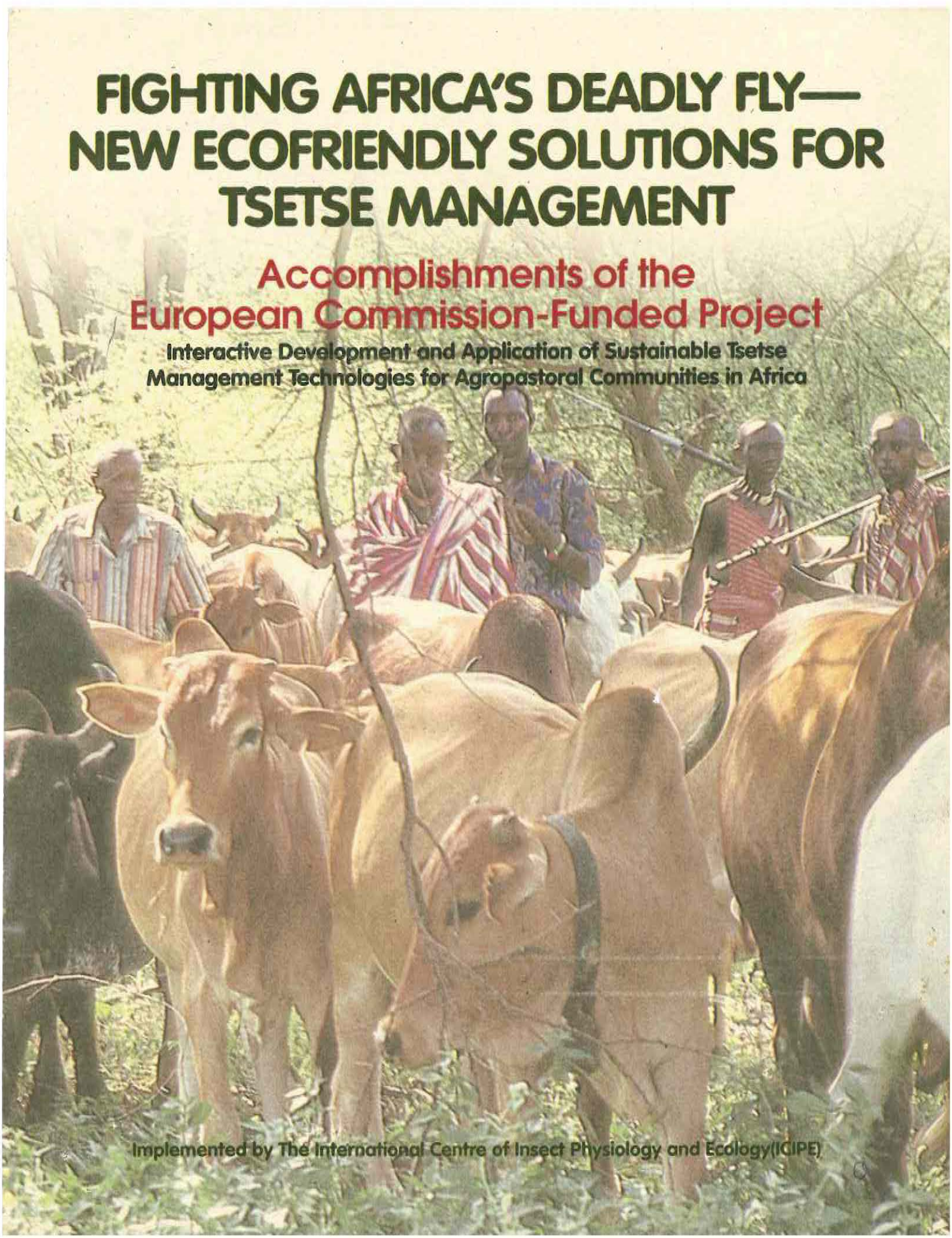
FIGHTING AFRICA'S DEADLY FLY— NEW ECOFRIENDLY SOLUTIONS FOR TSETSE MANAGEMENT

Accomplishments of the European Commission-Funded Project

Interactive Development and Application of Sustainable Tsetse Management Technologies for Agropastoral Communities in Africa



Implemented by The International Centre of Insect Physiology and Ecology(ICIPE)

Tsetse—Africa's Deadly Fly

Throughout the African continent, from the vast expanses of the savanna to the dense riverine forests, the tsetse (flies of the *Glossina* genus) pose a major constraint to livestock and crop production. Tsetse abound in the very regions— the humid and sub-humid zones— that hold the greatest potential for increased agricultural production. Found only in Africa, the blood-feeding tsetse carry the trypanosome parasites that cause a group of debilitating and often fatal diseases known as trypanosomoses.

