THE "BIG FIVE" - IMPLEMENTING SUSTAINABLE HOLISTIC INTERNAL PARASITE MANAGEMENT IN SHEEP AND GOATS

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ABSTRACT

Because we became an unintended world leader in the development of multiple anthelmintic resistance, South Africa has had to find, embrace and implement more sustainable and holistic methods of managing helminths in sheep. The problem has been to wean farmers off a heavy reliance on anthelmintics and to use a wide array of measures that require more management, in the face of inertia and attempts by some unscrupulous drug purveyors to block the needed changes. Packaging the available and proven measures into five practical sections helps to make the change more palatable and attractive to farmers.

1. Host resistance and resilience: In the past we have concentrated too much on anthelmintic resistance (AR) and not enough on SR (sheep resistance). The motto must be "Stop Selecting Sissy Sheep!" To achieve this we can apply selection of rams by faecal egg counts (FEC) or FAMACHA, culling of ewes based on Targeted Selective Treatment (TST) results, good nutrition, especially protein and trace elements needed to support immunity, enough exposure to worms for immunity to develop, and control of other diseases.

2. Reducing parasite load: Since the outcome of parasitosis is largely determined by numbers, this needs ongoing attention. This can be achieved by reducing the length of stay in a pasture, reducing the grazing pressure if this is not possible, increasing the time of absence from a pasture, especially at danger times, alternation with non-susceptible grazing species where possible, avoiding worm "hot spots" like grassed pens and leaking water troughs.

3. Evaluate pasture factors: The farmer and advisor have to consider the height (length) of grazing as it affects its risk for parasite transfer, the type (pasture species) as it will influence risk, the pasture slope affecting run-off and thus the suitability for larval survival, and the aspect (direction facing) should also be used to assess risk.

4. Monitoring the situation: Farm situations can be assessed by regular (monthly or bimonthly) pooled flock FECs, AR assessments using FEC reduction tests (FECRTs) or other measures, measures using TST like the 5 POINT CHECK, a weather watch to predict conditions favourable for larval development (rain, humidity, temperature) and grazing monitoring to assess developing dangers.

5. Optimise drugs to be used: Drug usage must be rationalised and minimised. Implement TST and TT (Targeted Treatment); read the label, follow instructions and check the spectrum covered; weigh the sheep, set dose according to the heaviest in the group and check the gun for accuracy and repeatability; target the most vulnerable (lambs and lactating or heavily pregnant ewes) for special attention; do not buy on cost alone and do not formulate (mix) own farm mixtures.

By emphasising the "Big Five" we can encourage and enable farmers to implement four or more items in each section, and thus minimise the long-term effects of internal parasites on farm profitability. This approach has assisted with getting farmers to use sustainable, holistic internal parasite management (SHIPM) in sheep flocks. A reminder in the form of a poster to be hung on the wall of the farm office will help encourage continuous implementation.

INTRODUCTION

This contribution is based on findings and observations applicable to South Africa. As a regional perspective on what is being applied regarding internal parasite management it is impossible to back all statements and opinions with references to published scientific reports or articles. However the observations represent an overview of current successes, problems, findings and developments that characterise this region.

It is widely acknowledged that relying largely or completely on drugs to control helminths is dangerous and unsustainable in the long term (Martin, 1985; Barger, 1999; Bird *et al*., 2001; van Wyk *et al*., 2002; Besier and Love, 2003). Yet overreliance has led to multiple anthelmintic resistance (MAR) world-wide (le Jambre, 1978; Papadopoulos, 2008). Because South Africa became an unintended world leader in the development of MAR, it has had to find, embrace and implement more sustainable and holistic methods of managing helminths in sheep. The emphasis has been on long term, practical and cheap solutions that are integrated with one another. Management is the goal, not unachievable eradication or elimination (Waller, 1999; Bath *et al*., 2001; Anonymous, 2002; Bath, 2006; Jackson *et al*., 2008).

There will always be those farmers and even their advisors who ignore all warnings, advice and evidence, and will continue to practice unsustainable measures until they fail. These farmers will eventually be forced into a corner where there are no longer any easy options, and they will either at last listen to advice, or abandon small ruminant farming. The latter may well happen with the blame being placed on the animals rather than with the farmer or advisors.

