Restricted application of pyrethroids to cattle

S.J. Torr and G.A. Vale

Natural Resources Institute, University of Greenwich

Introduction

During the last decade there has been increasing emphasis on getting farmers to control tsetse themselves, instead of relying on governments or donor organizations. The only techniques that are feasible in such self-help schemes are bait methods, and the most cost-effective of these is the application of pyrethroids to cattle, provided there are adequate numbers of cattle spread fairly evenly within the tsetse habitat. The original protocol for these applications involved the treatment of all the cattle, using the standard "whole body" dose as recommended for tick control, and applied at intervals of about a month. However, this is still too costly for ready adoption by poor farmers, especially since usually they have to use the expensive pour-on insecticides. While the dip or spray formulations are cheaper in themselves, their use necessitates the construction of costly dip tanks or spray races, and also requires a plentiful and guaranteed supply of water.

Part of the solution to these difficulties is simply in shopping around to get the best price for the insecticides, since the market now includes new firms that can supply various generic formulations at substantially reduced prices. However, the main solution must involve reducing the quantities of insecticide required, so lowering the insecticide costs and also minimizing the need for the expensive spraying or dipping facilities associated with bulk applications. Moreover, a substantial reduction in insecticide use is shown to avoid any significant contamination of cattle dung, so decreasing the threat to the dung fauna that are important in the productivity of peasant farming. The reduced application of insecticide might also be important in minimizing the impact on tick populations, so that young cattle still get bitten by ticks and thus develop a natural immunity to tick-borne diseases.

The present paper describes work to reduce the use of insecticide by two expedients: limiting the number of cattle treated, and restricting the parts of the body to which insecticide is applied.

Reducing the number of cattle treated

The opportunity to reduce the number of animals treated was first suggested by observing that relatively few tsetse feed on calves, so that only adult cattle need be treated. In several parts of Africa, the policy of not treating calves was already practiced to ensure that young cattle had the required exposure to ticks. Thus, the simple recommendation not to treat calves served mainly to emphasize that dipping practices designed to control tick-borne diseases would not undermine tsetse control.

Furthermore, studies of the feeding behaviour of tsetse attracted to herds of cattle suggested that it was not even necessary to treat each of the older animals. For instance, work with Mashona cattle in Zimbabwe showed that in herds comprising a mixture of two oxen, four cows/steers and two calves, 80% (range, 67% - 91%) of meals were from the two largest animals and only 0 – 3 % were from the calves (Fig 1). For the herds used in these studies, the two largest animals constituted 40% of the total liveweight, so that treating just these two would reduce insecticide costs by at least half.

Population models show that it is possible to reduce yet further the number of larger cattle to be treated. For example, in an area not subject to massive pressure of tsetse invasion and where cattle form about 75% of tsetse diet, the flies would be controlled effectively by treating only a third of the larger cattle. This implies that the demand for insecticide could be reduced to around 15% of that originally required to treat all cattle in the herds. Restricting the parts of the body to which insecticide is applied would reduce the insecticide demand even more.

Restricting the body parts treated

The option to restrict the body parts treated was suggested by the long-standing observations that tsetse tend to alight mostly on certain parts of cattle – perhaps insecticide need be applied only to those parts. This option is being investigated at Rekomitjie Research Station, Zimbabwe, in a project supported jointly by the Zimbabwe Department of Veterinary Services and the Animal Health and Livestock Production programmes of DFID. The preliminary results of this project are reported below.

Research in progress

Tsetse distribution on cattle. – Counts were made of *G. pallidipes* on various parts of an ox, giving particular attention to divisions of the legs (fig. 2). The distribution of the tsetse that fed was much the same as the distribution of those that alighted without feeding. Figure 3 shows the distribution of feeders, and indicates that the flies prefer the belly and legs, especially the lower front legs, *ie*, the cannons and pasterns.

