PRESIDENT'S MALARIA INITIATIVE

INDOOR RESIDUAL SPRAYING FOR MALARIA CONTROL

Ethiopia End of Spray Round Report

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

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Country Background

Ethiopia was identified by USAID as one of the third wave of countries to receive funding under the United States' (U.S.) President's Malaria Initiative (PMI). The U.S. Agency for International Development (USAID), the Ethiopia National Malaria Control Program (NMCP), and the Oromia Regional Health Bureau (ORHB) identified three epidemic-prone zones in Oromia Region (East Shoa, Arsi, and West Arsi) for indoor residual spraying (IRS) activities. In 2008, USAID and the ORHB agreed to focus spraying activities in the 11 districts of East Shoa zone, five selected districts in Arsi zone, and four selected districts in West Arsi zone, with the intention of expanding IRS coverage to additional districts in the future.

RTI was tasked with providing strategic, technical, environmental compliance, management, and operations support for IRS activities in the above mentioned districts. While the planning projection was to cover 425,000 structures, however 377,093 housing structures were found in the field and targeted for IRS. The 337,093 structures were set as the operational target with a corresponding population of 1,229,878 people, representing approximately 230,000 households in 20 districts during the first round of PMI supported IRS.

In addition, RTI developed and implemented entomological and environmental monitoring plans in Ethiopia in collaboration with the Malaria Reference and Training Center (MRTC), Addis Ababa University Department of Pathobiology, the Ethiopia Health and Nutrition Institute, the Environmental Protection Authority, zonal and district health officers, and other USAID and national partners.

This end of spray round report presents the program's activities during the 2008 spraying campaign which began on July 22, 2008 and ended on September 2, 2008 and summarizes the project's achievements, outstanding issues, and lessons learned.

Summary Results

In this first round of USAID/PMI supported IRS operations:

- A total of 316, 829 (91.9 percent) unit structures out of the 377,093 structures found were sprayed;
- The total number of residents in the sprayed structures was 1,000,526 (91.74 percent of people in the targeted structures), of which 161,144 or 16.1 percent were children under 5 years of age, 488,957 or 48.87 percent were female and 12,496 or 1.25 percent were pregnant women;
- A total of 1,154 day laborers (1,046 spray operators and porters and 108 washers and guards) were engaged;
- 306 Ministry of Health (MOH) staff participated as squad and team leaders, supervisors, and district and zone coordinators;
- 152 people including district and zonal malaria focal persons and environmental health focal persons were trained during the IRS training of trainers (TOT) and in turn trained 1,046 people (839 spray operators and 207 reserve spray operators);
- 36 district health education focal persons received IRS information, education and communication (IEC) TOT and in turn trained and oriented 835 community leaders and district political figures;
- The spray campaign was carried out from July 22 to September 2, 2008 in 19 districts in three zones of Oromia region.

IRS Preparation

Environmental Assessment

RTI conducted an environmental review that satisfied the regulatory requirements of 22 CFR 216 and prepared an environmental assessment (EA) for Ethiopia. The document was submitted to USAID on March 28 and RTI received formal approval on June 25. Further environmental mitigation activities are described below in the environmental compliance section.

Geographic Reconnaissance and Logistics Assessment

Ethiopia has a long history of conducting IRS. District representatives and malaria focal persons organized their IRS set-up based on experience from previous campaigns. During an RTI supported micro-planning meeting held April 16 and 17, 2008, a plan was developed for the implementation of PMI-supported IRS in the districts. Based on the agreed upon detailed plan, 377,093 unit structures were targeted for spraying in 360 *kebeles* (the lowest administrative structure) and 1,229,878 people were estimated to live in these structures (see Table 1).

The logistics assessment was performed as part of the micro-planning meeting held with representatives from all the districts. Each district provided information on the status of IRS equipment and logistical needs for the IRS campaign. A session was held to determine what gaps RTI through PMI could alleviate. Detailed computation was performed to arrive at the total number of spray pumps, personal protective equipment (PPE) and other IRS materials required by each district. These items were procured and sent to each IRS district accordingly (see Tables 2, 3, and 4). In addition, the number and type of vehicles required to run the IRS campaign in each district was determined based on the number of spray operators and squad leaders participating in the campaign (see Table 6).

Table 1. District details from micro-planning meetings.

	District	*Kebeles* per district	*Kebeles* targeted	Unit structures	Population in targeted *kebeles*	Number of days	Structures sprayed per day	Structures per operator per day	Spray operators	Reserve operators (porters)	Squad leaders	Team leaders	Field district supervisor	Total personnel
East Shoa	Adama	46	18	29310	61891	30	977	14	70	17	17	5	2	111
	Adea	27	13	12,346	32,172	30	412	14	29	7	7	2	1	47
	Adami Tulu	48	28	22,052	149,901	30	735	14	53	13	13	3	1	83
	Akaki	29	16	7,044	17775	30	235	12	20	5	5	1	1	32
	Boset	40	29	24840	32143	30	828	14	55	13	13	3	2	88
	Bora	19	17	15,800	61,618	30	527	13	41	10	10	3	1	64
	Dugda	39	14	16,900	44692	30	563	14	40	10	10	3	1	64
	Fantale	31	19	23516	48915	30	784	14	54	13	13	3	2	86
	Gimbichu	35	8	2,188	10,695	30	73	8	9	2	2	1	1	15
	Lume	38	18	16,996	45,572	30	567	14	40	10	10	3	1	64
	Liben Zikala	29	18	20,412	68,033	30	680	15	45	11	11	3	2	73
Arsi	Dodota			14,413	55,000	30	480	14	34	9	9	2	1	55
	Jeju	29	9	7,527	28,500	30	251	14	18	4	4	1	1	29
	Merti	21	17	20,890	66,849	30	696	14	50	12	12	3	1	79
	Sire			7,727	23875	30	258	14	18	5	5	1	1	30
	Z/Dugda			12,142	45329	30	405	14	29	7	7	2	1	46
West Arsi	Siraro	26	14	29,279	75,781	30	976	14	70	17	17	4	1	110
	Shalla	39	30	33,468	117,450	30	1116	14	80	20	20	5	1	126
	Shashemane	40	21	25,727	128,635	30	858	14	61	15	15	4	1	97
	Arsi Negele	47	27	34,516	115,052	30	1151	14	82	21	21	5	1	129
Total		**544**	**302**	**377,093**	**1,229,878**	**30**	**12572**	**14**	**898**	**221**	**221**	**57**	**24**	**1428**

IRS Equipment

The following items were purchased and distributed to districts for the Ethiopia IRS program.

Table 2. Spray pumps and spare parts per district.

Districts	IRS Equipment		
	Spray Pumps	Nozzle Tips	Spare Kits
Adama	72	76	18
Adea	32	32	7
Adami Tulu	56	57	13
Akaki	18	18	4
Boset	64	64	15
Bora	42	41	10
Dugda	44	43	10
Fantale	56	60	14
Gimbichu	6	6	1
Lume	44	44	10
Liben Zikala	52	52	12
Dodota	36	37	9
Jeju	20	19	5
Merti	52	54	13
Sire	20	20	5
Z/Dugda	30	31	7
Siraro	78	75	18
Shalla	88	86	20
Shashemane	68	66	16
Arsi Negele	92	89	21
Total	**970**	**970**	**228**

Table 3. Personal protective equipment (PPE).