The problem has been to wean farmers off a heavy reliance on anthelmintics and to use a wide array of measures that require more management and planning, in the face of inertia and attempts by some unscrupulous drug purveyors to block the needed changes (Bath, 2006). It must be conceded that accepting the need for change is difficult and a combined long term effort shared by advisors and pharmaceutical firms is needed. The pharmaceu-tical industry is powerful, therefore an antagonistic stance would be unproductive and bound to fail. By combining forces on an agreed set of principles that safeguard the financial security of this industry, a successful outcome is far more likely.

Sustainability must be a key issue, yet is often ignored in the quest for quick answers in the short term. It is uncontestable that integrated and sustainable control is inherently more difficult than a reliance on drugs, but because something is difficult it does not mean that it is either unattainable or not worth trying to achieve.

Holism is a concept coined by the South African soldier, statesman and philosopher Jan Christiaan Smuts (1870-1950) in his book “Holism and Evolution” (1926). The original meaning has been blurred and changed, it is advisable it to revert to some of its original intentions. Currently holism has become a vague term connoting an all-embracing, rather non-scientific concept, used enthusiastically but wrongly by New Age and Alternative Lifestyle proponents. For Smuts, holism meant “the tendency in nature to form wholes that are greater than the sum of the parts through creative evolution” and it is in this sense that the term is used in this paper.

Fortunately, there are many well tested and confirmed methods other than drug administration that control the impact of helminth parasitism, (Michel, 1985; Bath *et al*., 1996; Bisset and Morris, 1996; Barger, 1999; Bath and van Wyk, 2009; Kenyon *et al*., 2009) and there is no need for further extensive research before this knowledge can be implemented. However, as pointed out many times before (van Wyk *et al*., 2002; Besier and Love, 2003; Anonymous, 2004; Bath, 2006; Jackson *et al*., 2009;), the problem has always been in getting most farmers to accept the changes necessary, and to implement most of the aspects that constitute holistic, integrated and sustainable parasite management.

This reluctance to change and implement new methods is at least in part due to the large number of points that have to be remembered, considered and put to use in an orderly way. Depending on what is counted and subdivisions, this number can total 25 to 40 items – little wonder then that well-meaning attempts usually fail. However, by packaging the points into five major groups of 5 (or more) items each, the problem is much more manageable and liable to be implemented. The five groups of like or related items help concentrate attention on the most important factors that determine success in managing internal parasitism in sheep and goats. This approach has been given the name “The Big Five” although of course it has no further connection with the African wildlife Big Five from which it derives.

THE BIG FIVE: A NEW APPROACH

Instead of starting with drugs, this systematic approach ends at this point – not because drugs are of little value or can be eliminated, but rather because their importance has been over emphasized to the detriment of other important factors (van Wyk and van Schalkwyk, 1990; van Wyk, 2001; Waghorn et al., 2008; Waghorn et al., 2009). We therefore start with all the factors that promote resistance and resilience against parasites in animals, then deal with the factors that reduce the parasite load, thereafter the pasture characteristics to be noted and used, following this practical ways of monitoring the situation, and finally correct drug use. Packaging the available and proven measures into five practical sections helps to make the change more palatable and attractive to farmers.

1. <u>Strengthen host resistance and resilience</u>

For far too long we have concentrated largely on anthelmintic resistance (AR) and not enough on sheep resistance (SR). The motto must be "Stop Selecting Sissy Sheep!" or in a positive way "Strong Sheep Seldom Succumb".

Improving host resistance and resilience (R & R) can be achieved by selection and culling. Work done in South Africa (Bisset *et al*., 2001; Riley and van Wyk, 2009; Riley and van Wyk, 2011), Australia (Albers *et al*., 1987; Karlsson and Greef, 2006; Kemper *et al*., 2010; Karlsson and Greeff, 2012) as well as New Zealand (Bisset and Morris, 1996) has clearly demonstrated the value of breeding sheep for resistance and/or resilience. An added benefit appears to be that this inherent ability to withstand the effects of parasitism is not limited to a single species of helminth. Thus, selection for resistance or resilience against *Haemonchus contortus* has a benefit for developing resistance against *Trichostrongylus* infections and vice versa. Since the same basic immune or other mechanisms are likely to be involved, this should not be surprising.

