
Application of the Sterile Insect Technique as a tool for mosquitos (*Aedes aegypti*) control in Brazil



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Moscamed Brazil
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”Social Organization Moscamed Brasil ”



- ✓ Non-profit institution
- ✓ Designated as a IAEA Collaborating Centre
- ✓ Recognized as “ Social Organization” by Ministry of Agriculture, Livestock and Supply- MAPA and the Government of the State of Bahia
- ✓ Biotechnology applied to Agriculture and Public Health



SIT - Sterile Insect Technique in the world

In the 1930's, problem with screwworm fly (*Cochliomyia hominivorax*) - motivated studies and the search for solution with SIT



E.F. Knipling
Picture: USDA

SIT in Brazil

- ▶ In the 70's SIT was established in Brazil, and the first tests in laboratory scale are led by the Center for Nuclear Energy in Agriculture - CENA / USP



Julio Walder, the Cena / USP, with an irradiator used in the experiments.
CREDIT: CENA / USP /

Moscamed Brasil and SIT

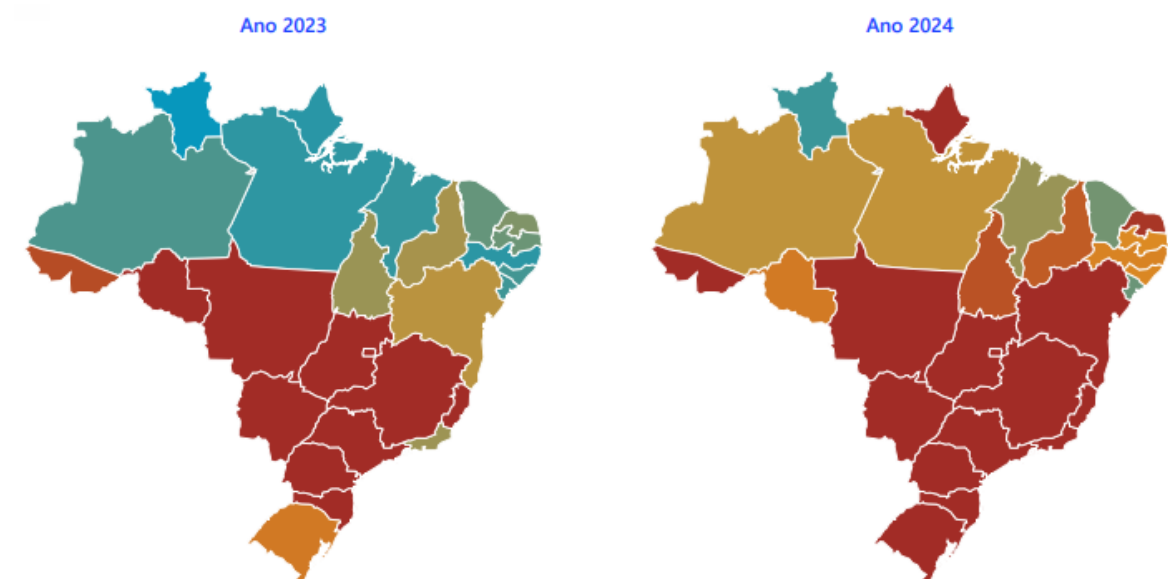
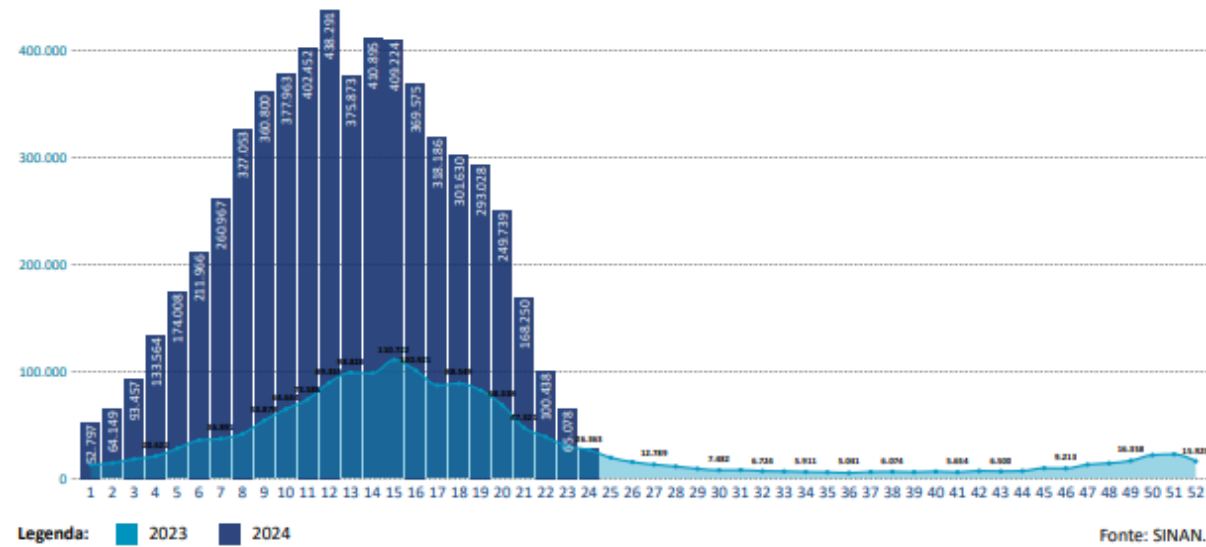
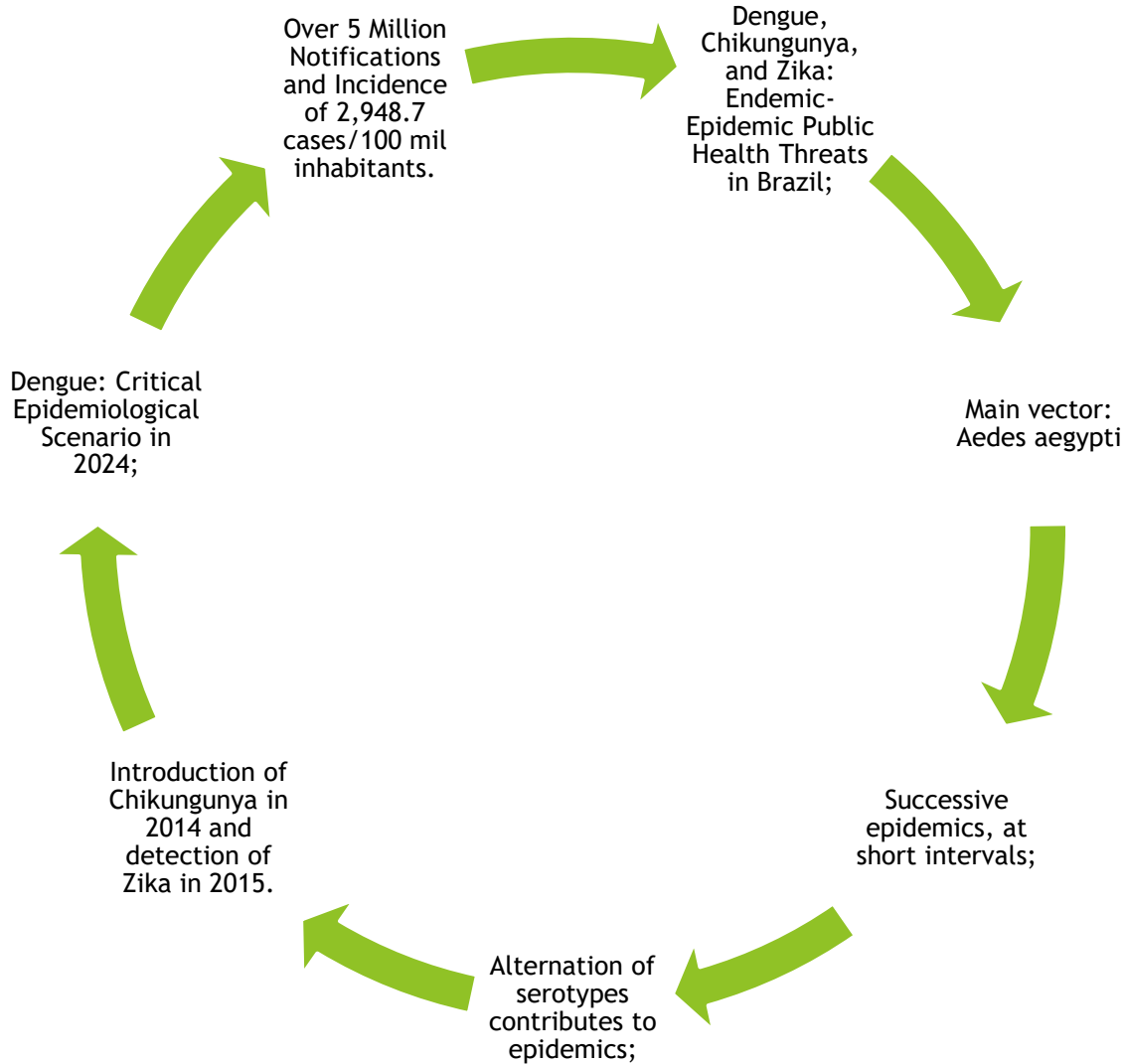
- ▶ In 2006, with the opening of Moscamed Brazil, begins local production of Mediterranean fruit fly sterile males.



SIT for mosquitoes



Brazil- current epidemiological scenario



Source: Sinan Online (databank 2024, updated on 18/06/2024).

Vector control

institution responsible for vector control:



Health and Environment Surveillance Secretariat -
Ministry of Health

Control actions

- Control strategies aim to eliminate and treat breeding sites and eradicate adult insects using insecticides.
- Review and analysis - Brazilian National Dengue Control Plan.

