



U.S. PRESIDENT'S MALARIA INITIATIVE



THE PMI AIRS PROJECT SEMIANNUAL REPORT OCTOBER 1, 2017–MARCH 31, 2018

Recommended Citation: The PMI Africa Indoor Residual Spraying (AIRS) Project. Semiannual Report: October 1, 2017–March 31, 2018. Rockville, MD. The PMI AIRS Project, Abt Associates.

Contract: GHN-I-00-09-00013-00

Task Order: AID-OAA-TO-14-00035

Submitted to: United States Agency for International Development/PMI

Approved:



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ACRONYMS

AIRS	Africa Indoor Residual Spraying Project
ASTMH	American Society of Tropical Medicine and Hygiene
CDC	U.S. Centers for Disease Control and Prevention
CS	Capsule Suspension
DRC	Democratic Republic of the Congo
HLC	human landing catch
IEC	information and education communication
IRS	indoor residual spraying
M&E	monitoring and evaluation
NIMR	Nigeria Institute for Medical Research
NMCP	National Malaria Control Program
PMI	President's Malaria Initiative
PSC	pyrethrum spray catch
PSDQA	Post-Spray Data Quality Audit
TL	team leader
USAID	United States Agency for International Development
WHO	World Health Organization

EXECUTIVE SUMMARY

The U.S. President's Malaria Initiative (PMI) Africa Indoor Residual Spraying (AIRS) Project, funded by the United States Agency for International Development (USAID), continued implementation under Task Order 6 to prevent and control malaria in 17 African countries through indoor residual spraying (IRS) and entomological monitoring. During this reporting period (October 1, 2017 to March 31, 2018), the project successfully implemented IRS campaigns in Kenya, Mozambique, Rwanda, Tanzania, Zambia, Zimbabwe. More than 10 million people were protected from malaria during this period. Details regarding all monitoring and evaluation (M&E) outcomes by country are reported in Annex A.

TOP-LINE RESULTS FROM IRS CAMPAIGNS, OCT 2017-MAR 2018

- 94.4% average spray coverage
- 2,642,421 structures sprayed
- 10,829,090 people protected from malaria including:
 - 351,936 pregnant women
 - 1,660,913 children under 5 years of age
- 16,577 people trained to deliver IRS using United States Government funds

HIGHLIGHTS FROM THIS REPORTING PERIOD ARE LISTED BELOW

- Carried out the transition from PMI AIRS to the new contract mechanism (PMI VectorLink) in 18 countries with no interruption.
- Held a regional entomology laboratory training in Cotonou, Benin for 12 participants from 6 PMI AIRS countries.
- Successfully carried out the project's first SumiShield pilot in Musoma Rural, Tanzania.
- Continued data collection for two operational research studies in Ghana.
- AIRS Kenya introduced new mHealth tools and expanded entomological surveillance.
- AIRS Mozambique adopted an improved spray operator and Team Leader training strategy, and introduced new cadres of staff to improve mobilization.
- AIRS Rwanda adopted the innovative "walk to work" strategy, and used electronic maps and mobile devices for data collection and operations management.
- The AIRS Zambia 2017 spray coverage outcome of 92.7% fell within the Post-Spray Data Quality Audit's (PSDQA) 95% confidence interval (91.2 to 94.1), indicating that AIRS Zambia had implemented successful measures for increasing data accuracy and spray coverage.

I. COUNTRY HIGHLIGHTS

I.1 BENIN

PROGRAM HIGHLIGHTS

- Africa Indoor Residual Spraying Project (AIRS) Benin facilitated logistics and provided technical support for the regional entomology training organized in Cotonou (Benin) from November 16 to November 24, 2017, for 12 participants drawn from six PMI AIRS countries..
- At the Vector Control Technical Working Group’s workshop, AIRS presented the results of the 2017 indoor residual spraying (IRS) campaign, and discussed the 2018 IRS campaign, particularly with respect to the intervention zone and selection of the insecticide to be used.
- AIRS Benin organized the geographical reconnaissance used to update the environmental component of the IRS intervention area.
- The AIRS Benin team performed all TO6 contract close-out activities, including all human resources, contractual, financial, and administrative tasks needed for the phased close-out of AIRS on January 1, 2018, and the phased start-up of President’s Malaria Initiative (PMI) VectorLink, the follow-on project under a brand new contracting mechanism. Abt transitioned staff, inventory, and activities from one project to the other.

I.2 BURKINA FASO

- Program Highlights WHO tube tests revealed high-frequency resistance in *An. gambiae* s.l. for all pyrethroids tested, but only moderate resistance to bendiocarb. Three rounds of susceptibility testing confirmed the presence of pirimiphos-methyl resistant *An. gambiae* s.l. in four sites in the Southwest region (Kampti, Gaoua, Mangodara, and Tiefora). Based on these results, SumiShield 50WG was chosen for the 2018 IRS campaign in Kampti.
- The highest entomological inoculation rate was 647 infective bites per person in Mangodara (indoors) over seven months (June–December).

I.3 BURUNDI

- Program Highlights Entomological data were collected monthly from October 2017 to March 2018 in eight sentinel sites (Cankuzo, Gihofi, Kiremba, Mabayi, Matana, Mpanda, Nyanza-Lac, and Vumbi). Data collected included vector bionomics and susceptibility to insecticides.
- The average human biting rate of *An. gambiae* s.l. varied among the eight sentinel sites, and ranged from 10.40 bites/person/night to 17.54 bites/person/night. The lowest biting rate was observed in January (10.40 bites/person/night), while the highest was observed in March (17.79 bites/person/night).
- The susceptibility of *An. gambiae* s.l. to insecticides was determined at four sites, and the vector was shown to be susceptible to pirimiphos-methyl and bendiocarb at Gihofi, Mpanda, Nyanza-Lac, and Vumbi.
- The PMI AIRS project closed and its staff, inventory, and activities transitioned to PMI VectorLink in December 2017.

I.4 DEMOCRATIC REPUBLIC OF THE CONGO

PROGRAM HIGHLIGHTS

- AIRS Democratic Republic of the Congo (DRC), through the National Institute of Biomedical Research, implemented entomological monitoring activities in 11 provinces. Activities included pyrethrum spray catch (PSC) and human landing catch (HLC) collections, and insecticide susceptibility testing to permethrin, deltamethrin, alpha-cypermethrin, pirimiphos methyl, and chlorfenapyr in 11 sentinel sites.
- *Anopheles gambiae* s.l. was the predominant malaria vector in all sites.
- Monthly vector monitoring in Kalemie (Tanganyika) and Kabondo (Tshopo) through March 2018 showed that *An. gambiae* s.l. and *An. funestus* s.l. were predominantly captured.
- Insecticide susceptibility bioassays using *Anopheles gambiae* s.l. were completed for permethrin, deltamethrin, and alpha-cypermethrin at 1, 2, 5, and 10 times the diagnostic doses in Kingasani, and bottle bioassays were conducted to determine the chlorfenapyr resistance profile in Kalemie (Tanganyika). The team documented high resistance to permethrin and moderate resistance to deltamethrin and alpha-cypermethrin in *An. gambiae* s.l. populations from Kingasani (Kinshasa).
- The PMI AIRS project closed and its staff, inventory, and activities transitioned to PMI VectorLink in December 2017.

