PMI | Africa IRS (AIRS) Project

Indoor Residual Spraying (IRS 2) Task Order Four

SEMI-ANNUAL REPORT
OCTOBER 2012–MARCH 2013

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ACRONYMS

AIRS	Africa Indoor Residual Spraying Project
CDC	Centers for Disease Control and Prevention
CHV	Community Health Volunteers
COP	Chief of Party
COR	Contracting Officer's Representative
CREC	Entomological Research Center of Cotonou
ECO	environmental compliance officer
EEM	enhanced entomological monitoring
IEC/BCC	Information, Education, Communication and Behavior Change Communication
INRB	Institute for Bio-medical Research/Institute National de Recherche Bio-medicales
IRS	Indoor Residual Spraying
M&E	Monitoring and Evaluation
MOU	Memorandum of Understanding
N/A	Not Available
NMCC	National Malaria Control Centre
NMCP	National Malaria Control Program
PMI	President's Malaria Initiative
PPE	Personal Protective Equipment
PSDQA	Post-Spray Data Quality Audit
RTT	RTT Group, Ltd
STTA	short-term technical assistance
UCAD	Université Cheikh Anta Diop
USAID	U.S. Agency for International Development
USG	United States Government
WHO	World Health Organization

EXECUTIVE SUMMARY

During this reporting period the Africa Indoor Residual Spraying project (AIRS) implemented indoor residual spraying (IRS) campaigns in Angola, Ghana, Liberia, Madagascar, Mozambique, Rwanda, Zambia, and Zimbabwe, covering an average of 97% of targeted structures with IRS and protecting more than 5.5 million people from malaria. Monitoring and evaluation (M&E) of outcomes by country are reported in Appendix C.

TOP-LINE RESULTS FROM IRS CAMPAIGNS, OCTOBER 2012–MARCH 2013[1] [2]

- 1,073,610 structures sprayed
- 97% average spray coverage
- 5,577,141 people protected from malaria including:
  - 246,096 pregnant women
  - 778,992 children under five
- 5,556 people trained with United States government (USG) funds to deliver IRS

Entomological monitoring continued to be a core activity to help field staff prepare for and evaluate the IRS campaign. Entomologists identified common mosquito vectors and measured vector susceptibility to different classes of insecticide. These data ultimately informed decisions on insecticide selection. AIRS assessed quality of spraying and found decreases at various sentinel sites in human-vector contact after IRS, suggesting reductions in the transmission of malaria. During this period, AIRS also began enhanced entomological surveillance work in Burundi and the Democratic Republic of Congo.

AIRS developed new tools and provided trainings to facilitate smooth execution of IRS campaigns in all technical areas.

- Operations: AIRS implemented tools such as the Race to the Starting Line to help country managers ensure all preparations for the IRS campaign were completed on time.
- Environmental Compliance: The pre-season environmental compliance assessment was developed into a smartphone application to increase accountability among environmental compliance officers.
- Monitoring and Evaluation (M&E): AIRS developed the new M&E Error Eliminator tool to ensure data is accurately captured during spray operations and the post spray data quality audit (PSDQA) to identify and correct errors in data entry.

Finally, AIRS compiled operations, environmental compliance, and M&E tools to create the *AIRS Supervisory Toolkit for Better Indoor Residual Spraying*. Country operations managers learned how to use these tools during a week-long training in February 2013.

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[1] Does not include data from the AIRS Madagascar campaign, which targeted approximately 410,000 structures and 1.8 million people, since data were not final when this report was completed.

[2] Does not include data from the Zambia and Zimbabwe IRS campaigns, since AIRS is not leading spray operations or collecting data for these campaigns.

To ensure high quality completion of spray campaigns, AIRS dispatched experienced field staff to other AIRS countries to provide south-to-south technical assistance and, when needed, sent home office staff.

AIRS completed a costing study to better understand the cost of implementing IRS, how costs vary among different countries, and what the primary drivers of cost difference among countries are. In addition, AIRS developed a capacity assessment to measure the ability of country governments at the national and district level to carry out IRS without foreign technical assistance and identify capacity building opportunities. IRS best practices and success stories identified by AIRS were captured and disseminated via a new project website, e-letter, a knowledge management tool, a symposium at the American Society of Tropical Medicine and Hygiene conference, and presentations at the Roll Back Malaria Vector Control Technical Working Group.

1. COUNTRY PROGRAM HIGHLIGHTS

1.1 ANGOLA

TABLE 1: AIRS ANGOLA AT A GLANCE

Number of provinces/districts covered by President's Malaria Initiative (PMI)-supported IRS in 2012	3 (Huambo, Huila, Cunene)
Insecticide	Pyrethroid (Deltamethrin)
Number of structures covered by PMI-supported IRS	141,782
Number of structures targeted by PMI-supported IRS	145,107
2012 spray coverage	98%
Total population protected by PMI-supported IRS Pregnant women protected Children under five protected	676,090 37,049 115,678
Dates of PMI-supported IRS campaign	October 29–December 18, 2012
Length of IRS campaign	44 days
Number of people trained with USG funds to deliver IRS[1]	691

[1]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.

Entomology

The first entomological data collection on vector density, distribution, seasonality, and behavior was completed before the onset of the 2012 spray campaign in October. Spray quality was monitored within the first two weeks of spraying in Huambo, and insecticide decay monitoring continued through the end of March 2013. Since AIRS Angola does not have access to a susceptible colony, larvae and pupae were collected from the field and reared to adulthood in a temporary insectary in the AIRS Angola office for cone bioassay testing. Larvae were collected in the three neighborhoods of Caala, Chivela, and Benfica in the municipality of Huambo. The test mortality rates were 98% within two weeks of spraying, 97% one month after spraying, and 80% two months after spraying. The 2-3% survivorship of the exposed mosquitoes two weeks after spraying, and one month after spraying, could be explained by the susceptibility level of the local vectors to deltamethrin. The 20% survival rate of the tested mosquitoes two months after spraying might be due to insecticide decay and, to a lesser extent, decreased susceptibility of the vector to the sprayed insecticide. Experience from the other AIRS countries has also shown early declines in test mortality rates when wild mosquitoes of a certain degree of resistance are used for the cone bioassay, as compared to a susceptible colony. Based on these previous observations, higher test mortality rates would be anticipated if a susceptible mosquito colony were to be used.

With the assistance of the AIRS technical director, AIRS Angola conducted a susceptibility study in February 2013 to help guide insecticide selection for the 2013 spray campaign. Larval collections were carried out in Huambo and Huila. Larval densities were relatively low in Huambo, making it more challenging to find the known malaria vectors. The two species of anopheles mosquitoes collected in adequate numbers necessary to do separate testing for each were *An. gambiae* s.l. in Huila and *An. coustani* in Huambo. *An. coustani* from Huambo was fully susceptible to deltamethrin 0.05%, fenitrothion 1%, and bendiocarb 0.1% (100% test mortality rates). In Huila, *An. gambiae* s.l. was tested for susceptibility to the three insecticides— deltamethrin 0.05%, fenitrothion 1%, and bendiocarb 0.1%. A test mortality rate of 95% was noted for deltamethrin 0.05%, possibly suggesting the emergence of

resistance. One hundred percent test mortality was observed for both fenitrothion and bendiocarb, suggesting that the vector was completely susceptible to these two insecticides. The technical director also provided on-the-job training to the AIRS Angola entomological coordinator and to other entomological technicians who have been supporting entomological monitoring in Huambo. Finally, the technical director assessed the feasibility of setting up a mobile insectary in Angola, based on the success of the insectary-in-a-box that AIRS created by renovating a shipping container in Mali in 2012.

Program Highlights

Abt implemented the 2012 IRS spray campaign working in close collaboration with PMI Angola and the Angolan national, provincial, and municipal government authorities. The 2012 spray campaign was Angola's eighth round of PMI-funded IRS as part of the National Integrated Vector Control Management Strategy. The 2012 campaign targeted the provinces of Huambo, Huila, and Cunene. During October, AIRS Angola carried out mobilization and enumeration activities, as well as trainings for spray operators, health clinicians, washers, warehouse managers and assistants, drivers, and entomological technicians. Insecticides and personal protective equipment (PPE) procured internationally were delivered a week before the onset of the spray campaign. Distribution from the central warehouse was conducted in two phases.

During the first two weeks of the spray campaign, the AIRS Angola technical coordinator conducted an operations oversight trip. Her observations on warehousing, environmental compliance, M&E, and operations were all addressed in a timely fashion. The AIRS Angola chief of party (COP), operations manager, and the environmental compliance officer (ECO) were deployed in all three provinces throughout the campaign, ensuring the maximum level of supervision at all times. Though different challenges were faced and promptly rectified throughout the campaign, there were no major incidents, and no stock-outs. The AIRS project director visited the AIRS Angola team and spray sites in Huambo in November 2012. While in Huambo, he met with the Provincial Directorate of Heath, as well as PMI and the NMCP, to discuss year one challenges and opportunities, as well as preliminary plans for 2013.

Post-campaign spray activities consisted of post-spray radio messaging, demobilization and cleaning of warehouses and operational sites, and incineration of 1700kg of solid waste, which was completed by January 28. Evaluation meetings were held in all three provinces during February. These meetings reviewed preliminary campaign results, and served as a forum for feedback from provincial and municipal government stakeholders, beneficiaries, and other PMI partners on challenges and lessons learned.

In March 2013, the AIRS COP attended the Annual Planning Meeting at the NMCP with Directorates of Health from all 18 provinces as well as other stakeholders. AIRS received praise from the **Cunene provincial malaria program officer, Dr. Zephirin Meya Mpambu. "I want to congratulate Abt for an excellent spray campaign; this was the sixth campaign I have participated, which has included Namibe, Huambo, and Cunene Provinces. Two thousand and twelve was by far the best campaign, from the technical expertise, management, and partnership, which we look forward to building upon for the years to come."**

In February 2013, AIRS Angola staff, including the operations manager, logistics coordinator, and procurement coordinator, participated in the AIRS operations, logistics, and procurement regional workshop in Senegal. In addition, the AIRS Angola ECO traveled to Nigeria for additional hands-on training and for an in-country training on new environmental compliance tools and procedures, held by the AIRS environmental compliance manager.

The AIRS Angola Mini Work Plan was approved on February 1.

Challenges and Lessons Learned

- Community leaders and traditional authorities were expected to have a greater presence during mobilization and spray campaigns, in order to strengthen advocacy and community participation and acceptance of IRS. AIRS Angola will emphasize their role and participation from the micro-planning

stages in 2013.