✓ New Technologies available and recommended by the Ministry of Health:

Dissemination Stations – PPF/ Fiocruz Manaus;
Incompatible Insect technique (IIT/Wolbachia) /Fiocruz Rio
Janeiro; **Sterile Insect Technique (SIT)/ Moscamed Brasil;**



Ministério da Saúde
Secretaria de Vigilância em Saúde e Ambiente
Departamento de Doenças Transmissíveis
Coordenação-Geral de Vigilância de Arboviroses

NOTA INFORMATIVA Nº 37/2023-CGARB/DEDT/SVSA/MS

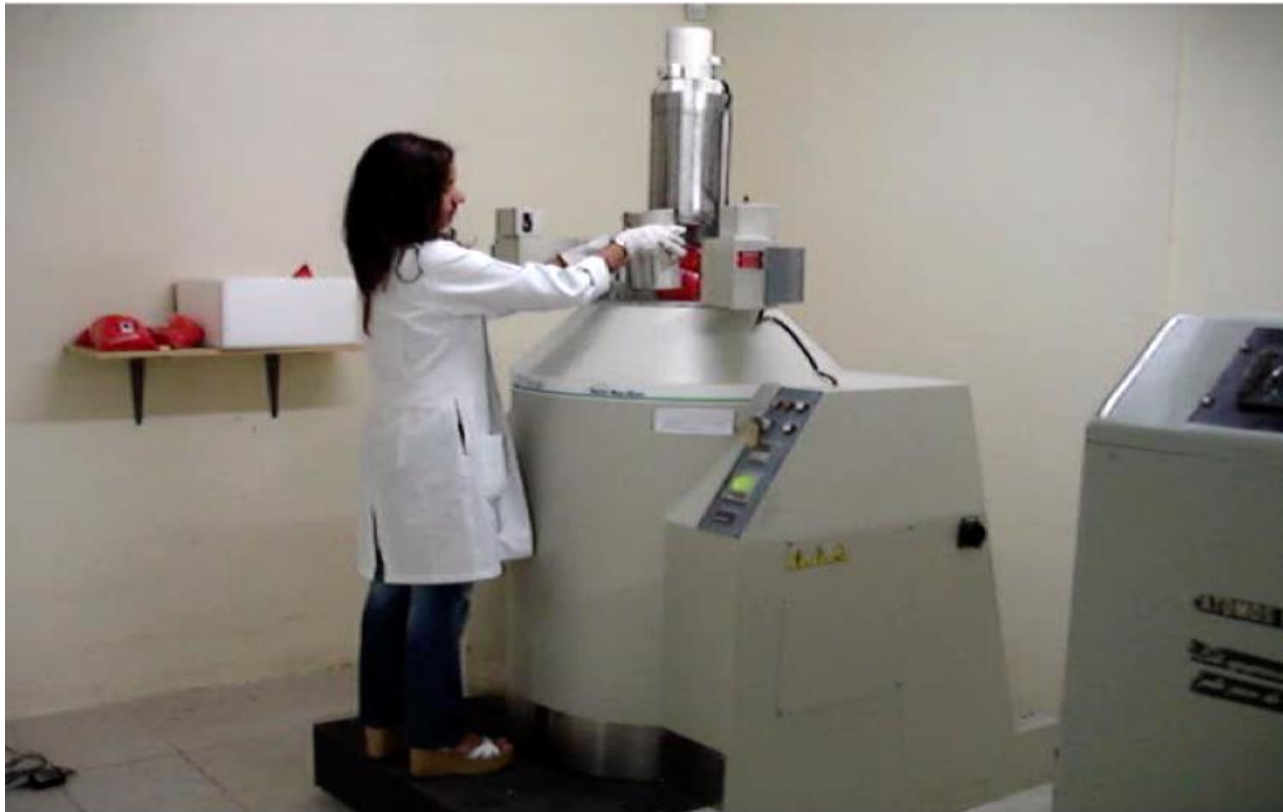
1. **ASSUNTO**

1. Apresenta orientações para implementação de novas tecnologias de controle vetorial em municípios acima de 100 mil habitantes.

4. **TECNOLOGIAS RECOMENDADAS**

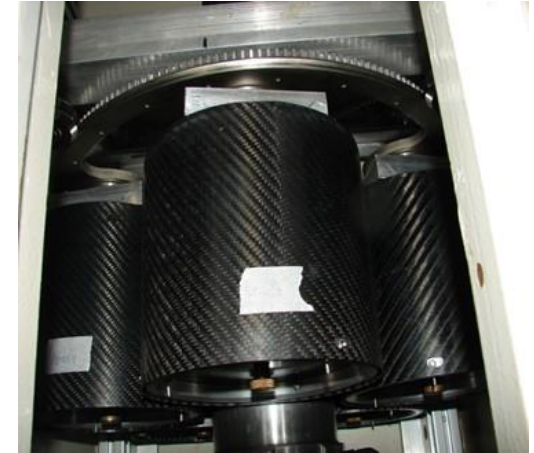
4.1. Dentre as tecnologias recomendadas estão a implementação do monitoramento entomológico por ovitampas², borrifação residual intradomiciliar (BRI-*Aedes*) em imóveis especiais³, utilização de estações disseminadoras de larvicidas (EDL)⁴, uso de mosquitos com *Wolbachia*⁵, e utilização de mosquitos estéreis por irradiação (TIE-irradiados) para controle do *Aedes aegypti*⁶. Estas

Irradiation with Gammacell 220 (Co₆₀)



DEN/UFPE

X Ray Machine RS-2400



✓ positioned horizontally inside the X Ray Machine chamber



✓ Control panel (define irradiation conditions)

X-Ray or Gamma Ray?

- ✓ There is no difference in the results obtained in the insect sterilization process
- ✓ Gamma Ray irradiators are expensive, more stable, requires less maintenance, but licensing for operation is more complicated and time-consuming
- ✓ X-Ray irradiators are cheaper, easier licensing but require more maintenance and suffer from overheating.

Sterilizing Insects with Ionizing Radiation

Authors [Authors and affiliations](#)

A. Bakri, K. Mehta, D. R. Lance

Chapter

20

44

2.2k

Citations Readers Downloads

Summary

Exposure to ionizing radiation is currently the method of choice for rendering insects reproductively sterile for area-wide integrated pest management (AW-IPM) programmes that integrate the sterile insect technique (SIT). Gamma radiation from isotopic sources (cobalt-60 or caesium-137) is most often used, but high-energy electrons and X-rays are other practical options. Insect irradiation is safe and reliable when established safety and quality-assurance

A New Generation of X Ray Irradiators for Insect Sterilization

T. Mastrangelo ✉, A. G. Parker, A. Jessup, R. Pereira, D. Orozco-Dávila, A. Islam, T. Dammalage, J.M.M. Walder

Journal of Economic Entomology, Volume 103, Issue 1, 1 February 2010, Pages 85–94, <https://doi.org/10.1603/EC09139>

Published: 01 February 2010 [Article history](#) ▼

Abstract

Recent fears of terrorism have provoked an increase in delays and denials of transboundary shipments of radioisotopes. This represents a serious constraint to sterile insect technique (SIT) programs around the world as they rely on the use of ionizing radiation from radioisotopes for insect sterilization. To validate a novel X ray irradiator, a series of studies on *Ceratitidis capitata* (Wiedemann) and *Anastrepha fraterculus* (Wiedemann) (Diptera: Tephritidae) were carried out, comparing the relative biological effectiveness (RBE)



Rearing mosquitoes

About mass rearing of *Ae. aegypti*

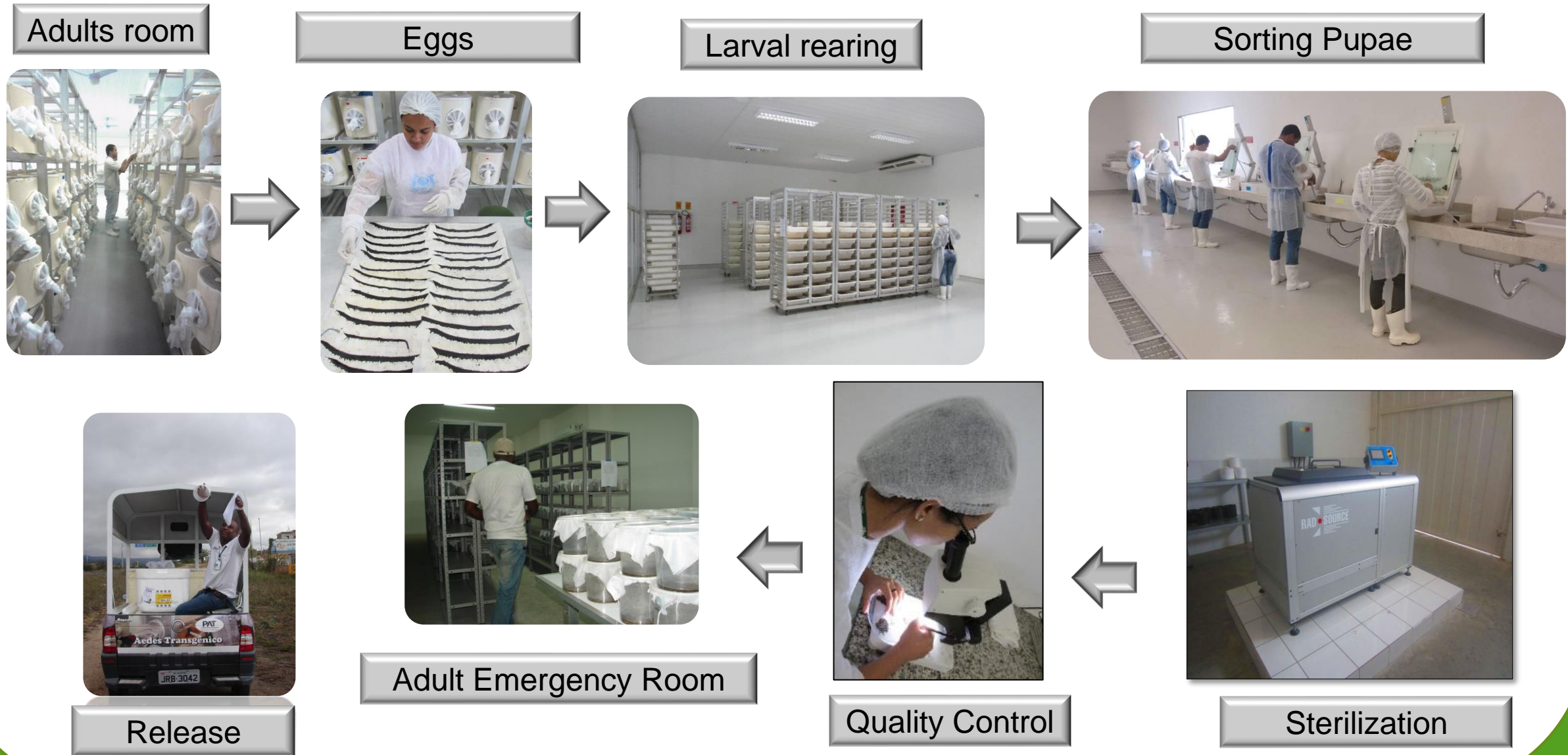


Mass-rearing Unit
4 million sterile males/week

- ✓ Strains: MBR-002
- ✓ Local genetic background;
- ✓ Origin: eggs collected in Recife, Pernambuco