District	Items								
	Gloves	Boots	Coverall	Reflective Jacket	Nose and Mouth Masks	Helmets	Face Shield	Apron	Soap 250g
Adama	317	119	238	21	1074	154	154	8	636
Adea	135	51	101	9	455	66	66	8	274
Adami Tulu	242	91	181	17	813	118	118	6	490
Akaki	77	29	58	5	260	38	38	4	158
Boset	274	103	205	19	919	133	133	12	548
Bora	171	64	128	11	575	83	83	4	344
Dugda	183	69	137	12	615	89	89	4	368
Fantale	259	97	194	18	870	126	126	8	519
Gimbichu	26	10	19	2	86	12	12	-	-
Lume	184	69	138	12	618	90	90	4	373
Liben Zikala	224	84	168	15	752	110	110	12	449
Dodota	158	59	118	11	534	77	77	8	315
Jeju	83	31	62	6	277	40	40	4	163
Merti	229	86	172	16	770	111	111	4	461
Sire	85	32	63	6	285	41	41	4	169
Z/Dugda	133	50	100	9	448	65	65	8	268
Siraro	317	119	237	21	1065	154	154	4	636
Shalla	362	136	271	24	1217	176	176	4	729
Shashemane	279	105	209	18	936	135	135	6	560
Arsi Negele	374	141	280	24	1255	182	182	4	753
Total	**4115**	**1548**	**3080**	**276**	**13824**	**2000**	**2000**	**116**	**8213**

Table 4. Other commodities.

Districts	Description of Materials											
	Big Washing Basin	20 L Bucket	2 L Jug	1 L Jug	25 L Jerry can	3000 L Tanker	220 L Barrel	Funnel	Funnel Screen	Tents	Plastic Sheeting	Mattress
Adama	8	45	30	2	35	1	12	38	57	9	2	87
Adea	8	25	30	2	15	0	22	16	24	4	2	36
Adami Tulu	8	35	30	3	26	3	33	29	44	7	3	66
Akaki	4	15	15	1	8	1	12	9	13	2	1	27
Boset	8	40	30	3	30	3	33	34	50	7	3	74
Bora	4	25	15	1	19	1	12	20	30	5	1	47
Dugda	4	25	15	1	20	1	12	22	34	5	1	50
Fantale	8	35	30	2	28	2	22	31	47	7	2	70
Lume	4	25	15	1	20	1	12	22	34	5	1	50
Liben Zikala	4	30	15	1	24	1	12	27	40	6	1	61
Dodota	4	20	15	2	17	2	12	20	30	4	2	43
Jeju	4	15	15	1	9	1	12	9	13	2	1	22
Merti	4	30	15	1	25	1	12	27	40	6	1	62
Sire	8	15	30	1	9	1	12	11	17	2	1	23
Z/Dugda	8	20	30	2	15	2	22	16	24	4	2	36
Siraro	4	50	20	1	35	1	12	38	57	9	1	87
Shalla	4	54	18	1	40	1	12	45	67	10	1	100
Shashemane	4	40	15	1	31	1	12	34	50	8	1	76
Arsi Negele	4	56	15	1	41	1	12	47	71	10	1	103
Total	**104**	**600**	**400**	**28**	**450**	**25**	**300**	**500**	**750**	**112**	**28**	**1120**

Recruitment and Training of Spray Teams

During the micro-planning meeting, consensus was reached with target IRS districts on the number of IRS team leaders, squad leaders, spray operators and reserve spray operators that would be needed for the campaign. It was also agreed that in accordance with other Ethiopian campaigns, the team and squad leaders, supervisors and organizers would be MOH staff. On this basis, the districts identified their team and squad leaders based on past experience in IRS.

Spray operations were planned to start by mid-May but were postponed until July 22 due to delays in procuring and shipping PPE and in establishing evaporation tanks in the operational centers. As a result, the TOT and spray operator training were also delayed, and Gimbichu district, in which the rains were threatening, decided to commence their spray operations on their own. The TOT was held from June 16 through June 19 in Adama, where a total of 152 people fully participated. Participants were zonal and district malaria focal persons, health officers and malaria technicians (92), environmental health focal persons (23), nurses (21) and health extension workers (16) from 19 districts (see Table 5).

All 19 district health offices placed job announcements indicating the requirements for temporary workers for IRS operations. Selections were made by the district health office on the basis of the candidate's physical fitness for IRS and residency in the district of operation, among other criteria. The training of spray operators and reserve spray operators was

conducted between July 7 and 13 for 5 consecutive days in each district. A total of 839 spray operators (94.4 percent of micro-planning estimates) and 207 reserve spray operators (94.5 percent of micro-planning estimates) were recruited and trained in all 19 districts by trained team and squad leaders (see Table 5).

Table 5. IRS TOT and spray operator training.

Zone	District	IRS TOT Participants	Spray Operators			Reserve Spray Operators		
			Target	Trained	%	Target	Trained	%
East Shoa	Adama	14	70	68	97.1	17	17	100.0
	Adea	5	29	29	100.0	7	7	100.0
	Adamitulu	9	53	52	98.1	13	13	100.0
	Akaki	2	20	20	100.0	5	5	100.0
	Boset	4	55	55	100.0	13	13	100.0
	Bora	6	41	32	78.0	10	8	80.0
	Dugda	8	40	40	100.0	10	10	100.0
	Fantale	10	54	54	100.0	13	10	76.9
	Lume	6	40	40	100.0	10	10	100.0
	Liben Chiquala	7	45	49	108.9	12	12	100.0
	Subtotal	71	447	439	98.2	110	105	95.5
Arsi	Dodota	7	34	34	100.0	9	9	100.0
	Merti	13	50	48	96.0	14	14	100.0
	Jaju	4	18	18	100.0	4	4	100.0
	Sire	4	18	18	100.0	5	5	100.0
	Z/Dugda	6	29	28	96.6	7	7	100.0
	Subtotal	34	149	146	98.0	39	39	100.0
West Arsi	Arsi Negele	13	82	82	100.0	21	21	100.0
	Shashamene	12	61	48	78.7	15	12	80.0
	Shala	13	80	60	75.0	20	14	70.0
	Siraro	9	70	64	91.4	17	16	94.1
	Subtotal	47	293	254	86.7	73	63	86.3
Total		**152**	**889**	**839**	**94.4**	**222**	**207**	**93.2**

Adequate training of spray operators is of key importance and contributes significantly to the success of the IRS program. Spray operators were trained to be technically sound in insecticide application techniques, correct spray pump handling, and efficient communication to beneficiaries. To acquaint the trainees with these subjects, the national training curriculum for the training of spray operators was used and human and environmental safety aspects were included by RTI. The trainees were introduced to malaria control, spray operation organization, spray equipment, spray operation techniques, and messages to the households. The trainees passed through a series of intensive practical application sessions in order to ensure correct spray technique and application of insecticide on the sprayable surfaces.

