American Consortium for Small Ruminant Parasite Control (ACSPRC)

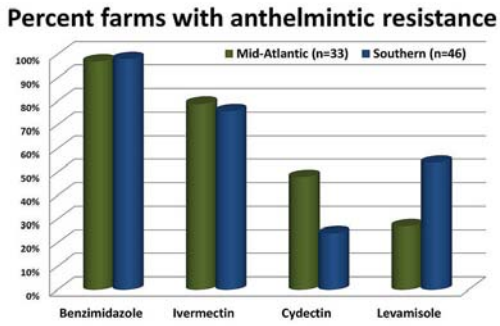
www.acsrpc.org
www.wormx.info

Anthelmintic (dewormer) resistance

- Resistance is inevitable; no treatment will kill 100 percent of worms.
- Worms have developed resistance to all dewormers and all dewormer classes.
- Resistance varies by geographic region and individual farm and is the result of past deworming practices.

Anthelmintic = Dewormer

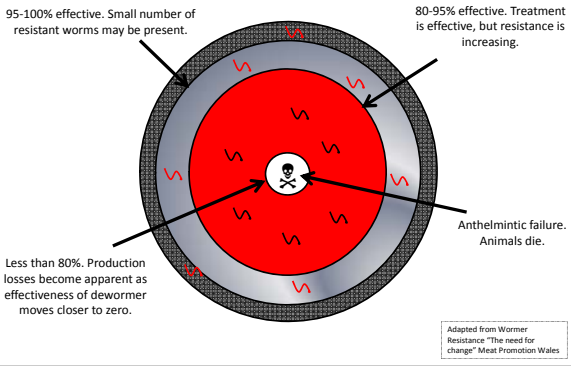
Anthelmintic resistance quantified



Anthelmintic (dewormer) resistance

- Resistant worms pass their resistant genes onto their offspring; resistance is permanent!
- You cannot prevent resistance, but you can affect the rate by which it develops.
- On most farms, resistance is probably still at a level where there is still time to slow it down and enable the continued use of some anthelmintics.

Understanding anthelmintic resistance



You can slow drug resistance by increasing refugia.

- Decrease frequency of anthelmintic treatments.
- Do not treat everyone; leave some animals untreated.
- Do not move treated animals to a clean pasture.
- Do not deworm when there is a low level of pasture contamination or infection in animals.
- Leave animals in dry lot after treatment for 24-48 hours.
- Re-introduce susceptible worms (?) to your farm.

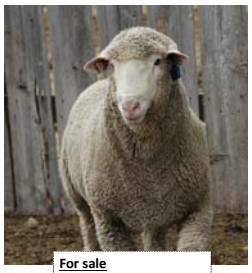
Refugia are worms that have not been exposed to drug(s): "in refuge".

Don't make it easier for worms to develop resistance to the drugs.

- By exposing them to sub-therapeutic levels of drug(s) via:
  1) Underdosing
  2) Injecting dewormers
  3) Pouring dewormer on back
  4) Administering drugs improperly
     - Squirting injectable into mouth
     - Drenching with pour-on
  5) Depositing drug into mouth instead of esophagus.
  6) Using persistent activity dewormer.
  7) Rotating dewormers

Do not introduce resistant worms to your farm

- Quarantine drenching: to prevent the introduction of resistant worms to your farm, deworm all newly acquired animals with anthelmintics from 2-3 anthelmintic classes.
  1. Moxidectin + levamisole
  2. Albendazole + moxidectin + levamisole
- In Western Maryland Pasture-Based Meat Goat Performance Test, sequential deworming with albendazole, moxidectin, and levamisole usually reduces fecal egg counts by more than 95 percent (in 6-12 days).



For sale
Ram - $1,000
Resistant worms - free

Anthelmintics 101

There are only 3 families of drugs.

BENZIMIDAZOLES 1

1. Fenbendazole
   Safeguard®
   Panacur®
2. Albendazole
   Valbazen®
3. Oxybendazole
   Synanthic®

MACROCYLIC LACTONES 2

1. Avermectins
   a) Ivermectin
      Ivomec®
      Primectin®
      Privermectin®
   b) Eprinomectin
      Eprinex®
   c) Doramectin
      Dectomax®
2. Milbimycins
   a) Moxidectin
      Cydectin®
      Quest®

NICOTINIC AGONISTS 3

1. Imidazothiaoles
   a) Levamisole
      Prohibit®
2. Tetrahydropyrimidines
   a) Morantel
      Rumatel®
      Positive Goat Pellet
      Goat dewormer
   b) Pyrantel
      Strongid®

FDA-approved anthelmintics for sheep

	(1) Benzimidazoles	(2) Macrocylic lactones		(3) Nicotinics
		Avermectins	Milbimycins	
Adult worms	✔	✔	✔	✔
Immature worms (L4)	✔	✔	✔	✔
Hypobiotic larvae	✔	✔	✔	✔?
Lung worms	✔	✔	✔	✔+
Tape worms	✔			
Adult liver flukes	✔			
Coccidia				
External parasites		✔	✔	
Persistent activity			✔	
Safety	Restricted use during early pregnancy	++++	++++	++
Resistance	++++	+++	++	+
FDA-approved	**Valbazen®**	**Ivomec®**	**Cydectin®**	**Levamisole®**
Labeled dosage	3 ml/100 lbs.	3 ml/26 lbs.	1 ml/11 lbs.	2 ml/50 lbs.
Meat withdrawal	7 days	11 days	7 days	3 days

