PMI | Africa IRS (AIRS) Project

Indoor Residual Spraying (IRS 2) Task Order Four

LIBERIA
2013 END OF SPRAY REPORT

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ACRONYMS

AIRS	Africa Indoor Residual Spraying Project
BCC	Behavior Change Communication
BMP	Best Management Practices Manual
BPN	bites/person/night
CDC	Centers for Disease Control and Prevention
CHT	County Health Team
CHV	Community Health Volunteer
COP	Chief of Party
DHO	District Health Officer
EC	Environmental Compliance
EPA	Environmental Protection Agency
HLC	Human Landing Catch
IEC	Information, Education, and Communication
IRS	Indoor Residual Spraying
IVM	Integrated Vector Management
M&E	Monitoring and Evaluation
MOA	Ministry of Agriculture
MOHSW	Ministry of Health and Social Welfare
MSDS	Material Safety Data Sheet
NMCP	National Malaria Control Program
OP	Organophosphate
PMI	Presidential Malaria Initiative
PPE	Personal Protective Equipment
PSC	Pyrethrum Spray Collection
SEA	Supplement Environmental Assessment
SKT	Sergeant Kollie Town
SOP	Spray Operator
TOT	Training of Trainers
UNMIL	United Nations Mission in Liberia
USAID	United States Agency for International Development
UTM	Universal Transverse Mercator
WHO	World Health Organization

EXECUTIVE SUMMARY

In August 2011, Abt Associates was awarded a three-year Africa indoor residual spraying (AIRS) project, funded by the United States Agency for International Development (USAID) under the President's Malaria Initiative (PMI). Liberia was one of the countries that received support to implement Indoor Residual Spraying (IRS). The key objectives of the AIRS project in Liberia are to reduce malaria-associated morbidity and mortality in selected areas with high malaria burden and to build local capacity to implement sustainable IRS campaigns. The initial target for the 2013 IRS campaign was to spray structures in five districts in Bong County; however, two more districts (Zota and Sanoyea) were added in order to reach a spray target of at least 40,000 structures. As a result, AIRS Liberia sprayed 42,708 structures in seven districts in Bong County. The IRS campaign used a long- lasting organophosphate (OP) class insecticide that was selected after identifying high levels of pyrethroid resistance in Liberia. The 2013 IRS campaign began on March 19 and was completed on May 4, taking 40 operational days. This report covers activities that occurred during the campaign.

The IRS campaign implementation was conducted in close collaboration with the National Malaria Control Program (NMCP), County Health Team (CHT), the Environmental Protection Agency (EPA), and local authorities in the targeted districts.

Additionally, AIRS Liberia conducted an entomological study to monitor the quality of spray and the decay rate of the sprayed OP insecticide, as well as resistance/susceptibility to other classes of insecticides. Local mosquitoes in IRS districts were susceptible to the OP insecticide. Table 1 demonstrates key results of AIRS Liberia during the 2013 IRS campaign.

TABLE 1: 2013 IRS CAMPAIGN SUMMARY OF ACHIEVEMENTS

Number of people trained with USG funds	597
Number of men trained	468
Number of women trained	129
Number of structures targeted for spraying with USG funds as found by spray operators (SOPs)	44,328
Number of structures sprayed with IRS with USG funds	42,708
Spray coverage based on structures found by spray operators	96.3%
Total number of people protected	367,930
Total number of pregnant women protected	16,287
Total number of children less than 5 years old protected	63,714

1. Introduction

Liberia lies on the West African coast of Africa and is administratively divided into 15 counties. It is among the 15 African countries with the highest transmission of malaria in the West African region; in 2010, according to the World Malaria Report, all of Liberia's population was classified as at risk for malaria infection.

One of the key National Malaria Control Program (NMCP) strategies for malaria control in Liberia is to conduct targeted Indoor Residual Spraying (IRS) of households in areas with a high malaria burden. To implement this strategy, the NMCP has been working in close collaboration with Abt Associates' Africa Indoor Residual Spraying Project (AIRS), the implementing partner contracted by the President's Malaria Initiative (PMI) to conduct IRS in Liberia.

2013 marked the fifth year of IRS implementation in Liberia. The introduction of IRS was aimed at reducing malaria morbidity and mortality, saving human lives, and promoting economic and social growth. The AIRS objectives for 2013 were to spray at least 40,000 structures, build local capacity, and transfer skills and knowledge in IRS planning, implementation, and environmental compliance (EC) to the NMCP. In addition, AIRS strived to strengthen entomological monitoring with an emphasis on mosquito collection methods, morphological identification of local malaria vectors, insecticide resistance surveillance, and real-time efficacy monitoring.

The IRS campaign operations were conducted in seven districts within Bong County, located in central Liberia region. This region was selected because it has the second highest malaria prevalence rate, is densely populated and easily accessible, making it a desirable place to conduct IRS logistically and operationally. This report highlights the activities completed before, during, and after the 2013 IRS campaign, and the results of the 2013 IRS campaign, including recent entomological surveillance findings.

1.1 Key IRS Program Objectives in 2013

The two overall goals of the AIRS Liberia project according the 2013 work plan were:

1. To contribute to the NMCP and PMI goal of reducing malaria associated morbidity and mortality in Liberia.
2. To establish an IRS program that will set national performance standards and serve as a best practice model among national and international implementers.

The specific objectives for the 2013 IRS campaign were:

- To achieve spray coverage of at least 85 percent of the target number of structures in the seven selected districts;
- To strengthen the capacity for IRS implementation, monitoring, and supervision at the national, district, and county levels;
- To support the NMCP to conduct entomological surveillance activities, monitor insecticide resistance, and complete quality assurance of the actual spraying completed by the AIRS Liberia seasonal staff; and
- To comply with environmental regulations, and establish local capacity in the target districts for insecticide handling and usage for IRS.

2. PRE-SPRAY ACTIVITIES

2.1 DISTRICT SELECTION AND GENERAL PLANNING

The IRS Integrated Vector Management (IVM) Task Force met on November 30, 2012, reviewed the latest available data on malaria burden and insecticide susceptibility, and decided that Bong County should be the target for the 2013 IRS campaign. The IRS districts for 2013 were selected based on the Ministry of Health and Social Welfare (MOHSW) policy, which outlines three criteria to be taken into consideration in the selection of IRS sites:

- Areas with the highest malaria burden;
- Under-served areas, in terms of access to health services; and
- Areas with relatively easy physical or geographical access.

In addition, technical, geographical and logistical information for cost-effective operations was taken into consideration by the IVM stakeholders, the NMCP, Environmental Protection Agency (EPA), PMI mission office, and Ministry of Agriculture (MOA) when selecting districts for the 2013 IRS campaign. Thus, the IRS campaign planned to target structures in four districts that had previously received IRS, and Jorquelleh district, which had not been previously sprayed. However, due to a shortfall in the number of targeted structures in Jorquelleh district, spray operations were extended to two more new districts, Zota and Sanoyea, to assure the 2013 IRS campaign would spray more than 40,000 structures as shown in Table 2.

TABLE 2: 2013 OPERATIONAL SITES AND ESTIMATED NUMBER OF STRUCTURES TO SPRAY

County	Target Districts	Structures to Spray
Bong	Fuamah	7,000
Bong	Panta	5,500
Bong	Kpaai	3,700
Bong	Kokoyah	7,000
Bong	Jorquelleh	14,000
Bong	Sanoyea	2,000
Bong	Zota	1,000
Total for all Districts		**40,200**

For the 2013 IRS operations, there was a switch in the insecticide class from pyrethroids and carbamates to an organophosphate (Actellic CS) due to observed resistance in the local malaria vectors against pyrethroids (K-Othrine and Fendona). AIRS Liberia instituted specific training and strict environmental compliance (EC) monitoring to ensure that the insecticide was used and disposed of properly.

Since Jorquelleh was a new IRS district, enumeration was conducted to get the exact number of eligible structures in the district. The actual count identified a total of 14,000 structures, which left a shortage of 3,000 structures to reach the target of at least 40,000. In order to meet the target and following a joint discussion with the NMCP and County Health Team (CHT), it was decided to spray parts of two other

districts in Bong County. Sanoyea and Zota districts were selected because they were logistically feasible to spray using operational sites in Fuamah and Jorquelleh.

Initial IRS awareness and advocacy meetings were held with community leaders and district health authorities, which included numerous field visits. The AIRS project collaborated with local authorities and health authorities to select spray operators (SOPs) and community mobilizers, and to encourage participation of the community at large. A resource assessment was also conducted during this phase to determine the availability of IRS supplies and the gaps in order to have local and international procurement orders take place.

2.2 Insecticide Selection

The selection of insecticide class to be used during the 2013 IRS campaign was done by the IRS Task Force during a meeting held on November 30, 2012. The IRS Task Force reviewed the susceptibility and bioassay data presented by AIRS entomology staff and decided that organophosphates (Actellic CS) should be used during the 2013 campaign because of the detected local mosquitoes' high resistance to pyrethroids. The IRS Task Force is co-chaired by the Assistant Minister for Preventive Health in the MOHSW and the NMCP Program Manager. Other members of the IRS Task Force include the MOHSW, MOA, EPA, Department of Environmental and Occupational Health (DEOH), PMI Resident Advisors, and other international and local partners working on malaria control in Liberia. Annex A provides additional information on the selection decision.

2.3 Micro-Planning

Micro-planning for spray operations started mid-February 2013. This exercise was facilitated by AIRS Liberia and involved officials from the NMCP. An activity plan was prepared containing personnel needs and criteria for staff recruitment and mobilization. The logistical requirements were outlined, which included the number of vehicles needed, locations of warehouses and soak pit sites, IRS equipment and insecticide needs, and the training schedule. All partners agreed that spray operations should commence on March 19 and last for 31 operational days.

Additionally, during micro-planning, the NMCP and AIRS Liberia made several decisions about entomological surveillance activities to be carried out during the 2013 IRS campaign. These included:

- Following AIRS Liberia recommendations, Palala in Kpaai district and Haindi in Fuamah district were selected as intervention study sites, while Sergeant Kollie Town (SKT) in Suakoko district was selected as a control study site. One of the previous IRS sites, Frank Town, was selected as a location to monitor vector dynamics after IRS withdrawal.
- AIRS Liberia and the NMCP would approach the CHT to identify two community health volunteers (CHVs) to assist the entomology teams at each entomological surveillance site.
- AIRS Liberia and the NMCP would work with the CHT to identify a suitable building in Jorquelleh district to be used as a temporary insectary during IRS monitoring.

2.4 Logistical Needs And Procurement

The project has two permanent warehouses (one in Monrovia and one in Gbarnga), 12 sub-warehouses and 12 soak pits to support the IRS spray operations. The warehouse in Gbarnga (located in Jorquelleh district) was opened as a regional warehouse to store and supply sub-warehouses in the other districts in Bong County. All of the warehouses were rented from local communities, and some required refurbishment to ensure optimal storage of project equipment and materials. A proper warehouse management system was used, whereby commodities received and dispatched were recorded on stock

cards in addition to ledger books. Distribution of items was controlled by a requisition and delivery note system using waybills. During the campaign, logistics staff kept an on-going inventory of all stock, and the Operations Manager conducted regular spot checks to monitor warehousing procedure.

The project conducted an open tender procurement and bid analysis to identify companies that would provide vehicles to support the spray campaign. A tender notice was advertised in the national newspapers. Out of five respondents, three were selected to provide transport for the IRS operation based on price competitiveness and business reputation. Vehicles supplied included 4x4 jeeps and small trucks to carry SOPs and supplies to and from the field.

A review of the existing stock of materials and equipment was conducted to determine the items that needed to be procured. Tables B-1 and B-2 in Annex B present information on pre-spray inventory and commodities procured internationally and domestically. The insecticide required for the spray campaign was procured and delivered in March 2013.

2.5 Human Resource Requirements

To determine the number of spray personnel needed to reach the target of 40,200 structures, the project considered the previous spray campaign experience and estimated that 208 SOPs would suffice. The IRS target area was divided into 3 regions and each region was allocated with regional coordinators (RC) to manage day to day spray campaign, provide onsite leadership oversight and deployment of SOP.

The SOPs were selected at the district level with assistance from the District Health Officers and local authorities from each of the operational districts, including the mayor and community leaders. The selection was done according to the following criteria: reading and writing ability, physical and medical fitness, and residence in the target community. Female SOPs were encouraged to apply, as long as they were not pregnant or breastfeeding. Pregnancy tests were administered to all female SOPs and washers at the clinic near the IRS operation site. A total of 96 pregnancy tests were conducted and out of those, only one was found to be positive.

2.6 Training

The objectives of the AIRS Liberia project's trainings were to continue to build the capacity of the host country at the national and district levels to implement a well-organized IRS program, and to ensure that seasonal spray staff had the skills and knowledge to implement spraying at a high level of quality. The training process was organized into two parts: (1) the training of trainers (TOT) at the national level; (2) the training of SOPs, community mobilizers, and other relevant AIRS staff at the district level. The IRS operational training manual and IRS mobilizer handouts were used as reference materials to train SOPs and mobilizers, respectively. At the end of the training, each participant received a training manual to use in the future as a reference guide. Training included lectures, demonstrations, and practical sessions on the use of IRS equipment (handling pumps) and personal protective equipment (PPE), spray techniques and monitoring and evaluation (M&E) tools to capture data. Field worker training took place in March 2013. In total, AIRS Liberia trained 597 people on various aspects of IRS implementation, as summarized in Table 3 by gender and cadre.

2.6.1 Training of Trainers

The TOT training was held for five days between February 26 and March 1, 2013 in Gbarnga, Bong County. The training, which included both theoretical and practical sessions, was jointly facilitated by officers from the NMCP, AIRS, Bong CHT, EPA and MOA. A total of 23 participants (15 SOP supervisors and eight mobilizer supervisors) attended the TOT, which included people with previous

experience as a SOP. In addition, the project logistics and technical maintenance staff (11 storekeepers/ warehouse clerks and two pump technicians) were invited and oriented on the aspects of the TOT.

Topics covered during the TOT were:

- Introduction to IRS;
- Spray pump use, assembly and maintenance (practical training and mock spraying); and
- Insecticide use, handling, and safety, and EC (lecture on EC and demonstration on PPE and progressive rinsing).

The first day of the training involved all TOT participants because the topics covered were useful to everyone. In subsequent days, the attendees were split into two groups. The first group included SOP supervisors, storekeepers and pump technicians. The content of their training session was based on the spray operations training manual and covered the following topics:

- Spray technique (practical training);
- Spray supervision (roles of team leader / supervisor, use of supervisor check list etc.);
- Logistics management (stock management and warehouse tracking forms); and
- Performance monitoring, M&E and data recording and verification (lecture and practical session on various M&E tools).

The second group of TOT participants included community mobilizer supervisors. Their training session covered Information, Education and Communication (IEC) topics. The majority of these trainees had previous IRS experience, and thus, the training mainly served as a refresher course.

2.6.2 Spray Operator Training at the District Level

Training for spray operators (SOPs) at the district level in Bong Country was conducted by graduates of the TOT training, with support from other AIRS staff, the NMCP and CHT. The length of the training was four days for SOPs with previous IRS experience (approximately 88 percent), plus an additional day for newly-hired SOPs. The training included both theoretical and practical sessions.

During the district level training, TOT graduates supervised by AIRS Liberia trained 208 SOPs and 40 team leaders. In addition to SOPs and team leaders, the project trained 44 washers, 32 security guards, nine janitors, 24 drivers, and six conveyors (i.e., locals hired to transport materials to sites with no road access) in protection measures against insecticide poisoning and environmental contamination.

District health officers conducted a general medical examination of all SOPs and performed a pregnancy test on all female SOPs and washers. Only those female SOPs and washers who had negative pregnancy test results and were not breastfeeding were allowed to participate in the IRS operations.

2.6.3 IEC Mobilizer Training

Through the CHTs, the project selected community mobilizers with IRS experience and provided a three-day refresher training on house-to-house mobilization in each district. The majority (approximately 90 percent) of mobilizers are CHVs with strong visibility and extensive experience in health awareness campaigns in the community. Newly-hired mobilizers without prior experience in IRS in Jorquelleh district received an additional day of training. In collaboration with AIRS and NMCP staff, a total of 117 mobilizers and team leaders were trained. The training included lecture and practical demonstration, and covered the following topics:

- Introduction to IRS;

- Communication basics and strategies;
- Community entry approaches;
- Overview of malaria parasite transmission and control;
- Data collection and reporting (practical session on data collection); and
- IRS messages (i.e., household preparation, handling of animals, safety measures and steps to take in case of exposure to insecticide). Each participant received a one-page handout of key messages for IRS mobilization.

2.6.4 Storekeeper Training

Training for storekeepers was led by the AIRS Operations Manager and the Procurement/Logistics Coordinator in Gbarnga, Bong County for nine storekeepers and two dispatchers. They were recruited to manage the sub-warehouses, support distribution, and also maintain accurate inventory of IRS materials. The training covered the following topics:

- Proper storage procedures for IRS commodities, especially insecticides and other safety considerations;
- Inventory control;
- Material handling and transportation; and
- Introduction and use of logistics management tools.

