PMI | Africa IRS (AIRS) Project

Indoor Residual Spraying (IRS 2) Task Order Four

NIGERIA
END OF SPRAY REPORT 2012

Contract GHN-I-00-09-00012-00

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ACRONYMS

AIRS	Africa Indoor Residual Spraying
GR	Geographical Reconnaissance
HLC	Human Landing Catch
IBA	Incinerator Bottom Ash
ICC	Inventory Control Cards
IEC	Information, Education and Communication
IRS	Indoor Residual Spraying
LGA	Local Government Area
M&E	Monitoring and Evaluation
NESREA	National Environmental Standards and Regulations Enforcement Agency
NIPRD	National Institute of Pharmaceutical Research and Development
NMVCP	National Malaria and Vector Control Program
PMI	President's Malaria Initiative
PPE	Personal Protective Equipment
RTI	Research Triangle Institute International
SEA	Supplemental Environmental Assessment
SMOH	State Ministry of Health
USAID	United States Agency for International Development
WHO	World Health Organization

EXECUTIVE SUMMARY

In August 2011, Abt Associates was awarded a three-year Africa-wide Indoor Residual Spraying project (AIRS), IRS 2 Task Order 4, funded by USAID under the President's Malaria Initiative. The mandate of the project is to limit exposure to malaria and reduce the incidence and prevalence of malaria in up to 17 countries in sub-Saharan Africa through the implementation of indoor residual spraying programs. The key objectives of the program in Nigeria is to reduce malaria-associated morbidity and mortality in two selected Local Government Areas (LGAs), Doma and Nassarawa Eggon, in Nasarawa State, as well as to establish a model IRS program that will set national performance standards.

Abt implemented the project in close collaboration with Nigeria's National Malaria Control Program, the Nasarawa State Ministry of Health, the National Environmental Standards and Regulations Enforcement Agency, the Federal Ministry of Environment, and LGA officials in Doma and Nassarawa Eggon.

When the AIRS office opened in Lafia in early December 2011, the project team faced two immediate tasks: complete start-up operations to create an enabling environment for high-level project performance; and prepare for the spray campaign scheduled to start in April. Both of these challenges were successfully met and the 2012 spray campaign started on time.

The project achieved the following results during the spray campaign, which operated for 32 days over the period April 4 through May 31:

1. Trained 626 spray operations personnel (82.7 percent male; 17.3 percent female).
2. Sprayed a total of 58,704 structures out of 59,229 structures found by the spray operators, which represents 99.1 percent spray coverage.
3. Protected a total population of 346,115, which included 15,900 pregnant women and 62,584 children under age five.

As part of entomological monitoring, AIRS conducted baseline and monthly monitoring activities. To determine quality of spraying the project conducted quality assurance tests in 10 houses. The test results of average 24-hour mortality were 94.7 percent for the month of April, 72.5 percent for the month of May and 60.4 percent for the month of June using standard World Health Organization (WHO) cone assay.

1. INTRODUCTION

1.1 PROJECT OBJECTIVES IN 2012

The AIRS Nigeria project had two major objectives for the spray campaign of 2012. These were:

1. To further the National Malaria Control Program (NMCP) and President's Malaria Initiative (PMI) goal of reducing malaria-associated mortality in the two selected LGAs in Nasarawa State, Nigeria.
2. To establish a model indoor residual spraying (IRS) program at a state/local government authority (LGA) level that will set national performance standards and serve as a best practice for national and international implementers working to expand IRS.

A key longer-term project objective is to transfer the IRS program to Nasarawa State after 2–3 years of assistance.

Specific objectives for 2012 of the AIRS Nigeria program included the following:

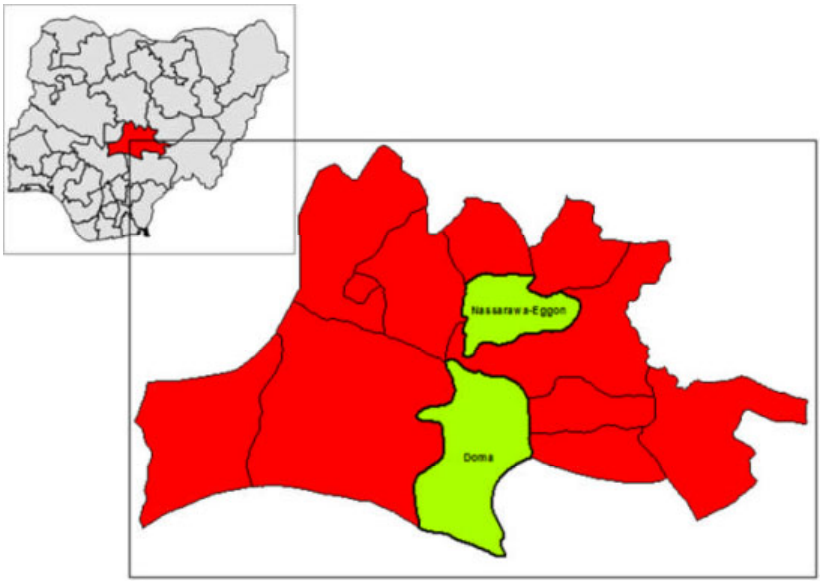
- Achieve spray coverage of at least 85 percent of the target number of structures in Doma and Nassarawa Eggon LGAs of Nasarawa State.
- Strengthen capacity at the federal and state level to create evidence-based IRS strategies and implement IRS, through close collaboration with the NMCP and interested states on developing and revising relevant policies, strategies, and guidelines.
- Ensure compliance with environmental regulations and establish local capacity for best practices in the target districts for insecticide handling and usage for IRS.
- Establish effective monitoring and evaluation (M&E) of all activities in order to demonstrate results that can be adapted for possible scale-up of IRS implementation in Nigeria.

PMI and NMCP jointly selected Doma and Nassarawa Eggon LGAs to be the project sites based on the malaria prevalence data and acceptance of IRS by the LGA authorities.

1.2 SPRAY SITES

Doma LGA, located in the southern part of Nasarawa state (Figure 1), is made up of flat terrain with alluvial fertile soil. Centrally located Nassarawa Eggon is generally hilly and rocky, with numerous rivers and streams that empty into the Benue River. LGAs are divided into electoral wards; Doma comprises 10 wards with a population of 168,062; Nassarawa Eggon comprises 14 with a population of 174, 566. In both LGAs combined, AIRS has established 15 operational centers with soak pits and refurbished stores. It also has a central warehouse in Lafia.

FIGURE 1: MAP OF NASARAWA STATE WITH TWO IRS LGAS



1.3 INSECTICIDES

The insecticide used for the 2012 spray was alpha-cypermethrin from the pyrethroid class. In October 2011, the former PMI IRS implementing partner, Research Triangle Institute International (RTI), conducted an insecticide resistance study in Nassarawa Eggon using a total of 1,005 non-blood fed female *Anopheles* mosquitoes. Using CDC bottle bioassays, *Anopheles* species in the study area were found to be fully susceptible (100% mortality) to all the insecticides tested from three of the four classes of insecticides recommended for public health use, i.e., pyrethroids (Alpha-cypermethrin, Deltamethrin, Lambda-cyhalothrin, and Permethrin), organophosphates (Malathion and Fenitrothion), and carbamates (Bendiocarb). However, the study did show probable resistance to DDT (91% mortality). See Table 1 below for the complete knockdown times by insecticide. The NMCP and PMI used the study results together with criteria recommended by WHOPES to select the insecticide for the 2012 spray round.