Knockdowns with restricted application. -- A number of experiments have been conducted at different seasons to assess the efficacy of applying deltamethrin pyrethroid to only one or a combination of the various preferred sites, at doses reflecting the surface area of these sites. For example, the belly and four legs represent about 20% of the whole surface of an ox, so these sites were treated with a total of 20% of the insecticide normally used for whole-body coverage. With the treatment of the lower front legs the dose was 2% of the whole-body dose. Each experiment used four oxen: a) untreated control, b) ox sprayed all over with Decatix, c) ox with restricted application of Decatix spray, and d) ox with restricted application of Spoton pour-on. The cattle were penned separately overnight and grazed separately during the day. On most days up to a month or so after treatment, about 30 wild flies were caught feeding on any part of the ox, and were scored for knockdowns. Control knockdowns were only about 1% and hence no correction for these was performed. No tests were made of the effect of the whole-body dose of Spoton since many previous studies have shown that this treatment is about as effective as the whole-body spray with Decatix, despite the fact that the amount of active ingredient applied is about 2.5 times greater with Spoton.

Figure 4 exemplifies the type of data produced and shows two important features. First, although the restricted applications were associated with reduced knockdowns, the reduction was very small in relation the reduction in insecticide demand. Second, the restricted doses of Spoton were about as effective as the restricted doses of Decatix. Given that the restricted treatments require very little insecticide per application, it is feasible to double the frequency of applications and still save money. For example, if the belly and legs treatment were applied every 15 days instead of once a month, then the insecticide demand would still be only 40% of that needed for the whole body treatment. Moreover, the daily rate of knockdown would be more steady – a potentially important matter in maintaining invasion barriers. More intriguingly, while the average daily knockdown of most restricted treatments would then approach more closely the knockdowns produced by treating the whole-body, in the case of the belly and legs treatment it seems likely to produce a performance that is about 30% better than the whole-body treatment. These matters are indicated in table 1.

Restricting the body parts to be treated means that one might easily afford the insecticide needed to treat a higher proportion of the older cattle. For example, with the Spoton treatment of the lower front legs one might double both the frequency of application and the number of animals treated. The insecticide would still be very low, ie, 8% of that needed for the whole-body treatment of fewer animals less frequently. However, the total knockdowns seem likely to be very good. The gross saving in insecticide requirement would be offset in part by the extra time needed to treat more animals more frequently, but for poor farmers the insecticide costs are often more important than labour. In any event, a restricted treatment with Decatix could be performed relatively cheaply with leg or foot baths, or perhaps by paint brushes or small hand-sprayers, so avoiding the need for the dip tanks and spray races normally required to benefit from the low cost of this formulation.

The reduced insecticide demands per individual animal (table 1) are additional to those reductions, discussed earlier, that are associated with treating only some of only the older cattle. Putting both types of reduction together it seems likely that effective control of *G. pallidipes* can be achieved with at least a 90% decrease in the insecticide costs associated with the original protocols for cattle treatment. The saving would be at least 95% if dip or spray formulations were used in those many areas were previously only the costly pour-ons were practicable.

Persistence. -- Contrary to indications from the exposure of laboratory-reared tsetse to cattle in sheds in Burkina Faso, the whole-body treatments at Rekomitjie have never given high levels of knockdown for three months. The full set of data from the present trials of restricted applications, and the 100 or so trials of whole-body treatments at Rekomitjie in the 1980s and 90s, show that it usually takes less than a month for knockdowns to decline to 50% in the field.

The general pattern of the Rekomitjie data can be seen from bioassays of Decatix applied as a whole-body spray on 14 separate occasions between May 2002 and October 2003. This treatment has been repeated many times as a positive control in studies of the restricted applications. For each trial, a total of between 448 and 1040 tsetse were caught feeding from the ox at 1-40 days after treatment and scored for knock-down. The results (Fig. 5) show that the time to drop to KD_{50} varied from just two days in January, in the middle of the hot-wet season, to 26 days in August at the end of the cool-dry season. The persistence at each time of year (Fig. 6) is inversely related to ambient temperature, with a possible additional effect of rain explaining the particularly short persistence in January. These and previous data are being analysed to quantify the impact of environmental variables on insecticide persistence.

Caution

Despite the encouraging indications of great economies available via restricted application of insecticides, the following cautions are as yet required.

