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THE PMI VECTORLINK PROJECT ANNUAL REPORT OCTOBER 1, 2020– SEPTEMBER 30, 2021

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ACRONYMS

AIRS	Africa Indoor Residual Spraying
CDC	U.S. Centers for Disease Control and Prevention
CDWG	Continuous Distribution Working Group
CERMES	Centre de Recherche Médical et Sanitaire
DHIS2	District Health Information Software 2
DHO	District Health Office
ECO	Environmental Compliance Officer
ECOS	Environmental compliance operations support
HLC	Human landing catch
IG2	Interceptor G2 [Net]
IRM	Insecticide resistance management
IRS	Indoor residual spraying
ITN	Insecticide-treated nets
M&E	Monitoring and evaluation
M-DIVE	Malaria Data Integration Visualization for Elimination
MOPDD	Malaria and Other Parasitic Diseases Division
NMCP	National malaria control program (generically)
NMEP	National Malaria Elimination Program
PBO	Piperonyl butoxide
PCR	Polymerase chain reaction
PMI	President's Malaria Initiative
PSC	Pyrethrum spray catch
PSI	Population Services International
SBC	Social behavior change
SEA	Supplemental Environmental Assessment
SOP	Spray Operator
TOT	Training of trainers
USAID	United States Agency for International Development
VCTWG	Vector Control Technical Working Group
WHO	World Health Organization

EXECUTIVE SUMMARY

The U.S. President's Malaria Initiative (PMI) VectorLink Project is funded by the United States Agency for International Development (USAID), through PMI, and was awarded to Abt Associates on September 30, 2017. PMI VectorLink builds on the indoor residual spraying (IRS) campaigns and entomological monitoring activities implemented under the predecessor PMI Africa Indoor Residual Spraying (AIRS) Project, with an expanded focus which includes support for insecticide-treated nets (ITNs) in addition to IRS under a broader vector control mandate. PMI VectorLink also includes a focus on data analytics and data visualization to support vector control decisions and measure their impact. These activities are being supported by Abt's core subcontract partners Population Services International (PSI) and PATH. Other technical subcontractors include:

- BAO Systems, supporting VectorLink Collect, which is based on the District Health Information Software 2 (DHIS2)
- Dimagi Inc., supporting IRS supervision and reporting tools
- The Malaria Consortium, supporting national malaria control programs (NMCPs) in developing insecticide resistance management (IRM) plans and integrated vector control strategies

Encompass helped standardize select monitoring and evaluation (M&E) resources and supported the design of targeted resources that aimed to facilitate the roll-out of ongoing enhancements to VectorLink Collect. During this reporting period (Oct. 1, 2020–Sept. 30, 2021), PMI VectorLink conducted successful IRS campaigns in 17 countries: Benin, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, and Zimbabwe. PMI VectorLink conducted IRS for the first time in Sierra Leone. Routine entomological monitoring continued in 26 countries, and operational research studies continued in Colombia, Cote D'Ivoire, and Ethiopia. This year PMI VectorLink directly managed distribution of nets in Cote D'Ivoire, Tanzania, and Senegal. PMI VectorLink carried out net durability monitoring work in 11 countries and supported local government planning and implementation efforts with insecticide-treated nets (ITNs) in Cameroon, Côte D'Ivoire, Ghana, Niger and Zambia.

TOP-LINE RESULTS FROM VECTOR CONTROL ACTIVITIES, OCT 2020–SEPT 2021

- **5,998,542** structures were sprayed, protecting **21,898,014** people from malaria:
  - **3,479,257** children under 5 years of age
  - **692,000** pregnant women
- **33,086** people were trained to deliver IRS with U.S. Government funds.
- PMI VectorLink directly distributed **6,676,811** ITNs (Cote D'Ivoire, Senegal and Tanzania), protecting approximately **13,353,622** people from malaria.

HIGHLIGHTS FROM THIS REPORTING PERIOD

During this period of performance PMI VectorLink continued to successfully manage the significant operational and technical challenges of implementation in the context of COVID-19. The project continued to adopt and update strict measures for prevention of and response to COVID-19, enabling it to sustain the scale of its life-saving malaria vector control activities during the pandemic. The project's Senior Management Team proactively encouraged PMI VectorLink staff to get COVID-19 vaccinations over the course of the year (when available), which also contributed to the project's successful continuation of activities. Unfortunately, despite our best efforts to protect our staff and beneficiaries, PMI VectorLink lost three staff this year due to COVID-19.

PMI VectorLink continued to show resilience in overcoming supply chain barriers posed by the pandemic. The project's Home Office Procurement and Logistics Team worked closely with country teams to ensure

adherence to stricter and longer lead times for all orders. Doing so ensured the on-time start of the 2021 spray campaigns that occurred during this reporting period.

As a result of the pandemic, PMI VectorLink relied almost exclusively on targeted south-to-south technical assistance, remote technical assistance from headquarters, and remote trainings.

In 2021, PMI VectorLink conducted an operational research study in Tiassalé, Côte D'Ivoire, evaluating two iterations of partial wall spraying to assess the efficacy of SumiShield 50WG and Fludora Fusion 56.25WP-SB (neonicotinoid-based insecticides), and Actellic 300CS (pirimiphos-methyl), when partially sprayed in experimental huts against free-flying populations of *An. gambiae* s.l. In Ethiopia, PMI VectorLink investigated the presence of *An. stephensi* in seven urban sites in the central and eastern part of the country, out of which three were positive for presence. The project team participated in a virtual regional workshop in March 2021, a webinar on *An. stephensi* in August 2021, and a conference in Djibouti in September 2021 organized by the Controlling Emergent *Anopheles stephensi* in Ethiopia and Sudan project (CEASE).

During this reporting period, the project continued to improve and enhance monitoring and evaluation (M&E) approaches to improve quality and efficiency. This included finalizing the roll-out of VectorLink Collect entomology modules; the expanded use of mobile spray data collection solutions; and enhanced analytics and visualization within VectorLink Collect to support data use. Several new initiatives were also launched during this reporting period, including a summary IRS data program in VectorLink Collect to facilitate data sharing with PMI's Malaria Data Integration Visualization for Elimination (M-DIVE) platform, the final integration of legacy IRS and insecticide resistance datasets into VectorLink Collect to facilitate longitudinal analyses, and the design and launch of a core-funded pilot of mobile data collection for entomological data in Ghana.