The most direct economic impact of trypanosomosis is on cattle. Losses here amount to an estimated 3 million deaths annually, mainly of young stock, with up to a quarter of pre-weaning calves succumbing. Sick animals produce lower milk and meat yields, and reproduce less. With nearly 50 million head of cattle (94% of the continent's total) distributed at the fringes of the tsetse belt(see map), estimates put the direct monetary losses at US$ 0.6 to 1.2 billion annually. Other valuable livestock such as camels also suffer from trypanosomosis.

Crop production is indirectly affected by the presence of tsetse: in the absence of cattle, there is less draught power for ploughing, less manure to use as fertilizer, and fewer crop residues and by-products for feeding of animals. Fear of contracting sleeping sickness makes many farmers avoid tsetse-infested areas.

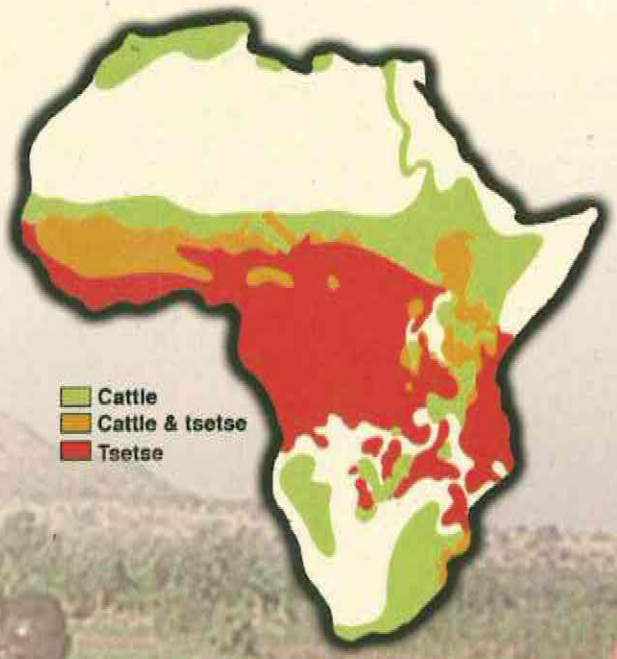
Some species of savannah and riverine tsetse pose a direct threat to human populations: human trypanosomosis (sleeping sickness) is on the increase, and with an estimated 300,000 current cases per year, the disease has now returned to the epidemic levels of the 1930s. Human sleeping sickness is of special concern in regions experiencing large-scale migrations and inadequate medical care, such as in South Sudan, Zaire, and Angola.

ICIPE's Tsetse Programme

Programme Goal: To improve human and animal health in the tropics through the development, integration and promotion of appropriate technologies for the sustainable management of disease vectors within sustainable farming systems.

This goal is being achieved through research and development of integrated vector control approaches based on a sound understanding of the flies' behaviour, population ecology and tsetse-trypanosome and tsetse-host relationships. Over the past 25 years, ICIPE's work in developing traps (of which tens of thousands have been deployed), odour baits, and modelling has been recognised and applied in tsetse control operations in many countries in Africa. The ICIPE NGU series of traps, for instance, are made of several pieces of coloured cloth stapled to poles or sticks. Blue is used to attract the flies, after which they land on the black target, and are then led by the white cloth at the top into a plastic bag, where the heat of the sun kills them. This low cost trap, made of locally available materials, effectively removes the flies from the environment, reducing fly populations by as much as 99%. The effectiveness of the traps can be increased by applying volatile odour baits to attract the flies from afar.

Recognising that the quest for a truely effective and sustainable solution to the tsetse problem will remain futile unless a community's socio-economic and cultural profile is taken into account, ICIPE has incorporated social science research as an integral part of its Tsetse Research Programme. Likewise, capacity building at all levels—from farmers to extension workers and researchers—helps support the sustainability of the tsetse control efforts.



The African tsetse belt

Major Accomplishments of ICIPE's EC-Funded Project

Potent repellent identified for savannah tsetse

Building on ICIPE's work over the past 25 years on trap and odour bait development for the savannah group of tsetse, a new weapon in the arsenal to protect livestock has been discovered by the Project, in the form of a tsetse repellent. A patent (Saini & Hassanali, 1999) has been filed for potent analogues of this repellent and their use. This will allow ICIPE to have control over its commercialisation and affordability. One of the analogues of the repellent significantly reduces the risk of biting by the flies (the 'challenge').

