

ACHIEVABLE BREAKTHROUGH VIEWPOINT ON THE CHALLENGE OF CREATING TSETSE-FREE ZONES IN SUB-SAHARAN AFRICA

BY QIAN JIHUI AND THOMAS TISUE

The tsetse fly transmits trypanosomes that sicken and kill both animals and man. It is one of the major roots of poverty in countries south of the Sahara, an ecological factor that exists nowhere else in the world.

The causal link is simple: the disease the fly spreads, *trypanosomosis*, makes it very difficult to raise productive cattle in tsetse-infested regions. In the whole world, it is only in these regions of Africa where a single disease has so hindered agricultural productivity and largely prevented integration of cattle rearing with crop farming.* Where fertile and productive areas cannot be cultivated by mixed farming systems, where no draught animals thrive, subsistence farmers must till by hand. Consequently, actual agricultural productivity is many times lower than if healthy animals can be reared to provide draught power and manure.**

A Growing Problem. Tsetse-infested regions are vast and spreading: parts of 36 countries comprising 9 to 10 million



square kilometers are affected. According to the United Nations Food and Agriculture Organization (FAO), the direct loss in meat and milk production, added to the cost of attempted control programmes, totals US \$0.6 to \$1.2 billion annually. This rises to US \$4.5 billion if losses in potential production are considered. Moreover, the World Health Organization (WHO) estimates that 55 to 60 million people are at risk of human trypanosomosis —

sleeping sickness — with more than 300,000 currently infected and 40,000 deaths in 1998.***

The sad fact is that tsetse is regarded as a bigger problem today than it was when control efforts began decades ago at the time the first generation of insecticides was introduced. This situation starkly calls into question both the effectiveness

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* One result is that people in countries South of the Sahara get a third or less of the calories, and half as much protein from animal products, as people in developed countries.

**For example, tenfold increases in milk production alone can follow introduction of high-yield but trypano-intolerant cross-bred cattle.

***Recent alarming reports indicate that in some areas, half the population is infected; the situation is now as bad as during the epidemics of the 1930s.

Photo: More African countries are looking to apply radiation technology in integrated campaigns against the tsetse fly. (Credit: Kinley/IAEA)

and sustainability of the many attempts since then to deal with the vector (tsetse) and the disease. Though newer pesticides have come along, their use remains controversial, in part because of their effects on non-target organisms. Attempts to develop vaccines for livestock have foundered in the face of the trypanosomes' complex biology.

A business network has sprung up to supply trypanocidal drugs, the preferred tool of needy farmers in tsetse-infested areas, who use them for protecting livestock without much regulation.* As a result, there are already increasing numbers of reports about resistance against trypanocidal drugs.

In part as a result of this discouraging history, political leaders and opinion-makers among both donors and recipients tend to think the tsetse-trypanosomosis problem is impossible to solve. Yet large sums continue to be spent on measures which lack coordination and sustainability.

Achievable Measures Exist. Today, better approaches exist to combat the tsetse fly. We now command cost-effective and environmentally friendly measures to remove tsetse from large areas in Africa if the world community chooses to do so.

Two things transform the creation of large tsetse-free zones from a dream to an achievable goal: the right

managerial concept and the right technology.

The key management concept is area-wide intervention, using a phased approach and a mix of technologies. A key tool in the final phase of such a tsetse eradication campaign is the sterile insect technique (SIT).

Area-wide Management.

The area-wide management approach targets entire insect populations. It has proven its merit many times over with a wide variety of crop and livestock pests and disease vectors. In the case of tsetse, the area-wide concept integrates several control methods for maximum cost-effectiveness and minimum environmental side effects.

Disease prevention through vector elimination is the logical last step of the integrated and area-wide management approach, whenever it is technically feasible and economically justifiable. After decades of exploring alternatives, the scientific community has begun to shift emphasis to the area-wide approach for combatting tsetse and trypanosomosis.

Sterile Insect Technique.

The SIT is the most environment friendly pest control method. It involves mass production and systematic aerial releases of radiation-sterilized but behaviourally competent male insects, who seek out females in the wild for mating. These

unproductive matings interfere with reproduction of the target population, which declines to the point where it is no longer self-sustaining, leading to eradication.

SIT has been the basis for successful eradication campaigns against the New World Screwworm (NWS) in Libya, the United States, Mexico, and Central America, and against the Mediterranean fruit fly (Medfly) in several parts of the world.

