

# FINAL TECHNICAL REPORT

## Message in a bottle: disseminating tsetse control technologies

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## EXECUTIVE SUMMARY

### *Project Purpose*

The purpose of this project was to validate, promote and disseminate strategies to improve sustainably the health and productivity of livestock maintained by poor livestock keepers in semi-arid production systems.

Tsetse-borne trypanosomiasis is a severe constraint to the health and productivity of livestock across 10 million km<sup>2</sup> of sub-Saharan Africa and is a major contributor to the poverty of many livestock keepers. Currently, most tsetse-affected communities rely on their own limited resources to control the disease, using a combination of trypanocidal drugs and bait technologies (i.e. insecticide-treated targets, traps and insecticide-treated cattle). The results of these community-based efforts, however, have been disappointing, largely because the communities do not have access to information on how to apply the technology appropriately and even the cheapest methods, such as using insecticide-treated cattle, are too expensive.

This project therefore aimed to:-

- Reduce the cost of using insecticide-treated cattle to control tsetse.
- Assess the efficacy of farmer-based strategies for reducing the biting rate of tsetse, especially for owners of zero-grazed cattle.
- Develop decision support tools that can be used by NGOs and government agencies to plan and implement technically- and financially-sound interventions against tsetse.

### *Outputs:*

#### *Insecticide-treated cattle*

Studies of the feeding behaviour of four species of tsetse in South Africa, Tanzania and Zimbabwe showed that ~75% of tsetse fed on the legs or belly and ~50% fed on the legs. By applying insecticide to these body regions at 2-3 week intervals, the cost of the technique can be reduced by ~90%, allowing farmers to control tsetse for <US\$1/animal/year.

#### *Livestock protection*

In East Africa, many livestock keepers use wood smoke and/or treat their cattle with insecticide in the belief that these measures repel tsetse and other flies from their cattle. And in some areas, owners of zero-grazed cattle protect their cattle by surrounding their cattle kraals with a barrier of insecticide-treated netting. Studies of the efficacy of these techniques showed that smoke halved the biting rate and that barriers, constructed from netting or wood, reduced the feeding rate by ~90%. Treating cattle with insecticide had no significant direct effect on the feeding behaviour of tsetse. The results suggest that for owners of zero-grazed cattle, a simple physical barrier would reduce the biting rate by >90% which, in areas of low to moderate challenge (<1 bite/animal/day), would reduce the impact of trypanosomiasis significantly.

#### *Decision support tools*

A computer-based system to help NGOs design and implement community-based interventions against tsetse was developed. The system includes an interactive programme ('Tsetse Plan') to help users design and implement community-based interventions against tsetse using bait technologies. The programme synthesises knowledge from 20 years of research and, using a user-friendly interface, allows non-specialists to assess the feasibility, cost and impact of various tsetse control strategies. Prototype versions of this programme were used in the design of several tsetse control programmes undertaken by NGOs, national and donor institutions. The decision support system was disseminated via the world-wide-web ([www.tsetse.org](http://www.tsetse.org)) and CD-ROMs distributed at meetings held in five tsetse-affected countries.

## PROJECT LOGICAL FRAMEWORK

Narrative Summary	Indicators of Achievement	Means of Verification	Risks and Assumptions
<b>Goal</b>			
<i>The goal is given by DFID</i>			
<b>Purpose</b>			
Strategies to improve sustainably the health and productivity of livestock maintained by poor livestock keepers validated, promoted and disseminated	<ol style="list-style-type: none"> <li>1. By 2002 pro-poor target institutions information needs and dissemination pathways identified in target countries.</li> <li>2. By 2004 dissemination strategy and materials developed and promoted using knowledge generated above.</li> <li>3. By 2005, dissemination, outputs adopted by one or more target organisations.</li> <li>4. By 2006 pro-poor impact of strategies assessed for Tanzania, Ethiopia.</li> </ol>	<ol style="list-style-type: none"> <li>1. Stakeholder workshop report; other workshop reports; case studies; AHP reports.</li> <li>2. Stakeholder workshop report. Target institution reports and other feedback</li> <li>3. Stakeholder workshop report. Target institution reports and external reviews</li> <li>4. AHP reports. Target institution reports.</li> </ol>	<i>(Purpose to Goal)</i> Enabling environment (institutional, policy and resource constraints) prevents target institutions from adopting and/or applying new knowledge.
<b>Outputs</b>			
<ol style="list-style-type: none"> <li>1. Cost-effective methods of treating cattle with insecticide developed.</li> <li>2. Methods of protecting individual animals from tsetse and trypanosomiasis appropriate for landless livestock owners reviewed and validated.</li> <li>3. Current knowledge base and information needs of organisations promoting community-based tsetse and trypanosomiasis control in Ethiopia and Tanzania assessed.</li> <li>4. Dissemination materials enabling organisations to plan, manage and implement community-based tsetse and trypanosomiasis control produced.</li> <li>5. Recommendations and dissemination materials on community-based tsetse and trypanosomiasis control promoted to target institutions.</li> <li>6. Uptake and value of dissemination outputs evaluated.</li> </ol>	<ol style="list-style-type: none"> <li>2.1 Cost effective strategy to reduce insecticide use by 80% developed (March 2003)               <ol style="list-style-type: none"> <li>1.1 Information on protecting cattle from tsetse collected and analysed (March 2002), validated (March 2003) and tested for acceptability by farmers in two countries (March 2004).</li> <li>3.1 Information on tsetse control activities, knowledge, communication channels and media collected (March 2002).</li> <li>4.1 Appropriate draft dissemination materials developed (March 2003).</li> <li>4.2 Dissemination materials pretested and modified (December 2003).</li> <li>5.1 Outputs promoted nationally in two countries and internationally (June 2004)</li> </ol> </li> <li>6.1 Uptake and value of outputs evaluated for at least two target organisations (September 2005)</li> </ol>	<ol style="list-style-type: none"> <li>1 and 2 Project and AHP reports, scientific papers.</li> <li>3. Project reports, workshop proceedings and case study reports</li> <li>4 Project reports and dissemination materials.</li> <li>5 Final technical reports and dissemination outputs</li> <li>6. Project and AHP reports, scientific papers.</li> </ol>	<i>(Output to Purpose)</i> Pro-poor and appropriate methods for controlling tsetse for individual animals exist.  Enabling environment (institutional, policy and resource constraints) does not prevent target institutions from adopting new knowledge.

Activities															
<p>2.1. Assess effect of treating legs of cattle with standard veterinary formulations of deltamethrin.</p> <p>1.1 Review methods of protecting individual animals from tsetse through literature, networks and other contacts.</p> <p>1.2 Consult with collaborators and livestock owners in Tanzania and Ethiopia.</p> <p>1.3 Assess effectiveness of most promising methods to reduce tsetse feeding on cattle in Tanzania and/or Zimbabwe.</p> <p>1.4 Assess suitability and acceptability of methods to resource-poor livestock owners.</p> <p>3.1 Preliminary networking to identify organisations with relevant experience/interests and information currently available.</p> <p>3.2 Hold stakeholder workshops in Ethiopia and Tanzania to examine community-based tsetse and trypanosomiasis control activities and information needs.</p> <p>3.3 Undertake case studies of approach, design, implementation, impact (on disease and livelihoods) and sustainability of tsetse control operations in Ethiopia and Tanzania.</p> <p>4.1 Develop suitable materials to address knowledge gaps and opportunities identified above.</p> <p>4.2 Pre-test dissemination materials with partners and improve materials in light of experience.</p> <p>5. Disseminate and promote project outputs nationally via project workshops and other channels and internationally via regional workshops, the www and the FITCA and PAAT programmes.</p> <p>6. Assess uptake and extent of use of outputs by at least two target organisations.</p>	<p>Inputs/Resources:</p> <p>Project Budget</p> <table border="0"> <tr> <td>Staff costs</td> <td>£104,448</td> </tr> <tr> <td>Overheads costs</td> <td>£91,660</td> </tr> <tr> <td>Equipment costs</td> <td>£0</td> </tr> <tr> <td>Overseas travel</td> <td>£40,000</td> </tr> <tr> <td>Consumables</td> <td>£32,000</td> </tr> <tr> <td><b>TOTAL</b></td> <td><b>£268,108</b></td> </tr> </table> <p>(over 4 years)</p>	Staff costs	£104,448	Overheads costs	£91,660	Equipment costs	£0	Overseas travel	£40,000	Consumables	£32,000	<b>TOTAL</b>	<b>£268,108</b>	<p>Quarterly, annual and final reports.</p>	<p><i>(Activity to Output)</i></p> <p>Active collaboration of FARM-Africa, KDA, KCBP and Konso community and involvement of trained field personnel. Provision of research facilities at Institute of Pathobiology.</p>
Staff costs	£104,448														
Overheads costs	£91,660														
Equipment costs	£0														
Overseas travel	£40,000														
Consumables	£32,000														
<b>TOTAL</b>	<b>£268,108</b>														

## BACKGROUND

### *Trypanosomiasis control*

Animal trypanosomiasis is a major constraint to agricultural production over more than 11 million square kilometres of sub-Saharan Africa. The disease is a serious constraint to livestock health and production, resulting in estimated annual losses worth ~US\$4.5 billion (Budd, 1999).

The disease can be controlled either by treating livestock with trypanocides or by controlling tsetse flies, the vectors of the disease. In the past, large-scale tsetse control operations have been undertaken by governments and international donors, but a decline in funding and institutional capacity has meant that increasingly the disease has to be managed on a more local scale by NGOs and livestock-owning communities (Holden *et al.*, 1996). In this context, DFID-funded research has made a major contribution to development of bait technologies such as odour-baited traps (Dransfield *et al.*, 1990) and targets (Vale *et al.*, 1988) and insecticide-treated cattle (Hargrove, 2000), which provide relatively simple means of controlling tsetse and can be tailored to suit local requirements. Other DFID-funded research has investigated socio-economic factors influencing the effectiveness and sustainability of community-organised attempts to control tsetse and trypanosomiasis (Okali and Barrett, 1998; Torr *et al.*, 2000).

### *Getting the message*

Although a range of tools now exists to enable livestock-owning communities themselves to undertake tsetse and trypanosomiasis control schemes on a more local scale, information on these is generally found in technical journals and handbooks aimed at specialist scientists. However, these are often both unavailable and unsuitable for the implementing organisations and end-users (Morton *et al.*, 1997). Furthermore, the information is largely fragmented and there is no single source that provides a comprehensive and unbiased summary of the technical and socio-economic information required to plan and implement tsetse and trypanosomiasis control. The lack of ready access to such knowledge has meant that the recent history of tsetse control contains numerous examples of community-based schemes that have been designed with inadequate socio-economic and/or technical advice, and which have faced institutional constraints. Consequently, operations have been undertaken with fundamental design flaws such as inadequate numbers and/or distributions of baits, inappropriate odours or trap designs, and inadequate attention to social and economic factors. As a result, tsetse have not been controlled effectively, control programmes have been unsustainable and the scant resources of NGOs and poor farmers have been squandered.

### *Reducing the cost of tsetse control*

While the cost and practicability of tsetse control has improved greatly over the past decade, cost still remains a major constraint. For the poorest livestock owners, the cheapest and easiest method of controlling tsetse is to treat their cattle with a pyrethroid insecticide. However, to be effective, farmers must not only treat their cattle with a synthetic pyrethroid at monthly intervals for a year or so but also act collectively over a large area (~1000 km<sup>2</sup>) to prevent tsetse reinvading from neighbouring infestations. By contrast, a single dose with a curative trypanocide can cure an animal of disease, for less than the cost of a single monthly dose of pyrethroid. Hence, the poorest individual livestock-owners rationally choose the private, immediate and obvious benefits of using trypanocides rather than the more public and long-term benefits of controlling tsetse. Ultimately however, this trypanocide-based strategy is not sustainable: resistance to trypanocides is increasing and livestock systems 'protected' by trypanocides are much less productive than those where tsetse and trypanosomiasis has been eliminated.

Farmers attempt to reduce the cost of treating cattle with insecticide by treating their cattle at 2-4 month intervals rather than the recommended interval of 1 month or less. Scientific data on the persistence of insecticides applied to cattle are however equivocal. Data from Zimbabwe, for instance, suggests that formulations are effective for 5-50 days whereas those

from Burkina Faso suggest that the insecticide may be effective for ~100 days (see Vale *et al.*, 1999 and references therein). Clearly, there is an urgent need to establish a scientifically sound recommendation on a cost:effective treatment interval for treating cattle.

Greater opportunities to reduce cost are suggested by studies showing that at least one major vector of trypanosomiasis, *Glossina pallidipes*, feeds largely on the lower legs of older and larger cattle (Vale *et al.*, 1999; Torr and Hargrove, 1999; Torr *et al.*, 2001). These findings suggest that treating only the feeding sites of tsetse on older and larger cattle can control this vector at a tenth of the current cost. Moreover, this selective approach should also avoid the potentially negative impact of pyrethroids on (i) enzootic stability for tick-borne diseases (Torr *et al.*, 2002) and (ii) beneficial insects such as dung beetles (Vale and Grant, 2001). There is, therefore, the very exciting prospect that tsetse control might be cheaper than using trypanocides. Results to date apply to *G. pallidipes* only and thus, if the approach is to be generalised, similar studies need to be made of other major vectors from southern (*G. austeni*, *G. brevipalpis*), central (*G. morsitans*) and east (*G. fuscipes*, *G. swynnertoni*) Africa.

#### *Landless livestock keepers: a special case*

All current means of reducing trypanosomiasis by controlling tsetse require agencies or communities to act in concert over relatively large areas. There are no effective methods currently available for individual poor farmers. This is an especially significant problem for landless livestock keepers such as those owning stall-fed cattle in the Tanga region of Tanzania, 40% of whom are women. Such individuals typically own just three animals with limited or non-existent grazing ranges and treating such cattle with insecticide to control tsetse is virtually useless (Torr and Kindness, 2000). Moreover, the labour demands of supplying feed and a paucity of financial resources mean that such owners are unable to afford the extra labour or financial costs of deploying traps or targets. Consequently, landless livestock-owners are entirely reliant on using trypanocidal drugs in an area where drug resistance is widespread.

Livestock owners in this area of Tanzania practice various cultural methods aimed at reducing contact between tsetse and cattle. Some have independently built netted bandas and many farmers use wood smoke to protect their cattle from flies. The largely sedentary nature of the livestock means that such protective strategies are particularly appropriate. Following various stakeholder meetings undertaken in Pangani and Tanga in 2000, the EU-funded FITCA programme is intending to promote this approach in Tanzania. However, little is really known about the efficacy and acceptability of these strategies. Recent work in Zimbabwe has already established methods for studying the responses of tsetse to cattle in bomas (Torr *et al.*, 2001), and this work has shown that the design of even normal bomas, without netting, can offer some protection to cattle.

In previous work by NRI, TTCB (Zimbabwe) and ICIPE (Kenya), several phenolic compounds were identified as potential tsetse repellents (e.g. Torr *et al.*, 1996). In initial studies it was not possible to demonstrate that these significantly reduced the tsetse challenge to an animal. However, more recent results from the continuing TTCB research programme have shown that the efficacy of these repellents is very dependent on the method of dispensing these odours and significant reductions in both the numbers of flies attracted to an animal and the number feeding on it have been demonstrated. Neem extracts have been reported to have a strong repellent effect on tsetse (Makoundou *et al.*, 1995), and IACR Rothamsted have developed a repellent for nuisance flies on cattle in Europe (John Pickett, *pers comm.*). These and other undocumented practices designed to minimise tsetse-cattle contact need to be explored and their efficacy and acceptability assessed.

Development of methods for protecting animals directly from tsetse would provide a new approach for individual farmers and would be equally applicable to community or larger groups. Community approaches to tsetse control based on bait technologies are often difficult to sustain because of difficulties in organisation and loss of enthusiasm by individuals within the community. Provision of methods to protect animals directly from tsetse should

encourage a more sustained commitment by individuals who are then responsible for the health and productivity of their own animals.

#### *Project aims*

This project undertook research to (i) identify more cost-effective insecticide application regimes suitable for controlling four major vectors of animal trypanosomiasis and (ii) assess the efficacy of the existing livestock-protection methods. The main aim of the project, however, was to develop better ways of disseminating information on methods of controlling tsetse to users in Africa. To achieve this, the project developed a partnership between technical specialists and potential users of the technologies working with NGOs, projects and government agencies concerned with controlling tsetse in Tanzania, Ethiopia, South Africa and Zimbabwe. Through this partnership, the project developed systems to help non-specialists design and implement tsetse and trypanosomiasis control programmes.

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## **PROJECT PURPOSE**

The purpose of this project was to validate, promote and disseminate strategies to improve sustainably the health and productivity of livestock maintained by poor livestock keepers in semi-arid production systems.

## **RESEARCH ACTIVITIES AND OUTPUTS**

This project's Activities and Outputs can be grouped into three broad themes.

First, research undertaken in South Africa, Tanzania and Zimbabwe aimed to reduce the cost and improve the efficacy of using insecticide-treated cattle to control tsetse. (Output 1)

Second, field studies in Ethiopia, Tanzania and Zimbabwe aimed to assess the use and efficacy of methods to prevent tsetse biting zero-grazed cattle (Output 2).

Third, the project developed a computer-based system to help non-specialist users design and implement interventions against tsetse. This system incorporated not only existing information on methods of tsetse control but also the novel methods developed by the project itself (Outputs 3-6).

For the convenience of the reader, the project's activities and outputs are grouped according to these three themes.

## THEME 1: IMPROVING THE COST-EFFECTIVENESS OF USING INSECTICIDE-TREATED CATTLE TO CONTROL TSETSE<sup>1</sup>

### Activities

Field studies were undertaken to identify restricted application regimes suitable for controlling four major vectors of animal trypanosomiasis. Results from these studies were then analysed, in combination with extensive data on the efficacy and persistence of whole-body applications generated by earlier Zimbabwe-based experiments, to provide a robust model of the effective life of insecticides applied to cattle. This general model was incorporated into a computer-based decision support system to allow users to identify an optimal application regime that suits the user's particular agro-ecological and socio-economic circumstances.

The theme's specific activities were as follows.

- Activity 1.1 Undertake field studies in Zimbabwe, Tanzania and South Africa to quantify the distribution of tsetse (*Glossina pallidipes*, *G. morsitans morsitans*, *G. austeni*, *G. brevipalpis*) feeding on cattle.
- Activity 2.1 Quantify the mortality of tsetse *spp.* exposed to cattle with insecticide applied to the entire body or selectively to tsetse feeding sites.
- Activity 3.1 Incorporate quantitative data into a user-friendly programme to allow non-specialists to identify cost-effective regime for controlling tsetse using insecticide-treated cattle.
- Activity 4.1 Disseminate and promote modified version of 'Tsetse Plan' via free distribution of CDs, establishment of a dedicated website ('tsetse.org') and dissemination workshops.

### **Activity 1.1 Distribution of tsetse feeding on cattle**

Observations of the feeding behaviour of tsetse were undertaken at:

- Rekomitjie Research Station in the Mana Pools Game Reserve of the Zambezi Valley, Zimbabwe where *G. pallidipes* and *G. m. morsitans* are present;
- Hellsgate within the St Lucia Wetlands Reserve, KwaZulu-Natal, South Africa where *G. austeni* and *G. brevipalpi* are present and;
- Bushiri and Mkindi in the Pangani and Handeni Districts of Tanzania. *G. pallidipes* is abundant at both these sites. In addition, *G. austeni* and *G. brevipalpis* are present at Bushiri and *G. m. morsitans* is present at Mkindi.

At each site, observers stood adjacent to local cattle and recorded the numbers of tsetse landing and/or feeding on various body regions of adult cattle. All observations were undertaken between May 2002 and December 2004 and covered both dry and wet seasons in each country, with at least four different animals being observed at each site. The observers recorded the numbers of tsetse landing or feeding on various parts of an ox, giving particular attention to divisions of the legs (fig. 1).

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<sup>1</sup> Research reported in Theme 1 includes work supported by DFID's Livestock Protection Programme (Project ZC0254) and FAO.

## **Activity 1.2 Mortality and behaviour of tsetse exposed to insecticide-treated cattle**

### *General methods*

All bioassays were undertaken at Rekomitjie Research Station in Zimbabwe. Test cattle were Mashona oxen and weighed ~400 kg.

### *Insecticides*

Unless stated otherwise, cattle were treated separately with one of the following commercial formulations of deltamethrin supplied by Ecomark (Zimbabwe) Ltd.

- Decatix – 50 g l<sup>-1</sup> suspension concentrate of deltamethrin diluted with water to a concentration of 0.05 g l<sup>-1</sup> and applied over the entire of an ox using a knapsack sprayer or to selected parts using a hand pump sprayer.
- SpotOn – 10 g l<sup>-1</sup> solution of deltamethrin in oil applied to various selected parts of an ox's body using a syringe.

### *Bioassays*

Except where stated otherwise, bioassays were performed with wild female *G. pallidipes*. In general, each trial comprised at least four oxen from the herd at Rekomitjie. To provide experimental controls for each trial, one animal was sprayed all over with the standard formulation of Decatix and a second animal was untreated. The remaining two, or more, animals were treated with insecticides applied to restricted regions of the animals' bodies.

All treatments were applied at about 0900 h. Between 1500 h and 1800 h on the day of treatment and for 10-40 days thereafter, each animal was sited at least 500 m apart within 1 km of the research station. Engorged tsetse were collected from each of the four cattle using hand-nets and transferred to glass tubes (2.5 cm wide x 7.5 cm long) with netting sealing one end and a cork at the other. To minimise contamination, a clean net was used to collect just one fly. For each fly, the body region (front leg, hind leg, belly, other) from where the fly was collected was recorded. Tubes containing the collected flies were stored in a humidified, polystyrene box. Catching continued until 30 flies had been collected or dusk, whichever was the sooner, and then the flies were transferred to an insectary held at ~25°C and ~70% RH for 2 h (i.e. ~3.5 h after exposure) when the number of flies knocked down was scored. Between each collection, the cattle were penned and grazed separately to avoid contamination. The duration of each trial varied according to the persistence of the standard (whole body) treatment but generally ceased when the knockdown from the standard whole-body treatment had declined to ~10%.

Studies of the landing sites of tsetse suggested a number of restricted application regimes. On the one hand, one might treat the legs and belly since virtually all *G. pallidipes* landed on this region. This area represents about 20% of the total surface area of an animal and thus treating just the legs and belly might reduce insecticide costs by 80%. On the other hand, one might consider treating say just the middle+lower front legs of an animal; this region represents just 2% of the animal's surface area but ~50% of *G. pallidipes* feed there (fig. 2). Accordingly, we assessed the persistence of five different restricted application regimes: (1.) belly and legs only, (2) legs only, (3) front legs only, (4.) lower (cannon+pastern) front legs only and (5.) front pasterns only (fig. 1). For each regime, test animals were treated with either Spot-on or Decatix and each treatment was replicated in the hot-wet and cool-dry seasons.

### *Statistical analyses*

Bioassay data were analysed with GLIM4 (Francis *et al.*, 1993) using a binomial error structure and a log link. The response variable was the number of tsetse knocked down and the binomial denominator the number exposed for a given parameter (e.g. treatment, host, formulation). Changes in the knockdown rate over time were assessed by regressing ln (days since treatment) against knock-down rate. The maximal model was first fitted to the data

and then the interactions and main effects were removed stepwise (Crawley, 1993). Changes in deviance were evaluated by chi-square, or by F-test after re-scaling if overdispersion was evident (Crawley, 1993). The time taken for knock-down to decline to 50% (KD50) and the corresponding 95% confidence limits were estimated using Fieller's theorem (Crawley, 1993).

In addition to the 22 trials undertaken during the course of this project, data from >100 bioassays of insecticide-treated cattle undertaken at Rekomitjie since 1997 were also analysed. The data included unpublished results from trials undertaken for insecticide registration purposes and previously published data (Vale *et al.*, 1999). These data were collated and analysed, as above, to assess the effect of season on the effective life of various pyrethroid formulations.

#### *Behavioural effects*

Pyrethroids can have excito-repellent effects on insects. This might repel tsetse from landing or feeding on the insecticide-treated parts of an animal which, in turn, could undermine the efficacy of a restricted application regime. Accordingly, the location and duration of tsetse landing on untreated and treated cattle was recorded by observers standing adjacent to the cattle or from an observation pit (Hargrove, 1976).

#### **Activity 1.3 Incorporate data into a decision-support tool**

The general quantitative data and models developed by Activity 1.2 were incorporated into an Excel/VBA programme which provides a convenient interface for users to model the effect of various insecticide regimes.

#### **Activity 1.4. Disseminate and promote research outputs**

AHP project R7987 has established promotion pathways to disseminate the interactive programme 'Tsetse Plan'. These include free distribution of CDs, establishment of a dedicated website and convening dissemination workshops in Ethiopia, Kenya and Tanzania. This project capitalised on these opportunities, as well as other workshops convened by the AHP, to promote the project's outputs.

## **Outputs**

#### **Activity 1. Distribution of tsetse feeding on cattle.**

Very small numbers of *G. austeni* and *G. m. morsitans* were observed in South Africa and Tanzania respectively and the data for these species in those particular countries are not considered further.

Fig. 2 shows the distribution of *G. pallidipes* observed feeding on cattle in Zimbabwe, and indicates that the flies prefer the belly and legs, especially the lower front legs, i.e. the cannons and pasterns. While the proportion on the belly and legs was always very high (~99%), the relative importance of the legs and belly varied and there is an indication that the proportion on the legs was lower for trials undertaken during the wet season (December – March; fig. 3).

Observations of tsetse from other countries showed that these species were also biased towards feeding from the legs and belly of cattle (fig. 4). There were however, consistent interspecific differences with, for instance, *G. m. morsitans* and *G. brevipalpis* showing a higher proportion on the flank and belly respectively. The upshot of all these studies is that for all species, study sites and seasons, >75% of tsetse consistently landed on the legs or belly of cattle. These two regions constitute about 20% of the total surface area of the animal and thus treating just these regions could greatly reduce the amount of insecticide used – and hence the cost – while still maintaining a high level of mortality. Accordingly, studies were made of the mortality and behaviour of tsetse exposed to cattle treated with restricted applications of insecticide.

## **Activity 2. Mortality and behaviour of tsetse exposed to insecticide-treated cattle**

### *Untreated cattle*

The knock-down rates of *G. pallidipes* and *G. m. morsitans* exposed to untreated control cattle were just 0.98% (118/12059) and 0.21% (3/1416) respectively. Since these percentages were so low, the knockdown rates for the various insecticidal treatments were not corrected for the control rate.

### *Insecticide-treated cattle – whole body applications*

The persistence of the whole body treatment varied markedly between trials, as illustrated by the knock-down rates for trials conducted in August 2002 and January 2003 (fig. 5). Plotting the KD50s for the 19 separate trials of the whole body treatment against month shows that there is a clear seasonal pattern, with the KD50 being ~1 week in October-February compared to ~4 weeks in June-July (fig. 6). This fluctuation is strongly correlated with seasonal variation in ambient temperature (fig. 7); for every 1°C increase in temperature, the length of the KD50 decreased by 1.5 days ( $r^2=0.58$ ). In addition to temperature, rain also decreased the effective life of a treatment significantly; the six shortest KD50s, for instance, all occurred in wet months. Hence, the shortest period of efficacy is in November-February, which are typically warm and wet in Zimbabwe, while the longest periods are in June-July which are cool and dry (fig. 6).

### *Other pyrethroid formulations.*

Not all of the trials of pyrethroid formulations undertaken at Rekomitjie since 1997 could be analysed to produce KD50 estimates; some trials, for instance, were not continued for a sufficiently long period to allow the knockdown to decline to <50%. However, KD50s were estimated from 50 trials of various formulations of deltamethrin, cyfluthrin and alphacypermethrin. Manufacturers produced a variety of formulations for each of pyrethroids. Coopers, for example, produced the largest range of products for testing and these included the well-established products Decatix and Spoton as well as developmental formulations that included, for instance, the synergist piperonyl butoxide or consisted of different pour-on formulations with more cost-effective spreading agents. There were generally no marked differences in the performance of formulation types and so, for the purpose of this report, we simply distinguish formulations by their manufacturer.

Fig. 8 shows a scattergram of KD50 against temperature for 50 trials of various pyrethroid formulations. Regression analysis of the deltamethrin formulations produced by Coopers' gave a similar regression co-efficient (-1.9;  $r^2=0.52$ ) to that from the 19 trials undertaken during the course of this project (fig. 7). The deltamethrin formulations produced by Zimphos and the alphacypermethrin products developed by Coopers and Fort Dodge, also produced KD50s comparable to the deltamethrin products of Coopers. There is, however, a suggestion of two differences between products. First, the cyfluthrin formulation seems to be less effective than deltamethrin and, second, the deltamethrin formulation produced by Bayer (coincidentally, the producer of cyfluthrin) seems remarkably effective. Overall however, the results show that none of the formulations had a KD50 of >30 days, and in the hotter times of year the effective of life of any formulation is only 1-2 weeks. This period is considerably shorter than the effective life of 4-8 weeks generally claimed by manufacturers.

### *Insecticide-treated cattle – restricted applications*

Each trial was subjected to regression analysis to assess whether the restricted application regimes differed from each other or from the standard whole-body treatment. In general, there was no clear or consistent difference in the effective life of Decatix and Spot-on and, as expected, the persistence of the restricted application regimes varied with season. Both these features can be illustrated by considering three trials where the legs and belly of cattle were treated (fig. 9). Regression analysis showed that there was no significant difference in the persistence of the restricted Spot-on and Decatix applications but these were consistently, and significantly, less than that of the whole body regime. It is noteworthy that for this regime, season had a bigger effect on persistence than the application regime. In the cool season (July) for instance, the KD50 for an animal sprayed with Decatix over its entire body

was 20.3 days (18.8-21.4, 95% CI) compared to 15.6 days (14.5-16.8) for the restricted application. By contrast, in the hot-wet season (February) the respective KD50s were 9.1 (7.7-10.7) and 5.4 (4.3-6.6).

The KD50s for the leg-and-belly and the leg-only applications ranged between ~2 and 25 days according to temperature (fig. 10). The more restricted applications all had very short KD50s, with the maximum, from four trials of each regime, being 2.6 days (1.9-3.3, 95% CL), 3.4 days (1.2-5.3) and 5.7 days (4.0-7.2) days for the front legs-, lower front legs- and front pasterns-only applications respectively. While the effective lives of these application regimes are very short, the amount of insecticide applied is also very small. For example, applying insecticide to the front pasterns only uses 1% of the insecticide required for the whole body regime.

The reduction in efficacy with the restricted application regimes could be because there is less insecticide on the animal as a whole and/or because tsetse have a reduced probability of contacting an insecticide-treated part of the animal. The knockdown of tsetse landing on treated- and untreated-regions of the body (fig. 11) show that for all application regimes, there is a significant knockdown of tsetse from treated and untreated zones but that knockdown is generally greater for flies that were caught from a treated zone. Moreover, as the overall area treated diminished, the knockdown of tsetse caught from the treated and untreated regions declined. Presumably, these trends are due to the movement of insecticide and tsetse from treated to untreated parts of the body. Thus the reduction in efficacy seems to be due to both tsetse landing and feeding on untreated areas that have not been treated with insecticide and because there is less insecticide on the animal in total.

The finding that knockdown is reduced for restricted application regimes, even for flies landing on the treated regions, suggested that greater efficacy might be achieved by restricting the application while increasing the concentration of the formulation applied. Accordingly, studies were made of the knockdown produced by applying Spot-on to the lower front legs at five times the normal concentration (i.e. 10% of the standard whole body dose). The overall results (fig. 12), as well as those for tsetse that had landed on the front legs, back legs or belly (fig. 13), did not indicate that this regime was any better than the standard concentration applied to the lower front legs only (fig. 7, D).

#### *Restricted application regimes for G. m. morsitans*

Limited studies were undertaken in March – May 2003 to assess whether a restricted application regime was also effective against *G. m. morsitans* which exhibits a bias towards landing and feeding on the legs of cattle but not as marked as that shown by *G. pallidipes* (fig. 2). The results (fig. 14) show that the efficacy of a deltamethrin applied to the legs and belly only is similar to that for *G. pallidipes* for that time of year (fig. 8).