Protocols for mass-rearing of *Ae. aegypti*



✓ Mass rearing protocols described by Carvalho et al., (2014), some adaptations

In a mass rearing

Requires trained manpower, and turnover is high

Separation of pupae is labor intensive

Production is continuous 24/7.

There are no weekends or holidays.

Expensive diet. Look for alternatives to reduce larval diet costs, looking for local ingredients, or mixing with local and imported ingredients

Adults irradiation

- ▶ Logistics of pupae sorting more efficient and convenient (1 sorting / day).
- ▶ Reduces the loss of material (pupae). We can make better use of the batch in term of sterile males produced;
- ▶ Adults can be immobilized, confine more insects in a smaller space, reduce dose variation and mechanical damage;

Packaging and transport

01

Transport logistics must prioritize the shortest travel time

02

Cold chain is crucial for this phase

03

Develop devices that facilitate the packing and transport of mosquitoes. Density is a key factor.

Authorizations and agreements with those involved



- ✓ Project approved by Ethics Committee (monitoring activities, release of sterile insects, MRR tests).
- ✓ Technical cooperation agreement between Recife City and Moscamed

 INSTITUTO DE MEDICINA INTEGRAL PROFESSOR FERNANDO FIGUEIRA - 

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: PESQUISA E INOVAÇÃO PARA APLICAÇÃO DA TÉCNICA DO INSETO ESTÉRIL, ASSOCIADA A TÉCNICA DO INSETO INCOMPATÍVEL NO CONTROLE DO VETOR AEDES AEGYPTI (DIPTERA: CULICIDAE)

Pesquisador: JAIR FERNANDES VIRGINIO

Área Temática: Pesquisas com coordenação e/ou patrocínio originados fora do Brasil, excetuadas aquelas com copatrocínio do Governo Brasileiro;

Versão: 3

CAAE: 87963318.6.0000.5201

Instituição Proponente: BIOFÁBRICA MOSCAMED BRASIL - BIOMOSCAMED

Patrocinador Principal: Agência Internacional de Energia Atômica
FUNDO MUNICIPAL DE SAÚDE

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

RECIFE, 10 de Dezembro de 2018

Assinado por:
Edvaldo da Silva Souza
(Coordenador(a))


PREFEITURA DO
RECIFE

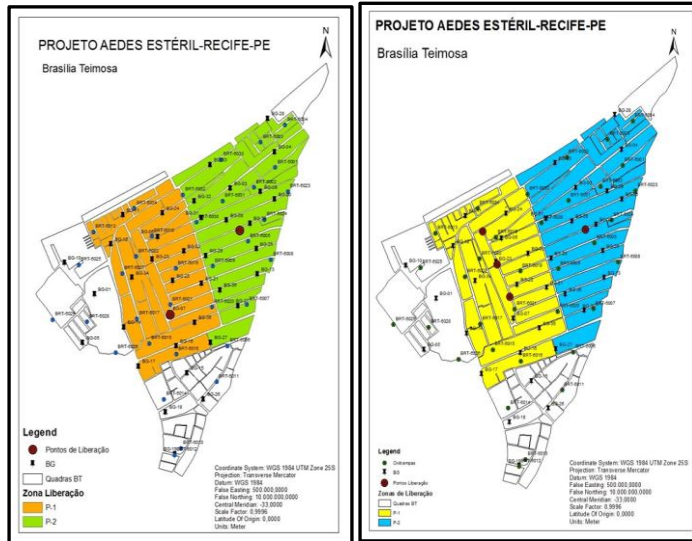
TERMO DE COOPERAÇÃO TÉCNICA

TERMO DE COOPERAÇÃO TÉCNICA CELEBRADO ENTRE A SECRETARIA DE SAÚDE DO RECIFE E A BIOFÁBRICA MOSCAMED BRASIL.

O MUNICÍPIO DO RECIFE, através da SECRETARIA MUNICIPAL DE SAÚDE, representado neste ato pelo Secretário Municipal de Saúde o Dr. JAILSON DE BARROS CORREIA, inscrito no CPF/MF sob o nº 631.466.494-20, RG. nº 589.491-7 SSP/PE, residente e domiciliado na cidade do Recife/PE, nomeado pela Portaria nº 10, publicada no DOM, de 01/01/2013, e a BIOFÁBRICA MOSCAMED BRASIL, com sede na Avenida C 1, Lote 15, Quadra D 13, Distrito Industrial do São Francisco na cidade de Juazeiro, no estado da Bahia, inscrita no CNPJ sob nº 05.378.378/0001-47, neste ato representada pelo Dr. JAIR FERNANDES VIRGINIO, RG. nº- 759.604 SSP/PB e CPF nº 374.337.414-53 resolvem celebrar o presente instrumento, nos termos da legislação pertinente em vigor e de acordo com os termos e condições a seguir pactuados.

Mark-Release-Recapture trial (MRR)

✓ Carried out to define of local strain behavior



Results:

- ✓ Ground release
- ✓ Treated area (Brasilia Teimosa)
- ✓ Two releases per week
- ✓ Single point
- ✓ Males marked with different colors

→ Average dispersal of the sterile males:
Approximately 100 meter;

→ Sterile males survived for 4 days after
release under urban conditions;

→ Sterile males introduced approximately
30% sterility in the wild population;

Sterile male releases

✓ **TARGET AREA: Brasilia Teimosa, Recife**

→ Releases: Oct 2020 to Apr 2022

✓ Ground release

→ Plastic pot with a 1,000 sterile males

✓ Once a week, 250 - 300 thousand/week

✓ Twice a week, 0.5 - 1 million/week

✓ 5,000 – 9,000 mosquitos/ha



Area description

Area selection for intervention and no-intervention

- ✓ **CONTROL AREA:** Pina - 58ha; ~ 22.100 inhabitants
- ✓ **TARGET AREA:** Brasilia Teimosa 60 ha; ~ 18.300 inhabitants
- ✓ **Distance from production:** 720 km

Monitoring network

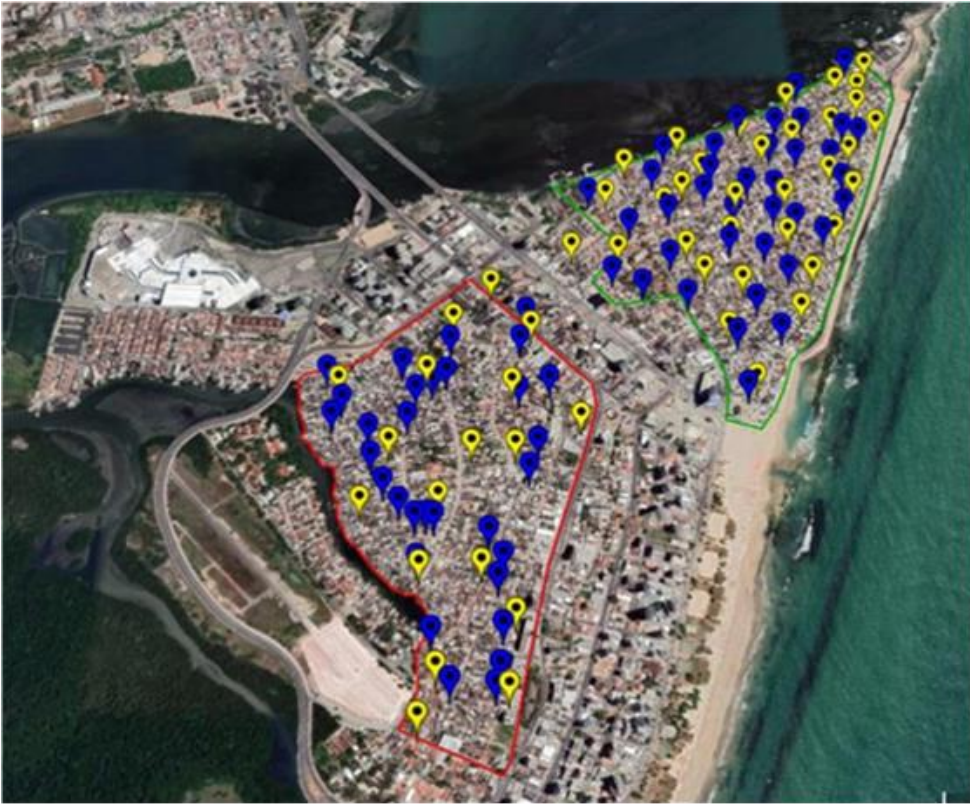
- ✓ **Logistics:** Collection once a week; (continuous surveillance)