2.6.5 Data Entry Clerk Training

Six data entry clerks were recruited and trained at the AIRS Liberia project office in Monrovia in preparation for data entry. The training covered the following topics:

- Navigation of the AIRS Microsoft Access database;
- Introduction to data collection tools;
- Protocol for reporting issues to the Database and M&E Managers; and
- Data quality control and assurance procedures.

In addition, AIRS Liberia Database Manager and Abt Associates' Client Technology Center provided on-the-job training and support to data entry clerks during the operations.

2.6.6 Poison Management Training

The AIRS Chief of Party and NMCP clinician conducted a five-hour poison management training workshop at the Bong County Health Team Training Hall in CB Dumbar hospital in March. A total of 21 health care providers, representing 18 health facilities/clinics from the IRS catchment area, attended the training: 15officers in charge of health care facilities, three physician assistants (screeners), and three District Health Officers (DHOs) from health facilities in the target districts. The objective of the training was to provide clinicians with the skills to manage and treat poisoning as a result of insecticide exposure. In the event of an accident, clinicians were informed of the recommended drugs to manage insecticide poisoning and acute exposure symptoms. Reference materials were issued to the attendees so that they could share the information with the rest of the staff at their respective clinics. In addition, clinicians who attended the training received the drug to use in their clinics, and they were requested to report suspected poison cases to DHOs and IRS coordinators. The topics covered during the training include:

- Introduction to IRS pesticide and measures to prevent insecticide exposure;
- Signs and symptoms of OP poisoning;
- Diagnosis and treatment of OP pesticide poisoning (OIC of health facility / clinics without antidotes were issued atropine at the end of training); and
- First aid and decontamination.

TABLE 3: NUMBER OF FIELD WORKERS TRAINED IN IRS IMPLEMENTATION

Persons Trained	Training on IRS Delivery								Other Trainings										Total
	Training of Trainers		Spraying Operations		Data Capture		Logistics/ Technical Maintenance		IEC/BCC Mobilization		Overalls Washing & General cleaning		Security		Medical Treatment of Intoxication Cases		Transport Security		
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
Supervisors	22	1																	23
SOPs			177	31															208
SOP Team Leaders			27	13															40
Data Clerks					5	1													6
Storekeepers							5	4											9
Dispatchers							2	0											2
Pump Technicians							2	0											2
IEC Mobilizers									130	27									157
IEC Team Leaders									12	2									14
Washers											3	41							44
Janitors											2	7							9
Security													32	0					32
Clinicians															19	2			21
Drivers																	24	0	24
Conveyers/Escorts																	6	0	6
TOTAL M/F	**22**	**1**	**204**	**44**	**5**	**1**	**9**	**4**	**142**	**29**	**5**	**48**	**32**	**0**	**19**	**2**	**30**	**0**	**597**
TOTAL CADRE	**23**		**248**		**6**		**13**		**171**		**53**		**32**		**21**		**30**		
TOTAL																			**597**

2.7 ENVIRONMENTAL COMPLIANCE

AIRS, in collaboration with the NMCP, Ministry of Agriculture (MOA) and EPA, carried out an EC assessment to examine the condition of the warehouses, sub-warehouses and soak pits in the seven selected districts for the IRS campaign.

The following EC activities were conducted before the commencement of spray operations:

- Assessed insecticide storage facilities and soak pits to note areas of compliance and non-compliance with regard to relevant local and international EC laws, as well as PMI's Best Management Practices (BMP) Manual standards. Non-compliance issues were identified and either solved immediately or the site was given a timeline to address the problems. Changes were checked during a follow-up inspection.
- Developed a monitoring plan and checklists for the insecticide storage facilities and soak pits to use during the IRS campaign.
- Developed an accidental contamination safety response document for AIRS Liberia and seasonal staff to use during the spray operations. Contamination safety response key messages were used to train drivers, storekeepers, and spray operator trainers and clinicians.
- Reviewed all soak pits to assure they were constructed and/or repaired to meet PMI's BMP standards.
- Assured all layers of degrading materials (rocks, sand, coal, etc.) in the soak pits were in good condition and arranged according to prescribed directions.
- Established monitoring systems to track used insecticide sachets to guard against insecticide loss.
- Trained storekeepers and washers on the proper management of both storage facilities and soak pits.

Expanded operational site upgrade results are shown in Annex C.

A new Supplemental Environmental Assessment (SEA) was developed by AIRS in late 2012, and was approved by PMI/USAID on February 4, 2013. The SEA noted new environmental measures and mitigations that needed to be considered in Liberia given that the 2013 IRS campaign would include the spraying of organophosphates. The completion and acceptance of the SEA in Liberia was required before AIRS Liberia could begin its 2013 IRS campaign.

A joint national pre-spray environmental inspection was conducted by Abt Associates, NMCP, EPA and MOA just before the IRS campaign was scheduled to begin. The joint inspection team monitored the following EC requirements at all warehouses and soak pits:

1. Storage facilities and soak pits are ideally located (long distance from water bodies and locations are not vulnerable to flooding);
2. Soak pits are adequately fenced, and include gates with a good locking system to prevent access from non-IRS campaign staff;
3. All safety materials are available at each warehouse; and
4. Warehouses are guarded by security personnel.

Overall, the joint inspection teams noted that all EC requirements were met at all warehouses and soak pits. The EPA, as the leading environmental agency in Liberia, thereafter certified that the 2013 IRS campaign could begin.

2.8 IEC Activities and Community Mobilization

AIRS Liberia worked closely with the NMCP, CHT, and local authorities to educate and seek support from local leaders and the communities to better prepare for the mobilization and spray campaigns. The AIRS Regional Coordinators stationed in the districts also worked with the CHT Malaria Focal Persons, mobilizers, town announcers and SOP team leaders to conduct community mobilization in the targeted districts. A total of 157 mobilizers, 14 team leaders and eight supervisors participated in the mobilization and sensitization of communities in the seven districts.

Mobilizers informed households about the importance and benefits of IRS programs and the household responsibilities before, during and after spraying. Mobilizers collected data related to the eligibility of structures for spraying via the IEC/Behavior Change Communication (BCC) Mobilization Form and disseminated IRS malaria service cards to household heads, explaining that the cards should be kept in a safe and accessible place. Radio talk shows and IRS IEC/BCC messages on local radio stations were also used to create awareness in IRS target districts. Section 3.2 IEC Activities and Community Mobilization provides more information on mobilization and IRS messaging efforts during spray activities.

The IRS launch ceremony was held on May 23, 2013 with the intent to create publicity and bring onboard key stakeholders for IRS support and implementation. The AIRS project held a meeting with NMCP (Program Manager, Vector Control Director Deputy for Technical, IEC/BCC Coordinator, and IRS Coordinator) to develop a plan for the IRS launch in Gbarnga, Bong County. A joint NMCP and AIRS team spent a few days in Gbarnga prior to the actual launch date to distribute invitation letters and fact sheet about IRS, meet with local leaders, and conduct radio talk shows to rally the community for the launch. IRS T-shirts with the inscription 'IRS Campaign: Working Together to Fight Malaria in Liberia' were distributed to students, members of the Motorcycle Union, the press, local officials, and school children. A parade involving various stakeholders toured the major streets of Gbarnga and assembled at the Gbarnga City Hall, where an indoor program, highlighting the fight against malaria and solicitation of support for IRS, was held. The parade was headed with a banner with the inscription "Building a Successful IRS Program in Liberia through partnership; Prevention is better than cure, together we fight malaria through IRS". Stakeholders representing community leaders, CHT, local government, NMCP and MOH made speeches on the IRS launch day. Creating a platform for presenting the case for IRS in Liberia, the Program Manager of the NMCP stressed the achievements in Liberia's fight against malaria, and the need for sustenance and continuity in this fight. The launch event was covered by the press and media, which included an interview with the deputy Minister Tolbert Nyenswah.

3. Spray Activities

3.1 Spray Operations

The 2013 IRS campaign began on March 19, 2013. The duration of IRS campaign operations in each district varied, depending on the number of eligible structures to spray and the difficulty in accessing remote communities. Table 4 below provides key spray operations roll out statistics.

TABLE 4: NUMBER OF TEAMS, SPRAY DAYS AND START DATES

County	Districts	Type of Insecticide Used	Start Date	Days of Operation	Number of Spray Teams
Bong	Fuamah	Actellic 300CS	March 19, 2013	28	8
	Kokoyah		March 20, 2013	20	7
	Kpaai		March 20, 2013	27	6
	Panta		March 20, 2013	22	5
	Jorquelleh		March 19, 2013	33	14
	Sanoyea		March 27, 2013	12	8
	Zota		April 22, 2013	4	7
				Total	**102**

For the 2013 IRS campaign, 208 SOPs and 155 community mobilizers were hired to complete mobilization and the actual spraying of the eligible structures. Tables 5 and 6 provide information about the number of people hired to support and implement IRS in 2013. Table 5 notes the number of people hired for each position by operational district, and Table 6 notes the number of people hired to complete each seasonal staff position, disaggregated by gender.

TABLE 5: NUMBER OF SEASONAL STAFF BY OPERATIONAL DISTRICT

Districts	Spray Operators	Team Leaders	Supervisors	Mobilizers	Mobilizer Team Leaders	Mobilizer Supervisors	Washers	Storekeepers	Dispatchers	Conveyors	Escorts	Security Guards	Cleaners/ Janitors	Pump Service Technicians
Fuamah	46	8	3	30	3	2	16	2	0	7	3	12	4	1
Kokoyah	35	7	2	25	2	1	4	2	0	0	0	3	1	0
Kpaai	30	6	2	25	2	1	4	2	0	0	0	3	1	0
Panta	25	5	2	25	2	1	4	1	0	0	0	3	1	0
Jorquelleh	72	14	6	50	5	3	16	2	2	0	0	11	2	1
Total	**208**	**40**	**15**	**155**	**14**	**8**	**44**	**9**	**2**	**7**	**3**	**32**	**9**	**2**

TABLE 6: NUMBER OF SEASONAL STAFF BY GENDER

Position	Males	Females	Total
SOPs	177	31	208
Team Leaders	27	13	40
Supervisors	14	1	15
Storekeepers/Dispatchers	7	4	11
Conveyors/Escorts	10	0	10
Pump Service Technicians	2	0	2
Washers	3	41	44
Cleaners/Janitors	2	7	9
Security Guards	32	0	32
Mobilizers	126	29	155
Mobilizer Team Leaders	12	2	14
Mobilizer Supervisors	8	0	8
Data Clerks	4	1	5
Total	**424**	**129**	**553**

AIRS Liberia staff actively contributed to the successful implementation of IRS through regular field visits to oversee and supervise spray campaign operations, monitor EC, ensure correct spray techniques, and ensure proper storekeeping and warehouse management. AIRS Liberia senior officers (Chief of Party (COP), Ops Manager, Tech Manager, Database Officer, and Logistics Officer) were continuously in the field for the first 10 days of spray operations to actively monitor and observe spray techniques and make certain that data collection was completed according to protocol. Where necessary, AIRS Liberia staff provided onsite instruction and training to various seasonal staff to correct any errors (e.g., improper filling of data forms, use of PPE, and safety measures) that were observed during the first 10 days of the spray campaign.

In order to monitor the progress of spraying, IRS Coordinators were required to send a daily mobile text message to the AIRS Liberia COP and Operations Manager, noting the number of structures found and sprayed, population protected, and number of insecticide sachets used. This helped the AIRS Liberia staff to track the progress of the IRS campaign and forecast the amount of insecticide needed to complete the IRS campaign. The data also allowed the COP and Operations Managers to identify areas that were struggling to meet spray campaign targets, which needed more support and supervision in order to improve IRS campaign implementation.

Spray data were collected by the SOPs, collated and verified by their team leaders, and then deposited at the warehouses. The supervisors then picked up the forms from the warehouses and completed their own check. Twice per week the supervisors sent the reviewed data forms to the AIRS Liberia Monrovia office for data entry.

AIRS Liberia collaborated closely with EPA and NMCP teams, who also monitored and supervised implementation of IRS activities, especially with regards to EC and safety issues. Overall, the communities covered by the 2013 IRS campaign were receptive to the spray teams and appreciative of their efforts.

In total, 11 trucks and 21 Toyota Land Cruiser 4x4 vehicles were hired to transport SOPs to and from spray sites. Other types of vehicles were hired for short time periods to help AIRS Liberia staff to monitor and supervise the IRS campaign.

3.2 IEC Activities And Community Mobilization

Successful mobilization plays a key role in the success of an IRS spray campaign. Door-to-door mobilization was conducted to deliver messages concerning IRS that focused on when and how households should prepare for the spray campaign. One day before spraying, mobilizers visited the target communities to prepare them for spraying with IRS messages. Mobilizers then returned to target areas the day of spraying to lead the spray teams around the community and to be available to the household tenants for questions.

Mobilizers were assigned to spray teams and reported to the team leaders. The IEC Officer kept in touch with the team leaders to monitor mobilizer performance and progress. Prior to the commencement of mobilization, town announcers were sent to the communities, and radio talk shows were aired to announce the spray schedule, promote compliance, and address possible misconceptions about IRS. As shown in Table 7, mobilizers also distributed IRS promotional materials such as posters, brochures and T-shirts (with PMI/MOH logo, front Inscription "IRS Campaign: Working Together to Fight Malaria in Liberia" and graphic on the back of an SOP in PPE holding a spray pump).

TABLE 7: IEC MATERIALS DISTRIBUTED IN TARGET AREAS

District	Posters	Brochures	T-shirts
Fuamah	2,000	2,000	234
Panta	1,000	500	244
Kpaii	2,500	500	250
Kokoyah	4,000	500	350
Jorquelleh	5,000	1,000	412
Zota	500	500	0
Sanoyea	1500	1500	0
Total	**16,500**	**6,500**	**1,490**

The AIRS team held several advocacy meetings before and during the campaign in various communities that solicited the attention of local leadership and residents. The meetings were coordinated by the AIRS IEC Officer and supervised by the Regional Coordinators, NMCP staff, and CHT communication officers. Additionally, the IEC Officer organized and participated in radio talk shows, as demonstrated in Annex D, and facilitated discussions to clarify any issues related to the IRS campaign and reinforce adherence to other malaria interventions (especially the use of long lasting insecticidal nets (LLINs)). The meetings were used as an entry point into the communities to notify and educate beneficiaries about the IRS campaign. Table 8 provides a quantitative summary of these outreach efforts.

TABLE 8: NUMBERS OF COMMUNITY IRS AWARENESS MOBILIZATION MEETINGS

District	Mobilization meetings	Radio talk shows
Fuamah	2	2
Panta	1	0
Kpaii	1	0
Kokoyah	1	0
Jorquelleh	5	9
Totals	**10**	**11**

The target number of structures (40,200) was higher than the number of structures found during enumeration and mobilization activities in the four previously sprayed districts and the new district,

Jorquelleh (see Table 9). Because AIRS Liberia was not going to meet the 40,200-structure target in the five PMI IRS districts, AIRS Liberia identified two smaller districts (Sanoyea and Zota) within Bong County that were eligible for spraying and quickly mobilized teams to prepare those communities for IRS in order to reach the campaign target.

During the mobilization, AIRS Liberia found 34,799 eligible structures and sensitized 34,594 (99.4 percent). The team reached 153,348 adults (52.4 percent female) with IEC/BCC messages during sensitization and 99 percent of eligible structures agreed to participate in the spray campaign this year. Table 9 provides more details.

Mobilizers found and sensitized fewer structures than SOPs found and sprayed (see Section 6.4 of this report). There are a few reasons for this. First, SOPs found and sprayed several structures in Yaindawound Clan in Jorquelleh District, which was not previously enumerated. Following an investigation by AIRS Liberia, the District Health Officer (DHO) for Bong County informed the AIRS IEC Officer that this clan was omitted from the count of eligible structures during enumeration because enumerator supervisors did not consider the clan officially part of Jorquelleh District. However, after a meeting with the Clan Chief of Yaindawoun, the DHO asked AIRS to spray the clan (1,857 structures) because they are typically included as part of Jorquelleh District for health care interventions and other benefits.

Second, regional coordinators observed during the field visits that mobilizers did not receive proper supervision throughout the sensitization exercise. Some of supervisors hired (three out of eight) to oversee mobilizer activity were DHOs that were already fully employed by the local or national government. These officers assume various responsibilities as government health workers. With additional AIRS supervisory tasks, they could not effectively supervise the mobilizers across many towns and villages located in remote areas. As a result, mobilizers were often left on their own to complete their daily quotas with only intermittent supervisory visits from AIRS senior management.

Finally, some spray areas were located in very hard-to-reach areas, and it was not always possible to directly recruit mobilizers from each community. AIRS Liberia hired enough mobilizers to sensitize all target communities, but the project encountered resistance from mobilizers that complained about the difficulties of getting to these remote locations. AIRS Liberia supplied motor bikes and gasoline to supervisors assigned to these areas. However, given the challenges faced with poor supervision, few mobilizers were accountable for their work if an area had not yet been sensitized. To account for poor mobilization coverage in these areas, the project trained SOPs in basics of IEC messaging and supplied them with brochures to distribute among and the households before spray.

