TESTING THE STERILE INSECT TECHNIQUE AS A VECTOR CONTROL TOOL AGAINST *AEDES*-BORNE DISEASES

THE CHALLENGE:
Controlling mosquito populations is currently the only measure used to reduce risk and incidence of certain vector-borne diseases such as dengue, chikungunya and Zika. So far, the use of insecticides has been the primary vector control method, but due to an increasing trend in insecticide resistance in mosquito vectors, as well as the residual effects of insecticides on the environment, there is an urgent need for alternative methods.

THE APPROACH:
TDR (the Special Programme for Research and Training in Tropical Diseases), the International Atomic Energy Agency (IAEA), in partnership with the Food and Agriculture Organization of the United Nations (FAO), and WHO's Department of Neglected Tropical Diseases, have developed guidance for countries interested in testing the Sterile Insect Technique (SIT) to control diseases carried by *Aedes* mosquitoes such as dengue, chikungunya and Zika.

The SIT was first used by the U.S. Department of Agriculture and has been deployed successfully for more than 60 years to target insect pests that attack crops and livestock, such as the Mediterranean fruit fly, Tsetse flies and the New World screwworm fly. TDR jointly with IAEA plans to support three multi-country teams of research institutions, vector control agencies and public health stakeholders that will be selected to test the SIT against *Aedes* mosquitoes.

IAEA

FAO FIAT PANIS IAEA Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

TDR For research on diseases of poverty
UNICEF • UNDP • World Bank • WHO

World Health Organization

Burden of major *Aedes*-borne diseases

Dengue – **3.34 million cases in 2016**, 128 countries at risk, all WHO regions affected

(Numbers are not compiled yet for 2019, but the data show that the outbreaks are at least equivalent or more significant than the 2016 outbreaks.

Chikungunya – **1.2 million cases reported in 2015**

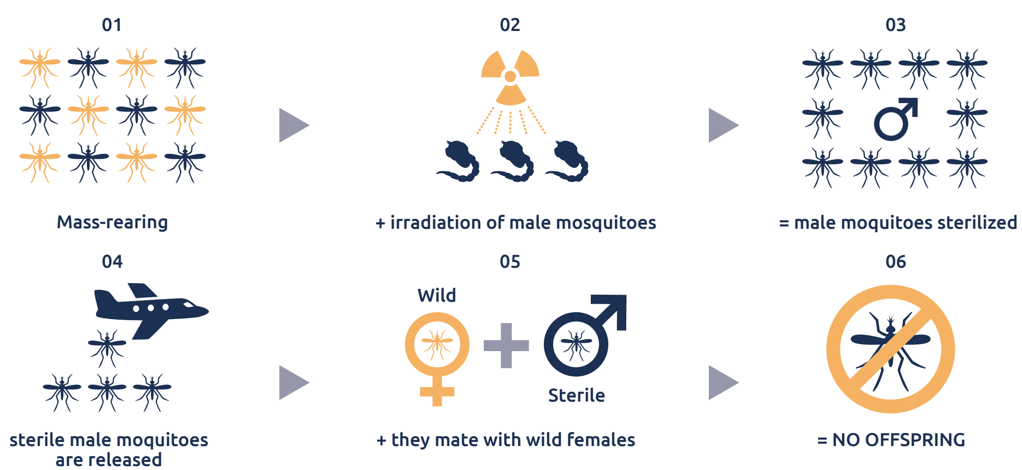
Zika – **1.5 million cases estimated in 2015-2016**

Sources: WHO, CDC, ECDC

How the Sterile Insect Technique (SIT) works:

The SIT, a form of insect birth control, uses radiation to sterilize male mosquitos, which are then released to mate with wild females. As these do not produce any offspring, the insect population declines over time.

Sterile Insect Technique to control dengue, Zika and chikungunya



"Guidance Framework for Testing the Sterile Insect Technique as a Vector Control Tool Against *Aedes*-Borne Diseases"

This guidance prepared as part of the collaboration between the IAEA, in partnership with the FAO, TDR and WHO, addresses all relevant topics for testing at large scale the SIT on mosquito populations. It details the SIT application phased approach, which starts from research in controlled conditions in phase I, moves to small-scale field trials in phase II, then large-scale trials in natural conditions in phase III, and finally pilot implementation in phase IV. Evidence of the efficacy of the SIT in reducing disease transmission will help inform larger-scale deployment of the technology.