FDA-approved anthelmintics for goats

	(1) Benzimidazoles		(3) Nicotinics
	SafeGuard®	Valbazen®	Rumatel®
Adult worms	✔	✔	✔
Immature worms (L4)	✔	✔	
Hypobiotic larvae	✔	✔	
Lung worms	✔	✔	
Tape worms	not labeled		
Adult liver flukes		✔	
Coccidia			
External parasites			
Safety	++++	Restricted use during early pregnancy	+++
Resistance	++++	na	?
Labeled dosage per 100 lbs.	2.3 ml	4 ml	0.44 g
Meat withdrawal	6 days	7 days	30 days
Milk withdrawal	NA	NA	0 days

Extra-label anthelmintics for goats (Rx)

	(1) Benzimidazoles		(2) Macrocylic lactones		(3) Nicotinics
	SafeGuard®	Valbazen®	Ivomec®	Cydectin®	Prohibit®
Adult worms	✓	✓	✓	✓	✓
Immature worms (L4)	✓	✓	✓	✓	✓
Hypobiotic larvae	✓	✓	✓	✓	✓?
Lung worms	✓	✓	✓	✓	✓+
Tape worms	✓	✓			
Adult liver flukes		✓			
Coccidia					
External parasites			✓	✓	
Persistent activity				?	
Safety	++++	Restricted use during early pregnancy	++++	++++	++
Resistance	++++	++++	+++	++	+
Dosage per 25 lbs.	1.1 ml	2 ml	6 ml	4.5 ml	2.7 ml
Meat withdrawal	16 days	9 days	14 days	17 days	4 days
Milk withdrawal	4 days	7 days	9 days	8 days	3 days

Zolvix® (monepantel): a new anthelmintic

- New drug class: amino-acetonitrile derivative.
- Unique mode of action.
- First new anthelmintic in 25 years.
- Kills worms that are resistant to other drugs.
- Resistance already reported in Australia (in goats).
- Not yet available in US (soon?).
- Will be available by prescription (Rx) only. ELDU for goats.
- Will be expensive (?).

"Alternative" (non-chemical) dewormers

- Many natural compounds are purported to have "anthelmintic-like" properties; the list is overwhelming!
- Studies are lacking, inconsistent, and/or not repeatable.
- There is no consistency as to if and how alternative dewormers have been evaluated or reported in the scientific literature.
- Some natural anthelmintics are potentially toxic to the animal, e.g. copper sulfate, nicotine sulfate.
- Considerable research is being done on alternative or natural "dewormers."

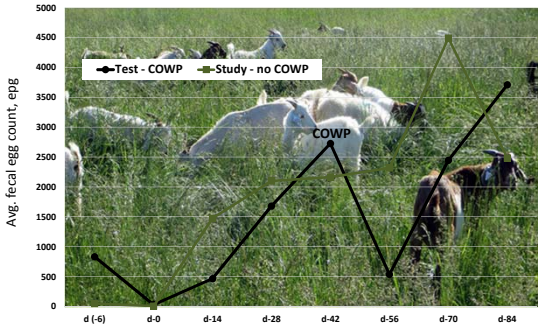
2014 Western Maryland Pasture-Based Meat Goat Performance Test
Anthelmintic effect of copper oxide wire particles (COWPs)

- Mid-way through the test, at day 42, which was the end of the "parasite challenge phase" of test, test bucks (n=77) were given a gel cap containing ~0.5 g of copper oxide wire particles (COWPs).
- On day 42, nine (9/77) bucks required deworming (based on FAMACHA© and 5 Point ✓©) and were also dewormed with a commercial dewormer (levamisole or moxidectin).
- Fifteen (15) bucks from our pen vs. pasture study (pasture group) served as controls: they did not receive any treatment.

2014 Western Maryland Pasture-Based Meat Goat Performance Test
Anthelmintic effect of copper oxide wire particles (COWPs)

Treatment		# goats	July 17 Avg. FEC	July 31 Avg. FEC	Avg. FECR
Dewormer	Effective	8	8735	103	98.6
	Ineffective	1	500	275	45.0
COWP	Effective	53	2768	388	81.7
	Ineffective	8	723	2000	< 0
No treatment (Control)	Pasture	15	2164	2371	< 0
	Pen	12	1216	758	37.7

2014 Western Maryland Pasture-Based Meat Goat Performance Test
Anthelmintic effect of copper oxide wire particles (COWPs)



My perspective and recommendation on alternative "dewormers"

- Alternative dewormers are <u>not likely</u> to replace commercial anthelmintics.
- Alternative dewormers may <u>complement</u> commercial dewormers by:

  + Disrupting the free-living stage of the parasite (e.g. inhibit egg hatching or larvae development)
  + Improving natural immunity of animal
  + Improving overall management of the herd

  = **Reducing the number of animals that require treatment with a commercial dewormer.**

- It's okay to use alternative dewormers, even unproven ones, so long as you continue to <u>regularly monitor</u> animals for signs of parasitism and deworm those showing clinical signs with an effective drug.

