MULTISECTORAL APPROACH
FOR MALARIA VECTOR
CONTROL AND MITIGATION OF
INSECTICIDE RESISTANCE

A pilot multisectoral intervention for controlling malaria vectors, mitigating insecticide resistance, and assessing WaSH facilities at health care units in selected coastal and Sahelian West African countries.

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Supporting a multisectoral approach to malaria

TDR in 2020 published a conceptual framework covering the essential elements of successful multisectoral collaborations.

TDR is now supporting research teams in low- and middle-income countries that are piloting this multisectoral approach.
Introduction

1. ITNS/LLINS, IRS, and larviciding have significantly reduced malaria incidences in several African settings.

2. However, recent reports indicate persistent malaria cases in some African countries despite scaling up.

3. Contributors to this residual malaria include:
   
   a. Intense rice production maintaining mosquito breeding sites during prolonged dried seasons
   
   b. Pesticide misuse and overuse in agriculture which further spread insecticide resistance
   
   c. Natural environmental conditions such as riverbeds identified as hotspots for larvae of malaria vectors during the dry season
   
   d. The low presence of insecticide residues in LLINs is likely to reduce the efficacy of treated nets and increase insecticide resistance selection in malaria vectors
   
   e. Poor quality of WASH facilities which further contributes to increased transmission risk of water and vector-borne diseases

4. Apart from the classical malaria control interventions, this study proposes a new holistic multisectoral approach targeting hotspots (rice fields, riverbeds, and vegetable farms) to control residual malaria.
Study sites

Mali
Fishing hamlets located in the district of Kati, Mali.

Benin
The main localities (Cotonou, Abomey-Calavi, and Ouidah) of southern Benin.

Burkina Faso
Bama, a department and a rural commune of Burkina Faso.

Nigeria
Three senatorial divisions in Lagos state, Nigeria.
Collaboration with environmental sector for vector control

Approach

1. Mapping and control of breeding sites in riverbeds: physically modifying or destroying small habitats and treating larger water bodies with bio-pesticide *Bacillus thuringiensis*.

2. Identification and control of Anopheles swarms: sprayed with Actellic 300cs every two weeks over three consecutive days.

3. Insecticide susceptibility profiles: conducted bioassays with young females from breeding sites exposed to insecticide-impregnated papers.

4. Determination of mosquito density: Used pyrethrum spray catch in 20 human dwellings every two weeks to collect adult mosquitoes, determining infection rates and entomological inoculation rates.
## Results

<table>
<thead>
<tr>
<th><strong>Anopheles gambiae s.l displayed:</strong></th>
<th><strong>In Human dwellings along the river</strong></th>
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<tbody>
<tr>
<td>• moderate to high resistance to deltamethrin.</td>
<td>• 66.7% reduction of mosquito density in March.</td>
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<tr>
<td>• partial restoration observed after pre-exposure to PBO.</td>
<td>• 61.1% reduction in April.</td>
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During the dry season, anopheline mosquitoes bred in brick pits and water pools along the river. Community intervention combining larval source management and swarm killing reduced mosquito densities by 60%, despite high resistance to pesticides.
Collaboration with agricultural sector for the best use of pesticides

Approach

1. Experimental Layout and Design for pest management
   a) farmers’ practice (multiple pesticide use)
   b) optimal pesticide practice use (reduced insecticide use)

2. Applied treatments consistently using Honest sprayers

3. Agronomic Data Collection:
   a) Monitored cabbage growth
   b) insect presence
   c) yield increases

Results

**Effect of management practices against diamondback moth on yield of cabbage**

**Abomey-Calavi:** Recorded the **lowest cabbage infestation** by diamondback moth compared to farmers’ practices.

**Ouidah:** Cabbage weight varied across localities and agricultural practices.

**Cotonou:** There was **no significant difference in cabbage weight** between farmers practice and the control across the three localities.

**Pesticide residues:** Emanectin benzoate residues were reduced by more than **50%** in soil at alternative methods sites.

The study suggests that Emacot and Lambdace pesticide formulations are more effective against diamondback moth on cabbage compared to multiple insecticides used by farmers, with lower pesticide residues (<50%) in soil and on vegetables, potentially reducing mosquito resistance and minimizing health impacts.
Assessing the quality of LLINs sold in the market in Nigeria

**Approach**

1. **Bio-efficacy Tests:** Evaluated net effectiveness on *An. gambiae* strain with rectangular cuts, conducting cone tests and observing knockdown mosquitoes at various intervals in controlled lab conditions.