#### *Do pyrethroids repel tsetse?*

The numbers of tsetse caught from the front legs, hind legs, belly and other regions in the course of the bioassays provided an indication as to whether applying insecticide to one part of an animal caused tsetse to move to another, untreated region. The results (fig. 15) show that treating an animal with insecticide reduced, slightly but consistently, the proportion of tsetse caught on the belly and increased the proportion on the legs. Nonetheless, the distributions with the various restricted regimes were not markedly different from that with the whole-body regime. Observation of tsetse alighting and/or feeding on treated and untreated cattle did not indicate that the duration that they rested on an animal was affected by the presence of insecticide (fig. 16). Overall, these results suggest that the insecticide has no materially important repellent effect on tsetse.

### **Activity 3. Incorporate quantitative data into a user-friendly decision-support tool**

The studies undertaken by this project produced three important points that need to be included in the algorithm used to select a cost-effective regime for treating cattle.

First, observations of the feeding behaviour of various species of tsetse indicated that all species showed exhibited a marked bias towards landing on the legs and belly of cattle. There were some interspecific differences but these were not marked and thus the general strategy of applying insecticide to the legs and belly of cattle is suitable for *G. pallidipes*, *G.m. morsitans*, *G. brevipalis* and *G. austeni*.

Second, the bioassays revealed a marked seasonal variation in the performance of insecticides, ranging from one week in the hot-wet season to four weeks in the cool-dry season.

Third, restricted application of insecticides will reduce costs and, to some extent, efficacy, according to the degree of restriction. A robust compromise between cost and efficacy, is provided by applying insecticide to the legs+belly or legs-only.

Taking account of these three factors, a user-friendly programme was produced to enable users to select an appropriate restricted application regime. The user is provided with choices on the application regime and method through a series of drop-down menus. The programme provides a suggestion for the most cost-effective regime and provides background information on the science that underpins these choices. This programme was incorporated into the more general Tsetse Plan decision support system (see Theme 3)

#### **Activity 4. Dissemination**

The research undertaken by this project was disseminated at workshops in Ethiopia (March 2004), Ghana (September, 2004), Kenya (October 2003, July 2004, February 2005), South Africa (May 2004), Tanzania (March 2005), Zimbabwe (September 2004, June 2005) and the UK (October and December 2004; March, 2005). During the course of the project, a number of peer-reviewed papers related to the use of insecticide-treated cattle to control tsetse were also produced<sup>2</sup>. These include:-

Vale, G.A. and Grant, I.F. (2002) Modelled impact of insecticide-contaminated dung on the abundance and distribution of dung fauna. *Bulletin of Entomological Research*, **92**, 251-263.

Schofield, S. and Torr, S.J. (2002) A comparison of the feeding behaviour of tsetse and stable flies. *Medical and Veterinary Entomology*, **16**, 177-185.

Hargrove, J.W., Torr, S.J. and Kindness, H.M. (2003) Insecticide-treated cattle against tsetse (Diptera: Glossinidae): what governs success? *Bulletin of Entomological Research*, **93**, 203-217.

Vale, G.A. and Grant, I.F., Dewhurst C.F., Aigreau D. (2004) Biological and chemical assays of pyrethroids in cattle dung. *Bulletin of Entomological Research*, **94**, 273-282.

Zollner, G.E., Torr, S.J., Amman, C. and Meixner, F.X. (2004) Dispersion of carbon dioxide plumes in African woodland: implications for host-finding by tsetse flies. *Physiological Entomology*, **29**, 381 – 394.

Foil, L.D., Coleman, P., Eisler, M., Fragoso-Sanchez, H., Garcia-Vazquez, Z., Guerrero, F.D., Jonsson, N.N., Langstaff, I.G., Li, A.Y., Machila, N., Miller, R.J., Morton, J., Pruettt, J.H., Torr S. (2004) Factors that influence the prevalence of acaricide resistance and tick-borne diseases. *Veterinary Parasitology* **124**, 163-181.

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<sup>2</sup> These papers include outputs from previous AHP-supported projects.



Torr, S.J., Mangwiro, T.N.C. and Hall, D.R. (2005) The effects of host physiology on the attraction of tsetse (Diptera: Glossinidae) and *Stomoxys* (Diptera: Muscidae) to cattle. *Bulletin of Entomological Research*, **95**, (in press).

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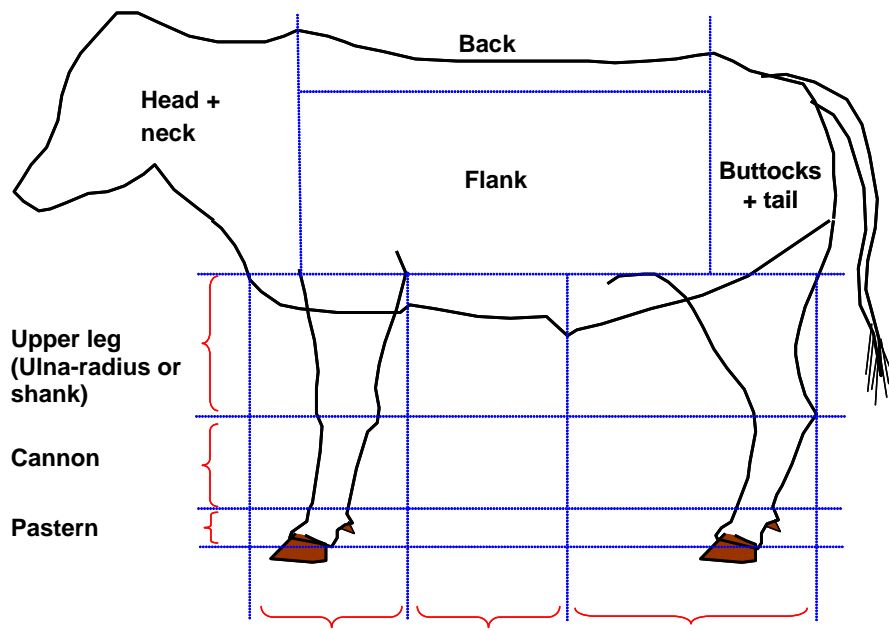


Fig. 1. Parts of an ox used to score the feeding sites of tsetse.

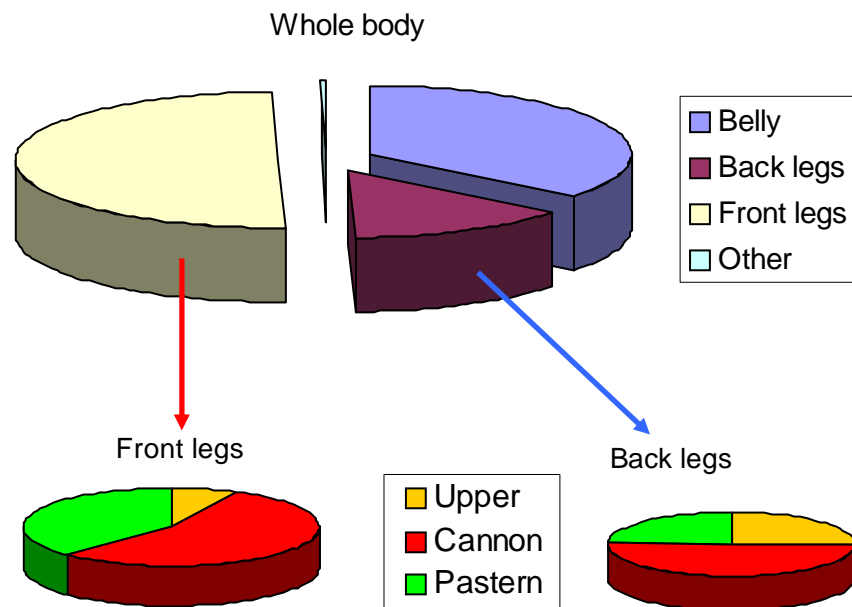


Fig. 2. Distribution of *G. pallidipes* observed feeding on oxen in Zimbabwe. (n=33591)

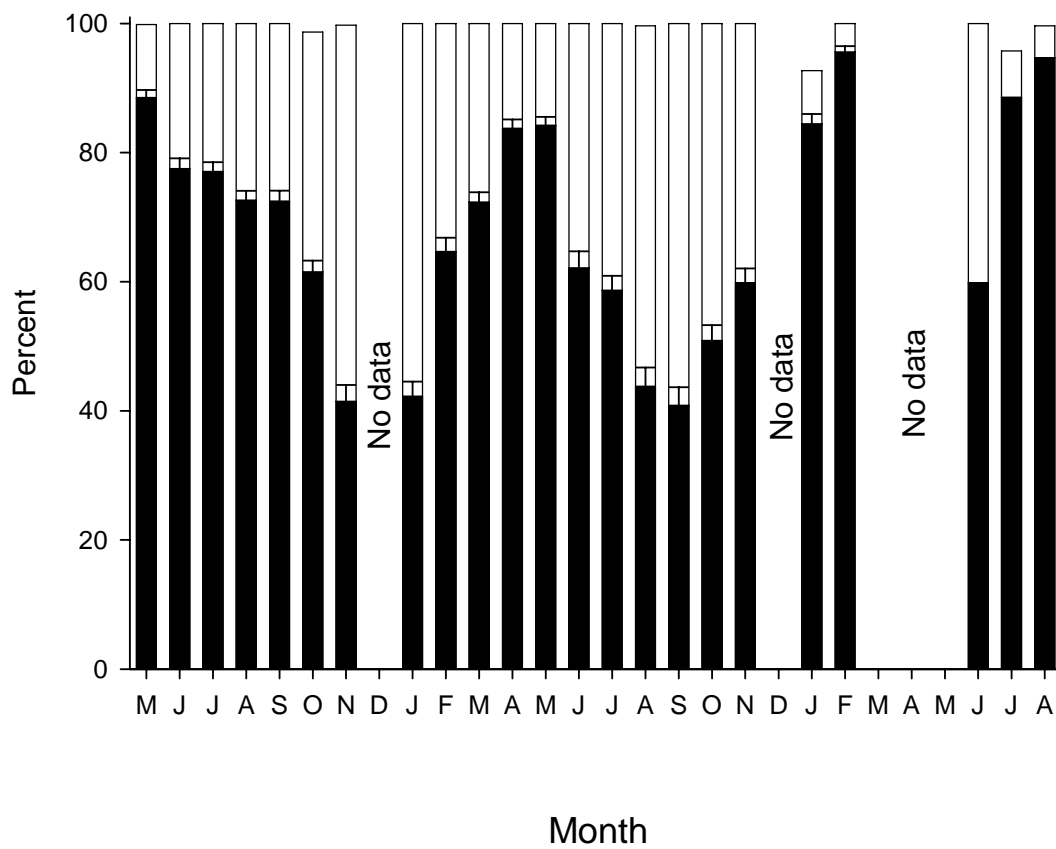


Fig. 3. Proportion of fed female *G. pallidipes* caught from legs or belly between May 2002 and August 2004. Sample size for each month varied between 299 and 929. Standard errors shown for percentages on legs only.

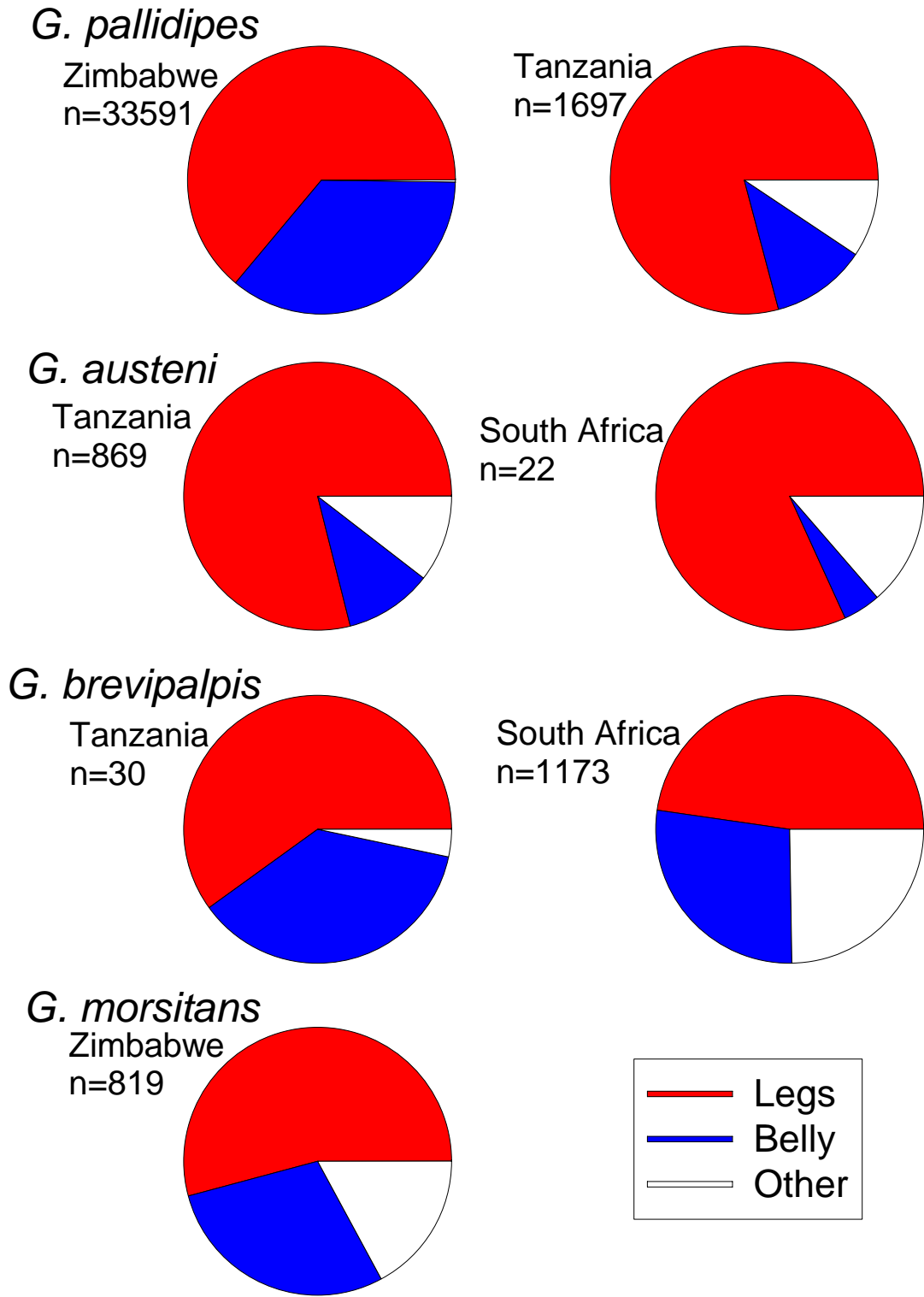


Fig. 4. Distribution of *Glossina* spp. observed landing or feeding on cattle. Data from Tanzania and South Africa collected by V. Kovacic and J. Esterhuizen respectively.

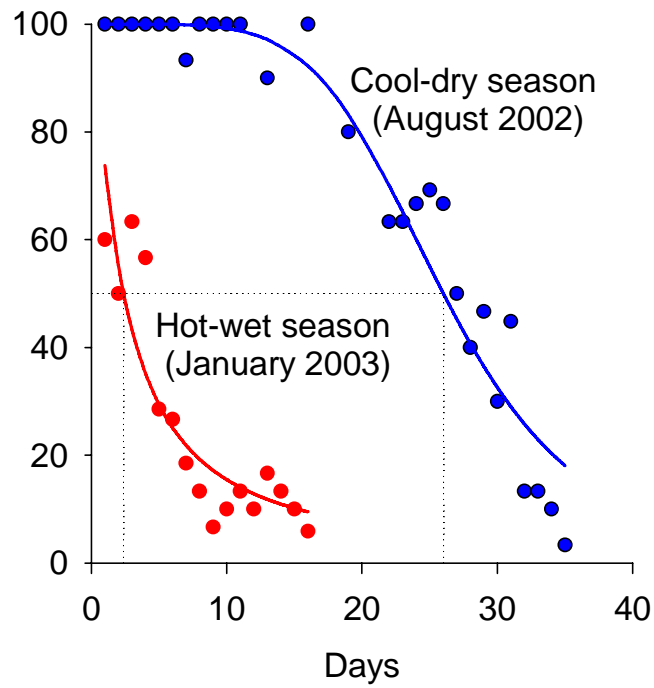


Fig. 5 Knock-down of *G. pallidipes* collected from cattle sprayed with 0.005% deltamethrin during the hot-wet (red line) and cool-dry (blue line) seasons. Dotted drop-lines indicate the times at which knock-down declined to 50% (KD<sub>50</sub>). Curves fitted by logistic regression using GLIM4, with a logit link and  $\ln(\text{days})$  as the explanatory variable.

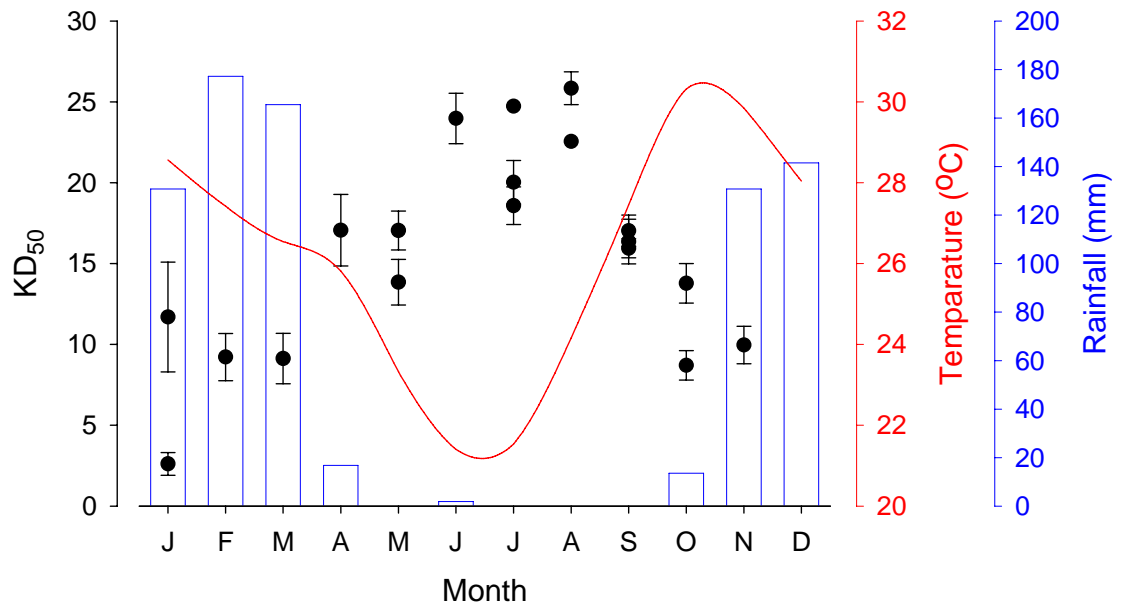


Fig. 6. Seasonal change in the period required for knockdown to decline to 50% (KD<sub>50</sub>) (solid circles, KD<sub>50</sub> ±95% C.I.). Estimated from the results of 19 separate trials of cattle treated with Decatix applied to the whole body, carried out between May 2002 and October 2003. Solid red line shows the mean monthly temperature and the blue bars indicates monthly rainfall.



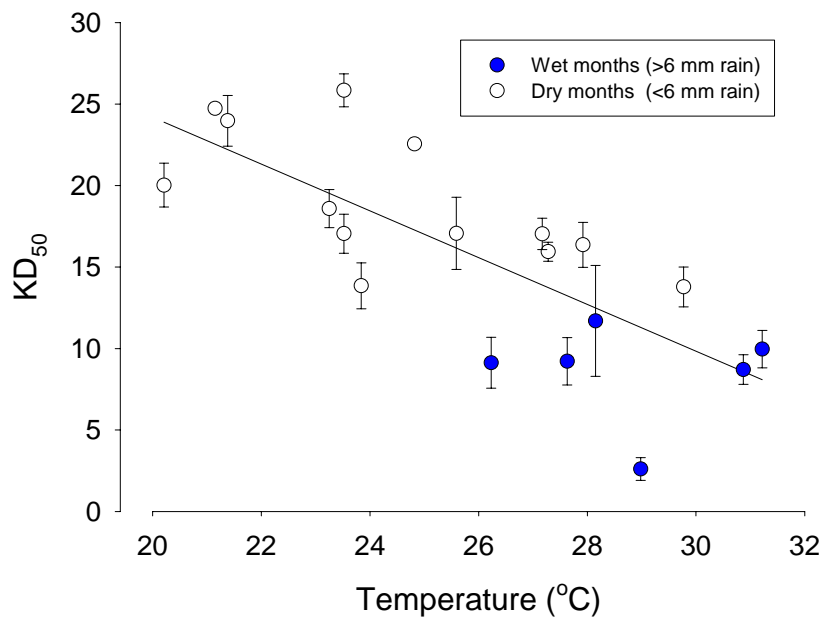


Fig. 7. Scatterplot of  $KD_{50s}$  ( $\pm 95\%$  C.I.) against mean temperature for 19 separate trials of cattle treated with Decatix applied to the whole body, carried out between May 2002 and October 2003. Open and solid (blue) circles indicate dry and wet months respectively line shows the mean monthly temperature and the blue bars indicates monthly rainfall. Line fitted by regression.

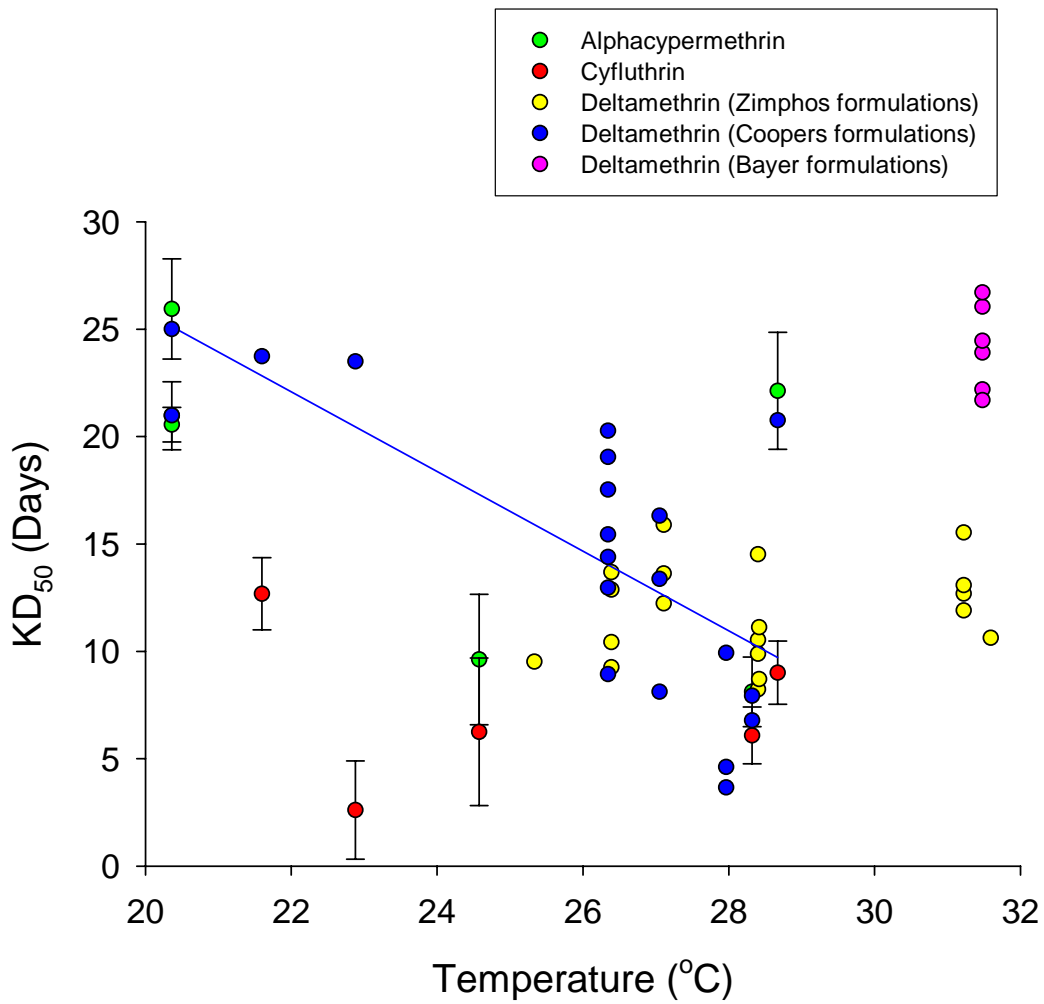
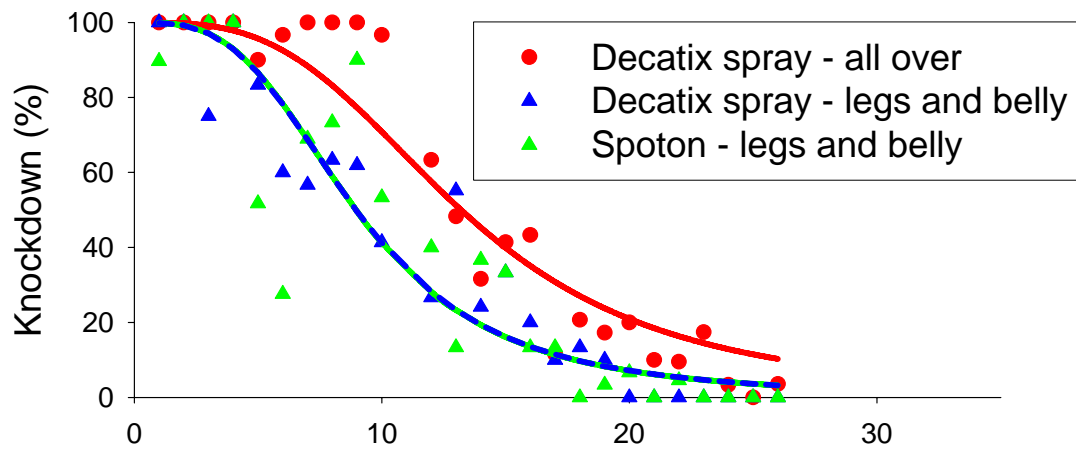
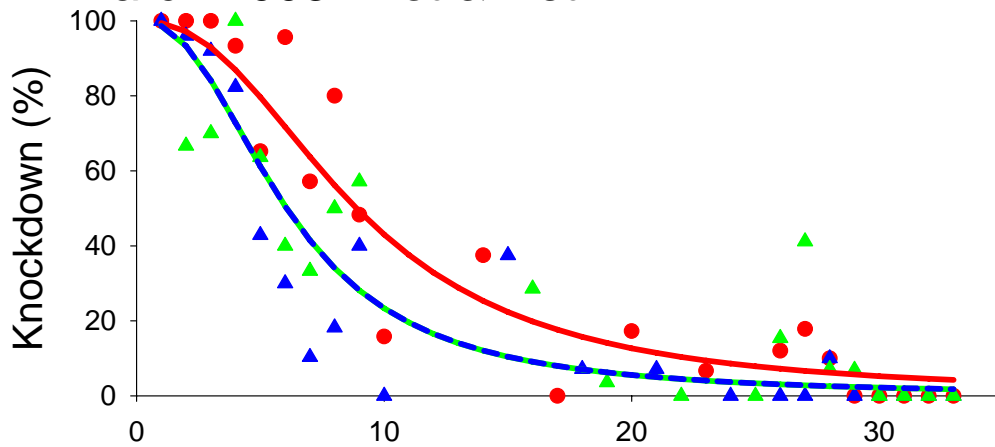


Fig. 8. Scatterplot of KD<sub>50</sub>s against mean temperature for 45 separate trials of cattle treated with various formulations of pyrethroid. Line indicates regression of KD<sub>50</sub> against temperature ( $KD_{50}=62.9-1.9.T$ ;  $r^2=0.52$ ) for Coopers formulations of deltamethrin. For clarity, 95% confidence intervals are shown for alphacypermethrin and cyfluthrin only; 95% C.I for deltamethrin formulations averaged 1.9 days (range, 0.2-6.0).

### A. October 2003 - hot & dry



### B. March 2003 - hot & wet



### C. July 2003 - cool & dry

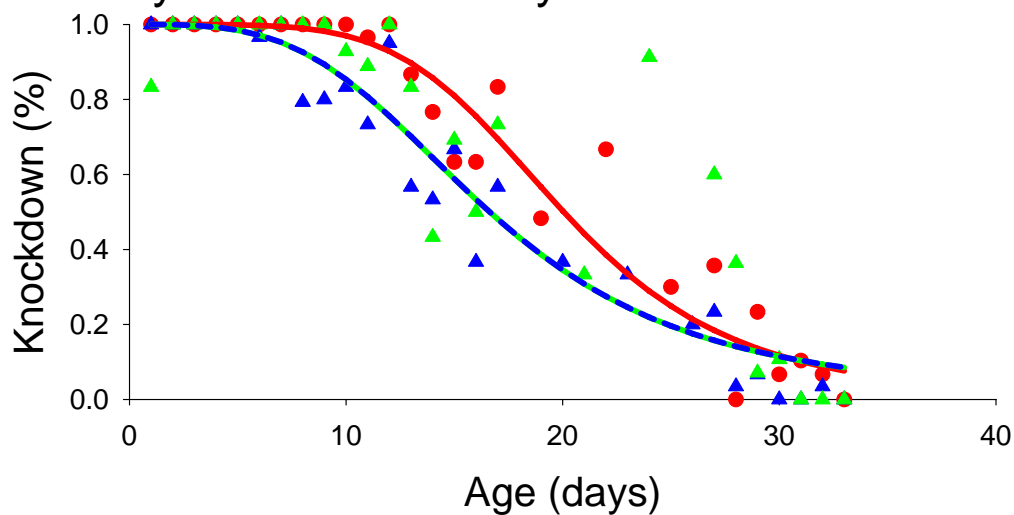
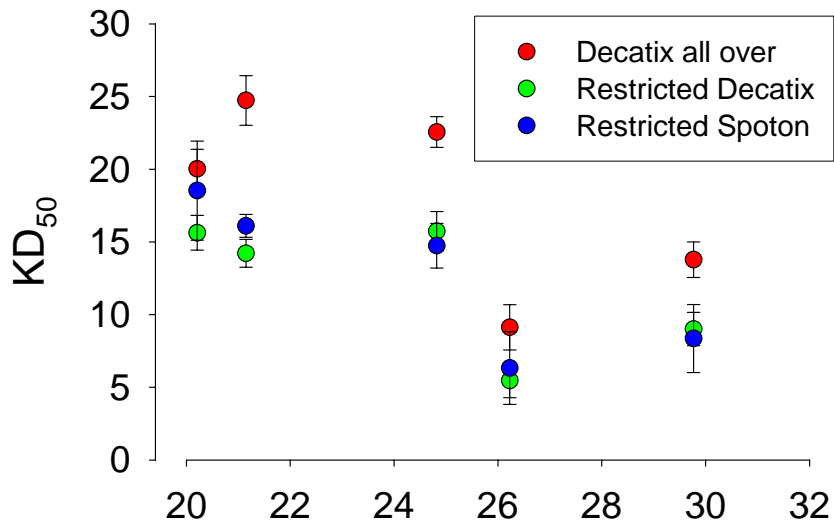


Fig. 9. Knock-down of female *G. pallidipes* collected from cattle treated with deltamethrin applied to the whole body or to just the legs and belly. Decatix was applied as a 0.0375% spray. Curves fitted by logistic regression using GLIM4, with a logit link and  $\ln(\text{days})$  as the explanatory variable.