Through core partner PATH, PMI VectorLink supported the evaluation of IRS and ITN activities in Burkina Faso, Cote D'Ivoire, Ethiopia, Liberia, Madagascar, Mali, Malawi, Nigeria, Sierra Leone, and Mozambique (in development). In Zambia, PMI VectorLink supported broader vector control planning with development of integrated and interactive data dashboards. Also, with efforts coordinated by PATH, PMI VectorLink revised the Vector Control Integrated Data Analytics and Visualization Best Practices Guide.

PMI VectorLink facilitated insecticide rotation and forecasting discussions with national vector control steering committees to mitigate resistance. This resulted in 13 PMI VectorLink countries spraying Fludora Fusion, 13 spraying SumiShield 50WG, and eight spraying Actellic. Out of 17 IRS country programs, seven used two different insecticides, five used all three insecticides, and only five countries used one insecticide.

1. Country Highlights

1.1 Angola

1.1.1 Program Highlights

- Trained 21 mosquito brigade staff across seven provinces to collect mosquito larvae and adults using standard methods, identify samples to genus level, collect geolocation data, and preserve and properly store samples for lab analyses. Participants also reviewed and observed susceptibility testing protocols.
- Conducted insecticide susceptibility tests and PBO synergist assays in six provinces (Cuanza Norte, Luanda, Lunda Sul, Malanje, Uige, and Zaire) to inform future ITN procurements. *An. gambiae* s.l. from Cuanza Norte, Lunda Sul, Malanje, Uige, and Zaire were resistant to permethrin, deltamethrin, and alpha-cypermethrin. In Luanda, mosquitoes were found to be resistant to deltamethrin and alpha-cypermethrin. (Note: A sub-sample of Luanda mosquitoes were originally identified and tested as *An. funestus* s.l. but later confirmed by PCR to be *An. azevedoi/listeri*. Therefore, all or part of these mosquitoes tested from Luanda could be *An. azevedoi/listeri*. Tests will be repeated in 2021 with *An. funestus* s.l.)
- Began monthly community-based entomological surveillance in November 2020 at one site in Huambo Province to assess species composition, vector behavior, and insecticide susceptibility. A weeklong training preceded surveillance for representatives of PMI VectorLink, Global Fund/MENTOR, the Angola NMCP, and Instituto Nacional de Investigação em Saúde, on using U.S. Centers for Disease Control and Prevention (CDC) light traps for surveillance and susceptibility testing, and on conducting World Health Organization (WHO) tube tests.
- Developed summary reports on key activities, preliminary data, and results of capacity-building efforts by province, which were translated into Portuguese and disseminated to national and local officials.
- Expanded the Huambo insectary following approval from the Ministry of Health to import a susceptible strain of *An. gambiae* mosquitoes in February 2021, for mosquito rearing, identification, and processing; susceptibility testing; data entry; and equipment storage, as well as an animal house with rabbits for bloodfeeding. Developed an insectary rearing and management protocol and imported initial batches of *An. coluzzii* SUA strain from The University of the Witwatersrand in South Africa.
- Continued collaboration with and capacity building of Instituto Nacional de Investigação em Saúde through the development of a laboratory inventory management tracker, procurement of necessary supplies and reagents, and review of relevant protocols in preparation for lab analysis.
- Helped the NMCP develop an updated national Insecticide Resistance Management Plan and Vector Control Management Plan and convened three Vector Control Working Group meetings.

1.2 Benin

Table 1: PMI VectorLink Benin Vector Control at a Glance

IRS	**Dates and length of PMI-supported IRS campaign**	April 26–May 20, 2021 16 operational days		
	Number of districts covered by PMI-supported IRS	6 (Copargo, Djougou, Ouaké, Gogounou, Kandi, and Segbana)		
	Insecticide(s)	SumiShield 50WG (43,417 units)		
	IRS results	Structures sprayed: 280,237	Structures found: 299,800	Spray coverage: 93.5 %
	Population protected by PMI-supported IRS	Total: 927,007	Pregnant women: 40,470	Children < 5: 107,330

	Number of people trained with U.S. govt. funds to deliver IRS*	Total: 1,850 (287 female, 15.5% female)

* Throughout this report, the indicator "Number of people trained with U.S. govt. funds" to deliver IRS is based on the PMI indicator definition, and includes only spray staff such as Spray Operators, Team Leaders, and Supervisors. It excludes clinicians; Data Entry Clerks; Information, Education, and Communication Mobilizers; drivers; washers; porters; pump technicians; and security guards.

1.2.1 Program Highlights

- Carried out activities in anticipation of the 2021 IRS campaign, including: updating of geographical reconnaissance using satellite imagery to ensure better coverage of the IRS targeted areas, updating of data on the enumeration of structures, identification of operations site locations, assessment of needs, procurement of local and international equipment and materials, organization of the information visit to the health and politico-administrative authorities, and organization of planning meetings at all levels.
- Collaborated with the Entomological Research Center of Cotonou to conduct wall bioassays to assess the quality of spraying in the target districts. Mortality of mosquitoes exposed to sprayed surfaces was 100% within two weeks of spraying, indicating quality of spraying was satisfactory.
- Continued to implement mobile data collection for the first time with smartphones at the primary point of collection through all Spray Operators to facilitate reporting and operational decision making.
- Complied with COVID-19 mitigation measures to ensure the safe implementation of spray activities for all spray personnel and beneficiaries.

