



Agribusiness 2017

Driving today's
agricultural revolution

**Genetic pest
management
– the future?**

Prof Luke Alphey
Pirbright Institute



Genetic pest management – the future of pest management?

Luke Alphey

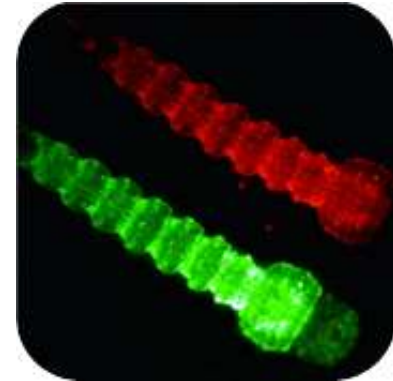
goals



Combat insect borne diseases
Improve crop yields

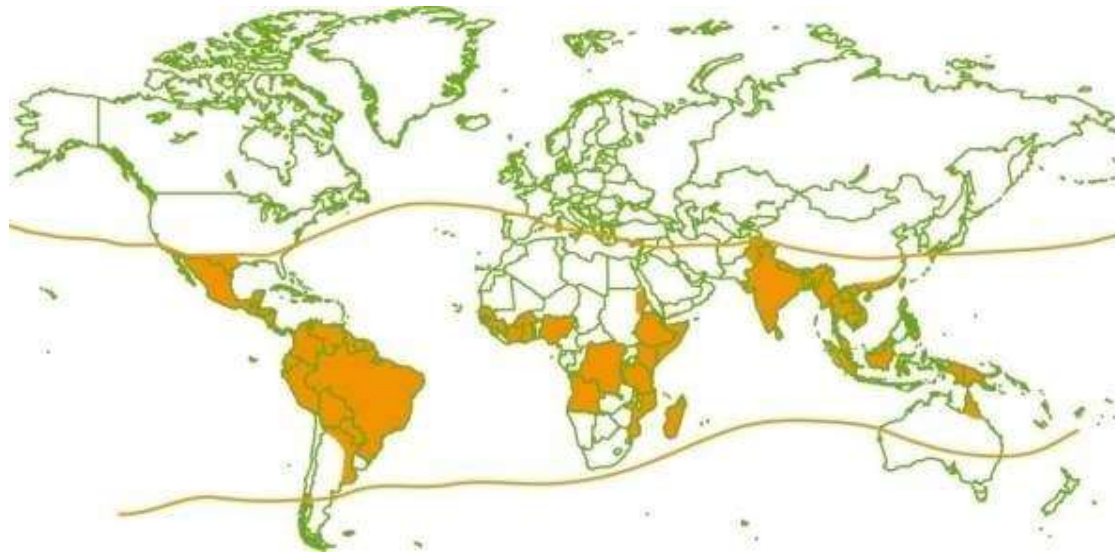


through the reduction of the insect population causing disease or damaging crops



genetic approach that is safe, sustainable, economic and applicable to many insect species worldwide

dengue fever – a global unmet health challenge



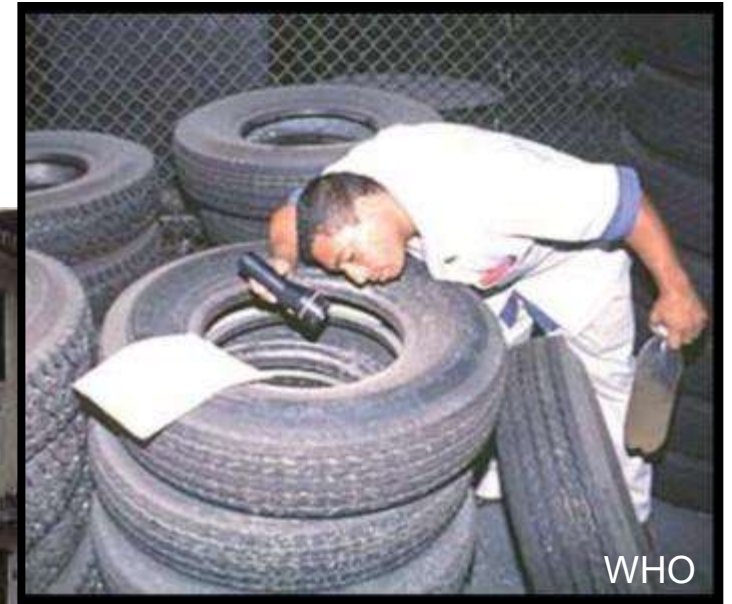
50 -100 million cases pa, increasing
\$5 Bn burden of cost
Aedes aegypti: alien invasive species in most countries
Symptoms – joint/muscle pain ‘Breakbone fever’
Severe form Dengue Haemorrhagic Fever (DHF)
No specific medication or vaccine yet
Same vector – Chikungunya, Yellow Fever and Zika viruses



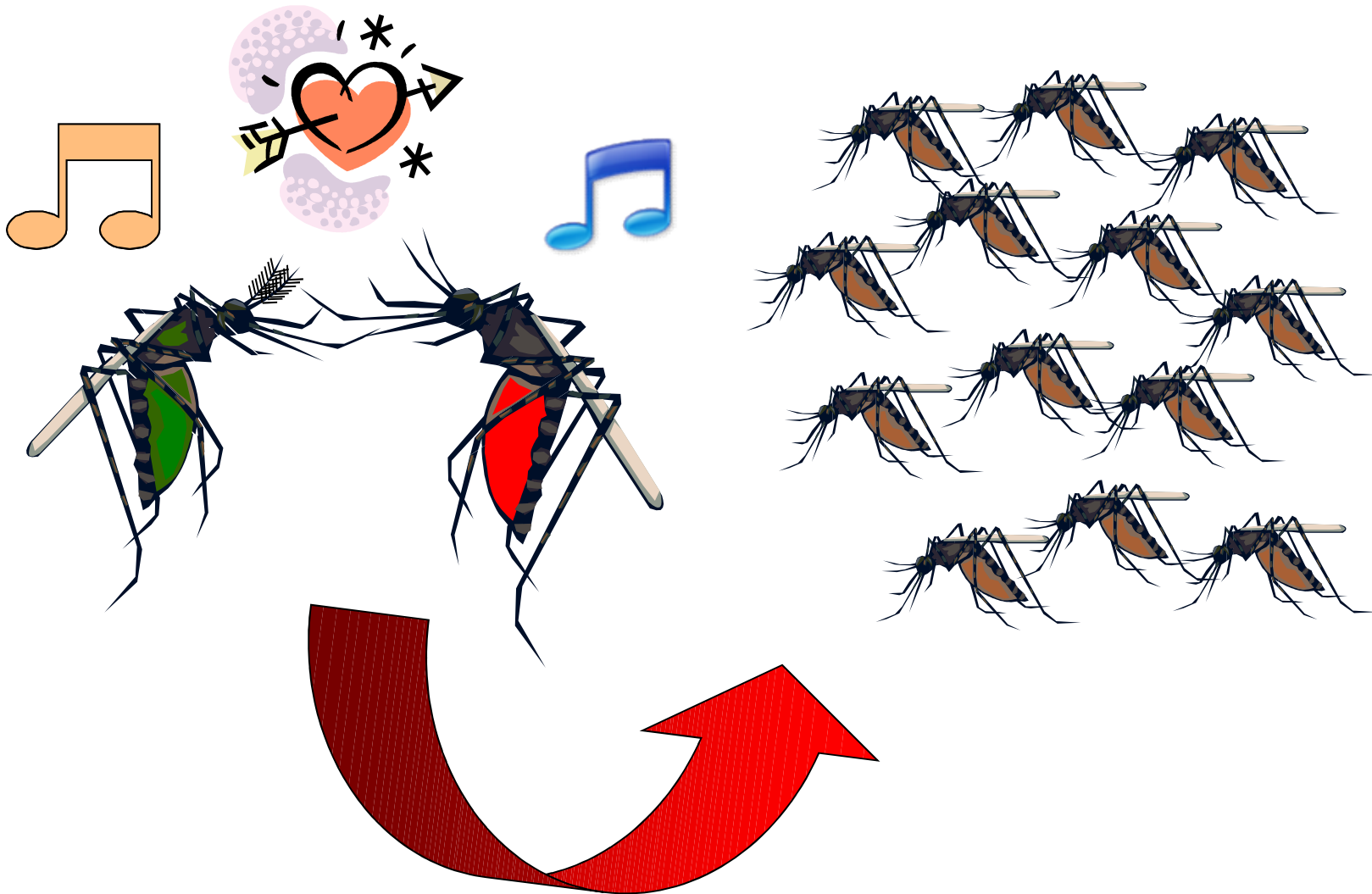
“Today, dengue ranks as the most important mosquito-borne viral disease in the world. Everywhere the human and economic costs are staggering”

