INDOOR RESIDUAL SPRAYING FOR MALARIA CONTROL

Benin End of Spray Round Report

Indoor Residual Spraying (IRS) for Malaria Control Indefinite Quantity Contract (IQC) Task Order 1

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Acronyms

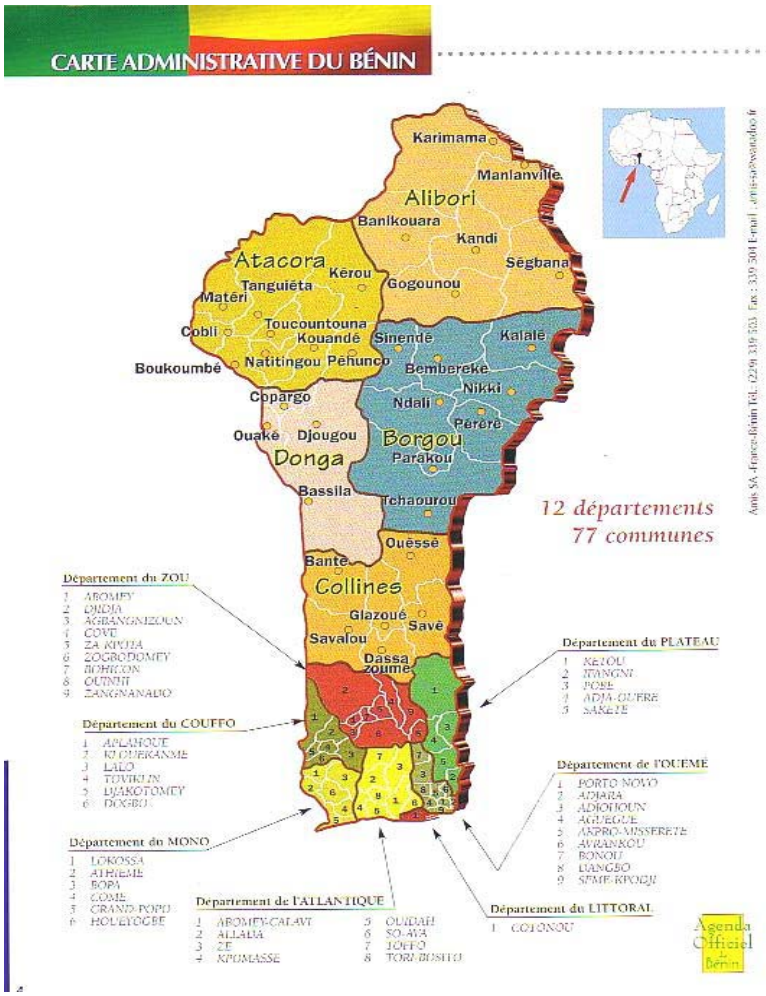
ABE	Benin Environmental Agency (Agence Béninoise pour L'Environnement)
CHERG	Child Health Epidemiology Reference Group
CNAC	National Accreditation and Control Committee for Registration of Pharmaceutical Products (Comité National d'Agrément et de Contrôle des Produits Phytopharmaceutiques)
CREC	Entomologic Research Center of Cotonou (Centre de Recherche Entomologique de Cotonou)
DDS	Regional Directorate for Health (Direction Départementale de la Santé)
DDEPN	Regional Directorate for the Environment and Natural Protection (Direction Départementale de l'Environnement et de la Protection de la Nature)
DHAB	National Directorate of Hygiene (Direction de l'Hygiène et de l'Assainissement de Base)
EMP	Environmental Management Plan
FAO	Food and Agriculture Organization
GOB	Government of Benin
SNIGS	National Health Management Information Systems (Système National d'Information et de Gestion Sanitaires)
IEC	Information Education and Communication
IRS	Indoor Residual Spraying
LLIN	Long Lasting Insecticide Impregnated Net
MOENP	Ministry of Environment and Natural Protection
MOH	Ministry Of Health
PPE	Personal Protective Equipment
PMI	President Malaria Initiative
PNLP	Benin National Malaria Control Program (Programme National de Lutte contre le Paludisme)
RTI	Research Triangle Institute
SEA	Supplemental Environmental Assessment
TOR	Terms of Reference
TOT	Training Of Trainers
USAID	United Agency for International Development
WHO	World Health Organization

Country Background

Benin was identified by USAID as one of the second wave of countries to receive funding under the United States' (U.S.) President's Malaria Initiative (PMI). The U.S. Agency for International Development (USAID) and the Benin National Malaria Control Program (Programme National Lutte contre le Paludisme [PNLP]) identified 4 epidemic prone districts: Akpro-Misserete, Dangbo, Adjohoun, and Seme-Podji in the region of Ouémé for indoor residual spraying (IRS) activities. In 2008, USAID and the PNLP agreed to focus spraying activities in the Ouémé Region with the intention of expanding IRS coverage to others Region in 2009.

RTI International (RTI) was tasked with providing strategic, technical, management and operations support for IRS activities in the above mentioned districts. RTI and the PNLP treated 141,154 households and protected 521,738 people with residual insecticide in four districts during the first round of IRS.

Figure 1. Map of Benin.



In addition, RTI in collaboration with PNLP distributed long lasting insecticide impregnated nets (LLINs) in Dangbo, Adjohoun, and Seme-Podji to households which are located close to a flood plain or in United Nations (UN) Heritage and Ramsar site wetlands. Through this LLIN distribution process, RTI also strengthened local capacity of the PNLP.

This end of spray round report summarizes the program's activities in support of the spray round which began on July 3, 2008 and ended in August 23, 2008 in the four districts of the Oueme Region.

Summary Results

IRS operations began on July 3 and ended on August 23, 2008 in the four targeted districts. Of the 151,783 structures targeted by 265 spray operators deployed in the field, 142,814 were sprayed and 521,738 people were protected. A total of 20,984 sachets of Bendiocarb were used during this first round of IRS.

The spraying was conducted according to World Health Organization (WHO) guidelines on IRS and to the supplemental environmental assessment (SEA) and environmental impact assessment (EIA) approved by USAID and the government of the Republic of Benin (GOB). Compliance with these regulations was verified by an environmental inspection conducted by RTI's environmental inspectors in July 2008.

During IRS operations, the spray operators collected data on the usage of mosquito nets in each district. The data showed that although LLINs are used more often than ordinary nets, ordinary nets are still present in households in the target districts.

The hanging of LLINs in target households by women's associations under PNLP and RTI supervision is an innovative approach to the Benin malaria program. In the past, LLINs have been distributed in large campaigns at health centers where women bring their children to get vaccines. RTI chose instead to work with women's associations to hang LLINs in each household and explain the benefits of LLINs during net hanging. A total of 47 villages in the districts Seme-Podji, Adjohoun, and Dangbo were not eligible to benefit from IRS because of their location in flood zones. Therefore, in these 47 villages, one LLIN was hung per household. A total of 16,000 LLINs were provided by PNLP and distributed in 15,857 households in the three recipient districts.

Background

Malaria in Benin

Malaria is the leading cause of morbidity in Benin, with an average incidence rate of 65.8 per 1,000 people and accounting for 35 percent of outpatient visits (1.6 million recorded visits in 2001[1]). The national health management information system (Système National d'Information et de Gestion Sanitaires [SNIGS]) indicates that in 2005, about 900,000 malaria cases and 1,581 malaria deaths were reported. This data, however, seriously underestimates true malaria cases and deaths. Roll Back Malaria (RBM) estimated that in 2004 there were about 3 million cases of malaria illness, and the WHO-convened Child Health Epidemiology Reference Group (CHERG) estimated that in the year 2000 between 10,000 and 13,000 malaria deaths occurred in children under five years of age.

[1] Louis, F. 2001, Benin, Report prepared on behalf of the Institute of Tropical Medicine of Health Service of the Armies. Available at http://asmt.louis.free.fr/niv3_1_4.html.