TABLE 1: KNOCKDOWN TIME OF INSECTICIDES TESTED FOR SUSCEPTIBILITY BY RTI

Insecticide	Class of Insecticide	Complete Knockdown Time (Minutes)
Bendiocarb	Carbamate	05
Lambdacyhalothrin	Pyrethroid	12
Malathion	Organophosphate	13
Alpha-cypermethrin	Pyrethroid	15
Fenitrothion	Organophosphate	20
Deltamethrin	Pyrethroid	30
Permethrin	Pyrethroid	30
DDT	Organochloride	120

2. Pre-spray Activities

2.1 Geographical Reconnaissance

Geographical reconnaissance (GR) of Doma and Nassarawa Eggon LGAs was carried out to define spatial distribution of target populations and map out the terrain, natural water bodies, and road infrastructure in order to plan effective and efficient implementation of the IRS campaign. The data collection lasted for 26 days in February 2012. During the GR, data collectors identified 49,622 households spread across 424 settlements in the two LGAs. Collectors recorded a total population of 331,242 persons including 69,415 children under five years of age, and 11,867 pregnant women.

2.2 Microplanning

Microplanning took place in February 2012. The project staff facilitated the meetings and worked closely with officials of the NMCP, the State Ministry of Health (SMOH), and Doma and Nassarawa Eggon LGAs.

The staff prepared a detailed roll-out strategy and action plan. It contained personnel requirements and selection criteria as well as logistics and transportation requirements. The staff also decided on the number and location of stores and soak pit sites, quantities for IRS equipment, and training schedule.

2.3 Logistics Needs and Procurement

The logistics needs assessment started with the development of the 2012 IRS work plan. Because the AIRS project in Nigeria was new and no prior IRS campaign had taken place in the two LGAs, the AIRS team used the target of 100,000-household coverage as a reference point to calculate human resources, material, and logistics needs. Table A-1in the annex shows the key commodities the project procured internationally and domestically for the spray operation. LGA demographic data helped the team to come up with the number of operational base stores, soak pits, and spray teams needed for the spray operation in each ward. A total of 15 stores and 15 soak pits locations were established for 50 spray teams in the two LGAs. Communities provided the storage spaces at no cost. The project refurbished a central warehouse and 15 community stores.

2.4 Human Resource Requirements

The project deployed 530 seasonal workers, 16.4 percent of whom were female, for the IRS operation and mobilization/enumeration in the two LGAs as shown in Table A-2 in the annex.

Workers were recruited in March 2012. Candidates who passed the health check and a written exam attended the trainings. The project added a 6 percent buffer to the number of spray operators invited for training.

Training of Spray Operators in Nassarawa Eggon

An operational team of 50 team leaders coordinated and managed 250 spray operators. Six supervisors, 2 LGA coordinators, 15 storekeepers, 15 pump technicians, 15 washers, 30 security personnel, 2 data assistants, and 10 data entry clerks supported the operations.

2.5 TRAINING

Effective training is essential to successful IRS operations. AIRS Project, Nigeria therefore facilitated 11 types of training shown in Table 2 for various categories of field workers and stakeholder organizations' personnel in February and March 2012. A four-day training of trainers was conducted for central, state, and district government partners who in turn trained the seasonal workers on the components of IRS. The team arranged for a five-day spray operator training that took place simultaneously at the two LGA secretariats. The project extended the training by two days so that the trainees could do practical exercises. Other groups trained included: GR data collectors, information, education and communication (IEC) mobilizers, health workers, pump technicians, storekeepers, washers, drivers, security, and data entry clerks. In total, the project trained 626 persons, as reported in Table A-3 in the annex.

TABLE 2: CATEGORIES OF TRAINING CONDUCTED

S/No.	Categories of Training
1.	Geographical Reconnaissance
2.	Training of Trainers (Coordinators, Supervisors, Team leaders, Data assistants)
3.	Spray operators' training
4.	Mobilizers' training
5.	Health workers' training
6.	Store Keepers' training
7.	Data entry clerks
8.	Drivers
9.	Washers
10.	Security
11.	Pump technicians

2.6 ENVIRONMENTAL COMPLIANCE

A Supplemental Environmental Assessment (SEA) was carried out by RTI in August 2011 and approved by USAID in November 2011. Because of this timing, a letter report was not required prior to the 2012 spray campaign.

During the pre-spray period, the project established the following to comply with local and international environmental standards:

- All soak pits were constructed to meet international standards and recommendations, and were ready to be used for spray operations.
- All specified materials in the soak pits (sawdust, charcoal, stones) were arranged according to prescribed dimensions.
- All stores were renovated to meet PMI standards preparatory to spray operations.
- Monitoring systems to track used insecticide sachets were established, and all storekeepers and washers were trained on the proper management of both the stores and soak pits.

The Environmental Compliance Officer in close collaboration with NESREA carried out an assessment of environmental compliance in all 15 stores and 15 soak pits for pre-IRS operations. The officer also developed an environmental compliance monitoring plan and checklists for the insecticide storage facilities and soak pits, and safety responses required during spray operations. There were no adverse reactions neither reported nor observed during the spray operations.

3. Advocacy, Communication, and Social Mobilization

The AIRS Project, Nigeria used various means of communication to promote the upcoming IRS campaign. Over the course of the pre-spray and spray period, the project organized advocacy events, and in collaboration with the mass media, produced and distributed various promotional materials, and directly reached out to communities.

In the planning stage, AIRS Nigeria held sessions for communication planning and message design and review with representatives from the Roll Back Malaria information unit within the SMOH, the local media and NGOs, and the USAID-funded Malaria Action Plan for States project. As a result, the participants formulated and adapted key pre-spray, spray, and post-spray messages. They also adapted and finalized specific messages to be placed in communication and promotional materials (posters, handbills, and T-shirts). All communication materials were branded with the PMI logo and Nigeria Coat of Arms. Table 3 shows the types and numbers of communication materials produced and distributed during this spray period.

TABLE 3: IRS CAMPAIGN COMMUNICATION MATERIALS

Item	No. Distributed
Illustrated fact sheet	5,000
Educational leaflet with pictures	40,000
IRS household card	76,500
T-shirt	725
Cap	400

Table 4 lists major communications and promotional activities carried out. Pre-spray messages were aired on radio in five local dialects and English. Mobilizers conducted sensitization and outreach among villagers and distributed most of the print materials. During the actual spraying, mobilizers first accompanied spray teams and then went ahead of them to sensitize members of the adjacent community/s on when to expect the spray teams. After doing this, the mobilizers would re-join the spray teams in previously sensitized communities and help remove household items from the structures that were to be sprayed.

TABLE 4: IRS CAMPAIGN COMMUNICATION ACTIVITIES

Activity	Frequency
Advocacy visits (NMVCP, MAPS project, SMOH, Fire Service, State Police, NESREA, Nasarawa Broadcasting Service, Ministry of Environment, and traditional leaders)	13
Radio spots (pre, during, and after spray)	65 slots
Radio program (interactive show)	1
Newspaper articles	2
Road shows (during flag-off)	2 (1 per LGA)
Project launch	1

AIRS Nigeria also had a project launch and campaign flag-off events to officially mark the beginning of the global AIRS project work in Nigeria and commence the spray campaign.

3.1.1 MOBILIZERS' ENUMERATION DATA

The AIRS project added a structure enumeration process to the mobilization campaigns; this consisted of identifying each eligible structure with a unique serialized IRS structure card. Initially, AIRS Nigeria recruited 50 enumerators/mobilizers and two supervisors and trained them on structure identification and door-to-door mobilization. Later, 43 more mobilizers were trained to complete the exercise in a timely manner. The enumeration and sensitization exercise lasted for 20 days. Door-to-door IRS messaging outreach results by gender are shown in Table 5 and enumeration results are reported in Table 6.