**Dr Margaret Chan, 2012
Director General, WHO**

dengue control



mosquito reproduction



RIDL “genetically sterile” males



RIDL®

Sterile Insect Technique



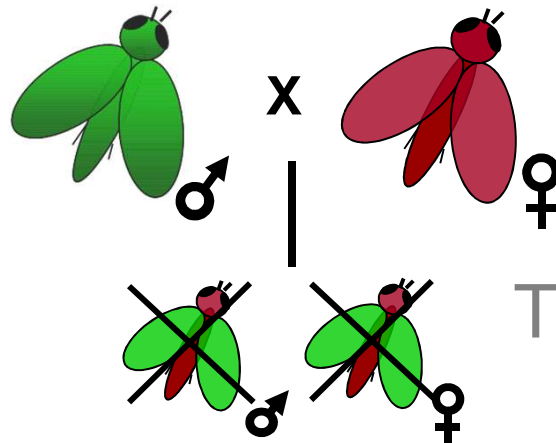
RIDL – “genetic sterility”

RIDL insects are genetically sterile

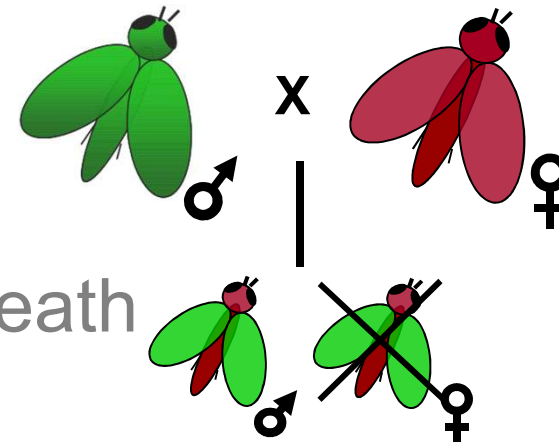
Repressible

Release homozygous males

Bi-sex lethal



Female-specific lethal



Time of death

Thomas et al. 2000 Science 287: 2474-6

Gong et al. 2010 Nat Biotech 23: 453-6

Fu et al. 2007 PNAS 107: 4550-4

Wise de Valdez et al. 2009 PNAS 108: 4772-5

www.pirbright.ac.uk

classifying pest control strategies



Population suppression

Goal: reduce numerical size of pest population

engineered
sterile males

“Population replacement” or “Refractory insect strategy”

Goal: change pest population to less harmful form

Self-limiting

*Modification will be eliminated from population
unless maintained by periodic releases*

- *Sterile insect methods*

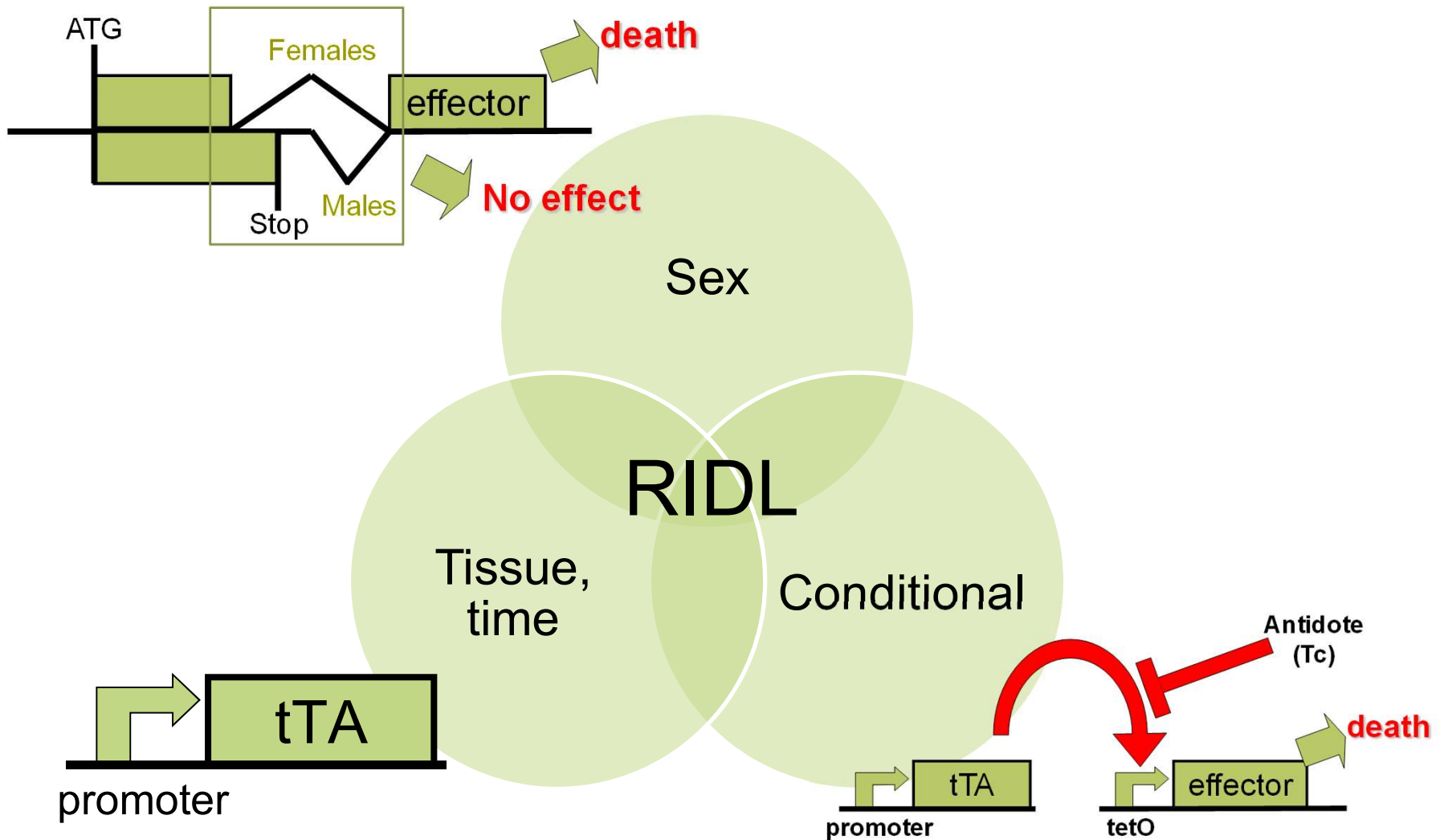
engineered
sterile males

Self-sustaining (invasive)