Methods which have been shown to work at least in South Africa comprise the following:

- Selection of rams by faecal egg counts (FEC) or FAMACHA.
  The rams are ranked by FEC within an index system, where the average FEC is 100 and variations below and above this number are scored as a percentage in variation around this mean. Logarithmic transformations may be preferred. Lower scores are the target, the lower the better. In the work of Van Wyk, there has been a very good correlation between FEC, FAMACHA score and haematocrit (where measured) and thus if *H. contortus* is the dominant or overwhelming worm when scoring is done, FAMACHA can safely and cheaply be substituted for FEC's.

  There are several important genetic issued to note. Heritability of resistance and resilience in various investigations vary around 0.25 – thus it will take several years to reap the benefits of this selection process. However, if farmers see this as an obstacle to implementation, it is as well to point out that because it takes several years to see improvement in terms of lessened treatment needs (thus also in costs and in the development of AR), the sooner selection starts, the better.

  Another key genetic issue is the performance and productivity of R & R tested animals and their progeny. Although some studies have suggested that host resistance or resilience against helminths may be linked with lower production and performance, this is not so in later and current studies (Albers *et al*., 1987; Bisset and Morris, 1996; Liu *et al*., 2005; Karlsson and Greeff, 2006; van Wyk, 2008; Karlsson and Greeff, 2012; Leask *et al*., 2013). The proviso for evaluating results must always be that the tested animals must be subjected to a significant parasite challenge. In these cases, susceptible animals invariably succumb to infection and deliver poor performance, or have to be treated for parasitism and thus should either be appropriately penalised or be excluded from the analysis (van Wyk and Bath, 2002; Riley and van Wyk, 2011). Since rams contribute 50% of the genetics yet in most breeding systems only comprise 2-4% of the breeding flock (Cottle, 1991; Maree and Casey, 1993), they have a huge influence on the genetic direction that is taken, and thus strict selection for the ability to withstand helminth infection and its results is imperative to make worthwhile progress in as short a time as possible.

- Culling of ewes based on Targeted Selective Treatment (TST) results.
  The ewe flock presents a different situation, since the demands for production and continuity in a breeding flock do not allow for selection and culling at the same strict levels that can be applied to rams. However, the worst performers, that seldom make up more than 5-10% of a flock (van Wyk , 2008), can be identified by Targeted Selective Treatment

(TST) and especially the Five Point Check (5•√) which is practical, cheap, quick and effective in identifying candidates for culling (Bath and van Wyk, 2009). By getting rid of the worst animals that cannot cope with infection without frequent treatment, the frequency and need for blanket treatments of all sheep is significantly lowered or eliminated, with the inherent cost savings, but culling will also assist with genetic improvement in the flock. Advisors can assure farmers that they will see the benefits if they persist with implementation for 3-5 years.

- Good nutrition, especially protein and trace elements are needed to support immunity. Sheep cannot express genetic R & R if they are inadequately fed. There has been ample evidence of the key role that dietary protein plays in this respect (Swartz *et al*., 2007; Burke *et al*., 2009, Jackson *et al*., 2009; Stafford *et al*., 2009). The important of sufficient trace elements in supporting the ability to withstand helminth infection has been less clearly established, but their role in supporting immune mechanisms in general is well known.

- Enough exposure to worms for immunity to develop.
  There are still many farmers, and some advisors, who seek to reduce parasite numbers to an absolute minimum, or even try to eradicate infections. In most cases this is futile and dangerous – a balance between parasite and host must be sought and maintained. We cannot expect that animals will develop and maintain satisfactory immunity in the absence of sufficient parasite challenge. Of course, wel also have to be on our guard to ensure that the challenge does not become excessive and overwhelm the animal's ability to resist worms or their effects.

- The control of other diseases is important for allowing animals to express their innate or acquired immunity or resilience to helminth infection. Sheep suffering from other diseases like bluetongue or sheep scab will have a lowered ability to cope with concurrent helminthiasis.

- Quarantine procedures must be in place when animals are brought in from elsewhere so that MAR worms are not introduced to the farm at the same time.