TABLE 5. IRS MESSAGING OUTREACH

LGA	Males	Females	Total
Nassarawa Eggon	68,031	70,698	138,729
Doma	65,269	70,803	136,072
Total			274,801

TABLE 6. IRS CAMPAIGN ENUMERATION DATA

Total number of structures enumerated		Enumerated Structures found to be ineligible for spraying in 2012 since they were not sleeping structures[1].		Final (Clean) Enumeration Data	
Nassarawa Eggon	Doma	Nassarawa Eggon	Doma	Nassarawa Eggon	Doma
37,775	26,276	6,603	140[2]	31,172	26,136
64,051		6,743		57,308	

Note:[1] The decision not to spray non-living structures due to the limited quantity of insecticide was made after enumeration had begun; hence, these structures had to be removed to get the accurate living-structure enumeration value found by mobilizers.

[2] The low figure in Doma is most likely due to the fact that over 50% of the LGA is clustered in peri-urban areas around Doma town, which suggests that the reason for the insignificant number of stand-alone non-living structures is limited land space.

Globally, the AIRS project will report spray coverage in each country based on structures found by spray operators (See Section 7.2 Spray Results). This is done to maintain consistency across all AIRS countries since not all have/will carry out a separate enumeration exercise and to be consistent with the reporting structure under the former implementer.

AIRS Nigeria has tracked lessons learned from the 2012 enumeration exercise and will use that to decide whether to repeat this activity in 2013.

4. SPRAY ACTIVITIES

4.1 SPRAY OPERATIONS

IRS operations began in both LGAs on April 4 and lasted for 32 working days. Daily spray operations took place in all wards simultaneously except for Doka (a ward in Doma LGA), where community crises disrupted spraying for six days. Officials from the NMCP, NESREA, SMOH, and LGA monitored the exercise. AIRS Nigeria provided the observers with supervisory check lists to ensure an objective assessment of the operations. In addition, supervisory PMI officials, both Nigeria- and U.S.-based, monitored the first few days of operations.

The contribution of the PMI team was invaluable, as they identified several areas that needed improvement. These areas included record keeping at the stores, insufficient mobilization prior to spray team visit in some areas, inadequate number of gumboots of the largest size, non-observance of some spray protocols, and inadequate and inconsistent supervision. To address these issues, the team organized a two-day refresher training/reorientation for all spray personnel and provided replacement of poor quality and undersized PPEs.

The number of spray teams deployed per ward was based on the population of the ward and ranged from one to five as shown in Table 7. The maximum number of spray teams per store/soak pit site was seven.

TABLE 7: DISTRIBUTION OF SPRAY TEAMS BY WARD

S/No	NASARAWA EGGON LGA	No. of Spray teams		S/No	DOMA LGA	No. of Spray teams
1.	Nasarawa Eggon	4		1.	Galadima	5
2.	Alogani	2		2.	Sabon Gari	2
3.	Ogbagi/Agunji	1		3.	Sarkin dawaki	3
4.	Umme	2		4.	Madauchi	2
5.	Kagbu	2		5.	Madaki	2
6.	Lambaga/Arikpa	1		6.	Akpanaja	1
7.	Alushi/Ginda	2		7.	Rukubi	2
8.	Wakama	2		8.	Alagye	2
9.	Ende	2		9.	Abgashi	3
10.	Ubbe/Ogba	1		10.	Doka	2
11.	Iggah/Burum Burum	2				
12.	Mada Station	2				
13.	Ikka/Wangibi	2				
14.	Lizzen/Keffi	1				
	TOTAL	26			TOTAL	24

Half way into the campaign, the spray operation was interrupted due to a stock-out of Fendona®. This was occasioned by a miscalculation of the average structure size established during the start-up of the program. This quantification error was attributed to the report submitted by the consultant who carried out the measurement of the sizes of structures in the two LGAs. In his report, the average size of a structure was calculated as 36sqm. This informed the forecasting of the quantity of insecticide needed for the operations, including a 10% buffer. However, when the spray campaign was launched, it became clear that the average size of a structure is about 70 sqm. Because the team had already begun spraying, it was not feasible to replenish the insecticide stock without interrupting of the campaign. After 17 days of spraying, the project had a two-week interlude while waiting for the supplementary insecticide to be procured and delivered. The project thus used this interlude to conduct refresher orientations for the seasonal workers and supervisors and clean the collected data. Based on this experience, the AIRS project had determined that all future insecticide procurements would include a 20% vs. the original 10% buffer.

The operations did not experience any disruption due to rainfall. Daily spray activities commenced at about 8 am and generally ended at 2 pm. However, during the second phase of the spraying, the spray teams had to occasionally stay beyond 2 pm to spray the structures of farmers who left homes for field work early in the morning and did not come back by 2 pm. Discipline was enforced among the spray operators and team leaders. Persons who did not follow regulations were promptly replaced. Spray teams traveled to hard-to-reach communities on motor bikes rather than in the regular minibuses. No accidents or injuries were recorded for the duration of the spray exercise. The communities were generally receptive to the spray team and appreciative of the generosity of the U.S. government in funding the program.

Spray operators collected spray data, and their team leaders collated and verified the data and then deposited them at the stores, which served as operational hubs. The supervisors retrieved the forms from the stores, and vetted and delivered them to the LGA office. From there, the data assistant took them to the AIRS office in Lafia on a daily basis.

Supervision and monitoring was prioritized throughout the spray period and included representatives from several government agencies, as shown in Table 8.

TABLE 8: SUPERVISION AND MONITORING BY PARTNERS

Organization	Number of People	Number of Days
PMI	4	3 (Doma), 6(N Eggon)
NMVCP	3	10 (Doma), 10 (N Eggon)
NESREA	3	10 (Doma), 10 (N Eggon)
Doma LGA	4	10 (Doma)
Nassarawa Eggon LGA	3	10 (N Eggon)
SMOH	6	10 (Doma), 10 (N Eggon)

4.2 LOGISTICS AND STOCK MANAGEMENT

The project used inventory control cards (ICC) for recording each item in the warehouse and 15 site stores. At the stores, issuance and receipts of items were recorded on the card with details of transactions and quantities involved. The ICC for the insecticide stock in every storeroom was closely monitored. Storekeepers updated the cards daily with the movement of stock in or out of the storage facility, and conducted routine physical stock count to ensure that the actual stock matched the ICC record.

Prior to dispatch of commodities from the warehouse to operational stores, the team numbered spray pumps and PPEs to reflect a complete set of a spray operator's kit. The share of insecticide boxes for each store was labeled to track them to the intended destination. A dispatch note was used to track distribution from the warehouse to the operational store, which returned a signed copy as proof of delivery. The quantities of each item received were entered on the item's ICC.

In the operational stores, insecticide sachets were only issued to team leaders, who filled and signed the issue forms. The store keeper would immediately enter this on the ICC to obtain the stock balance record. At the end of each spray day, spray operators turned in their used and unused sachets to the team leader, who collated and submitted them to a store keeper. The store keeper recorded the full sachets on the stock card as a positive adjustment, updated the stock balance, and returned the unused sachets to the full stock. The used/empty sachets were recorded on the daily utilization record form that tracks each store's empty sachets and utilization trend. This reconciliation process enabled the store keepers to ensure a valid daily inventory and to alert AIRS program staff of discrepancies between the stock and the records.