Logistics Support

RTI posted an announcement in the Daily Monitor on June 28, 2008 to invite potential car rental companies to bid for transportation activities associated with the spray operations. Two companies were identified based on their ability to supply a sufficient number of vehicles and their financial competitiveness. An agreement was made with *Sof Omar Car Rental Company* to provide 98 vehicles and *Queen of Sheba Car Rental Company* to provide 20 vehicles. The rate for daily rental included the cost of fuel and included an average mileage per day to be covered by each vehicle, based on the geographical coverage expected in each district. RTI verified mileage based on dispatch slips (which listed the starting kilometer [km] reading) and a vehicle movement monitoring sheet signed daily by the IRS team leaders during the operation. These sheets were reviewed and approved by the logistics officer, finance manager and chief of party (COP).

During the first 10 days of IRS operations, the companies were unable to supply the required number of vehicles. In addition, most of the target villages in two districts (Akaki and Liben Zikala) were inaccessible to vehicles due to the condition of roads during the rainy season. A total of 74 vehicles (64 from Sof Omar and 10 from Queen of Sheba) for 17 districts and 28 donkeys for Akaki and Liben Zikala districts were deployed for IRS operations (see Table 6). Most districts also used motorcycles for supervision purposes in the villages.

Table 6. Vehicles in support of IRS campaign.

Zone	Place of Assignment	Micro-planning estimate	Actual Assignment
	Addis Ababa	2	2
East Shoa	East Shoa	2	1
	Adama	8	4
	Adea	3	3
	Adami Tulu	6	5
	Akaki	2	0
	Boset	7	6
	Bora	4	3
	Dugda	5	3
	Fentale	7	4
	Gimbichu	1	0
	Lume	5	3
	Liben Zikala	6	0
Arsi	Arsi Zone	2	1
	Dodota	4	3
	Merti	6	4
	Jeju	2	2
	Sire	3	2
	Z.Dugda	4	3
West Arsi	West Arsi Zone	2	1
	Arsi negele	10	7
	Shashemene	8	5
	Shala	10	5
	Siraro	9	7
Total		**118**	**74**

The quantity of vehicles needed in each IRS district was less than originally planned because:

- Liben Zikuala and Akaki districts used animal transportation instead of eight vehicles.
- Gimbichu district carried out IRS without RTI vehicle support as a result of delay in the start date of the IRS campaign.
- Almost all districts used motorcycles for supervision purpose in the villages, which reduced the demand for additional vehicles.
- The car rental companies were not able to provide the specific types of vehicles requested at the onset of the campaign. To fill the gaps, RTI chose to use slightly less comfortable vehicles with a greater capacity to accommodate people and IRS materials.

The ORHB assigned eight trucks to transport all locally procured IRS plastic materials, tents, mattresses, and funnels to each IRS district from Addis Ababa. RTI supported the fuel and drivers' per diem costs.

IEC Activities and Community Mobilization

IEC Material Design and Development

Using IEC materials from other PMI-supported IRS countries and those already used in Ethiopia's IRS campaigns, RTI developed IEC materials appropriate to the local context and language in the form of posters and leaflets. A total of 5,000 posters and 20,000 leaflets were produced and distributed to all target district mobilizers and community members through district health offices and IRS teams.

Training of IEC Mobilizers

A TOT workshop for IEC was held on June 30. The training addressed various malaria prevention messages as they relate to IRS, provided responses to questions frequently asked by household residents, and outlined the best method of information dissemination at the *kebele* household level. Thirty-five people participated in the IRS IEC TOT and were subsequently designated as district focal points for IEC. The focal points in turn trained additional IEC workers and mobilized political leaders and community representatives in their respective districts. In total, about 835 persons were mobilized by the program for IEC (see Table 7). The *kebele* administrators, capacity building focal persons, and community heads were key in organizing message dissemination.

Table 7. IEC TOT, community and political leaders mobilized.

Zone	District	IEC TOT Participant	Political Leaders and Community Heads
East Shoa	Adama	1	69
	Adea	2	25
	Adami Tulu	1	44
	Akaki	0	14
	Bora	1	19
	Boset	1	85
	Dugda	1	16
	Fentale	2	20
	Liben	0	12
	Lume	2	35
	Subtotal	11	339
Arsi	Dodota	3	81
	Merti	2	46
	Jeju	2	23
	Sire	3	59
	Zeway Ddugda	3	43
	Subtotal	13	252
West Arsi	Arisi Negele	4	63
	Shashemene	3	61
	Shala	2	65
	Siraro	3	55
	Subtotal	12	244
Total		**36**	**835**

IRS Operations

In Ethiopia, the ideal time for IRS implementation is from mid-May to mid-June, before the start of the main rainy season in July and August. Due to the delay in the procurement and shipment of PPE and the prolonged process of establishing the evaporation tanks, IRS operations officially started on July 22 in five districts. Other districts commenced their spray campaigns within the following four days (see Table 8). Four districts completed operations on August 24 and the last day of operations for the first round RTI IRS campaign in Ethiopia was September 2, 2008.

All zonal and district health offices have malaria control focal persons with overall responsibility for the coordination of malaria control activities, including IRS. RTI utilized this government structure to organize the IRS operation in each zone and district. A total of 1,495 people were deployed (see Table 11). Spray operators and reserve operators (porters) constituted 70 percent of this workforce and 7.2 percent were washers and guards. Seventy-seven percent of all personnel were daily laborers, while the technical staff (coordinators and

supervisors) constituted 23 percent. There was a high degree of collaboration between the Federal Ministry of Health (FMOH) and RTI staff throughout the campaign. Other than the delay in commencement, the campaign was well organized and was completed smoothly.

Data Collection

Although the districts already had spray operation data collection forms from previous IRS programs, the forms were modified to accommodate additional variables and monitor PMI indicators while avoiding major deviation from other government-funded IRS program data in the region. RTI developed a weekly summary and monthly IRS coverage data template. Data collection templates were distributed to all target districts. The squad leaders were the primary data collectors, reviewing houses sprayed by each spray operator and the number of people living in each house. This information was summarized and compiled daily by each squad and team leader and was then sent to the zonal health office weekly. The daily and weekly output of each squad and team were entered into a database weekly at the zonal level by temporary data clerks.

Table 8. Start and Ending Date of Spray Operation by District.

