President's Malaria Initiative

Tanzania Vector Control Scale-up Project: Spray Performance Report

November 2011–May 2012

Contract No. 621-A-00-10-00015-00
March 9, 2010–March 8, 2015

Prepared for:
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List of Abbreviations

ACT	artemisinin-based combination therapy
BCC	behavior change communication
BQK	Bendiocarb Quantification Kit
CBO	community-based organization
CCA	community change agents
CCHP	Comprehensive Council Health Plan
CFR	U.S. Code of Federal Regulations
COMMIT	Communication and Malaria Initiative in Tanzania (USAID project)
CS	capsulated suspension
DC	District Council
DEMO	District Environmental Management Officer
DITC	District IRS Technical Committee
DITT	District IRS Technical Team
DMO	District Medical Officer
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
FAO	United Nations Food and Agriculture Organization
GDC	Geita District Council
GGM	Geita Gold Mine
HPLC	high performance liquid chromatography
HR	human resources
IEC	information, education and communication
IHI	Ifakara Institute of Health
IMCI	Integrated Management of Childhood Illness
IMVC	Integrated Malaria Vector Control
IPTp	Intermittent Preventive Treatment for Pregnancy
IQK	Insecticide Quantification Kit
IRS	Indoor Residual Spraying
IT	information technology
ITN	insecticide-treated net
JHU	John Hopkins University
CCP	Center for Communication Programs, Johns Hopkins University
LLIN	long-lasting insecticide-treated net
LSM	larval source management
LSHTM	London School of Hygiene and Tropical Medicine
M&E	monitoring and evaluation
MEEDS	malaria early epidemic detection system
MEO	Monitoring and Evaluation Officer
MIS	Malaria Indicator Survey
MoHSW	Ministry of Health and Social Welfare
NEMC	National Environment Management Council
NGO	nongovernmental organization
NIMR	National Institute for Medical Research
NMB	National Microfinance Bank

NMCP	National Malaria Control Programme
OS	Operation Site
PAMVERC	Pan African Malaria Vector Research Consortium
PEA	Preliminary Environmental Assessment
PMI	President's Malaria Initiative
PPE	personal protective equipment
PPP	Public Private Partnership
PSA	Public service announcement
SEA	Supplemental Environmental Assessment
SIM	Site IEC Mobilizer
SOP	standard operating procedure
THMIS	Tanzania HIV and Malaria Indicator Survey
TOT	training of trainers
TPRI	Tropical Pesticide Research Institute
TVCSP	Tanzania Vector Control Scale up Project
USAID	United States Agency for International Development
VC	vector control
VCO	vector control officers
WEO	Ward Executive Officer
WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation Scheme
WP	Wettable powder
ZMCP	Zanzibar Malaria Control Programme

I. Executive Summary

In 2006, RTI International was awarded a Cooperative Agreement by the U.S. Agency for International Development (USAID) under the U.S. President's Malaria Initiative to implement indoor residual spraying (IRS) and other malaria control and prevention activities in Mainland Tanzania and Zanzibar. Between 2006 and July 2010, RTI conducted IRS in Zanzibar and Kagera Region in the Lake Zone in Mainland Tanzania. In 2010, IRS was expanded to cover two additional Lake Zone regions, Mwanza and Mara. Over the course of the 2010–2011 IRS spray season, a total of 18 districts in the Lake Zone (seven districts in Kagera Region, six districts in Mwanza Region, and five districts in Mara Region) and 10 districts in Zanzibar benefited from IRS.

In 2011–2012, IRS continued in the Lake Zone and Zanzibar. However, there were some changes in IRS strategy, which partly led to a change in insecticide used, as well as the imminent scale down of IRS in some areas. In Muleba, Karagwe, and Zanzibar, pyrethroids (lambda-cyhalothrin) insecticide was substituted with carbamate (bendiocarb) in accordance with insecticide rotation, as recommended by the expert panel working on the development of an Insecticide Resistance Mitigation Plan. Because of the expected shorter duration of the newly introduced insecticide, selected villages in Muleba were sprayed twice to provide optimal protection during the malaria transmission season. The same strategy applies in Zanzibar, where a second spray round is anticipated in September 2012.

Furthermore, Muleba District (in Mainland Tanzania) and Zanzibar introduced targeted spraying as part of the exit strategy. In December 2011, following a reported malaria outbreak in Zanzibar, a focal spray was conducted in Tumbe, Pemba. In six districts of Mwanza Region, and in five districts of Mara Region, a second blanket spray round was conducted. In five districts of Kagera Region, a third round of blanket IRS was conducted. In Karagwe and Muleba districts, third, fourth, fifth, and sixth spray rounds were conducted, based on the time period that IRS was initiated.

Prior to any spraying, however, many preparatory and foundational activities had to be carried out, such as the following:

- Select eligible spray areas based on national strategic priorities and logistic and epidemiological considerations;
- Conduct a preliminary logistics assessment to quantify eligible house structures, the target population, spray equipment, insecticide, and spray teams, and identify suitable sites to host temporary storage and effluent waste-disposal facilities;
- To satisfy both USAID and Government of Tanzania environmental requirements, submit documentation for the shift from pyrethroids to carbamate insecticide;
- Refurbish existing IRS sites for temporary, proper storage of IRS equipment and insecticide and effluent waste disposal facilities;

- Implement a plan for safer use of insecticide and institute an environmental mitigation plan, including safe transport and secure storage of insecticide, testing of female spray technicians for pregnancy, and training of clinicians on treatment of pesticide side-effects;
- Perform insecticide quality assurance tests;
- Introduce the Insecticide Quantification Kit (IQK) for bendiocarb;
- Procure, transport, and store all necessary spray and personnel protective equipment (PPE), insecticides, and consumables;
- Train spray teams in a variety of positions, including site managers, team leaders, spray operators, suit washers, site attendants, security guards, and water fetchers; and
- Promote acceptance of IRS in the targeted communities through information, education, and communication (IEC) activities.

In the Lake Zone, at the close of IRS operations in May 2012, a total of 1,224,095 house structures (93% of those eligible) were sprayed of which 37,974 were sprayed twice in Muleba. As a result, 6,340,333 people were protected, including 181,614 pregnant women and 1,383,447 children under the age of five. In Zanzibar, a total of 114,858 house structures were sprayed (95% of those eligible), with 586,657 people protected, including 14,080 pregnant women and 103,984 children under the age of five.

Other important achievements during the last IRS reporting period were as follows:

- Introduction of standardized training modules to facilitate standardization of training cascade and improve training quality;
- Establishment of spray quality monitoring tools to guide spray supervisors to improve and maintain standard operating procedures (SOPs) during operations;
- Registration of households, leading to a reliable sprayed house structures denominator;
- Recruitment of community change agents (CCAs) as Site IEC Mobilizers (SIMs) in place of using nongovernmental organizations (NGOs) and community-based organizations (CBOs) for IEC and sensitization at ward and village levels;
- Epidemiological surveillance in selected health facilities for real time monitoring impact of IRS campaign;
- Introduction of Insecticide Quantification Kits (IQK) to determine concentration of insecticide after spray and to monitor decay; IQK is an important tool to improve spray technique during operations and to monitor the duration of the insecticides on the walls after spray;
- Monitoring of annual insecticide susceptibility in sentinel sites is crucial to determine the efficacy of insecticide and selection of the appropriate and most cost effective one; and

- Extensive cone bioassay monitoring to monitor duration of insecticide after spray over the time and in different substrates.

II. Country Background

Intervention Areas

The United Republic of Tanzania is located between longitudes 28°E and 40°E; latitudes 1°S and 12°S. The country has a total area of 947,480 km^2, of which 883,349 km^2 constitute land, and the remainder is made up of water bodies. Administratively, the country includes Mainland Tanzania and the archipelago of Zanzibar.

Mainland Tanzania

Mainland Tanzania has 21 regions and 132 councils. Each council is divided into 4–5 divisions, which in turn are composed of 3–4 wards. Approximately 5–7 villages form a ward. There are approximate 10,045 villages in Mainland Tanzania. Each village is subdivided into hamlets (3–6 per village). The country has an estimated population of 43.1 million (2010 estimate), with an annual growth rate of 2.8%. Seventy-six percent of the population lives in rural communities. Twenty percent of the population is made up of children less than five years of age, 27% are 5–15 years old, and 20% are women of reproductive age (between 15 and 49 years of age).

The Lake Zone Regions in Mainland Tanzania

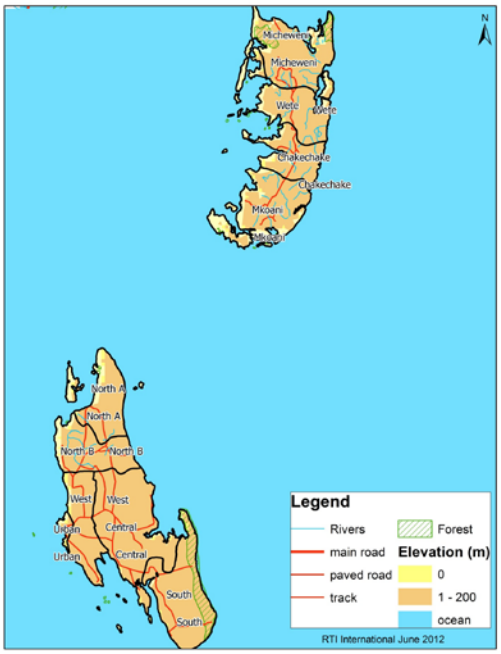
Mainland Tanzania is divided into seven zones (East, South, Southern Highlands, West, Central, Lake, and North). The Lake Zone has a total surface of 77,392 km^2 and a population of 11,794,791 (based on a 2010 estimate). The Lake Zone is divided into four regions (*Figure 1*): (1) Shinyanga (50,781 km^2, 8 districts, and 3,841,788 residents, based on a 2010 estimate); (2) Kagera (40,838 km^2, eight districts, and 2,563,870 residents, based on a 2010 estimate); (3) Mwanza (19,592 km^2, 8 districts, and 3,566,263 residents, based on a 2010 estimate); and (4) Mara (16,962 km^2, 6 districts, and 1,822,870 residents, based on a 2010 estimate). In the Lake Zone, two new regions were recently established, Simiyu and Geita, with a consequent redistribution of the administrative districts, surface area, and population. In this report, we use the administrative designations prior to the rearrangement.

Figure 1. Map of Lake Zone

Zanzibar

The Zanzibar archipelago consists of two main islands, Unguja and Pemba, and several minor islands (*Figure 2*). The total surface area is 1,658 km^2, with a population of 1.3 million (2010 census projection). The administrative setup in Zanzibar includes five regions—three in Unguja and two in Pemba—10 districts, and 335 *shehia*[1].

Figure 2. Map of Zanzibar, Unguja and Pemba



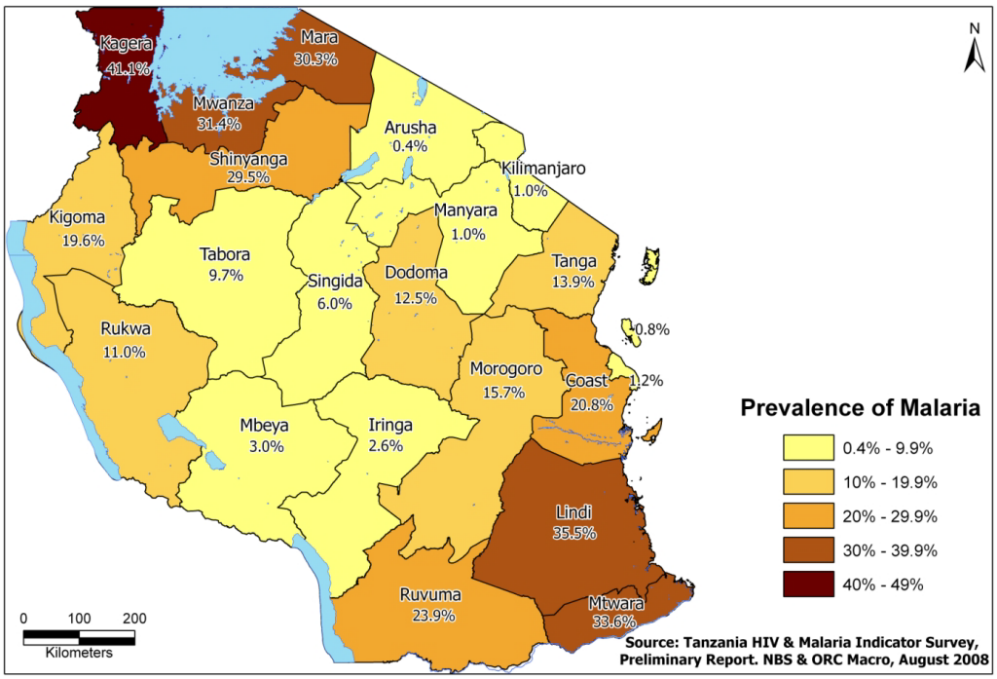
[1] *Shehia* is the equivalent of a ward in Zanzibar's administrative setup.

Malaria Transmission in Mainland Tanzania and Zanzibar

The transmission of malaria in Mainland Tanzania is highly variable, depending on geographic, climatic, and human settings. The most recent national population-based survey data (Tanzania Health Management Information Survey [THMIS] 2008) show that 18% of children under five tested positive for malaria in Mainland Tanzania, in contrast to only 0.8% in the two islands of Pemba and Unguja in Zanzibar. In Zanzibar, a Malaria Indicator Survey (MIS) carried out by the Zanzibar Malaria Control Programme (ZMCP) in 2010 showed further reduction of malaria prevalence to less than 0.1%.

The 2008 THMIS data show marked regional variations, ranging from 0.4% in Arusha to 41.1% in the northwestern region of Kagera (see *Figure 3)* among children under five in Mainland Tanzania. Updated national and regional representative prevalence data from the 2012 THMIS are expected to be delivered later this year. Perennial intense malaria transmission is typical in the Lake Zone (upper northwest) and coastal belt (east and south), with prevalence between 20% and more than 40%. There is seasonal malaria transmission, with prevalence between 5% and 20% in the Central Plateau. Low or seasonal transmission (shorter than 3 months per year) is the pattern in the Southern and Northern Highlands, with a prevalence of lower than 5%. Dar es Salaam City has exceptionally low malaria transmission. In Mainland Tanzania, rural areas had a higher prevalence (20%) compared to urban areas (8%).

Figure 3. Tanzania malaria prevalence in children under five years of age



Malaria Medium-Term Strategic Plan for Mainland Tanzania and Zanzibar

Mainland Tanzania

In Mainland Tanzania, the goal of the second 2008–2013 Medium-Term Strategic Plan is to reduce malaria prevalence by 50% by the end of 2013. The main targets are as follows:

- 80% of malaria patients diagnosed and treated with effective antimalarial medicines, such as artemisinin-based combination therapy (ACT), within 24 hours of the onset of fever;
- 80% of all pregnant women receive two or more doses of intermittent preventive treatment (IPTp);
- 80% of people in malarious areas protected through the use of insecticide-treated nets (ITNs);
- 80% of people in target areas protected through IRS; and
- Early detection and containment of 80% of malaria epidemics within two weeks from onset.

The current plan aims to rapidly scale up the levels of coverage for the main interventions and includes a comprehensive array of activities. The plan also includes measures for strengthening malaria surveillance systems to inform decision makers and institute timely preventive measures.

Zanzibar

In Zanzibar, the long-term goal is malaria elimination. The medium-term goal of the current strategic plan is to assess the potentialities for malaria elimination and to reduce morbidity and mortality due to malaria in Zanzibar's population to a level that the disease no longer poses a public health threat, especially among most vulnerable groups, such as children under five, pregnant women, and the poor. The Zanzibar medium-term targets are similar to those for Mainland Tanzania. Zanzibar has three additional targets for effective malaria epidemic preparedness and response: (1) over 90% of health facilities weekly reports are submitted on time to early detect abnormal raise in malaria cases; (2) investigation of reported epidemics is initiated within 24 hours; and (3) supplies are at hand to mount a response, if necessary, within two weeks from the notification of the outbreak. Furthermore, the strategic plan includes a target to assess the potential for sustainable elimination of malaria from Zanzibar, using newly available data from surveillance and operational research, as well as experience from implementation of previous IRS rounds.

III. IRS in the Context of Malaria Strategies in Mainland Tanzania and Zanzibar

Recent History of IRS in Mainland Tanzania and Zanzibar

Zanzibar

The PMI has assisted ZMCP with its IRS program since 2006, contributing to the substantial drop in malaria transmission. Between June 2006 and June 2012, RTI, in collaboration with ZMCP, conducted IRS in Zanzibar for six blanket rounds (*Table 1*), two reactive focal spray initiatives (2008 in Bumbwini and 2011 in Tumbe), and one targeted spray. About 200,000 house structures were sprayed per blanket round, protecting almost 1.2 million people. The spray coverage was consistently over 90%.

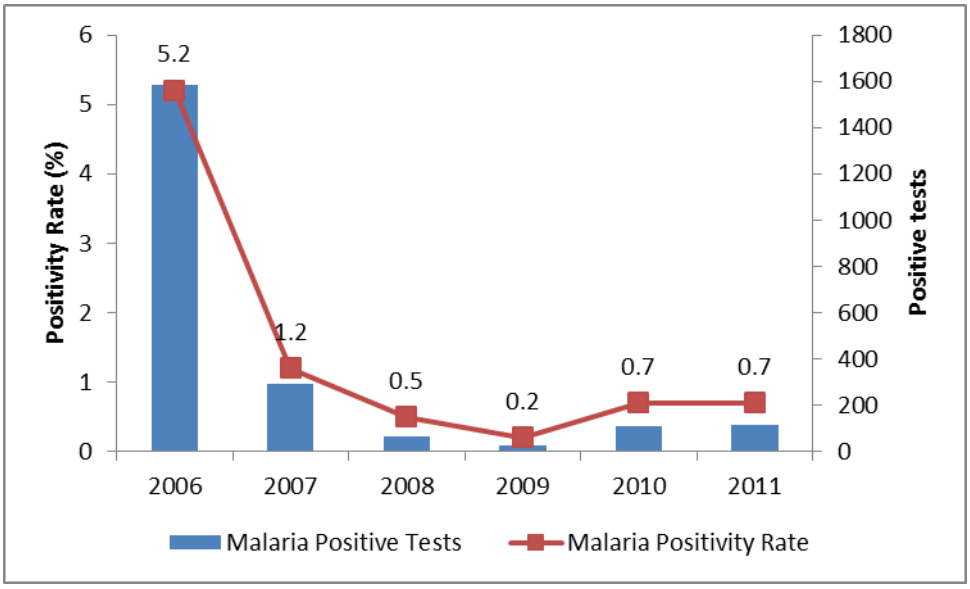
Table 1. Spray performance in Zanzibar (structures sprayed), 2006–2012

Location	Round 1	Round 2	Round 3	Focal Spray	Round 4	Round 5	Round 6	Focal Spray	Targeted Spray
	2006	2007	2007	2008	2008	2010	2011	2011	2012
Unguja									
Central	15,167 (92%)	15,258 (89%)	15,737 (95%)	—	13,897 (94%)	15,046 (89%)	14,883 (94%)	—	15,392 (93%)
North A	21,729 (98%)	21,575 (96%)	22,961 (100%)	—	22,097 (97%)	18,595 (88%)	21,524 (100%)	—	18,274 (93%)
North B	11,829 (95%)	10,819 (93%)	11,737 (95%)	4,797	10,562 (93%)	10,397 (89%)	11,480 (97%)	—	11,294 (99%)
South	8,036 (99%)	8,871 (100%)	9,167 (99%)	—	9,417 (100%)	8,604 (88%)	8,472 (94%)	—	5,644 (93%)
Urban	25,670 (92%)	23,764 (79%)	25,828 (88%)	—	27,464 (97%)	22,355 (78%)	23,127 (86.7%)	—	excluded
West	41,182 (92%)	37,370 (81%)	47,739 (98%)	—	43,053 (84%)	40,202 (88%)	40,422 (94.9%)	—	24,463 (90%)
Pemba									
Chakechake	16,211 (99%)	16,829 (100%)	16,637 (99%)	—	16,437 (96%)	16,280 (88%)	16,866 (94%)	—	8,682 (98%)
Micheweni	21,015 (100%)	20,824 (100%)	20,920 (100%)	—	18,164 (97%)	16,811 (87%)	20,305 (96%)	2,003	12,744 (98%)
Mkoani	19,804 (100%)	20,067 (100%)	19,560 (98%)	—	18,653 (98%)	18,224 (98%)	18,267 (100%)	—	10,047 (100%)
Wete	21,376 (100%)	21,596 (100%)	22,371 (99%)	—	20,987 (98%)	19,532 (90%)	19,462 (93%)	—	8,318 (98%)
Total	202,019 (96%)	196,973 (91%)	212,657 (97%)	4,797	200,731 (94%)	186,046 (88%)	194,808 (95%)	—	114,858 (95%)

All spray rounds between 2006 and 2011 were done using pyrethroids. For the 2011 focal spray and 2012 targeted spray, bendiocarb was introduced. This massive effort,

together with other interventions, has contributed significantly to bringing malaria prevalence to less than 1% and advancing Zanzibar to a pre-elimination phase in malaria control (*Figure 4*).

Figure 4. Malaria positive tests (right, vertical axis) and malaria positivity rate (left, vertical axis) in six hospitals (Kivunge, Makunduchi, Chakechake, Wete, Micheweni, and Mkoani) in Zanzibar, 2006–2011



Mainland Tanzania

In its 2008–2013 Medium-Term Strategic Plan, the Tanzania National Malaria Control Programme (NMCP) targets IRS scale-up from one district in 2007 to cover about 60 districts by 2013, protecting 50% of the country's population. This scale-up will be implemented through the NMCP's Integrated Malaria Vector Control (IMVC) strategy, which includes malaria preventive methods such as ITNs and long-lasting insecticide-treated nets (LLINs), larval source management (LSM) in large urbanized areas, and effective environmental management.

PMI began supporting IRS in Mainland Tanzania in 2007. PMI first contracted RTI to assist the Ministry of Health and Social Welfare (MoHSW) in controlling malaria outbreaks in the malaria-unstable areas of Karagwe and Muleba districts in Kagera Region. In 2009, IRS operations were scaled up in Kagera to cover the remaining stable and high-transmission areas covering the other five districts (Biharamuro, Bukoba Rural, Chato, Misenyi, and Ngara). In 2010, IRS operations were scaled up to cover 11 districts of Mara and Mwanza regions (*Table 2* and *Figure 5*). In 2012, a third and a second IRS round took place in the same 5 and 11 districts of Kagera and Mwanza/Mara, respectively. In Muleba District, a targeted spray was initiated in 2012 while in Karagwe District, another blanket spray was conducted. Pyrethroids (lambda-cyhalothrin) were used for IRS in the area from 2007. In the 2011/2012 IRS season bendiocarb was introduced in Muleba and Karagwe districts.

Table 2. Spray performance in Mainland Tanzania (structures sprayed), 2007–2012

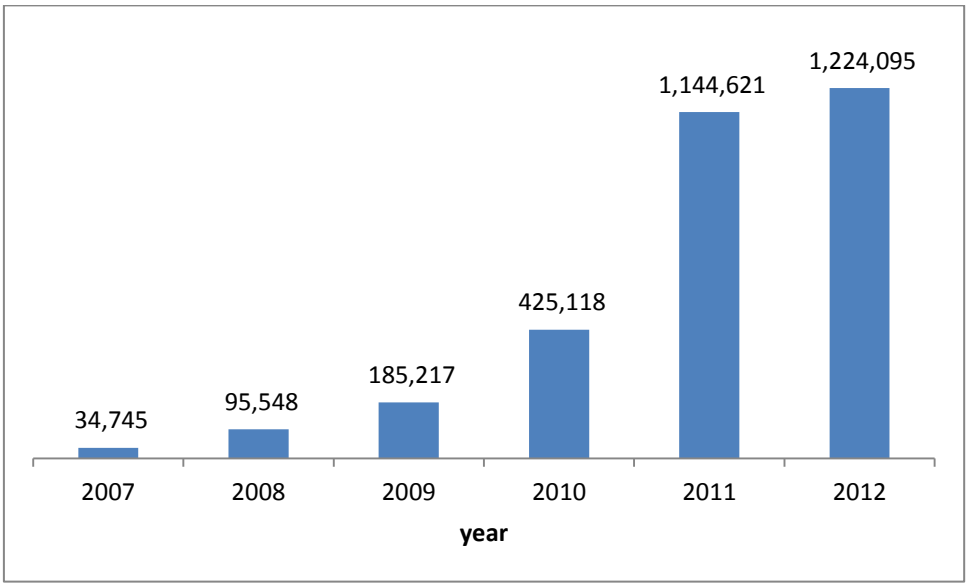
Region/ Districts		Houses eligible, sprayed, and percent covered						
		2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	
Kagera Region								
Biharamulo	Sprayed	—	—	—	31,382	38,032	40,331	—
	Visited				32,253	40,304	44,510	
	(coverage)				(97.3%)	(94.4%)	(91%)	
Bukoba R	Sprayed	—	—	—	55,183	60,548	58,925	—
	Visited				57,783	62,730	61,312	
	(coverage)				(95.5%)	(96.5%)	(96%)	
Chato	Sprayed	—	—	—	56,233	60,571	58,319	—
	Visited				57,972	62,337	61,259	
	(coverage)				(97.0%)	(97.2%)	(95%)	
Karagwe	Sprayed	—	59,177	103,631	111,047	115,669	109,102	—
	Visited		60,078	107,057	111,270	115,972	117,277	
	(coverage)		(98.5%)	(96.8%)	(99.8%)	(99.7%)	(93%)	
			Selected	Blanket	Blanket	Blanket	Blanket	
Missenyi	Sprayed	—	—	—	36,891	37,698	37,580	—
	Visited				38,751	40,135	40,813	
	(coverage)				(95.2%)	(93.9%)	(92%)	
Muleba	Sprayed	34,745	36,371	81,586	86,163	101,394	52,312	37,874
	Visited	36,612	36,850	85,163	86,336	101,491	56,148	39,946
	(coverage)	(94.9%)	(98.7%)	(95.8%)	(99.8%)	(99.9%)	(93%)	(95%)
		S	S	B	B	B	T	T
Ngara	Sprayed	—	—	—	48,219	46,264	46,069	—
	Visited				54,118	54,578	54,066	

Region/ Districts		Houses eligible, sprayed, and percent covered						
		2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	
	(coverage)				(89.1%)	(84.8%)	(95%)	
Mara Region								
Bunda	Sprayed	—	—	—	—	45,811	54,744	—
	Visited					51,710	57,457	
	(coverage)					(88.6%)	(95%)	
Musoma	Sprayed	—	—	—	—	60,363	73,157	—
	Visited					70,597	79,401	
	(coverage)					(85.5%)	(92%)	
Rorya	Sprayed	—	—	—	—	47,200	70,218	—
	Visited					49,306	74,665	
	(coverage)					(95.7%)	(94%)	
Serengeti	Sprayed	—	—	—	—	58,993	51,761	—
	Visited					59,366	55,614	
	(coverage)					(99.4%)	(93%)	
Tarime	Sprayed	—	—	—	—	53,136	74,645	—
	Visited					54,838	82,363	
	(coverage)					(96.9%)	(91%)	
Mwanza Region								
Geita	Sprayed	—	—	—	—	127,075	123,196	—
	Visited					127,454	130,475	
	(coverage)					(99.7%)	(94%)	
Geita Town	Sprayed	—	—	—	—	—	18,206	—
	Visited						20,193	
	(coverage)						(90%)	

		Houses eligible, sprayed, and percent covered						
Region/ Districts		**2006–2007**	**2007–2008**	**2008–2009**	**2009–2010**	**2010–2011**	**2011–2012**	
Kwimba	Sprayed	—	—	—	—	52,718	57,467	—
	Visited					58,180	61,348	
	(coverage)					(91.7%)	(94%)	
Magu	Sprayed	—	—	—	—	65,462	75,218	—
	Visited					78,767	81,228	
	(coverage)					(83.1%)	(93%)	
Missungwi	Sprayed	—	—	—	—	38,693	45,385	—
	Visited					43,839	49,154	
	(coverage)					(89.3%)	(92%)	
Sengerema	Sprayed	—	—	—	—	84,558	86,065	—
	Visited					87,134	91,547	
	(coverage)					(97.0%)	(94%)	
Ukerewe	Sprayed	—	—	—	—	50,436	53,520	—
	Visited					52,859	55,229	
	(coverage)					(95.4%)	(97%)	
Total	Sprayed	34,745	95,548	185,217	425,118	1,144,621	1,224,095	
	(coverage)	(94.9%)	(98.6%)	(96.3%)	(96.2%)	(94.5%)	(93%)	

Note: B = Blanket, T = Targeted, S = Selective.