In addition, the store keepers prepared and submitted a comprehensive bi-weekly stock report to the AIRS Nigeria Logistics and Procurement Coordinator. The coordinator then generated aggregated insecticide utilization data and replacement needs. This procedure helped with planning of insecticide distribution, and provided inventory status and security across the stores.

4.3 Environmental Compliance Supervision

To ensure that environmental standards and regulations were adhered to, the AIRS project worked closely with local NESREA office throughout the operation. Environmental compliance inspections were jointly carried out to evaluate mitigation measures put in place. Such measures included poison warning signs, documented emergency and spill procedures in stores, and well-constructed soak pits to manage the effluent waste generated before and after the day's activities.

The spraying personnel followed the safety rules regarding wearing PPEs. There were no spills of insecticides observed during the supervision visits, and the human and environmental exposure to insecticides was within the norms. There were no health issues reported as a result of misuse of insecticide.

The inspecting teams were satisfied with the environmental compliance practices and measures in place and the general practice in the field. There were no reported serious issues or adverse events associated with the spray exercise.

5. POST-SPRAY ACTIVITIES

5.1 CLOSING OF IRS OPERATIONS

The 2012 IRS operations officially ended on May 31. AIRS held the post-spray conference in Lafia on June 26. Participants included representatives from the NMCP, the SMOH led by the Director of Public Health, Nasarawa State, Doma and Nassarawa Eggon LGAs, NESREA, the entomology team from University of Jos, and selected members of all categories of the spray team. The focus of the conference was to report results, document challenges encountered during the spray operations, discuss lessons learned, and make recommendations for the next (2013) spray cycle.

The meeting agenda had two broad sessions: a plenary session with presentations by all categories of participants, and then breakout meetings for eight working groups. During the breakout, participants discussed how to proceed on the following topics:

- Recruitment of IRS personnel
- Effective mobilization of the communities
- Preventing poor spray quality
- Meeting spray targets
- Preventing pilferage of IRS materials
- Adhering to environmental compliance
- Motivation of the spray team
- Sustainability of the IRS project in Nasarawa State.

The overall view was that the spray coverage was high (99.1 percent), but there is need for improvement in the recruitment process, IRS communication, motivation of the spray teams, and commitment of the SMOH to take over the project at the expiration of its lifespan. The Chief of Party, Dr. Henry Nsa, presented recognition awards to the best-performing seasonal workers.

5.2 POST-SPRAY COMMUNICATION ACTIVITIES

Post-spray radio messages were aired to remind the communities of the need to avoid behaviors that will negate the spray campaign such as repainting, re-plastering, and covering the sprayed walls with objects. In addition, the project will continue behavior change communication activities until the next spray cycle to ensure that the IRS concept is fully accepted by the communities and stakeholders and required actions are taken to extend residual life of insecticide on the walls. The post-spray activities may include dissemination of IRS information in partnership with faith-based organizations, community chiefs, schools, and the LGA authorities. The aim is to maintain IRS awareness in the communities until the next spray cycle, thus enhancing the activities of the next spray operations.

5.3 DEMOBILIZATION AND LOGISTICS

Following completion of spray operations, stocks of insecticide were moved from the 15 operational centers to the central warehouse in Lafia. The AIRS project handled the transportation of used insecticide sachets, unused sachets, pumps, and other commodities to the central warehouse facility.

Progressive rinsing barrels and washing buckets were also collected and stored during the demobilization exercise. The inventory shown in Table A-4 in Annex A will be maintained and monitored until the next spray round.

Solid waste from the campaign were packaged in WHO-recommended yellow bin liners, and stored in the central warehouse awaiting incineration. The weight of used sachets was 146.036 kg, and bin liners 10 kg.

A post-spray environmental compliance assessment was completed and documented. The safety signs at the soak pits' sites remain in place. There is plant growth around the soak pits indicating non-pollution or contamination of the surrounding soil.

5.4 Incineration and Final Disposal

In line with Supplementary Environmental Assessment recommendations on incineration of IRS solid waste, the project used the incinerator at the National Institute of Pharmaceutical Research and Development (NIPRD), Idu Industrial Estate, Abuja, for the incineration and final disposal of the incinerated bottom ash (IBA). A total of 156.036kg of waste, consisting of used sachets and yellow bin liners, was incinerated.

After the incineration, 5.896kg of bottom ash was fixed/ encapsulated to immobilize the hazards contained in the IBA according to local environmental compliance regulations. A certificate of disposal was duly issued by NIPRD.

5.5 Strengthening Performance Standards and Capacity

As part of the objective to establish a model IRS program at a state/LGA level, AIRS project introduced M&E protocols and environmental compliance procedures for the soak pits and store facilities. LGA and state level authorities acknowledged benefits and value of the new standards, which are also been slated for adoption by NMCP. By actively engaging local and central authorities in the IRS micro-planning and training the project introduced requirements and standards for operational task force and managerial expertise essential for implementation of IRS.

To strengthen the federal capabilities in implementing IRS, the project is currently reviewing the national policy for the implementation of Indoor residual spraying for malaria Vector control in Nigeria as well as the manual for Health Workers on integrated Vector Management for Malaria Control in Nigeria (Part two: Indoor Residual Spraying (IRS) training manual for managers). These two documents will be presented to the NMCP for discussion with the purpose of improving in-country IRS operational standards.

6. ENTOMOLOGY

The IRS project worked closely with the Integrated Vector Management Unit of the NMCP and the University of Jos to provide entomological monitoring. The most experienced among the RTI-trained technicians were engaged in the baseline data collection and some of the monitoring activities. For monitoring vector behavior, density, composition, and seasonality, three sentinel sites (Doma, Nassarawa Eggon, and Lafia LGAs) were selected, one in the each intervention LGA and one in a comparable site from adjacent non-operational LGA.

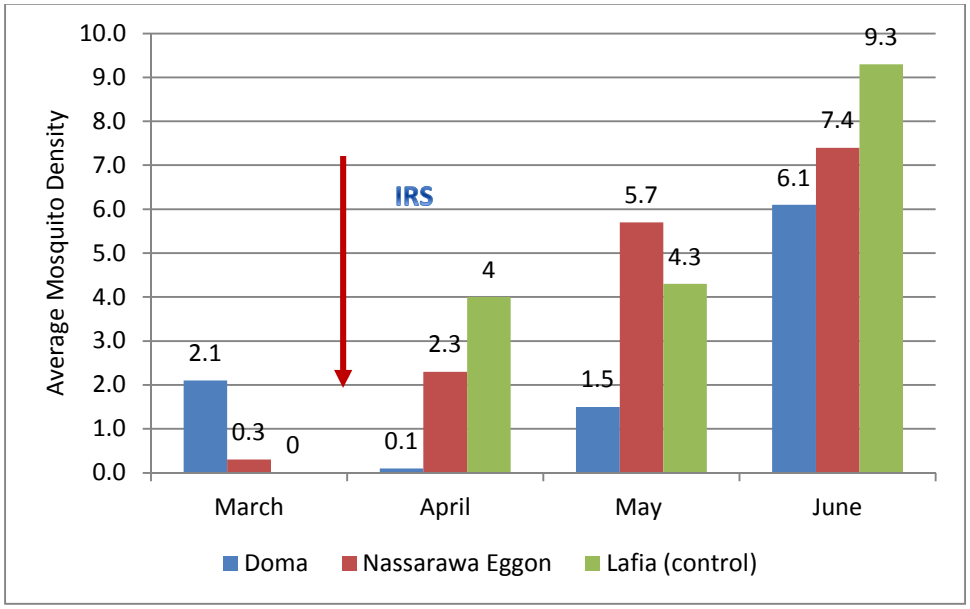
6.1 MONITORING VECTOR DENSITY, DISTRIBUTION, AND SEASONALITY AND BEHAVIOR

The first entomological data collection on vector density, distribution, and seasonality and behavior was completed before the commencement of spraying operation. Subsequent post-spray entomological monitoring activities will be conducted monthly for six months.

