INDOOR RESIDUAL SPRAYING FOR MALARIA CONTROL

Spray Performance Report for Apac and Oyam Districts, Uganda

March - May 2008

Indoor Residual Spraying (IRS) Indefinite Quantity Contract (IQC)

Task Order 1

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Background

Funded by the United States (U.S.) President's Malaria Initiative (PMI) through the U.S. Agency for International Development (USAID), RTI International is providing strategic, technical, management, operations, and financial support to the Uganda National Malaria Control Program (NMCP) to expand the use of indoor residual spraying (IRS) as an intervention for malaria prevention and control. This support is provided under the IRS Indefinite Quantity Contract (IQC) Task Order. USAID and the NMCP have agreed to scale up IRS activities into 10 districts of Uganda (Amolatar, Amuru, Dokolo, Gulu, Kabale, Kanungu, Kitgum, Lira, Pader, Rukungiri). This effort will lead to the spraying of 807,000 residential houses with residual insecticide that will provide protection to an estimated 3.5 million people against malaria in the targeted districts.

In 2007, the Ugandan Ministry of Health (MOH) approved the re-introduction of dichloro-diphenyl-trichloroethane (DDT) for malaria vector control. This report summarizes the first round spray program activities conducted in the highly malaria endemic districts of Apac and Oyam using DDT during the period March - May 2008. An alternative insecticide, lambda cyhalothrin (ICON CS), was used to spray selected households located in sensitive areas in accordance with conditions set forth by Uganda's National Environmental Management Agency (NEMA). [1]

Summary Results

The program surpassed the goal of spraying at least 85% of all residential houses[2] in both Apac and Oyam districts as reflected by the summary results presented in Tables 1 and 2 below.

Table 1: Summary of IRS Output Indicators for Oyam District

Indicator	Status
Total houses found	101,908
Houses fully sprayed [3]	87,269
Houses partly sprayed[4]	7,607
Houses not sprayed	6,407
Percentages of houses partly or fully sprayed	93.1
Percentage of houses fully sprayed	85.6
Percentage of houses partly sprayed	7.5
Percentage of houses not sprayed at all	6.3
Total population residing in houses fully or partly sprayed	315,765
Total population residing in houses not sprayed at all (estimate)	26,004
Target population	341,769

[1] Sensitive areas are defined as areas of particular interest due to their ecological or economic value (wetlands, forests and open waters).
[2] Throughout the report, we use the words houses and structures interchangeably. In each case, we refer to actual units/structures sprayed rather than households/homes that at times own more than one residential structure/house.
[3] Houses fully sprayed refer to houses in which all rooms were treated with insecticide.
[4] Houses partly sprayed refer to houses in which not all rooms were treated with insecticide because of closure, serving as food store, etc.

Percentage of targeted population residing in houses fully or partly sprayed	92.9
Average number of houses sprayed per sachet of insecticide (DDT / ICON CS)	3.0
Number of children under five residing in houses fully/partly sprayed	70,549
Percentage of population that is female	51.5
Number of pregnant women residing in houses fully/partly sprayed (estimated)	12,274
ICON CS Insecticide used (in Sachets of 62.5 grams)	225
DDT Insecticide used (in Sachets of 540 grams)	30,939
Number of spray days in district	20

Table 2: Summary of IRS Output Indicators for Apac District

Indicator	Status
Total houses found	111,534
Houses fully sprayed	95,228
Houses partly sprayed	7,797
Houses not sprayed	8,509
Percentages of houses partly or fully sprayed	92.4
Percentage of houses fully sprayed	85.4
Percentage of houses partly sprayed	7.0
Percentage of houses not sprayed at all	7.6
Total population residing in houses fully/partly sprayed	322,697
Total population residing in houses not sprayed at all (estimate) unprotected	31,808
Target population	354,505
Percentage of targeted population in houses fully/partly sprayed	91.0
Average number of houses sprayed per sachet of insecticide (DDT / ICON CS)	3.4
Number of children under five protected	78,761
Percentage of protected population that is female	61.2
Number of pregnant women protected	16,298
Number of mosquito nets found	90,470
Number of children under 5 sleeping under net	38,758
ICON CS Insecticide used (in Sachets of 62.5 grams)	1,557
DDT Insecticide used (in Sachets of 540 grams)	28,788
Number of spray days in district	28

Roles and Responsibilities of Participating Organizations

RTI provided overall technical and managerial support towards the implementation of activities in both districts and partnered with NMCP, District Health Offices (DHOs), NEMA, and Health Communications Partnership (HCP) in this effort. Specific roles of each partner included the following:

- MOH/NMCP conducted clinical examinations of spray operators pre- and post-spraying.
- MOH/DHOs in Apac and Oyam organized and participated in planning and district sensitization meetings. They also provided personnel for supervisory positions on spray teams and were involved in the selection of spray operators used in each district.
- The Vector Control Department of the MOH performed bioassays and other entomological monitoring tests to ascertain the effectiveness of spray operations in the various districts.
- HCP provided technical support in the implementation of information, education and communication (IEC) activities in both districts.
- MOH/NMCP, Ministry of Agriculture, NEMA, and private organic farmers (specifically the Maruzi Farmers Association) participated in providing overall monitoring and supervision of spray activities.
- The School of Entomology and Parasitology in Mulago provided students who participated in supervising the spraying exercise and supported the monitoring against pilferage of DDT during spray operations.

IRS Operations

Planning, Procurements and Logistics

Through a collaborative process with MOH/NMCP and district officials, RTI conducted planning and needs assessment exercises to determine the material, logistical, and financial support required for the IRS program and associated environmental compliance activities. Commodities and logistics necessary for the program (including insecticide [DDT and ICON CS], spray pumps, personal protection equipment [PPE], and other relevant commodities) were procured and distributed to the operational centers (at the sub-county level) from which activities were coordinated. Table 3 below summarizes the key materials that were procured for IRS activities in Apac and Oyam. In addition to these items, spray pumps that were purchased previously for use in other districts (Gulu, Kabale, Kanungu and Amuru) were also used in Apac and Oyam. RTI also used balances of other materials (such as batteries and liquid soap) procured during previous spray rounds in Uganda.

Table 3: Items Procured for Oyam and Apac Exercise

Items	Unit	Quantity
Nose & mouth masks	Pieces	61,000
Socks (pairs)	Pieces	3,019
Haversack (pieces)	Pieces	2,171
Rubber gloves (short)	Pairs	3,857
Rubber gloves (long for wash persons)	Pairs	408
Overalls	Number	3,272
Gumboots (non-steel toe)	Pairs	1,646
Helmets	Pieces	2,142
Face shield	Pieces	4,284
Nose & mouth masks	Cartons	792
Spray pumps	Number	604
Hard hats	Number	2148
Towels	Number	10
Insecticide – DDT 75%WP	Sachets	119,556

In accordance with the supplemental environment assessment (SEA), RTI implemented a strict regimen of pesticide management to ensure that insecticide is accounted for at every step of the program implementation process. DDT was procured from Avima in South Africa. The ICON CS used was procured from Syngenta in Kenya and came from a batch purchased previously to cover Kitgum and Pader districts. Starting from the port of entry (Entebbe International Airport), all the insecticides were escorted directly to the stores in the field. Storekeepers and district supervisors received training on insecticide tracking and record keeping.

To ensure the smooth launch of the DDT spraying, RTI brought to Uganda two technical staff with prior experience implementing IRS activities using DDT (in Mozambique) to provide guidance during the implementation of activities. One of the staff, Ms. Catherine Ngugi, stayed in the field for about one month supervising the spraying exercise. This enabled the local RTI staff, MOH, and district health staff to acquire the necessary guidance to conduct the exercise according to the required standards.