- While refusal rates were relatively low, some homeowners were not very cooperative, claiming lack of time, or inconvenience of moving personal belongings outside for the required period of time, even when mobilizers and spray operators were willing to assist.
- The mobilization/enumeration training-of-trainers and the two-day mobilizer training did not provide sufficient time for mobilizers to become proficient. This led to the need for refresher trainings to improve the quality of worker performance, which was ultimately achieved.
- The lack of entomological capability, and the distance between target areas, made consistent entomological monitoring of all municipalities very challenging or sometimes even impossible.
- The pool of qualified data entry clerks was limited. Of those selected, most did not meet the criteria and therefore needed further training and closer supervision throughout the season. This attention did, however, significantly improve the selected candidates' technical skills and professional capacity.
- Significant delays with respect to data entry and data cleaning occurred in Angola. Limited supervision during the holidays was a major contributing factor. In 2013, AIRS Angola will ensure better field supervision for both the mobilization and spray campaigns, to guarantee enough on-the-ground supervision of data collection. The project will also employ more data entry clerks and M&E assistants to ensure more expeditious data entry.

1.2 BENIN

Entomology

AIRS Benin ended its subcontract with the Entomological Research Center of Cotonou (CREC) on October 31, 2012. AIRS will continue to coordinate with CREC for the 2013 IRS campaign, but PMI/Benin will contract with CREC directly to complete entomological surveillance.

Program Highlights

During the period covered by this report, AIRS Benin focused on planning and preparing for the May–June 2013 IRS campaign. On November 29, 2012 the NMCP, AIRS Benin, and PMI/Benin held a meeting to select districts that the 2013 IRS campaign will cover and the insecticide to be used during the 2013 IRS campaign. All meeting participants agreed to cover all nine districts in Atacora during the 2013 IRS campaign. It was also agreed that five districts (Materi, Cobly, Tanguieta, Toucountouna, and Kouande) will be sprayed with organophosphate in 2013, due to decreased susceptibility to carbamates among their populations of mosquitoes. The remaining four districts (Natitingou, Boukoumbe, Pehunco, and Kerou) will continue to be sprayed by carbamates. PMI and AIRS both noted that with the decreased susceptibility to carbamate in Atacora Region, the entomological surveillance of the IRS campaign in the four carbamate districts will need to be closely monitored, particularly with regard to the residual life of the carbamates that are sprayed. Additionally, the NMCP noted that only the EC formulation of organophosphate can be used during the 2013 IRS campaign, as the CS formulation of organophosphate has not received approvals from the World Health Organization Pesticide Evaluation Scheme (WHOPES). Residual life of the EC formulation will also be closely monitored.

In February 2013, AIRS Benin completed an initial review of all soak pit and store room sites that will be used for the 2013 IRS campaign. The data gained from the review was used to write the 2013 Benin Letter Report, which was submitted on February 28, 2013.

Other activities completed by the AIRS Benin team include the initial procurements of PPE and other IRS commodities for the 2013 IRS campaign, and review and revision of IRS campaign training materials, with regard to spraying organophosphates. AIRS Benin also finalized its End of Spray Report in late 2012, and submitted its 2013 work plan on November 1, 2012. AIRS Benin also provided south-to-south

short-term technical assistance (STTA), with the project's COP and technical manager traveling to Burkina Faso to help close the AIRS Burkina Faso project, and the AIRS Benin operations manager traveling to Madagascar in December to help the AIRS Madagascar team manage its IRS campaign in the central highlands.

The AIRS Benin team also conducted an internal Post-Spray Data Quality Audit (PSDQA) as a form of auditing the data that was collected during the 2012 IRS campaign in November 2012. The results showed that the difference in spray coverage is small, with the audit showing 88.4% of eligible structures sprayed, compared to 94.79% reported in the 2012 End-of-Spray Report.

Finally, the AIRS Benin team was pleased to host the U.S. Ambassador to Benin, James Knight, during a trip to Atacora Region to review USG-funded activities on March 12, 2013. Ambassador Knight visited Toucountouna district and had an opportunity to meet with local officials regarding the IRS programs. AIRS Benin also helped arrange the opportunity for Ambassador Knight to speak with IRS campaign beneficiaries, who noted that IRS programming had helped to limit malaria in their communities.

Challenges and Lessons Learned

- Overall AIRS is pleased with the project's work in Benin, and is aiming to move forward with new activities in 2013 to build the NMCP's capacity to take a larger role in IRS. This will chiefly consist of mentoring NMCP staff to develop their capacity in the daily operations management of IRS campaigns.
- The largest future challenge involves budget and program decisions about insecticide selection.
- AIRS Benin will spray with both carbamates (four districts) and organophosphates (five districts) in 2013, but with the vectors' susceptibility to carbamates continuing to decrease, IRS stakeholders will need to consider spraying all districts in Atacora Region with organophosphates or another class of insecticide. Depending on the class of insecticide selected, this could have a significant impact on future project budgets.
- The AIRS Core team has high praise for the AIRS Benin team, for developing its own covers for all 16 soak pits in the Atacora Region. The 16 soak pit covers contain galvanized steel inserted with four metal supports at each corner. Each cover was designed to be locked into place with two padlocks to prevent its being stolen, while allowing the covers to securely enclose the soak pits during non-spray months.

1.3 BURKINA FASO

Entomology

No entomology activities to report on during this period.

Program Highlights

The AIRS Burkina office formally closed in December. By October 2012 most of the staff had already found new jobs and only a few staff remained. The AIRS Benin COP and AIRS Benin technical manager each went to Burkina once, to ensure a smooth close-out operation and to represent Abt in senior-level meetings and in meetings with local counterparts regarding the 2012 spray campaign. In December, AIRS sent a close-out specialist, Jessica Erbacher, to coordinate close-out activities including: inventory check and disposition per USAID/Burkina's guidance; handover of office space; shipment of paper files to the Home Office; and shipment of leftover insecticide to Benin. All activities were properly closed out in time, and the remaining staffs were given their severance payments according to local labor law. The AIRS Burkina Faso End-of-Spray Report was approved on January 8.

Challenges and Lessons Learned

The only challenge faced during the close-out period involved finding the appropriate shipping company to deliver the leftover insecticide to Benin. After gathering three quotes, we selected one vendor, but the transaction later fell through, as they were unwilling to carry out the shipment by land (our preferred method) due to complications expected at the border. This delayed shipments. We settled with another vendor, which carried out the shipment, but not without also having some logistical challenges in getting it out of the country. Ultimately, the shipment arrived safely in Benin and the delay did not affect the closeout of the project.

1.4 BURUNDI

Program Highlights

Malaria is the number one cause of child mortality in Burundi. To maximize the impact of malaria prevention programs and prevent child deaths, AIRS received funds from PMI to analyze mosquito density and behavior in Burundi, along with insecticide susceptibility. Specifically, the objective is to work with the National Malaria Control Program (NMCP) on enhanced entomological monitoring (EEM) and to establish a functioning insectary.

In October, two AIRS project staff—a technical coordinator and the AIRS Rwanda integrated vector management advisor—traveled to Burundi to attend an NMCP work planning retreat, and identified specific areas for support. A first work plan draft was submitted on October 15, 2012. The AIRS Burundi technical coordinator, Ms. Jane Coleman, joined the project in November and began communicating with the Contract Officer Representative (COR) team and the USAID/Burundi Program on the work plan activities and budget to ensure AIRS was meeting the NMCP's needs.

In January, Ms. Coleman traveled to Burundi to finalize the work plan, attend the Roll Back Malaria Meeting, and meet with the NMCP to discuss program activities. Between February and March, AIRS Burundi recruited an entomologist consultant to help the NMCP identify sentinel sites, organize EEM activities, and begin to establish a functional insectary. The entomologist is based in Bujumbura and began a five-month consultancy on April 1. The work plan and budget were approved, and internationally procured items were ordered and shipped to the NMCP in April.

Challenges

All communication has been via email and phone, which has led to some miscommunications and delays in start-up activities. However, AIRS recruited and hired an entomologist to work with the NMCP on a daily basis, which will improve communication between AIRS, the NMCP, and other USAID partners based in Burundi. Also, AIRS is working to put a system in place to facilitate local procurement.

1.5 DEMOCRATIC REPUBLIC OF THE CONGO

Program Highlights

Although DRC is not currently using IRS to prevent malaria, approximately 51% of households have at least one long-lasting insecticide-treated net. To ensure that the nets are effective in preventing malaria, AIRS received funding from PMI to test insecticide susceptibility and analyze mosquito behavior. The objective of this activity is for AIRS to work with the NMCP to strengthen entomological monitoring and to support a research institute affiliated with the University of Kinshasa, Institute National de Recherche Bio-medicales (INRB). AIRS was asked to support INRB in performing EEM activities, providing a two-week training, and procuring entomological equipment. The work plan and budget were created, reviewed, and approved by the COR team, PMI Mission, and an entomologist from the Centers for Disease Control and Prevention (CDC) working with PMI on DRC activities. A subcontract was created between AIRS and INRB for the period of performance: April 15, 2013 to September 10, 2013.

INRB identified international procurements that were needed for the training and for sentinel-site field activities.

Challenges

Due to the lack of an AIRS field office or any local staff on the ground, all communication has been via email and phone, which has led to delays in start-up activities, due to problems with internet connectivity and miscommunication. A proposed STTA trip is in place for the technical coordinator and technical director to visit the subcontractor and USAID Mission.

1.6 ETHIOPIA

Entomology

Through the end of December 2012, the project continued undertaking entomological monitoring activities that included all PMI primary indicators. Residual efficacy of bendiocarb was monitored monthly after the spray began in mid-August. Wall bioassay tests showed that in December, four months after spraying with the susceptible colony, the average test mortality rate of the vector had declined to 86%.

During the reporting period, the project assessed susceptibility of the main vector against 10 WHO-approved IRS insecticides in one sentinel site (Bahrdar). Test results showed that the vector was fully susceptible to pirimiphos methyl, fenitrothion and propoxur (100% test mortality). Possible resistance to bendiocarb (87% test mortality) and resistance to deltamethrin (44 %, test mortality), alphacypermethrin (42% test mortality), etofenoprox (21% test mortality), DDT (6% test mortality) and malathion (26% test mortality) were noted. Findings are consistent with the results from four other sentinel sites.

Monthly vector monitoring showed that vector density was significantly reduced after IRS in both deltamethrin- and bendiocarb-sprayed sentinel sites with higher reduction in the bendiocarb-sprayed area. Four months after spraying, the density of *An gambiae* s.l. was 19 times, 28 times and 7 times lower in a deltamethrin sprayed village, a bendiocarb sprayed village, and a control village, respectively, as compared to the pre-spray baseline. While results from the control area suggest factors other than IRS may have contributed to the reduction of mosquito density, the dramatic reduction in the two intervention areas suggests IRS impacted mosquito density. More *An. gambiae* s.l. attempted to bite outdoors than indoors and this was similar to previous investigations in other parts of Ethiopia. Given *An. arabiensis* is the member of *An. gambiae* complex found in Ethiopia, the result is consistent with previous findings.