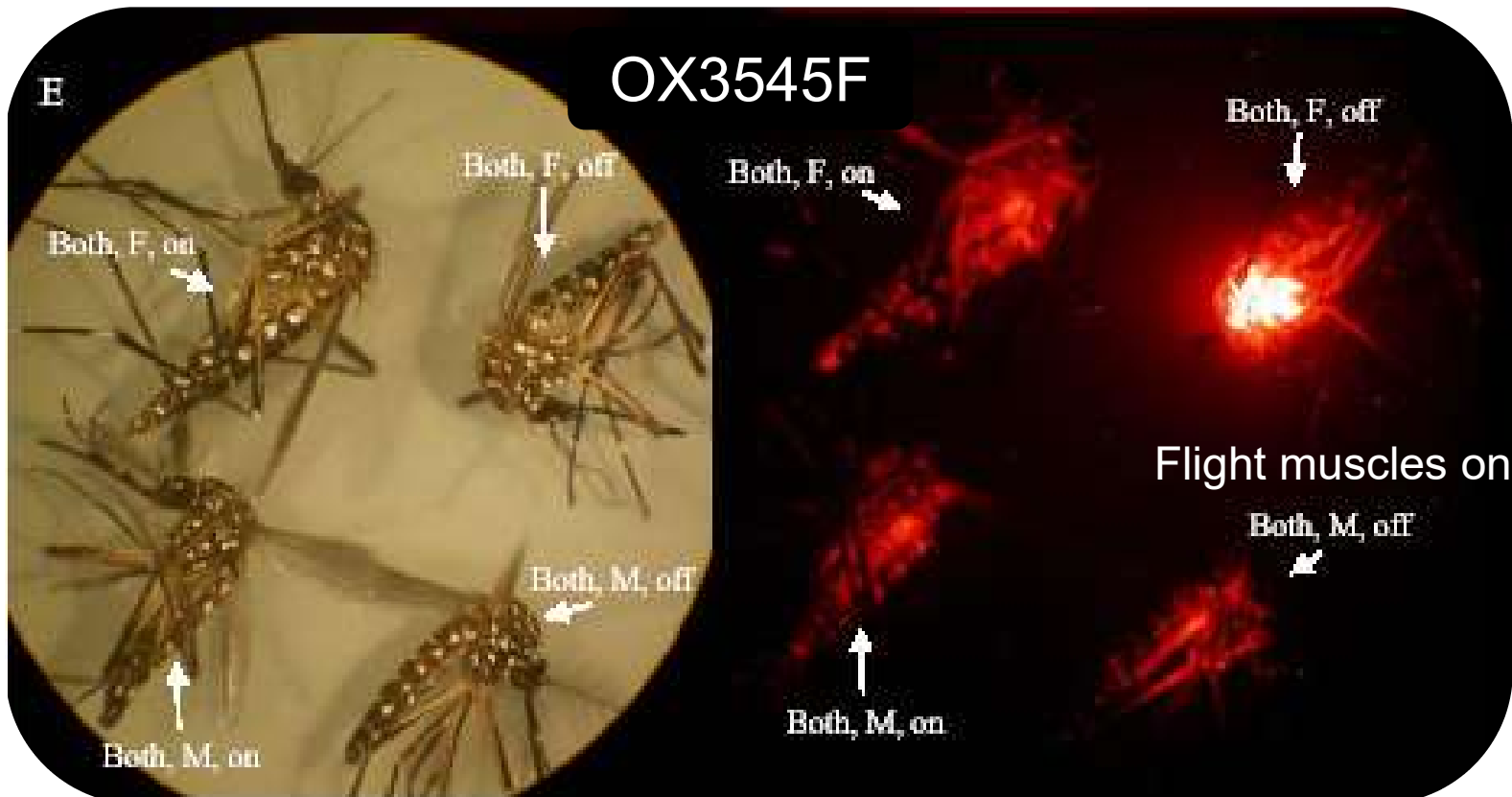
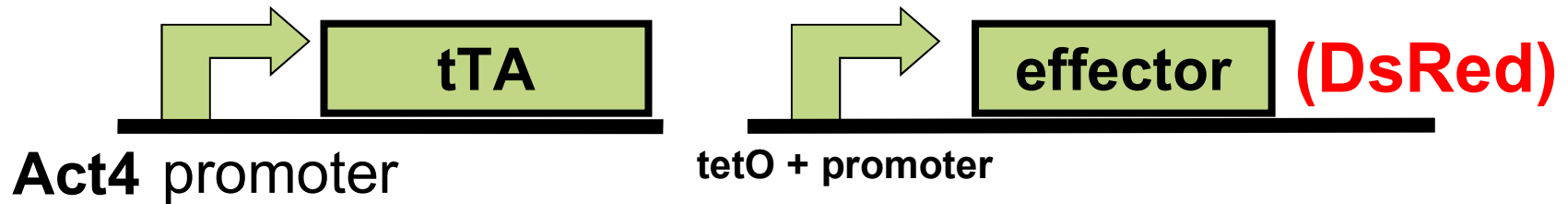
*Modification will persist and spread in population
(and potentially beyond)*

