

## ANNEX B: FINAL REPORT

### Final Report Guidelines

The report is to be a maximum of 4 sides of A4 size paper excluding the Output to Purpose report

Date

10 March 2003

Title Of Project & Project Ref. No.

Controlling malaria and trypanosomiasis with insecticide-treated cattle C1-P40

Organisation

Natural Resources Institute, Chatham, UK

Reporting Period

from 1 August 2001

To 31 March 2003

Anticipated Completion Date

31 March 2003

### 1 Goal Purpose and Outputs :

#### *Project goal*

To improve significantly the health of the poor and to reduce the physical and functional disabling effects of infectious disease.

#### *Project purpose*

To develop cost-effective and appropriate technologies to reduce mortality and the disabling effects of malaria that affect the livelihoods of the poor.

#### *Project outputs*

1. Quantitative data on the effects of the insecticide-treated cattle on mosquitoes.
2. Recommendations on the suitability of insecticide-treated cattle to control malaria in the project area in particular and Africa in general.

### 2 Summary of work carried out in this period :

All field studies were carried out in southern Ethiopia and Zimbabwe. Laboratory analyses were undertaken at the Natural Resources Institute, Chatham, UK.

#### 1. *Field studies of the mortality of mosquitoes exposed to insecticide-treated cattle.*

Test animals were treated with a pour-on formulation of deltamethrin (Spot-on) widely used for tick and tsetse control in Africa and the mortality of mosquitoes exposed to treated cattle was assessed using two different protocols. First, groups of ~10 wild-caught mosquitoes were placed in an exposure funnel which was applied to the surface of treated and untreated cattle for 3 minutes. Knock down and mortality of the treated and control mosquitoes was assessed at 1 h and 24 h post-treatment. Second, susceptibility was assessed by tethering individual insecticide-treated cattle within a large netting enclosure (4 m x 3 m x 5m). A 30 cm gap at ground level allowed mosquitoes to enter the tent and each morning *Anopheles arabiensis* retained in the tent were collected and categorized as dead, alive, fed or unfed. The results were compared with those from untreated control animals. In both protocols, four pairs of treated and untreated animals were compared for 30 days, comparing four pairs of animals.

2. *Field studies of the attraction and feeding responses of mosquitoes to insecticide-treated cattle.*

Single cattle, either treated with deltamethrin or not, were tethered within 2 m of two human collectors who collected mosquitoes landing on each other. If treatment diverted mosquitoes from the cattle to the humans, then the collectors would be expected to collect more mosquitoes on nights when they are adjacent to a treated animal. The experiment was repeated with four matched pairs of cattle continued for 30 days for each pair of animals. In addition, visual observations were made of mosquitoes feeding on treated and untreated cattle and feeding time and success from treated and untreated cattle were compared.

3. *Field studies to determine whether mosquitoes feed selectively on particular (e.g. age, size) cattle within a herd.*

A PCR-based technique for identifying the individual-specific sources of cattle bloodmeals was used to determine whether mosquitoes feed preferentially on certain cattle. Groups of 2-3 animals were placed in a netting enclosure which allowed mosquitoes to enter during the night. The following morning, blood-fed mosquitoes were collected and subsequent laboratory-based analyses determined the individual-specific source(s) of the bloodmeal. The experiments focussed on determining whether there were significant difference in responses to young (< 3 years) and mature cattle; African farmers controlling ticks and tsetse tend not to treat young cattle with insecticide.

4. *Make recommendations on the suitability of using insecticide-treated cattle to control malaria and hold dissemination workshops.*

To disseminate the findings within Ethiopia, >50 representatives from government, scientific and NGO organisations concerned with human and animal health were invited to a 3-day workshop convened in Arba Minch in December 2002. The meeting was conducted in Amharic and Dr Habtewold presented the scientific findings and recommendations of this project. To disseminate the project outputs more widely, a one-day workshop on interactions between agriculture and vector-borne diseases was organised at the Royal Entomological Society in London in April 2003. Some 100 UK- and Africa-based scientists/administrators concerned with the control of vector-borne diseases, including malaria, attended the meeting. Dr Habtewold gave a 30 min presentation on the outputs of this project. One scientific paper on aspects of this project was published in the scientific press (Prior & Torr, 2002) and a second is in preparation.

### 3 Overall Results of findings obtained by the project:

#### *Susceptibility of mosquitoes exposed to insecticide-treated cattle.*

The results from the two bioassay protocols gave markedly different results. On the one hand the assay based on exposing mosquitoes to the flanks of cattle indicated that the insecticide produced mortalities >50% for 4 weeks whereas the tent-assay indicated that the insecticide was effective for only 1 week (Figure 1).