Further tests. – The present data suggest the belly-plus-legs or legs-only treatments, could be tried now against *G. pallidipes* occupying large areas of southern and central Africa. However, more work needs to be performed before opting for the more heavily restricted treatments against this species. It is also necessary to produce data for other species of tsetse in a variety of situations, there being collaborative work planned or in progress with *G. morsitans* in Zimbabwe, *G. pallidipes* in Zambia, *G. fuscipes* in Uganda and *G. austeni* and *G. brevipalpis* in South Africa. Moreover, to identify protocols needed for maximum cost-effectiveness it is required to explore the merits of insecticide formulations and application systems that are designed specifically for restricted applications, and to investigate any benefits of changing the amount of active ingredient per unit of body surface.

Planning. -- The field work associated with the treatment of only some animals that are treated over only part of their body is no more complex, and perhaps even simpler, than the whole-body treatment of all animals. However, the identification of exactly how many cattle should be treated, how often and over which part of the body is highly involved. It will differ substantially according to the species, density and invasion pressure of tsetse, the abundance of cattle and alternative hosts, and the size, shape and location of the operational area. Professional advice is essential in this matter, but it can be costly and difficult to secure if a visit by a specialist is required. To make advice freely available to organizations that promote or assist the self-help schemes, it is intended that the forthcoming results of the persistence studies and the various collaborative investigations be incorporated into Tsetse Plan, the interactive planning aid discussed elsewhere in this publication.
END

Site of application	Formulation	30-day intervals		15-day intervals	
		Demand	Efficacy	Demand	Efficacy
Belly and all legs	Spoton	20	79	40	129
	Decatix	8	77	16	131
All legs	Spoton	10	59	20	87
	Decatix	4	61	8	94
Front legs	Spoton	5	26	10	47
	Decatix	2	34	4	63
Lower front legs	Spoton	2	31	4	49
	Decatix	0.8	34	1.6	49

Table 1. Annual demand for, and efficacy of, deltamethrin insecticide formulated as Spoton (pour-on) or Decatix (dip/spray) applied to only certain parts of an ox at intervals of 30 or 15 days. Demand is the quantity of active ingredient required, as a percentage of that required for a standard (whole body) dose of Spoton applied at 30 day intervals. Efficacy is the number of *G. pallidipes* knocked-down, as a percentage of those knocked down by the standard treatment at 30 day intervals.

