Assessment of a hands-on method for FAMACHA© system training

Authors: Dhéri Maia[1], Fernanda Rosalinski-Moraes[2], Jan Aucamp van Wyk [3], Saulo Weber[4], Cristina Santos Sotomaior[1]

[1] Graduate Program in Animal Science, School of Agricultural Sciences and Veterinary Medicine - Pontifícia Universidade Católica do Paraná (PUCPR), São José dos Pinhais, Paraná, 83010-500, Brazil

[2] Faculdade de Medicina Veterinária, Universidade Federal de Uberlândia, Uberlândia, Minas Gerais, Ceara St, n/n, Block2T, Office 104, 38405-315, Brazil

[3] Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, P/Bag X04, 0110 Onderstepoort, South Africa

[4] School of Agricultural Sciences and Veterinary Medicine - Pontifícia Universidade Católica do Paraná (PUCPR), São José dos Pinhais, Paraná, 83010-500, Brazil

corresponding author:

C.S.Sotomaior

Graduate Program in Animal Science

School of Agricultural Sciences and Veterinary Medicine

Pontifícia Universidade Católica do Paraná – PUCPR

Rodovia BR 376 – Km 14

São José dos Pinhais, Paraná, 83010-500, Brazil

Email:cristina.sotomaior@pucpr.br

Phone: 55 – 41 3299 4437 Fax: 55 – 41 32994363

ABSTRACT

The FAMACHA© system is a method for selective anthelmintic treatment comprising early detection of haemonchosis in sheep and goats. In order to evaluate the hands-on training methodology and the learning level of the participants, we analyzed data from 30 training events involving 47 training classes conducted in the State of Paraná, Brazil, from July/2009 to May/2011, during which period a total of 1004 participants did 20,080 FAMACHA© classifications. In the practical training sessions, each participant individually evaluated 20 animals with known haematocrit values. Every participant per training event was given a unique number, whereupon each of the animals in a given event was FAMACHA© classified by all the trainees involved, in the same trainee number sequence. After each consecutive animal had been evaluated by every one of the participants, its haematocrit and corresponding FAMACHA© category were announced before the next animal was presented. The number of persons in training, which ranged from 5 to 39 per session, did not significantly affect the average error of the groups of participants involved ($p > 0.05$). The average error in the classification of the first animal on a scale with a perfect score of zero was 2.5, significantly greater than the error of 0.56 of the twentieth one ($p < 0.05$), indicating an inverse relationship between the error and the cumulative number of animals already evaluated by each trainee involved, with the reduction in mean error per animal in a given training event found by linear regression to be 0.0713. When the same animal was assessed twice in the same training event, the average error of the second evaluation (1.05) was significantly lower than the 1.70 of the first ($p < 0.05$). While the total of 686 sheep used in the training events (73%) was considerably larger than the corresponding number of 254 goats (27%), the average statistical errors, respectively 1.34 and 1.23, were not significantly different ($p > 0.05$). Similarly, the average errors in

FAMACHA© classification were not significantly influenced by the occupation or gender of the participants, nor whether there were animals in all five FAMACHA© categories or only in categories 1, 2, 3 and 4 per training event ($p > 0.05$).

Keywords: FAMACHA©; training; sheep; goats; *Haemonchus*; worm control

INTRODUCTION

Gastrointestinal parasites are a limiting factor for the production of small ruminants in various regions of the world, with the haematophagous nematode *Haemonchus contortus* standing out as a parasite of major significance due to its high prevalence, pathogenicity (O´Connor et al., 2006; Molento et al., 2011) and present apparently global expansion in range (Ehrhardt, 2013; Meling Domke et al., 2013).

The indiscriminate use of anthelmintics as practically the only method of control of gastrointestinal parasites resulted in an extremely serious problem of anthelmintic resistance (AR) in parasite populations (Van Wyk et al., 1997; Thomaz-Soccol et al., 2004; Papadopoulos, 2008; Kaplan and Vidyashankar, 2012). The development of AR is a great challenge for the production and the well-being of small ruminants on pasture. However, by using a targeted selective treatment (TST) system to ensure that with each anthelmintic treatment, a large proportion of the parasites in the system are not exposed to the drug(s) used and are subsequently able to infect susceptible hosts and produce viable offspring (i.e. are in refugia - Van Wyk, 2001; Leathwick et al. 2006, 2008; Torres-Acosta and Hoste, 2008), selection for AR is considerably reduced through preservation of the genes of susceptible parasites.

