



PRESIDENT'S MALARIA INITIATIVE



# PMI | Africa IRS (AIRS) Project

## Indoor Residual Spraying (IRS 2) Task Order Six

# THE PMI AIRS PROJECT SEMI-ANNUAL REPORT

OCTOBER 1, 2015 – MARCH 31, 2016

**Recommended Citation:** The PMI Africa Indoor Residual Spraying (AIRS) Project. Semi-Annual Report: October 1, 2015 – March 31, 2016. Bethesda, MD. The PMI AIRS Project, Abt Associates Inc.

**Contract and Task Order Number 6:** AID-GHN-I-00-09-00013 & AID- OAA-TO-14-00035

**Submitted to:** The United States Agency for International Development/President's Malaria Initiative

*The views expressed in this document do not necessarily reflect the views of the United States Agency for International Development or the United States Government.*



Abt Associates Inc. | 4550 Montgomery Avenue | Suite 800 North  
| Bethesda, Maryland 20814 | T. 301.347.5000 | F. 301.913.9061  
| [www.abtassociates.com](http://www.abtassociates.com)

**THE PMI AIRS PROJECT  
SEMI-ANNUAL REPORT  
OCTOBER 1, 2015- MARCH 31, 2016**

---



# CONTENTS

---

<b>Contents</b> .....	<b>iii</b>
<b>Acronyms</b> .....	<b>v</b>
<b>Executive Summary</b> .....	<b>vii</b>
<b>I. Country Section</b> .....	<b>I</b>
<b>I.1 Angola</b> .....	<b>1</b>
<b>I.2 Benin</b> .....	<b>1</b>
<b>I.3 Burundi</b> .....	<b>2</b>
<b>I.4 Democratic Republic of Congo</b> .....	<b>2</b>
<b>I.5 Ethiopia</b> .....	<b>3</b>
<b>I.6 Ghana</b> .....	<b>4</b>
<b>I.7 Kenya</b> .....	<b>5</b>
<b>I.8 Liberia</b> .....	<b>6</b>
<b>I.9 Madagascar</b> .....	<b>6</b>
<b>I.10 Mali</b> .....	<b>7</b>
<b>I.11 Mozambique</b> .....	<b>8</b>
<b>I.12 Nigeria</b> .....	<b>10</b>
<b>I.13 Rwanda</b> .....	<b>11</b>
<b>I.14 Senegal</b> .....	<b>12</b>
<b>I.15 Tanzania</b> .....	<b>13</b>
<b>I.16 Zambia</b> .....	<b>15</b>
<b>I.17 Zimbabwe</b> .....	<b>17</b>
<b>2. Core Section</b> .....	<b>19</b>
<b>2.1 Capacity Building</b> .....	<b>19</b>
<b>2.2 Environmental Compliance</b> .....	<b>19</b>
<b>2.3 mHealth</b> .....	<b>20</b>
<b>2.4 Gender</b> .....	<b>20</b>
<b>2.5 Epidemiological Surveillance</b> .....	<b>21</b>
<b>2.6 Cost Efficiency</b> .....	<b>21</b>
<b>2.7 Zambia Operational Research Study</b> .....	<b>22</b>
<b>2.8 Disease Data management Systems (DDMS)</b> .....	<b>22</b>
<b>2.9 Evaluation of Pirimiphos-Methyl Efficacy when Sprayed on Half the Usual Surface Area</b> .....	<b>22</b>
<b>2.10 UNITAID</b> .....	<b>23</b>
<b>2.11 Conferences</b> .....	<b>23</b>
<b>2.12 Communications</b> .....	<b>24</b>
<b>2.13 Journal Publications</b> .....	<b>25</b>
<b>2.14 New Employees</b> .....	<b>25</b>
<b>Annex A: M&amp;E Results Summary</b> .....	<b>27</b>
<b>Annex B: Insecticide and Equipment Procurement</b> .....	<b>29</b>

**LIST OF TABLES**

TABLE 1: AIRS MOZAMBIQUE AT A GLANCE.....8  
TABLE 2: AIRS RWANDA AT A GLANCE.....11  
TABLE 3: AIRS TANZANIA AT A GLANCE.....13  
TABLE 4: AIRS ZAMBIA AT A GLANCE.....15  
TABLE 5: AIRS ZIMBABWE AT A GLANCE.....17

# ACRONYMS

---

<b>AIRS</b>	Africa Indoor Residual Spraying Project
<b>CDC</b>	Centers for Disease Control and Prevention
<b>COR</b>	Contracting Officer's Representative
<b>DCV</b>	Data Collection Verification
<b>DDT</b>	Dichlorodiphenyltrichloroethane
<b>EC</b>	Environmental Compliance
<b>ECO</b>	Environmental Compliance Officer
<b>EOSR</b>	End-of-Spray Report
<b>FMOH</b>	Federal Ministry of Health
<b>HLC</b>	Human Landing Catch
<b>IEC</b>	Information, Education, and Communication
<b>IRS</b>	Indoor Residual Spraying
<b>kdr</b>	Knockdown resistance
<b>IVCC</b>	Innovative Vector Control Consortium (IVCC)
<b>LLIN</b>	Long-lasting insecticide-treated nets
<b>M&amp;E</b>	Monitoring and Evaluation
<b>MSP</b>	Mobile Soak Pit
<b>NMCP</b>	National Malaria Control Program
<b>NIMR</b>	National Institute for Medical Research
<b>PAMCA</b>	Pan African Mosquito Control Association
<b>PMI</b>	President's Malaria Initiative
<b>PMT</b>	Performance Management Tracker
<b>PPE</b>	Personal Protective Equipment
<b>PSC</b>	Pyrethrum Spray Catch
<b>PSECA</b>	Pre-Spray Environmental Compliance Assessment
<b>SEA</b>	Supplemental Environmental Assessment
<b>SMS</b>	Short Message Service
<b>SOP</b>	Spray Operator
<b>UCAD</b>	Université Cheikh Anta Diop de Dakar
<b>USAID</b>	United States Agency for International Development
<b>USG</b>	United States Government
<b>WHO</b>	World Health Organization
<b>WHOPES</b>	World Health Organization Pesticide Evaluation Scheme
<b>ZAMEP</b>	Zanzibar Malaria Elimination Programme



# EXECUTIVE SUMMARY

---

During this reporting period (October 1, 2015, through March 31, 2016), the President's Malaria Initiative (PMI) Africa Indoor Residual Spraying (AIRS) Project, funded by the United States Agency for International Development, continued implementation under Task Order 6. The Project implemented indoor residual spraying (IRS) campaigns in Mozambique, Rwanda, Zambia, Zimbabwe, and, for the first time, Tanzania. The PMI AIRS Project covered an average of 93.4% of targeted structures, and protected more than 7.2 million people from malaria. Details regarding all monitoring and evaluation (M&E) outcomes by country are reported in Annex A.

## TOP-LINE RESULTS FROM IRS CAMPAIGNS, OCT 2015-MARCH 2016

- 1,682,322 structures sprayed
- 93.4 percent average spray coverage
- 7,200,667 people protected from malaria including:
  - 250,366 pregnant women
  - 1,233,841 children under 5 years of age
- 8,718 people trained with United States Government funds to deliver IRS

During the reporting period, the PMI AIRS Project also:

- Announced its partnership with UNITAID and the Innovative Vector Control Consortium (IVCC) to expand the use of new long-lasting, non-pyrethroid insecticides to defeat malaria. The project is called 'NGenIRS' and will invest US\$65.1M to shape the global marketplace for new insecticides. In the first year of implementation, Ethiopia, Mali, Mozambique, Rwanda, and Zambia will benefit from this initiative;
- Held a three-day workshop in Cape Town, South Africa, to evaluate the project's progress, disseminate best practices, and set priorities for the coming year. A three-day operations training workshop for all PMI AIRS Country Operations Managers was conducted immediately prior;
- Continued to roll out the project's three mHealth tools (i.e., Performance Management Tracker (PMT), mobile supervisory forms, and short message service (SMS)-based job aids to all IRS countries and introduced the digitized data collection verification (DCV) form in Rwanda and Tanzania;
- Conducted gender norms surveys in Rwanda and Zimbabwe with seasonal staff. Data collected in Rwanda during the February 2016 campaign showed a statistically significant increase in gender norm scores, suggesting that workers' opinions about appropriate roles for men and women changed to be more egalitarian;
- Completed the final draft of the new comprehensive IRS training curriculum;
- Submitted five journal article manuscripts to PMI, three of which were cleared and submitted to journals. Two of those manuscripts are in press with journals.
- Initiated the development of new supplemental environmental assessments (SEAs) for Benin and Mali; and

- Presented at the 64<sup>th</sup> annual American Society for Tropical Medicine and Hygiene conference in Philadelphia, Pennsylvania; the 2<sup>nd</sup> annual conference of the Pan African Mosquito Control Association in Dar es Salaam, Tanzania; the American Public Health Association's (APHA) Annual Conference in Chicago, Illinois; the 11<sup>th</sup> annual RBM Vector Control Working Group (VCWG) meeting in Geneva; and participated in the 7<sup>th</sup> annual mHealth Summit in Washington, D.C.

# I. COUNTRY SECTION

---

## I.1 ANGOLA

### PROGRAM HIGHLIGHTS

- Conducted monthly entomological monitoring activities in three sentinel sites in Angola, namely Cunene, Huambo and Malanje, from November 2015 to March 2016, using Centers for Disease Control and Prevention (CDC) light traps, Prokopack aspirators, and Pyrethrum Spray Catch (PSC) sampling methods.
- Entomological monitoring activities were conducted in collaboration with provincial health staff, where provincial and municipal malaria supervisors were actively involved in these activities.
- In total 5,075 *Anopheles* mosquitoes were collected of which, 3,732 (73.5%) mosquitoes were caught using CDC light traps (97.0% caught indoors, 3.0% caught outdoors), 200 (3.9%) mosquitoes were caught using Prokopack aspirators, and 1,143 (22.5%) were caught using PSC.
- Out of the 5,075 anophelines, 4,632 (91.3%) were *An. funestus* and 268 (5.3%) were *An. gambiae* s.l. The remaining 175 (3.4%) were comprised of nine other *Anopheles* species, the majority being *An. coustani* (69; 1.4%) and *An. squamous* (62; 1.2%).
- Out of the *Anopheles* mosquitoes collected, 39 (0.77%), 721 (14.2%), and 4,318 (85.0%) were collected from Cunene, Huambo and the Malanje sentinel sites, respectively.
- Molecular analysis results from the national susceptibility study were received from CDC only for mosquito samples sent from Huambo Province. Out of 348 mosquitoes, 149 (42.8%) were *An. arabiensis* and 136 (39.1%) were *An. rufipes*. The remaining 63 were *An. coustani*, *An. vagus*-like and *An. theileri*-like, while 24 were not amplified. Samples from the other eight provinces are still to be processed.