Zone	District	Start date	End date	Total days*	Daily output per operator
East Shoa	Adama	7/22/2008	8/24/2008	34	12
	Adea	7/22/2008	8/30/2008	40	13
	Adami-Tulu	7/23/2008	8/24/2008	33	13
	Akaki	7/23/2008	8/24/2008	33	11
	Boset	7/25/2008	8/30/2008	37	14
	Bora	7/25/2008	8/28/2008	35	11
	Dugda	7/25/2008	8/24/2008	31	15
	Fentale	7/25/2008	8/30/2008	37	6
	Lume	7/24/2008	8/31/2008	39	12
	L/Zikuala	7/23/2008	8/29/2008	38	13
Arsi	Dodota	7/22/2008	8/30/2008	40	15
	Merti	7/23/2008	8/28/2008	37	12
	Jeju	7/23/2008	8/29/2008	38	14
	Sire	7/22/2008	8/30/2008	40	14
	Z/Dugda	7/25/2008	9/2/2008	40	14
West Arsi	Arsi-Negele	7/22/2008	9/2/2008	43	13
	Shashemane	7/23/2008	9/2/2008	42	13
	Shalla	7/24/2008	8/28/2008	36	12
	Siraro	7/26/2008	8/31/2008	37	9
	Average daily output of unit structures per spray operator				**12**

*****Total days include travel and camping days as well as nozzle tip testing and cleaning days.

Though there were challenges due to heavy rain, particularly accessing some of the villages and removal of household property for at least two hours in very wet weather conditions, 99 percent of the *kebeles* were accessed and 91.9 percent of the visited structures were sprayed, while 91.7 percent of the population in the sprayed communities was protected (see Table 9). Out of the total protected population, 161,297 were children under five years of age and 12,496 were pregnant women (see Table 10). However, the number of pregnant mothers seems low and does not match estimates by the FMOH. It is likely that early pregnancies were not recorded, as women in rural areas of Ethiopia do not confess that they are pregnant, for cultural reasons, until they are showing.

Spray coverage in most districts, both in unit structure and population coverage, was well above 90 percent. However, in Adama and Fentale districts, unit structure coverage was under 85 percent and the population coverage of Boset and Lume districts was also below 85 percent. Although intensive IEC activity and supervision was implemented to improve performance, refusal rates were comparatively higher in agro-industrial districts (Adama, Fentale, and Boset). The most common reason for refusal was the unwillingness of the households to have the white DDT deposit on the painted walls of the relatively modern (cemented) housing in the agro-developmental areas.

During the micro-planning meeting, the daily output of unit structures per spray operator was estimated to be 14 unit structures. However, only six districts managed to spray 14 or more unit structures per day per spray operator and the average unit structures per day per spray operator for all districts was 12 (see Figure 13). This deviation was generally related to disruption of the daily activity by rain. Fentale district's daily output, in particular, was extremely low for this reason and because of the high refusal rate in the Metehara sugar estate area.

Spray teams also collected information on insecticide treated net (ITN) usage. Data showed that only 49.5 percent of children under five years of age slept under ITNs. For pregnant women, the figure stood at 69.6 percent (see Figure 10). However, as indicated above, the percentage for pregnant mothers may not fully reflect actual conditions as pregnancy was largely under reported.

In the targeted districts, the population and unit structure coverage of this round of PMI-supported IRS far surpassed that of the 2007 government-supported IRS (see Figure 12).

Table 9. IRS Operation Target and Performance by Districts.

Zone	District	Unit structure				Population				Not protected
		Unit structures found	Unit structures sprayed	Unit structures not sprayed	% sprayed	Target	Protected			
							Total	%	Female	
East Shoa	Adama	26409	22192	4217	84	57722	47180	81.7	23323	10542
	Adea	12866	12535	331	97.4	31559	31368	99.4	14951	191
	Adamitulu	19799	18514	1285	93.5	72918	67135	92.1	33536	5783
	Akaki	6341	6087	254	96	17785	17416	97.9	8322	369
	Boset	24841	23569	1272	94.9	68974	57932	84	28012	11042
	Bora	11147	10052	1095	90.2	35091	30711	87.5	14643	4380
	Dugda	16900	14749	2151	87.3	44692	42384	94.8	20669	2308
	Fantale	14407	9848	4559	68.4	38459	32332	84.1	15599	6127
	Lume	16063	14959	1104	93.1	33890	28718	84.7	13821	5172
	L/Zikuala	22410	20715	1695	92.4	68003	65321	96.1	31528	2682
	Subtotal	171183	153220	17963	89.51	469093	420497	89.64	203895	48596
Arsi	Dodota	17673	17027	646	96.3	44918	43258	96.3	21307	1660
	Merti	19338	18578	760	96.1	63622	59822	94	28191	3800
	Jaju	8047	7872	175	97.8	19978	19553	97.9	9386	425
	Sire	8779	8460	319	96.4	23875	23079	96.7	11183	796
	Z/Dugda	13987	12955	1032	92.6	45329	43142	95.2	21356	2187
	Subtotal	67824	64892	2932	95.68	197722	188854	95.51	91762	8868
West Arsi	Arsi Negele	38661	36252	2409	93.8	128869	118207	91.7	58865	10662
	Shashamene	24795	22798	1997	91.9	111058	102245	92.1	50497	8813
	Shala	21803	21602	201	99.1	96292	93443	97	45967	2849
	Siraro	20279	18065	2214	89.1	87521	77280	88.3	38222	10241
	Subtotal	105538	98717	6821	93.54	423740	391175	92.31	193564	32565
Total		**344545**	**316829**	**27716**	**91.96**	**1090555**	**1000526**	**91.74**	**488943**	**90029**

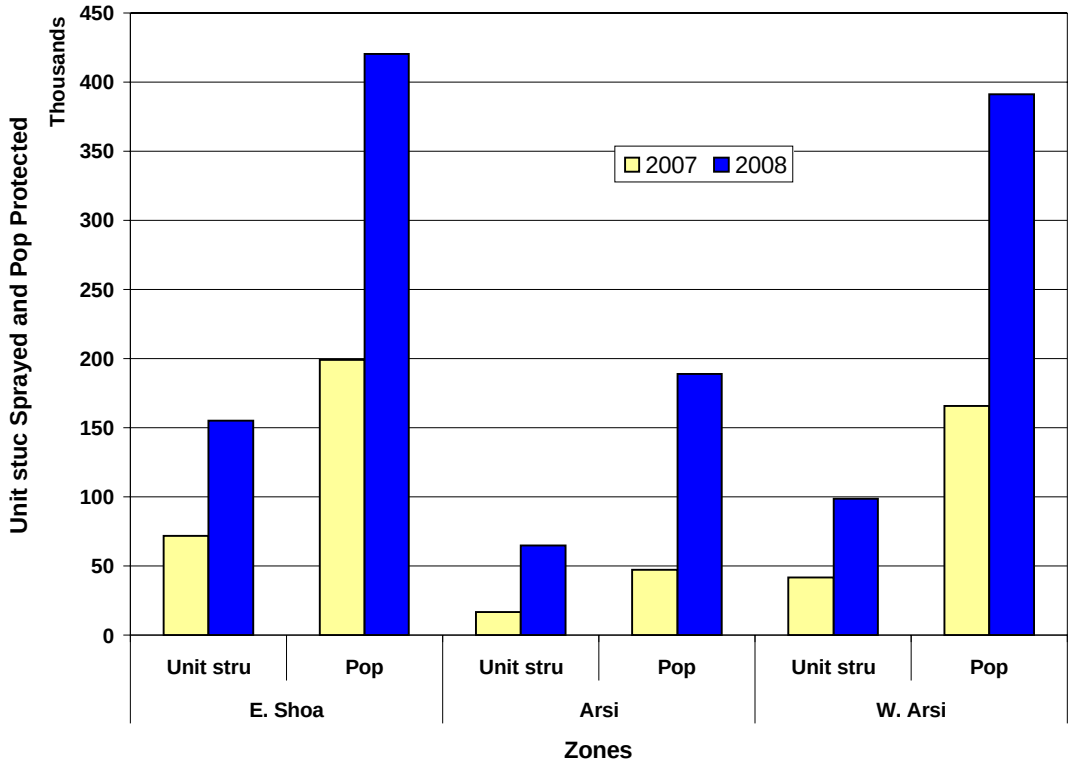
Table 10. Protected women, children under five years old, and pregnant women.