2. <u>Reducing the parasite load</u>

Since the outcome of parasitosis is largely determined by numbers, this needs on-going attention. The numbers referred to here included faecal egg counts, numbers of larvae on pasture hatching, maturing and surving, numbers of infective larva consumed, numbers of larvae maturing to adults, and numbers of eggs laid (Barger, 1985; Larsen *et al*., 1994, Leathwick *et al*., 2006). Other numbers of importance include numbers of livestock in different categories, number of days in pastures, number of days of pasture rest, and prolificacy in egg laying.

The only practical point to control these numbers outside of drug usage, is the method of pasture utilisation. This aspect of sustainable, holistic and integrated parasite management is all too often largely disregarded.

- Reduce the length of stay in a pasture if this is possible, since depending on climate, it can take a week to several months for larvae to hatch, then progress from L_1 to L_3 stages and become infective. The shorter the period of grazing, the less the chance of a severe build-up of infective larvae. A short duration of grazing has other benefits for the farmer and should be advocated on this basis. Short duration, high pressure grazing ensures maximal utilisation of pasture, but does not allow grazing of regrowth, which will progressively lower plant vigour. This grazing system can be advised on optimum pasture utilisation grounds alone, but brings parasite control benefits too.

- Reduce the grazing pressure if this is not possible. Pasture contamination can be lowered by reducing the number of animals per unit area, but this is not always a practical proposition. However, utilisation of natural pastures (veld in South Africa) can assist in lowering contamination because the natural carrying capacity of veld is much lower than pastures (Danckwerts and Teague, 1989; le Roux *et al*., 1994).

- Increase the time of absence from a pasture, especially at danger times. The period of paddock rest is crucial to reducing a build-up of infective larvae and thus the challenge to grazing sheep or goats. The period of rest required varies from just a month in tropical climates to several months in high latitude temperate zones, this has to be known and taken into account in advising the length of absence needed. This principle fits in well with short duration, high intensity grazing provided that there are enough paddocks (Danckwerts and Teague, 1989).

  However, in some situations the paddock may be ready for grazing before it is helminthologically safe to do so. This problem can be overcome by alternation.

- Alternate with non-susceptible grazing species where possible will remove infective larvae during grazing of plants by a species not susceptible to sheep and goat parasites (Horak, 1981). Horses, cattle and ostriches have been used with success for this purpose. Better pasture utilisation is accompanied by lower parasite challenge in small ruminants, and this principle can be used together with high intensity, short duration grazing systems. The effective absence of sheep and goats is lengthened considerably, from 6 to 12 weeks in southern African conditions – the latter being an effective rest period.

- Avoid worm "hot spots" like grassed pens and leaking water troughs. This factor is frequently overlooked and is especially important in areas with a dry climate. Under these conditions the sheep or goats are attracted to the better watered grazing spots, and urination and defecation also fertilise the soil, further encouraging growth and attracting animals to graze these areas even more. With the dung pellets come helminth eggs which can hatch, survive and mature to infective larvae on a massive scale. Under South African conditions sheep and goats are often kept in small paddocks every night to prevent theft and predation. If these security pens are grassed, the risk of severe helminthiasis is unavoidable. Farmers have to mend leaking water troughs, fence off marshy areas, and remove grass (which contributes a negligible amount of feed for the stock) from all holding and security pens. These actions alone have contributed significantly to many farmers being able to bring internal parasitism on their farms down to manageable proportions.

- Fertilisation of pastures encourages plant growth and thus indirectly protects larvae from desiccation. In addition it makes pastures more palatable and this encourages intake of grass containing larvae. This factor also needs some consideration when evaluating the worm risk on pastures.

3. <u>Evaluate pasture factors</u>

Awareness is the key objective in this cluster, since there can be no objective measurements involved.

- Height (length) of grazing affects its risk for parasite transfer.
  It is well known (Krecek *et al*., 1995) that the infectivity of a pasture decreases in a logarithmic fashion as the length of a pasture increases. Short-cropped pastures may indicate high and efficient utilisation, but they also carry the increasing risk of high levels of infection by helminth larvae. Farmers and advisors must be aware of this risk factor and make allowances for it in planning control measures.