- *Gene drive systems*

combinatorial control



Female flight muscles + Red fluor



OX3604C RIDL mosquitoes



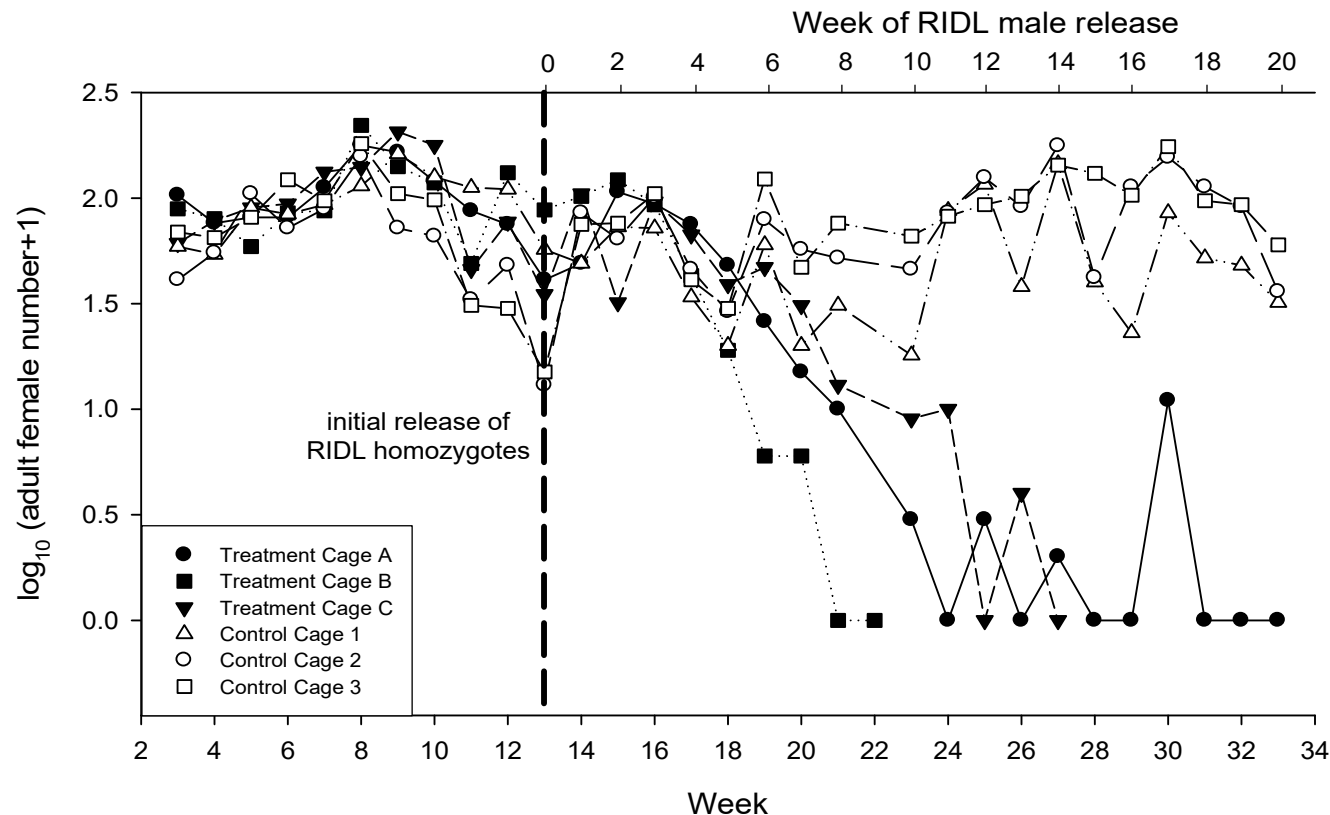
Males



Females

Flightless mosquitoes cannot survive in wild (or find hosts).
Unable to mate even in laboratory. Males have normal flight ability, as
have females given antidote as larvae.

Aedes aegypti cage suppression



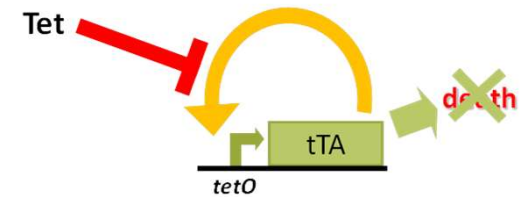
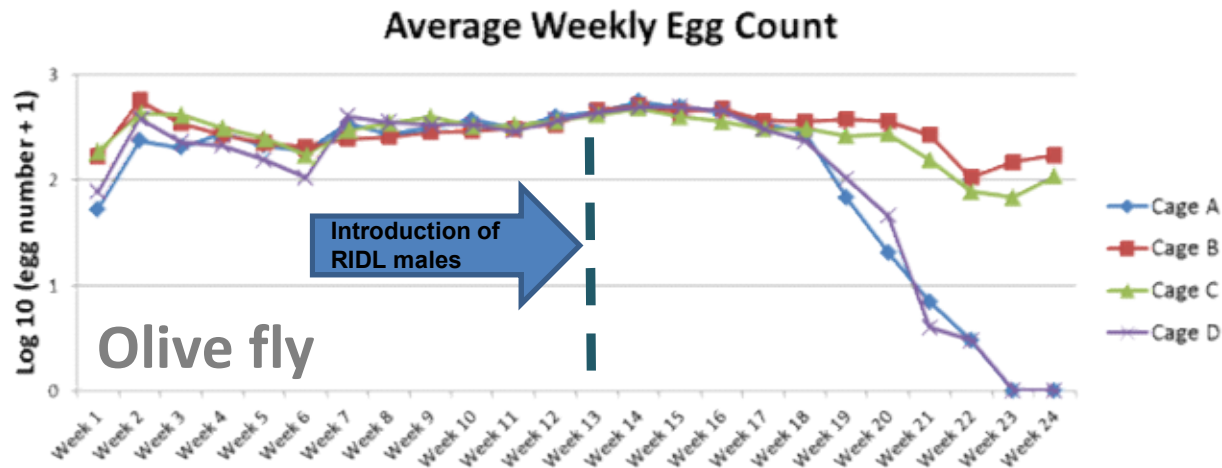
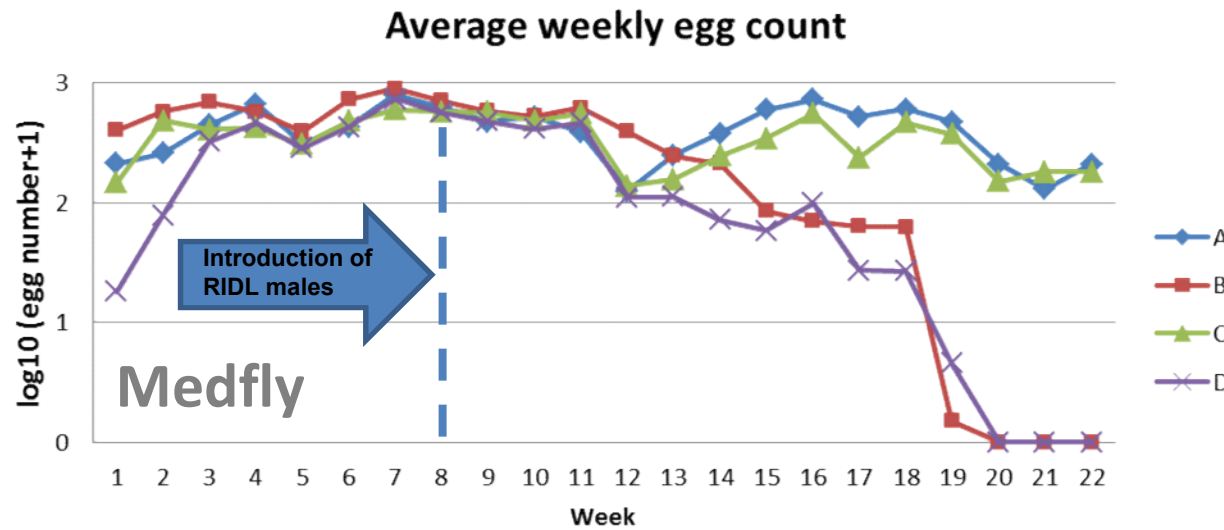
Colorado State University experiment in indoor cages