With about 30 percent of the population living below the poverty line and a per capita income of only $530, malaria places an enormous economic strain on Benin's development. Households in Benin spend approximately 34 percent of their annual income on the treatment and prevention of malaria.

The GOB views malaria control as a top priority for the development of the country. The PNLP has developed a five year strategic plan (2006 to 2010) that builds on recent changes in the national malaria policy to include LLINs, rapid diagnostic tests (RDTs), artemisinin-based combination therapies (ACTs), and intermittent preventive treatment (IPT) for pregnant women. The overall goal of the GOB is to reduce malaria morbidity and mortality by 50 percent by the year 2010.

In 2007, Benin was selected as one of eight countries to receive funding during the third year of the PMI. To support the Beninese government in its strategy of malaria control, the PMI developed a strategy of IRS in collaboration with the GOB. As vector control is an effective means of malaria prevention, IRS is included in the PNLP's 2006 to 2010 malaria strategic plan.

The malaria situation in Benin reflects the presence of vector breeding sites throughout the country and a seasonal rainfall pattern that increases the number of sites during the rainy season. Ubiquitous vector production in the presence of a large reservoir of gametocytes explains why malaria is endemic and transmission is stable everywhere. Transmission peaks in May during and after the rainy season. There are no epidemic prone areas. The Mapping Malaria Risk in Africa (MARA) 1999 project estimates that 100 percent of population lives in areas with high intensity transmission. Entomological inoculation rates for *Anopheles gambiae* range from 11 to 58 infective bites per person per year. Most of these (75 percent) occur during the long rainy season. Focusing on areas with high malaria prevalence in target groups, high entomological inoculation rates, high vector densities, and high infant mortality rates has led the PNLP to target areas in the south of Benin (Ouémé/Plateau Regions, Mono/Couffo Regions, and Zou/Collines Regions) and northeast (city of Natitingou) for IRS.

Four districts within the Region of Ouémé have been chosen by the PNLP to conduct IRS: Dangbo, Seme-Podji, Adjohoun, and Akpro-Misserete. Ouémé is situated within the humid zones of southeast Benin and was chosen for spraying notably because it has the highest incidence of malaria in the country. Out of a population of 1.3 million inhabitants in Oueme in 2006 (Annual Stats, 2006), there were 186,000 cases of malaria, accounting for 37 percent in 2006, 384 deaths were recorded due to malaria.

Preparations for IRS

Environmental Assessment

The PNLP and the PMI proposed an IRS pilot program in the Region of Ouémé to determine the feasibility and desirability of IRS in Benin as a major public health intervention. RTI is responsible for providing substantial technical assistance to the PNLP and the Oueme Region's District Health Office to plan and implement the IRS project.

RTI conducted an SEA in March 2008 in accordance with USAID's 22 CFR 216.3(b) environmental regulation. The SEA:

- Identified environmental and socio-economic resources potentially affected by the project;
- Predicted positive and negative effects and the extent to which positive effects could be enhanced and negative effects mitigated;
- Quantified and assessed the significance of effects where possible;
- Considered the need to compensate for any significant residual negative effects; and
- Identified methods to mitigate and monitor resources that might be affected by the project.

The SEA was reviewed and approved by USAID. An EIA drafted in French was approved by the Benin Environmental Agency (ABE). The SEA and EIA were prepared by RTI with collaboration from Entomologic Research Center of Cotonou (Centre de Recherche Entomologique de Cotonou [CREC]).

Major components of program implementation that was supported by PMI through RTI included:

- Purchase of insecticide, spraying equipment, and adequate amounts of Personal Protective Equipment (PPE) for staff;
- Operational training and implementation;
- Technical advisors to plan the program, train field staff, and supervise field operations;
- Information, Education and Communication (IEC) campaigns to inform beneficiaries, raise public awareness, promote behavior change and promote cooperation;
- Financial, Technical and Operational support for renting a storage facility for the insecticide, empty sachets, spray and cleaning equipment; and
- Additional human health and environmental safety components as described in the Environmental Management Plan (EMP).

In June 2008, the Ministry of Environment and Natural Protection (MOENP) issued the environment conformity certificate with an environmental management plan (EMP) to be implemented during the IRS operation.

Carbamates were chosen as the preferred class of insecticides following scientific evidence collected by CREC after a study of five other insecticides in accordance with WHO procedures. Bendiocarb was selected as the insecticide to be used during IRS following a competitive procurement process. Bendiocarb is recommended for IRS use by WHO and is registered in Benin by the National Accreditation and Control Committee for the registration of pharmaceutical products (CNAC).

Logistic Needs Assessment

A joint team from RTI, PNLP, and CREC visited the four selected districts to carry out geographical reconnaissance to determine the technical, financial, human resources, and other operational needs required to implement IRS activity in the targeted zones. The team comprised of the logistics officer from RTI Senegal, the PNLP focal point at the vector control unit, and the RTI home office technical manager from Washington D.C. During the geographical reconnaissance, the team visited selected villages in the four districts to investigate average household size, household types, distance between villages, road access

to better plan for operations, routes to be used during IRS operations, and commodities to be procured.

The team met with the director of CREC, the PNLP coordinator, USAID, ABE, and other stakeholders in country. After preliminary discussions with country officials, the team conducted field visits to the targeted districts. Meetings were organized with district officials to collect information about population at risk, field conditions, infrastructure (storage, security, availability of water, vehicles, etc.) and human and other resources. The team had discussions with prefects, mayors, and regional and district health officers.

Before the operational phase, the RTI driver and mechanic selected appropriate means of transportation for spray operators, supervisors, and staff of RTI. Because spray operations were conducted during the rainy season, vehicles had to be in good condition to qualify for use by the IRS project. Of the 60 vehicles tested, 44 were retained for the IRS spray operations.

Insecticide and Spray Equipment Requirements

A total of 4,400 kilograms (kg) of Bendiocarb (FICAM) was procured for spray operations. The quantification was based on the field reconnaissance and data provided by the Ministry of Health (MOH). WHO-approved Hudson X-Pert compression sprayers were procured for each spray operator with an extra 10 percent as backup for emergency and repair situations. Two sets personal protective equipment (PPE) in accordance with WHO specifications were provided to each spray operator and team leaders. The table below provides a summary of PPE procured.

Figure 2. PPE procured for IRS operations.

Description	Quantity
Compression Sprayers S-Pert, Model 67462AD 4 Gallon	400
Compress Sprayer Repair Kits for Item 1, Model	50
Compression Sprayer Nozzles Tip T-JET 8001, Model	550
Compression Sprayer Filters Nylon X-Pert, Model 152-356	750
Heavy Duty Gloves	3,000
Respirator Masks	20,000
One-Piece Coveralls	1,200
PVC Gumboots	550
Lightweight Helmet and Face Shield	550
Pregnancy Test Kits 8 x 25	180
Reflective Jackets – Green	65
Reflective Jackets - Red or Orange	35
Medical First Aid Kits - 10 Person/Kit	36
Barrel	90
Bendiocarb	4,400 Kg

Human Resource Requirements

Based on the logistics assessment performed during the preparatory phase, a spray operator was expected to spray an average of seven structures in 5 hour workday. The total number of structures to be sprayed was estimated at 151,783 and thus 265 spray operators were deployed for 44 days of spray operations. Spray operators were supported by an operations

team of 41 spray team leaders and 19 supervisors, 4 district coordinators, 4 data clerks, 4 logistics assistants and 1 finance assistant.

The hygiene agents from the Hygiene Service (Service d'Hygiene) from Region of Ouémé provided additional supervision to ensure adequate team planning, safety, quality control, and environmental compliance. Spray operators were selected at the district level with assistance from the chief doctors and local authorities including the mayor and community leaders. The selection was based on the following criteria: literacy and numeracy, physical and medical fitness, and origination of the target community. Both males and females were eligible.

