Uganda IRS Project, Kabale District

Project Report

October 2006

This publication was produced for review by the United States Agency for International Development. It was prepared by RTI International.

Uganda IRS Project, Kabale District

Final Report

Contract GHS-I-01-03-00028-00

Prepared for
United States Agency for International Development

Prepared by
RTI International
3040 Cornwallis Road
Post Office Box 12194
Research Triangle Park, NC 27709-2194

RTI International is dedicated to conducting research and development that improves the human condition by turning knowledge into practice. With a staff of more than 2,500, RTI offers innovative research and technical solutions to governments and businesses worldwide in the areas of health and pharmaceuticals, education and training, surveys and statistics, democratic governance, economic and social development, advanced technology, energy, and the environment. The second largest independent nonprofit research organization in the United States, RTI maintains nine offices in the U.S., five international offices, and one international subsidiary, as well as project offices around the world.

RTI International is a trade name of Research Triangle Institute.

The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

Table of Contents

Page

List of Figures iv

List of Tables v

Acronyms vi

1. Introduction 1

2. Background 2
- 2.1 The Epidemiology of Malaria in Kabale District 2
- 2.2 Justification for IRS in Kabale 4
- 2.3 Basis for Using lambda-Cyhalothrin Insecticide for this IRS Program 4

3. Logistics Needs Assessment 6
- 3.1 Population and Housing Coverage 6
- 3.2 Timing of IRS Implementation 7
- 3.3 Human Resource Requirement 7
- 3.4 Insecticide and Spray Equipment Requirements 8

4. Recruiting and Training Spray Operators and Conducting Baseline Surveys 11
- 4.1 Training Course on IRS and Spray Pump Maintenance and Repair. 11
- 4.2 Procurement of Insecticides and Other IRS Equipment 12
- 4.3 IEC Activities and Community Mobilization on IRS Project 12
- 4.4 Transportation of Spray Teams 13
- 4.5 Storage Facility Requirements 13
- 4.6 Entomological Monitoring 13
- 4.7 Clinical Evaluation of Spray Operators 14
- 4.8 Environmental Impact Assessment 14

5. Implementation of IRS Activities 18
- 5.1 IRS Results 20
- 5.2 Program Monitoring and Technical Support Supervision 24
- 5.3 Safety Measures and Management of Side Effects 27
- 5.4 Follow-up Actions 30

6. Lessons Learned and Recommendations for Future Programs 31

References 33

List of Figures

Page

Figure 1. Clinical Malaria Trends in Kabale District from 2000 to September 2005.....2

Figure 2. Malaria Reported Cases in Kabale [2002–2005].....3

List of Tables

Page

Table 1. Alternative Vector Control Measures Considered for Use 5

Table 2. Human Resource Requirement 8

Table 3. PPE and Other Equipment Required for Kabale IRS Project 10

Table 4. Materials for Entomological Surveillance Activities.....14

Table 5. Level of Project Environment Compliance to PERSUAP Conditions 15

Table 6. Summary of Coverage Results Achieved under Kabale IRS Project 20

Table 7. Summary IRS project Output Indicators by Each Day of the Spray Campaign.....21

Table 8. Persons that Worked on Kabale IRS Program by Designation 31

Acronyms

CDC	Centers for Disease Control and Prevention
DDHS	District Directorate for Health Services
FAO	Food and Agricultural Organization
HIMAL	Highland Malaria Project
IEC	information, education, and communication
IRS	indoor residual spray(ing)
IUCN	World Conservation Union
KRRH	Kabale Regional Referral Hospital
MUINER	Makerere University Institute of Environment and Natural Resources
MOH	Ministry of Health
NEMA	National Environment Management Authority
NMCP	National Malaria Control Program
PPE	personal protection equipment
PERSUAP	Pesticide Evaluation Report and Safe Use Action Plan
USAID	U.S. Agency for International Development
WP	wettable powder
WHO	World Health Organization

1. Introduction

Malaria remains one of the major causes of disease burden and mortality in Uganda. As one of its core interventions to combat this disease, the National Malaria Control Program (NMCP)—within Uganda's Ministry of Health (MOH)—promotes vector control through the use of indoor residual spraying (IRS), especially in areas with unstable transmission of malaria. Funded by the U.S. President's Malaria Initiative through the U.S. Agency for International Development (USAID), Research Triangle Institute (RTI International) is providing technical and financial support to the MOH/NMCP to conduct an IRS model program in Kabale district targeting all residential households. It is hoped that IRS activities will be scaled up to other parts of the country in the subsequent periods using lessons learned from this model program.

RTI's support focuses on the following components:

- Purchasing insecticide, spraying equipment, and adequate amounts of personal protective clothing and equipment for spray operators and wash persons
- Providing financial support and transportation for trainers and spray teams
- Providing financial support for storage facility construction and renovation
- Supplying technical advisors to plan the program, train field staff, and supervise field operations
- Promoting health education to raise public awareness and to foster cooperation for IRS activities
- Establishing and monitoring human health and environmental safety components.

This report provides a description of activities conducted under the first round of this program during the fiscal year 2006, in Kabale district and the results that were accomplished.

Indoor residual spraying in Kabale District, Southwestern Uganda.

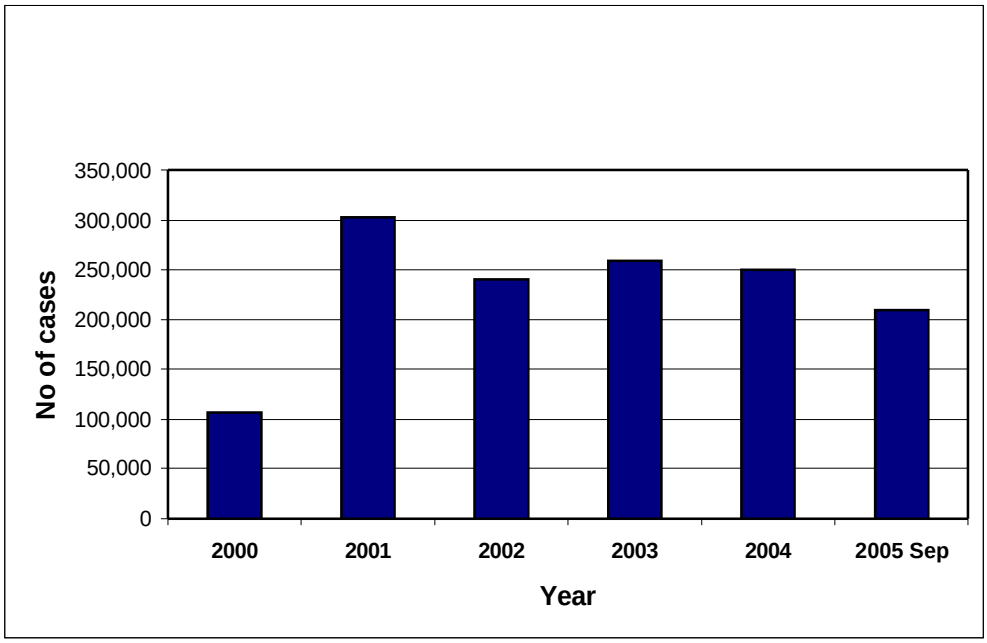
2. Background

2.1 The Epidemiology of Malaria in Kabale District

Located in the southwestern region of Uganda, Kabale is one of the most malaria-prone highland districts in the nation; in fact, malaria is the most common cause of morbidity and mortality to Kabale's population. Ninety-three percent of the total population in Kabale is estimated to be at risk for contracting malaria. Because the disease is unstable, there is a high potential for epidemics to occur due to swamp cultivation of Irish potatoes, brick making, hoof prints, and flooding. Although all four species of the malaria parasite exist in Kabale, *Plasmodium falciparum*, the most dangerous form, is responsible for more than 95% of cases. This parasite has shown increasing resistance to both chloroquine and sulfadoxine pyremethamine when used separately as single therapy and more recently in combination therapy. It is estimated that a single episode of malaria costs the equivalent of 10 working days. This poses a significant loss to the district's productivity and, ultimately, to its social and economic progress.

