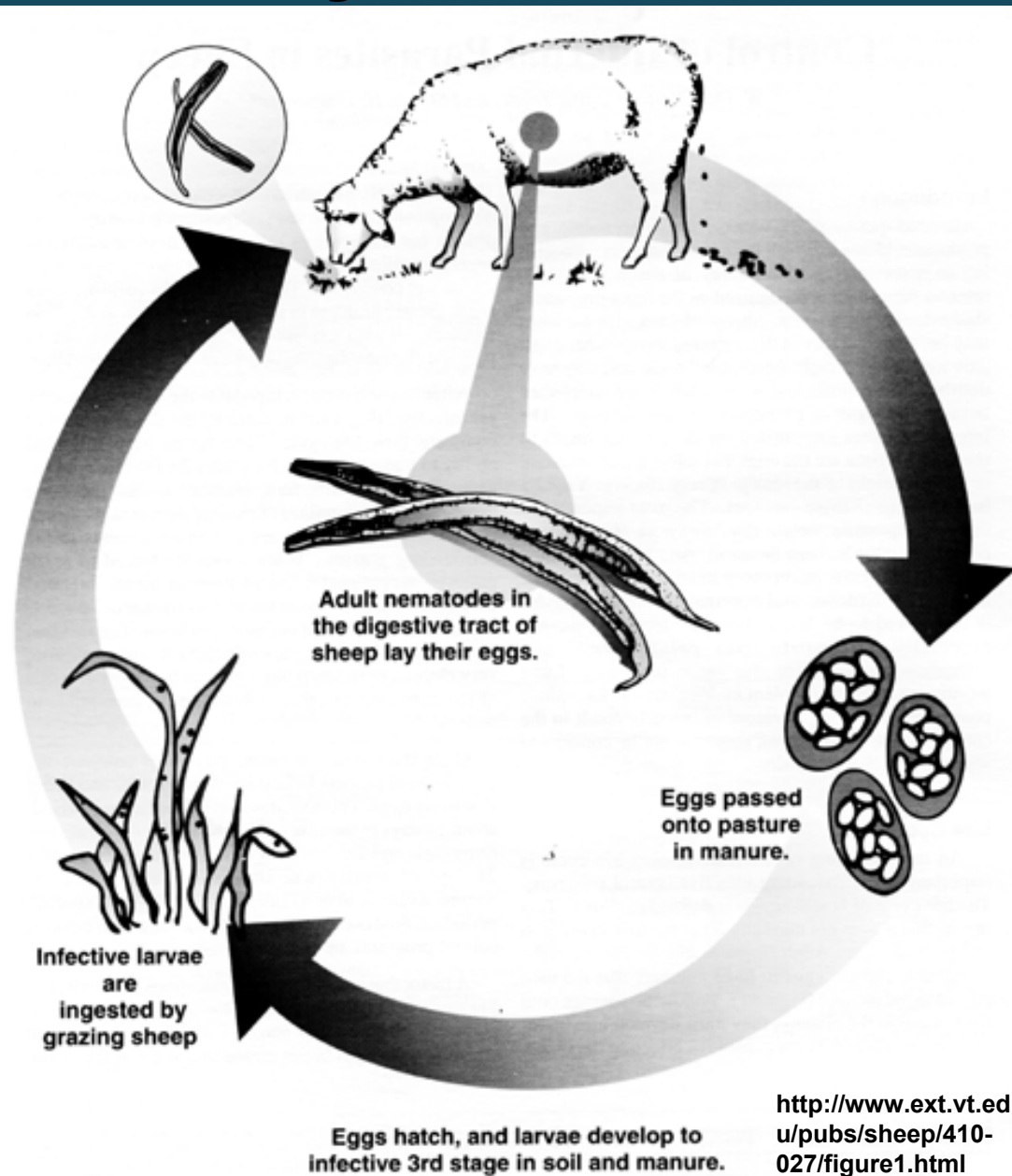
*Cooperia*

*Oesophagostomum*

*Trichuris*



# Life Cycle of GI Nematodes



# ***Haemonchus contortus*** **(Barber Pole Worm)**

- Sheep, goats, deer, exotic ruminants
- Blood-sucking parasite
  - highly pathogenic
  - anemia
  - hypoproteïnemia -- “bottle jaw”
- Most important parasite in sheep/goats raised in warm/wet environments
  - Frequent problem even in cool climates
    - In much of Northern US primary problem in summer