The FAMACHA© system was developed by South African researchers who aimed to facilitate the clinical identification of sheep infected with *Haemonchus contortus* by comparing the colour of the ocular conjunctival mucosae with a colour card depicting five colour categories, ranging from 1 (F1) (bright red colour) through 2 (F2), 3 (F3) and 4 (F4), to 5 (F5) (practically white), respectively corresponding to haematocrit (Ht) categories from ≥ 28, 23-27, 18-22, 13-17 and ≤ 12%. In this system of classification only animals judged to be in categories 3-5 are routinely treated (Van Wyk and Bath, 2002), while the rest are left untreated and continue to pass unselected parasites, thus promoting availability of unselected worm stages in refugia (Van Wyk, 2001).

The FAMACHA© system, in use in a variety of countries, has numerous advantages, such as on-farm application by farmers without the need for routine laboratory intervention; high flexibility for use in virtually any production system; reduced deworming costs; and decreased selection pressure for resistance of parasites to anthelmintics through early detection of the anaemia of haemonchosis and treatment of only the animals judged to be unable to manage unaided (Bath et al., 2001; Malan et al., 2001; Van Wyk and Bath, 2002; Kaplan et al., 2004; Molento et al., 2004; 2009; Mahieu et al., 2007; Burke et al., 2007; Di Loria et al., 2009; Scheuerle et al., 2010; Sotomaior et al., 2012; Kaplan and Vidyashankar, 2012; Rosalinski-Moraes et al. 2012; Besier, 2012).

The present study reports on the results of two years of training of persons from a variety of different walks of life in the principles of integrated worm management and effective application of TST through use of the FAMACHA© system. An important part of the initiative was evaluation of the extent to which the trainees involved were successful at correctly classifying the conjunctivae into the relevant FAMACHA© categories during hands-on training.

MATERIALS AND METHODS

The present study involved FAMACHA© system training events (TEv) conducted between July 2009 and May 2011 in various municipalities of the state of Paraná in Brazil. Each TEv was conducted over two days and consisted of a theoretical and a practical session, respectively of eight and two hours' duration. While the theoretical session on the first day comprised basic information on parasites, parasite resistance, and the position of the FAMACHA© system in integrated parasite management, in the practical session on the second day participants were trained and tested in the correct use of the FAMACHA© system through hands-on animal evaluation. To participate in the training, the person was required to provide personal information, amongst others on professional activity, categorised into higher level technician (i.e. either veterinarian, agronomist or animal scientist); agricultural technician; student; sheep or goat breeder; breeder of other species; and farmers.

Individual TEv's in each city were organised with the participation of either the city council concerned, or various development agencies, which were responsible for inviting the participants for the different training events in each city.

2.1 Practical training methodology

The practical training was conducted according to the methodology described by Bath et al. (2001), by using 20 sheep and/or goats, selected previously by a veterinarian trained and experienced in the use of the system. For each TEv, the animals with the widest range of conjunctival colours in the available animals were selected by clinical evaluation, using the FAMACHA© system (Van Wyk and Bath, 2002). Thereafter, on the day before the training session, blood was collected by venepuncture from the external jugular vein of

each animal, in Vacutainer® tubes containing EDTA anticoagulant. On the day of blood collection, microhaematocrit determination was done by the routine method of Jain (1986).

At the beginning of each practical training occasion each trainee was given a form on which his or her name and profession were recorded in preparation for the test, and provision was made for entering the following information per test animal: estimated FAMACHA© score, correct FAMACHA© score, Ht percentage and other observations. Thereupon the participants were shown how to properly expose the mucosa of the animal according to Bath et al. (2001), by gently sliding the upper eyelid downwards to cover the eyeball and the membrana nictitans, while exposing the lower conjunctiva by similar downward sliding pressure on the sub-ocular skin of the animal. In this way the trainees were shown the difference between normal (red) and anaemic (pale) mucosae, as illustrated on the FAMACHA© card.