Trapping systems

- ✓ **Trap type:** Ovitrap (eggs collection); BG trap (adults collection)



✓ Mosquito surveillance network based on ovitraps and BG traps



ENTOMOLOGICAL INDICATORS

- ✓ Average number of eggs/trap
- ✓ Index of positive traps
- ✓ Eggs hatching

- ✓ Wild population density
 - ✓ Sex ratio
 - ✓ Species of Aedes



Releases

Vector control AW-IVM

Population suppression of mosquitoes before start with SIT:

Dissemination Station (PPF)

Mass Egg Capture (Ex. BTi or Spinosad)

Continuous data analysis for course correction in field

Buffer zone

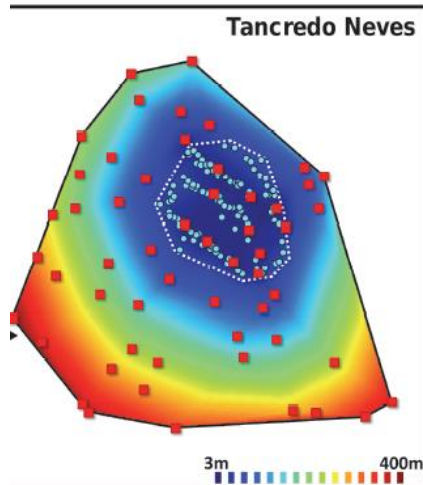
Release once or twice a week

RESEARCH ARTICLE

Mosquito-Disseminated Pyriproxyfen Yields High Breeding-Site Coverage and Boosts Juvenile Mosquito Mortality at the Neighborhood Scale

Fernando Abad-Franch^{1,*}, Elvira Zamora-Perea¹, Gonçalo Ferraz^{2,3}, Samael D. Padilla-Torres¹, Sérgio L. B. Luz¹

¹ Laboratório de Ecologia de Doenças Transmissíveis na Amazônia, Instituto Leônidas e Maria Deane—Fiocruz Amazônia, Manaus, Brazil, ² Departamento de Ecologia, Instituto de Biociências, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, ³ Biological Dynamics of Forest Fragments Project, Smithsonian Tropical Research Institute/Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil



RESEARCH ARTICLE

Mosquito-Disseminated Insecticide for Citywide Vector Control and Its Potential to Block Arbovirus Epidemics: Entomological Observations and Modeling Results from Amazonian Brazil

Fernando Abad-Franch^{1,2,*}, Elvira Zamora-Perea², Sérgio L. B. Luz²

¹ Laboratório de Triatomíneos e Epidemiologia da Doença de Chagas, Centro de Pesquisa René Rachou, Fundação Oswaldo Cruz, Belo Horizonte, Minas Gerais, Brazil, ² Laboratório de Ecologia de Doenças Transmissíveis na Amazônia, Instituto Leônidas e Maria Deane, Fundação Oswaldo Cruz, Manaus, Amazonas, Brazil



Ground Release Steriles Males

- ▶ Ground release
 - ▶ 1 plastic pot with a 1,000 sterile males
- ▶ Twice a week, 0.5 - 0.7 million/week
- ▶ 5,000 - 9,000 mosquitos/ha



Surveillance

>> Ovitrap traps give better answer to figure it out what is going on in the field.

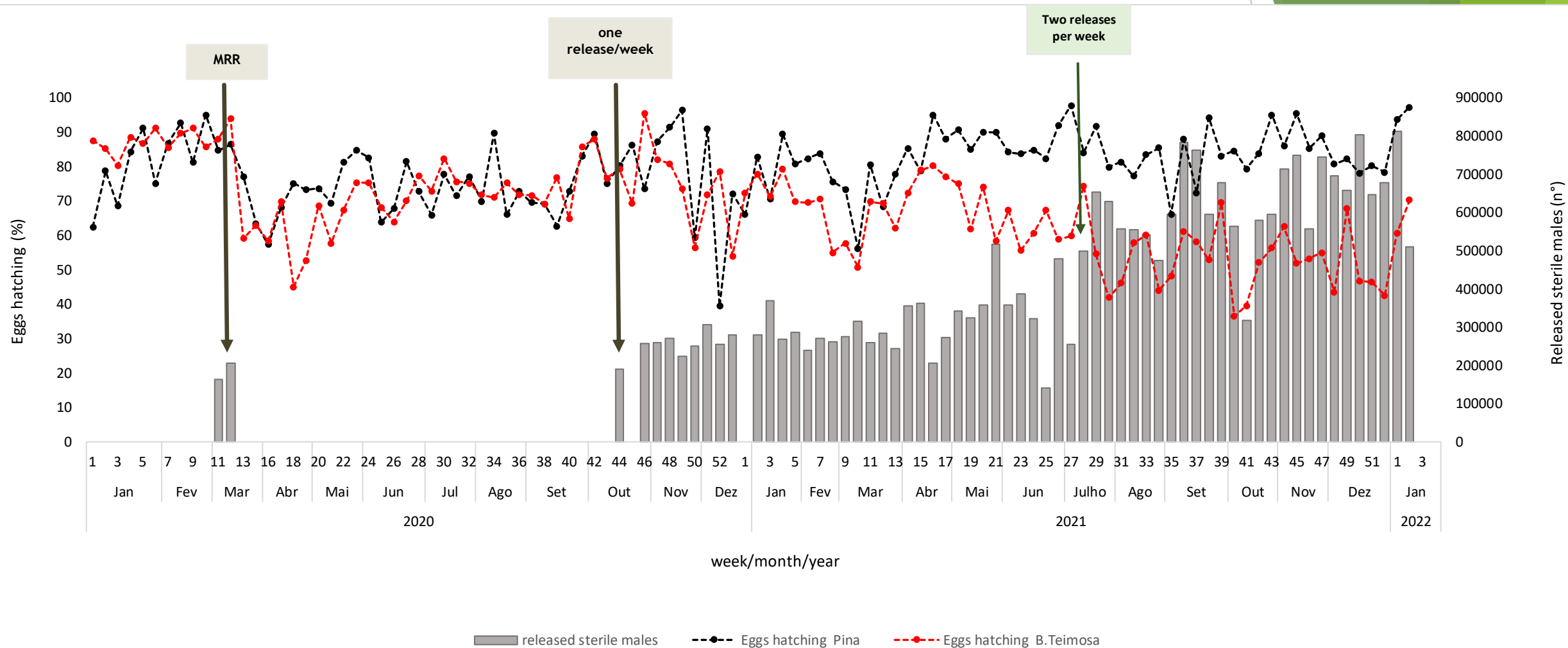
>> Doubt if the BG's were on all the time

>> It was very common to relocate traps for better development of activities

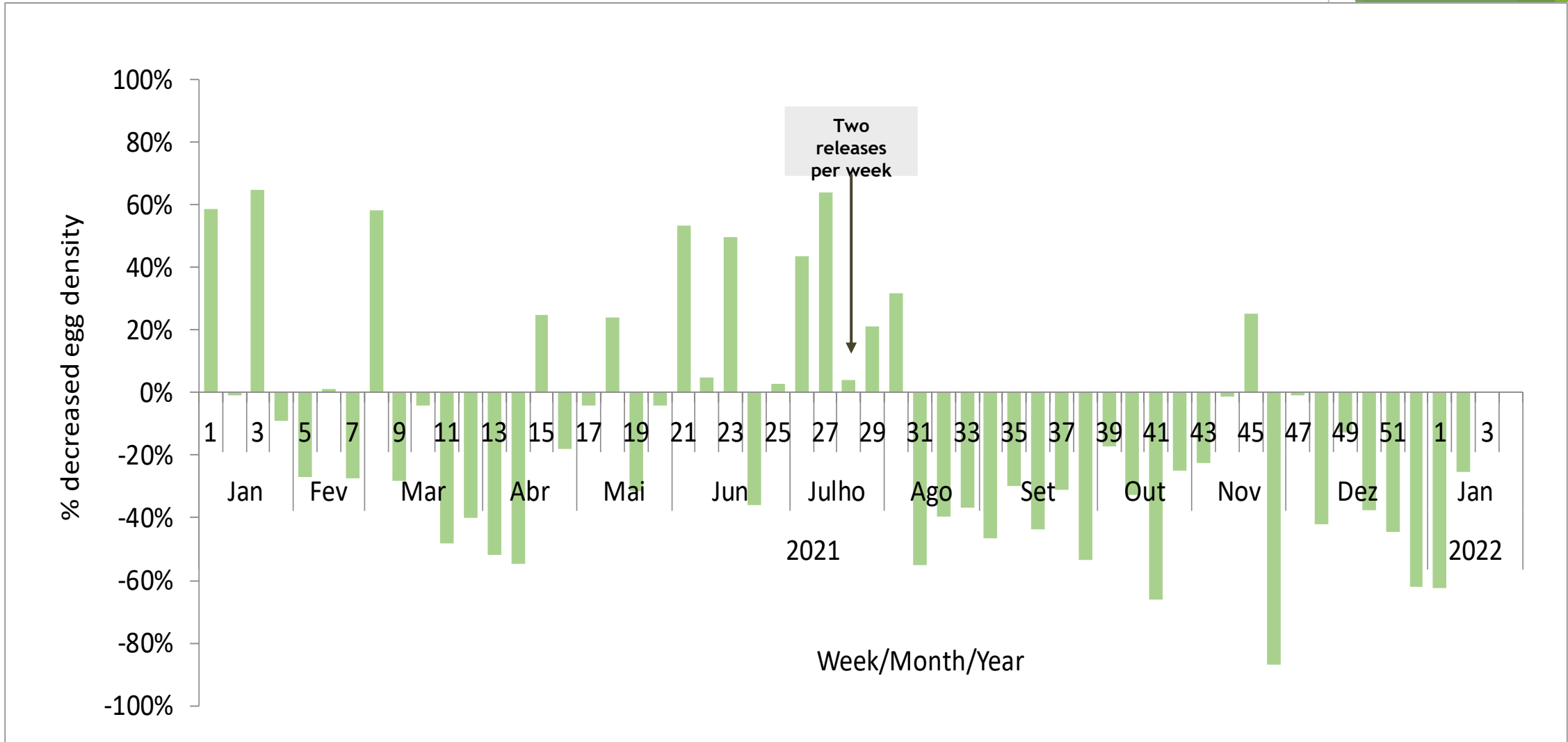
>> Continuous data analysis to learn what is going on. It is essential to have a database installed to facilitate assessments during the project.

