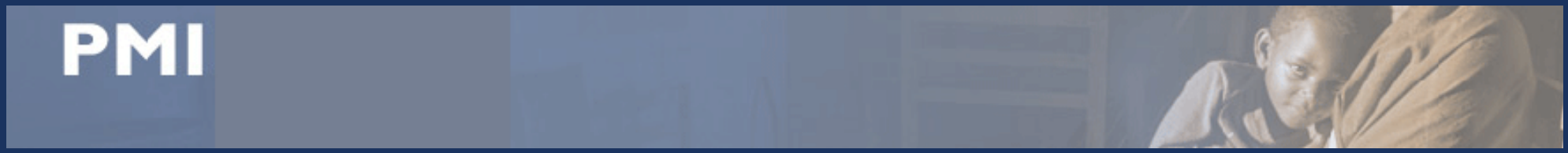



# President's Malaria Initiative

## Vector Control and Entomological Monitoring

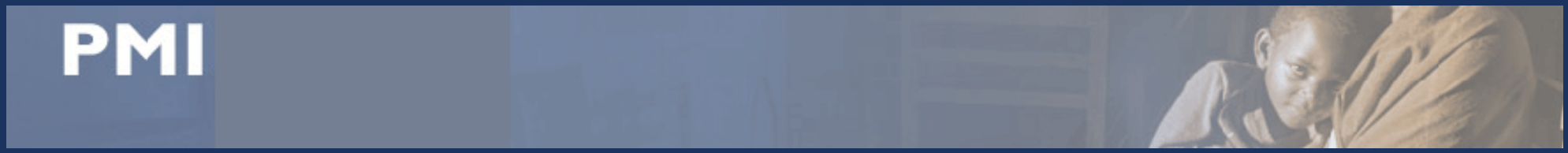
Michael Macdonald, USAID

Robert Wirtz, CDC

# President's Malaria Initiative:

## *USAID and CDC implementation*

*Plus*: WHO GMP, PES, AFRO, SEARO, WPRO; RBM; commercial sector (GBC) NMCPs, national training and research institutions,




# PMI and Vector Control

- PMI focus areas

- Tactical challenges
  - LLIN and IRS deployment
  - Implementation Research
- Strategic challenges
  - Insecticide Resistance monitoring and mitigation
  - Reorientation to Integrated Vector Management
  - Personal protection outside the house

PMI

# PMI Focus:


| Year | Funding |
|---|---|
| 2006 | $30 M |
| 2007 | $135 M |
| 2008<br>2009 | $ 300 M |
| 2010 | $ 500 M |
| TOTAL | $1.265 B |

**<u>Plus</u>: Amazon, Mekong, Nigeria, SSudan, DRC $85m**

# USG Expanded Malaria Control Program (2010-2014)

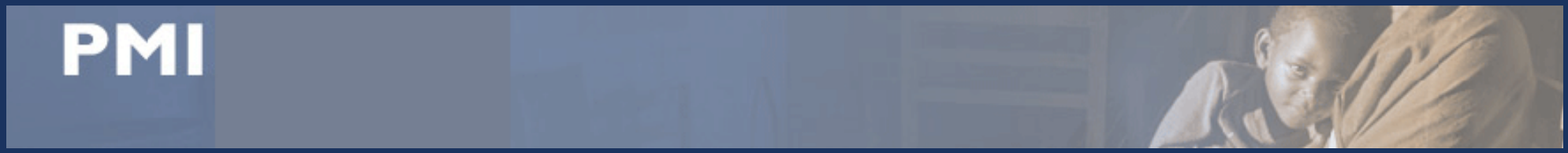
***Africa*:**

- Original 15 PMI focus countries
  - 70% reduction in malaria burden compared with 2006/07 baseline
- Additional countries: Nigeria, DRC, Burundi, Burkina Faso,
  - 50% reduction in malaria burden compared with 2009/10 baseline

***South America:*** 8 –country Amazon Malaria Initiative

***Asia*:** 6-country Mekong Malaria Program

- Strengthen efforts to contain spread of multi-drug resistant falciparum malaria:
  - antimalarial drug resistance surveillance
  - building drug quality control capability
  - reducing malaria transmission




