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Indoor Residual Spraying (IRS 2) Task Order Four

AFRICA IRS FINAL REPORT

AUGUST 11, 2011 – DECEMBER 31, 2014

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AFRICA IRS FINAL REPORT
AUGUST 11, 2011-DECEMBER 31, 2014

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ACRONYMS

AIRS	Africa Indoor Residual Spraying
BMP	Best Management Practices
CDC	Centers for Disease Control and Prevention
COP	Chief of Party
DDMS	Disease Data Management System
DQA	Data Quality Audit
EC	Environment Compliance
ECO	Environmental Compliance Officer
ELISA	enzyme-linked immunosorbent assay
EMMP	Environmental Mitigation and Monitoring Plan
EOSR	End of Spray Report
EP	Enhanced Polymer
EPA	Environmental Protection Agency
FCA	Finance and Contracts Analyst
HLC	Human Landing Catch
IQC	Indefinite Quantity Contract
IQK	Insecticide Quantification Kit
IRS	Indoor Residual Spraying
IVCC	Innovative Vector Control Consortium
LQAS	Lot quality assurance sampling
M&E	Monitoring & Evaluation
MOE	Ministry of Environment
MSP	Mobile Soak Pit
NIMR	Nigeria Institute of Medical Research
NMCP	National Malaria Control Program
NMEP	National Malaria Elimination Program
NMIMR	Noguchi Memorial Institute of Medical Research
OIG	Office of the Inspector General
OM	Operations Manager
PCR	polymerase chain reaction
PMI	President's Malaria Initiative

PPE	Personal Protective Equipment
PSC	pyrethrum spray catch
PSDQA	Post-Spray Data Quality Audit
PSECA	Pre-Season Environmental Compliance Assessment
SC	Suspension Concentrate
SEA	Supplementary Environmental Assessment
SMS	Short Message Service
SUAP	Safer Use Action Plan
TO	Task Order
TOT	Training of Trainers
USAID	United States Agency for International Development
WG	wettable granule
WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation Scheme

EXECUTIVE SUMMARY

THREE YEARS IN REVIEW

The United States Agency for International Development (USAID) through the President's Malaria Initiative (PMI) awarded Abt Associates the Indoor Residual Spraying Indefinite Quantity Contract, Task Order 4 (IRS 2 IQC, TO4) on August 11, 2011.

Under TO4, named the Africa IRS project (AIRS), Abt Associates implemented safe, cost-effective, efficient, and high-impact IRS programs in 14 countries, and conducted entomological monitoring in 16 countries, in partnership with host-country governments.

Abt Associates worked to ensure IRS program decisions were driven by entomological data. The project built the capacity of National Malaria Control Programs (NMCPs) and environmental agencies to plan, implement, and monitor high-quality, cost-effective, and environmentally-compliant IRS programs.

Abt Associates completed IRS campaigns on time and on or under budget while training entomological personnel in all AIRS countries and producing reliable, valid, and increasingly standardized entomological data, a first for USAID and PMI-supported countries. The project ensured environmental controls in PMI's IRS programs now meet or exceed PMI standards, and developed innovative solutions, such as the Mobile Soak Pit, to improve operational efficiency, allow for better environmental protection, and reduce costs.

The AIRS project successfully improved day-to-day management of IRS operations, collected and reported on vector resistance data to guide IRS programming, and developed and implemented quality assurance and control measures for high-quality, effective IRS operations. The project frequently collaborated with other malaria control experts and within international working groups, contributing to the public dialogue and policies around vector control. Abt Associates shared its findings and disseminated best practices and successes through international conferences, social media, videos, newsletters, e-alerts, and a project website.

Based on the overall success of the project, AIRS won the 2014 Clark Abt Prize for Outstanding Social Impact for reducing the morbidity and mortality of malaria in Africa.

This final report covers the duration of project implementation from August 11, 2011, to December 31, 2014.

INTRODUCTION

In sub-Saharan Africa, malaria reportedly kills more than 1,000 children every day. Although there has been a significant decline in under-five mortality in recent years, malaria remains a serious health threat and socio-economic burden to millions of people of all ages. Indoor residual spraying (IRS) remains one of the most effective ways of preventing this deadly disease.

In August 2011, the United States Agency for International Development (USAID) through the President's Malaria Initiative (PMI) entrusted Abt Associates with implementing the IRS 2 Indefinite Quantity Contract Task Order 4 (TO4). TO4 was designed to support PMI, as well as USAID Missions and Bureaus, in planning and implementing IRS programs with the overall goal of reducing the burden of malaria in Africa.

TO4, named the Africa Indoor Residual Spraying (AIRS) Project, was tasked with ensuring that IRS remains a safe, cost-effective vector control strategy to reduce malaria morbidity and mortality. With direction from PMI and in partnership with host-country governments, Abt Associates implemented IRS and/or conducted entomological monitoring and surveillance activities in 16 countries (Angola, Benin, Burkina Faso, Burundi, Democratic Republic of the Congo, Ethiopia, Ghana, Liberia, Madagascar, Mali, Mozambique, Nigeria, Rwanda, Senegal, Zambia, Zimbabwe) from August 2011- December 2014, protecting more than 36 million people from malaria. At PMI's request, AIRS also provided technical assistance to the NMCP of Malawi for its 2013-2014 IRS campaign.

TABLE 1: IRS RESULTS AUGUST 2011 – DECEMBER 2014

Country	Structures Found	Structures Sprayed	% Spray Coverage	Total Population Protected	Pregnant Women Protected	Children <5 Protected	People Trained*
Angola	268,128	254,567	94.9%	1,153,813	61,921	202,751	1,549
Benin	726,956	693,403	95.4%	2,137,389	63,379	412,675	3,271
Burkina Faso	37,126	36,870	99.3%	115,638	2,188	23,118	332
Ethiopia	1,862,538	1,850,185	99.3%	4,783,330	72,439	697,295	7,830
Ghana	844,817	758,163	89.7%	2,045,872	45,929	396,794	2,411
Liberia	143,564	139,609	97.2%	1,237,637	64,073	209,559	957
Madagascar	1,014,832	989,394	97.4%	4,677,503	155,309	843,310	5,022
Mali	677,712	663,403	97.9%	2,448,418	63,318	454,679	2,636
Mozambique	1,527,524	1,395,908	91.4%	7,225,887	473,699	1,286,211	3,603
Nigeria	123,420	121,296	98.3%	692,913	32,633	129,788	732
Rwanda	651,904	640,269	98.3%	2,720,609	44,427	411,470	5,412
Senegal	735,520	718,191	97.6%	2,494,121	59,095	476,960	3,087
Zambia	438,252	409,544	93.4%	2,000,824	60,978	309,250	1,012
Zimbabwe	1,433,033	1,271,861	89%	2,930,975	4,542	54,553	303
TOTAL	**10,485,326**	**9,942,663**	**95.6%**	**36,664,929**	**1,204,540**	**5,908,413**	**38,157**

Note: *This is based on the PMI indicator definition. It includes only spray staff such as spray operators, team leaders, supervisors, and clinicians. It excludes data clerks, IEC mobilizers, drivers, washers, porters, pump technicians, and security guards. AIRS did not conduct IRS campaigns in Burundi and the Democratic Republic of the Congo.

IRS is a highly complex logistical undertaking that requires meticulous planning and management at the national, district, and village levels. It entails detailed micro-planning for each IRS district, procuring insecticide and equipment, managing warehouses and logistics across dozens of operations sites, and training thousands of seasonal workers on how to conduct high quality spraying in thousands of homes while following environmental and health guidelines. Abt Associates encountered and successfully responded to many challenges, such as the rising cost of insecticide, inadequate systems for spray supervision, a lack of infrastructure and local human resources to conduct high quality entomological monitoring, civil unrest, gender biases, hard-to-reach communities, and insufficient monitoring and evaluation (M&E) systems to produce timely data on spray progress and quality (see details in Annex A).

A large, complex, and challenging project, AIRS was structured under five components which aimed to:

1. Establish cost-effective supply chain mechanisms including procurement, distribution and storage of IRS-related commodities, and execute all aspects of logistical plans for IRS-related activities;
2. Implement safe and high-quality IRS programs and provide operational management support (i.e. field supervision, operations planning, day-to-day implementation management) and expert short- and long-term technical and administrative assistance, primarily in the PMI-focus countries but also in other countries where USAID supports malaria programs;
3. Provide on-going monitoring and evaluation for activities and ensure quality control measures for commodities, operations, and monitoring are established and/or refined and implemented;
4. Contribute to global IRS policy-setting and country-level policy development of evidence-based IRS and disseminate experiences and best practices; and
5. Strengthen the capacity of NMCPs, health personnel, and other relevant institutions in the managerial, technical, supervisory, and evaluative functions of IRS (Components 1-3) by engaging, training, and supervising personnel at the central, provincial, and district levels. In addition, ensure that planning, and implementation of IRS includes sufficient attention to gender considerations and that IRS continues to protect women and children of targeted communities from malaria.

This report lays out each component and the various tasks Abt Associates undertook to achieve success. Results from each country are included in Annex A of this report.

1. Component 1

1.1 Establish Cost-effective Supply Chain Mechanisms, including Procurement, Distribution and Storage of IRS-related Commodities, and Execute All Aspects of Logistical Plans for IRS-related Activities.

1.1.1 Supply Chain Mechanisms

AIRS established and implemented cost-effective supply chain mechanisms for IRS-related materials. The mechanisms were implemented in compliance with USAID procurement guidelines, and with host-country laws and policies. In order to benefit from economies of scale, stronger bargaining power, and efficiencies associated with pooling orders, all insecticides and spray equipment were procured centrally at the project's headquarters. Some personal protective equipment (PPE) was not available in the local markets in a few countries and instead was procured through the head office. The rest of the IRS-related materials were procured locally by the country offices. These materials included PPE items, containers used for cleaning purposes, supplies (e.g. soap), stationery, and communication materials. Standards for delivery timelines of procured materials were set based on the *Race to the Starting Line* planning tool, developed by the AIRS team. Local procurements were to be concluded six weeks prior to the start of a spray campaign, and all international procurements were to be delivered in country one month before the campaign start date.