2. **LLINs Chemical Analysis:** Analyzed LLINs using WHOPES-accredited methods, extracting and determining deltamethrin using HPLC-DAD and alphacypermethrin using GC-FID with internal standard calibration for quality control.

3. **Deltamethrin** from nets extracted with iso-octane/dioxane, analyzed by HPLC-DAD with internal standard calibration.

4. **Alphacypermethrin** from Duranet plus extracted with xylene, analyzed by GC-FID with internal standard calibration for quality control.
Results

Effect of long-lasting insecticidal nets (LLIN’s)

Bio-efficacy Tests:

• Showed 100% mortality 24 hours post-exposure.
• alphacypermethrin demonstrated the highest knockdown rate at 3 minutes.

All the nets tested showed optimal concentrations of insecticides, suggesting that LLINs available at point-of-sales in Lagos have strong bio-efficacy against susceptible populations of *Anopheles gambiae*. To make the LLINs more useful, efforts should be focused on increasing the interest of the inhabitants in using them properly.
Assessing WASH conditions and practices in the selected study sites

Approach

1. **Multidisciplinary Approach**: Social science specialists led a team conducting WASH activities.

2. **Assessment Methods**: Employed both quantitative and qualitative approaches for evaluating WASH conditions.

3. **Qualitative Tools**: Used in-depth interviews and focus group discussions to gather stakeholder insights.

4. **Group Discussions**: Conducted in each health zone to ensure comprehensive data collection.

5. **Quantitative Data Collection**: Utilized semi-structured questionnaires digitized with ODK software for quantitative information gathering.

6. **Direct Observation**: Established a group for direct observation of facilities in each health center.
• WASH conditions vary.
• Challenges persist in waste management and provision of facilities for special needs individuals.

• Latrines were inadequate and challenging to access, especially for people with reduced mobility.

• WaSH conditions are reasonably good, recommendations for regular tank washing and communication about water treatment efforts to staff and patients.

• Weaknesses in WASH services in health centers, particularly inadequate and inconvenient latrines and limited access to clean water.
All results achieved through multisectoral taskforces established in each country

1. **In Mali**, a multi-sectoral technical advisory group was formed, building upon an existing committee for indoor residual spraying, with the first meeting held on March 28, 2022.

2. **In Benin**, a similar group was established under the integrated vector control program, aiming to combat insecticide resistance and enhance malaria control.

3. **Nigeria's** National Malaria Elimination Programme collaborated with NIMR to establish a multisectoral task team.

4. **Burkina Faso** appointed a focal person within the National Malaria Control Program to coordinate multi-sectoral activities within an existing advisory group for vector control.
Mali
Reduction of mosquito density by 66.7% and 61.1% in March, and April, respectively in Fishing hamlets along the rivers.

Burkina Faso
Weaknesses in WASH services in health centers, particularly inadequate and inconvenient latrines and limited access to clean water.

Benin
Emacot & Lambdace pesticides formulations were more effective compared to multiple insecticides used by farmers.
Lower pesticide residues observed in soil, potentially reducing mosquito resistance.

Nigeria
All LLINs tested showed optimal concentrations of insecticides.
Efforts should be focused on increasing the interest of the inhabitants in using them properly.
Multisectoral approach to malaria: Strengths, weaknesses, opportunities and threats

**Strengths**
1. Increased community awareness and participation in larval source management and optimal use of pesticides
2. Availability of diverse water sources, ensuring a steady water supply
3. Improved collaboration with other non-health sectors that contribute multiple benefits

**Weaknesses**
1. Difficulties synchronizing programmes of different stakeholders
2. Limited WASH knowledge
3. Insufficient sanitation, inadequate latrine facilities and poor hygiene standards among healthcare centers
4. Water quality concerns
5. Inconsistent waste management

**Opportunities**
1. Opportunities for educational programs.
2. Investments in water infrastructure and sanitation facilities could improve healthcare service delivery.
3. Involving communities in WASH initiatives to promote sustainable practices and infrastructure development.
4. Leveraging technology for water treatment and waste management.

**Threats**
1. How to map the success of MSA interventions to MSA pillars.
2. How to maintain the multisectoral advisory task force after the end of the project.
3. How to ensure research results are taken up by policy-makers, especially in the case of cross-sectoral policies.
Thank you for your attention