# Tactical challenges

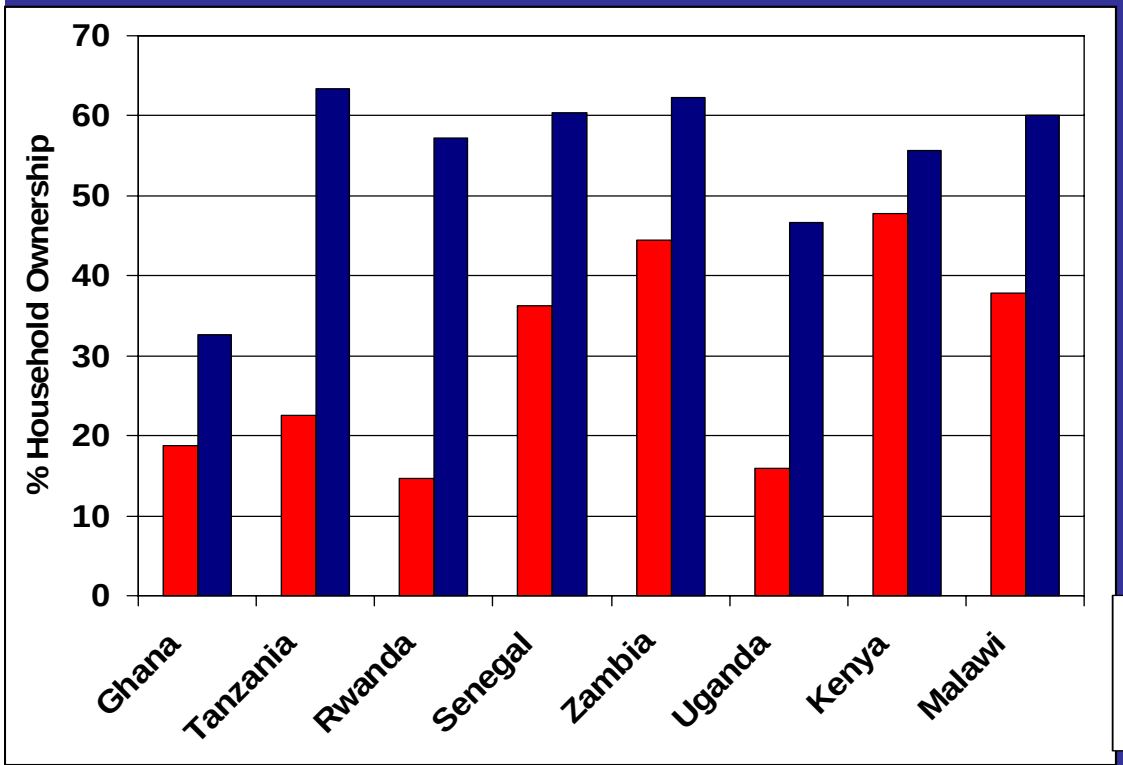
- LLIN and IRS deployment best practices
- Implementation Research

# LLINs

Since 2008:

25 m LLINs procured and distributed by PMI

>300m by all partners


- Pyrethroid insecticides;
- Cost ~ $6 each;
  Plus $1-2 shipping, delivery, BCC

# Deployment “best practices”

ITNs on Display in Shoprite Store

## Mass Campaign

(RBM-AMP)

## Continuous

(RBM- VCWG)

- Clinics, EPI services
- Targeted subsidies (vouchers)
- Facilitate commercial sector

## Communications

for appropriate use

PMI

# IRS

Now >27 m persons protected
In 15 countries (largely pyrethroids)

New re-introduction to most PMI-supported countries in Africa

Also focus on improved pesticide management

# Management guides

## Environmental Assessment

**Mapping, Targeting and Quantification**

***GIS, GPS***

**Evaluation**

***Epidemiological***
***Entomological***
***Environmental***

**Action**

***Supervision, information management, environmental compliance***

**Training**

***Spray teams, supervisors***

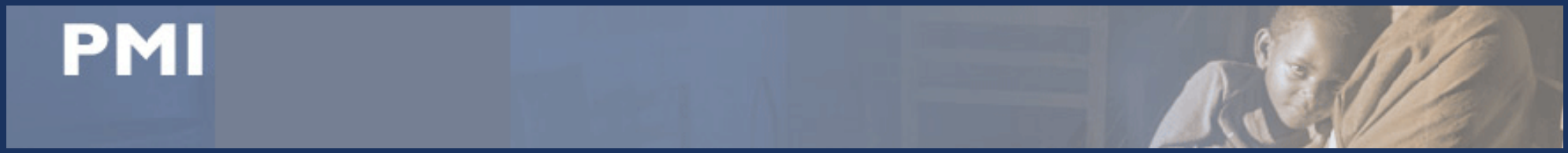
**Organization logistics**

***Teams, transport, supplies, systems***

**Micro-Planning**

***Timing and Program of spraying***

**Pesticide Selection and Procurement**




# Implementation Research

- *Products:*
  - » Durable wall linings
- *Formulations*:
  - » Durability of LLINs
  - » Duration of efficacy of IRS chemicals
- *Combinations*:
  - » LLINs and IRS
  - » IRS and larval control
- *Community acceptance:*
  - » LLIN usage

PMI

# Products: Durable Wall Linings

Photo: J. Gimnig

# Formulations: Duration and Durability

New IRS formulations and a.i.s

LATH residual insecticide test
(Photos: J. Hemingway)

Physical durability protocols (WHO)

X-ray fluorometer - deltamethrin in PermaNets (Photo: S. Smith)

# Combinations: LLINs and IRS

## Co-deployment:

Impact and transition for long-term control as IRS becomes more focal

## Sustain success:

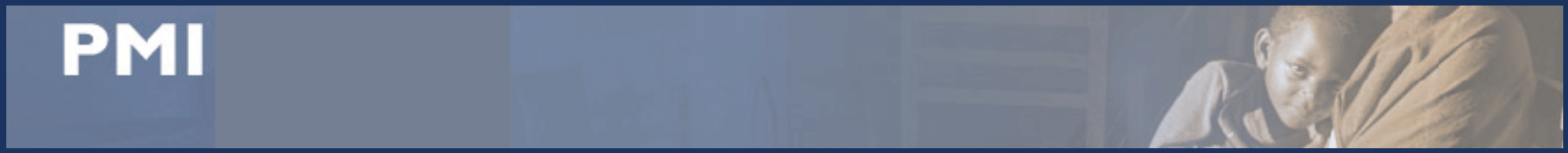
Maintain high LLIN coverage after campaign