Progress of the spraying exercise was assessed on a daily basis and challenges were addressed in a timely manner as they arose. In addition, RTI worked with the School of Entomology and Parasitology at Mulago to identify students who would take part in the monitoring of spray operators and truck drivers against pilferage for the first three weeks of the program. This decision was based on the fact that Oyam and Apac were pilot districts for DDT use and considering the contentious nature of the discussions around the possibility of DDT pilferage and/or contamination with agricultural products and crops. In return, the students (who are training to qualify as vector control officers) benefited from observing spray activities, an experience that would be invaluable for the country as IRS activities are expanded in the future. 35 district vector control officers around the country also took part in the monitoring efforts.

Independent sample analyses were conducted by the National Drug Authority (NDA) on a sample of the DDT imported to ensure authenticity of the chemical.

IEC Development and Implementation

Since fiscal year 2007 funds were used for this activity, IEC activities were conducted by the HCP under a separate agreement with USAID. A healthy working relationship was maintained between RTI and HCP. However, because HCP had only one IEC coordinator available at the district level, they occasionally did not have time to mobilize activities well enough to educate communities in a manner harmonized with the spray operations. In addition, HCP had limited funds and had not budgeted for some key activities, such as the launch of the IRS activities, detailed community sensitization meetings, and additional talk shows to address impromptu issues arising during the spraying exercise. Therefore, in these instances, RTI had to utilize additional resources to fund and coordinate these activities. IEC and sensitization activities conducted by both HCP and RTI were done in collaboration with MOH/NMCP and district officials and included radio talk shows and spot messages; community sensitization meetings (using film vans and health talks at various levels within the district); and distribution of IEC materials with malaria prevention messages and guidelines on how to prepare homes for IRS activities. Table 4 below summarizes IEC activities that were either lead by RTI or HCP activities in which RTI had significant involvement.

Table 4: Summary of IEC Activities Conducted in Apac and Oyam Districts March 1 - May 31, 2008

IEC material/activity	Apac	Oyam	Total
T-Shirts	900	500	1,400
Leaflets	38,700	23,800	62,500
Banners	15	11	26
Radio spots	455	455	910
Sensitization meetings	82	56	138
Banners	15	11	26

A total of 138 (82 in Apac and 56 in Oyam) sensitization meetings, with average attendance ranging from 41 to 65 persons, were held during the spray exercise at the district, sub-county, and parish levels. The program also facilitated radio talk shows with various local stations and film shows on malaria prevention and control in 20 sub-counties of Apac and Oyam districts. Radio spots on IRS were sponsored on local FM stations, running 5 times a day for three months from March 1 - May 31, 2008. In addition, district health officials and politicians, local council officials, village health team members, religious leaders, and private organic farmers participated in various IEC activities. A total of 62,500 (38,700 in Apac and 23,800 in Oyam) leaflets with facts and frequently asked questions (FAQs) on IRS and DDT, 1,400 t-shirts (900 in Apac and 500 in Oyam), and 26 banners (11 in Oyam and 15 in Apac) were distributed.

IRS activities were launched in the Lango sub-region by the Honorable Minister of Health Dr. Stephen Mallinga (Figure. 1) on April 11, 2008 in the attendance of district government and political leaders from Oyam and Apac, senior central MOH officials, and development partners.

Figure 1: Hon. Minister of Health Dr. Mallinga preparing to launch IRS activities in Apac District

Recruitment and training of spray personnel

All spray personnel were recruited and hired by the MOH through its DHOs), although RTI identified additional staff who participated in overseeing spray activities. The daily rates to be paid to spray operators and other field operations seasonal contractors (including supervisors and team leaders) were determined by the Government of Uganda. RTI directly managed the payment of all field workers. Table 5 displays the number of spray personnel trained and deployed in each category by district. A total of 1,959 field workers were deployed in Oyam and Apac districts. The project also facilitated transportation and accommodation expenses for some central government employees to work on IRS activities in the target districts.

Two sets of trainings were conducted: a training of trainers (TOT) and spray operator (SO) training. The trainings were conducted by a team of MOH and RTI staff with expertise in entomology, vector control, epidemiology, environmental science, IEC, data management, logistics and stock control.

Table 5: IRS-related Training Provided by Category of Trainees and District

Category	Oyam District	Apac District	Total
Spray personnel	1131	746	1877
Clinicians	33	30	63
Environmentalists	9	15	24

During the TOT, supervisors were taught basic skills associated with IRS, including basic spraying techniques, team management, environmental compliance and safety, and spray-data collection. The trainers then facilitated the training of spray operators in similar topics. All training on IRS-related topics was conducted in accordance with established protocols and guidelines and trainees had to demonstrate proficiency during the practical sessions of the training.

Topics covered during training include:

- Record keeping
- Pump repair and maintenance
- Insecticide mixing
- Safe use of insecticide, sprayers and PPE
- Environmental compliance
- Clean up during IRS implementation
- Community mobilization
- Occupation safety
- Poison control

Clinicians and medical doctors working in the district were trained in poison control and management of adverse reactions related to exposure to DDT and other insecticides. Poison control medicines were provided to the health facilities in the districts. All drivers who were involved in the program also received training on environmental safety measures including proper handling of insecticides and management of spillages.

Spray personnel were examined for fitness to participate in the spray program and bio specimens were drawn from a sample of them for laboratory investigation. This activity was done by the MOH but results have not been released yet.

Entomological Assessment

A baseline entomological study was conducted earlier in Apac and Oyam by the MOH with support from the Centers for Disease Control and Prevention (CDC). The report which was shared with PMI partners is attached in Appendix 2. The study showed that *Anopheles funestus* was the dominant malaria vector in the two districts.

Implementation of IRS Activities

Actual implementation of IRS activities took 20 days in Oyam and 28 days in Apac districts. In both districts, a high coverage of houses was attained as depicted in Tables 1 and 2 above. To ensure spray operations were conducted in accordance with prescribed technical procedures, technical supervision and monitoring was provided by the various partners involved in the IRS exercise. The support supervision conducted focused on the following issues.

- Cleanliness of stores and inventory management
- Readiness to handle emergencies (such as fires) in the stores
- Evidence of records used in tracking of insecticide and chain of custody
- Level of restrictions in terms of access to insecticide stores
- Quality and coverage of spraying activities
- Awareness, readiness, and compliance of community members for IRS activities
- Level of adherence to guidelines for environmental compliance
- Management of waste from the spray program including the use of evaporation tanks and the "triple progressing rinse" method to minimize environmental contamination.
- Level of adherence to occupational safety

Corrective actions to address any mistakes made by spray operators during campaigns were taken immediately. At the end of each spray day, a debrief meeting was held with everyone who was involved in the field activities and an action plan for the subsequent day was developed. Spray teams were then briefed every morning on mistakes identified the day before and how they should be corrected before embarking on the day's spray activities. It was noted that in both districts, the quality, efficiency, and productivity of spray operators significantly improved after the first two days of operations.

Procedures taken to ensure compliance & safety

- Use of secure and guarded storage facilities
- Construction and maintenance of evaporation tanks, soak pits and bath shelters
- Effective training of spray personnel in use of spray pumps and PPE
- Restriction of eating and smoking during work
- Proper handling of spillages
- Proper management of waste
- Maintenance of accurate and up-to-date records
- Performance of clinical exams for spray personnel

Environmental Monitoring and Compliance

As part of environmental assessment and compliance requirements, RTI conducted an environmental review to satisfy the regulatory requirements Section 216 of the U.S Code of Federal Regulations and prepared a supplemental environmental assessment (SEA) report. The SEA detailed the procedures that were to be followed to minimize potential risks to human health and the environment from the use of specified insecticides in IRS. Environmental monitoring and compliance activities under this program were carried out under the SEA and NEMA regulations by RTI in collaboration with district environment officers in the two districts. Details of each component are explained below.