The IRS management structure was composed of the chief of party (COP), national coordinator, finance officer, logistic officer, administrative assistant, and driver at the national level. Supervision was provided by an MOH team, six PNLP representatives, seven hygiene agents from the Ouémé Regional Directorate of Hygiene, four chief doctors, one hygiene agent from the National Directorate of Hygiene (Direction de l'Hygiéne et de l'Assainissement de Base [DHAB]), and one technician from MOENP. The following seasonal district staff supported IRS operations:

- 4 district coordinators
- 4 district logisticians
- 4 data clerks
- 1 monitoring and evaluation officer
- 1 environmental officer
- 1 IEC officer
- 1 IEC assistant
- 20 washers
- 1 storekeeper
- 3 security guards
- 11 service technicians
- 205 spray operators
- 41 team leaders
- 19 supervisors.

Training

The aim of the training was to build the capacity of the host government at the national and district levels to implement a well organized IRS program. The training was organized in two parts, the training of trainers (TOT) and the training of spray operators.

Training of Trainers

The TOT was held from June 16 to 21 at the Porto Novo warehouse and was conducted by two trainers from the MOH of Senegal who worked in close collaboration with the RTI Benin team and PNLP representatives. Forty two hygiene technicians from Ouémé Region were trained as trainers. In addition, four chief doctors representing each district, the malaria coordinator from the Ouémé Regional Directorate for Health (Direction Départementale de la Santé [DDS]), and senior staff from PNLP were among the trainees. There were 70 participants in total, with 19 women and 51 men.

Participants were trained in the following topics:

- Vectors and malaria control

- IRS in context
- Pesticide safety: choice, transportation, storage, and disposal
- Choice of application equipment and nozzles for different tasks
- Calibration of spraying equipment
- Mixing pesticides safety and accurately
- Maintenance of spraying equipment
- Applying pesticides
- Ensuring efficiency and security of equipment and other associated inputs
- Reporting and data submission
- Quality insurance and impact assessment.

Training of Spray Operators

The training of spray operators at the district level was conducted by the trainees from the TOT and overseen by the trainers from Senegal for the first two of days. It was conducted conducted in each of the four districts, with a total of nine training sites, as follows:

- Adjohoun, 2 training sites with 35 participants at each site. One female participant. At the end of the training after taking the written and practical tests, 58 people were selected as spray operators
- Akpro-Misserete, 2 training sites. There were 39 participants at one site and 38 at the other site, all male. Of the 77 people who took the written and practical tests, 65 were selected as spray operators.
- Dangbo, 2 training sites. There were 70 participants and among them there were 2 women. At the end of the training after taking the written and practical tests, 45 participants were selected as spray operators.
- Seme-Podji, 3 training sites. There were 112 participants, of which 7 women. At the end of training after taking the written and practical test, 97 were selected as spray operators. Among the chosen spray operators was one woman selected to be a team leader.

The spray operators were trained in the following topics:

- Managing pesticides safely (transportation, storage, disposal, etc.)
- Calibration of spray equipment
- Mixing pesticides safely and accurately
- Maintenance of spray equipment
- Applying pesticides
- Ensuring security of equipment and other inputs
- Reporting and data submission.

In addition to spray operators, 22 washers and 28 drivers were trained in IRS and on how to protect themselves during the transportation and cleaning of PPE.

Medical Test of Spray Operators

A general medical examination was conducted for all trainees by the chief doctor of each district to assess their medical ability to perform IRS activities. All women spray operators (including washers) were tested for human chorionic gonadotropin levels to rule out pregnancy. None of the women tested were pregnant and all the spray operators who were submitted to a medical test passed and were fit to conduct IRS activities.

IEC Activities and Community Involvement

The IEC component is one of the critical components of IRS. IEC improves the knowledge and understanding of the benefits of IRS to the target population. IRS mobilization more specifically informs the recipients of the precautions to be taken before, during, and after IRS. The objective of IEC in Benin was to ensure that each household is correctly informed about the benefit and precautions during IRS. Throughout this process, the RTI team worked in close collaboration with the Ministries of Health, Environment, Communication, and Interior.

To meet the overall objectives of the IEC campaign, RTI:

- RTI developed an IEC strategy in collaboration with the PNLP. Once developed, the IEC strategy was approved in a workshop led by PNLP that included a number of malaria partners, including the MOH at the national and district level
- Once the strategy was approved by PNLP and MOH, IEC materials were developed by RTI in collaboration with PNLP. The IEC materials were approved by the MOH at the national and district level.
- Utilized five community radio stations to broadcast IEC messages, skits, and radio spots about the benefits and precautions to take during IRS in local languages.
- Worked with existing community structures, including chiefs of villages, traditional and religious leaders, local council members, heads of district, mayors, heads of townships, and members of associations (mostly women's associations).
- Posted banners and posters in the villages being sprayed.
- Deployed IEC mobilizers in each targeted area to go door to door to inform the households about the benefits of IRS and the precautions to be taken before, during, and after IRS.

IEC activities began three weeks prior to the start of IRS.

Implementation of IEC Strategy

RTI held numerous meetings in collaboration with the PNLP, DDS Ouémé, and the chief doctors of the four targeted districts to talk to local officials about IRS strategy and goals and to gain their support. Participants of the meetings included districts leaders, chiefs of villages, and representatives of nongovernmental organizations (NGOs) working in the targeted districts. Once support from local officials was obtained, the chiefs held a series of meetings for community members to select IEC mobilizers. Mobilizers were chosen based on their experience in other health projects or activities, their reputation as an active member of the community, and literacy. A total of 150 IEC mobilizers were recruited for the spray operations, or one mobilizer per village.

Head nurses from each the townships where spray operations occurred received a one day training on IRS, including data collection. They in turn trained the IEC mobilizers. Each mobilizer was equipped with a bag containing leaflets, posters, and other IRS IEC documents. The mobilizers then went door to door to visit each household, distribute leaflets, and inform households about the benefit of IRS and the precautions to be taken before, during and after spraying. At the end of each visit, stickers were glued to the door of each household visited and signed by the mobilizer to show that a house had been visited. These stickers were later signed by the team leader and the supervisor after a house had been sprayed and inspected.

IEC mobilization in the districts was reinforced by radio broadcasts and mass mobilization which consisted of organizing concerts at the district level where well known artists sang in local languages about the benefits of IRS and where village, traditional, and religious leaders spoke about IRS. There were public reminders done by the village crier who went around the village right before dawn giving information about the spray schedule. In addition, mobilizers passed through each household once more 24 to 48 hours prior to the start of spray operations to remind the population about the spray schedule and when their village would be sprayed. During spray operations, each mobilizer was responsible to visit every household in the village at least twice. Unfortunately, not all houses were visited twice due to poor accessibility to some villages or to villages that were too large to be handled by a single mobilizer. To compensate for this lack, health nurses, village leaders, and spray operators conducted IEC to inform villages of the spray schedule.

Five community radios were contracted to broadcast information regarding IRS. The contract included radios spots, shows, and skits which were all broadcast at prime times during the day throughout the spray operations. Short discussions about the benefits of IRS and what to do before, during, and after IRS were broadcast 3 to 5 times per day and radio spots were broadcast 7 times per day. Throughout the campaign there were 25 radio shows, 10 interviews, 3 skits per week, two debates per week where people called in to discuss their impression about IRS after their households had been sprayed, testimonies from beneficiaries broadcast daily, and interviews of local leaders broadcast throughout the operations.

Throughout spray operations, supervision of IEC mobilizers was conducted by 43 head nurses from the townships. Data collection forms were used by head nurses to collect the following information: numbers of communication materials distributed (leaflets, posters, T-shirts, booklets, bags, CDs of IRS songs, and stickers); number of IRS plays performed by associations, and number of games played by the communities to show what to do before, during, and after IRS.