Institutionalize IRS into district and national budgets

# Combinations: larval control

*Where does it work?*


*Where's the proof?*

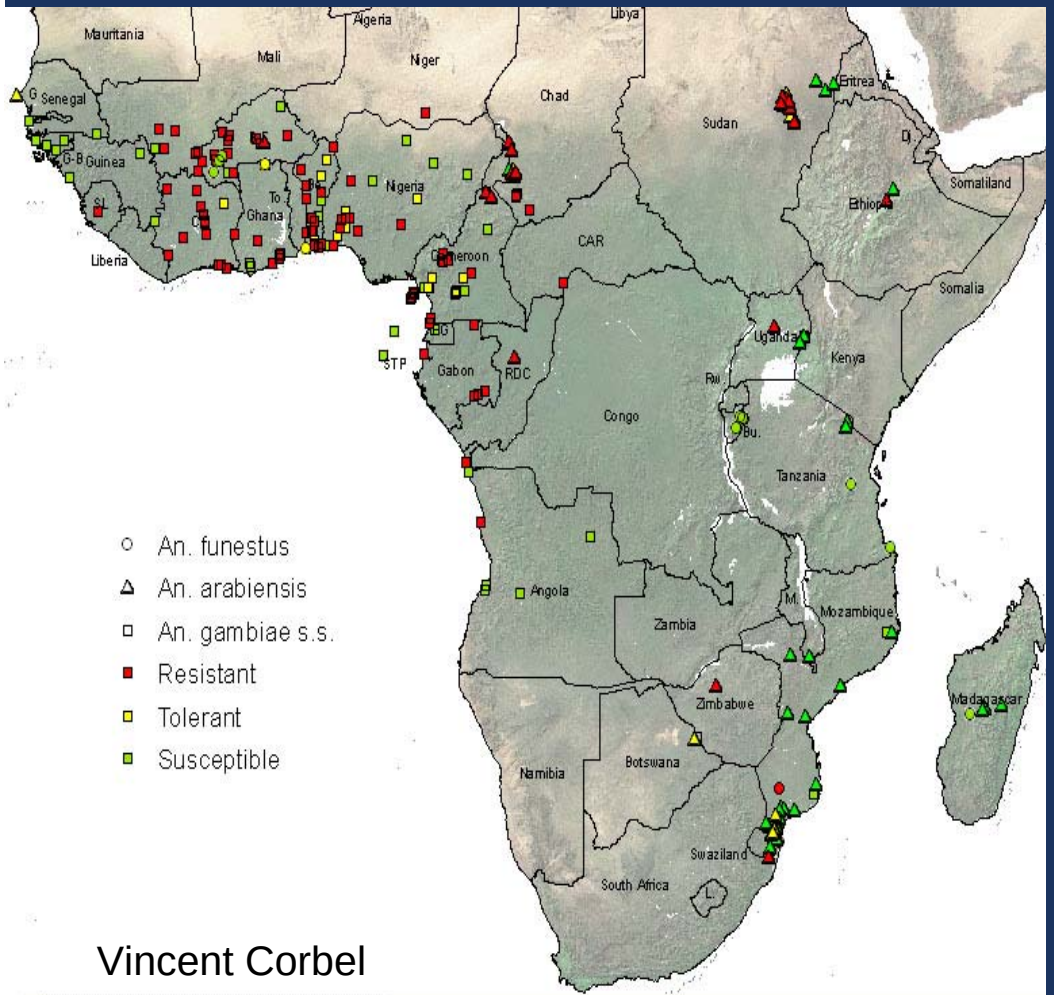



# Strategic Challenges

- **Insecticide Resistance**
  monitoring and mitigation
- **Integrated Vector Management**,
  program reorientation
- **Personal Protection**
  Strategy development

# Strategic Challenge #1: Monitoring and Mitigation of Insecticide Resistance

**Develop guidelines for:**




Vincent Corbel

- Basic entomological monitoring package
- Resistance monitoring
- Insecticide selection
- Long-term management