I.5 ETHIOPIA

PROGRAM HIGHLIGHTS

- AIRS Ethiopia finalized the Ethiopia capacity-building assessment and plan for 2017.
- AIRS Ethiopia's staff, inventory, and activities transitioned to the PMI VectorLink Project on January 1, 2018.
- PMI decided to implement IRS in 44 districts in 2018: 10 districts in Oromia, 14 new districts in Gambella, and 20 districts (12 new) in Benishangul Gumuz. The 26 new districts replaced 26 districts in Oromia that were graduated and handed over to the GoE.
- The new chief of party, Dr. Peter Mumba, was transferred from AIRS Zambia to PMI VectorLink Ethiopia in February 2018, and some new staff were hired.
- Routine entomological monitoring activities were conducted in three PMI project sites (Abaya and Nono in Oromia, and Bambasi in Benishangul Gumuz), as well as in four non-PMI districts. Results show that *An. gambiae* s.l. (presumably *An. arabiensis*, the main vector of malaria in Ethiopia) was the predominant species in all areas. The vector population in all the sites was susceptible to pirimiphos-methyl. Resistance to bendiocarb and propoxur was observed in one locality only. Resistance to pyrethroids was widespread. Synergistic tests provided evidence of the role of mixed function oxidases (monooxygenases) in the resistance to deltamethrin. The intensity of resistance to deltamethrin varied from low to high. Clothianidin susceptibility tests from Adama and Abaya showed mortality of 96.8% and 98.8% *An. arabiensis* respectively on day 7.
- Results also showed that the residual life of Actellic®300CS [capsule suspension] in Bako was 1–3 months, in Chewaka it was 3–5 months, and in Goro and Nono it was more than 6 months on different wall surfaces.

I.6 GHANA

PROGRAM HIGHLIGHTS

- In October 2017 AIRS Ghana began planning activities for the 2018 spray campaign, and embarked on the transition to the PMI VectorLink Project, with a start date of January 1, 2018.
This included assigning a new chief of party, Lena Kolyada, who moved to Ghana in mid-February to assume the position.
- Based on discussions with PMI, Sumitomo, a manufacturer of a new IRS insecticide (SumiShield 50WG) agreed to donate 5,000 units of SumiShield to PMI VectorLink Ghana to conduct a field pilot in one district in the Northern region during the 2018 IRS campaign.
- In March, the Ghana team presented program results and plans for PMI's Malaria Operational Plan (MOP) team, and travelled with them to the Northern region. AIRS Ghana also participated in a national malaria stakeholder meeting.
- Upon PMI's request, the Ghana team procured 1,000 electronic tablets for the National Malaria Control Program (NMCP) to support a mass distribution campaign, launched March 19, 2018.
- Results from wall bioassays to assess the decay rate of the pirimiphos-methyl insecticide Actellic® 300CS showed that the insecticide remained effective above the cut-off mortality level (80% 24-hour mortality) on all surfaces in the communities tested, at 7–8 months post-IRS.
- *An. gambiae* s.l. remained the dominant species across all sites. Results from the insecticide susceptibility tests and resistance intensity assays, using the WHO tube tests, indicate that vector species from all AIRS Ghana sentinel sites remain susceptible to pirimiphos-methyl but are highly resistant to DDT and to the 1x, 5x, and 10x concentrations of alpha-cypermethrin, deltamethrin, and bendiocarb.
- The team continued with data collections for the two operational research studies. Collections for the experimental hut study ended in December 2017, while data collection for the *Anopheles* vector behavior studies is ongoing.
- AIRS Ghana provided financial support to the National Insecticide Resistance Monitoring Partnership to conduct tests in 10 sites. The results of the tests show widespread pyrethroid resistance across all sites surveyed. Follow-up synergistic assays with piperonyl butoxide (PBO) suggest that oxidases could be contributing to resistance observed in the local vector species from all sites.

I.7 KENYA

TABLE 1: AIRS KENYA AT A GLANCE

Result	Homa Bay County	Migori County	Total
Number of sub-counties covered by IRS	8	6	14
Insecticide	Organophosphate	Organophosphate	Organophosphate
Number of structures found	265,826	202,830	468,656
Number of structures sprayed	251,741	189,228	440,969
Spray coverage (<i>number of structures sprayed divided by number of structures found</i>)	94.70%	93.30%	94.1%

Population protected	989,157	844,703	1,833,860
Pregnant women protected	14,662	17,315	31,977
Children under 5 protected	121,855	107,125	228,980
Dates of PMI-supported IRS campaign	February 12– March 24	February 19– March 24	February 12– March 24
Length of campaign	36 days	30 days	36 days
Number of people trained with U.S. government funds to deliver IRS*	3,203	2,571	5,774

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

PROGRAM HIGHLIGHTS

AIRS Kenya implemented IRS using Actellic®300CS in 14 sub-counties across two counties in the Lake endemic zone: eight sub-counties in Homa Bay County which doubled the size of the spray campaign as compared to 2017 (Homa Bay Township, Kabondo, Kasipul, Ndhiwa, Rachuonyo North, Rangwe, Suba, and Mbita), and six sub-counties in Migori County (Awendo, Nyatike, Rongo, Suna East, Suna West, and Uriri). AIRS Kenya introduced mHealth tools designed in response to specific challenges experienced during the 2017 IRS campaign. These included an automated, short message service-based inventory management system (e-Inventory 2.0), a mobile application for incident reporting, and three other smartphone or tablet-based tools to track spray performance, daily mobilization results, and financial payments to the thousands of seasonal workers.

Other program highlights include:

- The AIRS Kenya Technical Manager gave an oral presentation at the American Society of Tropical Medicine and Hygiene (ASTMH) 66th Annual Conference on November 8, 2018, in Baltimore, MD.
- The AIRS Kenya Operations Manager provided short-term technical assistance for field supervision during AIRS Mozambique's IRS campaign on October 10–November 8, 2018.
- AIRS Kenya began implementing health facility surveillance to measure the effects of IRS on reported malaria cases in Western Kenya. On September 25, 2018, AIRS Kenya began data collection from outpatient departments and lab registers at four sites in Migori (Rongo Sub-County Hospital (SCH), Uriri SCH, Macalder and Suri Korungu), and two sites in Homa Bay (Ndhiwa and Marindi). A CDC EIS Officer visited Rongo and Uriri sub-country hospitals with AIRS Kenya's chief of party, and she supports AIRS Kenya's technical approach.
- From October through December 2017, AIRS Kenya led sensitization meetings with community leaders, village elders, county/sub-county teams, and others in Homa Bay and Migori.
- AIRS Kenya submitted the Environmental and Social Impact Assessment for IRS in Homa Bay County to Kenya's National Environmental Management Authority on November 12, 2017. The Environmental and Social Impact Assessment approval was received on January 24, 2018 and is valid for two years.
- AIRS Kenya procured, and handled customs clearance of 115,400 bottles of Actellic®300CS.
- On December 4, 2018, AIRS Kenya's operations manager participated in a one-day, Bill and Melinda Gates Foundation-funded workshop in Naivasha on engaging women in vector control.
- AIRS Kenya facilitated sensitization meetings between Homa Bay county assembly members and the county director of health at the county assembly on January 26, 2018. Homa Bay's governor led the

IRS Launch Ceremony on February 12, 2018, and together with AIRS Kenya's chief of party recorded a statement on television and radio on February 9, 2018.