In addition to community mobilization, a news bulletin called “IRS Info” was developed by the IEC consultant and distributed throughout the spray operations highlighting key activities that occurred during IRS. Throughout the IRS spray operations there were a total of 15 ‘IRS Info” bulletins written and distributed to all the partners working in malaria control in Benin to keep them informed of the progress made on IRS.

The following tables summarize the IEC data collected during spray operation.

Figure 3. IEC materials distributed.

IEC material	Number of materials distributed or events held
Banners	34
Leaflet	110,046
Stickers	603
T-shirts	2,045
IRS booklets	37
IRS Info bulletin	15
CD of IRS songs	60
IRS bags	500
Labels put on doors by mobilizers	70,000

Figure 4. IEC activities conducted.

Activities	Number conducted
Concerts to promote IRS and to portray IRS benefits.	4
IRS radio shows	575
Interviews with local officials, village and religious leaders	651
Broadcasts	221
Debates	20
Media communication	1,335
Radio Spots	1,335
Interviews and testimonials after houses are sprayed	523

Implementation of IRS Activities

On July 8, 2008, the IRS operations were officially launched by the Beninese Minister of Health Dr. Kessile Tchala Sare and the USAID Mission Director Mr. Rudolph Thomas at the warehouse at Porto Novo. Health and community officials at the national and district levels attended the ceremony and visited the field to see the work being done by the spray operators.

Figure 5. Dr. Kessile Tchala Sare, Minister of Health of Benin, during IRS launch ceremony.

IRS operations in the four targeted districts (Adjohoun, Akpro-Misserete, Dangbo, and Seme-Podji) began on July 3, lasted for 44 days, and ended on August 23. In total, 142,814 structures were sprayed and 521,738 people were protected in all four districts. The IRS program reached 94 percent of houses in the targeted areas. Operators used 20,984 pesticide sachets to spray 388,455 rooms. Although the proportion of refusals reached 14 percent at the beginning of operations, testimonies from households already sprayed, involvement of local leaders, and continuous information, education, and communication (IEC) activities significantly reduced the rate of refusals. By the end of spray operations, the total refusal rate was only 4 percent.

The total spray personnel were made up of 205 spray operators, 41 team leaders, and 19 supervisors. Spray operations were conducted under the supervision of a team from the Beninese MOH and MOENP made up of PNLP supervisors, hygiene agents from DDS Oueme, chief doctors, a hygiene agent from the DHAB, and a technician from the MOE.

Storage of Commodities

As per the Food and Agriculture Organization (FAO) and WHO standards regarding the storage of pesticides, doors were added to the warehouse in Porto Novo and fans were installed on ceilings to enable ventilation. Thermometers were placed throughout the warehouse and the temperature was recorded three times daily (morning, afternoon, evening). Fire extinguishers were placed in strategic locations inside and outside the central warehouse, in the partitioned section, and also in the administrative section where offices were located. Personnel working daily in the central warehouse were trained by fire fighters on how to use the fire extinguishers.

All products and equipment in the central warehouse were stored on pallets to protect them from moisture and heat. Following compliance rules, pallets were placed 1 meter (3.28 feet) away from the wall to allow proper air circulation. Contaminated solid wastes were stored separately from other IRS PPE and spray equipment.

Figure 5 and 6. Left, barrels stored in the warehouse before the start of operations. Right, spray pumps stored in the warehouse after a day's work.

At the end of spray the operations, all the used PPE was washed and stored in the warehouse and spray pumps were stored according to regulation.

Logistics Management for Spray Operations

Transportation

During IRS operations, 22 buses with a capacity of 12 to 18 people each were rented and distributed to the districts. There were two teams of 6 sprayers per vehicle. During the 44 days of IRS activities, vehicles were deployed each morning for the transportation of spray operators residing in the districts to the Porto Novo warehouse to get their spray equipment and start the spray day. Maintenance technicians worked side by side with spray operators to conduct on-the-spot repairs for compressor sprayers. Forms were used to track transportation and fuel consumption and mileage. At the end of each spray day, operators were taken back to the Porto Novo warehouse to drop off their equipment and wash up prior to be returned to their respective districts.

Figure 7. Spray operators prepare to spray a household.

Washing Areas

The progressive rinsing areas and nine soak pits were divided per commune to avoid any confusion during operation, such as spray operators returning the following day and not remembering at which wash area their overalls had been hung. These soak pits were built according to environmental standards. Each spray operator and washer was instructed to use the washing area and the soak pit assigned to their district. The logistician of each district under the supervision of logistics manager was in charge of making sure that everyone was at their assigned location throughout the spray operations period. At the end of the day, 20 washers were deployed to rinse all overalls. An average of 10 overalls was washed daily per washer.

Warehouse Layout

IRS operations were managed at the Porto Novo warehouse. Prior to the start of operations, the warehouse was divided into five sections to make sure that all the environmental rules and regulations were followed and to best control the operation flow. The first section of the warehouse was used as the central warehouse where the pesticide and PPE were stored and the remaining four sections were designated for each of districts. Each district's storage was managed by a district logistician in charge of withdrawing materials from the central warehouse and tracking the movement of materials by forms. The district logisticians received pesticide on a weekly basis from the central warehouse manager. The PPE was allocated according to the size of the district and distributed to the group and team leaders after they signed a receipt form.

At the end of each day, empty sachets were collected by the district group leader, recorded on M&E forms, and given to the district logistician in the presence of the logistics manager. Both logisticians counted all the empty sachets and sealed them in barrels together. All solid waste including masks and gloves were also sealed in barrels. As per environmental rules and regulations, wastes were sealed in different barrels.

Forms were used to keep track of commodity movement in the field and between the central warehouse and district storages to track the flow but also to detect any loss, misplacement, or dysfunction in the system as soon as it arose.

Figure 8. Allocation of PPE per commune/district

Districts / Communes	Suits	Helmets	Pumps	Boots	Mask	Gloves
Adjohoun	116	58	58	58	1.873	600
Akpro Misserete	130	65	65	65	1.099	702
Dangbo	90	45	45	45	1.453	470
Seme-Podji	194	97	97	97	3.168	970
CREC*	29	14	13	14	967	43

*PPE was given to CREC as it has a subcontract with RTI and conducted operational research including IRS and entomological monitoring.

The IRS spray operation was conducted following the guidelines contained in the SEA and EIA approved by USAID and the GOB. Compliance with the regulations of both the GOB and USAID was confirmed during the inspection which was done in July 2008 by the RTI environmental specialist based in the regional office in Nairobi.

Monitoring and Evaluation

Prior to the start of spray operations, trainers and spray operators were trained in data collection and how to fill out the daily forms. Supervisors, team leaders, and spray operators each filled out data collection forms on a daily basis during spray operations. Three levels of supervision were put in place to ensure quality data recording: Team leaders checked the spray operators' forms each day, group heads checked the team leaders' forms each day, and the district coordinators checked all forms: spray operators', team leaders' and heads of groups'.

The data collected was summarized by district coordinators for daily reporting and sent to the data clerks for data processing. Prior to data entry, each form was matched against a numbering system that was developed the M&E consultant to track all the daily spray cards filled out by the spray operators. Four data clerks completed a one day course clerks to familiarize themselves with the various data entry forms of IRS and the different binary codes for each district. Each clerk was assigned a district. The data clerks were composed of three women and one man. Data clerks keyed in daily forms filled out by 265 operators, 41 team leaders, and 19 heads of group.

After data was keyed in by the clerks on a daily basis, an M&E spreadsheet detailing the data collected on the standard PMI indicators was completed by the M&E consultant.

In regards to environmental monitoring, the environmental consultant tracked three components to ensure compliance with regulations:

- Human health, by evaluating the impact of spraying on the population and the fauna;
- Transportation, by determining if drivers were transporting the commodities according to the environmental rules and guidelines; and
- Management of waste, by evaluating the degree to which sprayers, washers, service agents, and others working in the spray operations followed waste management guidelines.