1.3 Burkina Faso

Table 2: PMI VectorLink Burkina Faso Vector Control at a Glance

IRS	**Dates and length of PMI-supported IRS campaign**	May 10–June 4, 2021 in Solenzo May 20–June 19, 2021 in Kampti 20 operational days		
	Number of districts covered by PMI-supported IRS	2 (Kampti and Solenzo)		
	Insecticide(s)	SumiShield 50WG (10,581 units), Fludora Fusion WP-SB (21,075 units), and Actellic 300CS (6,421 units)		
	IRS results	Structures sprayed: 175,523	Structures found: 189,425	Spray coverage: 92.7%
	Population protected by PMI-supported IRS	Total: 586,249	Pregnant women: 31,218	Children < 5: 120,019
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 1,798 (343 female, 19.1% female)		

1.3.1 Program Highlights

- Conducted wall bioassays through the Institute of Research on Health Sciences in houses sprayed with SumiShield 50WG and Fludora Fusion WP-SB. Results showed 100% mortality of exposed mosquitoes two weeks after spraying.
- Continued monitoring the residual efficacy of the sprayed insecticides; The residual efficacy of the sprayed insecticides show mosquito mortality is 100% through November 2021 post-IRS.
- Conducted monthly entomological monitoring in eight districts, including two IRS sites (Kampti and Solenzo), two paired unsprayed control sites (Nouna and Gaoua), one former IRS site (Kongoussi, sprayed 2018–2019) and its paired control site (Seguenega), as well as two sites that had received PBO nets in 2019 (Soumousso and Karangasso-Vigue).
- Developed an IRM plan, which includes rotation schedules for organophosphate and neonicotinoid insecticides used for IRS in different districts. The plan provides the guiding principles for insecticide procurement planning; targeting different types of ITNs; entomological monitoring; and the use of insecticide resistance and other relevant data for decision making. It also presents the main IRM strategies and situations for sustainable and effective vector control in the country.

- Completed remote training of trainers (TOT), in-person training, and data collection for two out of three study districts for the 24-month durability monitoring of the 2019 mass ITN distribution. Sites completed are Gaoua (Interceptor G2 (IG2) net) and Orodara (PermaNet 3.0). Remote TOT was conducted on June 21–23, in-person fieldworker training on June 28–July 1, and data collection on July 3–August 20. Refresher training and data collection in the third district, Banfora, where IG2 nets are being monitored, will take place in Year 5.
- Completed bioassay testing of standard pyrethroid, PBO synergist, and dual active ingredient IG2 field ITNs collected during the 12-month durability monitoring round.
- Completed chemical testing of baseline and 12-month ITN samples, and revised the associated reports.
- Completed an evaluation of the 2018 IRS campaign, which documented an 18% decrease in malaria case incidence in the three sprayed districts (Solenzo, Kongoussi, and Kampti) compared to unsprayed districts in the nine months following IRS.

1.4 BURUNDI

1.4.1 PROGRAM HIGHLIGHTS

- Conducted the 12-month study of ITN durability monitoring in January 2021 in two sites: Vumbi (PBO ITN) and Gashoho (standard deltamethrin ITN). A remote TOT preceded in-person fieldworker training and data collection. Three NMCP technicians received training and conducted ITN bio-efficacy tests under the supervision of PMI VectorLink.
- Held an ITN durability monitoring results dissemination workshop for members of the NMCP to review and discuss results to date, given the relatively high level of net attrition and poor physical integrity recorded at the 12-month round. Recommendations included sharing results at the regional and community level to raise awareness of the challenge among stakeholders and community members and inform social behavioral change (SBC) approaches to the planned 2022 mass ITN campaign. An action plan by the NMCP is in progress to strengthen better care of ITNs in the community.
- Provided technical assistance to the NMCP to develop the national IRS intervention guidelines through a three-day workshop supported by PMI VectorLink in collaboration with Médecins Sans Frontières Belgium and WHO. The document was discussed among stakeholders and approved by the Minister of Health.
- Provided technical assistance for wall cone bioassays to monitor insecticide decay after the government-implemented IRS campaign in October 2020 in Nogzi and Muyinga Provinces. The mortality of susceptible *An. gambiae* Kisumu strain in the wall cone bioassays was above 80% 12 months after IRS, indicating long residual life of Fludora Fusion WP-SB in the areas.
- Monthly longitudinal entomological surveys were conducted in nine sentinel sites, using human landing catch (HLC), pyrethrum spray catch (PSC), and CDC light trap collections. The results indicated that *Anopheles gambiae* s.l. represented more than 75% of the total mosquito collections, followed by *Anopheles funestus* s.l. (around 17%). *An. funestus* s.l. is the second predominant malaria vector in Burundi.
- Vector indoor biting activity was high in Mpanda and Nyanza-Lac, with a mean human biting rate varying between 12 and 31 bites per person per night. The human biting rate was relatively low in Kiremba (IRS site), Gihofi, Mabayi, and Matana in comparison to the other sites.
- At all sites where the tests were conducted, the vector was susceptible (100% mortality) to clothianidin and pirimiphos-methyl. The vector was either susceptible to pyrethroids or showed possible resistance.

1.5 CAMBODIA

1.5.1 PROGRAM HIGHLIGHTS

- Received the technical manager, an entomologist, in Cambodia in January 2021 after a nine-month delay due to COVID-19-related international travel restrictions. In addition, the project hired a replacement Finance and Administration Manager in July 2021 and a Chief of Party in August 2021.

- Conducted monthly entomological monitoring in four sentinel sites in Mondulkiri (annex village of Pu Till and nearby forest site), and in Stung Treng (annex village of Ou Chay village and nearby forest site). Longitudinal monitoring covered October 2020 to September 2021, except for March and April 2021, as a national COVID-19 lockdown restricted movement to the provinces. Monthly collections provided on-the-job capacity building of provincial health and operational district staff.
- Used longitudinal monitoring: human double net, cow bait double net, Furvela tent trap, and CDC light trap for village sites, and human double net and Furvela tent trap at forest sites. During the collection period, *Anopheles* abundance and species richness was higher in Mondulkiri (total collected=11,341, species=31) than in Stung Treng (total collected=6,949, species=26). The primary vectors, *An. dirus*, *An. minimus*, and *An. maculatus*, were found in both provinces: *An. dirus* was the predominant vector (Mondulkiri n=1,183; Stung Treng n=1,136). However, *An. minimus* s.l. and *An. maculatus* s.l. also occurred in high numbers in Mondulkiri but not Stung Treng.
- Confirmed from monitoring results that the highest risk of being bitten by a primary malaria vector species is outdoors, particularly in the forest fringe; the risk is much lower indoors, reinforcing the need for additional outdoor protection measures.
- Began insecticide susceptibility testing for *An. dirus* in August 2021 in the rainy season in both provinces against deltamethrin and alpha-cypermethrin.
- Finalized the terms of reference for Vector Control Working Group meetings. The first meeting was scheduled for March 2021 in Phnom Penh; however, due to COVID-19, the meeting was postponed and is yet to be rescheduled with the concurrence of the Cambodian National Center for Malaria Control, Parasitology, and Entomology.
- Conducted laboratory capacity assessment for molecular entomology in August 2021 at the laboratory of the National Center for Parasitology, Entomology, and Malaria Control, and the genetic laboratory of Royal University of Phnom Penh in preparation for collaboration and testing in Year 4.