- On February 2, 2018, AIRS Kenya assisted the NMCP, at the PMI Kenya mission's request, with funding estimates for future IRS scale-up, by coordinating additional support from the Global Fund.
- AIRS Kenya's entomology team expanded surveillance to 16 sentinel sites, including new control sites in Kisumu County and intervention sites in Homa Bay County. Data collection began with expanded sites in November 2017.
- Entomological surveillance results showed that IRS with pirimiphos-methyl greatly reduced densities of *An. funestus*, the predominant malaria vector. However, *An. arabiensis* numbers were unaffected by spraying and this has become the predominant species in the IRS study areas. Biting rates of *An. funestus* were markedly reduced across the whole collection period, and no sporozoite infection was detected in mosquitoes sampled in IRS sites during the post-IRS period.
- Residual life testing of Actellic®300CS showed at least eight months' residual life following the 2017 IRS campaign. Insecticide resistance tests showed 100% mortality of wild FI *An. funestus* and FI *An. arabiensis* to pirimiphos-methyl. Pyrethroid resistance was observed for all malaria vectors.

1.8 LIBERIA

- Program Highlights AIRS Liberia and the Liberia NMCP vector control team conducted monthly malaria vector monitoring in three sentinel sites: Tomato Camp (Bong County), Jeneta (Margibi County), and Frank Town (Montserrado County). Mosquitoes were collected monthly, using CDC light traps and PSC. The HLCs collections were done every two months.
- The most abundant vector in all sites was *An. gambiae* s.l. (94%), followed by *An. funestus* (6%). Insecticide resistance intensity assays were done in different sites using 1X, 2X, 5X, and 10X. In Bomi County, the intensity of deltamethrin resistance was high, at the 10X level. The data collected in Cari, Bong County showed high-intensity deltamethrin resistance in the area.
- Synergist assays conducted at four sites indicated that PBO did not restore full susceptibility to pyrethroids in the populations of *An. gambiae* s.l. at the diagnostic time, suggesting the existence of mechanisms of resistance other than oxidases.

1.9 MADAGASCAR

PROGRAM HIGHLIGHTS

- Following the end of the spray campaign in Madagascar on September 30, 2018, the team closed all operations sites, dispatched all spray materials back to the central warehouse in Tamatave, and cleaned the data.
- The team performed all TO6 contract close-out activities, including all human resources, contractual, financial, and administrative tasks for a transition date of January 1, 2018.
- The AIRS team met with PMI and the Vector Control Working Group to share results from the geographical reconnaissance in Tulear II and Sakaraha and discuss the appropriate strategies to put in place to address security concerns.
- AIRS Madagascar temporarily loaned some IRS materials (500 pumps, 70 helmets) to the *Direction de Lutte Contre le Paludisme*/Malaria Control Program Unit for its focalized indoor residual spray campaign in the South West.
- Entomological data collected through December 2017 indicates that *Anopheles gambiae* s.l., *Anopheles funestus*, and *Anopheles mascarensis* vector species, and one potential vector, *An. coustani*, are present

at different prevalence in various sentinel sites. *Anopheles gambiae* s.l. is the most common mosquito in the East Coast and the South East. Results of the vector susceptibility tests indicate susceptibility of *Anopheles gambiae* s.l. to pirimiphos-methyl in all spray areas.

- The monthly monitoring of the insecticide decay rate for the insecticide used (Actellic® 300CS) showed that pirimiphos-methyl remains effective five months after spraying on all sprayed surface types in the South East and three months in the East (> 90% mortality).
- Entomological experts from Benin traveled to Madagascar to provide a practical one-week training session to the National Malaria Control Program's Entomology Lab personnel as part of capacity building.

1.10 MALAWI

PROGRAM HIGHLIGHTS

- Program Highlights The Malaria Alert Centre was subcontracted to conduct routine entomological monitoring in two sentinel sites in seven districts in Malawi.
- CDC light trap, PSC, and window exit trap methods were used to determine monthly vector density and sporozoite infections within *Anopheles* species, and to assess the impact of PBO nets in seven sites. The Malaria Alert Centre also conducted susceptibility tests to organophosphates, carbamates, and organochlorines using the standard WHO test kits and procedures.
- Preliminary analysis of data showed a high resistance to pyrethroids.
- Further analysis is required on vector density. In view of the low numbers of *Anopheles* mosquitoes, the non-systematic distribution of standard long-lasting insecticide-treated nets and PBO nets, and the fact that IRS will be conducted in Nkhosvota District, two districts will be changed going forward.

1.11 MALI

PROGRAM HIGHLIGHTS

- AIRS Mali staff, inventory, and activities transitioned to PMI VectorLink on January 1, 2018. In preparation for the transition, AIRS Mali worked on the inventory disposition plan and all of the necessary HR actions to close out and re-start the project on time.
- During the reporting period, the team developed the 2018 work plan and established regular monthly meetings with the mission, and quarterly meetings with the NMCP.
- Two representatives from the *Laboratoire de Biologie Moleculaire Appliquee* participated in the regional laboratory training at the Entomological Research Center of Cotonou (CREC) in Benin from November 13 to 24, 2017, which covered all commonly used AIRS laboratory protocols.
- The University of Notre Dame conducted a follow-up practical training at *Laboratoire de Biologie Moleculaire Appliquee* on December 4–8, 2017. The focus was on specific protocols for species identification and sporozoite ELISA.
- Using cone bioassays, the mortality rates of *An. gambiae* Kisumu in October 2017 (3 months post IRS) were found to be between 87.3% and 99.3% depending on the type of walls. In January 2018 (6 months post IRS), those mortality rates decreased and were between 54.2% and 85.3%.
- From October to December 2017, morphological identification of mosquitoes collected from HLC and PSC indicated that *An. gambiae* s.l. was the major malaria vector (95% of the collected vectors).

- The 2017 AIRS Mali entomological monitoring report was submitted to PMI on March 30, 2018 for review. It was subsequently translated into French and shared with the NMCP.

1.12 MOZAMBIQUE

TABLE 2: 2017 SPRAY CAMPAIGN RESULTS AT A GLANCE

Number of Provinces/Districts Covered by PMI-Supported IRS in 2017	Seven districts in Zambézia Province (Derre, Milange, Mocuba, Molumbo, Mopeia, Morrumbala, and Maganja da Costa)
Insecticide Class	Organophosphate (Actellic® CS)
Number of Structures Targeted for PMI-Supported IRS in 2017 (based on structures found by spray operators in 2016 as amended in cosultantation with NMCP)	438,764
Number of Structures Found by spray operators in 2017	435,395
Number of Structures Sprayed by PMI-supported IRS in 2017	381,463
2017 Spray Coverage	88%
Population Protected by PMI-Supported IRS in 2017	1,711,518 103,302 pregnant women 253,962 children under 5
Dates of PMI-Supported IRS Campaign	October 17–December 13, 2017
Length of 2017 Spray Campaign	50 days
Number of People Trained with U.S. Government Funds to Deliver IRS*	1,697
*Based on the PMI indicator definition, this number includes only spray personnel such as spray operators, TLs, brigade supervisors, and clinicians. It excludes data entry clerks, M&E assistants, database coordinators, drivers, washers, porters, pump technicians, and security guards.	