Passive case detection is the most common method for diagnosing clinical malaria cases. However, data collection is inconsistent. Annually, 250,000–300,000 clinical malaria cases are reported in Kabale (Figure 1), and records from the Kabale Regional Referral Hospital (KRRH) indicate that malaria accounts for 30–50% of hospital admissions.

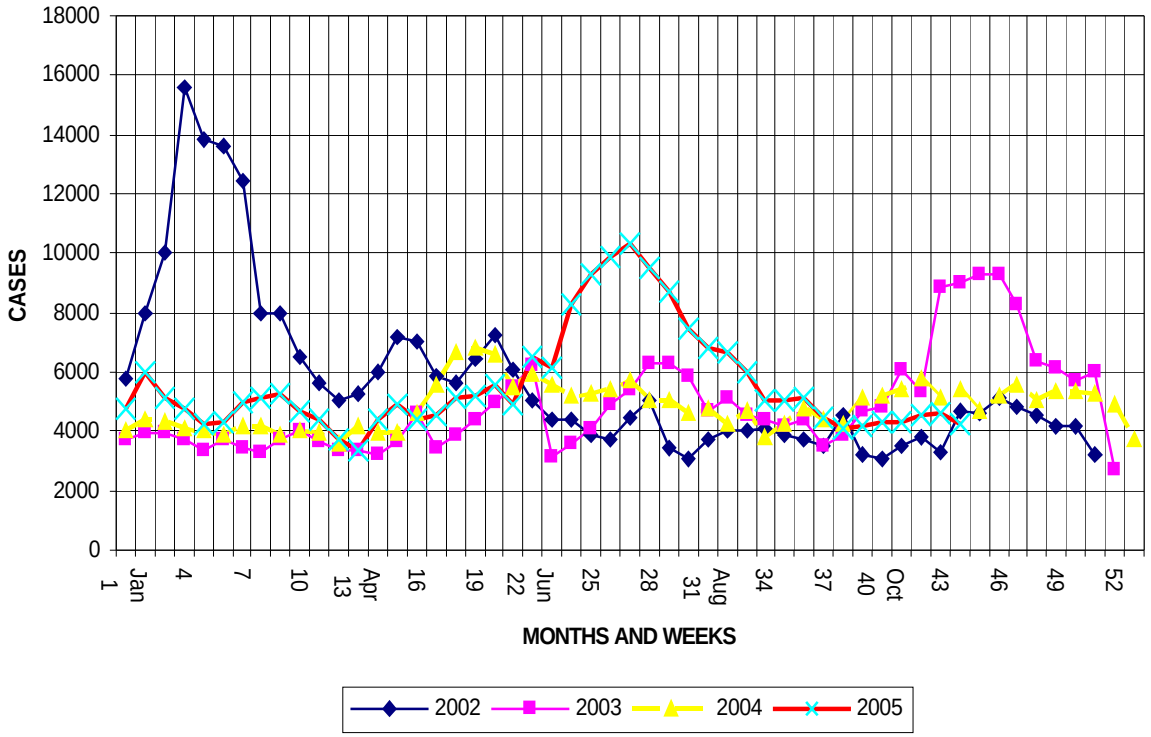
Figure 1. Clinical Malaria Trends in Kabale District from 2000 to September 2005



In recent years, a series of malaria epidemics occurred in the highland areas of Uganda. In 1992 and 1994, malaria epidemics occurred in Rukungiri and Kabale; in 1997, epidemics occurred in Kapchorwa (Mouchet et al., 1998; Lindblade et al., 2000). In 1998, most of Uganda's low endemic areas, especially the highland districts in the southwest, experienced a severe malaria epidemic following El Nino rains (Kilian et al., 1999; Lindblade et al., 1999) that resulted in high mortality and had serious socioeconomic consequences. Although some of these epidemics were partially controlled using IRS with ICON™ 10% wettable powder (WP) (Malaria Control Program Reports), the magnitude and impact of these epidemics could have been minimized had these epidemics been forecasted and proactive control measures (including IRS) had been used.

Weekly clinical malaria data collected by the Highland Malaria Project (HIMAL) in Kabale shows that significant epidemics occurred in February 2002, November 2003, and June–July 2005 (Figure 2).

Figure 2. Malaria Reported Cases in Kabale [2002–2005]



2.2 Justification for IRS in Kabale

Given its geographic attributes, malaria epidemiology, and prior experience using IRS, the Kabale district was selected to be the pilot site for a large-scale, well-targeted IRS project that can be used to develop a robust IRS system for scaling up activities to other parts of the country. The major malaria vectors in Kabale, *Anopheles gambiae s.l.* and *An. funestus* are both highly endophagic and endophilic (feed and rest indoors). Because of their behavior, these vectors are controllable with IRS. In addition to epidemic-prone districts, the NMCP plans to apply IRS in congested places, such as peri-urban centers, internally displaced people camps, and institutions located in endemic areas. In so doing, the MOH can gather significant data and apply the lessons learned to future programs in the rest of the country.

2.3 Basis for Using lambda-Cyhalothrin Insecticide for this IRS Program

lambda-Cyhalothrin (ICON™ 10% WP) was selected as the insecticide for this IRS project as a balance between the known health and economic risks of malaria and the health and environmental risks of IRS.[1] lambda-Cyhalothrin is the most commonly used synthetic pyrethroid (IPCS, 1990) for pest control—especially mosquitoes—and it is usually sprayed on interior walls or used to impregnate bed nets (EXTOXNET, 1996). However, in the United States, use of this insecticide is restricted; i.e., it can be purchased and used only by certified applicators (EXTOXNET, 1996). In addition to mosquitoes, it is effectively used to control cockroaches, ticks, fleas, aphids, Colorado beetles, cutworms, and butterfly larvae (IPCS, 1990; EXTOXNET, 1996).

ICON™ WP was selected for the following reasons:

- It is currently registered in Uganda for use through IRS, per World Health Organization (WHO) recommendation.
- The MOH has prior experience using the formulation with anecdotal evidence of strong impact in reducing the vector population.[2]
- Vector resistance and residual persistence. In Uganda, pyrethroid resistance ranges from 3 to 30%, depending on the district. In Kabale district, *An. gambiae s.l.* was detected as having 14% resistance.[3]
- According to the U.S. Environmental Protection Agency, lambda-cyhalothrin is a category II pesticide. It is low-to-moderately toxic, noncarcinogenic, and

[1] lambda-Cyhalothrin is used interchangeably with ICON™ WP.

[2] However, at the start of this program, no data on the use of ICON™ WP were available in Uganda. Entomological surveys were conducted as part of this model IRS project (one done pre-IRS project in May–June 2006 and one is scheduled in October 2006) to determine the effectiveness of ICON™ WP.

[3] The MOH recommends that public health insecticides be replaced when resistance reaches 25%. Pyrethroids are commonly used in Kabale's agricultural sector, but the extent of their use and potential impact on *Anopheles* resistance is unknown. Monitoring activities conducted by vector control specialists from the MOH/NMCP will determine the effectiveness and residual effects of ICON™ WP in these indoor ecosystems.

biodegradable. It is registered for use on the following residential non-food sites: general indoor/outdoor pest control (crack/crevice/spot); termiticide; ornamental plants and lawns around homes, parks, recreation areas, and athletic fields; and golf course turf (62 FR 603002–63010).

Table 1 provides a summary of other alternatives that were considered to control the vector population and the rationale for not using those particular alternatives in this project.

Table 1. Alternative Vector Control Measures Considered for Use

ICON™ WP Alternatives and Corresponding Rationale for Not Selecting Them	
IRS project using ICON CS™	ICON CS™ was not yet registered in Uganda. Trials on its efficacy are not complete, and thus, ICON CS would not be available by the beginning of spray operations.
IRS project using organophosphates, carbamates, or other pyrethroids.	Recent field tests (2005) in Kabale district demonstrated a low level of resistance to deltamethrin, lambda-cyhalothrin, and permethrin in anopheline mosquitoes. However, the MOH prefers not to use pyrethroids other than lambda-cyhalothrin, organophosphates, or carbamates for IRS. Pyrethroids, including lambda-cyhalothrin, are generally less toxic to humans than organophosphates or carbamates. lambda-Cyhalothrin was also preferred by the MOH, based on its prior experience with the pesticide.
IRS project using DDT	By the time of this activity, Uganda had not completed the in-country environmental processes necessary to approve DDT use for public health. Additionally, USAID support for DDT use requires an environmental assessment that must be conducted in conjunction with in-country environmental processes.
Larviciding	Larviciding is not a strategy currently supported by the MOH. Larviciding could prove a useful long-term strategy for malaria control in Kabale. IRS, however, is an intervention best-suited for short-term prevention of epidemics, which is the current focus of the MOH.
Environmental Management	Environmental Management is not a strategy currently supported by the MOH. Environmental management could prove a useful long-term strategy for malaria control in Kabale. IRS, however, is an intervention best-suited for short-term prevention of epidemics, which is the current focus of the MOH.