Determining anthelmintic resistance

- It is recommended that you test for anthelmintic resistance every 2-3 years.
- FAMACHA© and the Five Point Check© don't work if you don't have an <u>effective</u> treatment(s) for clinically-parasitized animals.
- Clinically-parasitized animals will almost always <u>die</u> without an <u>effective</u> anthelmintic treatment (deworming).
- There are <u>two</u> ways to test for anthelmintic resistance.
  1) Fecal egg count reduction test (FECRT)
  2) DrenchRite® Assay

1) Fecal egg count reduction test (FECRT)

- Determines the effectiveness of an individual treatment.
- In Mid-Atlantic region, best time to do is early to mid-summer when *Haemonchus* (barber pole worm) is most active.
- Collect fecal samples (FECs $\geq$ 250 epg) from treated animals (ideally, n $\geq$ 15) for each anthelmintic (or combination) you want to test.
- Favor animals with higher FAMACHA© and dag scores and lower BCSs.
- If possible, include a group (n $\geq$ 15) of untreated animals as a <u>control</u> group.

→ Doing a fecal egg count reduction test on one or a few animals may suggest resistance or effectiveness, but it does not prove it.

Fecal egg count reduction test (FECRT)

- Compare pre- and post-treatment fecal egg counts
  a) 8-10 days for benzimidazoles (SafeGuard®, Valbazen®)
  b) 14-17 days for macrocylic lactones (Ivomec®, Cydectin®)
  c) 5-7 days for levamisole (Prohibit®)
  d) 10-14 days for all dewormers

http://www.uaex.edu/Other_Areas/publications/PDF/FSA-9608.pdf

Fecal egg count reduction test

2012 Western Maryland Pasture-Based Meat Goat Performance Test

[Pre-test Tx: albendazole + moxidectin + levamisole]

	2-Jun	14-Jun	14-Jun
TEST ID	FEC-0	FEC-1	FECRT
01	4100	150	96.3%
02	6033	0	100.0%
03	1200	0	100.0%
04	3900	0	100.0%
05	2500	ns	na
06	3000	175	94.2%
07	533	0	100.0%
08	4775	467	90.2%
09	700	0	100.0%
10	850	0	100.0%
11	ns	0	na
12	1033	0	100.0%
13	4300	25	99.4%
14	6833	0	100.0%
15	11000	33	99.7%
16	13267	0	100.0%
17	3160	0	100.0%
18	4360	0	100.0%
20	80	25	68.8%
21	2200	0	100.0%
73	15150	0	100.0%
24	1325	0	100.0%
25	1067	25	97.7%

	2-Jun	14-Jun	14-Jun
TEST ID	FEC-0	FEC-1	FECRT
26	1600	0	100.0%
27	1257	0	100.0%
28	40	0	100.0%
29	ns	0	na
30	800	0	100.0%
32	1600	0	100.0%
52	1625	0	100.0%
33	80	0	100.0%
34	0	0	na
35	0	0	na
36	857	0	100.0%
37	467	0	100.0%
38	2300	0	100.0%
39	3350	75	97.8%
40	1275	86	93.3%
42	25	0	100.0%
43	40	0	100.0%
44	500	67	86.6%
45	375	0	100.0%
51	280	0	100.0%
46	1875	120	93.6%
47	450	50	88.9%
48	1257	ns	na
49	ns	0	na

	2-Jun	14-Jun	14-Jun
TEST ID	FEC-0	FEC-1	FECRT
AVERAGE	2532	29	97.7%
MEDIAN	1266	0	100.0%
STDEV	3373	76	5.77%

Fecal egg count reduction test

Sheep farm (Katahdins) in West Virginia (2013)

Control

FEC1	FEC2	FECR
800	425	47%
475	2000	-321%
2300	2625	-14%
1850	3750	-103%
1475	2200	-49%
2375	3125	-32%
7025	7475	-6%

Cydectin

FEC1	FEC2	FECR
6075	1075	82%
3000	1025	66%
2425	1275	47%
2625	750	71%

Ivermectin

FEC1	FEC2	FECR
2175	100	95%
275	325	-18%
1500	4675	-212%
1400	375	73%
775	25	97%
3000	1275	58%
7350	3850	48%
10500	1075	90%

Levamisole

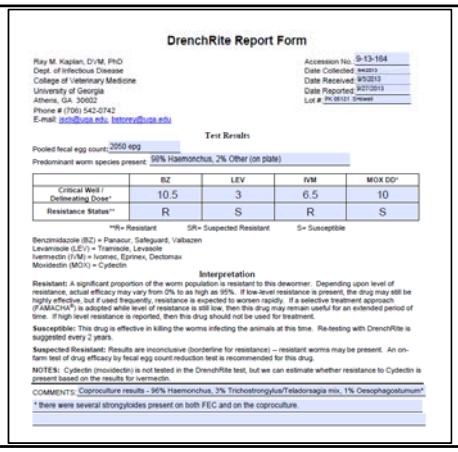
FEC1	FEC2	FECR
850	225	74%
1175	1750	-49%
2375	100	96%
10925	450	96%
2775	125	95%
5325	50	99%
3600	475	87%
12300	100	99%

Valbazen

FEC1	FEC2	FECR
575	7425	-1191%
425	200	53%
3725	725	81%
575	250	57%
3400	900	74%
2275	875	62%
8925	525	94%
6285	1250	80%
7150	3799	47%

2) DrenchRite® or larval development assay

- Determines drug resistance for all anthelmintic classes simultaneously from a pooled fecal sample.
  - → Resistance to Cydectin® is predicted based on the results for ivermectin.
- Also determines which parasites your animals have.
- Collect a pooled fecal sample from at least 10 animals with FECs ≥350-500 epg.
- Follow instructions for collecting, handling, and shipping sample to Dr. Ray Kaplan's lab at the University of Georgia.