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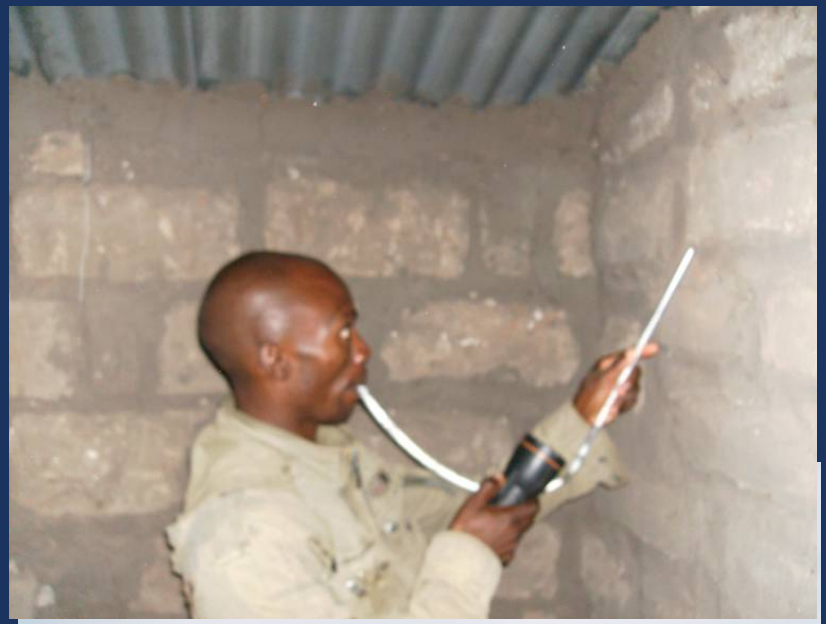
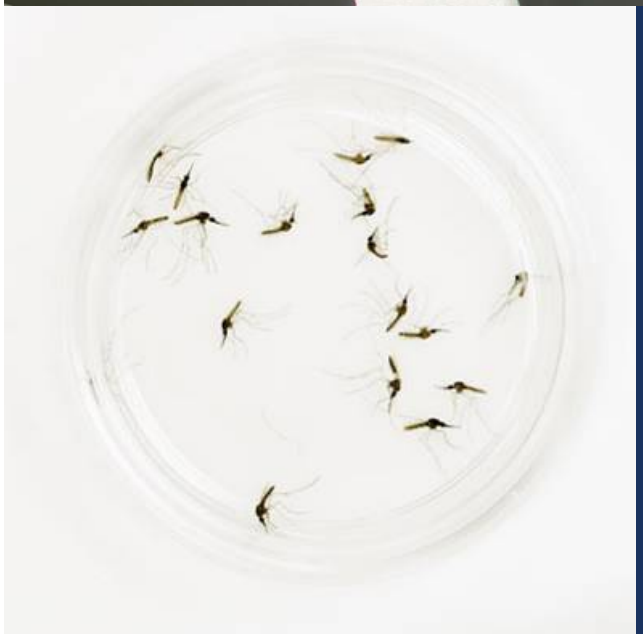
# Mosquito Collection