AIRS developed a *Quantification Tool* to calculate the amounts of various equipment, supplies and materials required for a successful spray campaign. The tool enables project managers at various levels to determine the quantities of materials that need to be procured for each spray campaign.

Working closely with insecticide manufacturers, AIRS developed planning logistics and schedules to ensure timely delivery of the insecticides to the country warehouses. This made it possible for AIRS to use sea freight for shipping insecticides to each country, which resulted in significant savings for the project. In all cases, AIRS adhered to World Health Organization (WHO) and PMI Best Management Practices (BMP) guidelines governing transportation of pesticides.

In September 2012, AIRS began pre-shipment quality testing of all insecticide batches procured for the project. The testing methods are based on the World Health Organization Pesticide Evaluation Scheme (WHOPES) guidelines. The logistical and operational details regarding the testing were agreed upon among AIRS, the insecticide manufacturers, and the accredited laboratories where the analyses and reports were done.

A *Product Catalogue* was developed to document the product specifications for PPE procured across the project. The catalogue enabled AIRS to have uniform standards for PPE for in-country (local) procurements.

1.1.2 Supply Chain Assessments

RTT USA Inc. (now called Imperial Health Sciences) was a subcontractor to AIRS and conducted supply chain assessments of the AIRS project in Angola, Benin, Ethiopia, Ghana, Liberia, Madagascar, Mali, Mozambique, Nigeria, Rwanda, and Senegal. The assessments covered the following areas: warehousing; distribution; materials handling; stock management, including stock card usage; stock levels;

environmental health and safety; chain of custody/stock visibility; documentation; human capital; standardization of processes; and overall performance. AIRS implemented the recommendations made in the reports that were submitted following the assessments. RTT also conducted training on IRS warehousing and supply chain management in Angola and Zambia.

1.1.3 Inventory Management and Security

From the point of receipt, AIRS ensured that all insecticide stock in transit and under storage was protected by a security guard. Physical stock counts were conducted at all points in the distribution chain, such as delivery from the central warehouse to district stores. AIRS standardized the documentation used across the insecticide supply chain. The documentation includes delivery notes, issue notes, goods received notes, store ledgers, and stock cards. In addition, AIRS developed *Insecticide Tracking Sheets* and *Spray Performance Tracking Sheets*, which were used to monitor the flow of insecticide stock at each operation site, between storekeepers and spray teams.

Insecticide stock was transported in vehicles that met the specifications detailed in the PMI IRS BMP, such as the requirement for the vehicles to be lockable. AIRS introduced a system of inspecting and pre-certifying vehicles used for transportation of insecticides and spray personnel during spray campaigns.

Twenty-four hour security was in place at all stores that carried insecticide stock. Spot checks were routinely carried out by supervisors to confirm that physical quantities of insecticide matched store records.

AIRS also developed a logistics management information system to allow countries to track the inventory movements of insecticide, equipment and supplies from the central warehouse, to district warehouses, to site operations stores, to final issue to spray teams.

1.1.4 Timely Payments

Many countries and spray districts lack traditional banking facilities to pay seasonal workers. To ensure daily allowances to spray personnel were handled in a timely manner, AIRS established worker bank accounts and used district banks, microfinance institutions (Benin, Ethiopia, Rwanda), and mobile banking platforms for payments. In countries such as Madagascar, Zambia, and Zimbabwe, AIRS successfully used mobile phone payments, which resulted in cost-savings and improved efficiency for both seasonal workers and the project. Mobile payments also mitigate the risk of theft to seasonal workers.

1.1.5 Cost Analysis Study

AIRS produced a cost analysis report that presents and compares the expenses that were incurred during the first two years of IRS program implementation under the project, using a methodology that can be repeated on an annual basis. The purpose of the assessment is to evaluate the overall level of spending in each of these countries, by program activity and by cost category, as well as the unit costs. Specifically, the total program costs, unit cost per person protected, unit cost per structure sprayed, and unit cost per area sprayed (in units of 100 m^2) are calculated using unburdened, burdened, and U.S.-based costs. The findings help to inform stakeholders of the country-specific costs associated with implementing an IRS project.

2. COMPONENT 2

2.1 IMPLEMENT SAFE AND HIGH-QUALITY IRS PROGRAMS AND PROVIDE OPERATIONAL MANAGEMENT SUPPORT AND EXPERT SHORT- AND LONG-TERM TECHNICAL AND ADMINISTRATIVE ASSISTANCE, PRIMARILY IN THE PMI-FOCUS COUNTRIES BUT ALSO IN OTHER COUNTRIES WHERE USAID SUPPORTS MALARIA PROGRAMS.

2.1.1 OPERATIONS PLANNING

In each country, about six months before spraying, AIRS and NMCP staff held planning workshops to set the spray schedule and number of structures to be sprayed, define roles and responsibilities, and determine resource allocations. The meetings were an opportunity to review lessons learned, determine future needs, and harmonize plans for the next campaign with NMCPs. During these meetings, the End-of-Spray Reports (EOSR) from the previous campaigns and the most recent environmental assessment documents were reviewed. Country teams then worked with district health and environmental managers to plan campaign details through a series of district-level micro-planning meetings. The tasks of the micro-planning meetings included the following:

- Complete the *Micro-planning Quantification Sheet,* which details the number and location of storage facilities and soak pits, and requirements for spray operators, wash persons, storekeepers, team leaders, and supervisors;
- Ensure environmental risks are mitigated by following guidance in the Supplemental Environmental Assessments (SEA);
- Confirm spray schedule, including training, logistics/deliveries, and mobilization activities;
- Confirm spray personnel terms of reference and operational budgets; and
- Complete supervision, monitoring, and reporting plans.

All relevant stakeholders signed off on final plans in the last district micro-planning meeting before each campaign, held at least eight weeks before the start of spraying. The final eight weeks of campaign preparation were guided by the AIRS *Race to the Starting Line* tool. By outlining each step, person responsible, and deadline for completion, this tool was used to ensure an on-time start to spraying.

Insecticide resistance and residual activity data were used to inform selection of insecticides for IRS. All attempts were made to test at least one insecticide from each of the four classes of insecticides recommended by WHOPES for IRS for resistance by AIRS annually before selection of insecticide for the following year. Data on residual life of insecticides was also collected each month following the spray campaign to evaluate how long the insecticide remained effective. The reports on insecticide resistance and residual life were submitted to PMI and the NMCP to guide selection of insecticides by National Vector Control or Malaria Control steering committees in each country.

2.1.2 Improving Quality of Spraying through Supervision and Standardization

AIRS carried out IRS in accordance with technical specifications outlined by WHO and developed in partnership with PMI and other donor organizations. Spray teams adhered to calendars indicating the villages to be sprayed each day of the campaign. District Coordinators and Operation Site Supervisors monitored and tracked performance of spray teams using the *Spray Performance Tracking Sheet*. This tool establishes and tracks daily targets for structures to be sprayed by individual, team, and operational site.

With local government counterparts, AIRS ran district-level training of trainers (TOTs) before each spray campaign. Field supervisors trained in the TOTs trained seasonal workers in the sub-districts. Among the supervisors were officials from NMCP, the district health offices and local governments, regulatory bodies such as the Environmental Protection Agency, and the local community. In collaboration with local leaders and district officials, AIRS recruited and trained the following seasonal personnel from their communities: Spray Team Leaders (who supervised around five spray operators), Spray Team Supervisors (who oversaw three to five spray teams), Site Supervisors (who managed operation sites), and support personnel, including washers, drivers, store managers, security guards, and pump technicians. Priority was given to community health volunteers and those with previous IRS experience during the recruitment of seasonal workers.

To ensure compliance with environmental protection and worker safety standards, AIRS held regional environmental compliance (EC) trainings in Ghana, Mali, and Mozambique from February-May 2012 for in-country Operations Managers (OMs) and Environmental Compliance Officers (ECOs). Guided by the PMI BMP Manual, the trainings provided a forum for the exchange of ideas and experiences and enabled the establishment of high-quality, uniform EC standards across all AIRS countries. It was during these trainings that the detailed system for environmental compliance assessments and inspections by ECOs was developed. The ECOs and OMs were trained on using their country-specific SEA and Environmental Mitigation and Monitoring Plans (EMMP) for guidance in adhering to environmental compliance protocols in their respective countries. ECOs and OMs also were trained in providing EC guidance to other AIRS staff, as well as their governmental counterparts, to increase overall capacity for environmental compliance.

2.1.3 Day-to-Day Management

As the AIRS project progressed, job-specific tools and guidance were developed and disseminated, first to AIRS staff, and gradually to government counterparts to ensure IRS operations are efficient, on schedule, and environmentally compliant. In all cases, this led to substantially improved operations and environmental compliance throughout country programs.

The AIRS-developed *IRS Team Leader Guide*, *IRS Storekeeper Pocket Guide* and *IRS Spray Operator Pocket Guide* complement the trainings supervisors, spray operators, and storekeepers undergo before the start of a spray campaign and promote a higher level of standardization in operational performance.

2.1.4 Entomological Monitoring

AIRS successfully established robust entomological monitoring in 12 PMI-supported IRS and two non-IRS countries that generate standardized entomological data reports to inform and guide vector control programs, particularly the IRS program. The AIRS project worked closely with centers of excellence such as the Cotonou Entomology Research Center in Benin, National Institute of Bio-Medical Research (Institut National de INRB in French) in the Democratic Republic of the Congo, Jimma University in Ethiopia, Noguchi Memorial Institute for Medical Research in Ghana, the Pasteur Institute in Madagascar, the Malaria Research and Training Center (MRTC) in Mali, the Nigeria Institute of Medical Research, and five other universities in Nigeria to build entomological monitoring capacity within NMCPs and to collect high quality data.

2.1.5 Standardization of Data Collection Tools/Forms

In year one of the project, AIRS developed and distributed standard entomological data collection tools and protocols to each of the country offices in which it worked. The data collection forms cover all mosquito sampling methods used in the project and standard mosquito test methods. The forms helped the project to collect increasingly standardized data across AIRS countries and enabled entomology teams to capture essential entomological data necessary for effective planning and assessing impact of IRS on entomological indicators.