PROGRAM HIGHLIGHTS

- In collaboration with the NMCP, and several other local stakeholders, AIRS Mozambique conducted IRS using Actellic® 300CS in seven districts: Derre, Maganja da Costa, Milange, Mocuba, Molumbo, Mopeia and Morrumbala. Maganja da Costa was last sprayed in 2011 and as such was considered a new district in 2017.
- AIRS Mozambique adopted an improved spray operator and TL training strategy. Instead of a single central training for all spray operators and TLs in each district, the project conducted spray operator and TL training at the various operations sites. Training included “live fire” training in which spray operators were provided with practical real-life simulations.
- To improve mobilization, AIRS Mozambique introduced new cadres of staff: IEC assistants and community-based mobilizers. Each IEC assistant was responsible for and led all social mobilization activities for a designated operations site. The IEC assistants reported to the District Services for Health, Women and Social Welfare IEC coordinator and the AIRS district coordinators.
- The project located and rehabilitated 25 operations sites within the seven districts, all located in close proximity to the District Services for Health, Women and Social Welfare health center. In addition, the project built and used 34 mobile soak pits (MOPs).
- The project ensured all the 2016 leftover insecticide stock of 21,296 bottles was fully used, before spraying with the new 2017 insecticide stock. A total of 205,221 bottles were used and cleaned;

55,000 empty bottles were sent to two different plastics recycling companies for recycling into chairs and watering cans, while the remaining 150,221 are scheduled to be recycled in May 2018.

- AIRS provided technical support to the NMCP to implement the Nampula province spray campaign. The project conducted Pre Season Environmental Compliance Assessments on proposed operations sites for Nampula, provided materials and supplies, and oversaw construction of 10 mobile soak pits. To support NMCP IRS activities, the project conducted a national Training of Trainers on how to manage IRS operations. Representatives from collaborating national, provincial, and district government partners attended. In Nampula, data on malaria vector species composition, density, biting time, and seasonality was collected using CDC light traps, HLC, and PSC in all selected sentinel sites: Nampula, Monapo, and Erati (the control site).
- Entomological monitoring was conducted in five intervention districts in Zambezia province: Mocuba, Milange, Morrumbala, Maganja da Costa, and Mopeia, which is the operational research study district, and the control district Molevala. In Mopeia, entomological monitoring data was collected using CDC light traps and HLC. In Mocuba, Morrumbala, Milange, Maganja da Costa, and Molevala, entomological monitoring data was collected based on PSC, CDC light trap, and HLC.
- Monthly wall bioassays conducted for T1 showed mortality rates of 100% in all districts except in Maganja da Costa, where the T1 mortality was 80%. Monthly wall bioassays (T2-T5) were only conducted in some districts due to a shortage in the supply of mosquitoes from the insectary. In Mopeia, T2 and T3 cone wall bioassays showed 100% mortality, but there was a drop to 35.6% at T4 but increased 56.3% at T5. In Morrumballa, T2 and T5 tests were conducted and showed 100% and 97% mortalities, respectively.
- Susceptibility tests were conducted and showed that both *An. funestus* s.l. and *An. gambiae* s.l. were susceptible to pirimiphos-methyl at all sites. Resistance to pyrethroids was found at all sites. Intense resistance at 10 times the diagnostic dosage was found in *An. gambiae* s.l. populations at Morrumbala and Milange. Results of synergistic assays conducted at Morrumbala indicate metabolic resistance possibly due to monooxygenases.
- AIRS Mozambique continued to support the NMCP and the National Health Institute in carrying out entomological monitoring activities and enhancing capacity for entomological monitoring. The project also provided technical assistance to the NMCP to carry out susceptibility testing in seven provinces: Niassa, Tete, Manica, Sofala, Inhambane, Maputo, and Gaza.

1.13 NIGERIA

PROGRAM HIGHLIGHTS

- AIRS Nigeria staff, inventory, and activities transitioned to PMI VectorLink on January 1, 2018.
- The team developed the 2018 work plan, which was approved by PMI in March 2018, and also began preparing the subcontract for the Nigeria Institute for Medical Research (NIMR). The team also prepared contracts for principal investigators and entomology technicians, and procured entomology materials for both PMI-supported sentinel sites and Global Fund-supported sites.
- Entomological monitoring using various sampling methods was conducted in six sentinel sites representing all ecological zones of Nigeria.
- *An. gambiae* s.l. was the dominant malaria vector, representing 94% of the total *Anopheles* mosquitoes collected. Among the sibling species of *An. gambiae* s.l., *An. gambiae* s.s. was predominant, followed by *An. arabiensis*.

- Further analysis of the molecular forms of *An. gambiae* s.s. revealed that *An. gambiae* was the most abundant species found in five of the sentinel sites—the exception was in Ebonyi, where *An. coluzzii* was predominant.
- *An. gambiae* s.l. was found to be resistant to pyrethroids and susceptible to carbamate and organophosphate insecticides at most of the sentinel sites. The intensity of pyrethroid resistance was high, at 10 times the diagnostic dosage in the rainforest (Ebonyi and Oyo) sites. Also in Oyo and Ebonyi, additional resistance mechanisms are likely, as piperonyl butoxide did not increase mortality to 100%. These findings have operational significance for any planned vector control activities including LLINs or IRS.

1.14 RWANDA

TABLE 3: AIRS RWANDA AT A GLANCE

Number of districts covered by PMI-supported IRS	Three districts (Gisagara, Kirehe and Nyagatare)
Insecticide	Organophosphate
Number of structures sprayed by PMI-supported IRS	231,258
Number of structures found by PMI-supported IRS	232,966
Spray coverage	99.3%
Population protected by PMI-supported IRS	919,735 (14,433 pregnant women; 131,734 children under 5 years old)
Dates of PMI-supported IRS campaign	September 18–October 10, 2017, in Kirehe and Nyagatare Districts; and October 16–November 21, 2017, in Gisagara District
Length of campaign	20 days from September 18 to October 10, 2017, in the Kirehe and Nyagatare Districts, and from October 16 to November 21, 2017, in the Gisagara District.
Number of people trained with U.S. government funds to deliver IRS	2,203

PROGRAM HIGHLIGHTS

- AIRS Rwanda implemented an innovation dubbed “IRS Walk to Work Strategy.” The strategy’s main aim was to reduce costs associated with vehicles used to transport spray operators during spray operations. Additional benefits include reducing the project’s carbon footprint and health benefits to workers by promoting physical activity.
- AIRS Rwanda used electronic maps and mobile devices for data collection and operations management in the Nyagatare District. The platform was a cloud-based data recording and management system that allowed spray personnel to electronically collect spray data and GPS coordinates using tablets.
- AIRS Rwanda piloted the construction of two new soak pits in Kirehe and Nyagatare Districts using a sloped wash area that pipes effluent to a separate soak pit.
- AIRS Rwanda appointed two staff to provide full-time support to the Ministry of Health-supported IRS districts (one in each district) in the preparation for and during the implementation of the spray operations. In addition, AIRS Rwanda provided technical support for trainings, environmental compliance, store management, and data entry and management during Ministry of Health IRS operations.

- During the transition period from AIRS Rwanda to PMI VectorLink Rwanda, AIRS Rwanda conducted an inventory of IRS materials and equipment; identified all items for disposal; conducted a close-out of AIRS Rwanda including termination and rehiring of all employees by February 28, 2018; and oversaw startup of Rwanda PMI VectorLink on March 1, 2018.
- Monthly cone bioassays conducted following the September–October 2017 spray campaign in two districts (Nyagatare and Kirehe) showed 100% mortality of susceptible *An. gambiae* s.s. six months post-spray on all surfaces in all sites.
- PSCs and HLCs were conducted during the reporting period in three IRS districts (Bugesera, Kirehe, and Nyagatare) and one non-IRS (control) district, Ngoma. Morphological identification showed that *An. gambiae* s.l. was the major vector collected in all sites. Proportionately, very few *An. pharoensis*, *An. ziemanni*, *An. coustani*, and *An. funestus* were also collected. A molecular analysis conducted on samples of *Anopheles gambiae* s.l. showed that 64% were *Anopheles arabiensis*.
- AIRS conducted a refresher training of 30 sentinel site technicians on the evaluation of insecticide resistance in vectors using the CDC bottle bioassay, identification, and data analysis.