Figure 5. Mainland Tanzania IRS scale-up: Number of house structures sprayed per fiscal year, 2007–2012



The impact of IRS has been seen in Kagera Region. All malaria-related indicators (e.g., number of outpatient department cases, blood transfusions, admissions due to malaria and anemia) decreased consistently. Monthly positivity rates before and after spraying are illustrated in *Figures 6, 7, and 8*.

Figure 6. Monthly positivity rates and regression lines in three hospitals in Kagera Region, 2006–2011

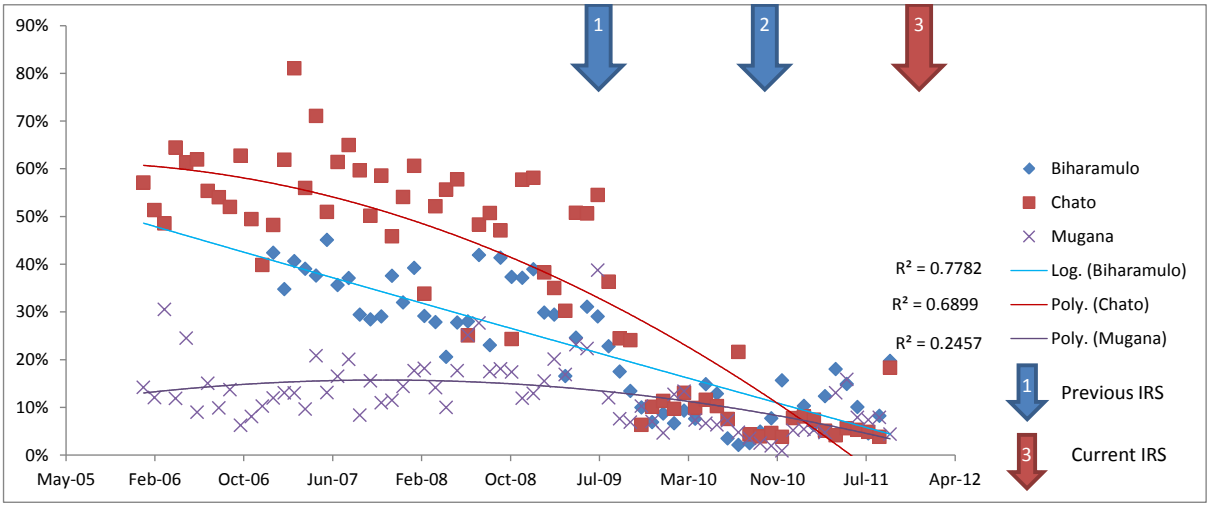


Figure 7. Monthly positivity rates and regression lines in three hospitals in Mwanza Region, IRS started September 2010, 2008–2011

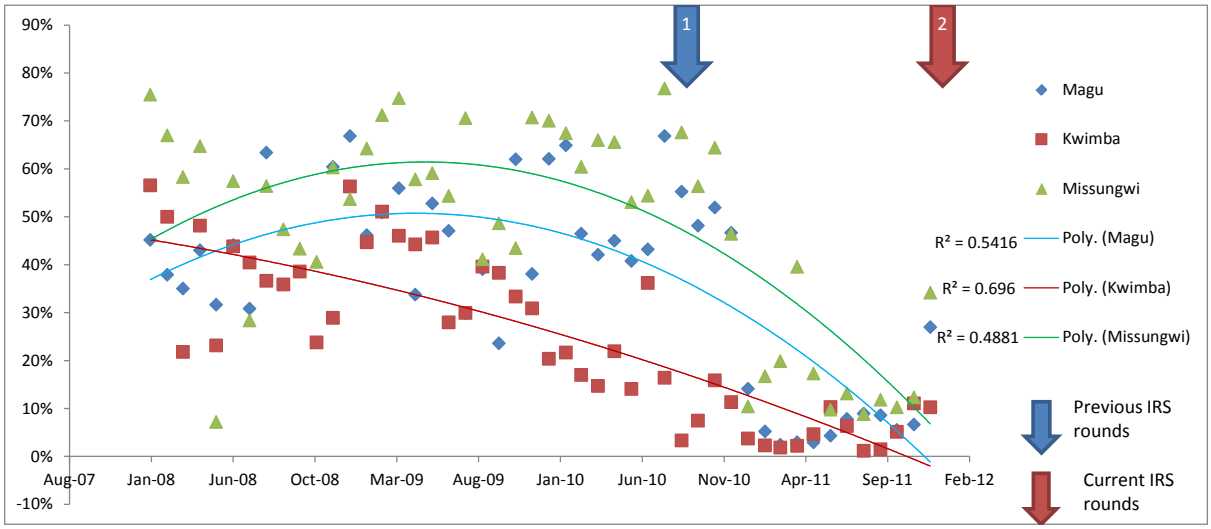
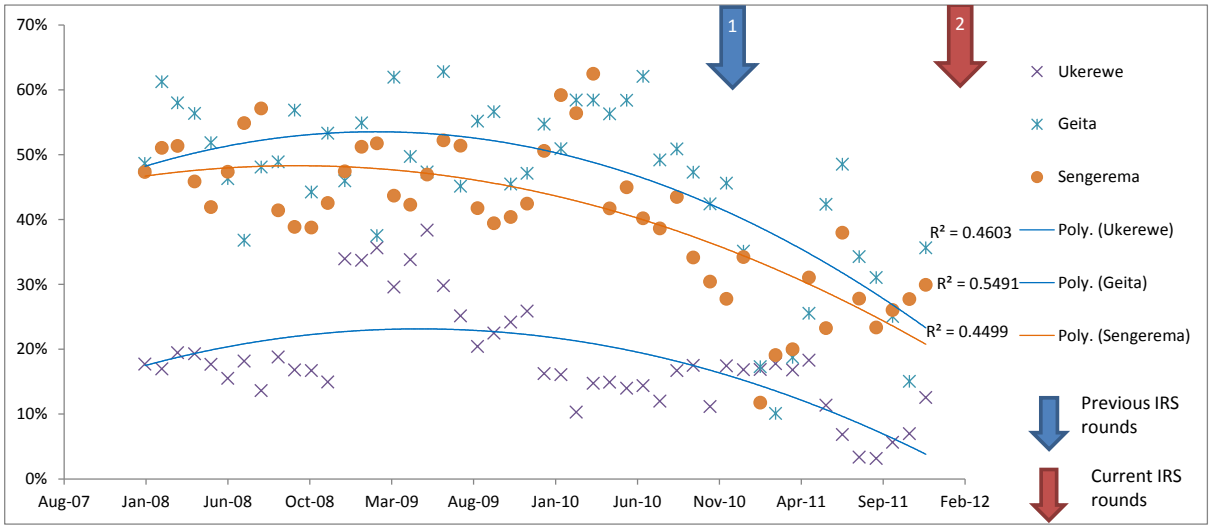


Figure 8. Monthly positivity rates and regression lines in three hospitals in Mwanza Region, IRS started January 2011, 2008–2011



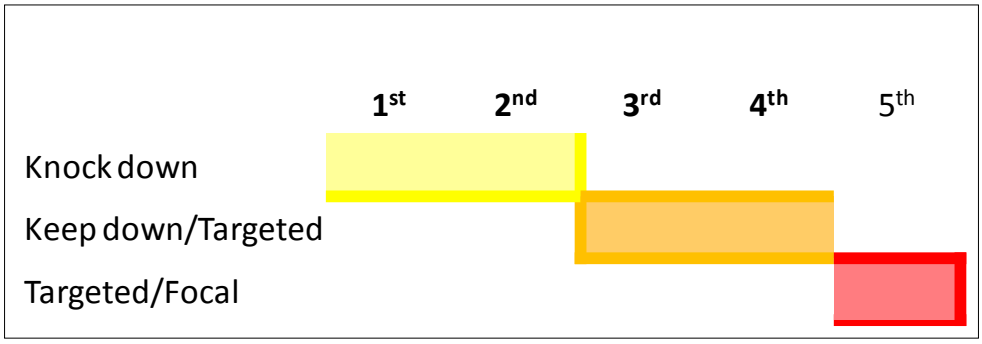
IRS Strategic Design for Zanzibar and Mainland Tanzania

Mainland Tanzania

In the NMCP 2008–2013 Medium-Term Strategic Plan, IRS is envisaged as being used in various settings in an integrated manner with other vector control interventions, mainly LLINs. The current strategic design for IRS is oriented with consideration of the geographic and climatic diversity in Mainland Tanzania and the consequent variation in the malaria situation, as described in the previous section. The strategic design for IRS will provide a rapid "knock-down" (generally 1–2 years of blanket spraying) effect on malaria transmission and prevalence. The knock-down phase should, at least, halve the malaria cases, ideally reducing them up to 75%. After this initial knock-down phase, IRS will contribute to the maintenance phase (or "keep-down" phase, which involves another one to two years of targeted spraying in large geographic areas) to keep the area at its anticipated low endemic level.

Following the introduction of appropriate surveillance and a strategy to maintain high coverage of LLINs, IRS will be scaled down to cover selected areas (through an additional two years of IRS campaigns). After achieving the above milestones, IRS will be implemented on a targeted basis to preempt or contain focal transmission in identified hot spots to prevent malaria resurgence (see *Figure* 9). This ultimate step requires establishing effective surveillance and epidemic preparedness and response systems.

Figure 9. Strategic design for IRS implementation in Mainland Tanzania



Since the inception of IRS in Muleba and Karagwe districts of Kagera Region in 2007 and 2008, respectively, the intervention has expanded to cover all 18 districts of the Lake Zone. Currently, Mwanza and Mara regions are in the knock-down phase, and six districts of Kagera Region are in the keep-down phase (see *Figure 10*). Only Muleba District has reached the targeted spray phase (see *Figure 11*).

Figure 10. Malaria prevalence over the IRS implementation plan in Mainland Tanzania, Chato District

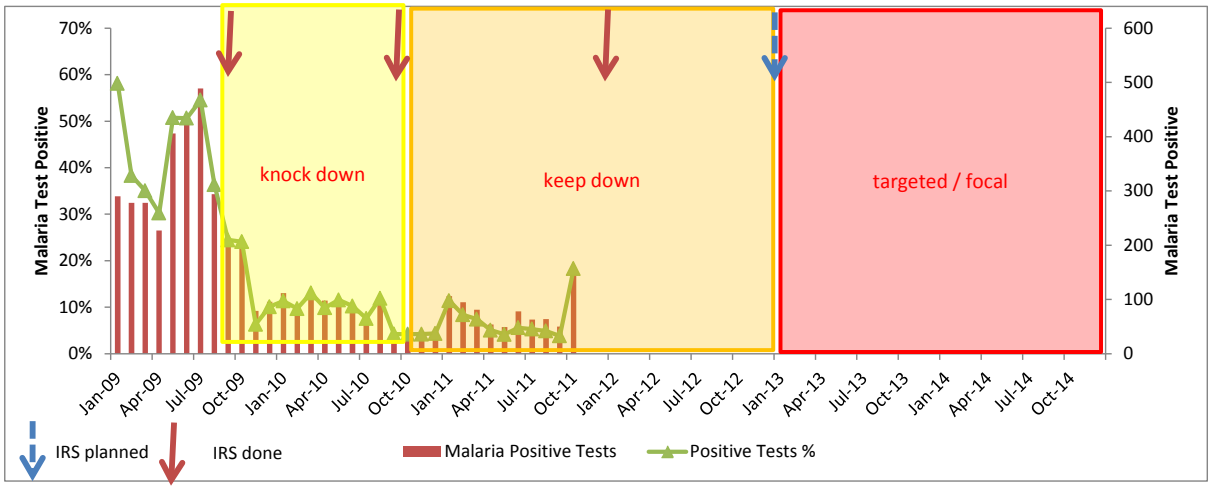
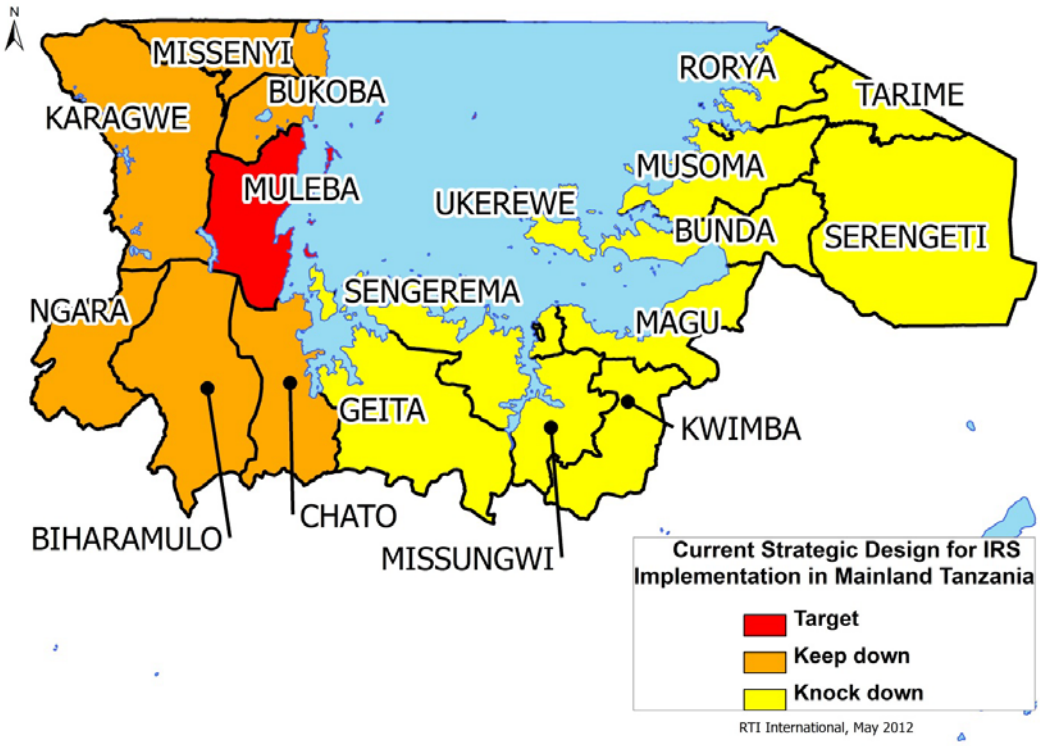


Figure 11. Current IRS malaria intervention status in Mwanza, Mara, and Kagera regions in relation to intervention mode



Zanzibar

After completing the sixth round of blanket spraying in Zanzibar in 2011, the islands reached a stage where only targeted IRS application is used. The IRS strategic design is now linked and integrated with the following initiatives: (1) implementation of targeted IRS to complement the universal coverage of LLINs; (2) implementation of focal spraying as a response to abnormal increases in malaria cases; (3) implementation of an aggressive behavior change communication (BCC) campaign that will promote the continuous use of LLINs; (4) consolidation and improvement of the malaria surveillance system, including active malaria case detection; and (5) effective use of entomological monitoring as part of surveillance (*Figures 12* and *13*).

Figure 12. Strategic design for IRS implementation in Zanzibar

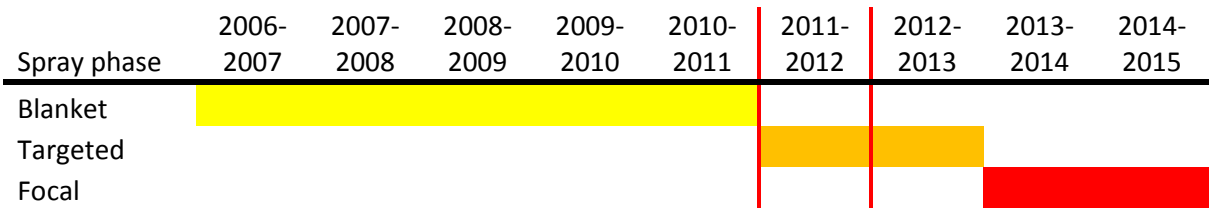
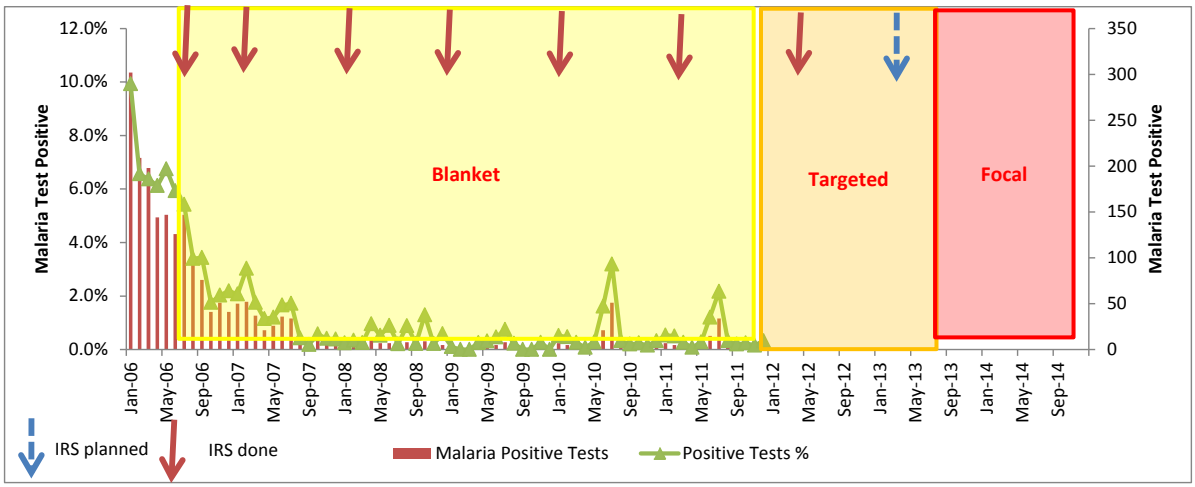


Figure 13. Malaria prevalence over IRS implementation plan in Zanzibar



Selection of Eligible Spray Areas

Mainland Tanzania

The eligible IRS districts were selected on the basis of the country's current strategic approach, which is to give priority to high endemic areas. The Lake Zone has the highest burden of malaria in Mainland Tanzania, and it was decided in a 2009 PMI consultative meeting to give priority to areas with high malaria burden. Among the four regions of the Lake Zone, three were selected either to continue (Kagera) or to expand (Mara and Mwanza) IRS. The 2008–2013 Medium-Term Strategic Plan suggests that rural areas should be prioritized over urban areas. Therefore, the four municipalities of Musoma, Bukoba, Nyamagana, and Ilemela (Mwanza City) were excluded, and a total of 18 districts in the Lake Zone (seven districts in Kagera Region, six districts in Mwanza Region, and five districts in Mara Region) were selected for IRS. In the 18 districts, the main urbanized areas were also excluded for logistic, epidemiological, and entomological reasons.

The other selection criteria for spray eligibility are the implementation of the strategic IRS design described in the previous paragraph. According to this strategic approach, some selected areas in Muleba shifted in the 2011–2012 spray season from blanket to targeted spraying.

Muleba District

In 2012, Muleba District shifted from blanket to targeted spraying. Some areas of the districts were sprayed five times (two selective and three blanket spray rounds) while other areas were sprayed three times.

In 2011, under the auspices of the PMI, a Malaria Prevention Trial also was initiated in the district. The trial had two arms: (1) LLIN universal coverage alone and (2) LLINs with IRS. For the study's purpose, the district was stratified into intervention (128 villages) and non-intervention areas (37 villages).

A number of factors influenced the stratification of the district to select targeted spraying areas, including interventions coverage, inclusion criteria in the Malaria Prevention Trial, and malaria prevalence.

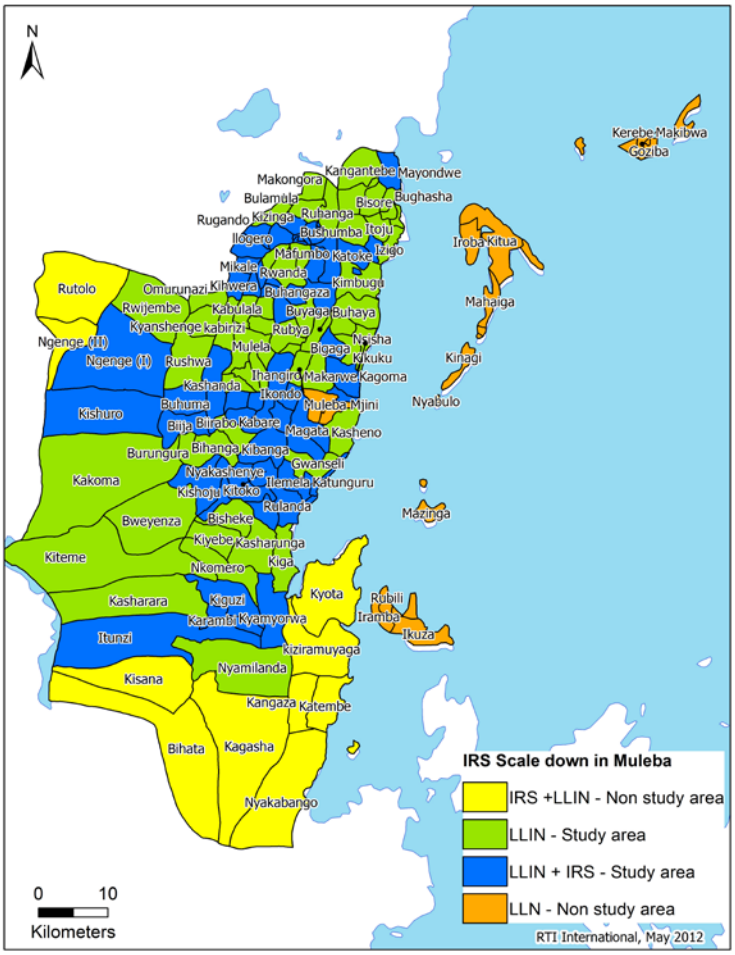
In accordance with the above criteria, 66 and 62 villages in the intervention strata were selected randomly for the LLIN alone and LLIN plus IRS arms, respectively. In the non-intervention areas, the Lake Victoria islands were excluded for two major reasons: (1) the scarce evidence of malaria transmission in the area and (2) the prevalence of substrates unsuitable for spraying due to the temporary nature of the construction. Muleba Town also was excluded because of the factors mentioned in the previous paragraph.

About 52% of houses (52,996) were selected for targeted spraying (*Table 3*). The geographical extent of the scale-down process is depicted in *Figure 14*, where the villages targeted for different interventions are represented in different colors.

Table 3. Houses targeted in Muleba District by strata

Arm	Houses	Percent
Malaria Prevention Trial Intervention Areas		
LLIN	41,534	41%
IRS LLIN	37,889	37%
Malaria Prevention Trial Non-Intervention Areas		
LLIN	7,990	8%
IRS LLIN	15,107	15%
Muleba District Overall		
LLIN	49,524	48%
IRS LLIN	52,996	52%
Total	102,520	—

Figure 14. Areas targeted for different interventions in Muleba district, according to scale-down



Zanzibar

Over the past two years (2010–2011), a strong foundation was established for scaling up malaria surveillance, adopting a revised insecticide mitigation plan, and instituting multiple control interventions, such as LLIN universal coverage and LSM, thereby enabling Zanzibar to shift its IRS strategy from blanket to targeted spraying.

IRS has played a key role in reducing and maintaining low malaria prevalence in Zanzibar. Ideally, even within the scale-down process, IRS should continue to be used in synergy with other vector control interventions to maintain the achieved low malaria endemicity level.

The selection process for targeted spraying, deliberated by ZMCP and partners, looked at a number of criteria (including operational, epidemiological, entomological, and socioeconomic, as shown in *Box 1*) with specific criteria selected based on evidence to determine high- and low-risk areas from which eligibility could be obtained.

Box 1. Criteria for selecting targeted areas in Zanzibar

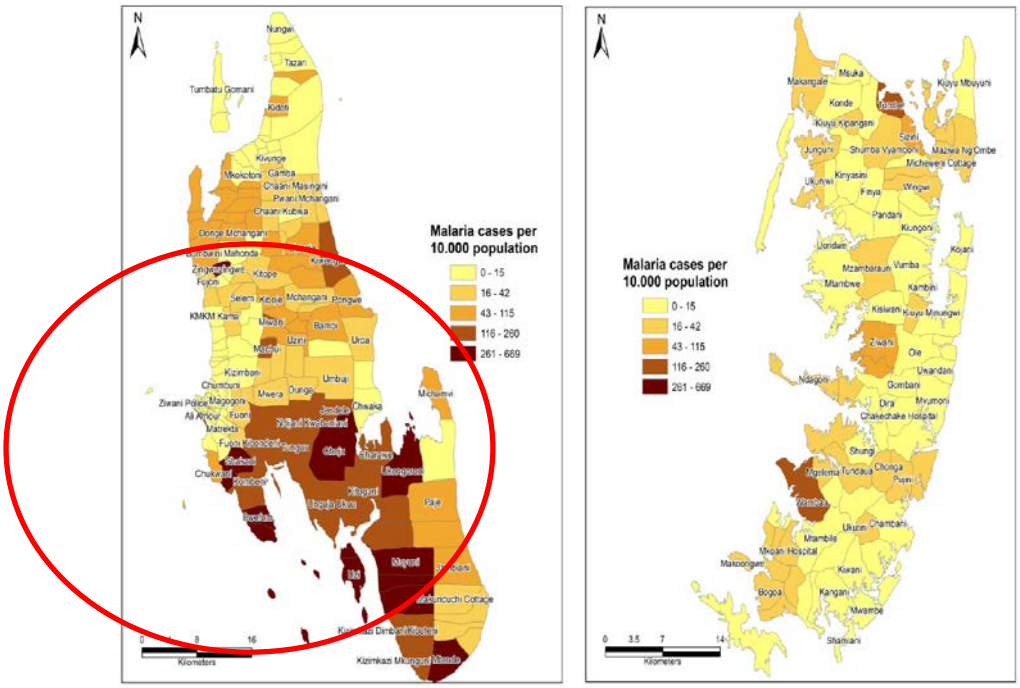
- Operational: This criterion considers the established number of structures ZMCP will be targeting for IRS. According to the 2012 Malaria Operational Plan from PMI, funding was provided for 135,000 house structures out of the eligible 210,000 households in Zanzibar. The implication is that approximately 75,000 households (32% of the population) will be excluded.
- Socio-demographic Indicators: This indicator considers the type of housing and population density.
- Malaria transmission risk: Factors that can induce higher (or lower) transmission patterns—such as precipitation levels, house characteristics (specifically type of wall surfaces), as well as urban or rural settings—should be considered for inclusion or exclusion of IRS.
- Epidemiological: According to retrospective reference data such as the malaria early epidemic detection system (MEEDS), malaria epidemiology is highly seasonal, peaking after the rainy periods, with inter-peak caseload lower than what it was in 2008 and before. Stratification of cases shows they come from specific location in certain districts, which can be targeted for IRS.
- Costs: This criterion overlaps with operational costs, whereby the cost of the currently used carbamate pesticide (US$12) is four times the price of previously used lambda cyhalothrin. However, this should not be a major concern, given that other operational costs are optimized through experience and improved efficiency.
- Malaria control coverage: This criterion considers other control interventions (specifically LLIN coverage and LSM) that can be compared across districts and other areas to prioritize IRS in places where exposure to multiple interventions is low.
- Insecticide selection and duration: This criterion considers the length of effect on treated walls for the currently used insecticide (carbamate) and its relation to the frequency of spray rounds to optimize the duration of effectiveness in sprayed areas.
- Entomological: This criterion has a number of key parameters (such as vector density in urban versus rural areas) that can be useful in decision making for target spraying. Unfortunately, lack of timely data limits the use of this criterion.
- Insecticide resistance: By rotating a different class of insecticide and spraying across the regions, it is possible to reduce mutation in mosquitoes and counter resistance. This criterion can be specifically applied to areas where there is resistance to pyrethroid and are considered for IRS.
- pH of treated surfaces: This criterion measures the reduced potency of bendiocarb in alkaline conditions of the water used to mix insecticide, as well as on treated surfaces. However it is a broad measure and has limited value until and unless tangible information can be obtained for decision making.
- BCC: This criterion is important to consider, because it has implications on the population excluded from IRS. A BCC strategy must be developed in a well-defined, properly understood manner to address concerns or questions of the public within and outside the target area for spraying

Following a round of thorough deliberation, along with extensive analysis already available information, ZMCP proposed to principally use the epidemiological data to establish the eligibility of areas targeted for IRS. MEEDS data over the past four years is quite extensive—especially for 2011, where weekly data on malaria cases are represented from over 140 health facilities all 10 districts of Zanzibar.