>> Production of maps helps a lot for the data analysis.

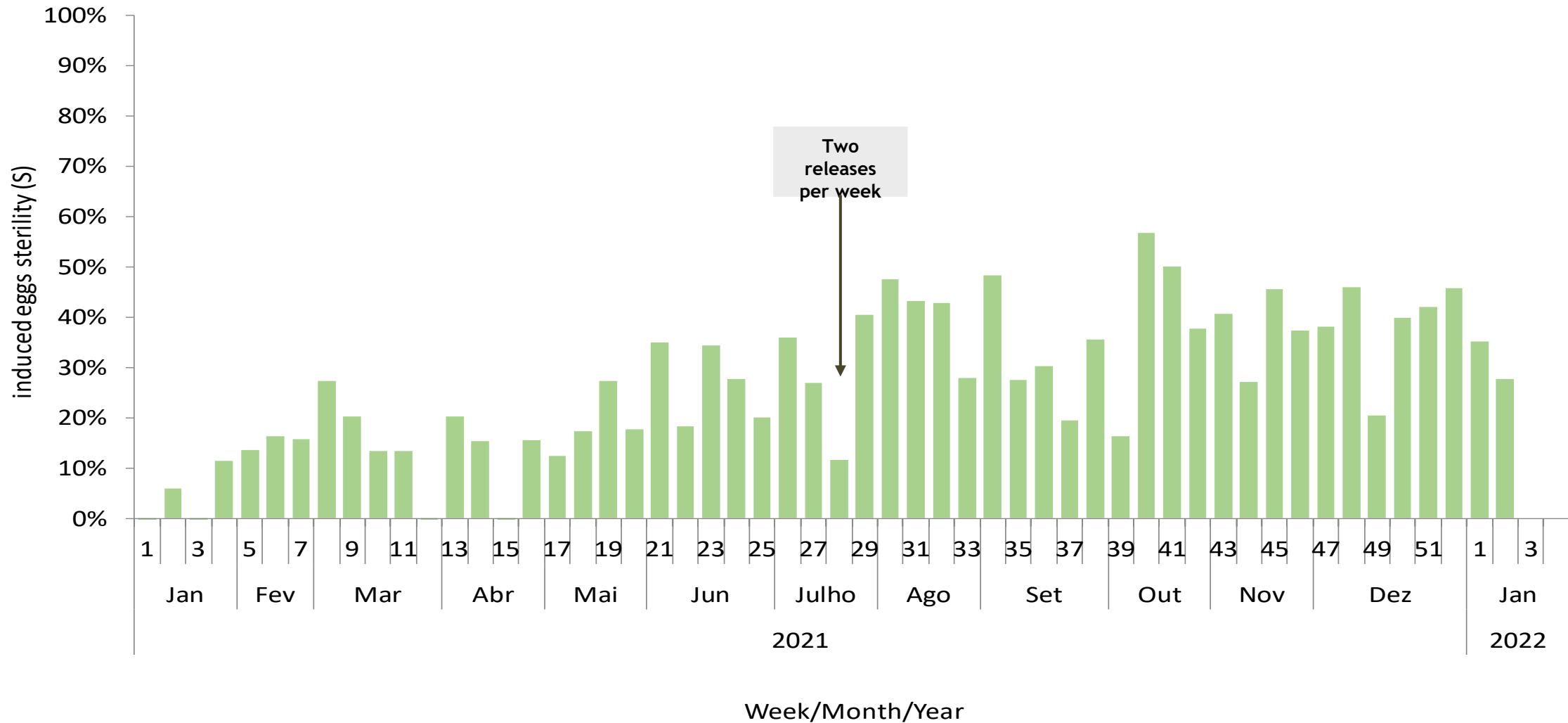
✓ Eggs Hatching - Pina and B. Teimosa



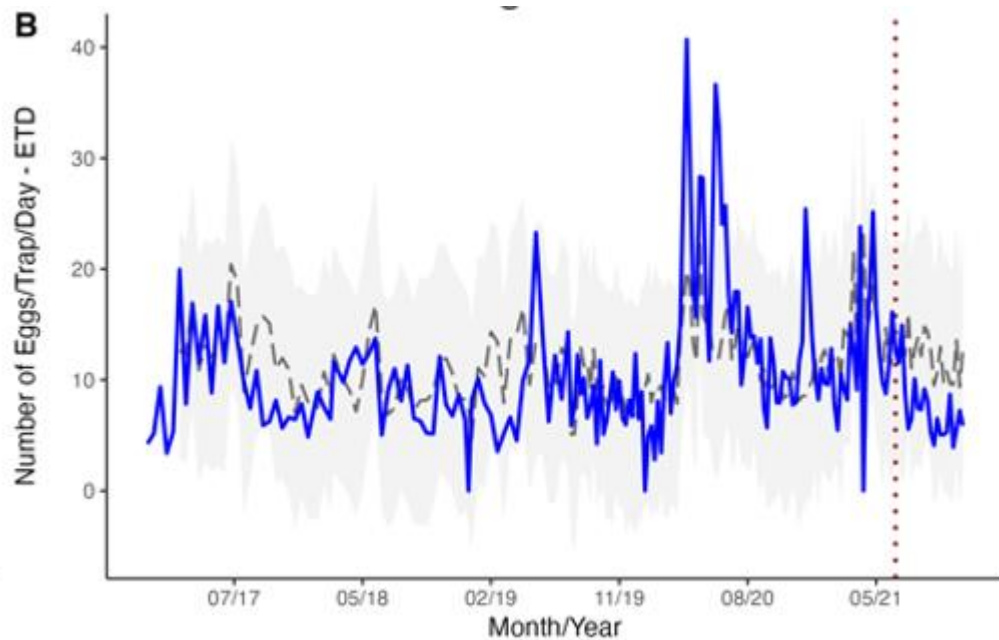
✓ % of decreased egg density during releases