More half-gravid and gravid compared to fed mosquitoes (with a ratio of 1 fed to 2.63 gravid and half gravid) were collected with pyrethrum spray catch in the bendiocarb-sprayed site during the pre-spray collection, indicating an indoor resting tendency. Lower proportions of gravid mosquitoes were collected indoors after spraying, indicating that bendiocarb affected resting patterns. Peak biting time differed from site to site but, in general, landing was higher in the second half of the night than the first half. The parity rate was reduced by 35% four months after spraying in the bendiocarb-sprayed site, whereas the reduction in parity in the deltamethrin-sprayed site was 12.9 %. Parity rates increased in the control villages as compared to the baseline.

Program Highlights

During this period, AIRS Ethiopia completed a post-spray evaluation of the 24 districts graduated from PMI support in 2012, analyzed the community-based IRS pilot implemented in Kersa district, and conducted a gender analysis of IRS operations, which was led by AIRS subcontractor Cultural Practice. AIRS Ethiopia arranged a training on incinerator use and maintenance by a Kenya-based company that supplies incineration machinery across Africa. The Kenyan supplier also calibrated the two incinerators inherited from the previous contractor and diagnosed an issue with one of them. The project replaced a malfunctioning part and began the incineration process in January 2013. The project is completing the

procurement of a large amount of equipment and materials to be donated to Jimma University, to enhance the university's molecular and biochemical analysis capacity.

Several contractual documents were approved during this time including the end-of-spray report on February 25, the 2013 work plan on March 22, and the enhanced entomological surveillance work plan on January 31.

The AIRS Ethiopia operations manager and logistics and procurement coordinator attended a regional AIRS training in Senegal, on the topics of logistics management, procurement procedures, and innovations in IRS operations.

At PMI's request, AIRS Ethiopia is continuing to investigate the best manner to transport obsolete DDT and DDT waste from 60 PMI-supported districts to a central location, for future reformulation or waste disposal. AIRS analyzed the cost of this activity and the labor and transportation aid required. Jointly with PMI/Ethiopia, the project visited the local DDT manufacturing plant at Adami Tulu, and spoke with plant managers to discuss options for storing DDT at the plant.

Challenges and Lessons Learned

- At the end of February, district authorities stopped the incineration process on the grounds of health and environmental risks, even though the Ethiopian Environmental Protection Agency had certified the machinery, the procedure, and the work site. Further discussions with the local officers indicated that it was mainly a political decision due to upcoming local elections. To address the issue, AIRS Ethiopia is working with the local government to set up a working group and conduct sensitization meetings with community leaders and health authorities in the area.
- The challenge with implementing activities under the Expanded Entomological Support work plan is inconsistent collaboration and responsiveness from district health offices. As part of the work plan, AIRS Ethiopia provided a national training on insecticide resistance where only 21 out of 26 invited districts sent participants. The project invited the five missing districts for a follow-up practical training, and only four of them sent representatives. To make sure the quality of work meets the standards at sentinel sites, AIRS is planning enhanced supervision in all 26 sentinel sites (districts) during the actual insecticide-resistance data collection.

1.7 GHANA

TABLE 2: AIRS GHANA AT A GLANCE

Number of districts covered by PMI-supported IRS	Half of one district as part of an operational research study: Bunkpurugu/Yunyoo
Insecticides	Pyrethroids
Number of structures covered by PMI-supported IRS	16,354
Number of structures targeted by PMI-supported IRS	17,239
Spray coverage	95%
Total population protected by PMI-supported IRS Pregnant women protected Children under five protected	41,100 710 6,778
Dates of PMI-supported IRS campaign in 2012	October 29–November 24, 2012
Length of campaign	22 days
Number of people trained with USG funds to deliver IRS[1]	N/A

[1]All trainings were completed before this reporting period.

Entomology

In the spring of 2012, 9 districts were sprayed in the northern region of Ghana. A combination of insecticides were used, pyrethroids were used in 3 districts and organophosphates were used in 5 districts. The remaining district was sprayed in one half with pyrethroids in the other half with organophosphates. In the fall, half of one district (Bunkpurugu/Yunyoo) was sprayed as part of an operational research study in October and November.

As part of the entomological monitoring activities in 2012, monthly surveys were conducted in three of the nine districts sprayed (Savelugu/Nanton, Tolon/Kumbungu, and Bunkpurugu/Yunyoo districts) and one unsprayed district (Tamale metropolis). Results from the surveys conducted by AIRS, Ghana Health Service, and the Noguchi Memorial Institute of Medical Research joint team showed a high quality of spraying in Bunkpurugu/Yunyoo and reduced entomological transmission indicators in IRS areas.

- The numbers of indoor resting mosquitoes in the IRS areas were less than in the control district. Average room densities recorded were 65 and 11 for the intervention districts of Tolon and Savelugu, respectively, compared to 88 for Tamale, the control district. There was also a reduction in parity rates of mosquitoes in the IRS operational areas compared to in Tamale, indicating a reduction in mosquito longevity. The mean parity rates for the IRS areas, Tolon, and Savelugu districts, for the period from October 2012 to March 2013 were 42.1% and 36.2%, respectively, while the control area (Tamale) had a mean parity rate of 67.9%.
- Entomological monitoring data from the WHO wall bioassays suggests that both the sprayed organophosphate and pyrethroid insecticides were effective at killing vector mosquitoes. The cone bioassay tests conducted through December 2012, which exposed susceptible mosquito colonies to both the organophosphate- and pyrethroid-sprayed walls, showed high test mortality rates. The residual life of the sprayed organophosphate insecticides (Actellic CS) remained higher than the 80% acceptable threshold, even six months after the walls were sprayed. The test mortalities ranged from 90.0-93.4% six months after spraying, while the control mortalities ranged from 0.0-10.0%. The bioassay tests were also used to assess the quality of spraying during the fall IRS campaign in Bunkpurugu/Yunyoo district. The results indicated a high quality of work by the spray teams that sprayed the area, and strong performance of the insecticide. One hundred percent mortalities were recorded among the three different types of walls tested: wood, cement, and mud.

Program Highlights

A new COP and F&A manager took up posts in Ghana in October 2012.

As part of a PMI-funded operational research study, the Ghana AIRS team provided logistical support for the Anemia and Parasitemia study (AP5), which was conducted in the Bunkpurugu/Yunyoo district at the end of the peak transmission season of 2012 (October 15–30). AIRS conducted information, education, and communication and behavior change communication (IEC/BCC) activities, coordinated vehicle transportation, and provided per diem for the members of the study team. Spraying in Bunkpurugu/Yunyoo district was performed from October 29 through November 24, 2012. As part of environmental compliance activities, the team collected all Actellic bottles from the Spring spray rounds and took them to a recycling plant where they were recycled into pavement blocks, plastic chairs, and plastic ceiling tiles. The AIRS Ghana End-of-Spray report was submitted during this time and approved on March 11.

In 2013, the Ghana AIRS team decided to shorten the length of the spray campaign in order to finish operations just before the malaria transmission period increases dramatically. This decision was based on entomological evidence collected over the previous years. The spray campaign is scheduled to take

place from mid-April to mid-June. In preparation for the campaign, they conducted environmental compliance assessments, recruited and trained seasonal staff, performed IEC/BCC activities, prepared our logistics and transportation plan, and procured international and local supplies.

Lastly, AIRS is coordinating a scoping exercise to determine whether there is another location within Ghana that could potentially be more beneficial to spray than the northeastern part of Ghana. As part of this exercise, AIRS contracted the Liverpool School of Tropical Medicine to conduct a literature review. Once the literature review is completed, entomological data will be collected and analyzed.

Challenges and Lessons Learned

The main challenge that the Ghana AIRS team faced during this time period involved the Actellic shipment. The insecticide was first shipped by sea from Belgium to Durban, South Africa where it was anchored for several weeks and then sent to the South African Bureau of Standards for pre-shipment quality assurance testing. It was then shipped by sea to Ghana. It then took several weeks to clear the insecticide from the port. Due to the long time the insecticide spent in a metal shipping container at sea and in port, the AIRS team and PMI were worried that the heat and sun might have had a negative impact on the insecticide's effectiveness. Several samples were flown to back the South African Bureau of Standards for testing, and the results showed that the active ingredient did not meet the established standards. Since results from quality assurance testing of insecticides are not always reliable, AIRS Ghana worked with the supplier to test the insecticide at two other labs (one in South Africa and one in the United Kingdom), including testing it for toxic byproducts, and all test results met the established standards. While the insecticide was ultimately deemed to be safe and effective for spraying, the testing took several weeks to coordinate, and delayed the start date of the campaign from April 15 to April 29.

1.8 LIBERIA

TABLE 3: AIRS LIBERIA AT A GLANCE

Number of provinces/districts covered by PMI-supported IRS	2 counties located in 2 districts located in 2 counties (Margibi and Montserrado)	7 counties located in 1 district (Bong)
Insecticide	Carbamates	Organophosphates
Number of structures sprayed by PMI-supported IRS	21,152	
Number of structures targeted by PMI-supported IRS	21,564	40,000
Spray coverage	98%	
Total population protected by PMI-supported IRS Pregnant women protected Children under 5 protected	196,279 7,875 28,860	
Dates of PMI-supported IRS campaign	October 3 – November 9, 2012	March 19 – May 3, 2013[1]
Length of campaign	31 days	
Number of people trained with USG funds to deliver IRS[2]	153	

[1]Spray campaign data for the 2013 campaign will be finalized 60 days after the spray campaign finishes.
[2]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.

Entomology

The IRS program worked closely with the Vector Control Unit of the NMCP and the Liberia Institute for Biomedical Research to provide entomological monitoring of insecticide resistance and quality of spraying.

During the 2013 spray campaign, four sentinel sites—two representing IRS areas (Palala town in Panta district and Haindi in Fuamah district), one representing a non-IRS area (SKT town in Suakoko district), and one representing a former IRS district (Frank Town in Careysburg district)—were selected to monitor mosquito densities, behavior, and insecticide resistance status. The entomological baseline study was intended to form the basis of a before and after assessment of IRS operations. Before the start of baseline data collection, a two-day training in adult mosquito collection methods was organized for two community health volunteers (CHVs) selected from each study site. The CHVs received practical training on how to conduct pyrethrum spray catches and human landing catches, and how to set up CDC light traps. The training was conducted by the AIRS technical manager and one NMCP technician.

Entomology surveillance for 2013 started with baseline mosquito collection conducted during the dry season. As expected, low vector densities were observed in three of the study sites. *An. gambiae* s.l. was the most commonly collected malaria vector during this baseline study. Most vectors sought to bite humans indoors rather than outdoors, suggesting that most vectors were endophilic. It was also observed that the CHVs had limited knowledge of malaria vectors, and it will take effort to build their knowledge base in malaria entomology.