1.6 CAMEROON

1.6.1 PROGRAM HIGHLIGHTS

- Trained 51 regional and district health personnel in the South (17), Far North (16), and North (18) Regions on vector surveillance techniques (mosquito collection, morphological identification, sample preservation, and larvae habitat identification and collection). Participants are now involved in routine vector surveillance carried out in the selected sentinel sites.
- Conducted longitudinal entomological vector surveillance in five sentinel sites (Gounougou and Simatou in the North, and Bonabéri, Mangoum, and Nyabessang in the South) monthly from October 2020 to March 2021 and every other month from May to September 2021.
- Assisted the NMCP to update the country's Insecticide Resistance Management Plan in late 2020. Supported and participated in a validation workshop in February 2021 resulting in the full ratification of the plan by the Ministry of Health and NMCP. PMI VectorLink also collaborated with the NMCP to organize and participate in two other Vector Control Committee meetings in the reporting period.
- Conducted insecticide susceptibility testing to assess *An. gambiae* s.l. resistance status (and resistance intensity and synergism when pyrethroid resistance was confirmed) using WHO test kits and CDC bottle assays in five new insecticide resistance entomological sites (Gazawa, Garoua, Mada, Mogode, and Touboro) in August–September 2021.
- PMI VectorLink supported the development of national ITN continuous distribution guidelines with the NMCP. During a workshop facilitated by PMI VectorLink in December 2020, results of a NetCalc exercise on ITN estimations and use of the ITN distribution channel selection tool were presented and informed the guidelines. The project printed and disseminated 2,000 copies to the central and regional levels, and supported the training of 92 North and Far North Region health care workers on the new guidelines.

- Conducted quarterly ITN continuous distribution supervision visits in the North and Far North in collaboration with the regional NMCP, monitored routine ITN distribution data in the DHIS2, and conducted a data audit to follow up on identified issues. PMI VectorLink also produced net inventory management tools (e.g., delivery notes, stock cards) for 670 health facilities in the North and Far North and supported district data validation meetings in November 2020 and January 2021 in the two regions.

1.7 CÔTE D'IVOIRE

TABLE 3: PMI VECTORLINK CÔTE D'IVOIRE VECTOR CONTROL AT A GLANCE

IRS	**Dates and duration of PMI-supported IRS campaign**	August 2–September 4, 2021 30 operational days		
	Number of districts covered by PMI-supported IRS	2 (Sakassou, Nassian)		
	Insecticide(s)	SumiShield 50WG (7,908 units) and Fludora Fusion WP-SB (15,457 units)		
	IRS results	Structures sprayed: 60,496	Structures found: 62,551	Spray coverage: 96.7%
	Population protected by PMI-supported IRS	Total: 201,178	Pregnant women: 5,008	Children < 5: 32,068
	Number of people trained with U.S. govt. funds to deliver IRS	268 including 31 women (12%)		
ITN	**ITN distribution channel(s) and dates of distribution**	National mass campaign April 2, 2021–May 2, 2021		
	Number of districts included in distribution	11 districts: Abengourou, Bouaflé, Koro, Ouaninou, San-Pédro, Sinfra, Touba, Vavoua, Yamoussoukro, Yopougon East, Yopougon West		
	Number of ITNs distributed	Distributed by PMI VectorLink: 3,074,527	Distributed by partners with PMI VectorLink support: 0	
	Type and brand of ITNs Distributed	ITN types distributed: PBO	ITN types distributed: N/A	

1.7.1 PROGRAM HIGHLIGHTS

- PMI VectorLink Côte d'Ivoire conducted the IRS campaign for the second year, in the same two districts as in 2020, Sakassou and Nassian. The project learned lessons from the previous campaign and put in place a tailored information, education, and communication approach to engage local authorities and community leadership in mobilizing their communities to accept IRS. The community expressed satisfaction with the first campaign, which contributed to the even higher IRS coverage in 2021 (96.7%) than in 2020 (91.9%).
- Conducted a series of trainings for NMCP personnel, the National Vector Control Steering Committee, national and regional environmental agents, and community IRS actors. The trainings focused on specific skills for each component of IRS (supervision, logistics, M&E, and SBC). In total the project trained 268 people including 31 women (12%).
- Introduced cost reduction initiatives in for IRS sustainability, such as increasing daily spray targets for Spray Operators based on 2020 performance (from 7.5 to 10.5 average structures per day), and consequently reduced the number of Spray Operators from 278 in 2020 to 194 in 2021. This reduction in Spray Operators also resulted in fewer vehicles and in savings on fuel. The project was able to achieve further cost savings from transportation by introducing a rotation system for shorter distances and conducting all one-day trainings directly at operations sites.
- Collaborated with the NMCP and the Regional Environment Directorate to inspect 23 facilities used for IRS (20 storerooms, two district warehouses, and one central warehouse) to ensure alignment with the PMI Best Management Practices. The 2021 IRS campaign was observed by an independent environmental compliance operations support (ECOS) auditor whose report commended the project for the rigorous implementation of IRS in compliance with USAID and national environmental

regulations and stringent COVID-19 prevention measures to protect all actors and beneficiaries. In addition to incineration of all insecticide-contaminated waste, the project worked with the United Nations Children's Fund to recycle plastic materials into bricks for school construction.

