

# Genetically Speaking...

## Is the FAMACHA® System Accurate for All Breeds of Sheep?

by Dr. Debra K. Aaron

In this issue of HoofPrint, we'll step away from "genetically speaking" per se and take a look at results of a study conducted at the University of Kentucky that evaluated accuracy of the FAMACHA® system for categorizing Hampshire, Polypay and White Dorper ewes on the basis of severity of *Haemonchus contortus* induced anemia.

### A Little Background

**H***aemonchus contortus* (commonly referred to as the barber pole worm, stomach worm or wire worm), is the most pathogenic internal parasite of small ruminants. This blood-sucking parasite is capable of consuming up to one-tenth of an infected animal's total blood volume in a single day. Thus, heavy *H. contortus* infestation can result in severe anemia and, in some cases, edema or "bottle jaw," which is an accumulation of fluid or swelling under the lower jaw resulting from blood protein loss. Both conditions are evident in the ewe photographed in **Figure 1**. This ewe, extremely anemic with "bottle jaw," needs immediate treatment (drenching) with an anthelmintic (dewormer). There is no time to waste; death may result when parasitism is this severe. In the past, when one animal needed treatment, a producer might have treated the whole flock. This was expensive and, on many farms, led to development of resistance of parasites to the dewormers. Producers are now encouraged to treat animals, like the ewe in **Figure 1**, on an individual basis (selective deworming) to reduce costs and, most importantly, prolong efficacy of commercially-available dewormers.

The FAMACHA® system is designed with this in mind. It uses clinical anemia as the determining factor for detection of *H. contortus* infection in sheep and goats. Anemic animals are identified by the color of the ocular conjunctiva (mucus membranes of the lower eyelid). A bright red or pink color indicates the animal has few or no worms or that it has the capacity to tolerate the parasites. No treatment (drenching) is necessary. An almost white eyelid color is a warning sign of very bad anemia; the worms present in the abomasum (true stomach) are in such numbers that they are draining the



Figure 1. Ewe exhibiting anemia and edema or "bottle jaw."

animal of its blood. If left untreated, such an animal will likely die.

A scale of bright red, red-pink, pink, pink-white and white corresponds to FAMACHA® eyelid scores of 1, 2, 3, 4 and 5, respectively (**Figure 2**). As indicated above, treatment (drenching) is based on the eyelid score. Animals with eyelid scores of 1 and 2 are not considered anemic whereas 3 is questionable or borderline, and animals with eyelid scores of 4 and 5 are considered anemic and should be drenched.

Anemia can also be detected through measurement of packed cell volume (PCV). A PCV is a measure of the percentage of blood made up of red cells; it is also called a blood hematocrit. The larger the percentage, the less anemic the animal. Measured PCV should be negatively or inversely correlated with FAMACHA® scores; the lower the FAMACHA® score, the higher the PCV and vice versa. For example, an animal with a eyelid score of 1 would be expected to have a PCV of 28 or higher while an animal with a eyelid score of 5 would be expected to have






Category	Expected PCV
1  OPTIMAL - NO DOSE	≥ 28
2  ACCEPTABLE - NO DOSE	23 - 27
3  BORDERLINE - DOSE?	18 - 22
4  DANGEROUS - DOSE!	13 - 17
5  FATAL - DOSE!!	≤ 12

Figure 2. FAMACHA® color chart.

a PCV of 12 or less (**Figure 2**). Although accurate, measuring PCV requires blood be drawn from the animal, which increases time and labor. It also requires microhematocrit tubes, a centrifuge and a microhematocrit reader, equipment most producers aren't

likely to have. On the other hand, the FAMACHA® system is designed to be a tool for on-farm detection of anemia caused by *H. contortus* infection. Each eyelid score is expected to correspond to a range of PCV as shown in **Figure 2**. So to estimate PCV and detect anemia, a producer needs only



Figure 3. Using the FAMACHA® card to assign an eyelid score.

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the FAMACHA® card (**Figure 3**) and the training provided when he or she is certified. Also, less labor is required.

The FAMACHA® system is generally a good indicator of clinical anemia due to *H. contortus* infection. But, there are circumstances that can affect its accuracy of detection. Put another way, there are factors that can weaken the association or correlation between PCV and eyelid scores. Certainly, the amount and type of light in which animals are examined, agitation or overhandling of animals, training and skill of the handler (scorer) and even length of time the animal's eyes are held open are all factors that can affect eyelid scores.

Of particular interest in this study was whether breed-specific differences (for example, color of the mucosa or face color) might affect use of this system across breeds. Thus, our objective was to evaluate accuracy of the FAMACHA® system for categorizing Hampshire, Polypay and White Dorper ewes on the basis of severity of anemia as measured by PCV.

### Eyelid Scores based on the FAMACHA® System




Breed	1	2	3	4	5	Total
 H	22	125	210	53	4	414
 PP	76	155	97	48	9	385
 WD	184	301	164	49	10	708
<b>Total</b>	<b>282</b>	<b>581</b>	<b>471</b>	<b>150</b>	<b>23</b>	<b>1507</b>

Table 1. Distribution of eyelid scores by breed (H = Hampshire, PP = Polypay, WD = White Dorper).

### The Study

Over a four-year period, records were collected on 414 Hampshire (H), 385 Polypay (PP) and 708 White Dorper (WD) ewes. Eyelid scores, based on color of the ocular conjunctiva (1 = red, healthy to 5 = white, anemic) were assigned by the same trained technician using the FAMACHA® card (**Figure 3**). All scoring was done in the same handling facility at the University of Kentucky Sheep Unit under similar conditions. Blood samples were collected via jugular vein and PCV (%) were determined using a digital microhematocrit reader. Data were statistically analyzed to 1) compare breeds with respect to distribution of PCV and eyelid scores, 2) determine strength of association between PCV and eyelid scores, and 3) assess value of eyelid scores for predicting *H. contortus* infection.