- Type (pasture species) will influence risk. In South Africa, kikuyu grass (*Pennisetum clandestinum*) is a popular tropical summer pasture with high yields and a high capacity to withstand severe grazing. It forms a dense mat of stolons that also help to protect the sward from desiccation. However these factors are also conducive to parasite survival and infection, particularly the most dangerous *H. contortus.* Thus advantages have to be considered together with with dangers and appropriate action taken.

South Africa has seen the widespread and increasing use of the legume *Lespedeza cuneata,* often called Sericia Lespedeza (SL), or inappropriately "Poor Man's Lucerne". Apart from its many other advantages in improving the soil, hardness, and increasing carrying capacity, it is also of value in contributing to parasite control (SCSRPC website), apparently due to its condensed tannin content. While most of the published research has concentrated on the plant dried as hay, there is evidence of its usefulness when fed fresh. Under South African conditions SL is only viable if rain is above 600 mm per year, falling mainly in summer. However this is the area that haemonchosis presents the greatest danger. We have shown that utilising SL as grazing in summer in high risk situations has a considerably but variable effect on lowering faecal egg outputs, as well as the need for individual anthelmintic treatment (Bath, 2012). This was with both relatively pure SL grazing as well as optional alteration with natural pasture, compared against purely natural (veld) grazing. Importantly, there was no penalty in growth rates in spite of higher stocking rates for SL on its own or combined with veld. Other plants have also been shown to be of use (Chandrawathani *et al*., 2006) but implementation has not yet been tried and tested in South Africa.

These experiences and findings illustrate the great importance of considering and using knowledge on pasture types to assist in the control of helminthiasis.

- Slope affects run-off and thus the suitability for larval survival. We observe that paddocks with good drainage carry a lower risk of severe parasite infection than flatter, poorly drained paddocks. This is attributed to moisture retention and thus larval hatching and survival.

- Aspect (direction facing) should also be used to assess risk. In the southern hemisphere, south-facing slopes get less direct sun and are thus cooler so that they retain their moisture longer and are more suited to parasite survival, both of eggs and larvae. This is particularly important in low latitudes and drier tropical and subtropical climates where the desiccating effects of sunlight are greater. Farmers and advisors have to take this into account when planning parasite management.

- Irrigation can dramatically alter the parasite survival picture and has turned "safe" farms into "dangerous" farms. Parasites adapted to cooler conditions (notably *Trichostrongylus* species) are becoming much more important in areas formerly dominated by *H. contortus*, and vice versa.

- Soil type may have an influence. Heavy, clay-rich soils retain moisture and are thus more prone to favour larval survival.

4. <u>Monitoring the situation</u>

- Regular (monthly or bimonthly) pooled flock FECs are very useful to monitor the infection rate onto the pasture, but less useful in indicating the parasite burden in the sheep, other than young, susceptible lambs. To make these checks practical and economical for farmers, pooled samples must be used. The farmer needs to take the same amount of faeces from each of 10-20 sheep representing the same class of animal for a useful indication to be obtained. We use a discarded disposable plastic injection syringe of 5-10 ml capacity, with the nozzle and cone carefully cut away at the zero mark. The farmer takes several pellets from each sheep and pushes and squeezes them into the opened end of the syringe at a predetermined, constant mark of 3, 4 or 5 ml. These equal samples can be placed into a plastic bag together, or if preferred, in separate bags. Air is expressed out to discourage egg hatching. The bag is then sealed and put in a cooled polystyrene box until examined. The objection raised by some against this method is the well-known problem of over-distribution of FECs, where many sheep have FECs below the mean and a few much higher. However since the phenomenon is well known and inherent in any group sample, the average represents the pasture contamination rate. The other objection is more serious. Since different parasites have different fecundities, what constitutes an acceptable FEC for one parasite (say *H. contortus*) will represent an unacceptable situation in others (say *Trichostrongylus* species). Until simple, quick and cheap ways are found of differentiating between the eggs of major helminths which are morphologically similar, this problem remains inherent in interpretations. In the interim we have to rely on circumstantial indicators and slow, expensive larval cultures (Taylor, 2010). However, regular sampling and recording of bulk FECs does give an indication of the situation and changes that may occur.