Furthermore, central, regional, and district partners monitored IRS operations throughout the 44 days, including hygiene agents, PNLP, DDS, DHAB, MOH, and MOENP representatives, as follows:

- Six representatives from PNLP and DHAB (central and regional level) worked on IRS supervision and monitoring two days per week during spraying.
- One head doctor from PNLP of Ouémé/Plateau Region worked on the IRS planning, supervision, and monitoring.
- Four chief doctors identified the spray operators and IEC mobilizers, participated in the TOT, and worked 3 days per week during spray operations on the planning, coordination, supervision, and monitoring.
- The head of the Hygiene Service worked 3 days per week during spray operations on the planning, coordination, field supervision, and monitoring of quality control.
- 25 hygiene agents took turns working weekly on IRS supervision and facilitating community mobilization. They also participated in the TOT and they in turn trained the spray operators.
- A representative from CNAC monitored the quality of the insecticide procured to make sure that it corresponded to the WHO and FAO guidelines.
- A representative from Regional Directorate of Environment and Natural Protection worked with the RTI environmental consultant to make sure that spray operations were environmentally compliant.

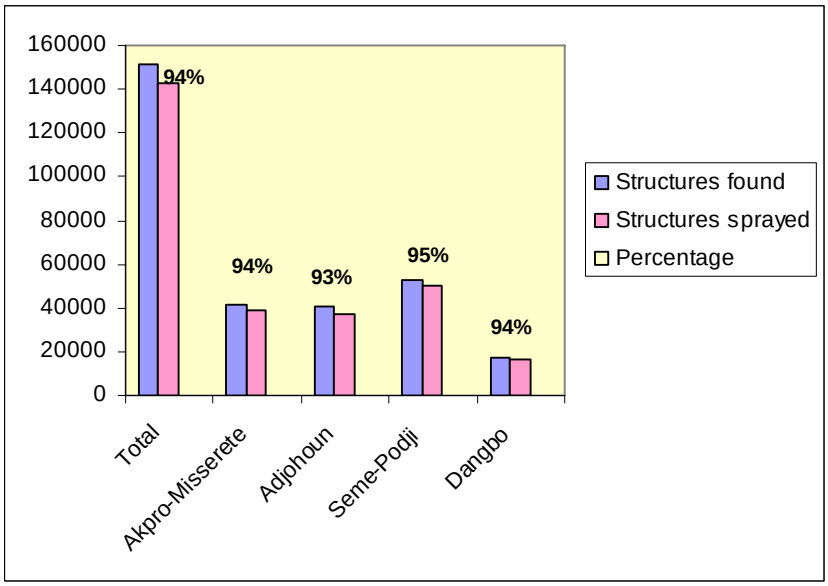
Results

IRS Results

All the players on various levels of IRS operations carried out their job satisfactorily and played a part in the success of IRS in Benin. No female spray operators or washers tested positive for pregnancy during or after spray operations and there were no known cases of pesticide poisoning or exposure.

During IRS operations, 40 villages in Adjohoun, 40 villages in Akpro-Misserete, 38 villages in Seme-Podji, and 18 villages in Dangbo were sprayed.

Figure 9. Structures sprayed in the four IRS districts.



The protected total population was 521,738. That is 205,377 people in the district of Seme-Podji; 140,965 people in Akpro-Misserete, 117,422 in Adjohoun, and 57,974 in Dangbo.

Figure 10. Population protected by IRS.

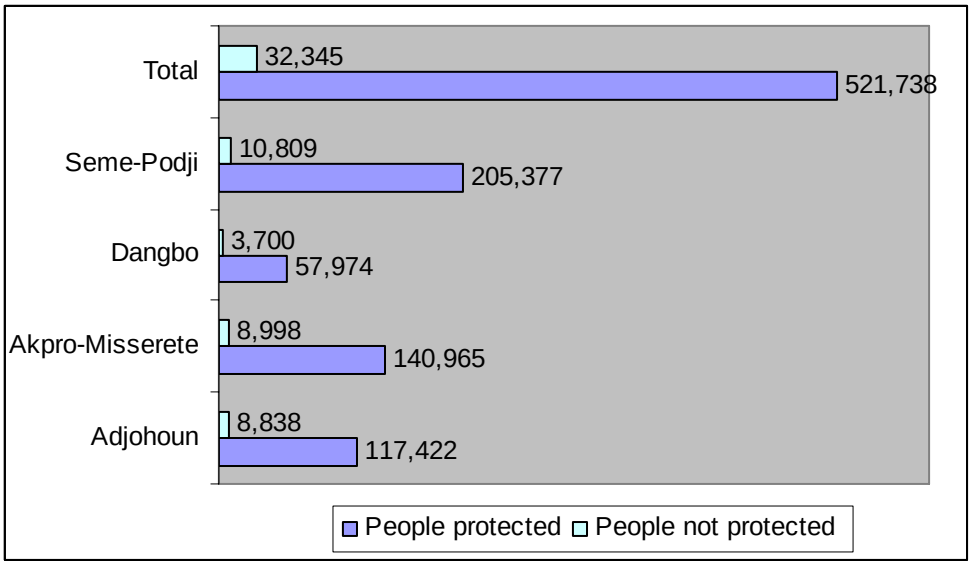
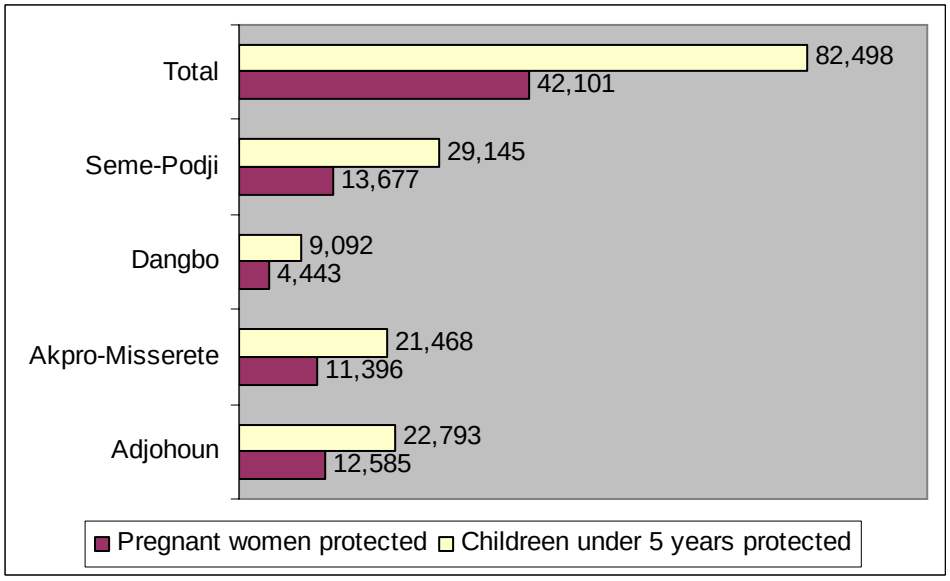


Figure 11. Pregnant women and children under 5 protected by IRS.



The following table shows a summary of the structures and the population protect by district in each targeted district.

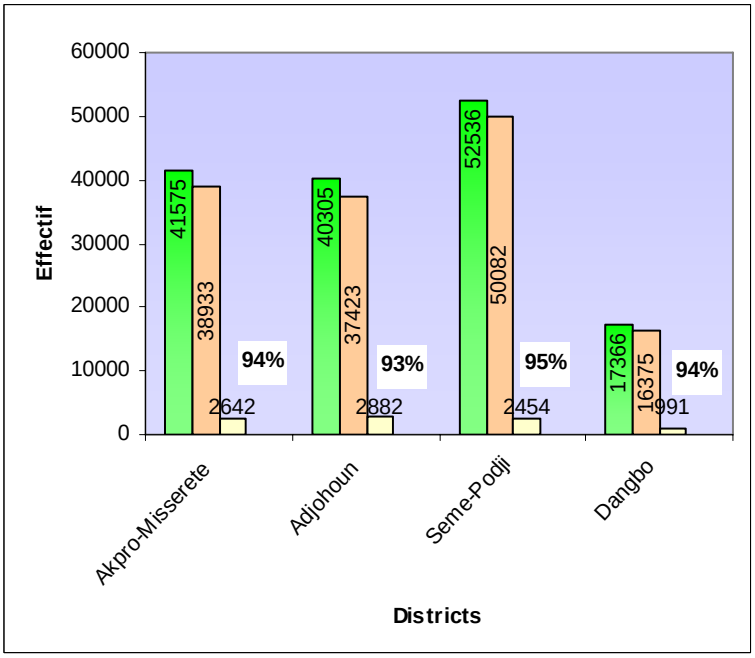
Figure 12. Structures and population protected in the 4 districts.