1.15 SENEGAL

PROGRAM HIGHLIGHTS

- After the NMCP Senegal decision to stop IRS with PMI funding, all 30 soak pits were dismantled as of November 2017.
- 49,098 empty bottles of Actellic® 300CS from the 2017 spray campaign were given to a recycling center. 742.2 kg of contaminated wastes (masks, Tyvek suits, wet wipes, activated charcoal) were incinerated by a regional hospital through the National Hygiene Services.
- The remaining insecticide (5,297 bottles of Actellic® 300CS) was sent to Burkina Faso in March 2018.
- PMI AIRS materials were inventoried and PMI approved a disposition plan for old equipment.
- AIRS Senegal was closed out in December 2017, and the PMI VectorLink Project started January 1, 2018 with the recruitment of a technical specialist as chief of party, a finance and administration manager, a regional environmentalist manager, and a driver.
- PMI VectorLink Senegal staff provided technical and operational assistance for the start-up of the project in Niger (chief of party, finance and administration) and Burkina Faso (finance and administration and regional Environmental Control Manager).
- In 2017 IRS districts, cone bioassays on walls (mud and cement) sprayed with pirimiphos-methyl (Actellic® CS300) produced mean mortality rates greater than the threshold of 80% between three to five months after spraying.
- *An. gambiae* s.l. was the main species collected in three sites, with *An. funestus* s.l. continuing to be the predominant species in Nioro.
- Overall, there was evidence that IRS had an impact in terms of vector biting rates and resting densities. However, the low general vector densities and high zoophily rate of *An. arabiensis* and *An. funestus* s.l. across the majority of Senegal, even in unsprayed areas, makes it difficult to quantify the degree of impact in terms of disease transmission. In Velingara and Kedougou, the vector trends are different, and highly anthropophilic *An. gambiae* predominated.
- *Anopheles gambiae* s.l. showed resistance to all three pyrethroid insecticides tested. For pirimiphos-methyl 0.25%, the vector populations were fully susceptible in all IRS sites, but resistance occurred in Dakar suburb and Diourbel.

- The two lab entomology technicians who participated to the regional training held in Benin shared recommendations with local partners in an aim to harmonize the protocols.

1.16 TANZANIA

TABLE 4: AIRS TANZANIA AT A GLANCE

	Zanzibar	Tanzania Mainland		Total
Number of districts sprayed by PMI-supported IRS in 2017/2018	8 (Central, Chakechake, Micheweni, North A, North B, South, West, Wete)	8 (Bukoba Rural, Missenyi, Ngara, Chato, Nyang'hwale, Butiama, Kwimba, Sengerema)	1 (Musoma Rural)	17
Insecticide	Pirimiphos-methyl (Actellic®300CS)	Pirimiphos-methyl (Actellic®300CS)	Clothianidin (SumiShield 50WG)	
Number of structures targeted by PMI-supported IRS	63,596	614,058	43,880	721,534
Number of structures found by spray operators	71,355	659,061	49,210	779,626
Number of structures sprayed by PMI-supported IRS	67,450	630,834	46,313	744,597
Spray coverage	94.5%	95.7%	94.1%	95.5%
Total population protected by PMI-supported IRS;	334,715	2,325,446	180,766	2,840,927
Children under five	57,314	423,715	34,789	515,818
Pregnant women	9,354	102,019	5,524	116,897
Dates of PMI-supported IRS campaign	Jan. 20–Feb. 11, 2018	Nov. 23–Dec. 20 2017 Feb. 14–Mar. 13, 2018		
Length of campaign (in days)	20	48		68
Number of people trained with United States Government funds to deliver IRS*	404	3,146	228	3,778

Note:

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

PROGRAM HIGHLIGHTS

- The 2017/2018 AIRS Tanzania spray campaign was conducted in three phases over 68 days in nine districts on mainland Tanzania and eight districts in Zanzibar per the table above.
-
- The project used 220,786 bottles of Actellic®300CS insecticide to spray 698,284 structures in 16 IRS districts, with a utilization ratio of approximately 3.2 structures sprayed per bottle of insecticide.

- The project used 14,144 sachets of SumiShield 50WG insecticide to spray 46,313 structures in the remaining district (Musoma Rural District), with a utilization ratio of approximately 3.3 structures sprayed per sachet of insecticide.
- Monthly monitoring of the insecticide decay rate in all sprayed districts showed that Actellic® remains potent after six months in Geita and Kagera Districts, as well as three months in Mwanza and Mara Districts – decay rate testing remains ongoing.
- A SumiShield 50WG (clothianidin) pilot was undertaken in Musoma Rural (entomological component), where local malaria vectors were found to be susceptible to it. Insecticide decay rate monitoring shows that the insecticide is still effective three months after spraying with SumiShield.
- AIRS Tanzania conducted refresher training of surveillance teams with the NIMR Amani Centre: 24 participants from three institutions.
- AIRS Tanzania funded two NIMR staff for an intensive two week entomological training in at the National Institute for Communicable Diseases, South Africa.

1.17 ZAMBIA

TABLE 5: AIRS ZAMBIA AT A GLANCE

Insecticide used	Organophosphates (Actellic® 300CS)
Number of provinces covered by PMI-supported IRS	4 (Eastern, Northern, Muchinga and Luapula)
Number of districts covered by PMI-supported IRS	36
Number of structures found by spray operators	684,635
Number of structures sprayed by PMI-supported IRS	634,371
2017 spray coverage	93%
Population protected by PMI-supported IRS	Total population: 3,005,676 Children under 5: 443,140 Pregnant women: 77,206
Dates of PMI-supported IRS campaign	October 2–December 16, 2017
Length of campaign (total days)	66 days
Number of people trained* with U.S. Government funds to deliver IRS	2,438

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

PROGRAM HIGHLIGHTS

- AIRS Zambia sprayed 36 districts in four provinces (Eastern, Muchinga, Luapula, and Northern). The start of the 2017 spray campaign was phased, with two districts starting on October 2, 2017, to accommodate the early rainy season; 25 districts starting on October 16, 2017; and nine districts starting on October 30, 2017. AIRS Zambia conducted extensive pre-season preparation activities and coordinated closely with Zambian government staff to ensure improved quality of IRS implementation in 2017. The 2017 spray season started later than in previous years, in response to the 2016 entomological recommendations to spray as close to the rainy season as possible.
- AIRS Zambia, in partnership with Akros, supported the implementation of an operational research study using mobile devices for data collection and management (mSpray) in six districts in Eastern province.
- In February, a post-spray review meeting was organized in each provincial capital and attended by PMI, AIRS, the National Malaria Elimination Program, and other stakeholders. During these

meetings, attendees discussed the operations, successes, challenges, lessons learned, and recommendations for the way forward for the 2018 campaign.