Environmental Monitoring

Environmental baseline surveys and sampling was carried out prior to the IRS campaigns from December 2007 through March 2008, to determine background concentrations of DDT in Apac and Oyam resulting from agricultural use in the 1950's and 1960's. Locations for collecting baseline samples were selected based on knowledge of widespread use of DDT in Apac and Oyam 40- 50 years ago, and on the current concern over possible contamination of crops produced for export. Baseline samples were taken at locations including homesteads, organic farms, crop fields, market/trading centers, wetlands, forest reserves, natural and artificial water-bodies, and evaporation tanks in the two districts.

In addition to identifying sampling locations, RTI also identified buffer zones around sensitive areas and followed the recommendations of the NEMA and National Forest Authority (NFA) to establish the size of these zones. The buffers zones were defined in order to specify areas to be sprayed with the alternative insecticide (ICON CS), and to guarantee adequate monitoring of these areas. A 50 meter buffer was established for wetlands, 100 meter for rivers, and 200 meter for lakes and forest reserves. For organic farms, it was not easy to establish buffer zones because they were not gazetted, making it difficult to determine the buffer sizes. In addition, most of the households claimed to be practicing organic farming making it hard to identify genuine organic farms. Houses within the accessible buffers were identified and counted for all the sensitive areas. The estimates of the number of houses within a given buffer were based both on actual house counts and upon estimates provided by local officials. The methods used to obtain the number of houses located within the buffers around sensitive areas included observations during focus group discussions and review of secondary data. All the accessible wetlands and forests were visited using the existing inventories of wetlands and forest reserves from NEMA, WIS, and NFA as a guide. The number of households was estimated with the help of the local leaders and members of households adjacent to all the sensitive areas. Physical counting of structures was undertaken in some

areas, in particular around small wetlands. Details on the samples collected, by sample location type and sample type, are presented in Appendix 1: Status Report on Baseline DDT Results for Apac and Oyam Districts.

Prior to the beginning of baseline sampling, five environmentalists that led the sample collection efforts underwent a two-days training on the appropriate sampling techniques. This training included a review of the monitoring plan (RTI Environmental Monitoring Plan for DDT-based IRS) and hands-on training in the field. The trained group trained the samplers from the local communities. Samples were collected from indoors and outdoors. Indoor samples included: indoor surfaces (walls and floors), air samples, and crops stored in the house. Outdoor samples included: soil, crops and other agricultural products (e.g., honey, milk, eggs, coffee, simsim, maize, and sunflowers), surface water and sediments from wetlands and water-bodies, and biota (e.g. forest and wetland vegetation, earthworms, chicken, honey bees, fish, and frogs).

Using the environmental monitoring plan for DDT-based IRS, sample locations were identified. The following criteria were used:

1. Locations where DDT was sprayed in the past (e.g., old cotton and grazing fields), as well as locations where DDT was not likely to be sprayed.
2. Homesteads with agricultural products of interest (i.e., organic produce and agricultural exports such as coffee, simsim, maize, sunflower, and cotton).
3. Forests, wetlands, and other water-bodies in close proximity to villages where DDT will be sprayed and where the sampling team can get access.
4. Trading and market places in close proximity to old cotton or grazing fields.

To identify laboratories with the capability to analyze the samples to be collected, consultation was made with Dr. Walter Benson, who led a study of Uganda analytical laboratory capacity for the International Union for Pure and Applied Chemistry, and Dr. Thomas Deeb, who conducted a similar study for the World Bank. Three organizations were identified that met requirements for facilities, personnel, and International Organization for Standardization (ISO) certification for the required analyses. Of these, Chemiphar was identified as the most immediately prepared to take in work. This was determined, in part, from recommendations, telephone conversations, and an in-person site visit by RTI staff in December 2007. Initial sample analyses were performed under a purchase order; a draft statement of work (SOW) was provided to guide future work until a formal contract is in place.

Sampling and Analysis Status

RTI collected almost 400 baseline samples across Apac and Oyam districts to be analyzed for DDT and related compounds and has sent around 40 percent of those for analysis to Chemiphar's laboratories in Kampala. The additional baseline samples are being safely stored in RTI's Kampala office and may be selected for analysis in consultation with the Mission, depending on budget and needs for additional baseline data to establish background conditions. Three tasks are still pending completion: (1) a decision on additional samples to send for analysis after agreement with the USAID Mission in Uganda and according to available funding, process the results of those analysis, and incorporate them into the final report; (2) review of laboratory performance with respect to quality control samples to verify that the laboratory maintained acceptable quality assurance during the analytical process; and (3) review of the results from Chemiphar's audit being performed by RTI employees in Uganda and prepare a report to be incorporated in the final baseline monitoring report.

Quality assurance (QA) activities for baseline monitoring are in progress. Method performance data provided by the analytical laboratory has been reviewed and found to be acceptable. Data from sample field data sheets have been entered into the database housing all the monitoring results and discrepancies in sample records have been resolved with the in-country staff to the extent possible. Qualifiers have been added to the database to note any discrepancies that could not be resolved and are presented in the reports as relevant (See Appendix 1). Quality control samples (i.e., duplicates, spikes, and blanks) are also planned for analysis by Chemiphar's Kampala laboratory as well as by one or two independent laboratories. We are also conducting a QA review at Chemiphar's laboratory to assess methods and practices, as well as a review and audit of field collection and documentation practices so that methods can be adjusted and improved for future sampling rounds.

Sample Results and Findings

Details on the baseline sample results obtained to date are presented in the attached report (Appendix 1). These results show that there are background levels of DDT across Apac and Oyam districts, most likely from the past use of DDT on cotton and other crops in the 1950's and 1960's. Significant findings include:

- Overall, about 20 percent of the samples showed detectable DDT, with the most and highest DDT detections associated with samples taken in houses across the districts (about one half of homestead samples [Table 3 in Appendix 1] and three-quarters of samples taken in houses).

- The three highest DDT levels (615, 37, and 15 mg/kg) were from samples of wall "dust" (material scraped from the walls) from houses in three different counties (Kwania, Kole, and Oyam). Much lower levels were detected in floor samples, and DDT levels in soil samples taken at the same homesteads were trace or not detectable.

- DDT was detected in samples taken from an old cotton store in Ocok Can village and in samples taken from the Palango Ginnery and from soils and a house from the same village.

- Soil samples showed much lower DDT levels, with only 8 of 69 soil samples showing detectable DDT, at levels less than one part per million (from 0.014 to 0.20 mg/kg). All soil samples with DDT detections were taken from homesteads.

- None of the 14 crop samples analyzed (including simsim, onions, coffee, and beans) showed detectable DDT.

- Of 15 biota samples analyzed, only one (a fish taken from a pond) showed trace levels of DDT.

- Of 37 analyzed samples taken in sensitive areas (forest reserves, wetlands, lakes, and river) no samples showed detectable levels of DDT. This represents about one-third of the baseline samples taken from sensitive areas.

In summary, all 'significant' DDT detections are associated with homesteads or old cotton processing facilities. House wall and floor samples showed the highest concentrations of DDT, with detectable soil levels below 1 mg/kg (ppm) in about 10 percent of the soil samples. No DDT has been detected in crops or sensitive areas, and biota samples were also below detection, except for trace levels detected in a fish from a pond in Kole county.

Environmental Compliance

Environmental compliance (EC) is a key activity to maximize the health and safety of workers and beneficiaries of the IRS program, as well as to ensure maximum effectiveness of the IRS intervention. Check lists were developed from the EMMTS for the IRS SEA which were used during the IRS environmental inspections. Below are the observations.