A Proven Tool. The SIT's effectiveness in controlling the Medfly and the NWS signals what can be done against species of the tsetse fly.

The elements essential to the SIT's feasibility as an area-wide tool are a) industrial-scale production of sterilized insects, and b) their release from aircraft over the target area. One only needs to look at the campaign against the NWS in the United States, Mexico and Central America to see that this approach works. There, aerial releases of sterile NWS flies raised in large insect factories have resulted in the eradication of screwworm from its former range extending from the southern US to the Isthmus of Panama. The total land area freed from NWS in four decades is approaching the extent of tsetse-infested zones in Africa.

What has worked against the NWS is applicable to integrated eradication campaigns against the tsetse. Semi-automated tsetse rearing systems are being developed. And aerial release technology has been adapted to tsetse's requirements and is being further refined. Proof-of-principle took place in

**It is estimated that about 35 million doses per year are used in Africa to cure the disease (Greer & Holmes, 1998). In some countries, 70% to 80% of the income of private veterinarians result from the sale of trypanocidal drugs. Each diagnosis for animal trypanosomosis costs about US \$4 to \$5. As a result, more than 90% of the doses are applied without a reliable diagnosis (Bauer, 1999).*

Zanzibar in 1995-97, where aerial releases of sterilized males over the 1500 square kilometer Unguja island resulted in the eradication of tsetse there. Trypanosomosis became undetectable within a few months thereafter.

ACTION PLAN: A PHASED & INTEGRATED APPROACH

Completion of the essential research and development over the past two decades, together with the positive results in Zanzibar, constitute the end of Phase I in an action plan that can sustainably free wide areas from tsetse. This will permit the introduction of intensified agriculture and livestock systems, thus minimizing the need for agricultural expansion into wildlife areas.

The distribution of tsetse is not continuous across its range. Many “islands” exist in the sense that sub-populations occur within confined areas whose limits are set by both physical factors (e.g., mountain ranges, large bodies of water, and deserts) and by the tsetse fly’s limited range of tolerance to temperature, humidity, and natural cover.*

Phase II: Defining Boundaries. As part of the action plan’s Phase II, the boundaries of these tsetse population “islands” will be defined. Modern molecular

tools of insect population genetics will greatly speed this task and make the results unambiguous. Removal of these confined populations one-by-one will create ever expanding tsetse-free zones not requiring artificial barriers for sustainability. The target of this phase is clear: sustainable removal of confined tsetse populations, creating the equivalent of many “Zanzibars” on the mainland.

Such confined populations, which resemble virtual islands, already are being mapped in, for example, Ethiopia and Mali; on and near the shore of Lake Victoria; and in Botswana.

The Ethiopian Government is preparing for population suppression and sterile fly releases in the Southern Rift Valley and has invited other partners, including the IAEA, to participate in this area-wide effort. Elsewhere, pre-project planning is moving forward. Overall, momentum is gathering as the realization grows that the tsetse and trypanosomosis problem no longer needs to be regarded as an immutable fact of life in Africa.

With growing support from African governments and the international development community, Phase II will mark the fuller maturation of the technology to minimize costs and maximize benefits.

Phase III: Integrating Techniques. Phase III will integrate selected conventional techniques and the SIT in a strategic rolling-up approach for expanding the “mosaic” of tsetse-free areas. The aims will be to establish extensive and sustainable tsetse-free zones.

Phase IV: Sustained Efforts Through National Expertise.

Phase IV of the action plan is directed at the long term and entails the widespread industrialization and commercialization of fly rearing and aerial release campaigns, integrated in an area-wide approach with selected conventional techniques. Such an approach will permit a full-scale attack on tsetse across major areas of Africa.