3. Logistics Needs Assessment

RTI conducted a detailed malaria situation analysis and logistics needs assessment to determine the technical, financial, human capacity, and operational needs that would be required to implement an IRS activity of this magnitude in the district. Data were collected through site visits, interviews, and discussions with various partners and stakeholders with extensive experience in malaria control and prevention in Kabale district.

3.1 Population and Housing Coverage

Kabale district covers a total area of 1,827 square kilometers with a population density of 281 persons per square kilometer. The district comprises three rural counties and one municipality; at lower administrative levels, the district has 20 sub-counties, 120 parishes, and 1,397 villages. Based on the 2002 provisional census and the observed inter-censal rate of population growth, the district's population in 2006 was projected to be 491,340 residing in an estimated 98,268 households with an average household size of 5 people. These demographic and housing data were used to plan program activities for this IRS round because no geographical surveys have been conducted to map and establish the actual number of houses in the district.

Rural housing in Kabale district

3.2 Timing of IRS Implementation

The available monthly and weekly malaria case data for the last 4 years did not identify clear malaria seasonality in Kabale district. Reasons for this include the quality, reliability, and consistency of the data. With assistance from the national and district malaria control technical staff, a minor malaria peak was identified soon after the April rain through July and a major malaria peak was identified in November–December after the October rain. Given this, the ideal timeframes for IRS in Kabale would be February–March or August–September. However, the NMCP and District Directorate of Health Services (DDHS) disagreed and, instead, strongly recommended avoiding IRS operations during rainy months because of transport difficulties; the resident population being engaged with their farming activities; and possible poor household cooperation in moving furniture, foodstuff, and other household items during the rainy season.

After holding discussions with various stakeholders and considering the malaria epidemiology in Kabale district and its seasonality, program officials felt that June–July would be the best period for an IRS project. These months are usually dry in Kabale, and most of the residents are available to participate in the program (either as sprayers or by removing furniture and foodstuffs from the home) during the post-harvesting period. Conducting IRS in this period would also affect the June–July malaria peak. Moreover, if the sprayed insecticide (ICON™10 WP) remained effective for 6 months, it would also help reduce malaria transmission during the November–December period. Therefore, the first spray cycle was scheduled to start in early June 2006, lasting until late July.

Before spraying began, additional preparatory activities needed to occur. These included recruiting and training sprayers, team leaders, and supervisors; conducting pre-spray entomological and environmental surveys and human health assessments; and implementing an information, education, and communication (IEC) campaign to create or enhance awareness about IRS in the district and to mobilize and garner support of the district leaders and community members for the IRS project. These activities were planned for and conducted between April and June 2006.

3.3 Human Resource Requirement

Given the wide coverage area and the short period, IRS operations had to occur concurrently in each sub-county to complete the program on time. Based on past experience conducting IRS in this district, the NMCP and DDHS suggested that a single spray operator could be expected to spray eight households in an 8-hour work day. To spray the estimated 98,268 houses, the program required a total of

12,284 spray operator days. To do so within 46–48 working days required deploying 267 spray operators. Considering the district's existing road conditions and geographical infrastructure, the program planned to mobilize 45 spray teams, each consisting of 5–7 spray operators. Each spray team self-selected a team leader—who was literate, demonstrated leadership qualities and supervisory skills, and had excellent interpersonal communication skills. Sub-county supervisors would oversee spray teams operations, by traveling between spray team sites and observing spray operators and team leaders in the preparation, application, cleanup, and disposal of IRS waste products during the IRS project.

Table 2 provides a summary of human resource plans. DDHS, with support from RTI technical staff, recruited all team members on a temporary basis. Then, team members were trained by NMCP and RTI staff in accordance with guidelines from the WHO *Manual for Indoor Residual Spraying* (WHO 2002) and the H.D. Hudson Manufacturing Company guide *Indoor Residual Spray Team Training: A Cascade Training Guide and Checklist*.

Table 2. Human Resource Requirement

Category	Number
Spray teams	45
Spray operators	267
Team leaders	45
Sub-county supervisors	20
Total	**332**

Throughout the spray period, RTI staff provided technical assistance and support supervision to the spray teams. Additional technical support supervision of spray activities was conducted by a team of vector control officers from NMCP and DDHS offices.

3.4 Insecticide and Spray Equipment Requirements

The proposed insecticide for this program is ICON™ 10% WP. Using the average size of residential houses in the district, we estimated that in order to achieve 100% coverage, the total sprayable surface in 98,268 houses would be 19,653,600 square meters, which required 4,913 kg of ICON 10% WP.

Hudson X-Pert® sprayers, which are WHO approved for IRS operations, were recommended for this program. A total of 314 eight-liter spray pumps (one for each spray operator and one extra pump for each spray team to be used in an emergency or for a repair) would be needed for the whole operation. Each team also required a set of spare parts for day-to-day repair and maintenance of sprayers and a toolkit for repair maintenance of sprayers. Personal protection equipment (PPE) in accordance with WHO specifications were provided to each spray operator and the team leader. Table 3 provides a summary of PPE and other required equipment.

After completing the needs assessment, RTI staff conducted a number of planning activities in preparation for spraying as summarized in the next section.

A team leader directs a spray operator to the next household.

Table 3. PPE and Other Equipment Required for Kabale IRS Project

Category	No.	Description	Amount
Geographical Reconnaissance	1	Clipboard	45
	2	Pen	45
	3	Pencil	45
	4	Compass	45
	5	Drawing sheet set (30)	45
	6	GPS	45
	7	Data collection forms	5,000
PPE for spray operators	8	Overall	534
	9	Pairs of socks	724
	10	Gum boot	312
	11	Hard rubber gloves	534
	12	Clear face shield	267
	13	Mouth/nose mask	6,408
	14	Helmet	267
	15	Toiletry kits (with towels)	534
	16	Soap	1,335
PPE for wash persons	17	Apron	40
	18	Gloves	40
	19	Gum boot	20
	20	Soap	40
	21	Tub	40
	22	Barrel	70
IRS	23	Haversack	90
	24	Filter cloth	534
	25	Toolkit[1]	45
	26	Strainer	173
	27	Data forms (set)	45
	28	Stationery (set)	45
Entomology	29	Bioassay cones	100
	30	Light traps	2
	31	PSC sheets	10
	32	Pyrethrum (liters)	5
	33	Mosquito cups	100
	34	Other materials	
	35	Stationery	

[1] Toolkit included an adjustable spanner, a pair of pliers, and a set of screw drivers.

4. Recruiting and Training Spray Operators and Conducting Baseline Surveys

4.1 Training Course on IRS and Spray Pump Maintenance and Repair

Training of Trainers (TOT)—Between April 15 and May 2, 2006, RTI in collaboration with the MOH and the DDHS conducted two 5-day TOT workshops on IRS and spray pump maintenance and repair techniques. The objective of the training was to enhance the skills and competence of participants in IRS and spray pump repair and maintenance and to identify potential/future spray operator trainers among participants.

The workshops included lecture presentations, demonstrations, role plays, and practical sessions. During the 5-day period, participants received intensive training on spraying techniques; the use, operation, calibration, and repair and maintenance of the sprayer; and practical exercises on spraying. The workshops also addressed issues related to planning of IRS, house arrangements, record keeping, community mobilization, and safer use of insecticides including sprayer and PPE cleanup during the IRS project. Participants also received training on personnel management, environmental aspects of IRS, entomological monitoring, geographical reconnaissance, and data recording and analysis.