6.1.1 PYRETHRUM SPRAY COLLECTION

A total of 246 adult mosquitoes were collected in all LGAs sampled during the months of March and April 2012. Of these, 59 collected in the three LGAs in March belonged to two mosquito species: *Anopheles gambiae s.l* (61 percent) and *Culex* species (39 percent). The 187 mosquitoes collected in April were, 61.5 percent *Anopheles gambiae s.l* and 38.5 percent *Culex* species. In May, 250 adult mosquitoes were collected: 81 percent were *Anopheles gambiae s.l* and 19 percent were *Culex* species. In June, out of the 389 adult mosquitoes collected, 373 (95.9 percent) were *Anopheles gambiae* s.l while 16 (4.1 percent) were *Culex* species. The resting density of female *Anopheles gambiae s.l* is shown in Figure 2.

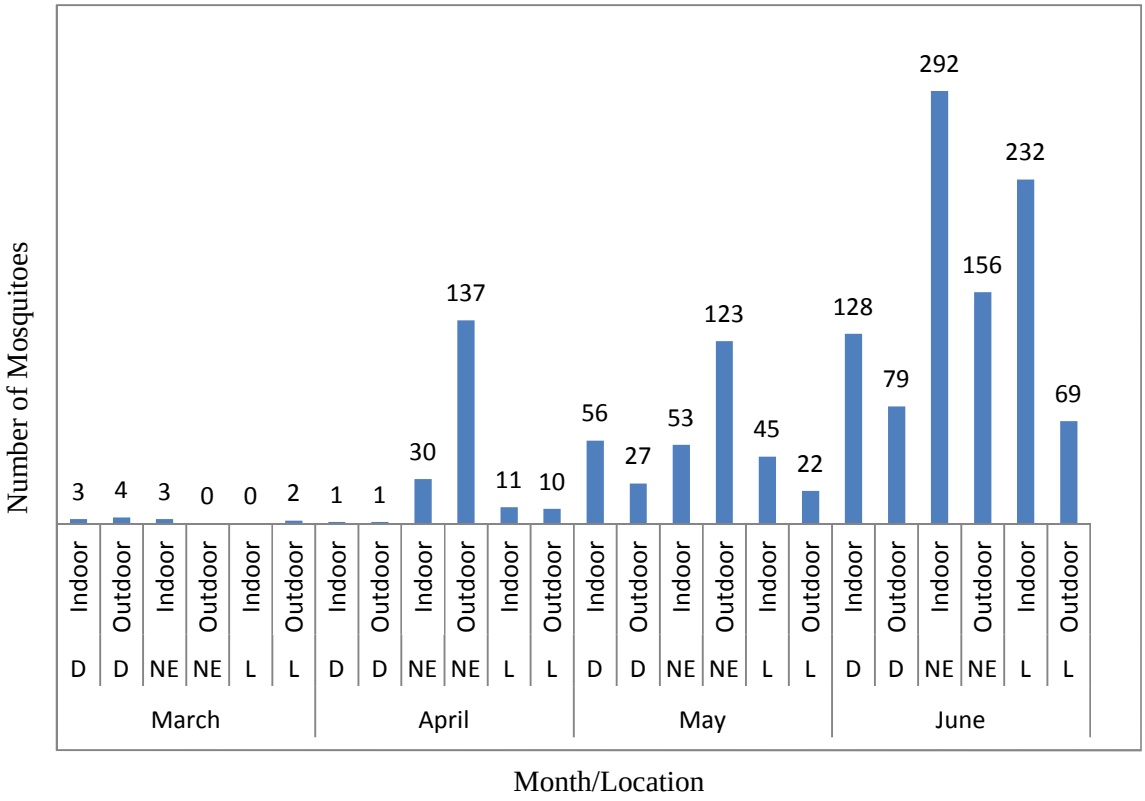
FIGURE 2: AVERAGE MOSQUITO DENSITY PER HH IN 3 SENTINEL SITES



6.1.2 HUMAN LANDING CATCHES

In each LGA, the project selected a cluster of five structures within one village for 12-hour mosquito collections (6 pm–6 am) to monitor vector feeding time, feeding location, and vector density. Adult mosquitoes were collected once monthly (March, April, May and June) using Human Landing Catches (HLC) with six human baits positioned indoors and outdoors at each collection point. All human baits/collectors/supervisors involved in the collection were provided with prophylactic treatment to protect them from malaria. HLC conclusively generated evidence of direct indoor and outdoor contact between *Anopheles gambiae s.l* and humans in the three LGAs.

FIGURE 3: HUMAN LANDING CATCH OF ANOPHELES GAMBIAE S.L FINDINGS, MARCH–JUNE 2012



The data showed an occurrence of *Anopheles gambiae* s.l. at 92.3 percent in March, 57.23 percent in April, 56.30 percent in May and 86.05 percent in June as the main malaria vector, active both indoors and outdoors between the hours of 9 pm and 6 am. However, before the spraying, the man-biting rate was low indoors and outdoors most likely because there are fewer mosquitoes during the dry season. After spraying, the man-vector contact seems to increase outdoor as compared to indoor, as shown in Figure 3. These early findings show that IRS affects the outdoor feeding and resting behavior of the vectors and therefore may impact malaria transmission.

6.2 CONE/WALL BIOASSAY TESTS

6.2.1 DETERMINATION OF QUALITY OF SPRAYING AND PERSISTENCE

The standard WHO cone assay was used to evaluate the quality of spraying and potency of the insecticide at selected resting surface heights of 0.5 meters, 1.0 meters, 1.5 meters, and 2.0 meters. The results were an average 24-hour mortality of 94.7 percent for the month of April, 72.5 percent for May and 60.4 percent in June. Possible reasons for the rapid decline in the test mortality rate of the vector may be due to the following:

Quality of spraying: It is known that the rate of deterioration of insecticide after spraying is to some extent dependent on the amount of insecticide deposited. The low mortality rate observed in some houses within one week after spraying and fast deterioration rate might be partially linked to applying less than the recommended amount of insecticide. However, as indicated above, the average mortality rate after 24 hours was recorded at 94.7 percent with a 100 percent mortality rate achieved in 62 percent of the tested houses. Therefore, this factor may contribute to but not be fully attributed to the rapidly declining mortality rate.

Quality of Insecticide: This might affect the residual life of the insecticide. Vector mortality rate was 100% in some of the houses earlier in the test. However, if the active ingredient formulation is compromised, it could still produce 100% mortality after 24 hours of spray but may fade away in subsequent months faster than expected.

Testing houses: The research team consistently used only six out of 23 houses during the three months of the cone bioassay test, which contradicts WHO protocols. The main reason was communal clashes in the control area. This might also have introduced bias and might have affected the results.

Vector resistance is less likely to contribute to the high mortality rate given that Nigeria has limited distribution of resistance vectors.

The following steps will be taken and allow for firm conclusions on vector mortality test results in future:

- Use susceptible colony of mosquitoes or mosquitoes of known source and susceptibility level.
- Pre-shipment test of the quality of insecticide to be sprayed.
- Follow WHO protocol during cone bioassay test.