- AR assessments using FEC reduction tests (FECRTs) or other measures is essential to ensure that the drug used is working well enough, and to monitor any serious deterioration in efficacy so that the use of a drug can be stopped before its usefulness is seriously compromised. Efficacy tests on commonly used drugs can be done quite easily and cheaply if bulk samples from the same animals before and after treatment are used. While individual samples are preferred, the costs and difficulties may persuade farmers not to test if we insist on this – at least the bulk FEC is an indicator of the level of efficacy. There is no absolute need to test for all drug groups at once, although this is preferable. Efficacy against the Barber's Pole Worm is quickly and reliably determined (even though no numerical efficacy can be given) if anaemic sheep are treated with a drug and the FAMACHA scores are compared at treatment and 10-14 days later. Effective drugs give a noticeable improvement of 1-2 FAMACHA scores. Though this may be deemed rough-and-ready, it does give farmers a quick, easy way of checking the use of drugs for *H. contortus* on-farm. Other methods of AR assessment have not found widespread use in South Africa.

- Measures using TST like the 5 POINT CHECK, weight changes, milk production and the "happy factor" are useful and practical for assessing the state of affairs regarding parasite impact (Mahieu *et al*., 2007; Bath & van Wyk, 2009; Cringoli *et al*., 2009; Greer *et al*., 2009; Kenyon *et al.* 2009; Stafford *et al*, 2009). The most extensively researched and proven component of TST is the FAMACHA system of clinical anaemia assessment (van Wyk & Bath, 2002). By counting sheep numbers allocated to each score category, and expressing this as a percentage or in graphic form, the degree of R & R versus decompensation is easily seen, and the relative risk assessed for the flock at that point in time.

- A weather watch to predict conditions favourable for larval development (rain, humidity, temperature) must be maintained, even though at present a scientifically based risk formula is not yet commercially available. However, Reinecke and co-workers (Reynecke et al., 2011(a); Reynecke et al., 2011(b); van Wyk and Reynecke, 2011) have published work which indicates that these determinants of risk for haemonchosis at least are capable of reduction into a multiple component mathematical model.

- Grazing monitoring to assess developing dangers. Monitoring the grazing conditions that are either favourable or inimical to the hatching, development and survival of larvae on pastures will help to assess the risk of parasitism, and predict danger periods when heightened action may be required. Although once again a system of applying this principle in a practical way on farmers is still under development, the theoretical mathematical basis for this has already been published (Reynecke *et al*, 2011; van Wyk and Reynecke, 2011).

- Bulk faecal haemoglobin assessment (Colditz and le Jambre, 2008) as an indicator of haemonchosis has not been widely adopted but should be of value in summer rainfall areas.

5. <u>Optimise drugs to be used</u>

Drugs are important, in many cases absolutely essential, but need to be used frugally and effectively if their useful life is to be extended. Time and again, the emergence of MAR can be traced back to prolific, inappropriate use of drugs.

- Implement TST and TT (Targeted Treatment). The use of this principle is well-established, and has been extensively tested in many situations (Greer *et al*., 2009). This applies especially to clinical anaemia assessment using the FAMACHA system, but there is increasing evidence for the use of the :"happy factor" for other worms (Greer *et al*., 2009). The FIVE POINT CHECK is a simplified extension of the FAMACHA system for use against other major parasites, and is gradually gaining acceptance (Bath and van Wyk, 2009).

- Read the label, follow instructions and check the spectrum covered. Registering authorities go to great lengths to ensure that drugs are properly tested and labelled in South Africa, but veterinary advisors must assist farmers in always reading the label, and following instructions.

- Weigh the sheep, set dose according to the heaviest in the group and check the gun for accuracy and repeatability. It is surprising how poorly the majority of farmers may estimate the weights of their sheep and how few actually check their dosing guns for accuracy and repeatability. Since a correct dose is essential for efficacy, these simple practical checks must become part of the routine on every farm. Advisors have the duty to give regular reminders and check on implementation.

- Target the most vulnerable (lambs and lactating or heavily pregnant ewes) for special attention. It is largely these groups that will need more treatments and greater vigilance. Concentrating on them can reduce the unnecessary treatment of other groups that can act as parasite havens for refugia.

- Do not buy on cost alone and do not formulate (mix) own farm mixtures. Only registered drugs produced by reputable manufacturers and distributors should be used. There are claims for a variety of herbs, farm products and nostrums but none of these have been substantiated (Burke *et al*., 2009), also in South Africa (Malan, unpublished data) and since they have not been registered for parasite control, their sale or recommendation is illegal.