One of the Training of trainer courses held in April–May 2006.

A total of 97 participants attended the two workshops, the majority of whom became supervisors and team leaders for the IRS project. Participants included 13 Kampala-based and 33 district-level government officials (14 health assistants, 4 health educators, 8 health inspectors, 3 nursing assistants, and 6 community development assistants), and 51 team leaders who were selected from all parts of the district. Pre- and post-training assessments indicated that the majority of participants had been well prepared to conduct

appropriate supervision and monitoring of IRS activities and for some to act as trainers for spray operators.

Training of Spray Operators—All identified spray operators and wash persons were also trained by the team leaders and supervisors with support from RTI staff during May and June 2006. The training programs were modeled on earlier TOT sessions and included all aspects of the IRS techniques in accordance with WHO guidelines. Six 5-day training sessions were conducted during this period, and all 267 operators were trained.

4.2 Procurement of Insecticides and Other IRS Equipment

All items required for spraying (as identified in section 3.3) were procured and delivered to Kabale district in April and May 2006. The insecticide was ordered and shipped directly from the Syngenta manufacturers in Switzerland, a process that took about 2 months. A slightly higher amount of ICON™ 10% WP (5,000 kg compared with the estimated required amount of 4,913 kg) was procured to ensure that there would be no shortages during the spray period in the event that the district had more than the estimated number of residential houses.

4.3 IEC Activities and Community Mobilization on IRS Project

During April 2006, DDHS and NMCP, in partnership with RTI and other district stakeholders, conducted several planning meetings to determine the most appropriate avenues for publicizing and promoting the IRS project throughout the district. The following activities were identified with an implementation plan of early May through the end of the spray period in July 2006.

- District leaders/stakeholders sensitization (May 3, 2006)
- IEC material development workshop (May 4, 2006)
- 20 sub-county sensitization meetings (May–June 2006)
- Radio spots on IRS (twice a day from May 8 to July 31, 2006)
- Radio talk shows (every Sunday from May 7 to July 31)
- 118 parish sensitization meetings (throughout spray period)
- 30 film shown in villages (from May 15 to June 30)
- Preparation and printing of 20,000 IRS fact sheets (in English/local language)

This component of the program was led by the district health team with support from RTI project staff and the NMCP. A total of 7,356 people were directly reached (at the district, sub-county, and parish levels) through the sensitization meetings and included youth leaders, community drug distributors, local council officials, religious leaders, and leaders of civil society groups. Once trained, these individuals were then expected to act as IRS peer educators in their communities. However, it is not possible to ascertain how many people the peer educators reached.

In addition. one to two film shows were hosted in each sub-county with varied attendance that ranged between 100 to 300 participants (mainly youths and young adults). The radio talk shows which were aired on Sunday evenings and radio spots aired twice every day were carried by radio stations that had full coverage of the district population. However, the team did not ascertain the number of persons reached through this IEC medium.

4.4 Transportation of Spray Teams

Because of the short timeframe of IRS activities and the terrain of Kabale district, the project staff rented 32 double cabin four-wheel drive vehicles to transport spray operators and team leaders. In addition, one motorcycle was rented for each supervisor to assist them in their daily support supervision activities.

4.5 Storage Facility Requirements

In addition to storage facilities that were required for washing and storing PPEs, the project staff anticipated refurbishing a central warehouse in Kabale and purchasing storage containers for insecticide and other spray equipment (to be stationed at each sub-county). However, the idea of purchasing containers was dropped because of the limited resources available during this spray round. Therefore, sub-county supervisors were asked to identify potential storage facilities in their areas. During April and May, RTI field technical staff, together with the District Vector Control Officer, made on-site visits to all sub-counties to assess the identified insecticide/spray pump/personal protective storage facilities. In most of the locations, only minor repairs were required (e.g., fixing door hinges, replacing some windows and vents, etc.), which the project team completed shortly thereafter. Security guards were hired to patrol and protect the facilities during the spray season.

4.6 Entomological Monitoring

This activity was led by NMCP with support from RTI and Centers for Disease Control and Prevention (CDC). Technical officials identified several items that were needed to conduct entomological surveillance activities in the Kabale district. With support from the CDC, the following items and materials were procured and delivered to Kabale. Monitoring activities commenced on May 31, 2006. Table 4 shows the materials used for entomological surveillance activities.

Table 4. Materials for Entomological Surveillance Activities

• Four CDC light traps	• Mosquito nets/nettings
• Mosquito cage materials	• Basins/rubber bands
• Materials for CDC bottle assays	• Kerosene cooker
• Bioassay cones	• Forceps
• Torch/batteries	• Magnifying glasses
• Chemicals	• Hand sprayers

A team of MOH entomologists and vector control officers breed mosquitoes for surveillance activities.

4.7 Clinical Evaluation of Spray Operators

A general medical examination was conducted on all spray operators, washpersons, team leaders, and supervisors to assess their medical fitness for the IRS activities. All female operators and team leaders were tested for human chorionic gonadotropin levels to rule out pregnancy. Findings indicated that no female staff member was pregnant and that the team was generally medically fit to conduct IRS activities. An end-of-spray reevaluation of all the staff will be conducted.

4.8 Environmental Impact Assessment

As part of environmental compliance activities, RTI subcontracted the World Conservation Union (IUCN) to conduct pre- and post-spray monitoring to determine the impact of spraying on the environment. IUCN worked on this activity in partnership with the National Environment Management Authority (NEMA) and the Makerere University

Institute of Environment and Natural Resources (MUINER). The team tested for ICON residues in wetland worms; wetland fish and amphibians; soil pesticide residue content at daily clean-up sites for spray operators and around sprayed homes; indoor dust; and soil biodiversity and impacts on bees. Samples of these indicators were collected from five sub-counties within the Kabale district, with varying numbers of samples collected for each indicator. Sample sites were selected to target critical or protected ecosystems and wetlands.

Because samples are still being analyzed, baseline data are available only for soil biodiversity and pesticide residue content. The results for soil pesticide residue content indicate that, of the 20 sites sampled, two pre-spray soil samples contained lambda-cyhalothrin residue (Rubaya Store with 0.15 µg/kg and Kyanamira Store with 0.81 µg/kg). These samples are being retested to confirm the results. If the lambda-cyhalothrin residue is connected to the program, it could be a result of spillage during ICON delivery to the storage facilities.

Additionally, two persistent organochlorine pesticides were identified in the pre-spray samples: three soil samples contained DDT metabolites (o-p DDT, o-p DDD, and DDE-pp) and one soil sample contained endosulfan sulfate. However, the presence of these chemicals is unrelated to ICON use in the IRS project. Until all pre- and post-spray analyses have been conducted, conclusions cannot be drawn regarding the environmental impact of ICON use in IRS.

Table 5 summarizes the level of environmental compliance under this project in relation to the specific conditions stated in the Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP) that was developed before the IRS project began. Comments on how to better address the required activities under each condition are discussed.

Table 5. Level of Project Environment Compliance to PERSUAP Conditions

Summary of PERSUAP required activities	Comments on how well these actions were conducted and suggestions for future activities
A central storage facility in the district will be remodeled according to Food and Agricultural Organization (FAO) standards. The facility is located in a locked, guarded transport yard in Kabale Town. 20 sub-counties in Kabale District will each be supplied with 2 cargo containers: one for insecticide/sprayer storage and one for a storekeeper office and storage of personal protection equipments. Containers will be located at sub-county government offices, where security is highest. Containers will be outfitted based on FAO standards, and double-padlocking will reduce risk of pilferage.	*Condition not fully met.* During this spray round, available funds were limited and thus, the project was not able to remodel a central storage facility in Kabale and purchase containers for each sub-county store. However, alternative but secure storage arrangements were used (section 4.5). Although this approach was effective for the short term, it was evident that it will be challenging in the long term. Before the next round begins, there is need to reconsider the most appropriate and cost-effective way to address this issue.