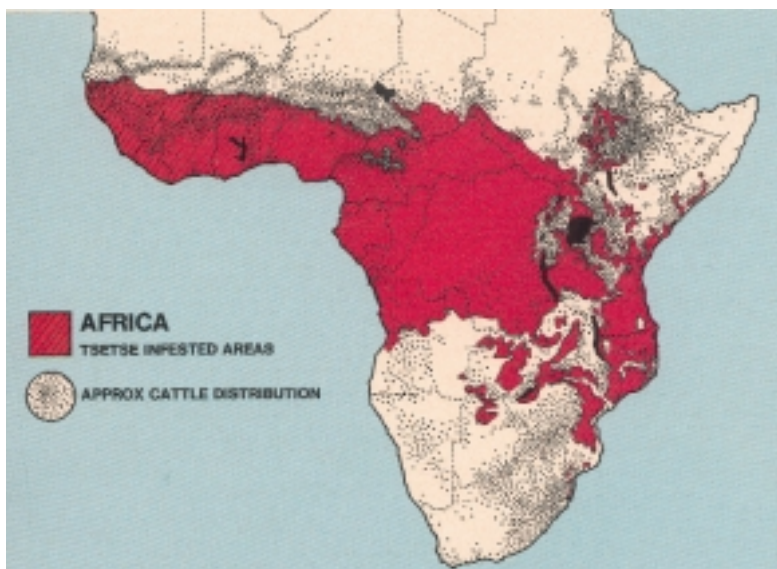
A key feature of this phase is that it would be done by Africans, building on the success of previous technology transfer and capacity-building efforts. These earlier (and ongoing) efforts have created a mature opportunity for large-scale interventions.

Two crucial shifts in thinking — away from continuous and reactive disease management to preventative vector control; and away from scattered local vector and disease interventions to concerted area-wide management that includes the SIT — show the direction that future efforts must take.

A central issue will be for leaders of several tsetse-affected African nations to agree on a concerted area-wide approach for creating major tsetse-free zones, thus preventing trypanosomosis. A model exists -- namely, the successful Southern Cone Initiative against biting bugs that are vectors of the Chagas disease in South America. In this unique effort, several Presidents of South American States decided to eliminate the Chagas disease (caused by *Trypanosoma cruzi* and transmitted by triatomine biting bugs) from Argentina,

**Immature stages of tsetse are carried within the adult tsetse and, therefore, cannot be transported passively with traded animals or fruit, as is the case with the NWS or Medfly, respectively. Adult tsetse also cannot fly long distances as NWS flies can.*

DISTRIBUTION OF CATTLE & TSETSE INFESTED AREAS



Bolivia, Brazil, Chile, Paraguay, and Uruguay, mainly by means of vector elimination.

Interruption of transmission was achieved in Uruguay in 1997 and is expected to be achieved in the remaining countries within the next years.

Costs & Benefits of Tsetse-Free Campaigns. A recent study funded by the Department for International Development (DFID), United Kingdom, provides an economic analysis of the tsetse and trypanosomosis problem. In analyzing investments for large-scale control/eradication projects (over 100,000 km²), the study projected a benefit-to-cost ratio of 2.6 : 1 over the first 20 years, which will

gradually increase to 5.2 : 1 thereafter. In analyzing investments for small scale farmer-based projects (1 to 10 km²), the study estimated they would achieve a benefit-to-cost ratio over a 20-year period of 2.1 to 2.4 : 1.

The study's preface states that *"... it is evident that combating trypanosomosis will be one of the most cost-effective ways of addressing poverty on a wide scale. This report represents a challenge to Governments, Politicians, International and National Aid Agencies, NGOs, Churches and every individual for whom the reduction and eventual eradication of poverty is a professional objective. Those who ignore the opportunity*

presented here must question their own commitment to that objective."

APPLYING SUSTAINABLE SOLUTIONS

Successful demonstrations in Phase II, along with cost-benefit considerations, are crucial to building political will and donor motivation.*

However, it is not necessary to go into detail in order to appreciate that sustainable solutions -- for example, the creation of large, naturally maintained tsetse-free zones -- will always win out economically and environmentally over approaches that involve recurring costs for trypanocides, insecticides, etc., in perpetuity and which leave the underlying ecological constraint in place.** The only question is the affordability of the sustainable solution, and that is often as much a matter of political will as it is of dollars.

More important still, our view of costs and benefits must take into account the fundamental seriousness of the problem. In this case, the problem lies at the root of poverty for a large portion of Africa. Our vision must expand to embrace the enormous socio-political advancements that its solution will make possible.

The means are at hand to solve the tsetse-trypanosomosis problem in a sustainable way. These means are technically and logistically feasible, and reasonably affordable. The remaining hurdles are political and managerial; neither is insurmountable. □

* In many places, tsetse problems are transnational. Strong international collaboration and support will be important.

**In order to feed the rapidly growing human population in Africa, it will either be necessary to continue expanding low-productivity livestock/farming systems into current forest and wildlife areas or to introduce intensified systems in existing agricultural areas, in particular in peri-urban zones, and thus achieve protection of wildlife areas. The latter is only possible by introducing improved cattle breeds, something that is not feasible without prior eradication of tsetse.