To eliminate factors that may affect quality of spraying the project will enhance training; on-the-job coaching and supportive supervision for spray operators.

The team is implementing the following activities in order to narrow down reasons for the 2012 test results: a) Quality control tests on used batches of Fendona are currently being carried out in order to ascertain the amount of active ingredient contained. The results will be added to the report and communicated to PMI as soon as they are received; b) the project is closely working with the research consultant to ensure that the same houses are tested every month.

7. MONITORING AND EVALUATION

7.1 KEY OBJECTIVES AND APPROACH

The 2012 spraying implemented by the AIRS Project is the first IRS activity sponsored by the PMI in Nigeria. As a result, the project adopted lessons learned from IRS programs in other countries and from IRS campaigns conducted by other partners in Nigeria to:

- Emphasize accuracy of both data collection and entry processes through comprehensive trainings and supervision at all levels
- Streamline and standardize data information flow to minimize errors and facilitate timely reporting
- Ensure IRS data security and storage for future reference through establishment and enforcement of proper protocols.

7.2 DATA COLLECTION

The data collection closely followed the process described in the country work plan. AIRS employed 10 data clerks to record operations in Doma and Nassarawa Eggon LGAs. The project procured 10 mini laptops and installed the AIRS Nigeria database on each of them. The networking access built into the database, which used the Microsoft Access program, was able to provide automated real-time updates of spray operation reports both locally and internationally. The electronic data were backed up onto a web-based server each day. Server backup was scheduled to run each day to capture incremental changes with a full backup done each week.

7.3 SPRAY RESULTS

7.3.1 SPRAY OPERATION DATA

Through data cleaning and rectification carried out post-spray, the program identified several errors that were corrected. During spray operations there were issues with the reporting function of the Access database, hence, preliminary analysis was done using totals from team leader forms entered into Excel. This method provided the figures in the final weekly IRS progress report that was sent to PMI on June 1, 63,259 structures found by spray operators and 61,903 structures sprayed with 97.9 percent overall spray coverage. This method did not have the quality assurance protection function for data entry that the AIRS Access database does, resulting in some double and missed entries.

When issues with the Access database were resolved and data cleaning was completed, the analysis of by-structure entries from the Spray Operator Forms showed that the total number of structures found by spray operators was 59,229 (28,097 in Doma and 31,132 in Nassarawa Eggon) and the number of structures sprayed was 58,704 (27,969 in Doma and 30,735 in Nassarawa Eggon). This brings the overall spray coverage to 99.1 percent as shown in Table 9.

TABLE 9: IRS COVERAGE: PERCENTAGE OF ELIGIBLE STRUCTURES IN TARGETED AREAS SPRAYED

Indicators	Doma	Nassarawa Eggon	Total
No. of structures found by spray operators	28,097	31,132	59,229
No. of structures sprayed	27,969	30,735	58,704
Spray coverage (based on structures found by spray operators)	99.5%	98.7%	99.1%

7.3.2 POPULATION PROTECTED

The total population protected by IRS (all ages) is 346,115. Of these, 49.6 percent represented the female population while 50.4 percent were males. This is consistent with the findings of the 2010 Malaria Indicator Survey, which indicated that households in Nigeria are made up of 50 percent males and 50 percent females. A total of 62,584 children under the age of five years and 15,900 pregnant women were protected.

7.3.3 OUTPUT/PROCESS AND OTHER INDICATORS

Results for output and process indicators described in the 2012 country work plan are reported in Table A-5 in the annex.

Data on insecticide usage, number of structures sprayed by operator, and the use of mosquito nets are presented in the Tables 10, 11, and 12.

TABLE 10: INSECTICIDE USAGE

Item	Unit of measure	Received	Sample for QA	ToT	Distributed	Used	Wastage/Loss	Stock Balance
Insecticide	Sachets	44,240	50	1	30,756	29,177	82	14,930

Note: ToT=training of trainers

TABLE 11: SPRAY PERFORMANCE AND INSECTICIDE USAGE

Average # of structures sprayed per spray operator per day	**8.2**
Average ratio of structures covered per sachet of insecticide	2.0

TABLE 12: MOSQUITO NETS DISAGGREGATED BY VULNERABLE GROUPS' USE

Number of mosquito nets found	90,274
Used by pregnant women	10,770
Used by children under 5	38,866

8. FINANCE AND PAYMENT STRATEGIES

The finance unit of the AIRS Project worked closely with the technical teams to fashion out the best strategy for the payment of stipends to operators. Three different options were therefore tested during the course of time. These included: direct cash payment approach, bi-weekly wiring of money into operators' accounts, and finally, payment through the use of bank drafts.

The first option (direct cash payment) was effected with a view to assuage the initial financial difficulties experienced by spray operators and also helped to ascertain workers' identity. Subsequently, a direct bank transfer approach was used in order to facilitate payment and reduce the risk of conveying cash. This approach was efficient until some problems emerged due to a prevailing bank-merger and takeover in Nigeria. The third option (use of bank draft) was finally applied and found to be relatively risk-free and effective, as all field workers were paid in less than four hours in each LGA.

9. Lessons Learned and Challenges

1. **Daily post-field technical review meetings**: These meetings were invaluable to the success of the IRS operation.
2. **Difficult terrain and poor road network:** Reaching some communities proved to be challenging, particularly those in the hills. Getting there entailed using a combination of motorcycles and prolonged trekking. Some of the roads that did exist were difficult to travel, especially after rainfall. The lack of a good road network occasionally necessitated traveling long distances, at times going through other wards before accessing a neighboring community. This was particularly true in Rukubi and Alagye wards in Doma LGA.
3. **PPE durability:** Some of the PPE items procured (example, gloves) were not durable and needed to be replaced during the spray operations.
4. **Uncooperative attitude:** Some householders were reluctant to move their property outside even when mobilizers and spray operators were willing to assist.
5. **Availability of water:** Access to water for IRS operations was a challenge in some wards. In some cases, the water source (wells and streams) dried up. In others, LGA authorities who earlier had given assurance to provide water disengaged mid-way through the spray operation, allegedly due to financial constraints. In such cases, the project had to purchase water for the operational sites.
6. **Fendona stock-out:** Miscalculation of the average structure size resulted in the stock-out of the insecticide and therefore suspension of the spraying mid-way. However, the challenge was effectively managed by quickly importing a supplemental quantity of the insecticide.
7. **Communal clashes:** Clashes in Doka ward, Doma LGA, disrupted spray activities for six days. During the interruption, spray teams were re-assigned to another ward, allowing them to continue working.
8. **Recruitment:** Some district stakeholders were uncooperative and did not use the AIRS selection criteria for the recruitment of the right caliber of field staff, which is crucial to the success of IRS operations. This posed a major challenge in determining the integrity and good conduct of IRS personnel.
9. **Operational centers:** The number of stores and soak pits used were insufficient. This necessitated long-distance trips resulting in a loss of man-hours and efficiency.
10. **Supervision:** Effective supervision is strategic to IRS implementation regardless of the level of training given to spray teams. The number of non-project staff for supervision was relatively inadequate as were the days allotted for supervision.
11. **Field worker welfare:** The field workers felt that their daily remuneration should have been increased from 2,000 NGN to 5,000 NGN. This occasionally affected their motivation for work.
12. **Training period:** The duration of field worker training was insufficient. This led to challenges with the quality of worker performance.