The repellent is effective against *Glossina pallidipes* and *Glossina morsitans morsitans*, both important vectors of nagana, or animal trypanosomosis. Tests show that when the repellent is applied to traps, it lowers trap catches—even when attractive cattle odour is present—by more than 80%. The feeding efficiency of the flies on cattle is also significantly reduced.

The repellent could be used to directly protect cattle, or used in 'push-pull' strategies to direct flies to trapping/killing sites. It might also find use in barriers and in protecting humans from tsetse bites. This and other repellents being identified from un-preferred animals could be used in an integrated approach, and will reinforce the benefits of using trypanotolerant cattle and those already being treated with prophylactic drugs.

Measuring the tsetse challenge on a cow treated with the repellent. The circle of electric screens is used to monitor the flies

Repellents from un-preferred hosts

Some animals are naturally unattractive as sources of bloodmeals for the tsetse flies. During the Project, several such animals were screened. Potential repellents have been found in the whole-body volatiles and sebum(skin oils) of waterbuck. The volatile fraction contains 11 biologically active compounds, and has been substantially characterised by GC-EAD and GC-MS. Two active compounds have been detected in the sebum, and work is continuing on identifying the other active components.

Technique for trapping body volatiles of host animals

An important part of basic tsetse research is knowing which animals the blood-sucking flies feed from, and exactly what it is about these hosts that attracts (or repels) the flies. A new technique for collecting the air-borne volatiles given off from animals (for instance in their breath and body secretions) has been developed and optimised by the Project.

The simple device is made of packets containing different adsorbents sandwiched between aluminium foil and wire gauze, which can then be plastered on any part of the animal under study.

Along the shores of Lake Victoria, a pyramidal trap is baited with monitor lizard volatiles to attract *G. fuscipes fuscipes*

Odour bait for *G. fuscipes fuscipes*

No effective odour baits exist for this species of tsetse, and other members of the riverine group. Project research discovered the favourite host for this fly—the monitor lizard, an animal which lives along river banks and under outcroppings of rocks. The lizard volatiles have provided 3 compounds which elicit strong responses in the flies. Field testing has been done using stabilised formulations dispensed from a custom-designed controlled release device in two countries, Ethiopia and Kenya. In the former, a blend of these aldehydes increased trap catches 2-3 times.

The finding that *G.f. fuscipes* responds to host odours is contrary to commonly held views, and is encouraging from the standpoint of improving trap catches and developing future control strategies for this important vector species, which carries the trypanosomes responsible for both nagana and human sleeping sickness.

Reptiles' role in trypanosomoses

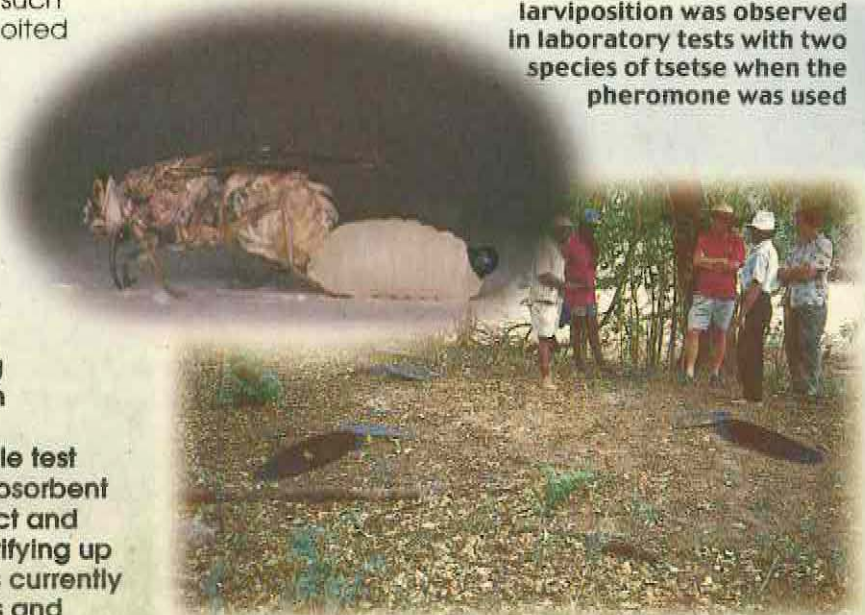
ICIPE's research into the behavioural and chemical ecology of the flies and their hosts has shown that reptiles cannot be ignored in the epidemiology of trypanosomoses. Another important Project outcome is the discovery that the monitor lizard serves as a host for *Trypanosoma brucei*, and as such can play an important link in the transmission cycle of the parasite between the tsetse vector and mammals.