Using the weekly aggregated cases from health facilities, an extensive analysis was done by stratifying the malaria morbidity at defined catchment areas comprising *sheihas* for each allocated health facility. This approach gives a more specific variance of morbidity, thereby giving a more precise result in decision making when considering eligible targeted areas.

Malaria morbidity for Unguja (*Figure 16, left*) illustrates the variance in different areas in and within the districts, with West, Central, and South districts showing very diverse risk areas per the defined catchment areas. Malaria morbidity for Pemba also illustrates varying morbidity at the defined catchment areas in the four districts (*Figure 15, right*).

Figure 15. Malaria morbidity for Unguja and Pemba Islands, 2011 MEEDS

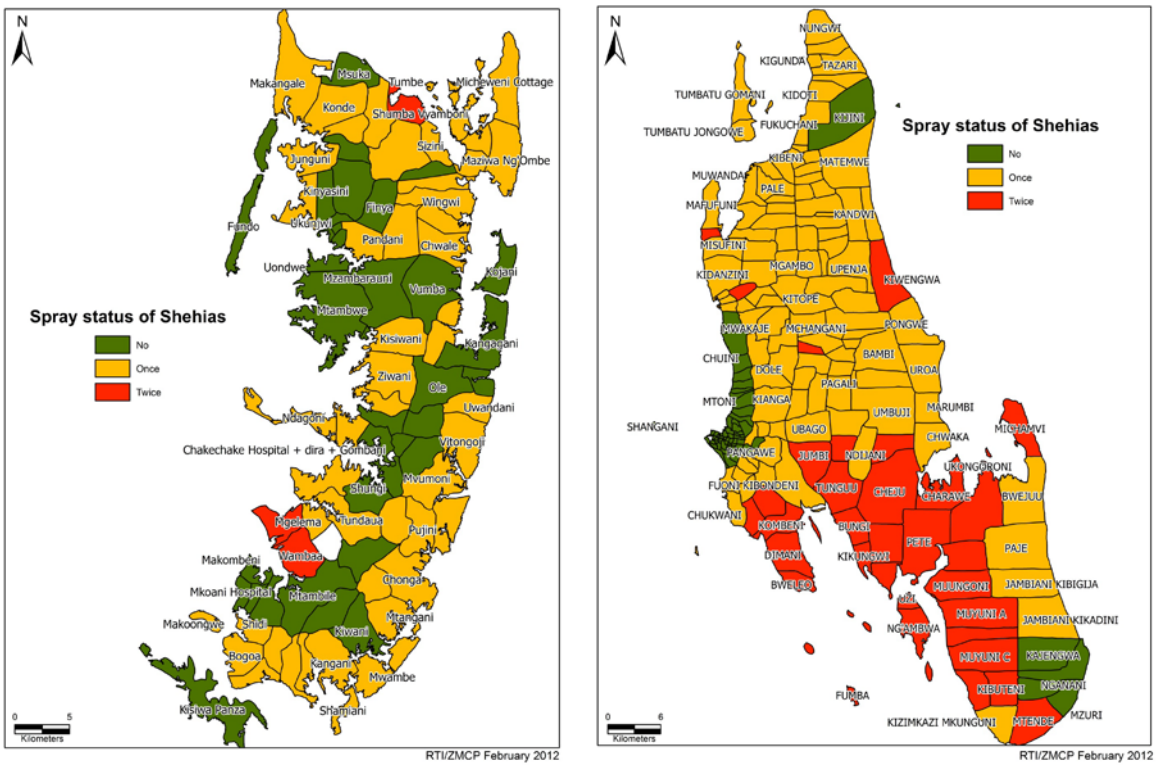


Using the annual morbidity rate of 1,000 persons for each of the allocated health facility catchment area, 123,000 houses were selected to be sprayed in a single round of IRS (incidence > 0.3 per 1,000 population); 15,000 houses were targeted to be sprayed twice, with one spray round consequently following the other to cover the peak transmission periods following seasonal rains (refer to spray timing section) in areas with incidence higher than 15 cases per 1,000 population.

Based on the criteria set, a total of around 137,000 houses are eligible for spraying. With an efficiency gain, a further 10% of houses (14,700) can be sprayed by one round of IRS. This can be considered a buffer for response.

The areas targeted for one and two rounds are illustrated in *Figure 16.*

Figure 16. Areas targeted for one and two rounds for 2012 spray season, Unguja and Pemba



IV. 2010–2011 IRS Preliminary Activities

Assessing the Environment and Planning Mitigation Options for the Safer Use of Pesticides

Environmental Assessment

RTI, in collaboration with NMCP and ZMCP, prepared and sent to USAID a justification letter report (see *Annex T*) to inform them of the status of environmental management in IRS, as stipulated in Tanzania Supplemental Environmental Assessment (SEA) of 2010. The letter report included the environmental risk mitigation actions undertaken by the project and the rationale for shifting from one class of insecticide to another, according to the insecticide rotation management to mitigate the insurgence of resistance. After USAID approved the letter, RTI started the procurement process of insecticide for the upcoming IRS round—e.g., pyrethroids and carbamate. The letter report was submitted in fulfillment of the U.S. regulation 22 CFR 216.

In November 2011, the program received the long-awaited Environmental Impact Assessment (EIA) certificate from NEMC. This was received following submission on September 17, 2010, of the Preliminary Environmental Assessment (PEA) report for Mara and Mwanza regions in fulfillment of Government of Tanzania environmental regulations (EMA Act No. 20: 2004).

Adhering to PEA requirements, RTI—in collaboration with NMCP—sought an insecticide importation permit from the Tropical Pesticide Research Institute (TPRI) in November 2011, fulfilling the Plant Protection Act of 1997, which regulates the importation of insecticides in Tanzania.

The Department of Environment of the Revolutionary Government of Zanzibar requested that RTI and USAID submit the available documentation in support of the expected change of insecticide class.

Insecticide Management and Environmental Mitigation Plan

After setting up the required standard for permanent and temporary storage facilities, the program quantified and selected the four levels of storage required: (1) zonal (two permanent warehouses); (2) regional (three warehouses); (3) district (18 temporary stores); and (4) and IRS sites (190 temporary IRS sub-stores). A total of 173 effluent waste disposal structures and temporary storage and sanitary facilities were repaired/refurbished in preparation for IRS operations.

TVCSP prepared environmental mitigation guidelines and SOPs for spray operators and pump technicians, including use of triple- rinsing for pump cleaning at the end of the spray day, inspection of pumps for leakage and their general maintenance, as well as disposal of washouts and solid waste. Before the start of operations, all spray teams were trained on all aspects of environmental compliance. During operations, spray teams were supervised to maintain protection and safety measures for themselves and for residents, as well as emergency preparedness in case of insecticide adverse reactions and accidental exposure to insecticide. In addition, to manage insecticide stocks, a control system was instituted that included bin cards, ledgers, issues vouchers, and daily/weekly trackers. Measures for strictly tracking the movement of insecticide sachets from the temporary storage facilities to the spray teams were meant to prevent pilferage and potential misuse, to promote safer use of pesticide, and to protect the environment and human health. At the end of every spray day, empty sachets were returned by spray operators and counted. All observed discrepancies were reported and investigated.

Pregnancy tests were given to all female IRS staff before spraying operations began, and medical attendance forms were available for monitoring undesirable and adverse reactions to insecticides for all IRS staff.

TVCSP continued to use insecticide tracking forms to monitor consumption and empty sachets returned.

SOPs guided the disposal of solid waste, including empty sachets, according to best management practices.

Selection and Management of Insecticide for IRS

Insurgence of Insecticide Resistance in Mainland Tanzania and Zanzibar

In 2010, malaria vector resistance to pyrethroids was reported in Pemba for the first time. Since the reintroduction of IRS in Zanzibar in 2006, the program has relied

entirely on the use of a pyrethroid. This is the same class of insecticide used to treat bed nets.

Pyrethroid resistance was also reported in several districts in Mainland Tanzania in 2011. The NIMR and Malaria Prevention Trial (PAMVERC) reported important insecticide resistance to pyrethroids in anopheline mosquitoes in Muleba District.

The continuous use of the same class of insecticide for IRS and LLIN, as well as for agriculture, has been associated with the evolution of resistance.

Insecticide Resistance Mitigation Plan

In order to mitigate the vector resistance to pyrethroid insecticide, RTI, in collaboration with ZMCP and NMCP, hired two consultants (one from the World Health Organization [WHO] and one from the academic sector) to develop an insecticide resistance mitigation plan. In addition, an expert consultative meeting was convened in August 2011 to deliberate on (1) the process of formulating an insecticide resistance mitigation plan and (2) immediate interim measures to mitigate resistance pressure in the country. The meeting attendees recommended that ZMCP and NMCP consider replacing a pyrethroid with a carbamate for IRS in a rotational strategy for at least two years until new formulations become available. Carbamate was recommended to be introduced immediately in the areas where pyrethroids have been used for several years (Zanzibar and selected areas of Kagera Region). The panel also recommended the intensification of monitoring insecticide susceptibility in the areas where IRS is conducted.

The insecticide resistance mitigation plan is expected to be finalized and disseminated by the end of 2012.

Selection of Appropriate Insecticide

Selection of an IRS insecticide for a public health intervention is usually based on (1) approval by the World Health Organization Pesticide Evaluation Scheme (WHOPES); (2) registration by TPRI in Tanzania; (3) availability of a good profile on vector susceptibility in Tanzania; and (4) expected longer residual duration compared to decreases in the frequency of spraying and reductions in cost.

After a competitive process, RTI—in collaboration with ZMCP and NMCP—selected bendiocarb (FICAM® wettable powder [WP]), an insecticide of the carbamate class, for the applications in Zanzibar, Karagwe and Muleba districts. In other areas of Mainland Tanzania, the pyrethroid Lambda Cyhalothrin (ICON ® 10 capsulated suspension [CS]) was selected once again.

Assessing the IRS Logistics

In August–September 2011, RTI and NMCP staff, in collaboration with regional and district authorities, conducted a logistics reassessment in all IRS districts in the Lake Zone. In Zanzibar, this activity was conducted in collaboration with ZMCP and district authorities in January 2012. The reassessment involved collecting updated information to facilitate the planning, designing, budgeting, implementation, and

monitoring and evaluation (M&E) of IRS operations (*Box 2*). All IRS operational sites and temporary district storage facilities were visited to determine the needs for repairs and refurbishment.

Box 2. Activities included in comprehensive logistics assessment

Data collected by logistics reassessment teams

- Updated demographic statistics
- Changes in administrative setup
- Updated meteorological indicators
- Updated epidemiological malaria data
- Estimate of average sprayable surface for insecticide quantification

Tasks performed by logistics reassessment teams

- Selection of target areas suitable for IRS implementation according to strategic option (blanket or targeted spraying)
- Identification of new main regional warehouse
- Identification of refurbishment needs for IRS sites
- Redefinition of catchment areas and population for the respective IRS substations
- Calculation of total insecticide required per district and substation
- Quantification of human resources requirements per district and substation
- Realignment of the operational organogram
- Quantification of consumables and replacement/repair of spraying equipment and PPE
- Setup of stakeholder teams, technical committees, and operations teams (e.g., logistics, advocacy and health education, vector control, M&E)
- Meetings with relevant partners/stakeholders; definition of roles and responsibilities
- Definition of a preliminary time frame for activities
- Tentative budget for the operation

Important considerations for the application of residual insecticides include the number of structures to be sprayed, as well as their type, location, number of eligible sprayable surfaces of different substrates, and accessibility. For the last IRS round, this information was updated through a process for registering housing structures in IRS areas.

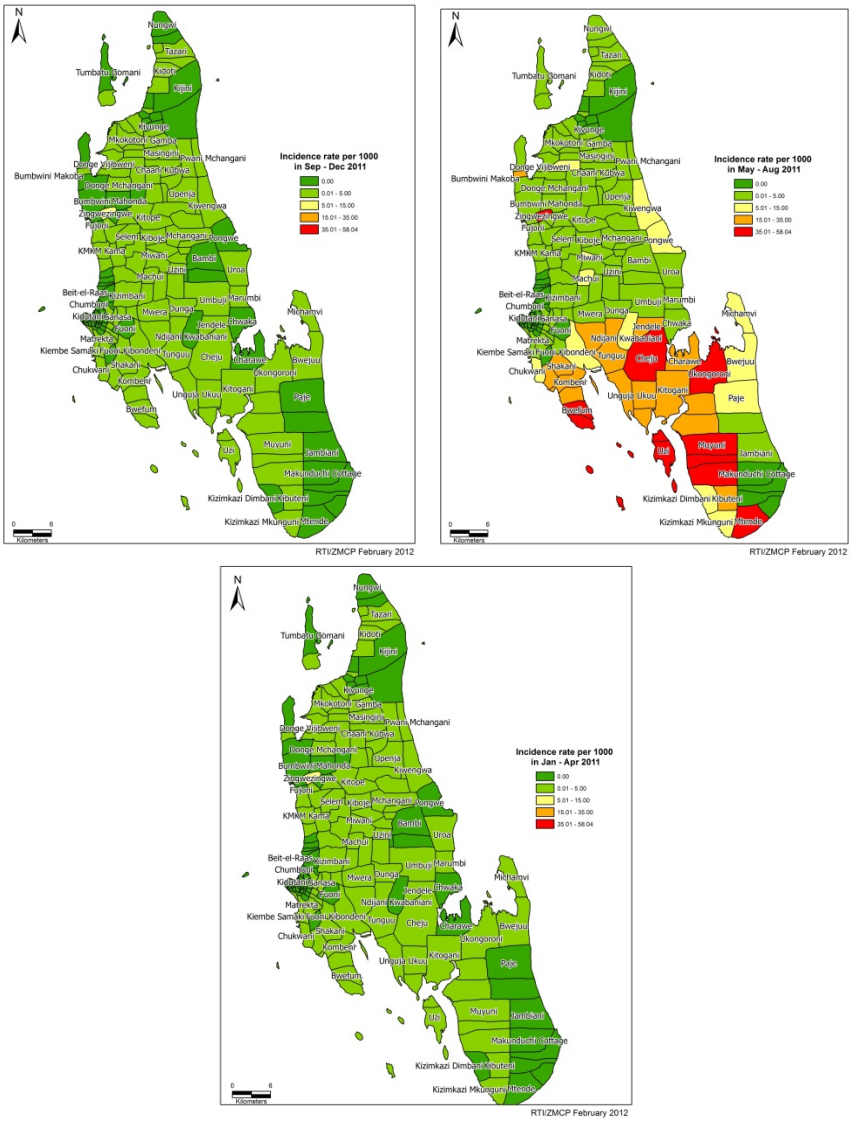
Selecting the Ideal Spray Period and Preparing the Operations Plan

Rationale for Selection of Spray Period in Zanzibar

Malaria cases in Zanzibar tend to occur at higher rates between May and August. This is a result of higher-than-average precipitation, resulting from seasonal rainfall between early April and late May (see *Figure 17*).

As such, ZMCP and TVCSP decided to start IRS by early March to enable the insecticide residual effect to cover this period, thereby reducing transmission and eventually the number of cases than what was anticipated.

Figure 17. Seasonal malaria transmission in Unguja Island: 2011 malaria incidence per 1,000 population (MEEDS data), by trimester



Rationale for Selection of Spraying Period in Lake Zone

Based on the expected residual duration of the selected insecticide class, as well as the precipitation pattern and the epidemiological information on hand, the project team determined the specific spray periods during which IRS operations should be carried out in the Mainland Tanzania.

The rainfall pattern in the Lake Zone of Mainland Tanzania is bimodal, with maximum precipitation in the two periods of March–May and September–December. The two relatively dry periods of January–February and June–August are characterized by high mosquito density and high malaria transmission.

Expected insecticide half-life on walls is 3–6 months (some suggest even up to nine months) for lambda-cyhalothrin and 2–6 months for bendiocarb. The duration is determined mainly by concentration of insecticide, temperature, humidity, quality of spray, and wall substrate.

Box 3 shows the timing of spraying selected for the different areas according to expected precipitation, vector abundance, and malaria incidence.

Box 3. Precipitation, vector abundance, malaria transmission, insecticide used, and proposed time of intervention. The color scales show lower to higher intensity of precipitations, vector abundance and malaria transmission respectively

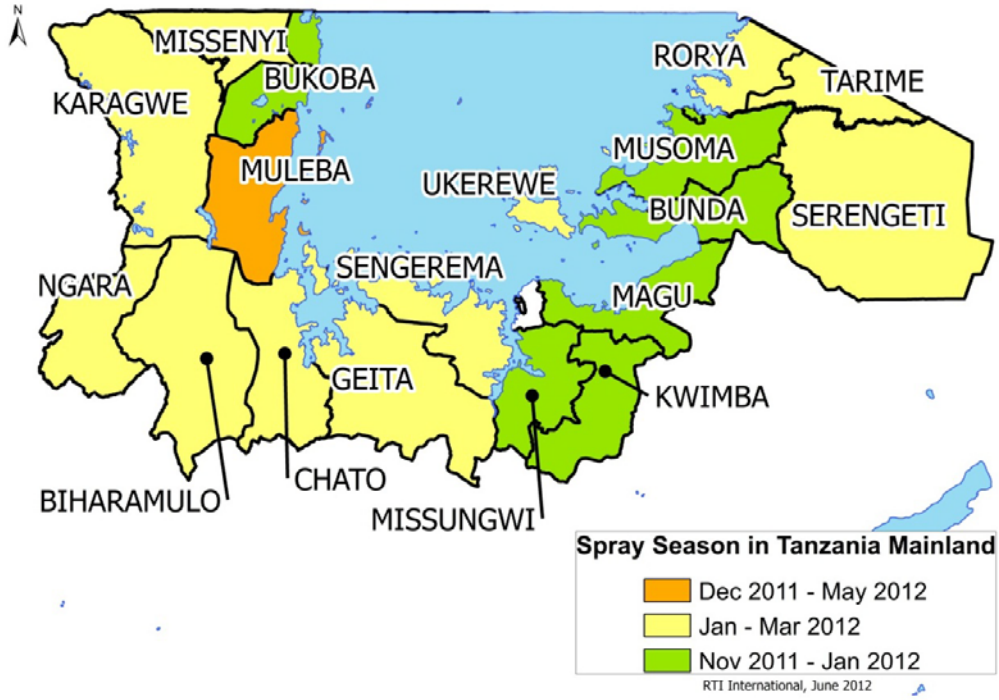
Determinant	Insecticide	Duration (months)	Oct 2011	Nov	Dec	Jan 2012	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation														
Vector abundance														
Malaria Incidence														
Muleba	Bendio-carb	2-6												
Karagwe	Bendio-carb	2-6												
Zanzibar	Bendio-carb	2-6												
Other Districts 1	Lambda-cyhalo-thrin	3-9												
Other Districts 2	Lambda-cyhalo-thrin	3-9												

Spray Season

IRS operations in the Lake Zone were conducted in two seasons: November 2011–January 2012 (season one) and February–March 2012 (season two). Muleba targeted-spray areas benefitted from a second round in April–May 2012. The spray seasons were essentially determined by precipitation (i.e., immediately before the long rainy period) in order to (1) provide ideal logistics for the operations (minimal rainy days) and (2) maximize human protection during the transmission peaks, as described in *Exhibit 3* above. Another important reason was to optimize the use of human resources for training and supervision. In Mwanza and Mara, RTI, in collaboration with the NMCP and regional and district authorities, conducted the round-two blanket spraying. In the first IRS season, between November 28, 2011, and January 16, 2012, IRS was conducted in the three districts of Kwimba, Magu, and Missungwi, in Mwanza Region; and Bunda and Musoma rural districts in Mara Region. In the second IRS season, between January 17 and March 16, 2012, the districts sprayed

were Geita, Sengerema, and Ukerewe in Mwanza Region and three districts of Rorya, Serengeti, and Tarime in Mara Region. In Kagera Region, a third round of IRS was conducted during the first season (November 28, 2011–January 10, 2012), covering the three districts of Bukoba, Missenyi, and Muleba, whereas the second season (January 28–March 11, 2012) covered the districts of Karagwe, Chato, Biharamulo, and Ngara (see *Figure 18*).

Figure 18. Spray seasons in Mainland Tanzania, November 2011–May 2012



In Zanzibar, RTI, in collaboration with ZMCP, conducted the seventh round of IRS (first targeted round) in 9 out of 10 districts. The spray periods were selected based on the same logistical and entomological reasons described above and timed for a minimal overlap with the previous round of implementation in order to optimize the use of insecticide. A first spray cycle was conducted in March 2012. A second targeted spray is expected in September 2012.

Setting the Targets: Household Registration

In Mainland Tanzania, according to the eligibility criteria, 18 districts, 541 wards, 1,982 villages, 10,810 hamlets, and 1,314,005 house structures were included in the IRS plan. In Zanzibar, 9 districts, 281 *shehia*, and 122,409 house structures were eligible for the first targeted IRS (see *Table 4* and *Annex A*).

In the previous IRS round, the TVCSP team established targets by taking into account the main available statistics up to the village and sub-village (hamlet) levels from (1) 2002 population census projections and (2) data collected in the recent malaria interventions (IRS previous rounds and LLIN distribution campaigns). These data were useful in the planning process, but in some cases, there was significant variation

between IRS performance data (actual households registered during the IRS campaign) and other data as stated above.

To overcome this problem, as noted earlier, the TVCSP introduced a system of household registration for IRS eligibility in all districts of Mainland Tanzania. The household registration will establish a permanent registry at the sub-village level. This registry will record information about all the indicators associated with the malaria prevention campaign. The approach involved designing and printing household registers, designing a registration protocol, designing statistical templates for analyzing data, and training the enumerators. RTI staff trained District IRS Technical Teams (DITTs) and ward and village executive officers, who in turn trained hamlet leaders. The hamlet leaders conducted the house-to-house registration. Information captured included name of household head, number of people in the household categorized by sex, and number of sprayable structures. Also, the household register design allows follow-up with households in the hamlet up to five years later.

The household registration was conducted between August and October 2011. The process capitalized on the experience attained during a pilot registration exercise that was conducted in a few districts before 2010–2011 spray season. A number of issues were refined, such as definition of a household, structure eligible for IRS, review of the protocol for registration, strengthening of the supervision system, and adequate supplies of registration booklets (see *Box 4*). The 2011–2012 spray season registration resulted in the acquisition of reliable data to identify households and house structures eligible for IRS.

Box 4. Definitions used for the registration of eligible house structures for IRS

- Household: A group of related people sharing the same pot for meals. A number of issues were raised due to traditional norms and practices such as extended families, polygamy, rural lifestyle, separation of population segments (e.g., young adults in pre-marriage age).
- House structures eligible for IRS: Stand-alone buildings where people are living and sleeping. Separate standing kitchens and sanitary facilities were excluded, as well as crop storage facilities and domestic animals. Apartments in the same block were considered separate house structures.
- Number of rooms: Rooms eligible for spraying, such as bedrooms and sitting rooms.
- Household members: People who usually live in the premises. Visiting guests were excluded.
- Sleeping places: Spaces where people usually sleep, regardless of availability of beds.
- LLIN: Available nets hanging and used in the house.

In some districts—such as Tarime, Rorya, and Serengeti—the number of eligible house structures increased significantly compared to the figures recorded in the 2010–2011 IRS season.

This community-centered registration allowed the TVCSP to get close to community leaders and to involve them in an active and responsible manner in the IRS planning phase. Based on this very important exercise, IRS targets and consequently IRS denominators were adjusted.

Table 4. Zonal and regional targets

Region/Zone	Kagera Region	Mara Region	Mwanza Region	Lake Zone	Pemba	Unguja	Zanzibar	Tanzania Total
Eligible Household	475,473	349,500	489,174	1,314,147	40,536	80,935	121,471	1,435,618
Eligible Population	2,436,929	1,885,005	3,098,362	7,420,296	231,054	388,189	619,243	8,039,539
# Sites	62	44	71	177	5	9	14	191
# Wards (*sheiha*)	208	144	189	541	119	162	281	822
# Villages	733	494	755	1,982	NA	NA	NA	1,982
# hamlets	4,064	2,448	4,298	10,810	NA	NA	NA	10,810
Wards (*sheihas*) Per district	30	29	32	30	30	32	31	30
Villages per ward	4	3	4	4	NA	NA	NA	4
hamlets per village	6	5	6	5	NA	NA	NA	5
ward (*sheiha*) per site	3	3	3	3	24	18	20	4
Village/site	12	11	11	11	NA	NA	NA	11
District	7	5	6	18	4	5	9	27

Establish District IRS Management

In Mainland Tanzania, the basic IRS management and implementation unit is the DITT. In all, 18 District IRS Technical Committees (DITCs) were established, one in each district. In Zanzibar, the functional management and implementation units were located at the zonal level in the two ZMCP offices of Zanzibar for Unguja and Wete for Pemba.

The DITT is chaired by the District Medical Officer (DMO) and includes five main staff positions: (1) Malaria Integrated Management of Childhood Illness (IMCI) focal person, (2) vector control specialist, (3) data manager, (4) logistics officer/store-keeper, and (5) health education focal persons. For the first time, during the 2011–2012 IRS operations, two new positions were added to the DITT: the District Environmental Management Officer (DEMO) and the Monitoring and Evaluation Officer (MEO).

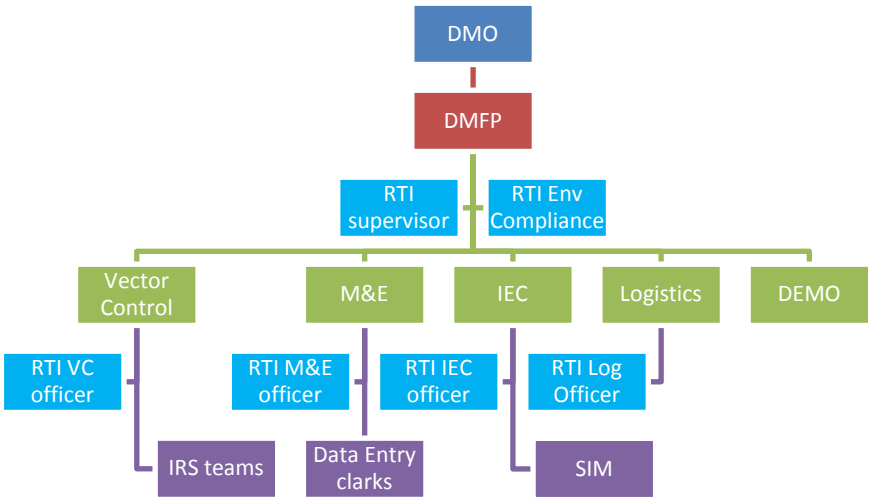
The Malaria IMCI focal person was selected as the overall IRS coordinator and was responsible for the day-to-day implementation of the activities.