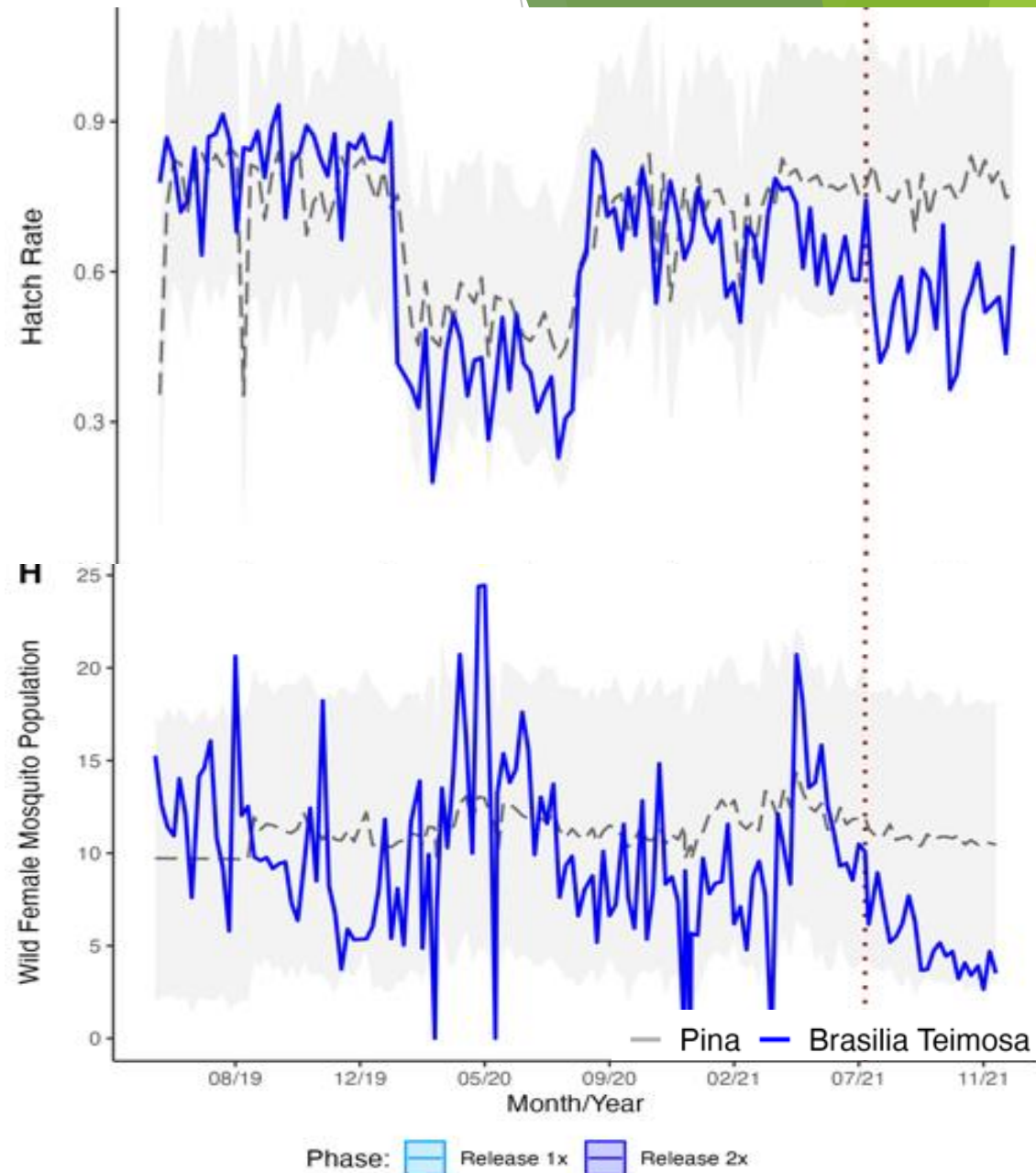
✓ Induced eggs sterility



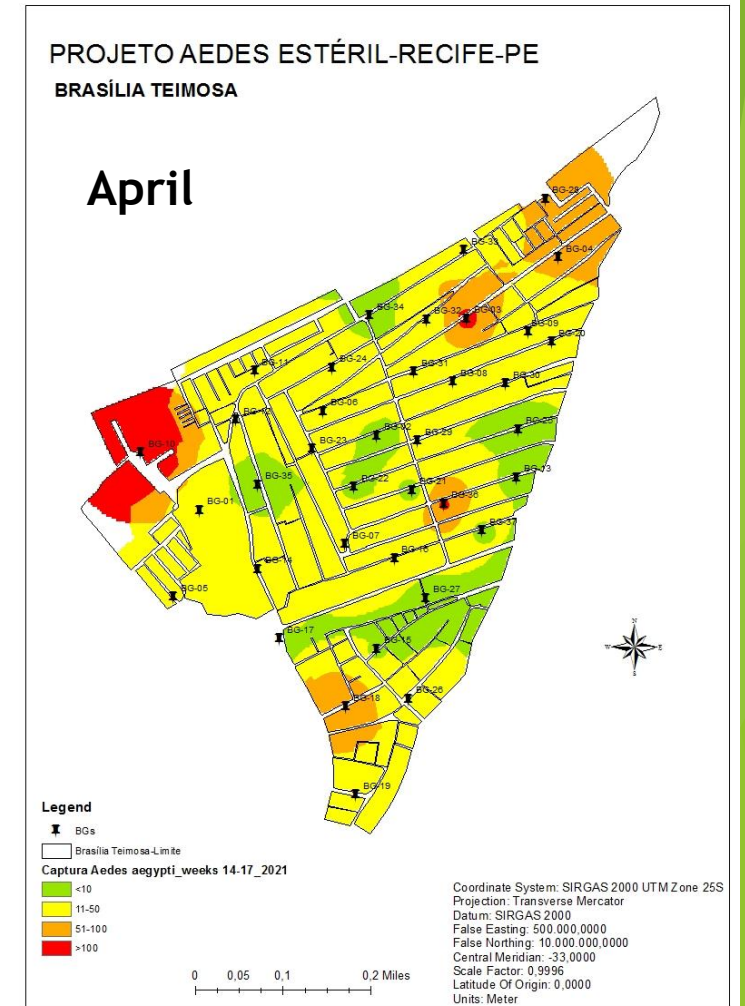
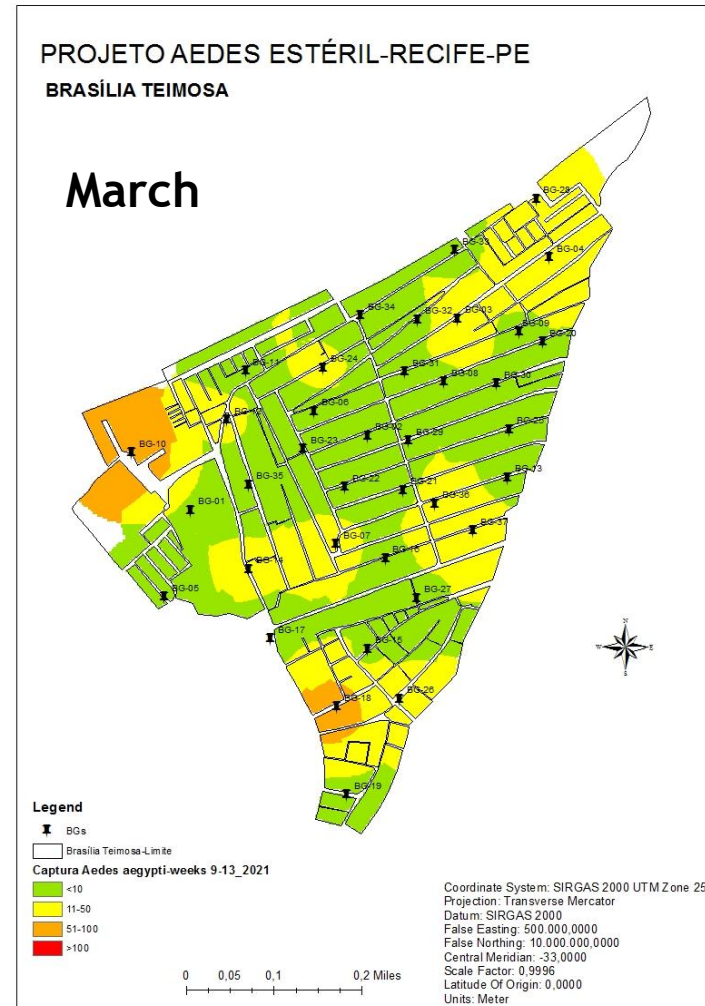
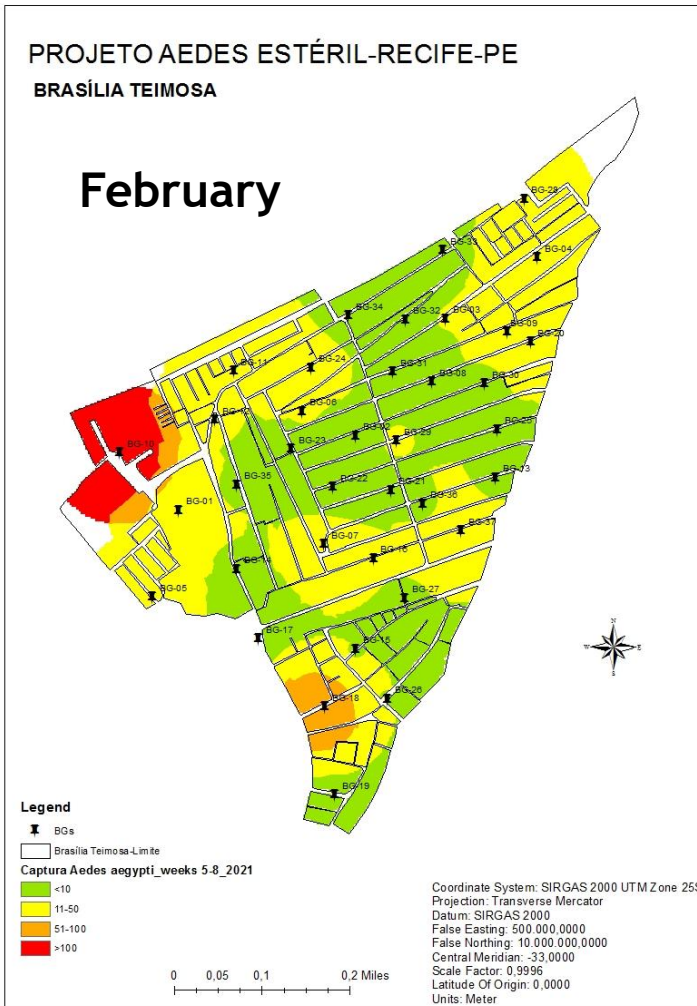
Results..



- Decrease of 39% ETD
- 33% reduction in hatch rate,
- induced sterility from around 30 %