## I.2 BENIN

### PROGRAM HIGHLIGHTS

- AIRS Benin continued to reinforce National Malaria Control Program (NMCP) staff capacity to lead and manage the IRS campaign; and implement cost-efficient activities through strong oversight, effective management and the use of information & mobile technology.
- For the residual life study of insecticides, relevant data were collected by Centre de Recherche Entomologique de Cotonou (CREC) for analysis in different sites within the intervention area.
- AIRS Benin coordinated logistics for a national level strategy workshop October 1-2, 2015, where NMCP, PMI, and other stakeholders discussed the country's IRS strategy for the next five years. Discussions focused on the sustainability of the intervention with greater involvement from the NMCP and the future relocation of intervention sites.
- AIRS Benin hired a consultant to develop a new SEA that will serve the IRS program in Benin for the period 2016-2020. The consultant traveled to Benin January 13-26, 2016, to update all relevant information. This document will provide clearance for the use of three classes of World Health Organization Pesticide Evaluation Scheme (WHOPES)-recommended insecticides, and will expand

the authorization to include the use of chlorfenapyr (upon WHOPEs approval).

- The Pre-Season Environmental Compliance Assessment (PSECA) was conducted by the Environmental Compliance Officer (ECO) February 22-27, 2016, to assess the needs for store and site refurbishments prior to the 2016 IRS campaign.
- From February to March, AIRS Benin held several meetings with the NMCP to improve macro-planning for the 2016 spray campaign.

## 1.3 BURUNDI

### PROGRAM HIGHLIGHTS

- The political crisis affecting Burundi since 2015 greatly affected the implementation of activities planned for the period covered by this report, particularly entomological surveys that take place in sentinel sites. Under the difficult conditions, AIRS Burundi managed to ensure proper operation of the insectary and update entomological monitoring data. Partial analysis of samples of mosquitoes collected in several parts of Burundi and sent to the University of Witwatersrand (South Africa) laboratory have shown that *An. gambiae* s.s. and *An. funestus* s.s. are predominant in the *An. gambiae* complex and *An. funestus* group, respectively, with an infection rate of about 2% for both species.
- The project hired three new staff to fill vacant positions.
  - A new Medical Entomologist was hired and will travel to Burundi in May to resume post and implement project activities;
  - A new Finance and Administration Manager was hired in February;
  - A Program Coordinator was hired to provide general support to the Medical Entomologist to help implement project activities.

### CHALLENGES

The political unrest this year led to a displacement of populations and a situation of insecurity, limiting the proper implementation of activities, especially field work in sentinel sites.

## 1.4 DEMOCRATIC REPUBLIC OF CONGO

### PROGRAM HIGHLIGHTS

- AIRS Democratic Republic of the Congo (DRC), through the National Institute of Biomedical Research (NIBR), implemented entomological monitoring activities in seven sentinel sites, namely: Lodja, Kabondo, Kalemie, Kapolowe, Katana, Kingasani, and Mikalayi. Entomological monitoring activities include PSC and human landing catch (HLC) collections and insecticide susceptibility testing.
- In 2015 *An. gambiae* s.l. was the predominant malaria vector caught through HLC and PSC in most sentinel sites. The exceptions were Kapolowe (Katanga) and Lodja (Kasaï Orientale) where the most common species was *An. paludis*.
- *An. gambiae* s.l. were fully susceptible to bendiocarb and pirimiphos-methyl at all seven sites in 2015. Dichlorodiphenyltrichloroethane (DDT) resistance was widespread, while permethrin resistance was recorded at five of seven sites, with emerging resistance at two sites.
- In general, indoor biting by *An. gambiae* s.l. was primarily late at night between 22:00 – 05:00. Particularly high biting rates were recorded in Lodja and Kabondo.
- In Katana, Kalemie, and Kapolowe the *An. gambiae* s.l. biting rate was low at <3 bites person/night year round.

## I.5 ETHIOPIA

### PROGRAM HIGHLIGHTS

- AIRS Ethiopia provided support to the Federal Ministry of Health (FMOH) for the removal of obsolete DDT and contaminated waste present in 47 stores within PMI-supported districts. Training of 40 technicians, 47 supervisors, 5 AIRS staff and 5 representatives from the Ministry of Agriculture, Ministry of Environment and Forests, and FMOH on hazardous waste handling and management was conducted by Mabbett, Inc. in preparation for the repacking and removal. The training focused on potential chemical and physical hazards that could be encountered during handling of the obsolete DDT and DDT wastes. Repacking of 117 tons of DDT and DDT-contaminated waste was completed and the wastes were transported to the AIRS warehouse in Addis Ababa awaiting shipment to Poland for incineration through the facilitation of Veolia ES Field Services. Work continued on procuring the necessary documentation for shipment according to international conventions, but was notably delayed by the lack of response from the competent authority in Djibouti.
- During this DDT activity, AIRS used Tyvek suits and wet wipe cleaning for PPE, and ran a successful demonstration of DDT filtration using the mobile soak pit (MSP).
- AIRS Ethiopia participated in the development of the FMOH's National Malaria Elimination Guidelines and the Insecticide Resistance Monitoring and Management Strategy.
- In collaboration with Jimma and Addis Ababa Universities, AIRS Ethiopia is conducting studies to determine the decay rate of different insecticides (Actellic® 300 CS, bendiocarb and propoxur) in experimental huts in two sites. Insecticide resistance, wall bioassays, vector density and behavioral studies were also conducted.

### ENTOMOLOGY

- Results from the 12-month entomological study showed that *An. gambiae* s.l. started proliferation in April 2015 and reached its peak at variable times between June and September, with densities dropping from October onwards. Based on these results, starting IRS in the month of June with long-lasting insecticides would provide sufficient protection.
- The decay rate of bendiocarb and Actellic® 300 CS was monitored after spraying for four and seven months, respectively. The test mortality of wild and susceptible mosquitoes was 100% for all wall surfaces conducted three to six days after spraying with pirimiphos-methyl. In bendiocarb sprayed houses the mortality of wild and susceptible mosquitoes was 100% for all dung plastered and painted houses within seven days of spraying. However, mortality of wild and susceptible *An. gambiae* s.l. mosquitoes ranged from 90-95% on mud wall surfaces. Average mortality of susceptible mosquitoes was 81.6% one month after spraying with bendiocarb and dropped to 77.7% at two months post spray. At five, six, and seven months after spraying with pirimiphos-methyl, the average mortality recorded was 88.1%, 68.1%, and 57.8%, respectively.
- *An. gambiae* s.l. specimens were analyzed using polymerase chain reaction, and the results showed that *An. arabiensis* was the only species of the *gambiae* complex represented in the study sites.
- Molecular analysis of insecticide resistance mechanisms was conducted and results showed that the West African knockdown resistance (kdr) allele (L1014F) was common in populations of *An. arabiensis* tested from the eight study sites. The kdr allele frequency in surviving mosquitoes following the bioassay tests ranged from 31% to 100% for DDT and 36% to 100% for deltamethrin. The kdr allele frequency in dead mosquitoes following bioassay tests ranged from 13% to 88% for DDT and 13% to 75% for deltamethrin.
- The susceptibility of *An. gambiae* s.l. tested using the World Health Organization (WHO) tube test

in eight sites showed the vector was fully susceptible to pirimiphos-methyl, fenitrothion, and propoxur in all study sites. It was fully susceptible to bendiocarb in six sites. Suspected resistance was shown in one of eight sites and resistance to bendiocarb was noted in one of eight sites. *An. gambiae* s.l. was resistant to DDT and all the pyrethroids tested, including etofenprox in all sites.

## 1.6 GHANA

### PROGRAM HIGHLIGHTS

In late October 2015, AIRS Ghana began planning activities for the 2016 spray campaign. In mid-January 2016, the country team conducted a PSECA. Following the assessment findings, the team rehabilitated all 16 operational sites. The team produced a letter report that was approved two months ahead of the campaign start, which was planned for April 22, 2016.

AIRS Ghana successfully completed all recruitment and training, local and international procurements, rental of vehicles to transport spray operators (SOPs) and materials, and distribution of materials to the operational sites. AIRS Ghana continued engaging with local governments and communities during the mobilization and sensitization process. Specifically, the country team agreed to continue sharing spray plans and spray progress with District Assemblies, District Health Directorates, and community leaders. Community leaders also promised to give their support to the project to help improve spray coverage.

To improve supervision and reporting, the country team moved supervisory forms from the Abt-managed cloud system to Dimagi's cloud-based system, CommCare. The IRS database went through some modifications to capture changes that have been made to the spray operator form. This included adding the gender of the household member who accepted or refused spraying.

The Country Operations Manager provided south-to-south assistance in Mozambique for about three weeks in mid-November to support the implementation of AIRS Mozambique's 2015 spray campaign.

The PMI AIRS project is collaborating with two experts on gender in vector control to better understand why men and women accept or decline IRS for their homes in Ghana and whether the gender of spray operator teams may impact that decision. During the reporting period, the team developed a study protocol, to include focus groups and key informant interviews.

### ENTOMOLOGY

- October 2015 through December 2015, the project continued monthly entomological monitoring across all five districts.
- Results from the ovary dissections showed significantly lower longevity of vector species in IRS districts (Kumbungu [KD] and Bunkpurugu-Yunyoo [BYD]) compared to the non-sprayed districts (Tolon [TD] and Tamale).
- Monthly wall bioassays conducted after spraying to assess the residual efficacy of the sprayed insecticide showed that Actellic® 300 CS remained effective, killing more than 80% of mosquitoes up to seven months post-IRS.
- *An. gambiae* s.l. in the tested sites were resistant (35% - 89% mortality) to pyrethroids (alpha-cypermethrin 0.05% and deltamethrin 0.05%). They were resistant (87%) to bendiocarb 0.1% in Gbullung (KD), but susceptible in Kumbungu Town to both bendiocarb and propoxur 0.1%, and they were fully susceptible (98-100%) to pirimiphos-methyl in all IRS communities. Pyrethroid resistance intensity at 1x, 2x and 5x concentrations of alpha-cypermethrin was also documented in Savelugu-Nanton District. Results from the synergist assays are suggestive of a role of monooxygenases in the resistance of *An. gambiae* s.l. from Tarikpaa to the pyrethroids tested. However, resistance to the insecticides was only partially abolished, and hence it is not the only mechanism involved for insecticide resistance in the area.

- Eighty local insect collectors and 24 supervisors received a one-day refresher training on mosquito collection techniques and packaging of samples.
- PMI supported the Network for Insecticide Resistance Monitoring Partnership to collect data on insecticide resistance from 10 sentinel sites in all 10 regions of Ghana. Data showed that *An. gambiae* s.l. was susceptible to pirimiphos-methyl in eight out of nine sites (in five regions) tested in the Northern Sector, with possible resistance at one site. There is high pyrethroid and DDT resistance across all sites surveyed.
- The AIRS Ghana entomologist presented on reduction in malaria transmission intensity after indoor residual spraying at the Pan African Mosquito Control Association (PAMCA) conference in Tanzania in October 2015. A draft manuscript of the same title is under preparation.

## CHALLENGE

The reporting of molecular analysis from the subcontractor, Noguchi Memorial of Health Research Institute, was delayed.

