NEWS TO EWES:
Can Copper Sulfate Control Stomach Worm Infestations?

By Donald G. Ely

Stomach worms have put many sheep producers out of business because of a lack of knowledge about how to control and/or the extra effort and expense wasn't worth trying to develop a control. Although pasture rotation has been recommended, producers have relied most heavily on commercial dewormers (drenches), used under a variety of recommended schedules, to control stomach worms over the past 40 years. Indiscriminate use of commercial drenches to try and "stem the tide" when sudden rises in stomach worm infestations occur has led to development of worm populations that are resistant to these drenches. This situation developed in the University of Kentucky Hampshire ewe flock, forcing us to search for alternatives to the commonly used commercial drenches in order to control this parasite. This search, finding, and application is described here.

LAMBING AND PRE-WEANING: MARCH, 2007

Hampshire ewes scheduled to lamb in January/February, 2007 were brought into the barn in late December, 2006 where they remained in the barn until lambs were weaned. Some ewes exhibited edema (bottle jaw), a classic sign of stomach worm infestation, during the latter part of the 60-day lactation. This finding stimulated an evaluation of all ewes (59) on March 27, 2007 for stomach worm infestation by FAMACHA score, blood serum packed cell volume (PCV) and fecal egg count (FEC). FAMACHA evaluates the level of anemia caused by the blood sucking stomach worm. A score of 1.0 means there is no anemia and the sheep should be relatively free of stomach worm infestation. On the other hand, a score of 5.0 indicates the sheep is anemic and is carrying a heavy load of worms. The PCV is closely related to FAMACHA, in that the higher the percentage of red blood cells (PCV) the less anemia and the lower the FAMACHA score. So, sheep that are free from stomach worms should have a low FAMACHA score and a high PCV. Eggs produced by female stomach worms pass out of the animal through the feces, an essential step in the worms' life cycle. Therefore, an analysis of the egg concentration in the feces (FEC) can be an indicator of the worm infestation in the digestive tract of sheep.

SEARCH FOR A DRENCH

The presence of bottle jaw was surprising because sheep maintained in confinement typically do not have a high stomach worm (Haemonchus contortus) population because pasture forage is necessary for this parasite to complete its life cycle. Assays conducted at the University of Georgia showed the University of Kentucky internal parasites (in the sheep) had a high resistance to Panacure, Safeguard, Valbazen, Tramisol and Levasole, a resistance to Eprinex and Dectomax, and a low resistance to Cydectin. The efficacy of Cydectin was estimated at 80 to 95% compared with 0 to 50% for the other drenches. The fear of encountering a resistance, because of the potential overuse of Cydectin, stimulated a search for alternative methods of controlling stomach worms in the University of Kentucky Hampshire ewe flock.

The scientific literature, extension bulletins, popular press articles, and text books described many methods of treatment (control) that had been used successfully or unsuccessfully from the 1930's until the 1970's when commercially manufactured dewormers first came on the market. Some of the "old-time" remedies included garlic, lead arsenate, tetrachlorethylene, phenothiazine, and a cunic mixture (copper sulfate and nicotine sulfate). For example, results of a 16-year study with copper sulfate ($CuSO_4$), reported in 1932, showed $CuSO_4$ was 97% effective in controlling stomach worms.

Table 1. FAMACHA, PCV, and FEC of Drenched and Nondrenched Hampshire Ewes at Weaning and 11 Days Later

	Treatment[a]		
	D	ND	Difference[e]
Number ewes	29	30	
FAMACHA[b]			
Day 0	3.6	2.9	+0.7
Day 11	3.2	2.8	+0.4
Change	-0.4 (-11)[d]	-0.1 (-3)[d]	
PCV, % red blood cells			
Day 0	26.3	30.2	-3.9
Day 11	31.0	33.0	-2.0
Change	+4.7 (+18)[d]	+2.8 (+9)[d]	
FEC[c]			
Day 0	10,308	3,414	+6,894
Day 11	2,401	2,209	-168
Change	-8,267 (-80)[d]	-1,205 (-35)[d]	

[a] D = drenched; ND = no drench.
[b] 1 = bright red; 5 = white.
[c] Eggs/gram feces.
[d] Percent change, day 0 to 11.
[e] D vs. ND.

When nicotine sulfate and $CuSO_4$ were combined, both stomach and tape worms were controlled. The test conducted in 2007 at Georgia (described above) concluded the predominant worm species in the University of Kentucky Hampshire flock was H. contortus 96% of the time and this was the worm that was resistant to the commercial drenches. This indicated nicotine sulfate was unnecessary because its use is primarily for tapeworms. Therefore, UK elected to try $CuSO_4$ as a drench to control the stomach worm infestation in the Hampshire flock.