RTI supported the DITT through the initial training and by allocating supervisors and consultants during the operations for further on-the-job training of the district team and mentoring. An overall RTI supervisor from the RTI zonal or regional office was appointed for each district.

The DITTs were equipped by the program during previous IRS rounds with computers and accessories and with communication equipment (modems).

Implementation teams (sub-units) for advocacy and health education, vector control, and M&E (see *Figure 19)* met daily during the IRS operations, while the DITT was scheduled to meet weekly.

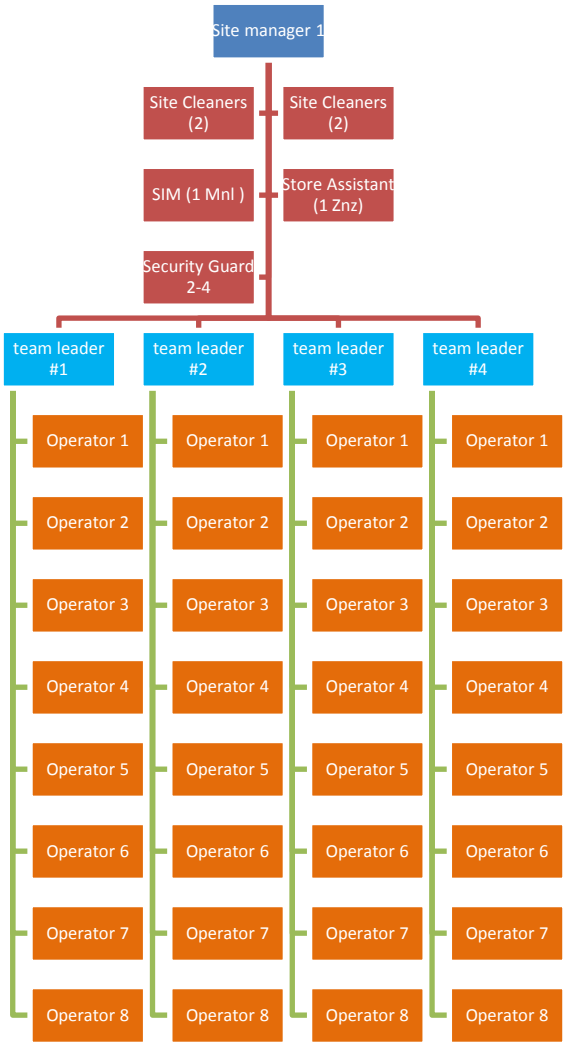
Figure 19. Organizational structures for district IRS implementation teams



Developing and Organizing the IRS Sites: Design and Phases

RTI continued to maintain an IRS delivery model initiated in 2006.This model involves extensive use of human resources and deployment logistics. The program requires a high degree of organization and capacity (see *Figure 20*).

Figure 20. IRS teams organizational structure



The general TVCSP IRS design is based on the operation site (OS). Each site has an operation target, ranging from 5,000 to 10,000 houses. The OS receives adequate infrastructure for effluent waste disposal, sanitary accommodations for operators, and storage facilities. The OS effort is led by a site manager supported by an average of four spray teams (range 2–8 persons per team) and 4–8 site attendants, depending on the size of the site. Time of operation per site, number of operation days, and allocated resources (e.g., human resources, insecticide, equipment, and consumables) are calculated based on targets. The TVCSP decided to select an average duration of operation of about 17 days per site.

In Mainland Tanzania, each IRS team has eight operators; there are seven operators per team in Zanzibar, with an average of 41 and 54 spray operators per site in the Mainland and Zanzibar, respectively (see *Table 5*). Each team is headed by a team leader. The team leaders and spray operators were selected from the targeted

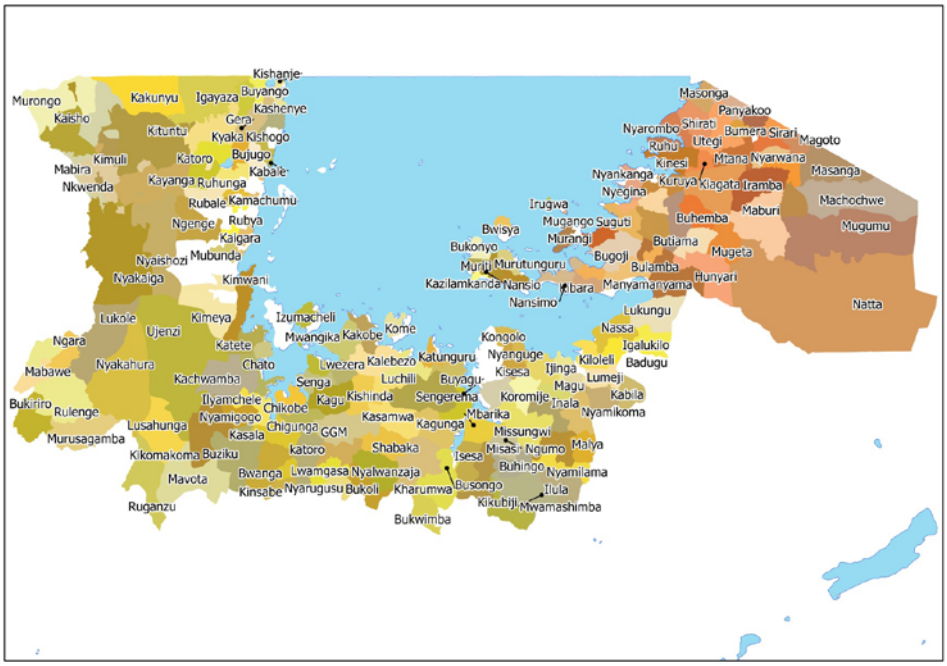
communities. The OS manager is assisted by support staff who maintain spray equipment, wash suits, clean the site, fetch water, and handle security. A rate of 10 sprayed houses per operator per day was used to calculate the daily workload and to develop the spray schedule. An average of 30 liters of water per each operator per day was calculated. In the predominantly rural areas, water was provided by operational site staff fetching water from the nearest source.

Table 5. Average and range for number of staff per IRS site

	Mara	Mwanza	Kagera	Pemba	Unguja
Average	47	39	40	60	50
Maximum	105	80	73	84	84
Minimum	6	7	13	7	7

The 2011–2012 IRS season covered a total of 170 operation sites in Mainland Tanzania—three less than in the previous season due to the scale-down in Muleba district (*see Figure 21*)—and 14 in Zanzibar (one site per district, and one site for each of five satellite islands targeted, three sites less than the previous spray round due to the targeted spray); see OS locations in *Annexes G, I, K,* and *M*). All sites were refurbished/renovated before the start of the operations to comply with international and local environmental impact and mitigation measures for safe pesticide use, storage, and sound effluent waste disposal. The sites therefore comply with the Pesticide Storage and Stock Control/User Guidelines of WHO and the United Nations Food and Agriculture Organization (FAO).

Figure 21. IRS operational sites location in the Lake zone



Two different designs were used in the 2011–2012 spray season: (1) one-phase and (2) two-phase models. In the one-phase model, all IRS operational sites ran concurrently; in the two-phase model, respective districts were divided into two operational areas working in consecutive phases. The advantage of the two-phase approach was that only half the amount of spray equipment was required since durable items were moved from sites in the first phase to those in the second phase. More supervision and quality control was ensured by district overseers in the two-phase design since fewer sites were working at the same time (see *Figures 22* and *23*). All districts in Mainland Tanzania except two used a two-phased approach in this year's IRS while all Zanzibar sites adopted the one-phase approach.

Figure 22. District IRS site structure, one-phase design (Zanzibar, Serengeti, and Karagwe)

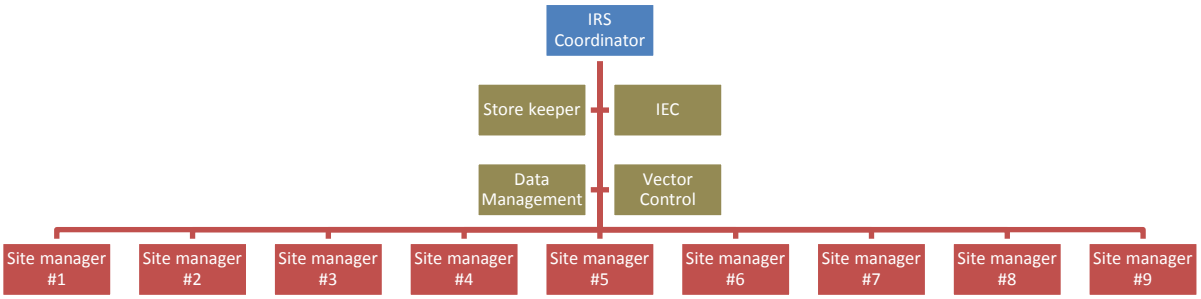
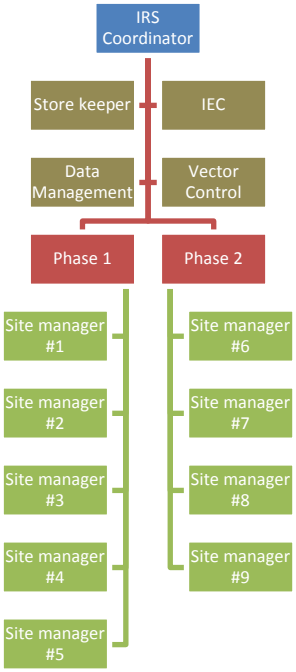


Figure 23. District IRS site structure, two-phase design (16 districts in Mainland Tanzania)



Insecticide Quantification, Procurement, Safe Transport, and Storage

TVCSP technical team, in collaboration with the malaria control programs of Mainland Tanzania and Zanzibar, quantified the lambda-cyhalothrin and bendiocarb during the logistical assessment after establishing the sizes and numbers of structures to be sprayed. The calculations for both Zanzibar and Mainland Tanzania were based on the dosage range 0.02–0.03 g active ingredient/m^2 for lambda-cyhalothrin (CS) and 0.1–0.4 g active ingredient /m^2 for bendiocarb WP. The logistics assessment anticipated a total of 1,282, 900 structures to be sprayed in Mainland Tanzania and Zanzibar. Based on the above assumptions, 31,250 total liters of ICON® 10 CS and 24,255 kg of FICAM® WP were quantified; new stock of ICON® 10 CS (28,612 liters) and FICAM® vector control (VC) (22,050 kg) were procured, then transported from the ports of entry (Zanzibar and Dar es Salaam) to the zonal warehouses of Zanzibar and Mwanza and to Bukoba regional warehouses.

All insecticides (i.e., lambda-cyhalothrin and bendiocarb), spray operators, PPE, and other equipment were procured according to USAID and RTI policy. Prior to the long-distance transport of the insecticide from the port of entry to the central store and to the district, RTI was responsible for informing the contracted transporter about general issues surrounding the insecticide and how to handle emergency situations (such as road accidents). Training included the following information: intended use the insecticide; toxicity of the insecticide; security issues; implications of the insecticide getting into the hands of the public; handling of an accident or emergency (according to FAO standards); combustibility; and combustion byproducts of insecticide. Insecticide samples received from the supplier were sent to TPRI, the designated reference laboratory for the country to be analyzed for quality. Results from the analysis indicated an active potency level of the active ingredient of the insecticide.

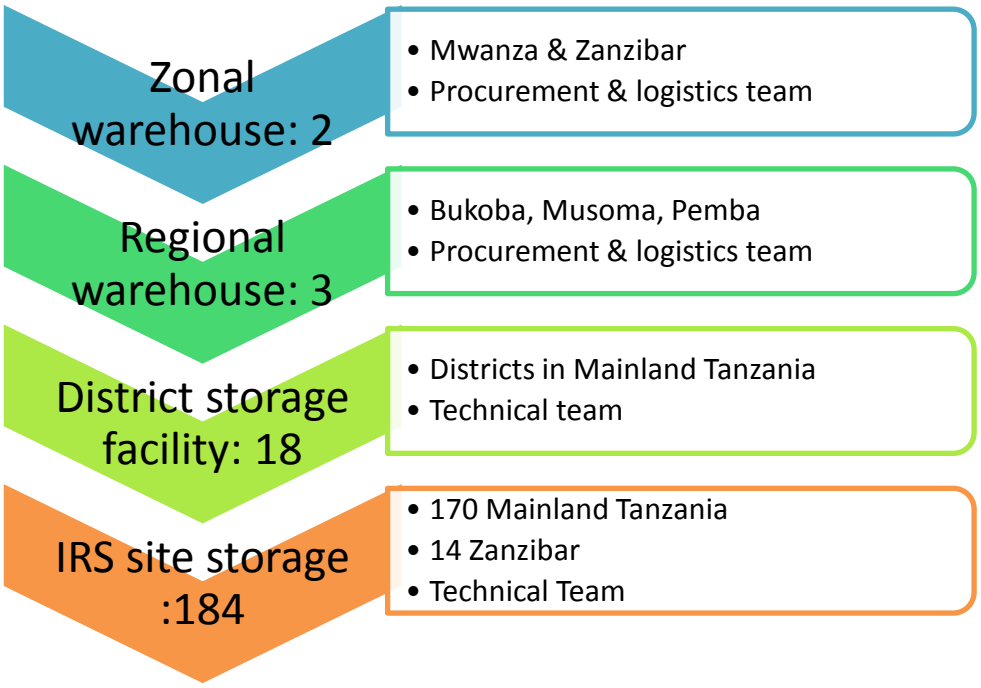
Handling Equipment, Materials, and Vehicles

The central RTI IRS unit provided quantification and procurement of insecticide, IRS equipment, PPE, and consumables. The quantification included the reconciliation of available supplies in the warehouses, replacement requirements, and coverage of new areas.

The RTI IRS unit also quantified vehicles for operator transport for each district and site. A total of 563 vehicles and 9 boats were needed to transport operators from IRS operational sites to targeted villages and to the islands of Zanzibar and in Lake Victoria, in Mainland Tanzania. All vehicles were inspected and certified by competent road and marine authorities. All vehicle drivers and boat captains were instructed on environmental mitigation measures during and after the end of spray operations.

Insecticides and other IRS supplies were stored and distributed at four levels (*see Figure 24*) from zonal to regional warehouses under the control of the TVCSP logistic team and from district to temporary storage facilities of IRS staging sites under the management of the TVCSP technical team. Special transport was provided for distribution at those levels.

Figure 24. Type and number of storage facilities by levels and responsible TVCSP team



Managing Human Resources for IRS

Active IRS operations require a large number of temporary operational IRS field staff and other technical, coordination, and supervisory support staff. RTI, in collaboration with district authorities, recruited 10,872 temporary staff, 9,818 in Mainland Tanzania and 1,054 in Zanzibar (see *Table 6 and Annex B*). The selection process was led by local government authorities and supervised by the delegated DITT and RTI personnel (see *Box 5* for the selection criteria). Broad and equal representation from targeted communities was sought.

Table 6. Temporary staff recruited to support IRS operations

	Kagera Region	Mara Region	Mwanza Region	Lake Zone	Pemba Island	Unguja Island	Zanzibar	Total Lake Zone and Zanzibar
Spray operators	*2,465*	*2,081*	*2,742*	**7,288**	*301*	*448*	**749**	**8,037**
Tem leaders	*308*	*260*	*343*	**911**	*43*	*64*	**107**	**1,018**
Site managers	*8*	*5*	*7*	**20**	*5*	*9*	**14**	**34**
Drivers	*156*	*128*	*171*	**456**	*25*	*35*	**60**	**516**
Pump technicians	*65*	*44*	*126*	**235**	*13*	*20*	**33**	**268**
Cleaners	*64*	*44*	*71*	**179**	*5*	*9*	**14**	**193**
Suit washers	*128*	*88*	*69*	**285**	*13*	*20*	**33**	**318**
Watchmen	*122*	*88*	*129*	**339**	*10*	*18*	**28**	**367**
Water fetchers	*61*	*44*	-	**105**	-	-	**-**	**105**
Storekeepers	-	-	-	**-**	*1*	*3*	**4**	**4**
Assistant storekeepers	-	-	-	**-**	*5*	*7*	**12**	**12**
Total IRS staff	*3,377*	*2,782*	*3,658*	**9,818**	*421*	*633*	**1,054**	**10,872**

Box 5. Criteria for IRS operators selection

- Age: 18–40 years
- Sex: Either (50% or more women)
- Education: Standard 7 and above and efficient in reading and writing Kiswahili
- Possession of a valid National Microfinance Bank (NMB) personal account
- Acceptance in the community
- Good enough health to carry pumps and walk long distances
- Experience
- Physical and mental fitness
- Residence in the service area

Mechanisms were set up to guarantee a transparent and fair process. However, even though gender balance was set as a selection criterion, only a third of the temporary laborers selected by the community were female (see *Table 7*).

Table 7. Proportion of temporary staff recruited during IRS campaign, by gender

	Staff cadre	Male	Female
IRS field staff	Team leaders and supervisors	72%	28%
	Drivers	100%	0%
	Spray operators and site attendants	67%	33%
	IRS teams total	**69%**	**31%**
District staff	Clinician trainer of trainers	–	–
	Clinician	71%	29%
	Data management specialists	56%	44%
	DITT	76%	24%
	Master trainers, IEC	50%	50%
	Master trainers, IRS	70%	30%
	Storekeepers	84%	16%
	District IRS staff total	**70%**	**30%**

The selected staff was provided personnel details, a photograph, bank account details, and a medical certificate of good health. The respective RTI offices filed all documents and provided an identity card. The selected individuals also signed a consent form. At the IRS operational site level, TVCSP opened a file for each temporary staff member to include a medical attendance form and other personal

documents. All female operators were tested for pregnancy prior to enrollment, and those who tested positive were disqualified.

The RTI finance team transferred compensation for temporary staff to their personal bank accounts at fixed intervals (two weeks).

Informing and Mobilizing Communities

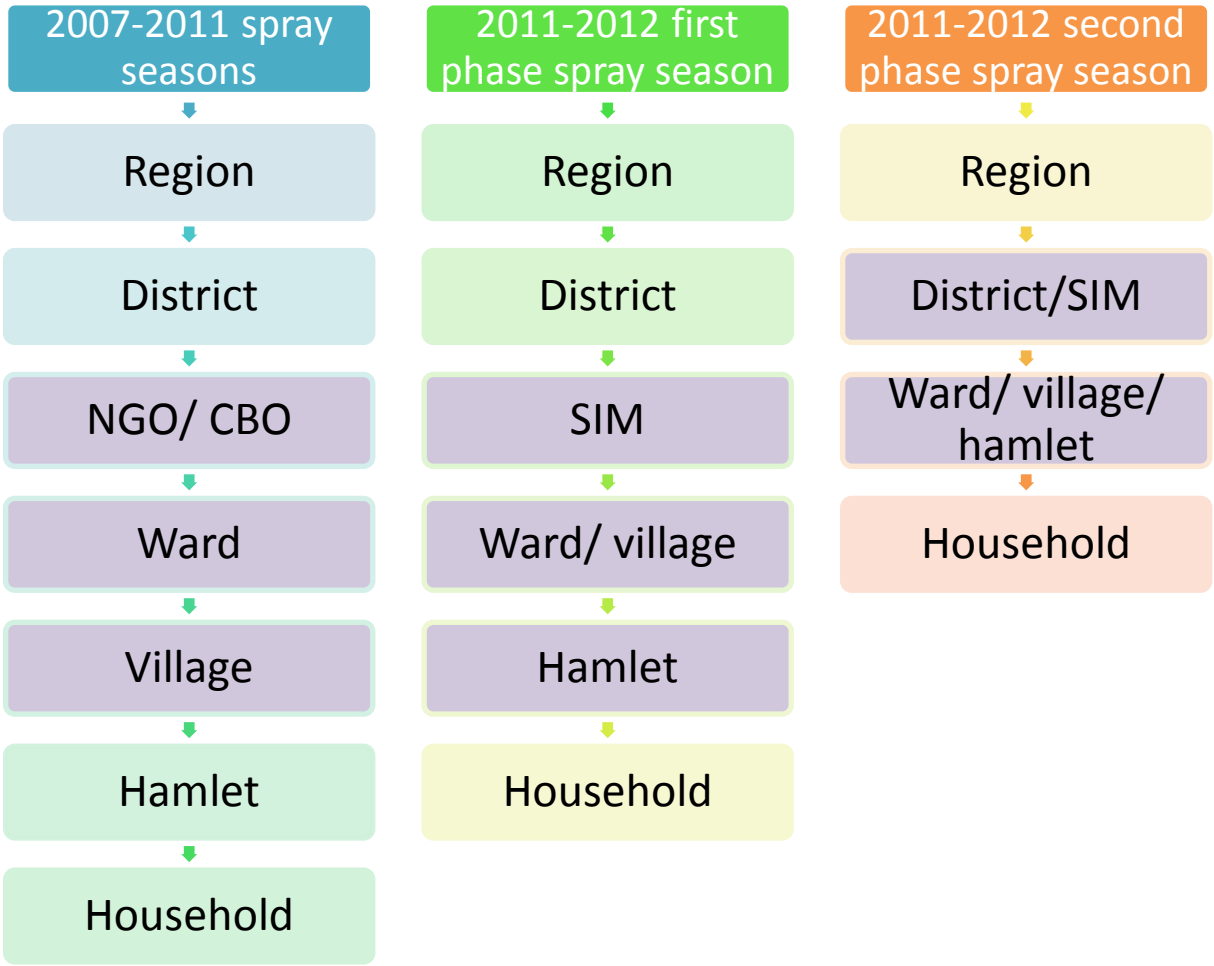
Implementation of Information, Education, and Communication Activities: IEC Design in 2011–2012 Spray Season

IEC is an essential component for successful delivery of IRS at the community level. The ultimate purpose of this component is to inform and mobilize all residents in IRS-eligible areas to ensure their active participation in IRS activities and to increase the level of acceptance. In previous IRS rounds, interpersonal communication was used effectively to convey messages and information to the communities. The component also targets various stakeholders, including government leaders at regional, district, divisional, ward, village, and hamlet levels.

During the 2011–2012 campaign, a cascade of events aimed to reach every single household. The main actor of the IEC component was identified as the hamlet chairperson, the elected leader at the sub-village level (50–100 households in rural areas). The program approached these community leaders in a systematic way through the facilitation of local government authorities to whom they were responsible. Because of the large number of people involved in the activity (over 22,000) and the limited time for implementation, RTI promoted a chain of events and meetings from one level to the next. Historically, a number of agents/implementers have been used: local government officials at district and ward level (2007–2009), NGOs and CBOs. *Figure 25* illustrates the IEC design for 2011–2012 as compared to the earlier campaigns.

During the 2011–2012 spraying season, TVCSP introduced some tangible changes in the IEC design. The cascade of events to reach the households was modified to simplify and shorten the messaging from seven steps to four. Also, the main IEC delivering partners shifted from local authorities, NGOs, and CBOs to the more community-based IRS SIMs.

Figure 25. IEC design in spray seasons from 2007 to 2012



TVCSP awarded John Hopkins University (JHU) a subcontract to assist in the delivery of IEC during IRS. During the 2010–2011 spray season, JHU (1) reviewed IEC materials, (2) developed and broadcast electronic media messages, and (3) allocated one staff member to coordinate IEC implementation at the RTI office in Dar es Salaam. JHU also recruited three new staff members and posted them at the regional RTI offices in Musoma, Bukoba, and Mwanza to support and oversee IEC implementation in the respective regions. Finally, JHU arranged to air a radio program and developed a documentary video.

Advocacy to Local Government Authorities: Region, District, Division, Ward, and Village Levels

As part of its responsibilities, the TVCSP technical team identified local government authorities (regional and district local authorities and ward and village executive officers) to serve as key actors in leading IEC activities (see *Table 8*).

TVCSP staff in collaboration with the respective DITT sensitized local government authorities and mobilized them to provide needed support for the implementation of IRS. Regional and district IRS advocacy committee meetings were organized in all three regions and 18 districts. In all, 342 participants attended regional and district level meetings.

Table 8. Number of participants at different levels of advocacy meetings, by region and gender

		Kagera				Mara				Mwanza				Lake			
Meeting	Phase	Male	Female	Total	Sessions	Male	Female	Total	Sessions	Male	Female	Total	Sessions	Total Male	Total Female	Total	Sessions
Advocacy: Regional		58	9	67	1	41	4	45	1	33	11	44	1	132	24	156	3
	1&2	87%	13%	100%		91%	9%	100%		75%	25%	100%		85%	15%	100%	
Advocacy: District		34	7	41	7	39	19	58	5	69	18	87	6	142	44	186	18
	1&2	83%	17%	100%		67%	33%	100%		79%	21%	100%		76%	24%	100%	
SIM Training		38	23	61	1	59	11	70	1	23	11	34	1	120	45	165	3
	1&2	62%	38%	100%		84%	16%	100%		68%	32%	100%		73%	27%	100%	
Advocacy: Ward				0	0	354	61	415	62	930	170	1,100	81	1,284	231	1,515	223
	1			0		85%	15%	100%		85%	15%	100%		85%	15%	100%	
Advocacy: Village		3,379	1,059	4,438	80	1,280	281	1,561		4,299	420	4,719		8,958	1,760	10,718	
	1	76%	24%	100%		82%	18%	100%		91%	9%	100%		84%	16%	100%	

		Kagera				Mara				Mwanza				Lake			
Advocacy: Ward and Village		4,309	1,571	5,880	34	972	61	1,033	12	2,750	144	2,894	15	8,031	1,776	9,807	61
	2	73%	27%	100%		94%	6%	100%		95%	5%	100%		82%	18%	100%	
Total		***7,818***	***2,669***	***10,487***	***114***	***2,745***	***437***	***3,182***	***74***	***8,104***	***774***	***8,878***	***96***	***18,667***	***3,880***	***22,547***	***284***
		75%	***25%***	***100%***		***86%***	***14%***	***100%***		***91%***	***9%***	***100%***		***83%***	***17%***	***100%***	

In the first phase of the spray season, the TVCSP staff and partners sensitized ward and village leaders through meetings held in the respective wards. In the second phase, the division officer led the organization and conduct of these meetings.

A total of 284 meetings were organized at the ward and division levels for a total of 22,040 participants, with an average of 8.9 participants per each targeted village and ward.

Only 17% of the local government and community leaders involved in the program were female, reflecting the gender imbalance in the government administration (see *Table 8*).

Sensitization at Community Level: SIMs and Hamlet Leaders

The IRS SIMs is a cadre newly created for this spray season and designed to facilitate the linkage between IRS operating site and the served community. The establishment of this new cadre aimed to make the process less top-down and to deliver IEC in a more community-based way. The new design was also cheaper and less cumbersome in terms of management. It maintained, and in some cases improved upon, the previously reached high levels of IRS coverage.

The SIMs were selected from their respective communities. One SIM was allocated to each average-sized IRS OSs. In few cases, two SIMs were allocated to serve exceptionally large IRS sites.

Criteria used to select SIMs were

- Educated to minimum of form IV
- Experience in malaria intervention campaigns
- Age: 25–45 years
- Fluent in Swahili and vernacular of the area to be served
- Not employed by another entity for the whole duration of IRS campaign
- Well accepted in the community
- In possession of a mobile phone and valid bank account

The majority of SIMs were selected from among the CCAs previously trained on community health matters under the auspices of the USAID-funded Communication and Malaria Initiative in Tanzania (COMMIT) project implemented by the JHU Center for Communication Programs (CCP).

SIMs were given a one-week training course covering general knowledge of IRS, communication skills, and use of IEC materials. During the implementation, RTI facilitated their tasks by providing IEC materials, megaphones, and hired transport (motorbikes); see *Box 6*.