Image courtesy of Biozetica





**Anemia**



**Bottle Jaw**







# ***Ostertagia (Teladorsagia) circumcincta***

## **(brown stomach worm)**

- Most important parasite of sheep in cool climates
- 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

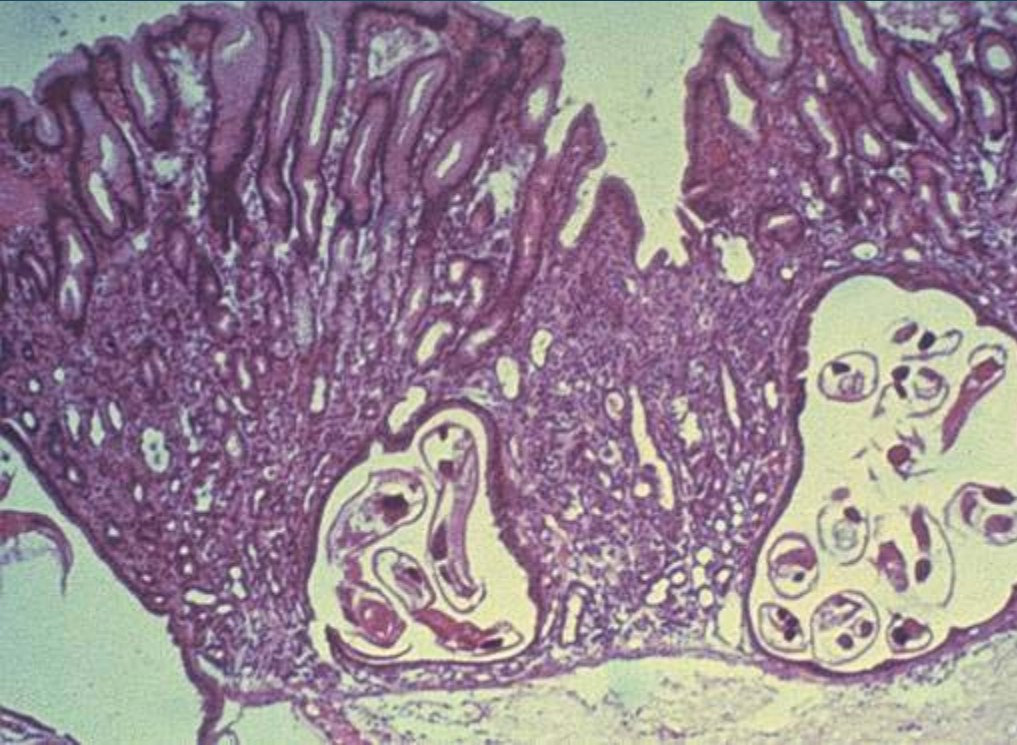


# *Ostertagia circumcincta* (brown stomach worm)

- Appearance - slender, reddish-brown
  - < 1 cm, only visible on very close inspection



# ***Ostertagia* in Gastric Glands**



**Damage to  
stomach wall**



# Anthelmintic Resistance

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



# Definition of Resistance

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- The ability of worms in a population to survive drug treatments that are generally effective against the same species and stage of infection at the same dose rate
  - Caused by changes in allele frequencies of “resistance” genes
  - Result of drug treatment that places genetic selection on populations of worms



# Where Do Resistant Worms Come From ???

- “Resistant” worms exist within pop’ns prior to the introduction of a drug
  - Initial frequency is very low
  - Genetic diversity in parasite pop’ns is great
- Treatment eliminates parasites whose genotype renders them susceptible
- Parasites that are resistant survive and pass on their “resistant” genes