CONCLUSION

It should be noted that in Southern Africa there are several internal parasites either not seen or not recorded as important elsewhere. *Calicophoron microbothrium* (the conical fluke) can cause impredictable but devastating outbreraks of severe, often fatal, diarrhoea. *Gaigeria pachyscelis* (sandveld hookworm) can cause severe anaemia in arid areas, and the giant liver fluke (*Fasciola gigantica*) is a problem towards the north. Similarly bilharzia becomes increasingly prevalent in northern regions. These parasites add considerably to the complexity of internal parasite control in southern Africa.

When farmers are asked on what basis they purchase drugs, all too often there are wry smiles before they admit that they do so on cost. Low prices are often the concomitants of poor quality generic products, or stock clearances, or products near expiry. Even worse, sales persons may be given some form of incentive to sell a product – whether this is in cash, or in kind. The ethical advisor has to give guidance based on efficacy for the purpose and cost-effectiveness of products and it is better if this advice comes from those who have no financial interest in drug sales. The product guide in the FIVE POINT CHECK is intended to assist users in identifying which products will be useful for a specified helminth problem, but the best guidance is still that given by a local and experienced veterinary advisor who knows all the factors that impinge on decisions made for which drugs should be used.

Advisors must appreciate that it is not easy for farmers to change their approach to helminth management, and therefore they must be given all the encouragement and support possible to facilitate the necessary adjustments. Simply supplying a list of actions without follow-up is likely to result in no action at all.

Farmers need reminders and reinforcement of the message conveyed, just like all other people. Professional agricultural extension officers have found that it takes up to seven effective exposures to a new idea for the majority of farmers to adopt it – a minority need much more, and the last acceptors may only be adopting the practice after two decades.

Pharmaceutical firms are well aware of the benefits of repeating a message that they want to be adopted, and spend a lot of money on advertising to do so. Advisors would do well to follow this proven method of effecting change.

Measuring the results of change is another potent way to encourage adoption. The farmer may have records that can be used to assess costs, production or other indicators of the results of change. Alternately the advisor can set up a simple on-farm trial where the farmer can measure results and see the benefits in the most direct way. In terms of TST, the immediate and significant (around 60%) lowering of the costs of treatment ensure farmer attention and support, even though lowering costs is not the main intention of TST. When trying to introduce changes, and especially if these changes require considerable shifts in thinking, approach and management, it is of little value to try to involve all farmers simultaneously. The great majority will be likely to wait and see what happens with others, Instead, advisors should target entrepeneurs and opinion leaders to solicit their interest, acceptance and support. There early accepters will be the most effective advocates and disseminators of new approaches to fellow farmers. Nothing convinces farmers more than the advice and experience of a fellow farmer.

Congratulations where appropriate never go amiss. As farmers make progress with implementing sustainable, holistic and integrated systems of internal parasite management, they need positive reinforcement to stay on course and make further progress.

There will be opponents and those who disagree with changes advocated, and these allegations must be answered and refuted in a science-based, dispassionate way. Incorrect perceptions must also be corrected. One of the biggest misconceptions for TST has been the erronious belief that its advocates are trying to eliminate all anthelmintic treatments. It has to be repeated that the objective is rational treatment of livestock that will benefit, and not to treat those that can cope and thrive without it.

When answering allegations that sustainable holistic methods do not work, it is as well to ask who is giving this advice. Almost invariably these opponents have a direct or indirect vested interest in drug sales, and when this is pointed out to farmers, they are able to draw their own conclusions on the value, reliability and unbiased nature of this advice.

By emphasising the “Big Five” we can encourage and enable farmers to implement four or more items in each section, and thus minimise the long-term effects of internal parasites on farm profitability. This approach has assisted with getting farmers to use sustainable, holistic internal parasite management (SHIPM) in sheep flocks.

Some form of physical reminder and reinforcement should be positioned in the farm office. To be most effective, this can take the form of a poster that separates necessary actions into the “BIG FIVE:” components. When the veterinary advisor is on farm for regular flock health visits, this can be used as a starting point for discussions, evaluations, updates and reminders, as well as deciding on which aspects used special attention.

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