Districts	Protected women	Protected <5	Protected pregnant	% Pregnant sleeping under ITN	% <5 sleeping under ITN
Adama	23323	5122	242	71.2	72.2
Adaa	14951	3351	264	56.4	42.9
A/Tulu	33536	10980	556	63.6	38.6
Akaki	8322	2460	274	56.3	48.9
Boset	28012	7389	539	48.8	57.7
Bora	14643	4922	271	33.2	42.4
Dugda	20669	6251	451	52.9	45.4
Fentale	15599	4101	356	79.2	59.7
Lume	13821	2727	112	46.2	34.9
Liben Zikuala	31528	10906	1196	93.0	44.5
Dodota	21307	7254	384	46.7	58.3
Merti	28191	8842	785	47.8	36.8
Jeju	9386	2994	247	43.8	61.0
Sire	11183	3435	306	40.8	48.6
Z/Dugda	21356	7452	879	77.9	82.5
A/Negele	58865	20477	1312	47.5	47.2
Shashemene	50497	19310	1678	93.1	50.5
Shala	45967	17797	1605	92.3	27.5
Siraro	38222	15527	1039	68.9	56.8
Total	**488943**	**161297**	**12496**	**69.6**	**49.5**

Table 11. IRS workforce.

Zone	District	Squad chief	Team leader	IEC	Supervisors	District coordinator	Spray operators	Reserve operators	Washers	Guards	Total
East Shoa	Adama	17	5	3	2	2	68	17	4	4	122
	Adea	7	2	1	2	1	29	7	4	3	56
	Adami-Tulu	13	3	2	1	1	52	13	3	3	91
	Akaki	5	1	0	1	1	20	5	2	1	36
	Boset	13	3	3	1	1	55	13	6	6	101
	Bora	8	2	1	1	1	32	8	2	2	57
	Dugda	10	3	2	1	1	40	10	2	2	71
	Fentale	10	3	3	3	1	54	10	4	4	92
	Lume	10	2	2	1	1	40	10	2	3	71
	Liben Zikuala	12	4	2	1	1	49	12	4	4	89
Arsi	Dodota	9	1	3	2	1	34	9	4	4	67
	Merti	12	3	2	2	2	48	14	2	2	87
	Jeju	4	1	2	1	1	18	4	2	2	35
	Sire	4	2	2	1	1	18	5	2	2	37
	Z/Dugda	7	1	2	1	1	28	7	4	2	53
West Arsi	Arsi-Negele	21	5	2	2	2	82	21	2	2	139
	Shashemane	12	3	1	2	1	48	12	3	2	84
	Shalla	14	2	2	1	1	60	14	2	2	98
	Siraro	16	4	3	1	1	64	16	2	2	109
Total		**204**	**50**	**38**	**27**	**22**	**839**	**207**	**56**	**52**	**1495**

Figure 1. Unit structures sprayed and population protected in 2007 (FMOH) and 2008 (RTI).



Supervision

The district health office malaria focal persons, environmental health officers, and district health office heads were used to organize, follow-up, and supervise the daily activity of spray teams in each district. Likewise, besides supervision provided by the RTI and the RHB malaria control department staff, the zonal health department heads, malaria focal persons, and environmental health officers were used to support and supervise districts' IRS performance. The findings during the supervisory visits showed there was some degree of reluctance from spray operators, squad leaders, and team leaders in strictly following technical procedure, particularly in relation to environmental compliance aspects. Partial spraying of unit structures was also observed in some districts by a few spray operators. Immediate corrective measures were taken in most instances and two spray operators were dismissed and replaced in Shashemene district. In Liben Zikala a squad leader was also dismissed due to repeated failure to respect working discipline, and their inability to organize the spray operators.

Environmental Compliance

Environmental Mitigation Set-up

Based on the formally approved Ethiopia EA, RTI worked to meet standard and acceptable IRS waste management procedures. Districts were visited by RTI environmental specialist

Mr. Tito Kodiaga to assess the degree of environmental compliance of the project. RTI worked with its partner Crown Agents to initiate the construction of evaporation tanks at IRS operational sites identified by the districts.

A total of 29 staging areas and camping sites were identified in 20 districts for triple rinsing and evaporation tanks to capture waste water (see Table 12). RTI, ORHB, and the districts worked to identify which operational sites would be most prudent for the citing of evaporation tanks. Gimbichu district was excluded from 2008 IRS support due to inaccessibility with the onset of the rainy season. Similar conditions in Akaki and Liben Zikuala districts did not allow transportation of construction materials for the establishment of evaporation tanks. The two districts were also omitted from 2008 evaporation tank construction as well. Initially, RTI planned to establish 24 evaporation tanks in the identified staging areas. However, as a result of the introduction of value added tax (VAT) by the government, as well as higher than anticipated contractor costs, only 21 evaporation tanks were established.

The specifications and design of the evaporation tanks and wash areas were drafted by RTI and delivered to Crown Agents/Ethiopia to request bids and issue contracts to winning contractors. Two contractors were found eligible to carry out the construction of evaporation tanks and an agreement was signed between Crown Agents/Ethiopia and each contractor. The work was to be split between the two contractors and, after a pilot evaporation tank had been constructed by both, each bidder agreed to proceed with concurrent evaporation tank construction in the remainder of the districts.

The speed at which the concrete evaporation tanks were established by the contractors was slow. Given the compelling factors to start the IRS operations before heavy rains, RTI developed an alternative and temporary method to capture contaminated wash water. In 25 sites, reinforced water tanks of 3,000 liter (L) capacity were used to collect dichloro-diphenyl-trichloroethane (DDT) waste water and plastic sheeting was used to prevent spillage to the ground from washing basins. The collected DDT wash water was then transferred to the evaporation tanks as soon as they were ready (see Table 12). However, DDT waste water is still being held in plastic tankers in seven sites, awaiting evaporation tank construction. Efforts are underway to establish the concrete tanks as early activities under the FY09 campaign. The 2008 post-spray evaluation meeting and 2009 micro-planning also identified additional needs for evaporation tanks in Gimbichu district and two others which will also be established during the FY09 operation.

In line with environmental compliance procedures for IRS, a mid-spray operation environmental compliance inspection visit was conducted by RTI/IRS environmental inspector, Mr. Autman Tembo, from August 18 to 23, 2008. This visit highlighted the need for improved storage facilities at district level, separate training for storekeepers, and stronger supervision to ensure compliance with human and environmental safety measures. Furthermore, poor quality DDT sachets (as packaged by the manufacturer, Adami Tulu Pesticide Plant) were found to be the cause for the limited spillage of DDT in some places. Discussion was held with the factory to improve the quality of packaging for the next spray round.