TABLE 9: SUMMARY MOBILIZATION RESULTS

District	Eligible Structures			Population Sensitized			IRS Acceptance	
	Found	Sensitized	Not Sensitized	Total	Males	Females	Yes	No
Panta	2,256	2,248	8	6,071	2,719	3,352	2,245	3
Kpaai	3,109	3,057	52	16,954	8,271	8,683	3,050	7
Kokoyah	6,882	6,882	0	29,168	13,385	15,783	6,870	12
Fuamah	7,034	6,976	58	41,880	20,819	21,061	6,951	25
Jorquelleh	12,179	12,092	87	42,268	19,438	22,830	12,055	37
*Zota**	*937*	*937*	*0*	*3,024*	*1,487*	*1,537*	*937*	*0*
*Sanoyea**	*2,402*	*2,402*	*0*	*13,983*	*6,848*	*7,135*	*2,393*	*9*
Total	**34,799**	**34,594**	**205**	**153,348**	**72,967**	**80,381**	**34,501**	**93**

* Newly added districts

3.3 Logistics and Stock Management

Two permanent warehouses, 12 secondary warehouses, and 12 soak pits were used to support spray operations in the seven spray districts. For inventory management, each commodity was recorded on stock cards (to provide a record of physical inventory in stock) and a ledger book (to note the various inventory transactions). The project established very diligent and strict paperwork to ensure proper distribution process. Drivers and store keepers from both originating and receiving warehouses had to sign off on waybills to confirm the quantities provided, transported, and received were correct.

During the IRS campaign, AIRS Liberia senior staff (the COP, Operations Manager and logistics staff) completed regular inventory "spot" checks at each warehouse. The spot checks were completed to assure stock cards matched physical inventory, make certain that warehouse management protocol was followed, and to note and prevent any improper inventory management record keeping that could allow for theft and fraudulent activities.

3.4 Environmental Compliance Supervision

The IRS program must adhere to Liberian and PMI's BMP standards and regulations for EC and safety. Thereby, the AIRS project worked closely with local EPA officials throughout the spray period to complete joint AIRS/EPA EC inspections. These compliance inspections worked to achieve the following objectives:

- Observe IRS activities during implementation to note any EC issues, and immediately provide corrective actions and re-training;
- Ensure accurate record keeping and daily collection of empty OP bottles;
- Ensure that progressive rinsing method was used at all soak pits, and that leftover insecticide solution was re-used for spraying the next day to prevent environmental contamination;
- Monitor whether SOPs, washers, team leaders and supervisors were knowledgeable of the correct way to handle and apply insecticides; and
- Observe that all seasonal staff involved in the spray campaign used PPE correctly.

The AIRS Liberia team received support from the AIRS Ghana EC Officer, who visited Liberia to help with the pre-spray environmental inspection and observe the first two weeks of the IRS campaign. While in Liberia, the AIRS Ghana EC Officer also provided training in EC supervision for the AIRS Liberia and seasonal IRS campaign staff. Additionally, he noted several EC issues regarding the initial implementation of the 2013 IRS campaign and provided re-trainings and programmatic solutions to solve these issues. Table 10 lists the issues and the solutions that were provided.

TABLE 10: SUMMARY OF EC ISSUES ADDRESSED DURING THE SPRAY OPERATION

EC issues observed during first and second week of 2013 IRS Campaign	Solutions and actions taken
Petrol kept in the same room as insecticide in Garmue	Petrol and all other items were separated and moved out of the insecticide storage room.
Some warehouses did not have a material safety data sheet (MSDS) clearly posted on walls	All sites were issued copies of the MSDS, which were posted in the warehouses.
Some warehouses did not have double locks on the	All storage facilities were issued and provided

insecticide storage room	assistance to install double locks on insecticide storage rooms.
Some wash area floors were not covered entirely with polythene sheets, allowing for the possibility of insecticide residue to contaminate the soil.	All wash areas were issued extensive quantities of polythene sheets to adequately cover their floors and provide adequate protection for the soil. The EC officer assisted with installation of the polythene sheets.
Triple rinse of Actellic bottles was not properly completed by SOPs because they lacked correct equipment to adequately provide water into the Actellic bottle for further rinsing of the insecticide residue (via the triple rinse method).	Plastic cups were provided to enable SOPs conduct the triple rinse effectively.
Some SOP caught carrying food in their bags	AIRS Liberia staff and seasonal IRS campaign supervisors were made aware of this issue, and afterwards they inspected SOPs' bags regularly during IRS campaign supervision. Re-trainings were provided to the SOPs to assure their understanding of the risks of ingesting food that could be contaminated with insecticide residue. The EC officer conducted random inspections and confiscated/destroyed all food found in SOPs' backpacks.
Some SOP team leaders and supervisors were observed handling insecticide without their full PPE	One-page tips on EC and correct use of PPE, including warnings regarding insecticide intoxication, were provided to every spray team as a reminder. The EC officer distirbuted reminder cards with key safety points.

Midway through the IRS campaign, the AIRS Liberia team completed a mid-spray environmental inspection (April 10 through April 14) in order to review:

1. The condition of all soak pits and note if they required any repairs;
2. The condition of all warehouses and note if they required any repairs;
3. If SOPs, washers, and other staff in contact with the insecticide used their PPE correctly and followed EC policies;
4. If proper record keeping of IRS materials issued and received by all seasonal staff was followed correctly;
5. If progressive rinsing was completed as a routine procedure by all SOP; and
6. If washers washed overalls correctly.

A well near the operation site in Botota did not have a cover. AIRS Liberia quickly fixed the problem and installed a cover for the well soon after the issue was noted. Other than this issue, AIRS Liberia observed that all soak pits, warehouses, and seasonal staff were in compliance with EC policies.

4. POST-SPRAY ACTIVITIES

4.1 CLOSING IRS OPERATIONS

The IRS campaign ended officially on May 4, 2013 after 40 days of operation. The original plan was to complete the operation in 31 days. The project extended the operations by nine more days to use the seasonal workers involved in the original five districts to spray the structures in the two new districts. The end-of-spray review meetings were conducted June 14 through 23, 2013. The team constituted of AIRS, NMCP and Bong CHT officials conducted a quick post-spray survey to gather feedback on the perception of spray effectiveness, understand the challenges faced during the spray campaign, and solicit recommendations for possible improvement in subsequent IRS programs. The team interviewed beneficiaries, field workers (SOPs and mobilizers) and local leaders in all seven districts as shown in Table 11.

Based on the feedback obtained during post-spray review meetings, overall, the interviewed households noticed a dramatic reduction in mosquitoes and other insects (flies, cockroaches, etc.) after the spraying. The beneficiaries complimented the SOPs and mobilizers for the job well done during the spray campaign and were happy the campaign provided economic opportunities for some community members. The majority of community members were happy to get a chance to express their views on the program, and they recommended that latrines and bathrooms be sprayed.

Local leaders expressed satisfaction with the spray campaign, and anecdotal reports from various communities indicated that the OP insecticide used was strong and effective in reducing mosquito populations. The involvement of local leaders to educate the community was difficult due to lack of transportation, poor road conditions, and the risk of crossing large water bodies in some places. Local leaders indicated that many beneficiaries complained about the bad odor of the insecticide and of the difficulty of removing household belongings to enable spraying to take place. Overall, the leaders recommended an increase in the number of mobilizers and consideration to provide transportation during spray operations to effectively enable them to reach their target areas.

TABLE 11: POST-SPRAY INTERVIEW SUMMARY

District	The number of interviews conducted		
	Households	SOP	Mobilizers
Fuamah	153	7	3
Jorquelleh	151	4	3
Kokoyah	144	3	0
Kpaii	75	2	1
Panta	27	2	2

The field workers interviewed expressed satisfaction with the high level of community acceptance to IRS. They confirmed that supervisors and coordinators conducted regular meetings with field workers to provide feedback on progress and address any concerns about the program; these meetings were very appreciated by field workers because they created good working relations. Field workers complained about the long distances they had to cover to reach certain areas. Carrying heavy liquid chemical was tedious and this damaged backpacks used by SOPs. Field workers also wanted to receive 10 to 25 percent of their salary during their first week of work.

IEC/BCC Activities in IRS Phased-out Districts

AIRS and NMCP conducted meetings with CHT and community leaders and held radio talk shows in phased-out IRS districts. The purpose of the meetings and radio talk shows was to communicate standard messages on malaria prevention (net use and malaria case management) to the communities in Gand Bassa, Careysburg and Mamba Kabah. The NMCP brochure on malaria was used to guide discussion, which covered symptoms of malaria, transmission and emphasis the use of nets. Participants were informed that the most common malaria mosquito in Liberia is also a vector of filariasis. This was news to most of the participants and they suggested that such information should be included in IEC/BCC messages because this will give another good reason for people to sleep under nets. Participants were informed about the 2011 LMIS data indicating low net usage and emphasized the need to educate the community to achieve a maximum protection benefit by sleeping under nets. Local leaders and members of CHT who attended the meeting were provided with a malaria brochure and were requested to spread the news whenever they have public meetings. The meetings and radio talk shows were held between May 21and May 26, 2013.

TABLE 12: SUMMARY OF ACTIVITIES IN PHASED-OUT IRS DISTRICTS

County / District*	Meeting Participants	Radio Spots**
Careysburg / Mamba Kabah	10	4
Grand Bassa (8 Districts)	16	4
TOTAL	26	8

* Each district was represented by at least two community leaders;
** Each radio spot lasted for one hour

4.2 LOGISTICS

In the last week of the spray campaign in each district, the Operations Manager and logistic officer were in the field to re-orient the storekeepers on proper end of spray inventory of all IRS materials and transportation of materials from sub-warehouses to the central warehouse as part of the commodity retrieval process. The storekeepers were all provided with clearance forms, which listed project materials with quantities issued to field staff during the spray period. On the last day of operations, staff members who returned all of their materials (especially those intended for reuse) were cleared for final payments by the storekeepers and a team leader or supervisor. All of the retrieved project items from the various operational sites were transported to the central warehouse in Schefflin (Table 13:).

TABLE 13: LIST OF REMAINING MATERIALS

Item	Unit	Quantity Before the Campaign	Quantity Used, including Damaged Items[1]	Remaining Stock After Campaign
Insecticide FICAM	sachets	4,786	0	4,786
Insecticide K-Othrine	sachets	8,756	0	8,756
Actellic 300CS	bottles	43,776	34,474	9,259
Overalls	pcs	2,345	1,145	1,200
Rain Boots	pairs	751	143	608
Nose Masks	pcs	19,490	13,190	6,300
Hand Gloves	pairs	2,785	937	1,848
Backpacks	pcs	837	630	207

[1] Damaged items are beyond repair and are excluded from the final count.

Item	Unit	Quantity Before the Campaign	Quantity Used, including Damaged Items[1]	Remaining Stock After Campaign
First Aid Kits	kits	108	92	16
Vitamin "E" Cream	pcs	251	221	30
Pregnancy Tests	pcs	100	96	4
Atropine Injection	pks	50	43	7
Washing Soap	pcs	3,226	3,095	131
Bath Soap	pcs	2,543	2,471	72
Powder Soap	pcs	7,239	6,489	750
Ink Pen	pcs	2,200	1,965	235
Note Pad	pcs	1,631	1,124	507
Face Towel	pcs	600	378	222
Tissue	pcs	1,545	1,321	224
Correction Fluid	pcs	64	41	23
Brown Tape	pcs	39	16	23
Scotch Tape	pcs	47	21	26
Masking Tape	pcs	15	5	10
Flip Chart Pad	pcs	35	19	16
Battery D/Size	pairs	1,603	832	771
Battery B/Size	pairs	644	474	170
Chalk	pks	74	39	35
A-4 Envelope	pcs	1,660	659	1,001
USAID Sticker B/Size	pcs	1,267	192	1,075
USAID Sticker S/Size	pcs	125	00	125
USAID Abt Tag	pcs	2,000	1,050	950
Marker	pcs	590	224	366
IRS T-Shirt	pcs	1,500	1,490	10
IRS Poster	pcs	16,888	16,863	25
IRS Brochures	pcs	6,500	6,500	0
SOP Form	pcs	20,045	16,045	4,000
Team Leader Form	pcs	22,504	8,504	14,000
MOB Form	pcs	42,530	29,330	13,200
Stock Card	pcs	1,950	650	1,300
Consumable Form	pcs	8,140	1,140	7,000
Non-Consumable Form	pcs	9,140	1,640	7,500
Store Request Form	pcs	6,975	2,475	4,500
Daily Attendance Form	pcs	2,880	1,130	1,750
Insec Tracking Form	pcs	7,725	1,925	5,800

4.3 Post-Spray Environmental Inspection, Demobilization and Waste Disposal

A post-spray EC inspection was completed May 9 to May 12, 2013 to account for all of the solid waste that was generated by the IRS campaign, and to close out all soak pits and warehouses. Close-out procedures assure that soak pits and store rooms were clean and properly locked and note if the soak pits or warehouses need future repairs.

The solid waste (comprising of packaging materials, empty insecticide bottles, torn gloves, and used disposable nose masks) was packaged and transported to the central warehouse to await proper disposal. The EC Officer supervised this process to ensure that all EC procedures were followed.

All of the empty insecticide bottles have been loaded into a 40-foot shipping container and are currently in the process of being shipped to Ghana. AIRS Ghana has helped AIRS Liberia arrange for the recycling of the bottles at the Cyclus Elmina plant. The plant recycled AIRS Ghana's empty bottles from the 2012 IRS campaign. The plastic bottles are cut into small pieces and melted down to produce material for manufacturing pavement for roads. In 2013, the plant will work with AIRS Ghana on recycling them again.

The incineration plan and quantities of other waste generated during the campaign are presented in Table 14. AIRS Liberia delivered waste at the United Nations Mission in Liberia (UNMIL) on July 16, 2013; the materials will be incinerated and a certificate issued once the exercise is completed.

TABLE 14: DETAILS OF WASTE GENERATED DURING IRS CAMPAIGN FOR SPRAY ACTIVITIES

Type of Waste	Amount of Waste (number of units)	Total Weight in Kg	Means of Disposal
Empty bottles	34,475	NA	To be shipped to Ghana for recycling
Nose masks	13,190	285	Incineration at UNMIL
Hand gloves	937	425	Incineration at UNMIL
Backpacks*	630	140	Incineration
Cardboard*	212	15	Incineration
Overalls*	1,145	N/A	Incineration
Rain boots	143 pairs	N/A	Shredded and land filling

*These materials were incinerated at Schefflin Central Warehouse

For all unused OPs, AIRS Liberia is currently working with their colleagues in Madagascar to schedule a shipment of the remaining stock (9,259 bottles) for use in the upcoming IRS campaign in Madagascar.

5. ENTOMOLOGY

Entomological monitoring of IRS operations was conducted in two sentinel areas with active IRS operations (Tomato Camp and Haindi), one control site without IRS operations (Sergeant Kollie Town), and one former IRS site from which IRS operations had been withdrawn (Frank Town). The main objective of the entomological monitoring was to evaluate PMI primary indicators, which include: malaria vector species identification, vector distribution and seasonality, vector feeding time and location, insecticide susceptibility and mechanisms of resistance; and quality assurance of the IRS program. By the time of this reporting, insecticide susceptibility had not been conducted, and PMI secondary indicators were not assessed (sporozoite rates, age grading, and blood meal analysis). Susceptibility testing was planned for October and November, while secondary indicators will be assessed once a functioning insectary is in place.

Baseline surveillance involved the collection of adult mosquitoes using three sampling methods: pyrethrum spray catches, human landing collections, and CDC light traps. One month post-spraying, another entomological survey was conducted in all four sites to assess the effect of spraying on mosquito indoor and outdoor densities and biting behavior. The project also assessed the quality of spraying using cone wall bioassays in the two IRS intervention sites (Haindi and Palala).

The baseline surveillance was conducted in February before the commencement of IRS operations. The post-spray mosquito collection was conducted in May (March and April were active IRS months). The first assessment of the spray quality was conducted within 24 to 60 hours. A second round of cone bioassays was conducted 40 days post-spray in Kpaai district (Palala) and 28 days post-IRS in Fuamah district (Haindi). This section presents findings on entomological indicators at baseline and one month post-spray. It also includes results of the spray quality assurance testing and an assessment of residual efficacy of the sprayed insecticide one month after spraying.

5.1 OBJECTIVES

1. To determine the pre-and post-IRS indoor resting densities of malaria vectors;
2. To determine vector biting location and behavior of malaria vectors;
3. To train CHVs in entomological methods; and
4. To determine the quality of spraying and residual efficacy of the sprayed insecticide in two IRS intervention districts.

5.2 MATERIALS AND METHODS

5.2.1 STUDY SITES

Four villages (one in each of the following districts: Careysburg, Fuamah, Suakoko and Kpaai) were selected as sentinel sites for the project entomological monitoring. Frank Town, a village in Careysburg District, was not among the 2013 intervention sites; it was sprayed in 2012 and studies in this site were aimed at understanding malaria vector dynamics after IRS withdrawal. Haindi, a village in Fuamah District, and Tomato Camp, a village in Kpaai District, are the two intervention study sites. Criteria for selecting the intervention sites were spray status, road accessibility, and NMCP endorsement. Sergeant Kollie Town (SKT) was selected as the control site. It is a village in Suakoko District Bong County. The criteria for the control site was that it was a non-IRS district in Bong County located at least 5 km from

the IRS districts. Though there was no historical malaria prevalence or vector density data from the selected districts, the sites are ecologically similar, human populations live in houses made of the same materials, and the larval breeding sites are mainly rain-fed. The sites are characterized by scanty canopy and extensive clearing of the forests for human settlement. The breeding sites exploited by the main malaria vector, *Anopheles gambiae* s.l., are rain-dependent, shallow, transient water pools that disappear in the dry season (December to March). Figure 1 indicates the geographic locations for all entomological surveillance sites.