# Species Identification

PMI

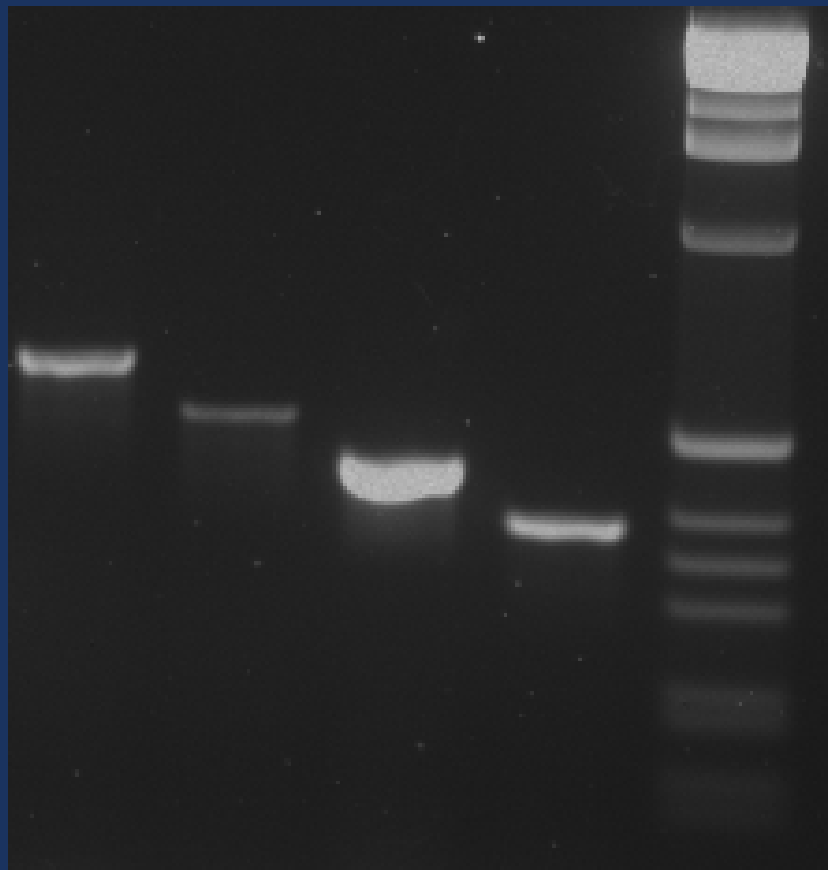
***An funestus s.l***

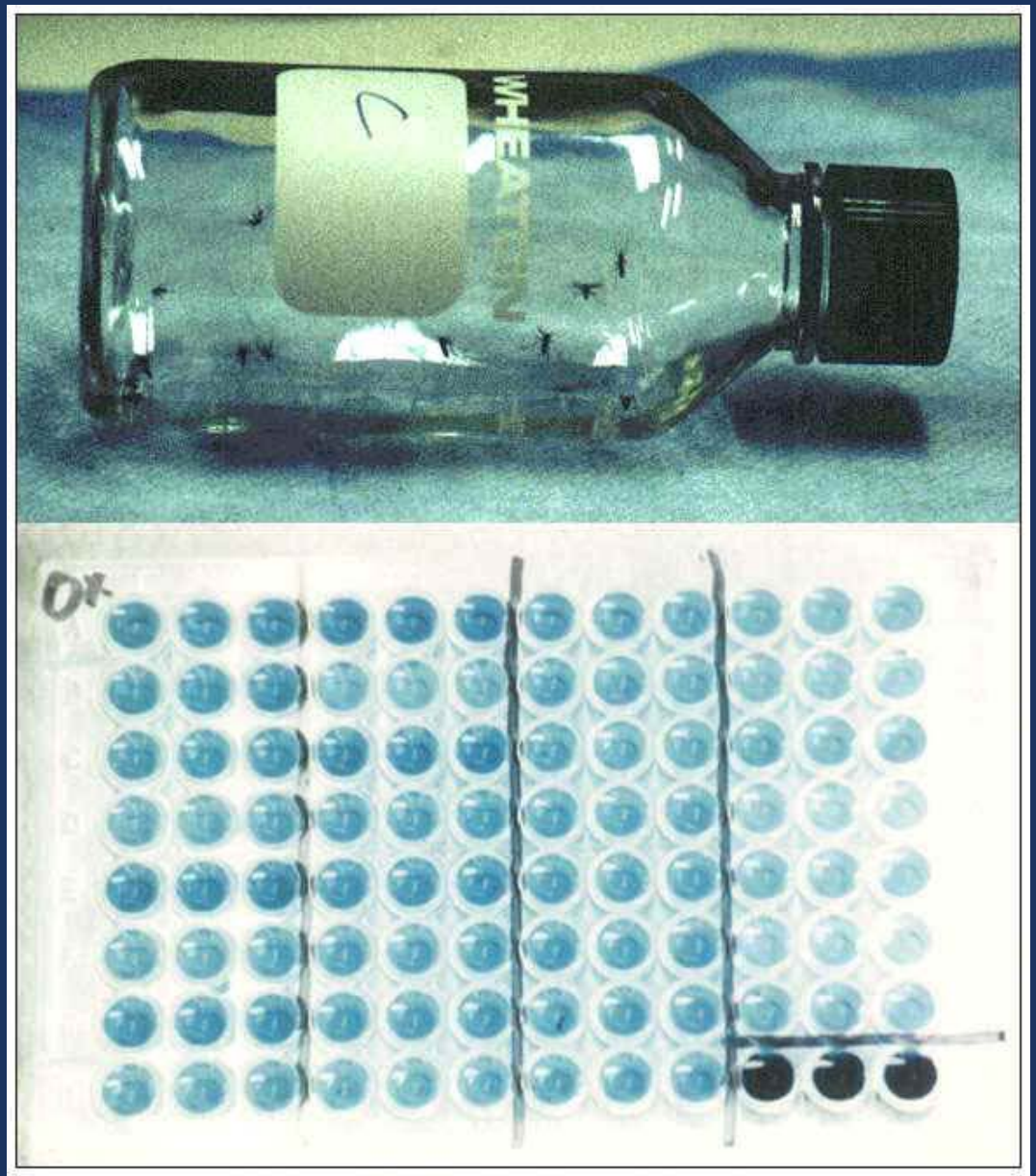
***An gambiae* s.l.**


***PCR Identification***

Lane 1 *An. quadriannulatus*,
Lane 2 *An. merus/melas*,
Lane 3 *An. gambiae*,
Lane 4 *An. arabiensis*,
Lane 5 1kb ladder