WEANING: MARCH, 2007

Lambs were weaned and ewes were placed in a drylot without feed or water for 24 hours. All ewes were fed 1.0 lb/hd of grass hay at 8 am before separating into drenched (D) and nondrenched (ND) groups. FAMACHA and PCV, along with an arbitrary FEC number, were used to distinguish between ewes that needed to be drenched and those that did not need drenching. This number was 6,000 eggs/gram feces and was adopted because previous samplings had shown that sheep with more than 6,000 eggs/gram had high FAMACHA (3, 4, 5) and low PCV (less than 20%). Twenty-nine ewes had FEC greater than 6,000 eggs/gram feces (av.=10,308) and remained in drylot without feed for the rest of the day. The 30 ewes with FEC less than 6,000 eggs/gram feces (av. = 3,414) were turned to pasture (ND). On the following day, D ewes were drenched with a 1% $CuSO_4$ solution, prepared and administered according to the guidelines published in 1955. The ewes were drenched at 8 am, fasted for 6 more hours, and then fed 1.0 lb/hd of grass hay at 2 pm. They remained in drylot until the next morning when they were offered another 1.0 lb/hd of grass hay before joining the ND ewes on pasture. Both groups remained in the same pasture for 10 more days, when they were re-evaluated by FAMACHA, PCV, and FEC.

Average FAMACHA, PCV, and FEC values of D and ND ewes on day 0 (day of drenching 29 ewes) and 11 days later are shown in **Table 1**. The D ewes had significantly higher FAMACHA (more anemic) than ND on day 0 (3.6 vs 2.9), but the values for the two groups became closer by day 11 (3.2 vs 2.8).

The average PCV for D ewes was significantly less (more anemic) than ND on day 0. Although PCV of both ewe groups increased to day 11, the 18% vs. 9% increase indicates that drenching with $CuSO_4$ may have killed some worms and, thus, decreased some anemia in the D ewes. Similarly, FEC of D ewes was significantly higher than ND on Day 0 (+6,894), but by 11 days after drenching, values were almost identical (2,401 vs. 2,209). Based on these results, it is concluded that drenching with $CuSO_4$ can be a method to reduce stomach worm populations to "manageable" levels so production is not adversely affected.

Table 2. FAMACHA, PCV, and FEC of Hampshire Ewes Before Flushing/Breeding on July 30, 2007 (Day 0) and 13 Days Later

	Treatment[a]	
	D	ND
Number ewes	4	78
FAMACHA[b]		
Day 0	2.75	2.94
Day 13	2.00	2.60
PCV, % red blood cells		
Day 0	21.8	30.3
Day 13	27.4	29.8
FEC[c]		
Day 0	5,013	871
Day 13	3,013	2,671

[a] D = drenched; ND = no drench.
[b] 1 = bright red; 5 = white.
[c] Eggs/gram feces.

POST-WEANING: 2007

All 59 ewes were evaluated for productivity after the $CuSO_4$ study just described. Some were culled because of poor lamb production, age, udder problems, disposition, or maintenance of poor body condition. The latter may have been a result of a continual heavy internal parasite infestation. Concurrently, virgin yearling ewes were added as replacements. There was no evaluation or drenching from April 12 to July 30, 2007. Eighty-two ewes were evaluated for FAMACHA, PCV, and FEC on this date (before flushing/breeding). Four ewes were identified to drench with $CuSO_4$ based on the data shown in **Table 2**. An arbitrary decision to drench or not to drench was made on the combination of FAMACHA, PCV, and FEC. Although FAMACHA scores were similar between D and ND on day 0, D ewes had lower PCV and higher FEC. FAMACHA decreased, PCV increased, and FEC decreased in D ewes from day 0 to 13. FAMACHA decreased only slightly, PCV remained basically the same, and FEC increased in ND ewes during the same 13 days.

LAMBING: 2008

All 71 ewes that lambed in January/February, 2008 were drenched with $CuSO_4$ (1% solution : 100 cc/ewe) and fecal sampled as they left the lambing jugs. The average FEC was 2,189 eggs/gram feces. All ewes were re-sampled 12 days later. The average FEC had decreased to 1,170 eggs/gram.

WEANING: 2008

Sixty-nine of the 71 ewes that left the lambing jugs weaned lambs at an average of 59 days of age. Changes in FAMACHA, PCV, and FEC of these ewes are shown in **Table 3**. The decision to drench was based on the FEC taken on day 0 (D = greater than 6,000 eggs/gram feces; ND = less than 6,000 eggs/gram feces). Initial FAMACHA was higher for D ewes (2.73)

Table 3. FAMACHA, PCV, and FEC of Drenched and Nondrenched Ewes at Weaning, 2008 (Day 0) and 12 Days Later

	Treatment[a]	
	D	ND
Number ewes	22	47
FAMACHA[b]		
Day 0	2.73	1.85
Day 12	2.86	2.64
Change	+0.13 (+5)[d]	+0.79 (+43)[d]
PCV, % red blood cells		
Day 0	25.7	29.8
Day 12	26.0	30.2
Change	+0.3 (+1)[d]	+0.4 (+1)[d]
FEC[c]		
Day 0	9,477	2,720
Day 12	2,414	1,834
Change	-7,063 (-75)[d]	-886 (-33)[d]

[a] D = drenched; ND = no drench.
[b] 1 = bright red; 5 = white.
[c] Eggs/gram feces.
[d] Percent change, Day 0 to 12.

than ND (1.85) indicating that D ewes had a higher worm population than the 47 of the ND group.