No IRS operations took place in the control district, while organophosphate insecticide (Actellic 300 CS) was sprayed in houses in the intervention sites.

FIGURE 1: LOCATION OF ENTOMOLOGICAL SURVEILLANCE SITES FOR THE 2013 IRS CAMPAIGN

5.2.2 Adult Mosquito Collections

The project used three mosquito collection methods to collect adult mosquitoes in the sentinel sites. Pyrethrum spray collection (PSC) was used to collect indoor resting mosquitoes between 6:30 AM and 9:00 AM at each study site; ten houses were sampled at each study village. Collection was done once per month starting in February 2013. Pyrethrum extract with Piperonyl Butoxide mixed with kerosene at a ratio of 1:10 was used for spraying in selected houses that had white cloth/sheet laid on the floor wall-to-wall. A hand held sprayer/atomizer was used to deliver a fine mist of pyrethrum-kerosene mixture in each house after windows and the door had been closed. A ten minute knock-down period was allowed and then the sheets were collected from the house and the knocked-down and/or dead mosquitoes were collected, identified, and recorded.

Human landing catches (HLC) was used to collect mosquitoes landing on human bait between 6:00 PM and 6:00 AM both inside and outside. With legs exposed to attract host-seeking mosquitoes, two people sat inside and another pair sat outside. The pairs then interchanged between outside and inside on an hourly basis. The collectors used flash lights and a tubing aspirator to collect mosquitoes once they landed on the legs before they could bite. One house was sampled at each study village using the HLC method, since there were only two pairs of collectors per site.

CDC light traps were also used to capture mosquitoes from 6:00 PM to 6:00 AM both inside and outside in each study village. Five CDC light traps were set up in selected houses where people slept under a mosquito net. The traps were placed toward the person's legs while asleep and hung 0.2 to 0.5 m above the ground, depending on whether the bait slept on a bed or the floor. The surveillance was conducted just one month after the NMCP had conducted a mass distribution of bed nets in the country, and in most houses, the residents were using the bed nets. Five outdoor CDC light traps were set outside the same houses with indoor traps. The criteria for selecting houses to conduct CDC light trap collection included the following: 1) the house was sprayed, 2) consent of the household head received, and 3) people in the selected house slept under a mosquito net. No bait was used for the outdoor light traps.

5.2.3 Training of Community Health Volunteers

Prior to the start of baseline data collection, a two-day training in adult mosquito collection methods was organized for all selected CHVs at each study site. The CHVs were practically trained on how to conduct PSC, HLC and to set up CDC light traps. Two CHVs were trained per site and were selected by the DHOs in their respective districts. The training was conducted by Abt Associates' Technical Manager and one NMCP technician.

5.3 Results and Discussion

5.3.1 *Anopheline* indoor resting densities

A total of 104 anopheline mosquitoes were collected indoors during baseline surveillance using PSC; 96.15 percent were *An. gambiae* s.l. and 3.84 percent were *An. funestus* s.l. Among all collected mosquitoes, 7.7 percent (8) were collected in Frank Town; 26.9 percent (28) were collected in Haindi; 8.6 percent (9) were collected in Tomato Camp and 56.7 percent (59) were collected in Sergeant Kollie Town (SKT). Haindi and Tomato Camp are the 2013 intervention sentinel sites. The mosquitoes collected in Frank Town, Haindi and Tomato Camp were all *An. gambiae* s.l. The control site (SKT) has never been sprayed before, and among the 56 mosquitoes collected at this site, 7.1 percent were *An. funestus* s.l.

During the post-spraying surveillance, a total of 202 female mosquitoes resting indoors were collected by PSC in both the intervention and control sites. *An. gambiae* s.l. were 92.1 percent of the collection and 7.9 percent were *An. funestus* s.l. Similar to the baseline surveillance, *An. funestus* s.l. were collected only in the control site, SKT. A total of 32 mosquitoes (15.8 percent) were collected from Frank Town (the IRS-withdrawn site), and 168 (83.1 percent) were collected from SKT (the

control site). Only 2 (1 percent) were collected from Tomato Camp, an intervention site, which is a 4.5 fold reduction compared to the baseline. There were no mosquitoes collected from Haindi, also an intervention site. This survey was conducted approximately one month after IRS. Results and discussion are mainly on *An. gambiae* s.l., the main malaria vector captured in the study sites.

Overall, there was a remarkable decrease in indoor resting densities in the intervention sites (Haindi and Tomato Camp) during the post-spray surveillance. In Haindi, the decrease was from 2.8 to 0 *An. gambiae* s.l. per house per day. In Tomato Camp, *An. gambiae* s.l. density decreased from 0.9 to 0.2 mosquitoes per house per day (Table 15). The decrease could be related to the effect of the insecticides repelling and/or killing the indoor resting mosquitoes in the sprayed houses. In contrast, there was an increase in indoor resting density in Frank Town and SKT; this could be attributed to abundant availability of rain-fed breeding sites. The post-spray surveillance was conducted during the rainy season. It is important to observe that despite the availability of breeding sites related to rains in the intervention sites, densities were lower in these sites at post-spray surveillance as compared to the baseline, which was conducted in the dry season.

Monthly surveillance will continue until the end of the AIRS 2013 work plan. More details will be presented in subsequent entomological reports.

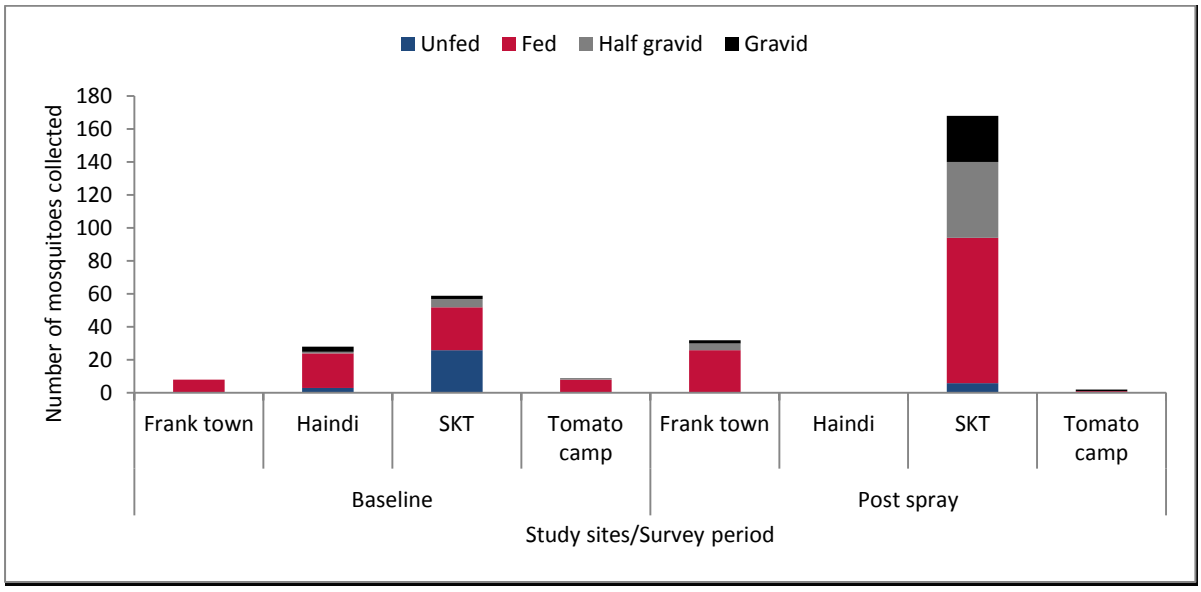
TABLE 15: NUMBER OF MOSQUITOES COLLECTED BY PSC AND INDOOR RESTING DENSITIES

Study site	Vector species	Pre-spray data (baseline)		Post-spray data	
		Number of mosquito. Collected	Vector density (Number of mosq/house/ day)	Number of mosquito Collected	Vector density (Number of mosq/house/ day)
Frank Town (IRS withdrawn)	*An gambiae* s.l.	8	0.8	32	3.2
Haindi (intervention)	*An gambiae* s.l.	28	2.8	0	0
Tomato Camp (intervention)	*An gambiae* s.l.	9	0.9	1	0.1
SKT (control)	*An gambiae* s.l.	55	5.5	142	14.2
	An funestus group	4	0.4	16	1.6

Among all collected *An. gambiae* s.l., 27.9 percent were unfed, 60.6 percent were fed, 6.7 percent were half gravid, and 4.8 percent were gravid. Almost half of fed vectors were collected resting indoors in the control site SKT. This site has not been sprayed before, and compared to the other sites, people were more engaged in farming activities. The forest has been cleared more extensively, and swamps have been rehabilitated for farming activities making it ecologically suitable for mosquito breeding habitats.

During the post-spray study period, there were no mosquitoes captured in Haindi, and in Tomato Camp, one fed and one gravid mosquito were captured. There was a significant increase in vector density in SKT (the control site), and in Frank Town (the IRS-withdrawn site), supporting the importance of IRS to reduce indoor resting density. Figure 2 shows the prevalence of various blood feeding stages of the *An. gambiae* s.l. collected in the four study sites during the baseline and post spray study periods.

FIGURE 2: PREVALENCE OF DIFFERENT BLOOD FEEDING STAGES AMONG *AN. GAMBIAE* S.L.



5.3.2 Human Landing Collections

A total of 848 *Anopheles* mosquitoes seeking to bite human bait were captured in the four study villages during both baseline and post-spray surveillance periods. Among them, 93.8 percent (796) were morphologically identified as *An. gambiae* s.l., 6 percent (51) as *An. funestus* s.l. and 0.1 percent (1) as *An. maculipalpis.*

During the baseline surveillance, the highest number (329) of host-seeking vectors was observed in SKT, compared to the other study sites. In Haindi, 27 vectors were captured, and 4 vectors were captured each in Frank Town and Tomato Camp. During post-spray surveillance, SKT still had the highest number (481) of host-seeking vectors, while no vectors were captured in either Haindi or Tomato Camp, the two intervention sites. In Frank Town, two *An. gambiae* s.l. and one *An. maculipalpis* were captured. Tables 16 and 17 present the numbers of *An. gambiae* s.l. collected and the associated bites/person/night (BPN), by indoor and outdoor results. The observed differences in BPN between the baseline and post-spray period suggest that the IRS operation had a significant effect on vector populations in the sprayed areas.

TABLE 16: *AN. GAMBIAE* S.L. CAPTURED AND NUMBER OF BPN COMPUTED VIA HLC, BASELINE

Site	Total Collected Indoor/Night	Indoor BPN	Total Collected Outdoor/Night	Outdoor BPN
Frank Town	1	0.5	3	1.5
Haindi	20	10	7	3.5
Sergeant Kollie Town	162	81	167	83.5
Tomato Camp	2	1	2	1

TABLE 17: *AN. GAMBIAE* S.L. CAPTURED AND NUMBER OF BPN COMPUTED VIA HLC, ONE MONTH POST-IRS

Site	Total Collected Indoor/Night	Indoor BPN	Total Collected Outdoor/Night	Outdoor BPN
Frank Town	2	1	0	0
Haindi	0	0	0	0
Sergeant Kollie Town	270	135	211	105.5
Tomato camp	0	0	0	0

The outdoor biting activity and rhythm during the baseline period were similar in all the sites as indicated in Figure 3. In general, the outdoor biting started around 10:00 PM, peaked around midnight, and declined by 3:00 AM. Based on data from the control site (SKT) during baseline activities, the indoor biting activity started at 9:00 PM and declined at 3:00 AM (Figure 4). During post-spray surveillance, the outdoor biting activity in the control site indicated that the vectors tended to bite all night, as shown in Figure 5. During post-spray surveillance, as with the outdoor biting activity in the control site, vectors tended to bite all night, as shown in Figure 6.

