Leave the Best, Treat the Rest - Targeted Selective Treatment for the Resource-Poor in Africa

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Drug Resistance

Global indiscriminate use of and over-reliance on the wide array of chemicals for management of most pests, be they of import to plant, animal or man, has resulted in development of resistance to almost all of the substances involved in parasite and/or pest management, to the extent that in many instances agricultural production and medical health are progressively coming under threat. Hence development of sustainable methods for managing worm resistance remains one of the main incentives for research on gastrointestinal nematode infection in the veterinary field (*Van Wyk & Reynecke, 2011. Vet. Parasitol.,177,212-223*).

Lack of Cooperation between Various Disciplines

Effective management of both internal and external parasites is essential for optimal, sustainable production of domesticated ruminants. Unfortunately, research on the parasites involved is too compartmentalised, resulting in clashes between management strategies for internal and external parasites, for instance regarding sustained efficacy of endectocides such as the macrocyclic lactones (MLs), and hence on the production of the hosts. Use of MLs at intervals as short as a few weeks for controlling ticks in cattle, or in winter in an attempt to eradicate sheep scab, selects very severely for resistance in *Haemonchus contortus*. Furthermore, there is too little research cooperation between forage and animal scientists and veterinary parasitologists for optimal animal production strategies.

Track Record of ACSRPC

One of the most important contributions of the ACSRPC in the decade of its existence has been the unique ability to integrate important research between veterinary, forage and animal scientists, centred on clinical evaluation of animals to enable Targeted Selective Treatment (TST), principally FAMACHA non-invasive evaluation of anaemia, now included with nasal discharge-, body condition-, dags- and submandibular oedema scoring in the Five-Point-Check ("**5.✓**") system of clinical evaluation (*Bath & Van Wyk, 2009. Small Rum.Res.,86,6-13*). South Africa contributed with development of FAMACHA and the TST approach. In reaction to extreme levels of resistance that developed to the range of available anthelmintics, the TST approach was ushered in in South Africa with the so-called FAMACHA method of clinical evaluation of the anaemia of haemonchosis (*Malan & Van Wyk, 1992. Proc. S.A. Vet. Ass. Bienn. Nat. Vet. Congr., Grahamstown, S. Africa, 7–10 Sept.*, 139; *Bath et al., 1996. Proc. 7th Ann.Congr.Livestock Hlth Prod. Group S.Afr.Vet.Ass., Port Elizabeth*), to be able clinically to detect anaemia and leave untreated any animals deemed unlikely to benefit from treatment, while the rest are dewormed ("Leave the best, treat the rest" – *Bath, 2012. BIT's Ann.Symp.Antiparasites, Guangzhou, China*). In the process the untreated animals continue to pass worm eggs onto pasture, adding to a build-up of an unselected population of worms, unexposed to the anthelmintic concerned and said to be in refugia.

FAMACHA, as Part of "5.✓" System for TST

The FAMACHA system, comprising comparison of the colour of the conjunctivae of sheep and goats to a colour chart for clinical detection of anaemia in animals under severe challenge with *H. contortus*, was developed and widely tested and found to be useful for field application by trained farmers in South Africa (*Bath et al., 2001. FAO Technical Cooperation Project No. TCP / SAF / 3321(A). 90+xxviii pp; Van Wyk & Bath, 2002. Vet. Res.* 33, 509–529). Thereafter, following on training by members of the South African team in the Americas and elsewhere, testing and/or adoption of the system spread to over twenty countries (Van Wyk & Bath, personal records, 2012), amongst others and particularly the southern states of the USA, where dedicated teams of trainers facilitate use mostly by farmers with small flocks of small ruminants (*Kaplan, R.M. et al., Vet. Parasitol., 123,105-120*). And in Brazil Maia, Rosalinski-Moraes, Sotomaior et al. (March, 2013, personal communication, Sotomaior) recently completed a project which, over a period of two years, entailed theoretical and hands-on practical training of more than 1,100 persons in FAMACHA and the theory of TST in general.

Pros and Cons of FAMACHA

From a considerable amount of field testing of the FAMACHA system (Van Wyk & Bath, 2002), the following positives have been shown: On-farm clinical evaluation by the farmer; low initial input cost; slowing of development of anthelmintic resistance; success in application not related to level of education; good genetic correlation with breeding values for animal production; and promoting of frequent examination of the animals. In contrast, the disadvantages of the method include high labour requirements; hands-on pre-training; multiple possible causes of the anaemia that is detected; complexity of optimal timing of application in relation to worm challenge; especially applicability to haematophagous worm species only. When supported by the "**5.✓**" system of clinical evaluation of infection, including nasal discharge, and body condition, submandibular oedema and dags scoring in addition to FAMACHA, the impact of major non-bloodsucking worm species as well as *Oestrus ovis* can be assessed, although not to the same degree of accuracy as for use of FAMACHA for the anaemia of haemonchosis.