## 1.7 KENYA

### PROGRAM HIGHLIGHTS

- AIRS Kenya provided IRS technical assistance to the NMCP to plan for a 2016 IRS campaign in Awendo and Rongo sub-counties, Migori County.
- AIRS Kenya facilitated the IRS micro-planning meeting held in Migori County on February 18-19, 2016. The meeting developed the 2016 IRS micro-plan, agreed on the community mobilization strategy, quantified the required IRS equipment and materials per sub-county, and drafted a budget for all the planned activities per sub-county. The meeting was attended by six NMCP officials, one WHO official, 24 county and sub-county staff, and four AIRS staff.
- AIRS Kenya completed environmental assessments of 14 proposed operational sites in Migori County. Findings and recommendations for each operational site were documented to guide improvements, and a letter to amend the SEA was revised and submitted for approval.
- Project offices and warehouses were established in Kisumu. AIRS Kenya oversaw the disposition of spray equipment from USAID/PMI to AIRS Kenya. Four shipping containers disposed from USAID/PMI to AIRS Kenya were distributed to four identified operational sites in Migori County to be used as storage facilities during IRS campaigns.
- Staff recruitment began in October 2015. AIRS Kenya Operations Manager began in November 2015 while the F&A Manager and program coordinator began in February 2016.

### ENTOMOLOGY

- AIRS Kenya conducted entomological surveillance at eight sentinel sites in western Kenya: four intervention areas and four control sites in Migori County. Entomological monitoring activities included monthly indoor biting rates, resistance testing and mosquito behavior monitoring.
- AIRS Kenya collected mosquitoes using PSC, CDC-light trap and HLC methods. All collected mosquitoes were transported to the Kenya Medical Research Institute Center for Global Health Research entomology lab for morphological and molecular analysis by Project consultants.
- Insecticide susceptibility testing is being conducted for bendiocarb 0.1%, pirimiphos-methyl 0.25%, permethrin 0.75% and deltamethrin 0.05%.
- Overall, 3,749 *Anopheles* and 14,152 *Culex* mosquitoes were collected by PSC, light trap and window exit traps. Of the *Anopheles*, 3,161 (84.32%) were morphologically identified as *An. funestus* s.l., 531

(14.16%) as *An. gambiae* s.l., 53 (1.41%) as *An. coustani*, 2 (0.05%) as *An. maculipalpis*, and 2 (0.05%) as *An. pharoensis*.

- Monthly indoor vector densities varied by collection method, site and collection period with a high of 12 mosquitoes per house from PSCs in December 2015 and a low of 0.1 mosquito per house from PSCs in March 2016. Vector numbers were lowest in March 2016.

## 1.8 LIBERIA

### PROGRAM HIGHLIGHTS

- From October 2015 to March 2016, entomological monitoring activities were conducted in two sentinel sites: Tomato Camp and Frank Town. Indoor resting density of *An. gambiae* s.l. was higher in Tomato Camp (N=571) than Frank Town sentinel site (N=120). HLCs from both sites showed that *An. gambiae* s.l. bite almost equally indoors and outdoors; however the number of mosquitoes collected in Tomato Camp (N=115) was higher than in Frank Town (N=67).
- Four classes of insecticides were tested against *Anopheles gambiae* s.l.: pyrethroid (deltamethrin 0.05% and alpha-cypermethrin 0.05%), carbamate (bendiocarb 0.1%), organophosphate (pirimiphos-methyl 0.1%), and organochlorine (DDT 4%). The tests were conducted in four counties (Margibi, Grand Bassa, Gbarpolu, and Bomi) to assess the susceptibility of *An. gambiae* s.l. to these insecticides. In Margibi County, the results showed that *An. gambiae* s.l. were fully susceptible to pirimiphos-methyl, with probable resistance to bendiocarb and resistance to DDT, deltamethrin, and alpha-cypermethrin. In Grand Bassa County, *An. gambiae* s.l. were fully susceptible to pirimiphos-methyl. However, a probable resistance to bendiocarb was observed, as well as resistance to DDT, alpha-cypermethrin, and deltamethrin. In Gbarpolu County, *An. gambiae* s.l. mosquitoes were susceptible to pirimiphos-methyl. A low level of resistance to bendiocarb was detected in this site. Tested mosquitoes were fully resistant to alpha-cypermethrin, and deltamethrin. In Bomi County, tested *An. gambiae* s.l. mosquitoes were susceptible to pirimiphos-methyl and a probable resistance to bendiocarb was observed. *An. gambiae* s.l. in Bomi were resistant to DDT, deltamethrin, and alpha-cypermethrin.

## 1.9 MADAGASCAR

### PROGRAM HIGHLIGHTS

- AIRS Madagascar completed post-spray activities including closing operations sites and temporary store rooms; cleaning personal protective equipment (PPE), spray equipment, and other IRS materials; and completing post-spray inventory.
- Plastic insecticide bottles leftover from the 2015 spray campaign were recycled.
- Regulatory approval from the Ministry of Environment was facilitated to safely and responsibly dispose of expired insecticide using an in-country vendor; the approval is expected soon.
- Spray campaign successes, challenges, and lessons learned were shared at an End-of-Spray Report (EOSR) dissemination meeting in November 2015 with the NMCP and other stakeholders in Tamatave.
- Health facility data on malaria incidence rates by IRS district in the East Coast and Southeast were collected and analyzed. Preliminary analysis, which controlled for elevation, rainfall and RDT stock outs, showed some reductions in malaria incidence rates for children under age five in districts receiving IRS. Further analysis will be completed around mid-2016. Spray planning for the 2016 IRS campaign began. New initiatives include expanding IRS to a fifth district (Vohipeno in the Southeast), piloting an e-inventory system to track insecticide stocks, and more routinely collecting data on

supervision and spray quality.

## ENTOMOLOGY

- Entomological data collected indicates that *An. gambiae* s.l., *An. funestus*, and *An. mascarensis* vector species were present at different prevalences in various sentinel sites.
- A total of 3,725 female anopheline and 3,749 culicine mosquitoes were collected during the monitoring period. The most abundant vector species were *An. gambiae* s.l. which constituted 49.8% (n=1,928) of the total anopheline mosquitoes collected. *An. funestus* and *An. mascarensis*, accounted only for 4.1% (n=153) and 2.6% (n=97), respectively.
- The results of the vector susceptibility tests indicate susceptibility of *An. gambiae* s.l. to bendiocarb and pirimiphos-methyl in all spray areas. Additionally, this year's susceptibility testing confirmed that DDT resistance was relatively widespread, with suspected resistance in Mahambo and Ambodifaho.
- Resistance to pyrethroids was observed in some sentinel sites: permethrin in Mahambo Vavatenina, Bekily and Ankafina Tsarafidy, and lambda-cyhalothrin in Bekily.
- Suspected resistance was noted for deltamethrin in Vohitrambato and Vavatenina; for permethrin in Ankafina Tsarafidy, Ambodifaho and Vohitrambato; for lambda-cyhalothrin in Imerina Imady; and for alpha-cypermethrin in Vohitrambato, Mahambo, and Imerina Imady.
- The monthly monitoring of the insecticide decay rate, for the insecticide used (Actellic® 300 CS), is still ongoing and will continue until the mortality rate falls under 80% for two consecutive months. Data from T6 (i.e., six months after spray) suggested the residual effect for the organophosphate insecticide was still satisfactory.

## 1.10 MALI

### PROGRAM HIGHLIGHTS

During the reporting period, AIRS Mali worked on the 2016 work plan, which incorporated a UNITAID subsidy for insecticide cost. The subsidy allowed adding a third district, Fana, to the 2016 spray campaign. Because Fana District had no previous experience with IRS, the team initiated a number of sensitization efforts with the local government and community leaders. AIRS Mali started geographical reconnaissance and enumeration work in this new district to gather information needed for the planning of IRS in that district.

AIRS Mali completed the seasonal epidemiological data collection. The main objective was to analyze the trends in seasonal epidemiological data related to morbidity and mortality due to malaria.

### ENTOMOLOGY

- AIRS Mali continued working on the long-lasting insecticide-treated net (LLIN) study to evaluate the impact of new combination products on entomological measures of malaria transmission in Southern Mali. The objective of the LLIN study is to determine whether the combination LLINs, PermaNet 3.0 and Olyset Plus, reduce sporozoite rates of *An. gambiae* s.l. compared with the conventional pyrethroid PermaNet 2.0 and Olyset LLINs.
- The findings of the study show:
  - Evidence over the two-year trial indicating a lower sporozoite rate in the PermaNet 3.0 arm than the PermaNet 2.0 arm. PermaNet 3.0 did not reduce vector density compared to PermaNet 2.0.

- There were clear differences between the two net brands in terms of durability, but no differences between the pyrethroid or PBO nets. Survivorship was lower for Olyset and Olyset Plus nets compared to PermaNet 2.0 and 3.0 after 24 months.
- The country team continued entomological monitoring through December 2015. *An. gambiae* s.l. was the primary malaria vector species group, and *An. funestus* s.l. was the secondary group present. The residual efficacy of pirimiphos-methyl CS, an insecticide used for 2015 IRS, was less than five months on mud, and three months on cement and kaolin/mud according to the WHO cutoff of 80% mortality. Both IRS sites had low densities of *An. gambiae* s.l. resting indoors by morning. The low density during the peak of the rainy season in IRS sites as compared to control sites could be due to the impact of IRS.
- AIRS Mali team also presented as part of a symposium and had a poster at the annual ASTMH conference in October 2016.

## CHALLENGES AND LESSONS LEARNED

- The selection of Fana as the new district required a significant amount of additional data. It took about two months to gather the required information from local partners and the NMCP in order to finalize the selection.
- Recruitment of the ECO took longer than expected because of the limited pool of qualified candidates who applied for the position.

## 1.11 MOZAMBIQUE

**TABLE 1: AIRS MOZAMBIQUE AT A GLANCE**

Number of provinces/districts covered by PMI-supported IRS in 2015	6 districts in Zambézia Province (Quelimane, Mocuba, Morrumbala, Derre, Milange and Molumbo)
Insecticide Class	Pyrethroids (K-Othrine & Pali) and Organophosphates (Actellic® 300 CS)
Number of structures targeted for PMI-supported IRS in 2015 (based on structures found by SOPs in 2014)	468,439
Number of structures found by SOPs in 2015	383,139*
Number of structures sprayed by PMI-supported IRS in 2015	337,433
2015 spray coverage	88.1%
Population protected by PMI-supported IRS in 2015	1,631,058
Children under 5	287,813
Pregnant Women	105,400
Dates of PMI-supported IRS campaign	October 19 – December 18, 2015**
Length of 2015 spray campaign**	36 days
Number of people trained with US government funds to deliver IRS***	1,746

Notes: \* Overall progress of the 2015 spray campaign was difficult to ascertain due to the discrepancies of targeted structures in all districts. Number of targeted structures was taken from the number of structures found during the 2014 campaign, but as spray teams and supervisors were out in the field, they found different numbers of structures than initially anticipated.

\*\*Spraying was completed in 36 operational days; however, the spray campaign was paused on November 7th in all six districts. It restarted in Quelimane and Mocuba on November 23rd; Morrumbala, Derre, Milange, and Molumbo Districts restarted on November 25, 2015.

\*\*\*Based on the PMI indicator definition, this number includes only spray personnel such as SOPs, TLs, supervisors, and clinicians. It excludes DECAs, drivers, washers, porters, pump technicians, and security guards.