For testing the ability of the trainees to apply the clinical FAMACHA© evaluation correctly, they were arranged in single file and each was given a number in relation to his/her position in the row, which number sequence was then maintained for evaluation of every animal. During the test, one animal at a time was placed in turn on its side on a table or other horizontal surface, with its head on the lap of an instructor who was responsible for exposing the lower conjunctiva of one eye while it was evaluated by every trainee in turn. In other words, the conjunctiva of a given animal was exposed to air for the duration of evaluation by all the trainees involved per training session, excepting that the grip on the lower eyelid tended to slip from time to time, with the result that the mucous membrane was not open continuously for the entire time, but closed for short spells over the period. While a second instructor continuously moved a FAMACHA© card back and forth with the colour bars in juxtaposition with the exposed conjunctiva, the different trainees in turn

classified the conjunctival colour of each successive animal into what he or she regarded as the relevant FAMACHA© colour category. At the conclusion of the evaluation of each animal by all participants, its haematocrit value and corresponding FAMACHA© score were announced and discussion thereof allowed.

When the testing had come to an end, every trainee received a translation of the original FAMACHA© brochure containing information about the system (Bath et al., 2001), a FAMACHA© chart and a certificate of participation.

2.2 Analysis of training

The criteria used to assess the success attained per trainee at FAMACHA© classification during the practical training comprised analysis of individual animal classification in relation to the correct FAMACHA© value (Van Wyk et al., 2001). This was achieved by converting each answer into a numerical value by counting the number of haematocrit points between the border of the category selected by the trainee and the actual corresponding haematocrit value determined for the animal concerned, as described by Van Wyk et al. (2001). The test score was allocated from the above, according to two tables (JvW, personal observations, 2000, Appendix 1 and 2), one for penalised and the other for non-penalised scoring of the participant's error according to the animal's haematocrit value, with zero being a perfect score. While the unpenalised score comprises the count as described above, in the case of the other, the score is progressively penalised in relation to the extent to which the error may have endangered the life of the sheep or goat due to non-treatment of potentially life-threatening anaemia. Thus, for this second method of evaluation it was considered a more serious error when an evaluator underestimated the

extent of anaemia of a given animal by assigning a smaller (i.e. less anaemic) FAMACHA© score than reality.

From the results two means were calculated, of which one was the mean error per participant for the animals per TEv, and the other was the mean of the scores of the participants involved per animal. From the mean errors obtained by converting the participants' evaluations into numerical values, with and without penalty, the influence on the mean error value was assessed for the following parameters: (i) number of participants per TEv, (ii) order of the trainee in the assessment line, (iii) use of the same animal at different times in the same TEv, (iv) animal species (sheep or goat), (v) trainee professional activity and gender, and (vi) whether all five FAMACHA© categories, from high normal (intensively red), to dangerously anaemic, were represented in the animals used per session, or only categories F1, F2, F3 and F4.

The data from all the TEv's were tabulated in Microsoft Excel spreadsheets, and Statigraphics Plus 4.1. software was used for the statistical analyses, at a 5% level of significance. All parameters were tested for variance homogeneity by Bartlett's test, which was followed by an analysis of variance (ANOVA) and Tukey's test. When there was no homogeneity, the values were transformed to log or log (n +1). For the null (H0) hypothesis, it was assumed that the parameters would not influence the mean error.

To assess the influence of the number of participants per TEv on the mean total number of errors, the participants were divided as follows according to the number of trainees per class to form up to four groups, depending on the numbers involved per session: zero to nine participants, 10 to 19, 20 to 29 and 30 to 40. When evaluating the effect of trainee profession as indicated on the registration form, different classes were established as follows: A (sheep and goat breeder); B (higher degree in agricultural

sciences); C (agricultural technician and students); D (breeder of other species and farmers); and E (no information listed).

A linear regression analysis between the mean error for each animal and the number of animals was used to assess the ratio of the mean error per animal as a function of the number of animals used for training.

Training events with fewer than 20 animals and all the evaluations from participants who failed to complete three or more assessments were excluded from the analysis. For all participants who reported more than one FAMACHA© score for the same animal, the most anaemic score was used. Answers comprising a non-existent or non-integer value for the FAMACHA© score were annulled, and when three or more responses of a given individual were annulled, all data concerned were excluded from analysis.

A descriptive analysis of the data relating to the total number of TEv's was also performed as follows: number of TEv's conducted, number of people trained, ratio of FAMACHA© scores in total and each TEv, ratio of sheep and goats used in total and in each TEv and the ratio of the professional activity in total TEv's.