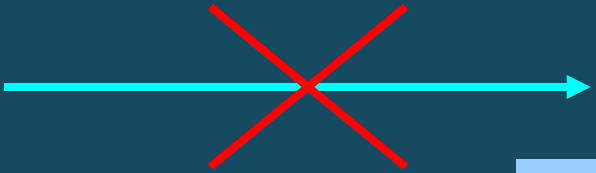
# Selection for Drug Resistance

Parents

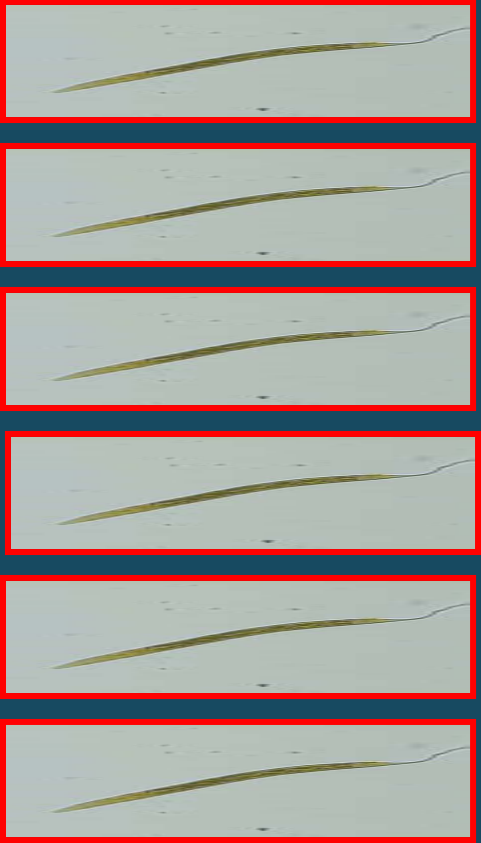


Susceptible

Drug Treatment



Next Generation



Resistant

Resistant

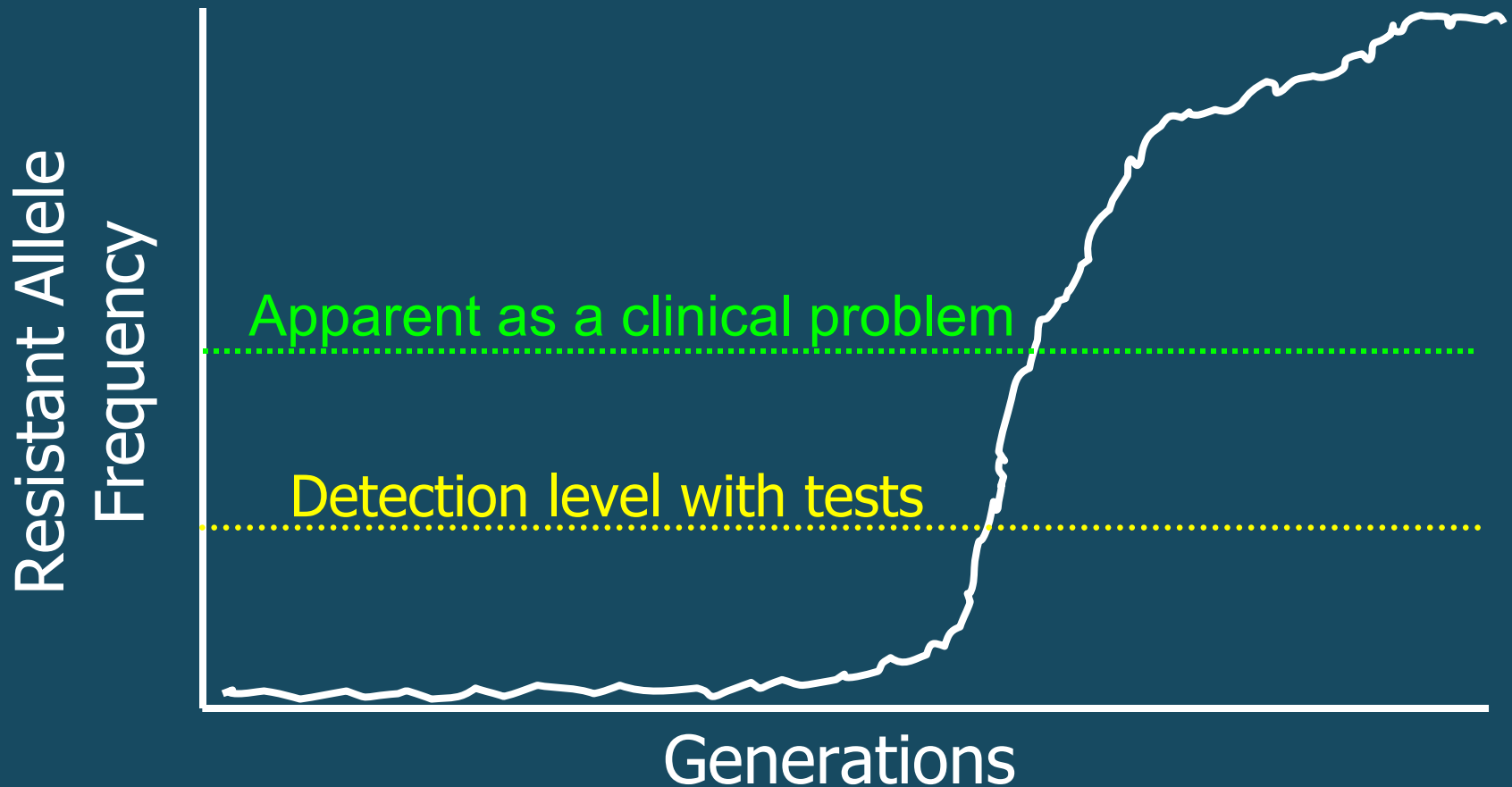


# Detection of Drug Resistance

- Resistant genes accumulate but are undetected
- As drug resistance develops further, more worms survive until treatment failure finally occurs
- **Clinical definition of resistance**
  - **when normal therapeutic dose is no longer fully effective**
    - <95% reduction in FEC
    - Many worms may still be killed by the drug



# Changes in Allele Frequency in Response to Drug Selection



# What Causes Resistance To Dewormers ???

- Frequent Treatments
  - $\geq 3$  treatments per year
- Treating and moving to clean pasture
- Under dosing
- Treating when few larvae are on the pasture
- **Treating all animals at same time**



# Resistance is Inevitable

- Natural biological consequence of drug treatment
- What Can We Do ???
  - Rate of selection for resistance can be greatly reduced
  - Preserve drug efficacy for as long as possible
    - Selective treatment
    - Increase refugia



# Refugia

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- The proportion of the population that is not selected by drug treatment
  - In “refuge” from drug
    - Worms in untreated animals
    - Eggs and larvae on pasture
- Provides a pool of sensitive genes
  - Dilutes resistant genes
- Until recently, overlooked as **the most important component of drug resistance selection**



# 3 Major Classes of Anthelmintics (Dewormers)



- Benzimidazoles (BZ)
  - fenbendazole (FBZ), albendazole (ABZ), others
- Avermectin / Milbemycins (Macrocyclic lactones)
  - ivermectin (IVM), eprinomectin (EPR), doramectin (DRM) moxidectin (MOX), others
- Imidazothiazoles / Tetrahydropyrimidines
  - levamisole (LEV), pyrantel (PYR), morantel (MOR) others



# Resistance Occurs Within Classes of Anthelmintics

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- 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**



# “Smart Drenching”

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- Using what we know to develop strategies that maximize the effectiveness of treatments while also decreasing the selection of drug resistance