Table 6: Level of Project Environment Compliance to SEA (Pesticide Evaluation Report and Safe Use Action Plan) Conditions

Pre, during and post IRS Campaigns	Comments on how well these actions were conducted and suggestions for future activities
Quality Control of Insecticide(s) and IRS Operations, including Resistance Monitoring - General - Compliance and Enforcement	- As required by the Uganda law NDA picked samples of the insecticide (DDT) for analysis. 17 sachets were picked from 17 barrels and air lifted to Walloon Agricultural Research Centre (Belgium) for analysis. (Results are yet to be released). - The insecticide (DDT) procured was meant for only the first round of IRS in the two districts. - The insecticide was contained in sealed drums each with a batch number. Most insecticide sachets were marked with a unique ID number. However some sachets lacked unique numbers and were not to be used during the IRS exercise. - All the procured DDT had a life span of 2-3 years. - Houses within sensitive areas and their buffer zones not to be sprayed with DDT were identified.
Controlling Leakage into the environment	- A strict chain of custody of insecticides was maintained. Drums containing the sachets were counted at the regional store on delivery. - To further control leaking, mixing of the insecticide was carried out when the pump was placed on a polythene sheet provided to each spray operator. - A number of spray pumps had leaking nozzles in the first week of the spray exercise. These were subsequently repaired or replaced. - Also, at the beginning of the exercise there was a lot of spillage during the triple rinse. Inspectors were constantly at the tank to ensure that this was corrected and noticed progressive improvement by the middle of the exercise. - All DDT spillage on the ground was scooped, collected and taken to the waste barrels at the stores. The major spillage during this exercise happened in five houses in Loro, Alito and Inomo sub counties. The incidents were immediately reported to the team leaders and all contaminated crops and spillage collected and kept at the sub county store for eventual management and disposal in accordance with international guidelines. The house owners were also compensated for the crops contaminated.
Training and Awareness Building	- Environmental and occupational safety issues were covered as part of the training of all spray operators and other field workers. Spray operators were also trained on the proper handling of insecticide and spray pumps. However, the drivers did not participate in this training in Oyam. Subsequently, this was corrected and they were trained in Apac. - It was also observed that during operations, some store keepers were not performing as expected and additional technical support was provided. - All communities received sensitization (through mobilizations and radio talks) that included guidance on how to prepare the house for IRS and precautions to take to avoid environmental contamination. Indeed, the majority of

	community residents knew clearly how what they had to do before, during and after spraying their homes—although at the beginning some time was lost as SOs found some homes not fully prepared and had to wait or assist in preparing them. - Environmental Compliance guidelines and posters were developed for the spray teams and store keepers. These materials were translated and distributed to all operation centers.
Spraying Operations and Use - **Environmental Safety** - **Resident Safety** - **Worker Safety**	- Evaporation tanks were constructed in all sub counties in the two districts. The tanks used to store DDT waste water until it evaporated were covered with tarpaulins and metallic netting to prevent rain flowing in and access of animals to them. All tanks were covered at night. On dry sunny days, the tarpaulins would be removed for the waster water to evaporate. However, the construction of some tanks was poorly done which resulted into cracks at their surfaces and for some, eventual collapse (Minakulu, Nambieso and Akororo). The tanks in Oyam were small compared to number of spray operators that used them. This also contributed to the destruction of the poorly constructed tanks. Some of the cracked and collapsed tanks were repaired during the IRS exercise. Waste water from these tanks was first removed and put in large barrels (200L) during their construction. However, for the one in Nambeiso, it was observed on the fifth day of operations that a large crack had developed on the joint of the wall and the floor of the tank. It is possible that some of the waste water may have sipped through this crack on the third and/or fourth day of operations. As with others, use of the tank was suspended until the crack was repaired. In addition, soak pits were constructed for use in disposing off water used in spraying ICON CS although some were small. - Waste barrels and those for triple rinse were secured at all evaporation tanks. The project also constructed temporary bath shelters for spray operators at all centers. However, many of the operators preferred to bathe at home after the spray activities. This was discouraged during the first week of the program and the operators complied. The bath shelters are to be covered after the end of the spray period. - Buffer zones were created around all sensitive ecosystems (wetlands, forests, and open waters). - Spray teams including truck drivers wore full PPEs throughout the whole IRS exercise. However there was a problem of poor quality gloves. These gloves were not robust and needed constant replacement. - On average, compliance was high except for select sub-counties. The most affected sub counties were Loro sub county in Oyam and Chawente and Nambeiso sub counties in Apac district. Apparently, organic farmers from outside the two districts threatened not to buy their produce if their houses were sprayed. In addition, they promised incentives such as bicycles and hoes to those who resisted spraying. Working in partnership with the DHOs, HCP, and other district staff, this problem was addressed.

	- Residents in Loro Sub County reported an adverse effect of diarrhea after sweeping the sprayed houses with DDT. But when this allegation was investigated by the DHO, it was dispelled. In these sub-counties, coverage was about 83%. - All PPE and equipment used during the IRS campaigns were collected back to the central stores as well as waste from IRS campaigns in preparation for disposal. Discussions are underway with AVIMA (Pty) Ltd (where the DDT insecticide was purchased) to collect and export all the waste resulting from the use of the insecticide. All empty sachets of ICON CS and other related waste will be incinerated in Gulu.
Pesticide Management - Storage of Insecticides - Transportation of Insecticides	- A regional store (Gulu) was in place where DDT was stored before distribution to the two districts. A strict system of custody was maintained right from port of entry, with proper records and verification at all stages up to the spraying level and recovery of empty sachets and other waste. - It was observed that a number of stores were not fit for storage of the insecticide. E.g. had mud flooring and ventilation. Because these were the only available in some communities, efforts were made to retrofit them with polythene sheets and pallets to avoid soil contamination. - Each store was in a stand-alone building and had a double lock system in place and was secured 24 hours. The exception was Aboke store which was next to the sleeping facility of SOs who had been transferred there to help with activities in the neighboring sub counties. Even in this case, the store was properly secured. - It is worth noting that due to lack of space in some operation centers, the insecticides were at times kept in the same store with the PPE and other commodities. - Spray operators were transported on trucks together with their insecticides when going to the field. This posed a risk to the health of the workers and the environment. Indeed, two accidents took place during the spray exercise in Oyam, but none resulted in spillage of insecticides.

Sensitive Ecosystems

Buffer zones were created for sensitive areas in Apac and Oyam districts. Buffer zone sizes were complied to and all houses within zones were sprayed. Global positioning system (GPS) readings were taken for over 3,228 households sprayed with ICON CS in Oyam and Apac districts.

There was significant compliance from the communities whose houses were sprayed with ICON CS. Communities inhabiting sensitive ecosystems were aware of the insecticide used on their houses, but this did not stop them from opening their houses.

There was an incident in Loro sub-county where some houses were located in sensitive areas (wetlands and forests) were sprayed with DDT. Although these were technically gazetted areas on the maps provided by NEMA, they had been significantly encroached and had no trees or wetland vegetation. On recognizing this, spray operators were advised to stop using DDT in that area and instead use ICON CS, which was complied with.