## A. Legs and belly



## B. Legs only

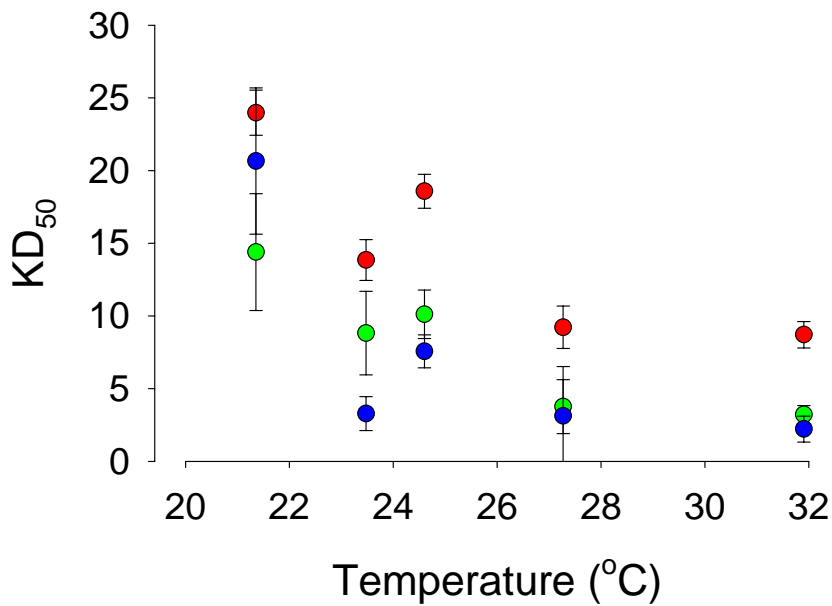


Fig. 10. Scatterplot of  $KD_{50}$ s ( $\pm 95\%$  C.I) against mean temperature for trials of cattle treated with with deltamethrin applied to the whole body or as restricted applications to the belly and legs only (A) or to the Legs only (B). Restricted applications were made with either Decatix (green circles) or Spoton (blue circles).

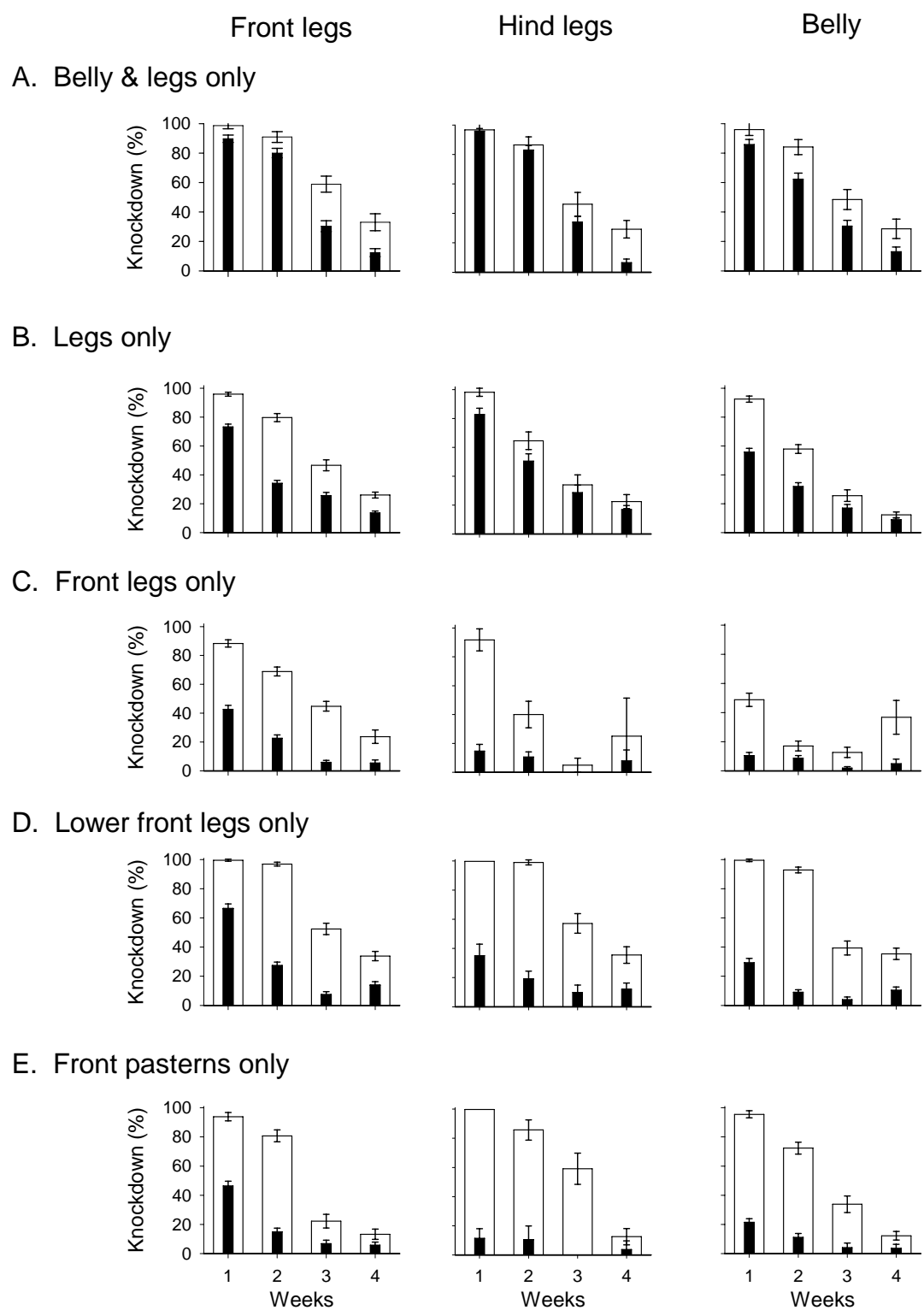


Fig. 11. Knockdown ( $\pm$ SE) of female *G. pallidipes* contacting various body regions of cattle treated with deltamethrin applied either to the entire body (open bars) or to restricted regions (solid bars). Error bars represent largest backtransformed value.

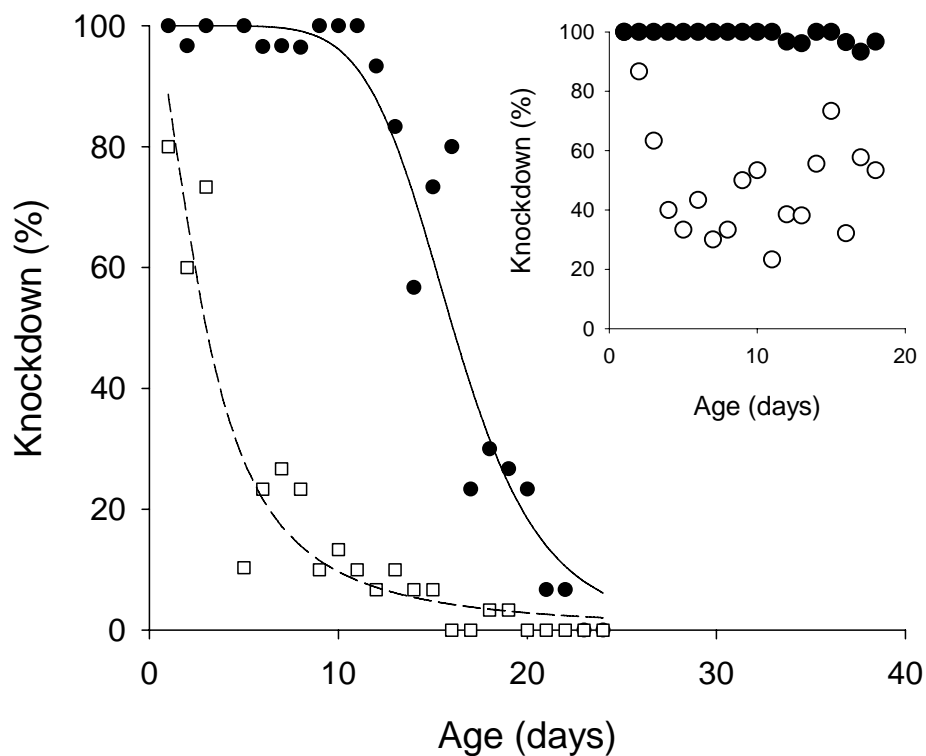
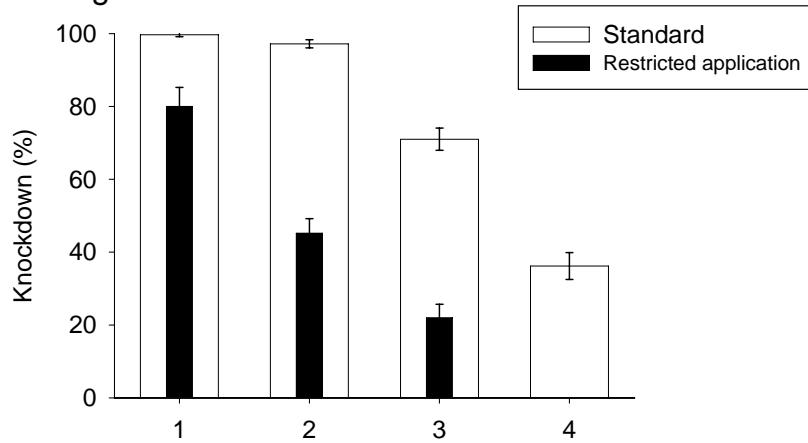
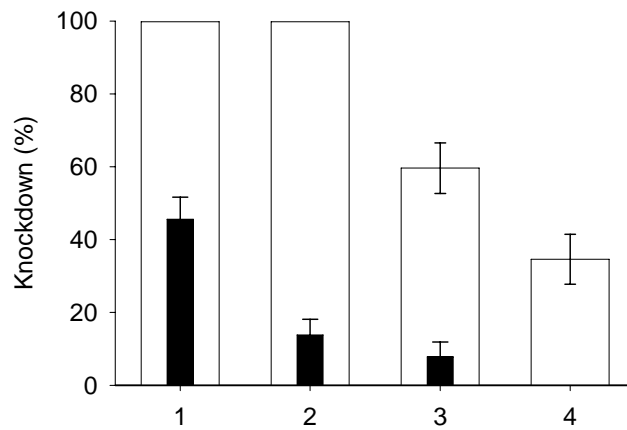


Fig 12. Knock-down of female *G. pallidipes* collected from cattle sprayed with Decatix applied as a 0.005% formulation to the whole body (solid circles) or with Spot-on applied at five times the usual rate belly and legs (open circles) only. Curves fitted by logistic regression using GLIM4, with a logit link and  $\ln(\text{days})$  as the explanatory variable. Inset shows a second trial where the whole body treatment was >90% for the duration of the experiment.

### A. Front legs



### B. Hind legs



### C. Belly

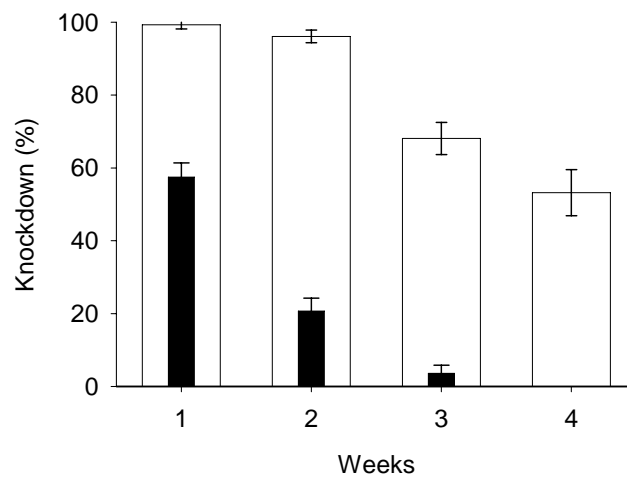


Fig . 13. Knockdown of female *G. pallidipes* contacting various body regions of cattle treated with deltamethrin applied either to the entire body (open bars) or to the lower front legs at five times the standard dose (solid bars). Error bars represent largest backtransformed value.

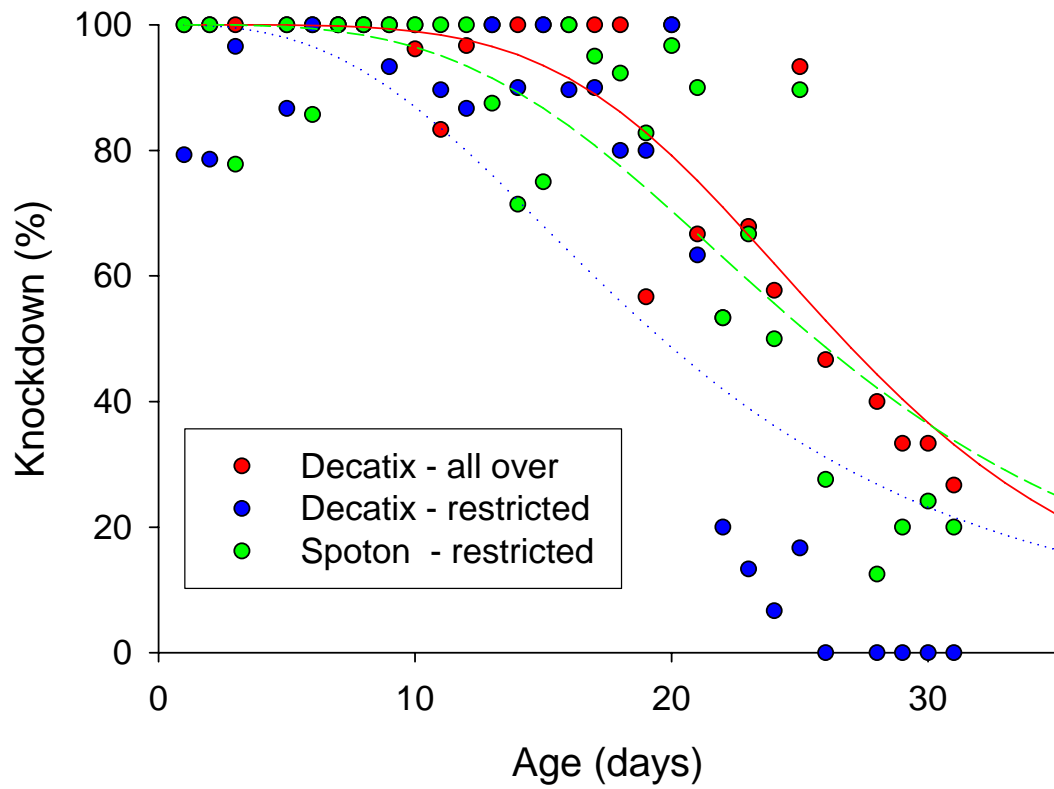


Fig. 14. Knock-down of female *G. m. morsitans* collected from cattle sprayed with 0.005% deltamethrin applied to the whole body (red circles) or to the belly and legs (blue and green circles for Decatix or Spoton respectively) only. Curves fitted by logistic regression using GLIM4, with a logit link and  $\ln(\text{days})$  as the explanatory variable.



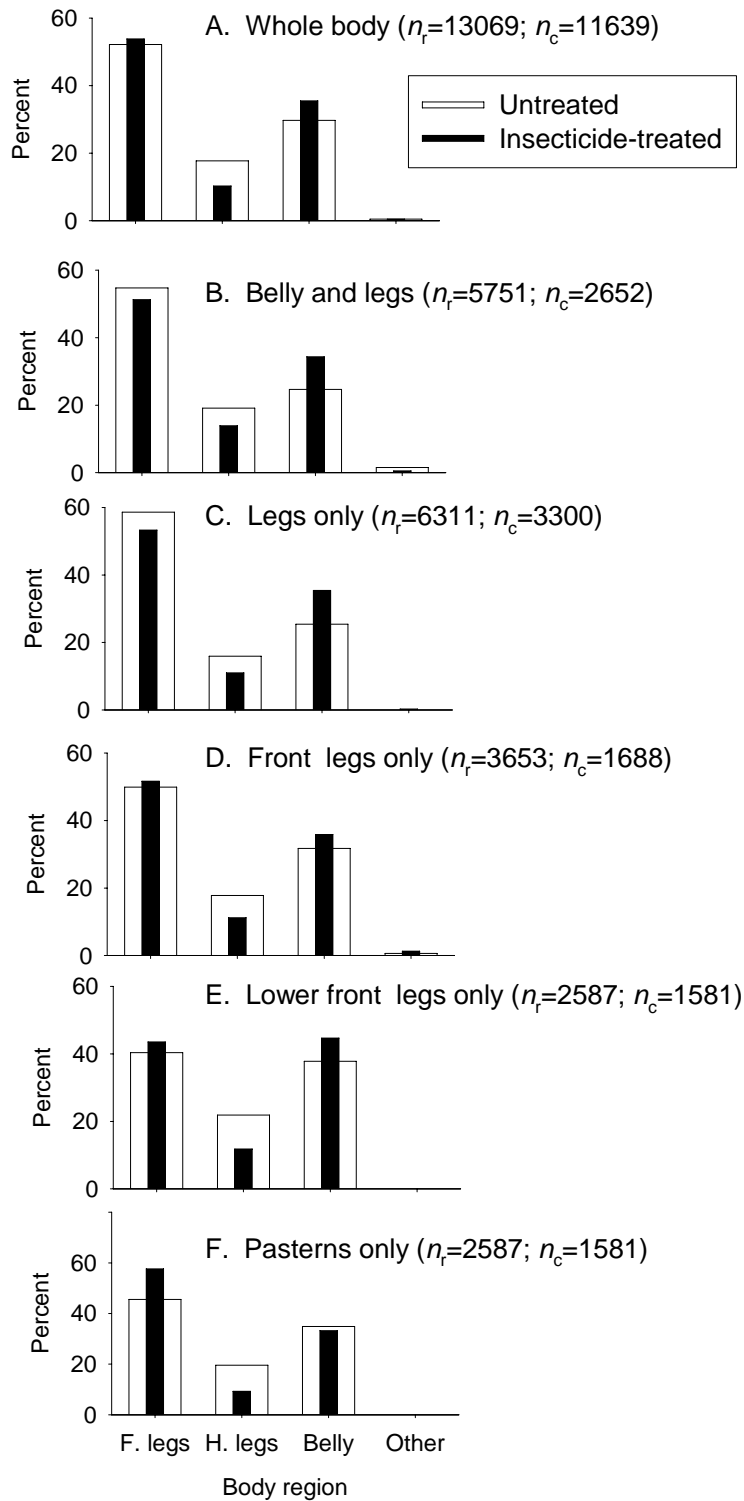


Fig. 15. Distribution of tsetse on untreated (open bars) and insecticide-treated (solid bars). Numbers of tsetse observed on treated and untreated cattle are  $n_r$  and  $n_c$  respectively;  $n_r$  includes cattle treated with Decatix or Spot-on and, hence, is generally twice as big as  $n_c$  for each treatment.

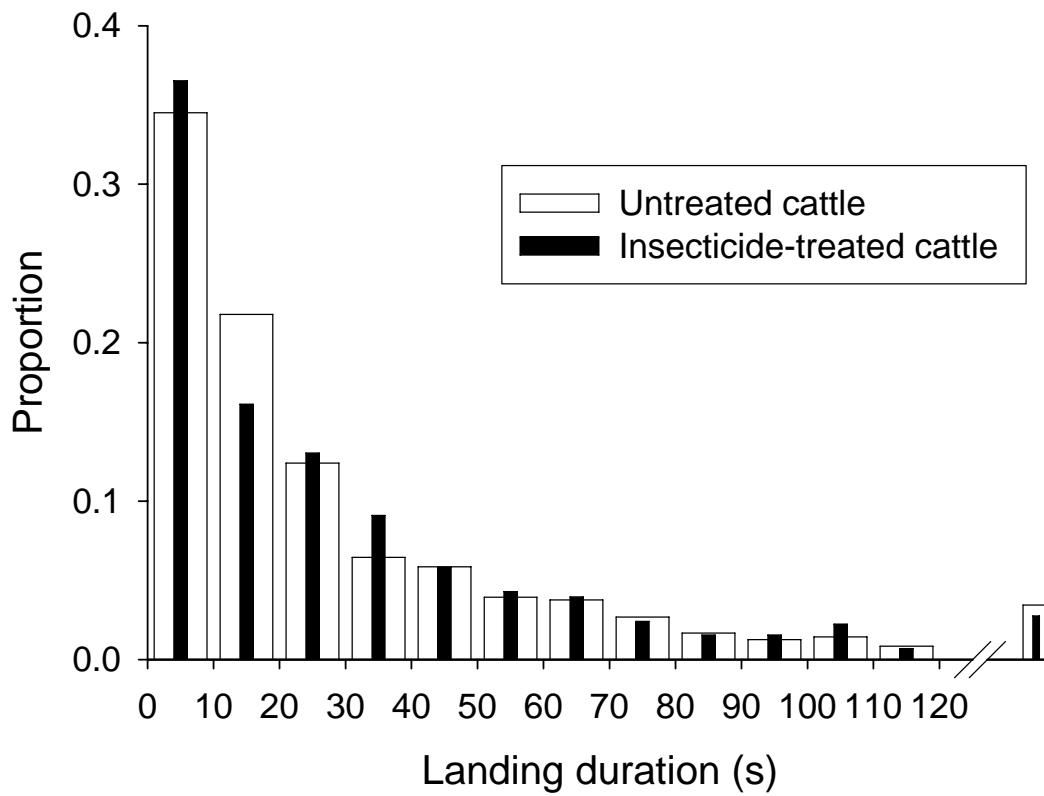


Fig. 16. Frequency of landing bouts for *G. pallidipes* feeding on untreated and insecticide-treated cattle. Data based on observation of 1194 tsetse on untreated cattle and 583 on treated cattle.

## THEME 2: LIVESTOCK PROTECTION: FARMER-BASED METHODS FOR PROTECTING ZERO-GRAZED CATTLE

### Activities

Activities within this theme aimed to identify strategies used by livestock keepers to protect their cattle from tsetse and, following on from this, field studies were undertaken to assess the efficacy of these methods.

The theme's specific activities were as follows.

2.1 Review methods of protecting individual animals from tsetse through literature, networks and other contacts and consultation livestock owners in Tanzania and Ethiopia.

2.2 Assess effectiveness of the most promising methods to reduce tsetse feeding on cattle in Tanzania and/or Zimbabwe.

2.3 Assess the suitability and acceptability of methods to resource-poor livestock owners.

### **2.1 Review methods of protecting individual**

A review of methods of protecting individual animals from tsetse and other biting flies was made, using information derived from published and grey literature and through the professional and personal contacts of the project scientists. In addition, a socio-economist and biologist visited Tanzania and Ethiopia to consult with collaborators and livestock owners on their knowledge and perceptions of methods for protecting individual animals from tsetse.

### **2.2 An Assessment of the effectiveness of methods to reduce tsetse feeding on cattle**

All studies were performed at Rekomitjie Research Station in the Zambezi Valley of Zimbabwe where *Glossina morsitans morsitans* Westwood and *G. pallidipes* Austen are present.

#### • *Responses to artificial hosts*

*Targets.*- Studies were made of the numbers of tsetse attracted to and landing on an odour-baited target. The host comprised a panel of black cloth (0.74 x 0.75 m) attached to the centre of an electric net (1.5 m x 1.5 m) mounted on a polybutene-coated tray. The target was baited with the odour from a ventilated pit (Vale, 1974) containing a single ox. The air from the pit was exhausted at 2000 L/min via a ventilation shaft (25 cm dia.) fitted with a 12 V co-axial fan (Vale, 1974).

*Traps.*- To assess the relative efficacy of different types of smoke, small (~1 m across) fires were made from the wood of either mopane (*Colophospermum mopane* Caesalpinioideae) or Zambezi coca tree (*Erythroxylum zambesiaceum* Erythroxylaceae) or dried cattle dung wood 2-10 m upwind of an Epsilon trap (Hargrove and Langley, 1990). The trap was baited with acetone (500 mg/h), 1-octen-3-ol (0.4 mg/h), 4-methylphenol (0.8 mg/h) and 3-*n*-propylphenol (0.1 mg/h) following the methods of Torr *et al.* (1997). The catch of the trap+smoke was compared with that from a similarly-baited Epsilon without a fire nearby.

Repellents can reduce the catch of traps by reducing (i) the numbers of tsetse attracted to the vicinity of a trap and/or (ii) the efficiency that flies within the vicinity of the trap enter and are retained (Vale and Hargrove, 1979). To estimate the effect of woodsmoke on these two parameters, traps baited with AOP, with or without a fire of mopane wood 6 m upwind, were placed within an incomplete ring (8 m dia) of six electric nets (1.5 m x 1.5 m). The total catch of the ring of nets plus trap provided an index of the numbers of tsetse attracted to the trap. A relative measure of trap efficiency with or without wood smoke was obtained by expressing the pooled catch of the trap as a proportion of that from the trap ( $\hat{A}$ ) plus the inside of the ring of nets ( $\hat{J}$ ). This index differs from the absolute efficiency used by Hargrove and Vale (1979) and Hargrove *et al.* (1995), amongst others, who made allowance for the

fact that the nets covered only a proportion of the circumference. The simpler index used in the present study facilitated statistical analyses of the results.

- *Responses to natural hosts*

To estimate the effect of barriers and repellents on the responses of tsetse to cattle, 1 - 4 oxen were placed at the centre of an incomplete ring (8-16 m diameter) of 6-12 electrocuting nets (Vale, 1974). The nets (1.5 x 1.5 m) were mounted on corrugated trays coated with sticky polybutene. Flies that struck the net were killed or stunned and fell on to a tray where they were retained. Tsetse caught on the outside or inside of the ring were presumed to be flying towards or away from the host, respectively. Flies with fresh blood visible through the abdominal wall were judged to have fed. Feeding efficiency was estimated as the number of fed flies caught on the inside of the ring of nets expressed as a proportion of the total catch from the inside.

*Woodsmoke*

To assess the effect of wood smoke, 1 - 4 small (~0.5 m dia.) fires of dried mopane logs were lit 2 m outside the ring of nets and 6 m upwind of the cattle.

*Traditional and netted bomas*

Traditional bomas were constructed using mopane poles, 1.5 m high. The poles were supported on a permanent steel frame and thus the boma could be assembled and dismantled within an hour, thereby allowing different designs of boma – or none - to be assembled at the experimental site each day. Netted bomas were constructed in much the same way, with netting rather than wooden poles being attached to the steel frame. Unless stated otherwise, the boma used for single animals was 3 m x 3m x 1.5 m high, while for groups of cattle, the boma was 6 x 6 x 1.5 m high.

*Insecticide*

The ring of nets was also used to assess whether treating an animal diverted tsetse from the treated host to an untreated one. Pairs of equally sized cattle were placed in adjacent pens within a ring (8 m diameter) of electric nets, with the pen for each animal being swapped randomly over each 2-day block to obviate biases due to position. For the first four days of the experiment neither animal was treated with insecticide. On the morning of the fifth day, one animal was treated with Spot-On, a pour-on formulation of deltamethrin (1% active ingredient), by applying the insecticide along its backline at the recommended rate of 0.1 ml/kg and the experiment continued for a further four days as before but with one animal treated. Treated and untreated cattle were kraaled and grazed separately and the experimental pen was cleaned daily to minimise insecticide contamination. The comparison was repeated for three pairs of cattle.

For this experiment only, the electric nets were mounted on plastic hoppers which were not coated with polybutene. Tsetse were collected from the hoppers at 30-min intervals and stored in individual tubes. The following morning, the abdomens of the flies were crushed onto filter papers, with all materials being handled with disposable gloves and instruments to avoid cross-contamination. To match the bloodmeals with cattle, samples of blood from all cattle at Rekomitjie were also collected onto filter papers which were dried and stored in the same manner as the bloodmeals samples.

At NRI, DNA was extracted from the filter papers using the protocols of Gulglich *et al.* (1994) or Ansell *et al.* (2000) and then amplified with up to five ungulate-specific primer sets (BM4513 and BM1225, Bishop *et al.*, 1994; MAP2C, Moore *et al.*, 1994; IGF-1, Kirkpatrick *et al.*, 1992; OLADRB, Peterson *et al.*, 1998) following the methods of Torr *et al.* (2001) and (Prior and Torr, 2002). Genotypes were scored from the samples and the individual-specific source(s) of each bloodmeal was identified by matching meals with cattle genotypes. Multiple meals were identified by the presence of more than two alleles per locus.

- *Experimental design and analysis*

All experiments were carried out in the 3 h before sunset when *G. pallidipes* and *G.m. morsitans* are most active (Hargrove and Brady, 1992). For experiments using the ring of nets, treatments were compared using a randomised block design; groups of adjacent days were regarded as different blocks and treatments were allocated randomly to days within these blocks. For all other experiments, treatments were incorporated into a series of replicated Latin squares consisting of days x sites x treatments.

Statistical analyses were carried out using GLIM4 (Francis *et al.*, 1993). Daily catches ( $n$ ) were transformed to  $\log_{10}(n+1)$  and then subjected to analysis of variance. To analyse changes in proportions (e.g. proportion feeding or entering a trap), a binomial model with a logit link was used and the significance of changes in deviance were assessed by  $\chi^2$ , or an  $F$ -test if the data were overdispersed and required re-scaling (Crawley, 1993). Means are accompanied by their standard errors.

## Outputs

### **2.1 Review methods of protecting individual cattle**

Some of the poorest livestock owners in tsetse-infested areas of East Africa are those owning small numbers of dairy cattle maintained on a cut-and-carry feeding regime. Such farmers are found in the Pangani district of Tanzania where households typically own ~1-2 Zebu-Fresian cows producing milk for both home consumption and sale, either locally or via various regional and national milk distribution networks.

Trypanosomiasis and ECF are the main disease-related concerns for these farmers. Trypanosomiasis prevalence is about 20% and surveys of the area indicated that all farmers treat their cattle frequently with various trypanocides, with many using Berenil at ~20-day intervals.

The only tsetse control technologies amenable to livestock owners in Pangani are the various forms of bait technology. However, none of these is suitable. On the one hand, the relatively low density of cattle, their static grazing regime and the patchy distribution of farmers – clustered mainly around main roads and towns for better access to markets – means that the use of insecticide-treated cattle will not control tsetse effectively. On the other hand, time and financial constraints mean that the use of odour-baited traps or insecticide-treated targets are neither practicable nor affordable to the farmers.

A survey of 106 small-scale dairy farmers conducted in 2002 in Pangani district revealed that virtually all farmers used wood smoke to reduce the numbers of flies, including tsetse, attacking their cattle. Many farmers also treated their cattle with insecticide, which they believed repelled tsetse, and a few farmers have also fitted their kraals with netting to prevent tsetse from biting their cattle.

Similar surveys of mixed crop-livestock farmers in the Konso district of southern Ethiopia (See Appendix 1) showed that a few farmers also used smoke to protect their cattle from flies. However, no farmers reported using netting to protect their cattle or any other cultural methods to protect their cattle from tsetse.

During the course of this project, the EU-supported Farming in Tsetse Controlled Areas (FITCA) programme actively promoted the use of netted bomas by small-scale dairy farmers in the Busia district of Kenya. The programme reported that farmers that kept their dairy cows within a protective barrier, 1.5-m high, of deltamethrin-treated netting had lower rates of trypanosomiasis and higher mean packed cell volumes (B. Bauer, unpublished data).

## 2.2 An Assessment of the effectiveness of methods to reduce tsetse feeding on cattle

### • Woodsmoke

*Odour-baited traps.* Wood smoke reduced the catch of an odour-baited trap significantly in all but one experiment (Table 1), with the catch, in general, being reduced by >80% in the presence of wood smoke.

Table 1. The detransformed mean catch (transformed means in brackets) of tsetse from odour-baited<sup>+</sup> Epsilon traps with or without wood smoke released 1-10 m upwind of the trap from *n* replicates. Asterisks indicate that the mean catches are significantly different at the  $P < 0.001$  level of significance (*F*-test).

Distance	<i>n</i>	Catch		SED	<i>df</i>	<i>F</i>
		-smoke	+smoke			
1 m	20	10.5 (1.062)	0.7 (0.231)	0.097	18	73.6***
3 m	10	15.9 (1.229)	3.1 (0.614)	0.101	8	37.2***
6 m	8	26.3 (1.436)	14.1 (1.179)	0.195	6	1.65ns
8 m	10	58.0 (1.771)	8.7 (0.986)	0.082	8	91.2***
10 m	16	84.5 (1.932)	14.4 (1.188)	0.058	14	163.0***

+Traps were baited with a blend of acetone, octenol, 4-methylphenol and 3-n-propylphenol.