Larviposition pheromones

An entirely new area of tsetse control possibilities has been opened up by the Project's work on larviposition pheromones of *G. morsitans morsitans* and *G. morsitans centralis*.

These pheromones are chemical signals produced by the larvae that in nature serve to attract gravid (pregnant) females to a favourable site where they can lay their larvae. *N*-pentadecane and *n*-dodecane were identified as the active components of the larviposition pheromones of the two species, respectively. Laboratory tests on the two compounds were followed by field trials in Zimbabwe in collaboration with another EDF-funded project: the Regional Tsetse and Trypanosomosis Control Programme (RTTCP). The tests showed encouraging results, manifested by an increase in the number of larvae deposited in artificial burrows baited with pentadecane. Work is continuing to test the hypothesis that such larviposition pheromones might be exploited to attract gravid females to special sites where they might be more easily trapped or killed. Considering that the tsetse bears only one live young(larva) per reproductive cycle (see photo), this could mean a doubling in potential impact.

A 3- to 4-fold increase in larviposition was observed in laboratory tests with two species of tsetse when the pheromone was used



Artificial larviposition burrows (dark patches) for testing the effectiveness of the larviposition pheromone in Zimbabwe.

Elisa bloodmeal analysis

Tsetse flies feed only on blood. Knowing which animals the flies prefer to feed on helps determine how the parasites (trypanosomes) are transmitted. A simple test based on ELISA (enzyme-linked immunosorbent assay) was developed during the Project and validated. The system, capable of identifying up to 50 wild and domestic animal hosts, is currently offered as a paid service to researchers and collaborators worldwide.

In Nguruman, drawing blood from goats for analysis

Barrier systems

Tsetse are notorious for making a comeback. After they have been cleared from a given area, they tend to reappear again after some months. Barrier systems, such as lines of traps/targets (screens) at the perimeter of the cleared areas, can be useful tools in preventing reinvasion of the flies.

The Project has done much to contribute to the basic knowledge required to develop sustainable barrier systems to prevent flies from immigrating from uncleared areas into cleared areas. Using the basic knowledge on tsetse behaviour and the ecology acquired through Project research and previously, improved barrier systems are now possible. One new approach being tested is the push-pull strategy, in which the repellents push the flies into a region where there are traps/targets baited with tsetse attractants (the pull).

New insights in sampling and suppression strategies

Researchers need to evaluate their technologies and the effectiveness of control operations. New insights have been gained through the Project on how best to measure the efficiency of tsetse traps, on the efficiency of the Latin square designs used in tsetse field experiments and, the models used to quantify the sampling bias of traps, and on the effect of sampling on the fly population dynamics. This information is important for guiding future tsetse sampling and suppression strategies.

A new trap for biting flies

Biting flies attack most animals. Project scientists have developed a new trap for these nuisance flies, which may also play a role in the mechanical transmission of trypanosomes. The *NZI* (Kiswahili for fly) trap is a simple, safe and economical cloth trap that promises to be an important tool for the control of these flies in grazing areas and animal enclosures such as stables and *bomas* (corrals).

The NZI trap for tsetse and biting flies.

Community adoption of trapping technologies

The two regions selected for ICIPE's EC-funded tsetse research differ dramatically in terms of the lifestyles, culture and occupations of the study communities, and offer valuable and interesting comparisons. The adoption of the tsetse trapping technology by pastoralists in Nguruman, Kenya and agriculturists in Sodo Bedesa and Gurage in southern Ethiopia was assessed by the Project's social scientists.

Nguruman—An agropastoralist community in transition

In Nguruman, the adoption of the tsetse suppression technology after it was handed over to the local community(see photo) did not prove to be sustainable. Socio-economic research showed that the community itself was not adequately committed to tsetse control. Other factors may also have caused the Maasai community in Nguruman to allocate their scarce resources to alternative uses. Valuable lessons have been learned about the importance of involving the community right from the beginning in project design and implementation.

Ethiopian agriculturalists

In Ethiopia, the activities were demand-driven, participatory and bottom-up from the start, with ownership and a strong commitment by the communities involved. The successful adoption process during the Ethiopian Control Operation in the two project sites has been the catalyst for many other trapping projects in that country.