Control from RIDL was as predicted in simulation model

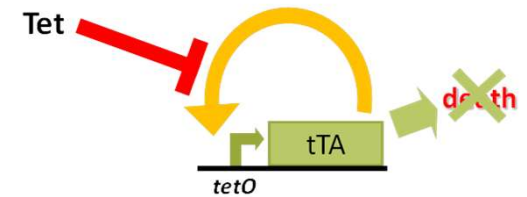
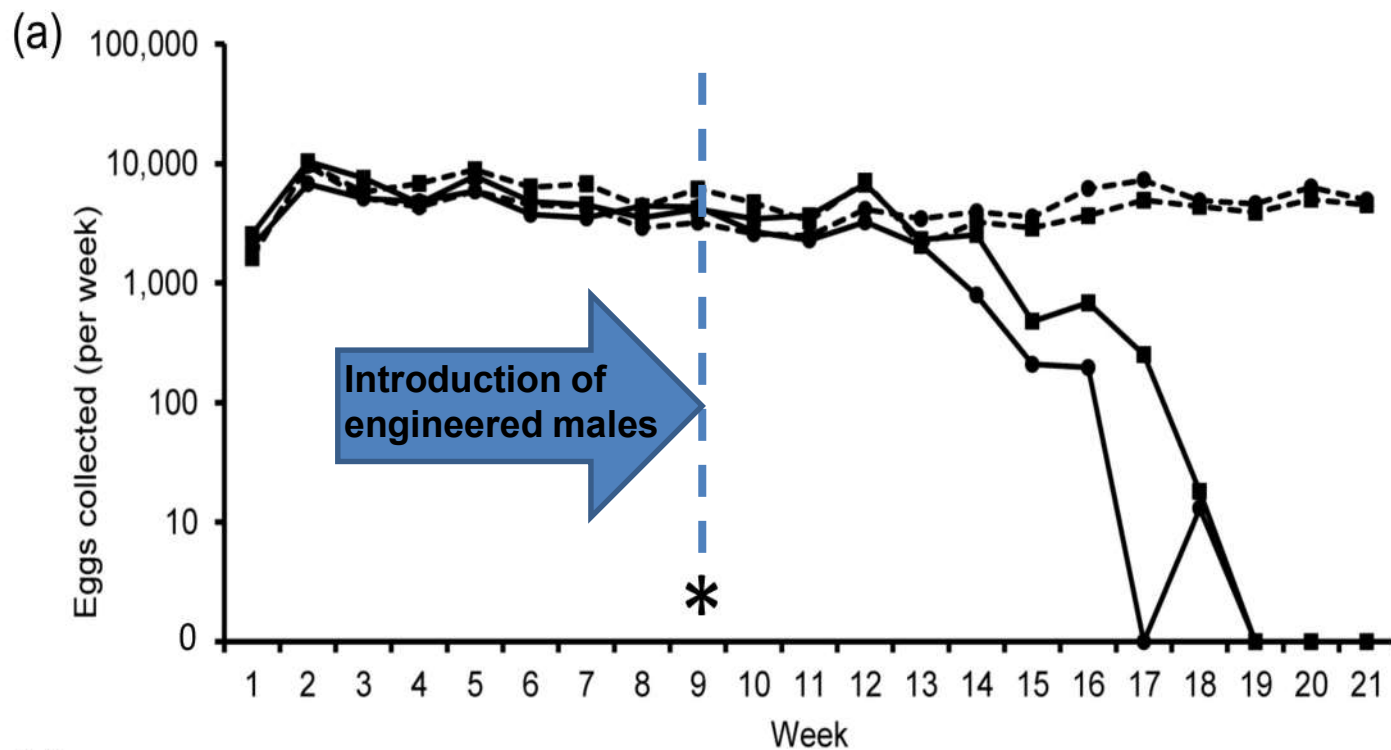
Cage populations eradicated in under 20 weeks

Wise de Valdez et al (2011) PNAS 108: 4772-4775

cage suppression trials: fruit flies



cage suppression trials: moths



Diamondback
moth

phased testing

contained

- Molecular characterisation
- Genetic and phenotypic stability
- Bionomic characteristics
- Mating competitiveness
- Mating compatibility
- Insecticide resistance
- Suppression trials

semi-field



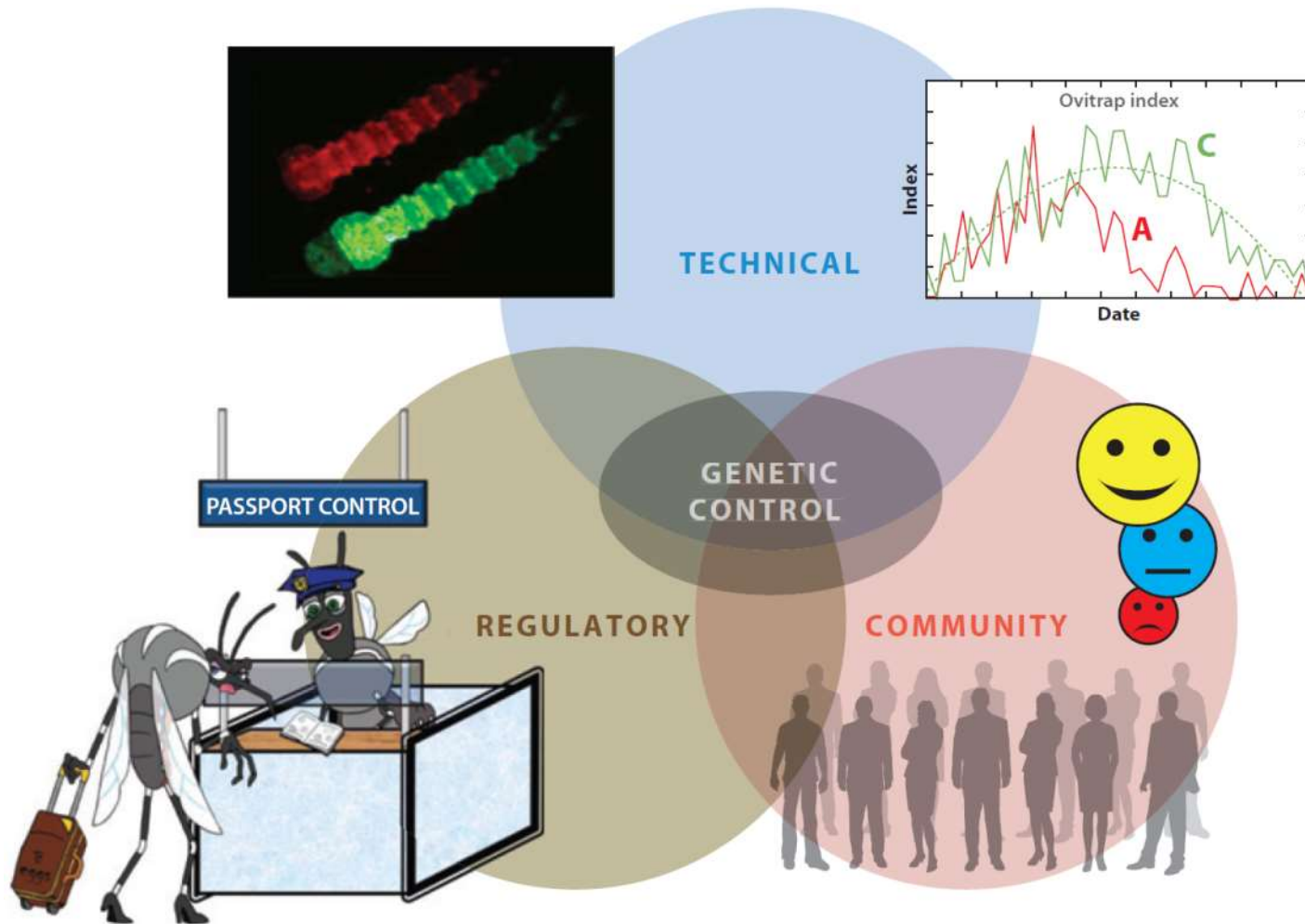
- Mating competitiveness in semi-natural conditions
- Cage suppression trials