Summary of PERSUAP required activities	Comments on how well these actions were conducted and suggestions for future activities
IRS supervisors, team leaders, and spray operators will be trained according to WHO standards. Insecticide poisoning management training will be provided to Kabale Regional Health physicians and Health Center III (HCIII) health workers. Insecticide storage facility storekeepers will also be trained on proper stores management.	*Condition fully met.* This approach will be used in future activities.
Occupational exposure to lambda-cyhalothrin will be minimized through PPE (according to WHO specs). Either a commercial laundry will be hired to wash all spray operator overalls during the program, or a wash-person (wearing apron, gloves, and boots) will be hired to wash overalls at the sub-county storage location at the end of every day of spraying. To minimize prenatal exposure to lambda-cyhalothrin, women sprayers will undergo pregnancy tests prior to the spray period. Treatment medications will be provided to Kabale Regional Hospital and HCIIIs in the case of hazardous occupational or residential exposure. An IEC activitiy will educate villagers on their roles and responsibilities during the spray campaign to avoid exposure, and supervisors will remind residents of these responsibilities during the spray campaign.	*Condition fully met.* However, the two reported cases of household members reentering their households earlier than the recommended time indicates a need for ongoing IEC activities during the actual spraying exercise to remind the community members of dangers associated with exposure lambda-cyhalothrin and the necessary precaution to be taken.
Spraying will not take place in protected and environmentally sensitive areas (e.g., non-cultivated wetlands). As Kabale District is an extremely important area environmentally, care will be taken to ensure lambda-cyhalothrin does not negatively impact sensitive areas. As far as possible, contaminated waste water/rinse water will be re-used in subsequent days of spraying (progressive rinsing).	*Condition fully met.* An environmental monitoring activity by IUCN is underway to determine the impact of the IRS activity on the sensitive areas.
An environmental reporting system will be developed and implemented, and environmental monitoring may also be conducted.	*Condition partly met.* IUCN in partnership with NEMA and MUINER was commissioned to conduct an environmental assessment before the start of spray activities. Soil and water samples taken before and after the spray period especially in areas designated for PPE washing and insecticide storage will assist in determining the impact of IRS activities on the environment.

Summary of PERSUAP required activities	Comments on how well these actions were conducted and suggestions for future activities
Contaminated sachets will be triple rinsed and disposed by incineration at an in-country power plant or cement kiln. According to FAO guidelines, a high-temperature incinerator for disposal of packaging is not necessary for ICON™ WP.	*Condition fully met.* This approach will also be used in future activities.
An environmental assessment (EA) will be prepared before the use of DDT in IRS operations. The Uganda MOH proposes to start planning for the carefully controlled use of DDT in IRS operations. Upon completion of environmental review by Uganda's NEMA, the use of DDT is expected to begin in 2007. An EA on DDT use has been prepared for MOH, as required by NEMA. This EA will be duly reviewed by USAID, revised as necessary, and duly approved by USAID before any consideration is given to supporting very specific application of DDT under epidemiologically justified conditions.	*Condition fully met.* DDT was not used in this round. After the review and approval of the EA by USAID, RTI will work with the MOH and other partners to plan for the use of DDT in IRS operations. Training and sensitization of community members on the use of DDT will be conducted ahead of spraying activities.
As required by ADS 204.5.4, *the Strategic Objective team must actively monitor ongoing activities for compliance with approved IEE[1]/PERSUAP recommendations*, and modify or end activities that are not in compliance. The SO team will also ensure that provisions in this IEE for mitigative measures and the conditions specified herein, along with the requirement to monitor, will be incorporated as appropriate in RFA/RFPs, APSs, contracts, cooperative agreements, grants, and sub-grants.	*Condition fully met.* RTI in partnership with the Kabale DDHS provided timely feedback to USAID and other partners about the adverse effects and emergencies encountered during the IRS exercise and how they were handled in accordance with recommended guidelines. This approach will be used in future activities.

[1] IEE, initial environmental examination.

5. Implementation of IRS Activities

The IRS program was officially launched by the honorable minister of health, Dr. Stephen Malinga on behalf of the president, on July 19, 2006, in Maziba sub-county in the attendance of senior central and district government officials and senior representatives from USAID and other development partners. Dr. Malinga and other officials also witnessed a demonstration of an IRS activity in one of the houses in Maziba. Actual spray activities had commenced on June 1, 2006, in Maziba sub-county; and on June 20, were extended to the other 19 sub-counties. This delay in starting activities in all 20 sub-counties was to ensure that all villages were notified about the upcoming activities so that villagers would be available to receive the spray teams.

The success of the Kabale IRS project largely depended on its organization, labor, logistics, and the cooperation of community members throughout the exercise. Efforts were made to ensure that spraying in all villages within a parish was completed before moving to the next parish. Within each village, household members were given a day's advance notice of the spray schedule in their respective areas through radio announcements, radio spots, megaphones, radio talk shows, or house-to-house visits by field supervisors and team leaders. Households were required to do the following: provide about 10 liters of clean water to spray operators; remove their property from the house before spraying; and keep the items outside their homes for a minimum of 2 hours (120 minutes) to allow the solvent in the formulation to vaporize and dry on the sprayable surface. After that period, residents were advised to sweep any dead insects found on the floor and dispose of them in pit latrines or burn them to avoid contaminating the food chain (i.e., that insects would be eaten by domesticated birds, chickens, ducks, and turkeys). Thereafter, they could move their property into the houses. Actual spraying was typically conducted between 9:00 am and 2:30 pm.

Launch of IRS program in Kabale district.

IRS data were collected from the spray operators who recorded their daily activities on a card. The following data were included on the information card: village, parish, and sub-county where the activities occurred; name of household head, house type, and total number of rooms in a household; number of sprayed and unsprayed rooms; total population residing in the sprayed housed by sex; number of children under the age of five in each household; and the rate of insecticide-treated net usage in the sprayed households. Houses found locked or whose owners refused spraying were also recorded on the spray operator's daily card; but it was not possible to obtain reliable information on the number of people residing in those households or the total number of rooms. As such, to estimate the total number of people unprotected, we used the average household size obtained from the houses sprayed and multiplied that by the number of households not sprayed. The spray operators also recorded the number of ICON sachets received, the number used, and those returned intact at the end of each working day. These cards were verified against the returned insecticide and empty/used sachets every day.

The completed cards were submitted to the team leader for verification and aggregation before being submitted to the supervisor, who in turn, collated the forms for submission to the project team. Project staff collected the collated data forms from each sub-county on a regular basis, and data on these forms were entered in the Kabale office into an Excel-based database. These data were used to monitor the daily and cumulative coverage of the IRS project and to track insecticide consumption.

The remaining part of this section, briefly describes the experiences encountered during the implementation of the IRS project in Kabale, highlighting results achieved and lessons learned.

5.1 IRS Results

Table 6 provides a summary of the overall results for the IRS project as reflected by the key output indicators. Overall, these results indicate that the program was successfully implemented, yielding a much higher coverage rate for the spray activities in the planned period of time. In addition, the application rate of the insecticide was within the recommended manufacturer's range, with a total average of 1.3 sachets per household. The very low refusal rate of less than 3% occurred primarily because some residents misconstrued the IRS project for something else. In many cases, the residents initially locked their homes and disappeared on the planned day of spraying, but after talking to their neighbors and listening to additional mobilization exercises, they understood the project's purpose and sought out the spray teams to spray their houses during the subsequent visits to the villages.

Table 6. Summary of Coverage Results Achieved under Kabale IRS Project[1]

Total houses found	107,400
Houses fully sprayed	89,566
Houses partly sprayed	13,763
Houses not sprayed	4,071
Percentages of houses partly or fully sprayed	96.2%
Percentage of houses fully sprayed	83.4%
Percentage of houses partly sprayed	12.7%
Percentage of houses not sprayed at all	3.8%
Total population protected	488,502
Total population unprotected[2]	20,355
Targeted population	508,857
Percentage of targeted population protected	95.9%
Average houses sprayed per sachet of insecticide	1.3
Number of children under five protected	82,275
Percentage of the protected population that is female	52%

[1] The primary reason for spraying some houses partly was because some of the rooms were used either as food establishments or stores for food. Thus, in these cases, we still assumed full coverage of sleeping spaces for those households.

[2] Used estimate of five persons per household for houses not sprayed, as residents in those houses could not be established.