FIGURE 3: OUTDOOR HOURLY BITING RHYTHM OF *AN. GAMBIAE* S.L., BASELINE

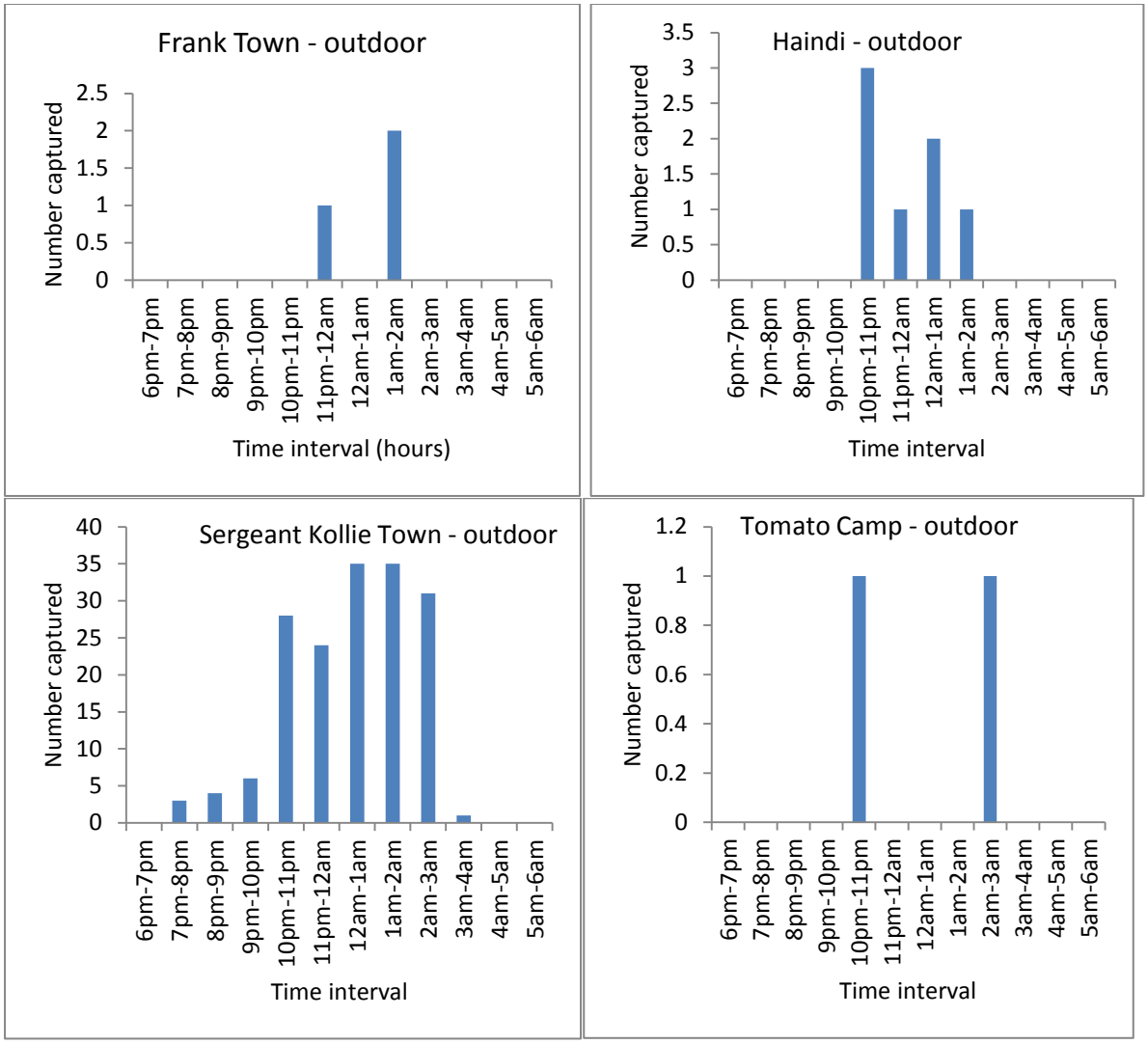


FIGURE 4: INDOOR HOURLY BITING RHYTHM OF *AN. GAMBIAE* S.L., BASELINE

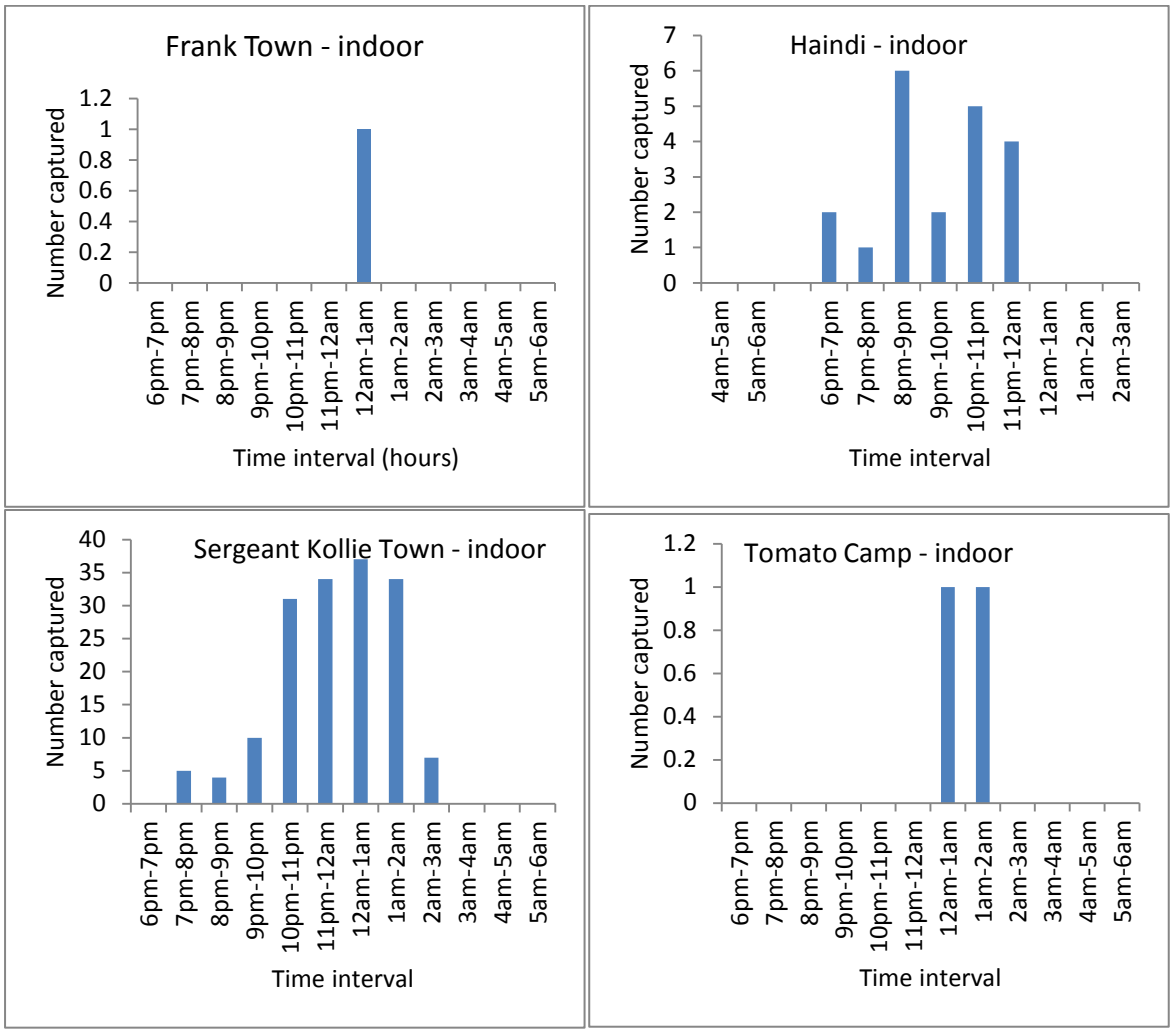


FIGURE 5: OUTDOOR HOURLY BITING RHYTHM OF *AN. GAMBIAE* S.L., POST-SPRAY

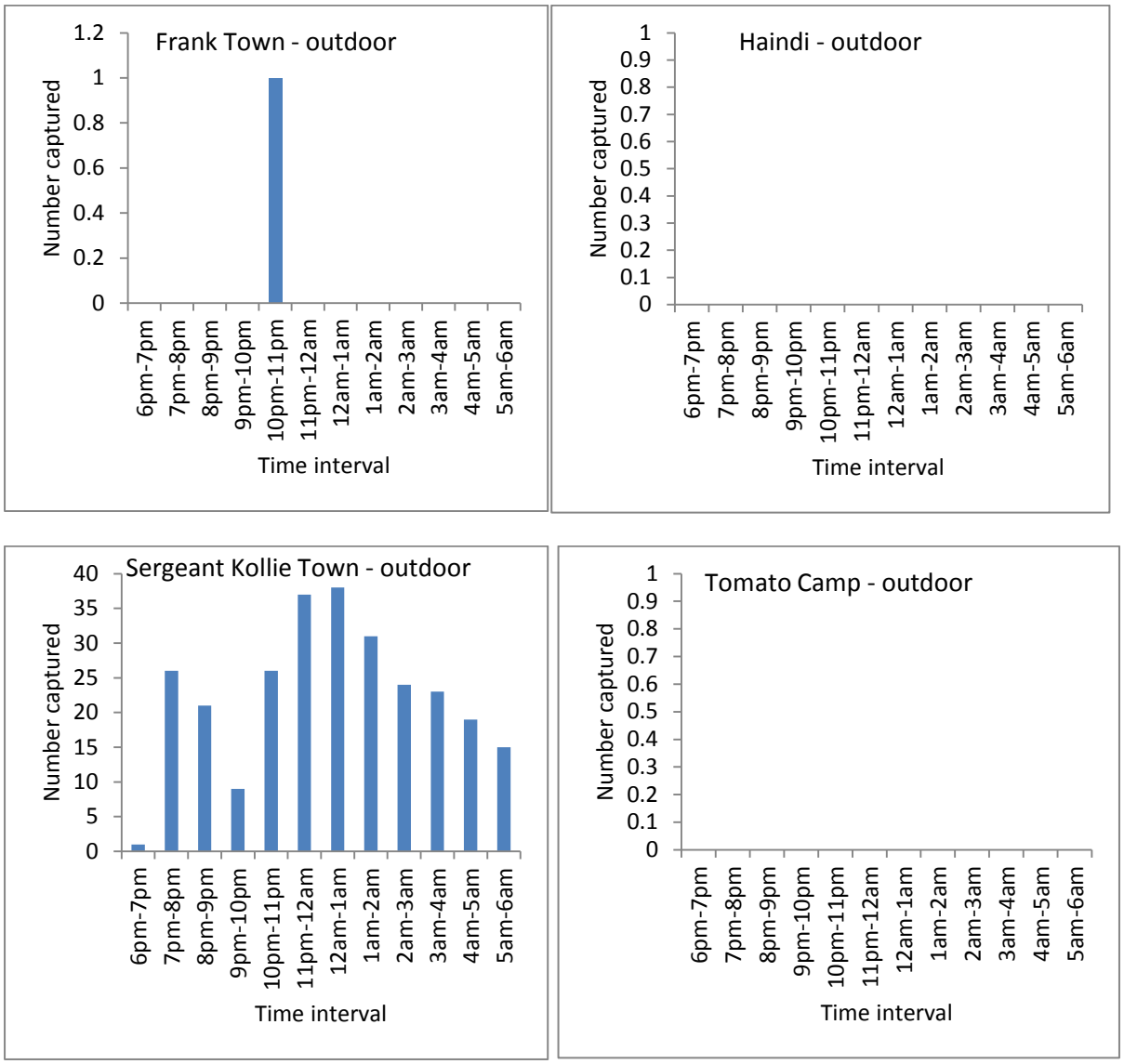
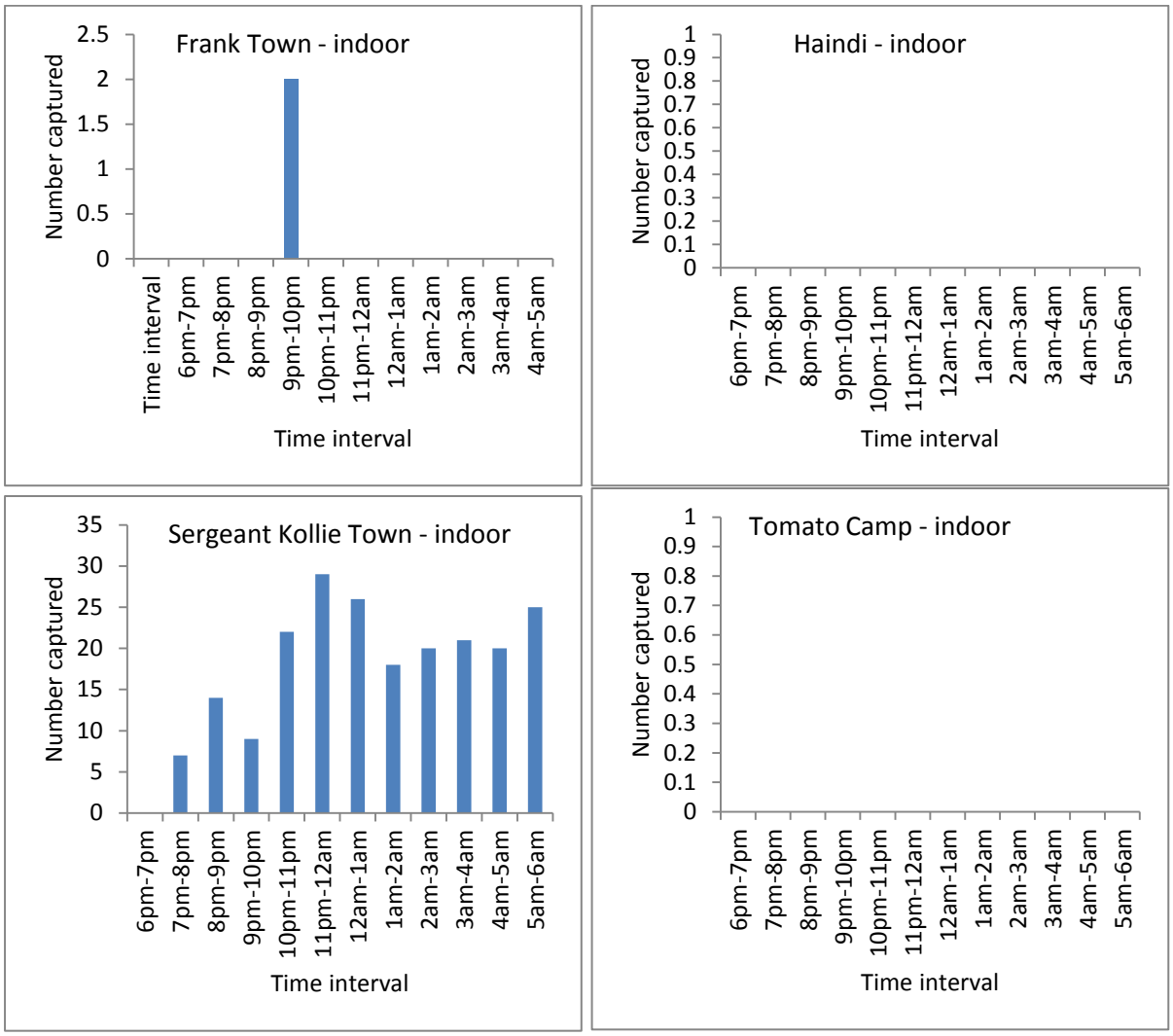


FIGURE 6: INDOOR HOURLY BITING RHYTHM OF *AN. GAMBIAE* S.L., POST-SPRAY



5.3.3 CDC Light Trap Collections

At each site five CDC light traps were set up indoors next to human bait sleeping under a treated mosquito net (the nets were distributed by the NMCP through a mass distribution program), and another five light traps were put up outdoors next to the houses with indoor CDC traps. A total of 778 *Anopheles* mosquitoes were collected from the light traps (indoor and outdoor) in all study sites. The highest number of mosquitoes (686) was collected in SKT, followed by Frank Town (80). Six mosquitoes were collected each in the light traps of Haindi and Tomato Camp.

Outdoor light traps captured a total of 48 mosquitoes, and two were morphologically identified as *An. maculipalpis* using keys by Gilles and Coetzee (1987)[2]. Indoor light traps captured a total of 730 *An. gambiae* s.l. The highest number (656) of vectors was captured at the control site (SKT), followed by Frank Town (72). In Tomato Camp, two vectors were caught indoors during the baseline period. None were captured indoors in Haindi during the two surveillance periods (Table 18).

There was an increase in the number of mosquitoes captured by the CDC light traps (both inside and outside) during the post-spray surveillance period in both Frank Town and SKT. This observation can be explained by an increase in mosquito numbers due to the rains. No increase was

[2] Gillies, M. T. and M. Coetzee. 1987. A supplement to the Anophelinae of Africa south of the Sahara (Afro- An tropical Region). Publ. S. Afr. Inst. Med. Res. No. 55.

observed in the Haindi in the indoor traps. A decrease was observed in Tomato Camp in both indoor and outdoor traps; this may be an effect of the IRS campaign in this intervention area.

TABLE 18: MOSQUITOES COLLECTED BY CDC LIGHT TRAPS, BASELINE AND POST-SPRAY

Site	Baseline		Post-spray		Total
	Outdoor	Indoor	Outdoor	Indoor	
Frank town	3	1	5	71	80
Haindi	0	0	6	0	6
SKT	5	87	25	569	686
Tomato Camp	4	2	0	0	6

5.3.4 Cone Bioassays

The results from the cone bioassays conducted in the two study villages suggested that the quality of spraying was good and that Actellic 300 CS was effective in killing the local malaria vectors exposed to the sprayed walls after 28 to 40 days. A summary of the cone tests is presented in Table 19. The first cone bioassays were conducted 60 hours after spraying in Palala and 24 hours after spraying in Haindi. A second round of cone bioassays was conducted 28 days post-spray in Haindi and 40 days post-spray in Palala. Observed average mortality among all exposed *An. gambiae* s.l. in the two study villages ranged from 94.3 percent to 100 percent. There were a total of 18 cone test replicates conducted at each site, i.e., nine test replicates for the first set of bioassays (T0) and nine for the second set of bioassays (T1). The mortality rates for the two sets of cone bioassays are shown in Figure 8 below. One control was used for each round of nine test replicates at each study site.

The overall mortality after a 24-hour holding period at T1 ranged from 94 to 100 percent as shown in Figure 8. During the second set of cone bioassays in Palala, the mortality rate for one house was lower (53 percent), and this contributed to the lower observed mortality rate in Palala. The test mortality rates in all other houses were 100 percent in both sites. The house with the lower mortality rate in Palala was not the same house used previously, as the house used in round one was unavailable (locked) at the time of the experiment; therefore, the next house was used.

Unlike the first exposure where exposed mosquitoes were reared from field-collected larvae and pupae, the mosquitoes used for the second round of cone bioassays were partly adult *An. gambiae* s.l. collected by HLC in the control site (SKT). The decision to use the field-collected adults was due to heavy rains that flooded out breeding sites. For seven days the team could not find a single aquatic stage *An. gambiae* s.l., even in breeding habitats that previously had been identified as highly productive.

TABLE 19: SUMMARY OF CONE BIOASSAYS, TWO INTERVENTION SITES

Site	Number of houses sampled	Type of surface			T0		T1	
		Cement	Mud	Wood	Mosquitoes exposed	% test mortality	Mosquitoes exposed	% test mortality
Haindi	6	3	2	1	107	100	132	100
Palala	6	5	1	0	75	100	122	94.2

5.4 Local Collaboration and Capacity Building: Involvement of CHVs and NMCP

Abt Associates, in execution of its mandate to implement the PMI Africa IRS project, works in close collaboration with the CHVs who are part of the CHT and the Liberia NMCP. One of the main AIRS

objectives is building human resource capacity in entomological monitoring for IRS among the local nationals. During the baseline, AIRS Liberia identified a total of eight CHVs (two per study site) who attended a practical training in three adult mosquito collection methods: PSC, HLC and CDC light traps. Since then, the CHVs have worked with the mosquito collection teams whenever fieldwork is conducted. The identified CHVs will continue to be involved in all entomological monitoring of IRS, which is conducted on monthly basis. This will enable them to learn and understand the following entomological techniques:

- Morphological identification of main malaria vectors in Liberia;
- Cone bioassays;
- World Health Organization (WHO) tube bioassays; and
- Larval sampling using dippers and pipettes.

5.5 Observations and Conclusions

The baseline study was conducted during the dry season, while post-spray collection was conducted during the rainy season. The number of mosquitoes collected in the control site (SKT) during the rainy season was 2.8 fold more than that collected during the baseline period in the dry season, suggesting that malaria vector mosquitoes in Liberia are highly dependent on rain-fed breeding habitats. Interestingly, the mosquito population did not increase in the intervention sites as observed in the unsprayed control site. This could suggest that spraying with Actellic 300 CS had an effect on malaria vector populations in the intervention sites.

As compared to the baseline study when the CHVs played more observatory and learning roles, they maximized their participation during the post-spray data collection, and almost independently conducted PSC, HLC, and setting up of CDC light traps. With monthly collections, the knowledge and practical skills of the CHVs would definitely improve.

6. Monitoring and Evaluation

6.1 Key Objectives

AIRS Liberia applied lessons learned from their previous two AIRS campaigns in 2012 and closely followed the M&E protocol outlined in the annual work plan to successfully carry out monitoring activities. Key M&E objectives of the 2013 campaign were to:

- Ensure accuracy of data collection and data entry through comprehensive training and supervision at all levels;
- Track progress towards contractual obligations and organize corresponding documentation;
- Streamline and standardize data flow to minimize errors and facilitate timely reporting and data entry; and
- Ensure IRS data security and storage for future reference through the establishment and enforcement of proper protocols.

6.2 Data Collection and Management

For the 2013 spray campaign, AIRS Liberia used the same data collection tools and Microsoft Access database as used in the 2012 spray rounds. All AIRS M&E protocol updates were incorporated into the database before the start of mobilization and spray to ensure high-quality data collection, management, and reporting. The Access database served as a tool for tracking key performance and output indicators and "real-time" reporting for quick feedback to minimize errors in data collection and entry.