Farmers use various types of wood or dried dung to produce smoke. Accordingly, an experiment was undertaken to assess whether the type of material used affected the response. The catch from a standard AOP-baited trap was compared with that from traps baited with AOP and smoke from: (i) cow dung or the wood from either (ii) mopane, a hardwood which produces relatively little smoke when burnt, or (iii) *Erthroxylum zambesiicum* (Erthroxylaceae), a softwood shrub which produced a dense white smoke. The burning dung or wood was placed 3 m upwind of an odour-baited trap and the catches were compared with the standard odour-baited trap for 12 replicates. The results showed that the three traps baited with smoke caught significantly ( $F_{3,21}=11.1$ ,  $P < 0.001$ ) fewer tsetse than the standard trap: the mean daily catches from traps with smoke from dung, hardwood and softwood were 9.8 ( $0.992 \pm 0.125$ ), 7.8 ( $0.891 \pm 0.074$ ) and 8.1 ( $0.909 \pm 0.125$ ) respectively, compared to 48.6 ( $1.687 \pm 0.135$ ) for the standard trap. Adding smoke to an otherwise unbaited trap also reduced the catch significantly ( $F_{1,10}=31.9$ ,  $P < 0.001$ ) from a mean catch of 22.6 ( $1.373 \pm 0.077$ ) without smoke to 9.3 ( $1.012 \pm 0.059$ ) when smoke was released 3 m upwind. To examine further the interaction between attractants and wood smoke, comparisons were made of the catches from (i) unbaited trap and traps baited with AOP with or without wood smoke. The results (Table 2) showed that the traps with attractants caught significantly more tsetse than the unbaited ones whereas those baited with attractants and smoke caught less, although only significantly so for the experiment where the smoke was released 10 m upwind. These results suggest that the smoke effect does not simply mask the effect of attractants but effectively repels tsetse.

Table 2. The detransformed mean catch (transformed means and standard errors of the difference in brackets) of tsetse from unbaited Epsilon traps (Trap), or odour-baited+ traps with (AOP+S) or without (AOP) woodsmoke released 3 -10 m upwind of the trap from n replicates.

Distance	n	No odour	AOP	AOP+S	SED	df	F
3 m	6	7.7 (0.940a)	74.5 (1.878b)	4.5 (0.740a)	(0.1637)	8	27.5***
6 m	6	4.21 (0.717a)	50.5 (1.712b)	2.29 (0.517a)	(0.1695)	8	28.5***
10 m	12	7.1 (0.909a)	25.6 (1.425b)	3.6 (0.659c)	(0.0661)	20	69.8***

+The odour bait comprised a blend of acetone, octenol, 4-methylphenol and 3-n-propylphenol. Asterisks indicate that the mean catches are significantly different at the  $P < 0.001$  level of significance (F-test). Means followed by the same letter differ at the  $P < 0.05$  level of probability (LSD-test).

#### *Effect of wood smoke on trap efficiency*

Wood smoke reduced significantly the mean number of tsetse attracted to the vicinity of the trap ( $F_{1,9} = 55.9$ ,  $P < 0.001$ ) and the proportion that subsequently entered it ( $F_{1,9} = 23.4$ ,  $P < 0.001$ ). In the absence of wood smoke, the mean number attracted was 37.5 ( $1.586 \pm 0.087$ ) and trap efficiency was 62.1% ( $\pm 3.4$ ) compared to 5.8 ( $0.831 \pm 0.071$ ) and 20.8% ( $\pm 8.0$ ) in its presence.

*Responses to natural hosts.* Dispensing wood smoke upwind of a host reduced the numbers of tsetse attracted but had no significant effect on the percentage feeding (Table 3). The smoke also reduced the numbers of other Diptera attracted to the cattle. For *Stomoxys* for instance, the mean catches for the control (no-smoke) treatment in the three experiments were 213.8 ( $2.332 \pm 0.109$ ), 145.6 ( $2.166 \pm 0.105$ ) and 95.2 ( $1.983 \pm 0.075$ ) compared to 66.9 ( $1.832 \pm 0.159$ ), 57.7 ( $1.769 \pm 0.117$ ) and 63.9 ( $1.812 \pm 0.089$ ) when smoke was dispensed 6, 8 and 10 m upwind respectively ( $P < 0.05$  for all experiments, F-test).

Table 3. The detransformed mean number of tsetse (transformed mean  $\pm$  SE in brackets) attracted to a stationary ox and the percentage feeding rate (SE in brackets) in the presence or absence of wood smoke from n replicates.

Distance(m)	n	Catches		Feeding rate (%)	
		-smoke	+smoke	-smoke	+smoke
6	8	74.9	22.4	73.4	68.9
		(1.880 $\pm$ 0.084)	(1.370 $\pm$ 0.136)	(2.2)	(3.8)
8	13	130.0	49.4	68.8	64.9
		(2.146 $\pm$ 0.065)	(1.702 $\pm$ 0.104)	(1.3)	(2.1)
10	8	133.3	72.6	81.1	63.0
		(2.128 $\pm$ 0.097)	(1.867 $\pm$ 0.071)	(1.4)	(2.4)

- *Bomas*

*Responses to artificial baits.* The catch from an artificial host was reduced significantly if a 1.5 m high boma of fine netting, thick netting or wooden poles completely surrounded it (Table 4, experiments a-d). There was no clear difference in the efficacy of the different types of boma, with each of them reducing the catch by 50-75%.

Table 4. Detransformed mean daily catch (transformed mean+SE in brackets) of tsetse from a standard target (- boma) or a target placed within a boma (+ boma) over *n* replicates. The bomas were constructed from various materials and varied in height. Asterisks indicate that the catch from the target within a boma is significantly different from the standard target at the  $P<0.05$  (\*),  $P<0.01$  (\*\*) or  $P<0.001$  (\*\*\*) levels of probability or not significant (ns) (*F*-test).

Boma material	Experi- ment	Height of boma (m)	<i>n</i>	Mean daily catch	
				- boma	+ boma
Wooden poles	a	1.5	12	168.8	49.8***
				(2.230±0.083)	(1.706±0.108)
Insecticide-treated netting	b	1.5	12	8.8	5.0ns
				(0.990±0.190)	(0.775±0.133)
Untreated 'shade' cloth	c	1.5	16	56.8	3.7ns
				(1.762±0.051)	(0.670±0.161)
				13.0***	14.5**
Untreated 'shade' cloth	d	1.5	12	59.5	14.5**
				(1.782±0.073)	(1.190±0.151)
				46.7	38.5ns
Untreated 'shade' cloth	e	0.3	10	(1.678±0.047)	(1.596±0.078)
				11.6**	11.6**
				3.2***	3.2***
		0.75		(0.627±0.123)	(0.627±0.123)

For the shade cloth only, studies were made of the effect of varying the height of the boma. The results (Table 4, experiment e) show that there was no significant effect when the boma was 0.75 m high but at 1.5 m and 3 m the catch was reduced significantly by 75% and 97% respectively. These results suggest that a boma, including the traditional wooden boma used by owners of zero-grazed cattle, can reduce the biting rate significantly.

In practice, bomas have some form of gate to allow the livestock and owner to enter and exit. Accordingly, studies were made of the catch from a target within a boma with or without a 1.5 m gap on the downwind-, upwind- or acrosswind-wall of the boma. The results (Table 2) show that such gaps increased the catch of the target 1.5 - 3.3-fold, suggesting that much of the protective value of the boma is lost with even relatively small gaps.



Table 5. Detransformed mean catch (transformed mean SE in brackets) from a target placed within a wooden boma with or without a 1.5 m wide gap on the downwind-, upwind- or acrosswind side of the boma from  $n$  replicates. Asterisks indicate that the catch from the target within a boma is significantly different from the standard target at the  $P<0.01$  (\*\*) or  $P<0.001$  (\*\*\*) levels of probability ( $F$ -test).

Gap position	$n$	closed	open	$F$
Downwind	12	49.8 (1.706±0.181)	168.8 (2.23±0.083)	95.9***
Acrosswind	18	321.1 (2.508±0.056)	455.0 (2.656±0.040)	13.0**
Upwind	16	133.3 (2.128±0.058)	308.0 (2.490±0.054)	47.3***

The problem of tsetse entering the boma via the entrances used by livestock keepers can obviously be prevented by placing some form of fly-proof gate at the entrance. Indeed, given that many tsetse enter via an open gate, it might be possible to exploit this behaviour by placing fine insecticide-treated netting at the gate. Such netting is virtually invisible to tsetse and, as a consequence they can collide with it and pick up a lethal dose of insecticide.

To examine the feasibility of this approach, we compared the catch of a target within a standard boma (3 x 3 x 1.5 m high) with a 1.5 m wide entrance on the downwind side that was either left open or blocked with a panel of fine- or shade-netting. The mean daily catch of tsetse, over 12 replicates, was 49.7 (1.705±0.113) with an open entrance compared to 13.6 (1.164±0.115) or 10.3 (1.052±0.114) when the entrance was blocked with fine- or shade- netting ( $F=42.6$ ,  $P<0.001$ ).

- *Responses to natural baits*

*Insecticide-treated netting.* Surrounding an ox with a 1.5 m high wall of insecticide-treated netting had no significant effect on the numbers of tsetse attracted: the detransformed mean daily catch from nine replicates was 42.8 (1.728±0.144) with the boma compared to 52.5 (1.641±0.087) without it. The boma did however reduce the feeding rate significantly ( $F_{1,8}=9.6$ ,  $P<0.05$  for difference between means) from 36.5% (±4.6) to 4.2% (±3.4).

*Wooden bomas.* Surrounding an ox with a traditional wooden boma reduced the feeding rate significantly but had no significant effect on the numbers of tsetse attracted (Table 6, Experiment 1). If the kraal had a 1.5 m gap, then the feeding rate (28%) was intermediate between the rates with (16%) and without (55%) a boma but placing netting across the gap reduced the feeding rate to 16%.

*Shade-netting boma.* A boma of shade netting also reduced the feeding rate from 78% to 22% (Table 6, Experiment 2) but had no significant effect on the numbers of tsetse attracted. However, if smoke was also released 6 m upwind of the ox, then the numbers of tsetse attracted reduced from 41 tsetse/day to 11/day, and by also placing the animal in a boma, the feeding rate was reduced to 41%. The upshot is that by combining both these methods the mean number of fed tsetse caught per day was reduced from 17.9 (1.277±0.054) fed tsetse/day with the single unprotected ox to 2.2 fed tsetse/day (0.504±0.085) when the ox was within a stable and smoke was present.

Table 7. The detransformed mean catch (transformed mean SE in brackets) and feeding rates (SE in brackets) of tsetse attracted to a single ox with or without various types of boma and/or wood smoke. Asterisks indicate that the *F*-value for the respective experiment and parameter is significant at the  $P < 0.001$  level of probability. For experiment 1, the boma wall was either continuous or had a 1.5-m gap on the downwind wall which was either left open or sealed with netting.

Treatment	Mean catch	Feeding rate (%)
<i>Experiment 1: 9 replicates</i>		
Ox only	176.0 (2.248± 0.097)	54.7 (2.8)
Ox in wooden boma	132.4 (2.125± 0.070)	16.2 (3.1)
Ox in wooden boma with gap <sup>+</sup>	165.7 (2.222± 0.072)	27.5 (3.0)
Ox in wooden boma with sealed gap <sup>+</sup>	140.9 (2.152±0.075)	16.2 (2.8)
<i>F</i> <sub>3,24</sub>	2.0 <i>ns</i>	13.2***
<i>Experiment 2: 16 replicates</i>		
Ox only	40.8 (1.621± 0.050)	78.0 (3.4)
Ox in netted boma	35.7 (1.565±0.076)	21.6 (3.7)
Ox with smoke	10.9 (1.074± 0.057)	37.9 (7.7)
Ox with netted boma + smoke	12.1 (1.118±0.081)	40.8 (7.0)
<i>F</i> <sub>3,45</sub>	37.5***	13.5***

*Insecticide-treated cattle*

Of the 438 tsetse fly bloodmeals examined, 352 (80%) produced bands when amplified with the OLADRB primers. Of these samples, only one produced a pattern that did not match that of one of the animals present within the ring. Five (1%) samples contained blood from one of the animals present and another unknown source.

The use of pour-on insecticide on one of the animals did not significantly alter the distribution of bloodmeals collected from the fed tsetse flies (Table 8) suggesting that the insecticide had no repellent effect.

Table 8. Percentage of bloodmeals taken from pairs of cattle (Animals A and B) when neither animal was treated with deltamethrin or only Animal A was treated. In each experiment, different pairs of cattle were compared. *P* is the probability that the percentage of meals from Animals A and B varied in the presence or absence of insecticide (Chi-squared test).

Experiment	Insecticide ?	% A	% B	Sample size	<i>P</i>
1	N	86 ± 3	14 ± 3	112	0.12
	Y	78 ± 7	22 ± 7	94	
2	N	51 ± 6	49 ± 6	69	0.23
	Y	38 ± 11	62 ± 11	34	
3	N	56 ± 9	44 ± 9	36	0.23
	Y	72 ± 14	28 ± 14	18	

### 2.3 Suitability and acceptability of livestock protection methods

While the surveys undertaken in Tanga region found that while most farmers used smoke to reduce flies around their cattle, many reported that they were concerned about the fire risk associated with the technique.

For the netted bomas, farmers were clearly very pleased when they first received them. However, when we returned to a village (Bhoza, Panagani District) in March 2005, a year after they had been introduced by the FITCA programme, the netting on every boma was badly damaged and would have been effectively useless. Moreover many owners of zero-grazed cattle allow their animals to graze for some of the time away from the boma where they will not be protected. The results from the FITCA-supported trial in Kenya suggested a similar problem with only ~20% of the dairy units reportedly keeping their cattle in permanently in bomas where the netting was not damaged (B. Bauer, unpublished data). The results from the current project suggest however that the delicate type of netting used in the trials was not necessary and either wooden poles or barriers constructed from old maize sacks would have been equally effective. Despite these problems, there is some evidence that the technique can produce significant health benefits and it is therefore suggested that a field trial of protective bomas, constructed from robust, cheap and readily available materials is conducted.

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## **THEME 3: DECISION SUPPORT TOOLS TO ASSIST IN THE PLANNING OF TSETSE CONTROL OPERATIONS**

Activities within this Theme aimed to develop systems to allow NGOs and non-specialist organisations to plan and implement schemes to control tsetse through the following activities.

Assessment of the current knowledge base and information needs of organisations promoting community-based tsetse and trypanosomiasis control in Ethiopia and Tanzania.

Production of materials to enable organisations to plan, manage and implement community-based tsetse and trypanosomiasis control operations.

Promotion of recommendations and dissemination materials on community-based tsetse and trypanosomiasis control to target institutions.

Evaluation of the uptake and value of dissemination outputs.

### **Activities**

#### ***3.1 Assessment of information needs***

Meetings and small workshops were conducted in Tanzania and Ethiopia with representatives from NGOs, governmental agencies, donors, (semi-)private veterinary service providers and livestock owners. Examples of existing dissemination media (pamphlets, handbooks, computer programmes) were presented at the meetings and the subsequent discussions aimed to solicit views on:-

- the aim, approach, type, effectiveness and constraints of tsetse and trypanosomiasis control schemes currently being pursued by government organisations, donor-supported projects and NGOs;
- current tsetse information sources and views on the content and perceived advantages and disadvantages of the media used;
- information needed and appropriate dissemination pathways and media.

Case studies were also made of community-based tsetse control operations in Tanzania and Ethiopia. These studies aimed to determine how and why the organisations planned and implemented the operations, assess the impact of the operations on tsetse, trypanosomiasis and livelihoods, and identify strengths and weaknesses. These studies focussed primarily on operations supported by FARM-Africa in the Konso district of Ethiopia and EU-supported operations in the Tanga region of Tanzania. These activities built on the substantial data gathered by earlier DFID/AHP- and DFID/ASSC-funded projects.

#### ***3.2 Development of dissemination materials***

Through the aforementioned combination of meetings, workshops and case studies, knowledge gaps were identified and means of bridging these were developed. The main output was the development of a computer-based decision support system.

This system was developed and pilot-tested with Africa-based partners of the project, including NGOs, projects and government institutions planning or undertaking tsetse control operations. These partners were provided with various components of the system as these were developed who then provided feedback on the use, practicability and efficacy of the media in the planning, implementation and monitoring of tsetse control operations. In addition, project entomologists, veterinarians and socio-economists assessed whether the system helped non-specialist users to make appropriate project management decisions.

In the light of feedback from technical experts and non-specialists, the decision-support system was modified and this process was iterated to improve the quality and practicability of

the decision support system. A number of the project partners were undertaking tsetse control activities thereby providing further opportunities to test and develop the utilities.

### **3.3 Promotion of dissemination materials**

The decision-support system was disseminated through workshops and meetings undertaken in Ethiopia, Kenya, Tanzania, South Africa, Uganda and Zimbabwe, via the World-Wide-Web and promotion pathways established by the FITCA and PAAT programmes.

### **3.4 Evaluation**

The above activities were completed within three years. In the final year of the project, visits were made to users in Ethiopia, Tanzania and Zimbabwe to assess the use of the decision support system. This final activity quantified the numbers and types of users and applications as well as general problems being experienced using the software. Such problems were rectified as necessary. To assess the wider uptake of project outputs, stakeholder meetings were convened with both project partners and tsetse control organisations not directly involved in the development of project outputs in Ethiopia and Tanzania.

## **Outputs**

### **3.1 Assessment of information needs**

The socio-economic activities of the project were based on the need to appreciate and understand, through hands-on practical collaboration, the needs for management and socio-economic information of the organizations typically involved in area-based tsetse control through insecticide-treated cattle (ITCs) or other bait technologies. Three visits involving collaboration with such organisations were made by the project social scientists, Dr J Morton:

- To Ethiopia in November-December 2001
- To Ethiopia in November-December 2002
- To Tanzania in January 2003

*Visit to Ethiopia 2001.* This visit consisted of an exploratory survey of Konso Special Woreda, Southern Region, Ethiopia. Konso is the home of the eponymous Konso people, who practice intensive hill agriculture, but also make use of adjoining lowland areas through a system of cattle camps. The British NGO FARM-Africa and its local partner the Konso Development Association (KDA) had attempted tsetse control in Konso using ITCs in 1994 and had then renewed their attempts, following advice from the NRI project leader in 2000 (Torr, Kindness *et al.*, 2000). The survey focused on livestock management practices and socio-economic factors that might assist or constrain the control of trypanosomiasis in cattle through insecticide-treated cattle. Information, mainly from semi-structured interviews, was collected and analysed on: objectives in keeping cattle; the fora (cattle camp) system and spatial grazing patterns; the practicalities of estimating cattle numbers, and operational grazing areas (for the purposes of calculating necessary levels of pour-on administration); trends in livestock management and livelihoods; major perceived problems in livestock production and existing management of trypanosomiasis.

An important insight gained during the study was that the costs for farmers of their current system – seeking trypanocidal treatment whenever animals show signs of trypanosomiasis, are manifold and hard to quantify, including direct mortality, the cost of trypanocides, the loss of milk from the remainder of the animal's lactation, and the loss of at least five days work if infection occurred in a draft ox during a working period. Some observations were made on methodologies for quantifying these various costs. Using these insights a comparison of the costs of the curative approach and different pour-on regimes was made, which certainly suggested that the long-term costs of using pour-ons could under certain conditions be less than the current alternative. A more structured and quantified survey was developed to investigate this further. Additional insights gained were of the problems posed to ITC methods by the sharing of grazing areas by different communities and ethnic groups, nominally belonging to different local government units, and of the importance of "transitional

costs" – having to pay both the cost of pour-ons and the costs associated with trypanosomiasis while the effectiveness of tsetse control using ITCs is building up.

A full report on this visit is provided in the appendices (Annex 1).

*Visit to Ethiopia 2002.* The second visit to the same served to refine the analysis of the costs of trypanosomiasis, and to gain a general impression of the progress, and therefore information needs, of community-based tsetse control by FARM-Africa and KDA.

The structured survey carried out by KDA yielded some useful information: unfortunately, the survey also produced conflicting findings on certain key variables such as livestock numbers which made full analysis very difficult. A shorter and simpler mini-survey was administered by Dr Morton on 10 randomly-selected cattle-owning households in Fuchucha kebele. Key findings were as follows:

- A conservative interpretation of the mortality rate from trypanosomiasis is around 17% per year
- Trypanosomiasis was the highest ranked reasons for losing cattle among farmers.
- Cattle mortality, cost of treatment and loss of draught power were the most important impacts of trypanosomiasis as perceived by farmers
- Farmers were experiencing an average of 2.5 abortions per year from trypanosomiasis
- Farmers overwhelmingly (>80%) treat trypanosomiasis every time symptoms appear
- Farmers are using 7.6 trypanocidal treatments per farmer per year, but some of these are local or traditional remedies. They appear to be paying on average Birr 13.26 per year.

As regards progress of tsetse control, it appeared that despite some level of farmer interest and reasonable performance by local applicators, the programme was in decline for a number of reasons, including:

- A lack of understanding by KDA and farmers that tsetse control is subject to a strong threshold effect, and that levels of benefits are not proportional to levels of expenditure, but that a low level of compliance will probably reduce a negligible benefit.
- A lack of extension work on the real costs of trypanosomiasis
- Delays in delivering pour-on to applicators as a result of misinterpretation of the existence of unused stocks.

Key Findings were prepared for FARM-Africa and KDA, and copied to the leader of the current project (see Annex 2).

*Visit to Tanzania 2003.* Dr Morton spent one and a half weeks with the EU-funded Tanzania Project, in order to:

- research issues of sustainability, collective action, willingness to pay and risk around tsetse control for pastoralists in Handeni District, in the light of FITCA Tanzania's forthcoming control initiatives;
- research the information needs of FITCA (as an example of donor-funded tsetse projects) on these topics;
- research on the feasibility of extending the work on malaria control through cattle to this area;
- otherwise assist FITCA as feasible.

The majority of the visit was spent in Handeni, an area mainly inhabited by Maasai pastoralists (but also Ziguwa mixed farmers), where FITCA was planning to implement tsetse

control through ITCs, but one day was spent in Pangani District, where some settled dairy farmers are using netted bomas for protection of individual animals.

At the time of the visit, the socio-economic prospects for tsetse control using a rehabilitated dip-tank under the management of village-based committees and an apex committee seemed good. Research on the impacts and costs of trypanosomiasis using semi-structured and semi-quantified methods as in Ethiopia strongly suggested that a return to dipping would be profitable for Handeni residents. Livestock-owners were confident they would be able to ensure general compliance (i.e. avoid “collective action problems”). Their expectations of being able to pass binding bye-laws was probably unrealistic, but several also pointed out that the withdrawal of the right to herd animals alongside those of the rest of the community was a very effective informal sanction. Recommendations and some guidelines on designing monitoring were shared with FITCA.

In Pangani, a small sample of farmers using netted bomas were interviewed. While their subjective satisfaction with the system was fairly high, they were also on occasions having to resort to trypanocides. Dairy farmers have an incentive to protect their cattle, but they make up a minority of the population and area-based strategies do not appear to be feasible. Unfortunately it was impossible to design any quantitative monitoring of the usefulness of netted bomas, because of the smallness of the sample, and the difficulties of doing quantitative analysis when the costs of trypanocidal treatment, the benefits from healthy animals in the form of milk, and the quality and quantity of the extremely mixed diet fed to the animals are all highly variable between farms and on one farm over time.

Full notes on the situation in and recommendations for Handeni were handed to FITCA (see Annex 3).

### **3.2 Development of dissemination materials**

As a consequence of the above consultations, a computer-based system to assist in the planning of tsetse control operations was developed. The system comprised three major components which were made available via a website ([www.tsetse.org](http://www.tsetse.org)) and distribution of free CDs.

*Tsetse Plan.*- The core component of the system is an interactive programme called ‘Tsetse Plan’ which simulates what might happen if a livestock owner or NGO was able to have a chat with an entomologist. The programme prompts the user with questions which allows the programme to build a picture of the local tsetse problem. The programme then uses the



Fig. 1 Screenshot from Tsetse Plan. The programme allows the user to specify the existing tsetse problem, and then to develop a customised plan to solve it.

information to produce a customised plan, shopping list, budget and implementation notes.

*Virtual library.*- Having a technical plan is only the first step towards controlling tsetse. The user needs to know many practical things such as how to build a trap or target, what attractants to use and how to apply insecticides. Some of this information is in the scientific



literature but this is generally neither accessible nor understood by livestock keepers living in rural parts of Africa.

Accordingly, the second component of *tsetse.org* is therefore a library of practical information provided in a simple and succinct form. This includes slideshows on how to make and use traps and targets, answers to frequently-asked questions on various aspects of tsetse biology and control, as well as socio-economic and environmental questions, and links to supporting technical papers where appropriate.

*Tsetse Muse*.- Tsetse Plan and the virtual library are designed largely to help in the design of community-based interventions to control tsetse using bait technologies on a small scale. There is an increasing interest in large-scale application of not only bait technologies but also aerial spraying and the sterile insect technique (SIT).

The third and most recent component of *tsetse.org* is therefore 'Tsetse Muse'<sup>3</sup>, an interactive programme to assist the more specialised user to plan large-scale operations using artificial baits, insecticide-treated cattle, ground and aerial spraying, and the SIT applied alone or in any temporal or spatial combinations.

Underlying 'Tsetse Muse' is a general tsetse population model. A large array of input fields allows the user to vary all key assumptions to assist in "what-if" analyses. Alternatively, the user can choose to circumvent such complexities by getting the programme to make suggestions based on in-built data.

The materials contained within the *tsetse.org* CD/website are extensive, comprising:-

- Compressed versions of Tsetse Plan and Tsetse Muse to facilitate easy downloading and installation of the programmes; Tsetse Plan and Tsetse Muse expand to ~30 Mb and 120 Mb respectively when they are installed.
- More than 140 separate pages providing answers to frequently-asked questions about tsetse biology and control.
- Slideshows on practical aspects of tsetse control showing tsetse control activities (e.g. making and deploying traps and targets) being conducted in Botswana, Ethiopia, Tanzania and Zimbabwe.

To view all these components, the reader is invited to visit [www.tsetse.org](http://www.tsetse.org) or use the CD associated with this report. However, to provide a general flavour of the programme, this report provides an overview of Tsetse Plan and the socio-economic components of *tsetse.org*. For reasons of space, only a few examples of screenshots from the programme are provided.

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<sup>3</sup> Tsetse Muse was produced with support from DFID's Livestock Production Programme (Project ZC2052). For more details on this programme please see the Final Technical Report for this project or visit [www.tsetse.org](http://www.tsetse.org)

## Tsetse Plan – a brief overview

### *Assessing the general feasibility of a tsetse control operation*

The first action in planning a tsetse control operation involves assessing whether the general plan is feasible. To do this, the programme asks the user a number of very simple questions which provides Tsetse Plan with sufficient basic information about the local situation to allow it to assess whether control is feasible.

First, the programme asks whether the user is trying to protect people or cattle, what species of tsetse is transmitting the disease and a rough estimate of the numbers of tsetse. The programme uses drop-down menus to provide various choices to these questions and provides numerous help buttons. For instance, for the question about the population density of tsetse, the help button simply asks how many flies the user caught and what method of capture was used.

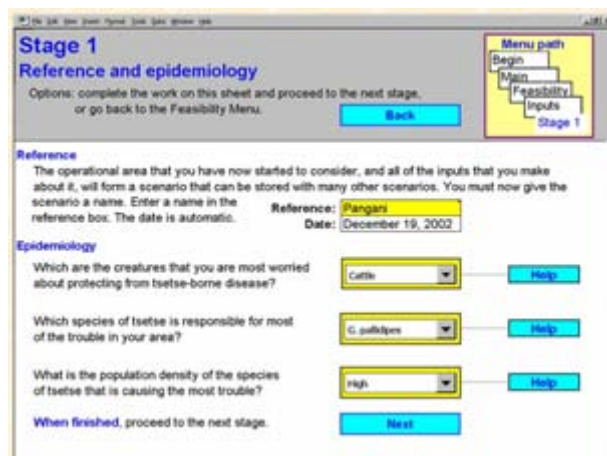


Fig. 2 Screenshot from the feasibility section of Tsetse Plan where the user is asked general questions about their particular tsetse problem.

Tsetse Plan then asks questions about the size and shape of the area that are being considered for the control operation, followed by questions about the possible sources of invasion. These questions enable Tsetse Plan to estimate how much of the controlled area is likely to be invaded from neighbouring areas that are infested with tsetse. If the area is likely to be overwhelmed by tsetse from neighbouring areas, then the programme produces a Stop! screen, telling the user to think about changing the size and shape of the operational area.

If the basic scale of the operation seems sensible then the user is asked further questions



Fig. 3 Screenshot from the feasibility section of Tsetse Plan. If the user is considering an intervention that cannot be effective, then the programme warns the user and suggests what action to take to remedy this.

about the density and distribution of cattle and wild hosts. Finally, the programme summarises the information provided and produces a brief report on the local situation with an indication of how tsetse might be controlled and how difficult this is likely to be.

*Describing the current situation*

Having completed the feasibility section, and concluded that there is a feasible control strategy, Tsetse Plan then needs to obtain a more detailed picture of the local area. In particular, it needs to know about the distribution and abundance of tsetse. This is determined by various environmental and biological characteristics of the area. Tsetse Plan has already gathered some pertinent information (e.g. the species of tsetse, the density of livestock and wild hosts) but it needs to be provided with more detailed information on matters such as local vegetation, the distribution of hosts and the location of other tsetse control operations that might be in progress.

First, the programme asks the user to produce a general vegetation map of the area. The map uses six, very general, categories of vegetation, and guidance on these is provided. Tsetse Plan then asks whether there are areas where conditions might be adverse for tsetse.

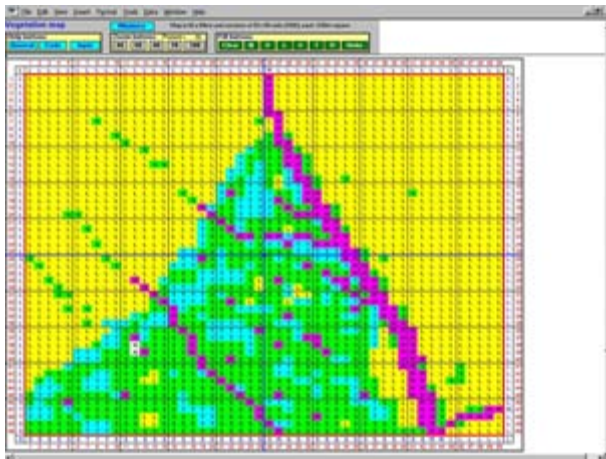


Fig. 3 Screenshot from the pre-treatment section of Tsetse Plan where the user is producing a simple vegetation map of the area.

For instance, there may be areas where there are few natural or wild hosts, or people may be treating their cattle to control tsetse in a neighbouring area. From these two maps, Tsetse Plan constructs a map of the relative abundance of tsetse in the area.

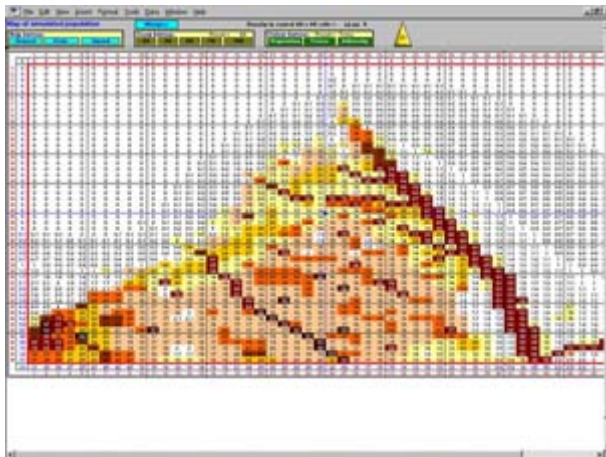


Fig. 4 Screenshot from the pre-treatment section of Tsetse Plan where the programme produces a prediction of the distribution of tsetse based on the vegetation and 'adversity' maps produced by the user.