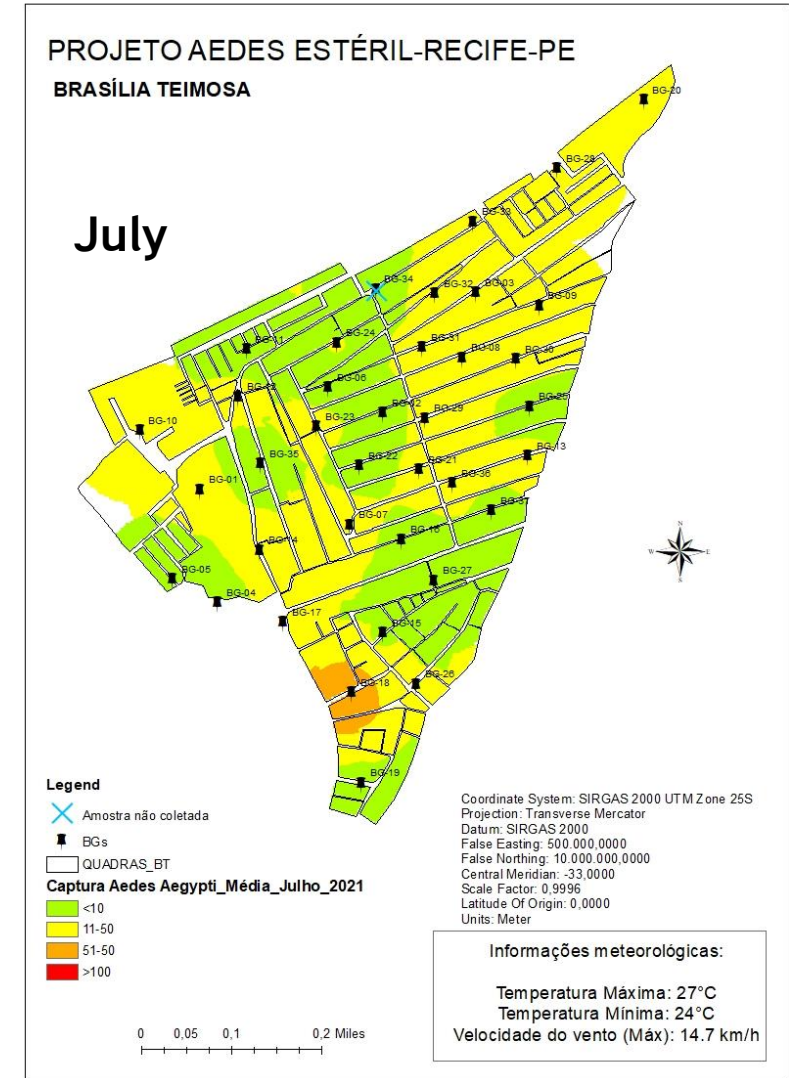
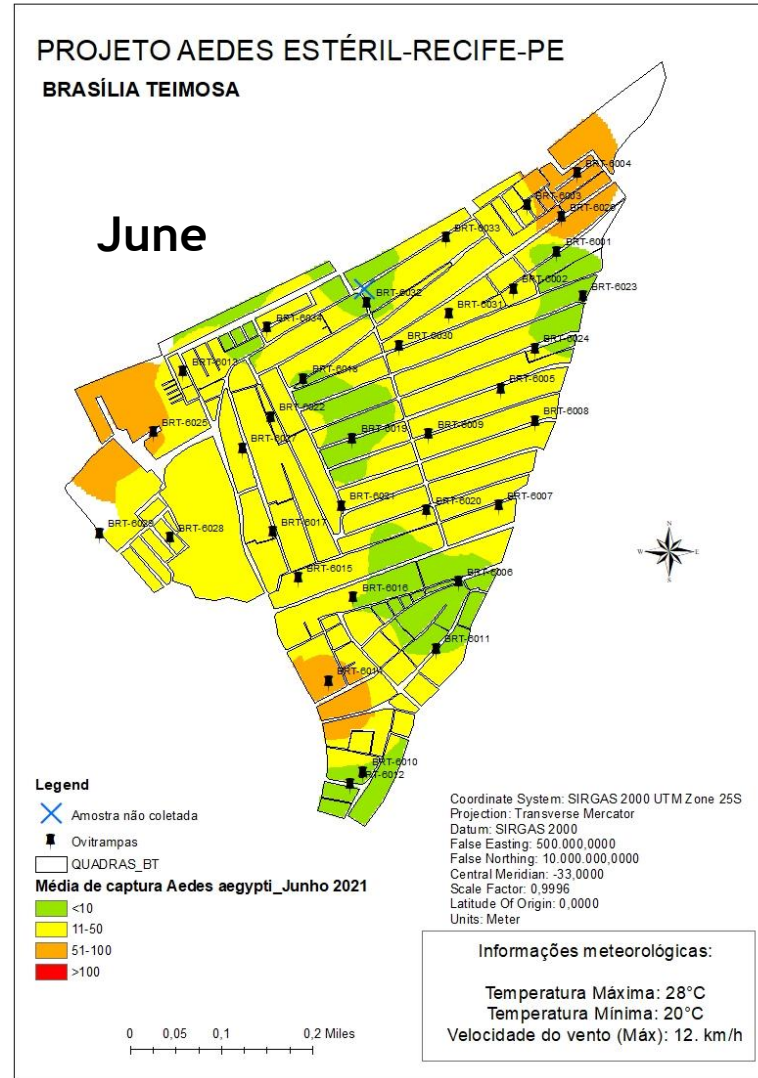
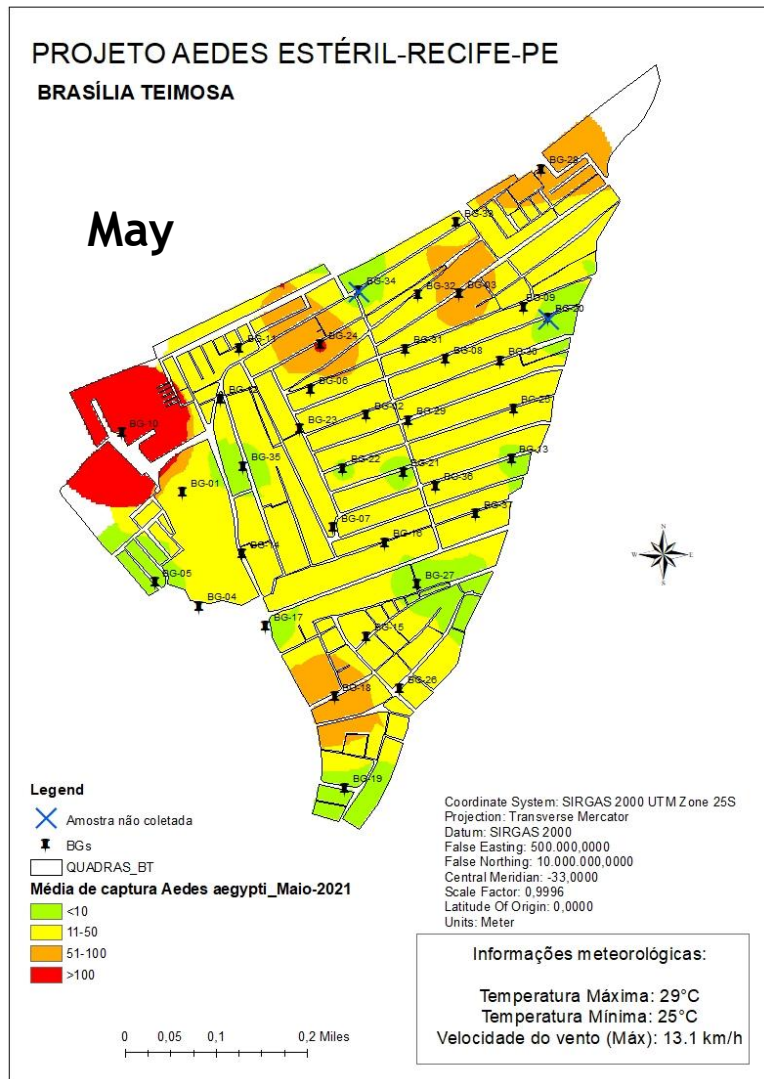