- A PSDQA was conducted 60 days after the completion of the campaign to evaluate whether data quality had improved compared to in the disappointing 2016 PSDQA results. The 2017 spray coverage outcome of 92.7% fell within the PSDQA’s 95% confidence interval (91.2 to 94.1), indicating that AIRS Zambia had implemented successful measures for increasing data accuracy and spray coverage.
- The most abundant malaria vector collected at AIRS entomological sites was *Anopheles funestus* s.l.
- The WHO cone bioassay was conducted in Kasama, Isoka, Milenge, and Mwense in October, and in Katete in November, following the IRS calendar, showing mortality at 100% 24 hours after spraying. The 100% mortality was also recorded at all sites for both mud and cement sprayed walls, corresponding to one and two months after spraying, respectively. The mortality for mud and cement sprayed walls three months after spraying was still above the 80% mortality threshold. Entomological surveillance was conducted in 12 sentinel sites in six districts in Zambia.

I.18 ZIMBABWE

TABLE 6: 2017 AIRS ZIMBABWE AT A GLANCE

Number of districts covered by PMI-supported IRS in 2017	Four districts: Chimanimani, Mutare, Mutasa, Nyanga
Insecticide	Organophosphate (Actellic®300CS)
Number of structures targeted by PMI-supported IRS	240,044
Number of structures found by spray operators during PMI-supported IRS spray season	216,864
Number of structures sprayed by PMI-supported IRS	209,055
Spray coverage	96.4%
Population protected by PMI-supported IRS	517,374 (including 8,121 pregnant women and 87,279 children under 5 years old)
Dates of PMI-supported IRS campaign	October 23 to November 30, 2017
Length of campaign	31 days
Number of people trained with U.S. Government funds to deliver IRS*	687 (594 men, 94 women)

* Based on the PMI indicator definition. It includes only spray personnel such as spray operators, TLs, supervisors, data managers, warners, IRS coordinators, provincial/district environmental health officers, provincial field officer, logistics assistant/transport officer, washers, storekeepers, guards, pump technicians, drivers, and clinicians.

PROGRAM HIGHLIGHTS

- In 2017, AIRS Zimbabwe continued to use pirimiphos-methyl CS formulation (Actellic®300CS), an organophosphate class insecticide, for malaria control in all four districts.
- PMI AIRS Zimbabwe continued working with provincial and district health officials in Manicaland province to lead, implement, and manage the IRS campaign in the same four districts.
- A month before the start of the 2017 IRS campaign, all personal protective equipment, other equipment, and commodities that had been procured and delivered to the AIRS Zimbabwe office in Harare were transferred and placed in the central warehouse in Mutare.

- The team recruited and trained seasonal staff for spray operations in time to launch the campaign on October 23, 2017. The campaign was extended by three days at most in one of the districts due to competing programs, which increased the number of call-backs needed.
- After the campaign, the country team held stakeholder and partner review meetings in February 2018 in Mutare, with a total of 40 participants drawn from all the seven districts in Manicaland.
- AIRS completed 12,133 environmental compliance inspections using smartphones. A total of 15 mobile soak pits piloted were successful. Twenty-two latrines were constructed at IRS campsites as a way of improving sanitation and promoting gender inclusion.
- The project incinerated 2,700 kg of IRS-contaminated waste generated during 2017 IRS campaign, which included used disposable respirators, used mutton cloth, and contaminated empty cardboard boxes. The incineration process took place at Hwange Colliery incinerator in January 2018.
- A total of 9,960 kg of triple-rinsed empty organophosphate bottles and 3,640 kg of uncontaminated empty organophosphate cardboard boxes generated from the 2017 spray campaign were recycled into electrical conduits, refuse bins, and tissue papers, in South Africa.
- The AIRS Zimbabwe project ended on February 28, 2018 and its staff, inventory, and activities transitioned to The PMI VectorLink Project on March 1, 2018.
- Monthly entomological monitoring was conducted at three sites (Burma Valley, Chakohwa, and Vumba) in Manicaland Province between October 2017 and March 2018. *Anopheles funestus* s.l. was the predominant species at all the sites, while *An. gambiae* s.l. was found in conjunction with *An. funestus* s.l. at Chakohwa.
- Monitoring insecticide decay revealed at least five months of residual activity of pirimiphos-methyl (an organophosphate class insecticide) at Burma Valley and Chakohwa. The insecticide decayed faster on painted and cement surfaces compared with mud and brick surfaces.
- Insecticide resistance tests were conducted on *An. gambiae* s.l. using DDT (4%), pirimiphos-methyl (0.25%), permethrin (0.75%), and chlorfenapyr. The result showed *An. gambiae* s.l. was resistant to DDT (80.5%) and pirimiphos-methyl (74%) in Makakavhule in Matebeleland South province; and to permethrin (88%) in Manjolo in Matebeleland North province. The same tests showed that this vector was susceptible to chlorfenapyr (100%) in Makakavhule and Kamhororo (Gokwe South province) and Manjolo.

2. CORE

2.1 TRANSITION TO NEW CONTRACT MECHANISM

During this reporting period, the 18 country programs transitioned from the PMI AIRS Project to the PMI VectorLink Project. The transition comprised a large volume of activities related to administration, finances, inventory disposition, and human resources. Annex C includes a list of all the transition dates and the work planning period of performance for each country.

2.2 OPERATIONS RESEARCH

Evaluation of pirimiphos-methyl efficacy in experimental huts when sprayed on half the usual surface area against natural populations of *Anopheles gambiae* s.l. in Ghana

The main objective of this study is to determine the efficacy of spraying pirimiphos-methyl in terms of percentage mortality in experimental huts partially sprayed (top or bottom half of the walls, with and without spraying ceilings), as compared to huts fully sprayed and negative controls that are not sprayed. The study is expected to determine whether the amount of insecticide sprayed and its operational cost can be reduced without compromising the efficacy of IRS.

The results from eight rounds of collections after spraying indicated that fully sprayed experimental huts showed the highest mortality (82.58%) of mosquitoes in morning collections. This was followed by huts sprayed on only the lower wall and the ceiling (67.20%), and then by huts sprayed only on the upper wall and ceiling (57.14%). Less than 50% mortality was observed in huts partially sprayed only on the upper half or lower half of the experimental huts. However, 53% of the mosquitoes were collected only during the first two rounds of post-spraying collections. The remaining six rounds of post-spraying collections only had 47% of the total post-spraying catches. The total number of mosquitoes collected from the eight rounds of post-spraying collections was less than the total collected at the baseline in one collection round.

The original design of experimental huts had the standard 1 cm windows slits, but this was modified to 3 cm window's slits due to poor access to the huts by the malaria vectors. Further collections with optimal design of the windows slit (3 cm) throughout the upcoming peak mosquito season (June through October) will help us get more-robust data to improve the sample size of mosquitoes collected and conclude the study with sufficient power. We proposed and received approval to continue data collection in the experimental huts during the upcoming transmission season to obtain an adequate sample size and conclude the study.

2.3 SUSCEPTIBILITY TESTING OF CHLORFENAPYR AND CLOTHIANIDIN

Bottle bioassays were conducted with a range of concentrations of chlorfenapyr to determine the diagnostic concentration (that which kills 100% of vectors tested). Results from 9 countries showed no signs of resistance to chlorfenapyr for a variety of species, including *An. gambiae*, *An. funestus* and *An. arabiensis*. The diagnostic dose varied by country, ranging from 12.5 to 200µg. The variation may have been partly due to variation in test conditions, as chlorfenapyr is known to be temperature sensitive in bioassays. CDC has recommended 100µg/bottle as the diagnostic concentration. This may need to be revised to 200µg/bottle following further discussion with partners.