Extension package

The important lessons learned from the socio-economic activities undertaken in the two countries have formed the basis for a generic package that can be used for purposes of developing and implementing similar activities elsewhere among communities with roughly similar circumstances.

Members of the Nguruman community

The Vice-President of Kenya, Prof. George Saitoti (in blue jacket) was the guest of honour at the ceremony for handing over the trapping technology to the Nguruman community

Ethiopian farmer examining the tsetse catch from an NGU2G trap, one of hundreds deployed in that country

Dissemination of Project results

Media Coverage: The work of the Project was broadcast on Radio France Science Corporation Programme and aired on 600 radio stations worldwide in 1996 and 1997. Other coverage was in *Science & Technology* magazine of Swiss Radio (1996); Swiss television (1996,1998); WREN Media (1997, 1998) and in the local (Kenyan) media. The ceremony for handing over the trapping

Training and Capacity Building

Training at all levels of society was undertaken in order to support the sustainability of the tsetse control activities:

- **Training of technicians:** 66 African technicians from East African countries have been trained in integrated tsetse management through two courses held in 1995 and 1997; 12 technicians from Somalia (sponsored by the International Committee of the Red Cross were trained in basic tsetse biology and trapping by Project staff in two courses held in 1996 and 1997.
- **Post-graduate training:** 4 doctoral students from 3 countries sponsored by the EC have completed their PhD theses.
- **Farmers' training:** More than 500 farmers have been trained through short-term training courses.
- **Workshop:** A Project-sponsored 'Workshop on Tsetse/Trypanosomosis Control Strategies—The Way Forward' held in Addis Ababa and Axum in February, 1997 was attended by about 100 participants. The Ethiopian Science and Technology Commission also provided logistical and financial support.

Ethiopian audience attending a planning session

The Project trained more than 500 farmers in several short courses, as shown here at Nguruman

Servicing the NGU trap in a Nguruman thicket

technology to the local community in Nguruman, Kenya, officiated by the Vice-President of Kenya, was well publicised. The project activities in Ethiopia were also extensively covered by the media in that country.

Publications: Project output includes one patent (applied for) and over 60 publications in international journals, with a similar number of presentations made in international fora.

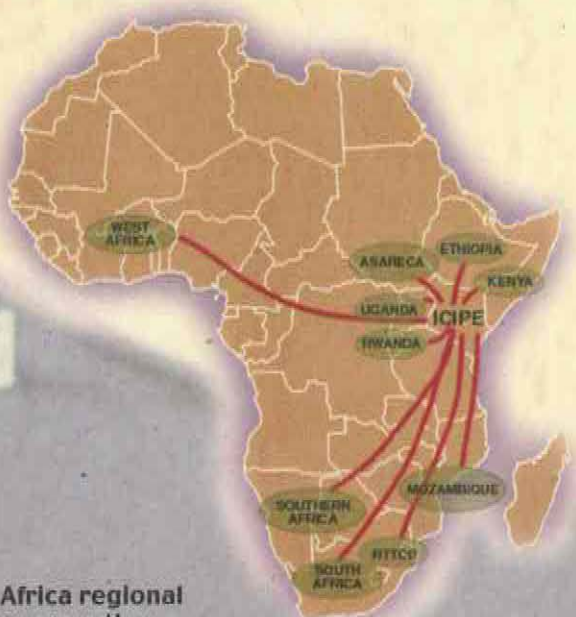
Rehabilitation of Nguruman Field Station

New facilities funded by the Project at the Nguruman Field Station, consisting of laboratories and refurbished boarding and lodging rooms, have greatly enhanced field operations. These excellent facilities not only provide an ideal location for tsetse ecological work, but also for biodiversity and horticulture-related activities in this evolving community.