### Distribution of Eyelid Scores by Breed

**Table 1** shows the distribution of eyelid scores by breed. Among the 414 H ewes, 35% were considered healthy (eyelid scores of 1 or 2), 51% borderline (score of 3) and only 14% were considered anemic (eyelid scores of 4 or 5) and in definite need of drenching. Among the 1,093 white faced (PP and WD) ewes, 65% were deemed healthy, 24% borderline and only 11% were considered anemic. The biggest difference between the black and white faced ewes was in the percentage of ewes categorized as either healthy or borderline (35% versus 65% healthy and 51% versus 24% borderline for black versus white faced ewes, respectively). This may be a reflection

of differences in color of the mucosa or face color as opposed to differences in degree of anemia. The percentage of ewes requiring immediate treatment (eyelid scores of 4 or 5) was similar for black and white faced ewes. Thus, the FAMACHA® system was sensitive enough to detect the most anemic animals regardless of breed.

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Average eyelid scores and PCV are shown in **Table 2**. Eyelid scores were highest for H ewes and lowest for WD ewes, meaning the H were healthiest and the WD most anemic as determined by the FAMACHA® system. The PP fell in between. Although we expected the PCV to reflect the same ranking with respect to severity of anemia, they did not. Based on average PCV measurements, WD ewes were as healthy as H ewes and PP ewes were slightly more anemic than either H or WD. Remember, the higher the PCV, the less anemic the animal. Either our eyelid scores did not reflect differences in color of the ocular conjunctiva or the association between eyelid scores and PCV was not the same across breeds.




Breed	n	Eyelid Score	PCV
 H	414	2.7	29.4
 PP	385	2.4	28.6
 WD	708	2.2	30.1

Table 2. Eyelid score and PCV means by breed (H = Hampshire, PP = Polypay, WD = White Dorper).

### Association between PCV and Eyelid Scores

Further statistical analyses confirmed that the correlation (association) between eyelid score and PCV was weakest for H (-0.39) and strongest for the PP (-0.67) and WD (-0.61). In other words, high eyelid scores tended to be less closely associated with low PCV, and vice versa, among the black faced ewes and more closely associated among the white faced ewes.

### Predictive Value of the FAMACHA® System

To assess value of the FAMACHA® system for predicting anemia due to *H. contortus* infection, a comparison of measured versus expected PCV was made among “healthy,” “borderline” and “anemic” ewes. “Healthy” ewes had eyelid scores less than or equal to 2 (**Table 3**), “borderline” ewes had eyelid scores of 3 (**Table 4**), and “anemic” ewes had eyelid scores greater than or equal to 4 (**Table**

5). As noted previously, the PCV expected for each eyelid score (1, healthy through 5, anemic) as determined by the FAMACHA® system is shown in **Figure 2**.

Predictive value of the FAMACHA® system was high for healthy ewes (**Table 3**); in other words, healthy ewes were accurately categorized by eyelid scores of 1 or 2. Across breeds, 98% of the ewes with eyelid scores of 1 or 2 had measured PCV greater than or






		Expected PCV: $\geq 23$	
		< 23	$\geq 23$
	 H	3%	97%
	 PP	2%	98%
	 WD	2%	98%
	<b>Overall</b>	2%	98%

Table 3. Comparison of actual and expected PCV for healthy ewes (H = Hampshire, PP = Polypay, WD = White Dorper).





		Expected PCV: 18-22		
		< 18	18-22	> 22
	 H	1%	5%	94%
	 PP	3%	7%	90%
	 WD	1%	11%	88%
	<b>Overall</b>	1%	7%	92%

Table 4. Comparison of actual and expected PCV for borderline ewes (H = Hampshire, PP = Polypay, WD = White Dorper).



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		Expected PCV: $\leq 17$	
		$\leq 17$	$> 17$
			
Breed		$\leq 17$	$> 17$
	<b>H</b>	0%	100%
	<b>PP</b>	19%	81%
	<b>WD</b>	24%	76%
<b>Overall</b>		<b>14%</b>	<b>86%</b>

Table 5. Comparison of actual and expected PCV for anemic ewes (H = Hampshire, PP = Polypay, WD = White Dorper).

equal to the expected lower limit of 23. Among ewes categorized as borderline (Table 4), 92% actually had PCV measurements higher than expected (greater than 22), meaning that the FAMACHA® system was overly sensitive. Ewes predicted to be borderline were actually healthy and should not be drenched. Among ewes categorized as anemic (Table 5), the FAMACHA® system was again overly sensitive. Overall, 86% of ewes categorized as anemic were actually borderline or healthier. According to measured PCV, none of the H ewes should have been classified as anemic (100% had PCV greater than 17). In contrast, 19% of PP and 24% of WD ewes had measured PCV below the threshold of 17. These animals were detected as anemic and appropriately drenched. The predictive value of the FAMACHA® system was good; anemic animals were properly categorized. At the same time, however, non-anemic ewes were drenched unnecessarily.

### The Take Home Message

The FAMACHA® system is a useful tool for identifying *Haemonchus contortus* induced anemia in sheep. However, if ewes with eyelid scores of 3, 4 and 5 are considered anemic, some non-anemic ewes may be unnecessarily treated for parasite infection. Also, the association between eyelid score and PCV may be influenced by breed-specific color of the mucosa or face color.

**NOTE:** The FAMACHA® color charts and cards used throughout this article were photographed by the author. Charts and cards are owned and copyrighted by the Livestock Health and Production Group of the South African Veterinary Association.

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