Districts	Townships	Structures sprayed	% Structures sprayed	People protected	% People protected
Adjohoun	Azowilissè	6,383.8	93%	25,009	93%
	Adjohoun	9,494.5	94%	37,198	94%
	Deme	1,226.8	92%	3,318	92%
	Kode	4,498.5	95%	13,994	95%
	Akpadanou	9,041.9	93%	25,891	93%
	Awonou	6,778.3	91%	12,012	91%
	Subtotal	37,423.9	93%	117,422	93%
Akpro-Misserete	Zougbome	2,568.4	95%	13,741	94%
	Vakon	8,439.7	94%	34,213	94%
	Gome	5,450.4	93%	25,245	94%
	Katagon	7,015.8	94%	18,006	94%
	Misserete	15,458.8	94%	49,760	94%
	Subtotal	38,933.1	94%	140,965	94%
Dangbo	Zoungue	2,698.5	94%	10,903	94%
	Dangbo	6,715.4	94%	25,624	94%
	Hozin	6,961.4	94%	21,447	94%
	Subtotal	16,375.4	94%	57,974	94%
Seme-Podji	Aholouyeme	1,105.1	95%	6,392	95%
	Tohoue	4,826.5	95%	29,428	95%
	Djregbe	4,027.9	94%	17,985	94%
	Seme Podji	5,958.5	96%	24,069	96%
	Ekpe	19,981.6	95%	75,647	95%
	Agblangandan	14,182.4	95%	51,856	95%
	Subtotal	50,082.0	95%	205,377	95%
Total		**142,814.3**	**94%**	**521,738**	**94%**

The variation between the pre-spraying estimates and the field is because population censuses in Benin are conducted every 10 years. The targeted districts experienced a great deal of growth since the last census in 2002, both from birth and from an influx of residents trying to escape the urban growth in Cotonou and Porto Novo. Additionally, because in Beninese villages the families are often broad and polygamy is seldom declared in the official studies, the figures in census are not reflective of reality.

As spray operations ended, the rate of IRS acceptance increased and of a total of 151,783 structures visited, 142,814 were sprayed (94 percent). When comparing among districts sprayed, Seme-Podji comes in first with 95 percent of structures sprayed and Adjohoun last with 93 percent sprayed. The districts of Akpro-Misserete and Dangbo both reached 94 percent of structures sprayed.

Figure 13. Acceptance of IRS in each district.



Only 6 percent of the structures visited were not sprayed. Reasons for not spraying included the absence of residents, rooms being locked, rooms not prepared before the arrival of spray operators, refusal, and other reasons of a socio-cultural and political type.

Spray operators received 25,568 sachets of pesticide, used 20,984 sachets, and returned 4,584 sachets, representing an 82 percent use of insecticide. All 20,984 empty sachets of Bendiocarb are stored in the Porto Novo warehouse.

Figure 14. Use of pesticide.

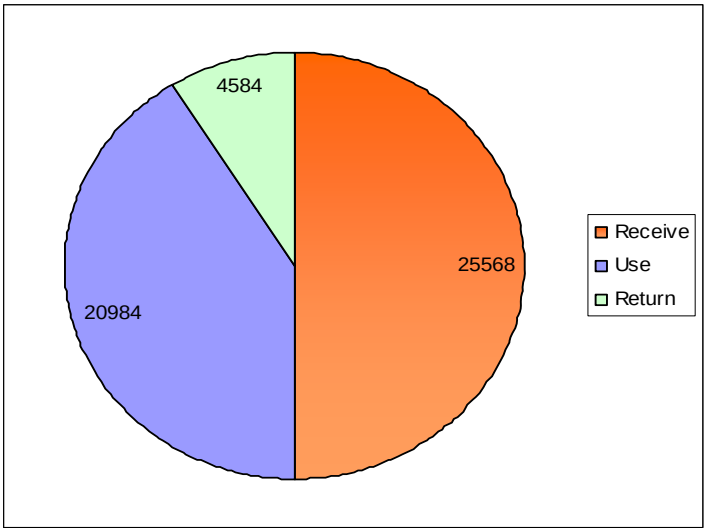
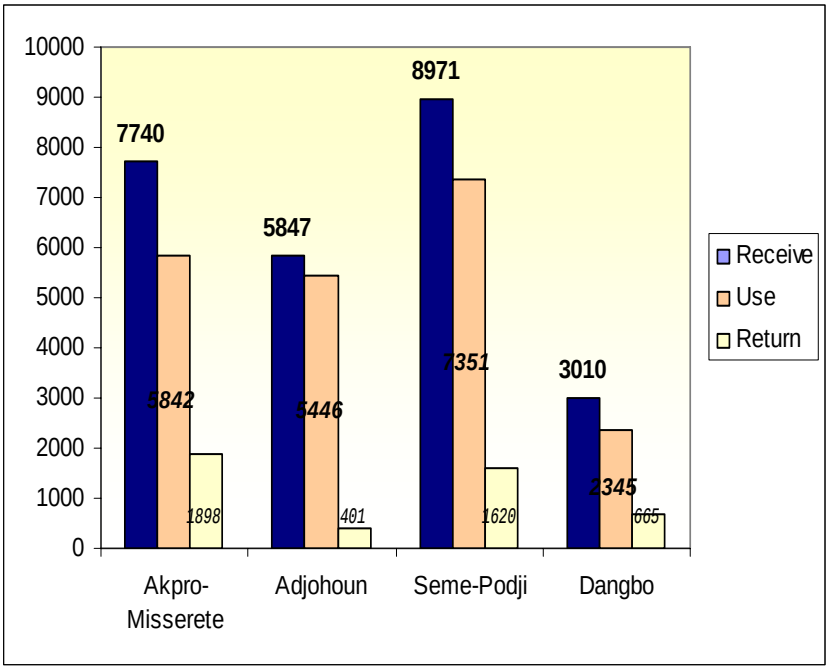


Figure 15. Use of pesticide per district.



As for the usage of mosquito nets, according to people interviewed LLINs were used more often than ordinary nets (a total of 88,838 LLINs and 83,011 ordinary nets were reported).

Figure 16. Mosquito net use in all districts.