FAMACHA increased only 0.13 in D ewes, but increased 0.79 in the ND ewes. The PCV of D ewes was lower than ND on both day 0 and day 12. The change in PCV from day 0 to day 12 was not significant in either D or ND groups. However, FEC of D ewes was higher than ND on day 0 because ewes were divided into D and ND groups on this day (>6,000 vs < 6,000 eggs/gram). By day 12, the average FEC of D and ND were similar (2,414 vs. 1,834 eggs/gram). The dramatic decrease found in D ewes points to the fact that $CuSO_4$ drench decreased the size of a stomach worm population.

PRE-LAMBING: 2009

Twelve ewes of 71 were drenched with $CuSO_4$ after assessment of FAMACHA, PCV, and FEC on November 11, 2008, as all ewes prepared to enter the last 4 to 6 weeks of gestation. The 12 ewes deemed to be drenched had initial FAMACHA, PCV, and FEC of 2.7, 28.0%, and 9,079 eggs/gram feces. Concurrent initial data for 59 ND ewes were 1.6, 31.5%, and 2,074 eggs/gram. When ewes were re-sampled 13 days later, the FAMACHA scores of the D and ND groups were the same as previously determined (2.7 and 1.6). Only the 12 ewes previously drenched were re-sampled for PCV and FEC on day 13. The PCV increased from 28.0 to 30.1% and FEC decreased from 9,079 to 4,489 eggs/gram feces.

LAMBING: 2009

All ewes received $CuSO_4$, were evaluated for FAMACHA and a fecal sample was taken for FEC as they exited the lambing jugs 2 to 5 days post-lambing (day 0). FAMACHA and FEC on day 0 and 12 days post-drenching are shown below.

	FAMACHA	FEC
Day 0	1.8	1,537
Day 12	1.6	521

None of the ewes had FAMACHA greater than 3.0 or FEC exceeding 6,000 eggs/gram feces on day 12.

WEANING: 2009

Sixty-eight of the 71 ewes that lambed were evaluated when lambs were weaned on March 13, 2009. Only one ewe required drenching. Although the FAMACHA was 2.0, her PCV was 25.5% and FEC was 9,000 eggs. Averages, on March 13, for the other 67 ewes were 1.7, 29.7%, and 856 eggs/gram feces. None of these ewes had an FEC greater than 6,000. The ewe de-wormed at weaning still had more than 6,000 eggs on March 25. Evidently, the $CuSO_4$ drench was ineffective in decreasing this isolated case of heavy stomach worm infestation. This ewe was drenched again on March 25, but was not re-sampled. Instead, she was culled from the flock because of continual poor body condition and excessive FEC. Culling this ewe follows the recommended practices for sheep flocks managed within the FAMACHA system for internal parasite control. It is a widely accepted fact that ewes like this carry 70 to 80% of the eggs within a flock and, therefore, are contaminators of ewes with lower levels of stomach worm infestations.

WEANING: 2009 TO LAMBING 2013

All ewes were drenched with $CuSO_4$ as they left the lambing jugs each time they lambed, regardless of the FAMACHA, PCV, and/or FEC evaluations. Drenching at this time helps reduce some of the periparturient rise in stomach worm populations shortly after ewes lamb. Ewes were monitored for invasions, by FAMACHA, PCV, and/or FEC, before flushing/breeding (August), before the late gestation period (November), and at the end of lactation (March/April) each year from 2009 to 2013. Other evaluations (FAMACHA, PCV, FEC) were made periodically depending on the general condition/appearance of the flock. There were occasions when individual ewes or the entire flock required drenching. The only drench used was $CuSO_4$. Generally, ewes that showed continued evidence of heavy worm infestation during a production year were the poorest producers in the flock. These ewes were culled before the next production year, first because of worms, and secondly, because of poor production.

CONCLUSION:

The 64-ewe flock that produced 110 lambs in January/February, 2013, evolved through a management system that strategically used only $CuSO_4$, as a drench, to keep stomach worms at "manageable" levels since 2007. Ewes contracted worms during the 6-year period, some more than others. Ewes were culled because of continual heavy infestations and/or poor production. Others left the flock for reasons that typical producers encounter. Replacements were added as ewes left in order to maintain a relatively constant flock size (60 to 70 head). The $CuSO_4$ drench guidelines developed during this 6-year period are shown below.

COPPER SULFATE DRENCH GUIDELINES:

- Add 1 ounce copper sulfate (Feed Grade) to 3 quarts warm water in a plastic or glass container.
- Mix until completely dissolved.

Dosage:

40 to 60 lb lamb	28 to 42 ml (cc)
60 to 80 lb lamb	42 to 56 ml (cc)
80 to 100 lb lamb	56 to 85 ml (cc)
Adult sheep	85 to 115 ml (cc)

For best results:

1. Fast for 12 to 18 hrs before drenching (no feed or water)
2. Keep off feed and water for 3 hrs after drenching
3. Provide water and 1.0 lb grass hay/head
4. Return to normal management

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