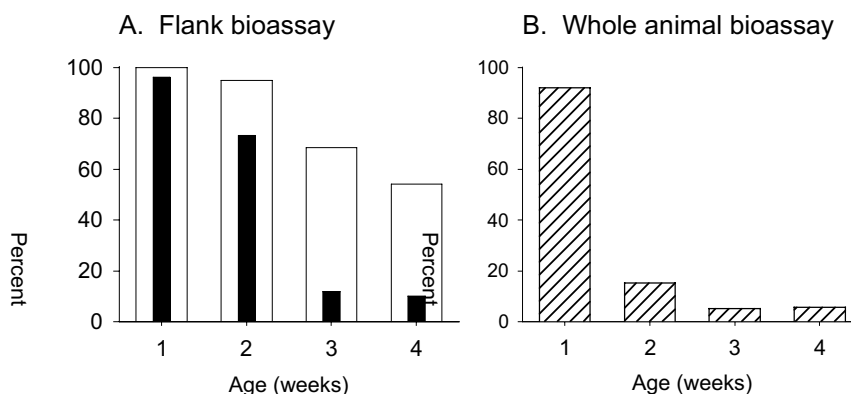


Fig. 1. Knockdown and mortality of *An. arabiensis* exposed to cattle treated with deltamethrin pour on, bioassayed by either exposing mosquitoes to the flank of a treated animal for 3 minutes (A) or allowing them to feed naturally on a host within a netting enclosure (B). Solid bars=mortality after 24 h; open bars=knockdown after 1 h; crosshatched bars = mortality after 1 h.

### Behavioural responses of mosquitoes to insecticide-treated cattle

Dispensing ox odour adjacent to a human bait collector increased the numbers of *Anopheles* spp. captured (Fig. 2). However placing either an insecticide-treated or an untreated ox next to a human had no significant effect on the numbers of *An. arabiensis* captured, but decreased the numbers of *An. pharoensis* and increased the numbers of *An. tenebrosus* (fig. 2). These results suggest first that treating cattle with insecticide did not increase the numbers of mosquitoes landing on a human and thus the treatment is not likely to increase malaria risk. The results also indicate that placing an ox next to a human increases the numbers of mosquitoes attracted to the vicinity of the baits but that interspecific differences in the close-range selection of hosts results in either an increase (*An. tenebrosus*), a decrease (*An. pharoensis*) or no change in the numbers of mosquitoes landing on a human. ing effect of having placing ox odour or an ox next to a human presumably reflects the of *Anopheles* spp. presumably

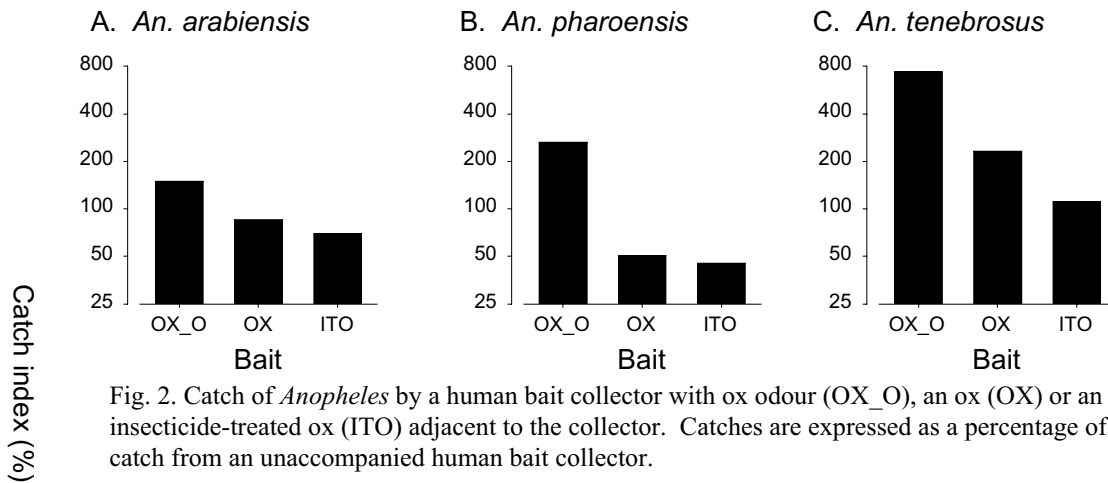


Fig. 2. Catch of *Anopheles* by a human bait collector with ox odour (OX\_O), an ox (OX) or an insecticide-treated ox (ITO) adjacent to the collector. Catches are expressed as a percentage of the catch from an unaccompanied human bait collector.

Observations of *An. arabiensis* feeding on insecticide-treated and untreated cattle showed that the duration was significantly shorter on treated cattle (Fig. 3) with for instance 51% of mosquitoes resting for <30 s on a treated animal compared to 33% on a clean one. These results suggest that the insecticide has a slight excito-repellent effect.