open field
population
suppression



- Validation in field conditions

bringing new technology to the field



presentations



TV and radio



local festivals



leaflets



PAT

- Não há impacto ecológico no meio ambiente;
- Esta tecnologia possui vantagens ecológicas porque diminui o uso de inseticidas que costumam afetar outras espécies;
- O Aedes macho transgênico não causa danos a outros insetos ou animais;
- Os machos não se alimentam de sangue, logo não transmitem doenças, apenas as fêmeas;
- Severos machos são liberados no ambiente;
- Os machos de Aedes transgênico só cruzam com fêmeas da mesma espécie.

Benefícios

6

DENGUE

A dengue é um dos principais problemas de saúde pública do mundo. As estratégias usadas no controle do mosquito Aedes aegypti, são atividades preventivas, como a eliminação de criadouros, adoção de medidas comunitárias de conscientização e aplicação de inseticidas.

- Não há vacinas nem medicamentos específicos para o vírus do dengue.
- A transmissão do vírus ocorre através da picada de fêmeas do mosquito Aedes aegypti.

Curiosidades

- vive 4 meses de vida, que são mais 1,5 a 2 quilômetros por hora e são capazes de viajar até "vôlans" a 25 - 30 milhas de distância;
- voam a uma velocidade média de 1,5 a 2 quilômetros por hora e são capazes de viajar até "vôlans" a 25 - 30 milhas de distância;
- localizar a "vôlans" pela calor (radiação infravermelha) e a respiração (gás carbônico);
- são bem mais barulhentos no corpo e emite pernilheira, caso de de e a murmurar os barulhos;
- além do vírus do dengue, o Aedes aegypti também pode transmitir a vírus da febre amarela;

www.moscamed.org.br

Projeto Aedes Transgênico

Esse faz a diferença

PROJETO AEDES TRANSGÊNICO - PAT

transgênico

As fêmeas de mosquito que teve seu DNA transgênico e carrega um gene letal ou seja, o macho passa essa informação para os filhotes e estes vão na fase de larvas ou de pupa. E por isso, não transmitir a doença.

Aedes Transgênico

Produção em Laboratório

Os mosquitos transgênicos são produzidos em laboratório, e liberados para cruzar com as fêmeas selvagens. A separação é feita utilizando diferenças morfológicas através do tamanho de pupa, machos e fêmeas.

Após o cruzamento no campo os mosquitos geneticos não chegam a fase adulta.

3 Etapa

Teste de Supressão

- Liberação em campo e acompanhamento;
- Redução da população dos mosquitos transmissores.

Atuação em Campo

1 Etapa

- Escolha dos bairros para liberação;
- Monitoramento com captura semanal de ovos;
- Análise de dados coletados para avaliação da índice populacional do mosquito.

2 Etapa

Experimentos em Campo

- Estimativa do nível populacional do Aedes aegypti;
- Aspersão dos mosquitos nas residências por 10 minutos;
- Identificação dos mosquitos capturados;
- Análise do nível de vida, expectativa de vida e capacidade de cruzamento com fêmeas do campo.

4 Etapa

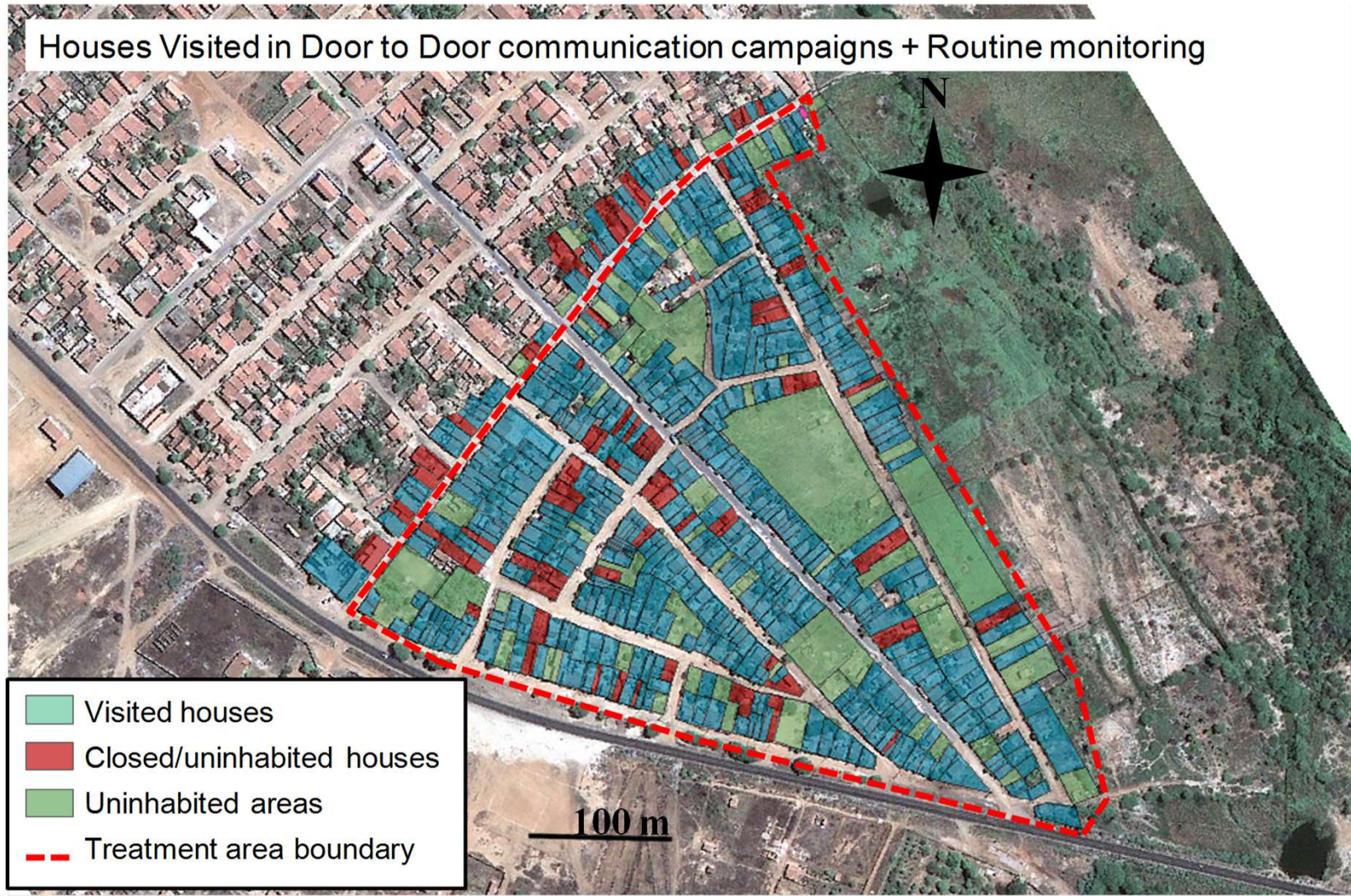
Monitoramento

- Monitoramento para avaliação dos resultados e dos insetos capturados para análise da redução populacional.