Box 6. Scope of work and specific tasks for SIMs

Scope of work of SIMs

- Organize and conduct ward IRS committee meetings in the respective sites (in the first phase of the spray season)
- Participate in and facilitate division meetings with all IEC stakeholders (in the first phase of the spray season)
- Distribute IEC materials to targeted villages
- Verify whether IEC materials (such as posters, brochures, and tear-off sheets) reached the target
- Supervise the hamlet leaders on house-to-house sensitization
- Verify spray targets with Village Executive Leaders and provide the targets, update registration booklets
- Investigate and anticipate refusal in the targeted villages, and liaise with village and ward leaders to resolve them

Specific tasks of SIMs

- Report to the site manager and inform on the advocacy activities, anticipated challenges, and plans to overcome challenges
- Visit the villages before the scheduled start of spray operations to verify that all preparations are in place. After spraying, return to villages to verify that coverage was adequate. If follow-up is needed (e.g., missed house structures), record those households and submit them to site manager for planning and follow up

During the sensitization process at the community level, 284 meetings were organized (233 at the ward level in the first phase and 61 at the division level in the second phase). A total of 20,547 community leaders participated (refer to *Table 8*). Among them 10,810 hamlet chairpersons were identified to conduct house-to-house visits before the spray.

Organization of Interpersonal Communication in Zanzibar

In Zanzibar, district authorities organized and supervised IEC. Three categories of mobilizers were identified at national, district, and *shehia* levels. A total of 34 district mobilizers were trained and were responsible to supervise the respective *shehia's* mobilizers. Each *shehia* in the IRS eligible areas, recruited five mobilizers to inform communities through house to house visit. At national level, an IEC campaign was supervised by four health educators, two in Pemba and two in Unguja. Their role was to coordinate central (ZMCP) and district IEC activities. Apart from house-to-house approach, the IEC campaign included audio programs by using radio and community announcements broadcast through megaphones. The spray schedule was planned in advanced in collaboration with *shehia* leaders and shared with mobilizers at all levels.

Other IEC Supportive Activities

For IRS, interpersonal communication is the primary vehicle for communication in IEC. Interpersonal communication is supplemented with other routes of message delivery, including the following:

Printed IEC Materials

A number of materials were printed and distributed, targeting different groups who either used the materials: (1) for reference while educating others; or (2) to get more clarity on and reinforce messages previously communicated from other sources.

Printed materials consisted of a set of tools that included (1) an IRS fact sheet used by leaders tasked to inform the respective communities; (2) Frequently Asked Questions (FAQ) distributed to the hamlet leaders; (3) posters to be displayed in public places containing simple IRS messages and dates on which IRS would be conducted in areas; (4) household tear-off sheet distributed by hamlet leaders while conducting house-to- house sensitization; and (5) IRS brochures distributed to the general public (see *Table 9*).

Table 9. Printed and distributed IEC materials

Type of material	Mwanza	Mara	Kagera
Fact sheet	4,341	4,803	3,000
FAQ sheet	3,499	3,019	3,000
Posters	4,271	3,979	2,016
Household tear off sheet	70	30	40
Brochures	19,906	16,763	18,666

Radio Program

JHU-CCP and RTI revised three radio spots and produced one jingle. The spots were aired from November 24, 2011, to the end of February 2012 during the intensive IRS periods. Three local FM stations (Karagwe FM in Kagera, Victoria FM in Mara, and Living Water FM in Mwanza) and one national radio station (Radio Free Africa) were contacted by JHU. Each radio station aired 720 prime time public service announcements (PSAs), which translates to eight PSAs per day for three months. Also, each contracted radio station conducted 30-minute radio discussions on IRS was conducted twice a week.

Public Addressing through Megaphone

TVCSP introduced megaphones in this IRS season, which were used by SIMs to announce IRS in the villages. In cases of IRS schedule changes due to some shortfalls, SIMs used megaphones to announce the changes and the new dates.

Managing Knowledge and Skills

IRS Teams Training in Lake Zone

IRS training for field IRS teams was conducted in a cascade fashion to manage the large number of trainees scattered in the large area of more than 100km^2 (see *Figure*

26). In the Lake Zone, a total of 9,663 (6,601 and 3,062 male and female, respectively) staff were trained before IRS operations. Among them, 8,380 were from personnel from the IRS spray teams; the remaining 1,283 were supervisors and district, regional, and zonal technical staff (see *Table 10*).

Two important aspects of IRS operations training include: (1) providing the skills and ability to perform IRS to all personnel involved in IRS activities; and (2) strengthening capacity to implement and supervise the IRS program at the national, regional, and local levels.

A training curriculum and training package, including SOPs, were developed prior to the start of the training. The package consists of the following nine Modules: (1) Guiding Principles for Planning and Implementing IRS; (2) IRS Management at District Level; (3) Management of IRS Operational Sites; (4) Spray Team; (5) Malaria; (6) Environmental Safety and Compliance; (7) Insecticide Adverse Effect and Treatment; (8) Community Sensitization; and (9) Strategic Information Management.

Under the cascade model, training was conducted for various cadres of staff (see *Figure 26*).

Core Facilitators Training

The core facilitators training was conducted at the zonal level. A total of 18 core facilitators participated in the training, including 13 RTI staff, 3 regional/district staff, and 2 national staff. All nine training modules were used.

Master Trainers

Core facilitators organized and facilitated five master trainings sessions. A total of 78 trainees participated of which 22 were IRS masters, 19 logisticians, 18 Environmental Compliance Officers (DEMO) and 18 M&E officers. IRS masters were trained using Modules 2, 3, and 4. M&E and DEMO personnel and logisticians were trained in modules 9, 6, and 3, respectively.

Training of Trainers (ToT)

The master trainers were mandated to organize and conduct ToT sessions in their respective districts. The ToT targeted site managers and team leaders. A total of 850 participants were trained (female trainees totaled 28%).

IRS Teams

TVCSP provided different trainings for new and returning IRS staff. A total of 8,380 spray operators and site attendants were trained in 235 training sessions, with an average of 41 participants per session. Among the trainees, 33% were female.

Figure 26. Cascade of training for IRS operation

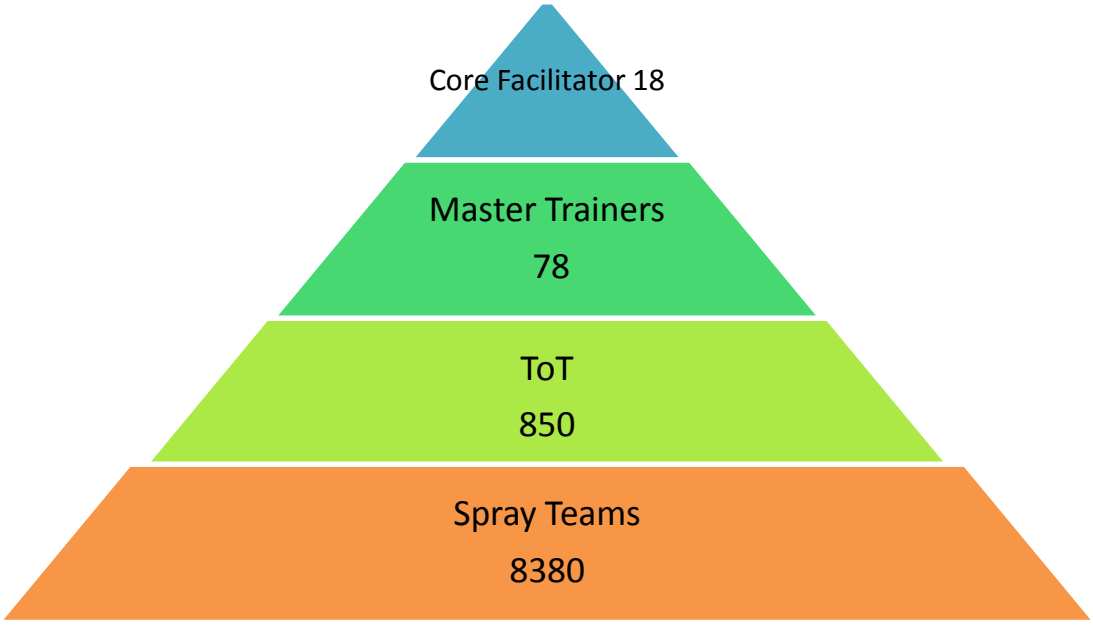


Table 10 delineates the total number of training sessions and trainees that underwent training in each of the targeted zones.

Table 10. Training conducted to technical team during IRS operations

		Kagera			Mara			Mwanza			Lake Zone		
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Clinician Training		–	–	–	144	58	202	0	0	0	144	58	202
		–	–	–	–	–	0	–	–	0	71%	29%	1
Data Management Training		–	–	–	6	2	8	1	5	6	7	7	14
		–	–	–	–	–	0	17%	83%	1	50%	50%	1
District TOT		182	74	256	143	51	194	289	111	400	614	236	850
		71%	29%	1	74%	26%	1	72%	28%	1	72%	28%	1
DITT		5	2	7	–	–	0	0	0	0	5	2	7
		71%	29%	1	–	–	0	–	–	0	71%	29%	1
Drivers Training		–	–	–	42	0	42	90	0	90	132	0	132
		–	–	–	100%	0%	1	100%	0%	1	2	0	2
Master DEMO Training	*	–	–	–	–	–	0	16	2	18	16	2	18
		–	–	–	–	–	0	89%	11%	1	89%	11%	1
Master District M&E Officers	*	–	–	–	–	–	0	15	3	18	15	3	18
		–	–	–	–	–	0	83%	17%	1	83%	17%	1
Master Store Keepers	*	–	–	–	–	–	0	16	3	19	16	3	19

		Kagera			Mara			Mwanza			Lake Zone		
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
		–	–	–	–	–	0	84%	16%	1	84%	16%	1
Master Trainers	*	8	3	11	0	0	0	8	4	12	16	7	23
		73%	27%	1	–	–	0	67%	33%	1	70%	30%	1
Spray Operator Training		1,655	938	2,593	1,800	816	2,616	2,181	990	3171	5,636	2,744	8,380
		64%	36%	1	69%	31%	1	69%	31%	1	67%	33%	1
		1,850	1,017	2,867	2,135	927	3,062	2,616	1,118	3734	6,601	3,062	9,663
		65%	35%	1	70%	30%	1	70%	30%	1	68%	32%	1

* Training done at zonal level.

Monitoring the IRS Process

Training Monitoring

Before implementation of IRS, field trainings were conducted for various cadres in the Lake Zone and Zanzibar. The M&E Unit in each zonal office was responsible for tracking the number of people trained in different capacities in each of their respective districts. Training tools, such as enrollment sheets and summary sheets, were utilized with the help of the facilitators at every training. Trainees recorded their names and signatures on a sign-in form, and the number of participants were aggregated at the end of training sessions. M&E officers summarized the training outcomes, including the number of participants by gender, in pre-designed electronic Excel templates, which captured the number of trainees in each district by gender and cadre.

Developing the IRS Tools and Templates

Prior to IRS operations commencing, the TVCSP refined existing M&E tools. Some new tools were introduced to manage the collection and measurement of inputs, processes, and outputs more effectively. In addition to the training and household registration tools, spray operator, team leader, and site manager forms were better coded, with consistency checks put in place to verify accuracy of information such as sachet movement and house structure count. Development of a daily monitoring chart was a new innovation, which was used at the site level to track the daily monitoring of spray performance in a graphical form. Stock and property control booklets were also introduced at the site level to account for the receiving, requisition, and return of IRS items. In addition, insecticide management and transport monitoring tools were also revamped.

Electronic templates in Excel format used for data entry were also developed for each district. Excel has proven ideal for managing IRS information since it is widely utilized and understood by data entry clerks, who are first-line staff in entering data from hard copy spray forms into electronic templates at each district office. The electronic database template reflects the information collected on the ground by spray operators, team leaders, and site managers.

Getting RTI Prepared to Support the IRS Process

RTI established two zonal offices in Zanzibar (2006) and Mwanza (2010) and three regional offices in Wete (2010), Bukoba (2009), and Musoma (2010) to provide support to implementing partners (district authority, communities, and the private sector).

The Mwanza Lake Zone office is equipped with staff in two categories: (1) finance and administration, including accountants, office manager, logistics officer, and store keeper; and (2) technical expertise, including the zonal manager, environmental compliance officer, IEC specialist, and data manager. The zonal office provides support to the regional teams. Further, the office was supplied with vehicles and equipped with

computers and communication facilities. The main zonal office functions are: (1) organizing and implementing master training for district trainers and supervisors; (2) conducting zonal management meetings convened every other two weeks; and (3) providing supervisory/support visits to IRS field operations.

The regional offices are organized in the same way; however, in the area of technical expertise, they include vector control specialists either permanently employed or seasonally hired, especially during active stages of IRS implementation. The regional offices are as well supplied with transport and information technology (IT) facilities (e.g., computers, Internet, and printers). Their main management functions are: support training of ToTs in collaboration with district trainers, weekly meetings with DITTs, field supervision, and human resource management.

During the 2011–2012 IRS season, an IEC coordinator was posted in the three regional offices of the Lake Zone.

In each district, RTI appointed a focal person with appreciable experience in IRS to provide technical support to the established district IRS technical teams. Where necessary, RTI contracted a vector control expert to provide supervision on the quality of spray and adherence to environmental regulations.

The RTI IRS unit in collaboration with NMCP provides supportive supervision to zones, regions, and district levels. The team is composed of IRS field technical specialists, environmental specialists, and IEC specialists.

Other initiatives spearheaded by RTI to support IRS implementation monitoring insecticide susceptibility and insecticide decay through bioassay (implemented by NIMR) and monitoring malaria trends in selected health facilities.

Introducing Public-Private-Partnership in IRS implementation in the Lake Zone

In Geita District, the two urban and peri-urban wards, Kalangalala and Mtakuja, were also included in the second cycle of the TVCSP's IRS campaign. This round of IRS in Geita District took place between January 31 and February 26, 2012; it was a collaborative public private partnership (PPP). The PPP was made up of three main players—Geita District Council, Geita Gold Mine (GGM), and RTI. Other collaborators included NIMR and Plan International. Each partner played a key role: GGM provided financial support while the Geita District Council took on a coordination role. TVCSP brought in IRS technical expertise and experience accrued from its longstanding work on the ground in implementing IRS activities in sub-Saharan Africa. TVCSP's technical support included procurement of insecticide and equipment and provision of experienced technical field staff who provided supervision and on-the-job training toward building local capacity for IRS.

As part of the collaboration, TVCSP determined the quantity of insecticide and equipment required and procured and supplied 10,393 sachets of lambda cyhalothrin

insecticide and 82 spray pumps (Hudson® Expert). TVCSP also oversaw the advocacy, sensitization, and community mobilization for the IRS round. The multifaceted community media approach utilized a combination of radio spots, flyers, and public address systems, in addition to interpersonal communication through hamlet chairpersons. This multifaceted approach ensured that the districts' residents were prepared for the operation.

In his inauguration speech, Mwanza Regional Commissioner Evarist Ndikilo applauded the collaborative effort by all the partners and emphasized the need for long-term sustainability. "Along with other partners, I would like to commend the corporate social responsibility demonstrated by Geita Gold Mine. This spirit of establishing public-private partnership between business and development agencies needs to be replicated elsewhere in the country," said Ndikilo. GGM's financial contribution was approximately 70% of the total cost of the IRS operation in Geita. Apart from TVCSP's technical expertise and advocacy operation, TVCSP's financial contribution was 30% of the total operation cost. In a sector where collaboration between corporate and traditional donors is rare, GGM was the first private company in Tanzania's Lake Zone (where gold mining is prevalent) to recognize the benefits of collaborative PPPs.

The collaborative partnership resulted in the spraying of 18,206 houses (over 90% coverage) out of the targeted 20,193 sprayable structures. This achievement led to the protection of 111,563 people in Geita District living in Kalangalala and Mtakuja wards. In addition, the numbers of pregnant women and children under five years old protected by IRS were estimated at 4,821 and 22,547, respectively. Part of the sustainability plan of the IRS operation includes local capacity building. A total of 238 people from local communities were trained and temporarily deployed by Geita District Council as seasonal IRS staff. The TVCSP technical team trained these staff (through a cascading training-of trainers approach) in spray techniques, community mobilization, human safety, and environmental risk mitigation. The training and skills transfer has enabled local capacity development in the district.

V. Implementation of IRS Activities

Quality Control of Spray

A major challenge to conducting a successful IRS program is ensuring an acceptable quality of spray and that a large number of spray operators adhere to SOPs and best practices in spray technique. Quality control of spraying is an integral part of IRS implementation since its inception. Quality control was maintained by conducting appropriate training for and multilevel supervision of spray personnel.

The key elements of quality control are the team leader, the immediate supervisors of the spray operators. During the 2011–2012 spray seasons, a number of innovations were introduced to facilitate their role.

- Rigorous selection process to identify qualified candidate for the role of team leaders;
- Comprehensive training of team leaders;
- Development of an original protocol for daily operators follow up;
- Introduction of quality assessment tools with a score system;
- Empowerment of site managers to adopt disciplinary action in case of deviation from standard operation procedures;
- Introduction of segregation of duties for the vector control officers to alleviate them from other management duties and make them dedicated to quality control; and
- Introduction of Insecticide quantification kits (see section VII in this report).

The District Vector Control Officers (VCOs) were tasked to perform full-time field supervision of team leaders and spray operators.

Each team leader was tasked to intensively supervise four spray operators per day. The team leader assessed the operators and awarded performance scores. At the end of the day, he/she filled the summary form with recommendations on corrective measures.

Daily feedback to all operators was provided in the morning by site managers and team leaders after compiling the previous day's reports.

Feedback concerning spray supervision was provided in in the following areas:

- Compliance with use of PPE;
- Compliance with preparations of the household and general environmental protection prior to spraying;
- Compliance with spray techniques (insecticide dilution, pump pressure, speed of movement, distance from the wall, and overlapping);
- Coverage of eligible spray able surfaces (e.g., rooms, corridors and ceiling);
- Uniformity of insecticide concentration at all levels of spray surfaces (e.g., upper, middle, and lower);
- Coverage of households targeted in the hamlet and in the village;
- Documenting the correct information/education messages delivered to members of the sprayed households;
- Appropriate recording of all indicators monitored; and
- Good customer-service practices.

The newly developed system provided an action-oriented approach at IRS operational levels. Each site could evaluate each day's performance and could take action on the eventual gaps found. The district was able to access IRS quality reports through the VCO at weekly meetings.

Monitoring Performances of Spray Teams and Use of Insecticide

The daily performance and output of every spray operator, team leader, and supervisor was tracked daily using data sheets (e.g., daily spray cards, team leader, and supervisor cards).

The data sheets recorded the number of structures sprayed per sachets of insecticide used. Through this method, the monitoring teams were able to detect operational problems; recommendations were put in place immediately, as needed, to support the spray operations and to improve the quality of data on the IRS project.

The insecticide used was usually monitored by store keepers at the site store at district, regional, and zonal levels, with close collaboration from the environmental officers. The insecticides used were tracked by insecticide control books and forms. Other IRS supplies and equipment were tracked using books, such as a store ledgers.

Environmental Monitoring and Mitigation Activities

Environmental monitoring and environmental compliance inspections were carried out in all operational sites by the RTI environmental team. DEMOs conducted their own independent inspections in their respective districts to ensure program compliance to the mitigation measures during IRS campaigns. The NEMC conducted an independent IRS environmental audit in February 2012 in the Lake Zone to assess program compliance with mitigation measures, as stipulated in PEA report and in the 2011 EIA certificate.

During IRS operations in the Lake Zone and Zanzibar, pre-, mid-, and post-spray environmental compliance inspections were conducted by the RTI environmental team and DEMOs in the respective districts. A total of 174 inspections were conducted at different stages of the operations. Pre-spray environmental compliance inspections in the Lake Zone were conducted November 24–29, 2011. Mid-spray compliance inspection for Mainland Tanzania and Zanzibar were conducted in February 2012 and April 2012, respectively.

During the mid-IRS inspections, a total of 52 sites out of 180 (29%) were visited. IRS operational sites were visited in the early morning before spray operators left for the field and in the late afternoon when they returned from the field to assess the preparedness for environmental mitigation actions and the compliance to standard norms during the delicate daily closing up of the operations. Mitigation actions were also monitored during the actual field operations at household level.

Table 11 and *Figures 27, 28,* and *29* summarize the major mid-IRS findings. In the assessment of the pre-spray mitigation activities, updating of stock cards and preparedness of drivers on insecticide spill procedures showed 83% and 17% compliance, respectively. These observations helped the program to continually improve operations by addressing all the negative observation once they occurred and maintaining the good ones. The assessment of post-spray mitigation actions in Zanzibar revealed that one out of six sites visited had problems with the drainage of effluents in soak pits. Spray

operators showed 100% compliance with the standard norms during the actual house spraying

Figure 27: Proportion of mitigation actions before daily spray that complied with environmental regulations (52 sites)

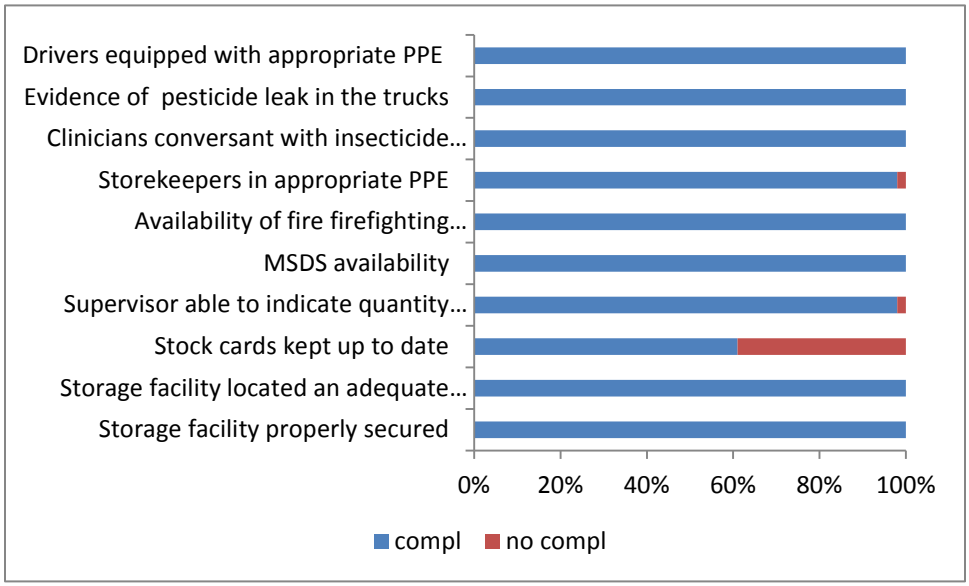


Figure 28. Proportion of mitigation actions during daily spray that complied with environmental regulations (52 sites)

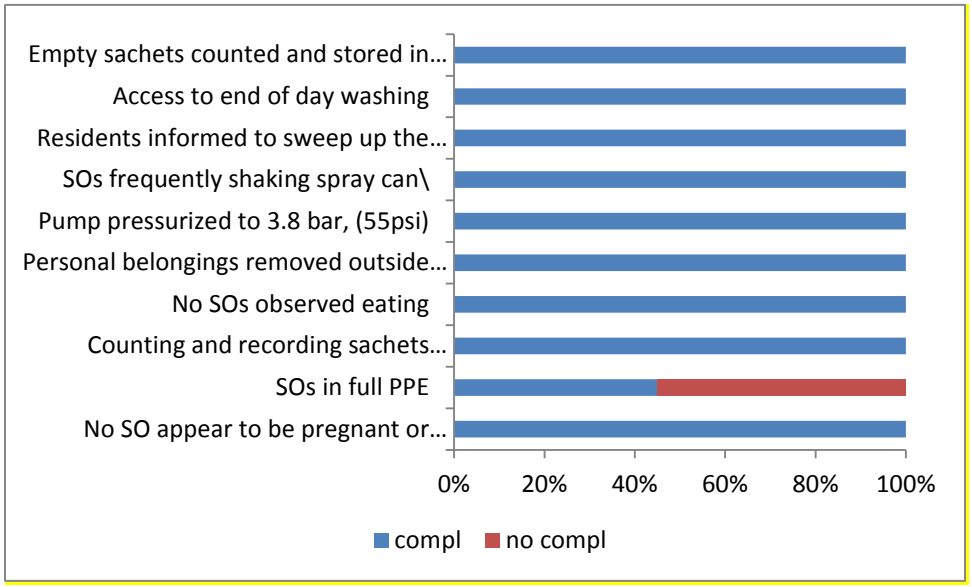


Figure 29. Proportion of mitigation actions after daily spray that complied with environmental regulations (52 sites)

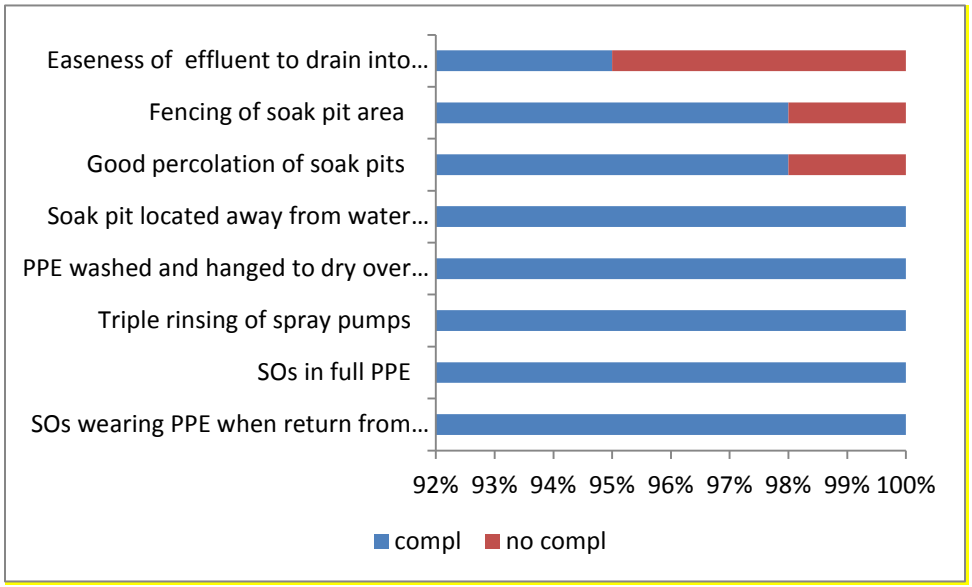


Table 11. Environmental compliance inspections results during IRS operations

Mitigation Actions	Mara Region			Mwanza Region			Kagera Region			Zanzibar		
	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl
During Spray Activities												
No spray operators appear to be pregnant or breast feeding?	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Spray operators in full PPE?	7	7	100%	24	0	0%	7	7	100%	6	6	100%
Counting and recording sachets before distribution to SO?	7	7	100%	24	24	100%	7	7	100%	6	6	100%
No spray operators observed eating	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Personal belongings removed outside the house	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Pump pressurized to 3.8 bar, (55psi)	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Spray operators frequently shaking spray can	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Residents informed to sweep up the house and deposit dump in a pit latrine after spraying	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Access to end of day washing	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Empty sachets counted and stored in labeled, sealed containers	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Before Spray Activities												
Storage facility properly secured	7	7	100%	24	24	100%	7	7	100%	6	6	100%

Mitigation Actions	Mara Region			Mwanza Region			Kagera Region			Zanzibar		
	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl
Storage facility located an adequate distance from schools, homes, and water bodies	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Stock cards kept up to date	7	7	100%	24	10	42%	7	7	100%	6	3	50%
Supervisor able to indicate quantity of the stock that has been used	7	7	100%	24	24	100%	7	7	100%	6	5	83%
MSDS availability	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Availability of fire firefighting equipment	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Storekeepers in appropriate PPE	7	7	100%	24	24	100%	7	6	86%	6	6	100%
Clinicians conversant with insecticide poisoning mgt	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Evidence of pesticide leak in the trucks	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Drivers equipped with appropriate PPE	7	7	100%	24	24	100%	7	7	100%	6	6	100%
After Spray Activities												
SOs wearing PPE when return from spraying	7	7	100%	24	24	100%	7	7	100%	6	6	100%
SOs in full PPE	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Triple rinsing of spray pumps	7	7	100%	24	24	100%	7	7	100%	6	6	100%

Mitigation Actions	Mara Region			Mwanza Region			Kagera Region			Zanzibar		
	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl	Sites Visited	Site Complying	% Compl
PPE washed and hanged to dry over the soak pits	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Soak pit located away from water bodies	7	7	100%	24	24	100%	7	7	100%	6	6	100%
Good percolation of soak pits	7	6	86%	24	24	100%	7	7	100%	6	6	100%
Fencing of soak pit area	7	7	100%	24	24	100%	7	7	100%	6	5	83%
Ease of effluent to drain into the soak pit	7	6	86%	24	24	100%	7	7	100%	6	5	83%

Spraying Public Institutions

In the 2011–2012 spray season, a total of 86 public institutions (29, 35 and 22 in Mwanza, Mara and Kagera, respectively) including prisons, boarding schools, colleges, hospitals, and military barracks were sprayed (see *Box 7*). This activity was conducted in collaboration with the respective institution management boards after a formal request from them. IEC activities were carried out prior the spray operations.