If the map fits with the user's general expectations then the programme saves the data and proceeds to develop a control strategy.

### Developing a strategy

Having gathered all the basic data necessary, Tsetse Plan simulates the impact of various levels of control on the local population of tsetse. To do this, the programme asks the user to select where baits should be deployed; the user can choose or the programme can suggest where the baits should be deployed using data provided by the user to identify areas where baits would be particularly effective.

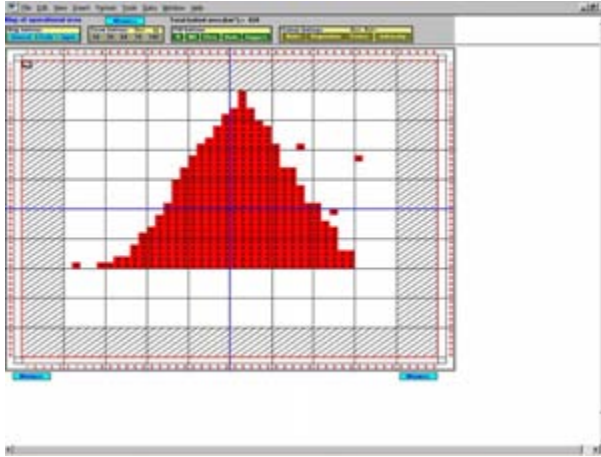


Fig. 5 Screenshot from the strategy section of Tsetse Plan where the programme suggests where the user should deploy baits.

Next, the programme runs four simulations showing what would happen if 2%, 4%, 8% or 16% of the tsetse population was killed per day in areas where baits were deployed. The output of the simulations is shown as both colour-coded changes in the density of tsetse over the entire operational area, and as a series of line graphs indicating what will happen in the monitoring area.

At the end of this process, users can look at the effects of the various levels of control (i.e. 2%, 4%, etc) and the rate that tsetse declined. From this they might decide that they want to have something slightly better than the effect produced by a 4% mortality but not necessarily as fast as 8%. The programme then lets users select any integer value of control between 1 and 16% and then observe the effect on the tsetse population.

Having seen simulations of the effect of various levels of control on the local tsetse population, the user can then investigate how the desired level of control might be achieved in practice using a combination of artificial and natural baits.

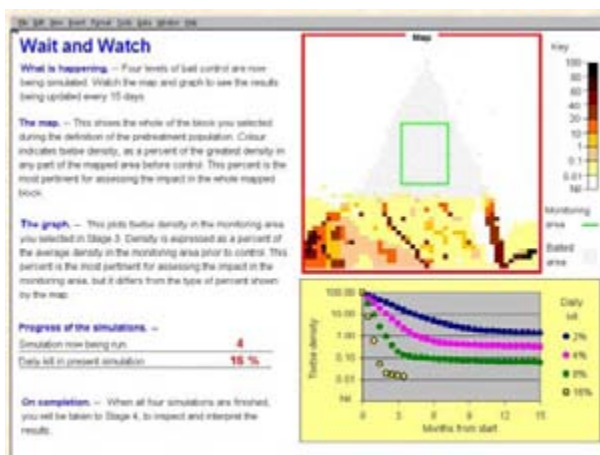


Fig. 6 Screenshot from the strategy section of Tsetse Plan where the programme predicts the impact of the baits on the tsetse population.

### Developing the tactics

First, the programme asks the user questions regarding the treatment of cattle with insecticide and the types of target, attractants and monitoring traps. As before, if the user is not sure what to do, Tsetse Plan will suggest, for instance, insecticide treatments and designs of target that are appropriate for the local situation.

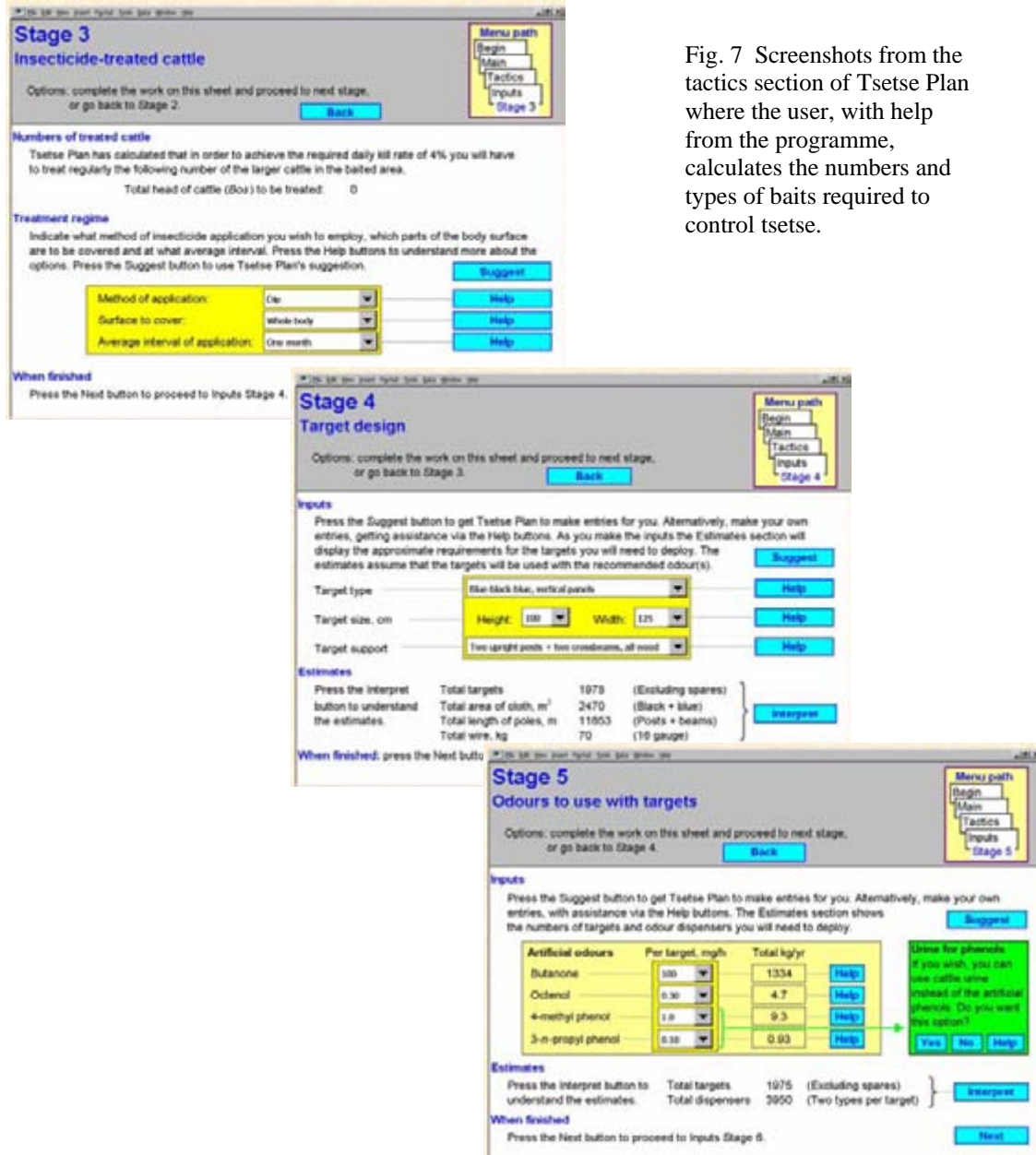


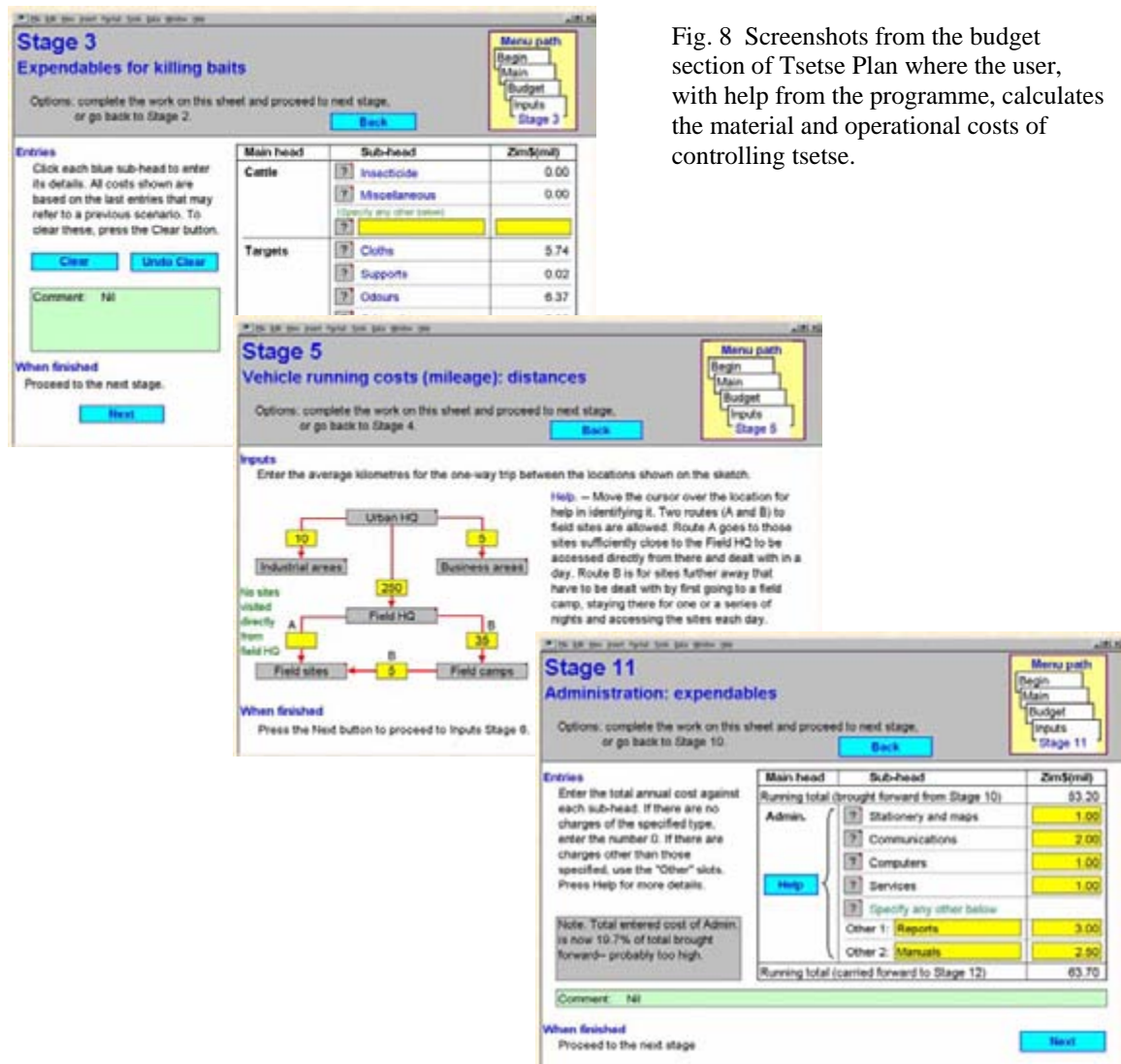
Fig. 7 Screenshots from the tactics section of Tsetse Plan where the user, with help from the programme, calculates the numbers and types of baits required to control tsetse.



### Calculating a budget

Finally, having identified the tsetse problem, designed a control strategy and developed a tactical plan to achieve this, the programme helps the user to estimate how much the intervention will cost.

Tsetse Plan first asks some very general questions, such as the costs of fuel and labour, as well as more specific ones concerning the costs of insecticides, attractants and targets, the distances between the manager's office and field stations, the numbers and costs of staff, training requirements and office equipment. From these data, the programme produces a detailed shopping list and budget.



Typically, the user finds that the cost of controlling tsetse is more expensive than they had initially imagined. However, with Tsetse Plan the user can revise the strategy, the tactics and the logistical costs, to arrive at a tsetse plan that is both effective and affordable.

### Socio-economic module of tsetse.org

Following visits to community-based interventions against tsetse in Tanzania and Ethiopia, a conceptual schema was drawn up to guide the design of the Socio-Economic Module of Tsetse.org. This module was created in html, which allows a branching structure and multiple cross-links.

The module is based on the idea that there are five key socio-economic and management factors in the realisation of community-based tsetse control using bait technologies:

- Profitability
- Entry/transitional costs
- Cashflow
- Collective action
- Knowledge and attitudes

The factors are included in what we feel are their broad order of importance, reflecting our sense that collective action issues are less of a problem than has previously been suggested (see also Barrett and Okali 1998) compared to the more basic questions of whether bait technologies are profitable to farmers, and whether farmers are able to budget for bait technologies, especially in the initial period as they begin to take effect. However, the branching structure of the module means that the user can read information on the five factors in any order.

There are links to a number of subsidiary pages on methods for investigating these factors in real-world tsetse control situations, and on practical guidelines for dealing with them so as to improve management of control. Because of the importance of profitability, and the need, reinforced by our research, to take into account various hidden costs of farmers' common practice of merely treating animals when they become sick, there is most documentation on this issue, including guidelines on the appropriate (in the main semi-quantitative) methods of assessing profitability.

Key references are provided, both to literature on tsetse/trypanosomiasis control, and to more general literature on the socio-economic issues and methods. Separate from the management and socio-economic module, but with many cross-links to it, is a set of 9 questions of a socio-economic nature in the Frequently Asked Questions.

#### *Promotion of dissemination materials*

The tsetse.org CD/website was promoted at workshops and meetings in Ethiopia (March, 2004; September, 2005), Kenya (October, 2003; February 2004), Tanzania (December, 2002; January, 2004; March 2005), South Africa (May, 2004), Uganda (December, 2005), Zimbabwe (April and September 2004; June 2005) and Austria (IAEA headquarters - January, 2005). At each of these meetings, CDs of tsetse.org were distributed and formal oral presentations and/or posters were produced. In addition, demonstrations of the programme and/or training in the use of the programme was provided, either in formal settings or informally with interested participants.

During the course of this project, a number of scientific papers related to the models that underpin Tsetse Plan and Tsetse Muse were published in peer-reviewed journals. These include:-

Hargrove, J.W (2003) Optimized simulation of the control of tsetse flies *Glossina pallidipes* and *G. m. morsitans* (Diptera : Glossinidae) using odour-baited targets in Zimbabwe. *Bulletin of Entomological Research*, **93**, 19-29.

Hargrove, J.W., Torr, S.J. and Kindness, H.M. (2003) Insecticide-treated cattle against tsetse (Diptera: Glossinidae): what governs success? *Bulletin of Entomological Research*, **93**, 203-217.

Vale, G.A. and Torr, S.J. (2005) User-friendly models of the costs and efficacy of tsetse control: application to sterilizing and insecticidal techniques. *Medical and Veterinary Entomology*, **19**, 293-305.

Hargrove, J.W. (2005) Extinction probabilities and times to extinction for populations of tsetse flies *Glossina* spp. (Diptera: Glossinidae) subjected to various control measures. *Bulletin of Entomological Research*, **95**, 1-9.

### Evaluation

*Website statistics.* Various statistics on the use of the tsetse.org website were gathered automatically. The site was made public on October 2003 and there has been a steady increase in the number of visitors to the site over the past two years (fig. 9). During the last year of the project the average number of pages viewed per month exceeded 3000. The most visited pages, excluding index pages, were those concerned with answers to frequently-asked-questions such as the chemical properties of attractants (961 visits), how to prevent ants eating the catch from traps (431 visits) and advice concerning appropriate types of trap (397 visits). During the project, there were 277 requests for the Tsetse Plan or Tsetse Muse programme, >600 downloads of the slideshows and >3800 downloads of documents (pdf files).

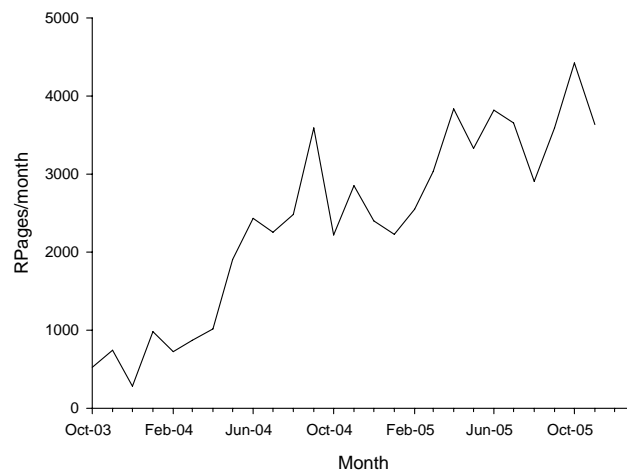


Fig. 9 Mean number of pages from www.tsetse.org viewed per month since October 2003. Data excludes pages visited by search engines and University of Greenwich staff concerned with maintaining the site.



### *Interviews.*

In November and December 2004, Dr Morton conducted a series of interviews in Addis Ababa with people involved in tsetse control to evaluate various aspects of tsetse.org and Tsetse Plan. Other individuals were invited to participate by email or post, but unfortunately uptake was low.

Diffusion of tsetse.org and Tsetse Plan has been slow, even in a country like Ethiopia where the project has done much work and been able to network intensively. None of our interviewees (nor with the possible exception of the Ethiopian NTTICC who we were unable to contact, any other people or agencies in Ethiopia) had actually used Tsetse Plan for its intended purpose of planning control. This might be thought disappointing, but evaluation was done only about one year after the official launch of tsetse.org and Tsetse Plan, and experience has shown that the use of electronic resources such as tsetse.org and Tsetse Plan generally needs several years to gather momentum.

None of the interviews fundamentally disagreed with the idea of using electronic resources such as TPTO for tsetse control at area level. Their comments on Tsetse Plan were limited by not having had the detailed experience of using it, but those who had explored it in detail, rated it highly for relevance and ease of use, and reported very positive reactions from Ethiopian staff and students to which they had introduced it. In general the interviewees gave the view that Tsetse Plan was not 100% self-explanatory and that its use required some personal training – 5-6 hours was probably the most realistic estimate.

On tsetse.org, ratings given to its different aspects (relevance, ease of use, accuracy) and different modules were almost all high, 1 or 2 on a scale of 1-5. It appeared that tsetse.org (and to some extent Tsetse Plan) had been used in teaching, or were thought by interviewees to be suitable for training uses, a slightly unexpected development.<sup>4</sup>

Some themes emerging from the interviews were as follows:

- Most interviewees wanted the scope broadened, to include other tsetse control techniques, and in one case, more information on trypanocidal drugs
- Some Ethiopian interviewees noted a Southern African bias, particularly as regards trap technologies
- Several interviewees had experienced technical problems, particularly in installing Tsetse Plan
- There was general agreement on the usefulness of a feedback section, including the possibility of posting more appropriate visual material, though no-one agreed with more radical suggestions such as allowing user input into the Tsetse Plan model or tsetse.org content themselves.
- There is clearly a need to consider the future of tsetse.org and Tsetse Plan after the end of DFID funding. There are two aspects to this, responsibility for maintenance and updating. The clearest views were for the first, and possibly the second, to be passed to an international organisation such as FAO.

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<sup>4</sup> Though it is not unusual for electronic resources to find a slightly different (and often slightly more senior or better educated) audience, see Morton, J., Adams, M., Pocard-Chapuis, R. and Bastos da Veiga, J. "The Utility, Acceptability and Relevance of the Livestock-Environment Toolbox: A Case Study of Brazilian Amazonia" Report for Livestock, Environment and Development Initiative (1999)

## CONTRIBUTION OF OUTPUTS

Work undertaken by this project produced the following outputs.

### *Theme 1: Insecticide-treated cattle*

Data on the preferred feeding sites of four major vectors (*Glossina pallidipes*, *G. m. morsitans*, *G. austeni* and *G. brevipalpis*) of trypanosomiasis.

Data on the mortality of tsetse exposed to cattle treated with insecticide applied to the feeding sites of tsetse.

A user-friendly programme, based on the above data, to help users select an appropriate and cost-effective insecticide application regime.

### *Theme 2: Livestock protection*

Data on methods used by owners of zero-grazed cattle to protect their cattle from tsetse and nuisance flies.

Data on the efficacy of these protection techniques and indications as to how these might be made more effective.

Through collaboration with the EU-supported FITCA programme, data on the feasibility and acceptability of the livestock protection methods were gathered.

### *Theme 3: Dissemination of tsetse control technologies*

A CD and website ([www.tsetse.org](http://www.tsetse.org)) on methods of controlling tsetse was developed and widely distributed to individuals, NGOs, government and international organisations concerned with tsetse control. The CD/website contained:-

A decision support system (Tsetse Plan) which allowed non-specialist users to develop and implement community based schemes to control tsetse.

A decision support system (Tsetse Muse) to allow specialist users (e.g. entomologists, socioeconomists, veterinarians concerned with government- and donor-supported tsetse control projects) to develop large-scale strategies to control tsetse using all available methods.

>140 pages providing answers to frequently-asked-questions and examples of how to use or make various pieces of equipment used in the control of tsetse.

These outputs will contribute to several aspects of the health and productivity of livestock, and hence livelihoods, in the tsetse-infested regions of sub-Saharan Africa

### *Reducing the cost of tsetse control*

The findings of this project will enable livestock owners to improve the cost-effectiveness of using insecticide-treated cattle to control tsetse-borne-trypanosomiasis. Treating, for example, only the belly and legs of cattle will reduce insecticide costs by 80% but there is also a reduction in efficacy associated with this costs saving. At an average temperature of 25°C for example, the KD50 for the whole body regime is ~15 days compared to ~10 days for the restricted one.

From a practical point of view, it is more useful to consider the average percentage knock-down over equivalent periods. For example, using the regression equations from a trial conducted in August 2004, where the mean temperature was 24.8°C, the average

knockdown over 28 days would be 78% compared to 57% for the restricted (belly+legs) regime. Thus while the ratio of insecticide costs for the restricted and whole body regimes is 1:5, the benefit ratio is 0.57:0.78 and hence the overall reduction in cost is effectively 73% rather than 80%. However, if we consider shorter re-treatment periods the benefit ratio of the restricted application regime improves: at fortnightly intervals the ratio is 0.93:0.99 and at weekly intervals the ratio is 1:1. In short, the economic benefits of using a restricted application regime are greater as treatment intervals become shorter.

#### *Improving the effectiveness of using insecticide-treated cattle to control tsetse*

The present study provides conclusive evidence that the effective life of insecticides is between 1-4 weeks, in marked contrast to the widespread perception that far longer re-treatment intervals are adequate. For instance, livestock keepers in the Konso district of Ethiopia have used treatment intervals of 4-12 weeks to control tsetse over the past decade, and we are aware of similar periods being used in tsetse control operations elsewhere in Ethiopia and Tanzania. These long intervals are largely because farmers cannot afford the cost of frequently treating their cattle.

In the case of Konso for instance, farmers were prepared to treat their cattle four times per year. The average knockdown produced by an animal treated at this interval would be just 27%. If, on the other hand, they used the restricted application regime at monthly intervals, the average knockdown would be more than doubled (57%) and their insecticide costs would be reduced by 40%. Even better improvements in control would occur however if they treated their cattle at, say, three week intervals. In this case, the insecticide costs would still be less than the current (whole-body) regime but the average knockdown would be nearly tripled (73%). Three-fold improvements in the mortality imposed on a tsetse population can have a profound impact; killing 1% of the female population per day would reduce a population by 99% over the course of a year whereas a 3% reduction would reduce it by 99.99% (Vale and Torr, 2004). Thus the restricted application regime not only allows farmers to reduce costs but will enable them to achieve far better control.

#### *Improving animal productivity*

In most tsetse-affected areas, livestock keepers use trypanocides to combat trypanosomiasis in their cattle. Generally farmers tend to favour using curative drugs such as diminazene aceturate rather than prophylactic drugs such as isometamidium chloride; curative drugs are cheaper, easier to administer, cause less stress to the animal and can also cure the tick-borne disease babesiosis. Each treatment costs about US\$1 but in addition there are a number of more significant costs inherent in this approach, largely because the animal contracts trypanosomiasis. These costs include: mortality of adult cattle, abortion, loss of milk and loss of draught power. Morton (2001; see example in the tsetse.org site) estimated that for livestock keepers in Konso, these indirect costs amounted to 19 Birr/animal/year compared to 3 Birr/animal/year (0.5 treatments/animal/year) for use of trypanocides and 20 Birr/animal/year (~8 Birr = 1\$ at 2001 prices) to treat their cattle at 3-month intervals. With a restricted application regime, the farmers could have improved the impact of control as described above. Improving control of tsetse would have reduced the incidence of trypanosomiasis and hence reduce the production-related costs of controlling trypanosomiasis with drugs.

However, it is striking that the cost of tsetse control was similar to the trypanosomiasis-related losses and considerably more expensive than the cost of using trypanocides. Consequently, sustainable control of tsetse in Konso has proved to be very difficult. While this is just one example, it is typical of the situation in the poorer, tsetse-affected regions of Africa.

More recently, the cost of pyrethroids has declined dramatically, largely because they are no longer under patent and hence not subject to monopolistic price distortions. For example, a suspension concentrate of 40% alphacypermethrin shipped to Africa costs US\$25 per litre (personal communication, F. O'Shea, Insect Applications Ltd, Berkamstead). Allowing for

dilution at 2000:1 and spraying with 1.8 litres per animal (i.e. sufficient to treat the whole body) would cost \$0.0225 per fortnightly treatment. After making a generous, ten-fold allowance for import duty and the cost of equipment and labour for spraying, the price of each treatment is \$0.23 and the annual cost is just \$5.87/animal/year. If we then include the economies made possible by needing to treat only the larger animals within a herd (Torr *et al.*, 2001) with a restricted application of insecticide, then the per capita cost of treating cattle is <\$1/year, ie comparable to a single treatment with a trypanocide. These changes mean that, at last, the costs of tsetse control are comparable with those of using trypanocides but without the inherent problems of drug resistance and chronic losses in animal productivity.

#### *Integrated control of vector-borne diseases*

*Tick-borne diseases.* Poorer communities in Africa generally keep indigenous breeds of cattle. These breeds have the important advantage of being resistant to several important tick-borne diseases. The resistance depends on young cattle being bitten by infected ticks; the young cattle become infected, experience only mild and transitory disease and are immune thereafter. This condition, termed enzootic stability, can be undermined by widespread and frequent treatment of cattle with pyrethroids for tsetse control. However, the attachment sites of ticks and the feeding sites of tsetse differ (Torr *et al.*, 2003) and >95% tsetse feed on adult cattle (Torr *et al.*, 2001). Thus, by treating only the legs and bellies of older cattle effective tsetse control can be achieved while reducing the threat to enzootic stability.

*Malaria.* The most exciting additional benefit arising from the treatment of cattle with pyrethroids to control tsetse relates to the possibility that this technique might also contribute to the control of malaria. In the arid regions of Africa (e.g. Greater Horn region, the Maasai steppe of East Africa and southern Africa) *Anopheles arabiensis* is the main vector of malaria. This species feeds on humans and cattle and thus the treatment of cattle with pyrethroids could lead to a reduction on vectorial capacity for malaria and hence disease incidence. Several DFID-funded projects (e.g. R8214, AHP) have undertaken research in areas of southern Ethiopia where malaria and trypanosomiasis are the most important diseases of humans and livestock respectively. Results show that the pyrethroid formulations and application regimes used to control tsetse are also effective against *An. arabiensis* and theoretical models of malaria suggest that seasonal treatment of cattle with pyrethroids could produce significant reductions in malaria incidence.

#### *Cleaner tsetse control*

Results from an earlier LPP-supported project (R7539) showed that pyrethroids had a significant impact on the invertebrate fauna involved in breaking down cattle dung (Vale and Grant, 2001; Vale *et al.*, 2004). This has potentially serious implications for those production systems where cattle dung plays an important role in maintaining soil fertility. However, the effect on dung fauna is largely obviated by restricting insecticide to the legs and belly (Vale, data being prepared for publication). Thus the restricted regime is not only cheaper and more effective but also has negligible environmental impact.

#### *Promoting rational interventions against tsetse*

'Tsetse Plan' will help non-specialists (e.g. development NGOs and projects) design and implement more cost-effective interventions against tsetse. While bait techniques to control tsetse have been available to rural communities for nearly 20 years, these methods have often been applied inappropriately. The decision support system and associated information on bait techniques will promote better use of these technologies. Similarly, the Tsetse Muse support system will assist donor agencies (e.g. FAO, PATTEC) and African governments to develop cost-effective strategies. As an example, FAO and PATTEC are currently (December 2005) using Tsetse Muse to develop a programme to control human and animal trypanosomiasis in Uganda.

### *Protecting zero-grazed cattle*

The EU-supported FITCA programme has promoted the use of netted bomas to reduce trypanosomiasis in zero-grazed cattle. The technique has drawn a lot of attention from farmers, governments and donors. However, there is scant data on the efficacy of the technique and there are practical problems in maintaining the relatively fragile netting. This project has provided data on the efficacy of the technique and also suggested how more robust netting, or even traditional bomas might be adapted to produce similar benefits.

### *Policy implications and impact*

The most important policy implication of this research relates to the Tsetse Plan and Tsetse Muse decision support systems which provides a rigorous framework for designing and implementing tsetse control programmes. The Tsetse Plan programme synthesises knowledge from 20 years of research and, using a user-friendly interface, allows non-specialist users to assess the feasibility of various tsetse control strategies. Earlier versions of this programme have been used in the design of several tsetse control programmes undertaken by NGOs (e.g. FARM Africa), national (Southern Tsetse Eradication Programme, Ethiopia) and donor (EU-supported FITCA projects in Tanzania, ADB) institutions.

The research also provides important implications for the integrated management of vector-borne diseases. In particular, results from the present study show how tsetse control can be implemented without undermining the sustainable management of tick-borne diseases and whether malaria in Africa might be controlled by pyrethroid-treated cattle.

### *Current impact especially on the poor*

The 1999 review of DFID's trypanosomiasis research programme makes it clear that DFID has been the most important supporter of the development of bait technology for controlling tsetse. This technology is now the mainstay of farmer-based methods of tsetse control and virtually every tsetse control operation currently being undertaken in east and southern Africa is using at least some components of technology developed or refined by DFID-funded research. In Zimbabwe, for example, bait technologies made an important contribution towards eliminating tsetse from 50,000 km<sup>2</sup> of the country and reducing the national incidence of trypanosomiasis from >10,000 cases/year (1984) to <100 (1995). There are many published examples of bait technology reducing the incidence of trypanosomiasis and improving the productivity of cattle in various countries, including Ethiopia, Burkina Faso, Kenya, Zambia and South Africa.

The research reported here on the restricted application of insecticide to cattle is very recent and thus its current impact is limited. Nonetheless, we are aware of projects in Zambia, Uganda and Ethiopia that are promoting the restricted application of pyrethroids to control tsetse and the tsetse.org website and CD-ROM has been used by institutions and individuals concerned with controlling tsetse in Ethiopia, Kenya, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.

### *Potential impact, especially on the poor*

On a continental scale, the extent and impact of trypanosomiasis is probably worse than it was 50 years ago. Alleviating the extent of tsetse would have an enormous impact on the livelihoods of the poor in sub-Saharan Africa. Currently, sustainable community-based control of tsetse by such farmers is proving elusive largely because they are unable to deploy and maintain baits over relatively large areas (>500 km<sup>2</sup>) and for extended periods (>12 months). A large part of this problem is that individual farmers cannot afford the costs of bait technology and hence prefer to invest in trypanocidal drugs which provide clear private benefits in their cattle's health compared to the less immediate and obvious but, ultimately, greater public benefit of controlling tsetse. A combination of the research outlined in this report and changes in the market price of pyrethroids is reducing the cost of treating cattle to ~10 cents per treatment/animal compared to ~\$1 for a trypanocide and thus tsetse control will be a more attractive alternative. By explicitly linking tsetse control to benefits in animal productivity, the control of ticks and, possibly, malarial mosquitoes, it is likely that livestock

keepers would be willing and able to treat their cattle regularly and hence accrue the massive benefits of area-wide tsetse control.