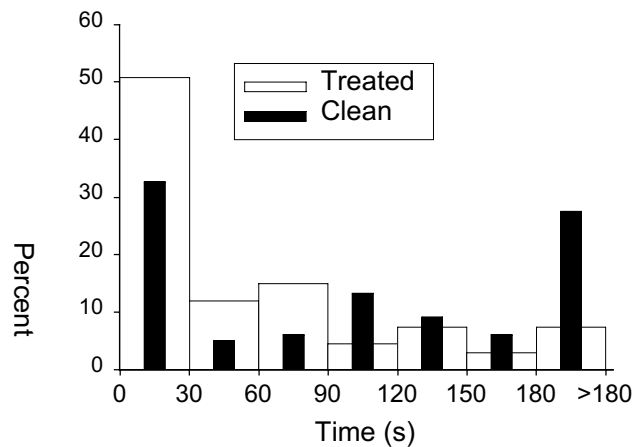


Fig. 3. Landing durations for *An. arabiensis* alighting on either clean or insecticide-treated cattle.

### Host selection

Studies of the responses of mosquitoes to pairs of cattle were undertaken at Rektomitjie Research Station in Zimbabwe where the sampled mosquito population comprised a mixture of *An. arabiensis* (31%) and *An. quadriannulatus* (69%). The results showed that when the hut contained an adult and a calf, the percentage of bloodmeals from the adult, the calf and adult + calf were 58%, 27% and 15% respectively; the trend towards meals from the adult host was consistent but not always significant. When the pair of cattle comprised two adults of roughly equal size and age, then mosquitoes generally showed no significant bias towards feeding from one individual. There was no significant difference in the pattern of host selection made by *An. arabiensis* and *An. quadriannulatus* but the former had a significantly higher percentage (20%) of mixed meals than *An.*

*quadriannulatus* (9%). It seems that the slight bias of *Anopheles* towards older and/or larger cattle may be related to the host's larger surface area. Studies undertaken in Ethiopia with groups of three cattle, comprising two adults and one calf were broadly in agreement with the Zimbabwean data; there was no significant difference in the numbers of mosquitoes feeding on the adults but only 6% fed from the calf. The above results suggest *An. arabiensis* tend to select older and/or larger hosts, and hence the selective treatment of these cattle would be a cost-effective strategy.

#### *Dissemination and recommendations*

In December 2002, FARM Africa convened a three day workshop in Arba Minch, Ethiopia. The workshop was attended by representatives from various NGOs (FARM Africa, Konso Development Association, SOS Sahel, Action for Development, World Vision), farmer groups from various districts, government agencies (Offices of Health and Agriculture from the district, zone and region administrative levels; regional planning office; Southern Region Tsetse Control Project) and agricultural research institutions (Awassa College of Agriculture). In addition to providing an opportunity for exchanging information, the meeting agreed to establish a permanent forum to assist in the co-ordination of tsetse and malaria control and research activities within the region.

One scientific paper on aspects of this project was published (Prior, A.R. & Torr, S.J. (2002). Host selection in *Anopheles arabiensis* Patton and *An. quadriannulatus* Theobald feeding on cattle in Zimbabwe. *Medical and Veterinary Entomology* **16**, 207-213.) and a second (Habtewold, T., Prior, A., Torr, S.J. & Gibson, G. (2003) Effect of pyrethroid-treated cattle on the mortality and behaviour of *Anopheles arabiensis* Patton. *Medical and Veterinary Entomology*) is in preparation.

#### **4 Implications of the results or findings for achieving the outputs and purpose of the project :**

The project achieved all its intended outputs by establishing that the insecticidal treatment of cattle to control ticks and tsetse also kills malaria-transmitting mosquitoes. The purpose of the project has not yet been achieved. However, the DFID Animal Health Programme initiated a project in October 2002 to obtain social, economic and epidemiological data to establish whether treating cattle with insecticide can contribute to the alleviation of malaria. This new project leads directly on from the KaR-funded project and will be conducted in collaboration with FARM Africa in the Konso District of southern Ethiopia.

#### **5 Priority Activities tasks for follow-up in order to pursue the Goal:**

Further action required to promote the project's outputs include:-

- the publication of a paper that is currently in draft form in the scientific literature;
- successful completion of a scientific workshop in London in April 2003;
- presentation of aspects of the project at the International Forum on Ecosystem Approaches to Human Health in Montreal, Canada, in May 2003.

These dissemination activities will be undertaken by the project team, supported at least in part by funding from the University of Greenwich.



Research activities aimed at establishing whether insecticide-treated cattle would be an effective means of controlling malaria in other agro-ecological zones is required. Applications to support this work have been made to DFID and Systemwide Initiative on Malaria and Agriculture (SIMA). The application to DFID failed and we are currently awaiting the outcome of the SIMA application.