DrenchRite Report Form

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College of Veterinary Medicine
University of Georgia
Athens, GA 30602
Phone # (706) 542-0742
E-mail: jsch@uga.edu, betorey@uga.edu

Accession No. 9-13-164
Date Collected 9/4/2013
Date Received 9/5/2013
Date Reported 9/27/2013
Lot #: PN 06101 Dirkwell

Test Results

Pooled fecal egg count: 2050 epg
Predominant worm species present: 98% Haemonchus, 2% Other (on plate)

	BZ	LEV	IVM	MOX DD*
Critical Well / Delineating Dose*	10.5	3	6.5	10
Resistance Status**	R	S	R	S

**R= Resistant SR= Suspected Resistant S= Susceptible

Benzimidazole (BZ) = Panacur, Safeguard, Valbazen
Levamisole (LEV) = Tramisole, Levasole
Ivermectin (IVM) = Ivomec, Eprinex, Dectomax
Moxidectin (MOX) = Cydectin

Interpretation

Resistant: A significant proportion of the worm population is resistant to this dewormer. Depending upon level of resistance, actual efficacy may vary from 0% to as high as 95%. If low-level resistance is present, the drug may still be highly effective, but if used frequently, resistance is expected to worsen rapidly. If a selective treatment approach (FAMACHA®) is adopted while level of resistance is still low, then this drug may remain useful for an extended period of time. If high level resistance is reported, then this drug should not be used for treatment.

Susceptible: This drug is effective in killing the worms infecting the animals at this time. Re-testing with DrenchRite is suggested every 2 years.

Suspected Resistant: Results are inconclusive (borderline for resistance) -- resistant worms may be present. An on-farm test of drug efficacy by fecal egg count reduction test is recommended for this drug.

NOTE: Cydectin (moxidectin) is not tested in the DrenchRite test, but we can estimate whether resistance to Cydectin is present based on the results for ivermectin.

COMMENTS: Coproculture results - 96% Haemonchus, 3% Trichostrongylus/Teladorsagia mix, 1% Oesophagostumum*

* there were several strongyloides present on both FEC and on the coproculture.

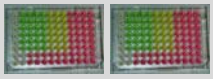
A comparison of tests

FECRT

- Takes 7-14 days to get results, longer if someone else does FECs.
- Cost for 75 samples
  (15 samples x 4 drugs + control group)
  75 x Labor = ?
  75 x $5 = $375
  75 x $10 = $750
- Need more animals
- Results: % efficacy.
- Results can vary by animal, which is why you need to do enough animals for results to be valid.

DrenchRite® Assay

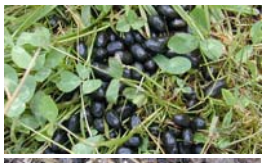
- Labor-intensive lab test
- Only one lab in US does DrenchRite® Test (UGA)
- Takes 3-4 weeks to get results
- Results: S, SR, R
- Cost $450 per sample



Small ruminants are affected by many internal parasites, but only a few are usually important.

Multi-cellular (helminths)

a) Nematodes
   Roundworms
b) Cestodes
   Tapeworms
c) Trematodes
   Flukes



Single-cell (protozoa)

Roundworms - nematodes – *strongyle*-type

Primary

1. *Haemonchus contortus*
   Barber pole worm
2. *Teladorsagia circumcinta (Ostertagia)*
   brown stomach
3. *Trichostrongylus* spp.
   black scour
   stomach hair

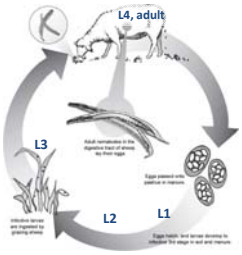
Secondary

- *Cooperia*
  small intestinal
- *Nematodirus*
  thread or thin necked intestinal
- *Oesaphagostomum*
  nodule worm
- *Bunostomum*
  Hookworm
- *Trichuris ovis*
  Whipworm
- Strongyloides
- Lungworms

- *Parelaphostrongylus tenuis*
  Meningeal worm
  Deer worm, brain worm

Haemonchus – Trichostrongylus – Teladorsagia

- Short, direct life cycles (avg. 3-4 weeks) that are weather-dependent.
- Can overwinter on pasture.
- Ability to go into hypobiotic (arrested) state (in host) when environmental conditions are not conducive to their development (hot, dry or cold, dry).
- Vary in their egg laying ability.
- Eggs look same under microscope.



Haemonchus contortus
Barber pole worm

- Primary parasite in warm, moist climates and/or during summer grazing season (in more northern climates).
- One of the most pathogenic parasites
- Prolific egg layer
- Blood sucker/feeder
- Causes anemia and bottle jaw.
- Other symptoms: weight loss, loss of body condition, poor stamina, anorexia -- but not usually diarrhea.
- Death can also be sudden (acute haemonchosis).

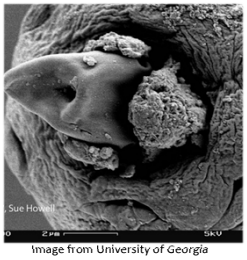


Image from University of Georgia

Other strongyle-type
Teladorsagia and *Trichostrongylus*

- Usually of secondary importance.
- Usually part of mixed infections with barber pole worm.
- Cause production loss, weight loss, dagginess (scours) - only occasional death.
- May be more problematic in cooler, wet climates, e.g. Pacific Northwest, UK, and Canada.

Lungworms

- Direct or indirect life cycle
- Larvae visible in feces.
- Severe infestations can cause respiratory symptoms: coughing, fluid on lungs, pneumonia.
- Difficult to diagnose in live animal; usually diagnosed at necropsy.
- Drugs which control GI parasites will also control lungworms.