## PROGRAM HIGHLIGHTS

The Provincial Departments of Health led community mobilization efforts; however, they were implemented too close to the onset of the spray campaign to have an impact on the level of acceptance by communities. There were extensive issues with SOPs underreporting eligible structures that were found but not sprayed; that is, SOPs were routinely not reporting structures that were closed, locked, or unattended. This affected the spray data's denominator, and thus the reported spray coverage rates. For these and other reasons, AIRS Mozambique paused the spray team for 12 operational days and deployed two experienced Operations Managers from AIRS Ghana and AIRS Rwanda. These additional resources led refresher trainings on spray techniques, insecticide mixing, supply chain management, and data collection. Also, AIRS Mozambique conducted a detailed stock audit during the pause to gain a better understanding of the irregularities observed during the first half of the spray campaign.

## ENTOMOLOGY

- To monitor vector behavior, density, species composition, and seasonality, AIRS Mozambique selected five sentinel sites (Milange, Morrumbala, Mocuba, Quelimane and Maganja da Costa): four sentinel sites in intervention areas and one site in a comparable non-intervention district (Maganja da Costa). PSC, CDC light trap and HLC collections were conducted in all the districts with the exception of Quelimane where only cone wall bioassays were conducted.
- Quality assurance testing was conducted from October 20 – 30, 2016; the spray campaign began on October 19 in all six districts. Observed mortality rate (24hr holding period) of susceptible mosquitoes used from the insectary was 100% in Milange, Morrumbala, and Mocuba. However, in Quelimane mortality rate was 78%. This area was sprayed again, and a second cone wall assay was conducted whereby quality improved significantly with a mortality of 97%.
- Cone wall bioassays were conducted monthly following initial spray quality assurance tests to determine insecticide residual life. In areas sprayed with organophosphate mortality fell to less than 80% in March 2016, five months post-spray. In areas sprayed with deltamethrin mortality was 88% through March 2016.
- AIRS Mozambique conducted susceptibility testing in January and February 2016. Resistance was observed against deltamethrin and lambda-cyhalothrin in Mocuba, Morrumbala and Milange districts; however, no resistance was found against organophosphate, carbamate or organochlorine insecticides.

## CHALLENGES AND LESSONS LEARNED

- AIRS Mozambique should play a key role in collaboration with the District Services for Health, Women, and Social Welfare and community leaders during recruitment of seasonal personnel at the community level.
- AIRS Mozambique should conduct a capacity building boot camp that will include curricula for high-level and low-level trainings, including SOP training. It is important to decentralize spray operator training to the site level to ensure there are fewer numbers of trainees for each trainer and that spray operators who need special attention can be attended to and additional emphasis can be given.
- Supervision was minimal during AIRS Mozambique's 2015 IRS campaign in terms of capacity and commitment by district supervision teams. AIRS Mozambique will develop a cadre of supervisors similar to other AIRS countries and will ensure supervision tools are used consistently.
- AIRS should separate team leaders (TLs) from SOPs during training to emphasize their supervisory

role. For 2016 and beyond, the number of SOPs per spray team should be reduced to four or five SOPs per spray team to increase the ratio of TLs and supervisors to SOPs.

- Although historically led by the Provincial Departments of Health, AIRS Mozambique must play a more primary role in community mobilization, seasonal worker recruitment, and supervision of spray operations.
- SOP and TL trainings should re-emphasize proper ways to handle and use insecticide including the environmental and human health risks caused by improper use. Also, AIRS Mozambique should enhance community education about insecticide safety, specifically the dangers of Actellic® 300CS when used inappropriately.

## 1.12 NIGERIA

### PROGRAM HIGHLIGHTS

- The National Malaria Elimination Program in collaboration with the State Ministries of Health and the PMI AIRS Project held advocacy visits to four new sentinel sites in the PMI focal states to complete the transitional program to six PMI focal states. This was followed by a visit to the community leaders as well as selection of sites, prior to the commencement of trainings for Principal Investigators and Entomology Technicians from the newly established sentinel sites of Bauchi, Oyo, Akwa Ibom, and Ebonyi states. Due to delays in realigning two of the sentinel sites, the trainings were staggered, with the training for Bauchi and Oyo held December 14-16, 2015, while that of Akwa Ibom and Ebonyi were held February 22-24, 2016. The trainings were organized with the following objectives:
  - Train the Principal Investigators and Entomology Technicians for Bauchi, Oyo, Akwa Ibom and Ebonyi sentinel sites on entomological methods;
  - Build capacity of the state Principal Investigators and Technicians on entomological surveillance; and
  - Strengthen and expand field laboratories/insectary facilities at sentinel sites for entomological surveillance by collaborating with institutions supporting these sites.

The trainings were followed with the commencement of surveillance activities in all six sentinel sites in PMI-supported states, representing all the ecological zones in Nigeria.

### ENTOMOLOGY

- The study teams used baited CDC light traps and PSC sampling methods to collect 1,654 *Anopheles* mosquitoes. Of this number, 1,243 (75.2%) were caught using the PSC method; 411 (24.8%) mosquitoes were caught using CDC light traps, with 206 (50.1%) caught indoors and 205 (49.9%) caught outdoors.
- This study has established the predominance of *An. gambiae* s.l. (in all sentinel sites) compared to other *Anopheles* species during the reporting period, which is in agreement with previous findings in similar locations. Important minor species such as *An. funestus*, *An. coustani*, and *An. squamosus* were observed. *An. funestus* and *An. squamosus* were more prevalent in Ebonyi, while *An. coustani* was observed in Ebonyi, Bauchi, and Nasarawa.
- The indoor resting density of the *Anopheles* mosquitoes was highest in Ebonyi State in the rain forest. The peak biting hours of the main malaria vector, *An. gambiae* s.l., varied with time across all the sentinel sites.

## I.13 RWANDA

**TABLE 2: AIRS RWANDA AT A GLANCE**

Number of districts sprayed by PMI-supported IRS	2 districts (Nyagatare, Kirehe)
Insecticide	Carbamates
Number of structures targeted by PMI-supported IRS	150,818
Number of structures sprayed by PMI-supported IRS	147,947
Spray coverage	98.1%
Total population protected by PMI-supported IRS	618,696
Children under five	90,089
Pregnant women	10,256
Dates of PMI-supported IRS campaign	February 15 – March 9, 2016
Length of campaign	20 days
Number of people trained with USG funds to deliver IRS*	1,384

Note: \*This is based on the PMI indicator definition. It includes only spray staff such as spray operators, team leaders, supervisors, and clinicians. It excludes data clerks, IEC mobilizers, drivers, washers, porters, pump technicians, and security guards.

### PROGRAM HIGHLIGHTS

AIRS Rwanda continued to use the mHealth tools in supervision and reporting during the February 2016 spray campaign. Working in close collaboration with the Malaria and Other Parasitic Diseases Division and District authorities, supervision was enhanced based on lessons learned in past IRS campaigns.

### ENTOMOLOGY

- WHO cone bioassay tests were conducted monthly (October 2015-January 2016) following the September 2015 IRS campaign. Mortality of more than 80% was observed on all three surface types tested in the four districts (Bugesera, Gisagara, Nyagatare and Kirehe) up to two months post-spraying except on the plastered not painted (PNP) surface in Gisagara District. The mortality rate for PNP surfaces, however, rose in the following month to 80%. At four months post spraying, the plastered and painted (PP) surfaces and PNP surfaces recorded over 80% mortality rates in all four districts. Mud surfaces showed less than 80% mortality in Gisagara District while that of the other three districts remained above the 80% threshold.
- During the February 2016 IRS campaign cone bioassays were conducted within the first week of spraying for quality assurance. In all test cones, 100% mortality of susceptible *An. gambiae* s.s. was recorded. In March 2016, one month post-IRS, test mortalities of 100% were recorded in all sites in the two districts (Nyagatare and Kirehe).
- *An. gambiae* s.l. was the only important malaria vector that was identified during the entomological monitoring collections. The vector generally showed slightly more exophagic than endophagic behavior in the four intervention districts and also the control district.
- Vector density (average *An. gambiae* s.l./house/day) was highest in Kirehe, the control district in October 2015 (but then sprayed in 2016), through the reporting period. Kirehe showed the highest vector density relative to the other IRS districts.

### CHALLENGES AND LESSONS LEARNED

- SOPs did not record/mark all unsprayed structures during the first days of spraying. This was corrected, and with vigilant supervision, adhered to by the second week through the end of the campaign.
- Absence of some households during time of spraying because of farming, market days, work days,

funerals and some refusals meant that some structures could not be covered, even after mop-up.

- Local community elections conducted during February 2016 affected IRS operations with spraying cancelled on February 22<sup>nd</sup>, postponing the end date of spray operations by one day to March 9<sup>th</sup>.
- Improvement was noted on the use of the mobile phone for supervision and reporting by the supervisors; however, AIRS strongly recommends that the checklists be translated to Kinyarwanda for better understanding and more accurate reporting among the supervisors.
- Good communication with the mHealth consultant (Dimagi LLC) was important in sorting out day-to-day issues that occurred with the mHealth tools.
- Engagement of community health workers' supervisors at operational sites for IEC coordination in the sectors enhanced coordination of IRS activities at the community level. Further, while local leaders are critical in mobilizing and enhancing IRS acceptability, their role and engagement in IRS needs to be re-evaluated to maximize their involvement.
- Involving all relevant stakeholders in the recruitment of SOPs and other seasonal workers ensured all SOPs were community health workers, and the stakeholders displayed more responsibility in their supervision.

## I.14 SENEGAL

### PROGRAM HIGHLIGHTS

- AIRS Senegal Chief of Party and officials from the NMCP (Director, IRS focal person and IEC manager) conducted an advocacy visit to local authorities in IRS regions and districts to promote more local community contribution (i.e., office space, operational sites, transport, community mobilization, refusal case management, etc.) during the 2016 campaign. Local authorities in the IRS districts (except for Nioro) committed to providing most of the operational sites and districts' office spaces free of charge to the project.
- AIRS Senegal revised all training tools and manuals based on lessons learned and new IRS guidelines (e.g., TL supervision, environmental compliance).
- The IRS Working Group discussed the upcoming spray campaign preparation, which included agreeing on a specific date for the IRS national workshop and the microplanning workshop; community contribution for free district offices and operational site facilities; community-based IRS strategy with regional ECOs, and the protocol for the IEC data collection modalities that will be transferred to the NMCP during the 2016 campaign.
- AIRS Senegal held a team building workshop February 10-12, 2016, in Toubab Dialaw, to improve staff working relationships and discuss lessons learned and recommendations from the previous campaign as well as from the Global PMI AIRS Workshop (Cape Town). The workshop provided an opportunity for brainstorming on IRS innovations to be initiated locally during the next spray campaign.

### ENTOMOLOGY

- AIRS Senegal worked with Université Cheikh Anta Diop de Dakar (UCAD) to conduct entomological monitoring in the IRS target districts.
- UCAD conducted cone bioassays tests in the four IRS districts (Koumpentoum, Malem Hoddar, Kounghoul, and Nioro). The residual efficacy of IRS with pirimiphos-methyl (Actellic® 300 CS) using an organophosphate susceptible strain of *Anopheles gambiae* (kisumu) was monitored for six months after spraying. IRS remained effective (providing >80% mortality in cone bioassay) for five months in the districts of Kounghoul, Koumpentoum and Malem Hodar, with similar levels of mortality on

treated mud and concrete walls. However, the residual duration of Actellic® 300 CS was shorter in Nioro District and lasted just two months. Also, in Nioro District, houses in NDRAMÉ NDIMB were sprayed with bendiocarb (Ficam WG 10%), but the residual efficacy was even shorter, with mortality greater than 80% for only one month.