Wall bioassay tests were conducted to determine the potency of the insecticide deposits in 14 houses in Maziba, Bubare, and Buhara. The results indicated there was 100% mortality for mosquitoes exposed to the sprayed walls within an hour or less after exposure. Mosquitoes exposed to plastered walls died sooner than those exposed to mud walls.

Table 7 lists IRS output indicators by each day of the spray campaign to provide an idea on the magnitude of the coverage on a daily basis and the variance in the level of efficiency by the spray teams over time.

Table 7. Summary IRS project Output Indicators by Each Day of the Spray Campaign

Date	Summary Indicators					
	Total Houses Found	Houses Fully Sprayed	%age of Houses Fully Sprayed	Cumulative Houses Sprayed	Average Houses Sprayed per Sachet	Population Protected (cumulative)
6/1/2006	62	62	100.0	62	1.7	287
6/2/2006	82	79	96.3	141	1.4	696
6/3/2006	87	87	100.0	228	1.1	1,125
6/4/2006						
6/5/2006	99	97	98.0	325	1.7	1,611
6/6/2006	101	99	98.0	424	1.5	1,989
6/7/2006	70	70	100.0	494	1.3	2,338
6/8/2006	77	76	98.7	570	1.2	2,659
6/9/2006	77	75	97.4	645	1.6	3,059
6/10/2006	109	109	100.0	754	1.2	3,497
6/11/2006						
6/12/2006	131	115	87.8	869	2.3	4,002
6/13/2006	111	110	99.1	979	2.0	4,554
6/14/2006	76	74	97.4	1,053	2.1	4,895
6/15/2006	86	86	100.0	1,139	1.5	5,293
6/16/2006	88	85	96.6	1,224	1.6	5,675
6/17/2006	82	77	93.9	1,301	1.7	6,023
6/18/2006						
6/19/2006	1,954	1,661	85.0	2,962	1.2	14,777

Date	Summary Indicators					
	Total Houses Found	Houses Fully Sprayed	%age of Houses Fully Sprayed	Cumulative Houses Sprayed	Average Houses Sprayed per Sachet	Population Protected (cumulative)
6/20/2006	2,271	2,040	89.8	5,002	1.4	25,394
6/21/2006	2,069	1,811	87.5	6,813	1.3	34,762
6/22/2006	2,387	2,045	85.7	8,858	1.4	45,786
6/23/2006	2,259	1,998	88.4	10,856	1.3	56,239
6/24/2006	2,311	1,978	85.6	12,834	1.3	66,759
6/25/2006						
6/26/2006	2,186	1,893	86.6	14,727	1.3	76,618
6/27/2006	2,136	1,842	86.2	16,569	1.3	86,025
6/28/2006	2,218	1,816	81.9	18,385	1.3	95,345
6/29/2006	2,190	1,950	89.0	20,335	1.3	105,483
6/30/2006	2,270	2,011	88.6	22,346	1.3	115,511
7/1/2006	2,193	1,935	88.2	24,281	1.4	125,838
7/2/2006						
7/3/2006	2,076	1,803	86.8	26,084	1.3	135,441
7/4/2006	2,008	1,700	84.7	27,784	1.2	144,174
7/5/2006	2,004	1,687	84.2	29,471	1.2	153,513
7/6/2006	2,120	1,824	86.0	31,295	1.3	163,453
7/7/2006	1,931	1,576	81.6	32,871	1.3	172,421
7/8/2006	1,866	1,547	82.9	34,418	1.3	181,837
7/9/2006						
7/12/2006	2,007	1,784	88.9	39,660	1.5	208,958
7/13/2006	1,962	1,677	85.5	41,337	1.4	217,990
7/14/2006	1,980	1,714	86.6	43,051	1.4	226,755
7/15/2006	1,910	1,592	83.4	44,643	1.5	235,101
7/16/2006						
7/17/2006	1,993	1,713	86.0	46,356	1.4	243,673
7/18/2006	741	281	37.9	46,637	1.5	244,977
7/19/2006	1,907	1,614	84.6	48,251	1.4	254,632

Date	Summary Indicators					
	Total Houses Found	Houses Fully Sprayed	%age of Houses Fully Sprayed	Cumulative Houses Sprayed	Average Houses Sprayed per Sachet	Population Protected (cumulative)
7/20/2006	2,035	1,781	87.5	50,032	1.5	263,515
7/21/2006	1,910	1,665	87.2	51,697	1.6	272,295
7/22/2006	2,172	1,802	83.0	53,499	1.4	282,443
7/23/2006						
7/24/2006	1,536	1,257	81.8	5,4756	1.3	289,658
7/25/2006	2,043	1,682	82.3	5,6438	1.5	299,203
7/26/2006	2,161	1,862	86.2	5,8300	1.4	309,088
7/27/2006	2,158	1,841	85.3	60,141	1.5	318,678
7/28/2006	2,209	1,828	82.8	61,969	1.4	328,630
7/29/2006	2,137	1,725	80.7	63,694	1.3	338,425
7/30/2006						
7/31/2006	2,221	1,837	82.7	65,531	1.4	348,497
8/1/2006	2,327	1,943	83.5	67,474	1.4	359,055
8/2/2006	2,197	1,773	80.7	69,247	1.4	368,979
8/3/2006	1,750	1,336	76.3	70,583	1.3	376,859
8/4/2006	2,070	1,521	73.5	72,104	1.3	386,319
8/5/2006	2,026	1,458	72.0	73,562	1.3	395,355
8/6/2006						
8/7/2006	1,799	1,390	77.3	74,952	1.5	403,193
8/8/2006	1,660	1304	78.6	76,256	1.4	410,609
8/9/2006	1,899	1466	77.2	77,722	1.4	419,203
8/10/2006	1,794	1442	80.4	7,9164	1.3	427,395
8/11/2006	1,832	1513	82.6	80,677	1.4	435,250
8/12/2006	1,585	1197	75.5	8,1874	1.2	442,497
8/13/2006						
8/14/2006	1,952	1,626	83.3	83,500	1.4	451,291
8/15/2006	1,722	1,392	80.8	84,892	1.3	458,673
8/16/2006	1,871	1,471	78.6	86,363	1.3	467,342

Date	Summary Indicators					
	Total Houses Found	Houses Fully Sprayed	%age of Houses Fully Sprayed	Cumulative Houses Sprayed	Average Houses Sprayed per Sachet	Population Protected (cumulative)
8/17/2006	1,512	1,288	85.2	87,651	1.3	475,115
8/18/2006	1,141	961	84.2	88,612	1.2	481,674
8/19/2006	852	701	82.3	89,313	1.3	486,796
8/20/2006						
8/21/2006	379	253	66.8	89,566	1.1	488,502
TOTAL	**107,400**	**89,566**	**83.4**	**89,566**	**1.3**	**488,502**

5.2 Program Monitoring and Technical Support Supervision

Technical support supervision—Technical support supervision was provided by RTI project staff, DDHS, and NMCP staff to ensure that spray operations were conducted in accordance with prescribed technical procedures for dose dispensation on the wall, ceiling, eaves, and other surfaces suitable for mosquito resting. Corrective actions for the identified spray operators' mistakes were taken immediately to improve performance and efficiency of the team.

Using IRS coverage data, RTI supervisors evaluated the productivity of each spray team and spray operator in terms of the number of structures sprayed vis–a–vis the amount of insecticide sprayed per structure. This enabled the project staff to detect operational problems early, led to prompt investigation and supportive corrective action, and helped to improve the project's overall efficiency. The major cause of inefficiency during the project's early days was due to the slower speed of spraying by spray operators and/or them putting the

nozzle tip nearer to the wall than the recommended distance of 45 cm. Through regular support, this problem was overcome and the efficiency improved significantly. However, as the project approached completion (in early August 2006), some supervisors and team leaders slowed the whole exercise with the expectation of earning more money—as they saw it, a delay in completing spray activities would extend their working days. This slowdown also coincided with the onset of the early August rains, which caused transportation delays and interrupted the schedule of operations. To keep on schedule, RTI mobilized wash persons who had received prior training on IRS to work as spray operators. In addition, spray teams from sub-counties that had completed activities early were mobilized to assist with spraying remaining villages in other sub-counties. This approach proved to be effective and enabled the program to complete just 5 days behind schedule. Overall, the fact that 9,132 more households than originally estimated were found in the district, the program was generally completed on schedule.