The 2013 spray campaign started on March 19 in all districts located in Bong County. Cone bioassays were conducted within 24 and 60 hours after spraying in two selected study sites, Palala and Haindi respectively, to assess the quality of spraying and the susceptibility of local mosquitoes to the Actellic 300 CS-sprayed walls. A total of 222 female mosquitoes were exposed to sprayed mud and cement walls for 30 minutes. Twenty-four hours after spraying, the mosquito test mortality rates among local *An. gambiae* s.l. were 100% in both study villages, suggesting that the quality of spraying was good and insecticide deposited on the tested walls was sufficient to kill malaria vectors landing and resting on them.

Program Highlights

IRS was conducted in the two districts that used a carbamate from October 3 through November 9, 2012. Spray operations were monitored by AIRS staff, the NMCP, the Ministry of Health, the Liberia Environmental Protection Agency, and local officials. In an effort to build the capacity of local stakeholders, the IRS supervisors in various districts were government officers from the NMCP, community health teams, and district health offices. It took 31 days to complete spraying in both districts. The end-of-spray report for this campaign was approved on February 19 and the work plan for the following campaign was approved on March 1.

The Liberia team began preparing for spraying again at the beginning of the year, and IRS operations started in the five target districts on March 19. The target was to spray 40,000 structures and achieve at least 85% spray coverage. Preliminary calculations showed that there might not be enough structures in the five identified districts to reach this target, thus the team sprayed in two additional, adjacent districts, Zota and Sanoya. Spraying will continue throughout April and should finish in the beginning of May. Actellic CS, an organophosphate, is the insecticide of choice for the 2013 spray campaign.

In addition to spraying, the Liberia team hired a local contractor to create a container insectary modeled off the AIRS Mali insectary-in-a-box. Before the vendor is allowed to start setting up the insectary on NMCP grounds, several approvals and administrative procedures need to be finalized with the Ministry of Health.

Challenges and Lessons Learned

- Because of the dry season, few mosquitoes were available during the pre-spray baseline survey. Once spray operations began, entomology quality assurance testing was conducted on time. The team will monitor insecticide decay rates on sprayed walls on a monthly basis until December 2013.
- Administrative procedures and requirements have postponed the start of the work on the mobile insectary.

1.9 MADAGASCAR

TABLE 4: AIRS MADAGASCAR AT A GLANCE

Number of provinces/districts covered by PMI-supported IRS in 2012	15 districts Central highlands (Ambatofinandrahana, Ambohimahasoa, Ambositra, Ankazobe, Anjozorobe, Betafo, and Mandoto) Southern (Amboasary, Ambovombe, Ampanihy, Bekily, Beloha, Betroka, Tolagnaro, and Tsihombe)
Insecticide	Carbamate: Ambatofinandrahana, Ankazobe, Anjozorobe, Betafo, Mandoto, Amboasary, Ambovombe, Ampanihy, Bekily, Beloha, Betroka, Tolagnaro, and Tsihombe Pyrethroid: Ambohimahasoa and Ambositra
Estimated number of structures targeted for spray as reported in 2012 Work Plan	410,000
2012 spray coverage	N/A
Estimated population targeted by PMI-supported IRS in 2012	1,800,000
Dates of PMI-supported IRS campaign	Central highlands: November 17, 2012–December 22, 2012 South: February 4, 2013–April 29, 2013
Length of IRS campaign	Central highlands: 28 days South: 56 days
Number of people trained with USG funds to deliver IRS[1]	N/A[2]

[1]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.
[2] The data from Madagascar is not available for this semi-annual report, as Madagascar will continue with mop-up spraying in April. Therefore, all spray campaign data, including the number of people trained, will not be available until all of the IRS campaigns have been completed, and AIRS has a chance to clean its IRS campaign data.

Entomology

AIRS Madagascar, through the work of its technical director/entomologist, and the project's four entomological surveillance teams, completed significant entomological surveillance at ten sentinel sites, including collecting data at three national sentinel sites to help the NMCP with its national malaria surveillance. The AIRS Madagascar entomological surveillance teams completed a baseline data collection one month before the IRS campaign in the central highlands (in September) and in the south (in November), noting that *An. gambiae* s.l. continues to be the most prevalent vector species in the areas where AIRS completes its IRS campaigns.

During the first week of the IRS campaigns in the central highlands and the south, AIRS Madagascar completed wall bioassays tests at four sentinel sites in the central highlands, and at one sentinel site in the south. AIRS Madagascar found the quality of spraying was good with test mortality rates of 100% 24 hours after spraying at all sentinel sites.

As of March 2013, carbamate and pyrethroid insecticides (measured at Antoetra in Ambositra district) remained effective, with a test mortality rate of 100% at all of the sentinel sites in the central highlands.

This means that the insecticides sprayed during the 2012 IRS campaign in the central highlands, which began in November 2012, remain effective three to four months after spraying. Additionally, one month after spraying started in the south (February 2013), wall bioassay tests at the one sentinel site in the south noted that carbamate remains effective, with 100% mortality.

AIRS completed insecticide resistance testing in eight sentinel sites using both the WHO tube test and the CDC bottle bioassay test.

WHO Tube Test:

The WHO tube test results indicated full susceptibility of *An. gambiae* s.l. *to:*

- Deltamethrin (100% test mortality in all the eight sites)
- Bendiocarb (98%–100% test mortality in all eight sites)
- Lambda-cyhalothrin (99%–100% test mortality in all eight sites)
- Fenitrothion (100% test mortality in seven sites)

Permethrin (a pyrethroid) was tested in only two sites. The vector was susceptible in Ambilobe, with 100% test mortality rate recorded. In the second site, Ampasy Nahampoana, 94% mortality was achieved, which falls under the possible resistance classification.

An. gambiae s.l. was also tested for DDT in seven sentinel sits. Findings indicate:

- Vector is susceptible to DDT in two sites (98 % and 100% mortality)
- Insecticide resistance was seen in two sites (36% and 72% mortality)
- Possible resistance was seen in three sites (90%, 95%, and 97% mortality)

CDC Bottle Bioassay Test:

The results of the susceptibility tests using CDC bottle bioassays indicated:

Susceptibility was noted for deltamethrin (in seven sites), bendiocarb (in all eight sites) and lambda-cyhalothrin (in five sites). In all the sites where these three insecticides were tested, *An. gambiae* s.l. were fully susceptible to deltamethrin, bendiocarb, and lambda-cyhalothrin; the test mortality rates ranged from 98 to 100%. The CDC bottle bioassay test results for these three insecticides are consistent with the WHO tube test results.

Possible resistance was noted for permethrin (a pyrethroid) at three sites (84% in Anivorano, 82% in Soavina/Betafo, and 97% in Soavina/Ambatofinandrahana). However, after 45 minutes of exposure, 100% test mortality was observed in Anivorano and Soavino/Ambatofinandrahana. In Soavina/Betafo mortality remained at 93%.

For DDT, resistance was confirmed at one site (Kiangara), while susceptibility was noted in one site (Anivorano, with 100 % mortality), and possible resistance was noted at three sites (Soavina/Betafo, Soavina/Ambatofinandrahana, and Antoetra), where a 90-95% test mortality was noted.

The vector was fully susceptible to fenitrothion at one site (Kiangara). Possible resistance was noted at four sites (Anivorano, Amboasary, Soavina/Betafo, and Soavina/Ambatofinandrahana). But with the extension of the exposure time to 45 minutes, the mortality rate increased significantly and mortality was recorded at between 99% and 100% in all the sites. This might be an early indication that *An.gambiae* s.l. is slowly developing tolerance to the insecticide. The WHO tube did note susceptibility for fenitrothion.

Entomological monitoring is ongoing in Madagascar, and will conclude in May. A final report compiling all entomological data regarding the various entomological indicators (vector density, vector susceptibility, species identification, etc.) will be submitted to PMI in June, 2013.

Program Highlights

AIRS Madagascar hired its COP, Dr. Xavier Pitroipa (the former COP for AIRS Burkina Faso), in September, 2012. Dr. Pitroipa relocated to Madagascar in October.

Central Highlands

This was the first time that the IRS campaigns in the central highlands and the south were not completed concurrently during November/December. PMI advised AIRS to complete the IRS campaign in the south in early 2013, as the peak malaria season in the south occurs in March.
From November 26 to December 31, 2012, AIRS Madagascar completed its IRS campaign in the central highlands. The IRS campaign sprayed 41 *communes* designated by the Malagasy NMCP, Roll Back Malaria Committee, and PMI-Madagascar for IRS programming. Spray coverage in the central highlands exceeded 85% for target communes in all districts in the central highlands.

Regrettably, violence in Ankazobe district prevented AIRS Madagascar from spraying certain areas. However, AIRS Madagascar completed a mop-up campaign in the communities of Androva and Amparihikambana (Ankazobe district) in February 2013 in response to a malaria outbreak that occurred in January.

South

Since AIRS Madagascar did not have enough staff to concurrently spray and close an IRS campaign in the central highlands (which ended on December 31) and prepare the IRS campaign for the south (which was originally planned to start on January 3) it was necessary to delay the start of the IRS campaign in the south by one month, until February 4, 2013. This allowed the AIRS Madagascar staff to travel to the south in mid-January, after closing out the IRS campaign in the central highlands, and begin IRS campaign preparations for the south. The IRS campaign in the south provided "blanketed" coverage, or spraying as many eligible structures as possible in seven districts, and four *communes* in Taolagnaro (Ft. Dauphin) district.

The IRS campaign's community-based model employs community members as spray operators for one week. While this model has worked in the central highlands, it was problematic in the south due to the significant distances between spray areas and the low-capacity/inexperience of many of the spray operators and district coordinators that were working on the spray campaign.

Unfortunately, insecurity due to cattle theft and violence in northern Amboasary district in the south of Madagascar left AIRS unable to spray several *communes*. Four districts had reached the 85% spray coverage mark by the targeted spray campaign end date of March 18.

Challenges and Lessons Learned

- AIRS Madagascar has struggled to find a local operations manager. For the IRS campaign in the central highlands, the AIRS Benin operations manager came to Madagascar and managed the implementation of spraying in the central highlands. The IRS campaign in the south has been assisted by the extended STTA of the AIRS Mali operations manager. AIRS Madagascar has expanded its advertisement for this position, and is now considering non-Malagasy candidates.
- The community-based model required AIRS to hire more than 12,000 seasonal staff (who work for one week each) and develop 200 soak pits and 150 store rooms to prepare work sites. It was difficult to prepare so many work sites and supervise the large number of employees. Also, since the soak pits and store rooms would only be used for one week, the amount of effort that was taken to

develop and manage this infrastructure is not cost-efficient. To resolve these issues AIRS Madagascar will propose in its next work plan to hire a smaller group of spray operators that will cover an entire district during the six weeks of the spray campaign and will provide each group of spray operators with a vehicle. This will allow spray operators to be based from two or three centrally located operation sites, reducing the number of soak pits and warehouses needed and increasing supervision.