Spray data were collected by SOPs, verified by team leaders and supervisors, and transmitted to the data centers for entry. For the mobilization activities, data collection and verification followed the same process. The M&E-Database Manager performed a final verification of spray data via data quality and arithmetic checks of the *Daily Spray Operator Forms* before submitting to the data clerks for entry into the database. At the end of each day, data clerks electronically transmitted data via the project network to the M&E-Database Manager for final review. For quality control purposes and the timely generation of weekly spray progress reports, all data were entered within 48 to 72 hours of spraying. AIRS Liberia sprayed in a few hard-to-reach areas, making it difficult for SOPs and team leaders to return from villages for timely data delivery to the data center. Nonetheless, AIRS Liberia worked hard to ensure data were delivered to the data center twice a week, and managed to meet the project-defined timeline for data entry and weekly reporting.

Finally, a daily electronic back-up was performed to the AIRS Liberia server and to an external hard drive for data safety and storage. Paper copies of *Daily Spray Operator Forms* were filed and archived at the AIRS Liberia office in Monrovia for future reference, if needed.

6.3 Data Quality Assurance and Supervision

In addition to the data quality measures incorporated into the design of the database, AIRS Liberia, PMI Mission and NMCP staff performed daily data quality assurance checks throughout the spray campaign. Staff used the tools from the newly developed *AIRS Supervisory Toolkit* during the field visits and at the data center to guarantee and support high-quality IRS data.

1. *Error Eliminator:* Team leaders, supervisors, and regional coordinators used the *Error Eliminator* (EE) method on a daily basis during spray activity to verify data collected by SOPs. Staff randomly selected spray forms from the SOPs either during spray or at the end of the day, and checked for arithmetic and data recording accuracy. Errors found on spray forms were corrected on the

spot and discussed with both the SOP and the team leader, if s/he was not the person finding the error. During morning deployment meetings, supervisors and regional coordinators discussed errors from the previous day with teams and provided corrections and explanations to avoid repeat errors.

2. *Data Collection Verification Tool:* Supervisors, regional coordinators, and AIRS Liberia senior management used this tool when visiting target areas a few days after a community was sprayed to interview households and collect spray coverage data. The AIRS Liberia M&E team crosschecked the information collected from households with the *Daily Spray Operator Forms* for accuracy and consistency. Any errors were corrected directly on the spray forms, as well as in the database, and addressed at the next day's deployment meeting.
3. *Data Entry Verification Tool:* The M&E-Database Manager used this tool to check data entry accuracy and data clerk performance. Specifically, the M&E-Database Manager verified that the data on the spray forms matched the data entered into the database for reduced data entry and human error.
4. If the M&E-Database Manager identified errors on spray forms, he directly contacted the regional coordinator(s) to discuss the issue or visited the field himself to reconcile and provide refreshing training on proper data collection and verification.

6.4 RESULTS

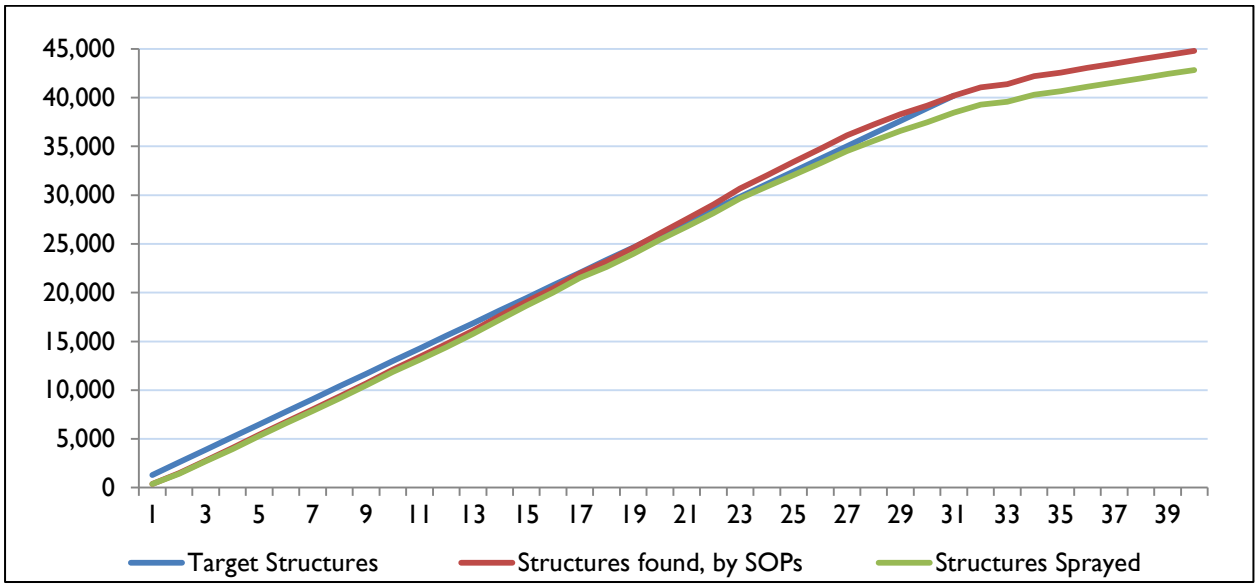
All AIRS Liberia performance indicators are presented in the Monitoring and Evaluation Plan matrix in Annex E. Details of some key IRS indicators such as number of structures sprayed, people protected and insecticide-treated net availability and use are provided in this section.

During the 40-day campaign, AIRS Liberia sprayed 42,708 eligible structures out of 44,328 structures found by spray operators, resulting in 96.3 percent spray coverage (Table 20). The IRS campaign protected a total of 367,930 people, including 16,287 pregnant women (4.4 percent) and 63,714 children under five years old (17.3 percent). Daily spray progress during the campaign is shown in Figure 7.

TABLE 20: SPRAY COVERAGE AND POPULATION PROTECTED, BY DISTRICT

District	Eligible Structures Found	Eligible Structures Sprayed	% Structures Sprayed	Population Protected	Population Not Protected	% Population Protected	Pregnant Women	Children <5 years
Zota	730	728	99.7	6,392	27	99.6	207	1,109
Sanoyea	2,084	2,079	99.8	16,999	26	99.8	1,033	3,352
Panta	3,871	3,728	96.3	35,597	1,266	96.6	1,692	6,060
Kpaai	6,025	5,808	96.4	58,598	1,828	97.0	1,744	10,387
Fuamah	7,342	7,084	96.5	53,602	1,936	96.5	3,052	9,920
Kokoyah	7,915	7,681	97.0	65,688	1,694	97.5	3,064	10,175
Jorquelleh	16,361	15,600	95.4	131,054	6,073	95.6	5,495	22,711
Total	**44,328**	**42,708**	**96.3**	**367,930**	**12,850**	**96.6**	**16,287**	**63,714**

FIGURE 7: AIRS LIBERIA 2013 DAILY SPRAY PROGRESS



Mosquito Nets

The total number of mosquito nets reported by households as available in the target districts is 73,258. Among the 16,287 pregnant women protected by IRS, 11,464 (70.4 percent) slept under a mosquito net the previous night. Among children under five years of age protected by IRS, 33,833 (53.1 percent) slept under a mosquito net the previous night (Table 21).

TABLE 21: MOSQUITO NET AVAILABILITY AND COVERAGE

District	Total Nets Reported Available	Pregnant Women Reported Sleeping Under Nets	Pregnant Women Protected by IRS	Children <5 Years Old Reported Sleeping Under Nets	Children <5 Years Old Protected by IRS
Zota	1,248	131	207	635	1,109
Sanoyea	5,141	953	1,033	2,425	3,352
Panta	3,063	913	1,692	1,782	6,060
Kpaai	9,451	965	1,744	3,961	10,387
Fuamah	7,791	1,796	3,052	3,868	9,920
Kokoyah	7,638	1,934	3,064	4,097	10,175
Jorquelleh	38,926	4,772	5,495	17,065	22,711
Total	**73,258**	**11,464**	**16,287**	**33,833**	**63,714**

Insecticide Usage

AIRS Liberia used Actellic 300 CS for the 2013 campaign and received continuous positive feedback from beneficiaries about its effectiveness. During field supervisory visits, residents reported that the insecticide immediately eliminated mosquitoes and other insects and rodents after their structures were sprayed. AIRS Liberia used a total of 34,332 bottles of insecticide to spray 42,708 structures, resulting in an average of 1.2 structures sprayed per insecticide bottle (Table 22). SOPs sprayed an average of 6.6 structures per day using roughly 5.5 bottles of insecticide.

TABLE 22: INSECTICIDE CONSUMPTION AND SPRAY OPERATOR PERFORMANCE

District	Structures Sprayed	Insecticide Consumption			Spray Operator Performance		
		Bottles Issued	Bottles Used	Bottles Lost/ Damaged	Structures/ Bottle	Structures/ SOP	Bottles/ SOP
Zota	728	794	730	-	1.0	6.9	6.9
Sanoyea	2,079	2,072	1,726	-	1.2	5.0	4.1
Panta	3,728	3,325	3,321	-	1.1	6.8	6.0
Kpaai	5,808	5,238	5,003	-	1.2	7.2	6.2
Fuamah	7,084	5,782	5,093	-	1.4	5.5	4.0
Kokoyah	7,681	5,281	5,202	-	1.5	7.4	5.0
Jorquelleh	15,600	14,674	13,257	-	1.2	7.2	6.1
Total	**42,708**	**37,166**	**34,332**	**-**	**1.2**	**6.6**	**5.5**

7. Challenges, Lessons Learned and Recommendations

This chapter describes the challenges, lessons learned, and recommendations that were identified by the AIRS project team throughout the process of spray implementation.

7.1 Challenges

1. **Delayed programing and planning of activities:** The actual planning for this year's operation started late due to several reasons. Insecticide selection and site location decisions were not made by the IRS/IVM task team until November 30, 2012, and organophosphate was selected as the insecticide of choice to be sprayed in five districts in Bong County. This meant that operational sites in phased-out districts (10 districts in Grand Bassa, Margibi and Montserrado counties) had to be withdrawn. As a result, the AIRS Liberia team was engaged in closing down warehouses and decommissioning soak pits in the phased-out districts for a few weeks during the pre-spray period.
2. **Delayed completion of targeted community and spray personnel lists for the database:** The AIRS database was deployed in time for the AIRS Liberia 2013 campaign, followed by training of data entry clerks. However, there were some difficulties acquiring names of towns and villages in the target areas early enough to assemble a complete list of spray locations and incorporate them into the database. As a result, the data entry process was slower in the beginning because the data clerks waited for the missing information to begin the entry process. To prevent such delays in the future, AIRS Liberia recommends acquiring the names of target districts, clans, towns and villages from regional coordinators at the beginning of the pre-spray work and definitely prior to the start of mobilization and spraying. If such information cannot be retrieved from the regional coordinators, it would be best to contact the Liberia Institute for Statistics and Geo-Information Services, Liberia Monitoring and Evaluation Program, Ministry of Health, or the local county officials. However, AIRS Liberia has noted discrepancies in the population data provided by the Liberian government and various agencies. If needed, it is also recommended to visit regional headquarters of the clans to obtain names that cannot otherwise be provided by the above listed agencies. In addition, the M&E team had difficulties collecting names of all spray personnel to establish their records in the database. In the future, the project should collect such data during the training of the personnel and immediately communicate the information to the M&E-Database Manager.
3. **Field staff non-adherence to M&E protocols:** AIRS Liberia experienced several problems with consistency in data collection by SOPs, mobilizers and their direct supervisors (e.g., team leaders). As a result, the M&E-Database Manager made several visits at the beginning of the campaign to address multiple errors with data collection.
4. **DHOs' role:** DHOs played a significant role in IRS mobilization and supervision. Their IRS responsibilities are added on to their primary job duties as DHOs. Therefore, they had a difficult time upholding the IRS supervisory tasks; more so in 2013 campaign than in the 2012 spray cycle because this year's spray cycle coincided with other health activities (e.g., a polio campaign). To improve their input in future campaigns, level of supervision of the field personnel should be adjusted to line up with their daily activities. All requirements and expectations should be properly communicated to achieve better performance results.
5. **Entomology:** Lack of a functional insectary to rear mosquitoes was a big challenge to conducting timely experiments to assess the quality of spraying and insecticide decay rates. The

issue for this round of spraying was resolved by using wild mosquitoes instead of a susceptible colony. The team reared field-collected larvae to adult stage, and in some cases used field-collected adult mosquitoes. Larvae density varies with rainfall pattern and sometimes it is difficult to get enough larvae because the rain washes out breeding sites. As a consequence, the collectors spend more days in the field and this becomes costly work. The project is working to resolve this issue by establishing a container insectary.

6. **Bad road network and poor infrastructure:** Reaching some communities proved to be challenging, particularly those where rivers had to be crossed by canoe. This was particularly challenging in Faumah and parts of Jorquelleh districts. In several districts, AIRS Liberia could not secure a standard warehouse, so the project renovated other types of buildings and converted them into storage facilities. The local vehicle rental companies own old and heavily-used vehicles. Some of the vehicles were unreliable and had frequent breakdowns in the field, which had an impact on the daily outputs.
7. **Field worker welfare and payment modalities:** The workers felt that their daily remuneration should be increased. Currently, it is 10 USD per day, which is above the minimum wage of 6 USD for a day of work. This occasionally affected their motivation to work. The project was forced to pay field workers in cash because of limited banking facilities and the lack of alternative means for delivering funds to rural operational sites. All necessary precautions were taken to minimize risk associated with cash payments and to confirm the identity of field staff receiving payments.
8. **Poor community compliance to IRS preparation in some areas:** The heads of households in certain communities were reluctant to move their property outside even when mobilizers and SOPs were willing to assist. AIRS Liberia and the NMCP communication unit intervened by holding meetings with community leaders and aired radio broadcasts to clarify the importance of such compliance, and the problem was eventually resolved.
9. **Low capacity of seasonal workers:** Overall, the capacity of seasonal workers was low due to the high illiteracy level in Liberia, which is a result of 14 years of civil war. The AIRS project had a selection condition that field staff was from the communities they worked in during the campaign. However, it was difficult to find people within the communities with the background required for working on the IRS campaign. In addition, recruitment was also a political issue because many community leaders and local authorities insisted on having people from their own communities recruited for the spray campaign.

7.2 Lessons Learned

1. **M&E**: Adherence of M&E protocols is essential for reporting valid data and timely data entry. The *M&E Error Eliminator* was introduced in Liberia in 2013, and following brief trainings for the M&E and operations Staff, the AIRS Liberia team trained seasonal staff (supervisors and team leaders) and NMCP supervisors on how to use the tool. The tool was effective in addressing data collection errors and noting various data calculation errors by SOPs and other seasonal staff.
2. **Supervision**: Effective supervision is essential to achieve successful IRS implementation irrespective of the level of experience, training, and knowledge level of the teams. IRS coordinators, EC and IEC officers, and field logistic officers should be proactive in their supervisory roles. They need to be more engaged with the workers in the field. In the 2013 campaign, some coordinators lacked such a level of initiative.
3. **Larger engagement of local stakeholders**: During the planning process, it is important to bring together major stakeholders at the district level, especially Ministry of Internal Affairs and CHT officials. Community leaders serving as chief mobilizers can be an effective channel to transmit IRS messages. This modality may substitute for IRS door-to-door mobilization campaigns in the future. Likewise, the use of some CHVs as SOPs yielded good results. This

approach should be evaluated because it may lead to decreasing annual training costs for the IRS operation.

4. **Logistics**: Transport management is one of the most challenging activities for an IRS operation. It is critical to engage transport vendors early on and firmly clarify terms and conditions before signing contracts.

7.3 RECOMMENDATIONS

1. **Supervision and monitoring**: Rigorous supervision and monitoring of operations, including data collection, should be routine because they directly impact outputs and performance quality. Whenever problems are discovered, onsite training should be provided.
2. **Insectary**: A fully functional insectary equipped with temperature control equipment is needed to establish and maintain a mosquito colony required for quality assurance, resistance monitoring, and training of local entomologists. Currently, AIRS Liberia and PMI are going through negotiations with the MOHSW regarding the establishment of a container insectary on NMCP property.
3. **Entomological staffing:** In order to maintain a mosquito colony, insectary technicians have to be recruited and stationed at the insectary facility. In addition, AIRS will continue mentoring and conducting on-the-job training of Vector Control Unit staff at the NMCP to improve competence in various entomological techniques.
4. **Human resources**: Given high levels of illiteracy in Liberia, there is a need to continue training of field staff at all levels of IRS operations. The IRS training curriculum should include a pre-training screening questionnaire and pre- and post- training examinations to assess background knowledge of malaria, critical thinking skills, and ability to perform simple arithmetic. Community leaders should recommend the candidates, but selection should be based on the recruitment criteria established by the project or NMCP. In order to increase efficiency of IRS spray teams, there is a need to provide leadership training to IRS coordinators as part of the program's capacity building efforts.
5. **SOP training:** The SOP training did not include a competency test at the end of training because AIRS wanted to maximize the time allotted for training. It could be very helpful to add a competency test at the end of the training in the future, if time permits. The test could weed out the SOPs who did not fully understand the training and help improve the quality of spraying in future campaigns.

ANNEX A: IRS/IVM TASK FORCE PLANNING FOR 2013 SPRAY CAMPAIGN

INDOOR RESIDUAL SPRAYING (IRS) TASK FORCE MEETING
Friday, November 30, 2012
Conference Room, NMCP, Capitol Bye-Pass

- The IRS task force meeting was called to order and chaired by Mr. Oliver Pratt, Deputy Program Manager of the NMCP;
- The meeting was to go on until the arrival of the Chair, Hon. Tolbert Nyenswah.