# Components of a Smart Drenching Program

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- Know the resistance status of the flock
- Sound pasture management
- Keep resistant worms off the farm
- Administer the proper dose
- Utilize host physiology
- Selective treatment -- FAMACHA



# Know the Resistance Status of the Flock

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



# Recommendations For Pasture Management

- Use appropriate stocking rates
- Build fences – provide safe pastures
- Use dilution strategies
  - mix 2 or more species on same pasture (sheep with cattle or horses)
  - rotate pastures between different species



# Do Not Buy Resistant Worms

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- All new additions should be quarantined and aggressively dewormed upon arrival
- Deworm with 3 anthelmintics from different drug classes
- Should remain in quarantine for 10 - 14 days
  - Perform FEC to confirm that no eggs are shed



# Use Proper Technique

- Ensure proper dose is delivered
- Proper technique when drenching sheep 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](http://premier1supplies.com)

# Utilize Host Physiology to Maximize Drug Efficacy

- Restrict feed intake for 24 hours prior to treatment (BZ and AM)
  - Withholding feed decreases digesta flow rate leading to an increase in drug efficacy
  - Never in ewes 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



# Rotation of Dewormers






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- For rotation to be of value you must:
  - rotate between different drug classes
  - rotate on an annual basis – NOT with each treatment
- Where resistance is prevalent, traditional rotation may not be possible
- Although rec'd for many years there are new arguments against using rotation
  - **Rotation is NOT a replacement for proper resistance prevention measures**



# Selective Treatment

- FAMACHA<sup>®</sup>
  - For *H. contortus* only
- For other GI worms
  - FEC
  - Age
  - Body condition
  - Production level
  - Symptoms

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 i.e. 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.