### **Future work**

#### *Insecticide-treated cattle*

To increase the uptake and impact of using insecticide-treated cattle to control tsetse, more information is required on the landing patterns of other major vectors of trypanosomiasis, particularly the Palpalis-group species which are important vectors of sleeping sickness in central and west Africa. There are currently no published data on the feeding/landing sites of these species and hence no rational basis for developing a restricted application regime to control them.

More generally, the research undertaken by this project was confined largely to identifying means of reducing the amount of insecticide used. Field trials are now required to assess the impact of the restricted application regime on herd health and productivity. One such trial has been conducted in Uganda, with support from DFID's Animal Health Programme (R7360), but similar trials are required in other agro-ecological zones. If, as expected, the results of these trials indicate that the restricted application of insecticides provides a cost-effective means of controlling trypanosomiasis then the method should be widely promoted across the tsetse-affected regions of Africa.

#### *Livestock protection*

The results from the current project indicate that physical barriers can protect cattle from attack by tsetse. Field trials of this method were undertaken by FITCA in Kenya and Tanzania but while the results were encouraging, with animal health and productivity being better for cattle kept permanently within netted kraals, the trial did not provide rigorous statistical evidence that these improvements were due solely to the barrier reducing the incidence of trypanosomiasis. It is therefore premature to promote this method widely. Consequently, it is recommended that field trials are undertaken to assess the efficacy and acceptability of using physical barriers to protect zero-grazed cattle from tsetse-borne trypanosomiasis. If the results of these trials demonstrate that the barriers are effective, then the technology should be widely promoted, especially amongst the small-scale dairy producers of East Africa.

The research undertaken by this project highlights how an understanding of the behavioural interactions between tsetse and their hosts can provide a rational basis for reducing disease risk. The current project has focussed on animal trypanosomiasis, but the same approach could be applied to sleeping sickness. Indeed, since vectors of sleeping sickness generally have relatively low infection rates and low population densities, methods of reducing the biting rate through physical, chemical or behavioural means might be particularly cost-effective. We therefore recommend that strategic research is undertaken to (i) quantify factors affecting the probability of tsetse biting humans and thereby (ii) identify mechanisms by which the risk of sleeping sickness might be reduced. If this initial phase produced promising results, then further adaptive research would be required to develop cost-effective means of protecting humans from tsetse.

#### *Decision support tools*

The tsetse.org website provides a means of disseminating information on the control of tsetse-borne trypanosomiasis. To ensure that the website continues to promote up-to-date information and best practice, there is a need for some continuing site maintenance and occasional workshops to demonstrate development, obtain feedback and promote ownership of the tools by African institutions and scientists.

A major output of this project was a decision-support system to help NGOs and non-specialist users plan and implement interventions against tsetse, using farmer-based methods of control such as insecticide-treated cattle and odour-baited targets. While the application of these methods by communities is currently the mainstay of tsetse control, a number of large-scale programmes to control tsetse are being developed by national, regional and donor

agencies. These programmes aim to eliminate trypanosomiasis over large areas (e.g. >25,000 km<sup>2</sup>) using a range of control methods that include not only bait techniques but also aerial spraying, ground spraying and the Sterile Insect Technique (SIT). The scale, complexity and cost of these operations mean that effective planning is not only crucial but more difficult. Consequently, there is a pressing need for more specialised decision support tools to assist donor and government agencies in this planning process.

The programme 'Tsetse Muse' developed by this project goes some way towards meeting this need, but further work is required. For instance, Tsetse Muse allows users to assess the likely efficacy and cost of various interventions against tsetse populations but does not consider the likely benefits for human and/or animal health and productivity. It is therefore recommended that Tsetse Muse is further developed by collaboration between potential users and technical specialists (e.g. socio-economists, epidemiologists, animal health specialists, information scientists) to provide a robust and user-friendly tool for assessing the likely costs and benefits of any intervention against trypanosomiasis.

**ANNEXES.**

- ANNEX 1: Livestock managements and socio-economic factors affecting the feasibility of trypanosomiasis and malaria control in Konso Special Wereda, Ethiopia: Report of a preliminary survey.
- ANNEX 2: Mission to Konso (27 November – 9 December): A note on key findings prepared for FARM Africa and Konso Development Association.
- ANNEX 3: Notes on a visit to Handeni District, Tanzania (January 2003).



**ANNEX 1: LIVESTOCK MANAGEMENT AND SOCIO-ECONOMIC FACTORS  
AFFECTING THE FEASIBILITY OF TRYPANOSOMIASIS AND MALARIA  
CONTROL IN KONSO SPECIAL WOREDA, ETHIOPIA: REPORT OF A  
PRELIMINARY SURVEY**

**Dr J Morton, Livelihoods and Institutions Group, Natural Resources  
Institute**

**DFID Advisory and Support Services Commission Project X0102  
NRI Project O0133**

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## EXECUTIVE SUMMARY

This report presents results from an exploratory survey of Konso Special Woreda, Southern Region, Ethiopia. It focuses on livestock management practices and socio-economic factors that might assist or constrain the control of trypanosomiasis in cattle, and malaria in humans, through insecticide-treated cattle (ITC). Information, mainly from semi-structured interviews, is presented on: objectives in keeping cattle; the *fora* (cattle camp) system and spatial grazing patterns; the practicalities of estimating cattle numbers, and operational grazing areas (for the purposes of calculating necessary levels of pour-on administration); trends in livestock management and livelihoods; major perceived problems in livestock production and existing management of trypanosomiasis. A framework for quantifying the true costs of trypanosomiasis under current curative approaches to management is presented, with a sketch of a cost-benefit analysis of ITC. This is cautiously optimistic, and can be developed further using more structured survey methods, which are being developed. Herding and farming practices pose some risk of malaria to all sections of the population, and there are grounds for believing that ITC might reduce risks for much of the population, which further studies can explore. Some comments are made on the institutional issues raised by an ITC programme.

### 1. Introduction

This report presents results from an exploratory survey of livestock management practices and socio-economic factors that might assist or constrain the control of trypanosomiasis in cattle, and malaria in humans, in Konso Special Woreda, Southern Region, Ethiopia. The scientific background to integrated trypanosomiasis and malaria control, with particular reference to Konso, is set out in an earlier NRI report (Torr, Kindness et al. 2000). The present survey was funded by the Advisory and Support Services Commission of DFID, in support of FARM Africa's Konso Capacity Building Programme, with whom progress of the survey was discussed at regular intervals. The survey took place over twelve days (23.11.01-04.12.01), relying mainly on semi-structured group interviews and participatory mapping.<sup>5</sup> Ten villages and five *fora* (cattle camps) were visited in ten of the 45 kebeles (peasant associations or lower-level government units) of the woreda (see Figure 1). As management of livestock in the *fora* system is mainly the preserve of men, most interviews were with all-male groups; women were present at a few meetings.

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<sup>5</sup> Konsinya-English interpretation and research assistance were provided by Kasarto Orkaido of the Konso Service Co-operative, and formerly of FARM-Africa, whose contribution is gratefully acknowledged. The author thanks Steve Torr and Malcolm Iles for comments on earlier drafts.

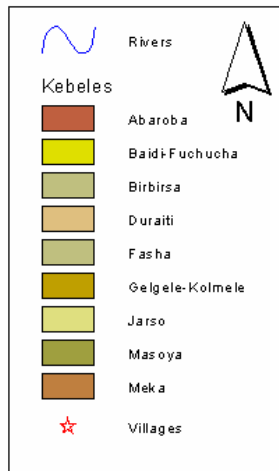
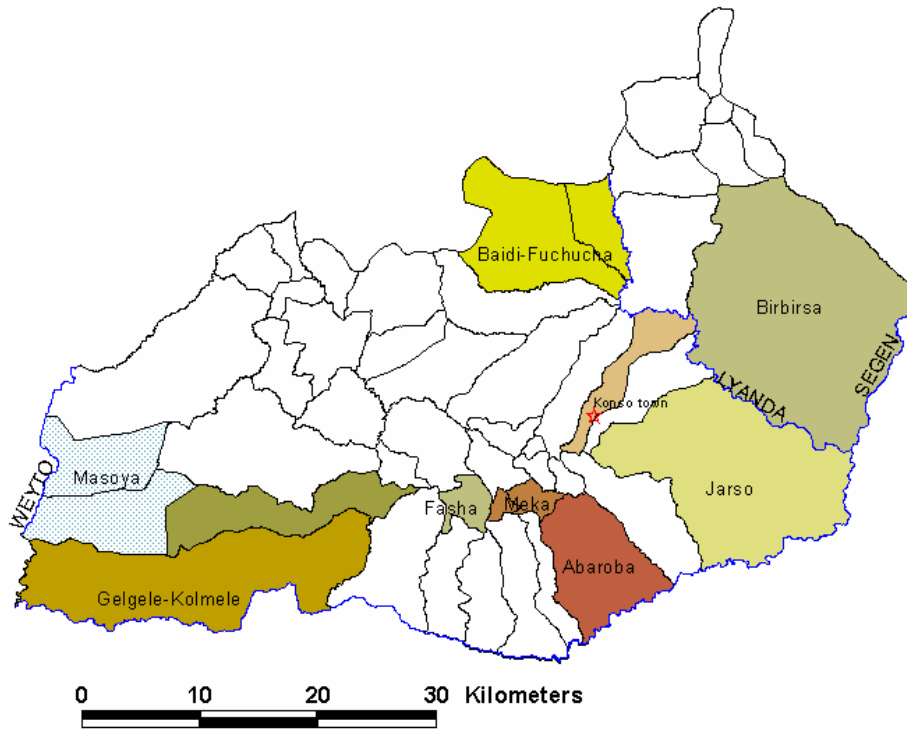


Fig. 1. Konso special wereda, with kebeles included in the present study coloured as indicated in the legend. Stippled area denotes the *de facto* extent of Masoya (see text).

## 2. Reasons for Keeping Cattle and Herd Structure

In most of the group interviews, livestock owners were asked to rank, verbally, their main reasons for keeping cattle or the importance they gave to different outputs from cattle. There was considerable difference in the rankings in different parts of the woreda.<sup>6</sup> However, draught power, supply of milk and butter, and sale are generally the three most important reasons, in different orders, plus manure in highland villages.

Table 1: ranking of reasons for keeping cattle/importance of cattle outputs

Abaroba	B-F (1)	B-F (2)	Birbirsa	Duraiti	Fasha	Jarso	Masoya	Meka
Sale	Draught	Draught	Draught	Milk/butter	Sale	Milk/butter	Draught	Milk/butter
Draught	Milk/butter	Milk/butter	Milk/butter	Sale	Milk/butter	Sale	Sale	Manure
Milk/butter	Sale	Sale	Sale	Skins	Skins	Meat	Milk/butter	Sale
Slaughter during funerals	Skins	Skins		Meat	Draught	Skins	Skins	
	Manure (render)	Meat		Draught		Manure	Horn	
	Horn			Manure				

Oxen are kept for draught power, but this is much more important, though not universal, in villages that are cultivating more extensively in lowland areas. The topography and size of holdings means that fields close to highland villages can only be cultivated by hoe.

Milk and butter are normally mentioned together, and normally as a food for children and sometimes pregnant women. In villages with a fora system, some cows in milk are generally kept in the villages "for the children". Milk from cows kept in the fora is consumed by the herders themselves or churned into butter and sent up to the villages, again "for the children".

Sale of cattle for cash, given as a reason for keeping cattle, is almost always qualified by "when there is a shortage of money", or "when need arises". Specific needs mentioned were to buy grain for consumption, to buy medication, to buy clothes and to pay taxes. In fact, cases of severe need arising fairly often, it seems to be a structural part of the economy, rather than an exception. In addition, the practice of ox-fattening is probably more frequent than it first appears. Oxen are fattened by stall-feeding on cut grass and crop residues by some households in the highland villages. Fattening takes one year or more: in Fasha we were told three to four years, which suggests this may not be exclusive stall-feeding and that oxen may continue to be worked. Fattening begins either at six or seven years of age, after a working life, or at four years, immediately after castration. A fattened ox can be sold

<sup>6</sup> Where comparative data between villages are given, they are identified by the kebele names. Names of the villages are given in the itinerary in Annex 1. B-F 1 refers to Galgalaidi village, B-F 2 to Fuchucha village, both in Baidi-Fuchucha.

for B600-800 or even B1000, representing an important gain over the unfattened price of B300-400.

Manure is used intensively, with arrangements for proper composting and easy turning-out of manure from the compound, in some highland villages. It is used little if at all on lowland fields.

Konso men make bridewealth payments on marriage. It is unclear if these were traditionally made in the form of cattle; it appears in any case that they are now made only in cash (between B500 and B1000), but sale of cattle is an important way for men to obtain such sums.

Ratios of male to female cattle in herds vary greatly, and are often surprisingly slanted to oxen, even when this does not appear justified by draught requirements. Table 2 shows ratios of female to male adult cattle in different kebeles: by overall village-level estimates, responses of non-random sampling of a few farmers in village meetings, and for comparison, the larger-scale random surveys of Tibebu (2000) (aggregating cattle kept at home and in fora).

Table 2: Ratios of female to male adult cattle

<b>Kebele</b>	<b>Method of estimation</b>	<b>Female:Male ratio</b>
Abaroba	Overall estimate - verbal	50:50 (or slightly more males)
B-F 1	Overall estimate – pile sorting <sup>7</sup>	67:33
	Three informants	63:37
B-F 2	Overall estimate – pile sorting	60:40
	Two informants	42:58
Birbirsa	Three informants	36:64
	Official village figures	44:56
Fasha	Three informants	50:50
Lultu	Total fora count (9 owners)	54:46
Masoya	Overall estimate – pile sorting	71:29
	Three informants	55:45
Debana	Tibebu 2000	82:18
Docato-Hailota	Tibebu 2000	40:60
Maderia-Gizaba	Tibebu 2000	62:38

<sup>7</sup> Estimates obtained by pile sorting were generally converted by eye into ratios and checked verbally with informants.

### 3. The Fora System and Pastoral Movements

In many, but not all, parts of Konso, the livestock production is based on *fora*, cattle camps maintained in lowland grazing areas at some distance from the village. Table 3 shows some estimates of ratios of cattle kept in fora to cattle kept in villages, by kebele. Because of our concern with tsetse and malaria issues our own data is generally for villages dependent on a fora system. By comparison, Tibebu's (2000) data is drawn from three purposively sampled villages representing a range of production systems.

Table 3: ratios of cattle kept in fora to cattle kept in villages

Kebele	Method of estimation	Fora:village cattle ratio
Abaroba	Overall estimate – verbal	Most in fora, some in village
B-F 1	Overall estimate – pile sorting	83:17
B-F 2	Overall estimate – verbal	60:40
Birbirsa	Overall estimate – pile sorting	83:17
Duraiti	Overall estimate – verbal	a few keep cattle in village
Fasha	Overall estimate – verbal	63:37
Gelgele-Kolmele	Overall estimate – verbal	93:07
Jarso	Overall estimate – verbal	some keep 1-2 cattle in village
Masoya	Overall estimate – pile sorting	75:25
Meka	Overall estimate – verbal	No fora exist for 7/8 villages
Debana	Tibebu 2000	04:96
Docato-Hailota	Tibebu 2000	30:70
Maderia-Gizaba	Tibebu 2000	50:50

One of the most important findings of our study was that fora membership is not closely linked to village membership: it is very common for a single fora to include cattle owners from different villages of a kebele, and to some extent from different kebeles. In Abaroba a single fora may contain cattle from up to six villages. The two neighbouring large fora known as Sala, on the eastern (Burji) side of the Segen river opposite Jarso, include cattle owners from seven different Jarso villages. In the 13 fora of Birbirsa kebele, an average of 1.8 (of the five) Birbirsa villages, and one outside kebele, are represented in each fora. Not only fora, but the *harra* or kraal-groups within them, are sometimes heterogeneous. Harra and fora are formed on the basis of friendship and mutual agreement, and not necessarily by kinship, affinity or between village neighbours

There is widespread grazing, and maintenance of fora, across kebele boundaries. Nine of the 13 fora in Birbirsa include cattle from outside the kebele, and at least six other kebeles are represented. Six outside kebeles also keep cattle in fora in Baidi-Fuchucha. In some cases cattle are kept in fora in one kebele by cattle owners of a directly adjoining kebele. There are also many cases where cattle owners maintain a fora in their own kebele, but graze on a daily basis within another kebele. But there is also a pattern of cattle owners from Kolme (an area including several kebeles in the southwest of Konso) keeping cattle in fora of Jarso and Birbirsa.

Some kebeles without lowland rangeland of their own maintain fora in other kebeles. Borjo village in Fasha kebele has cattle in 20 different fora in Baidi-Fuchucha, Lultu and Birbirsa (as well as outside Konso). Cattle in fora, and whole fora, can be moved relatively suddenly from one kebele to another, as part of seasonal grazing strategies or as a longer-term shift in grazing management.

In addition to cross-kebele grazing within Konso, there is widespread grazing across woreda boundaries:

- Jarso, Bibirsa and Kolme cattle owners maintain fora in otherwise ungrazed areas of Burji woreda across the Segen river, east of Birbirsa and Jarso (see Figure 2). The two Sala fora and one of the two fora known as Eto account for 750 Jarso cattle and 250 Kolme cattle.
- Cattle owners from Nayala Segen, Abaroba and Gelgele-Kolmele all maintain fora to the south of the Segen, in areas of Borana also grazed by Boran. Abaroba people maintain 12 fora south of the Segen. There are over 5000 cattle belonging to Gelgele-Kolmele owners on the Boran side of the Segen
- 405 cattle of Masoya people are kept west of the Woito River and north of the Jinka road, on Tsamai land in South Omo (see Figure 3, page 32)
- The only example reported of non-Konso grazing inside Konso was of Derashe people grazing (but not keeping fora) in Baidi-Fuchucha

The movement of Konso cattle beyond Konso boundaries appears to be a relatively recent and increasing trend. Relations with neighbouring ethnic groups vary. The Burji do not use the lowland grazing opposite Birbirsa and Jarso, but it appears that a peace agreement with the Boran around five years ago has meant that Konso can graze there in relative safety from Boran (although herders in the area go armed). Fasha cattle owners described uneasy relations with Boran, who sometimes "complain" about a shortage of grazing for their own cattle, at which point Konso move back to their own lands. Masoya herding cattle west of the Woito River "live together" with the Tsamai inhabitants, but maintain separate fora.

There are complex patterns of daily movements of cattle out of fora, seasonal variations in these, seasonal movements of fora, and long-term shifts in grazing management. Information about such movements can be contradictory, suggesting combinations of improvised strategies rather than strict seasonal patterns. The drivers of these strategies include availability of grass and water, and fear of insect pests and disease: biting flies, trypanosomiasis and blackleg, and malaria (as well as the need to manage relations with other ethnic groups).

Cattle can move outwards from fora at least 6-7km, and possibly 9 km a day. These movements may be made in different directions out from the fora as the seasons change, and in many cases the fora themselves do not move seasonally at all. In Abaroba, some fora herd cattle back up towards the villages in the long rainy season, and down towards the Segen river in the dry season and short rains - but fora may also be moved across the Segen. In Jarso, fora at the break



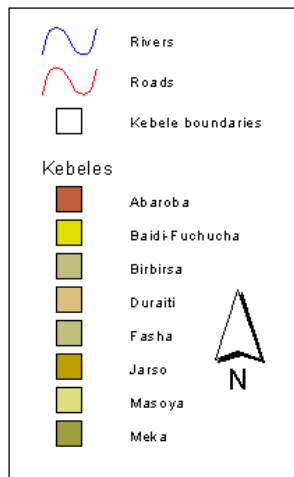
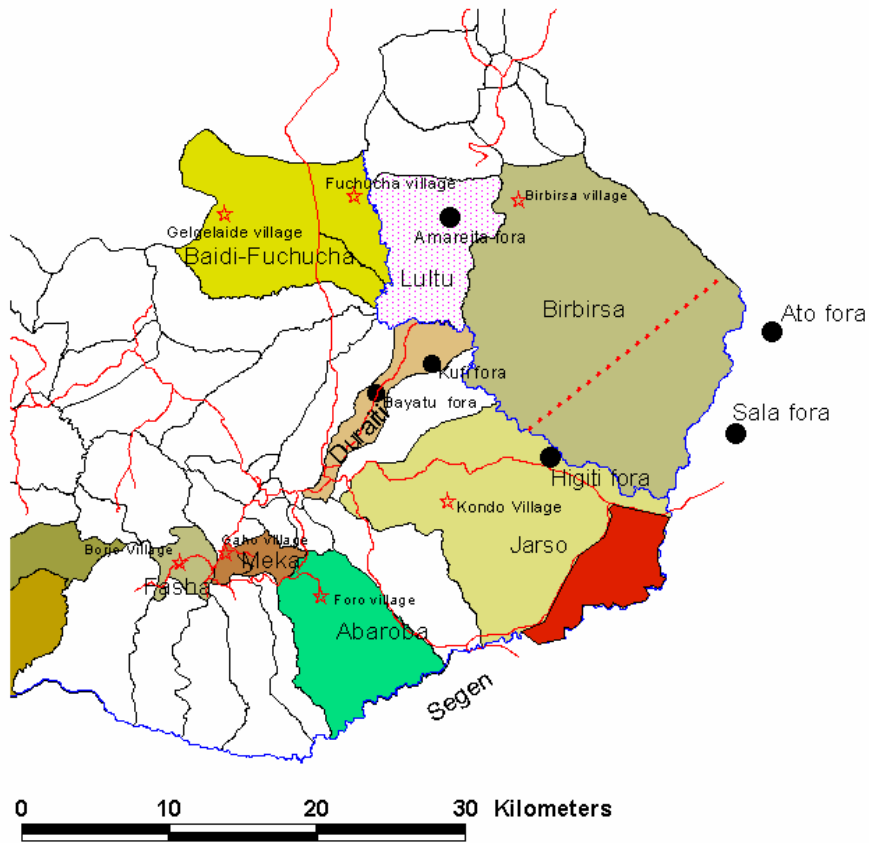


Fig. 2. Eastern Konso showing the *de facto* extent of Jarso Kebele extending into Birbirsa (dotted red line) but not SE towards the Segen river (red area), and selected fora and villages where interviews were conducted or which are mentioned in the text.

of slope, relatively close to the villages, are used in the long rains, when people fear malaria and trypanosomiasis on the far bank of the Segen. As the long rains finish, some people move their foras beyond the Segen, but not to the former sites (which are "muddy" and give a risk of blackleg). Other Jarso herders stay beyond the Segen all year round, in sites that enable watering access to the Segen in the dry season, and allow grazing well into Burji woreda at other times.

#### 4. Estimating Cattle Numbers

Fora vary greatly in size. During our study we were told of fora between 17 and 296 head of adult cattle, representing anything between 1 and 38 owners. Fora also vary on a continuum of whether they are pure herding camps or bases for both herding and cropping. In the latter case they may be virtual permanent residences for men, women and children.

Fora have recognised physical subdivisions, known as *harra*, in which the cattle are kraaled at night. Harra are not necessarily the units in which cattle are managed during the day, as owners may pool labour so calves and smallstock can graze in one place,<sup>8</sup> and adult cattle at another, they seem to be based on ties of friendship and solidarity even closer than those between other fora members, and to be the units in which Konso think about and quantify cattle ownership and management. Fora can consist of anything between 1 and 15 harra. Reliable sketch-maps of fora and their constituent harra, including fora mainly used by people from other kebeles, can usually be obtained from kebele committee members, although such counts would almost certainly need double checking if used for cattle census purposes. Herders appear to be able to give accurate counts (by sex and age) of cattle *within their own harra*. Unfortunately for present purposes, harra vary so greatly in size that a count of harra cannot be used as a short-cut to a count of cattle. Numbers of cattle in a harra can vary between 17 and 119. The least labour-intensive method of enumerating cattle that is also reliable appears to be involving a representative of each harra.

It should also be noted that there is great sensitivity to giving information on herd numbers that might be used for taxation purposes. FARM's attempts to obtain cattle numbers for calculating demand for pour-on have entailed strong undertakings that FARM will not allow this information to be accessed by tax authorities. This will need to be repeated, credibly, in future operations.

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<sup>8</sup> It is worth considering the possible increase in trypanosomiasis risk to calves of herding them away from adult cattle and with smallstock.

## 5. Mapping Ranges

The dynamism and flexibility of grazing movements outlined above suggests that defining ranges, within which cattle densities can be estimated for the purpose of calculating necessary levels of pour-on administration, will be complex and difficult. There are two other factors complicating this task further.

Firstly, in some cases the kebele boundaries marked on the Government of Ethiopia maps are significantly wrong. This is especially the case with the northeastern boundary of Jarso kebele, which is marked on official maps, and therefore on the GIS, as following the Lyanda river to its confluence with the Segen. In fact the boundary runs northeast from near the break of slope [Map Reference (3)410(5)940] to meet the Segen at around Northing (6)040, thus significantly increasing the grazing area belonging to Jarso kebele (and conversely reducing the area belonging to Birbirsa - see Figure 2, page 9). It was carefully confirmed that this was not a difference in official and traditional perceptions of the kebele boundary, but a mistake in the recording of the official boundary.

Secondly, there are some significant areas of lowland rangelands which are not grazed (for reasons which are unclear). The clearest example is the whole portion of Jarso kebele east of the break of slope and south of the Awassa road.

## 6. Trends in Livestock Management and Livelihoods

Konso production systems have undergone significant changes in the space of a generation and are bound to change further. Changes are likely to affect different Konso villages in different ways: identifying these trajectories and assessing their future course is not easy.

In a number of villages, villagers were asked to quantify, by pile-sorting, the current contribution to livelihoods (the total of household consumption and cash income) made by sheep, goats, cattle and cropping. Results are shown in Table 4.

Table 4: Contribution to livelihoods (estimated percentage) of livestock species and cropping

Kebele	Sheep	Goats	Cattle	Cropping
B-F 1	4	8	25	63
B-F 2	4	7	22	67
Birbirsa	3	6	30	60
Fasha	10	5	14	71
Masoya	5	11	21	63

Some comments should be made on these findings:

- They are necessarily rough and ready; we hoped that the concept of the aggregate of direct consumption and cash income could be understood and used in this way by villagers, but cannot guarantee that their understanding of what they were quantifying was the same as ours
- It is unlikely that informants considered the contribution of livestock *to cropping* in their estimates, so the overall contribution of livelihoods is probably underestimated

- For the sake of simplicity, non-farm, non-livestock income was not included. While there are limited possibilities for non-agricultural employment in Konso, out-migration, temporary and permanent is undoubtedly very important and arguably becoming more so. In Abaroba, it was said that most men from the kebele migrated to the gold mines of Moyale for the dry season.
- Again for the sake of simplicity, the contribution of gathered products, including wood, was not included.

We attempted to ask people to quantify the different contributions to livelihoods ten years ago (more or less corresponding to the fall of the Derg regime), and what they would expect in ten years time. Understandably, it was difficult to separate this question from people's overall prosperity, from the numbers of people and from the pressure on resources, but some interesting pointers emerged:

In Baidi, trypanosomiasis has got worse in the last ten years, so the benefit from cattle has decreased. The benefit derived from cropping has also decreased, because of problems with oxen, drought, and land degradation. Without control of trypanosomiasis, people expect an end to draught power, and a decline in cropping, besides a shortage of land relative to population.

In Fuchucha, cropping, carried out with a hoe or borrowed oxen, was more important ten years ago, relative to all species of livestock. In ten years time, people expect an increase in cropping with increased population, and a relatively smaller contribution of livestock to livelihoods.

In Birbirsa there is a clearer sense that livestock, especially cattle, was becoming more important relative to cropping. There is a strong sense that grazing land will remain adequate for livestock needs.

In Fasha, people felt that the relative importance of cropping and cattle had remained the same, but that crop yields (per unit area) and cattle productivity had dropped, due to lack of rain, land degradation, lack of grazing land and lack of grass (i.e. roadside grass) in the villages.

In Masoya, ten years ago "the whole pile would have been smaller" but the relative importance of cropping greater. Again, people expect a drop in soil fertility and in the availability of grazing.

In general, we can detect an increase in the relative importance of livestock over the last ten years, but misgivings in most areas (with the notable exception of Birbirsa) over whether grazing will remain adequate. A number of more fundamental trends seem to be involved:

- Human population growth seems to be exceptionally rapid, even by developing country standards, which is leading to high population densities relative to arable land in the highlands, and (despite the justly celebrated soil management of the Konso) land degradation
- In some highland villages, people may attempt to intensify current crop production but also reduce livestock holdings further, endangering manure supplies and soil productivity further.
- The fora system seems to be increasing in importance, as higher numbers and proportions of cattle are kept in the lowlands. This is despite some perceptions that the threat of trypanosomiasis has got worse, either over a ten-year

timescale, or over a 30-40 year timescale. However, grazing on Konso's own lowlands (see below) is threatened by cultivation, and the present Konso expansion into the grazing areas of other ethnic groups cannot be continued indefinitely

- Cropping (rainfed, spate-irrigated and river-irrigated) is extending apace into lowland areas, and in some cases permanent villages are being established. This process will be constrained by uncontrolled trypanosomiasis (through effect on draught oxen). If expansion continues, it will encroach increasingly on grazing lands, unless a more intensive form of mixed crop-livestock production can be evolved.

## 7. Problems in Livestock Production and the Management of Trypanosomiasis

Trypanosomiasis was almost invariably cited as the major cattle production problem. This was also the case for kebeles which do not have rangeland but maintain fora on the rangelands of others, such as Fasha, though not for kebeles without fora such as Meka. Trypanosomiasis is accompanied by a great range of other livestock diseases:

### **Box 1: Other diseases/symptoms mentioned**

liver disease	swollen pancreas
lung disease ( <i>sombesa</i> )	foot and mouth
"dried abomasum"	internal parasites including liver fluke
blackleg	anthrax
weeping from eyes	

Konso practice emergency slaughter of animals at or near death, and are therefore familiar with the internal manifestations of various animal diseases

Many informants distinguish "ordinary" trypanosomiasis or *gandi* from *gandi chilmale*, a particularly acute form characterised by bloody diarrhoea (also peeling of the skin and atrophy of the tail), which kills within days. The signs of "ordinary" trypanosomiasis include: hair standing on end, ears dropping or bleeding from the lobe of the ear, poor appetite, no desire to drink, lagging behind the herd, a dry nose, bad smelling breath; and post-mortem; intestine looks "cut", liver swollen. Some informants suggested that milk stops up to a month before other clinical signs, and that drying-up is not interpreted on its own as a symptom of trypanosomiasis. Ordinary trypanosomiasis, if left untreated, will lead to loss of condition and productivity, and death within weeks or months, though some informants referred to a third variety, chronic but non-fatal even if untreated.

There are traditional remedies to mitigate the symptoms of trypanosomiasis: *moringa* root, the leaf or root of *timultita*, and the root of *pata sigmutata*. In general however, all cattle-owners search for western veterinary medicine as soon as they recognise signs of trypanosomiasis, (though not necessarily if a cow dries up without other symptoms).

There are government Animal Health Stations in some villages, although it may be difficult for cattle-owners to get animals up to the village from the fora. In other areas, cattle-owners have recourse to trypanocides sold by village shops or itinerant

sellers, about which there is clearly some sensitivity. The frequency and costs of trypanocide treatment are dealt with below.

In many areas of Konso, cattle owners reported involvement in tsetse control operations through Insecticide-Treated Cattle, either during the 1995-97 campaigns or during the more recent campaign. There are clearly serious difficulties in motivating cattle-owners to make regular expenditure on pour-ons, at B9.75 per animal. In a society as cash-poor as Konso, expenditure to prevent trypanosomiasis, as distinct from treating it, seems to be a low priority – a problem that would probably remain even if a model for tsetse control was designed that was on paper economically viable (see below). But on top of this, the organisation of the current tsetse control programme appears haphazard viewed from a cattle-owner perspective:

- Cattle-owners in Baidi were confused by the use of an alternative pour-on to the familiar Spot-On, which was cheaper but seen as ineffective
- Information about how to administer pour-ons – 20ml from dewlap to tail – and the proportion of animals to treat – 50% - was delivered to cattle-owners, and seems to have been followed in most areas, at least for the first application.
- Cattle belonging to owners from other kebeles had sometimes been treated (and in some cases those owners trained in treatment), and community mechanisms exist to enforce treatment on such owners. Cattle in entire fora belonging to other kebeles were less likely to have been treated.
- There was no clear message about the frequency of application, or the relation between correct application and visible evidence of flies and ticks. In some areas cattle-owners had given up when there was not an immediate visible decline in flies and ticks after the first application, in other areas cattle-owners assumed wrongly that a second application was only necessary when flies returned.