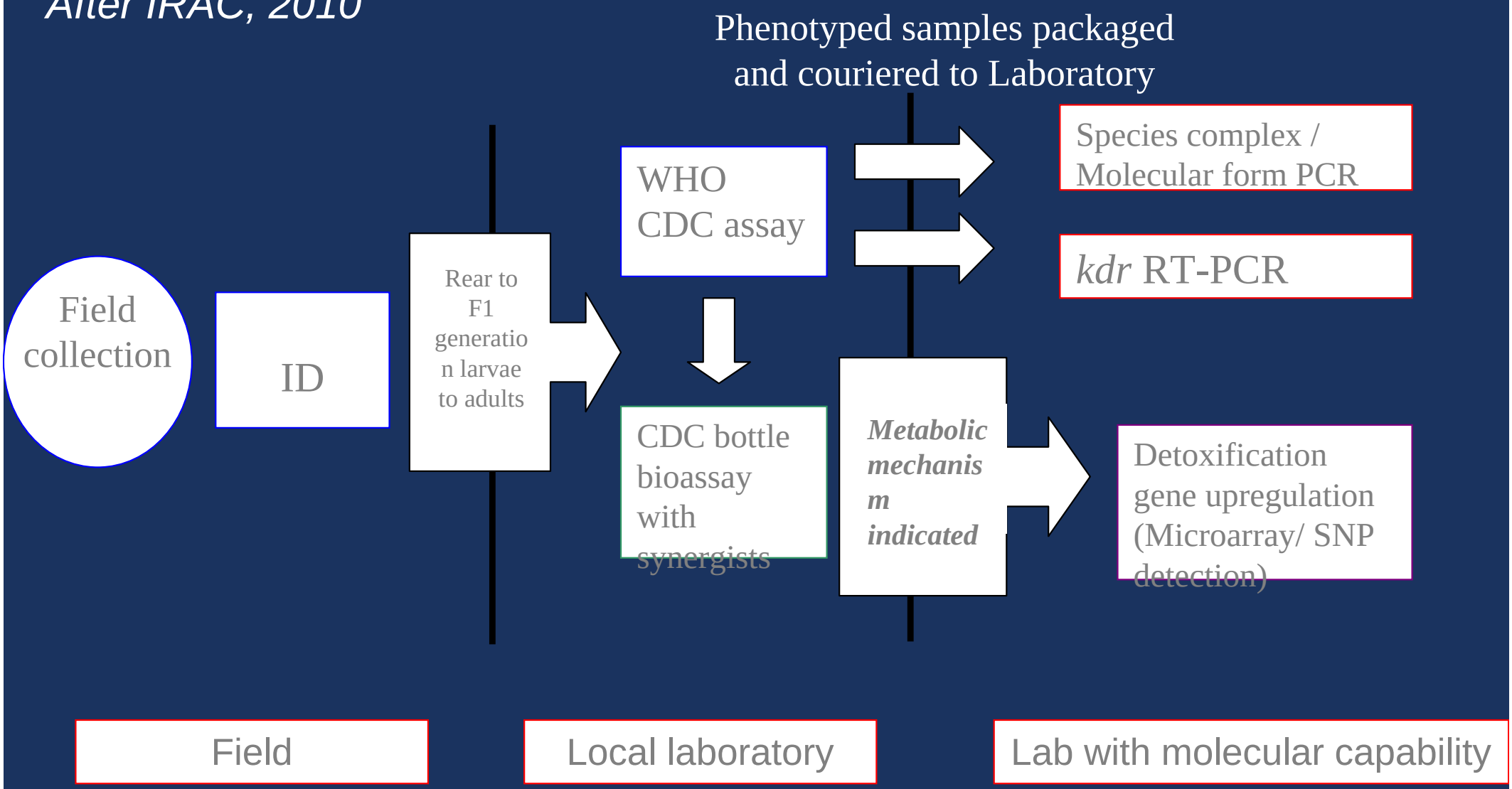


# Tube, bottle and biochemical assays



# mosquito specimen processing

*After IRAC, 2010*



# Insecticide selection

| Chemical class | Advantages | Disadvantages | Cost/sachet (200-250 $m^2$) |
|---|---|---|---|
| Pyrethroids | Low toxicity<br>Low cost<br>> 7 months duration | Resistance | $3.60 to $5 |
| Carbamates | Medium tox profile<br>Less resistance | High cost<br>< 4 month duration | $13 |
| Organo-phosphates | Less resistance | Toxicity problems<br>Higher costs<br>Variable duration | $12 |
| Organochlorines (DDT) | Low cost<br>> 7 months duration | Management costs<br>Resistance<br>Supply | $4 to $6.70 |
| | | | |

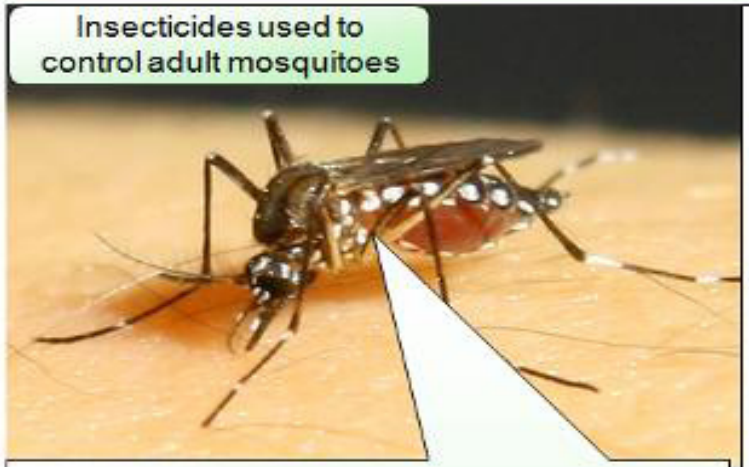
PMI

# Guidelines for rotation and mosaics

IRAC
Insecticide Resistance Action Committee

## Insecticide Mode of Action Classification:
## A Key to Effective Insecticide Resistance Management in Mosquitoes

### Insecticides used to control adult mosquitoes



### Insecticides acting on the nervous system

The nervous system is the only target in adult mosquitoes currently addressed by insecticides. However, within the nervous system there are a number of target sites on which insecticides with specific modes of action act:

Group 1 Acetylcholinesterase (AChE) inhibitors
Carbamates (Group 1A) and Organophosphates (Group 1B), act as AChE inhibitors at nerve synapse, resulting in hyperactivity in the nervous system.

Group 3 Sodium channel modulators
Pyrethroids and Pyrethrins (Group 3A) and DDT (Group 3B), rapidly interfere with the propagation of action potential along nerves, leading to hyperactivity and nerve block.

### Insecticides disrupting moulting and metamorphosis

Mosquito larvae moult several times during their development and undergo complete metamorphosis when becoming adults.