Due to SIT's long history as a tool for controlling agricultural pests, aspects of the technology are well-known. As a species-specific insect control tool, it poses no risks to non-target species and ecosystems.

Mass production of sterile mosquitoes

The SIT requires mass production of sterile insects of high quality. In the document, we describe the technology package for the mass rearing, sterilization, release and quality control of sterile *Aedes* mosquitoes.

Main steps in the mass rearing of *Aedes* mosquitoes

Government and community engagement

The role of governments in creating or cultivating an enabling policy and regulatory environment for mosquito SIT testing is essential to ensure and maintain public trust.

The guidance will provide advice on how to involve and inform communities and stakeholders in any preparatory research or ahead of interventions.

Measuring the impact of SIT

The **evaluation of entomological efficacy is essential**. The document provides broad guidelines for generating entomological evidence to enable decision-makers to advance an *Aedes* SIT program from the initial stages to operational use, through a series of evaluation steps of increasing complexity, with “go/no-go” decisions made at each phase.

Example of entomological indicators for the different phases

Phase I - Pupal mortality during irradiation process, survival of adults, flight ability, level of sterility

Phase II - Rate of induced sterility in females, mating competitiveness in large cages and in the field, longevity in large cages, survival rates, dispersal rates

Phase III and IV – Mosquito density in treated and control areas, disease transmission potential

Several steps are to be undertaken to plan and conduct epidemiological efficacy and effectiveness trials, in due consideration of the available funding, existing infrastructure, feasibility, acceptability, as well as ethical, social, legal and other considerations.

Step 1 - Develop the PICO (Population Intervention Comparator Outcome) question.

Step 2 - Design the study.

Step 3 - Determine the sample size.

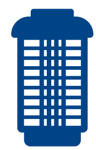
Step 4 - Select site for intervention and control.

Step 5 - Define the baseline parameters.

Step 6 - Ensure blinding of the studies.

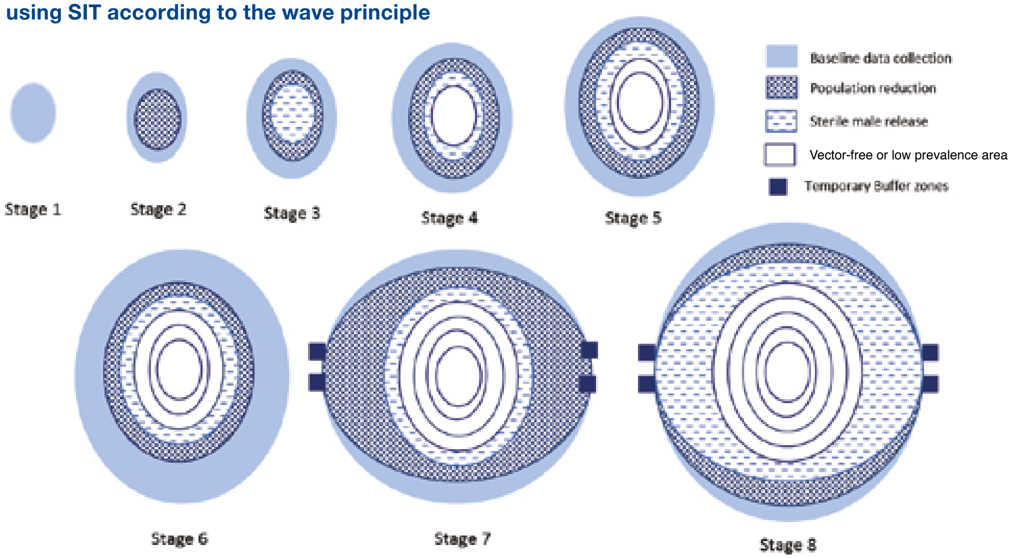
Step 7 - Establish partnership for field testing.

Step 8 - Measure the outcome and effectiveness of the technology.



A reduction in mosquitoes collected in fly traps would be one indicator of impact.

Plan for area-wide integrated pest management using SIT according to the wave principle



Assessing cost-effectiveness

To successfully and sustainably scale up interventions, decision-makers require evidence not only of an intervention’s impact on health outcomes, but also of its cost and cost-effectiveness. The guidance provides methods for conducting cost and cost-effectiveness analyses to inform deployment of SIT as a new mosquito control tool within an integrated vector management approach.