DDT Barrels arranged on pallets in Apac Central Store[5]

Lessons Learned and Recommendations for Future Programs

- Better harmonization of schedule for spray operations versus community mobilization is critical.
- Store keepers and drivers of spray operators need to be part of the spray operators' training to gain a better understanding of the spray activities. In this round, the store keepers participated in a training that focused primarily on stores management. Drivers were oriented on safety measures in handling of vehicles.
- There is need to provide standardized measurements for evaporation tanks and soak pits to be constructed at operation centers putting into consideration levels of usage. In addition, improved construction of evaporation tanks and demarcation of wash and rinse areas need to be arranged early enough to ensure proper implementation of activities.
- There were a number of unanticipated significant costs associated with the program that need to be considered in budgeting for future activities. These include external testing of DDT samples by NDA, transportation and security of DDT, providing funding for monitoring of spray activities by various stakeholders (farmers, government, and political officials), and conducting of environmental monitoring and compliance activities.
- Issue of "facilitation" for district political officials who expect per diems that are above the stipulated government rates should be clearly established for smooth implementation of project activities.
- Due to the often unanticipated communication issues that need to be addressed during the spraying program, the budget for IEC activities should be increased and to have a provision to address them.
- Whenever possible, there is need to separate storage of insecticide from storage of PPE.
- Transportation mechanisms—other than use of trucks—should be considered.

[5] All photos in the report were taken by Fred Nkurunziza.

Appendix 1: Status Report on Baseline DDT Results for Apac and Oyam Districts

From December 2007 through March, 2008, RTI conducted environmental sampling in Apac and Oyam districts to characterize the concentrations of DDT in the environment prior to the launch of an IRS program that is using DDT for malaria control. Samples were collected from farming homesteads (including organic farms), agricultural fields, market and trading centers, and sensitive areas including wetlands, forest reserves, lakes, and the River Nile. Sampling also focused on areas where cotton was grown and processed in the 1950's and 1960's as areas most likely to be contaminated by the previous use of DDT on cotton crops. This report describes the status and results of this "baseline" sampling effort.

RTI has received results from Chemiphar Laboratories (Kampala, Uganda) for the samples that have been sent for analysis (i.e., most of the samples collected have not been sent for analysis due to available funding). The results presented in this draft report should be regarded as preliminary since additional samples could be sent for analysis. Three tasks are still pending completion: (1) A decision on additional samples to send for analysis will be made after agreement with the USAID Mission in Uganda (The Mission) and according to available funding, process the results of those analysis, and incorporate them to the final report; (2) Review of laboratory performance with respect to quality control samples to verify that the laboratory maintained acceptable quality assurance during the analytical process; and (3) Review of the results from Chemiphar's audit being performed by RTI employees in Uganda and prepare a report to be incorporated in the final baseline monitoring report.

Baseline Sampling and Analysis Status

RTI collected over 400 baseline samples across Apac and Oyam districts to be analyzed for DDT and related compounds. Tables 1 and 2 summarize the samples collected by sample location type and sample type, respectively. Sample locations include:

- Agricultural fields for crop and soil samples.
- Evaporation tanks, soil samples where DDT washup wastes will be managed.
- Homesteads where soil, crop, biota[6], house[7], and air samples were collected to establish baseline conditions at typical households.
- Markets/trading centers, where crop and soil samples were taken.
- Cotton facilities, including soil and building[2] samples from ginneries and former cotton stores as well as soil samples from cotton fields.
- Sensitive areas including soil, biota[8], sediment, and water samples taken from forest reserves, wetlands, lakes, ponds, and the Nile river.

Tables 1 and 2 also show that approximately 38 percent of the samples collected have been analyzed by Chemiphar. The additional baseline samples are being safely stored in RTI's Kampala office, and may be selected for analysis in consultation with USAID depending on budget and needs for additional baseline data to establish background conditions.

[6] Eggs, milk, honey, bees, earthworms, frogs, and plant seeds or fruits.
[7] Scrapings from mud wall coverings and dirt floors of occupied homes and other buildings.
[8] Earthworms, fish, frogs, and plants.

Table 1: Baseline sample status, by type of location

Location Type	Total samples	Analyzed	Not Analyzed
Homesteads	203	75	128
Agricultural fields	47	25	22
Cotton facilities	8	6	2
Markets /Trading centers	17	6	11
Forest Reserves	19	3	16
Wetlands	69	34	35
Lakes	12	5	7
Rivers	8	1	7
Ponds	3	1	2
Wells	2	0	2
Evaporation tanks	23	1	22
Unknown	5	3	2
Total	**416**	**160**	**256**

Table 2. Baseline Sample Status, by Sample Type

Sample Type	Total samples	Analyzed	Not Analyzed
House dust (wall and floor)	51	25	26
Cotton building dust (wall and floor)	5	4	1
Crops	41	15	26
Biota	39	10	29
Soil	170	83	87
Sediment	32	16	16
Air	45	0	45
Water	33	7	26
Total	**416**	**160**	**256**

Sample Results and Findings

Tables 3 and 4 summarize the baseline sample results received to date, organized by location type and sample type, respectively. Table 5 shows results from homesteads where DDT was detected, and Table 6 shows results from areas where cotton was previously processed and sold. Detailed results for all 32 DDT detections are provided in a separate table as Attachment A. Attachment B provides a map of all baseline sample locations, including their analytical status (not analyzed, analyzed but not detected, and detected).

These results show that there are background levels of DDT across Apac and Oyam districts, most likely from the past use of DDT on cotton and other crops in the 1950's and 1960's. Significant findings include:

- Overall, about 20 percent of the samples showed detectable DDT, with the most and highest DDT detections being associated with samples taken in houses across the districts.

- The three highest DDT levels (615, 37, and 15 mg/kg) were from samples of wall "dust" (material scraped from the walls) from houses in three different counties (Kwania, Kole, and Oyam). Much lower levels were detected in floor samples, and DDT levels in soil samples at the same homesteads were trace or not detectable (Table 5). Locations with detectable DDT in the wall of the homestead include an organic farm in Oyam county.

- DDT was detected in samples taken from an old cotton store in Ocok Can village and in samples taken from the Palango Ginnery and from soils and a house from the same village (Table 6).

- Soil samples showed much lower DDT levels, with only 8 of 83 soil samples showing detectable DDT, at levels less than one part per million (from 0.014 to 0.20 mg/kg). All soil samples with DDT detections were taken from homesteads.

- None of the 15 crop samples analyzed (including simsim, onions, coffee, and beans) showed detectable DDT.

- Of 10 biota samples analyzed, only one, a fish taken from a pond, showed trace levels of DDT.

- Of 43 analyzed samples taken in sensitive areas (forest reserves, wetlands, lakes, and river), no samples showed detectable levels of DDT. This represents about 40 percent of the baseline samples taken from sensitive areas.

In summary, all 'significant' DDT detections are associated with homesteads or old cotton processing facilities. House wall and floor samples showed the highest concentrations of DDT, with detectable soil levels below 1 mg/kg (ppm) in about 10 percent of the soil samples. No DDT has been detected in crops or sensitive areas, and biota samples were also below detection, except for trace levels detected in a fish from a pond in Kole county.