AGENDA

1. Opening prayer
2. Welcome remarks
3. Past minutes review & matters arising
4. Business:
   - Presentation by Abt Associates
   - Presentation by Pest Eliminators
   - Presentation by Jerry Johnson
5. Partners' update
6. AOBs
7. Adjournment

- Closing prayer

- **Opening prayer** by Wollo Jetoh;
- Mr. Pratt welcomed everyone to the meeting and stated that today's meeting was intended to decide which insecticides were to be used during the 2013 spraying campaign and where we were spraying;
- Everyone quickly went through the minutes page-by-page

Matters arising:

- **Action points and status from previous meeting:**
  - IRS strategy going through the printing process;
  - Didn't have meeting with LAC
  - Had discussion with the military barrack telling them what will be given to them, etc.
  - Obtained a second that the minutes be added to the archive

Business:

- **Abt Associates presentation:**
  - The chair informed the minister that during the regular update with Abt it was disclosed that funding for IRS has reduced and also the number of structures has reduced to 25,000 structures;
  - Min. Nyenswah expressed concern why there was a reduction in the number of structures to be sprayed in 2013;
  - PMI's representative Madam Traore informed them that there was a cut in funds
  - The first of Abt Associates 2 presentations was done by Dr. Emmanuel Temu, COP of Abt Associates;
  - He gave an overview of the IRS 2012 progress and achievement for the 1st and 2nd spray cycles;
  - A total of 97,547 structures were sprayed;
  - A total population of 884,600 were protected (47,786 pregnant women and 147,991 children under 50);

- He informed the body that FY 13 and 14 budget will be combined to fund FY 13 activities and there are no PMI funds allocated for spraying in 2014;
- The body was presented with cost and longevity of 3 major insecticides: pyrethroid/deltamethrin ($2.7 per sachet lasts for 9 months), carbamate/bendiocarb ($13.00 per sachet lasts 3-6 months 2 rounds per year) and organo-phosphate/pirimiphos methyl/actellic CS ($23.00 per sachet lasts 9 months);
- He presented 3 scenarios for the site selection for 2013:

Scenario #1: Maryland County:

- 49% malaria prevalence LMIS 2011 (+)
- Maryland population ~ 136,000, expected malaria cases = 67,000 (-)
- Around 80% of population living within 5 km of a HF (page 36, MOHSW 2011-2012 Annual Review Report) (-);
- Poor accessibility in terms of road condition. (-);
- Logistic & operational challenges due to distance and bad road condition (-);
- High set up cost,longer time for preparation (3.5 months needed), deployment and operation (-)
- NO entomology data (-)
- Target structures = 30,000 one spray cycle (-)

Scenario #2: Bong County:

- 35% malaria prevalence, second to SEB (LMIS 2011) (+);
- Bong population is 334,000, expected cases is 117,000 (+);
- Less than 50% of population living within 5 km of a HF in Bong (page 36, MOHSW 2011-2012 Annual Review Report), (+);
- Better accessibility in terms of road condition (+);
- Infrastructure exist, minimum set up cost, shorter time for preparation, deployment and operation (+);
- Entomology: mosquitoes resistant to PY and fully susceptible to OP (+);
- Target structures = 40,000 one spray cycle (+)

Scenario #3: Any district sprayed in 2012 with => 20% malaria prevalence

- Selection criteria: Identify district with high (>=20%) malaria prevalence (+);
- Infrastructure exist which means minimum set up cost, shorter time for preparation, deployment and operation (+);
- Better accessibility in terms of road condition(+);
- Entomology: mosquitoes are resistant to PY and susceptible to OP (+);
- Target structures = 40,000, one spray cycle (+);

  - **IRS TASK FORCE DECISION, NOV. 30, 2012:**
  - Choice of insecticide: Replace PY with OP - Actellic CS because it is effective for 9 months, that said required one spray cycle and therefore cost effective;
  - Sites: Bong county – 4 IRS current districts (Fuamah, Panta, Kpaai & Kokoya) and additional district (Jorquelleh);
  - Current LLIN distribution (Nov - Dec 2012) scheduled by NMCP/MOH will cover IRS districts that will not be sprayed in FY13.

- Abt Associates 2nd presentation was done by Godwil Munyekenye, Entomologist of Abt Associates;
- His topic was the role of entomological surveillance;

Footnote: Positive (+) and negative (-) scores for selection criteria of each scenario

Annex B: Inventory and Procurement Stocks

TABLE B-1: PRE-SPRAY INVENTORY AND INTERNATIONAL PROCUREMENT

Description	Quantity in Stock Before the IRS Campaign	Quantity Procured Internationally	Total
Insecticide: FICAM	4,786	0	4,786
Insecticide: K-Othrine	8,756	0	8,756
Insecticide: Actellic 300 CS	0	43,776	43,776
Spray pumps (10 liters)	230	0	230
Spray pumps (8 liters)	130	0	130
Face Shield	720	0	720
Hardhat Suspension	560	0	560
Coverall	1,545	800	2,345
Backpack	337	500	837
Hand Glove	2,785	0	2,785
Respirator/Nose Marks	19,490	0	19,490
Pump Cylinder Assembly	430	0	430
Hose Assembly	130	0	130
Ward Assembly	800	0	800
Strip	120	0	120
Cotter Pin	360	0	360
Chain Cover	120	0	120
Spring	120	0	120
Valve Assembly	145	0	145
Cover Assembly	120	0	120
Gasket	120	0	120
Adaptor Supply Tube	154	0	154
O-ring	120	0	120
Supply Tube	120	0	120
Filter	1,000	0	1,000
Gasket/Nozzle	1,260	0	1,260
Nozzle Tip	1,000	0	1,000
Extension Sub Assem.	150	0	150
Cup Replacement Kit	810	0	810
Gauge	221	0	221
Filter Assembly	1,000	0	1,000
Adaptor House	120	0	120

TABLE B-2. PRE-SPRAY INVENTORY AND LOCAL PROCUREMENT

Description	Quantity in Stock Before IRS Campaign	Quantity Procured	Total
Overalls	2,345 pcs	0	2,345 pcs
Rain Boots	601 pairs	150 pairs	751 pairs
Nose Masks	19,490 pcs	0	19,490 pcs
Hand Gloves (Heavy duty)	2,785 pairs	0 pairs	2,785 pairs
Helmets	971 pcs	0	971 pcs
Helmets Inserts	587 pcs	0	587 pcs
Large Barrels	47 pcs	0	47 pcs
Medium Barrels	65 pcs	0	65 pcs
Small Barrels	13 pcs	0	13 pcs
Face Shields	750 pcs	0	750 pcs
First Aid Kits	58 kits	50kits	108 kits
Vitamin "E" Cream	251 pcs	0	251 pcs
Pregnancy Tests Strip	40 strips	60 Strips	100 strips
Apo Furosemide Tablets	3 tins	0	3 tins
Atrop 50 X1MC Ampules	0	50 packs	50 pcks
Green Vests	75 pcs	0	75 pcs
Orange Vests	33 pcs	0	33 pcs
Back bags	837 pcs	0	837 pcs
Malaria Service Cards	8,400 pcs	50,000pcs	58,400 pcs
IEC/BCC Data Collection Forms	73,467 pcs	35,300pcs	108,767 pcs
Stock Cards	1,950 pcs	0	1,950 pcs
Mobilizer Training Manuals	0	210pcs	210 pcs
SOP Manual	0	300pcs	300 pcs
Vehicle Log Sheets/Book	11 pcs	49pcs	60 pcs
Laundry Detergent /Powder Soap	41 carton & 89 pcs (150 pcs in carton)	6 carton + 100pcs	48 cartons + 39 pcs
Tablet Soap for Washing	28 cartons & 46 pc (60 pcs in carton)	25 carton	53 cartons + 46 pcs
Bathing Soap	24 carton & 11pcs (72 pcs in carton)	11 carton & 12pcs	35 carton + 23 pcs
Tissue	29 bags & 1pcs (36 in bags)	13 bags & 32 pcs	42 bags + 33 pcs
Towel	415 pcs	185 pcs	600 pcs
White Chalk	44 packs	56 packs	100 packs
Writing Pen	32 packs & 48 pcs (50 pcs in pack)	11 packs & 2 pcs	44 packs
Plastic Folder	798 pcs	0	798 pcs
Paper Glue	56 pcs	0	56 pcs
Hard Cover Ledger	58 pcs	0	58 pcs
Correction Fluid	14 pcs	50 pcs	64 pcs
Note Pad	1,131 pcs	500 pcs	1,631 pcs
Flip Chart	15 pcs	20 pcs	35 pcs
Marker	18 packs & 8 pcs (12 pcs in pack)	41 packs & 8 pcs	60 packs + 4 pcs
Flip Chart Stand	0	2 pcs	2 pcs

ANNEX C: EC ASSESSMENT RESULTS

District	Site Location	Facilities (Warehouse/Health Center/etc)	Site Refurbished
Jorquelleh (supported Zota)	Gbarnga warehouse	Warehouse facility, CB Dumbar health center	Soak pit constructed, store room renovated
	Wainsue	Warehouse facility, CB Dumbar health facility	Soak pit constructed along with store room renovated
	Beletanla	Warehouse facility. No health facility located nearby	Soak pit constructed, store room renovated
	Gbenequelleh	Warehouse facility. No health center located nearby	Soak pit constructed. Store room renovated
Fuamah (supported Sanoyea)	Haindii	Warehouse renovated, haindii clinic	Soak pit renovated along with store room
	Bong mines	Warehouse renovated, bong mines hospital	Soak pit renovated along with store room
	Kankalan town	Warehouse renovated, clinic is located far from site	Soak pit renovated along with store room
	Degei	Warehouse renovated, Degei clinic	Soak pit renovated along with store room
Panta	Garmue	Warehouse renovated, Garmue clinic	Soak pit renovated along with store room
Kokoyah	Botota	Warehouse renovated, Botota clinic	Soak pit renovated along with store room
	Bindashorquelleh	Warehouse renovated. Rockcrusher clinic	Soak pit renovated along with store room
Kpaii	Zowienta	Warehouse renovated. Zowienta clinic	Soak pit renovated along with store room

Annex D: Summary of Radio Talk Shows during the IRS Campaign

Date 2013	County / District	Radio Station/ Duration	Affiliation of Participants	Comments
March 16,2013	Bong County-Gbarnga-Jorquelleh District	Radio Gbarnga/1 hour	IEC-BCC Coordinator NMCP, IEC-BCC Officer Abt Associates	Spray has bad odor
March 17,2013	Bong County-Gbarnga-Jorquelleh District	Radio Gbarnga/1 hour	IEC-BCC Coordinator NMCP, IEC-BCC Officer Abt Associates	Spray has bad odor
March 17,2013	Bong County-Gbarnga-Jorquelleh District	Radio Gbarnga/1 hour	IEC Coordinator NMCP, IEC Officer Abt Associates	Spray has bad odor
April 6,2013	Bong County-Gbarnga-Jorquelleh District	Radio Gbarnga/1 hour	IEC-BCC Coordinator NMCP, IEC-BCC Officer Abt Associates	Spray has bad odor, difficulty in carrying things in and out of the house
April 8,2013	Bong County-Gbarnga-Jorquelleh District	Radio Gbarnga/1 hour	IEC-BCC Coordinator NMCP, IEC-BCC Officer Abt Associates	Spray has bad odor
April 9,2013	Bong County-Gbarnga-Jorquelleh District	Super Bongese Radio	NMCP-IEC-BCC Coordinator, IEC-BCC Officer Abt Associates, Mobilizer supervisor	Spray has bad odor
April 10,2013	Bong County-Gbarnga-Jorquelleh District	Super Bongese Radio	Database Manager youth leader, community leader Officer Abt Associates Mobilizer supervisor	Spray has bad odor
April 12,2013	Bong County-Gbarnga-Jorquelleh District	Super Bongese Radio	Database Manager youth leader, community leader Officer Abt Associates Mobilizer supervisor	Spray has bad odor
April 15,2013	Bong County-Gbarnga-Jorquelleh District	Super Bongese Radio	IEC/BCC Officer Abt Associates, youth leader community leader	Spray has bad odor, difficulty in moving things in an out of house
April 26,2013	Bong County-Fuamah District	Bong Mine Community Radio	IEC-BCC Officer Abt Associates, Dev. Committee chairman, religious Lutheran Leader-Church, Paramount Chief, Community Security chairman and Clan Chief	Spray has bad odor
April 27,2013	Bong County-Fuamah District	Bong Mine Community Radio	IEC-BCC Officer Abt Associates, Dev. Committee chairman, religious Lutheran Leader-Church, Paramount Chief, Community Security chairman and Clan Chief	Spray has bad odor

ANNEX E. OUTPUT/PROCESS INDICATORS

TABLE E-1. LIBERIA MONITORING AND EVALUATION PLAN INDICATOR MATRIX

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
Component 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 Procurement									
1.1.1 Number and percentage of international insecticide procurement orders delivered in coutry, at port of entry, at least 30 days prior to the start of spray operations	[*Numerator:* Number of international insecticide procurement orders delivered in country, at port of entry, at least 30 days prior to the start of spray operations] [*Denominator:* Total number of international insecticide procurement orders] *Calculation:* [Numerator ÷ Denominator] x 100	Y1, Y2, Y3	*Data source*: Project records – international procurements *Reporting frequency*: Each spray season	By Spray Campaign	AIRS	Round 1: N.A.; 80% Round 2: N.A	Round 1: 0[5]; 0% Round 2: N.A.	1; 100%	1; 100%
1.1.2 Number and percentage of international procurement orders for equipment, including PPE, received at port of entry, 30 days	[*Numerator:* Number of international procurements for equipment, including PPE, at port of entry, 30 days prior to start of spray operations] [*Denominator*: Total number of	Y1, Y2, Y3	*Data source:* Project records *Reporting frequency*: Each spray season	By Spray Campaign	AIRS	Round 1: N.A.; 85% Round 2: N.A.	Round 1: N.A. Round 2: N.A.	N.A.	N.A.

[3] All results for Year 1's Round 2 spray will be added to the matrix after the completion of the 2012 End of Spray Report.

[4] All targets for Year 2 will be added to the matrix after the 2013 work plan has been approved.

[5] Both insecticide procurement orders were received before the start of spray, but not 30 days before commencement.

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
prior to start of spray operations.	international procurements for equipment, including PPE.*]* *Calculation:* [Numerator ÷ Denominator] x 100								
1.1.3 Number and percentage of local PPE procurement orders that are delivered to the main warehouse 14 days before the start of spray operations	[*[Numerator:* Number of local PPE procurement orders delivered to the main warehouse 14 days before the start of spray operations] [*Denominator*: Total number of local PPE procurements.] *Calculation:* [Numerator ÷ Denominator] x 100	Y1, Y2, Y3	*Data source:* Project records *Reporting frequency*: Each spray season	By Spray Campaign	AIRS	Round 1: N.A.; 80% Round 2: N.A.	Round 1: 0[6];100% Round 2: N.A.	N.A.	N.A.
1.1.4 Successfully completed spray operations without an insecticide stock-out	Milestone: (Completed/Not Completed)	Y1, Y2, Y3	*Data source:* Project records *Reporting frequency*: Each spray season	By Spray Campaign	AIRS	Round 1: Achieved Round 2: Achieved	Round 1: Achieved Round 2: Achieved	Acheived	Acheived
1.2 In-country Logistics, Warehousing, and Training									
1.2.1 Number and percentage of logistics and warehouse managers trained in IRS supply chain management	*[Numerator:* Total number of logistics and warehouse managers trained in IRS supply chain management using AIRS Project resources.] *[Denominator:* Total number of AIRS logistics and warehouse managers.] *Calculation*: [Numerator ÷ Denominator] x 100	Y1, Y2, Y3	*Data source*: Routine training records *Reporting frequency*: Semi-annually	By Spray Campaign By Gender	PMI	Round 1: N.A. Round 2: N.A.	Round 1: 18; 8 males, 10 females Round 2: N.A.	9; 100%	9; 100% 5 males, 4 females

[6] Local PPE procurements were received within 6 days of the start of spray, not within 14 days.