In addition to the data collection tools, PMI and AIRS developed an entomological database for two important entomological indicators: Insecticide Resistance and Cone Bioassay Tests. The entomology database uses web-based "cloud" storage capacities to allow for easy real-time sharing of information. As country teams entered the quality assurance cone bioassay, resistance or insecticide residual activity data to the PMI entomology database and uploaded it to the cloud-based storage system, the AIRS home office was able to immediately access data for analysis, evaluation, and feedback. The database allows for immediate corrective action, if needed.

2.1.6 Capacity Building

AIRS hired trained entomologists to coordinate and lead entomological activities in 12 out of 14 project countries. In year one of the project, a regional orientation and experience-sharing forum was organized and 13 participants from 12 countries attended the training. The forum enhanced both vertical and horizontal communication among AIRS entomologists, which was instrumental in improving the quality of entomological work.

In countries constrained by a lack of trained entomologists, such as Angola and Mozambique, AIRS hired high school graduates interested in entomology. Up to 10 days of extensive training was provided on basic entomological monitoring, with a focus on practical demonstrations and field exercises. To ensure the quality of their work, recruits were supplied with the necessary equipment and deployed to conduct field work under the direct supervision of experienced entomologists before being allowed to work independently. Continuous assessment, technical support, and on-the-job training were provided to improve their skills.

In Angola and Liberia, insectaries were lacking. In Mali AIRS was not able to access the MRTC insectary due to the military coup that occurred in 2012 per the US Government's suspension in working with the Government of Mali. AIRS took innovative measures to overcome these challenges, converting 40-foot shipping containers to functional insectaries. These insectaries provided an optimum environment for rearing and keeping of mosquitoes; testing; and identification, dissection, and preserving of mosquitoes for further analysis.

In Ethiopia, Nigeria, and Zimbabwe, PMI and AIRS organized a series of entomological surveillance trainings that brought in experts from the U.S. Centers for Disease Control and Prevention (CDC) and NMCPs as well as country research institutes to teach techniques for measuring vector resistance to insecticides, detail best practices for managing an insectary, and determine vector density and behavior. Participants from Zimbabwe and two participants from Angola were trained on polymerase chain reaction (PCR) and enzyme-linked immunosorbent assay (ELISA). Similar training was also provided in Burundi, the Democratic Republic of the Congo, and Nigeria. Participants from these countries actively participated in the 2013 and 2014 entomological monitoring activities.

2.1.7 Insecticide Resistance Data

The collection of vector-resistance data allows for informed decisions in the selection of insecticides – a vital component of a successful spraying program. Each year after a spray campaign was completed AIRS

collected data on vector resistance to potential insecticides selected from each of the four classes of insecticides (pyrethroids, carbamates, organophosphates, and organochlorines) recommended by WHOPES for use in IRS. AIRS used the WHO standard tube test and/or CDC bottle bioassay to collect this data. The results were analyzed and presented to local government and in-country partners to support the selection of insecticide for the following year's IRS campaign.

2.1.8 Quality Assurance and Residual List of Insecticides

AIRS conducted cone bioassay tests to assess the quality of IRS and determine the residual life of the sprayed insecticide. Spray quality assurance testing was conducted within two weeks of the start of the spraying campaign. This allowed for corrective action if the results raised doubts on the quality of spraying. Subsequent monthly cone bioassays were conducted to determine how long the insecticide remained effective on sprayed surfaces. This information complemented resistance data and other entomological data to inform insecticide selection and also to determine the most appropriate time for spraying to coincide with the peak malaria transmission season.

2.1.9 Vector Abundance and Behavior

AIRS collected baseline entomological data on vector density, longevity, and resting and feeding behavior prior to the start of the spraying in all the 12 countries where spraying was conducted in both intervention and control sentinel sites. Post-spray monthly collections were conducted at least for the duration of the malaria transmission season from the same sentinel sites. Standard entomological sampling methods, such as pyrethrum spray catches (PSCs), human landing catches (HLCs) used in 12 out of 14 countries, CDC light traps, outdoor pit traps, and exit traps were used to obtain mosquito samples. Data on entomological indicators were compared between sprayed and unsprayed villages, and pre-spray data was compared with post-spray data. The results of these activities helped to assess the impact of IRS on vector density, longevity, resting and feeding behavior.

2.1.10 Disease Data Management System (DDMS)

The Disease Data Management System (DDMS), developed by the Innovative Vector Control Consortium (IVCC), supports malaria data entry and storage, and helps to produce reports and thematic maps. The entomology module of this database was piloted in Ethiopia, under the AIRS project, and has proven to have the capacity to capture all entomological parameters, including: insecticide resistance, cone bioassay, vector density, and behavioral data. The AIRS Ethiopia team, which included the IT focal person, database manager, two entomologists, and the country M&E team were trained on DDMS. With support from the IT and country database manager, the AIRS Ethiopia entomology team was able to enter entomological data into validated spreadsheets, import the data to the DDMS, create and save queries, run interactive reports from the DDMS menu and export them as pdf files. In addition to simplifying the work of the entomologists, who previously had to generate summary entomological measures manually using spreadsheets, the DDMS helped to generate visual maps. The database also has the potential to overlay entomological data with other malaria indicators, such as epidemiological and spray coverage data to assess trends and impacts.

2.1.11 Carbamates and Pyrethroid Insecticide Quantification Kits

In 2013, AIRS, in collaboration with IVCC and Avima, implemented a pilot study in Ethiopia and Mozambique to field test an Insecticide Quantification Kit (IQK) to assess the amount of insecticide (carbamate or pyrethroid) deposited on sprayed surfaces—and hence, the quality of spraying. The carbamate pilot was carried out in two districts of Ethiopia's Jimma zone, which included both community-based and district-based IRS operations models. The pyrethroid IQK was piloted in Mozambique's Zambezia Province, in the city of Quelimane. Lot quality assurance sampling (LQAS) was

employed, which included the spray squad in the community-based IRS and the spray team in the district-based IRS model.

Prior to the pilot, IVCC and Avima trained three entomologists from the AIRS Ethiopia and Mozambique teams as well as government staff selected to take part in the IQK pilot. The training included step-by-step demonstrations of the sampling and methodology, which involves collection of the insecticide sample from the sprayed wall and chemical extraction of the insecticide, followed by a vial test with a sensor unit. Preliminary IQK testing ensured that the IQK method worked on the local surface substrates: typical surfaces already sprayed with known concentrations of insecticide. Both IQK kits proved their potential for future use during preliminary testing with some improvement. The precision of the carbamate IQK appeared slightly better than pyrethroid.

Some challenges were observed at the start of the pilot. The test was not able to produce the expected color indicator that matches the test control and insecticide concentration. With additional efforts from Avima and IVCC, the problem was partially resolved, and the IQK was able to identify teams with the required quality of spraying and teams for whom the quality needed further investigation or corrective action.

The IQKs demonstrated potential in assessing the quality of spraying in an operational setting. However, the field pilot also revealed a number of issues that needed to be addressed. Based on the pilots, AIRS provided a list of recommendations to be addressed before the IQK could be adopted as a tool for IRS program monitoring.

2.1.12 Study of the Residual Life of Two Deltamethrin Formulations, Suspension Concentrate (SC)-Enhanced Polymer (EP) and Wettable Granule (WG)

A comparative study of the residual life of deltamethrin suspension concentrate (SC)-enhanced polymer (EP) and deltamethrin WG (wettable granule) was conducted in Mozambique, in the Mugeba area of Mocuba District in the Central Region, about 200 km from the regional capital, Quelimane. AIRS Mozambique selected and sprayed five houses with deltamethrin SC-EP and five with deltamethrin WG. Cone bioassay data were collected simultaneously from the ten sprayed houses. The first data were collected 24 hours after spraying and then on a monthly basis from December 2013 to November 2015 (T0 up to T11). By T3, one of the houses sprayed with deltamethrin WG had been demolished; bioassays continued in the remaining four houses. Cone bioassay tests were regularly carried out using *An. arabiensis* Durban strain from the AIRS Mozambique Quelimane insectary, whose colony is susceptible to deltamethrin.

The study results indicated that both deltamethrin SC-EP and deltamethrin WG formulations were highly efficacious against *Anopheles arabiensis* Durban strain consistently for five months with test mortality of greater than the 80% WHO threshold for measuring efficacy. Exposure mortality dropped to less than 80% for both types of formulations at T6 and T7. The unusual sudden test morality drop noted at T6 as compared to T5 and a uniform increase observed at T7 as compared to T6 necessitated further data collection to verify the results. At T8 both formulations showed over 90% mortality against the same mosquito species. Though some fluctuations in the test mortality of mosquitoes were observed from month to month during the follow-up period, both formulations of insecticide appeared effective for 10 months post spraying (78% mortality for deltamethrin SC-EP and 89% for deltamethrin WG). No significant difference in the residual life between the two formulations of deltamethrin was observed in this study.

2.1.13 Experimental Huts Study

The residual life of carbamate insecticides, bendiocarb and propoxur, were studied in two phases using experimental huts in Ethiopia. Phase one was designed to assess the association between the pH of the

water used to make the insecticide suspension before spraying and the residual life of insecticides. Phase two assessed the association between the different surface types and residual activity of the two insecticides. The results indicated that the pH of spray water, when the insecticide suspension is mixed and sprayed immediately, had no effect on the decay rate of these insecticides. However, the type of wall surface significantly impacted the residual efficacy of bendiocarb and to a lesser extent propoxur. Bendiocarb and propoxur had a shorter residual efficacy when sprayed on porous mud surfaces than when sprayed on smoother painted or dung-plastered surfaces.

2.1.14 Chlorfenapyr Insecticide Testing

AIRS, in collaboration with BASF Pest Control Solutions Public Health, initiated an evaluation of the impact of chlorfenapyr, an insecticide that can be used for IRS, on important entomological parameters. The evaluation required a standard experimental hut trial with mosquito exit and entry windows. AIRS entered into an agreement with the Nigeria Institute of Medical Research (NIMR), one of the few research institutions in Africa, with the expertise and proper experimental huts required to sufficiently support the successful implementation of the study.