Group 7 Juvenile hormone mimics
JH analogues (Group 7A) and Pyriproxyfen (Group 7C) interfere with the hormonal regulation of development.

Group 15 Inhibitors of chitin synthesis
Benzoylureas, inhibit the production of chitin structures with in the insect

Group 17 Moulting disruptor, Dipteran.
Cyromazine, disrupts successful larval development

### Microbial disruptors of insect midgut membranes

Derived from bacteria, these toxins need to be ingested. Group 11 Microbial disruptors of insect midgut membranes *Bacillus thuringiensis* var. *Israelensis*, Bti, *Bacillus sphaericus*, Bs

### Insecticides used to control mosquito larvae

### Insecticides acting on the nervous system

Group 1
Acetylcholinesterase (AChE) inhibitors
Organophosphates (Group 1B), act as AChE inhibitors at nerve synapse, resulting in hyperactivity in the nervous system.

Group 5
Spinosyns, alter the function of nicotinic ion channels, depolarizing insect neurons, leading to neuron excitation.

**Insecticide classes for mosquito control**

| Group | Mode of Action | Chemical sub-group or exemplifying active ingredient |
|---|---|---|
| 1A | Acetylcholinesterase inhibitor | Carbamates |
| 1B | | Organophosphates |
| 3A & 3B | Sodium channel modulators | pyrethroids and pyrethrins, DDT |
| 5 | Nicotinic acetylcholine receptor agonists | Spinosyns |
| 7A | Juvenile hormone mimics | Juvenile hormone analogues |
| 7C | | Pyriproxyfen |
| 11 | Microbial disruptors of insect midgut membranes | *Bacillus thuringiensis* var. *israelensis* |
| | | *Bacillus sphaericus* |
| 15 | Inhibitors of chitin biosynthesis | Benzoylureas |
| 17 | Moulting disruptor, Dipteran | Cyromazine |

### Further reading


WHO (2006): Pesticides and their application.
WHO/CDS/NTD/WHOPES/GCDPP 6th edition, 114pp
www.who.int/whopes/en/

Prevention and management of insecticide resistance in vectors and pests of public health importance.
www.irac-online.org





www.irac-online.org


Designed and produced by the IRAC Public Health Team, August 2008, Ver 2.0. Photographs courtesy of Syngenta

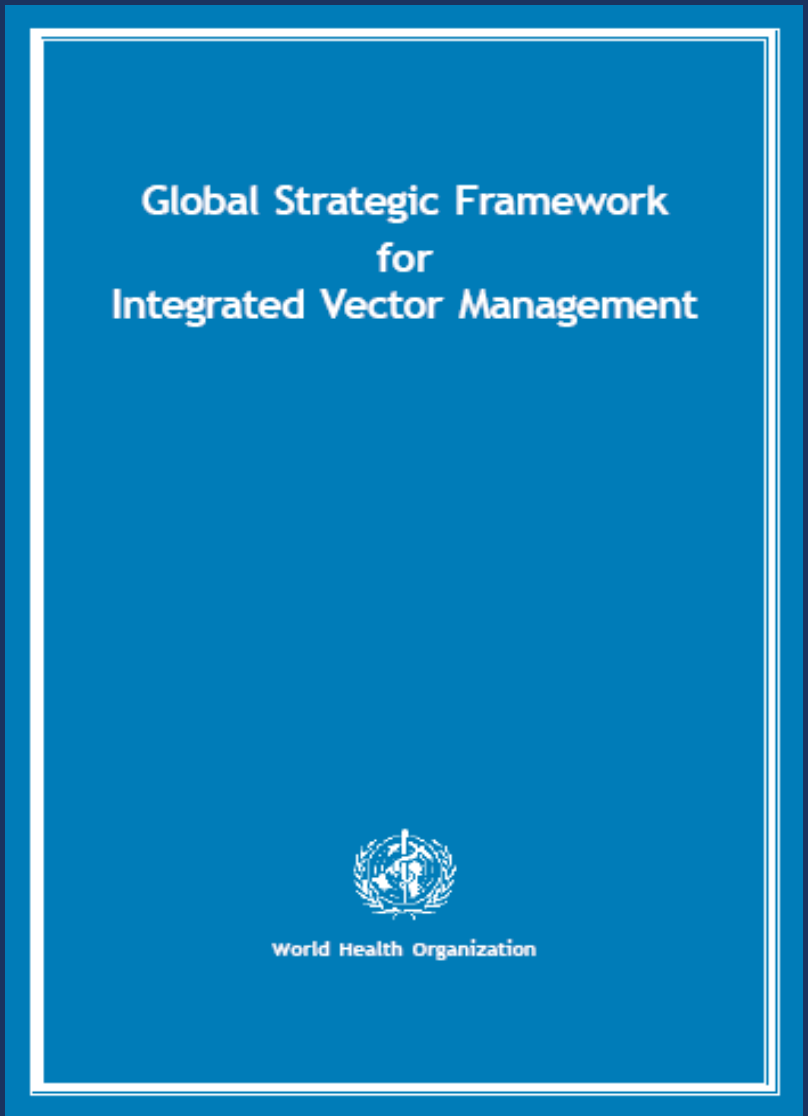
# Strategic Challenge #2

# Integrated Vector Management

A rational decision-making process for optimal use of resources for vector control