- The transition time in January, between closing out of the IRS campaign in the central highland and beginning the IRS campaign in the south was very short. In response to this challenge, AIRS Madagascar is also considering the establishment of a second office in the south, where staff would focus on the spray campaign in the south year-round.
- AIRS Madagascar encountered insecurity and unsafe conditions in parts of Ankazobe district in the central highlands, and Amboasary district in the south. For future IRS campaigns, AIRS would like to build a better relationship with the district health offices in the spray areas. Although USG regulations prevent AIRS from working directly with the district health offices, it would be beneficial to establish a line of communication to learn about the security well in advance of the IRS campaign.

1.10 MALI

Entomology

The entomological activities during the period of this report focused on residual efficacy, susceptibility testing, vector density, and biting behavior.

Spray quality monitoring was conducted within the first two weeks of spraying in Koulikoro, Bla, and Baraoueli districts in August, and insecticide decay monitoring continued through October 2012. Before a susceptible mosquito colony was established, cone bioassays were performed using wild mosquitoes with a known level of susceptibility to the sprayed insecticide (bendiocarb), which was measured as 96% test mortality rate. Susceptibility was determined using the WHO standard susceptibility test immediately prior to the start of spray. During the first cone bioassay test, completed within two weeks of spraying, mortality rates ranged from 97 to 100%, suggesting good quality spraying. But two months after spraying, mortality rates dropped below 60%. The rapid decline in the mosquito test mortality rates might be due to a combination of factors, mainly insecticide decay and decreased susceptibility of the vector to the sprayed insecticide. Experience from other AIRS countries has also shown early declines in test mortality rates when wild mosquitoes of a certain degree of resistance are used for the cone bioassay, as compared to a susceptible colony. Based on these previous observations, higher test mortality rates would be anticipated if a susceptible mosquito colony were to be used.

An. gambiae s.l. susceptibility to five insecticides—DDT (4%), deltamethrin 0.05%, lambda-cyhalothrin 0.05%, bendiocarb 0.1%, and fenitrothion 1%—was tested using the WHO tube test in 13 selected representative areas to determine the distribution and magnitude of resistance in the country.

The results of the susceptibility test indicated widespread resistance of *An. gambiae* s.l. to:

- Deltamethrin, in three out of the four sites where the insecticide was tested (test mortality ranged from 16 to 91%).
- DDT, in all 13 test sites with test mortality from 11 to 75%.
- Lambda-cyhalothrin in all nine sites where this insecticide was tested (7%–74% test mortality).

Emergence of resistance to fenitrothion (an organophosphate) in the *An. gambiae* s.l. population was noted in one site (84% test mortality rate). Possible resistance was found in three sites (test mortality 93%–97%) and full susceptibility of the vector to the insecticide was noted in nine sites (test mortality 98%–100%). WHO 2013 resistance classification criteria were used to interpret the vector resistance

test results. The presence of bendiocarb resistance in the *An gambiae* s.l. population was detected in four test sites (66%–88% test mortality rates). In the remaining nine sites *An. gambiae* s.l. was fully susceptible to bendiocarb (98%–100% mortality rates). Mosquitoes collected from cotton farms, where insecticides are extensively used, were found to be resistant to insecticides from all the four classes of insecticides approved for public health use, including in IRS.

Data from the pyrethrum spray collection conducted in October revealed an average *An. gambiae* s.l. density of 4.00 per house per night in the intervention areas, compared to 16.77 per house per night in the control villages. Vector density was higher in the control areas, even at the baseline. However, proportionally, the level of decline was higher in the intervention villages than in the control villages. This might be attributed to the impact of IRS. Human-vector contact data obtained through human landing catches consistently indicated high indoor biting in the control villages but more outdoor biting in the intervention areas after spraying. Though additional data is required to make a definitive conclusion about the impact of IRS with bendiocarb on vector biting behavior, there is an indication that the vector tended to bite outdoors in sprayed areas more than in the control areas.

Program Highlights

AIRS Mali conducted all activities after the 2012 IRS campaign without the involvement of the government of Mali, because USAID prohibited working with the government during the military coup in 2012. However, collaboration with the Mali government began again in January 2013 to help plan for the 2013 IRS campaign. In October, post-spray meetings took place to review strengths and weaknesses in each district, specifically for each site, and proposed action items were agreed on for improvements in the 2013 IRS campaign.

After completing the 2012 IRS campaign, the AIRS Mali team conducted an internal PSDQA to audit the data that had been collected during the campaign. The results showed a difference in spray coverage, with the audit showing 90.22% of eligible structures having been sprayed, compared to 98.71% reported in the 2012 End-of-Spray Report.

On November 15, the 2013 work plan was submitted. In February, the 2012 End of Spray Report was finalized and approved. The post-campaign environmental inspection for all the operational sites was conducted, and the AIRS Mali team worked on the Letter Report.

At the end of the 2012 IRS campaign, all solid waste was sent from the different operational sites to the three district warehouses. The three district warehouse solid waste containers were then sent to the incinerator in the Koulikoro region to properly dispose of waste. AIRS recruited and trained three seasonal incinerator operators under the supervision of the environmentalist and the logistic officer, to complete the incineration. The high volume of waste made one of the incinerator's burners break down repeatedly, which delayed the incineration.

The finance director and the logistics officer conducted the post-campaign inventory of the central stores in February and March to quantify the stocks of materials and equipment available and plan for the 2013 IRS campaign. In March 2013, the NMCP's steering committee meeting for IRS was held to present and validate the 2012 IRS campaign results and plan for the 2013 IRS campaign.

Challenges and Lessons Learned

- The post-campaign environmental inspection noted that wash areas needed some mending to clear weed growth and that roofs needed to be repaired on some store rooms.
- In the future, AIRS should plan to incinerate solid waste throughout the IRS campaign instead of incinerating it all at one time, to reduce delays.
- During the NMCP Steering Committee meeting, the representative of the territorial administration suggested sending a letter to the Minister before the start of the campaign to facilitate the

movement of teams during operations.

1.11 MOZAMBIQUE

TABLE 5: AIRS MOZAMBIQUE AT A GLANCE

Number of provinces/districts covered by PMI-supported IRS in 2012	6 districts in Zambézia province (Milange, Morrumbala, Mocuba, Namacurra, Nicoadala, and Quelimane)
Insecticide	Pyrethroid
Number of structures covered by PMI-supported IRS in 2012	536,558
Number of structures targeted by PMI-supported IRS in 2012	585,299
2012 spray coverage	92%
Population protected by PMI-supported IRS Pregnant women protected Children under five protected	2,716,176 174,370 501,522
Dates of PMI-supported IRS campaign	October 8–December 17, 2012
Length of IRS campaign	61 days
Number of people trained with USG funds to deliver IRS[1]	1,121[2]

[1]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.

[2]1,097 spray operators, plus 24 supervisors and government staff that attended the full IRS Training of Trainers.

Entomology

AIRS Mozambique worked closely with the NMCP and the Provincial Health Directorate to conduct IRS entomological monitoring. For monitoring vector behavior, density, composition, and seasonality during and after the spray campaign, four sentinel sites were selected including three intervention sites (Nicoadala, Mocuba, and Morrumbala), and one control site (Maganja da Costa). A total of 427 female adult mosquitoes were collected in all areas by pyrethrum spray collection during the months of September, October, and November 2012. Of these, the 123 collected in the four sites in September were *An. funestus* s.l. (37.4%) or Culex species (62.6%). The 108 mosquitoes collected in October were 11.1% *An. gambiae* s.l., 13.9% *An. funestus* s.l., and 75% Culex species. In November, 196 adult female mosquitoes were collected: 5.1% were *An. funestus* s.l., 0.5% were *An. coustani*, and 94.4% were Culex species. In the control site, the resting density of female *An. funestus* s.l. per house per day was 4.5, 1.1, and 0.9 in September, October, and November, respectively; while a maximum density of 0.2 *An. funestus* s.l. females was noted in October in the intervention areas. Similarly, a resting density of 1.1 and 1.2 female *An.gambiae* s.l. per house per day was noted in the control site in the months of September and October, respectively, but none were found in the intervention areas.

A total of 34 adult mosquitoes were collected during monthly human landing catches in September, October, and November, of which 19 (55.8%) were *An. gambiae* s.l. and 15 (44.1%) were *An. funestus* s.l. In Mocuba in October and November (post-spray), *An. funestus* s.l. was found mainly outdoors. In intervention areas the densities of malaria vectors were lower compared to in the control area. Of the 34 adult mosquitoes caught, 25 were collected in the control district (Maganja da Costa), while only 9 were collected from the intervention districts (Mocuba, Morrunbala and Nicoadala). The malaria vector density was therefore 2.77 times lower in the intervention areas as compared to the control area. It would be premature to draw conclusions; however, the spray catch and landing collection data indicate that IRS may be reducing human-vector contact.

Finally, WHO cone bioassays were used to evaluate the quality of the spray operation. The bioassay tests were conducted 24 hours after spraying in Samora Machel, Chico, and Coqueiro villages in the districts of Mocuba, Nicoadala, and Morrumbala, respectively. The bioassay tests showed 100% mortality rates among susceptible mosquitoes exposed to deltamethrin-sprayed walls in both Nicoadala (Chico) and Morrumbala (Coqueiro) districts, and to alpha-cypermethrin-sprayed walls in Mocuba (Samora Machel). Based on the results of cone bioassay tests from the three sites, the quality of spray operation appeared to be good.

Program Highlights

During the period of this semi-annual report, AIRS Mozambique successfully carried out the 2012 IRS campaign. IRS operations began in the six districts on October 8 and lasted for 61 working days, ending on December 17. Daily spray operations took place in all 28 base sites simultaneously, except for five days when some bases had rain. Throughout the campaign, the Provincial Health Directorate, District Health Directorate and health center supervisors observed the spray activities and were provided with checklists. In addition, a PMI official visited the spray operations during the ninth week of the spray campaign.

Immediately after the campaign came to an end, the environmental post-spray evaluation was implemented in the six districts in coordination with the Ministries of Health, Agriculture and Environment. The evaluation consisted of verifying the complete closure of latrines, rinsing areas, soak pits and washing areas, and ensuring that all environmental standards were followed during the movement of insecticide and empty sachets. Solid waste from the campaign, including packaging materials, and used disposable nose masks, was collected from all district warehouses to the central facility for incineration purposes. The incineration process took place in Nicoadala district during the first two weeks of January 2013.