## CHALLENGES

- AIRS Senegal advocated in all four spray districts for free district offices and operational sites to further reduce costs of spray, but this has been problematic in Nioro.
- IRS implementation at the community level to further reduce costs has been difficult, particularly the identification and use of available local resources including local transport (horses, bicycles, walking) and human resources (recruitment of seasonal workers at the site level).
- Of the 968 seasonal workers hired during the 2015 campaign, 30% were female. Increasing the number of female seasonal workers to join the team of seasonal staff for the spray campaign continues to be a challenge.

## 1.15 TANZANIA

**TABLE 3: AIRS TANZANIA AT A GLANCE**

	Zanzibar	Tanzania Mainland	Total
Number of districts sprayed by PMI-supported IRS in 2016	7 (Chakechake, Micheweni, Central, North A, North B, South, West)	8 (Bukoba Rural, Missenyi, Ngara, Chato, Sengerema, Kwimba, Butiama, Musoma rural)	15
Insecticide	Pirimiphos-methyl (Actellic®300 CS)	Pirimiphos-methyl (Actellic®300 CS)	
Number of structures targeted by PMI-supported IRS	29,528	453,406***	482,934
Number of structures found by SOPs*	30,095	513,770	543,865
Number of structures sprayed by PMI-supported IRS*	27,664	487,553	515,217
Spray coverage	91.9%	94.9%	94.3%
Total population protected by PMI-supported IRS*	130,170	1,912,391	2,042,561
Children under 5	21,623	378,691	400,314
Pregnant women	3,253	58,569	61,822
Dates of PMI-supported IRS campaign	March 1 – 16, 2016	February 3 – 27, 2016 March 9 – April 4, 2016	
Length of Campaign (in days)	14	44	51****
Number of people trained with USG funds to deliver IRS**	326	2,971	3,297

Note:

\* Data cleaning is ongoing and figures will change upon final submission.

\*\*This is based on the PMI indicator definition. It includes only spray staff such as spray operators, team leaders, supervisors, and clinicians. It excludes data clerks, IEC mobilizers, drivers, washers, porters, pump technicians, and security guards.

\*\*\*This excludes 20,000 structures to be sprayed through a PPP arrangement with Geita Gold Mine (GGM) that is yet to happen.

\*\*\*\* The last 7 days of the Zanzibar campaign overlapped with the March 9 campaign on the mainland.

## PROGRAM HIGHLIGHTS

- AIRS Tanzania collaborated with the NMCP and the Zanzibar Malaria Elimination Programme (ZAMEP) to conduct IRS in eight districts on Mainland Tanzania and seven districts in Zanzibar. The spray activity occurred in three campaigns from February 3–April 4, 2016.
- The project held stakeholder advocacy, sensitization and planning meetings to create the necessary awareness and effective involvement of all stakeholders for the spray campaigns. The meetings cascaded from regional, district, to the community level.
- AIRS Tanzania procured the necessary commodities based on the logistics needs assessment conducted by the AIRS Tanzania logistician prior to the campaign. AIRS Tanzania sourced procurements both locally and internationally and deployed commodities to districts and operation sites before the IRS start date in preparation for the IRS operations.
- Environmental compliance assessments were carried out by the ECO pre-, during and post-spray to ensure compliance with United States Government and Government of Tanzania environmental regulations.
- AIRS Tanzania drafted and submitted a structure definition document to PMI and NMCP prior to the commencement of the spray campaign.
- Trainings were conducted at regional and district levels for all cadres of staff. The training duration ranged from one to five days, and included gender content. Gender integration was emphasized with the display of the anti-sexual harassment policy in Swahili language at each operational site and clearly marked separate changing rooms and bath and toilet facilities for women and men.
- Spray supervision was prioritized and rapidly reported using two mHealth initiatives. Storekeepers used the Performance Management Tracker (PMT), and a daily Short Message Service (SMS) reporting, with mobile phones, to report daily spray data, which helped to identify and reach underperforming teams promptly. In addition, site supervisors, government supervisors and AIRS staff used mobile supervisory forms. The data was uploaded through a cloud system and disseminated by email to designated project and non-project recipients.
- A local plastic recycling company in Mwanza was contracted to recycle empty Actellic bottles into non-consumables based on their certification by the National Environmental Management Council.

## ENTOMOLOGY

- Entomological surveillance for AIRS Tanzania was subcontracted to the Mwanza and Amani Centers of the National Institute for Medical Research (NIMR).
- NIMR Mwanza trained community mosquito collectors from 10 sentinel sites (eight intervention and two control districts) to equip them with the required basic entomological skills.
- NIMR Amani Center in Muheza trained field workers on insecticide resistance monitoring involving revision and harmonization of test protocols (WHO and CDC techniques for testing vector susceptibility to insecticides and strength of resistance).
- NIMR Mwanza Centre conducted IRS quality assays in a random sample of houses in one village in each intervention district in Tanzania mainland. ZAMEP conducted the assays in Zanzibar, under AIRS supervision. The assays were conducted within the first 14 days after spray start date, in three houses of each of the commonly-found wall surfaces (mud, cement, whitewash, burnt bricks, painted and block-stone). The 24-hour mortality observed following half-hour exposure to sprayed surfaces ranged from 90.8% to 100%, confirming that IRS quality met the expected standards of >90% mortality. Reports of these quality assays have been shared with PMI. Monitoring will continue every month until the observed 24-hour mortality falls below 80%.
- Monitoring for vector abundance, behavior, and impact of IRS intervention in sprayed districts is

ongoing. AIRS Tanzania will share data in subsequent reports.

- AIRS Tanzania supported NIMR Amani and Mwanza Centers with procurement of laboratory and insectary equipment and supplies to further enhance their capacity to support the project and malaria control efforts in the country.

## CHALLENGES AND LESSONS LEARNED

- Some structures could not be sprayed for various reasons ranging from householders being away at the time, to having a very sick person in the house, holding funeral ceremonies, or simply refusing to have their houses sprayed. Spray teams made the effort to ‘mop-up’ unsprayed structures at a later date.
- Hamlet leaders were uncooperative during the spray campaign. Unlike previous spray campaigns, they were not paid because seasonal workers were engaged as community mobilizers who were embedded with spray teams.
- AIRS Tanzania engaged all relevant stakeholders, such as district administrators, police, and the anti-corruption bureau, in the recruitment process for all cadres at the district level, ensuring transparency and proper selection of competent seasonal workers based on interview performance.
- Building the capacity of government leaders and health managers by training them on all components of IRS operations enhanced their interest and ownership of the project activities.
- Informal engagement of community mobilizers from different Shehias for IEC made a significant contribution to the mobilization process.
- There was a challenge on allocation and delivery of sufficient quantities of IRS household cards during the initial days of the campaign. This was quickly corrected.
- Regular supervision by the AIRS staff, national supervisors, and district supervisors as well as holding regular feedback meetings were instrumental to the smooth implementation and achievement of high spray coverage recorded.
- Some supervisors were not consistent in meeting their weekly targets for completed mobile supervisory forms.

## 1.16 ZAMBIA

**TABLE 4: AIRS ZAMBIA AT A GLANCE**

Number of supported provinces	5 (Eastern, Nothern, Muchinga, Luapula, Central)
Number of districts covered by IRS	39
Number of structures targeted by IRS	547,548
Number of structures found by IRS	549,520
Number of structures sprayed by IRS	519,598
2015 Spray coverage	95%
Population protected by IRS	2,544,290
Children < five years	392,903
Pregnant women	67,107
Dates of IRS campaign	September 28 – November 25, 2015
Length of IRS campaign	51 days
Number of people trained with funds to deliver IRS*	1,912

\*Based on the PMI indicator definition; it includes only spray personnel such as SOPs, TLs, supervisors, and clinicians. It excludes DECAs, drivers, washers, porters, pump technicians, and security guards.

## PROGRAM HIGHLIGHTS

- Implementation of Zambia's IRS program in 2015 was built upon lessons learned as the country entered its eighth year of PMI support for IRS. AIRS Zambia continued to implement IRS in the same five provinces as in 2014, Central (4 districts), Eastern (9 districts), Luapula (10 districts), Muchinga (7 districts) and Northern (9 districts).
- The start dates for the 2015 IRS campaign in Zambia were staggered to allow the AIRS team to be in the field and supervise the logistic activities for the start of the campaign.
- To reduce costs and improve efficiency, the number of spray days was reduced to 51 days in 2015 from 65 days in 2014. While the number of seasonal staff, such as SOPs, increased during the shorter spray period, the number of vehicles stayed the same. Vehicles were used more efficiently, by making multiple trips per day. Supervision levels for SOPs remained the same to assure high spray quality. This was accomplished by increasing the total number of supervisors to maintain the ratio of one supervisor for every five SOPs.
- SOP coverage reporting was monitored on a daily basis.
- Local temporary staff were recruited and trained for the 2015 spray operations well before the start of the campaign.

## ENTOMOLOGY

- Entomological surveillance was conducted in 10 sentinel sites in six districts from November 2015 to March 2016 and is currently ongoing.
- The WHO cone bioassay tests performed 24h and one month after spraying showed 100% mortality of the susceptible malaria vectors exposed to the mud and cement sprayed walls.
- Pirimiphos-methyl was effective on both mud and cement surfaces in four sites (Kasama, Isoka, Katete and Mwense) in February four months after the spraying. The test mortality rate was less than the 80% WHO threshold on the mud and cement sprayed walls in Milenge and Serenje four months after spraying.
- *Anopheles funestus* s.l. is the most abundant malaria vector (64% of *Anopheles* species collected). The proportion of *An. gambiae* s.l. was 11% of the total *Anopheles* collected. The other *Anopheles* collected were *An. tenebrosus* (16%), *An. tchedii* (3%), *An. squamosus* (4%), *An. coustani* (2%), *An. rufipes* (0.02%), and *An. ziemanni* (0.1%).
- The parity rate was similar in both sprayed and control sites. There was no statistically significant difference between the parity in the sprayed and control sites even after spraying. The parity at most of the sites was high.

## CHALLENGES AND LESSONS LEARNED

- One of the new features of AIRS Zambia's management approach for the 2015 campaign was hiring District Coordinators (DCs) to manage the activities in their assigned districts. This approach proved to be helpful and successful in coordinating activities and problem solving as issues arose. Since these were new staff, it took them a little time to come up to speed with all of the details of the campaign. The AIRS Zambia management team deployed master trainers in those districts that faced challenges so that DCs could get the skills necessary to coordinate field activities.
- AIRS Zambia experienced some challenges during the campaign in Chipata District. The quality of supervision was below par and this threatened the quality of IRS. AIRS Zambia reported the problem to the local PMI team and the NMCP. Immediate measures were taken, including engaging the nearby district IRS team that had finished spraying to provide extra support to the team in Chipata. Three Master Trainers and two senior AIRS staff were deployed to Chipata to support the district in supervision of IRS implementation.