The main objectives of this evaluation were to determine the persistence of chlorfenapyr as follows:

- Assess the intrinsic insecticidal bioefficacy on key disease vectors (susceptible and insecticide resistant strains) to chlorfenapyr, alpha-cypermethrin, and bendiocarb;
- Determine the best bioassay techniques to estimate chlorfenapyr efficacy and residual activity on relevant wall substrates; and
- Compare the efficacy and residual activities of chlorfenapyr applied as an indoor residual spray on relevant substrates with that of bendiocarb and alpha-cypermethrin.

The testing began in August 2014, with the spraying of six experimental huts. Data collection lasted for six months and the initial results were reported in March 2015. Cone bioassay tests based on the 80% mortality threshold with a one-hour exposure and 48-hour post-exposure period showed that chlorfenapyr has a residual efficacy of four months against the Kisumu strain of *Anopheles gambiae* s.s. with a potential to control pyrethroid resistant *Anopheles* mosquitoes. In contrast, at the 80% threshold mortality level, using the Kisumu strain, with a one-hour exposure and 48-hour post-exposure period for bendiocarb and alpha-cypermethrin sprayed surfaces, the residual efficacy was less than two months and four months, respectively.

2.1.15 Mobilization

AIRS implemented communication, sensitization, and community mobilization activities at multiple levels to ensure that the spray coverage targets were achieved. On average, the spray coverage rates were sustained above 95%.The activities carried out included advocacy with national and district officials; sensitization meetings with technical, cultural, and political leaders at all levels; community mobilization meetings; house-to-house mobilization; radio talk-shows; radio spots; and print materials. District officials, local leaders, and community health volunteers were recruited and trained to participate in these activities. In some countries, AIRS also worked closely with other stakeholders engaged in similar activities, such as local NGOs. In an effort to reduce mobilization costs, SMS messaging was piloted in Mali. When the AIRS team analyzed cost and initial spray coverage, we found mobile-based mobilization was less effective and more expensive than traditional methods. In addition, a new system was introduced where community mobilizers are embedded with spray teams in some countries.

2.1.16 Supplemental Environmental Assessments

During TO4 AIRS revamped the system for the preparation of SEAs, adhering closely to the guidance in the Programmatic Environmental Assessment, while improving and standardizing EMMPs, and integrating

existing and innovative best practices. AIRS wrote or amended eight country-specific SEAs, following PMI guidance, whenever possible, to prepare five-year country-wide assessments that authorized three classes of WHO-recommended pesticides (excluding DDT in all but one country). This standard provided for robust SEA coverage and minimized the need for subsequent amendments. The AIRS project clarified with the assistance and guidance of the Africa and Global Health Bureau Environmental Officers that Pesticide Evaluation Report and Safer Use Action Plans were contained within SEAs, and were therefore not needed as a separate document for IRS. The project then consolidated all environmental health and safety guidance into a single chapter of the SEA, called the Safer Use Action Plan (SUAP), designed to be a detachable, user-friendly document with comprehensive guidance for managing IRS in an environmentally-responsible manner.

By incrementally improving and standardizing substantial parts of SEA development throughout TO4, the PMI approval process became more efficient and less time-consuming. AIRS also clarified PMI policy on spraying near protected areas, referring to the core area and buffer zone system promoted by the International Union for Conservation of Nature.

Additionally, AIRS developed and implemented a PMI Solid Waste Management Policy, with an ordered hierarchy of preferred methods to reduce, reuse, recycle, or dispose of IRS solid wastes with the smallest possible environmental footprint. Major components of this policy included the initiation of recycling programs for empty plastic pesticide containers, recycling cardboard boxes into greeting cards through the Cards from Africa organization in Rwanda (http://www.cardsfromafrica.co.uk/), and giveaways to spray staff for their personal use of commodities no longer usable in IRS programs. This policy was incorporated into the SUAP of each new SEA that was written subsequent to its development.

2.1.17 Smart Phone Data Collection

Early in TO4, AIRS developed an environmental compliance and supervisory smart phone data collection system, starting with the Pre-Season Environmental Compliance Assessment, and progressing through mid-spray and final, post-spray inspections. The checklists and questions were drawn from paper forms found in the 2010 PMI BMP manual annex, and also from the newly-developed (2011) EMMP. The smart-phone system allowed for the near real-time dissemination of outcomes from these inspections. As a result, management was able to respond quickly to non-compliances, reinforce messages from trainings, and change practices when necessary. Once this system was established for ECOs, the project put the technology to use in all 11 spraying countries by senior staff, district coordinators, sector managers, and even government staff in some cases. This dramatically improved bandwidth and ability to supervise operations, and provided assurance that EC and operations procedures were being followed. In addition, AIRS created an online database that can generate reports, and will be available to multiple interested parties, to evaluate the need for systemic changes.

2.1.18 Collaboration

AIRS has engaged and involved ministries of health, environment, and agriculture in IRS planning, operations, and supervision wherever possible. Counterparts attended the project's TOTs and learned about AIRS' latest developments. The project has developed and provided to governments a multitude of tools, including spray operations manuals as well as the above-mentioned EC assessment, inspection, and supervision tools. In many countries, such as Benin, Ghana, Mozambique, and Senegal, Ministry of Health (MOH) or Ministry of Environment (MOE) representatives traveled with AIRS ECOs during the pre-season assessments as well as during mid-spray inspections. This collaboration provided a great opportunity for the AIRS ECO to inform the officials of the latest developments in the program, as well as to get feedback from the officials on whether the cooperation and coordination was working, and/or whether changes were necessary. In some cases, MOH and MOE representatives have been introduced to the tools in paper form, and have then "graduated" to the use of smart phones, thereby expanding

the supervisory reach even further. In addition, in many countries, a partners' meeting is held at the end of the spray campaign to document the successes and shortcomings of the campaign, and what improvements could be made for the following year.

2.1.19 INNOVATION

AIRS developed, piloted, and brought to fruition several EC innovations. The smart phone data collection system began as a small pilot in a few countries using only the pre-season environmental compliance assessment checklist. It grew to become an established system in all 11 AIRS countries that conduct spray campaigns, with several applications and checklists covering geographic reconnaissance, spray performance and supervision, and monitoring and evaluation, in addition to its original EC function.

In addition, AIRS developed and tested the Mobile Soak Pit (MSP) for use in hard-to-reach target spray areas, where the distances are great, resources are limited, and only a few spray operators are needed. The MSP allows operators to perform their end-of-day cleanup operations wherever they finish their work for the day, rather than having to return to pre-determined and pre-constructed fixed soak pits. In most cases, this allows them to spray one or two additional hours per day, using time that was previously spent in transport. The MSP has been included as a PMI best management practice. AIRS successfully piloted MSPs in remote areas of Madagascar in 2013. In 2014, AIRS used MSPs in remote areas of Ethiopia, Mali, Senegal, and Zambia. Other MSP benefits include:

- Improved operational flexibility and reduced construction and labor costs compared to traditional soak pits. (Cost 10-20% less than a traditional soak pit.)
- Can be installed in less than 30 minutes, and broken down after use in the same timeframe.
- Improved control of insecticide waste because the residue is 'locked' in the activated carbon and carried away for later destruction, rather than left in the ground. During TO4, AIRS tested the efficiency of MSPs in trapping insecticide wastewater under simulated conditions. These tests determined that the capacity of a MSP in terms of liters of wastewater that can be processed is sufficient for a five-person spray team performing a 40-day spray campaign.
- Spray operators can clean contaminated gear immediately after completing daily spraying rather than traveling to the central wash area in contaminated PPE, reducing risk of exposure to pesticide residues.
- Spray teams can move by foot or bicycle from village to village, reducing the cost of transporting them back to a fixed soak pit by truck daily.

3. COMPONENT 3

3.1 PROVIDE ON-GOING MONITORING AND EVALUATION FOR ACTIVITIES AND ENSURE QUALITY CONTROL MEASURES FOR COMMODITIES, OPERATIONS, AND MONITORING ARE ESTABLISHED AND/OR REFINED AND IMPLEMENTED.

The AIRS project developed and implemented a significant number of quality assurance/quality control measures during the course of TO4. Table 2 highlights the various methods and tools put into place by technical area.

TABLE 2: AIRS METHODS AND TOOLS FOR QUALITY ASSURANCE (QA)/QUALITY CONTROL (QC)

QA/QC Issue	Method/Tools for Quality Assurance	Party Responsible
Insecticide Procurement	• Pre-shipment testing	• HQ Procurement Officer
Spray Operator Safety and Performance Monitoring	• Pre-spray training • ***Morning Mobilization/Field Transport Vehicle Inspection Checklist*** • Daily Spray Performance Tracker • ***Home Owner Preparation and SOP Performance Checklist*** • Adverse incidence reports • ***End-of-Day Clean Up Checklist***	• Country Operations Manager • All supervisory staff • Site Manager • All supervisory staff • ECO • All supervisory staff
Insecticide and Equipment Warehousing and Transport	• Warehouse manager/driver training • ***Storekeeper Performance Checklist*** • *Inventory Management Tracking System* • Storekeeper Pocket Guide • Daily Insecticide Stock Reconciliation (A=B+C) • Warehouse/Store Physical Stock Audit	• Logistics Manager • All supervisory staff • Logistics Manager • Logistics Manager • Storekeeper • District Coordinator/ Logistics Mgr/ECO
Environmental Compliance Monitoring	• Pre-spray training • Environmental Compliance Assurance Program • Pre-season Environmental Compliance Assessment (PSECA) • Pre-mid-end-of-spray assessments and spot checks	• ECO • ECO • ECO • ECO

Spray Data Collection and Reporting	• Data Entry Training
	• Spray Data Quality Assurance Tool Kit
	  ○ Error Eliminator: Paper checklist form used by Team Leaders to check the completeness and correctness of Spray Operator data before leaving the field.
	  ○ ***Data Collection Verification Form***: Tool used in spot checks to interview households about
		• M&E Manager
		• Team Leaders
		• Operations/ supervisory staff

QA/QC Issue	Method/Tools for Quality Assurance	Party Responsible
	IRS and the number of people protected so that the data reported on the Daily Spray Operator Forms can be verified. ○ AIRS Access Database Cleaning and Reporting Tool: Access database component that identifies data entry inconsistencies between total and detail data and facilitates data cleaning. The tool also provides push button reports available at the local data entry center that are used by the operations and M&E team to track spray progress and make programmatic decision. • Post-spray Data Quality Audit (PSDQA): An internal data audit "self-check" using a country-specific PSDQA protocol. AIRS teams collaborated with government counterparts to audit a representative sample of IRS areas, yielding independent verification that the 85% coverage target was met and revealing areas for improvement.	• Data Entry Clerks • Operations/ supervisory staff • All supervisory staff • M&E Manager
Entomological Monitoring	• Needs assessment of entomological needs and resources • Technical assistance from entomological surveillance consultants and entomological centers of excellence	• Technical Manager • Entomological Manager
Spray Operator Payment	• Spray Operator identity codes and database • Mobile phone payments as feasible	• Finance and Administration Manager

Quality assurance and control was a focus from the start of project implementation. Under the AIRS project, strict standards were put in place for ensuring everything from the quality of the insecticide, to the accuracy of payments, to spray quality. Using the five checklists bolded and italicized in Table 2, AIRS supervisors worked to provide supervision and feedback to every aspect of the spray campaign.