Storage Facilities

During the pre-operational environmental compliance visit, Tito Kodiga (RTI) visited the various districts to inspect storage space available. He discovered that some districts did not have storage space at all, while other districts had identified storage space but certain improvements were necessary. RTI worked with the districts to complete the necessary improvement for the current campaign, with a view to support extensive improvements before next year's campaign.

Accordingly, RTI put in place the following minimum requirements:

- Thermometers in all the storage facilities.
- Fire extinguishers in each storage facility.
- Skull and cross bone signs in all the warehouse and evaporation tanks sites.
- Double padlocked doors for storage facilities.

At present, four districts are renting storage space as they could not identify any space to store IRS materials. Warehouse/storage space remains a priority issue and RTI is working with the districts to resolve it.

Figures 2 and 3. Left, plastic sheeting and a 3,000 L tanker are used to manage waste water in lieu of an evaporation tank. Right, a completed rinse area and evaporation tank is ready for use.

Figure 4. A skull and crossbones sign posted outside of a DDT store room in a health center.

Table 12. Evaporation tanks by district and site.

District	Evaporation Tank Sites	Status	Contractor
Akaki	Abu Sera	To be considered for next year	NA
Liben Zikuala	Dololo Jila	To be considered for next year	NA
	Kusaye	To be considered for next year	NA
Adea	Debrezeit	Completed	Tesfeye
	Dire	Completed	Beabnew
Gimbichu		To be considered for next year	NA
Lume	Bika HP	Completed	Tesfaye
Bora	Alem Tena HC	Completed	Tesfaye
Dugda	Meki HC	Completed	Tesfaye
Adami Tulu	Abosa	Completed	Tesfaye
	Bulbula	Completed	Tesfaye
	Jido	Completed	Tesfaye
Adama	Awash Melkasa	Completed	Tesfaye
	Wonji	Completed	Tesfaye
Boset	Nura era	Not Awarded	NA
	Dongore Tiyo	Not Awarded	NA
	Bofa	Completed	Beabnew
Fentale	Metehara	Not Awarded	NA
Arsi Negele	Arsi Negele H/C	Completed	Tesfaye
Shashamane	Shashamane	Completed	Beabnew
Shala	Aje	Completed	Beabnew
Siraro	Rophi	Completed	Beabnew
Dodota	Dera	Completed	Beabnew
	Amude	Completed	Beabnew
Ziway Dugda	Kiyansho	Not Awarded	NA
	Burka lamafo	Completed	Beabnew
Sire	Ebseta Huduka	Completed	Beabnew
Merti	Abomsa	Completed	Beabnew
Jeju	Addis Hiwot	Completed	Beabnew

Insecticide Usage and Stock

The FMOH and ORHB supplied districts with a considerable amount of DDT in 2008 and RTI was not responsible for the purchase of DDT used during the 2008 IRS campaign. However, limited or no storage space at the district level made it extremely difficult for the districts to properly handle the insecticide. District health storekeepers, responsible for all the district health property including DDT, were not able to spend every day at the staging site to manage DDT storage. As a result, the team leaders distributed appropriate quantities of DDT to the squad leaders who then distributed an allocation to porters each day. The intact and empty sachets were accounted for at the end of each work day.

During the PMI-supported IRS campaign in the target districts in East Shoa, Arsi, and West Arsi zones, 117,403 sachets of DDT were used (see Table 13) to spray 316,829 unit structures. Thus, the usage ratio was one sachet per 2.7 structures.

Table 13. DDT usage, dosage, and balance.

District	Received kg	Used		Balance in kg	Unit structure average m^2	Unit structures sprayed	Dosage g/m^2
		Sachet	Kg				
Adama	3424	4304	2302.6	1939.9	53	22192	2.0
Adea	9501.6	4951	2648.8	6852.8	86	12535	2.5
Adami Tulu	5949.2	9646	5160.6	788.6	94	18514	3.0
Akaki	1155.6	2170	1155.6	0	86	6087	2.2
Boset	4044.6	6558	3508.5	536.1	67	23569	2.2
Bora	1883.2	2779	1486.8	396.4	94	10052	1.6
Dugda	7404.4	5350	2862.3	4542.2	92	14749	2.1
Fantale	3424	3082	1648.9	1775.1	67	9848	2.5
Lume	5863.6	5362	2868.7	2994.9	72	14959	2.7
Liban Zikala	7318.8	5600	2996	4322.8	72	20715	2.0
Dodota	6848	6799	3637.5	3210.5	86	17027	2.5
Martii	4922	7238	3872.3	1049.7	86	18578	2.4
Siree	2225.6	2616	1399.6	826	86	7872	2.1
Jajjuu	2653.6	3140	1679.9	973.7	84	8460	2.4
Z/Dugdaa	5970.6	5885	3148.5	2822.1	110	12955	2.2
Shashamane	9844	15165	8113.3	1730.7	97	36252	2.3
Arsi Negele	7768.2	10968	5867.9	1900.3	97	22798	2.7
Shala	6441.4	8448	4519.7	1921.7	97	21602	2.2
Siraro	7147.6	8872	4746.5	2401.1	97	18065	2.7
Total	**103790**	**117403**	**62805.3**	**40984.7**	**85.4**	**316829**	**2.3**

DDT Dosage

It is important to calculate the amount of DDT applied to the spray to determine if the insecticide is applied correctly such that the vector is killed and the disease burden impacted. This ratio is calculated from the amount of DDT used against the average sprayable surface area of unit structures. However, the average sprayable surface was difficult to estimate since no recent unit structure measurements were available for the districts. The data presented in the above table uses old average surface area measurements for the districts, giving close approximations about the dosage. RTI will work with the ORHB and districts to update the relevant data prior to the 2009 campaign.

Project Management and Administration

Staffing

The following RTI Ethiopia IRS staff supported the 2008 IRS campaign: the COP, Mr. Sheleme Chibsa; the logistics officer, Mr. Alemiye Wondimneh; the finance officer, Mr. Aklilu Mulate; and the technical specialist for entomology, Mr. Alemayehu Getachew. RTI also hired three finance assistants, one for each zone, to execute payments of per diems and daily wages for spray personnel at IRS operational sites for the period of IRS campaign.

Weekly per diems and wages for spray personnel were transferred to each of the 19 districts through nearest bank. Payment was effected in the presence of and approved by district malaria focal persons and spray team leaders based on signed daily attendance sheets.

Administrative Support

The Ethiopia IRS team is supported by RTI Nairobi and Washington. There were several visits by RTI staff in support of the project during this period.

In April, Joaquim Canelas, Operations Director (RTI/Nairobi), provided logistical assessment support to the project and training of operational aspects of IRS during the micro-planning meeting. Jacob Williams, IVM Project Director (RTI/Washington), provided environmental compliance training during the micro-planning meeting. Patricia Preware, Home Office Technical Manager, provided project administrative support and overall RTI management and IRS support training during the micro-planning meeting.

In May, Tito Kodiaga, Environmental Specialist (RTI/Washington), conducted an environmental compliance support visit and assisted with environmental compliance preparation and storage set-up.

In June, Samson Mesfin, IRS Financial Controller (RTI/Nairobi), provided financial set-up and administration assistance. Jacob Williams conducted training of trainers for operators and mobilizers in collaboration with RTI Ethiopia staff, with particular emphasis on environmental compliance and mitigation measures. He also provided technical oversight of evaporation tank construction. Patricia Preware provided administrative training and support to RTI Ethiopia staff.