RESULTS AND DISCUSSION

A total of 32 TEv's were conducted in 25 municipalities in the state of Paraná, totalling 1,375 participants in the theoretical and 1,126 in the practical training sessions. In 13 of the practical training events, the participants had to be divided into more than one class, giving a total of 52 classes trained. The number of persons per class ranged from five to 39 individuals, with an average of 21. For the statistical analyses, 30 practical training events and 47 classes were considered after application of the exclusion criteria listed

above, with totals of 1,004 participants and 20,080 assessments on 940 animals by the FAMACHA© system.

The error obtained with and without penalty on the individual assessment of an animal ranged respectively from 0-39 and 0-20. While some of the participants achieved a perfect mean error score of zero for both methods of evaluation, the maximum mean errors were 9.47 and 7.78, respectively with and without penalty, and the corresponding mean errors of the 1,004 participants were 1.42 and 1.31. As there was no statistically significant difference between the results of the evaluated parameters as regards penalized and non-penalized errors, it was decided to show only the data related to the former.

In the training sessions the mean percentages (with the total numbers of animals in all TEv's in brackets) that the FAMACHA© F5, F4, F3, F2 and F1 scores comprised in the test animals were respectively 1.5% (14), 9.5% (89), 14.1% (133), 27.3% (257), and 47.6% (447). The percentages of the 20 animals per TEv that were classified as F1 ranged from 25% (5 animals) to 70% (14), F2 ranged from 5% to 50%, F3 from 10% to 40%, F4 from 0% to 20% and in 34 of the 47 TEv's there were no animals representing the F5 category.

While, according to Van Wyk et al. (2001), it is important as far as possible to include all FAMACHA© categories in training, for the reason that the higher the range of FAMACHA© categories in the animals available for training, the higher the contrast between the shades of colour between non-anaemic and anaemic animals, in the absence of which trainees are inclined to expand the range of the relatively small variation they see to the entire FAMACHA© range of categories, F1 to F5. However, there was no significant difference ($p>0.05$) in the mean error between the TEv's with all categories of FAMACHA© (mean error 1.35) compared to those with animals in categories F1, F2, F3 and F4 only (mean error 1.4). This indicates that in every TEv there was sufficient variation

in the range of haematocrit values/FAMACHA© categories for comparison of anaemic and non-anaemic animals, without prejudice to the learning.

In contrast to the above, after a small number of training sessions, Van Wyk et al. (2001) reported a mean error of 2.6 when there was a mean of 27% of sheep in categories F4 and F5, compared to a mean of 4.8 with no sheep in these categories. Similarly, Burke et al. (2007) reported that the correct identification of anaemia becomes more difficult when there are disproportionate numbers of non-anaemic animals. In consequence, Bath et al. (2001) suggested that animals be bled to obtain anaemic animals for training. However, despite the low numbers of animals in category F5 in the TEv's presented here, for reason of animal welfare it was decided not to do so.

As described, per event the conjunctiva of each test animal was held open by an instructor during the course for evaluation by all trainees, excepting for short periods during which the grip on the lower eyelid slipped and the eyelids momentarily closed. In reaction to criticism from a variety of persons (Van Wyk, unpublished observations, 2000) that the red colour of the conjunctivae of a given sheep or goat would intensify by being exposed to air for relatively long periods while being evaluated and thus result in mounting inaccuracy in FAMACHA© evaluation during TEv testing as done in this study, it was decided to allocate a unique number per participant and to have every test animal in a given TEv evaluated in the same participant number sequence. However, when the means of the errors of the first (1.68) and the last participants (1.15) in the sequence of evaluation of each animal per TEv were compared, independent of the number of participants per class, the result was the opposite of that expounded by those who had reservations about the approach, in that the mean errors of the last evaluators in the queue were significantly lower than those of the ones higher up ($p = 0.002$). This result appears to be best explained by the

fact that the participants may progressively have been advantaged by communication and actions of other trainees during the evaluations; despite constant urging that they refrain from comments concerning their classifications until the haematocrit and FAMACHA© values had been given after all had completed their evaluations, there was still some speaking, or unintentional gestures that could have affected the classification by others coming after them. Therefore, it is important to reinforce during training that participants refrain from communicating during the evaluations. On the other hand, it is indeed also possible that the exposure of the conjunctiva could affect test results, although not necessarily negatively; even though this could not be evaluated due to the present testing approach, it seems possible that intensification of the red colour could have facilitated differentiation of the "redder" FAMACHA© categories 1 and 2 from the paler categories F4-F5 in the test animals.