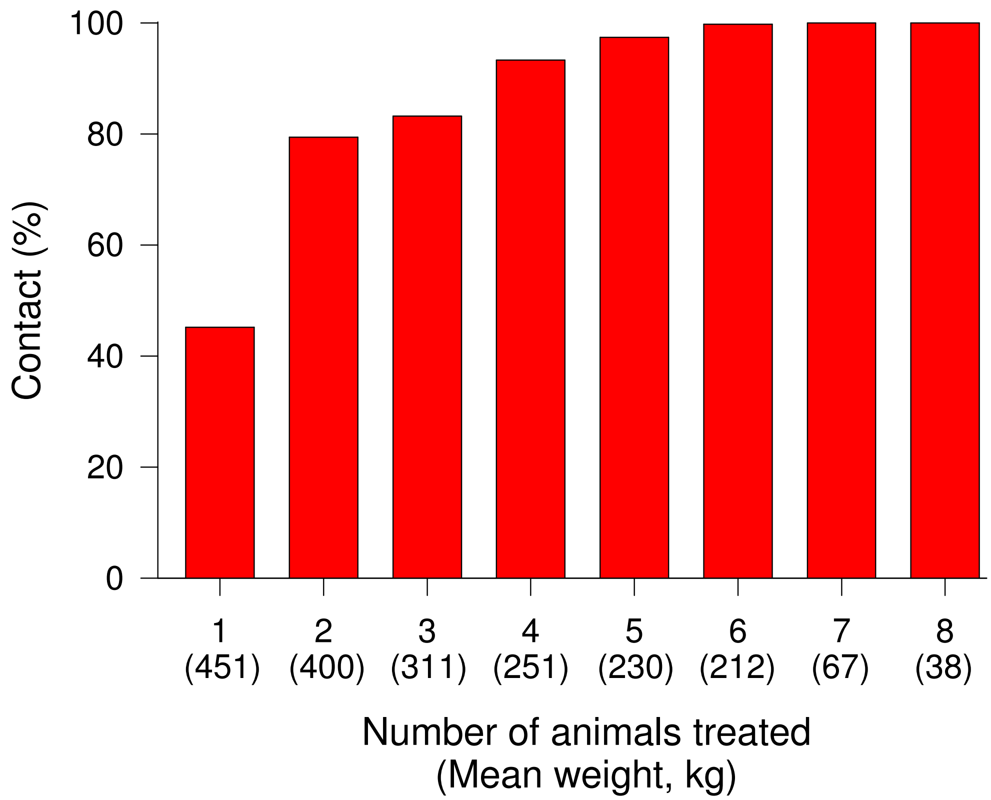

Fig. 1. Estimates of the percentage of tsetse contacting pyrethroid when different numbers of cattle in the herd are treated. The herd of eight animals comprised two calves, four cows/heifers and two oxen. When insecticide was applied to only some animals in the herd, it was always to the heaviest individual(s). Figures in brackets indicate the individual mean weight of each additional animal treated. Percentages are based on the pooled analyses of 458 tsetse feeding on four different herds of cattle.

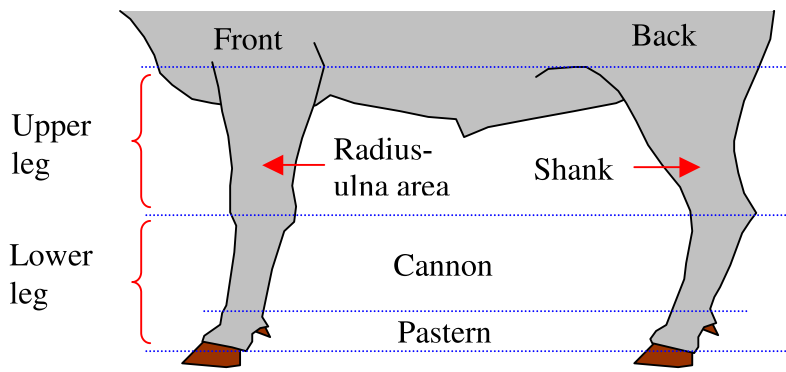

Fig. 2. Parts of the legs of an ox.

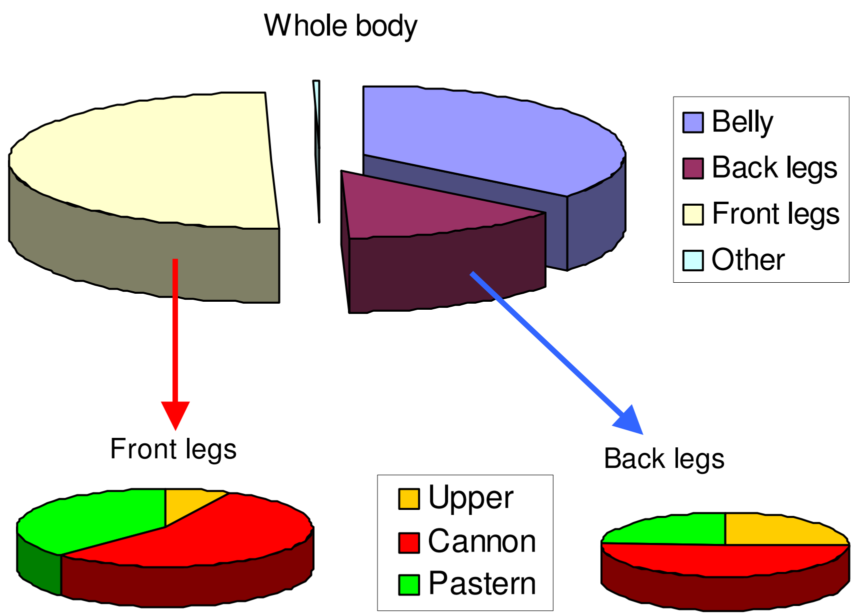

Fig. 3. Distribution of *G. pallidipes* feeding on an ox.