Because of the importance of robust supervision in spray data collection and data entry, AIRS also mandated the use of the Spray Data Quality Assurance Toolkit. Consisting of three data quality supervisory tools, this Toolkit reduced data collection and entry errors, allowed campaign supervisors to identify data quality issues early, and cut data cleaning times by 75% under AIRS.

3.1.1 Performance Monitoring and Reporting

Monitoring, supervision, and reporting on IRS activities have been a major focus of the AIRS project. Adapted from the original checklists in the 2010 PMI IRS BMP Manual, the applications developed for the smart phone data collection system in particular have been effective tools for increasing the reach and capacity of supervision and reporting systems. AIRS first supplied ECOs with smart phones loaded with a single application for assessing the state of facilities required for the environmentally-compliant IRS prior to spray operations, and quickly developed an automated email system that reported deficiencies out to the parties responsible for correcting them. This quickly developed into a "green light" process, with the requirement for a final inspection of facilities just prior to the onset of spray activities. Facilities meeting all environmental compliance requirements were given the "green light" to proceed, while any reported deficiencies were again directed to the responsible parties, as well as various senior staff and headquarters personnel. This system ensured that spray activities were not allowed until all facilities were in environmentally-compliant status, and all required commodities, such as PPE, first aid, and spill kits, were in place.

Once the pre-season assessment and inspection system were rolled out and functional, additional applications were developed for mid-spray inspections, which included specific directions for

immediately correcting any deficiencies. Once again, the inspection application quickly morphed into a supervisory system whereby all deficiencies were reported to OMs, COPs, Technical Coordinators, and environmental compliance personnel, and entered into a cloud-based database for evaluation and permanent data storage.

Throughout TO4, AIRS evaluated and refined technical standards as necessary, and by the close of the project, had submitted draft revisions to the PMI IRS BMP Manual and the standard EMMP, and developed a new Environmental Mitigation and Monitoring Report (EMMR) form that will be applied across all countries where PMI is conducting IRS. The significantly revised environmental compliance checklists were included in the revised BMP Manual, and in addition, were substantially adopted by WHO as their standard for IRS supervision, including the use of "Follow-up Action" columns to immediately correct deficiencies.

3.1.2 TECHNICAL ASSISTANCE

AIRS worked closely with national medical research institutes, local universities, national malaria control programs, and other mid- and low-level government health structures to collect entomological data in AIRS countries. With the goal of building local capacity to ensure quality of entomological monitoring activities and promote sustainability of the program, AIRS provided formal and on-the- job trainings for participants drawn from the collaborating institutions in each country. In Angola, Ethiopia, and Zimbabwe, provincial and district malaria focal persons and environmental officers, who are directly responsible for leading malaria control activities at the grassroots level, were trained on mosquito sampling techniques that included PSC, CDC light traps, larval collection, insecticide resistance testing using both WHO and CDC bottle bioassays, and recording, compilation and reporting of entomological data. After the training, they either led or were involved in the collection of entomological data, particularly insecticide resistance data in their respective areas. Participation in the actual field work provided them with an opportunity to further develop their skills, and built confidence and appreciation for the importance of generating and using local data for decision making.

AIRS also provided host-country counterparts with basic entomological equipment and supplies. In addition, collaborating research institutes and universities, (e.g., Jimma University of Ethiopia, JOS University of Nigeria, Noguchi Memorial Institute of Medical Research (NMIMR) in Ghana, the Malaria Research and Training Center in Mali, and the Institut National de Recherche Biomedical in DRC) were supplied with much-needed laboratory equipment and/or reagents to support molecular work at their laboratory. This effort contributed to the type and quality of entomological data generated from these countries.

4. COMPONENT 4

4.1 CONTRIBUTE TO GLOBAL IRS POLICY-SETTING AND COUNTRY-LEVEL POLICY DEVELOPMENT OF EVIDENCE-BASED IRS AND DISSEMINATE EXPERIENCES AND BEST PRACTICES.

4.1.1 GLOBAL POLICY SETTING

AIRS presented project work at conferences and meetings and convened with other malaria control experts and within international working groups, contributing to the public dialogue and policies around vector control. The project led symposia, hosted conference booths, presented oral presentations and posters on the project's entomological data, M&E best practices, and environmental compliance innovations. The project was actively engaged in Roll Back Malaria (RBM) as members of the Vector Control Working Group and worked in collaboration with IVCC to address the threat of insecticide resistance to malaria vector control and the problems associated with the short residual life of some insecticides recommended for IRS.

The project also participated in and hosted World Malaria Day commemorations throughout project countries. In 2014, AIRS served on the judges' panel with The Against Malaria Foundation, PATH, ONE and the World Health Organization for the Peace Corps Malaria Heroes contest to honor individuals that consistently go above and beyond the call of duty in malaria prevention.

AIRS held annual COP retreats, in conjunction with Abt Associates' annual COP conference, to address cross-cutting issues, promote south-to-south exchanges, build strong teams, and share lessons learned. The conferences and retreats the project held and/or participated in throughout TO4 are listed below.

1. AIRS Conference (Durban, South Africa, November 2012)
2. Multilateral Initiative on Malaria (Durban, South Africa, October 2013)
3. Roll Back Malaria Vector Control Working Group (Geneva, Switzerland, January 2013, 2014)
4. Global Health Mini University (Washington, DC, March 2013 and March 2014)
5. US Global Development Lab (Washington, DC, March 2014)
6. Vector Control Brown Bag (USAID Washington, April 2014)
7. AIRS Annual COP Conference (Annapolis, MD – June 2012; Richmond, VA - June 2013; Philadelphia, PA - June 2014)
8. Pan African Mosquito Control Association Conference (Nairobi, Kenya, October 2014)
9. American Society of Tropical Medicine and Hygiene Conference (New Orleans, LA - November 2014, Washington, DC - November 2013; Atlanta, GA - November 2012)
10. American Public Health Association Conference (New Orleans, LA, November 2014)
11. Global mHealth Forum (National Harbor, MD, December 2014)
12. Innovative Vector Control Consortium stakeholders' bi-annual meeting (Liverpool, England, June 2014)

4.1.2 COMMUNICATIONS

AIRS developed and executed a comprehensive communication strategy to disseminate best practices and share findings and achievements. During TO4, the project developed 27 success stories, 10 videos, nine e-letters, 12 e-alerts, one photo story, six technical briefs, one innovations brochure, and five spotlights on AIRS employees. A list of the technical briefs, stories, videos, and publications can be found in Annex B.

The project also initiated Monthly Tech Talks with the COPs and other country office technical staff to encourage peer-to-peer exchange across the project.

Website

AIRS developed a project website to serve as a project resource. The website (www.africairs.net), which launched on October 16, 2013, includes information about the project, a spray calendar, IRS resources and journal articles, project outcomes, and success stories. Visitors can track AIRS progress against project indicators, and find recent IRS research and tools.

Twitter

The project launched a Twitter account in March 2014 to increase knowledge about the project's success and activities on social media.

4.1.3 BEST PRACTICES

AIRS substantially improved its methods of conducting IRS as well as influenced the practices of several host governments. In particular, in 2014, the Mozambique NMCP gathered all of their provincial environmental health officers in Quelimane to learn about and adopt AIRS best practices, from the use of entomological data to inform IRS programming to the use of soak pits for responsible disposal of liquid IRS wastes. AIRS best practices also were adopted by national governments in Zimbabwe (environmental compliance) and Nigeria (entomology and operations).

The project also released the drafting and editing of the second edition of PMI's Best Management Practices for Indoor Residual Spraying in Vector Control Interventions.

4.1.4 DISSEMINATION AND SHARING DATA/LESSONS LEARNED

AIRS shared entomological monitoring data, particularly insecticide resistance data, with WHO at the country level in several AIRS countries in an effort to contribute to global reporting. Spray and entomological data were also shared with in-country malaria partners during malaria steering committee meetings, annual IRS reviews, and micro-planning meetings. As AIRS implemented IRS in collaboration with NMCPs, all project countries have shared M&E and entomological tools with government partners. AIRS also shared project data with other IRS stakeholders, including the Global Fund.

5. COMPONENT 5

5.1 STRENGTHEN THE CAPACITY OF NMCPS, HEALTH PERSONNEL, AND OTHER RELEVANT INSTITUTIONS IN THE MANAGERIAL, TECHNICAL, SUPERVISORY, AND EVALUATIVE FUNCTIONS OF IRS BY ENGAGING, TRAINING, AND SUPERVISING PERSONNEL AT THE CENTRAL, PROVINCIAL, AND DISTRICT LEVELS. ENSURE THAT PLANNING AND IMPLEMENTATION OF IRS INCLUDES SUFFICIENT ATTENTION TO GENDER CONSIDERATIONS AND THAT IRS CONTINUES TO PROTECT WOMEN AND CHILDREN OF TARGETED COMMUNITIES FROM MALARIA.