- Supported the distribution of 3,074,527 PBO ITNs to 5,479,980 people and 1,017,457 households in 11 districts, representing 96.31% and 94.81% of the people and households registered, respectively.
- Helped mobilize 9,524 community-based volunteers and mobilizers (3,767 women and 5,757 men) and 443 supervisors (80 women and 363 men) at various health systems levels to facilitate ITN distribution.
- Designed an ITN durability monitoring study covering two ITN brands in two sites (Abengourou department: PermaNet 3.0; Aboisso department: IG2), and began in-person fieldworker training, to be completed along with data collection in Year 5. PMI VectorLink also began planning for a continuous distribution assessment, which was implemented in October 2021.
- Conducted longitudinal entomological vector surveillance in four sites: Nassian, Sakassou (IRS districts), Béoumi, and Dabakala (control), and vector susceptibility tests in 18 sites (Abengourou, Abidjan, Aboisso, Bouaké, Bouna, Daloa, Gagnoa, Korhogo, Man, Odienné, San Pedro, Yamoussoukro, Nassian, Sakassou, Béoumi, Dabakala Gagnoa, and Jacqueville) through subcontractor CSRS and in collaboration with the three national research institutes. Residual life assessment of the 2020 IRS campaign was conducted from September 2020 to July 2021. Quality assurance of 2021 IRS operations was done in August 2021 and residual efficacy will be followed until mortality falls under 80% for two consecutive months.
- Developed interactive dashboards summarizing malaria case incidence, 2020 IRS campaign coverage, entomological indicators, climate data, Health Management Information System data quality, and the impact of COVID-19 on routine data sources to support the 2021 IRS campaign evaluation.
- Conducted a field audit of routine health facility data collected over a 24-month period in 19 health facilities in four districts (Sakassou, Nassian, Béoumi, and Dabakala) in preparation for the 2021 IRS campaign evaluation. The audit revealed low data completion rates for rapid diagnostic test results and confirmed malaria cases between June and November 2020, as the result of rapid diagnostic test stockouts at health facilities during this time.
- Supported the enhancement of entomological capabilities through insectary and facility rehabilitations – rehabilitation of Centre d'Entomologie Médicale et Vétérinaire laboratory animal shelter, and ongoing rehabilitation of Institut National d'Hygiène Publique insectary and the polymerase chain reaction (PCR) machine – and micropipettes purchased for Institut Pierre Richet, enabling local research institutes to increase the breadth and quality of vector control monitoring activities in compliance with international standards, and better support the vector control unit in planning appropriate vector control interventions.

1.8 Democratic Republic of the Congo

1.8.1 Program Highlights

- Conducted entomological activities through the National Institute of Biomedical Research in 12 provinces (Equateur, Haut Katanga, Haut Uele, Kinshasa, Kongo Central, Lomami, Mai-Ndombe, Mongala, Nord Ubangi, Sankuru, Sud Kivu, and Tshuapa).
- Conducted longitudinal entomological monitoring monthly in three sites: Inongo (Mai-Ndombe) Kimpese (Kongo Central), and Sankuru (Lodja).
- Conducted insecticide susceptibility testing with permethrin, deltamethrin, and alpha-cypermethrin in 12 provinces at one sentinel site per province. Pyrethroid resistance intensity, PBO synergist assays, and susceptibility tests with chlorfenapyr were conducted in seven sites to aid decision making regarding the type of nets to purchase for future ITN campaigns.
- Conducted the baseline survey for the comparative evaluation of standard (PermaNet 2.0) and dual-treated (PermaNet 3.0) ITN efficacy in Sud Ubangi, which included entomological and ITN bio-efficacy monitoring.

- Conducted baseline durability monitoring of ITNs distributed in Tanganyika Province.
- Conducted biannual monitoring (dry and rainy season) of reported and observed household net use in Tanganyika Province.
- Supported the National Institute of Biomedical Research in managing the insectary, including maintenance of the susceptible reference colony of *An. coluzzii* in Ngousso, ensuring that all activities in the insectary follow standard protocols.
- Conducted laboratory analyses of a subsample of malaria vectors from all sites where insecticide resistance and vector bionomics monitoring is conducted. Tests include mosquito species identification, detection of sporozoites, and presence of molecular markers of insecticide resistance.
- Supported the NMCP's biannual Vector Control Working Group workshop, to facilitate review of country data and inform vector control decision making.

1.9 ETHIOPIA

TABLE 4: PMI VECTORLINK ETHIOPIA VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	**Benishangul-Gumuz Region**: May 5–June 4, 2021 (26 operational days) September 16–20, 2021 (5 operational days) **Gambela Region:** May 17–June 4, 2021 (17 operational days) **Oromia Region:** May 5–June 4, 2021 (up to 20 operational days per district) **Amhara Region**: July 5–30, 2021(up to 20 operational days per district)		
	Number of districts covered by PMI-supported IRS	37: Benishangul-Gumuz (10), Gambela (14), Oromia (7), and Amhara (6)		
	Insecticide(s)	Actellic 300CS (88,905 units), SumiShield 50WG (46,714 units), and Fludora Fusion WP-SB (16,806 units)		
	IRS results	Structures sprayed: 604,921	Structures found: 637,138	Spray coverage: 94.9%
	Population protected by PMI-supported IRS	Total: 1,618,765	Pregnant women: 50,137	Children < 5: 221,612
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 3,430 (824 female, 24% female)		

1.9.1 PROGRAM HIGHLIGHTS

- In 2021, PMI VectorLink expanded IRS support to a fourth regional state, Amhara, and implemented IRS in six new districts, protecting an additional 608,301 people from malaria. A total of 98 soak pits were required for this operation to accommodate community-based IRS, the approach best suited to the operating environment.
- Sprayed 604,921 out of 637,138 structures found, achieving a coverage rate of 94.9% and protecting 1,618,765 people.
- Conducted the 2021 IRS campaign under an extremely challenging security situation, forcing the project to exclude two zones in Benishangul-Gumuz and a few other *kebeles*. In all areas, the PMI VectorLink Team administered daily check-ins with the local administration and police in the three regions to keep teams safe.
- Scaled up use of clothianidin insecticides following a pilot in 2020, which indicated a residual life of at least six months. In 2021, SumiShield 50WG was sprayed in nine districts in Benishangul-Gumuz and four districts in the Horo-Guduru zone of Oromia. Fludora Fusion was sprayed in three districts in West Guji zone of Oromia.
- Supported Ministry of Agriculture in developing guidelines for pesticide registration, monitoring, importation, distribution, and use. The tool will help reduce unnecessary accumulation and eventual expiration of pesticide.