Box 7. Public institutions sprayed during 2011–2012 IRS season

Mwanza	Mara	Kagera
Mwanza City 1. Seko Toure Regional Hospital Mwanza **Magu District** 1. Magu District Hospital 2. Magu Prison 3. Mugini Primary School 4. Magu Police 5. Magu Secondary School **Geita District** 1. Geita District Hospital 2. Nyang'wale Secondary School 3. Geita Nursing School 4. Bukoli Secondary School 5. Rwenzera Secondary School 6. Geita Prison **Kwimba District** 1. Ngudu District Hospital 2. Env Health School 3. Ngudu Prison **Sengerema District** 1. Sengerema Secondary School 2. Sengerema D District Hospital 3. Sengerema Urban Health Centre 4. Sengerema Prison 5. Kagunda Secondary School **Ukerewe District** 1. Nansio District Hospital 2. Murutunguru Secondary School 3. Gagungwi Secondary School **Missungwi District** 1. Missungwi District Hospital 2. Bukumbi Nursing School 3. Kalwande Tech School 4. Bukumbi Catechism School 5. Missungwi Police 6. Bukumbi Disabled Camp	**Musoma District** 1. Rwamikoma Jkt 2. Kiabakari Jwtz 3. Magereza Kiabakari 4. Butiama Hospital 5. Suguti Dispensary 6. Kiagata Health Centre 7. Chifu Enyiyo Secondary School **Bunda District** 1. Bunda District Prison 2. Manyamanyama Health Centre 3. Olympus Primary School 4. Olympus Secondary School 5. Safajoma Primary School 6. Ikizu Health Centre **Serengeti District** 1. Mugumu Taborab Prisons 2. Mugumu Police Custody 3. Kisare Nursing College 4. Kisagura Secondary School 5. Enyamai Primary School 6. Natta Police Post 7. Robanda [Police Post 8. Iramba Health Centre 9. Kibanche Banche Primary School **Tarime District** 1. Tarime District Prison 2. Tarime District Hospital 3. Mtana Primary School 4. Magoto Health Centre 5. Masanga Health Centre 6. Kiongera Health Centre 7. Nyarwana Dispensary 8. Rozana Health Centre 9. Rozana Primary School **Rorya District** 1. Kowak Girls Secondary School 2. Rao Health Centre 3. Shirati Hospital And Maternity Room 4. Nyasoko Dispensary	**Bukobsa District** 1. Iruya Secondary School 2. Maruku Secondary School 3. Chuo Cha Kilimo 4. Kaboba Secondary School **Missenyi District** 1. Bunazi Secondary School 2. Tweyambe Secondary School 3. Kadea Secondary School 4. Kanyigo Muslim School **Karagwe District** 1. Kitengule Prison 2. Karagwe Secondary School 3. Kayanga Magereza 4. Kayanga Vocational Training Centre (Kvtc) 5. Kayanga Development Vocational Training Centre (Kdvtc) Biharamulo 6. St Severin Primary School 7. St Clara Secondary School 8. Development College Rubondo **Chato** 1. Chato Secondary School 2. Magufuli High School 3. Zakia Megji Secondary School 4. Jikongoe High School 5. Ichwankima Secondary School 6. Chato District Hospital

Monitoring and Evaluation

With IRS ongoing concurrently in several sites in multiple districts, systematic monitoring was established to follow up on the inputs, processes, and outputs (see *Box 8)*.

The M&E unit in conjunction with RTI and DITTs was constantly involved in the collection and utilization of data before, during, and after spray operations. Relevant indicators were utilized to monitor performances, measure results, and ultimately maintain and/or improve the management of IRS. Daily monitoring was established during operations to ensure that processes and outcomes were tracked, allowing timely detection of gaps and constraints in order to trigger adequate responses, accordingly.

Box 8. Monitoring inputs, process, and outputs

Inputs

- Inputs—such as quantification of materials, PPEs, and insecticide for procurement; as well as fuel consumption of vehicles—were tracked mainly before the start of IRS.

Processes

- The M&E unit monitored spray performances, along with other indicators related to sensitizing communities before IRS, despite being the most demanding component of the monitoring process. The training process was also monitored.

Outputs

- Output indicators—such as spray management, safety procedures used by operators, and house structures visited and sprayed—were also tracked consistently.

Daily monitoring was established during operations to ensure the processes and outcomes were tracked, allowing timely detection of gaps and constraints in order to trigger adequate responses, accordingly.

In every region, RTI focal persons supervised operations and facilitated the collation of IRS data. During spray campaigns, operators interviewed respondents of visited households and collected the required information on Spray Operator Forms. These were then aggregated by the team leaders in their respective Team Leader Forms. Eventually, the site manager followed the same process of aggregating the team leaders' entries on specially designed Site Manager Forms.

At the end of each operation day, completed hard copy spray forms were then delivered to respective district offices by the site managers. These forms were sorted, filed, and then entered electronically in the IRS templates.

The data entry team entered the Site Manager Spray Forms and the Team Leader Spray Forms into separate electronic IRS database templates.

These electronic templates generated reports on key spray performance indicators on a daily basis, which were used for interpretation and action by the IRS technical team, along with the districts' team.

The technical team monitored the daily performances up to the site level in IRS districts. Among the numerous information collected, the number of households sprayed (and not sprayed) was assessed against the daily target. The number of

households that spray operators were sprayed per day was also captured. Insecticide consumption and stock for each day was also captured and monitored. Feedback on performances was periodically relayed to site managers and supervisors, as well as DMOs to assess progress and respond to gaps, if any, in a timely manner.

In addition, vehicle and fuel usage, equipment and consumable stocks, training, quality of spray, and compliance measures were also tracked on a timely basis.

After the completion of IRS, RTI produced summary tables, charts, and maps for dissemination to partners and stakeholders on progress and results achieved.

Logistics

Storage of Insecticide and Other Supplies

Insecticide and other IRS supplies are stored at the rented warehouses at the zonal and regional level. Other temporary stores at the district- and site-level are provided by district authorities. Most of the structures provided by the district required rehabilitation or repair in order to comply with required standards in terms of design and quality. This compelled RTI to provide preliminary rehabilitation and maintenance of the structures to meet the standards. Zonal and regional storage sites are managed by RTI staff while district and subsite stores are managed by temporary hired staff, who work as district store keepers and site managers for the site substores.

RTI operated two permanent zonal warehouses (Mwanza and Zanzibar), three permanent regional warehouses (Wete, Musoma, and Bukoba), 18 temporarily district warehouses (all in the Lake Zone), and 190 temporary IRS site substores.

Distribution of Insecticides and Other IRS supplies

The transportation and distribution of insecticides (ICON® CS and FICAM® WP) and other IRS supplies, such as respirators, that are sourced outside the country started from the port of entry in Dar es Salaam. These materials—along with domestic supplies, such as chemical resistant rubber gloves, soap, etc.,—were then delivered to the zonal warehouses for distribution to regional stores, then to district stores, and finally to IRS substores. During transportation of bulky insecticides, special trucks, as recommended by WHO and FAO, were used. Prior to transportation of bulk insecticides, drivers from contracted logistic companies were trained on safe transportation and emergency preparedness while transporting these insecticides. Also, during transportation, the drivers of vehicles with insecticides were in constant communication with RTI procurement teams both in Dar es Salaam and to the destinations (e.g., Mwanza and Kagera). This contact was maintained in order to know the transportation status of the sensitive consignment. Insecticide stocks and selected PPE consumables, before and after the campaign, are shown in *Table 12 and 13*. Insecticides and consumables rate of utilization shown in warehouse records is consistent with the one reported through spray operators records. Durable spray equipment and PPE movement summary by warehouse are shown in *Table 14*. The management of PPE and spray equipment showed that the durable property control was optimal throughout the program areas. A minimal amount of PPE was lost during

the operation (<1%). The proportion of PPE and equipment that need replacement or major services is 17%, 19% and 8% for spray can, coverall and boots, respectively.

Table 12. Insecticide movements by type and by warehouse

Lambda cyhalothrin	Sachets(Liters)		
Warehouse	Initial	Used	Remaining
Mwanza	216,102 (13,506.4)	213,526 (13345.4)	2,576 (161)
Bukoba	120,120 (7,575.5)	106,800 (6,675)	13,320 (832.5)
Musoma	128,778 (8,048.6)	125,059 (7816.2)	3,719 (232.4)
Zanzibar	0	0	0
Total	465,000 (29,062.5)	445,385 (27836.6)	19,615 (1,225.9)
Bendiocarb	Sachets (Kg)		
Bukoba	108,840 (13,605)	86368 (10,796)	22472 (2,809)
Zanzibar	67560 (8,445)	46822 (5,852.3)	20738 (2,592.3)

Table 13. PPE consumables movements by type and by warehouse

Gloves			
	Initial	Used	Remaining
Mwanza	14,155	13,322	833
Bukoba	4,676	4,525	151
Musoma	5,814	5,619	195
Zanzibar	2,500	2,276	224
Total	27,145	25,742	1,403

Mask			
Warehouse	Initial	Used	Remaining

Mask			
Mwanza	72,640	72,520	120
Bukoba	45,600	44,188	1,412
Musoma	32,170	29,530	2,640
Zanzibar	14,196	11,626	2570
Total	164,606	157,864	6,742

Table 14. Selected PPE and spray equipment movement by type and warehouse

Spray Pumps Hudson Expert					
Warehouse	Initial balance	Received/ issued	Final balance	Working	Out of order
Mwanza	1,794	-217	1,577	1,188	389
Bukoba	1,191	0	1,191	891	300
Musoma	804	0	804	774	30
Zanzibar	**577**	**217**	**794**	**774**	**20**
Total	4,366	0	4,366	3,627	739

Coverall					
	Initial	Received	Remaining	Intact	Worn out
Mwanza	3,280	-1,460	1,820	896	924
Bukoba	4,676	0	4,676	3,776	900
Musoma	2,130	0	2,033	2,013	20
Zanzibar	**1,348**	**1,460**	**2,808**	**2,531**	**277**
Total	11,434	0	11,337	9,216	2,121

Boots					
	Initial	Received	Remaining	Intact	Worn out
Mwanza	2,456	-696	1,760	1729	31

Boots					
	Initial	Received	Remaining	Intact	Worn out
Bukoba	1,272	140	1,412	1212	200
Musoma	858	200	1,037	849	188
Zanzibar	**655**	**356**	1,011	**993**	**18**
Total	5,241	0	5,220	4,783	437

Provision of Transport for Operators and Supervisors

During IRS operations, numerous vehicles were hired to transport operators and supervisors from the national, regional, and district levels. The operators were transported by vans; where not feasible, 4-wheel drive vehicles or trucks were used. On the islands, both operators and supervisors were transported daily by hired boats. Operators were transported from IRS operational sites to targeted villages located 5–15 km away. Efficient transportation arrangements increased the operation's effectiveness by reducing travel time. This also provided the ideal controlled situation for transporting spray equipment and insecticide. Transportation for supervisors (average two per district) was provided daily to reach different locations with ongoing IRS operations. *Table 15* indicates the number of cars and boats hired during the last IRS round.

Table 15. Vehicles hired during IRS operations

		Lake Zone	Zanzibar	Total
Vehicles	Operators cars	456	107	563
	Supervisor cars	36	9	45
	Boats	5	4	9
	Total vehicles	497	120	617

End of Spray Activities

Post-spray Environmental Compliance Inspections and Site Decontamination and Decommissioning

Post-spray environmental compliance inspections were conducted in all IRS sites of Kagera, Mara, Mwanza, and Zanzibar. IRS site decontamination and decommissioning was carried out by making sites and storage areas safe for the surrounding community. After the inspections the IRS operational sites were handed over to the local authorities for safe custody until the next IRS operation.

Solid Waste Disposal

After the end of IRS operations, all insecticide-contaminated waste were transported back to the regional and zonal warehouse for storage to await disposal in a proper incinerating facilities that met international disposal requirements for contaminated insecticide. RTI in collaboration with ZMCP started incinerating insecticide-contaminated wastes stored in the zonal warehouse using a recently procured incinerator located at Kivunge Hospital in North A District. All insecticide-contaminated waste in Mainland Tanzania (in the Lake Zone) from previous IRS rounds were stored safely in sealed plastic barrels in regional and zonal warehouses. Incineration of Lake Zone waste will take place at a later stage after securing a new incinerator for Mainland Tanzania at the Nyanguge Health Centre, located 33 km from Mwanza. All preliminary processes for proper installation were conducted (e.g., environmental assessment, etc.), and RTI initiated the procurement process for the incinerator equipment.

End of Spray Inventory in Storage Facilities

End of spray inventory was conducted at three levels—site substore, district, and regional/zonal stores. The inventory process guides the tasks of equipment maintenance and repair, accounts for losses, and forecasts procurement for the following round.

Post-spray Verification of Eligible Structures, Targets, and Performances

A quick post-spray follow up was conducted to assess the quality of registration data used to set household targets that were completed by hamlet leaders. Follow up was also conducted to assess performance data captured by spray operators during their visit to households in targeted villages.

VI. IRS Results

Population and House Structures Found

House Characteristics and Population Profile

In Mainland Tanzania, out of 1,314,005 eligible house structures in the Lake Zone, 1,237,353 were found (94.1%) while in Zanzibar virtually all eligible houses (121,471) were visited. Wall characteristics of houses were only captured for Mainland Tanzania, where 81% of houses were mud-walled, with the remaining consisting of cement, 17% and other type of walls, 2%. The district variations are illustrated in *Figure 30 and 31*. On average, the size of houses in Kagera region was the largest (126 sqm) and in Mara region was the lowest (97 sqm) while Mwanza region was just in the middle (110 sqm). The size of household in Zanzibar was 96 and 108 respectively in Unguja and Pemba (see *Table 16*).

Table 17 presents the population breakdown of households visited in both Mainland Tanzania and Zanzibar. In total, 7,611,970 people were recorded during the spray operations, of which 24% were high-risk groups (pregnant women and under-fives).

The family size was 5.7 and 5.1 per household in the Lake Zone and Zanzibar, respectively. See *Figure 32 and 33* for district variations.

A summary of household characteristics and population by district, region, and zone is presented in *Annex C*.

Figure 30. House's walls characteristic by district Lake Zone

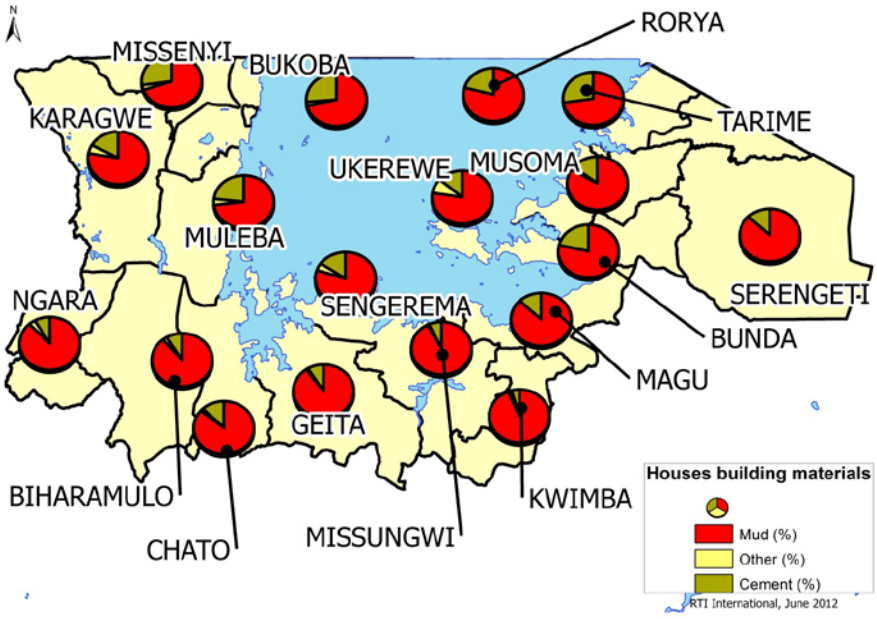


Figure 31. House's walls characteristic by district Lake Zone

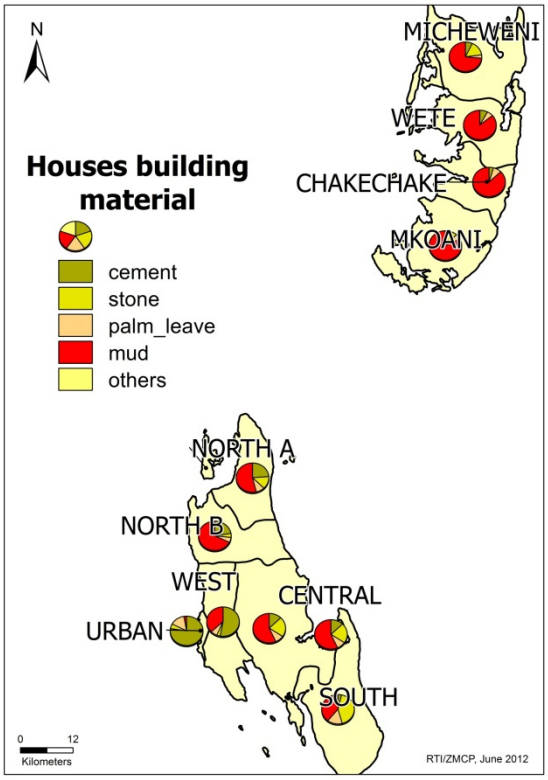


Table 16. Visited household characteristics

		Lake Zone	Zanzibar	Total
House structures found		1,237,353	121,471	1,358,824
Wall materials	Mud wall houses (%)	81%	–	–
	Bricks wall houses (%)	17%	–	–
	Other wall materials (%)	2%	–	–
Average # of rooms per house structure		3.7	4.4	–
Average house structure size (sqm)		108	100	107

Table 17. Population recorded during spray in visited households

		Lake Zone	Zanzibar	Total
Population	Total	6,992,727	619,243	7,611,970
Average Family size		5.7	5.1	5.6
Risk group	Under five years of age (%)	1,514,867 (22%)	109,562 (18%)	1,624,429 (21%)
	Pregnant women (%)	198,224 (3%)	14,899 (2%)	213,123 (3%)
Five years and above	Male (%)	2,615,175 (37%)	248,027 (40%)	2,863,202 (38%)
	Female (%)	2,664,460 (38%)	246,755 (40%)	2,911,215 (38%)

Figure 32. Family size per district, Lake Zone

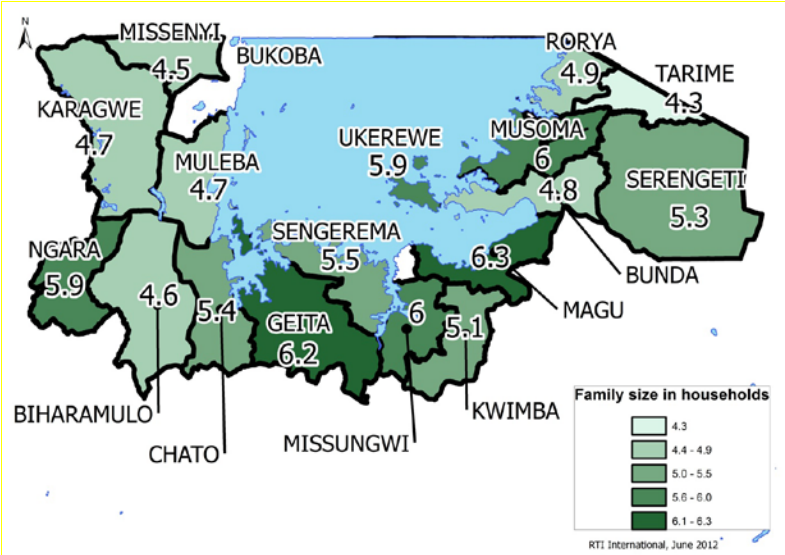
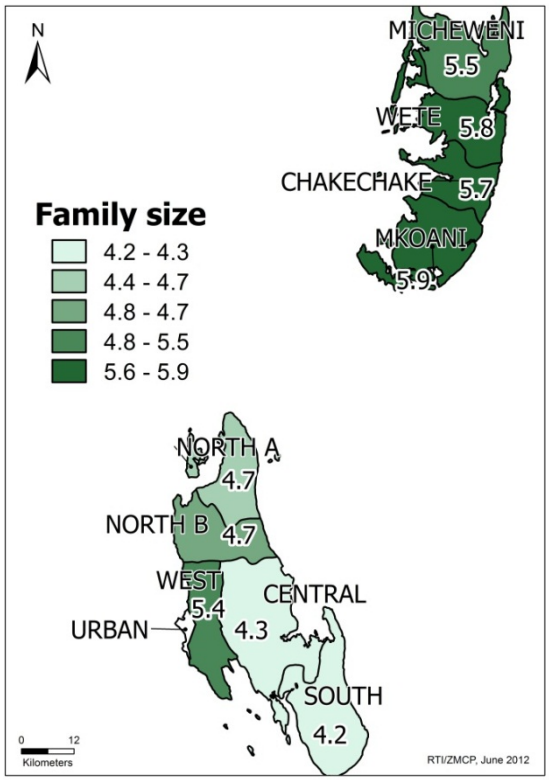


Figure 33. Family size per district, Zanzibar



Spray Results

Main Spray Indicators

In Mainland Tanzania, out of the eligible households, 94% were visited by spray operators. “Visited” is defined as houses that spray operators were able to reach, which are made up of sprayed and unsprayed houses. The remaining houses from the eligible were unreached, which the operators could not get to. On the other hand, all eligible houses were visited in Zanzibar.

The spray coverage reflects those houses that were visited and sprayed out of the targeted (i.e., eligible). Nearly 93% spray coverage was attained in Mainland Tanzania and 95% in Zanzibar (see *Table 18).*

The spray coverage by districts in Mainland Tanzania and Zanzibar is illustrated in *Figure 34* and *35*, respectively. In Mainland Tanzania, the lowest coverage was recorded in Ngara District (85%) while the highest was in Ukerewe District (97%). In Zanzibar, the range was between 90% (West District in Unguja Island) and 100% (Mkoani District in Pemba Island).

Summary of spray indicators by district region and zone are reported in *Annex D.* For spray indicators details by sites (*Annexes H, J, L,* and *N*). See also district summary details and maps in *Annex S.*

Table 18. Main spray indicators by area

House structures	Lake Zone	Zanzibar	Total
Eligible	1,314,005	121,471	1,435,476
Visited	1,237,353	121,471	1,358,824
Visited %	94%	100%	95%
Sprayed	1,224,095	114,858	1,338,953
Visited and not sprayed	13,258	6,613	19,871
Not reached	76,651	-	76,651
Spray coverage	93%	95%	93%

Figure 34. Spray coverage by districts of Lake Zone

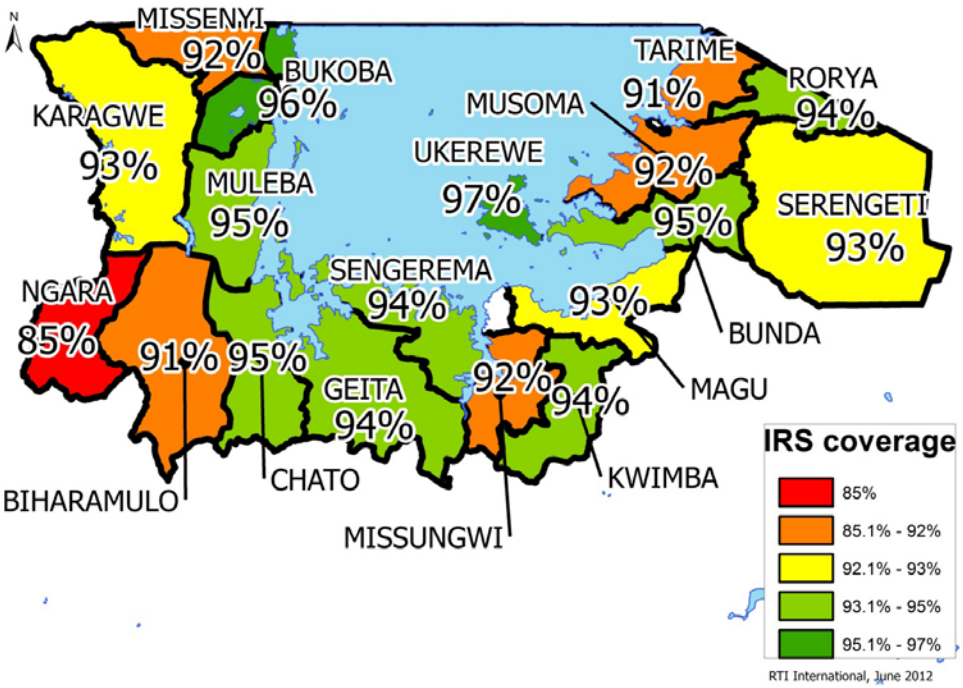
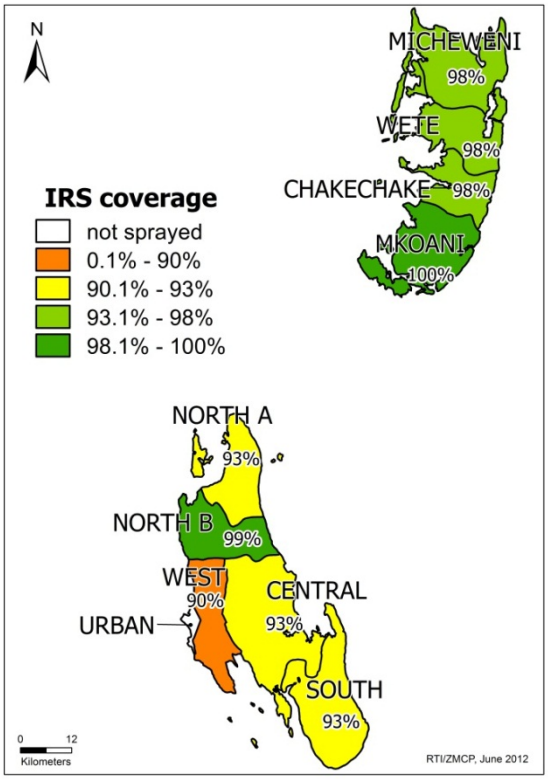


Figure 35. Spraying coverage in districts of Zanzibar



Refusal and Houses Not Reached

A total of 13,258 house structures in the Lake Zone were visited but not sprayed, which represent 1% of eligible house structures. This is due to a combination of reasons, e.g., funeral ceremonies, a very sick person in a house, stored crop inside the structure eligible for spray. A consistent percentage of refusals was due to other reasons (such as beliefs, myths, and misconceptions about IRS in general). Almost 40% of non-sprayed houses were closed at the time of the visit. The interpretation of this event is difficult, such as silent refusal or being uninformed about the operation (see *Table 19;* for district data, see *Annex O*).

A higher proportion of houses, about 6%, were not reached by spray teams (76,651). The main reason for failure to reach all eligible houses is due to their accessibility during the scheduled time. Unfavorable road conditions during the rainfall period significantly contributed to the missed houses.