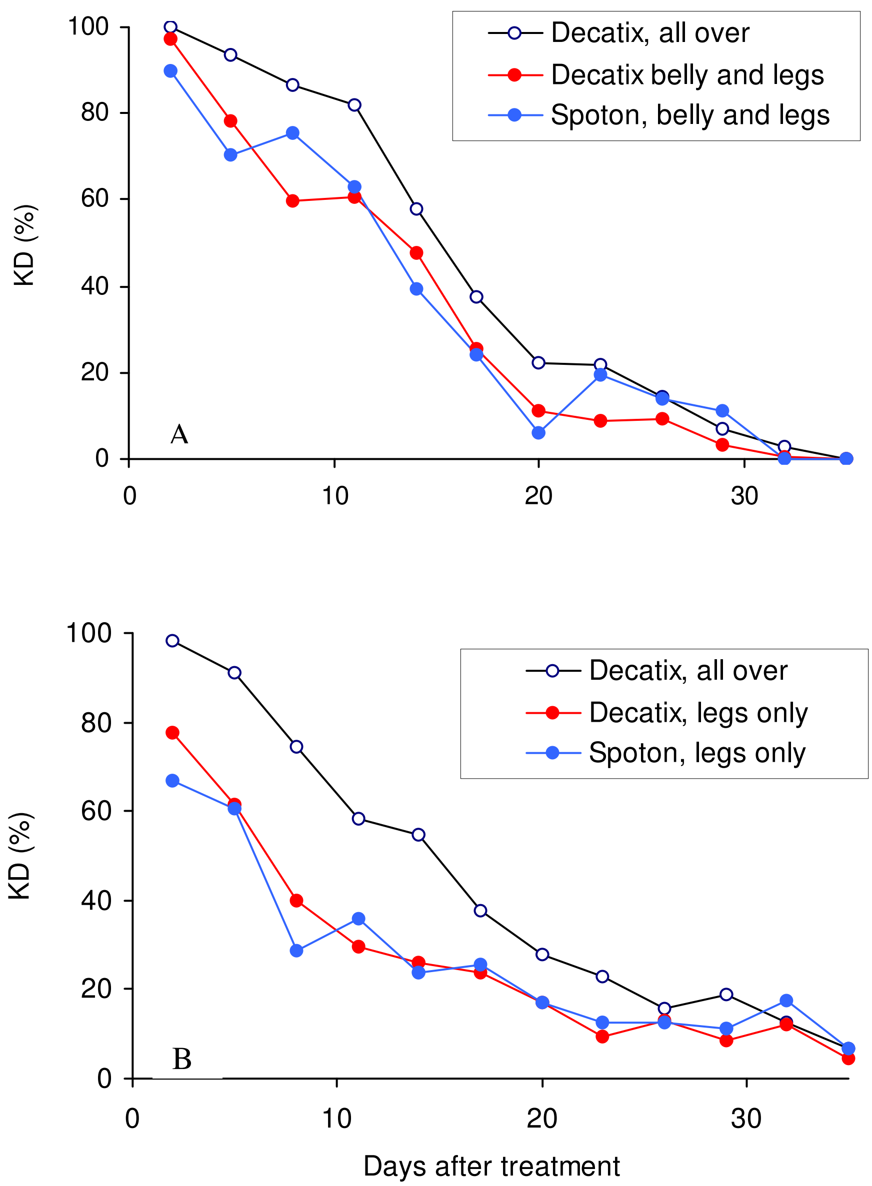

Fig. 4. Percentage knock-down of female *G. pallidipes* in two studies (A and B) to compare the performances of Decatix sprayed over the whole body of an ox , and Decatix spray and Spoton pour-on applied to only part of the body. Plots are pooled data for three-day periods in each of three replicates for A and five replicates for B.