#### **6 Summary of financial expenditure :**

(Q1 commenced 1 August 2001)

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	TOTAL
ACTUAL (£)	5309	20703	11489	3540	0	0	10873	51913

#### **7 Name and signature of author of this final report :**

	
S. J. Torr, Vector entomologist	G. Gibson, Vector entomologist

**OUTPUT TO PURPOSE SUMMARY REPORT**

**Title:** Controlling malaria and trypanosomiasis with insecticide-treated cattle.    **Country:** Ethiopia    **MISCODE:**

<b>Report No.</b> Final Technical Report	<b>Date:</b> 30-09-2002	<b>Project start date:</b> 1 August 2001 <b>Project end date:</b> 31 March 2002	<b>Stage of project:</b> End of Project.
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**Project Framework**

**Goal statement:** To improve significantly the health of the poor and to reduce the physical and functional disabling effects of infectious disease.

**Purpose statement:** To develop cost-effective and appropriate technologies to reduce mortality and the disabling effects of malaria that affect the livelihoods of the poor.

<b>Outputs:</b>	<b>OVis:</b>	<b>Progress:</b>	<b>Recommendation/actions:</b>	<b>Rating:</b>
1. Quantitative data on the effects of insecticide-treated cattle on mosquitoes.	<p>Data describing the susceptibility of mosquitoes to insecticide-treated cattle (Dec 2001).</p> <p>Data describing the behavioural responses of mosquitoes to insecticide-treated cattle (Dec 2001)</p>	<p>Data on the susceptibility of mosquitoes to insecticide-treated cattle for four pairs of test animals have been analysed. The results show that the formulation widely used to control tsetse and ticks in Africa (Coopers Spot-on) is effective against <i>An. arabiensis</i>.</p> <p>Direct observation of mosquitoes attracted to insecticide-treated and untreated control cattle indicate that the insecticide has a mildly repellent effect.</p> <p>Analysis of mosquitoes attracted to heterogeneous (calves+adults) groups of cattle show that mosquitoes select preferentially older/larger hosts and tend to feed on the host's legs.</p>	<p>Results from the bioassay and behavioural studies will be reported in technical reports and papers.</p> <p>The repellent effect does not appear to compromise the control technique.</p> <p>Selective application of insecticide to the legs of older hosts appears to be a cost-effective strategy. Research, supported by non-DFID donors, is currently testing this hypothesis.</p>	<p><i>[to be completed by DFID]</i></p>
2. Recommendations on the suitability of insecticide-treated cattle to control	<p>Recommendations on the viability of using insecticide-treated cattle</p>	<p>Findings to date indicate that insecticide-treated cattle will reduce mosquito populations. However, further research is required before general</p>	<p>Analyses of the experimental data have been completed and the findings will be presented in</p>	

<p>malaria in the project area in particular and Africa in general</p>	<p>made at dissemination workshops in Ethiopia (May 2002)</p>	<p>recommendations can be made regarding the use of insecticide-treated cattle to control malaria.</p>	<p>appropriate formats to national and international stakeholders.</p> <p>The DFID Animal Health Programme will provide financial support (£190K/3 years) for a research project to quantify the effect of insecticide-treated cattle on malaria transmission in southern Ethiopia.</p> <p>Further funding is being sought to assess the applicability of the technique in a variety of ecological and socio-economic settings.</p>
<p><b>Purpose:</b> To develop cost-effective and appropriate technologies to reduce mortality and the disabling effects of malaria that affect the livelihoods of the poor.</p>	<p><b>OVis</b> Suitable farming systems identified by 2002.</p> <p>Insecticide treatment regime applied in suitable farming systems by 2003.</p>	<p><b>Progress:</b> Work towards identifying an insecticide formulation effective against malarial mosquitoes is progressing satisfactorily.</p> <p>NGOs, with support from DFID, are providing socio-economic and technical advice to community organisations concerned with alleviating the effects of vector-borne diseases of livestock in southern Ethiopia. Links with similar community-based initiatives are being developed in Tanzania and Uganda.</p> <p>FARM is promoting the use of insecticide-treated cattle to control tsetse in Konso. Other NGOs (eg SOS Sahel) are promoting similar schemes elsewhere in southern Ethiopia.</p>	<p><b>Recommendations/action</b> Links between researchers, institutions, sectors and community organisations concerned with alleviating the effects of vector-borne diseases on the livelihoods of the poor should be strengthened further. Such links will facilitate the dissemination of the project outputs and their incorporation into human- and livestock-disease control activities in Ethiopia and elsewhere in Africa. The project stakeholders are actively promoting such links through their personal contacts with individuals and institutions in Ethiopia, Tanzania, Uganda, Kenya, Zimbabwe, China and the UK.</p>