Table 19. Reasons for nonspray

	Kagera Region		Mara Region		Mwanza Region		Lake Zone	
Crops Inside	797	25%	814	22%	1,580	33%	3,191	27%
Funeral	86	3%	194	5%	228	5%	508	4%
Sick Person	396	12%	400	11%	725	15%	1,521	13%
House Closed	1,170	36%	804	21%	1,948	41%	3,922	33%
Refused	495	15%	1,172	31%	1,206	25%	2,873	24%
Other Reasons	296	9%	375	10%	776	16%	1,446	12%

Use of Insecticides

A total of 442,480 sachets of lambda-cyhalothrin were used to spray a total of 1,024,807 house structures in the eligible 16 districts of Mainland Tanzania at a ratio of 0.43 sachets per house structure. An average of 8.5 rooms was sprayed per sachet. In Karagwe and Muleba districts, 86,119 bendiocarb sachets were consumed to spray 199,288 house structures with a sachet/house ratio of 0.43 and 8.1 rooms per sachet. (see *Table 19* for details by zone, *Figures 36 and 37,* and *Annex D*).

A total of 27,640 liters of ICON 10CS and 16,507 Kg of FICAM were used. After spray operations, 93.3% and 75% of ICON and FICAM stock available at the start of the spray season was respectively used. The remaining stock of bendiocarb will be used in the upcoming spray operations in Tanzania by September 2012 (see *Table 20*).

Table 20. Use of insecticide

	Lake Zone Lambda cyhalothrin	Zanzibar Bendiocarb	Karagwe and Muleba Bendiocarb
Sachets used	442,480	45,939	86,119
Liters	27,640	5,742	10,765
Sachets per house structure	0.43	0.40	0.43
Number of rooms sprayed per sachet	8.5	–	8.1

Figure 36. Sachet per house structure ratio by district in the Lake Zone

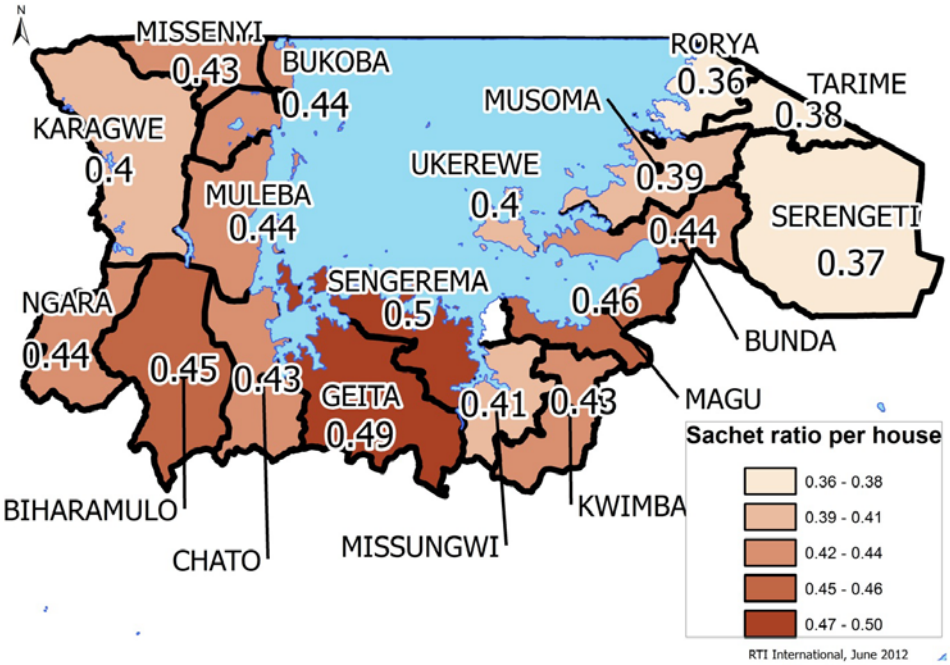
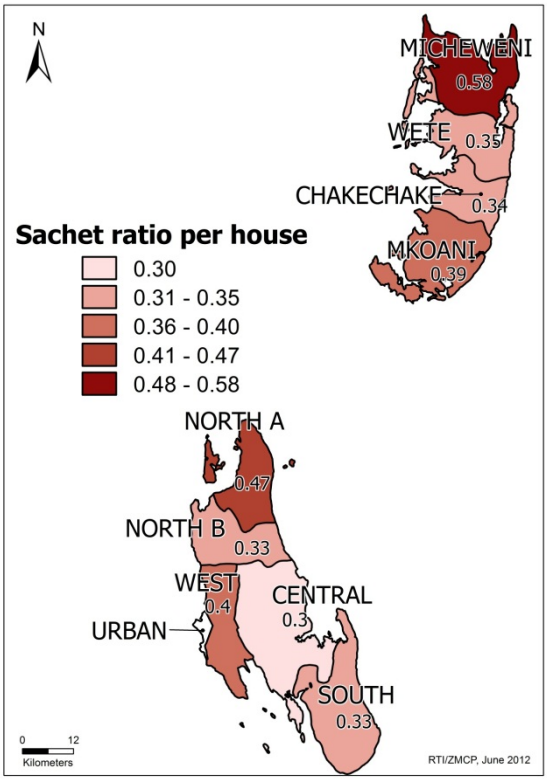


Figure 37. Sachet per house structure ratio by district in Zanzibar



Population Protected

A total of 6,340,333 and 586,657 people were protected with IRS respectively in the Lake Zone and Zanzibar out of 8,038,678 targeted eligible populations. The estimated number of pregnant women and children under the age of five protected by IRS[2] was 198,923 and 1,516,515, respectively (see *Table 21* and *Annex E*).

Table 21. Population protected by spray zone

Population protected	Lake Zone (1 spray cycle)	Lake Zone (2nd spray cycle Muleba)	Zanzibar	Total
Under fives	1,383,447	29,085	103,984	1,516,515
Pregnant women	181,614	3,229	14,080	198,923
Five years and above male	2,364,699	72,741	234,945	2,672,385
Five years and above female	2,410,573	72,733	233,649	2,716,954

[2] As per PMI's definition, the protected risk groups are those living in houses that have been sprayed.

Population protected	Lake Zone (1 spray cycle)	Lake Zone (2nd spray cycle Muleba)	Zanzibar	Total
Five years and above all	4,775,272	145,473	468,594	5,389,339
All	6,340,333	177,788	586,657	7,104,778
Eligible	7,221,793	197,642	619,243	8,038,678
Percent	88%	90%	95%	88%

Community Sensitization Results

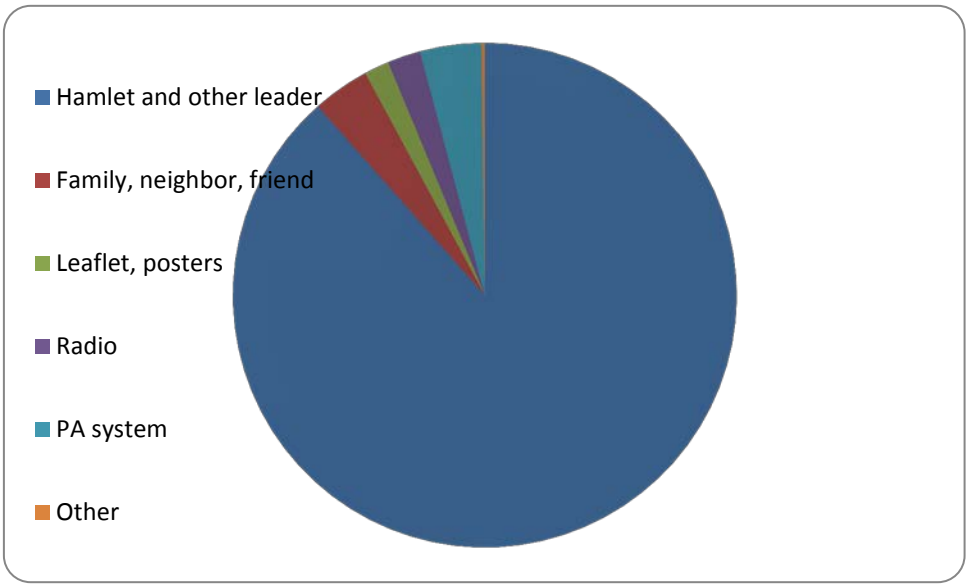
Source of Information

A large proportion (95%) of households (1,164,539) received information prior to an IRS operator's visit to the respective houses. Interpersonal communication from community leaders and other members was by far the largest source of information (92%). Other sources of information are reported in *Table 22, Figure 38, and Annexes Q and R*.

Table 22. IRS information and source by administrative level

	Kagera Region		Mara Region		Mwanza Region		Lake Zone	
Information on IRS not received	28,812	6.5%	18,612	5.7%	22,210	4.8%	69,634	5.6%
Information on IRS received	413,816	93.5%	309,026	94.3%	441,698	95.2%	1,164,539	94.4%
Source of information								
Interpersonal communication (community leaders and others)	400,078	95.5%	269,775	87.5%	403,365	91.5%	1,073,218	91.9%
Printed media (leaflets, posters)	5,305	1.3%	6,418	2.1%	6,958	1.6%	18,681	1.6%
Electronic media (radio, TV)	7,061	1.7%	10,233	3.3%	7,411	1.7%	24,704	2.1%
Public address system	4,210	1.0%	20,561	6.7%	21,026	4.8%	45,798	3.9%
Other sources	1,231	0.3%	751	0.2%	611	0.1%	2,593	0.2%
Total answers	417,885		307,738		439,372		1,164,994	
No answer	927	0.2%	623	0.2%	1,631	0.4%	3,181	0.3%
Total	418,812		308,361		441,003		1,168,175	

Figure 38. Source of Information of IRS



Perceived Advantages and Disadvantages from Previous IRS Rounds

Information for this indicator was specifically collected for the Lake Zone. The response rate was over 98.5% (see *Table 23*). Nearly 85% of respondents felt the main advantages of IRS were to reduce malaria, as well as the number of mosquitoes. About 82% of the respondents did not perceive any negative effects of IRS. The proportion is much higher in Mara and Kagera (about 92% and 93%, respectively). In some districts of Kagera, respondents complained about proliferation of fleas (see *Table 23*). However, this finding did not affect acceptance of IRS as demonstrated by the high spray coverage in the same districts (see *Annex P* for details).

Table 23. Advantages and disadvantages after IRS by administrative level

	Kagera		Mara		Mwanza		Lake Zone	
	Frequency	Percent						
Perceived Advantages from previous IRS								
Malaria/mosquitoes reduced	369,682	91.5%	243,956	77.1%	371,258	84.5%	984,895	84.9%
Other advantages	1,114	0.3%	2,760	0.9%	2,218	0.5%	6,092	0.5%
No advantages	30,910	7.6%	65,193	20.6%	56,196	12.8%	152,300	13.1%
Total answer	401,706		311,909		429,672		1,143,287	
No answer	2,472	0.6%	4,569	1.4%	9,573	2.2%	16,614	1.4%
Total	**404,178**		**316,478**		**439,245**		**1,159,901**	
Perceived Disadvantages from previous IRS								
None	256,266	62.5%	278,288	94.0%	374,015	93.0%	908,569	82.0%
Pest proliferation	149,176	36.4%	11,246	3.8%	17,024	4.2%	177,446	16.0%
Other disadvantages	1,465	0.4%	2,138	0.7%	1,616	0.4%	5,219	0.5%
Side effects	7,241	1.8%	8,919	3.0%	11,503	2.9%	27,663	2.5%
Total answer	406,907		291,671		392,655		1,091,234	

	Kagera		Mara		Mwanza		Lake Zone	
	Frequency	Percent						
No answer	2,835	0.7%	4,361	1.5%	9,621	2.4%	16,817	1.5%
Total	**409,742**		**296,032**		**402,277**		**1,108,051**	

Usage of ITNs

In Lake Zone, about 198,224 (93%) of pregnant woman and 1,430,675 (94%) of children under five years of age were declared to have slept under ITNs the previous night in the house structure visited during this reporting period (see *Table 24;* for district breakdown, see *Annex F*). *Figure 25* shows ITN usage in the three regions of the Lake Zone among pregnant women, children under five years of age, and the population above five years of age.

The results showed that overall net usage in the Lake Zone is 93% and 94% for pregnant woman and children under five years of age, respectively. Universal LLIN coverage was 84% in 2012 IRS campaign compared to 50% in 2011 (see *Figure 39 and 40*). It should be noted that LLIN universal coverage campaign was carried out in April 2011. *Table 24 and Figures 39 and 41* illustrate the main LLIN indicators collected during 2012 IRS season by zone and region.

Table 24. LLIN usage by region and zone by age group

Group		Kagera	Mara	Mwanza	Lake Zone	Pemba	Unguja	Zanzibar
Under five years	Slept under LLIN/ITN previous night	398,284	384,195	648,196	1,430,675	37,264	52,185	89,449
	Net usage %	92%	94%	96%	94%	83%	81%	82%
Pregnant women	Slept under LLIN/ITN previous night	50,604	59,199	88,421	198,224	4,395	7,177	11,572
	Net usage %	91%	92%	94%	93%	78%	78%	78%
Five years and above	Slept under LLIN/ITN previous night	1,407,589	1,030,668	1,786,614	4,224,870	130,745	220,128	350,873
	Net usage %	79%	79%	82%	80%	72%	70%	71%
All ages	Slept under LLIN/ITN previous night	1,856,477	1,474,062	2,523,230	5,853,770	172,404	279,490	451,894
	Net usage %	82%	83%	86%	84%	75%	72%	73%

Figure 39. Universal Net Coverage 2012 by district Lake Zone

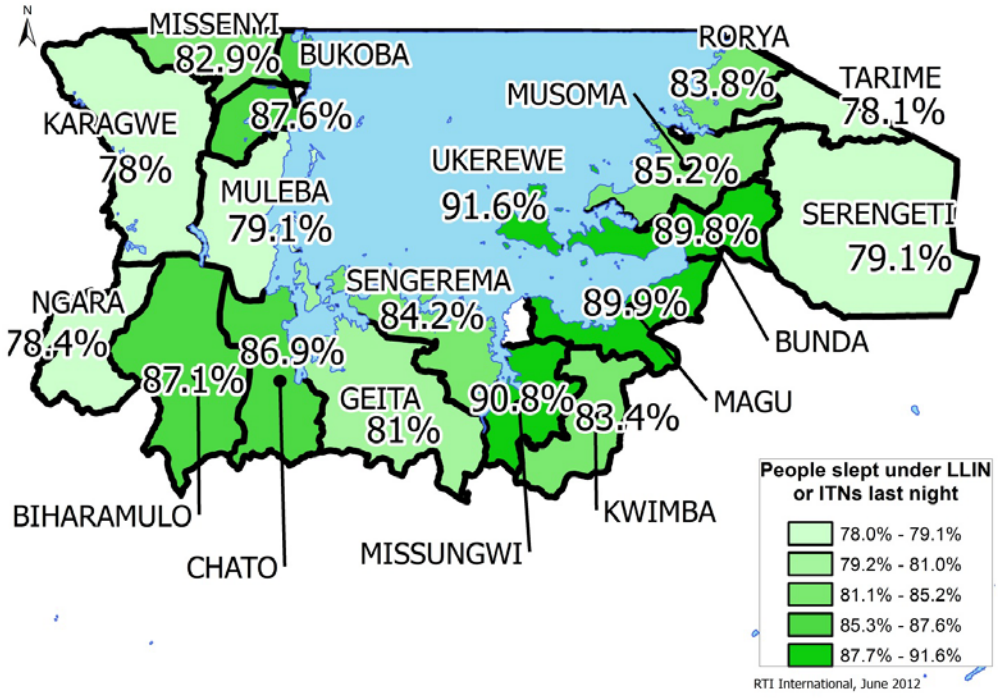


Figure 40. Universal Net Coverage 2011 by district Lake Zone

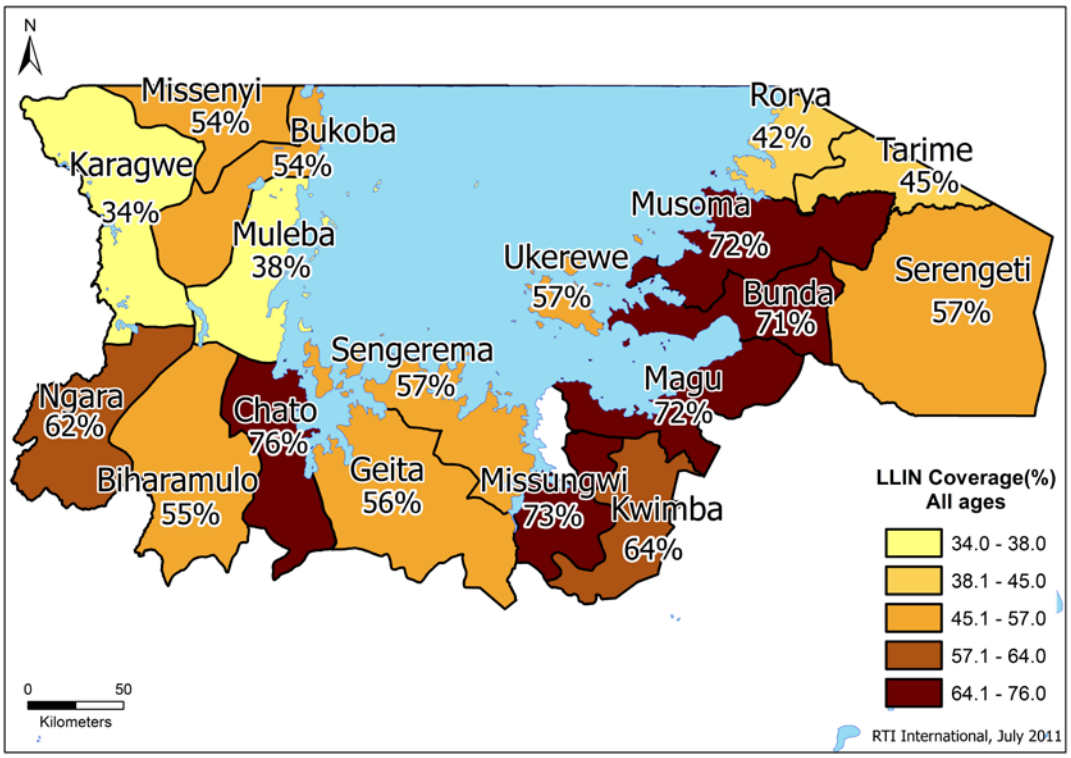
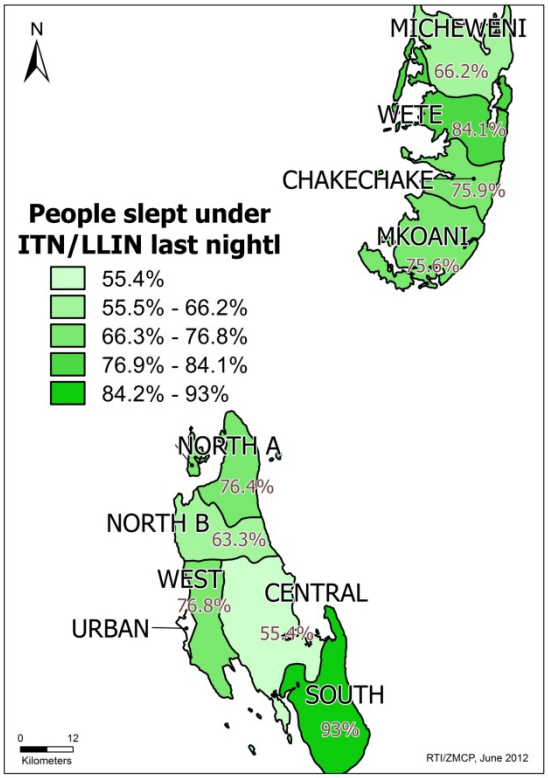


Figure 41. Universal Net Coverage 2012 by district Zanzibar



VII. Monitoring Insecticide Quantification After Spray, Insecticide Decay, and Insecticide Resistance

Introduction of IRS Bendiocarb Quantification Kits

In 2012, bendiocarb was introduced to the TVCSP's IRS program. Treatment with bendiocarb will only have the desired impact on malaria transmission if houses are properly sprayed and treatment is repeated before insecticide levels fall below their biologically active threshold concentration. Essential to the success of control campaigns is the implementation of quality control procedures. Traditionally, this has relied on insect bioassay and laboratory chemical analysis. However, the cost of insecticide quantification by high performance liquid chromatography HPLC is prohibitively high while insect bioassays require intensive insect rearing and entomological expertise.

Simple tests (Bendiocarb Quantification Kits, BQK) for detecting insecticides used in spray operations were recently developed by researchers at the University of Crete (Greece). BQK tests require relatively low-tech resources and can be carried out in intervention areas at a low cost per test (<US$2). The BQK can quantify the amount of bendiocarb on a sprayed/treated surface. The colorimetric IQK test does not calculate the exact amount of insecticide present on a wall, but it provides reliable

semiquantitative determinations (i.e.<0.1; 1-5; >10 μg/cm^2 or mg/m^2) and can detect walls with insecticide levels above certain thresholds. The BQK was successfully validated in the Bioko Island Malaria Control Project. There was a close correlation of IQK concentration estimates with HPLC and bioassay data. The BQK was easy to use by spray supervisors, and it was considered an excellent post-spray quality assurance tool to determine the proportion of houses treated within the target dose range and quality. TVCSP decided to introduce BQK to assess the quality of spray campaign over the time and on different sprayed substrates in Muleba and Karagwe districts and Zanzibar in collaboration with the ongoing Malaria Control Trial conducted by LSHTM/PAMVERC under the guidance of a consultant from the University of Crete, Dr. Evangelia Morou.

Dr. Morou's consultancy included capacity building of local RTI staff in use of the BQK and preparing the RTI team for scaling up routine use of the BQK to monitor future IRS programs.

BQK Activities February–May 2012

- Introduction of BQK one month after IRS in Muleba District, February 2012;
- Intra-operation BQK in Karagwe, February–March 2012;
- Intra-operation BQK in first round of spray in Zanzibar, March 2012;
- Bendiocarb decay quantification follow up in Zanzibar, starting from April 2012;
- Bendiocarb decay quantification follow up in Karagwe, starting from April 2012;
- Intra-operation BQK in the second round of spray in Muleba, May 2012; and
- Bendiocarb decay quantification follow up in Muleba, starting from June 2012.

Monitoring Quality Of Spray by Using Bendiocarb Quantification Kits During IRS Activities in Zanzibar and Kagera

BQKs were introduced for routine quality control in IRS operations, starting in February 2012. After training staff and procuring kits and laboratory equipment, four rounds of tests were done during the spray operations in Karagwe District, Muleba District, Pemba, and Unguja between March and May 2012. A total of 1,347 samples were taken from 251 randomly selected houses (5.5 samples per house). Among the four areas, 4% of houses were found to have no detectable insecticide on the walls while 83% of the houses had samples within the recommended concentration level. The remaining 13% of houses had samples with a mixed level of insecticide concentration (see *Table 25)*. In the intra-operation assessment, there were little differences in bendiocarb concentration on different wall substrates. There were definite differences in the performances by district and by sites within the same district. After introduction of BQK, all indicators showed an improvement, as demonstrated by the results obtained in the second spray cycle in Muleba (see *Figures*

42 and 43). Insecticide concentration was not influenced by the level and site of wall sprayed (see *Figure 44*) demonstrating uniformity in the spray technique.

Table 25. BQK results in four areas

	Karagwe	Muleba 2	Unguja	Pemba	Total
Period of testing	March	May	April	April	
Samples	292	218	461	403	1,374
Houses	62	46	80	63	251
% samples per house	4.7	4.7	5.8	6.4	5.5
Houses with no residual insecticide (<0.1µg/cm2) in all samples	3	0	5	0	8
	4.8%	0.0%	6.3%	0.0%	3.2%
Houses with suboptimal concentration (1–5 µg/cm2) in all samples	5	3	7	4	19
	8%	7%	9%	6%	8%
Houses with no residual insecticide (<0.1µg/cm2) in some samples	16	4	1	3	24
	26%	9%	1%	5%	10%
Houses with recommended concentration (10 40 µg/cm2) in all samples	45	39	68	56	208
	73%	85%	85%	89%	83%
Samples with suboptimal concentration (<0.1µg/cm2)	45	4	28	16	93
	15.4%	1.8%	29.0%	5.5%	7%
Samples with little or no insecticide detected (1–5 µg/cm2)	37	4	28	15	84
	12.7%	1.8%	6.1%	4%	6%
Samples with recommended concentration (10 40 µg/cm2)	210	210	404	372	1,196
	71.9%	96.3%	87.6%	92%	87%
Sites	6	6	5	4	21
Sites reporting suboptimal concentration in one or more samples	5	2	1	1	9
	83%	33%	20%	25%	43%

Figure 42. Results of residual concentration using BQK in all samples collected during the spray operation in four areas, March–April 2012

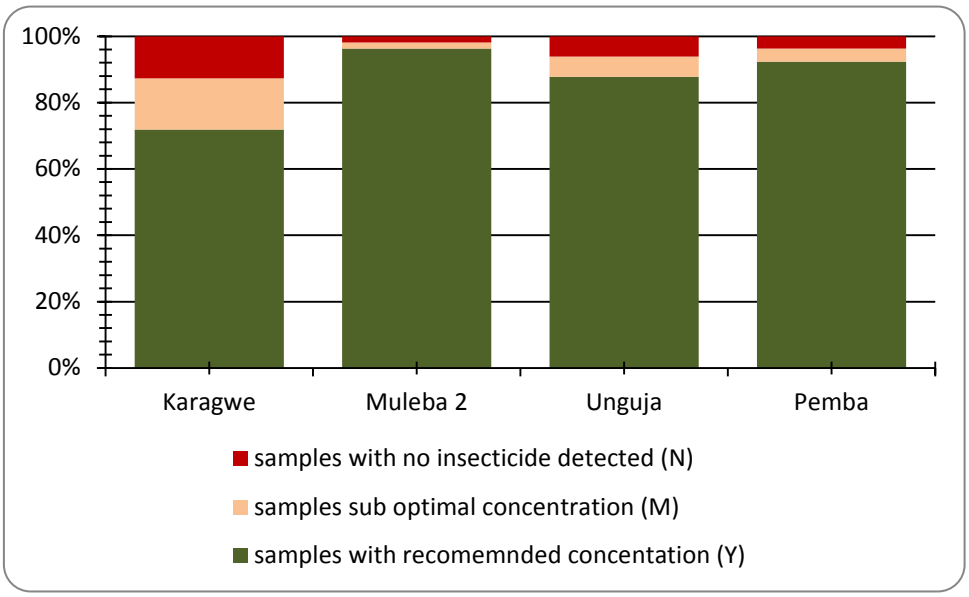


Figure 43. Results of residual concentration using BQK in houses during the spray operation in four areas, March–April 2012 (Y samples with recommended concentration, M samples with suboptimal concentration, N samples with no insecticide detected)