AIRS strengthened the technical skills and capacity among host country national and district officials to implement the core functions of spray operations planning, implementation, supervision, and environment compliance. Before each spray campaign, a TOT was conducted to equip trainers, who were predominantly selected from the NMCP, district health offices, and the community, with the skills to conduct lower-level trainings of seasonal spray workers. Dedicated training sessions were conducted for spray operators, spray team leaders, data clerks, washers, security guards, spray equipment technicians, storekeepers, community mobilizers, drivers, and in some countries, porters. In addition, a critical mass of seasonal spray workers at the community level was trained in each of the host countries. Routine training sessions were also conducted for health workers selected from local health facilities, and for district officials working with regulatory bodies such as EPA. Participants were trained in the use of the tools developed under AIRS for planning, supervision, and monitoring of spray operations.

5.1.1 COLLABORATION

Abt Associates provided technical feedback to country-level IRS expert/coordinating/steering committees. A few examples of the role the project played include:

- In Senegal, AIRS facilitated and was an active participant in Senegal's National IRS Steering Committee in the country's malaria control efforts. The IRS Steering Committee is responsible for making all IRS decisions collectively, including but not limited to: spray districts, spray dates, insecticide selection, and technical approach.
- In Ghana, AIRS was a contributing member of the Malaria Vector Control Oversight Committee, which is made up of government and partner organizations and responsible for policy decisions related to vector control, including IRS.
- AIRS Nigeria resuscitated the National Malaria Elimination Program's (NMEP) IRS expert committee group meeting, which prior to AIRS had become moribund due to lack of funding. The project played a key role in several recommendations of the committee, which were fed back to the NMEP for policy decisions.
- In Rwanda, AIRS participated in the Ministry of Health Malaria & Other Parasitic Diseases Division's development of the Integrated Vector Management Strategic Plan and Insecticide Resistance

Management Strategic Plan.

- AIRS Zimbabwe was an active member of the National Vector Control; Social Behavior Change Communications; and Surveillance, Monitoring and Evaluation subcommittees of NMCP, which meet quarterly to review various aspects of IRS and provide policy guidance to NMCP.
- In Ethiopia, AIRS was a member of the NMCP's support team; chair of the Coalition against Malaria in Ethiopia; a member of the Malaria Technical Advisory Committee, and a member of the Vector Control Working Group.

5.1.2 Knowledge Transfer

Aside from the many trainings led by AIRS, the project transferred knowledge to local institutions identified by the NMCP as responsible for future implementation of IRS activities. For example:

- AIRS carried out a national training in August 2013 in Nigeria on IRS best practices involving all 36 states of the federation and the Federal Capital Territory, Abuja.
- In Ethiopia, AIRS was involved in the development of a country malaria proposal to the Global Fund, the National Malaria Strategic Plan (2015-2020); the National Insecticide Resistance Management Strategy, and training of MOH staff on IRS and entomology.
- AIRS provided Zimbabwe's National Institute of Health Research with technical support in entomological surveillance and monitoring. AIRS Zimbabwe's entomologist also supervised post-graduate students conducting advanced entomological studies at the University of Zimbabwe.

5.1.3 Capacity Building Framework, Assessment and Action Plans

As part of the overall capacity building effort, the AIRS project developed a Country Capacity Assessment Framework. This tool rates the level of capacity currently existing by technical or operational area. The categories include: entomological monitoring, environmental compliance, pre-spray planning, spray operations, procurement and supply chain logistics, and M&E. Using the framework, AIRS country programs conducted assessments of the national capacities of their countries. They discussed the assessments jointly with NMCPs and other in-country players, such as environmental protection agencies and ministries of agriculture. After stakeholders agreed on country ratings, each AIRS country program, in collaboration with NMCP, was to develop a country capacity-building plan using the results of the assessment. The plan would have short-term activities to implement during the current performance year and long-term activities that would feed into the design of the next year's work.

Out of 13 countries active in year three of the project, 12 completed the assessments with the exception of Madagascar, where the project had limitations on engaging with the government to implement the IRS. Seven out of 12 countries produced capacity assessment summaries and capacity-building action plans based on the assessment results. Some countries went further with the skills building efforts. As part of the capacity-building action plan, AIRS Senegal conducted a workshop for approximately 25 NMCP staff where they shared tools, and trained NMCP staff on every aspect of IRS early in the year. AIRS Ethiopia held "Feedback and Lessons Learned" sessions on various IRS tools developed under AIRS at the 2014 post-spray evaluation conference. AIRS Benin, AIRS Ghana, and AIRS Rwanda completed hand-over workshops in October-November 2014.

5.1.4 GENDER INCLUSION

AIRS sought to ensure gender equality in the project through engagement with Cultural Practices. At the end of year one and beginning of year two of the project, Cultural Practices conducted a gender assessment of the IRS project in Ethiopia, Ghana, Rwanda, and Senegal. Their analysis identified ways to make the project more gender inclusive and how to engage government agencies to promote women as seasonal workers.

Furthermore, the AIRS team analyzed training data to understand which countries were having problems recruiting female seasonal workers and which were recruiting and training a large percentage of women as compared to the total number of seasonal workers. The project also analyzed the percentage of women trained by job type, which showed that more effort should be made to hire women in supervisory roles and as spray operators.

5.1.5 COST EFFORTS

Costs under the AIRS project were managed through program adherence to PMI-approved annual country Work Plan Budgets. The AIRS Home Office Finance and Contracts Administrators worked with COPs and field Finance Managers to prepare monthly budget trackers to ensure that expenditures were within the approved budget. When overages were anticipated, the team worked together to make adjustments in other line items and if overages could not be overcome within the overall work plan ceiling without compromising performance, the Abt team communicated immediately with PMI. Due to this collaborative and proactive method, average expenditures remained within 89-95% of country work plan budgets each year.

The AIRS project implemented several cost-saving initiatives under spray operations. In Benin and Mali, the initiatives enabled the project to treat as many structures in 2014 as in 2013, despite a switch to a higher-priced insecticide. The cost-saving initiatives included:

- Reducing the number of days of spray, which translates into lower vehicle rental costs;
- Rationalizing the number of vehicles used during spray campaigns, e.g., by having supervisors share vehicles, having spray teams share vehicles, and reducing the number of vehicles used in the final days of spray campaigns;
- Reducing the number of community mobilizers, e.g., by embedding mobilizers in spray teams;
- Changing the mobilization structure, e.g., doing less "door-to-door" mobilization and using more alternative channels such as community meetings and radio;
- Reducing the size of the buffer when procuring insecticide;
- Procuring spare parts of spray equipment by part, and not through full kits; and
- Piloting, and rolling out, the use of lower-priced sprayers, i.e., the IK 12 ("Goizper") sprayer.

6. Challenges and Lessons Learned

AIRS faced multiple challenges in project implementation, particularly at the outset of the project. A few of those challenges and AIRS' responses are listed below.

- *Lack of local infrastructure and human resources to conduct high-quality entomological monitoring*

The lack of local infrastructure and trained and experienced entomologists in malaria control programs were barriers to establishing strong entomological monitoring systems at the beginning of the project. Where possible, AIRS hired trained entomologists to coordinate and lead entomological activities in the project countries. In countries lacking trained entomologists, such as Angola and Mozambique, high school graduates interested in entomology were recruited locally by AIRS. Extensive training was provided on basic entomological monitoring, with a focus on practical demonstrations and field exercises. Recruits were supplied with the necessary equipment and deployed to conduct field work under the direct supervision of experienced entomologists before being allowed to work independently.

Many of the NMCPs also lacked adequate infrastructure for successful integrated vector management. In Angola and Liberia, insectaries were lacking. In Mali, due to the US Government's suspension in working with the Government of Mali, the project was not able to access the Malian's government's insectary. AIRS converted 40-foot shipping containers into functional insectaries (Insectary-in-a-Box), which provided an optimal environment for rearing and keeping of mosquitoes; testing; and identification, dissection and preserving of mosquitoes for further analysis.

- *Lack of standardization in data collection*

Countries used different entomological data collection and recording tools/forms that were not consistent and some countries lacked properly designed forms/tools to capture complete entomological data. In year one of the project, AIRS developed entomological data collection tools in an effort to standardize entomological data collected across all AIRS countries. These new tools were used to record entomological data obtained through various mosquito sampling methods that included HLC, PSC, and CDC light traps. AIRS also modified WHO cone bioassay and tube test data recoding tools to help capture additional information necessary for complete reporting.

- *Inefficient and Non-Standardized M&E System*

Prior to the AIRS project, the IRS M&E systems varied significantly in their execution from country-to-country, with individual databases designed separately for each country's needs. This resulted in a different database being used in each country, with each database having varying degrees of strengths and weaknesses.

AIRS worked to implement M&E standards across the project. This included standardizing and defining common terminology, including documenting the local definition of "structure" per country. Additionally, a standardized AIRS Database and Data Reporting and Cleaning Tool were rolled out across 10 AIRS countries. While Benin, Mali, Senegal, and Zimbabwe kept the locally-designed databases, they integrated several aspects of the AIRS Database design into their local databases, including the *Data Reporting and Cleaning Tool*. The project increased data quality by implementing a standard set of tools to ensure data reported was complete and accurate. Under the AIRS M&E system, data was entered and available through the cloud within 24-48 hours after spray, and data cleaning times were cut by 75%.

- *Financial misconduct*

The scope of work under AIRS had unique logistical and procurement elements that required the team to mobilize significant human resources and engage in a high volume of local procurements. In many local contexts, this can create an opportunity for unethical behavior. At the beginning of the project, the AIRS team uncovered financial misconduct in Ghana. Abt reported the misconduct to the Office of the Inspector General (OIG) and worked with the OIG and their designees to determine allowable costs to be billed and appropriate actions against those implicated.

In year two, Abt Associates implemented a program of field site visits by the project Finance and Contracts Analysts (FCAs). The Scope of Work for these trips was to review the financial, contractual, procurement, and administrative archives and work of the AIRS country team, and identify areas where the AIRS country team needed to increase capacity and receive more financial and contractual support and training from the AIRS headquarters. This was the first-time AIRS had the opportunity to perform an 'internal audit' of the project and review the finance and administration work of the field teams, including finalizing vehicle rental contracts, print contracts, seasonal staff contracts, and local procurement of materials and PPE. These visits emphasized the importance of ethical behavior and created a link between the field finance and procurement teams and the home office, which made reporting suspicious behavior or requesting clarification on policies and procedures far more commonplace. As a result, AIRS was able to enforce strict compliance through continued site visits when possible, careful and detailed review of monthly remote office vouchers (ROVs), changes in local staffing where required, and ongoing professional development of field finance and procurement staff.