Nguruman Field Station

Collaboration

Regional Collaboration was strengthened during the Project, and linkages with the following institutions/government departments established:
• **CIRDES,** Centre International de recherché-development sur l'élevage en zone subhumide, Burkina Faso • **ITC,** International Trypanotolerance Centre, Banjul, the Gambia • **RTTCP,** Regional Tsetse and Trypanosomiasis Control Programme, Zimbabwe • **COCTU,** Coordinating Office for the Control of Trypanosomosis in Uganda • **UTCC,** Uganda Trypanosomosis Control Council • **ESTC,** Ethiopia Science and Technology Commission • **OAU/IBAR,** Inter-Africa Bureau for Animal Resources of the Organisation for African Unity • **OAU/ISCTRC,** International Steering Committee for Trypanosomiasis Research and Control of the OAU • **ASARECA,** Association for Strengthening Agriculture Research in East and Central Africa • **Governments of Ethiopia, Rwanda, Mozambique** • **PAAT,** Programme against African Trypanosomiasis (FAO/IBAR/IAEA/WHO) • Kenya National Partners: **KETRI,** Kenya Trypanosomiasis Research Institute; **MOALDM,** Department of Veterinary Services, Ministry of Agriculture, Livestock Development and Marketing; **KWS,** Kenya Wildlife Services



Africa regional cooperation

Future perspectives and the new EC-funded regional projects

The research activities outlined in this brochure were designed to lay a strong foundation for the build-up of the EDF-funded FITCA (Farming in Tsetse Control Areas) projects. The achievements of the Project provide a model for integrating research, training and extension.

As one of the key Africa-based players in tsetse research and development, ICIPE will continue to play an important backstopping role in the planned regional projects. ICIPE'S main strengths as exemplified in this project are • development of integrated vector control technologies and strategies based on the detailed understanding of the biology and ecology of the vectors • development of technology transfer models and socio-economic tools for assessing their sustainability, economic viability and social compatibility • development of socio-economic and environmental indicators and methodologies for monitoring short-term and long-term impact of technologies adopted • individual and institutional capacity building at all levels of society, for ensuring the long-term sustainability of tsetse and trypanosomosis management.

In addition, ICIPE can also play a supporting role in the following areas: identification of preferred hosts by bloodmeal identification; mass rearing technologies for vectors; development of tsetse population models to guide strategic interventions and optimise their impact; strategic and logistical planning of control operations (including data management systems, deployment of GIS and remote sensing techniques, supply of baits and dispensers); and research planning and management.

From the lessons learned in this Project, it is clear that more work needs to be done on evaluating the use of the tsetse repellent with other trypanosomosis control tactics and for eventual large-scale use. Work should also continue on developing new repellents and odour baits for the riverine flies. ICIPE's work with baits for *Glossina fuscipes fuscipes*—one of the riverine species targeted for control in the EC Regional Project—can form the basis of future

evaluation and testing with national partners in Uganda and Kenya. The NZI trap for biting flies needs to be optimised for controlling these important livestock pests. New PCR techniques need to be deployed and optimised in order to make the ELISA test for identifying fly bloodmeals cheaper and easier to use. The potential of entomopathogens to control tsetse in large-scale field experiments needs to be investigated. The gains in ICIPE's training at post-graduate level and its contribution to building the pool of indigenous high-level human resources need to be augmented continuously and the base broadened to ensure the sustainability of tsetse and trypanosomosis management in the region.

Disease vectors continue to impede agricultural and human development in Africa. However, successful and sustainable development can be achieved only through transforming research results into working strategies within a holistic development paradigm. ICIPE's Biovillage Initiative in Ethiopia is one such example where vector control is being integrated with rural development, which is also the objective of the current FITCA projects. ICIPE is, only one player in such a venture, and will work in unison with its partners among the rural communities, national extension systems and other international organisations to achieve this objective.

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For over three decades, the Nairobi-based Intenational Centre of Insect Physiology and Ecology(ICIPE) has been a leader in research on Africa's tsetse flies, carriers of fatal livestock diseases and the dreaded human sleeping sickness. In 1992, ICIPE received a 5-year grant of ECU 5,440,000 from the European Development Fund (EDF) for implementing the project on **Interactive Development and Application of Sustainable Tsetse Management Technologies for Agro-Pastoral Communities in Africa.** The Project was carried out among one of the most traditional pastoral communities in East Africa— the Maasai and their neighbors living at the foot of the Nguruman escarpment in Kenya's great Rift Valley. The agriculturalist societies selected for participation were from the Solo Bedessa and Gurage areas of southern Ethiopia, a region which was once known as the breadbasket of the country but is now suffering the effects of severe environmental degradation.

The main objectives were to develop improved, low-cost and appropriate control methodologies for tsetse in these two markedly different socio-cultural environments; devise strategies for maintaining cleared areas from re-invasion by the flies; monitor adoption of the control methods by the local communities; and build the communities' capacity to manage the control programmes. This brochure highlights the major accomplishments of ICIPE's EC-funded project and provides suggestions for future work through application of the lessons learned.

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