The result seems to have been a virtual abandonment of pour-on use after the first or second application in Baidi, Birbirs and Jarso, and an ineffective system of application, only when flies become visible, in Fuchucha.

## 8. The Costs of Trypanosomiasis

In Konso, the effects of trypanosomiasis are felt in various ways: as mortality, loss of productivity, cost of regular trypanocidal treatment, and incidence of abortion. This is unlike the Southern African situation (Doran 2000) where widespread use of trypanocides incurs a financial cost but appears to minimise the other negative impacts.

In several villages, informants were asked to rank the different impacts of trypanosomiasis, from worst to least bad.<sup>9</sup>

**Table 5: Ranking of Impacts of Trypanosomiasis**

Masoya	Gelgele-Kolmele	B-F 1	B-F 2	Abaroba
Death of	Death of	Deaths of	Deaths of	Cost of

<sup>9</sup> This was done with a series of cards, on which each impact category was written in Amharic; with the exception of Abaroba, where the exercise was done purely orally.

animals	animals	animals	animals	treatment
Loss of ploughing	Cost of treatment	Loss of ploughing	Loss of ploughing	Loss of ploughing
Loss of milk	Loss of milk	Cost of treatment	Cost of treatment	Loss of milk
Cost of treatment	Loss of ploughing	Loss of milk/butter	Loss of milk/butter	
Abortion	Abortions	Abortions	Abortions	

The impacts that would be easiest to quantify are mortality, abortions and financial cost of trypanocidal treatment. Table 6 gives some idea of the dimensions of these through individual responses (not from randomly chosen informants) on these variables, with current herd sizes as referents.

Table 6: Individual Responses on Quantifiable Impacts of Trypanosomiasis

Kebele	Infor - mant	Current herd-size <sup>10</sup>	Mortality in last year	Abortions in last year	Outlay on trypanocides
Abaroba	A	1a	Not investigated		1 treatment <sup>11</sup>
	B	2a	Not investigated		4 treatments
	C	1a	Not investigated		1 treatment
B-F 1	A	6a + 5y	2a + 1y	0	>B200
	B	18a + 8y	5a + 2y	1	>B400
	C	11a + 9y	5a	0	B75
B-F 2	A	6a + 6y	5a + 2y	0	c. B200
	B	6a + 2y	0	0	10 treatments
Birbirsa	A	3a + 1y	0	0	4 treatments
	B	7a + 2y	1a (not tryps)	1	Not investigated
	C	4a	0	0	12 treatments
Duraiti	A	9a	0?	0?	15 treatments
Fasha	A	4a + 1y	0?	0?	14 treatments
	B	2a + 2y	1a + 1y	0?	4 treatments
G-K	A	120 inc. calves	30	Not investigated	all once, some twice (c. 200 treatments?)
	B	70 inc. calves	25	Not investigated	all once, some 2-3 times (c. 100 treatments?)
Jarso	A	8a + ?y	1y	2	5 treatments
Lultu	A	19a + 5y	2a + 1y	2	4 treatments
Masoya	A	10a + 10y	2a + 1y	0	30 treatments
	B	7a + 3y	1a (+1y not tryps)	0	5 treatments

<sup>10</sup> a = head of adult cattle, y = head of youngstock (approximately from birth to four years)

<sup>11</sup> All three Abaroba informants also reported outlay on “tablets”, possibly antibiotics to cleanse after abortion



These figures, non-random and non-standardised, do not permit calculation of average mortality rates, but suggest that they are very high: yearly mortality rates of 25% of year-end holdings are clearly not unusual. Abortions, in accordance with the rankings in Table 5, are less significant.

Berenil costs B6-7 per sachet. In Masoya, where people took animals to a resident paravet, they were paying B6 to treat a heifer and B8 for an ox, presumably according to a strict by-weight dosage. Elsewhere, a regime of one packet per adult bovine seem to be generally used. The ratios of numbers of treatments bought in the last year to current cattle holdings range from around 0.17:1 to 3:1, or B1-B18 per head of adult cattle.

In areas where oxen are used for ploughing, a trypanosomiasis attack, even when successfully treated, leads to the loss of an ox's draught power for at least a week, and often a month. Draft oxen are sometimes hired out in Konso, by the pair, with equipment and the services of the owner. There are also customs of exchange of ox for human labour (see Box 2).

#### **Box 2: Value of Ox hire**

**Meka:** 2 oxen + plough + services of owner hired for B10/day + food for owner and oxen

**Baidi:** 2 oxen + plough + services of owner hired for B10/day

**Fasha:** 2 oxen + plough + services of owner hired for B12/day

Food was not mentioned in the latter two cases but was probably assumed as additional to the hire

**Birbirsa:** 1 day of human work = 1 day of an ox span

**Abaroba:** Work on one field by oxen + owner = work on two fields by recipient

Adult male casual labour in Konso is hired for about B2.5/day plus food.

The Birbirsa rate appears anomalous, and the Abaroba rate hard to interpret, but overall, a shadow price of ox hire of B4-5 seems reasonable

Depending on whether ploughing takes place in the long and short rains (Baidi-Fuchucha, Masoya, or the long rains only (Abaroba), oxen may work, usually on a five- or six-day week basis, for anything between two months and five months a year.

There is very little trade in milk or buttermilk, but a small trade in butter. A trypanosomiasis attack, even when successfully treated, leads to an almost complete loss of milk and butter for human consumption for the rest of the lactation period. Some informants said that even after successful treatment there would not be enough milk to ensure the survival of the calf. Butter is accumulated over a few days, and sold in gourds or solid lumps of various sizes. Varying informant accounts of these prices and the number of cow/days they represent (cows are milked twice a day) are given in Box 3. Informant views on lactation periods and calving intervals are given in Box 4.

### **Box 3: Prices of Butter**

**Duraiti:** 3 cows x three milkings > one-third of a gourd butter. 1 gourd butter = 13.5 cow-days = B10. **1 cow-day = B0.75**

**Fasha:** butter from six milkings = B2. **1 cow-day = B0.67**

**Masoya:** 3 cow-days = B5. **1 cow-day = B1.67**

**Meka:** 7 cow-days = B5-8. **1 cow day = B0.78-1.14**

### **Box 4: Lactation Periods and Calving Intervals**

**Abaroba:** lactation period up to one year. No milking for first two months

**Baidi:** lactation period five-six months, or up to one year for some cows. No milking for first month

**Fuchucha:** lactation period six to eight months, or up to one year for some cows

**Duraiti:** six-eighteen months (sic)

**Fasha:** lactation period one year, cows calve every two years.

**Masoya:** lactation period eight-twelve months

**Meka:** lactation period six-eight months. Cow then kept from bulls for eight months, as too weak to bear a pregnancy. Calving interval of two years?

It is possible, with a number of very questionable assumptions, to arrive at overall financial costs of trypanosomiasis. This is done, using very conservative assumptions, in Box 5.

### Box 5: Sketch Analysis of Costs of Trypanosomiasis

Calculations relate to adult animals only

Male to female ratio in herd (see table 2): 60:40

Mortality from trypanosomiasis: 5% per year (see Table 6)

Value of adult bovine: B300

Cost of mortality per head of adult cattle: B15

Number of treatments required per adult animal per year: 0.5 (see Table 6)

Cost of treatment: B3

Proportion of herd represented by oxen infected during the year:  $60\% \times 50\% = 30\%$

Proportion of ox-time spent working: 20%

Probability of infection during working period: 6%

Working days lost to infection: 5

Price of working day: B4

Cost of lost draught power per adult animal per year: B1.2

Period allowing milking for human consumption: six months

Calving interval: two years

Proportion of herd represented by cattle in milk:  $25\% \times 40\% = 10\%$

Average lactation lost per infection: three months

Probability of infection: 50%

Average days of milking lost per adult animal:  $90 \text{ days} \times 50\% \times 10\% = 4.5 \text{ days}$

Value of butter: B0.67/day milked

Cost of lost milk per adult animal: B3

**Total cost per adult animal  $15 + 3 + 1.2 + 3 = B22.2$**

This figure should be compared to the cost of pour-on. If pour on is administered to half the herd (as seems to be the current recommendation, accepted in principle by cattle owners) the cost varies with the frequency of administration

**Table 7: Costs of Pour-On Regime** (Birr per adult animal in herd per year)

7 applications/year	as used in 1995 trial	B34.125
5 applications/year	agreement for 2001 trial	B24.750
4 applications/year	modified agreement for 2001 trial	B19.500

The cost of trypanosomiasis above is therefore slightly lower than the cost of pour-on administered to half the herd five times a year, and considerably lower than the cost of the technically more appropriate regime of seven applications per year.

However:

- the above calculation uses a conservative mortality rate, which is the biggest single component of the cost of trypanosomiasis

- it uses a conservative rate of infections treated per year at 0.5 per animal, whereas many informants recorded up to three
- it uses a low rate of ox utilisation, whereas in some areas oxen are used for 5 months per year or more (40%), and a low assumption of work days lost to infection. Additionally, Table 5 shows that in many areas loss of ploughing is seen as more important than direct costs of treatment.
- it does not factor in abortions/increases in calving intervals, treatment of aborted cattle, or costs of time spent searching for treatment

Using a mortality rate of 10%, a rate of infections per animal of one, a rate of ox utilisation of 40% and an assumption of ploughing days lost to infection of 10 days (still fairly conservative assumptions given our information), the overall cost per adult animal emerges as:

Mortality	30.0
Direct cost of treatment	6.0
Loss of ploughing	9.6
Loss of milk	6.0
<b>TOTAL</b>	<b>51.6 Birr</b>

or over twice the cost per animal of a five-application regime, and considerably more than a seven-application regime.

Given the uncertainty over the true valuation of lost milk and lost draught power, it is **not** recommended that any large-scale attempt to quantify these costs is made. It is recommended that a structured quantified survey be made to investigate mortality and direct costs of trypanocidal treatment.

Current yearly costs of trypanosomiasis treatments as a ratio of current holdings should be obtainable from such a survey, though some informants will give the number of times they treated each animal, and some a total yearly figure in Birr.

Informants can give (reasonably) reliable accounts of deaths and abortions from trypanosomiasis in the last year. From current herd numbers, deaths, sales and purchases, a mortality rate over year-beginning holdings can be calculated that will allow both cost-analysis and international comparison.<sup>12</sup>

It is recommended that the ranking method be used as part of the structured survey to establish an order of magnitude for lost draught power and lost milk production, relative to mortality and the direct cost of treatment, which can be quantified. A plan for such a survey, which can also investigate attitudes to trypanosomiasis treatment and tsetse control, and malaria risks, is being developed separately.

## 9. Malaria Issues

Konso are very well aware that staying overnight in lowland areas, especially in the long rainy season, brings an increased risk of malaria. It was stated in Duraiti that “people

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<sup>12</sup> From our experience, asking informants directly for an account of herd numbers one year ago would probably not be reliable. If farmer recall of sales and purchases proved unreliable, we would still be able to calculate a mortality rate of year-end holdings, which would be a reasonable proxy.

cannot live in the lowlands because of malaria". Partly perhaps for this reason, we were told in Birbirsra that children are "not allowed" in the fora.

However, as well as classic cattle fora, there is increasing cultivation in lowland areas. The name of fora may be given to small, even single-family, camps where people camp overnight to look after both the fields and the cattle, and there are also lowland farming camps. Some "fora" are virtually permanent villages, such as the group of Fasha families living in lowland Lultu. This group considered itself a fora for tenurial reasons, as it was in some sense dependent on a nearby Lultu village, but adult males lived there year-round, and women and children for all but the wettest three months of the year.

In practice, women and children may overnight even in cattle fora, particularly small fora and those nearer villages, but also larger and more distant fora if they go down to run errands, and especially in farming camps. Some families who go down to farm sleep on small hills or even in trees to avoid mosquitoes.

The layout of "classic" large cattle fora, where herder huts are surrounded by kraals containing tens or hundreds of cattle, might provide some protection from malaria if cattle were insecticide-treated. To assess the feasibility of ITC as malaria control in other types of lowland settlement would require more study of their topography and layout, combined with modelling of mosquito behaviour under different conditions.

Based on a preliminary assessment of Konso movements between fora and villages, there are grounds for believing that ICT might at least reduce risks of malaria for much of the population. If that is the case at a technical level, anti-malarial benefits could be used as an additional "selling-point" in motivating Konso to use ITC for tsetse control. As a next step, it should be possible to assess quantitatively the extent to which all sections of the population overnight in the lowlands, particularly during the (long) rainy season, and slightly less reliably, the sort of camp they stay in.

## **10. Preliminary Conclusions on the Feasibility Of Tsetse Control through ITCs**

The sketch above of an economic analysis above suggests it is possible that the long-term costs of tsetse control through insecticide-treated cattle *may* be less than the current costs of no tsetse control with expenditure on trypanocides, mortality and lost production.

This hypothesis needs to be verified by:

- more structured and quantified surveys on the current costs of trypanosomiasis (see above), and
- mapping of range areas and cattle numbers to allow modeling of the proportion of cattle recommended for insecticide treatment and the recommended frequency of treatment, and hence the costs of this method.

Combined processes of participatory mapping, some use of GPS/GIS and decentralised counting, through responsible men for each harra, could obtain reasonably accurate livestock figures and range areas. However these would remain subject to sudden

change, and the problem of grazing outside woreda boundaries and alongside Borana and Tsamai cattle (see below) remains.

Further to this analysis, the technical feasibility (if any) of reducing malaria risk through ITCs, could be counted as an additional (but unquantified) benefit to further offset the costs of tsetse control.

If all this analysis suggests that the current costs of trypanosomiasis outweigh the costs of tsetse control, there will still be one important technical problem to consider: the unpredictable cross-boundary movements of Konso cattle. There are two different scenarios here. Konso cattle graze in the lowlands of Burji woreda, where no other ethnic group is grazing, increasing the effective grazing areas for Konso people, thus increasing the proportion of cattle needing to be treated to attain threshold densities per unit area. The costs of an ITC programme are increased, but the principle is the same as would be applied within Konso. Konso cattle also graze in Borana, intermingled with Borana-owned cattle, but frequently re-crossing the river into Konso. Because of these crossings, it will be impossible to exclude any section of Konso cattle from an ITC programme, but assuming that the Borana are not involved in an ITC programme, high proportions of Konso cattle will need to be treated to meet the thresholds. Konso will in effect, be meeting the cost of ITC in parts of Boran (where they enjoy some, but not all of the grazing).

If a solution to this problem can be found, there will be further problems relating to the difference between an "objective" calculation of costs and benefits and people's real-life willingness to pay. Cattle-owners were unanimous in saying "they could not afford" Spot-On at B9.75, but this was not said in the same way about trypanocides at B6. It seems at present that cattle-owners will accept having to pay to cure an obviously ill cow, but not for prevention, however much they seem to have been convinced of its merits.

Further, an ITC programme raises classic problems of collective action: everyone has to be sure that everyone else is playing by the rules and not free-riding. While Konso appears to be a fairly tight-knit, norm-bound society where this is likely to be the case, the issue needs more investigation. The collective action problem is arguably made more complicated by cattle-owners maintaining fora and grazing across kebele boundaries, but indications were that this did not raise a specific problem for the organisation of an ITC programme.

If an ITC programme is pursued, it will need the following elements:

- Much more attention to careful training of paravets, and management of delivery mechanisms
- General outreach to farmers, pointing out the long-term benefits of tsetse control, if the community (cattle owners within a kebele) work together
- A very careful targeting on areas where ITC is technically and economically feasible, and where human resources exist for management, training and outreach.

In addition, serious consideration should be given to transitional subsidies. Even if the objective quantification of benefits of ITC is positive, a proportion (that could be

estimated) of the costs of trypanosomiasis will continue to be borne by cattle-owners while tsetse populations and trypanosomiasis incidence decline. For an initial period, then, cattle owners will be paying both for trypanosomiasis and for tsetse control. During this initial period (to be strictly defined) a case for a transitional subsidy, while not fashionable, can certainly be made.

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## ANNEX 1: ITINERARY

*22.11-25.11 with Steve Torr, Tibebu Habtewold*

22.11 Travel to Arba Minch

23.11 arrive Konso, Meet Michael Assefa, Resource Use Planner; drive to Segen River, Nayala Segen Kebele

24.11 Garsale Village, Duraiti Kebele; Kondo village, Jarso Kebele

25.11 Bayatu and Kufi foras of Garsale: drive to vicinity of Sala fora (belongs to Jarso Kebele, located in Burji Woreda)

26.11 Sala fora: writing up notes and planning

27.11 Higita fora, Jarso Kebele: Bibirsa Village, Bibirsa Kebele

28.11 Bibirsa Village, Bibirsa Kebele: Tarba fora, Lultu Kebele

29.11 Borjo village, Fasha Kebele: writing up notes and planning

30.11 Meeting with Michael; Foro village, Abaroba Kebele

01.12 Foro village, Abaroba Kebele; Gaho village, Meka Kebele

02.12 Masoya village, Masoya Kebele; Gete village, Gelgele-Kolmele Kebele

03.12 Galgalaidi Village, Baidi-Fuchucha Kebele

04.12 Galgalaidi Village, Baidi-Fuchucha Kebele; Fuchucha Village, Baidi-Fuchucha Kebele

05.12 Final meeting with Amare Mengistu (Programme Co-ordinator FARM-AFRICA), Michael Assefa, S Torr, Tibebu. Depart for Arba Minch

06.12 Travel to Addis Ababa

07.12 Depart for UK

## INFORMATION GATHERED ON LOCATION OF FORA AND CATTLE MOVEMENTS, BY KEBELE

### Abaroba

Foro village has 3 subdivisions: Orbaha, Mankle and Yelali, Amara  
3 other villages: Saba, Gurmale, Gabo. Saba village is scattered and not densely populated.

Boundaries of Kebele: upper reaches of Karfura River are boundary with Baso, lower reaches are boundary with Nalaya Segen. To N, NW and W the boundary with Geras meets the Daldo River and continues to the Segen River.

No estimate of cattle numbers from Baidi people, estimated 400 in Fuchucha village and 600 in Fuchucha fora

Fora within boundaries of Abaroba kebele, with numbers of harra as given on participatory map, 30/11/01:

Fora	No. of harra	Fora	No. of harra
Kalmata	4	Orabto	9
Dhole	3	Elota	6
Yelakuruta	5	Kiratatakadi	6
Chaka	3	Marezo	2
Wale	4	Yelatulo	2
Laga	9	Kargakuyo	7*
Kamso	2	Tarkale (2 fora)	4 + 2
Karale	2 + 3+ 3 + 4	Mukito	5
Ergaile	7		

\* marked as 7 separate fora of one harra each

Fora may include cattle from 1, 2, 3 or all six Abaroba villages. When there is grass and water, i.e. Jan-Jun (sic) rainy season, also during Sep-Oct short rains, they come closer to villages. In the dry season they move closer to Segen river and even beyond. After a few months some may stay there, others come back.

According to Abaroba people, no-one from other kebeles keeps cattle here – but Meka people say that people from Galga village, Meka K, keep cattle on boundaries of Meka and Abaroba.

Fora of Abaroba people south of Segen river (in Boran country), with numbers of harra:



<b>Fora</b>	<b>No. of harra</b>	<b>Fora</b>	<b>No. of harra</b>
Kota-aleka	4	Karmahena	6
Kokohe	3	Dakajaldesa	4
Natada	4	Korada Kole	3 + 2
Kubalata	3 + 4	Tarakalkalta	4
Onakolme	3	Kotara	3

This list is only for Abaroba people, people from Geras and Saugumi also keep cattle on Boran land. The furthest Abaroba fora from the river is Kulbatata, about 2.5 hours walk for a man without cattle from the river. The Borana foras are further from the river, but their cattle intermingle with Konso cattle.

### **Baidi-Fuchucha**

There are six villages in the Baidi section of the Kebele: Gelgelaide, Holohombo, Unna, Golaidi, Gedigaidi, Gangade. Fuchucha has its own Vice-Chairman and is quasi-separate, Baidi people did not mention Fuchucha. Land E of main Konso- Arba Minch road counts as Fuchucha, but Baidi people keep fora there.

Boundaries with Kola Mashile and Gato kebeles, Derashe Woreda, and Lultu and Tishmale kebeles. According to Fuchuch people, Gato River forms the North and East boundaries (i.e. with Gato and Lultu); according to Baidi people it is the Yanda which forms the boundary with Lultu. All georeferenced boundaries appear to match maps.

<b>Fora</b>	<b>No. of harra</b>	<b>Fora</b>	<b>No. of harra</b>
Baidi fora W of main road			
Koranto	1	Marsa	3
Baidi fora E of main road			
Dukuba	4	Sibile	2
Chabaye	4	Karbure	1 + 1
Gana	1 + 3	Adaya	5 x 2
Fuchucha fora, E of main road			
Elbache	4	Etapu	2
Fuchucha	6		

Baidi cattle graze only within the Kebele boundaries, drinking water from the Yanda. Marsa is the fora furthest from the Yanda: two hours grazing/walking = 1 hour walking for a man. All Fuchucha fora are within 45 minutes walk of Fuchucha village. Gato people (Derashe ethnic group) and Lultu people graze within Kebele boundaries, but do not have fora. Tishmale, Darra, Duraiti, Fasha, Kolme and Jarso people have their own fora – not marked on the maps.

**Birbirsa** (see also Figure 2, page 9)

5 villages in Kebele: Birbirsa (has 5 sub-villages), Sharanga, Maicha, Nalaya, Gamadara  
Gerseba river does not reach Segen but disperses in the plains.

Georeferences for villages and Lultu boundary match maps. See main text and Jarso for correction of Jarso-Birbirsa boundary.

Nalaya village keep their cattle on lowlands beside Iyanda river in Lultu Kebele.

Other Bibirsa villages keep cattle on the plains by the Segen river. When there is shortage of grazing they cross the river into Burji Woreda and come back in the evening. There is one Bibirsa fora in Burji, also known as Eto – ½ hour walk from Eto fora Jarso [which may be at (3)570(6)005]. Area north of the Gamagile Hills is Burji, area due north is Hailota Dukatu.

<b>Name of fora</b>	<b>No. harra</b>		<b>Villages/ Kebeles represented</b>
Lagabara	4	1+3	Gamadara, <i>Atiskebere</i> , <i>Berek</i> , <i>Hailota Dukatu</i> – each from a different fora
Erotatoltota	7	1+3	Sharanga, <i>Kolme</i> , <i>Darra</i> , <i>Hailota Dukatu</i> – each from a different fora
Monakasuto	2	1+0	<i>Birbirsa</i>
Malata	10	3+2	Sharanga, <i>Mecha</i> , <i>Birbirsa</i> , <i>Shile (Lultu K)</i> , <i>Kolme</i>
Lagasharanga	15	3+1	<i>Mecha</i> , Sharanga, Nalaya, <i>Kolme</i>
Kalda	4	2+1	Gamadara, <i>Birbirsa</i> , <i>Hailota Dukatu</i>
Nechsar	8	3+0	<i>Birbirsa</i> , Sharanga, Gamadara
Monabata	3	2+1	Sharanga, <i>Birbirsa</i> , <i>Kolme (1 family only)</i>
Kalota	3	1+0	Sharanga
Gasari	4	2+0	<i>Mecha</i> , Sharanga
Molicha	6	1+1	<i>Mecha</i> , <i>Darra</i>
Kabta	5	2+0	<i>Mecha</i> , Sharanga
Fohita	4	1+1	<i>Mecha</i> , <i>Lultu</i>

Average no. Birbirsa villages represented: 1.8. Average no. of outside kebeles represented; 1

The Busale fora in Lultu have 17 divisions in all, with cattle from Nalaya and Lultu villages, Nalaya's cattle are a bit more numerous.

Eto fora (Birbirsa) has 6 divisions, from *Mecha* + *Kolme*

Of cattle kept in Birbirsa Kebele there is a 1:3 ratio belongs to others:belongs to Birbirsa people.

It is impossible to get to fora by car, by any road (scarp down from here is steep, road from Sala is thick bush). The nearest is Nechsar, 2½ hours from Birbirsa village on foot. There is no written list of cattle numbers.

They move cattle in different directions at different times of year, but don't move foras. Farm fields are mainly between villages and foras. Some are in-between foras of the "first ring" (those nearest the villages), not beyond that.

### *Duraiti*

About 200 hhs from Garsale village have cattle in foras. There are 9 main foras and c.20 smaller ones, all within the kebele. The 9 foras are Iroda laha, Korimeta, Kitole, Gojoraiti\*, Bayatu, Oraili, Modoho, Arbali\*, Kadaiti\* (\*afterwards said to be part of Oraili). All around 2 hours on foot from the village. In a big foras there are 70-100 cattle, in a small foras 20-30 belonging to 1-3 people.

We interviewed at Bayatu foras – (3)303(5)960 – and Kufi foras - (3)338(5)978. Cattle walk (walk and graze) three hours outward from foras. Each herder moves separately, 2 take calves and goats, 2 take adults (i.e. divisions are not herding units). Most grazing area for Kufi is in other kebeles, i.e. mainly in Lultu – sometimes this side of river. Oraili herders mainly graze within kebele. Haraiti foras was part of Oraili, moved to Baidi, now permanently there, although part of Garsale for admin purposes, though may move back.

### ***Fasha***

Villages of Fasha kebele; Borjo, Gandala, Tarada, Gunyara, Molone, Kurtanga, Arkala, Taratawa

A guess as to the number of village livestock (probably meaning cattle): 2000 in village, 3400 elsewhere: in foras in Baidi (7), Lultu (12), Bibirsa (1-Gerseba foras). The rest are at Kaldo (a very large foras), Hawiya (smaller) and Jabbi, all to the S, beyond the Segen river in Teltele Woreda, Oromiya.

Foras are not permanent – they may move because of grazing shortages or disease problems. E.g. a foras in Baidi could move to Teltele. Before they leave they send 2-3 men to scout for grazing and water. If favourable they ask the local elders and are sent to the leaders of the kebele. Grazing land belongs to a kebele but Fasha K does not own grazing land – it is sandwiched between other kebeles.

Fasha people have fields around their foras in Baidi, Lultu and Teltele. In the crop season families that keep cattle move down to cultivate: even women go, and women and children stay over for some time.

### *Gelgele-Kolmele*

Gete village is in 2 Kebeles: Tebela-Guchale and Gelgele-Kolmele, on whose land it stands. People are still registered, and vote, under their respective individual kebeles.

First it was a fora, people came from T-G, many settled here and begun to cultivate land. It became a village. The main reason they settle is the shortage of food at Kolme. At first they diverted water from the river on their own. 4 years ago the government tried to divert the Segen, but didn't succeed.

Georeferenced boundary with Masoya matches map. They have no boundary with T-G in the east – they are combined.

There is no grazing near, they go to Wando (in Boran Zone, across the Segen), as well as grazing residues. There are five times more cattle in the fora than in the village. This year they vaccinated 4600 cattle (specified) of theirs across the Segen and ran out of vaccine – perhaps 5000. Less than 400 in the village.

G-K fora south of the Segen River

Fora	No. of harra	Fora	No. of harra
Korobo	3	Mansa	9
Kobo	5 + 6	Atobale	4
Otobale	6	Balesa	7

**Jarso (see also Figure 2, page 9)**

There are 16 villages in the kebele (15 on the NRI/FARM GIS). Named fora include Keltaila (5 harra), Hamaito (7 harra), Timbala, Hagadishe and Higita [(3)412(5)916] within the kebele boundaries (including the area northeast of the Yanda river given as Birbirsa on the map – see main text Section 5).

Higita fora currently has 2 divisions

Adult cattle	Calves	Owners
19	12	5
17	5	3

One man is from Geldeha village, others are from Baya [Baya is on south of road, just the Karat side of Oshali/Geldaha, marked as WM10. Geldaha is top of hill, Oshali just below it.]

There are two fora south of the Awassa road – Morateta marked on map while at Higiti, the other was named by the herder –Rali – it is a long walk. Each has only one harra. The road marked on map no longer exists: south of the Burji road is thick forest, it eventually comes out in Nalaya Segen and joins Yavelle road. Almost all herders moved out of this area three years ago when road was built, it is this, not Boran agreement, that triggered move to Eto and Sala.

Sep-Oct rains were good, but they effect mainly the highlands. If long rains are good, people move back to places like Higita at break of slope, because there will be grass,

and there is malaria and tryps on the Burji side. They build new fora. Stay about four months, till grass is finished and water is getting scarce, then move back to Burji side, but not to the ext sites – they fear blackleg and the sites are “muddy”.

They never camp right next to river, despite what was said before.

People from here graze the other side of the Yanda, if necessary as far as the Segen (N of confluence with Yanda) also a little bit south of the road, and sometimes back into the hills.

There are two fora called Sala E of the Segen in Burji territory – georeferenced to (3)556(5)930.

In the two fora there are cattle owned by men from: Darawaro, Kaweidu, Bisiti, Kondo, Derakoma, Lihaidi, Gulalta – all villages in Jarso kebele. One of the two divisions known as Kuweidu has the fora leader from Kondo, plus three men from Kuweidu village. Divisions are formed from men who love each other and can manage their cattle together, not by kinship.

Fora	Division	Adult cattle	calves	Owners
1	Kuweidu	49	22	4
1	Rubale	42	23	5
1	Bisiti	61	20	7
1	Kuweidu (sic)	49	15	6
1	Lihaiti	53	11	8
1	Tarakoma	42	8	7
2	-	53	27	6
2	-	25	8	2
2	-	119	37	13
TOTAL		493	171	58

Some numbers of owners may be underestimates, they were running small owners together.

No specific reason for size of last division.

There is also a fora called Eto mainly used by Jarso people, probably around (3)570(6)005.

### *Lultu*

Information here mainly concerns the settlement of Tarba Fora – WM 12 Map Ref (3)334(6)062. For notes on Birbirs, Duraiti and Fasha people grazing in Lultu, and Lultu people grazing in Baidi-Fuchucha, see under those kebeles.

Crossing of Iyanda is boundary Duraitu/Lultu as marked

Between this and Tarba is rolling country – looked very impenetrable but there were cattle moving, main grazing area for Tarba Fora.

Tarba fora "belongs" to Amaraita village in Lultu K. Very large fora, 20 huts? 100 granaries?, children of all ages, set amidst cropped fields, obviously livestock/cropping camp.

Between here and Amareita village is mainly cropland, Tarba fora residents do not graze here.

Tarba fora belongs to Lultu, but the group we spoke to were mainly from Fasha. One old man has been here since he was young, EC 1976. 24 families live here permanently, 1 from Mechello village, 2 from Kolme, 21 from Fasha. Only 9 families have cattle, all cultivate.

When they first came they paid rent to an Amhara landlord, but also contacted the Lultu village (they probably meant Amareita), and agreed to stay with them. Then their cattle died, some are cattle-less or have very few, they turned to cultivation. Since the Derg they have paid only tax, not rent. The area was originally forest when they came, now Lultu people are coming with their animals. Fora all around here. Only the Lultu men come here, they also cultivate.

Around the huts, they marked three fora of Tarba people (ex-Fasha and Mechello). Also W of the road are two fora of one harra each belonging to Lultu people. East of the road are seven fora of one harra each, two for Kolme people, five for Lultu people.