PAT, tecnologia para diminuir a população do mosquito Aedes aegypti.

Com o PAT, será o fim da picada do Aedes!!!

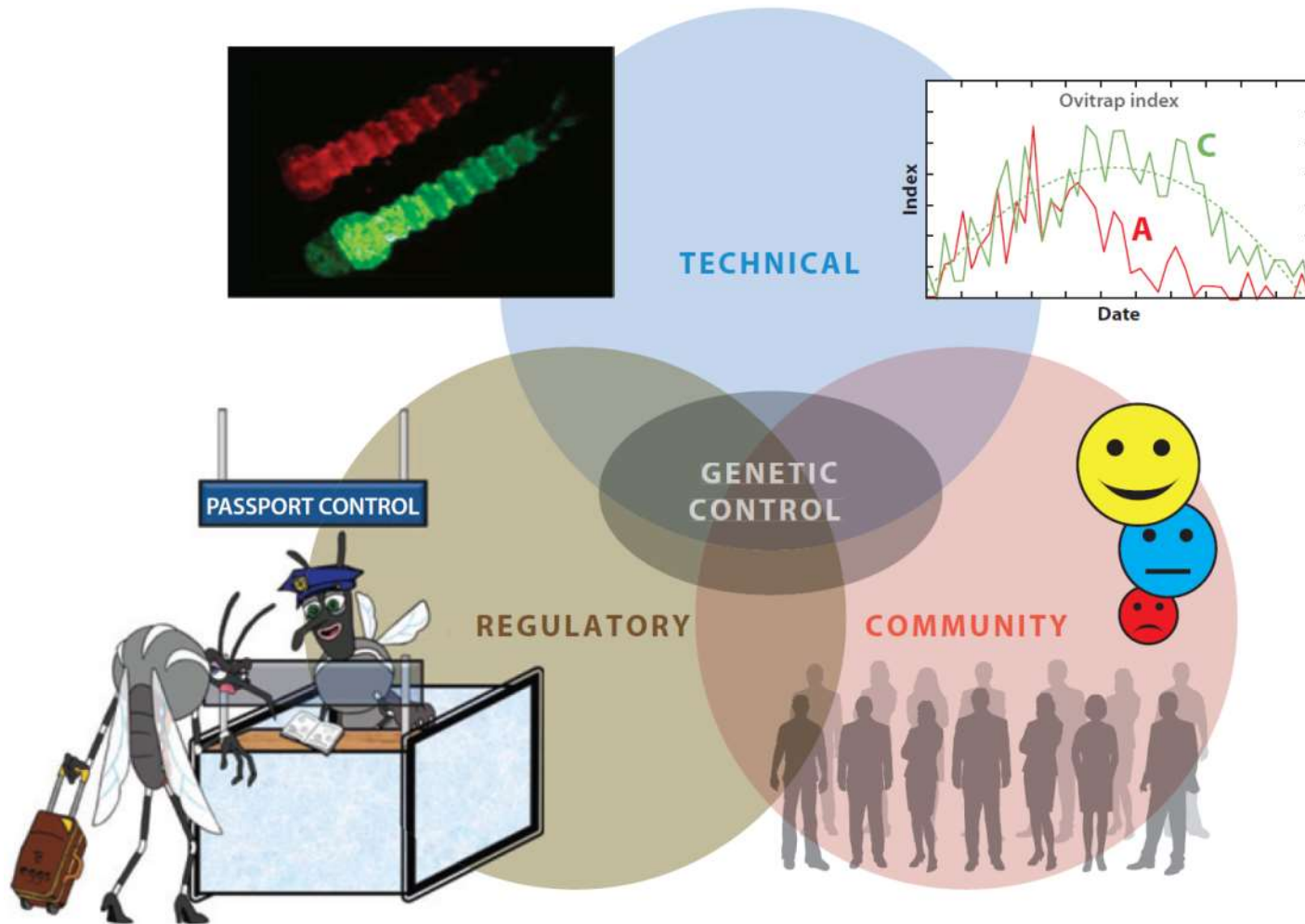
house visits



operations



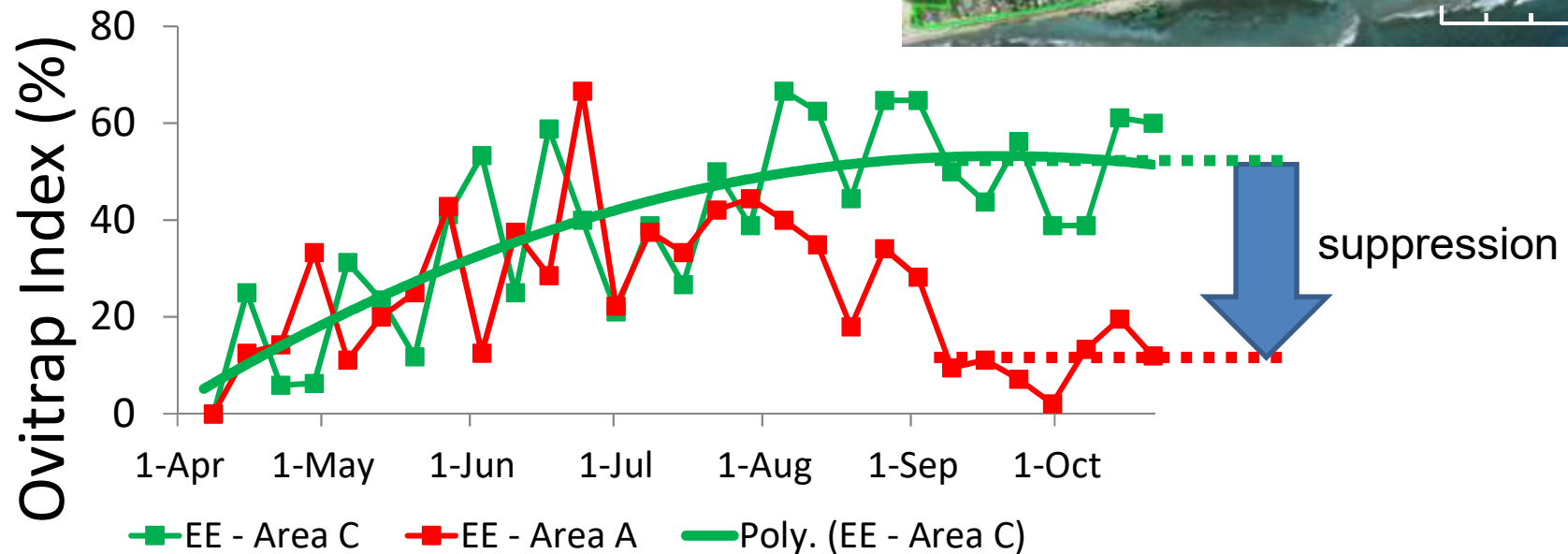
bringing new technology to the field



Cayman field trial 2010

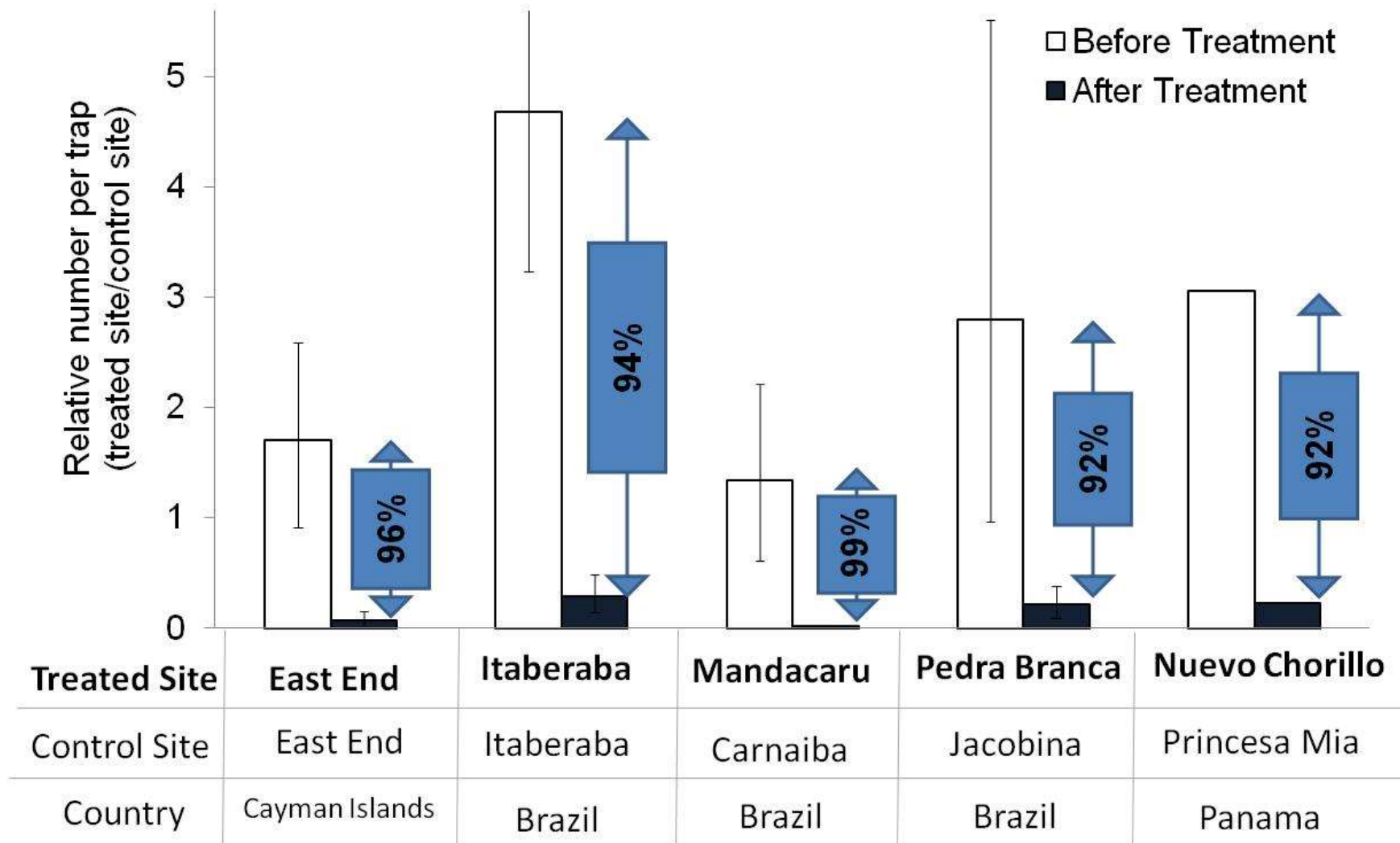


OVITRAP INDEX treated (A) & non-treated (C)



- Trial was complete success; all endpoints met
 - Clear suppression from early August
- Sustained release of RIDL OX513A males can suppress a field population of *Aedes aegypti* mosquitoes
 - Maximum degree of suppression limited by immigration
- GM mosquitoes can perform successfully in the field

RIDL is effective in multiple settings



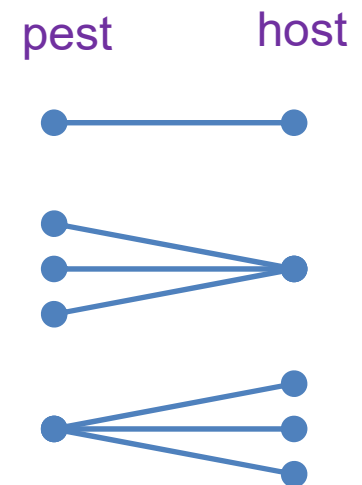
summary

Widespread use against dengue depends on efficacy, and public and regulatory approval

- ❑ **Efficacy:** periodic release of RIDL males suppressed wild target population
 - ❑ No conventional control for *Aedes aegypti*
 - ❑ Full suppression in 2-3 months
 - ❑ Target population recovered only slowly post-release
- ❑ **Public approval:** initial indications positive at trial sites
 - ❑ Intended goal of dengue control recognised as desirable
 - ❑ May vary by country (culture, prior experience of GMOs, etc)
- ❑ **Regulatory approval:** independent regulatory authorities have approved use
 - ❑ Field use in Cayman Islands, Malaysia, Brazil (& USA for pink bollworm)
 - ❑ Import permits in many additional countries