- Developed an IRM plan, which includes rotation schedules for organophosphate and neonicotinoid insecticides used for IRS in different regional states, to be used for insecticide procurement planning.
- Continued to build the IRS capacity of key government staff at the federal, regional, zonal, and district levels in four non-PMI regions (Afar, Amhara, Somali, and Southern Nations, Nationalities, and Peoples' Region) through training and supervision programs. The project also provided technical support and material support to 63 graduated districts in Oromia Region.
- An ECOS external compliance auditor observed the 2021 campaign and reported that the project is complying with the PMI best management practices manual in safeguarding spray actors, beneficiaries, and the environment from insecticide contamination.
- Evaluated the quality of IRS and decay rate of Actellic 300CS in Dera, Fogera, Jawi, Lare, Metema, and Quara Districts, Fludora Fusion WP-SB in Abaya and Gelana Districts, and SumiShield 50WG in Abe-Dongoro and Menge Districts. In the first week after spraying, all three insecticides killed 100% of insectary *Anopheles arabiensis* in all districts except Abe-Dongoro, where the mortality ranged from 84% to 91%. Mortality of *An. arabiensis* continues to exceed 80% at four months post IRS in all sites.
- Conducted longitudinal vector surveillance and collected data on mosquito abundance and behavior in Abaya, Bambasi, Benatsemay, Jabitehnan, Lare, Metema, and Salamago. *An. arabiensis* was the dominant species in five of the seven sites. *An. pharoensis* in Lare and *An. coustani* in Bambasi outnumber *An. arabiensis*.
- Conducted monthly surveillance of *An. stephensi* larvae in two sites and adults in one site. No adults were captured from adult surveillance. The density of larvae ranged from the lowest, 0.32 *An. stephensi*/dip/day, to 8.3 *An. stephensi*/dip/day.
- Conducted clothianidin susceptibility tests for *An. arabiensis* in two sites and *An. stephensi* in three sites.
- Investigated the presence of *An. stephensi* in seven urban sites in central and eastern Ethiopia, out of which three were positive for presence. The project team participated in a virtual regional workshop in March 2021, a webinar on *An. stephensi* in August 2021, and a conference in Djibouti organized by the Controlling Emergent *Anopheles stephensi* in Ethiopia and Sudan project in September 2021.
- Developed interactive dashboards and an evaluation report summarizing case incidence, vector control coverage, and descriptive analyses of the impact of IRS for the 2015 to 2019 campaigns in Benishangul-Gumuz and Gambela. The evaluation found that each 10% increase in the population protected by IRS was associated with a 7.2% lower malaria case incidence.
- Finalized the protocol and began the study to assess the impact of PBO ITNs compared to the combined intervention of IRS plus standard pyrethroid ITNs, and received approval from Abt Associates, the PATH Research Determination Committee, and Amhara Public Health Institute Research Ethics Review Committee.
- Trained 46 staff of the National Malaria Elimination Program (NMEP), universities, public health institutes, and district health bureaus in entomological monitoring methods. In addition, 71 community mosquito collectors and supervisors were trained for the IRS/PBO study.
- Continued to provide technical and material support to 11 universities (Addis Ababa, Arba Minch, Assosa, Debre Markos, Dilla, Dire Dawa, Gondar, Jigjiga, Jimma, Mekelle and Wollega), Armauer Hansen Research Institute, and Amhara Public Health Institute.

1.10 GHANA

TABLE 5: PMI VECTORLINK GHANA VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	March 23–May 4, 2021 30 operational days
	Number of districts covered by PMI-supported IRS	9 (Bunkpurugu-Nakpanduri, East Mamprusi, Gushegu, Karaga, Kumbungu, Mamprugu Moaduri, West Mamprusi, Tatale-Sanguli, and Yunyoo-Nasuan)

ITN	**Insecticide(s)**	Fludora Fusion WP-SB (36,145 units)and SumiShield 50WG (38,198 units)		
	IRS results	Structures sprayed: 329,838	Structures found: 364,469	Spray coverage: 90.5%
	Population protected by PMI-supported IRS	Total: 928,692	Pregnant women: 20,118	Children < 5: 156,671
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 920 (273 female, 29.7% female)		
	PMI VectorLink technical assistance to ITN distribution channel(s) and dates of distribution	School-based distribution: October–December 2020		
	Number of districts included in distribution	15 regions, 235 districts		
	Number of ITNs distributed	Distributed by PMI VectorLink: 0	Distributed by partners with PMI VectorLink support:* 1,175,249	
	Type and brand of ITNs distributed	ITN types distributed: N/A	ITN brands distributed: PermaNet 3.0	

* PMI VectorLink Ghana provided technical support to the NMCP for ITN distribution to health facilities, District Education Departments for ITN distribution to schools, and the ongoing national mass distribution campaign, but it did not manage direct distribution of these ITNs. This figure does not count toward PMI VectorLink Monitoring and Evaluation indicator 1.1.8, which captures ITNs that PMI VectorLink delivers to a distribution point.