The post-spray evaluation meeting took place on February 8, 2013, with all the covered district staff participating (supervisors, medical officers and District Health Directors). The focus of the conference was to report results, document challenges encountered during the spray operations, discuss lessons learned, and make recommendations for the next (2013) spray cycle.

The mini work plan for 2013 was approved in December 2012.

Challenges and Lessons Learned

- It was difficult to generate Ministry of Health ownership of the IRS activity at the district level, and this resulted in IRS refusals in certain villages. In certain cases, the province-level supervision team had to coordinate with the local community leaders in order to mobilize the refusing householders to get their structures sprayed.
- The M&E manager, in taking into account data entry clerk capacity, decided not to provide the data entry clerks with access to the back end of the M&E database. This meant that the M&E manager and database manager had to clean the data themselves, and they were unable to clean 24 back-end databases within the short period of time allotted, especially given that data cleaning was interrupted by the holiday season.
- During the IRS implementation period, AIRS had weekly meetings to discuss the progress of the IRS campaign district by district in order to improve the coverage. It was during these meetings that decisions related to districts requiring extra attention were made. These were invaluable.
- Effective supervision is essential to successful IRS implementation, regardless of the level of training given to spray teams. For effective supervision, a team composed of the Ministries of Health, Environment and Agriculture, together with Abt staff, implemented supervision during the IRS campaign to cover all the areas of the intervention. Checklists were used during this process. Also, meetings with the district-level staff were regularly held after a supervision session to highlight the

main concerns and recommend solutions to address the issues, or to or find solutions together.

1.12 NIGERIA

Entomology

A comprehensive susceptibility test for all four classes of insecticides was conducted in October 2012 to inform 2013 insecticide selection. The October 2012 results showed full susceptibility to organophosphates and carbamates (100% mortality rates for both), and some emerging resistance to pyrethroids (84-100% mortality rates). The NMCP discussed the results together with PMI and AIRS Nigeria, considered other factors such as the cost and reported residual life of insecticides, and recommended the use of pyrethroid insecticide. Following the results of a bid competition, the project selected Tagros, an Indian manufacturer of generic pyrethroids, as a supplier for the 2013 campaign.

The project negotiated a successful partnership with the Nasarawa State University, Keffi, to establish an insectary on the premises of the campus that also had a space for laboratory analysis. To date, the project has equipped the lab and insectary. The team also established the first colony of Kisumu strain susceptible mosquitoes to prepare for the 2013 spray campaign, and is raising laboratory-reared wild strains of *Anopheles* mosquitoes for cone bioassay testing to compare the performance of the sprayed insecticide against vectors from the two sources.

Program Highlights

During this period, the project mainly focused on preparation for the 2013 spray campaign originally scheduled for March 20. The work plan was approved on February 15. The team conducted detailed micro-planning meetings and trainings. To minimize the possibility of the poor insecticide residual efficacy that had been observed during 2012 spray season, the team revised the curriculum and enhanced the training for spray operators by adding two more days for practical spraying exercises. AIRS Nigeria also revised and strengthened the supervision plan, and assigned as leaders the project technical staff for each supervision team, consisting of the NMCP, Ministry of Environment, National Environmental Regulation Agency, and local government representatives. The team created two more operational sites (providing a soak pit and a store room for each) in the most remote areas to minimize travel time for operators. The project ECO ensured that all 17 soak pits and stores were prepared according to the standards for the spraying. Community mobilization took place in February, reaching a total population of 214,067 adults with the IRS messages.

AIRS Nigeria conducted a PSDQA in October to validate the spray coverage reported during the 2012 spray campaign. The results showed that the difference in spray coverage was negligible, with 97.5% eligible structures found to have been sprayed during the audit, compared to the 99.1% reported in the 2012 EOSR.

In November 2012, the project hosted an IRS Expert Group meeting with the NMCP and local research institutions to discuss and plan for vector control and insecticide resistance strategies for 2014 and beyond.

Challenges and Lessons Learned

The spray campaign was postponed by three weeks due to delays with the insecticide consignment. The delays were because the new supplier did not know how to deal with customs clearances for USG-funded programs. AIRS Nigeria will not be conducting a spray campaign in 2014. However, future IRS programs should communicate frequently with the supplier before sending the cargo to its destination, to ensure the documentation is in order and avoid delays.

1.13 RWANDA

TABLE 6: AIRS RWANDA AT A GLANCE

Number of provinces/districts covered by PMI-supported IRS	3 districts (Bugesera, Gisagara, and Nyagatare)	
Campaign	**2012**	**2013**
Insecticide	Pyrethroids	Pyrethroids
Number of structures targeted by PMI-supported IRS	242,589	121,697
Number of structures sprayed by PMI-supported IRS	236,610	121,154
Spray coverage	98%	100%
Population protected by PMI-supported IRS Pregnant women protected Children under five protected	1,025,181	522,315
Dates of PMI-supported IRS campaign	August 20–21, September 17–October 18	February 11–March 5
Length of campaign	30 days	20 days
Number of people trained with USG funds to deliver IRS	1,986	1,605

Entomology

AIRS used WHO cone bioassays to conduct quality assurance testing during the August 2012 IRS campaign. Results showed mortality rates of 96.7-99.3% using susceptible mosquitoes, indicating a good spray quality. The monthly bioassay data collected showed 82% mortality rates of susceptible *An. gambiae* four months post-spraying, which is an indication that the insecticide was still effective against the malaria vector during this time. The February 2013 quality assurance bioassay tests showed mean mortality rates of 95-100%. Vector studies conducted after the 2012 campaign through the 2013 IRS spray campaign that assessed vectors species, density, and behavior using human landing collections and pyrethrum spray catches have shown a predominance of *An. gambiae* with a 50% tendency to bite indoors. An. gambiae s.l man biting rates ranged from 3.8 in August to 24.4 bites per person per night in October. The peak MBR in October might be explained by an increase in the number of breeding sites and favorable environmental factors of mosquito breeding.

Program Highlights

Spraying started on August 20, 2012, but due to the unfortunate event of a spray operator death, operations were halted while an investigation occurred and AIRS was cleared to begin spraying again. Spraying resumed on September 17 and was completed on October 18. No further problems were encountered during the fall campaign, and AIRS conducted oversight of the campaign with extra vigilance and attention to spray operator health.

During the February-March 2013 spray campaign, 20 of the 42 sectors located in the same three districts were sprayed over a period of 20 days. AIRS Rwanda conducted all pre-spray, spray, and post-spray activities on time as scheduled, and collaborated with the NMCP to conduct inspections and supervision visits. The management team used several tools to help them prepare for and supervise spray operations, including the Race to the Starting Line and several environmental compliance checklists. All soak pits and warehouses were approved before the beginning of the spray campaign, and

the Kigali management used supervision checklists during the campaign to ensure adherence to all IRS requirements. Early preparation for the spray campaign and strong oversight during the campaign ensured a smooth, successful campaign. The end-of-spray report was approved on February 14.

Challenges and Lessons Learned

- A lesson learned during the last two spray rounds is that it is important to incorporate IRS into the district annual work plans for proper IRS coordination, and in order to work closely with local authorities on IRS planning, implementation, and supervision. It is critical to engage community health workers that are in charge of IEC coordinators in the sectors in order to enhance coordination and acceptability of IRS at the community level. It was a new requirement for mobilizers to be community health workers during this spray campaign.

1.14 SENEGAL

Entomology

The vector and parasite ecology laboratory of Université Cheikh Anta Diop (UCAD) in Dakar supports entomological monitoring for the IRS program.

UCAD completed bioassay tests, which showed that the residual efficacy of bendiocarb is less than or equal to three months.

The UCAD report recommended conducting IRS during August, September, and October when vectors are most abundant and transmission is more intense.

Results from susceptibly tests showed:

- Full susceptibility to organophosphates in all districts where the tests were conducted, with a test mortality range of 98%-100%
- Decreasing susceptibility to carbamates in two IRS districts (Malem Hodar and Velingara with test mortality rates of 96% and 97%, respectively) after three years using bendiocarb in the target districts
- Decreasing resistance to pyrethroids since 2011 in IRS districts. This could be explained by the replacement since 2011 of lambdacyhalothrin and deltamethrin with bendiocarb

For better resistance management, the UCAD report recommended that malaria stakeholders in Senegal keep using pyrethroids for long-lasting insecticide-treated nets and other insecticide classes for IRS. Based on the carbamate results in the susceptibility study, UCAD recommended that carbamates be used once again for the 2013 spray campaign.

Program Highlights

Between October and December the team focused on finalizing the 2012 End of Spray Report (which was approved on March 26), ensuring that all activities, challenges, and lessons learned were captured. They also worked on the 2013 work plan, which was approved on March 26. In late November, the AIRS Senegal team completed the incineration process of the IRS solid waste at Diourbel Hospital.

After completing the 2012 IRS campaign, the AIRS Senegal team conducted an internal PSDQA as a form of auditing the data that was collected during the campaign. The results showed that the difference in spray coverage is small, with 94.43% eligible structures found as sprayed during the audit as compared to 98.26% reported in the 2012 End-of-Spray Report.

In January 2013, the team began preliminary planning activities for the 2013 campaign including: review of IEC/BCC materials; planning site repairs in the four target districts and selection of new operational sites as needed; development of operational and logistics schedules; and development of the training

schedule for new district staff. They also worked on the planning and implementation of an enumeration exercise in all target districts (Malem Hodar, Koumpentoum, Koungheul, and Velingara) to determine the number of eligible structures to be sprayed in 2013. The enumeration data tools were tested in one district with the collaboration of PMI Senegal. The enumeration was conducted with the full support of the NMCP, the District Health Management Teams, and local partners and authorities. In addition, 26 data clerks were recruited and trained for the enumeration data entry process, which started at the end of March 2013.

In February 2013, the AIRS Senegal team hosted the Operations, Procurement and Logistics training led by the operations director, Allan Were. Operations mangers, procurement coordinators and logisticians from all AIRS countries benefited from this one-week training. Mr. Were also stayed for two additional days in Dakar, providing technical support to the operations team and attending meetings with PMI.

In February and March 2013, AIRS Senegal staff worked on the revision and update of all training materials related to IRS. The AIRS Senegal COP has initiated a tripartite periodic meeting with the NMCP coordinator and PMI in order to establish a consistent communication flow for a better IRS campaign in 2013.

Finally, in March 2013, Cultural Practice conducted a two-week assignment in Senegal to conduct a review on the use of females in Senegal's spray campaigns and to provide recommendations for how to increase female participation.