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
1.2.2 Number and percentage of base stores where physical inventories are verified by up-to-date stock records	*[Numerator:* Number of base stores where physical inventories are verified by up-to-date stock records] [*Denominator*: Total number of base stores audited.] *Calculation:* [Numerator ÷ Denominator] x 100 *(See PIRS for details on sample size for operational audits)*	Y2, Y3	*Data source:* Project records *Reporting frequency*: Each spray season	By Spray Campaign	AIRS	Round 1: N.A. Round 2: N.A.	Round 1: 19; 100% Round 2: 2; 100%	8; 100%	8; 100%
1.2.3 Submit up-to-date inventory records to AIRS Home Office 30 days after the end of each spray campaign	Milestone: (Completed/Not Completed)	Y2, Y3	*Data source:* Project records *Reporting frequency*: Each spray season	By Spray Campaign	AIRS	N.A.	N.A.	Completed	Completed
Component 2: Implement safe and high-quality IRS programs and provide operational management support									
2.1 Planning and Design of IRS Programs									
2.1.1 Annual IRS country work plan developed and submitted on time	Milestone: (Completed/Not Completed)	Y1, Y2, Y3	*Data source:* Project records *Reporting frequency*: Annually		AIRS	Completed	Completed	Completed	Completed

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
2.2 Support of Safety and Health Best Practices and Compliance with USAID and Host Country Environmental Regulations									
2.2.1 SEA/letter report submitted on time[7]	Milestone: (Completed/Not Completed)	Y1, Y2, Y3	*Data source*: Project records – submitted SEAs/ letter reports Reporting frequency: Each spray campaign	By Spray Campaign	AIRS	Round 1: Completed Round 2: Completed	Round 1: Completed Round 2: Completed	Completed	Completed
2.2.2 Number and percentage of soak pits and storehouses inspected and approved prior to spraying	[*Numerator:* Number and percentage of soak pits and warehouses/storerooms inspected and certified by an environmental officer/AIRS Environmental Compliance Officer prior to each spray campaign supported by the AIRS Project] [Denominator: Total number of project soak pits and/or storehouses] Calculation: *[Numerator ÷ Denominator] x 100*	Y1, Y2, Y3	Data source: Project records – Reports submitted by environmental officers Reporting frequency: Each spray season	By Spray Campaign By Soak Pit By Warehouse/ Storeroom	AIRS	Round 1: N.A.; 100% Round 2: N.A.; 100%	Round 1: 27; 100% 15 soak pits, 12 store-houses Round 2: 4; 100% 2 soak pits; 2 store-houses	N.A.; 100%	24; 100% 12 soak pits; 12 store-houses
2.2.3 Number of government environmental and health officers trained in IRS environmental compliance	Total number of government environmental and health officers trained in IRS environmental compliance using AIRS Project resources	Y1, Y2, Y3	*Data source:* Project training reports Reporting frequency: Semi-annually	By Spray Campaign By Gender	AIRS	Round 1: N.A. Round 2: N.A.	Round 1: N.A. Round 2: N.A.	N.A.	N.A.

[7] In Year 1, SEAs were due 30 days prior to the commencement of spraying and letter reports were to be submitted 14 days prior to the commencement of spraying. In Year 2, due dates agreed upon with Washington-PMI will be noted in each country-specific Monitoring and Evaluation Plan to assess indicator 2.2.1.

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
2.2.4 Number of spray personnel trained in environmental compliance and personal safety standards in IRS implementation	Total number of spray personnel who attend a training in environmental compliance and personal safety standards in IRS implementation using AIRS Project resources, includes all staff who received environmental compliance training - spray operators, team leaders, washpersons, storekeepers, etc.	Y1, Y2, Y3	Data source: Project records – Training reports Reporting frequency: Each spray season	By Spray Campaign By Gender	AIRS	Round 1: N.A. Round 2: N.A.	Round 1: 665; 558 males, 107 females Round 2: 153; 112 males, 41females	N.A.	597: 468 males 129 females
2.2.5 Number of health workers receiving insecticide poisoning case management training	Total number of clinical personnel trained in insecticide poisoning case management using AIRS Project resources	Y2, Y3	Data source: Project records – Training reports Reporting frequency: Each spray season	By Spray Campaign By Gender	AIRS	N.A.	Round 1: N.A. Round 2: 16; 8 males, 8 females	N.A.	21; 19 males, 2 females
2.2.6 Number of adverse reactions to pesticide exposure documented	Total number of incidents of pesticide exposure reported that resulted in a referral for medical care	Y1, Y2, Y3	Data source: Incident report forms that are required for each incidence of pesticide exposure Reporting frequency: Each spray season	By Spray Campaign By residential/occupational exposure	AIRS	Round 1: 0 Round 2: 0	Round 1: 0 Round 2: 0	0	0
2.2.7. Number of vehicular accidents reported	Total number of vehicular accidents reported	Y1, Y2, Y3	Data source: Vehicular incident report forms that are required for each accident Reporting frequency: Each spray season	By Spray Campaign	AIRS	Round 1: 0 Round 2: 0	Round 1: 0 Round 2: 0	0	0

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
2.3 Support Entomological Monitoring Activities and Insecticide Resistance Strategies									
2.3.1 Number of sentinel sites supported by the AIRS project	Total number of entomological sentinel sites supported by the AIRS project	Y1, Y2, Y3	Data source: Entomological reports Reporting frequency: Annually	By Spray Campaign	AIRS	Round 1: 6 Round 2: 6	Round 1: 6 Round 2: 6	4	4
2.3.2 Number and percentage of entomological monitoring sentinel sites measuring all five primary PMI entomological indicators	*[Numerator:* Number of entomological monitoring sites measuring all five primary PMI entomological indicators] *[Denominator:* Number of entomological monitoring sentinel sites] *Calculation:*[Numerator ÷ Denominator] x 100	Y1, Y2, Y3	Data source: Entomological reports *Reporting frequency:* Annually	By Spray Campaign	AIRS	Round 1: 6; 100% Round 2: 4; 100%	Round 1: 4; 67% Round 2: 4; 100%	4; 100%	4; 100%
2.3.3 Number and percentage of entomological moniotring sites measuring at least one secondary PMI indicator	*[Numerator:* Number of entomological monitoring sites measuring at least one secondary PMI indicator] *[Denominator:* Number of entomological monitoring sites] *Calculation:*[Numerator ÷ Denominator] x 100	Y1, Y2, Y3	Data source: Entomological reports Reporting frequency: Annually	By Spray Campaign	AIRS	Round 1: 0; 0% Round 2: 0; 0%	Round 1: 0; 0% Round 2: 0; 0%	4; 100%	In process
2.3.4 Number and percentage of insecticide resistance testing sites that tested at least one insecticide from each of	*[Numerator:* Number of insecticide resistance testing sites that tested at least one insecticide from each of the four classes of insecticides recommended for malaria vector control.]	Y1, Y2, Y3	Data source: Entomological reports Reporting frequency: Annually	By Spray Campaign By Type of Insecticide	AIRS	Round 1: 4; 100%	5[8]; 125%	4[9]; 100%	In process

[8] Testing sites conducted insecticide resistance testing on pyrethroids, carbamates, or organophosphates.
[9] Testing sites conducted insecticide resistance testing on pyrethroids, carbamates, or organophosphates.

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
the four classes of insecticides recommended for malaria vector control	*[Denominator:* Number of insecticide resistance testing sites] *Calculation:*[Numerator ÷ Denominator] x 100								
2.3.5 Number of wall bioassays conducted within 2 weeks of spraying to evaluate the quality of IRS	Total number of wall bioassay studies conducted in established sentinel sites to evaluate quality of IRS spraying activities	Y1, Y2, Y3	Data source: Entomological reports Reporting frequency: Per spray campaign	By Spray Campaign	PMI	Round 1: 9 Round 2: 0	Round 1: 9 Round 2: 0	18	18
2.3.6 Number of wall bioassays conducted after the completion of spraying at monthly intervals to evaluate insecticide decay	Total number of wall bioassay studies conducted at monthly intervals in established sentinel sites to evaluate the rate of insecticide decay on sprayed surfaces	Y1, Y2, Y3	*Data source:* Entomological reports Reporting frequency: *Per spray campaign*	By Spray Campaign	PMI	Round 1: 45 Round 2: 9	Round 1: 45 Round 2: 9	18	9
2.3.7 Number of vector susceptibility tests for different insecticides conducted in selected sentinel sites	Total number of vector susceptibility tests conducted to gauge the effectiveness of individual insecticides proposed for use in spray operations	Y1, Y2, Y3	Data source: Entomological reports Reporting frequency: Per spray campaign	By Spray Campaign By Type of Insecticide	PMI	2	4[10]	4	In process
2.4 Conduct Communications Activities and Community Mobilization									
2.4.1 Number of radio spots and talk shows aired	Total number of radio spots and talk shows aired in target spray districts to stress the safety and benefits of IRS, ensure successful spray coverage, timely vacating of premises and adherence to IRS safety precautions by community members	Y1, Y2, Y3	Data source: Project records Reporting frequency:Semi-annually	By Spray Campaign	AIRS	N.A.	Round 1: 14 Round 2: 4	15	11

[10] Deltamethrin, Cypermethrin, Bendiocarb, Fenitrothion and Pirimiphos-methyl

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
2.4.2 Number of IRS print materials disseminated	Total number of IRS educational materials developed, printed and distributed to community members in target spray districts using AIRS Project resources	Y1, Y2, Y3	Data source: Project records Reporting frequency:Semi-annually	By Spray Campaign By Type of printed material and message(s)	AIRS	N.A	Round 1: 107,871; 49,388 posters, 58,000 brochures, 483 t-shirts Round 2: 18,000; 8,000 posters, 10,000 brochures	N.A.	20,428; 14,500 posters, 4,500 brochures, 1,490 t-shirts
2.4.3 Number of people reached with IRS messages via door-to-door mobilization	Total number of adults reached with IRS message during pre-spray community, door-to-door mobilizaiton	Y1, Y2, Y3	Data source: Moblilization Data Collection Forms Reporting frequency: Daily per moblization conducted	By Spray Campaign By Gender	AIRS	N.A.	Round 1: 372,905; 182,722 males, 190,183 females Round 2: 246,149; 121,607 males; 124,542 females	N.A.	153,348; 72,967 males, 80,381 females

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
2.5 Spray Targeted Structures According to Technical Specifications									
2.5.1 Number of structures targeted for spraying[11]	Total number of structures found in targeted spray districts by Spray Operators	Y1, Y2, Y3	Data source:Daily Spray Operator Forms Reporting frequency:Daily per spray campaign	By Spray Campaign	PMI	Round 1: 80,000 Round 2: 22,000	Round 1: 99,236 Round 2: 21,564	40,200	44,328
2.5.2 Number of structures sprayed with IRS[12]	Total number of structures sprayed in targeted spray districts	Y1, Y2, Y3	Data source:Daily Spray Operator Forms Reporting frequency:Daily per spray campaign	By Spray Campaign	PMI	Round 1: 68,000 Round 2: 18,700	Round 1: 96,901 Round 2: 21,152	34,170	42,708
2.5.3 Percentage of total structures targeted for spraying that were sprayed with a residual insecticide (Spray Coverage)	[Numerator: Total number of structures sprayed in targeted districts] [Denominator: Total number of structures in targeted areas found by spray operators] Calculation: [Numerator ÷ Denominator] x 100	Y1, Y2, Y3	Data source:Daily Spray Operator Forms Reporting frequency:Daily per spray campaign	By Spray Campaign	PMI	Round 1: 85% Round 2: 85%	Round 1: 97.6% Round 2: 98.1%	85%	96.3%
2.5.4 Number of people residing in structures sprayed (Number of people protected by IRS)	Total number of people residing in structures sprayed (Actual numbers are collected during spray operations; population estimates are not used.)	Y1, Y2, Y3	Data source:Daily Spray Operator Forms Reporting frequency: Daily per spray campaign	By Spray Campaign By Number of pregnant women	PMI	N.A.	Round 1: 869,707; 47,786 pregnant women, 145,845	N.A.	367,930: 16,287 pregnant women; 63,714 children <5

[11] The yearly targets for this indicator are from the applicable work plan. The yearly results are the number of structures found by Spray Operators during the spray campaign.
[12] The target per year for this indicator is based on 85% of the number of structures to be targeted as noted in the applicable work plan.

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
				By Number of children <5 years old			children <5 years Round 2: 196,279; 7,875 pregnant women, 28,860 children <5 years		years
Component 3: Provide onngoing monitoring and evaluation and quality control measures									
3.1 Submit Monitoring and Evaluation Plan (MEP) to PMI-Liberia	*Milestone:* (Completed/Not Completed)	Y1, Y2, Y3	Data source:Project records Reporting frequency: Semi-annual		AIRS	Completed	Completed	Completed	In process
3.2 Submit a post-spray data quality audit report to the AIRS M&E specialist in the home office within 60-180 days of completion of spray operations	Milestone:*(Completed/Not Completed)*	Y1, Y2, Y3	Data source:Spray operations reports Reporting frequency:Per spray campaign	By Spray Campaign	AIRS	N.A.	N.A.	Completed	In process
3.3 Submit a country-specific Eligible Structure Definition Document to local PMI advisors and NMCP	*Milestone:*(Completed/Not Completed)	Y1	Data source:Project records Reporting frequency: *Semi-annually*		AIRS	Completed	N.A.	N.A.	N.A.

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
3.4 Supply chain review conducted by RTT	*Milestone: (Completed/Not Completed)*	Y1, Y2	Data source:RTT supply chain review reports Reporting frequency: Semi-annually	By Spray Campaign	AIRS	N.A.	N.A.	N.A.	N.A.
Component 4: Contribute to Global IRS Policy-Setting and Country-Level Policy Development of Evidence-Based IRS; Disseminate Experiences and Best Practices									
4.1 Number of guidelines/checklists/tools related to IRS operations developed or refined with project support	Total number of implementation guidelines, process checklists and program tools related to IRS operations developed or refined using the technical and/or financial resources of the AIRS Project	Y1, Y2, Y3	Data source:Project records – Activity reports Reporting frequency: Semi-annually	By Guideline/checklist/tool	AIRS	N.A.	3; New supervisory checklists	3	3; New data quality assurance/ supervisory tools
4.2 Number of articles/best practices documents published	Total number of articles or other best-practice documents that have been published in relevant journals or through PMI/USAID communications vehicles	Y2, Y3	Data source:Project records – Activity reports Reporting frequency: Semi-annually	By Spray Campaign By IRS Technical Area	AIRS	N.A.	N.A.	N.A.	N.A.
4.3 Number of best practice presentations given at national/ regional/international workshops and conferences	Total number of project-related oral and poster presentations delivered in national, regional and/or international meetings related to IRS.	Y2, Y3	Data source:Project records – Activity reports Reporting frequency:Semi-annually	By IRS Technical Area	AIRS	N.A.	N.A.	N.A.	N.A.
Component 5 (Cross-cutting): Capacity Building, Knowledge Transfer, Gender Inclusion									
5.1 Capacity Building (Gender Inclusion)									
5.1.1 Number of people trained in IRS implementation	Total number of personnel trained in IRS implementation using AIRS Project resources.	Y1, Y2, Y3	Data source:Project records – Training reports	By Spray Campaign	PMI	N.A.	Round 1: 665; 558 males, 107	23	292; 245 males, 47 females

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
	This figure only includes spray personnel such as spray operators, team leaders, supervisors, clinicians; it excludes data clerks, IEC mobilizers, drivers, washers, porters, pump technicians, security guards, etc.		Reporting frequency: Semi-annually	By Gender Percentage of Women Trained			females 16.1% women trained Round 2: 153; 112 males, 41 females 26.8% women trained		16.1% women trained
5.1.2 Number of people trained to deliver or support IRS in target districts	Total number of people trained using AIRS Project resources to implement/support elements of IRS in target districts. This figure includes all cadre that serve a role in IRS.	Y1, Y2, Y3	Data source:Project records – Training reports Reporting frequency: Semi-annually	By Spray Campaign By Gender By Role (e.g., spray operator, storekeeper[13]) Percentage of women trained	AIRS	885	Round 1: 1,300; 1,042 males, 258 females 19.8% women trained Round 2: 233; 167 males, 66 females 28.3% women trained	597	597; 468 males, 129 females 21.6% women trained
5.1.3 Number of personnel trained as IRS implementation trainers	Total number of personnel trained in Training of Trainers (TOT) for IRS delivery	Y1, Y2, Y3	Data source:Project records – Training reports	By Spray Campaign By Gender	AIRS	90	Round 1: 46; 40 males, 6 females	38	23; 22 males, 1 female 4.3% women

[13] See Annex B for staff trained disaggregated by staff role and gender.

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
			Reporting frequency: *Semi-annually*	Percentage of women trained			13% women trained Round 2: N.A.		trained
5.1.4 Number of government environmental and/or health officials trained in IRS oversight	Total number of national and sub-national/district government environmental and/or health officials who are trained in oversight of IRS implementation using AIRS Project resources	Y1, Y2, Y3	Data source:Project records – Training reports Reporting frequency: Semi-annually	By Spray Campaign By Gender Percentage of Women Trained Type of government official (e.g. environmental /health)	AIRS	N.A.	N.A.	N.A.	N.A. 0% women trained
5.1.5 AIRS conducted a capacity assessment	AIRS Liberia program conducted an assessment of IRS capacity among national and sub-national/district government health officials	Y1, Y2	Data source:Project records – Capacity assessment reports Reporting frequency: Semi-annually		AIRS	Completed	In process	Completed	Completed

Performance Indicator	Indicator Definition	Project Year(s) Reporting	Data Source(s) and Reporting Frequency	Dis-aggregate	PMI/AIRS Indicator	Annual Targets & Results			
						Year 1		Year 2	
						Targets	Results[3]	Targets[4]	Results
5.1.6 Number of capacity-building MOUs signed by AIRS, NMCP and partners/ institutions	Total number of Memoranda of Understanding (MOU) on provision of local capacity building finalized and signed between AIRS, the National Malaria Control Program, and other local partners and institutions	Y1, Y2, Y3	Data source:Project records – MOUs *Reporting frequency*: *Semi-annually*	By Spray Campaign	AIRS	1	In process	N.A.	In process[14]

[14] MOU for lab insectary is under review.