Table 3. Summary Results of Baseline Samples, by Location Type

Location Type	Total Samples (samples analyzed)	# of Samples with DDT below Detection	# of Samples with Detectable DDT	Lowest Detected DDT (ppm)	Highest Detected DDT (ppm)
Homesteads	203 (75)	48	27	*trace*	615
Agricultural fields	47 (25)	25	0	na	na
Cotton facilities	8 (6)	2	4	0.04	1.8
Markets /Trading centers	17 (6)	6	0	na	na
Forest Reserves	19 (3)	3	0	na	na
Wetlands	69 (34)	34	0	na	na
Lakes	12 (5)	5	0	na	na
Rivers	8 (1)	1	0	na	na
Ponds	3 (1)	0	1	*trace*	*trace*
Wells	2 (0)	na	na	na	na
Evaporation tanks	23 (1)	1	0	na	na
Unknown	5 (3)	3	0	na	na
Total	**416 (160)**	**128**	**32**	***trace***	**615**

ppm = parts per million (mg/kg); *trace* = detected but below quantitation limit; na = not applicable
DDT result is the sum of all isomers in samples with detections of at least 1 isomer, with "trace" = 0.005 and "ND" = 0.001

Table 4: Summary Results of Baseline Samples, by Type of Sample

Sample Type	Total Samples (samples analyzed)	# of Samples with DDT Nondetects	# of Samples with Detectable DDT	Lowest Detected DDT (ppm)	Highest Detected DDT (ppm)
House dust (wall and floor)	51 (25)	6	19	0.014	615
Cotton building dust (wall and floor)	5 (4)	0	4	0.04	1.8
Crops	41 (15)	15	0	na	na
Biota	39 (10)	9	1	*trace*	*trace*
Soil	170 (83)	75	8	0.014	0.20
Sediment	32 (16)	16	0	na	na
Air	45 (0)	0	0	na	na
Water	33 (7)	7	0	na	na
Total	**416 (160)**	**128**	**32**	***trace***	**615**

ppm = parts per million (mg/kg); *trace* = detected but below quantitation limit; na = not applicable

Table 5: Co-located Baseline Sample Results with Detections

Sample_ID	Sample Type	Total DDT[1]
Homestead in Olami B village		
HD1002G	wall	615
HS1002G	floor	8.0
ES1007M	soil	0.080
Homestead in Ocok Can village		
HD1013K	wall	37
HS1014L	floor	0.024
HS1015M	floor	0.025
Homestead in Acokara village		
HD1030L	wall	15
HS1029T	floor	3.6
ES1038U	soil	0.12
ES1037T	soil	ND
ES1036S	soil	ND
Homestead in Adyeda village		
AYD2	wall	2.6
AYS1	soil	*Trace*
Homestead in Oyetolei village		
HD1011HD	wall	4.7
ES1020J	soil	0.014
Homestead in Anyeke village		
HD1055V	wall	0.88
HS1046U	floor	0.28
ES1048W	soil	ND
ES1049X	soil	ND
Aduku citrus farm (Alele village)		
HD1001F	wall	0.019
HS1001F	floor	0.039
ES1002G	soil	ND
Organic farm (Unknown village, Oyam County)		
HD1056W	wall	0.37
HD1057X	wall	ND
HS1056W	floor	ND
HC1038U	simsim	ND
Homestead in Abanya village		
HD1028S	wall	0.079
HS1028S	floor	0.10
ES1029T	soil	0.037
ES1028S	soil	0.018

[1] sum of isomers, with "trace" = 0.005 and "ND" = 0.001; ND = not detected

Table 6: Samples Associated with Cotton Activities

Location Comments	Sample ID	Sample Type	Total DDT[1]
Samples from Ocok Can village			
Former cotton store	HS1013K	floor	1.5
Former cotton store	HD1012J	wall	0.04
Soil near cotton store entrance	ES1017P	soil	ND
Soil from former cotton field	ES1018Q	soil	ND
Samples from Ginnery Cell village			
Palango ginnery	HS1016N	floor	1.8
Palango ginnery	HD1015M	wall	0.14
Old house	HD1016ND	wall	0.93
House built in '50s	HS1017P	floor	0.33
2-year old homestead	ES1027R	soil	0.20
7-year old homestead	ES1027RD	soil	0.023
Homestead	ES1026Q	soil	ND

[1] sum of isomers, with "detected" = 0.005 and "ND" = 0.001; ND – not detected

Quality Assurance and Quality Control

As mentioned above, quality assurance activities for baseline monitoring are in progress. Method performance data provided by the analytical laboratory has been reviewed and has been found to be acceptable (Attachment B). Data from sample field data sheets have been entered to the database (DB) housing all the monitoring results and discrepancies in sample records have been resolved with the in-country staff to the extent allowed by the information collected during sampling. Qualifiers have been added to the database to note any discrepancies that could not be resolved and will be presented in the reports as relevant. Quality control samples (i.e., duplicates, spikes, and blanks) are also being prepared for analysis by Chemiphar's Kampala laboratory as well as by one or two independent laboratories.

The most significant problem encountered is slow analytical turn-around in by Chemiphar, which was selected for the baseline sample analysis based on a review of their qualifications and capacity. To rectify this problem for future sampling efforts, RTI is holding discussions with the Kampala laboratory, as well as lining up two additional African laboratories (in Kenya and South Africa) to provide additional capacity. These laboratories will also be used to analyze duplicate samples to ensure that analytical results are reproducible between laboratories.

We are also conducting a QA review at Chemiphar's Kampala laboratory to assess methods and practices, as well as a review and audit of field collection and documentation practices so that methods can be adjusted and improved for future sampling rounds.

Recommendations

The baseline sample effort has found detectable DDT in samples from the walls and floors of houses and buildings associated with cotton production, as well as lower levels in soils associated with homesteads and other buildings. No DDT has been detected in crops or field biota, with the exception of trace levels in a pond fish. No DDT has been detected in sensitive areas. Based on these results and according to what was budgeted to meet available funding, we recommend the following additional DDT analyses with respect to the remaining baseline samples:

- Analysis of Quality Assurance and Control (QA/QC) samples[9]. Confirmatory analysis of left over material from samples with DDT detections is also recommended as a way to verify the quality of the results. To cut costs, confirmatory analyses should be limited to one sample per location where DDT was detected.

- Analysis of additional soil and crop samples for locations where DDT was detected. Soil samples are particularly important as the outdoor media where DDT is most likely to accumulate. Crops are the DDT receptors of highest importance according to the goals of this monitoring.

- Analysis of additional crop samples from market/trading centers. These samples are important to improve the geographic coverage of the crops samples analyzed. Only 1 out of the 5 total crop samples collected at market/trading centers has been analyzed.

- No further baseline air or water sample analyses because of the low likelihood of detectable DDT.

In addition to the recommendations above, RTI also proposes the following samples for analysis if additional funding becomes available:

- Analysis of remaining samples obtained at identified organic farms.

- Analysis of additional crop samples to improve the geographic coverage obtained with this sample type.

- Analysis of soil and sediment samples in sensitive areas to verify no detectable DDT.

- Analysis of additional biota samples from sensitive areas.

RTI understands that these recommendations are subject to discussion and approval by The Mission and that any additional samples will be selected depending on mission preference and budgetary considerations.

[9] QA/QC samples include soil blanks to demonstrate freedom from contamination in the field; field controls (DDT spiked soil) to demonstrate that field conditions do not affect known concentrations, duplicate samples to define the reproducibility of sample collection/analysis, and duplicate samples to be sent to a QA lab for independent analysis.