Five-Point-Check System in Practice

Especially the drawback of the labour involved in using the FAMACHA and the "**5.✓**" system is reflected in its implementation mainly in countries such as Brazil and southern USA, where flocks and herds of small ruminants are relatively small or anthelmintic resistance is particularly prevalent and severe or labour is more available; it is certainly progressively less practical the larger the numbers of small ruminants involved. However, the level of education is not important to the success rate with application of FAMACHA, with the implication that the system has the potential for application by resource-poor (R-P) communal farmers in South Africa and indeed the entire continent of Africa and elsewhere. However, the challenge now is to firmly establish its use among these farmers.

Five-Point-Check System for the Resource-Poor

For application by R-P farmers in Africa, need for experienced trainers and facilities for easy handling and clinical evaluation of animals need to be addressed for hands-on farmer training. Even for small numbers of animals, effective handling facilities are essential, otherwise clinical evaluation becomes difficult and discourages uptake of TST. However, using locally available material such as fence poles cut from local bushes and trees, can make it possible at low cost. In addition, the majority of R-P farmers in most communal farming regions possess cell (mobile) phones (*Anonymous, 2005., Finance24, 17 April 2005, http//www.finance24.com*), presenting a wonderful opportunity for education, training, and for reporting of clinical results of evaluation for central computation, interpretation and feed-back. Presently interpretation and feed-back are seriously limited, however, by a dearth of persons with the necessary experience in parasitology for advising more than a handful of R-P farmers or communities, and effectively to interpret the large volumes of data to be expected if roll-out and participation of R-P farmers were to be successful.

Farmer Uptake

Farmers often fail to adopt practices which could help to avert introduction of potentially economically crippling disease conditions. For instance, despite serious warnings over decades, many farmers continue to purchase animals at auctions, thus running severe risk of introduction of seriously deleterious animal health conditions such as venereal diseases and resistant worm populations, which are extremely difficult to eradicate once established. Furthermore, in Australia and New Zealand continual emphasis by very active extension teams on routine anthelmintic efficacy testing as an early indication of development of and hedge against anthelmintic resistance has resulted in only 31% of farmers having ever had tests for efficacy done by 2006 (*Lawrence et al., 2007. NZ. Vet. J., 55,228-234*) and Leathwick (*2011, Rural News NZ*, 7 June, 2011, p61) and Le Feuvre (*2011, WormBoss, April, 2011*) estimate that in New Zealand and Australia merely 10% of farmers do comply with the oft repeated, strong recommendations.

Automated Decision Support

One of the possibilities being investigated now for facilitating application is through mathematical modelling and associated software to build systems for automated evaluation of incoming data. Such models are in the process of development for risk assessment (*Reynecke et al., 2011. Vet. Parasit., 177,231-241*). This progress to date was made possible by the fact that anaemia can be clinically graded on-farm by most people into the five different FAMACHA categories, from 1 (denoting absence of anaemia) to 5 (severe anaemia) without any routine laboratory testing being required. Hence, for FAMACHA only five different totals, corresponding to the range of FAMACHA categories, need be submitted electronically to a central computer system, making it a very straight-forward procedure. And if all aspects of the "**5.✓**" evaluation could be included, it would most often involve only another ten more totals for body condition- and dags scoring, since sub-mandibular oedema and *Oestrus ovis* infection, manifested as nasal soiling, are sufficiently covered by the standard operating instructions concerning the "**5.✓**" system. In the favour of development of a central decision support system is the fact that, despite a great deal of variation in details, much the same basic principles are involved in parasite management from place to place and in relation to farm management system. Hence development of the first automated system will largely put the structure in place, and can then be modified to accommodate other regions and management systems. (*Van Wyk & Reynecke, 2011. Vet. Parasit., 177,231-241*).

The necessary technology and voluminous metadata for development and initial validation of an automated decision system are available, and the main hurdle at present in the way of developing it is that it is a specialised and complicated undertaking.

Potential of the Cellphone in Relation to Central Automated Decision Support

Mobile phones have become so versatile in magnitude of functions, that they present an exciting range of possibilities for expansion of clinical evaluation systems to R-P farmers, first and foremost to serve as the essential link for two-way communication between the farmer and whatever central system is developed (*Van Wyk & Reynecke, 2011*):

- **Data submission**: Cellphones are admirably suited to data submission, even being able to function with relatively sophisticated software in disease-related surveys, for evaluating state of knowledge and levels of success with training of farmers, animal health technicians and other personnel.