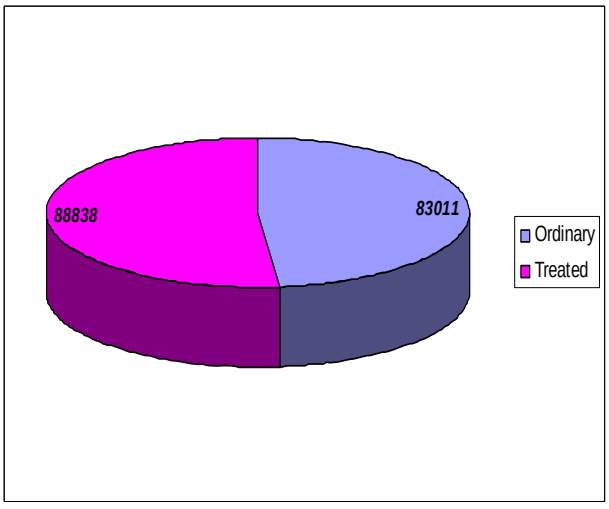
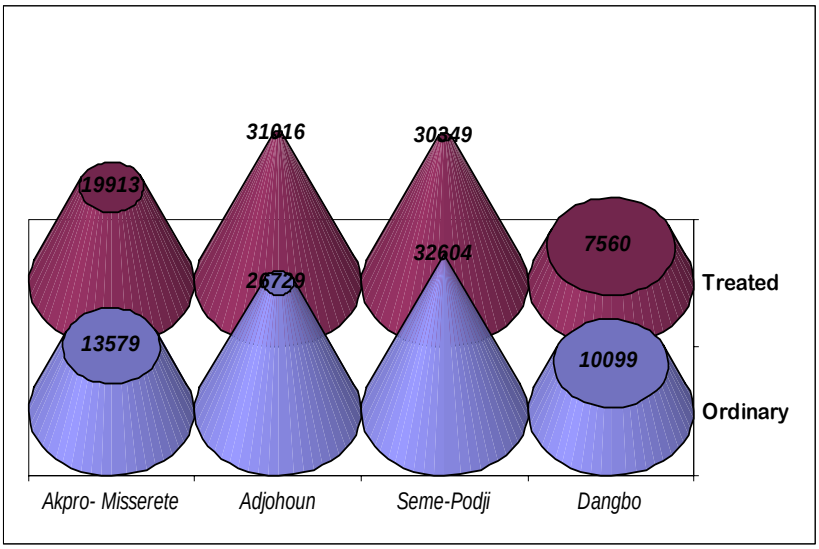


Figure 17. Mosquito net use per district.



In the districts of Seme-Podji and Dangbo, households using ordinary mosquito nets were more common than those who used LLINs. However, in Akpro-Misserete and Adjohoun, more people reported using LLINs.

The following table summarizes the main indicators for this first round in Benin.

Figure 18. Indicators for first round of IRS.

Indicators	District				
	Adjohoun	Akpro-Misserete	Dangbo	Sème-Podji	Total
Structures visited	40,305	41,575	16,375	52,536	**151,783**
Structures sprayed	37,423	38,933	17,366	50,082	**142,814**
People covered	117,422	140,965	57,974	20,5377	**521,738**
Children under > 5 years	22,793	21,468	9,092	29,145	**82,498**
Pregnant women	12,585	11,396	4,443	13,677	**42,101**
Household acceptance rate					
Total of structures	40,305	41,575	16,375	52,536	**151,783**
Structures sprayed	37,423	38,933	17,366	50,082	**142,814**
Structures not sprayed	2,882	2,642	991	2,454	**8,969**
Percentage of acceptance	93%	94%	94%	95%	**94%**
Insecticide usage					
Received	5,847	7,740	3,010	8,971	**25,568**
Used	5,446	5,842	2,345	7,351	**20,984**
Returned	401	1,898	665	1,620	**4,584**
Mosquito net usage					
Ordinary	26,729	13,579	10,099	32,604	**83,011**
LLINs	31,016	19,913	7,560	30,349	**88,838**

LLIN Hanging Results

As some villages are located in flood zones, they did not benefit from IRS. To ensure they had adequate protection, LLINs were hung in households in these zones. PNLP provided 16,000 LLINs to RTI for distribution; after the nets' arrival at the Porto Novo warehouse, it

was discovered that only 15,993 LLINs had been received and thus 7 nets were missing. The distribution and hanging of nets was done by local women's' associations who had worked with the PNLP during the general LLINs campaign conducted by MOH throughout the entire country. The women's' association used boats to circulate while distributing and hanging LLINs. This activity was placed under the direction of head nurses and chief doctors of each district and was supervised by the PNLP team, DDS, and RTI. RTI retrieved all plastic packaging and stored it at the Porto Novo warehouse.

Figure 19 and 20. Left, women use a boat to deliver LLINs. Right, an LLIN is hung in a household not protected by IRS.

During the distribution of LLINs, data was gathered on delivery and stock information, household information, evaluation and feedback, and supervision.

Three districts benefited from this activity: Adjohoun, Dangbo, and Seme-Podji. LLIN distribution took place in 47 villages and 15,993 LLINs were hung in 15,857 households. There was a 100 percent coverage of households selected to be protected using LLINs.

Figure 21. Distribution of the LLINs by township.

District	Townships	Households visited	Beneficiary households	LLINs hung
Adjohoun	Akpadanou	237	237	237
	Kode	488	488	488
	Gangban	2,329	2,347	2329
	Adjohoun	120	120	120
	Togbota	741	741	741
	Deme	218	218	218
	Azowlisse	191	191	191
	Subtotal	4,324	4,342	4,324
Dangbo	Dekin	3,709	1,607	1,740
	Gbeko	1,104	1,104	1,104
	Houedomey	3,019	2,998	3,019
	Kessounou	2,310	2,310	2,310
	Hozin	296	296	296
	Subtotal	10,438	8,315	8,469
Seme-Podji	Agblangandan	1,900	1,900	1,900
	Aholouyeme	1,300	1,300	1,300
	Subtotal	3,200	3,200	3,200
Total		**17,962**	**15,857**	**15,993**

Environmental Compliance

In IRS, the use of insecticide has potential for risks for spray operators, beneficiaries, and the environment. To minimize these risks, the various actors (particularly the spray operators, washers, drivers, storekeepers, service engineers, and other personnel working with pesticides) were trained on the proper handling of Bendiocarb and the precautions to take during IRS operations. Moreover, each spray operator, washer, and storekeeper was equipped with PPE consisting of a long sleeved shirt, a helmet, a face shield and a mask, a pair of robust boots, and resistant gloves.

Figure 22. Spray operators wear PPE during operations.

After the end of each working day, each spray operator gave the logistics assistant of the district his or her suit to be washed. The suits were washed daily by the washers, who also wore PPE except for the face shield and helmet. Used water contaminated by the pesticide was poured into the soak pits. Following guidelines from the environmental inspection, RTI installed a perimeter fence around each soak pit to prevent the dispersion of water outside of the soak pits and the rinsing area. The soak pit system consisted of layers from top to bottom of gravel, broken bricks, charcoal, and sawdust, permitting the purification of waste water before its infiltration into the ground. In effect, degradation of carbamates in soil is generally a function of volatility, leaching, soil moisture content, absorption, pH, temperature, photodecomposition, microbial degradation, and soil type. The half-life of Bendiocarb in soil varies from less than one week up to four weeks, depending on the type of soil and the pH.

To ensure the proper cleaning of spray equipment and to avoid accidental environmental or human contamination, the following instructions were given to spray operators during IRS. Supervisors made sure that these instructions were followed correctly to provide for the safest, most effective clean-up while minimizing water usage.

The water used to rinse out sprayers at the end of the day can be reused the next day to save water and reduce the potential for pollution from contaminated rinse-water. The best practice for rinse-water reuse, progressive rinsing, involves seven drums of approximately 200 liters (L) each in a line. Every other container is filled with water. During cleanup, the insecticide remaining in the pump is emptied into the first container (this will be a limited volume, less than half of the container, as most sprayers return from the field with empty pumps). The spray operator then fills the sprayer less than half full with water from the second container, closes and shakes the sprayer, and then dumps the water into the third container. The spray operator repeats the same steps with the fourth and fifth containers and the sixth and seventh containers, making sure to rinse the outside of the sprayer only at the sixth container (although not *in* the sixth container). The following day, the pumps are filled with liquid

from containers in the same sequential order: container one, then container three, then container five. Any remaining liquid in the fifth and seventh containers is quite dilute and can be disposed of in the soak pit.

Figure 23. A soak pit at the Porto Novo warehouse.

Other rules were put in place to minimize skin exposure or any inhalation or ingestion.