Attachment A. Results for all 32 DDT Detections

Location Comments	Sample_ID	Sample type	County	Sub-County	Village	Total DDT[1]	2,4'-DDD	2,4'-DDE	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT
none	HD1002G	wall	Kwania	Aduku	Olami B	615	0.804	0.351	5.971	35.051	7.138	565.854
homestead	HD1013K	wall	Kole	Aboke	Ocok Can	37	1.091	1.091	6.469	4.161	6.028	18.564
homestead	HD1030L	wall	Oyam	Otwal	Acokara	15	0.029	0.079	2.754	1.677	2.838	7.472
old house	HS1002G	floor	Kwania	Aduku	Olami B	8.0	0.038	0.015	0.289	1.139	1.642	4.839
old house	HD1011HD	wall	Kole	Ayer	oyetolei	4.7	0.076	0.158	0.996	0.126	1.277	2.026
floor renewed regularly	HS1029T	floor	Oyam	Otwal	Acokara	3.6	0.042	0.214	0.523	0.214	1.538	1.111
pilot sample	AYD2	wall	Kwania	Aduku	Adyeda	2.6	nr	nr	0.21	nr	0.33	2.07
Palango ginnery	HS1016N	floor	Maruzi	Ibuje	Ginnery cell	1.8	0.021	0.018	0.201	0.074	0.734	0.715
former cotton store	HS1013K	floor	Kole	Aboke	Ocok Can	1.5	0.013	ND	0.268	0.146	0.492	0.629
old house	HD1016ND	wall	Maruzi	Ibuje	Ginnery cell	0.93	0.01	0.01	0.206	0.04	0.108	0.551
walls smeared every year	HD1055V	wall	Oyam	Acaba	Anyeke	0.88	ND	ND	ND	0.129	0.209	0.543
organic farm	HD1056W	wall	Oyam	Minakulu	-	0.37	trace	trace	0.108	trace	0.138	0.109
house built in '50s	HS1017P	floor	Maruzi	Ibuje	Ginnery cell	0.33	trace	trace	0.025	0.032	0.078	0.181
homestead	HS1046U	floor	Oyam	Acaba	Anyeke	0.28	trace	trace	0.064	0.013	0.086	0.104
2-year old homestead	ES1027R	soil	Maruzi	Ibuje	Ginnery cell	0.20	ND	ND	0.015	trace	0.122	0.054
Palango ginnery	HD1015M	wall	Maruzi	Ibuje	Ginnery cell	0.14	trace	ND	0.042	trace	0.02	0.067
In front of house	ES1038U	soil	Oyam	Otwal	Acokara	0.12	ND	ND	ND	ND	0.077	0.041
homestead	HS1028S	floor	Oyam	Acaba	Abanya	0.10	ND	ND	ND	trace	0.034	0.054
central location - homestead	ES1007M	soil	Kwania	Aduku	Olami B	0.080	ND	ND	ND	ND	0.057	0.019
homestead	HD1028S	wall	Oyam	Acaba	Abanya	0.079	ND	ND	ND	trace	0.031	0.04
cotton store	HD1012J	wall	Kole	Aboke	Ocok Can	0.040	ND	ND	ND	ND	ND	0.035
Aduku citrus farm	HS1001F	floor	Kwania	Aduku	Alele	0.039	ND	ND	ND	trace	0.01	0.021
home garden	ES1029T	soil	Oyam	Acaba	Abanya	0.037	ND	ND	ND	ND	0.032	ND
homestead	HS1015M	floor	Kole	Aboke	Ocok Can	0.025	ND	ND	ND	ND	trace	0.016
homestead	HS1014L	floor	Kole	Aboke	Ocok Can	0.024	ND	ND	ND	ND	ND	0.019

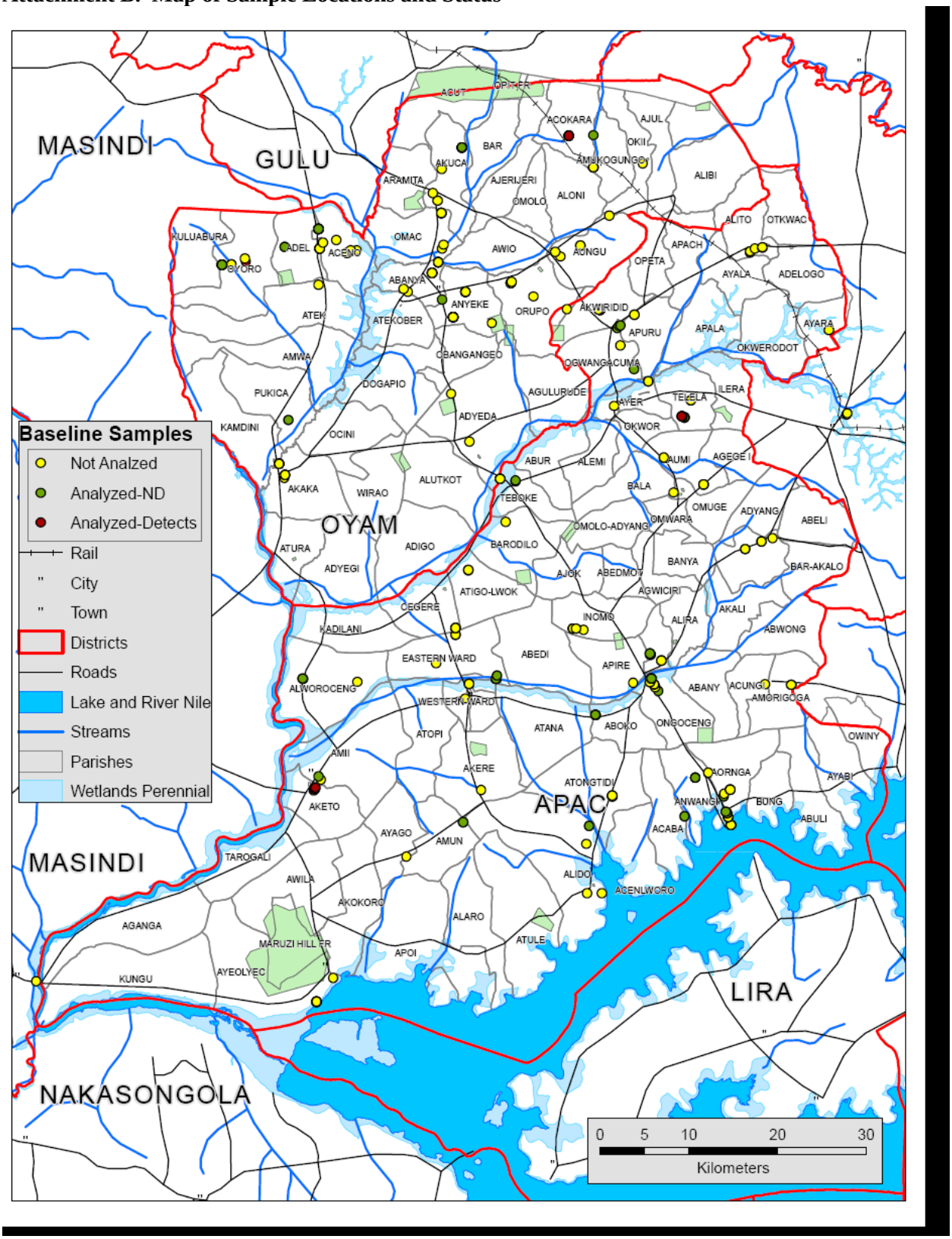
Attachment A. Results for all 32 DDT Detections

Location Comments	Sample_ID	Sample type	County	Sub-County	Village	Total DDT[1]	2,4'-DDD	2,4'-DDE	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT
7-year old homestead	ES1027RD	soil	Maruzi	Ibuje	Ginnery cell	0.023	ND	ND	ND	ND	0.014	trace
Aduku citrus farm	HD1001F	wall	Kwania	Aduku	Alele	0.019	ND	ND	ND	ND	ND	0.014
homestead	ES1028S	soil	Oyam	Acaba	Abanya	0.018	ND	ND	ND	trace	trace	trace
homestead	ES1020J	soil	Kole	Ayer	oyetolei	0.014	ND	ND	ND	ND	trace	trace
homestead	HD1014L	wall	Maruzi	Cegere	Adula	0.014	ND	ND	ND	ND	trace	trace
from compound	ES1047V	soil	unk.	unk.	unk.	0.014	ND	ND	ND	ND	trace	trace
from pond	FB1037T	fish	Kole	Ayer	Leye	0.01	ND	ND	ND	ND	trace	ND