Maps BGs- Feb to Apr /2021



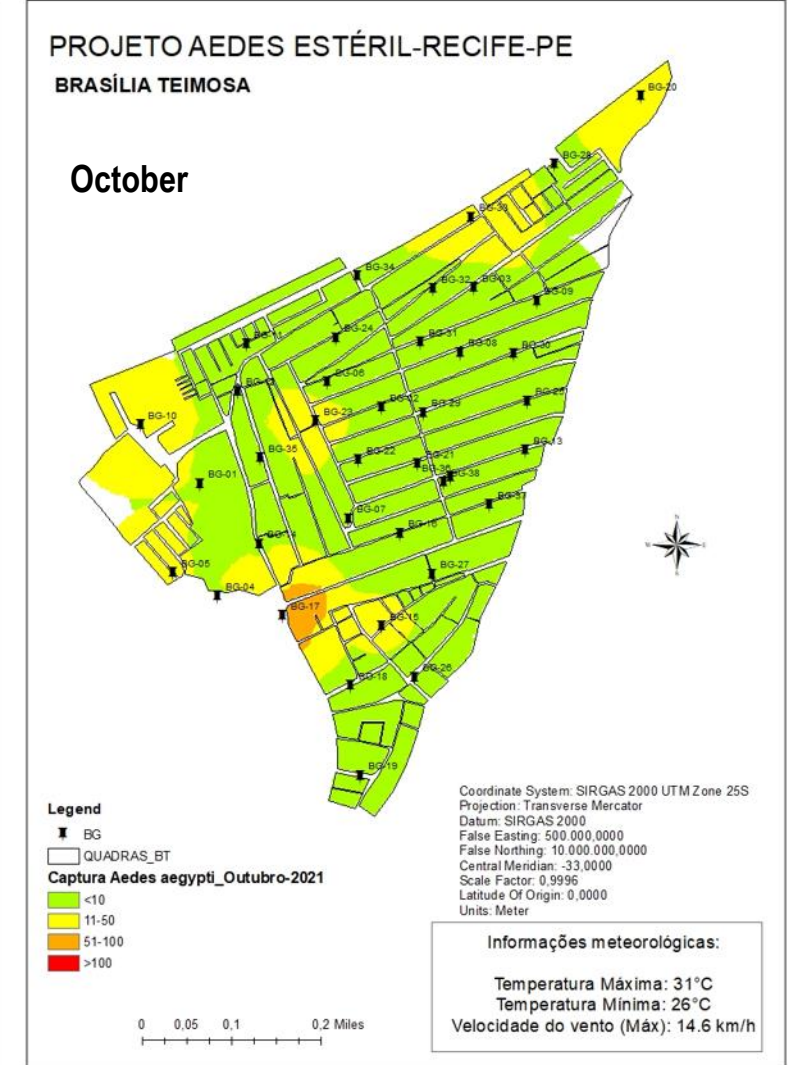
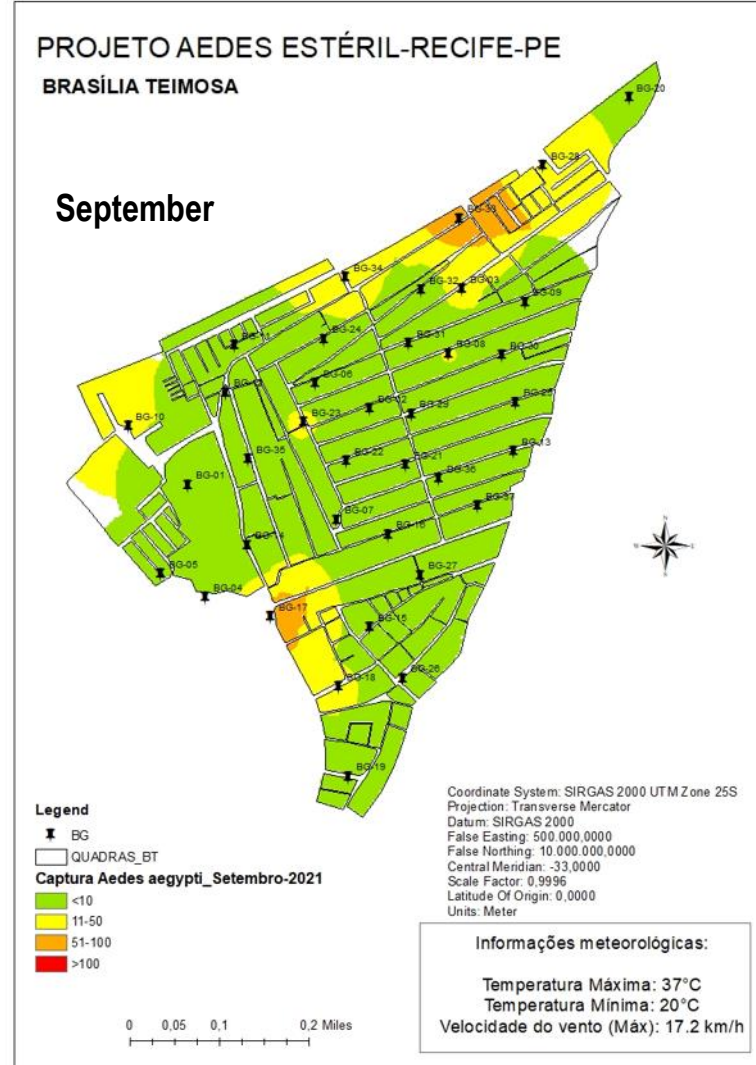
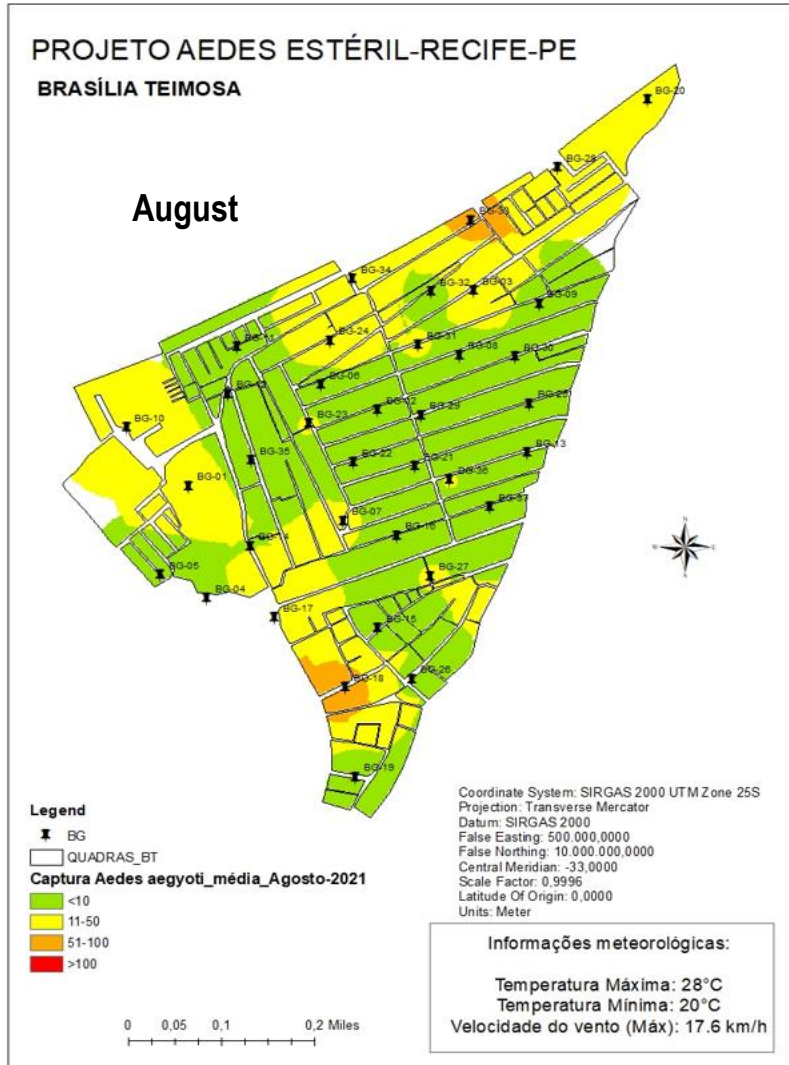
Infestation of *Ae. aegypti* adults Bairro Brasília Teimosa, Recife, Pernambuco, Brazil

Maps BGs- May and Jul/2021



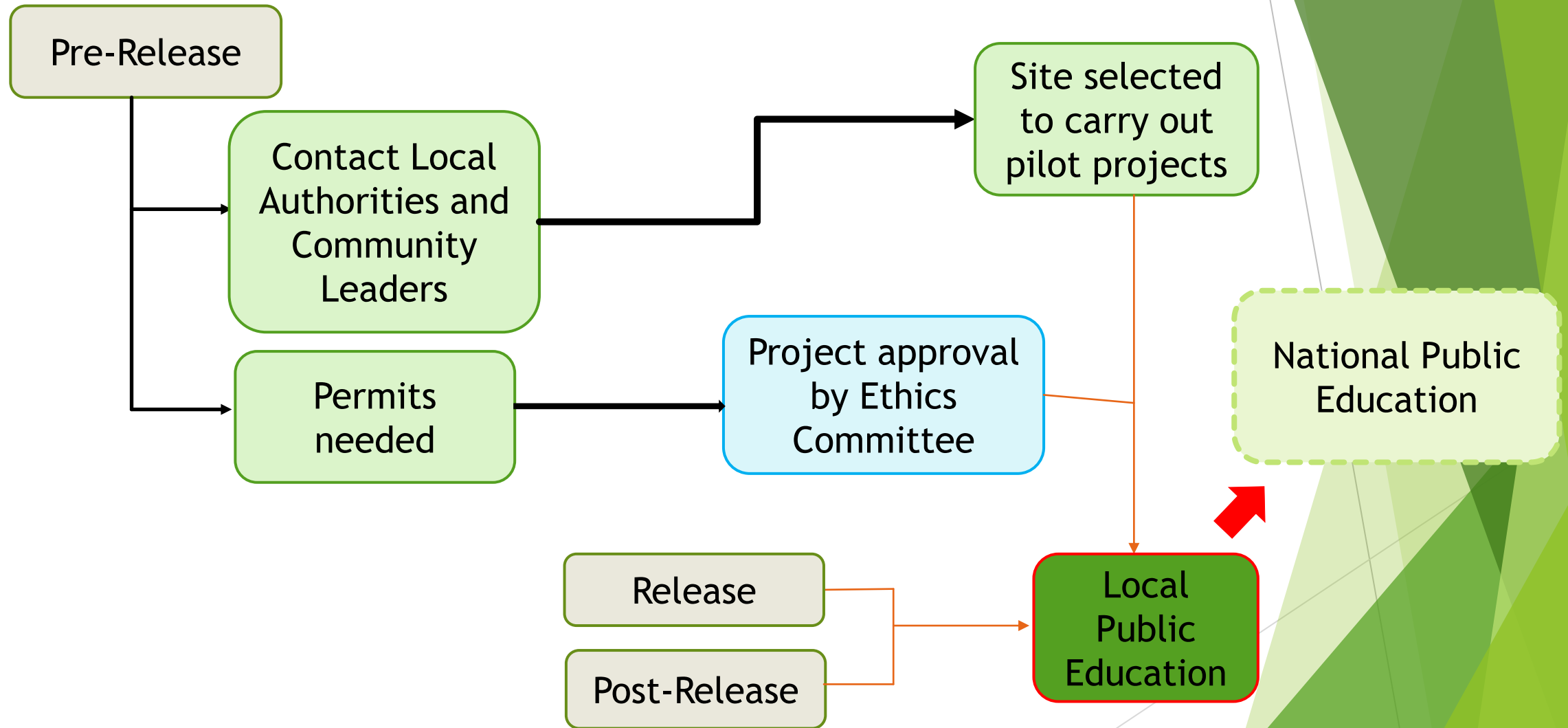
Infestation of *Ae. aegypti* adults Bairro Brasília Teimosa, Recife, Pernambuco, Brazil

Maps BGs- Aug to Oct /2021



Infestation of *Ae. aegypti* adults Bairro Brasília Teimosa, Recife, Pernambuco, Brazil

Community Engagement Activities



Community Engagement Activities: Pre-releases.



Institucional Support



Rafael Grossi, DG IAEA, visit the PAE in Recife, jul/21.

**Recognized as Collaborating Centre
of the International Atomic Energy Agency**



Some insights

- Surveillance is crucial and keep open mind to the results
- Create an institutional advisory group, with experts from entomology and epidemiology fields
- Assure quality of reared mosquitoes
- Choose the release mechanism that is easier to use (it doesn't matter if the release is ground or aerial)
- To promote the integration of the SIT with others control methods of the *A. aegypti* vector.



Lessons Learned

Adult irradiation

Release twice a week

Community engagement and involvement

Additional suppression tools

Challenges on irradiation, handling and transport of sterile males

Next steps

- Move from the pre-operational phase to the operational phase
- Expand and **automate** the facilities for producing sterile mosquitoes for irradiation
- IVM with focus in the SIT.
- Support other Member States in implementing their SIT Projects

Institutions involved

- ✓ **IAEA** - technical and financial support.
- ✓ **Government of the State of Bahia:** Institutional support and final user of the evaluated technology.
- ✓ **Ministry of Health:** financial agent; end-user of the evaluated technology
- ✓ **Ministry of Agriculture :** end-user of the evaluated technology
- ✓ **Ministry of Science, Technology and Innovation** - financial support. CNPq and FINEP.
- ✓ **Department of Nuclear Energy/Federal University of Pernambuco State**
Insect irradiation, supporting the dose definition tests, dose map and dosimetry.
- ✓ **PAHO** - technical support.
- ✓ **CNEN - NLO** and technical support.



Obrigado!

jair@moscamed.org.br



GOVERNO FEDERAL



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Comissão Nacional de Energia Nuclear



Estado da Bahia



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