- *Increased costs of insecticide*

Approximately midway through the project, AIRS was faced with a sharp increase in the proportion of cost spent on insecticide as many countries began switching to the insecticide pirimiphos-methyl capsule suspension (Actellic CS). Although the new insecticide has longer residual life (up to nine months) than the other non-pyrethroid (bendiocarb) insecticide used previously, it is nearly twice as expensive. Insecticide is the most expensive cost in IRS implementation. Restricted to similar country budgets as in previous years, AIRS conducted a project-wide cost-cutting analysis and identified several cost-savings strategies to offset the increased cost of insecticide in several countries that otherwise would have had to reduce spray coverage.

- *Insecticide production and shipment*

The introduction of Actellic CS brought many challenges aside from cost, including production and lead time. The initial issue AIRS faced was the inability to provide the supplier with a purchase order six months in advance because of the timeline for when insecticide selection decisions were made in country. AIRS overcame this issue by providing forecast estimates with the promise to provide the purchase order upon consent approval. With this, the supplier had sufficient information to prepare fresh stock for upcoming orders in support of countries spraying with Actellic CS. AIRS also mandated the shipment of Actellic CS via ocean freight rather than air freight, reducing shipping cost by approximately 50%.

- *Gender constraints*

Recruiting and retaining a sizable number of female seasonal workers was difficult due to several factors, including the cultural perception that IRS work is for men, a lack of proper-fitting PPE for women, and often a lack of separate and private changing and shower areas at the operational sites. These barriers resulted in low participation of women on the project. To address these barriers, the project conducted gender analyses, analyzed gender specific data, and observed practices in the field to find ways to make the project a better place for women to work, and thus be able to attract and retain more female seasonal workers. AIRS was able to diversify the number of field positions held by women to include Team Leader, Storekeeper, and M&E Specialists. Approximately 25% of seasonal IRS hires were women.

- *Civil unrest*

AIRS experienced various instances of civil unrest under TO4. For example, civil unrest and the coup in Mali postponed our work in 2012, while cattle thieves who terrorized spray operators in Amboasary in the south of Madagascar forced our project to stop spraying in that district. In all of these cases, AIRS communicated with the field staff on the ground, with the country PMI team, and the PMI Washington team to understand what the situation was and how, if possible, we could reach our project objectives while keeping all of our staff safe. Although AIRS Liberia faced civil unrest and an Ebola virus disease outbreak, all project staff remained safe.

7. Conclusion and Recommendations

Under guidance from PMI, the AIRS project successfully implemented safe, cost-effective, efficient, and high-impact IRS programs in 14 countries, and conducted entomological monitoring in 16 countries, in partnership with host-country governments.

As a result of the project, trained entomological personnel now exist in all AIRS countries and produce entomological data, a first for USAID and PMI-supported countries. Environmental controls in PMI's IRS programs meet or exceed PMI standards. Data quality controls are in place, yielding more reliable and valid data that is standardized across countries. Country teams at the national, district, and local levels increasingly tackle IRS planning and implementation themselves. Operational efficiencies that result in cost-savings and efficiency are now a component of every country's IRS program.

PMI's investments through the AIRS project have helped to ensure IRS remains a reliable, cost-effective vector control strategy. PMI's in-country partners have gained the skills they need to implement their own IRS programs, and the AIRS project has played an important role in the global dialogue on insecticide resistance. To further progress in IRS programs, Abt Associates recommends the following:

- **Scale-up existing innovations and test new ones** in IRS operations, environmental compliance, M&E, and entomological monitoring to maximize impact, efficiency, quality, and save money.
- **Find cost-saving strategies to preserve IRS beneficiary targets and maintain quality.** As countries shift to more expensive insecticides, cost-savings around transporting insecticides, optimizing the number of spray days, and reducing vehicle costs will all be critical to cost-savings.
- **Ensure data-driven decision making.** Ensure that NMCPs, country PMI offices, district health officials, program staff, and other local partners have, analyze, and use entomological, epidemiological, and spray data required for selecting insecticides, monitoring and assessing program quality and impact, and IRS targeting.
- **Mentor and train** entomological monitoring personnel and bring entomological capacity inside NMCP programs.
- Use the ***Country Capacity Assessments*** to create realistic capacity building and phase-out plans with target dates for increasing responsibilities. Specifically,
    - Build strong country teams, with limited in-country short-term-technical assistance
    - Build capacity vertically (i.e., in one IRS component) and horizontally (i.e., across all components)
    - Emphasize on-the-job training, mentoring and supervision, and use of proven tools.
    - Work with local leaders to set annual targets for the number and role of women in IRS campaigns.

- **Continue partner relationships** (e.g. Integrated Vector Control Consortium) to increase use of entomological and epidemiological data for decision making, improve IRS mobilization, supervision, and monitoring through mHealth technologies, and build capacity of government stakeholders.

ANNEX A: COUNTRY REPORTS

The Africa Indoor Residual Spraying project conducted IRS campaigns in 14 countries from 2011-2014. The results from the spray campaigns are included below. Please note that Abt Associates also provided technical assistance and operational support for entomological surveillance activities in Burundi and the Democratic Republic of the Congo to increase capacity to collect, analyze and use entomological data to inform the countries' malaria prevention control programs. The project did not provide assistance with spray campaigns in these countries. At PMI's request, the AIRS project provided technical assistance to the NMCP of Malawi for the 2013-14 IRS campaign. The technical assistance focused on transferring skills and increasing competencies of NMCP and district health officers to program, implement, and monitor IRS operations in accordance with the national and international standards for environmental health and safety.

ANGOLA

TABLE 3: AIRS ANGOLA RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	3	3	1	-
Insecticide	Pyrethroids	Pyrethroids	Pyrethroids	
Number of structures sprayed by PMI-supported IRS	141,782	98,136	14,649	254,567
Number of structures targeted by PMI-supported IRS	145,107	106,515	16,506	268,128
Spray coverage	97.7%	92.1%	88.8%	94.9%
Total population protected by PMI-supported IRS	676,090	419,353	58,370	1,153,813
Pregnant women protected	37,049	23,459	1,413	61,921
Children under five protected	115,678	74,542	12,531	202,751
Length of campaign (days)	44	42	29	
Number of people trained with US Government funds to deliver IRS*	691	671	187	1,549

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

BENIN

TABLE 4: AIRS BENIN RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	9	9	9	
Insecticide	Carbamates	Carbamates/ Organophosphates	Organophosphates	
Number of structures sprayed by PMI-supported IRS	210,380	228,951	254,072	693,403
Number of structures targeted by PMI-supported IRS	221,937	239,112	265,907	726,956
Spray coverage	94.8%	95.8%	95.5%	95.4%
Total population protected by PMI-supported IRS	652,777	694,729	789,883	2,137,389
Pregnant women protected	17,807	19,818	25,754	63,379
Children under five protected	127,133	134,045	151,497	412,675
Length of campaign (days)	35	32	20	
Number of people trained with US Government funds to deliver IRS*	825	804	1,642	3,271

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

BURKINA FASO

Program Highlights

AIRS Burkina Faso was active from October 2011 – December 2012 covering only the 2012 spray campaign in that time period. The program, which had originally been a USAID-funded pilot, closed in December 2012 given a re-prioritization of resources by the Government of Burkina Faso.

TABLE 5: AIRS BURKINA FASO RESULTS, 2012

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	1	NA	NA	
Insecticide	Carbamates			
Number of structures sprayed by PMI-supported IRS	36,870	NA	NA	36,870
Number of structures	37,126	NA	NA	37,126

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
targeted by PMI-supported IRS				
Spray coverage	99.3%	NA	NA	99.3%
Total population protected by PMI-supported IRS	115,638	NA	NA	115,638
Pregnant women protected	2,188	NA	NA	2,188
Children under five protected	23,118	NA	NA	23,118
Length of campaign	21 days	NA	NA	
Number of people trained with US Government funds to deliver IRS*	332	NA	NA	332

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

ETHIOPIA

TABLE 6: AIRS ETHIOPIA RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	TOTAL
Number of districts covered by PMI-supported IRS	36 districts in the Oromia region Round 1: 19 Districts Round 2: 17 Districts	36 districts in the Oromia region	36 districts in the Oromia region	
Insecticide	Deltamethrin/ Bendiocarb	Bendiocarb	Bendiocarb	
Number of structures sprayed by PMI-supported IRS	547,421	635,528	667,236	1,850,185
Number of structures targeted by PMI-supported IRS	554,062	638,173	670,303	1,862,538
Spray coverage	98.8%	99.6%	99.5%	99.3%
Total Population protected by PMI-supported IRS	1,506,273	1,629,958	1,647,099	4,783,330
Pregnant women protected	23,309	25,211	23,919	72,439
Children under five protected	225,875	240,558	230,862	697,295
Length of campaign (total days)	Round 1: 40 Days Round 2: 35 Days	37 days	44 days	
Number of people trained with U.S. Government funds to deliver IRS*	2,260 Round 1: 1,058 Round 2: 1,202	2,684	2,886	7,830

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

GHANA

TABLE 7: AIRS GHANA RESULTS, 2012-2014

Country Indicator	Y1-2012†	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	9	4	4	
Insecticide	Actelic 300CS/	Actelic 300CS	Actelic 300CS	
Number of structures sprayed by PMI-supported IRS	355,278	197,655	205,230	758,163
Number of structures targeted by PMI-supported IRS	383,142	216,876	244,799	844,817
Spray coverage	92.7%	91.1%	83.8%	89.7%
Total population protected by PMI-supported IRS	941,240	534,060	570,572	2,045,872
Pregnant women protected	21,774	11,617	12,538	45,929
Children under five protected	188,696	102,115	105,983	396,794
Length of campaign (days)	Round 1: 60 Round 2: 22	53	36	
Number of people trained with US Government funds to deliver IRS*	992	669	750	2,411

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

†There were 2 rounds of spray in Ghana in 2012. The data presented here is for the largest spray round to avoid double counting of Bunkpurugu Yunyoo, which was sprayed twice.