- **Data interpretation**: Since most small ruminants are infected with gastrointestinal nematodes almost all the time (*Gordon, 1981 Proc.# 58. Refr.Course Sh. Univer.Sydney. Post-Grad.Comm.Vet.Sci.*: 607-615), worm numbers determine pathogenesis, requiring quantitative-, in contrast to a qualitative diagnosis that suffices for most infectious diseases such as bluetongue or paratuberculosis. This, and variation in seasonal effect on parasites and farm management systems, make data interpretation complex and time-consuming (*Van Wyk & Reynecke, 2011*). Consequently, central, automated decision support is needed for the required increase in the numbers of farmers who could be accommodated per experienced adviser with utilization of the potential of cellphones.

- **Farmer training**: The complexities mentioned mean that messages short enough to be read by most farmers are seldom specific enough for use as a comprehensive guide. In contrast, those messages that are more comprehensive are seldom read. Electronic aids fill this gap - it seems possible that short explanations in the form of cellphone messages explaining decisions on disease management, specific per set of current conditions, could be developed. In the case of R-P farmers the structure of many resource-poor communities lends itself to training of farmers, in that training could focus on members of central farmers' committees existing in the communities and could, for instance, be maintained by pop-up cellphone messages.

- **Addressing poor farmer uptake into the future**: Practically the only feed-back that has been possible to date to farmers in relation to submitted diagnostic samples and data has been generic, with little if any background explanation relating to recommendations made by advisers. We suggest investigation of the possibility that well designed explanatory feed-back, automatically generated from farmer-derived, electronically submitted clinical data or sample analysis, could improve farmer uptake of such recommendations.

The Use of Forage with an Anthelmintic Effect

The use of such pastures shows promise. One of the best researched pastures, the legume *Lespedeza cuneata*, has been shown to contribute much to profitable farming. It can be used on the poorest soils, enriches them, is easily made into hay, and best of all, increases carrying capacity several fold. Trials by us in South Africa concentrated on the practical use of this forage plant as a green pasture, and confirmed its anthelmintic value, although at a lower

level than in trials in the USA (*Bath, unpublished observations, 2012*). Although its implementation on communal farms has been investigated on relatively small scale with good results in Swaziland and Mozambique, considerably more investigation is required.

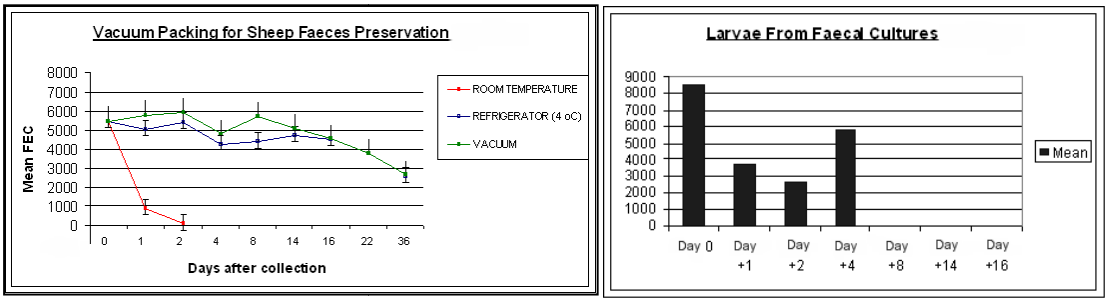
New Initiative

The latest South African initiative is a further attempt to help implement holistic, sustainable and integrated control measures for internal parasites, given the name "The Big Five" (*Bath, 2013. 8th Internat.Sheep Vet.Congr., Rotorua, N.Zealand*). The long list of known and proven measures for internal parasite management in sheep and goats has been repackaged into 5 groups of 5 measures each, much easier to remember than the long, disconnected list of 30 or 40 items. This enables farmers and advisors to concentrate on 5 major factors that determine success: (i) strengthening animals; (ii) controlling numbers; (iii) using pasture factors; (iv) monitoring the situation; and (v) effective drug use.

Preservation of Faeces for the Resource-Poor for Lab Analysis

Long distances and inadequate transport very much complicate submission of faecal samples by the resource-poor for worm egg counting (FEC), since the worm eggs in the faeces hatch within a few hours unless refrigerated. However, work in South Africa has shown that vacuum packing will preserve faeces for FECs for up to 3 weeks at room temperature. In lab trials faecal samples that were either vacuum packed and maintained at ambient room temperature (~18-30^{o}C), were compared with others that were not vacuum packed and maintained either under refrigeration or at the above ambient room temperature, from which it is clear that vacuum packing was very effective for faeces preservation for up to 3 weeks for FECs (Fig. 1, left, below), but that unfortunately, the worm eggs failed to hatch after a period of a few days at ambient temperature (Fig. 2, right, below).

Figure 1 (left) and 2 (right): Respectively faecal egg counts and numbers of infective larvae of *H. contortus* recovered from faecal cultures (*Van Wyk, unpublished EU PARASOL report, 2008*)



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