- Prohibition to eat, drink, and smoke during spraying.
- Prohibition to eat, drink, and smoke inside the warehouse.
- Spray operators must wash themselves with water and soap at the end of each working day prior to returning to their respective households.
- Masks must be changed every two days and gloves every ten days or each time they are damaged.

All IRS personnel including auxiliary staff were taught what to do in the event of an accidental pesticide discharge on the skin, in the eyes, or into the environment. Moreover, they were instructed to inform district coordinators working in the field so that the affected person could be sent to the health center where first aid kits were available. Each district coordinator carried at all times a first aid kit in their vehicle.

There was no case of contamination throughout the entire spray operations.

Results of the Environmental Monitoring

During the implementation the IRS, the RTI environmental officer based in the regional office in Nairobi conducted an inspection visit to ensure that the EMP was being followed throughout spray operations. The inspection report showed that the spray operation complied with the requirements in the EMP and the recommendations of FAO and WHO in regards to the transport, storage, and application of insecticide.

Insecticide Usage and Stock

There were 111 drums of Bendiocarb received for spray operations. Sixty eight drums of insecticide were used during spray operations (20,984 sachets of insecticide). One drum was

given to CREC, who was responsible for the entomological monitoring and operations research in Tori-bossito.

Figure 24. Usage of drums per district.

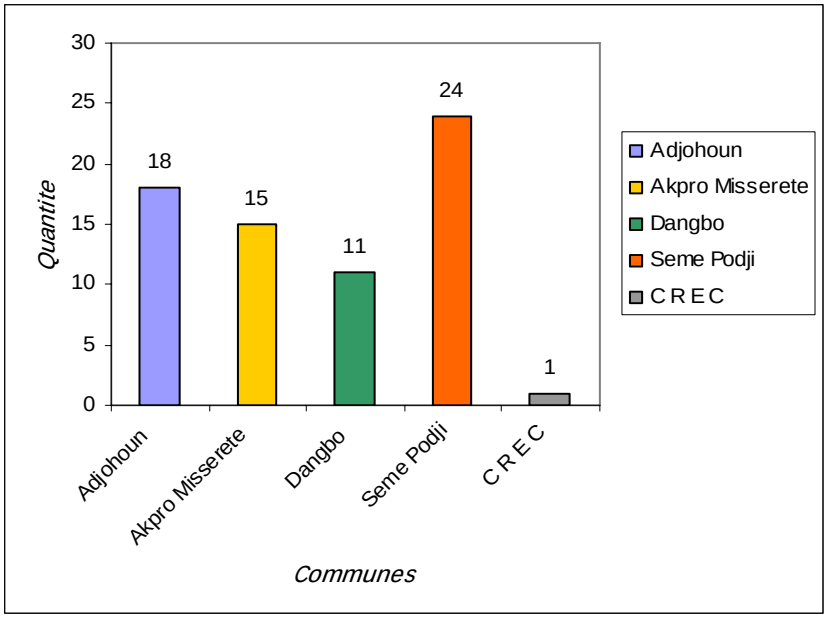
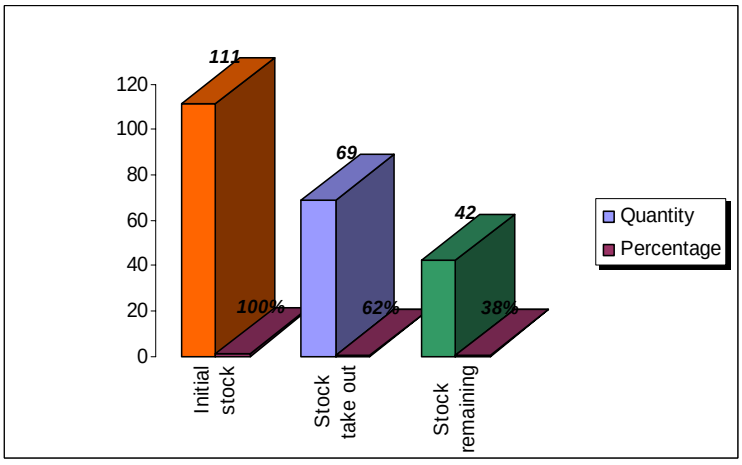


Figure 25. Pesticide Inventory.



Spray Operations Expenses

Figure 26. Daily stipends paid to personnel during operations.

Personnel	Number	Days	Daily rate (in CFA)
Operators	205	44	3,000
Team Leader	41	44	3,500
Group leader (Head of group)	19	44	4,000
Washers	20	46	2,000
Service engineers (pump repair men)	11	50	2,000
Data clerk	4	46	4,500
District/commune logisticians	4	57	6,500

Warehouse Managers	4	98	2,500
District/commune Coordinators	4	68	8,500
Finance Assistants	4	21	8,500

Figure 27. Daily stipends paid to IRS supervisors from Ministries.

Personnel	Number	Days	Daily rate (in CFA)
PNLP/DHAB	6	27	27,000
DDS Porto Novo	5	27	21,000
DDS Porto Novo	3	27	27,000
Hygiene Agents	25	46	8,500
DDEPN	1	12	27,000
Chief Doctor	4	27	27,000

In order to ensure the transfer of capacity to the national government, Ministry personnel were involved throughout the entire spray operations. They worked on IRS planning, spray operator recruitment, training, coordination, supervision, monitoring, and community mobilization. The use government staff and the payment of a per diem is an agreement between all the donors and the GOB. RTI received a copy of this agreement from USAID/Benin.

Figure 28. Other IRS costs.

Item	Number	Days	Daily rate (in CFA)
Meals for operators	269	46	1000 (per person)
Vehicles	38	46	35,000
Fuel	38	46	15,000

End of Round Evaluation and Lessons Learned

There were a number of lessons learned from the first round of IRS implementation. Most importantly, the success of the operations was due to the cooperation between and collaboration with partners at the central, regional and local levels from community health offices, DDS, PNLP, MOENP, and the Department of Family and Social Protection in the MOH.

Other success factors included:

- Participation in the World Malaria Day
- Trainings of spray operators at the district level
- Spray operators having their breakfast in the districts
- Participation in regional Beninese Independence Day parade on August 1
- Distribution of T-shirts, IRS songs on CDs, radio broadcasts, village gatherings, skits, banners and posters, and leaflets.

Lessons Learned

- Perform physical and biochemical tests before and after IRS for all personnel working on IRS operations including those working in the warehouse.
- Develop a system to easily identify each spray operator's individual PPE.
- Build more shower areas for male operators.

- Have the RTI M&E and environmental consultants as well as other technical staff on board prior to the start of IRS operations so that they are part of the preparatory phase of the spray operations.
- Encourage the involvement of local political authorities and religious leaders at all phases of IRS operations (before, during and after) to increase community acceptance.
- Increase the number of the IEC mobilizers during next spray operations and include the heads of villages and religious leaders or their representative in IEC activities so that they can participate fully and take ownership of the IEC activities. .
- Select rental companies that have vehicles that run on diesel to reduce fuel costs by renting vehicles on mileage.
- Have pictures badges for each spray operator to facilitate payments and avoid fraud.
- Increase the number of drying areas.
- Have more vehicles and respect the number of recommended people per vehicle.
- Conduct spray operations during the dry season (February to March).
- Increase the size of plastic sheeting used to cover household items that can not be moved during spray operations.
- Have present all personnel involved in the management of stock (district logistician, service engineers, warehouse manager, storekeeper, etc.) during the receipt and accounting of commodities to avoid variations. Include this section in store management training.
- Have a separate storage facility for Adjohoun to reduce transportation time.
- Organize a study tour for MOH senior staff in other IRS countries in the sub region.
- Collect chronological data on malaria morbidity and mortality in the IRS districts before and after the operation (to be conducted by the MOH).
- Provide the cost per person protected by IRS. RTI has been requested to provide the cost per person protected by IRS in Benin to MOH as soon as possible to help the MOH to raise funds to conduct IRS activity in other regions.
- Elaborate a long term IRS strategy by showing the roles and responsibilities of the GOB.