- The NMCP and AIRS Zambia have faced challenges with the management and disposal of insecticide containers since Actellic® 300 CS was introduced to the program in 2012 because there are no recycling companies to transform insecticide containers into non-consumptive products in Zambia. In November 2015, AIRS Zambia identified a local company to compress, bale, and transport empty bottles to South Africa for recycling. The recycling company has been identified and a MoU signed.

## I.17 ZIMBABWE

**TABLE 5: AIRS ZIMBABWE AT A GLANCE**

Number of districts covered by PMI-supported IRS in 2015	4 districts: Chimanimani, Mutare, Mutasa, Nyanga
Insecticide	Organophosphate (Actellic® 300 CS)
Number of structures targeted by PMI-supported IRS	163,922
Number of structures found by spray operators during PMI-supported IRS spray season	171,736
Number of structures sprayed by PMI-supported IRS	162,127
Spray coverage	94.4%
Population protected by PMI-supported IRS	365,425
Children under 5 years	62,937
Pregnant women	5,763
Dates of PMI-supported IRS campaign	October 11 to November 25, 2015
Length of campaign	38 days
Number of people trained with U.S. Government (USG) funds to deliver IRS*	351 (301 men, 50 women)

\*Based on the PMI indicator definition; it includes only spray personnel such as SOPs, TLs, supervisors, and clinicians. It excludes DECs, drivers, washers, porters, pump technicians, and security guards.

### PROGRAM HIGHLIGHTS

- The country team closely collaborated with provincial and district health officials in Manicaland.
- AIRS Zimbabwe provided technical assistance on various national-level IRS campaign issues, including the use of constant flow valve to maintain a uniform insecticide application rate and mentoring in IRS waste recycling and incineration.
- The team recruited and trained seasonal staff for spray operations in time to launch the campaign on October 1, 2015. However, in early October the spraying was postponed until October 11 as some of the key MOHCC district staff were involved in the annual mass drug administration campaign.
- For the first time in Zimbabwe, the country team introduced mHealth tools and SMS-messaged job aids to supervise spray operations, EC, and send reminders to the seasonal workers.
- The team carried out a gender norms study as part of the global PMI AIRS cross-country assessment.
- After the completion of the campaign, the country team held stakeholder and partner review meetings in January 2016.
- AIRS Zimbabwe completed recycling of 2015 empty bottles in February. However, the team was exploring options for incineration of 2015 IRS waste and expired 2014 insecticide, and complete recycling of and non-contaminated empty cardboard boxes.
- The Chief of Party and other senior technical team members participated in the National Malaria Program Review, which will inform the development of the 2016-2020 National Malaria Strategy.

## ENTOMOLOGY

- The country team completed cone bioassays to test spray quality within 24 hours after spray at Burma Valley site (Mutare District) in October. At Chakohwa (Chimanimani) site quality-of-spray tests were completed within one week after spray in the selected areas in November. The team conducted subsequent monthly cone bioassay tests to determine the decay rate of the pirimiphos-methyl through March at Burma Valley and through April at Chakohwa. The residual efficacy was four months for Burma Valley and five months for Chakohwa.
- The team conducted insecticide susceptibility testing at six sentinel sites outside of PMI IRS districts from April-December 2015. The results show that the local vector species from Old Mazowe Bridge and Kawere were susceptible to all four insecticides tested. At Chakar, the local vector was susceptible to pirimiphos-methyl and DDT but resistant to bendiocarb and lambda-cyhalothrin. At Kamhororo, the local vector was resistant to DDT and possibly resistant to lambda-cyhalothrin but susceptible to pirimiphos-methyl and bendiocarb. At Manjolo, possible resistance to lambda-cyhalothrin was detected; susceptibility to three other insecticides could not be ascertained, owing to inadequate mosquitoes available for the tests in 2015. At Makakavhule, the local vector was resistant to DDT and possibly resistant to pirimiphos-methyl but susceptible to bendiocarb and lambda-cyhalothrin.
- Currently, the team is working on mosquito collections at 10 sites: three sites in Manicaland and seven sites outside of Manicaland, plus vector surveillance in Mutare City. The team collected mosquitoes as part of the routine entomological monitoring using pyrethrum spray catches, the battery-powered Prokopack Aspirator, and CDC light traps. The findings showed that the major vector species in Burma Valley (Mutare district) is *An. funestus*, albeit in low densities. *An. gambiae* s.l. was collected at Chakohwa (Chimanimani district). Indoor resting densities of the malaria vectors remain low at the three sentinel sites in Manicaland. After IRS more mosquitoes were found resting in non-living structures (e.g., latrines) than sprayed, living structures.
- PMI AIRS completed distribution of entomological equipment to 17 sentinel sites by January 2016.
- The Technical Manager/Entomologist attended the National Malaria Conference in Mutare in November 2015, the Annual Malaria Planning Meeting in January 2016, and the Provincial IRS Review Meeting in February.

## CHALLENGES

- Limited storage and camping facilities at some operational sites.
- The expired insecticide and the empty cardboard boxes have not yet been disposed of due to unavailability of appropriate incineration facilities within the country. Various options are under consideration.
- Efforts to recruit an entomologist to be seconded to the NMCP are taking much longer than originally envisaged. The team identified a South Africa-based entomologist, who is expected to take the post by early summer.
- The National Institute of Health Research continued to lag behind with producing results from mosquito specimens sent to them in 2014. Partial results were provided in February 2016. AIRS Zimbabwe, with full support from PMI and NMCP, continues to explore alternative options for analyzing specimens locally and regionally.

## 2. CORE SECTION

---

### 2.1 CAPACITY BUILDING

#### **Regional training workshop for AIRS Country Operations Managers**

A three-day training workshop for all AIRS country Operations Managers was conducted in Cape Town November 29 - December 1, 2015. All country Operations Managers participated, with the exception of Rwanda. Topics covered included: Enhancing the Supervisory Role of Spray Team Leaders, Directly Observed Spray Supervision, IRS Cost Saving Initiatives, and Effective IRS Warehouse and Inventory Management. The AIRS Operations Director facilitated this workshop.

#### **New IRS Comprehensive Training Curriculum**

EnCompass submitted the final draft of the new comprehensive IRS training curriculum to the AIRS Operations Director on March 31, 2016. The PMI AIRS Operations Director led the effort to develop the new curriculum, working in close collaboration with EnCompass and the AIRS technical colleagues. Consultations were made with AIRS staff in the implementing countries, and with other relevant partners, during the development of the curriculum. The new curriculum builds on existing manuals to incorporate new developments and initiatives in IRS planning and implementation. Such initiatives include the emphasis on directly observed supervision of spray operators, the renewed focus on gender issues, the use of mobile soak pits, and the use of CFVs with spray equipment. The curriculum delivers a standardized way of explaining core concepts of IRS, tailored to responsibilities and literacy of each position involved. It contains 14 modules, comprising a full set of training materials for all cadres. The materials include facilitator guides, handouts, participant guides, slide decks, teach-back session guides, Excel file templates, group-work guidelines, draft timetables, pre-tests & post-tests, and guidelines for conducting training needs assessments. The curriculum includes workshops on facilitation/training skills to build the capacity of trainers at all levels.

### 2.2 ENVIRONMENTAL COMPLIANCE

The use of MSPs continued and expanded in Madagascar, Mali, Zambia, and Zimbabwe. The project completed laboratory testing of the capacity of the MSP for removal of Ficam and Actellic from water. These tests confirmed that the filter is capable of reducing the concentration of these insecticides to safe levels. The tests also demonstrated the capacity of the MSP to last through an IRS cycle of at least 40 days, which is equal to the length of the longest IRS campaign. This indicates that the MSP can be used for an entire campaign without replacement of the filter components.

AIRS developed and incorporated new incineration guidelines for contaminated IRS wastes into PMI IRS Best Practices. These new guidelines reduce the incineration temperature and post-combustion gas treatment required for most IRS wastes. The changes make it easier to locate acceptable incinerators in Africa for disposal of lightly contaminated IRS wastes such as face masks and empty pesticide sachets, as well as for disposal of non-chlorinated insecticides if it should be necessary.

Based on the success of the Tyvek suit usage for DDT repacking and consolidation in Ethiopia, the project will pilot these suits for IRS in three countries (Senegal, Mali, and Madagascar) in 2016. These pilots will also test a protocol for safe mid-day hydration breaks for spray operators.

Building upon the smart phone assessment and inspection success, the project developed user-friendly reports for supervisory inspections. These reports allow greater access to the data collected, and provide traceability down to the level of the spray operator for non-compliance issues.

AIRS relied on consultants for the development of new SEAs for Benin and Mali, and managed the development of Environmental Impact Assessments for Tanzania Lake Zone and Zanzibar.

Finally, the project developed project-wide EC training for ECOs and government counterparts to disseminate best practices and increase host-country capacity. The training was scheduled for April 2016.

## 2.3 MHEALTH

The project continued rollout of the three mobile tools to all spraying countries. Specifically, Rwanda, Tanzania, and Zimbabwe used the technology-based tools program-wide during the reporting period. Rwanda and Tanzania used the PMT, mobile supervisory forms, and SMS job aids. Zimbabwe applied only SMS job aids and mobile supervisory forms. The third tool, the PMT, which reports daily spray and progress results, could not be used due to complex data restrictions by NMCP Zimbabwe.

Upon request from the home office, the project technology partner, Dimagi, digitized an additional form, the Data Collection Verification (DCV) form, meant to validate the integrity of data collected in the field. In addition to the existing suite of mobile tools, Tanzania and Rwanda used the digitized DCV for M&E supervision during spray operations. Dimagi experts worked closely with the AIRS Ghana and AIRS Benin teams to prepare them for strong campaign starts scheduled for late April.

During the reporting period, Zimbabwe and Tanzania used mobile money as a payment mechanism during the spray campaign. Rwanda has a well-functioning system of microfinance organizations that the country team successfully uses to pay seasonal workers and thus did not implement this mHealth tool.

Technology partner Akros began implementing (for a second year) an mSpray system in Zambia. It is a cloud-based data recording and management system that allows spray personnel to electronically collect spray data and GPS coordinates on tablets. Improved Open Map Kit layers provided mSpray team leaders with better maps that increased the functionality of the mSpray tool for real-time decision making based on the location they were in.

In an attempt to optimize the mSpray teams, the project will create a new position of mobile data entry clerk for the 2016 campaign. This clerk will be solely responsible for data collection on tablets, allowing mSpray team leaders to effectively supervise their team of spray operators. Previously, the team leaders were also responsible for conducting data collection on tablets. This posed a significant challenge to the supervisory duties of the team leaders in the 2015 campaign that Abt and Akros managed to overcome through collaborative planning meetings.

Additionally, to increase the speed and ease of data verification and cleaning on the back end, the M&E team will incorporate a unique spray form ID code on the SOP data collection form. The code will link the forms to the summary team leader form that will be completed at the end of the day. The system will aggregate the data according to each team leader which will allow the M&E team in Zambia to verify it quickly. The AIRS Zambia M&E team is currently in the process of checking the condition of all tablets from last year's campaign to ensure sufficient quality and quantity of tablets for the 2016 IRS campaign.