In July, Judith Tukahirwa, IRS Environmental Officer for Uganda, conducted a baseline environmental monitoring visit to train local MOH staff in the collection of baseline samples, as well as conduct the collection of baseline samples for the 2008 IRS campaign.

In August, Autman Tembo, IRS Environmental Inspector, conducted a mid-spray environmental compliance visit to assess the status of environmental compliance of IRS operations during the campaign.

In November, Jacob Williams assisted the country team in carrying out the post IRS operation evaluation and micro-planning meeting. He held meetings with the FMOH, ORHB, Environmental Protection Agency and the manager of Adami Tulu Pesticide Plant regarding the final solution to DDT waste management. Furthermore, he assisted in better analysis and interpretation of entomological monitoring data and provided special input in the request made to the FMOH and ORHB in supporting the registration of RTI in Ethiopia. Patricia Preware assisted the country team in carrying out the post IRS operation evaluation and micro-planning meeting and in the production of a first draft of the FY09 work plan. She held meetings with FMOH, Environmental Protection Agency, and the manager of Adami Tulu Pesticide Plant regarding the final solution to DDT waste management. She also provided special input in the request made to the FMOH and ORHB in support of the registration of RTI in Ethiopia.

Entomological Monitoring

Through discussion with USAID/PMI team, 10 entomological monitoring sentinel sites were selected in different parts of Oromia Region. For FY 2008, it was agreed to start monitoring activities in three sites in three IRS project districts and one site in unsprayed village as a control: Merti (Kolonel Camp), Adami Tulu (Edo Kontola and Ziway 02, the control village) and Shala (Mechefera). This decision was made because of delays in the procurement and shipping of entomological equipment and the need to conduct baseline entomological monitoring before the commencement of IRS operations. Entomological monitoring will be expanded to all 10 sentinel sites in FY 2009, following receipt of the entomological equipment in December 2008. The major activities include:

- Morphological identification of local vectors using the criteria of Gilles and de Meillon (1968);
- Determination of vector density using spread sheet and human landing collection;
- Larval density measurements;
- Testing of bio-efficacy of insecticides using the standard World Health Organization (WHO) bioassay method; and
- Insecticide susceptibility testing using standard WHO methodology.

Except for the insecticide susceptibility test which is done once in a year, all other activities are repeated on a monthly basis at the selected sentinel site, beginning with baseline data collection before the commencement of spraying. Baseline entomological data collection was done from July 5 to 12 before the start of IRS operations and the monthly monitoring took place from September 18 to 26, October 11 to 20 and November 13 to 22 (see Tables 14, 15, and 16).

Anopheline Species

During the study period, a total of 838 adult female anophelines were collected using pyrethrum spray sheet and human landing collection techniques. These comprised:

- 92.6 percent *An. gambiae* complex
- 5.5 percent *An. pharoensis*
- 1.9 percent *An. coustani*

Likewise, a total of 388 anopheline larvae were collected, comprising:

- 47.4 percent *An. gambiae* complex
- 43.8 percent *An. pharoensis.*

Nocturnal Biting

Human bait was used to collect data with one person sitting indoors and the other sitting outdoors. According to this study, both *An. gambiae* complex and *An. pharoensis* exhibited exophagic tendencies in the area if given equal opportunity both indoors and outdoors. About 58 percent of *An. gambiae* complex and 56.7 percent of *An. pharoensis* were captured while trying to bite human baits outdoors. Biting continued throughout the night by both species. Peak outdoor and indoor biting of *An. gambiae* complex occurred after 10:00 PM. Exophilic tendencies are well noted among *An. gambiae* complex. Additional evaluation would be necessary to determine if there is a need for a complimentary intervention.

Man-biting Rates

Man-biting rates (MBR) of the two species were calculated using two methods. First, the MBR was estimated from the human landing collections, taking into consideration the night-time habits of the local population. Observations in the study village showed that the average villager spends one hour outdoors after dusk and that everyone remains indoors after 10:00 PM. The outdoor component of the MBR was therefore calculated as the average number of bites per hour during the period from 6:00 to 10:00 PM. The indoor component of the MBR constituted the average number of bites indoors during a three hour period of 6:00 to 10:00 PM (discounting one hour spent outdoors), plus all bites indoors after 10:00 PM. The highest man biting density was observed in Ziway town (an unsprayed area used as a control) with 27.3 bites/man/night, and the lowest was in Mechefera *kebele* with 2.8 bites/man/night.

Secondly, the MBR was also estimated from pyrethrum spray collection by dividing the number of fed females found in the houses by the number of human occupants of the houses from which mosquitoes were collected. The MBR estimated from indoor resting collections in Kolonel camp, Ziway town, Eddo Kontola, and Mechefera *kebeles* was 0.43, 0.48, 2.9 and 0.45 bites/man/night, respectively. The highest man biting was seen in Eddo Kontola *kebele*, where people live with animals in same house. The lowest, 0.43 bites/man/night, was found in Kolonel camp where human dwellings are far apart and separate from animal shelters. The computation for MBR in this section is made only for the principal vector, *An. gambiae* complex.

Table 14. Summary of man biting rate from spray sheet collection.

Study Site	Unit	Months				
		Jul	Sep	Oct	Nov	Total
Kolonol Camp	No occupant	12	12	9	9	42
	An.gambiae	0	11	4	3	18
	Man biting rate	0	0.9	0.4	0.3	0.43 (Average)
Ziway Town	No occupant	9	14	14	11	48
	An.gambiae	5	16	2	0	23
	Man biting rate	0.6	1.1	0.1	0	0.48(Average)
Eddo kontola	No occupant	6	15	10	13	44
	An.gambiae	8	86	32	5	131
	Man biting rate	1.3	5.7	3.2	0.38	2.98(Average)
Mechefera	No occupant	14	20	18	22	74
	An.gambiae	0	28	0	5	33
	Man biting rate	0	1.4	0	0.23	0.45(Average)

Table 15. Summary of man biting rate for from night man landing for *An. gambiae* complex.

Village	Month	Total catches indoors		Total catches outdoors	Man-biting rate			Average man biting rate
		6pm-10pm	10pm – 6am	6 – 10pm	Indoors (3+8 hrs)	Outdoors (1hr)	Total (12 hrs)	
Kolonel Camp	Jul	2	3	1	4.5	0.25	4.75	11.25
	Set	1	33	2	33.75	0.5	34.25	
	Oct	1	1	4	1.75	1	2.75	
	Nov	1	2	2	2.75	0.5	3.25	
	Total	5	39	9	42.75	2.25	45	
Ziway town	Jul	1	18	0	18.75	0	18.75	27.25
	Set	6	19	12	23.5	3	26.5	
	Oct	2	60	0	61.5	0	61.5	
	Nov	0	2	1	2	0.25	2.25	
	Total	9	99	13	105.75	3.25	109	
Eddo Kontola	Jul	1	3	6	3.75	1.5	4.25	13.5
	Set	9	35	11	41.75	2.75	44.5	
	Oct	1	4	1	4.75	0.25	5	
	Nov	0	1	0	0.75	0	0.75	
	Total	11	43	18	51	4.5	54.5	
Mechefera	Jul	1	1	0	1.75	0	1.75	2.75
	Set	0	8	0	8	0	8	
	Oct	0	0	1	0	0.25	0.25	
	Nov	1	0	1	0.75	0.25	1	
	Total	2	9	2	10.5	0.5	11	

Table 16. Summary of larval monitoring.