An important question in FAMACHA© training is whether the size of class has an effect on the levels of accuracy in FAMACHA© classification obtained. Hence this was

Table 1. Comparison of the mean error of the participants, according to the number of students per class, from the 47 classes trained in the FAMACHA© system.

No. of participants	No. of classes	Mean error	Standard error
0-9	4	1.37 [a]	± 0.05
10-19	21	1.38 [a]	± 0.13
20-29	16	1.46 [a]	± 0.09
30-40	6	1.49 [a]	± 0.18

*Different letters in the same column denote significant differences by Tukey's test ($p<0.05$).

evaluated by grouping the numbers of trainees per event in increments of 10 from 0-40 for evaluation, with a remnant of 11 in the largest group (Table 1). However, while there was a slight, progressive increase in the mean errors from 1.37 for 0-9 participants, to 1.49 for 30-40 participants, the differences were not statistically significant ($p > 0.05$). This indicates that within the limits of the project the numbers of persons per training class made little, if any difference. On the other hand, in classes with more than 25 participants the resultant long waiting periods between the animal evaluations appeared to affect the attentiveness of the participants, and some animals did become more agitated with increasing holding period. Therefore, for the reason of logistics, it is recommended to work with classes of not larger than 25 to 30 participants.

Another question put to the test was whether the mean FAMACHA© classification error of the trainees became reduced in relation to the numbers of test animals evaluated as the given TEv's progressed, and the results are listed in Table 2 and illustrated in figure 1. The 2.50 mean error of the animals evaluated first in the various TEv's is significantly higher than the 0.56 of the twentieth animal ($p<0.005$) (Table 2). While there was also a statistically significant difference between the mean errors of the trainees' evaluation of the first animal and those of the seventh animal (respectively 2.50 and 1.49) and onwards to the twentieth, the mean error remained constant from the twelfth animal, with no further significant differences. This could suggest that, in cases of a shortage of suitable animals, 12 sheep/goats would suffice per TEv.

Table 2. The mean error of the participants in the total of 47 classes for training in the FAMACHA© system, in relation to the number of animals evaluated.

Order of animal assessment	Mean error	Standard error
1st	2.50 e	± 0.20
2nd	2.09 de	± 0.21
3rd	2.00 cde	± 0.21
4th	2.04 cde	± 0.22
5th	1.74 bcde	± 0.22
6th	1.73 bcde	± 0.20
7th	1.49 bcd	± 0.15
8th	1.47 bcd	± 0.16
9th	0.99 ab	± 0.11
10th	1.64 bcd	± 0.24
11th	1.23 bcd	± 0.13
12th	1.08 ab	± 0.13
13th	1.17 abc	± 0.15
14th	1.04 ab	± 0.15
15th	0.97 ab	± 0.13
16th	1.33 bcd	± 0.19
17th	1.04 ab	± 0.13
18th	1.11 ab	± 0.15
19th	1.18 ab	± 0.18
20th	0.56 a	± 0.08

*Different letters between values in the "Mean error" column denote significant differences by Tukey's test ($p<0.05$), with data transformed to log(n +1).

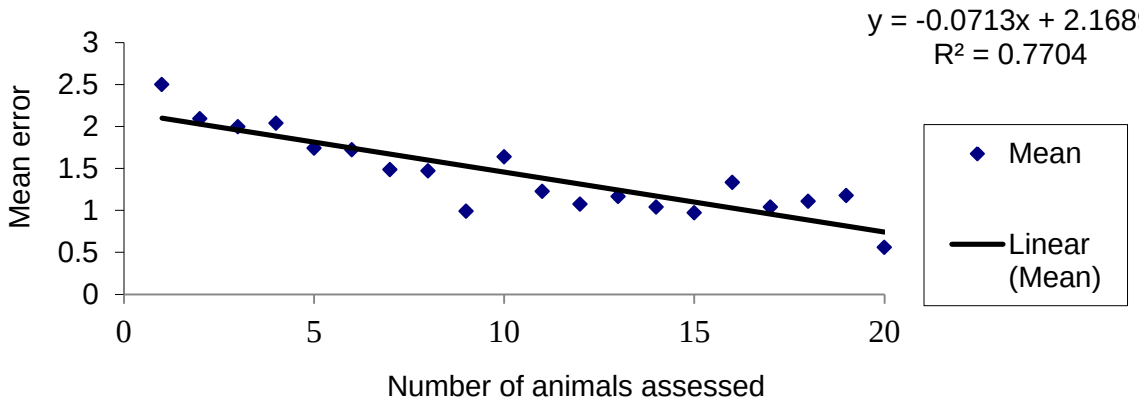

Figure 1. Trend in mean error, due to the growing numbers animals evaluated per training session (cumulative number of animals evaluated as each session advanced) among 1,004 participants in 47 training classes in the FAMACHA© system.