Challenges and Lessons Learned

- The cost of using Diourbel Hospital for incineration is very high, and unfortunately there are few other adequate incinerators in the country for IRS solid waste. In 2013, the team will need to explore other alternatives like the incinerators in cement factories.
- The work plan was finalized and approved before the enumeration activity was completed and before entomological monitoring recommendations were released. Numbers of spray operators, PPE, and insecticide had to be updated accordingly, which had some impact on the approved budget.

1.15 ZAMBIA

TABLE 7: AIRS ZAMBIA AT A GLANCE

Number of provinces/districts covered by PMI-supported IRS in 2012	All 20 districts in 3 provinces: Eastern Province, Muchinga Province, and Northern Province
Insecticide	Carbamates: Muchinga Province, Northern Province Organophosphates: Eastern Province
Number of structures targeted by PMI-supported IRS	531,791
Number of structures covered by PMI-supported IRS	449,801
Population protected by PMI-supported IRS in 2012	1,683,706
Dates of PMI-supported IRS campaign	October 21, 2012–January 5, 2013
Number of people trained with USG funds to deliver IRS	63 persons trained in stock control and inventory management

Note: AIRS provides technical assistance but does not lead IRS operations or collect IRS data in Zambia.

Entomology

AIRS does not provide entomological monitoring for the Zambia IRS campaign.

Program Highlights

Following up on a pesticide stock control and inventory management training in September 2012, AIRS Zambia conducted mid-spray inspections in November 2012. An operations expert from the AIRS subcontractor RTT participated in the inspections. He visited operational sites in eight districts to review operations and ensure staff were keeping proper records at store rooms and putting into practice skills learned at the September training. The RTT expert returned to Zambia in February 2013 to participate in a post-spray inspection for seven districts that had completed spraying with organophosphates.

During this period, AIRS Zambia developed a recycling plan for empty plastic OP bottles that had accumulated in the district stores after the 2011 and 2012 IRS campaigns. The project drafted a Memorandum of Understanding (MOU) with a local recycling plant and a waste disposal company. AIRS Zambia also provided procurement and logistics support to a second round of spraying with carbamates that was launched in March 2013.

In early January, a national IRS working group including National Malaria Control Centre (NMCC), PMI, and other partners reviewed the entomological data and made a decision to select the OP class of insecticide for the 2013 spray round in PMI-supported districts. The decision was made due to growing resistance to carbamates. An option of using DDT was discussed but was put on hold because additional training and significant environmental compliance groundwork are needed in order to properly prepare the districts for safe handling and disposal of DDT.

The mini work plan was approved on January 17.

Challenges and Lessons Learned

- Storage and disposal of empty bottles of OP has been a challenge. AIRS Zambia inherited some districts that already had this problem; when a similar type of insecticide was procured for 2012, the problem was compounded because bottled chemicals take additional space. The situation will be resolved after the recycling plan and MOU among all partners are in place. Developing an MOU for recycling empty OP bottles became a lengthy procedure because many players are involved in the process. To expedite the approval process and the actual recycling, the program decided not to enter into an MOU with NMCC, but to have a working agreement that the center will connect with the districts to ensure support with transportation of empty bottles and environmental compliance certification.
- Insufficient information from the districts on the various sizes of PPE (overalls, gumboots, etc.) resulted in procurement of one-size PPEs, leading to instances of non-compliance with spray protocols. To address this issue, AIRS Zambia has asked the districts to capture the various sizes for PPE as part of the needs assessment reporting.
- In some new districts that had not previously been sponsored by USAID/PMI, bringing environmental compliance practices up to PMI standards was a challenge. Some of them did not have facilities such as soak pits and store rooms compliant with PMI environmental standards. AIRS rehabilitated these facilities.

1.16 ZIMBABWE

TABLE 8: AIRS ZIMBABWE AT A GLANCE

Number of districts covered by PMI-supported IRS in 2012	17 districts Manicaland Province: Makoni, Buhera, Chipinge, Mutare, Mutasa, Nyanga, and Chimanimani Mashonaland West Province: Hurungwe, Chegutu, Kadoma, Zvimba, Makonde, and Kariba Mashonaland East Province: Murehwa, Mutoko, Mudzi, and Uzumba-Maramba-Pfungwe
Insecticide	Pyrethroids
Number of structures covered by PMI-supported IRS[1]	581,165
2012 spray coverage	86%
Estimated population protected by PMI-supported IRS in 2012	1,164,586
Dates of PMI-supported IRS campaign	October 1, 2012–February 4, 2013
Number of people trained with USG funds to deliver IRS	N/A

Note: AIRS provides technical assistance but does not lead IRS operations or collect IRS data in Zambia.
[1]The Zimbabwean NMCP tracks "rooms" as opposed to "structures" as the geographic indicator for the residential space covered by IRS campaigns. However, AIRS Zimbabwe developed an algorithm to convert the number of rooms sprayed to the number of structures sprayed.

Entomology

The AIRS Zimbabwe technical director/entomologist struggled to find enough larvae to breed enough mosquitoes for surveillance activities at most of the sentinel sites. AIRS Zimbabwe surmises the lack of larvae was due to a long dry season, which led to water shortages and a lack of mosquito breeding areas. The scarcity of mosquitoes may also be attributed to the impact of several decades of IRS in Zimbabwe, which may have led to fewer breeding areas for mosquitoes.

AIRS Zimbabwe completed entomological surveillance over the past six months at four sentinel sites and two control sites. During initial entomological surveillance after the IRS campaign began, *An. gambiae* s.l. was the most prevalent vector species in the areas Manicaland, Mashonaland East, and Mashonaland West.

Initial bioassays completed during the IRS campaign noted that the mortality rates for mosquitoes on all types of sprayed surfaces (cement, mud, and painted) at the sentinel sites were high, with 100% mortality 24 hours after spraying and six weeks after spraying. However, 12 weeks after the IRS campaign started AIRS Zimbabwe noted much lower mortality rates, ranging from 4.25% to 30.00% for mud walls, and recorded as 16.65% for cement walls. The exception was at the sentinel site in Murara, in Mutoko district. Here, 21 weeks after the IRS campaign, mortality rates of 86.67% were noted on mud walls, 73.33% on painted walls, and 38.34% on cement walls. The difference in the vector test mortality rates among the different sites might be explained by differences in the skills of the spray operators and quality of spraying (i.e., in some sites the quantity of insecticide sprayed on the wall may have been insufficient to kill vector mosquitoes).

Susceptibility testing also noted that *An. gambiae* s.l was fully susceptible to bendiocarb, DDT, and Pirimphos-methyl. However reduced susceptibility (93.75% mortality) was noted for deltamethrin. Additionally AIRS Zimbabwe has noted 90% and 90.83% mortality rates for *An. gambiae* s.l. from Kawere

and Kasimure sentinel sites, respectively, for lambda-cyhalothrin. The decreased susceptibility for deltamethrin and lambda-cyhalothrin may warrant further study.

Entomological monitoring is ongoing in Zimbabwe, as AIRS Zimbabwe is also planning to work with the National Institutes of Health Research regarding vector identification in the upcoming months. A final report, compiling all entomological data regarding the various entomological indicators (vector density, vector susceptibility, species identification, etc.), will be submitted to PMI in June 2013.

Program Highlights

Over the past six months, AIRS Zimbabwe trained district health officials on the importance of using soak pits to safely dispose of insecticide-contaminated water, and thereafter helped district health offices to construct 64 soak pits throughout the PMI-supported districts to ensure the safe disposal of liquid wastes resulting from the IRS campaign. AIRS Zimbabwe also led trainings on solid waste disposal for district and provincial health officers in Manicaland, Mashonaland East, and Mashonaland West. These trainings were done after AIRS Zimbabwe had examined the provincial incinerators that the health offices in the three provinces intended to use to incinerate solid waste from the IRS campaign, and noted that these incinerators were not able to reach the temperature needed to do this safely. AIRS Zimbabwe is currently discussing the possibility of arranging for the incineration of IRS campaign solid waste for all three provinces at an incinerator in Harare.

During the IRS campaign, AIRS Zimbabwe staff (along with four local consultants) embedded themselves within 27 of the 36 spray teams working in Manicaland, Mashonaland East, and Mashonaland West provinces, and closely observed the work of 200 spray operators. The AIRS Zimbabwe staff and local consultants helped monitor the IRS campaign and noted whether spraying followed the standards set forth in PMI's *Best Management Practice*. Overall, AIRS Zimbabwe found the work of the spray operators to be fairly strong, noting only a few areas of concern relating to spray operators not using some PPE articles (helmets and face shields), and having some trouble completing progressive rinsing correctly. Where possible the AIRS Zimbabwe staff and consultants provided impromptu training to correct these problems.

AIRS Zimbabwe also completed a post-spray environmental inspection of store rooms and soak pits. This resulted in AIRS Zimbabwe closing and locking all soak pits until the next IRS campaign, and noting and reporting on several IRS commodity storage issues (particularly poor security for IRS commodities, and disorganized storage systems for them). Currently, AIRS Zimbabwe is working to organize provincial IRS campaign review meetings for Manicaland, Mashonaland East, and Mashonaland West. During these meetings AIRS intends to go over the results of its monitoring of the IRS campaign and store rooms. Finally, AIRS Zimbabwe expanded its staff to four persons, as the project hired a new COP in February 2013 to provide overall project management. The project's former COP agreed to become the project's technical director/entomologist, and focus his time and work on entomological surveillance.

The final enhanced entomological surveillance work plan was approved on March 10 and the Zimbabwe supplemental work plan was approved on March 15.

Challenges and Lessons Learned

AIRS Zimbabwe plans to develop stronger relationships with the NMCP and Provincial Health Offices in the future, as this will help build greater trust regarding the technical support that AIRS Zimbabwe can provide. Additionally, this will help expedite the NMCP's communication with spray areas to assist with AIRS Zimbabwe's work.

During an STTA trip, the AIRS technical coordinator for Zimbabwe noted that DDT was being used in 4 of the 17 districts that PMI had agreed to support. The technical coordinator was able to alert PMI after returning to Harare. Given that the supplemental environmental assessment for Zimbabwe does not support PMI's work with DDT districts, PMI and AIRS Zimbabwe immediately pulled back support for

these four districts, with AIRS Zimbabwe moving forward with closing the soak pits in the districts (as DDT cannot be disposed of in a soak pit).