1.10.1 Program Highlights

- Engaged 282 community health nurses to support the spray campaign by mobilizing communities alongside spray teams and addressing issues of refusal in households in their Ghana Health Service-assigned communities. This represents an 83% increase in recruiting this cadre of workers since the last spray campaign.
- Continued spraying in animal shelters in five IRS districts to target vectors known to rest on the walls of these structures and continued to monitor vector resting behavior.
- Successfully implemented first-time mobile data collection across all districts, with minimal challenges, resulting in faster access to data to guide real-time campaign decisions.
- Connected 11 of 12 operations facilities that lacked electricity to the electric grid, enabling successful operations including daily charging of the mobile devices used for data collection and supervision during the spray campaign.
- Recycled 1,820 kg of obsolete paper data collection cards and packaging card boxes, and incinerated 1,373 kg of various contaminated plastic waste generated during the spray campaign.
- Conducted spray quality tests, which showed 100% mortality of exposed mosquitoes at 1-3 days after spraying of SumiShield 50WG and Fludora Fusion WP-SB, indicating high spray quality.
- Completed insecticide susceptibility bioassays across the project districts, which have newly detected resistance of the main vector to pirimiphos-methyl, the active ingredient of Actellic 300CS in 11 sites across six IRS and one non-IRS district. This is in addition to one site in East Mamprusi district with identified resistance in 2020. Vectors remain susceptible to clothianidin, the active ingredient of SumiShield 50WG and Fludora Fusion WP-SB.
- Conducted monthly entomological monitoring activities in eight PMI VectorLink Project districts and started data collection in four additional entomological surveillance sites as part of the national entomological monitoring led by the NMCP.
- Piloted a mobile platform for entomological data collection.
- Provided technical inputs to the NMCP and WHO to finalize the national entomological database on the DHIS2 platform.

- Developed a plan for equipment capacity enhancement for the entomology unit of the Biomedical Science Department of the Navrongo Health Research Center in northern Ghana.
- Trained 2,364 Ghana Education System employees from 233 districts to plan and implement school-based ITN distribution. As part of the exercise, supervised and monitored ITN distribution to 1,175, 249 pupils in 26,488 private and public schools in 235 districts.
- Conducted monthly analysis of DHIS2 ITN data on distribution of nets through antenatal and child welfare clinics to share as part of feedback interactions with the district health teams, and carried out peer-to-peer mentorship activity where health staff from high-performing health facilities are trained to provide supportive supervision to underperforming facilities in the same district.
- Engaged local nongovernmental Total Family Health Organization, which recruited and trained 175 ITN champions among midwives and nurses from 114 health facilities in five districts of Central Region to promote ITN use and care in health facilities (antenatal and child welfare clinics) and communities during outreach and home visits.
- Completed 36-month ITN durability monitoring data collection. In March 2021, the project trained field data collectors and supervisors. Data collection in Nanumba South and Zabzugu Districts was completed the following month. The final report is pre-approved, and the team awaits the results of the net chemical analysis to be completed by CDC Atlanta for completion of the report.
- Observed the project-wide COVID-19 mitigation guidelines[1] to ensure that IRS seasonal workers, project staff, government stakeholders, and communities were safe during the campaign.

1.11 KENYA

TABLE 6: PMI VECTORLINK KENYA VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	February 15–April 13, 2021 24 operational days		
	Number of districts covered by PMI-supported IRS	Migori and Homa Bay Counties; and 14 subcounties		
	Insecticide(s)	Fludora Fusion WP-SB (128,422 units) and Actellic 300CS (3,298 units)		
	IRS results	Structures sprayed: 497,564	Structures found: 510,797	Spray coverage: 97.4%
	Population protected by PMI-supported IRS	Total: 2,083,177	Pregnant women: 50,494	Children < 5: 244,948
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 2,462 (1,010 female, 41% female)		

1.11.1 PROGRAM HIGHLIGHTS

- Rotated insecticide in accordance with Kenya's Insecticide Resistance Management Plan 2020–2024, by spraying Fludora Fusion WP-SB.
- Conducted quality assurance cone bioassay for houses sprayed with Fludora Fusion WP-SB and Actellic 300CS, which indicated high-quality IRS application: 100% mortality of pyrethroid-resistant *An. funestus* was observed for both insecticides at the appropriate post-exposure scoring times.
- Conducted insecticide susceptibility tests for pyrethroids with and without synergist (PBO), chlorfenapyr, clothianidin, pirimiphos-methyl, and bendiocarb on malaria mosquitoes from eight counties. Performed pyrethroid intensity assays in four counties, which revealed low-to-moderate resistance intensity.
- Modified the mass mobilization strategy, adding assistant chiefs as mobilizers in addition to the community health volunteers, community health assistants, and village elders. In response to COVID-

[1] PMI VectorLink Project's Operating Standards to Reduce Transmission of COVID-19, August 2020.

19, converted the embedded mobilizer roles into sub-location mobilizer roles to intensify mobilization before the spray campaign through community gatherings; and during the campaign by accompanying spray teams while adhering to COVID-19 project and national protocols. Engagement of assistant chiefs minimized refusals that local leaders encountered.

- Intensified use of radio stations from one to eight to reach the community, as mass mobilization activities were limited due to government-imposed restrictions on gatherings.
- Conducted data collection verification, led by all supervisors at the structure level, despite COVID-19 challenges, a day after spraying in the villages. In 2021, a total of 9,867 verifications were conducted, a 52.1% increase from 2020.
- Conducted 36-month durability monitoring of DawaPlus 2.0 ITNs in Busia Subcounty and DuraNet ITNs in Kwale subcounty. Developed and disseminated a summary of results and presented the study data at the May 2021 Vector Control Committee of Experts meeting.
- Ended the PMI VectorLink Project in Kenya on September 30, 2021.