ARC • LNR  
University of Pretoria

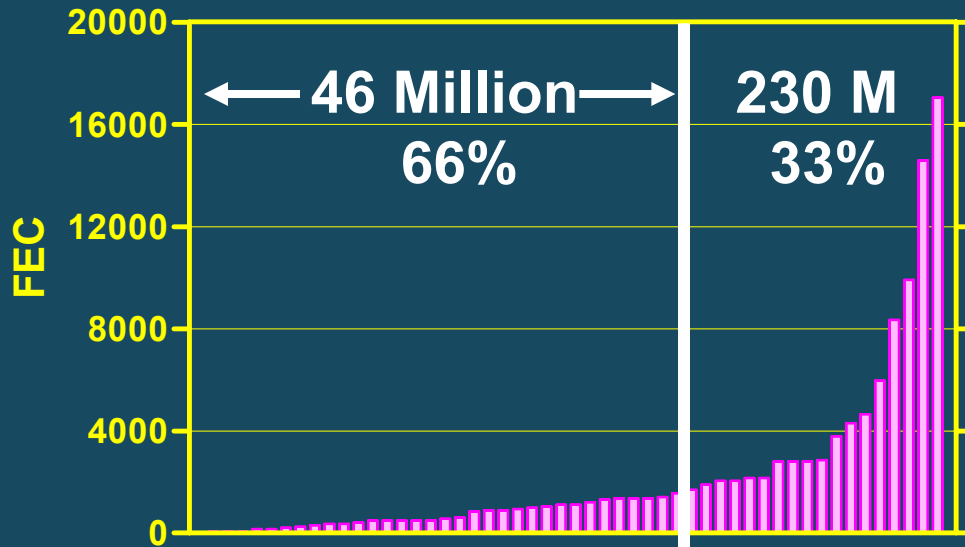


# Concept Behind Selective Treatment

- Parasites are not equally distributed in groups of animals
  - Overdispersed / aggregated distributions
  - 20-30 % of animals harbor most of worms
    - responsible for most of egg output



# Distribution of FEC in Goat Herds



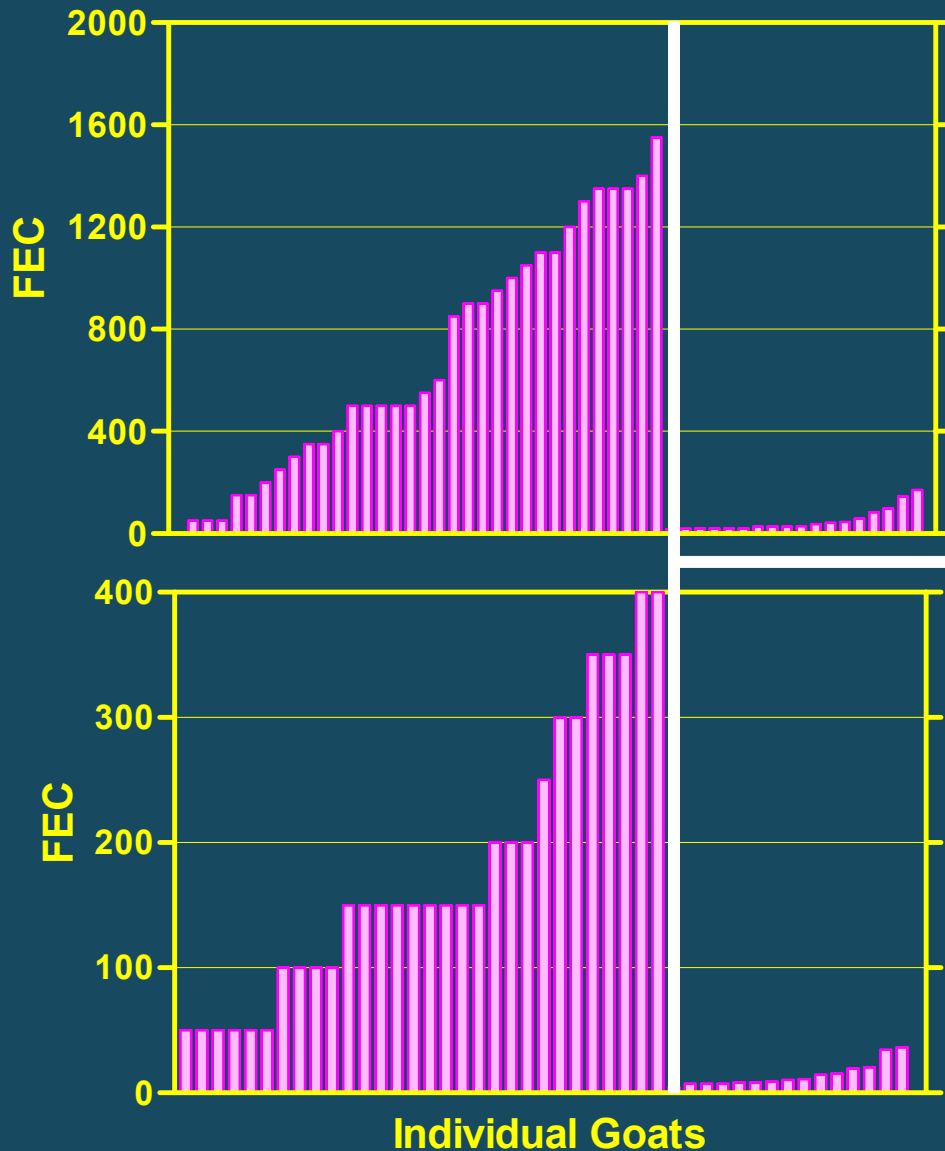
Treating high 33%  
Greatly Reduces  
Daily Pasture  
Contamination With  
Eggs