Figure 1 shows that there is a negative correlation between the error and the number of animals already evaluated. Additionally, the linear regression shown in figure 1, indicates that for each interaction between the participant and animal, there is a 0.0713 reduction in the error, with the mean trainee error of the first animal evaluated having been reduced by half by the time the sixteenth animal was evaluated. Hence the results indicate that the trainees gradually improved in the accuracy of classification of sheep and goats in the FAMACHA© system as the training sessions progressed, probably underpinned by the fact that the correct FAMACHA© classification and haematocrit values were announced for each animal immediately after evaluation by all participants.

With the exception of preliminary studies by Van Wyk et al. (2001) there have apparently been no similar studies previously with which to compare the present FAMACHA© results. Terrill et al. (2012) did report that more than 5000 farmers had been trained in the use of the FAMACHA© system by 2012 and that over 20,000 cards had been sold in hundreds of workshops all across the U.S., but despite the extent of this work, they

did not report on evaluation of the extent of learning during the TEv's they referred to. However, Bath et al. (2001) emphasised the importance of training and Vatta et al. (2001) reported better sensitivity for the system after the second, than the first year of their use of the system in South Africa.

When 83 animals were used twice, interspersed with the others, in 41 of the 47 TEv´s conducted, the mean error of 1.05 in the second evaluation of the same animal was significantly lower ($p<0.05$) than the mean error of 1.70 in the first. This, together with the learning curve during each training session, emphasises the importance of hands-on training for accuracy in the evaluation of the colour of the ocular conjunctival colour by the FAMACHA© system. In addition, up to a point as regards numbers of animals and colour and other points of identification of the individual animals involved, this may present a way out to ensure optimal training success where relatively few suitable animals are available for a given training event, especially since the trainees invariably expressed surprise when informed at the second evaluation of a given animal, that they had already classified it previously in the session. In other words, it is clear that the improvement was probably not due to memory of the first evaluation.

Of the total of 940 animals used in all the TEv's, 73% (686) were sheep, and 27% (254) goats, with 14 of 47 classes containing only sheep. In seven classes there were more goats than sheep, and the maximum number of goats used per training event was 14 (70%). The greater occurrence of numbers of sheep than of goats used in the training was occasioned by a preponderance of sheep in relation to goats in the state of Paraná, i.e. 640,000 head of sheep over against 185,000 goats according to data published by the Brazilian Institute of Geography and Statistics - IBGE (IBGE, 2011), as well as by availability of the species per property where the training was held.

The mean unpenalised errors of participants showed no statistically significant differences when comparing the use of sheep and goats for training ($p > 0.05$). While the 254 goats used in TEv presented an error of 1.23 (+/- 0.06), the 686 sheep used had an error of 1.34 (+/- 0.05). Although the use of the FAMACHA© system has been validated for use in goats by several authors, amongst others, Vatta et al. (2001), Molento et al. (2004), Burke et al. (2007), Scheuerle et al. (2010), Sotomaior et al. (2012), and Terrill et al. (2012), there are apparently no previous reports on the use of goats in FAMACHA© system training.

When grouped according to professional activity, 64% of the 1,004 trainees (643) were students or agricultural technicians; 22% (221) were sheep or goat breeders, 2% were breeders of other species, while the rest had higher level agricultural degrees (9%) or failed to list their professions (3%). With the exception of seven classes consisting only of students and/or agricultural technicians, the classes contained persons of all categories.

Table 3. Mean error of participants in the FAMACHA© system training according to trainee profession.