Liver flukes
Fasciola hepatica

- Regional problem: mostly Pacific Northwest and Gulf States.
- Require open water and aquatic snails as intermediate host.
- Similar symptoms as barber pole worm (anemia, bottle jaw).
- Treat adult liver flukes with albendazole (Valbazen®) or Ivomec® Plus (clorsulon).

Tapeworms *(Moniezia expansa)*

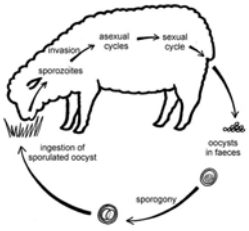
- Only worm that is visible in feces.
- Indirect life cycle; pasture mite is intermediate host.
- Usually non-pathogenic; usually no benefit to treatment.
- Heavy infestations may cause intestinal blockage (rare) or affect gut motility (occasional).
- Treat with SafeGuard® (2x dose, Rx), Valbazen® [Rx], or praziquantel* [Rx] (Quest Plus®, Equimax®, or Zimecterin Gold®).
- Sheep and goats are intermediate host for tapeworms that infect dogs.

Meningeal worm *(Parelaphostrongylus tenuis)*

- Parasite of white tail deer.
- Sheep, goats, and camelids are abnormal (and dead end) hosts.
- Has indirect life cycle: snail or slug required is intermediate host.
- Causes neurological symptoms that vary in severity.
- No definitive diagnosis in live animal.
- Treatment protocols involve high doses of anthelmintics and anti-inflammatory drugs.
- Fenbendazole (SafeGuard®) and ivermectin (Ivomec®) are drugs of choice for meningeal worm [Rx].
- Cornell University is working on vaccine and treatment protocols.

Coccidia (*Eimeria* spp.)

- Single-cell protozoa
- Species-specific
- Not all species pathogenic
- More complicated life cycle than roundworms.
- Damages lining of small intestines, affecting nutrient absorption; damage can be permanent.
- Causes diarrhea (not always), ill thrift, and death.



Coccidia (*Eimeria* spp.)

- Prevent mostly with good management and sanitation.
- Prevent with coccidiostats in water, mineral, feed, and/or milk replacer.
  - Lasalocid (Bovatec®) [Rx]
  - Monensin (Rumensin®) ☠
  - Decoquinate (Deccox®)
  - Amprolium (Corid) [Rx]
- Treat with Corid [Rx] or sulfa antibiotics [Rx]*.
- Sericea lespedeza pellets may provide "natural" control of coccidiosis.

http://www.wormx.info/Resources/Topics/SL-SS.html

Integrated parasite management (IPM)

Using chemical and non-chemical means to control parasites

Non-chemical

- Host immunity
- Kidding and weaning management
- Nutritional management
- Pasture and grazing management
- Genetic selection

Chemical

- Proper use of anthelmintics, including Targeted Selected Treatment (TST)
  - FAMACHA©
  - Five Point Check©
- Testing for anthelmintic resistance

Host immunity

Animals vary in their susceptibility to parasites

Most susceptible

- Lambs and kids
  - Weanlings
  - Early weaned
  - Spring born
  - Late-born
  - Artificially reared
- Periparturient females
  - High producing
  - Yearlings
- Geriatric animals

Less (but still) susceptible

- Mature males
- Dry females
- Pets

Birthing and weaning management

- You can manage lambing/kidding to lessen parasite problems.
- Optimal time to lamb/kid will vary by climate and other factors.
- In Mid-Atlantic region, producers who lamb/kid in winter and fall report less parasite problems.
- Can keep animals indoors during late gestation/early lactation to minimize effect of periparturient egg rise.
- Weaning age will affect susceptibility to parasites.
- There are pros and cons to different weaning ages.

Nutritional management

- Sheep/goats in better body condition and on a higher plane of nutrition are better able to tolerate the effects of parasitism.
- Sheep studies have shown that protein (especially by-pass) supplementation (above NRC requirements) in late pregnancy can reduce fecal egg counts in periparturient ewes.
- In the Mid-Atlantic region, pastures are usually deficient in energy.

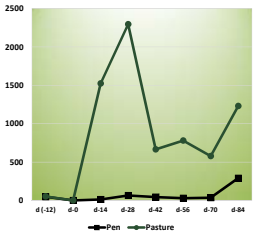
Bucks in 2014 test were supplemented with soy hulls during second half of test.

Pasture and grazing management

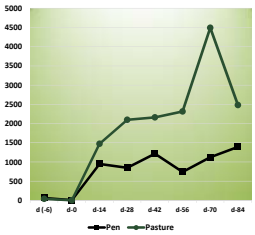
- Safe (clean) pastures
- Low risk pastures
- Evasive grazing
- Strip grazing
- Short-duration grazing
- Rotational grazing
- Management-intensive grazing (MIG)
- Multi-species grazing
- Composting manure before spreading on fields.
- Browsing
- Alternative forages
  - Tanniferous forages
  - Annuals
  - Legumes, forbs, herbs
- Minimum grazing height
- Delayed grazing
- Night pen
- Zero grazing (dry lot feeding)

Western Maryland Research & Education Center
Pen vs. pasture studies
Avg. fecal egg counts, epg

2013



2014



No pen goats required deworming. Pasture goats received 28 and 5 treatments, respectively, in 2013 and 2014.