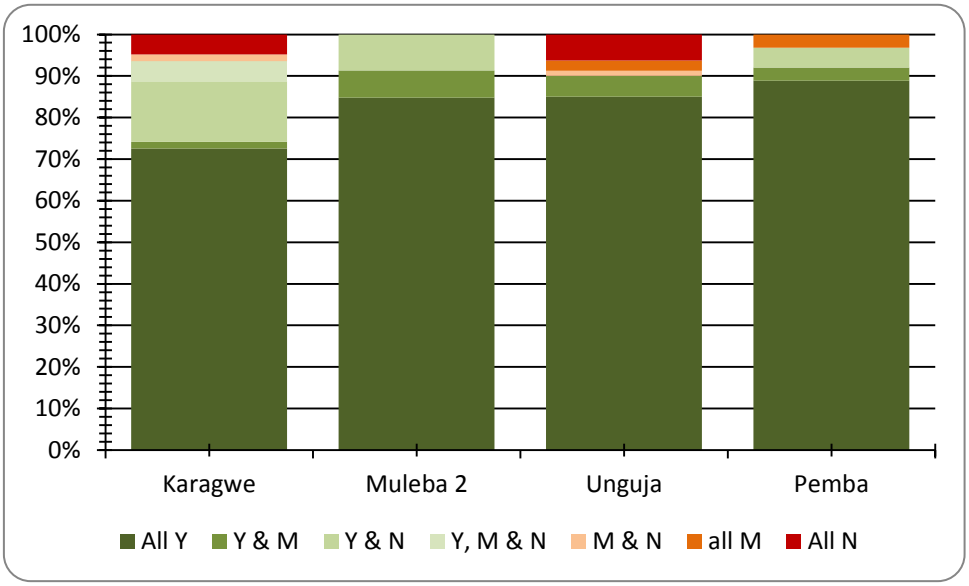
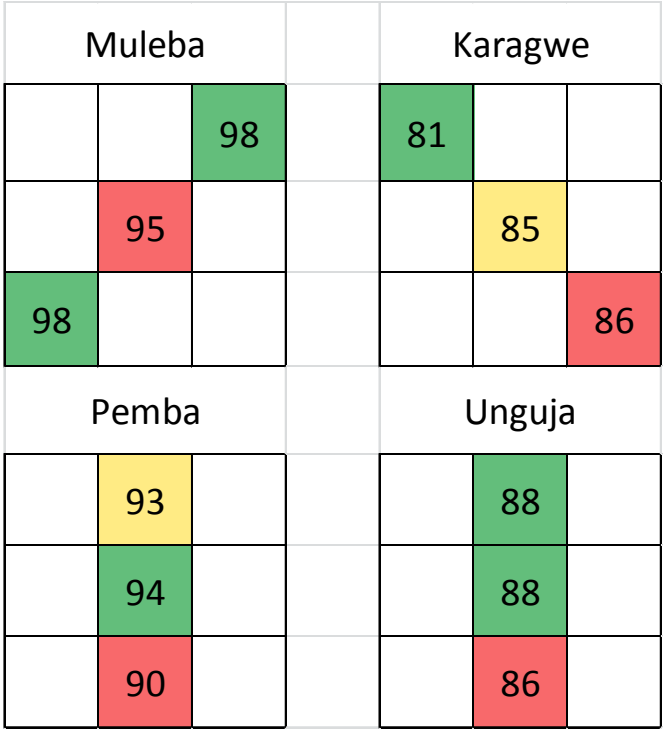


Figure 44. Proportion of BQK samples with recommended insecticide concentration by level of wall



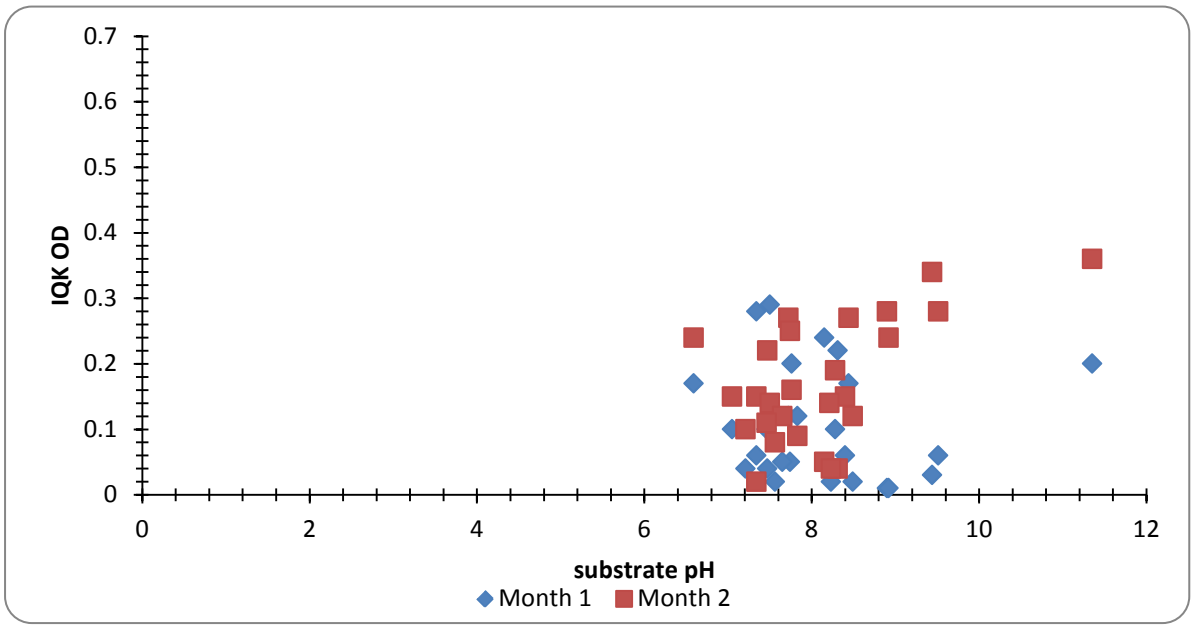
Decay Follow Up in Karagwe Four and Eight Weeks After Spray

In April and May 2012, four and eight weeks after the spray, two BQK follow ups were done in 28 randomly selected houses of Karagwe. After the second follow up, 93% of samples were within the recommended WHO range (see *Table 26*). The only samples outside the recommended range were found in alkaline surfaces with pH values more than nine (see *Figure 45*). Insecticide decay follow up is important to strategize for timing of following IRS round. The follow up is planned to be executed six months after spray.

Table 26. Karagwe monitoring insecticide decay after two months following spray

IQK value (mg/m$^{2)}$	Range	Month 1		Month 2	
Less than 0.3	100–400mg/m^2	28	100%	25	93%
0.3 to 0.39	20–100 mg/m^2	0	–	2	7%
Greater than 0.39	Below 20 mg/m^2	0	–	0	–

Figure 45. Insecticide concentration and walls' substrate pH one and two months after spray



Monitoring Insecticide Decay by Using Cone Bioassay

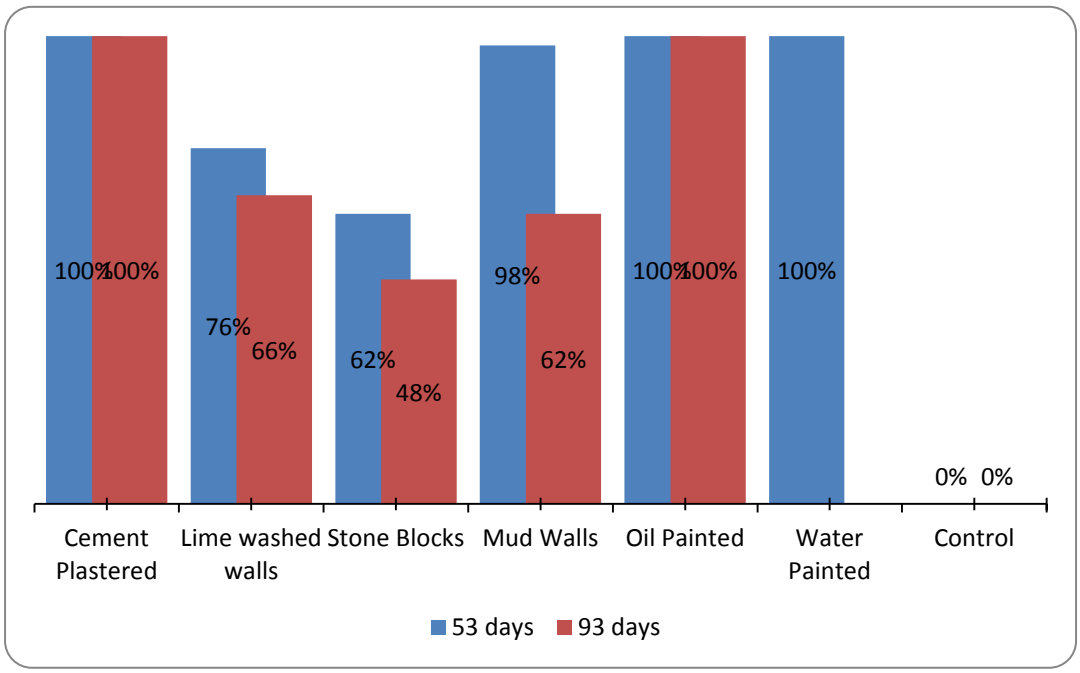
Determining the effectiveness of the insecticide used for spray over the time is key to the selection of the appropriate insecticide class and timing of spray. The use of cone bioassay is the gold standard for this purpose but has several shortfalls. It requires skilled people, a rearing mosquito facility, and transport of samples. It is a quite costly and time-consuming process. RTI, in collaboration with ZMCP, Ifakara Institute of Health (IHI), and NIMR conducted bioassays in three areas where bendiocarb was sprayed in the last spray season and in five areas where lambda-cyhalothrin was used.

Zanzibar

Bendiocarb Decay Monitoring by Using Cone Bioassay Preliminary Results After 2012 Spray Round in Tumbe, Pemba

So far, only two follow up at 53 and 93 days were conducted. Wall substrates seem to play a very crucial role in the effectiveness of bendiocarb, lime-based substrate (ph over eight), such as lime wash and lime stones, show a lower efficacy compared to other substrate (see *Figure 46).*

Figure 46. Cone bioassay in Tumbe Village 53 and 93 days after spray



Lake Zone

Bioassays were conducted in the Lake Zone by NIMR-Mwanza Centre under a subagreement from RTI. Eight houses were randomly selected at each sentinel district (Chato, Muleba, Karagwe, Serengeti, Tarime, Sengerema and Ukerewe in the Lake Zone). The wall building materials of the selected houses from each site were mud, cement, and white wash/painted and wood surfaces. Cone bioassays were performed according to WHO recommended standards. Bioassays were carried out within the marked points in the selected houses to assess the residual effect of insecticide on various sprayed surfaces. Twenty laboratory-maintained pyrethroid susceptible non-blood fed female *Anopheles gambiae s.s.* (Kisumu strain) 2–5 days old were exposed to treated surfaces for 30 minutes, as described by WHO guidelines (1981, 2006). The control surfaces were artificially constructed and dried blocks of cement, mud, wood, and color painted surfaces. Exposure on each treated surface was replicated twice while one replicate was maintained for each control surface. Mosquitoes exposed to both experimental and control surfaces were carefully siphoned out of the cone and transferred into holding paper cups covered with a piece of netting material fastened with rubber band. The mosquitoes were provided with 10% sugar solutions soaked in cotton wool, placed on the netting materials, and maintained at field laboratory rooms with relatively similar conditions to the insectary (i.e., temperature of 27±2◦C and 60-80% relative humidity) for a 24-hour holding period after exposure. Thereafter, the percentage mortalities were calculated from the total alive and dead mosquitoes for each surface in duplicate. Knockdown effect was scored at 60 minutes after exposure by visual examination based on the percentage of mosquitoes lying on their backs or sides rather than resting on their legs. Percentage mortality was also scored after a 24-hour holding period. Test results were repeated for mortalities whose controls exceeded 20%. Results were recorded on the respective data sheets.

The TVCSP recently established an experimental hut in Mwanza to test insecticide on the spray substrates commonly available in the regions where IRS is conducted. This activity is implemented in collaboration with NIMR-Mwanza Centre and the University of Dar es Salaam. Walls substrates have been collected both in the Lake Zone and Zanzibar. Results are expected to be disseminated by September 2012.

Insecticide Decay Monitoring by Using Cone Bioassay Preliminary Results After 2012 Spray Round with Lambda-cyhalothrin (Tarime, Serengeti, Ukerewe, Sengerema, and Chato) and Bendiocarb (Karagwe and Muleba)

Five districts were selected to monitor insecticide effectiveness on the walls after lambda-cyhalothrin application—Sengerema, Ukerewe, Chato, Serengeti, and Tarime. Three months after the last spray, lambda-cyhalothrin applications show that almost all surfaces are within the recommended WHO range (see *Figure 47*). Follow up is needed in 6–9 months. Differences of efficacy in different substrates have been detected (see *Figure 48*). Measuring the effectiveness of bendiocarb is done by monitoring two sites in Muleba and Karagwe.

Figure 47. Insecticide decay up to week 13 after lambda-cyhalothrin application in 2012 IRS campaign

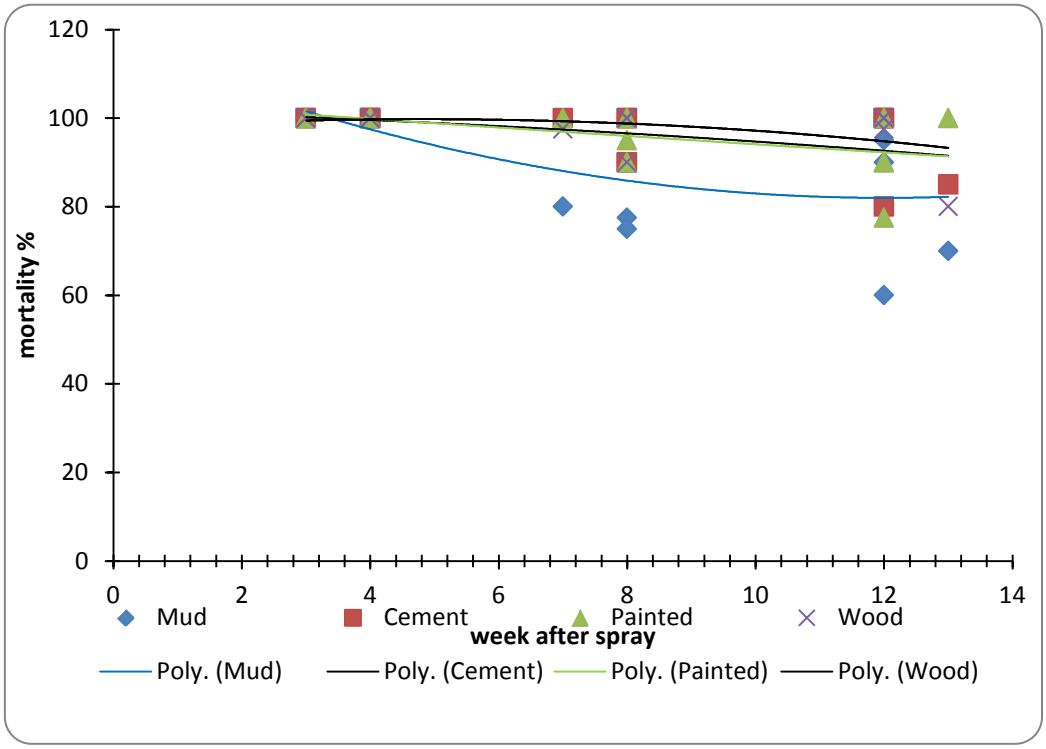
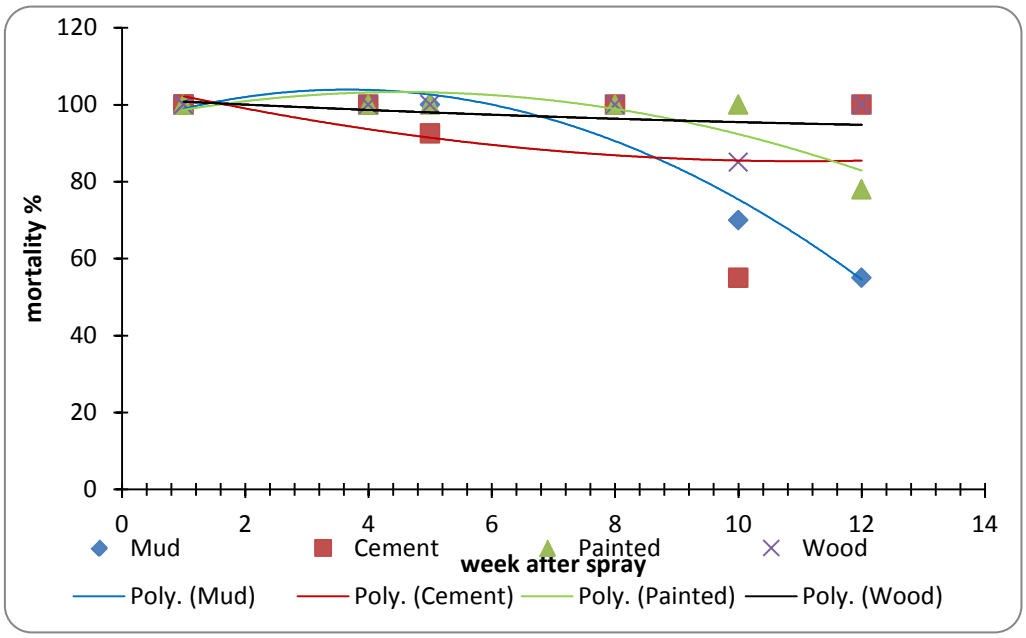


Figure 48. Insecticide decay up to week 13 after bendiocarb application in 2012 IRS campaign



Insecticide Resistance Monitoring in Lake Zone and Zanzibar

NIMR and IHI regularly monitor insecticide resistance in collaboration with NMCP and ZMCP in Mainland Tanzania and Zanzibar, respectively. RTI subcontracted the NIMR-Amani Centre to monitor insecticide resistance in national representative sites. Four areas where IRS is ongoing are regularly monitored—Magu, Muleba, (*see Figure 49*) Unguja, and Pemba (*see Figure 50*). In the last round of insecticide resistance tests, Muleba and Pemba reported some resistance to the pyrethroids used for IRS. More data on resistance are provided by partners in Muleba (such as LSHTM), confirming the insurgence of pyrethroid resistance.

Figure 49. Insecticide resistance monitoring results in Mainland Tanzania

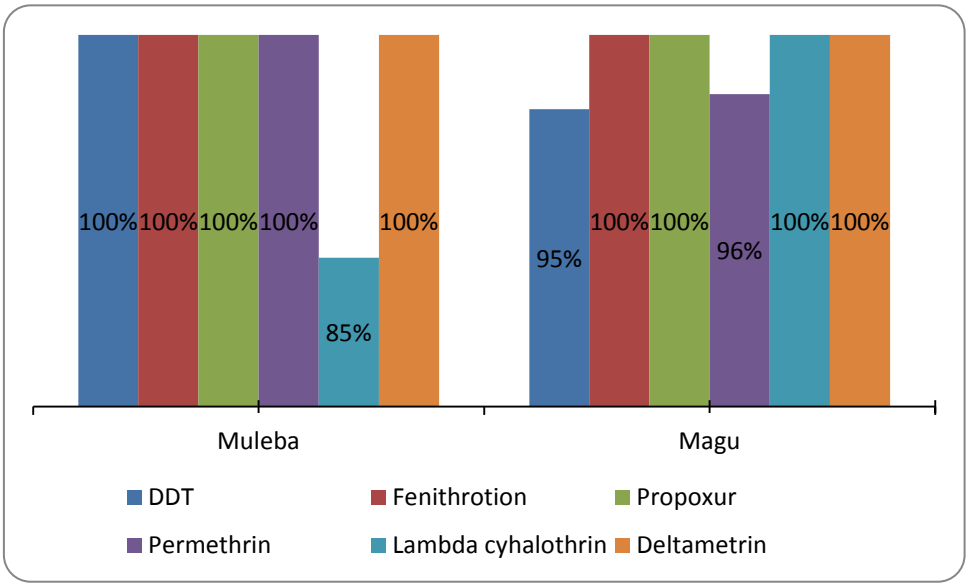
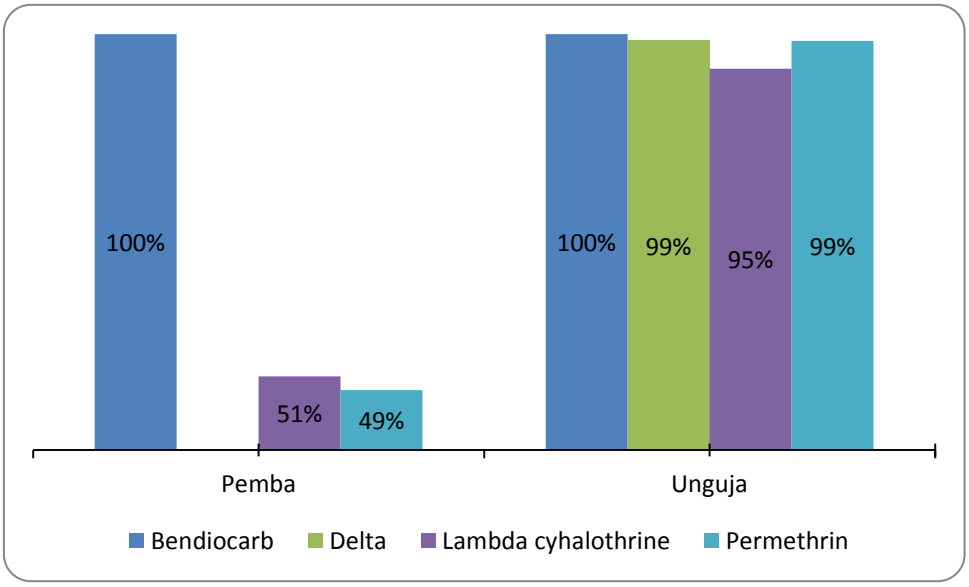


Figure 50. Insecticide resistance monitoring results in Zanzibar



VIII. Achievements/Lessons Learned

General Management for IRS

- RTI promoted a large partnership among different implementing entities, including local government, district health management, community leaders, nongovernmental and faith-based organizations, the private sector, and research institutions.
- Partnerships with private sector were successfully introduced in a large urban area in Geita District. Full cooperation among the district council authority, Geita Gold Mine, and RTI was achieved with excellent outcomes.

Capacity Development

- A relatively small RTI technical team provided support to a large number of implementing partners.
- The TVCSP team largely contributed to developing capacity of the implementing partners, principally the DITT and NGOs/CBOs. Local government employees, such as district IMCI; malaria focal persons; and VCOs involved in previous IRS operations were successfully deployed to mentor their peers in the newly involved districts. The DITTs, supported by RTI focal persons, provided guidance on the day to day implementation. RTI provided technical expertise and guidelines for implementation, but the operation relied heavily on community leaders to take ownership of the IRS initiative to ensure local compliance and project sustainability.
- Training packages were developed and standardized for various types and levels of training. Development of knowledge and skills were improved on various subject matters to bridge gaps as they were realized along the course of implementation, e.g., controlling quality of spray.

Information, Education, and Communication

- The involvement of community leaders greatly contributed to the high acceptance rates for IRS. Both in Zanzibar and in the Lake Zone, leaders from all levels—from hamlet to regional and zonal level—worked to facilitate IRS and promote not only awareness of the project but acceptance and understanding.
- Sensitization was conducted in an innovative way by using trained CCAs responsible for respective defined areas. CCAs gathered on local streets and informed community members the day before spray operations commenced, largely using megaphones to disseminate their messages.
- SIMs in collaboration with hamlet leaders greatly improved IRS community awareness, sensitization, and advocacy.
- Bed nets (especially LLIN) were found to be widely available and used.
- A large majority of people were reached with information about IRS prior to spray activities through interpersonal communication from community leaders, especially hamlet/street chairpersons. People showed acceptance and appreciated malaria preventive measures (LLIN and IRS). Most citizens reported several advantages after the last round of spray, such as decreased levels of mosquitoes and malaria.

Monitoring and Evaluation of IRS

- Selection of areas to be targeted in Zanzibar and Muleba District were successfully carried out. Criteria for eligibility vary from place to place, and epidemiological and operational indicators led the selection process.
- Registration of households was conducted before IRS implementation, which provided a close to precise denominator for the sprayed households.

Implementation

- IRS acceptance by the communities and public at large is gaining momentum at maximum pace. Most of the negative perceptions concerning IRS observed in some locations during the first spray round have dissipated. The public is becoming aware of the benefits and advantages resulting from IRS and are thus committed to participating in the implementation.
- An improved quality control scheme was introduced during the last spray round, which rendered immediate effects in terms of improved supervision of spray operators.
- IRS operations attained a high level of compliance in terms of environmental regulations and mitigating the potential harmful effects caused by using a large amount of insecticide.
- Compliance was met in terms of environmental mitigation procedures at both the IRS site and in the households.
- Urbanized areas were reached at an unexpected satisfactory spray coverage especially under the public private partnership introduced in Geita Town

- An incinerator for contaminated waste disposal was installed in Zanzibar. The incineration process incineration commenced..

Quality of Spray, Insecticide Decay, and Insecticide Resistance

- BQKs were successfully introduced to improve quality of spray. Results showed that the recommended level of insecticide detected by BQK was better after routine monitoring of spray operators by using BQK in the second round of IRS in Muleba.
- The insurgence of insecticide resistance in a number of sentinel sites was managed this spray season through the start of insecticide class rotation.
- The insecticide decay over time is crucial to understand the duration of application in different spray surfaces and in different geographical areas. Decay is constantly and successfully monitored by using experimental hut, BQKs, and cone bioassays.

IX. Challenges

Estimating the Eligible Structures

- When planning for spray operations, determining counts of eligible households for IRS is an important exercise. This determination helps quantify and allocate spray and personnel needs, as well as schedule spray activities in targeted villages. It also determines the spray coverage and its impact over the long run. Traditionally, establishing targets was done using population census projections data; where applicable, data from previous IRS rounds, as well as household information from other sources such as mass campaign for nets, etc., was also used. However, the TVCSP team observed that this approach was not always the most effective since the number of houses visited during actual spray operations in some districts yielded a higher (or lower) count than what was initially targeted. This variance is possible with the influx (or efflux) of settlements in some areas that can only be confirmed by updating registration booklets before the start of spray season.

IRS Management

- The recruitment of IRS site managers, a key person to carry out quality IRS activities, was wholly managed by the DMOs and DITT. In some cases, TVCSP technical staff observed a lack of commitment among the cadre and compromised accountability, which resulted in some repercussion in IRS outcomes. The TVCSP experienced difficulties in matching the established IRS timeframe with the designated spraying seasons due to delays in conditional environmental assessments, insecticide procurement, and release of funds.
- The TVCSP observed some occasions on which government and council officials demonstrated a lack of commitment in implementing IRS. Some

members of the DITTs often set aside their IRS duties and participated in other council activities, such as attending meetings and conducting other activities in their districts that were not related to IRS. This caused many inconveniences in terms of management of the spray rounds.

Poor Infrastructure Conditions in the Region

- Most of the roads in the region are seasonal roads and in poor condition. In some cases, the poor state of the roads caused the spray teams lost time spent travelling from one point to another.
- Geographical distribution and poor road infrastructure in the region was among the major challenges. Most of the sites are sparsely distributed, causing many difficulties during IRS supervision and follow-ups. This also affected the actual working hours for spray operators.

Logistic and Financial Challenges

- IRS is indeed a logistically complex operation. IRS requires multiple partnerships, a large quantity of equipment and materials to be handled, and a large number of temporary staff to be managed. A number of challenges are encountered in this type of complex operation. For example, transportation of IRS operators and equipment has to be provided on time on each day of operations to the most remote areas. It also involves training of a large number of staff and ensuring their timely wage payments. These requirements overstretch the TVCSP's administration and finance department during IRS operations.
- Nearly two-thirds of the hired temporary staff's bank accounts, especially in Tarime and Rorya districts, were either inactive or invalid. This resulted in delays in issuing payments to the temporary staff. The temporary staff also resisted this this modality of payment; most preferred cash payment to the bank transfers.
- A lack of ideal and reliable storage facilities for Rorya and Musoma districts has been a major obstacle to smooth operation and management of IRS equipment and other commodities.

Environmental Compliance

- Delays in installment of a proper incineration facility in Mainland Tanzania compels RTI to transport contaminated wastes from district to the main IRS warehouses in Mwanza for temporary safe storage. RTI is in the process of procuring and installing a suitable incineration facility in Mwanza that will rectify the situation.

Quality of Spray, Insecticide Decay, and Insecticide Resistance

- The introduction of BQK and the set-up of an experimental hut to monitor the effectiveness of different classes of insecticide demonstrates that there also are important differences in insecticide decay among different substrates. This evidence poses some challenges for the selection of the appropriate insecticide in different spray operation areas.

X. IRS in Action

Spray operators ready to receive the daily supply of insecticide for IRS operations.

Spray operators deploy to the IRS targeted village.

A spray operator in action.

Technical supervisor from RTI and NEMC visiting a targeted house.

A spray operator in action

Technical supervisor from RTI and NEMC visiting a targeted house.

Incineration of solid waste.

Washed PPE hang over soak-pit to dry, which is fenced and secured to keep out children and animals.