33% of Goats  
80% of Eggs



Treating 1/3 of  
goats 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 ↑↑↑

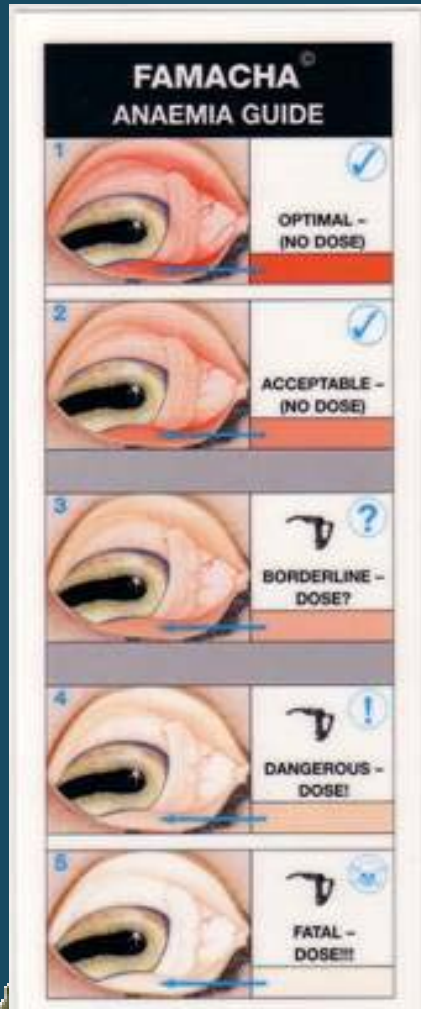
Less Resistance ↓↓↓

# How Do We Achieve Selective Treatment ???

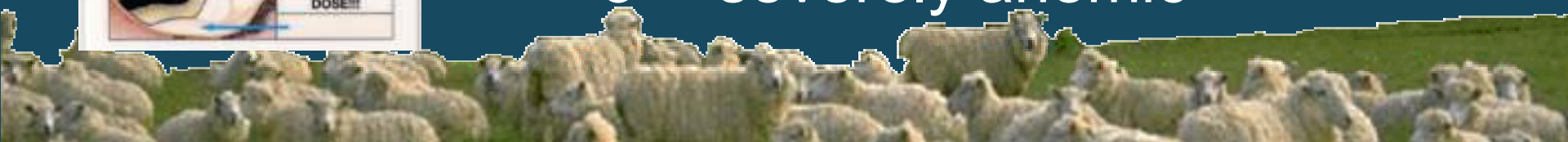
- **The FAMACHA<sup>©</sup> system**
  - Novel technique for the assessment of *Haemonchus contortus* and need for Tx
  - Developed in response to emergence of severe AR in South Africa
  - Method of selective chemotherapy which leads to a large reduction in the number of deworming treatments given
    - significantly decreases the rate of development of anthelmintic resistance



# The FAMACHA<sup>®</sup> 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



**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**



# Other Advantage of Selective Treatment (FAMACHA)

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- Identify sheep that need treatment most often
  - These are the ones contaminating the pasture for others in the flock
  - Cull these and improve genetics of resistance of the flock
  - Resistance/resilience to parasites is moderately heritable (0.3 – 0.4)



# Where Can I Get FAMACHA Charts ???

- Only properly trained lay individuals can purchase the cards
  - Sanctioned Training Workshop
- Through a veterinarian
  - Vets expected to train themselves before training clients
- Outside of US contact Professor Bath at:
  - [gareth.bath@up.ac.za](mailto:gareth.bath@up.ac.za)
- In US contact Dr. Kaplan
  - See [www.scsrpc.org](http://www.scsrpc.org)



Thanks