LIBERIA

TABLE 8: AIRS LIBERIA RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	14	7	-	-
Insecticide	Carbamates/ Pyrethroids	Organophosphates	-	
Number of structures sprayed by PMI-supported IRS	96,901	42,708	-	139,609
Number of structures targeted by PMI-supported IRS	99,236	44,328	-	143,564
Spray coverage	97.6%	96.3%	-	97.2%
Total population protected by PMI-supported IRS	869,707	367,930	-	1,237,637
Pregnant women protected	47,786	16,287	-	64,073
Children under five protected	145,845	63,714	-	209,559
Length of campaign (days)	114	40	-	
Number of people trained with US Government funds to deliver IRS*	665	292	-	957

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

MADAGASCAR

TABLE 9: AIRS MADAGASCAR RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	9	9	9	
Insecticide	Carbamates	Carbamates/ Organophosphates	Carbamates, Pyrethroids, Organophosphates	
Number of structures sprayed by PMI-supported IRS	371,391	343,470	274,533	989,394
Number of structures targeted by PMI-supported IRS	380,074	347,776	286,982	1,014,832

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Spray coverage	97.7%	98.8%	95.7%	97.4%
Total population protected by PMI-supported IRS	1,781,981	1,588,138	1,307,384	4,677,503
Pregnant women protected	60,146	64,792	25,754	155,309
Children under five protected	371,701	296,395	151,497	843,310
Length of campaign (days)	35	32	20	
Number of people trained with US Government funds to deliver IRS*	3,379	834	809	5,022

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

MALI

TABLE 10: AIRS MALI RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	3	3	3	
Insecticide	Carbamates	Carbamates	Carbamates and Organophosphates	
Number of structures sprayed by PMI-supported IRS	206,295	228,985	228,123	663,403
Number of structures targeted by PMI-supported IRS	210,217	233,789	233,706	677,712
Spray coverage	98.1%	97.9%	97.6%	97.9%
Total population protected by PMI-supported IRS	762,146	850,104	836,568	2,448,418
Pregnant women protected	18,561	22,405	22,352	63,318
Children under five protected	145,953	153,962	154,764	454,679
Length of campaign (days)	45	46	40	
Number of people trained with US Government funds to deliver IRS*	872	853	911	2,636

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

MOZAMBIQUE

TABLE 11: AIRS MOZAMBIQUE RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	6	4	5	
Insecticide	Pyrethroid	Pyrethroid	Pyrethroid	
Number of structures sprayed by PMI-supported IRS	536,558	414,232	445,118	1,395,908
Number of structures targeted by PMI-supported IRS	585,299	464,295	477,930	1,527,524
Spray coverage	91.6%	89.2%	93.1%	91.4%
Total population protected by PMI-supported IRS	2,716,176	2,181,896	2,327,815	7,225,887
Pregnant women protected	174,370	139,499	159,830	473,699
Children under five protected	501,522	379,982	404,707	1,286,211
Length of campaign (days)	61	47 days in Mocuba, 48 days in Milange and Morrumbala and 55 days in Quelimane	48	
Number of people trained with US Government funds to deliver IRS*	1,121	1,128	1,354	3,603

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

NIGERIA

TABLE 12: AIRS NIGERIA RESULTS, 2012-2013

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	2	2	-	-
Insecticide	Pyrethroid	Pyrethroid	-	
Number of structures sprayed by PMI-supported IRS	58,704	62,592	-	121,296
Number of structures targeted by PMI-supported	59,229	64,191	-	123,420

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
IRS				
Spray coverage	99.1%	97.5%	-	98.3
Total population protected by PMI-supported IRS	346,115	346,798	-	692,913
Pregnant women protected	15,900	16,733	-	32,633
Children under five protected	62,584	67,204	-	129,788
Length of campaign (days)	32	33	-	
Number of people trained with US Government funds to deliver IRS*	351	292	-	732

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

RWANDA

TABLE 13: AIRS RWANDA RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	3	3	3	
Insecticide	Pyrethroids	Pyrethroids and Carbamates	Carbamates	
Number of structures sprayed by PMI-supported IRS	236,610	230,573	173,086	640,269
Number of structures targeted by PMI-supported IRS	242,589	234,904	174,411	651,904
Spray coverage	97.5%	98.2%	99.2%	98.3%
Total population protected by PMI-supported IRS	1,025,181	990,380	705,048	2,720,609
Pregnant women protected	17,157	16,151	11,119	44,427
Children under five protected	160,399	147,663	103,408	411,470
Length of campaign	30 days	20 days in February 2013 and 30 days in September 2013	24 days for both February and September 2014	
Number of people trained with US Government funds to deliver IRS*	1,986	1,925	1,501	5,412

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

SENEGAL

TABLE 14: AIRS SENEGAL RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	6	4	4	-
Insecticide	Carbamates	Carbamates	Carbamates/ Organophosphates	
Number of structures sprayed by PMI-supported IRS	306,916	207,116	204,159	718,191
Number of structures targeted by PMI-supported IRS	312,938	212,979	209,603	735,520
Spray coverage	98.08%	97.25%	97.40%	97.64%
Total population protected by PMI-supported IRS	1,095,093	690,029	708,999	2,494,121
Pregnant women protected	26,263	15,592	17,240	59,095
Children under five protected	220,463	126,888	129,609	476,960
Length of campaign (days)	48	49	34	
Number of people trained with US Government funds to deliver IRS*	1,221	933	933	3,087

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

ZAMBIA

TABLE 15: AIRS ZAMBIA RESULTS, 2012-2014

Country Indicator	Y3-2014	Total
Number of districts covered by PMI-supported IRS	40	40
Insecticide	Organophosphate, pirimiphos-methyl (Actellic 300 CS)	
Number of structures sprayed by PMI-supported IRS	409,544	409,544
Number of structures targeted by PMI-supported IRS	438,252	438,252
Spray coverage	93.4%	93.4%

Country Indicator	Y3-2014	Total
Total population protected by PMI-supported IRS	2,000,824	2,000,824
Pregnant women protected	60,978	60,978
Children under five protected	309,250	309,250
Length of campaign (days)	65	65
Number of people trained with US Government funds to deliver IRS*	1,012[1]	1,012

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

ZIMBABWE

TABLE 16: AIRS ZIMBABWE RESULTS, 2012-2014

Country Indicator	Y1-2012	Y2-2013	Y3-2014	Total
Number of districts covered by PMI-supported IRS	17	25	4	25
Insecticide	Pyrethroids	Pyrethroids	Organophosphate	
Number of structures sprayed by PMI-supported IRS	501,613	622,299	147,949	1,271,861
Number of structures targeted by PMI-supported IRS	583,165	685,946	163,922	1,433,033
Spray coverage	86%	91%	90%	89.0%
Total population protected by PMI-supported IRS	1,164,586	1,431,643	344,746	2,930,975
Pregnant women protected	N/A	N/A	4,542	4,542[2]
Children under five protected	N/A	N/A	54,553	54,553
Length of campaign	63 days	63 days	39 days	
Number of people trained with US Government funds to deliver IRS*	N/A	N/A	303	303

[1] 448 additional people were trained with DFID funds for a total of 1,460 people trained to deliver IRS
[2] Data is from only one year of implementation

ANNEX B: COMMUNICATIONS

Please note that communications materials listed include from the beginning of project implementation until December 31, 2014. All materials can be found on the project website at: http://www.africairs.net/reports-and-journal-articles/.

Technical Briefs and Publications

1. AIRS Project Brief
2. Innovations in Indoor Residual Spraying
3. The Proof is in the Planning, Supervision, and Monitoring – AIRS Brings Efficiency and Efficacy to IRS Operations
4. Data Drives Decisions in IRS – Strong Entomological Monitoring Leads to Evidence-Based Decision Making
5. Environmental Compliance: Innovation Punctuates Protocols
6. Strong Systems and Innovative Pilots Improve AIRS Monitoring and Evaluation
7. Mapping Insecticide Resistance, Mali

Success Stories in TO4

1. Stepping Up, Cleaning Up
2. Building Blocks
3. Knowledge is Power
4. Narrowing the Gender Gap
5. New Insecticide Formulation Re-energizes Fight Against Malaria
6. More Bang for the Buck
7. AIRS Wins Award for Social Impact
8. Have Pit, Will Travel
9. Mobile Money Pays Off
10. Topping It Off
11. The Brain Gain in Nigeria
12. Blazing the Trail for Women in IRS
13. A Struggle without Borders
14. Progress against Malaria in Rwanda
15. Recycling Program Expands to Benin
16. Training the Next Generation of Entomologists
17. Angola Opens Country's First Laboratory to Study Mosquitoes
18. Jimma University to Become First Institution in Ethiopia to Carry Out Molecular Entomology
19. A Woman's Job Means More than a Paycheck
20. When Bosses Text
21. Country-led Innovation
22. AIRS Introduces Robust Quality Assurance Measures
23. Engaging Health Workers, Ethiopia Moves toward Community-based IRS
24. Partnering with Local Bank Ensures Timely Payment for Seasonal Staff

25. Mali Pilots "Insectary-in-a-box"
26. Community members: 'We know IRS is working because we can smell it."
27. Ghana-Angola Peer Mentoring Builds Capacity of Local Staff

Videos

1. How IRS Works (English and French - animation)
2. Armed in Malaria Prevention (speed drawing)
3. How to Build a Mobile Soak Pit
4. Women Take Charge in Malaria Prevention
5. Building Capacity to Fight Malaria
6. Piloting Community-based IRS in Ethiopia
7. Community Engagement is Key to Malaria Prevention
8. Mobile Application Improves Environmental Compliance of IRS
9. Recycling Gives Insecticide Bottles New Use
10. Insectary-in-a-box Solves Entomological Dilemma

Spotlights

1. Dr. Alfred Rutagengwa - Rwanda
2. Dr. Zephirin Meya – Angola
3. Bertille Onambele – Benin
4. Chioma Amajoh – Nigeria
5. Yemane Yihdego – Ethiopia

Photo Stories

Fighting Malaria in Ghana