Due to a miscommunication, AIRS Zimbabwe led the NMCP and Manicaland to believe that AIRS Zimbabwe could pay for NMCP-hired spray operators completing work in Buhera district. However, Abt Associates held lengthy discussions about the liability issues concerning the payment of spray operators employed by the NMCP, and decided that it cannot pay the spray operators. Abt Associates made this decision after recognizing that the spray campaign in Zimbabwe is implemented and managed by the NMCP and provincial health officials, and therefore AIRS Zimbabwe cannot ensure the quality of the work completed by the spray operators. Additionally, Abt Associates could not ensure the health and safety of any spray operator it would pay, and risk being liable if any spray operators were injured. Abt Associates and AIRS Zimbabwe eventually communicated its decision that the AIRS Zimbabwe project could not pay the spray operators right before the spray campaign was set to begin in Buhera district. In turn this left the NMCP and Manicaland Provincial Health office scrambling to find funds to pay the spray operators,

Overall, AIRS Zimbabwe noted strong interest in improving environmental compliance/safety among the NMCP and provincial/district health offices. This was evident in that both the NMCP and Provincial Health Offices supported the building of over 60 soak pits during the IRS campaign, and the high attendance at a solid waste management/ disposal training in February, 2013. The Environment Management Agency has also expressed strong interest in working with AIRS Zimbabwe to improve environmental safety for IRS programming in the future.

2. Core Activities

2.1 Project Retreat

Approximately 50 Abt staff from 14 countries and the PMI COR team members gathered in Durban, South Africa on December 3-6 at the AIRS retreat to share lessons learned, best practices, and emerging trends in IRS. To foster greater innovation across IRS countries and brainstorm methods to make IRS more efficient, cost-effective, and sustainable, the organizational development group Systematic Inventive Thinking facilitated a one-day workshop with field and home office staff. The AIRS team has had several follow-up meetings with the group and developed technical working groups to drive evaluation and implementation of ideas.

2.2 Capacity Assessment

The AIRS project continues to work on the Country Capacity Assessment. During the project retreat in Durban, South Africa, the participants (COPs, and operation and technical managers) tested the framework and indicators by filling out some of the sections. Based on their feedback and input from PMI, the project finalized the framework. To date, all country teams have completed the first step of the assessment, which includes grading all eight IRS components described in the framework. The next step will be to jointly discuss the grades with the home office and PMI in order to come to common ground on the country rating and prepare for a dissemination meeting with the country stakeholders. After the agreements are reached on country ratings during the stakeholder meetings, each AIRS country will develop a country capacity-building plan using the results of the assessment. The project aims to complete all stakeholder meetings within the first six months of 2013 and develop assessment summary reports by early August.

2.3 Cost Study

During this time period, the AIRS team worked with Abt costing specialists to gather the costing information needed for the program. The objective of this study was to quantify the cost of implementing IRS in year one of the project, at an overall level and at the country level, as well explore reasons for differences in costs across countries. Internal discussions focused on costing methodology, different types and levels of analysis, and presentation of the results. The final report was presented to PMI in April.

2.4 Supervisory Toolkit

The AIRS *Supervisory Toolkit for Better Indoor Residual Spraying* was developed and piloted in all spray campaigns during the period. It contains various tools such as checklists and guidelines on: spray supervision and monitoring; environment compliance and safety; and M&E and data quality management. It also contains planning tools such as the Race to the Starting Line. The Supervisory Toolkit was distributed to operations managers at the Senegal operations training in February 2013 and shared with PMI.

2.5 Operations, Procurement, Logistics, And Fraud Training

The regional training for all AIRS Operations, Logistics, and Procurement Managers was held in Dakar, Senegal, in February 2013. The finance & administration managers from Ghana and Zimbabwe attended

the procurement sessions of the training. All countries were represented, with the exception of Liberia and Madagascar, who were spraying or preparing for their IRS campaign. The main objective of the training was to equip the managers with the tools required to plan, supervise, and monitor spray operations in a performance-based atmosphere. The managers were introduced to the new tools developed for IRS supervisors. The procurement sessions included modules on fraud prevention and detection, and on the USAID procurement guidelines.

2.6 M&E Training

During the Operations training in Senegal in February 2013, the AIRS Operations Director Allan Were led a training developed by the AIRS Home Office M&E specialist on the operations team's role in program monitoring and evaluation. The training focused on: the coordination and collaboration needed between the M&E and operation teams; the importance of thorough data collection training and supervision; the proper use of the M&E Error Eliminator Form and Data Collection Verification Form; and the objectives and methodology of the PSDQA.

2.7 Environmental Compliance Assessment

Supervising the work of environmental compliance officers in each of the 13 countries and understanding field conditions is challenging, especially as staff expertise and motivation levels vary across the AIRS countries. Even when verbal and/or written descriptions of the conditions of facilities are available, they do not provide a true assurance or understanding of the compliance state of these operational sites. AIRS has developed a mobile application that provides geographically and temporally coded photographic evidence of site visits and conditions, and requires the completion of a rigorous checklist to ensure that the required environmental compliance features are present and in good condition. Training on the mobile checklist began in February 2013. AIRS staff in Angola, Benin, Liberia, Mali, Mozambique, Nigeria, and Senegal have begun training and are in various stages of implementation. Countries that have not received training on the mobile application are still required to complete an Excel version of the environmental compliance assessment, which is also available in the AIRS *Supervisory Toolkit for Better Indoor Residual Spraying*.

2.8 Subcontracts

2.8.1 RTT Assessment

All subcontract work performed by RTT during the period of this report is included and budgeted in country work plans. This includes warehousing and supply chain assessments done in Mozambique and Madagascar. RTT also conducted training for Abt staff and store managers in Angola.

2.8.2 Cultural Practice

Cultural Practice visited Ethiopia and Senegal to carry out assessments on the involvement of women in IRS activities during the period. The report for Ethiopia was received, and is under review. The report for Senegal was not completed during this reporting period.

2.9 South African Bureau of Standards

An agreement was signed between Abt and the South Africa Bureau of Standards laboratory—one of only two WHO collaborating laboratories in the world—in October 2012 to carry out quality assurance tests of insecticides procured for IRS activities. All countries that procured insecticide during this reporting period (Ghana, Liberia, and Nigeria) sent samples of every batch of insecticide to the laboratory to be tested before they were shipped to their respective countries.

2.10 New Employees

Ana Maria Paddack, senior finance and contracts analyst, provides financial management and contractual, administrative, and operational support to the AIRS Benin, Rwanda, and Madagascar projects.

Jane Coleman, technical coordinator for the AIRS Mali team, is also working on the start-up activities for the AIRS enhanced entomological monitoring countries of Burundi and the Democratic Republic of the Congo.

Elana Fiekowsky, M&E specialist, supports M&E efforts for Benin, Madagascar, Mali, and Senegal.

2.11 American Society of Tropical Medicine and Hygiene Conference

On November 15, 2012, AIRS staff led the symposium "Data-driven Decision-making in the Context of IRS Scale-Up and Increased Insecticide Resistance" at the American Society of Tropical Medicine and Hygiene's 61st Annual Meeting in Atlanta. The symposium was chaired by Dereje Dengela, Abt Associates, and Christen Fornadel, USAID. Presenters included Dengela, Ranjith de Alwis, Abt Associates, Richard Reithinger, RTI International, and Emmanuel Chanda, Zambia Ministry of Health.

2.12 Communications

2.12.1 Website

AIRS launched its website (www.africairs.net) on October 16, 2013. From its launch through March 31, the website received 3,583 visits (about 600 visits per month). Visitors are mostly from North America, Africa, and Europe. The website includes information about the project, a spray calendar, IRS resources and journal articles, project outcomes, and success stories. Content is updated at least once per month and can be automatically translated into several different languages. The AIRS communications specialist produces a quarterly report that tracks website visits overall, website visits by country and region, and e-letter opens, and analyzes trends to maximize the visibility of project communications.

2.12.2 E-letter

During this period, AIRS disseminated four email campaigns to a list of approximately 4,200 global health professionals. Quarterly e-letters were disseminated in December and March. E-alerts were disseminated announcing the launch of the website in October and AIRS participation in the American Society of Tropical Medicine and Hygiene conference in November 2012. Data consistently show that email campaigns drive traffic to the AIRS website.

2.12.3 Success Stories

Fourteen success stories were written and posted on the AIRS website. Articles feature project innovations, research and best practices, and Q&As with AIRS staff and partners.

2.13 Knowledge Management

In order to make important project documents readily available to home office and field staff and foster knowledge-sharing, AIRS began using a simple, online document-sharing site called Onehub. The communication specialist and Abt Client Technology Center staff trained Bethesda staff on January 31 and IT specialists in all field offices on February 12 and 13 via webinar. Then, IT specialists trained their office staff. In addition, AIRS produced a user guide in English, French, and Portuguese as well as a training video (http://www.youtube.com/watch?v=tLhNMQ1vHIE). Since it went live on March 31, 165

people have accessed Onehub. It has received 746 file views and 149 file downloads, showing that employees are actively using the tool.

2.14 Continuation of Study of the Residual Life of Carbamates

There is a hypothesis that pre-treating the IRS sprayable surfaces—mainly mud surfaces—with water will reduce the amount of insecticide absorbed by the surface and improve the bio-availability of insecticide after spraying, potentially increasing the residual life of carbamates. The effect expected is a longer residual life of the sprayed insecticide as compared to insecticide sprayed on surfaces without pre-treatment with water. This study was started by the AIRS Ethiopia entomologists in February 2013 and is currently underway. The study is being conducted in 12 experimental huts and the first cone bioassay test data was collected in March 2013. The data was collected 24 hours after spraying and test results have shown 100% test mortality of all exposed susceptible mosquitoes colonies irrespective of the water treatment. Data collected one month after spraying indicated a decline in the efficacy of bendiocarb on mud surfaces, with 66.7% test mortality in both pre-treated and untreated surfaces. Similarly, a slight decline in efficacy of propoxur was also noted at one month after spraying, with test mortality rates of 93% and 81% in pre-treated and untreated surfaces, respectively.

2.15 South-South Exchanges

Williams Abilla, environmental compliance officer for AIRS **Ghana**, traveled to **Liberia** at the beginning of the spray campaign to provide oversight, supervision, and training to the Liberia environmental compliance officer and other members of the Liberia AIRS team. Some of the areas on which Mr. Abilla focused were insecticide transportation and logistics, warehouse management, spray operator and seasonal staff personal protection, and field supervision.

Deolindo Dungala, the AIRS **Angola** ECO, went to **Nigeria** in March 2013 to get hands-on training from both the Nigeria ECO and the AIRS environmental compliance manager, Peter Chandonait. Among other things, Mr. Dungula was trained in the use of mobile phones to conduct the pre-season environmental compliance assessment.

AIRS **Benin** operations manager Eugene Kiti provided STTA to the AIRS **Madagascar** team during November/December 2012. Since the AIRS Madagascar team has had difficulty hiring an operations manager, Mr. Kiti led the operations management and supervised the implementation of the IRS campaign in the central highlands.

AIRS **Mali** operations manager Seydou Traore provided STTA to the AIRS **Madagascar** team from mid-January through mid-March 2013. Since the AIRS Madagascar team has had difficulty hiring an operations manager, Dr. Traore led the operations management and supervised the implementation of the IRS campaign in southern Madagascar.