Professional activity	No. of participants	Mean	Standard error
A (sheep and goat breeder)	217	1.47 [a]	± 0.07
B (higher level technician)	63	1.50 [a]	± 0.11
C (student and agricultural technician)	666	1.38 [a]	± 0.03
D (breeder of other species or farmer)	17	1.46 [a]	± 0.17
E (no profession listed)	40	1.67 [a]	± 0.13

*Different letters in the same column denote a significant difference by Tukey's test ($p<0.05$), with data transformed to log

The mean errors of the participants ranged from 1.38 for the class of agricultural technicians and students to 1.50 for the class of higher level technicians, with no statistically significant differences between the two groups (Table 3). Bath et al. (2001) suggest that the FAMACHA© chart should be understood even by illiterate individuals. Experiments in the United States (Kaplan et al., 2004; Burke et al., 2007) showed acceptable levels of sensitivity and specificity of the system when used by farmers. These data confirm that almost anyone can be successfully trained to use the FAMACHA© system.

The mean errors of 1.38 and 1.47 obtained respectively by male and female evaluators did not differ significantly ($p>0.05$), and as in the case of the various professions, there is apparently no data in the literature assessing the sensitivity and specificity of the system in relation to gender.

While it has proved its worth, the FAMACHA© system has definite limits, including applicability to only haematophagic worm species, the need for training of prospective users thereof to forestall unrealistic expectations and a tendency of farmers to regard it as a panacea across the board for all gastrointestinal worm species (Van Wyk and Bath, 2002; Kaplan et al., 2004). Merkel and Gipson (2011), in a survey after on-line training in herd health practices, found that reasons for adoption of selective deworming by producers included a better understanding of how use of this method could slow selection for AR, while reducing costs by dosing fewer animals. Therefore, it is important that users of the FAMACHA© system understand the principles on which TST rests, as well as the risks involved in improper application thereof and the precautions that should be taken. It is also important, as showed here, a hands-on method for FAMACHA© system training, so trainees can progressively became more proficient at FAMACHA© evaluation.

CONCLUSIONS

The data analysis showed that the method of FAMACHA© hands-on training used in the present investigations was effective, to the extent that with few exceptions, the trainees showed similarly very high levels of efficiency in correctly classifying the colours of the conjunctivae of both sheep and goats into the corresponding FAMACHA© categories, thus showing that it is valid to use goats in the FAMACHA© training events. Of special import were that individuals with different educational backgrounds or genders were similarly successful in the training and that a progressive decrease in the mean errors of the trainees during the training sessions was obtained by announcing the correct FAMACHA© classification and haematocrit values after each animal had been evaluated by all participants. Lastly, the number of individuals trained in a class did not influence the error significantly, but for reasons of logistics it is recommended to work with classes of not larger than 25 to 30 participants.

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Appendix 1 – Non-penalised FAMACHA© score in training: table for converting FAMACHA© classifications into numbers, according to hematocrit

FAMACHA© classification / Hematocrit	1	2	3	4	5
10	18	13	8	3	0
11	17	12	7	2	0
12	16	11	6	1	0
13	15	10	5	0	1
14	14	9	4	0	2
15	13	8	3	0	3
16	12	7	2	0	4
17	11	6	1	0	5
18	10	5	0	1	6
19	9	4	0	2	7
20	8	3	0	3	8
21	7	2	0	4	9
22	5	1	0	5	10
23	5	0	1	6	11
24	4	0	2	7	12
25	3	0	3	8	13
26	2	0	4	9	14
27	1	0	5	10	15
28	0	1	6	11	16
29	0	2	7	12	17
30	0	3	8	13	18
31	0	4	9	14	19
32	0	5	10	15	20

Appendix 2 – Penalised FAMACHA© score in training: table for converting FAMACHA© classifications into numbers, according to hematocrit

FAMACHA© classification / Hematocrit	1	2	3	4	5
10	54	26	12	3	0
11	51	24	10,5	2	0
12	48	22	9	1	0
13	45	20	7,5	0	1
14	42	18	6	0	2
15	39	16	4,5	0	3
16	36	14	3	0	4
17	33	12	1,5	0	5
18	20	7,5	0	1	6
19	18	6	0	2	7
20	16	4,5	0	3	8
21	14	3	0	4	9
22	12	1,5	0	5	10
23	5	0	1	6	11
24	4	0	2	7	12
25	3	0	3	8	13
26	2	0	4	9	14
27	1	0	5	10	15
28	0	1	6	11	16
29	0	2	7	12	17
30	0	3	8	13	18
31	0	4	9	14	19
32	0	5	10	15	20