Genetic selection

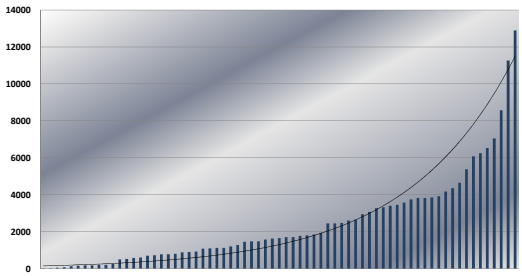
- There are documented differences in breeds with regards to parasite resistance.
- There is as much genetic variation within a breed as between breeds.
- Fecal egg counts are not evenly dispersed in a herd.

  Approximately20-30% of the herd is responsible for 70-80% of the pasture contamination.

One of the more resistant bucks in the 2014 test.

FECs are not evenly dispersed in a flock or herd of animals.

2014 Western Maryland Pasture-Based Meat Goat Performance Test
Fecal egg counts (EPG) on August 14 (d-70)



Genetic selection: two traits

RESISTANCE

- Ability of the host to reduce number of parasites that establish, reproduce, or survive in its body.
- Quantified by fecal egg counts (# worm eggs per gram of feces), which are an <u>indirect</u> measure of the worm burden in the animal.

RESILIENCE

- Ability of host to tolerate parasitic infection, i.e. maintain health, thrive, grow, and reproduce.
- Quantified by observation or measurement of clinical signs: packed cell volume (PCV), weight gain/loss, body condition, dag score.
- FAMACHA© scores are an <u>estimate</u> of PCV.

Genetic selection

- There are significant (though variable) correlations between FEC and PCV and FEC and FAMACHA© scores.
- Parasite resistance is a moderately heritable trait in sheep. Estimates for the heritability of FECs in goats are variable; there are no estimates for the US goat population.
- Lincoln University (in Missouri) has embarked on a long term selection study on parasite resistance in meat goats (research herd is ¾ Kiko x ¼ Boer).

Targeted Selective Treatment (TST)

What is it?

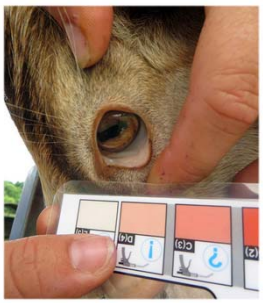
- Only treating animals that require treatment <u>or</u> only treating animals that would benefit from treatment.

What does it do?

1. Slows drug resistance, b/c
   - Reduces # of treatments
   - Increases refugia
2. Identifies resistant and susceptible animals for selection purposes.

Decision-making tools for TST

- TST requires practical decision-making tools that farmers/ producers can use.
- The first tool developed was the FAMACHA© system.
- The Five Point Check© is an extension of the FAMACHA© system.

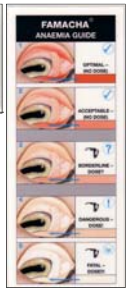


FAMACHA© System

- FAMACHA© system was developed for small-scale sheep farmers in South Africa in response to growing anthelmintic resistance.
  - System validated for goats
  - System validated in US for sheep and goats
- A system to assess anemia (primary symptom of barber pole worm infection) in sheep and goats and to determine the need for deworming individual animals.
- Named for its originator: Dr. Francois "Faffa" Malan **Fa**ffa **Ma**lan **Ch**art

FAMACHA© System

Clinical Category	Eye Lid Color	Packed Cell Volume/PCV	Treatment recommendation
1	Red	≥ 28	No
2	Red-Pink	23-27	No
3	Pink	18-22	?
4	Pink-White	13-17	Yes
5	White	≤ 12	Yes

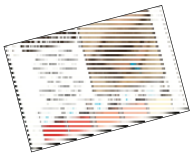


Decision-making: FAMACHA© score 3

Deworm	Don't deworm
Goats	Sheep
Kids and lambs	Mature animals
Periparturient females	Non periparturient females
Lactating females	Dry females
High parasite challenge	Low parasite challenge
Infrequent monitoring (> 3 weeks)	Frequent monitoring (1-3 weeks)
≥ 5-10% FAMACHA© 4s and 5s	< 5% FAMACHA© 4s and 5s
Downward trend in 1s and reciprocal increase in 2s and 3s	No downward trend in scores
Flock/herd not in good body condition and overall health	Flock/herd in good body condition and overall health
To increase sensitivity of system (probability of identifying anemic animals)	To increase specificity of system (probability of identifying non-anemic animals)

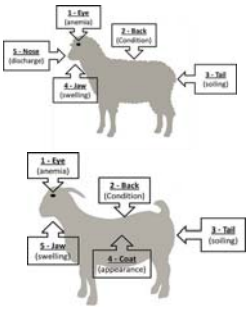
Tips for using FAMACHA©

- Check at appropriate intervals; varies by season, animals, and risk of infection/reinfection.
- No half scores, use paler score
- Be consistent
- Learn your animals
- Don't ignore other symptoms and factors.
- Test for anthelmintic resistance.
- Replace card, as necessary.



Five Point Check© 5.✓©

- Addresses limitations of FAMACHA©, which is only effective for blood feeding parasites, such as Haemonchus.
- Extension of TST to determine need for deworming for all internal parasites that affect sheep and goats.
- Especially useful when deciding whether or not to deworm FAMACHA© score 3's.
- Involves 5 check points on the animal: eye, back, tail, jaw, and nose.
- Developed for sheep.
  - For goats, can replace nose checkpoint with coat condition.