Clothianidin susceptibility testing using SumiShield treated filter papers was conducted in twelve AIRS countries to determine baseline susceptibility status of wild *Anopheles* malaria vectors by testing a tentative diagnostic dose in WHO tube tests. Mortality trends were similar in most of the sites, with low rates of knock-down at 30 and 60 minutes followed by a gradual increase in mortality between 1 and 4 days after exposure, with little increase in mortality between 4-7 days post exposure. In nearly all sites mortality trends were similar for susceptible insectary strains and FI wild *Anopheles*. In general, the results were positive and showed full susceptibility to clothianidin.

2.4 MHEALTH

During the reporting period, the project used mobile tools in the following spraying countries: Kenya, Mozambique, Rwanda, Tanzania, Zambia and Zimbabwe. Kenya, Mozambique, Rwanda, Tanzania and Zambia used all three of the Dimagi-supported mHealth tools. Zimbabwe only used two of the three tools, as their Ministry of Health does not support the use of the Performance Management Tracker.

In addition to the existing supervisory forms on the Open Data Kit (ODK) platform, AIRS Zimbabwe continued the use of the digitized version of the Directly Observed Spray form for spray quality supervision. Additionally, the AIRS Zambia, Tanzania, and Kenya M&E teams implemented and planned for PSDQA data collection using mobile devices. During the AIRS Zambia PSDQA, GPS coordinates were captured at each surveyed structure and at several boundary points for the selected village, providing the M&E team with a clearer picture of the sampling pattern employed by surveyors during the exercise. AIRS Tanzania's updated application also includes prompts to notify surveyors if sampled structures are too close together.

Continuing a three-year collaboration with PMI Zambia, technology partner Akros implemented the mSpray mobile data collection and decision-making system in Eastern Province for the first time. mSpray allowed teams to electronically collect spray data and GPS coordinates from specific structures via handheld tablets. The change in location was prompted by an operational research study designed and implemented by Akros in collaboration with Zambia's National Malaria Elimination Program, PMI, and AIRS Zambia.

AIRS Rwanda completed its e-data collection pilot in Nyagatare District, which had begun earlier, during this reporting period. Efficiency of data reporting was encouraging, but issues with physical hardware, the Fulcrum application's usability by spray TLs, the specificity of the pre-loaded maps, and data cleaning were areas noted for improvement.

2.5 COST EFFICIENCY

AIRS continued implementing a series of cost-efficiency initiatives in several countries; AIRS Tanzania expanded a quasi-community-based IRS approach to seven districts on the mainland. In this model, vehicles were used for the first 16 days, followed by bicycles for the remaining eight days. Operation plans focused on spraying the structures furthest away first, and then using bicycles to reach structures close to the operation sites in the last days of the campaign.

In Mozambique, AIRS conducted seasonal worker trainings at the operation sites, which reduced transportation and per diem costs for participants. The model also allowed for smaller groups, which meant trainers could give individual attention to spray operators, and allowed facilitators to conduct "live fire" training more effectively.

Other cost-efficiency measures by individual countries included: reducing the number of spray campaign days; minimizing the number of district warehouses; regularly maintaining soak pits and site offices during the non-spray period, thus reducing high renovation costs; assigning mobilization and supervision components to the local government; using government-owned vehicles for project activities free of charge; decreasing the number of mobilizers; staggering spray starts each day to reduce vehicle rentals;

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

2.6 GENDER

The project continued to build a gender-balanced seasonal workforce through our country-based gender focal points. Across the project, innovative approaches led by field-based staff advanced the project's gender mainstreaming and female empowerment goals, and the project continues to disseminate results to inform the global dialogue. AIRS Mozambique produced a video that featured a female spray operator and her supportive husband. Gender focal points from Kenya and Ghana participated in a workshop in Kenya funded by the Gates Foundation, at no cost to the project, on Engaging Women in Vector Control. The project's gender focal points participated in a virtual meeting on responding to sexual assault and attempted sexual assault. AIRS staff administered the third year of the gender norms survey in Zimbabwe. This year's version includes three new measures that were piloted last year in Ethiopia and Madagascar.

The project's article "Equal Opportunity, Equal Work: Increasing Women's Participation in the U.S. President's Malaria Initiative Africa Indoor Residual Spraying Project" was published in the December 2017 issue of the peer-reviewed journal *Global Health: Science and Practice*. The article discusses how the project's gender policies are increasing the engagement of women in all aspects of spray operations, especially in supervisory roles. The project also contributed to the WHO's Global Health Workforce Network Gender Equity Hub.

2.7 ENVIRONMENTAL COMPLIANCE AND SAFETY

PMI AIRS continued to reduce the burden of completing and submitting supervisory forms, rolling out a new version in Kenya and Tanzania. We also continued to work on improvements to the incident reporting system and template.

Environmental Compliance Officers continued to use a standardized environmental activities plan, which details specific actions and dates for completion leading up to, during, and after the campaign. We proposed an environmental compliance symposium for the Multilateral Initiative on Malaria and it was accepted, with speakers coming from Ghana, Ethiopia, and Madagascar to talk about bottle and cardboard recycling, the implementation of mobile soak pits, and the DDT collection and disposal project in Ethiopia. With AIRS Kenya leading the way, we designed and executed a seat belt pilot, and provided short-term technical assistance from the home office to assist with and supervise the pilot, as well as to provide support for Kenya's operations. Finally, AIRS environmental compliance staff prepared, submitted, and received approval for a Supplemental Environmental Assessment Amendment in Tanzania for the use of SumiShield, which allowed the pilot test there to proceed.

2.8 CONFERENCES

- PMI AIRS successfully organized a symposium at ASTMH entitled "Innovative approaches to monitor resistance and resistance management for effective vector control" that was well attended by ASTMH participants. Of the six abstracts we submitted to ASTMH, two abstracts were accepted for oral presentations and the remaining four for poster presentations. PMI AIRS project staff conducted the oral and the poster presentations at the scientific and poster sessions, respectively.
- PMI AIRS submitted five abstracts to Pan-Africa Mosquito Control Association (PAMCA). All five abstracts were accepted, three for poster and two for oral presentations. Five project staff attended and presented the abstracts at the PAMCA conference.

2.9 COMMUNICATIONS

During this reporting period, five success stories were written, posted on the project and PMI websites, and distributed via the AIRS quarterly e-letter. AIRS distributed one e-letter (in March) and two e-alerts (February and January for the Vector LearningXchange) to more than 3,700 global health professionals. PMI AIRS continued to contribute a number of resources, tool kits, trainings, and videos to the Vector LearningXchange for use and dissemination.

2.10 JOURNAL ARTICLES

Five manuscripts were submitted and published in peer-reviewed journals during this reporting period. These include:

- DRC insecticide resistance and mosquito behavior, published in *Malaria Journal* March 2018
- 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, published in *Parasites & Vectors* January 2018
- Equal opportunity, equal work: Increasing women's participation in the President's Malaria Initiative (PMI) African Indoor Residual Spray (AIRS) program to prevent malaria, published in *Global Health Science and Practice* December 2017
- A village level cluster-randomized entomological evaluation of combination long-lasting insecticidal nets containing pyrethroid plus piperonyl butoxide synergist in Southern Mali, published in *Malaria Journal* November 2017
- Combination of indoor residual spraying with long-lasting insecticide-treated nets for malaria control in Zambezia, Mozambique: a cluster randomized trial and cost-effectiveness study protocol, published in *BMJ Health Journal* in February 2017.