## 2.4 GENDER

The AIRS Gender Technical Working Group is examining whether exposure to an explicitly gender-equitable workplace, such as the PMI AIRS Project, results in changes in attitudes and beliefs among seasonal workers about roles of men and women in their society. Over the course of the project, data will be collected in Zimbabwe, Ethiopia, Madagascar and Rwanda. During this reporting period, the

project continued to collect data in Zimbabwe. Comparing results from before and after employment with PMI AIRS, the project found a small decrease in the average score, implying a shift towards more traditional, less egalitarian views, but this result was not statistically significant. On the other hand, data collected in Rwanda during the February 2016 campaign showed a statistically significant increase in gender norm scores, suggesting that workers' opinions about appropriate roles for men and women changed to be more egalitarian.

During this reporting period the project designed activities in Ghana and Zambia to better quantify the effect of fielding spray teams with different gender compositions on spray quality and acceptance rates. The Project also made several presentations on the project's gender work including a brownbag to USAID in October, a presentation at the PMI AIRS Global Workshop in December, and to the Global Fund in December.

## 2.5 EPIDEMIOLOGICAL SURVEILLANCE

Below is a summary of the epidemiological work completed per country during this reporting period.

- AIRS Benin continued its collaboration with the World Bank's Performance-Based Financing Project which collects health facility level data from clinics and hospitals in Kerou, Pehunco, and Kouande (spray areas) and Banikoara (located in Alibori, a bordering comparison district) in north Benin. The team received the first set of data and has begun analysis.
- AIRS Madagascar analyzed and reported health facility data from spray and comparison districts located on the East Coast. The data analysis included data from January 2013 to January 2016. Our model accounted for ecological factors, such as humidity and elevation. After presenting the data, PMI/Madagascar asked the AIRS team to continue to collect and analyze the 2016 data.
- AIRS Mali collected data on suspected and confirmed malaria cases among children under five from eight facilities in Koulikoro, Baraoueli, Bla, and Fasselebougou, totaling 32 health facilities. Koulikoro and Baraoueli Districts have received IRS previously and also received IRS in 2015. Bla was previously included in IRS districts, but was not included in IRS operations in 2015. The data for August through October from 2012 through 2015 was collected. The findings were summarized in a report and shared with PMI.
- AIRS Mozambique submitted an update to the Enhanced Surveillance work in the EOSR. This update included malaria data from 2013 through December 2015, with a focus on data collected from July through December 2015 from the seven supported health facilities. A final report will be submitted at the close of the work plan year.
- AIRS Senegal: Final data for the evaluation of using the "hot-spot" targeted approach were collected. An evaluation report summarizing the results of this analysis was sent to PMI in February.
- AIRS Zimbabwe: Following the submission of preliminary results of epidemiological analyses of the insecticide change, in select districts, from pyrethroids (or DDT) to OPs in 2015, the protocol was revised and expanded to include ecological variables and health facility-level data from the 2016 malaria transmission season. Analyses of these new variables and new data are ongoing and a revised report will be submitted in September 2016.

## 2.6 COST EFFICIENCY

AIRS implemented a series of cost-efficiency initiatives in several countries where feasible. The impact of these initiatives was observed mostly on an operational level. Actions taken by individual countries included: assigning the mobilization component to the local government; decreasing the number of mobilizers; staggering spray starts each day to reduce vehicle rental; reducing training days and spray campaign days; negotiating lower costs with local suppliers; using government help with incineration,

recycling and acquiring free operational sites from local authorities; reproducing in-house most of the items that were previously outsourced to printing companies; reducing the number of printed manuals and IEC tools by using previous year's documents; giving database ownership to countries and limiting the use of the Client Technology Center; and minimizing external reliability on partners/subcontractors.

## 2.7 ZAMBIA OPERATIONAL RESEARCH STUDY

This study aims to address the gap in knowledge on the links between insecticide resistance intensity and malaria control failure. The results from this study may inform as to where more concerted insecticide resistance management efforts need to be targeted. Baseline insecticide resistance intensity assays were conducted in Samfya and Milenge Districts of Luapula Province, northern Zambia, as part of a scoping exercise to identify villages with sufficient variations of insecticide resistance intensity across the *Anopheles funestus* transect area for study feasibility. Insecticide resistance intensity assays were carried out using the standard CDC bottle bioassay method in villages of the proposed transect of *An. funestus*. The main malaria vector in both districts is *Anopheles funestus*.

The baseline surveillance data indicated that there is considerable variation in insecticide resistance intensity along the transect. There are villages with intense deltamethrin resistance (100% survival at 5X and 43% survival at 10X the diagnostic dose) and low resistance (18% mortality at 1x diagnostic dosage). Based on the results from the insecticide resistance intensity assays, Miyambo, Pwele and Fumpa-Kulush villages are considered areas with high deltamethrin resistance intensity; and Shitambulli and Johny-Nkumba villages represent areas with moderate level of intensity. Chinkula-Yatem village showed low resistance intensity compared to the other villages of the transect. All the villages were not sprayed in the 2015 spray campaign, and will remain unsprayed in the 2016 spray campaign to allow the full assessment of data from this study. Currently, further tests have been conducted to ensure the stability of insecticide intensity levels in mosquitoes collected in all the villages. Mwense District is planned to serve as *Anopheles gambiae* transect. The baseline surveillance in January and February 2016 following the rainy season of the area produced only a few *An. gambiae* s.l. in the area. The team has continued further efforts to conduct tests on the *Anopheles gambiae* in the area.

The study protocol was drafted during the reporting period and reviewed.

## 2.8 DISEASE DATA MANAGEMENT SYSTEMS (DDMS)

- The DDMS implementation is proceeding well in Ethiopia, Ghana, Mali, Zambia, and Zimbabwe.
- Troubleshooting of minor issues related to data entry is ongoing in Ethiopia but progress is being made towards full implementation.
- Rollout of DDMS is in process for Madagascar, Mozambique, and Tanzania. The NMCPs in Mozambique and Tanzania are keen to implement the DDMS system.
- Collaborators in Madagascar, Mozambique, and Tanzania are in the process of purchasing servers.
- Historical data is being entered by Liverpool School of Tropical Medicine for each country in preparation for the training and for data archiving.

## 2.9 EVALUATION OF PIRIMIPHOS-METHYL EFFICACY WHEN SPRAYED ON HALF THE USUAL SURFACE AREA

- An experimental hut study, "Evaluation of pirimiphos-methyl efficacy in experimental huts when sprayed on half the usual surface area against natural populations of *Anopheles gambiae* in Ghana," will determine whether IRS with pirimiphos-methyl is effective when sprayed either only on the top or bottom half of house walls.

- If the quantity of insecticide sprayed can be reduced without any loss of efficacy there is potential for significant cost-savings, which could allow for a greater number of structures to be sprayed.
- The study protocol and concept note have been reviewed and a revised version resubmitted to PMI.
- The proposed starting date for the one-year study is June 2016.

## 2.10 UNITAID

Announced in Geneva on February 1, 2016, the PMI AIRS Project is partnering with UNITAID and the Innovative Vector Control Consortium (IVCC) to expand the use of new long-lasting, non-pyrethroid insecticides to defeat malaria through the NGenIRS Project. UNITAID is investing US \$65.1M through IVCC over four years to create a market for IRS products to reduce the price of a new insecticide from the current \$23.50 (for Actellic® 300 CS) to at least \$15 per unit by 2020. UNITAID and IVCC teamed up with the US President's Malaria Initiative, Abt Associates, PATH, and the Global Fund to work with industry and country malaria-control programs to make alternative insecticides with high efficacy more readily available in countries with a high burden of malaria. First year (2016) countries that will participate in the NGenIRS project include: Ethiopia, Mali, Mozambique, Rwanda and Zambia. These countries will receive a co-payment from UNITAID for the purchase of Actellic® 300 CS, which will enable these country programs to expand IRS coverage with Actellic® 300 CS rather than shrink IRS coverage due to the current high cost of this insecticide.

## 2.11 CONFERENCES

### American Society of Tropical Medicine and Hygiene Conference

The PMI AIRS Project hosted a symposium at the 64th annual American Society of Tropical Medicine and Hygiene Conference in Philadelphia, October 25-29, 2015, on *Combating Resistance: New Approaches to Vector Control*. The symposium included presentations by PMI AIRS Technical Director Dereje Dengela; CDC Resident Advisor for President's Malaria Initiative, Ghana, Dr. Philip Ricks; Dr. James W. Austin of BASF; and Director of the JHU/CCP VectorWorks Project Dr. Matthew Lynch. Their presentations were as follows:

- *The importance of Insecticide Resistance Monitoring to Maintain IRS Program Effectiveness*
- *Application of new approaches to measuring intensity of insecticide resistance*
- *Chlorfenapyr: An important new tool for combatting insecticide resistance*
- *Next-Generation LLINs: Programmatic Implications*

The PMI AIRS Project also presented five posters at the conference:

- High Levels of *Anopheles gambiae* s.l. Resistance to Pyrethroids, DDT and Malathion and Indications of Reduced Susceptibility to Carbamates in Oromia Region – Ethiopia
- *Anopheles* species diversity, behavior and sporozoite rates in six states in Nigeria
- Evidence of mixed-function oxidases mechanism in *Anopheles gambiae* s.l. with pyrethroid resistance in Mali
- The effect of malaria burden after a change in insecticide for IRS in Zimbabwe
- Zimbabwe beneficiary satisfaction assessment

### Pan African Mosquito Control Association Conference

The second annual conference of the Pan African Mosquito Control Association was held in Dar es Salaam, Tanzania, October 6-8, 2015. All four abstracts submitted from the PMI AIRS Project were

accepted for oral presentations in the scientific sessions. The following topics were presented by the PMI AIRS conference participants:

- *A reduction in malaria transmission intensity in Northern Ghana after indoor residual spraying* (Sylvester Coleman)
- *Comparative evaluation of Prokopack aspirator and pyrethrum spray catches for sampling indoor resting malaria vectors in Manicaland, Eastern Zimbabwe* (Hieronymo Masendu)
- *Multi-Country assessment of residual bio-efficacy of insecticides used for indoor residual spraying in malaria control on different surface types: Results from program monitoring of 15 PMI-supported countries* (Aklilu Seyoum)
- *Impact of indoor residual spraying on entomological inoculation rates in Mali* (Dereje Dengela)

### **Roll Back Malaria Vector Control Working Group**

Project Director Brad Lucas, Technical Director Dereje Dengela, and FCA Director Paula Wood attended the 11th annual RBM Vector Control Working Group (VCWG) meeting in Geneva, February 3-5, 2016. Dereje Dengela served as co-chair for the 'IRS and Insecticide Resistance Management (IRM)' work stream, which combined two previous work streams. In addition to the plenary and work stream sessions, the AIRS team and PMI COR team held meetings with insecticide manufactures/distributors, IRS spray tank manufacturers, and the UNITAID working group.

### **American Public Health Association Conference**

AIRS M&E Specialist Elana Fiekowsky presented *The Effect on Malaria Burden after a Change in Insecticide for IRS and Can A Malaria Service Delivery Project Improve Gender Equality* at the American Public Health Association's (APHA) Annual Conference in Chicago, Illinois, November 3, 2016.