During and after a monitoring exercise, team leaders and supervisors were notified of the most commonly identified mistakes and the recommended actions to ensure that these mistakes would not happen in the future. Key issues focused on during routine monitoring and supervision included the following:

- Observing the spray operators when they mixed the insecticide with water to ensure adherence to guidelines.
- Observing the spraying techniques of spray operators and checking the insecticide spray pattern on the sprayed surfaces to verify uniformity of deposits before drying up.
- Validating the number of rooms in each house sprayed completely, partly, and not at all.
- Verifying the information-recording process by the spray operators to account for their work and by the supervisors to ensure proper tallying of a day's activities.
- Validating the number of houses reported locked or refused to participate in the spray exercise.[4]
- Verifying the logistics supplied to each spray team against the numbers reportedly used, the balances, and the amount available in stock.
- Evaluating the cleaning and maintenance procedures followed by the spray team.
- Verifying the washing process of PPEs and sprayers, the denaturation of unused ICON-contaminated solutions, and the disposal of that water into pit latrines.
- Occasionally, conducting bioassay tests to assess effectiveness and persistence of the insecticide against the malaria vectors on the sprayed surface.

[4] For those houses where refusals were reported, project staff elicited information from neighbors on the factors cited for nonparticipation. This information would be used to develop messages used in subsequent mobilization events.

Cleaning and maintenance of spray equipment—All Hudson compression sprayers used in the project were regularly maintained according to the manufacturer's guidelines. This not only helped to ensure that pumps maintained the correct pressure for generating the flat fan swath required for efficient spray results, but also to extend their productive life. Spray teams were advised to observe the following maintenance and storage procedures:

- Clean the sprayers using the progressive rinsing method. The purpose of rinsing the sprayers was to remove any concentrated or large areas of the insecticide that might still be in or on the sprayer. Empty the unused or remaining insecticide at the end of each day into the first barrel. Several rinses using small volumes (between 1 to 2 liters of clean water) were preferred to filling the spray tank once with clean water to obtain a better outcome. Triple rinse the pumps to clean the inside of the pumps including the lance and nozzle; and wash the outside of the pump using a towel dipped into caustic soda, followed by liquid soap.
- Dispose used or insecticide-contaminated waste water into pit latrines after denaturing it with caustic soda (sodium hydroxide). Thereafter, the rinsed sprayers would be drained and moped prior to storage to minimize rusting and associated damage.
- After the final rinse, inspect sprayer and make necessary repairs using a checklist that included checking for the presence of nozzle and the white ring; damaged strainer screens; cracks and leakages on the pump; and the condition of pump valves and seals. Store cleaned sprayers at a slanting angle ready for use the next day.

Handling Pilferage of ICON™ 10% WP and other Commodities—Several measures were used to minimize pilferage and wastage. First, all procured items (ICON, PPE, sprayers, and other logistical items) were recorded using forms and checklists and tracked at each point of distribution up to the field stores. Only authorized staff were allowed to withdraw items from stores, and each withdrawal was documented. Second, all storage facilities were retrofitted and secured to avoid break-ins. Security guards were also hired to protect the facilities on a 24-hour basis. Third, in partnership with the district internal security officer, the police, and other intelligence organs, officials throughout the district conducted regular surveillance and reconnaissance activities to monitor the utilization of IRS materials, especially ICON, during the spray activities. Fourth, project staff and

DDHS officials conducted education exercises to community members and leaders on the importance of reporting any suspicious activities conducted by spray operators or other persons during the IRS exercise. Finally, each spray operator was required to account for all insecticide given at the beginning of the day by returning the empty sachets of the insecticide together with the unused insecticide at the end of the day. In addition, each operator would record the number of houses sprayed against which the reported used insecticide could be associated to increase efficiency.

Despite these measures, two incidents related to pilferage of ICON occurred. The first incident was in Kavu village where a head of household and a spray operator conspired to keep the remaining amount (about 2 liters) of the ICON solution after his house was sprayed. The head of household stored the solution in a milk jug; later, his wife ingested the ICON mistaking it for leftover milk (see *Kavu Parish* in the next section for details about the victim's treatment). When alerted, security officials apprehended both conspirators, and RTI project staff immediately terminated the spray operator's employment. In another incident in Kamwezi sub-county, the police—acting on tips provided by the DDHS and local leaders—raided a home of a drug distributor who was suspected of pilfering government drugs and ICON insecticide and found an assortment of empty ICON sachets, various public health medicines, and other unidentified materials. These materials were impounded and a sample of a white powder that was found in a polythene bag was submitted to the government chemist to ascertain its chemical content. Test results revealed that the confiscated substance was Talc, a finely powdered native hydrous magnesium silicate. Although the suspect was not arrested immediately, he has since disappeared from the village.

5.3 Safety Measures and Management of Side Effects

Safety—Occupational exposure to lambda-cyhalothrin for the spray groups, team leaders and wash persons was minimized by using PPE. The spray operators were provided with helmets, face shields, nose and mouth masks, long-sleeved cotton overalls, rubber gloves, pairs of cotton-rich stockings, and robust gum boots.

At the end of the day, spray operators handed over the PPE to the wash persons for cleaning. Wash persons were provided with similar PPE like spray operators with longer gloves to protect their arms and hands from contamination while washing. The leftover mixed insecticide for each working day was returned to the barrels and reused the next day to help minimize wastage. The waste water (contaminated with the insecticide) generated from washing the overalls was neutralized

using sodium hydroxide (caustic soda) before being emptied into pit latrines. These latrines were located on high ground, away from sensitive ecosystems, such as wetlands and watering points, to help minimize environmental contamination.

In summary, the following measures were taken prior to and during IRS activities to minimize exposure to the insecticide and the potential adverse experiences of such exposure.

- Prohibiting eating, drinking, or smoking while working (to avoid dermal exposure, inhalation, or ingestion exposure)
- Ensuring that workers washed their hands and face with soap and a large quantity (about 2 liters) of clean water after spraying and before eating, smoking or drinking to avoid dermal exposure, inhalation, or ingestion exposure)
- Washing used overalls every 2 days by the wash person(s) (to avoid dermal exposure, inhalation, or ingestion exposure)
- Providing the spray teams with soap tablets to bathe at the end of every working day and making sure that they changed into clean clothes [to avoid dermal exposure or inhalation)
- In case of accidental spillage of insecticide on the skin, advising the worker to wash the affected area(s) with soap and water immediately (to avoid prolonged dermal exposure)
- Advising spray operators and wash persons to immediately inform the supervisor or team leader about any adverse side effects of the insecticide (to seek health care early)
- Advising parents, guardians, or home caretakers to prevent children from coming into contact with sprayed surfaces after returning to the house (to avoid the transitory side effects of the insecticide) and to avoid plastering, painting, and placing pictures/photographs on the sprayed surfaces because these activities conceal the insecticide and reduce the sprayable surface).
- Stockpiling medicine and training clinicians in emergency procedures. Medicines (atropine, sodium chloride, hydrocortisone eye drop, hydrocortisone cream, hydrocortisone vial, and intravenous disposable sets) were purchased in Kampala and delivered to KRRH and all Health Center IV (HCIV) facilities to treat people who experienced adverse effects from ICON exposure. A total of 46 clinicians (HCIII and IV) and physicians (KRRH) were also trained at Kabale Lukiiko Hall (Makanga) on how to manage emergencies arising from pesticide exposure with special emphasis on lambda-cyhalothrin.

Management of adverse effects and emergencies—Despite the afore-mentioned safety measures, five emergency cases were recorded during the project. Below is a summary of how these cases were managed.

Kavu Parish—The first case occurred in Kavu Parish (Maziba sub-county) in which a woman accidentally ingested an ICON solution that had been left in a jug by a spray operator who had teamed up with the woman's spouse to pilfer the ICON solution. The children, who watched their father dealing with the spray operator, quickly alerted their mother that she was drinking a solution other than milk. It is not clear how much ICON the woman ingested before her children interceded. When project staff and DDHS authorities enquired from the victim and her husband about the amount ingested, they received conflicting accounts—ranging between half a glass (about 4 ounces) to one cup (about 15 ounces).