13. **Falsification of worker identity:** Some field workers were found to have falsified their identities and bank details. There were also instances of collusion among field staff to cover up absenteeism. Reconciling total days worked by each field worker posed a challenge, as workers failed to maintain the same format of registering their names on a daily basis.
14. **AIRS database deployment:** The project database was deployed a few days after the mobilizers started enumeration. This did not give much time for familiarization and rigorous database testing to inform modifications needed for smooth roll-out and use.

10. RECOMMENDATIONS

1. The project should work more closely with the local governments and community leaders to ensure that recruitment is timed to meet the IRS campaign needs and seasonal personnel are selected from the spray areas. Recruitment process should begin at the early stages of the pre-spray period.
2. The duration of training for certain categories of field staff needs to be increased: store keepers, three days; mobilizers, three days; spray operators, seven days. The project should enhance on-the-job coaching to the spray operators during the campaign.
3. To scale up capacity building on evidence-based IRS strategies at the federal and state levels through close collaboration with NMCP as well as developing and revising relevant policies, strategies and guidelines.
4. To collaborate with NMCP to facilitate demonstration as a model IRS project where other states and donors could buy-in.
5. The project should increase the number of external supervisors from partnering organizations. The number of days for monitoring should be increased to cover at least 60 percent of the spray cycle time.
6. The establishment of two additional operational centers, in Rukubi (Agryma) and Alagye (Ruttu) wards in Doma LGA, is required to reduce travel time wasted due to bad access to the communities.
7. The project should establish a clear pay schedule and payment mechanism for seasonal workers before spray operations begin. In addition, the project should help the workers to open bank accounts to ensure timely payment of their wages and good monitoring of wage payments.
8. The project should increase field workers' daily remuneration to 3,000 NGN to achieve better motivation.
9. Memorandum of understanding with the SMOH and the Government of Nasarawa state is needed to gain their fuller engagement and dedication to the IRS program, as well as to specify their roles and responsibilities in the campaign.
10. Adequate stock of insecticides including buffer stock should be procured in advance of spray operations to avoid stock-out. This calls for timely and accurate quantification of insecticides for the next spray round. The project will improve the insecticide tracking system to monitor the usage and address potential stock outs in a timely manner.
11. The IRS training curriculum for field operators should include financial and administrative components. The recommended modules are: payment terms and conditions, procedures for opening bank accounts, rules governing banking transactions, the bank-customer relationship, interpersonal relationships, and conflict resolution.
12. The database used in 2013 should be improved based on the lessons learned in 2012. It should be deployed and tested approximately one month before spray operations begin.
13. As mosquitoes may not always be available in time for quality assurance and susceptibility testing, a functional insectary should be put in place at the AIRS project office in Lafia to

complement the insectary at the University of Jos.

14. Larger sample size for entomology monitoring with increased number of days for surveillance is recommended. Sampling an analyzable percentage of structures will help to have a representative of the number of structures sprayed. The recommended sample sizes include:
    a. PSC (Pyrethrum spray catch): 30 structures per LGA instead of the present 15 structures
    b. HLC: 15 structures per LGA instead of the present five structures
    c. Quality assurance: 20 structures per LGA instead of the present five structures.
15. Quality control testing of insecticides should be done prior to shipment to the country to ensure the product meets required standards.
16. Entomology research protocols should be followed carefully to ensure data quality.
17. The project should continue building IRS model at state and LGA levels and strengthening national capacity to apply better management and implementation standards to IRS.

In conclusion, considering the fact that the first spray round was completed only five months after the project start-up, the project managed to implement the campaign in a timely manner. Furthermore, it laid a solid foundation upon which to build a more successful 2013 IRS operation in Nasarawa state.

ANNEX

TABLE A-1: INTERNATIONAL AND LOCAL PROCUREMENT INVENTORY

Items	Quantities received
International Procurement	
Insecticides (150 gr sachets)	44,240
Spray pumps	275
Face shields	300
Head gear/ Helmet	300
Rubber gloves-short	300
Rubber gloves-long	30
Spare parts kit	30
Light trap	12
6V Battery	24
6V Battery charger	3
Local Procurement	
Boots (pair)	340
Socks (pair)	680
Overalls	680
Apron	30
Mouth/Nose mask-reusable	310
Warning sign-soak pit	17
Padlock	15
Spill kit-metal bucket	15
Spill kit-long brush	50
Spill kit-short brush	50
Spill kit-shovel parker	50
Bathing soap- bar	130
Filter cloth	275
Chalk-100s	150
1L Lubricating oil	7
Towel	315
20L Liquid soap	25

Items	Quantities received
Local Procurement (continued)	
Thermometer	16
200L barrel	16
100L barrel	121
20L basin	32
40L basin	15
20L jerry can	32
2L Jug	79
Polythene sheet 3M	275
Calculator	61
Scissors	275
Screwdriver	65
Plier	65
First aid kit	17
Bucket-plastic	54
Shovel	15
Warning sign-store	17
Fire extinguisher	34
Wooden pallet	50
T-shirt	725
Face cap	400
Poster	5,000
Flyer	100,000
M&E forms	44,000
Spray card	120,000
Inventory book	21
Rubber bands (pack)	16
Notebook	30
Inventory card	1,150

TABLE A-2: NUMBER AND GENDER OF RECRUITED FIELD WORKERS

Type of Personnel	No. of Males	No. of Females	Total
Spray operator	213	37	250
Team leaders	42	8	50
Supervisors	6	0	6
Coordinators	2	0	2
IEC mobilizers	66	27	93
IEC supervisors	1	1	2
Pump technicians	15	0	15
Store keepers	10	5	15
Washers	6	9	15
Security	30	0	30
Drivers	41	0	41
Data assistant	1	1	2
Data entry clerk	10	0	10
Total	443	87	530
Percentage	**83.6**	**16.4**	100

TABLE A-3: NUMBER AND GENDER OF TRAINED FIELD WORKERS

Type of Personnel	No. of Males	No. of Females	Total
Geographical reconnaissance	47	5	52
Spray operator	227	40	267
Team leaders	42	8	50
Supervisors	6	0	6
Coordinators	2	0	2
IEC mobilizers	66	27	93
IEC supervisors	1	1	2
Health workers	14	12	26
Pump technicians	15	0	15
Store keepers	10	5	15
Washers	6	9	15
Security	30	0	30
Drivers	41	0	41
Data assistant	1	1	2
Data entry clerk	10	0	10
Total	518	108	626
Percentage	82.7	17.3	100