### **PMI AIRS Global Workshop**

The PMI AIRS Project held a three-day workshop in Cape Town, South Africa, December 2-4, 2015, to evaluate the project's progress, disseminate best practices, and set priorities for the coming year. The workshop's 59 participants included the PMI COR Team; Chiefs of Party, Operations and Technical Managers from 16 project countries, and all home office PMI AIRS Project staff.

The workshop included sessions on building the capacity of government stakeholders, operations, vector control strategies to control malaria, entomological monitoring, environmental compliance and safety, and practices and policies to support gender inclusion. Lessons learned and best practices were shared with an emphasis on successful new innovations (e.g., spray operations supervision, SMS spray data reporting, and electronic inventory systems).

### **mHealth Summit**

Keith Mangam and Ashley Thomas attended the 7th annual mHealth Summit in Washington, D.C., from November 9 -11, 2015. They also attended a separate Global mHealth Forum, organized by the mHealth Working Group, as part of the Summit Forum focused on mHealth activities, trends and gaps in low and middle income countries.

## **2.12 COMMUNICATIONS**

During this reporting period, The PMI AIRS Project enhanced its website ([www.africaairs.net](http://www.africaairs.net)) to include data visualization in its *Where We Work* section, located on the [home page](#). Users can click on the map to learn more about each country. Eight success stories were written, posted on the project and PMI websites and distributed via the AIRS quarterly e-letter. AIRS distributed two e-letters (in December and March) to more than 3,700 global health professionals. The mHealth Tech *Brief Integrating Mobile Technology into Project Implementation: Improving Efficiency in Malaria Control Operations* and the publication

*mHealth Matters: People Money and Performance, Case Studies from Africa* were completed and posted on the website.

One photo story (Zambia) was shared on the project website. One PMI AIRS Project Malaria Fighter profile was developed and shared widely through social media, and PMI, AIRS, and Abt websites.

The project's video *Women Take Charge in Malaria Prevention* was submitted and accepted to the Fourth Global Conference on Women, which was held in Copenhagen, Denmark, May 16-19th. A second video on the project's gender inclusion policies and its impact on women in Zambia was filmed during this time.

Tech Talks continued with the Chiefs of Party to encourage peer-to-peer exchange across the project. Topics included: Abt's Employee Review Process, Spray Quality Verification and Using EC Forms.

## 2.13 JOURNAL PUBLICATIONS

Five manuscripts were submitted to PMI during this reporting period, three of which were cleared and submitted to journals. Two of those manuscripts are in press with journals. Comments and inputs have been received from the COR and other PMI teams on the other three manuscripts. Manuscripts include:

- *Short Persistence of Bendiocarb Sprayed on Pervious Walls and Its Implication for the Indoor Residual Spray Program in Ethiopia* – Resubmitted January 2016. Accepted for May publication in *Parasites & Vectors*.
- *Feasibility and Efficacy of mHealth: A Case Study of Mobile Messaging in Mali* – Resubmitted to the *Global Health: Science and Practice* March 31st. To be published in June 2016.
- *Mobile Soak Pits Improve Spray Team Productivity and Environmental Compliance of Malaria Control Program* – Submitted to *Journal of Environmental Management* in November 2015. Revised for resubmission.
- *Multi-Country Assessment of Residual Bio-efficacy of Insecticides Used for Indoor Residual Spraying in Malaria Control on Different Surface Types: Results from Program Monitoring in 15 PMI/USAID supported IRS Countries* – Under revision for submission to *PLoS* journal.
- *Community-Based Indoor Residual Spraying: An innovative approach to deliver effective, cost-efficient, and sustainable malaria prevention in Ethiopia* – Submitted to PMI in March 2016.

## 2.14 NEW EMPLOYEES

Based in the UK, Richard Oxborough, Regional Entomologist Specialist, provides support to the AIRS entomological teams in Benin, DRC, Kenya, Mali, Senegal, and Tanzania.



# ANNEX A: M&E RESULTS SUMMARY

## IRS RESULTS OCTOBER 2015–MARCH 2016

Country	# Structures Sprayed	Spray Coverage	Total Population Protected	Children Under Five Protected	Pregnant Women Protected	# People Trained*
Mozambique	337,433	88.1%	1,631,058	287,813	105,400	1,746
Rwanda (February)	147,947	98.1%	618,696	90,089	10,256	1,384
Tanzania**	515,217	94.7%	2,042,561	400,314	61,822	3,297
Zambia	519,598	94.6%	2,544,290	392,903	67,107	1,912
Zimbabwe**	162,127	94.4%	365,425	62,937	5,763	368
<b>AIRS TOTAL</b>	<b>1,682,322</b>	<b>93.4%</b>	<b>7,200,667</b>	<b>1,233,841</b>	<b>250,366</b>	<b>8,718</b>

\*Includes spray staff (e.g., spray operators, team leaders, supervisors, clinicians) only. Excludes data clerks, IEC mobilizers, drivers, washers, porters, pump technicians, and security guards.

\*\*Data validated and final, but EOSR not yet approved.



# ANNEX B: INSECTICIDE AND EQUIPMENT PROCUREMENT

Commodity	Country	Description	Total Cost	Order/PO Date	Delivery Date
Insecticides	Benin	Organophosphates	\$1,001,063.77	12/24/2015	March 2015
Insecticides	Ethiopia	Organophosphates	\$6,888,000.00	2/4/2016	April, May, 2016
Insecticides	Ghana	Organophosphates	\$939,321.60	12/24/2016	February 2016
Insecticides	Mali	Organophosphates	\$1,188,517.20	12/24/2015	*May, 2016*
Insecticides	Mali	Organophosphates	\$966,968.60	2/23/2016	*May, 2016*
Insecticides	Senegal	Organophosphates	\$238,893.30	12/24/2015	*May, 2016*
Insecticides	Rwanda	Carbamates	\$1,360,111.00	12/21/2015	January, 2016
Insecticides	Tanzania	Organophosphates	\$91,675	11/26/2015	January, 2016
Goizper Sprayers	Mali	Sprayers & Spare Parts	\$76,462.93	2/22/2016	*May, 2016*
Goizper Sprayers	Mada, Benin	Sprayers & Spare Parts	\$64,765.50	3/14/2016	*May, 2016*
Goizper Sprayers	Ghana	Spare Parts	\$665.50	2/22/2016	March, 2016
Activated Carbon	Ghana	Activated Charcoal	\$377.66	11/9/2015	Nov 2015
Activated Carbon	Mali	Activated Charcoal	\$188.01	3/24/2016	March, 2016
Activated Carbon	Senegal	Activated Charcoal	\$280.00	3/24/2016	March, 2016
Micron	Tanzania, Senegal, Ghana, Madagascar, Ethiopia, Zambia	CFVs & Nozzles	\$119,041.13	12/15/2015	January – March, 2016
Hudson Sprayers & Parts	Tanzania	Sprayers & Spare Parts	\$27,274.00	11/23/2015	December 2015
Hudson Sprayers & Parts	Ghana	Sprayers & Spare Parts	\$2,692.40	2/19/2016	February 2016
Hudson Sprayers & Parts	Madagascar, Ethiopia, Benin	Sprayers & Spare Parts	\$83,261.90	3/15/2016	March 2016
Personal Protective Equipment	Ethiopia	DDT Clean-up PPE	\$3,826.19	11/11/2015	Nov 2015
Personal Protective Equipment	Rwanda	PPE Supplies	\$15,652.17	11/19/2015	December 2015
Personal Protective Equipment	Rwanda	PPE Supplies	\$13,220.50	11/30/2015	December 2015
Personal Protective Equipment	Tanzania	PPE Supplies	\$1,591.20	11/23/2015	January 2016

<b>Commodity</b>	<b>Country</b>	<b>Description</b>	<b>Total Cost</b>	<b>Order/PO Date</b>	<b>Delivery Date</b>
Personal Protective Equipment	Tanzania	PPE Supplies	\$56,842.80	2/10/2016	March 2016
Personal Protective Equipment	Ghana	PPE Supplies	\$27,651.80	2/18/2016	March 2016
Personal Protective Equipment	Benin	PPE Supplies	\$16,793.40	2/18/2016	March 2016
Personal Protective Equipment	Senegal	PPE Supplies	\$16,489.20	3/16/2016	March 2016
Personal Protective Equipment	Madagascar	PPE Supplies	\$130,936.30	3/17/2016	*Pending
Personal Protective Equipment	Madagascar, Mali, Senegal	PPE Supplies	\$2,800.50	3/30/2016	April 2016
Entomology Supplies	Angola	Entomology Monitoring Supplies	\$1,063.00	Mar, 2016	*Pending
Entomology Supplies	DRC	Entomology Monitoring Supplies	\$8,968.50	Mar, 2016	*Pending
Entomology Supplies	DRC	Impregnated Papers	\$1,282.60	Feb, 2015	April 2016
Entomology Supplies	Ethiopia	Entomology Monitoring Supplies	\$10,775.18	Mar, 2015	March-April 2016
Entomology Supplies	Ethiopia	Impregnated Papers	\$7,515.14	Nov, 2015	March 2016
Entomology Supplies	Ghana	Entomology Monitoring Supplies	\$1,417.13	Mar, 2015	*Pending
Entomology Supplies	Ghana	Impregnated Papers	\$7,046.88	Feb, 2016	April 2016
Entomology Supplies	Kenya	Entomology Monitoring Supplies	\$24,430.44	Jan, 2016	May 2016
Entomology Supplies	Kenya	Entomology Monitoring Supplies	\$10,996.42	Feb, 2016	May 2016
Entomology Supplies	Kenya	Impregnated Papers	\$1,091.80	Jan, 2016	March 2016
Entomology Supplies	Liberia	Entomology Monitoring Supplies	\$8,511.95	Feb, 2015	May 2016
Entomology Supplies	Mali	Entomology Monitoring Supplies	\$2,437.73	Feb, 2016	*Pending
Entomology Supplies	Mali	Impregnated Papers	\$3,663.36	Feb, 2016	April 2016
Entomology Supplies	Madagascar	Entomology Monitoring Supplies	\$3,902.58	Feb, 2016	April 2016
Entomology Supplies	Nigeria	Entomology Monitoring Supplies	\$904.51	Feb, 2016	March 2016
Entomology Supplies	Nigeria	Impregnated Papers	\$7,954.24	Nov, 2015	Feb 2016
Entomology Supplies	Rwanda	Entomology Monitoring Supplies	\$15,843.67	Feb, 2016	May 2016
Entomology Supplies	Rwanda	Impregnated Papers	\$2,972.24	Feb, 2016	April 2016
Entomology Supplies	Tanzania	Entomology Monitoring Supplies	\$45,970.04	Feb, 2016	April 2016
Entomology Supplies	Tanzania	Impregnated Papers	\$3,970.76	Feb, 2016	*Pending
Entomology Supplies	Zambia	Entomology Monitoring Supplies	\$13,524.62	Oct, 2015	Jan 2016

Entomology Supplies	Zambia	Entomology Monitoring Supplies	\$2,594.33	Dec, 2015	Jan 2016
Entomology Supplies	Zimbabwe	Entomology Monitoring Supplies	\$77.49	Feb, 2016	*Pending
Entomology Supplies	Zimbabwe	Impregnated Papers	\$954.00	Feb, 2016	April 2016