PMI

# IVM: Five Key Elements:




- Advocacy, social mobilization and legislation
- Cross sector collaboration
- Integrated approach
- Evidence-based decision-making
- Capacity-building

# WHO IVM Handbook (Jan 2011)

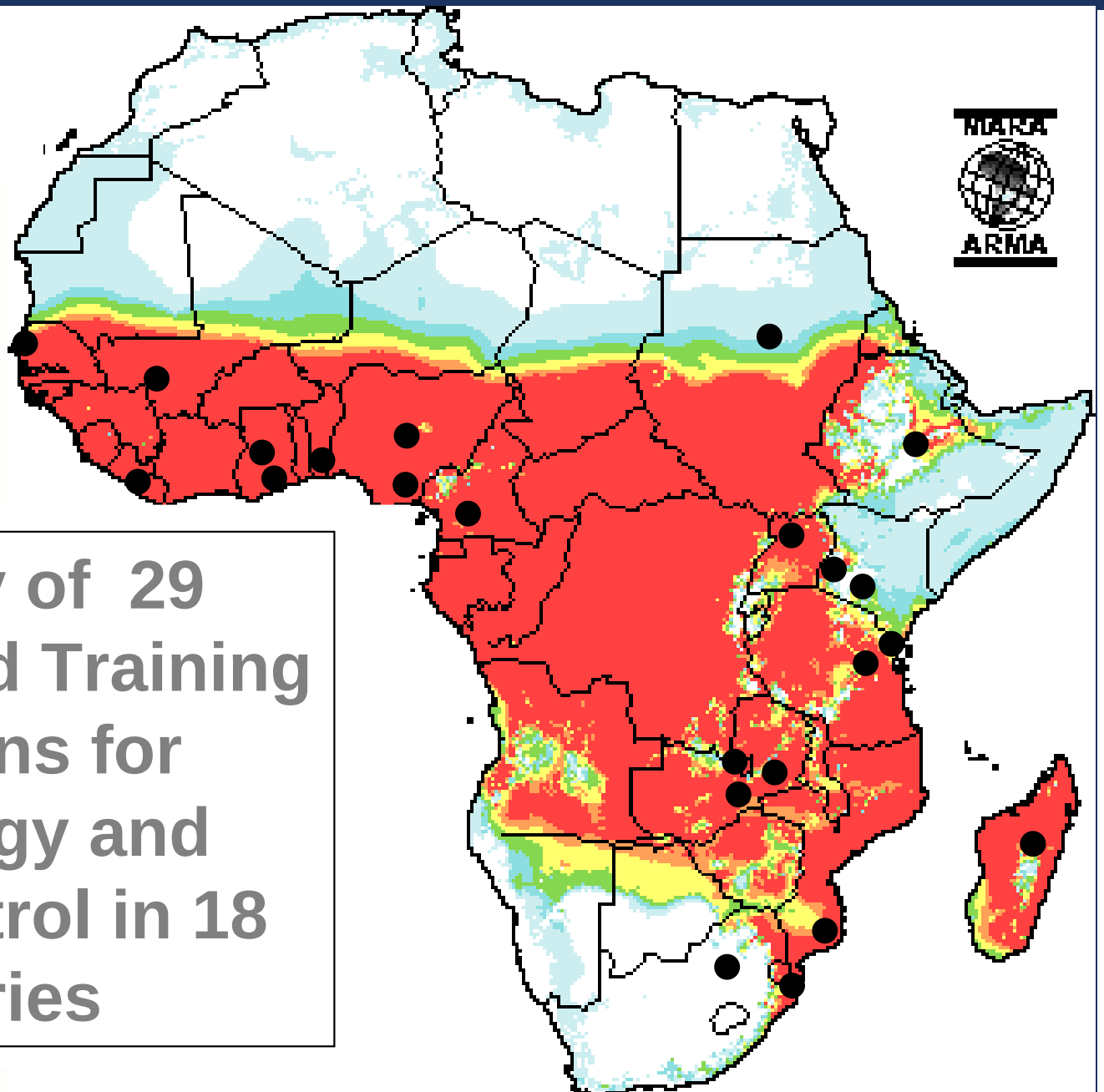
Preface

1. Introduction
2. Policy and stakeholder arrangements
3. Decision making on implementation
4. Monitoring & evaluation
5. Competencies, skills and capacity
6. Advocacy and communication
7. Management and mobilization of resources

Standard Core Curriculum (ACTMalaria Oct 2010)

# IVM Institutional Foundation

*Red = malaria endemic areas*




**Inventory of 29 Research and Training Institutions for Entomology and Vector Control in 18 Countries**

# Challenge #3 Where there is no house:

*personal protection for mobile populations*

# Personal Protection: can we pull it together?

- Remote sensing for targeting
- Vector bionomics

---

- Treated Hammocks / Nets
- Repellents
- Treated Clothing
- Insecticide Treated Plastic Sheeting

# Summary

*Facilitating partnerships to solve:*

- Tactical challenges
  - LLIN and IRS deployment
  - Products, formulations, combinations
- Strategic challenges
  - IVM and capacity-building
  - Insecticide resistance
  - Personal protection