Check Point	Observation	Possibilities
1. EYE	Anemia 1-5 (FAMACHA© card)	**Barber pole worm (*Haemonchus*)** Liver fluke Hook worms Other worms and causes
2. BACK	Body condition score 1-5 (BCS card)	**Brown stomach worm (*Teladorsagia*)** **Bankrupt worm (*Trichostrongylus*)** Nodular worm Other worms and causes
3. TAIL	Fecal soiling (1-5) Dag score card	**Brown stomach worm (*Teladorsagia*)** **Bankrupt worm (*Trichostrongylus*)** **Coccidia (*Eimeria*)** Nodular worm (Oesophagostomum) Other worms and causes
4. JAW	Soft swelling "Bottle jaw" 1-5	**Barber pole worm (*Haemonchus*)** **Coccidia (*Eimeria*)** Liver fluke Hook worms Other worms and causes
5. NOSE	Discharge 1-5	**Nasal botfly** Lungworms Pneumonia Other causes
5. COAT	Coat condition 1-3	**Barber pole worm (*Haemonchus*)** **Brown stomach worm (*Teladorsagia*)** **Bankrupt worm (*Trichostrongylus*)** **Coccidia (*Eimeria*)** External parasites Other causes

#2 - Back - Body condition score (BCS)

- Many parasites can cause a loss of body condition.
- Poor or declining body condition can also be a sign of age, poor nutrition, or other diseases.
- Animals also vary in their ability to carry and hold body condition.



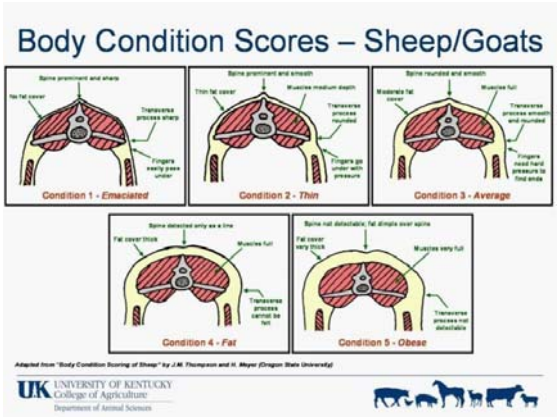
Body condition scoring (BCS)

- Is used to determine how fat or thin an animal is.
- Cannot be determined by simply looking at an animal.
- Is accomplished by feeling for the amount of fat and muscle over the back, ribs, and loin.
- Is one of the most useful management practices.
- Should be done on a regular basis.

Body Condition Scoring

Score		Spineous process	Rib cage	Loin eye
1	**Very thin**	Easy to see and feel, sharp	Easy to feel and can feel under	No fat covering
2	**Thin**	Easy to feel, but smooth	Smooth, slightly rounded, need to use slight pressure to feel	Smooth, even fat cover
3	**Good condition**	Smooth and rounded	Smooth, even feel	Smooth, even fat cover
4	**Fat**	Can feel with firm pressure, no points can be felt	Individual ribs cannot be felt, but can still feel indent between ribs	Thick fat
5	**Obese**	Smooth, no individual vertebra can be felt	Individual ribs cannot be felt. No separation of ribs felt.	Thick fat covering, may be lumpy and "jiggly"

Source: www.smallstock.info



#3 - Tail - dag score

- The hindquarters of the animal are assessed to determine dag score or degree of fecal soiling.
- Many parasites can cause scours (diarrhea).
- Stress and diet are other causes of diarrhea.


What are dags?

- Dried feces left dangling on the wool on a sheep's rear end.


Dag scoring

Score	Description	Action
0	No fecal soiling at all. No indication for treatment/action.	None
1	Very slight soiling on edge of tail/on each side	None
2	Slight soiling on edge of tail/on each side	Usually none
3	Moderate soiling, dag formation	Consider treatment/action
4	Severe soiling, severe dag formation	Treatment recommended
5	Very severe, watering diarrhea extending to hocks.	Treatment essential

Source: University of Pretoria, South Africa

#4 - Bottle jaw

(submandibular subcutaneous edema)

- An accumulation of fluid (swelling) under the lower jaw of a sheep, goat, or calf.
- Usually a result of anemia (blood loss).
- Occurs primarily due to the infestation of barber pole worms (*Haemonchus contortus*) or other blood-feeding parasites.
- Can also be caused by coccidiosis and other parasites.


#5 – Nose (or coat)

Sheep
Nose

- Nasal discharge (for nasal bots)

Goats
Coat condition

- The condition of a goat's hair coat can be indicative of its overall health and thriftiness.
- Diet (nutrition) also has a large effect on coat condition.

Other factors to consider

…especially when deciding whether to deworm FAMACHA 3's

- Fecal consistency
- Fecal egg count
- Weight gain
- Scores of other animals
- Risk of reinfection
- Frequency of FAMACHA© scoring and Five Point Check©

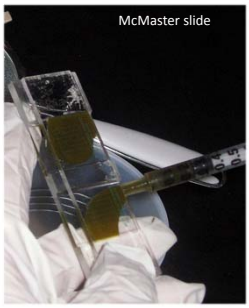
What do to when deworming is not enough or only marginally effective.

- Dose with another class of anthelmintic.
- Give supportive therapy
  - Vitamin B complex
  - Iron or Red cell
  - Nutri-drench
  - Probiotics
  - Electrolytes
  - Proteinaceous feeds
- Remove parasitized animal from pasture (source of reinfection).

Fecal Egg counts (FECs)

- A quantitative measurement that is expressed as eggs per gram of feces (EPG, epg).

  vs. "positive" or "negative" or +,++, +++ from a simple fecal flotation (which is not very useful!)
- Uses a measured amount of feces and flotation solution.
- An approximation of the worm load an animal is carrying.
- A "snapshot" in time.