TABLE A-4: POST-SPRAY EQUIPMENT AND MATERIALS INVENTORY

S/No.	Description	Initial Projection	Additional/Supplementary Quantity	Total Stock	Total Returned Useable	Repairs Required	Total Damages	Total missing	Stock Balance	Replacement Need	Remarks
1	Hudson X-pert sprayer	275	0	275	271	4[1]	0	0	271		
2	Spare parts kit-pack	30	0	30	9	0	0	0	9	21[2]	some unit parts used
3	Apron	30	0	30	30	0	0	0	30	0	
4	Helmet	300	0	300	299	0	1	0	299	1	
5	Face shield/bracket	300	0	300	197	0	103	0	197	103	
6	Gum boots-pairs	340	30	370	362	0	0	8	362	8	
7	Haversack	310	0	310	298	0	0	12	298	12	
8	Overalls	680	15	695	687	0	0	8	687	3	
9	Rubber gloves-short (pairs)	300	195	495	394	0	92	9	394	135[3]	
10	Rubber gloves-long (pairs)	30	0	30	29	0	1	0	29	1	
11	Towel	315	0	315	0	0	0	0	0	315	
12	Mouth/nose mask N95-disposable	0	440	440	105	0	0	0	105	335	
13	Mouth/nose mask-rubber, reusable	310	0	310	306	0	4	0	306	4	
14	Socks, cotton	680	0	680	32[4]	0	0	0	0	680	
15	Nylon rope 60metre	15	0	15	8	0	7	0	8	7	
16	Barrel 200L	15	0	15	15	0	0	0	15	0	
17	Barrel 100L	121	0	121	119	0	2	0	119	2	
18	Basin 20L	30	0	30	29	0	1	0	29	1	
19	Basin 40L	15	0	15	14	0	0	1	14	1	
20	Jerry can 20L	30	0	30	22	0	0	8	22	8	
21	Jug 2L	75	0	75	58	0	0	17	58	17	
22	Clear bag	0	0	0	0	0	0	0	0	0	
23	Polythene sheet 3M	275	0	275	250	0	0	25	250	25	
24	Calculator	60	0	60	52	0	0	8	52	8	
25	First aid kit	15	0	15	15	0	0	0	15	0	
26	Bucket-metal	15	15	30	30	0	0	0	30	0	
27	Bucket-plastic	90	0	90	90	0	0	0	90	0	

S/No.	Description	Initial Projection	Additional/Supplementary Quantity	Total Stock	Total Returned Useable	Repairs Required	Total Damages	Total missing	Stock Balance	Replacement Need	Remarks
28	Shovel-long handle	15	0	15	15	0	0	0	15	0	
29	Warning sign-store	15	0	15	15	0	0	0	15	0	
30	Warning sign-soak pit	15	0	15	15	0	0	0	15	0	
31	Padlock	30	0	30	24	0	6	0	24	6	
32	Brush-long handle	50	0	50	50	0	0	0	50	0	
33	Brush-short handle	50	0	50	48	0	2	0	48	0	
34	Bathing soap-tablet	130	950	1080	0	0	0	0	0	1200	
35	Liquid washing soap 20L	25	0	25	0	0	0	0	0	30	
36	Filter cloth	275	0	275	0	0	0	0	0	275	
37	Chalk-box of 100	150	0	150	7	0	0	0	7	143	
38	Lubricating oil 1L	7	0	7	0	0	0	0	0	15	
39	Batteries-pairs	0	90	90	0	0	0	0	0	45	
40	Hardcover notebook	45	0	45	0	0	0	0	0	45	
41	Pen	0	350	350	0	0	0	0	0	350	
42	Masking tape	0	15	15	1	0	0	0	1	14	
43	Marker pen-unit	0	180	180	40	0	0	0	40	140	
44	Rubber band-pack	15	15	30	0	0	0	0	0	30	
45	Pallet	30	0	30	30	0	0	0	30	0	
46	Parker-plastic	50	0	50	40	0	0	10	40	10	
47	Fire extinguisher	30	0	30	30	0	0	0	30	0	
48	Tool kit-plier adjustable	15	0	15	15	0	0	0	15	0	
49	Tool kit-plier	63	0	63	60	0	0	3	60	0	
50	Tool kit-screw driver	50	0	50	30	0	0	20	30	20	
51	Scissors	275	0	275	240	0	4	31	240	35	
52	Torchlight	0	15	15	0	0	15	0	0	15	
53	Whistles	0	30	30	2	0	0	28	2	28	
54	Thermometer	16	0	16	15	0	1	0	15	1	
55	Black liner	150	0	150	79	0	0	0	79	71	
56	Yellow liner	600	0	600	330	0	0	0	330	0	

Note: [1] Two pumps with pressure gauge broken, another two with short off valve damaged with pressure gauge.
[2] Kits label H were exhausted.
[3] Replenishment quantity needed to get rid of the original weak hand gloves. This quantity also takes care of technicians and store keepers.
[4] The socks have been used by spray operators during spray operation. It is not advisable to re-issue them.

TABLE A-5: OUTPUT/PROCESS INDICATORS

Quality Management Indicators		
	Data Collection Method/Comments	
A. Community Awareness / Communication Quality:		
a. Percentage of occupants informed about spray operation		99.3%
b. Percentage of structures prepared by occupants before spraying		95.3%
B. Information, Education and Communication		
a. Number of sensitization/mobilization meetings held (including advocacy visits at various levels to stakeholders (federal, state, local government, traditional rulers, relevant ministries, media houses)	a. Activity reports b. AIRS Project, Nigeria Database c. Receipts of radio spots aired	An actual number cannot be put to this since there were times meetings were rescheduled
b. Number of IRS educational brochures distributed		40,000
c. Number of radio spots aired		65
C. IRS Training/Supervision Effectiveness		
a. Percentage of spray operators fully implementing best IRS practices	1. Analysis of supervisory checklists 2. Daily spray operator and team leader form	89.9%
b. Supervisory Ratio – number of team leaders and spray operators reporting to each supervisor		Team supervisory supervisory ratio – 1 team leader to 5 spray operators Field supervisor ratio to spray team ratio - Average of 8 teams to one supervisor. This usually depended on access and terrain with regard to the geographic location under the jurisdiction of the supervisor
D. Stock Management/Record Keeping		
a. Percentage of storage facilities doing stock verification	Stock cards, stock verification reports, Spray Operator Daily Report forms, and end of spray waste disposal report and comparing relevant data to the IRS database tracking system.	100%
b. Complete tracking of number of sachets in stock, number of empty sachets returned, and number of sachets disposed of		100%
c. Number of insecticide sachets lost		82
E. Operational Safety		
a. Percentage of health facilities in IRS communities possessing insecticide antidotes and treatment medications	Surveys collecting operational safety information will be carried out at the	19.5%

Quality Management Indicators		
	Data Collection Method/Comments	
b. Percentage of health workers in targeted communities trained to treat cases of insecticide exposure and poisoning	beginning and end of the spray campaign. Data on severe adverse effects will be collected weekly.	19.5%
c. Percentage of female spray operators tested for pregnancy prior to undertaking spray operations		100%
d. Number of verified cases of adverse health events reported to health facilities in targeted communities		0
F. Entomological Indicators		
a. Vector species identification	The entomological monitoring reports will collect data on the applicable indicators. Data will be gathered by the IRS Nigeria in coordination with University of Jos.	*Anopheles gambiae; Culex sp.*
b. Vector density – change on vector distribution and seasonality		
c. Vector behavior – indoor vs. outdoor biting and resting		
d. Percentage of vectors susceptible to insecticide and mechanism of resistance		April: 94.7%; May: 72.5%; June: 60.4%
e. Insecticide decay rates on spray surfaces		
G. Environmental Indicators		
a. Environmental compliance officer oriented and trained	Data will be collected during environmental trainings, supervisions and inspections.	Yes
b. Number of supervisors, spray team leaders, and spray operators trained in environmental compliance and sensitivity		306
c. Number of national and sub-national environmental and/or health officers trained in environmental compliance		5
d. Number of storehouse/soak pits upgraded		15
e. Percent of storehouses inspected and approved		100%
f. Percentage of operations centers with pesticide exposure antidotes readily available		100%
g. Percentage of operation centers with adequate PPE		100%
h. Number of sites visited/audited by environmental compliance manager		15
i. Percentage of pre-spray, mid-spray, and post-spray inspections performed		99%

Quality Management Indicators		
	Data Collection Method/Comments	
j. Number of environmental/health incidents reported		0
k. SEAs completed		Yes
l. SEA amendment completed (if required)		NA