where to use?

- ❑ **Species-specific:** released insects mate only with own species
 - ❑ Aggressive gene drive systems may penetrate species complex with incomplete reproductive isolation
 - ❑ Environmentally friendly
 - ❑ How many pest species?
- ❑ **Case-by-case environmental analysis**
 - ❑ Native or invasive species?
- ❑ **Self-dispersing and target-seeking:**
 - ❑ Based on mating behaviour and mobility of insect
 - ❑ Need to consider reproductive behaviours and ecology
- ❑ **Other issues:**
 - ❑ Generation time, artificial diet, dispersal/mobility
- ❑ **Sterile males – simple precise suppression**
- ❑ **Gene drive systems – population- or species-level genetic modification**






Oxitec's portfolio




Agriculture

Target	Crop
 Diamondback moth	Brassicas
 Medfly/ Mexfly	Citrus/pome /stone fruit
 Olive fly	Olive
 Pink bollworm	Cotton
 <i>Tuta absoluta</i>	Tomato
 Spotted wing <i>Drosophila</i>	Soft fruit

Public health

Target	Vector of
 <i>Aedes aegypti</i>	Dengue
 <i>Aedes albopictus</i>	Chikungunya & dengue
 <i>Anopheles stephensi</i>	malaria

Other (sericulture)

Target	Purpose
 silkworm	Improved silk production

Thank you



OXITEC



Projeto Aedes Transgênico



Instituto Conmemorativo Gorgas de Estudios de la Salud

Líderes de la investigación, comprometidos con la solución de los problemas de la salud



MOSQUITO RESEARCH & CONTROL UNIT
CAYMAN ISLANDS GOVERNMENT



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agricultural revolution