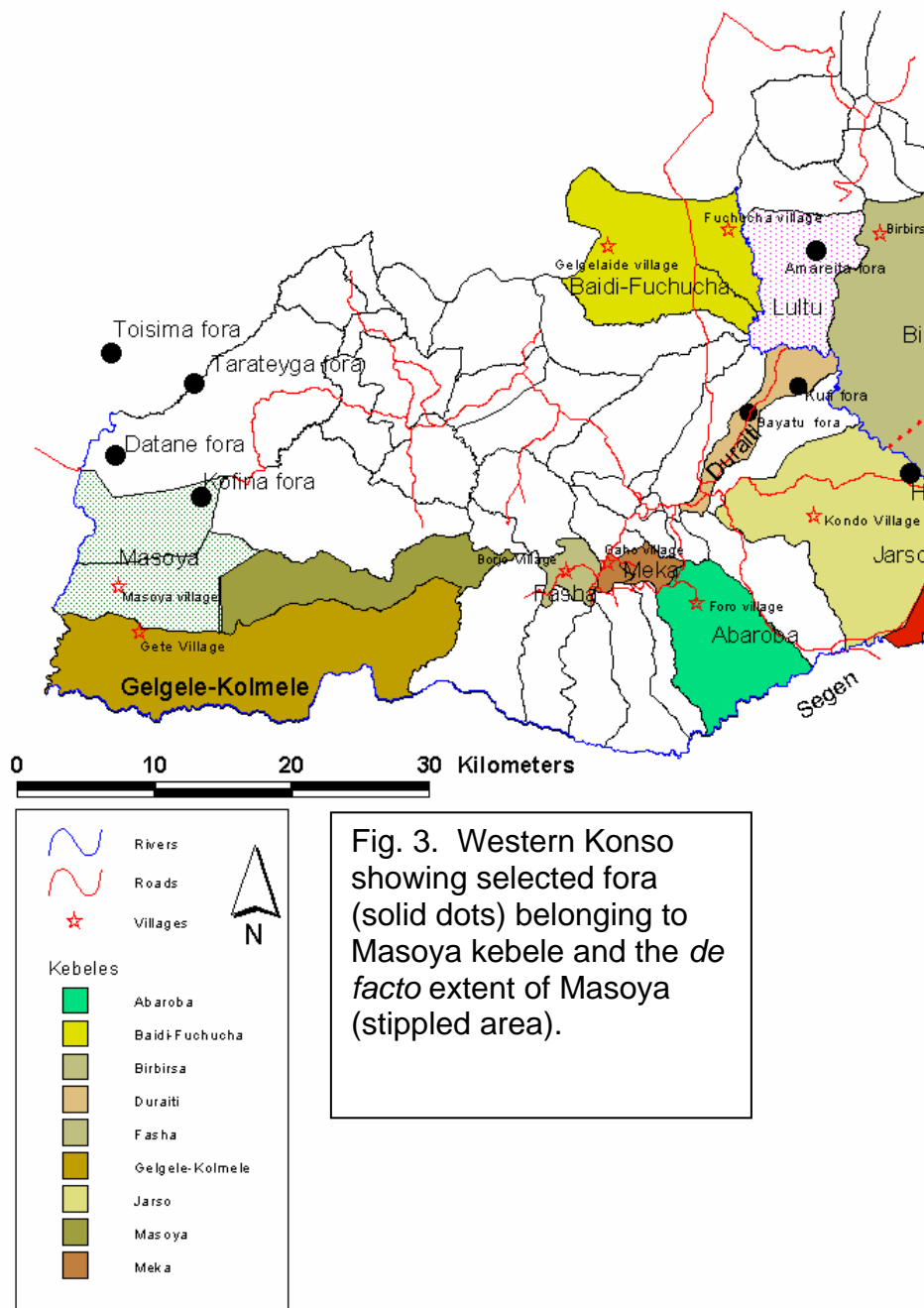


Fig. 3. Western Konso showing selected fora (solid dots) belonging to Masoya kebele and the *de facto* extent of Masoya (stippled area).

### Masoya (see Figure 3)

Boundary of new Masoya Kebele to the E (with Maderia-Gizaba) follows edge of hills. Other boundaries appear to be as on Government Maps. People appeared to refer to the river marked as Besa on the map as the Tahita, though they denied this.

There is one large village (dating from assisted resettlement in the 80s). It is located at (2)847(5)834 and **not** at the point marked "Weyto" on the map. Information on the distance and location of fora was obtained by map or interview in the village, enabling guesses as to location by map reference:

- Kofina fora is probably located around (2)930(5)900. It has five harra, comprising 388 cattle of eight extended families, plus a smaller fora immediately to the E, located in Maderia-Gizaba, with 120 cattle.
- Datane fora is located immediately N of the Jimka Road and E of the Weyto river, in Kerkete kebele – perhaps around (2)825(5)925. The cattle here all moved relatively recently to Tarateyga to the E, also in Kerkete, perhaps at (2)900(5)980. Datane appears to have four fora, comprising 205 cattle of 10 extended families.
- Toisima fora is in Dimeka Woreda, possibly at (2)845(6)000. It has five harra, comprising 405 cattle of seven extended families.

Total cattle in fora number 1118. No cattle from outside graze in this kebele. The people's estimate of cattle in the village is 750. From a pile sorting exercise it looked like twice as many cattle were in fora as in village, and people said there were three times as many.

The fora move [outwards from kebele?] in time of shortage of grass. In time of rain cattle return to nearer fora and to village (NB this was not said in previous discussion of cattle numbers). People/cattle at Toisima return to Datane.

In wet season they move ½ an hour's walk per day, then as dry season comes on one hour, then two hours. 2 hours walk for a cow = 1 hour for a man on foot [4-5 km].

### Meka

One village, Galga, has cattle on this side of the Segen river, on boundaries of this kebele and Abaroba. Other 7 villages do not have fora, but keep all their animals in the village. Some families keep one or two cattle in the house or on roadsides. Why do they not have fora in other kebeles like Fasha? A: they cannot afford to buy cattle in the market. B: If they take cattle to distant fields they risk losing everything from tryps. In Meka they do not have tryps.



## **ANNEX 2: MISSION TO KONSO BY JOHN MORTON (27.11.02-9.12.02): A NOTE ON KEY FINDINGS PREPARED FOR FARM-AFRICA AND KDA**

### *Structured survey*

Unfortunately analysis of the survey has been delayed. In addition it seems that the survey produced conflicting findings on certain key variables such as livestock numbers. However, there is much useful information, some of which can be disaggregated to kebele level. JM will work with Malcolm Iles at NRI to produce a full draft, with the best possible interpretations of data in the Konso context.

In the meantime, some key findings are as follows:

- Using stated deaths from tryps among cattle over 4 years old, together with the largest reported figures, in other words using the most conservative interpretation of the data, the mortality rate from tryps is around 17% per year
- Tryps (gandi and gandi chilmale) were the highest ranked reasons for losing cattle among farmers.
- Cattle mortality, cost of treatment and loss of draught power were the most important impacts of tryps as perceived by farmers
- Farmers were experiencing an average of 2.5 abortions per year from tryps
- Farmers overwhelmingly (>80%) treat tryps every time symptoms appear
- Farmers are using 7.62 tryps treatments per farmer per year, but some of these are local or traditional remedies. They appear to be paying on average Birr 13.26 per year
- Additional information on cattle marketing were also obtained

### *Mini-survey of Fuchucha*

In order to get data for comparison with the structured survey, a shorter and simpler survey of ten farmers in Fuchucha sub-kebele, a 10% random sample of those owning cattle (but NB only c.40% of Fuchucha farmers own cattle). Key findings were as follows:

- Average cattle holdings are 4 adult cattle and two calves.
- There is 12% tryps-related mortality, which constitutes 80% of total mortality
- There have been 0.2 abortions per farmer
- Farmers treat for tryps on average 8 times per year – the great majority of which is done with purchased drugs
- Farmers lose on average 12.1 days worth of ox-ploughing per year because of tryps

Based on both the larger survey and the mini-survey, cost-benefit analyses are being constructed, which will show that the *true costs of tryps*, including mortality, treatment and lost ploughing, *are well in excess of the cost of applying pour-ons, at unsubsidised prices, seven times a year.* See Appendix A

### *Progress of KDA/FARM tsetse control programme*

Information on the distribution of pour-on, its reimbursement, and operators' and cattle-owners' perceptions was collected, particularly in Jarso and Baidi-Fuchucha kebeles. This information will be considered further, in relation to cattle population and range area data, to produce recommendations. For the moment, it was noted:

- That there is considerable support for the programme from farmers, especially in Fuchucha, where farmers are perceiving benefits in terms of reduced mortality and increased production
- That FARM/KDA have agreed a significant transitional subsidy (though the rationale for this is not universally understood, and some farmers see it as a random price fluctuation or an effect of substituting an inferior insecticide)
- That local applicators are taking responsibility for distributing pour-on and farmers are paying the new price, in some areas in large numbers
- Kebele fora committees, or tsetse control committees, were not mentioned spontaneously by applicators or farmers and appear to have little to no role in the kebeles examined
- The question of collective action by farmers is hard to investigate. Current information suggests that if kebele and fora leaders were mobilised around tsetse control, strong sanctions could be enforced against non-appliers/non-payers
- However, the programme has shifted to a *de facto* position of recommending application once a year, for a number of reasons:
  - Farmers' ability/willingness to pay/cash flow
  - A lack of understanding that tsetse control is subject to a threshold effect, and that levels of benefits are not proportional to expenditure, but that a low level of compliance will probably produce a negligible benefit.
  - Lack of extension work, particularly comparing the costs of tsetse control to the real costs of tryps
  - KDA's/FARM's practice of delaying delivery of pour-on to applicators until there are no significant unused stocks at kebele level *and* until the previous installment is paid.
- Farmers' perceptions of benefits from the current programme do not seem to be as predicted by our current understanding of control and may involve other factors, which should be considered. Despite this, the current frequency of application is very concerning, and requires several actions.

I propose that:

- Subject to time constraints (as we have no funded time for technical assistance to FARM Africa *per se* and will have to do this under research budgets) we will use population and range area data collected to model tsetse control and calculate the least-cost application frequency that can be expected to have any significant benefit for farmers.
- I will produce prototypes of simple extension materials, particularly ones that compare cost of tryps and of pour-ons (see sketch at Appendix B).

- FARM/KDA should step up extension efforts, explaining to farmers and applicators that three (or preferably four) applications a year are not a menu from which they can pick and choose. FARM/KDA should also make it clearer to farmers that it has chosen to give a transitional subsidy on current stocks.
- FARM/KDA should de-link delivery of pour-ons to kebele level from short-term requirements for reimbursement. Even with a high willingness to pay, the logistics of collecting money in some kebeles will produce delays that if treated as a block on further delivery will make a three-month application timetable very difficult. Provision of what could be considered medium-term credit would seem a perfectly reasonable practice while trying to build demand, and not doing so risks breaking the system down.
- FARM/KDA should not assume that unused stocks indicate no need for further deliveries. What appear significant unused stocks may be inadequate to apply to large distant clusters of fora (e.g >500 cattle at Sala fora), where pour-on logistically has to be applied at one time. The re-interpretation of KDA figures at Appendix C shows that, while application rates are uniformly very low, there are serious problems in repayment and/or holding of unused stocks in only four of the twelve kebeles. FARM/KDA should investigate the situation in those four (Tishmale, Nalaya Segen, Duraiti and Fuchucha [where the situation has probably recently improved anyway]), while aiming to ensure a more continuous flow to the others.

*Information for the trypanosomiasis/malaria research project*

- Secondary information on human populations and cattle populations was obtained and reviewed.
- Locations of fora and spatial patterns of range-use were mapped for Jarso and Fuchucha (and to a lesser extent Baidi), which should allow modelling of tsetse control.
- Fuchucha, as a large lowland village, with a resident population of all ages and both sexes, a large night-time cattle population, and a high malaria risk, was identified as a particularly fruitful location for researching the anti-malarial effects of pour-ons.
- Information collected would also allow study of malaria risk factors in Jarso, at villages, fora and at the scattered temporary settlements around lowland cultivation sites.

Appendix A- Costs of tryps per household from Fuchucha Mini-Survey

Item	Quantity	Rate	Cost
Mortality	0.1 calves	200	20
	0.1 cow	300	30
	0.5 oxen	550	275
Abortions	0.2	???	0
Treatments	8	5	40
Lost plough-days	12.1	5	60.5
TOTAL			425.5

Compare pour-on treatment of two cattle (half of average of four)

7 times/year at market rate	9.75	136.5
4 times/year at market rate	9.75	78
7 times/year at subsidised rate	6.5	91
4 times/year at subsidised rate	6.5	52

APPENDIX B – SKETCH OF EXTENSION MATERIAL

(Assumes small herds, low mortality, high draught power losses, would be suitable for e.g. Fuchucha. Versions with larger herds, higher mortality and no mention of draft power could be produced for other areas))

**A farmer has two cows, two calves and two oxen (*pictures of all these*)**

<p>If the tsetse fly and gandi remain, in a year:</p> <p>One cow may die (picture of dead cow) Birr 300</p> <p>He may have to treat his animals four times (four sachets of Berenil) Birr 20</p> <p>He may lose 10 ploughing days (picture of ox ploughing with ten suns) Birr 50</p> <p>Not counting lost milk and butter, abortions, his time and energy spent searching for treatment, he will lose:</p> <p style="text-align: right;">Birr 370</p>	<p>If he participates in the tsetse control he will treat two of his animals at most seven times a year.</p> <p>(not sure of visual image)</p> <p>Even if he pays full cost this will be no more than:</p> <p style="text-align: right;">Birr 136.5</p>
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- COLLABORATE WITH YOUR NEIGHBOURS TO PROTECT EVERYBODY'S CATTLE
- FOLLOW THE RECOMMENDATION FROM KDA ON WHEN TO TREAT YOUR CATTLE
- JUST BECAUSE YOUR CATTLE DO NOT GET SICK, AND YOU DO NOT SEE THE FLY, YOU MUST NOT STOP. THE FLY CAN ALWAYS RETURN FROM OTHER WOREDAS

APPENDIX C

INSECTICIDE APPLICATIONS BY KEBELE, 2002

Kebele	Applied (litres)	Of which, % paid	Held at kebele (litres)	Fora cattle population <sup>a</sup>	% cattle treated <sup>b</sup>
<b>Dukatu</b>	<b>8</b>	<b>88</b>	<b>1</b>	973	41
<b>Lultu</b>	<b>11</b>	<b>92</b>	<b>1</b>	2422	23
Tishmale <sup>c</sup>	3	100	4	1817	27
Nalaya Segen <sup>d</sup>	0	0	3	1491	37
Duraiti <sup>d</sup>	5	0	3		
<i>Dera</i> <sup>d</sup>	6	50	2		
<i>Birbirsa</i>	18	56	5	3333	27
<b>Dukatu-Haylota</b>	<b>6</b>	<b>100</b>	<b>1</b>	1481	20
<b>Jarso</b>	<b>18</b>	<b>89</b>	<b>5</b>	1615	56
<b>Baidi</b>	<b>6</b>	<b>100</b>	<b>5</b>	3468	12
Fuchucha	2	0	0		
<i>Masoya</i>	6	50	2	1124	27
<i>Gelgele-Kolmele</i>	21.5	47	9.5	1669	64
Total	110.5	64	41.5	19393	28

**Bold + It.** = high repayment, low level of stocks relative to cattle numbers

**Bold** = high repayment, moderate level of stocks relative to cattle numbers

*It.* = Moderate repayment, low level of stocks relative to cattle numbers

Other = problem kebeles

a) from original FARM/KDA count with fora leaders

b) assumes no cattle treated more than once. 50% would indicate that the correct proportion of cattle have been treated once, 150-200% would be an optimum figure for the year.

c) probably equivalent to Turo in older documents

d) were formerly united as Mermere Kebele

### **ANNEX 3: NOTES ON A VISIT TO FITCA HANDENI, JANUARY 2003**

Group meetings were held with the dip/livestock committees for: Kinkwembe, Mkindi, Lengusero, Mabalanga, Mufaleta and Malezi. A follow-up meeting with one committee member, and two non-members from Kinkwembe, meetings with groups of livestock keepers from Kwamadule (sub-village of Malezi), and Lengusero, and a meeting with the Apex Committee at Mkuyu dip were also held.

All the villages named except Malezi are contributing to rehabilitation of the Mkuyu dip and intend to start regular dipping of all cattle there. There is no evidence of anyone adopting an interim control measure, e.g. spraying.

Livestock owners in Malezi, including Kwanamdule, opted to dip their cattle at the already functioning Nung'uli dip. However, it appears that very few, possibly only three, livestock keepers are doing this with any regularity at all, as the dip is far, the tracks to it pass through farmland which increases the possibility of disputes, and the costs are high and the pricing structure (possibly) geared only to weekly dipping.

An interesting comment was made in Malezi that tsetse (and ticks) in the area had previously been controlled by deliberate burning of the undergrowth in bush areas, which had stopped following the government's extension and media campaign against burning starting in 1995.

#### ***Ranking of animal diseases***

This was not attempted very systematically, as it has already been carried out, by NRI and by FITCA. Given the lack of a terminological distinction between pests and vectors, uncertain mapping of local onto scientific names of diseases, possible desire to give a priority that matched the researcher's, plus general PRA good practice, ranking would need to be done *very* slowly and carefully. One informant wanted to give a high rank to rinderpest (last seen in 1982)! In any case, it is clear that trypanosomiasis is a very high priority, but not consistently more important than *ndigana* (ECF and/or other TBDs), or TBDs as a category.

### ***Impacts of tryps and cost:benefit analysis***

Meeting participants were asked to rank the negative impacts of tryps/tsetse upon them using a series of cards, a technique that had proved helpful in Ethiopia. Results are given below.

Informant/location	Most important	2 <sup>nd</sup> most important	3 <sup>rd</sup> most important	4 <sup>th</sup> most important	5 <sup>th</sup> most important	Least important
Kinkwembe: individual Maasai cttee member	Cost of treatment	Abortion	Denial of grazing	Loss of milk	Death	*
Kinkwembe: individual Ziguwa cttee member	Cost of treatment	Death	Abortion	Denial of grazing	Loss of milk	*
Mkindi committee	Death	Denial of grazing	Cost of treatment	Poor prices	Abortion	Loss of milk
Lengusero committee	Denial of grazing	Death	Cost of treatment	Poor prices	Abortion	Loss of milk
Mabalanga committee	Cost of treatment	Abortion	Loss of milk	Denial of grazing	Poor prices	Death
Mufaleta committee	Death	Cost of treatment	Abortion	Loss of milk	Denial of grazing	Poor prices
Kwamadule livestock keepers	Denial of Grazing	Abortion	Death	Cost of treatment	Poor prices	Loss of milk
Lengusero livestock keepers	Cost of treatment	Abortion	Poor prices	Denial of Grazing	Loss of milk	Death

\* poor prices were not mentioned by these informants so were not included

A crude overall ranking would be: cost of treatment; abortion; death equal with denial of grazing; poor prices; loss of milk. However, this hides the great diversity of responses, which suggests a) that tryps is an overwhelming and multi-faceted problem and livestock keepers have difficulty in ranking its impacts, and b) responses vary according to location and herding strategy, e.g. for the Maasai such as the Lengusero committee members (who remain based in Mkindi) and for Kwamadule Maasai, denial of grazing is most important, as they see themselves prevented from settling in Lengusero, while for those who do bear the risk of herding in Lengusero, cost of treatment becomes most important.

Further notes on the "impacts"

*Cost of treatment* would be very difficult to quantify in any recall-based survey, given large herd-sizes, poor recall of quantities, and the number of drugs bought and used for other animal diseases. Some estimates seem fantastically high, but high estimates were given so consistently that 3 treatments per animal per year, or Tsh75,000 for a herd of 50, might well be conservative. Informants all said that they



treated as soon as possible after seeing clinical signs, including early signs such as loss of appetite and hair standing up.

*Deaths and abortions* would be extremely hard to quantify by recall survey, and hard to attribute to tryps rather than other diseases.

It would be impossible meaningfully to give a proxy price to *denial of grazing*, i.e. the fact that fear of tryps causes herders to avoid particular areas that would otherwise provide good grazing. It is an extremely important impact but also one that varies:

- between communities,
- probably between individuals depending on their risk aversion, willingness to survey herds continually for disease, and willingness to pay for treatment,
- and between years, as herders are driven to graze in heavily infested areas for lack of any alternative during drought years.

The mention of denial of grazing also raises the issue of whether some areas will present a problem for control solely by ITCs because they are so heavily infested they will never be grazed with the density of cattle required. This is discussed below.

*Poor prices* was an unexpected impact, but it is clear that Handeni livestock owners are selling large numbers of cattle that they themselves see as in poor condition because of recurrent or chronic tryps infections, (the District Livestock marketing officer confirms this) and are aware of the difference in price they are suffering as a result. More than 100 cattle may be sold at the weekly livestock market near Handeni town (though it can be many fewer). As there is considerable variation of price within the categories of "good condition" and "poor condition",<sup>13</sup> quantification would be difficult, although an estimate of TSh30,000 for each animal sold in poor condition would be conservative.

*Loss of milk* was consistently ranked low, probably because milk is not consistently marketed and remains (in good years) relatively plentiful. Livestock owners when asked generally said that a lactating cow that developed tryps and was promptly treated might go altogether dry, or have milk only for its calf, but would return to the previous yield within a month (I assume a full return is in fact unlikely. With a daily yield of 1 litre, and a farmgate price of milk, when sold, of TSh100/litre, this gives an estimated loss of TSh1500/infection of a lactating cow.

#### Cost benefit analysis

The costs of living with tryps in Handeni are multiple and almost completely unquantifiable at present. However, it is still clear that they are almost an order of magnitude above the likely costs of tsetse control through dipping:

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<sup>13</sup> And prices are rising generally

Cost of dipping 50 adult animals monthly @ TSh50: TSh30,000  
 Equals: Cost of treating 20 animals three times/year  
**Or** 30% of lowish price for **one** good quality ox  
**Or** 60% of lowish price for **one** good quality cow  
**Or** Low estimate of price difference between  
       good-quality and poor-quality animal  
**Or** Lost milk from 20 cows infected during lactation.

Given that all these impacts (plus abortion and denial of grazing) are felt, the abstract cost:benefit comparison with monthly dipping @ TSh50 is overwhelming, and positive for more frequent and more costly dipping regimes.

Given the considerable problems of recall surveys in these communities, it is not recommended that this is investigated through a structured survey.

If hard evidence of economic benefits were required, it might be possible to institute regular (monthly?) herd monitoring of a very small purposive sample.<sup>14</sup> As the communities that have chosen to use Nung'uli dip are unfortunately very unlikely to use it sufficiently to achieve tsetse control, they could be used as a "control" for areas of initially similar tsetse challenge in the Mkuyu dip catchment once dipping starts. See Annex 1.

#### *Sustainability and Collective Action Issues*

The enthusiasm of the dipping committees and the apex committee for instituting tsetse control through dipping are unmistakable. TSh 276,500 has been collected since last September, out of an assessed TSh 375,000 for dip rehabilitation and an additional TSh 100,000 for initial dip filling. The lowest contributions have been at Kinkwembe, the second furthest from the dip.<sup>15</sup>

Village Dip Committees (many prefer to be called "Livestock Committees") were elected (at least in some villages by written ballot of livestock-owners) after the August round of stakeholder meetings. The Mabalanga committee appears to have a very large overlap with the Village Committee, the others less so. Most of the committees are Ziguwa dominated, except for the Lengusero committee, made up of Maasai living at Mkindi. Mr Matanda Leposa is an influential member of the otherwise Ziguwa Kinkwembe committee. Maasai-Ziguwa cooperation here, as on the Apex committee, appears good.

Committees used various systems to assess members for initial contributions, flat-rate per boma, flat-rate per livestock-owner, differential rates for cattle owners and those only owning smallstock (it was not clear what the rationale for this was). Some had to levy the contribution in several tranches as the initial assessment proved inadequate.

<sup>14</sup> For example, x households each in the categories rich Maasai, poor Maasai, rich Ziguwa, poor Ziguwa, for Malezi/Kwamandule and for areas of similar initial tsetse challenge in the Mkuyu dip catchment.

<sup>15</sup> Figures on numbers of livestock-owning households have not been found. As the contributions were assessed equally for the five participating villages (and therefore unequally between households) it would be interesting to compare these with contributions received.

The committee members, including apex committee members, are not very clear on how often it is recommended to dip cattle, generally or specifically for tsetse control: the apex committee members seemed to think twice-monthly. They admit they do not know how much will be charged for dipping: this is to be worked out when the dip is ready for use. They are, or claimed to be, aware:

- a) that tsetse control will require all cattle-owners to dip regularly, and
- b) that dipping will have to continue indefinitely, even after there are no visible tsetse flies in the area.

When asked how they would handle a), the most common response was to say they would pass bye-laws that gave the committees the power to fine non-compliers, and that these bye-laws would be endorsed by the District Council. It seems that this plan has not been discussed in any detail with the District Council, and it is very doubtful if such bye-laws could be past at the level of individual villages. Some committees also referred to informal persuasion, and Maasai informants in particular spoke of not allowing non-dippers to herd with other members of the community, a very powerful sanction as it means effectively a suspension of labour-sharing arrangements.

On b) committees were confident they could encourage people to go on dipping after the end of a visible tsetse threat, as they would continue to wish to dip against ticks. Some informants regarded tick and tsetse control as equally important motives for dipping, others saw tsetse as a higher priority.

Problems foreseen by the committees tended to be external and material, particularly the long distances to dips faced by people at Lengusero and Kinkwembe – from Lengusero the round trip would take two days. As a single herder can take at least 50 cattle if necessary (in practice this is unlikely to be put to the test, and herding labour does not appear to be very scarce or have a high opportunity cost, I asked why this was a problem. The answers were that taking the cows in milk off for two days would deprive children of milk, and that the journey would be difficult for calves.

It was difficult to get out of committees any sense of the internal problems they might face, or the sorts of support they would need (other than material support such as subsidies, a new dip at Lengusero, etc). Asking whether there were factors that might make some committees better at assuring compliance than others did not really pick up useful answers, but it did seem that some of the committees were attempting to formulate needs for support in planning and in motivating livestock-owners.

Notes towards (mainly qualitative) monitoring of the committees are given in Annex 2.

### *"Hotspots" and Grazing Patterns*

As discussed above, livestock owners' inability or unwillingness to herd cattle in highly infested areas is an important impact of tryps. Names of some of those areas were collected, particularly the Mnunduzi river valley, and for many informants the

whole of Lengusero.<sup>16</sup> It will definitely be useful to continue to map these “hotspots” and to *consider* strategic use of targets within them, at least till there is an initial reduction in population.

Despite the fact that there is widespread grazing across village boundaries (by both Maasai and Ziguwa), all the committees were happy that any responsibility for maintaining, protecting and recharging targets should be a village and not an apex committee responsibility.

It is clear that the control of tsetse in Lengusero would bring an influx, not only of Maasai who see themselves temporarily resident in Mkindi, but also Maasai from (at least) Kinwembe and Kwanamdule. No-one admits to any concerns that this would cause overgrazing, though there were strong hints they would resist any settlement by Ziguwa or other farmers. Nor were there similar concerns for any other hotspots.

### *Malaria*

All the communities see malaria as an important human health issue. Where I (cautiously) explained the possibility that dipping cattle might reduce malaria, the response was very positive. In Mufaleta, informants said that if the hypothesis proved true, they would start to dip their chickens and even themselves, and then that they would be able to get non-livestock owners to contribute to dipping (which given the positive benefits to livestock keepers would probably be unnecessary as well as impractical). Any research on malaria would make it very important to have:

- Accurate data on numbers of livestock-owning and non-livestock owning families in each village
- Good idea of the micro-spatial distribution of humans and animals: Maasai bomas with houses around a kraal would appear very conducive to malaria control through dipping, but bigger, predominantly Ziguwa, village centres seem to have low cattle:human ratios.
- As there are significant numbers of households with smallstock but no cattle, it would be interesting to know more about *a.arabiensis* biting of goats.

### *Dissemination Issues*

Based on this visit and work in Konso, I am beginning to think about a socio-economic/institutional “module” of the tsetse toolkit, that could be structured around a hierarchy (decision-tree) of requirements for successful tsetse control:

- *Medium-term profitability for livestock owners*: this is the killer assumption. The cost of tsetse control will be determined in technical parts of the toolkit, but the benefits will be dependent on the costs of living with tryps. Methods to investigate these would need to recognise the multiplicity of tryps impacts, some of which might not be quantifiable, and the circumstances in which structured, quantifying approaches would be feasible or necessary.
- *Successful management of entry costs*: how to manage both initial investment in infrastructure, and “double costs” of tsetse control plus trypanocides while tsetse

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<sup>16</sup> Lengusero residents agreed with this, although they were ready to live with high infestation, but they seem to graze regularly only an inner section of Lengusero, as the perimeter, especially in the north, is too far from water.

populations decrease (issue of transitional subsidies). These issues might be particularly important where profitability is only moderately positive.

- *Cashflow*: there is a need either for livestock-owners to have cash in hand to pay for tsetse control, or for some sort of credit or payment-in-kind arrangement to be devised.
- *Management of collective action*: this is important, but probably only if the above three requirements are fulfilled. Key questions and issues would include: single-purpose or multi-functional institutions; strengthened traditional or new institutions; formal-coercive or informal sanctions; participation in planning stages; how to manage technically-determined boundaries for tsetse control not coinciding with existing social boundaries; rewards for those working for the collective good; identifying needs for practical organisational strengthening.
- *Pro-prevention attitudes*: is there a tendency to favour payment on treatment over payment for prevention? Is it relevant if the above requirements are met?
- *Confidence in technology*: to what extent will this be an important issue if above requirements are met? Need for extension.

Under each "requirement" there may be sections on research/monitoring questions, research/monitoring methods, and options for support.

Comments on this draft structure, relative importance of information needs under each heading, and suggestions of tools, can be collected from tsetse control projects by email contact.

### *Recommendations for FITCA*

1. There is a need for a clear recommendation to be communicated to livestock-owners on the frequency of dipping, and the proportion of cattle to be dipped *for purposes of tsetse control*. If possible this should allow for exemption of calves below x years, and cows with followers. Livestock-owners may be told that more frequent dipping will individually bring them tick-control benefits, but the tsetse recommendation will be the standard which committees will persuade (or coerce) livestock-owners to comply with.
2. FITCA should clarify if the District Council is really likely to endorse bye-laws giving village committees powers to fine defaulters, and tell committees immediately if this is not the case.
3. Forms will need to be devised for the apex committee to manage income and expenditure, record names of livestock-owners dipping, and communicate this back to village committees so they can monitor compliance. Training in the use of these forms/procedures should be given, but also some form of leadership training.
4. The apex committee and village committees should follow up with livestock-owners who have not made their initial contributions, but this should be outside the dipping price structure, which should not impose entry costs.
5. There should be (quarterly?) monitoring of village committees, including compliance with recommended dipping rates/proportions, but also a select range of qualitative indicators (see Annex 2).
6. Participatory identification of hotspots should be stepped up, the implications of hotspots included in modelling, and consideration given to use of targets where necessary
7. Participation of livestock-owners in tsetse monitoring should be institutionalised.
8. FITCA may wish to consider monthly monitoring of a small purposive sampling of herds for changes in herd composition including deaths from tryps and otherwise, abortions, expenditure on tryps treatments and days milk yield lost (see Annex 1).

## ANNEX 1: NOTES ON HERD MONITORING

For a small purposive sample representing Maasai, Ziguwa, rich, poor, cattle owners.

Establish baseline herd composition (over several visits)

On a monthly basis record:

- All changes in herd composition
- If deaths, due to tryps or otherwise
- Costs of tryps treatment
- Prices of cattle sold and quality (poor/middling/good)
- Days milk yield lost
- Any grazing areas used other than those habitual for the season

## ANNEX 2: NOTES ON MONITORING OF COMMITTEES

Baseline data:

- Total number bomas and number of families in village, of which numbers owning smallstock only and numbers owning cattle

On a quarterly basis:

- Numbers of cattle owners meeting dipping targets, those not meeting targets by how much
- Number of meetings of village dip committee
- Participation of committee members and others in apex committee work
- Participation of committee members in non-dip-related development activities
- Notable achievements of dip committee
- Problems faced between committee and livestock-owners, how managed
- Other problems faced in achieving dip targets
- Disagreements within committee
- Disagreements with other village committees or apex committee
- New or unusual areas grazed by village livestock-owners, by outsiders, any grazing disputes.
- Any other comments