Because the nearest government health facility was more than 5 hours away, the victim was admitted to a nearby private clinic, where she was treated with atropine, activated charcoal, Vitamin E, and intravenous fluids for three days and then discharged. The DDHS and RTI offices were notified about this case. DDHS and RTI supervisors followed her up for 4 weeks until she recovered from adverse effects. During a visit to the home of the victim after six weeks, project staff learned that, although she reported to be healthy, she had had a miscarriage the week before. Project staff will continue to monitor the health of this victim over the next several months.

RTI paid for the medical bills incurred at the private clinic. The spray operator involved in this incident and the victim's spouse were both apprehended by the district authorities.

Butobere Village—The second case of exposure took place in a home of four persons in Butobere village (Central Division sub-county). A mother and daughter aged 13 years entered the house in less than 30 minutes after spraying to seek shelter because it was raining. These two victims experienced eye pain, swelling of the face, itching and burning sensations (paresthesia) that was accompanied by sneezing (nasal irritation) and coughing. The two residents were taken to the emergency clinic at KRRH by RTI staff for examination and treatment with hydrocortisone cream, hydrocortisone eye drops, and Vitamin E (topopheral acetate) capsules. Like the case in Kavu parish, the victims of lambda-cyhalothrin exposure in Butobere village were followed up (but for 6 days) until recovery from their adverse experiences.

Nyanja Parish—In this case, a spray operator reportedly drank water during the spray activities without cleaning his hands. Within 30 minutes, he started complaining of an upset stomach. He was immediately removed from protective equipment, mouth/nose mask, and his hands were washed with soap and a large quantity of water. Thereafter, he was taken to the laboratory at KRRH for stool examination to determine if the adverse effect was due to lambda-cyhalothrin ingestion. Laboratory tests indicated that the adverse effects were unrelated to ingestion or exposure to ICON, and the operator was treated with antibiotics. He was able to report for duty the next day and served as a spray operator until the project's completion.

Central Division—In this case, a Local Council III woman representative in Central Division entered her home less than 1 hour after spraying and experienced the transitory

side effects similar to the case in Butobere village. She was provided a similar treatment and recovered well.

Northern Division—In this case, the walls of a home were reportedly over-sprayed by an operator leading to formation of some sporadic pools of formulation on the floor and washing dish in the kitchen. Household residents reported experiencing dermal and inhalation exposures, leading to skin irritation/inching, coughs, and sneezing. All three residents received similar treatment at KRRH. RTI paid for the cost of medication.

Southern Division—The last case was a reported death of two students at the Rushoroza Secondary School (St. Paul's Seminary) after the school's dormitories had been sprayed with ICON. A team of NMCP, DDHS, and project officials visited the school on several occasions, upon which it was verified that the deceased children had been sick before the spray exercise and had died of cerebral malaria and asthma. Nevertheless, to establish causality, some organ samples from the deceased students were sent to Mulago Hospital (Kampala). Final results from the toxicology tests are still pending.

5.4 Follow-up Actions

Two post-IRS surveys (to include clinical evaluation of spray operators, an entomological survey, and an environment impact assessment) will be done. The post-spray entomological survey will be conducted to assess the persistence of the sprayed insecticide on treated surfaces 2–3 months after the end of the IRS project, the susceptibility status of the vectors to the insecticide, and the indoor and outdoor resting density of anopheline mosquitoes in sample locations within the district.

The post-spray environment impact assessment will be conducted to assess the impact of the spraying campaign, if any, on the environment. In addition clinical evaluations will be conducted on a sample of spray operators to assess their medical fitness after the spray activities. Results from these exercises will be disseminated in early November 2006.

6. Lessons Learned and Recommendations for Future Programs

During the process of conducting IRS project activities in Kabale, project and government staff learned several lessons that will be invaluable in implementing similar programs in the future. Given these lessons, the following approaches/strategies are recommended for future IRS programs in Uganda.

- Geographical reconnaissance—A geographical survey of areas where IRS activities will be conducted should be done ahead of the spray season. This will assist in calculating a better estimate of the logistics required. In the case of the concluded effort, there was an underestimate of more than 9,000 households. Although a sufficient amount of insecticide had been ordered ahead of time, completing activities on time given the underestimate required additional resources.
- Utilization of government officials—The project placed a significant emphasis on the using government (district and central MOH) staff on various aspects of program implementation, including training and technical supervision. Table 8 shows the total number of government employees that played a significant role on this project as compared with the number of RTI staff. This approach was quite successful and will enable the government to better utilize the lessons learned from this effort during the scale-up phase. In future programs, it is also recommended that relevant government officials continue to take on more responsibility in the implementation of activities. District officials also should be involved in planning spray activities right from the beginning.

Table 8. Persons that Worked on Kabale IRS Program by Designation

Category of Staff	Number
RTI employees	12
Government employees	50
Short-term temporary workers hired specifically for IRS by DDHS	317

- Increased IEC activities at the community level—It was noted that there had been less emphasis of IEC activities at the community level during this spray round such that, in some villages, supervisors had to conduct additional education/mobilization of communities before deploying spray teams. In addition, some community members were not fully aware that the ICON insecticide was soluble, and they suspected that their houses were sprayed with plain water because they did not see any residue on the sprayed walls. In such cases, project

staff conducted wall bioassays on a sample of households and after mosquitoes exposed to the sprayed walls died, they were convinced that their houses had indeed been sprayed properly. Therefore, for future efforts, it is recommended that fewer resources be allocated for district-level sensitization meetings and, instead, redirected toward mobilization on the community level.

- Minimizing pilferage—It is possible to minimize pilferage of spray materials (especially insecticides). However, this requires vigilance and collaboration from all partners, including the police, intelligence officials, local leaders, and community members. By continuing to use monitoring mechanisms and data management procedures like those used during this spray exercise, future programs will be able to minimize this problem.
- Equipment maintenance training—The project experienced a higher-than-expected amount of damage and malfunctioning of PPEs and spray equipment. This problem was corrected through continuous technical support supervision and emphasis on maintaining personal responsibility by all spray operators. In the future, it is recommended that training programs emphasize this issue before initiating spray activities.
- Coordination of monitoring activities—It is hoped that, for future IRS exercises, this issue can be improved. This should include collection of more indicators that can help to assess the impact of spray activities on the disease burden.
- Storage of insecticides—It will likely be challenging to find appropriate secure storage facilities for insecticides and PPE in sub-county settings on a long-term basis. At the end of the spray exercise, all sprayers, PPE, and unused insecticide were collected from the sub-counties and are stored at the project office in Kabale. In the future, it is recommended that more consideration be made to providing resources for secure storage space with enough capacity to store all IRS materials.

References

EXTOXNET (Extension Toxicology Network). 1996. *Pesticide Information Profile: Lambda Cyhalothrin.* Revised June 1996. Available at http://pmep.cce.cornell.edu/profiles/extoxnet/haloxyfop-methylparathion/lambda-cyhalothrin-ext.html.

IPCS (International Program on Chemical Safety). 1990. *Environmental Health Criteria 99. Cyhalothrin*. Geneva: World Health Organization. Available at http://www.inchem.org/documents/ehc/ehc/ehc99.htm.

Kilian, A.H.D., P. Langi, A. Talisuna, and G. Kabagambe. 1999. Rainfall pattern, El Nino and malaria in Uganda. *Transaction of the Royal Society of Tropical Medicine and Hygiene.* 93: 22–23.

Lindblade, K.A., E.D. Walker, and M.L. Wilson. 2000. Early warning of malaria epidemics in African highlands using *Anopheles* (Diptera, Culicidae) indoor resting density. *Journal of Medical Entomology.* 37: 664–674.

Lindblade, K. A, F.D. Walker, A.W. Onapa, J. Katungu, and M.L. Wilson. 1999. Highland malaria in Uganda: prospective analysis of an epidemic associated with El Nino. *Transaction of the Royal Society of Tropical Medicine and Hygiene.* 93: 480–487.

Mouchet, J., J. Sircoulon, S. Manguin, A.W. Onapa, and S. Lowenture. 1998. Evolution of malaria in Africa for the past 40 years: impact of climatic and human factors. *Journal of American Mosquito Control Association.* 14: 121–130.