2.11 NEW EMPLOYEES

- Cheyenne Cook, project communications assistant, is supporting all AIRS countries and managing the Vector Learning Exchange website.
- Tiffany Clarke, technical program manager, is supporting DRC, Liberia, Senegal, and Zimbabwe.
- Kelley Ambrose, technical program manager, is supporting Nigeria and Zambia.
- Naomi Riley, Sr. finance and contract manager, is supporting Ghana, Ethiopia, Liberia, and Kenya.
- Howard Kaufman, procurement manager, is supporting all AIRS countries in procurement.

2.12 NGENIRS

The PMI AIRS team continued to have biweekly meetings with the Innovative Vector Control Consortium's NGenIRS Project throughout the reporting period. In December, PMI AIRS validated the forecast for all countries, and included Actellic/SumiShield scenarios for five countries, which PMI selected to at least partially spray SumiShield in 2018. These countries included: Tanzania (pilot), Ghana (5000 structures), Madagascar, Burkina Faso, and Mali.

ANNEX A: M&E RESULTS SUMMARY

IRS RESULTS OCTOBER 2017–MARCH 2018

Country	# Structures Sprayed	# Structures Found	Spray Coverage	Total Population Protected	Children <5 Protected	Pregnant Women Protected	# People Trained*
Kenya**	440,969	468,646	94%	2,072,648	228,980	31,977	5,774
Mozambique	381,463	435,395	88%	1,711,518	253,962	103,301	1,697
Rwanda	231,258	232,966	99%	919,735	131,734	14,433	2,203
Tanzania**	744,597	779,626	96%	2,840,927	57,314	9,354	3,778
Zambia	634,371	684,635	93%	3,005,676	443,140	77,206	2,438
Zimbabwe	209,055	216,864	96%	517,374	87,279	8,121	687
TOTAL	2,641,713	2,818,132	94%	11,067,878	1,202,409	244,392	16,577

*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.

**EOSR not yet approved.

ANNEX B: INSECTICIDE AND EQUIPMENT PROCUREMENT

Commodity	Country	Description	Total Cost	Order/PO Date	Delivery Date
Entomology Supplies	DRC	Entomological Monitoring Supplies	2,626.00	1/22/2018	5/11/2018
Entomology Supplies	DRC	Entomological Monitoring Supplies	3,780.00	12/8/2017	5/11/2018
Entomology Supplies	Ethiopia	Entomological Monitoring Supplies	725.05	1/31/2018	4/29/2018
Entomology Supplies	Ethiopia	Entomological Monitoring Supplies	8,315.23	2/12/2018	4/29/2018
Entomology Supplies	Ethiopia	Entomological Monitoring Supplies	15,034.29	9/1/2017	2/21/2018
Entomology Supplies	Ethiopia	Impregnated Paper	8,414.28	2/2/2018	3/5/2018
Entomology Supplies	Ghana	Entomological Monitoring Supplies	603.00	12/14/2017	3/16/2018
Entomology Supplies	Ghana	Entomological Monitoring Supplies	1,288.54	12/12/2017	3/16/2018
Entomology Supplies	Ghana	Impregnated Paper	1,066.36	2/2/2018	2/11/2018
Insecticides	Kenya	Organophosphates	1,769,124.80	8/31/2017	12/14/2017
Verona Safety Supply	Kenya	Personal Protective Equipment	89,201.66	10/5/2017	12/21/2017
Hudson Sprayers and Parts	Kenya	Nozzles, Spare Parts	28,522.35	12/7/2017	2/2/2018
Entomology Supplies	Kenya	Impregnated Paper	2,657.42	12/12/2017	2/7/2018
Entomology Supplies	Liberia	Entomological Monitoring Supplies	\$1,062.91	12/14/2017	3/13/2018
Entomology Supplies	Liberia	Entomological Monitoring Supplies	981.15	12/14/2017	3/13/2018
Entomology Supplies	Madagascar	Entomological Monitoring Supplies	2,213.42	3/9/2018	Pending
Entomology Supplies	Mali	Impregnated Paper	7,632.00	2/21/2018	3/31/2018
Insecticides	Tanzania	Organophosphates	2,200,274.55	8/31/2017	1/26/2018
Insecticides	Tanzania	Organophosphates	916,186.70	8/31/2017	1/26/2018

Commodity	Country	Description	Total Cost	Order/PO Date	Delivery Date
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	1,915.00	3/2/2018	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	14,008.49	2/16/2018	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	4,913.10	2/7/2018	Pending
Entomology Supplies	Tanzania	Impregnated Paper	7,112.60	1/29/2018	Pending
Entomology Supplies	Tanzania	Impregnated Paper	1,317.58	12/11/2017	1/15/2018
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	2,722.64	11/17/2017	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	1,691.57	11/16/2017	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	3,968.67	11/16/2017	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	16,481.62	11/20/2017	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	10,859.70	11/17/2017	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	10,197.20	11/17/2017	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	1,853.60	11/14/2017	Pending
Entomology Supplies	Tanzania	Entomological Monitoring Supplies	6,241.26	11/14/2018	Pending
Insecticides	Uganda	Organophosphates	8,608,554.14	10/26/2017	4/7/2018
Entomology Supplies	Zimbabwe	Entomological Monitoring Supplies	6,035.55	9/26/2017	2/15/2018
Entomology Supplies	Zimbabwe	Entomological Monitoring Supplies	930.98	9/22/2017	2/15/2018
Entomology Supplies	Zimbabwe	Entomological Monitoring Supplies	2,900.21	10/31/2017	2/15/2018
Entomology Supplies	Zimbabwe	Entomological Monitoring Supplies	1,073.26	10/30/2017	2/15/2018
Entomology Supplies	Zimbabwe	Impregnated Paper	841.36	9/19/2017	1/18/2018
Entomology Supplies	Zimbabwe	Entomological Monitoring Supplies	593.10	9/22/2017	2/15/2018

ANNEX C:

TRANSITION DATES AND WORK PLAN PERIOD OF PERFORMANCE

COUNTRY	WORK PLAN TIMING
Burundi	December 1, 2017–September 30, 2018
DRC	December 1, 2017–September 30, 2018
Liberia	December 1, 2017–September 30, 2018
Uganda	December 15, 2017–December 31, 2018
Core	January 1, 2018–December 31, 2018
Benin	January 1, 2018–December 31, 2018
Burkina Faso	January 1, 2018–December 31, 2018
Ethiopia	January 1, 2018–December 31, 2018
Ghana	January 1, 2018–December 31, 2018
Madagascar	January 1, 2018–December 31, 2018
Mali	January 1, 2018–December 31, 2018
Nigeria	January 1, 2018–September 30, 2018
Senegal	January 1, 2018–December 31, 2018
Zimbabwe	March 1, 2018–February 28, 2019
Cote D'Ivoire	March 1, 2018–February 28, 2019
Rwanda	March 1, 2018–February 28, 2018
Mozambique	March 1, 2018–February 28, 2019
Sierra Leone	March 15, 2018–February 28, 2018
Malawi	April 1, 2018–March 31, 2019
Zambia	April 1, 2018–March 31, 2019
Cameroon	May 1, 2018–April 30, 2019
Niger	April 1, 2018–March 31, 2019
Cambodia	February 1, 2018–December 31, 2018
Kenya	July 1, 2018–June 30, 2019
Tanzania	July 1, 2018–June 30, 2019