Month & Year	Breeding places	Water character	No of Dips	Anopheles larvae collected	Anopheles species		Unidentified (damaged)	Larvae/100dips
					An. gambiae	*An. pharoensis*		
July 2008	Swamp & Rain Pool	Temporary direct sun light	No larvae was found due to flooding.					0
Sept 2008	Swamp & Rain Pool	Temporary direct sun light	1,300	124	90	28	6	9.5
Oct 2008	Swamp & Rain Pool	Temporary direct sun light	1,110	107	64	23	20	9.6
Nov 2008	Swamp & Rain Pool	Temporary direct sun light	1,860	157	30	119	8	8.4
Total			**4,270**	**388**	**184**	**170**	**34**	**9.0**

Wall Bioassay

This test was conducted in October 2008 in Eddo Kontola *kebele* in two houses where DDT spraying was done in the first week of August 2008. The test mosquitoes were *An. gambiae* complex caught from a nearby, unsprayed *kebele*.

The overall test mortality was 17.4 percent (with 60 data points), while the control mortality was 15 percent (with 20 data points). According to WHO standard procedure, if the control mortality falls between 5 and 20 percent, test mortality must be corrected using Abbott's formula and thus the correction was made. Mortality rates differed according to the height of the exposure spot on the walls, presumably owing to erosion of the insecticide deposit through frequent human (or animal) touch and rubbing. The highest parts of the sprayed walls had the highest mortality rate (58.8 percent), and the lowest parts had no mortality. The mortality rate of mosquitoes exposed to middle part of the sprayed walls was 11.8 percent. As residual efficacy of DDT is at least six moths after spraying, pesticide decay is unlikely and thus other possibilities for low mosquito mortality need to be substantiated by further studies. Plausible explanations include spray operator error, physical disturbance (removal of insecticide from wall) by human activity or cattle (the communities where this mortality was observed normally keep cattle indoors), or the development of DDT resistance by the local vectors.

Susceptibility and Insecticide Resistance

This is a priority entomological monitoring activity as it affords a determination of the level of effectiveness of the insecticide on the vector population. However, due to a delay in obtaining and subsequently clearing the WHO test kits and insecticide impregnated papers through customs, this test has yet to be conducted.

Conclusion

This study result indicates that *An. gambiae* complex is still the predominant species of malaria vector during this period. The comparison of human landing density to spray sheet collections indicates that *An. gambiae* complex has shown a tendency for outdoor biting when given equal opportunity. A similar study result was observed in Ziwai area about 10 years ago (Abose *et al*., 1998). This exophagic habit of mosquitoes needs further investigation in different areas. Most of the biting habits of *An. gambiae* complex occurred while they were trying to bite outdoors, which was similar to previous investigators findings (Abose *et al*., 1998).

The highest man biting density of *An. gambiae* complex occurred in Ziway town where indoor residual spraying was not conducted. Unlike previous studies (Abose *et al*., 1998; Yohannes *et al*., 2005) the peak biting hours for *A. gambia*e complex was after 10:00 PM. Previous investigators reported that *An. gambiae* complex was exhibiting early night-biting before people went to bed. Study results indicated a similar pattern of biting cycle in the indoor and outdoor testing conducted in Sille area (Taye, *et al*., 2006).

Collaborating Organizations

MOH

RTI established strong collaboration with the Federal and Regional Ministry of Health authorities. Starting from the micro-planning meeting and training on IRS, RTI involved the regional and district health heads and malaria and environmental health focal persons. All districts health offices assigned their experts and health extension workers without any reservations to carry out IRS campaign, allowing a more integrated approach to IRS implementation, monitoring and evaluation.

The ORHB signed a memorandum of understanding with RTI and agreed to give all necessary support as required. The ORHB also agreed to provide RTI space in the Malaria Control Department office until such a time as RTI is formally registered in Ethiopia.

Political and Community Leaders

Both traditional and local administrative authorities participated in the implementation of IRS through IEC training and information dissemination. These local partners played a clear role in passing along important IEC messages associated with malaria, as well as informing communities of when spray operators were likely to visit their households.

End of Round Evaluation and Lessons Learned

A summary of discussions held at the post-spray evaluation meeting, items agreed upon, and recommendations for future rounds are presented below.

Lack of Proper Storage Facilities

RTI needs to work with districts to assess the status of storage facilities for IRS equipment, DDT and PPE and encourage districts to identify gaps, how to alleviate gaps, and how RTI can support their efforts.

Late Start-up

Late start-up of spray operations caused output to be compromised by heavy rain. The problem occurred due to very short preparation time for the overall operation. In the next round, IRS should start by mid-May and be completed before major rain.

Insufficient Training

Sufficient training time was not provided for newly joined health extension workers (HEW) on IRS. HEWs were in squad leader positions, which require good knowledge of IRS and vigorous effort. Some HEWs were deployed in IRS with four to five days training (IRS TOT or spray operators training). It was agreed to train new HEWs for more days to acquaint them fully with IRS operations.

Shortage of Vehicles

The shortage of vehicles occurred due to a delay in the IRS commencement date given to the car rental companies. The vehicles were committed elsewhere until the operations formally began. RTI will ensure the availability of all needed materials on time in the next round of IRS.

Waste Management

Empty sachets, cartons, and other contaminated materials were not handled properly in many districts. For the short-term, this gap will be addressed by transporting all empty sachets, cartons, and other contaminated materials to centrally rented storage until such a time as a chemical incinerator is established or another lasting solution is identified.

Faulty Evaporation Tanks

Some of constructed evaporation tanks were cracked and covering wire mesh was damaged. Some evaporation tanks were already undergoing maintenance during the meeting. Experience showed that good specifications, careful selection of bidders based on past performance, and day to day follow ups are a must to get quality construction.

Low Community Acceptance of DDT

Evidence-based and extensive IEC could be a solution and RTI and the district will explore ways to increase IEC during the next campaign.

Poor Quality of IRS Materials

Certain IRS materials (plastic jerry-cans, buckets and soap) purchased locally were found to be of poor quality, although the materials were manufactured from known competitive factories and bought directly from the manufacturer. In the next round, the local procurement will be done from wherever the best quality materials are available and not necessarily limited to major local manufacturing sources, as there are products on the local market from countries that may be of better quality.

Materials Shortage

During this round there was a shortage of family size tents and blankets and boots for washers. This problem will be solved in next round of IRS operations.

Shortage of Staging Sites

Spray operators experienced long distances from spray operations areas to staging sites in some districts and there were reports of more than 80 people triple rinsing on one evaporation tank in Arsi Negele district. To solve this shortage, requests for additional evaporation tanks have been accepted and will be constructed in FY09 in Merti and Arsi-Negele districts.