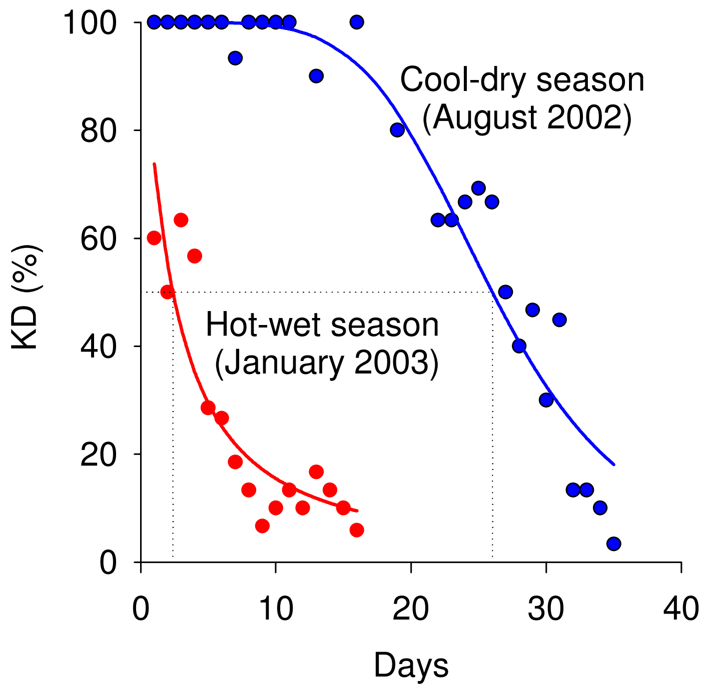

Fig. 5 Knock-down of tsetse collected from cattle sprayed with 0.0375% deltamethrin during the hot-wet (red line) and cool-dry (blue line) seasons. Dotted drop-lines indicate the times at which knock-down declined to 50% (KD_{50}). Curves fitted by logistic regression using GLIM4, with a logit link and *ln*(days) as the explanatory variable.

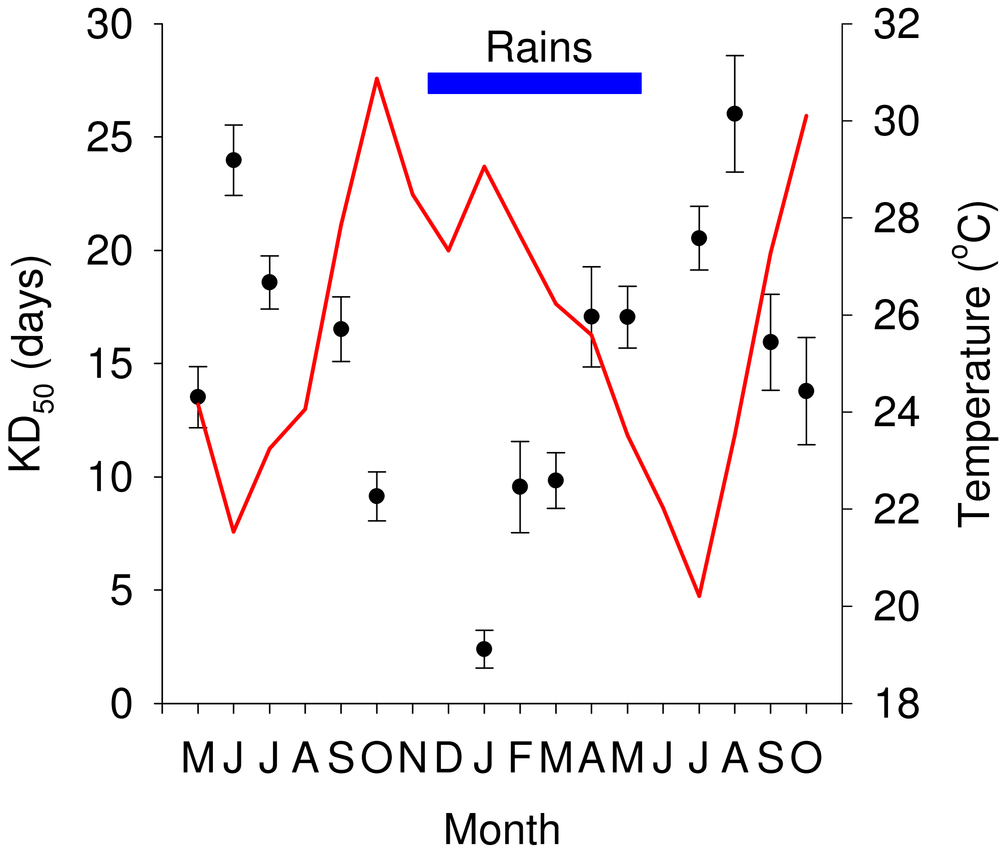

Fig. 6. Seasonal change in the period required for knockdown to decline to 50% (KD_{50}) (solid circles, KD_{50} ±95% C.I.). Estimated from the results of 14 separate trials carried out between May 2002 and October 2003. Solid red line shows the mean monthly temperature and the blue bar indicates the wet season.