FEC data from the Western Maryland Pasture-Based Meat Goat Performance Test

Test ID	FEC d-28	FAMACHA©
303	1650	3
304	1000	3
305	275	3
310	2040	2
334	125	3
335	3000	4
337	1300	3
338	3167	3
355	4650	2
356	6725	2
357	6000	3
358	4900	4
339	120	4
340	4240	3
351	14680	3
352	2125	5
353	33	4
359	867	3
360	200	2
361	1240	3
362	2225	2
363	525	2
367	200	2

Year	Genetic correlation (-1 to 1) between FECs and FAMACHA© scores	
2007	0.29	Intermediate
2008	0.42	Intermediate
2009	0.18	Weak
2010	0.23	Weak
2011	0.14	Weak
Avg. 5 years	0.25	Weak to intermediate

Limitations of fecal egg counts

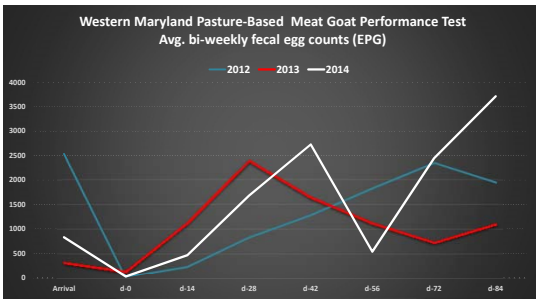
- Not a highly accurate test, especially at low numbers.
- Parasites vary in their egg producing capacity.
- Immature worms (L4s) suck blood, but do not lay eggs.
- Inhibited larvae do not lay eggs.
- There is a day-to-day variability in counts, even in stable worm populations.
- Eggs are not always evenly distributed in manure.
- Loose stools (diarrhea) may underestimate egg counts.
- Some eggs look the same and cannot be differentiated at the egg stage (e.g. *Haemonchus* vs. *Trichostrongylus*)
- Not all parasites (or strains) are pathogenic.
- There are different procedures for doing fecal egg counts.
- The possibility of human error.

Three main uses of fecal egg counts

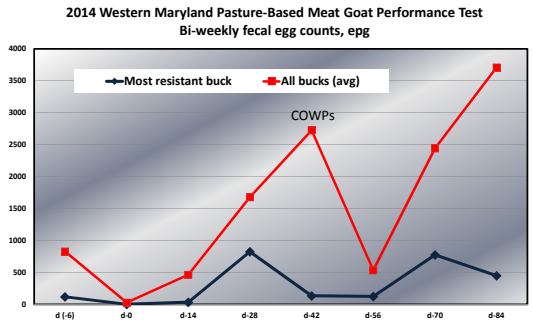
1) Determine anthelmintic (drug) resistance.
2) Monitor pasture contamination.
3) Select animals for their genetic ability to resist worms.
4) Not a reliable way to diagnose parasitic disease in an individual animal.

What do fecal worm egg counts tell us? http://ohioline.osu.edu/vme-fact/pdf/0027.pdf

Use fecal egg counts to monitor pasture contamination



Use fecal egg counts to select goats (especially bucks) that are more resistant to internal parasites.



Hands-on fecal egg counting

What you need

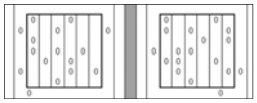
- Microscope (10 x 10 = 100x)
- McMaster slide
- Flotation solution
- Gram scale (optional)
- Cups or vials
- Craft stick or tongue depressors
- Cheese cloth or tea strainer
- Pipettes or syringes

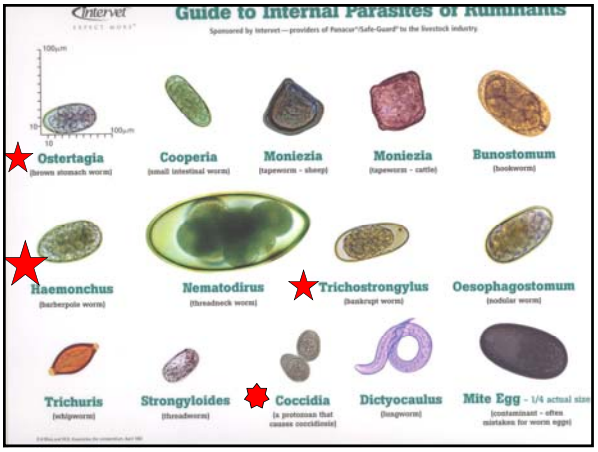
Modified McMaster Procedure

1) Weigh out 4 g of feces
2) Add 26 ml of flotation solution
3) Crush and mix feces using stick
4) Drain solution through cheese cloth or tea strainer into a clean cup
5) After stirring solution, draw up solution from top of mixture
6) Fill both sides of slide chamber.
7) Allow slide to sit for 5-10 minutes
8) Place slide on microscope
9) Focus on grid
10) Count strongyle-type eggs inside of and under grid lines
11) Record number of eggs for each grid.
12) Multiply their sum by 25 to get EPG

Note: If using 2 g of feces, add 28 ml of flotation solution and multiple number of eggs in both chambers by 50.

FIG. 1.67. Trichostrongyle eggs. Strongyle parasites of ruminants also produce similar eggs.





Thank you for your attention. Questions?

UNIVERSITY OF MARYLAND EXTENSION
SMALL RUMINANT PROGRAM

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