All analyses reported in mg/kg (ppm).
ND = not detected; "trace" means DDT was detected below the quantitation limit (0.01 mg/kg); nr = not reported by laboratory
[1] sum of isomers, with "trace" = 0.005 and "ND" = 0.001

Indoor sample
Biota sample
Soil sample

Attachment B. Map of Sample Locations and Status



Attachment C. Quality Assurance / Quality Control Results (to date)

Laboratory quality control

To date, 9 batches of samples have been analyzed. Laboratory QA policy dictates that if a reagent blank fails, a new aliquot from every sample from the batch extracted for analysis; if an instrument blank fails, the entire batch is re-injected. Thus, all data are presumed to be associated with passing blank values. The laboratory has provided data from 10 ppb control standard (n = 8) and 10 ppb (each analyte) spiked samples previously tested as non-detect for all analytes (n = 9). Control standard results were within acceptance limits (80-120%) except for a single analyte in one measurement (131%), but no samples from the associated batch yielded detectable analyte. Spike sample recoveries were mostly within the target range (70% - 130%), with a couple of low recoveries for DDE isomers (61-62%) in one sample. We will continue to track laboratory performance. Sufficient data are available to provide initial estimates of method performance, which are summarized in the Table. Overall, method accuracy and precision are acceptable.

Table B-1. Method Performance Summary

	4, 4'-DDT	2, 4'-DDT	4, 4'-DDE	2, 4'-DDE	4, 4'-DDD	2, 4'-DDD
% recovery, method	90%	104%	84%	87%	96%	87%
CV, %, instrument	10%	9%	7%	10%	13%	10%
CV, %, method	17%	13%	18%	20%	12%	12%

Appendix 2: Baseline Entomological Report in Apac and Oyam Districts

Pre-IRS Entomological Baseline for Apac and Oyam Districts
Jan/Feb 2008
Preliminary Results
John Quattrochi & Fred Ssenfuka, UVRI

Overview
Adult and larval mosquitoes were collected in Apac and Oyam districts from 27 January to 9 February, at the peak of the dry season, to quantify vector populations prior to indoor residual spraying (IRS). Within each district, mosquitoes were collected from two sub-counties (highlighted on map below) in order to cover a variety of ecological settings. Methods used to collect mosquitoes were: pyrethrum spray catch, human landing catch, light traps and larvae scooping.

Mosquito species presence, density and distribution
Pyrethrum spray catches in 150 homes revealed that both *An. gambiae s.l.* and *An. funestus* are present in all sub-counties surveyed (see table below). *An. funestus* densities were consistently greater than *An. gambiae*. As can be expected with mosquito populations, considerable variation was found within sub-counties. For example, within Aber sub-country, one village had vector densities (*An. gambiae* and

An. funestus combined) of 81.1 per house, while another village had just 2.9 vectors per house.

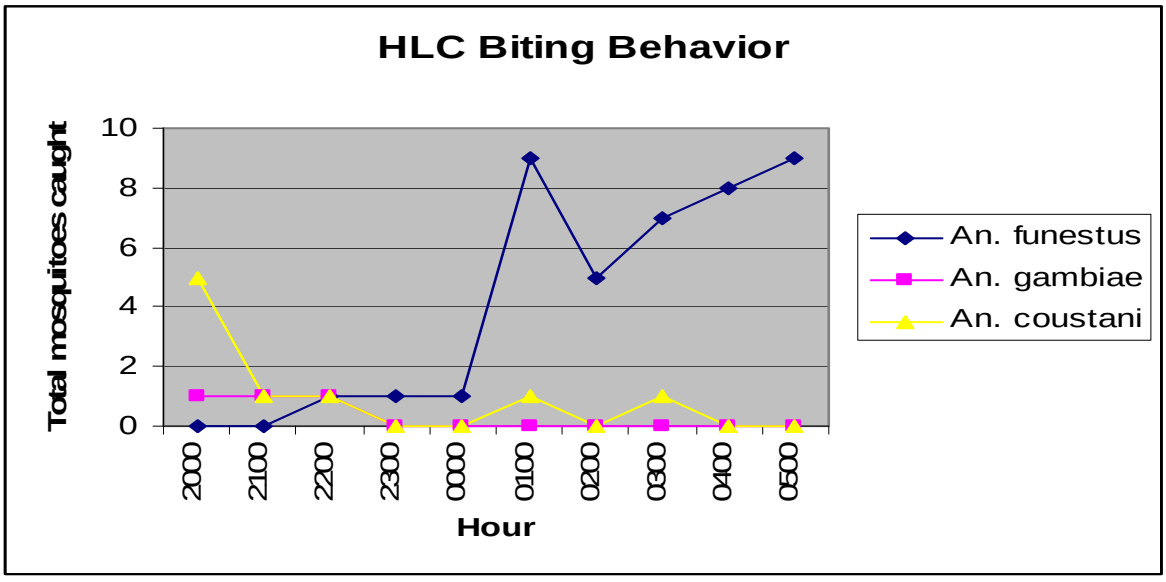
Other Culicines were also present in significant numbers. *Ma. uniformis* predominated among these mosquitoes in all areas.

PSC results (range in brackets)	Female *An. gambiae s.l.* per house	Female *An. funestus* per house	Female Culicines per house
Aber (Oyam)	5.8 (0 – 86)	23.8 (0 – 212)	1.1 (0 - 8)
Iceme (Oyam)	0.4 (0 – 7)	2.8 (0 – 32)	1.4 (0 - 20)
Akokoro (Apac)	0.1 (0 -	4.8 (0 – 15)	5.1 (0 - 30)
Aduku (Apac)	2.0 (0 - 17	5.1 (0 – 16)	5.1 (0 – 26)

Human landing catches in Akokoro (Apac) revealed the presence of *An. coustani* (9 individuals caught in 4 homes over 5 nights). In Iceme (Oyam), mosquitoes of the genus *Coquillettidia* were found in all human landing catches.

Further analysis of the specimens preserved from PSC will investigate which sub-species of *An. gambiae s.l.* are present (*An. gambiae s.s.*, *An. arabiensis,* etc.) and the sporozoite rate (i.e. the proportion capable of transmitting the malaria parasite).

Vector behavior
Human landing catches were conducted in 4 homes in each sub-country for 4-5 nights.



*The number on the x-axis corresponds to the beginning of the one hour period in which the mosquito was captured. For example, 5 *An. coustani* were captured between 2000 and 2100.

Over the two week period during which 72 trap-nights were conducted only six vectors were captured outdoors (they are included in the data above). One *An. gambiae* was

captured outdoors between 2200-2300, while five *An. coustani* were captured between 2000-2200.

Insecticide resistance

In Aduku (Apac), 33 adult *Anopheles* mosquitoes were collected using human-baited mosquito nets. 22 were exposed to bottles coated with 0.1ug/ml DDT. Knock-down time for 50% of the mosquitoes was 40 minutes. Twenty-four hours after exposure, 6 mosquitoes remained alive (mortality = 72.7%). 11 mosquitoes served as the control, all of which survived the 24 hour test period.

Also in Aduku, 35 *Anopheles* mosquitoes were successfully hatched from approximately 200 larvae collected. 25 were exposed to bottles coated with 0.1 ug/ml DDT. Knock-down time for 50% of the mosquitoes was 30 minutes. Twenty-four hours after exposure, 5 mosquitoes remained alive (mortality = 80%). 10 mosquitoes served as the control, all of which survived the 24 hour test period.

Larvae collected from Iceme (Oyam) have so far yielded ~25 adult mosquitoes from ~300 larvae in the insectary at UVRI. After more larvae hatch over the next several days an additional resistance test will be run. During the previous week over 250 larvae collected in Iceme yielded just 4 adults in a field-based insectary.