1.12 Latin America (Colombia)

1.12.1 Program Highlights

- Designed and implemented a two-armed randomized controlled trial to determine the entomological impact of ITNs and IRS on the Pacific coast of the Cauca department in Colombia in collaboration with the Ministry of Health and Social Protection and the Colombian National Institute of Health. Forty clusters were successfully selected and mapped, and a census completed prior to baseline data collection. Ten people were recruited for technical teams in Guapi and Timbiquí, and 42 field workers were hired and trained to collect mosquitoes.
- Adapted and translated into Spanish seven standard operating procedures for the Colombian context: HLCs, mosquito collection using Prokopack aspirators, insecticide susceptibility testing using CDC bottles, mosquito parity rates, *Anopheles* mosquito maintenance and rearing, and WHO cone bioassays for IRS and ITNs. In addition, the VectorLink Collect program has been successfully adapted to the needs and language of PMI VectorLink Colombia.
- Established an insectary strain of *An. albimanus* in Guapi. It has a productivity of approximately 5,000 pupae each week and is used as a susceptible strain for bioassays.
- Conducted baseline data collection between January and February 2021. A total of 160 households were sampled in a month by HLCs indoors and outdoors from 5:00pm to 7:00am. A total of 18,256 *Anopheles* mosquitoes were caught, composed of *An. neivai* (75.0%), *An. albimanus* (24.4%), and *An. apicimacula* (0.6%).
- Conducted baseline susceptibility tests using CDC bottle bioassays for deltamethrin (12.5 µg/ml), and alpha-cypermethrin (12.5 µg/ml), for two populations of *An. albimanus* and three populations of *An. neivai* mosquitoes before implementation of the vector control interventions by the Colombian Ministry of Health and the Cauca Department Health Secretariat.
- Carried out monthly entomological monitoring from April to September 2021 in the 40 clusters along Guapi and Timbiquí. Data on HLCs, Prokopack collections, parity rates, and mosquito species identification were recorded. Activities were suspended between May and July due to COVID-19.
- Established strong relationships with all stakeholders and engaged the community leaders of the study sites. Leaders have collaborated in the selection of the communities, the recruitment of field workers, and the random allocation of the treatments. A memorandum of understanding establishing the mechanisms and instruments of mutual collaboration between the Cauca Health Department's Secretariat and VectorLink Colombia was signed between the two parties.

1.13 LIBERIA

1.13.1 PROGRAM HIGHLIGHTS

- Conducted monthly vector surveillance activities in eight sentinel sites. Vector composition, behavior, and density were assessed at each site.
- Conducted CDC bottle assays in 11 sites across nine counties to assess *An. gambiae* s.l. resistance to deltamethrin and alpha-cypermethrin, and the effect of the synergist PBO on pyrethroid-resistant vectors. The vector was resistant to alpha-cypermethrin; susceptibility increased after pre-exposure to PBO, but full susceptibility was not restored, indicating that other mechanisms of resistance could also be involved.
- Conducted susceptibility tests of the vector to chlorfenapyr in eight of the nine counties targeted for insecticide resistance monitoring. *An. gambiae* s.l. was fully susceptible to chlorfenapyr in all sites.
- Resumed processing of mosquito samples using enzyme-linked immunosorbent assay in collaboration with the Liberia Institute of Biomedical Research, to determine the sporozoite rate. Procured all lab supplies required for molecular training and analysis of mosquito samples for species identification and insecticide resistance mutations diagnostics.
- Performed a pre-distribution bioassay of IG2 ITNs with susceptible lab colony for streamlined durability monitoring.
- Completed the 36-month round of standard durability monitoring of DuraNet ITNs in Lofa and Grand Gedeh counties.
- Transitioned to VectorLink Collect for data management and entered historical entomological data into the system from October 2020.
- Developed protocol for streamlined durability monitoring of IG2 ITNs in Bong and Bomi counties, with training and field implementation to begin in Year 5.
- Drafted baseline dashboards summarizing key epidemiological, entomological, and climate data, in preparation for monitoring the impact of the nationwide IG2 ITN campaign.

1.14 MADAGASCAR

TABLE 7: PMI VECTORLINK MADAGASCAR VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	November 2–December 3, 2020 24 operational days		
	Number of districts covered by PMI-supported IRS	5 (Tuléar II, Sakaraha, Betioky, Ihosy, and Iakora)		
	Insecticide(s)	Actellic300CS (12,096 units), SumiShield 50WG (14,081 units), and Fludora Fusion WP-SB (12,814 units)		
	IRS results	Structures sprayed: 197,787	Structures found: 203,028	Spray coverage: 97.4%
	Population protected by PMI-supported IRS	Total: 833,483	Pregnant women: 32,504	Children < 5: 138,031
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 948 (137 female, 14.5% female)		

1.14.1 PROGRAM HIGHLIGHTS

- Completed an evaluation of the 2017–2019 IRS campaigns in Madagascar, which found that IRS was associated with a 48% reduction in malaria incidence in the first six months after the campaigns.
- Conducted monthly entomological data collection, which showed the presence of *An. gambiae* s.l., *An. funestus* s.l., and *An. mascarensis* as malaria vectors, and *An. coustani*, a potential vector in various sentinel sites. *An. gambiae* s.l. was found to be the main vector in the East Coast (Analanjirofo), Fitovinany, Ihorombe, Menabe, and Vatovavy- South-West Regions.

- Conducted insecticide resistance monitoring in 13 selected sites across the country, including the IRS sites. Results indicated susceptibility of *An. gambiae* s.l. to pirimiphos-methyl, clothianidin, deltamethrin, permethrin, and chlorfenapyr in all sprayed and non-sprayed sites, except 5 of the 13 sites, where resistance to either deltamethrin or alpha-cypermethrin was observed.
- Conducted monthly WHO wall cone bioassays to test the residual efficacy of sprayed insecticides. The residual efficacy of Actellic 300CS was for at least four months. It was not possible to conduct testing during the fifth and sixth months after spraying, because of the country lockdown following COVID-19 security measures. For about seven months, SumiShield 50WG and Fludora Fusion WP-SB were effective.
- Conducted analysis and reporting for the 24-month round of durability monitoring, with the approved 24-month snapshot results shared with in-country malaria partners. Completed training and data collection for the 36-month round of durability monitoring. The activity monitored DawaPlus 2.0 ITNs in Bekily, Farafangana, and Maintirano Districts, and PermaNet 2.0 ITNs in Fort Dauphin District.
- Developed plan for Streamlined Durability Monitoring of PermaNet 3.0, SafeNet, and Yahe ITNs, with training and field implementation to begin in Year 5.
- Conducted the mapping of the districts of Ankazobe and Morombe to identify the appropriate *fokontany* eligible for larviciding.

1.15 MALAWI

TABLE 8: PMI VECTORLINK MALAWI VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	October 26–December 4, 2020 29 operational days		
	Number of districts covered by PMI-supported IRS	1 (Nkhotakota)		
	Insecticide(s)	Actellic 300CS (2,682 units) and SumiShield 50WG (60,851 units)		
	IRS results	Structures sprayed: 114,196	Structures found: 125,521	Spray coverage: 91.0%
	Population protected by PMI-supported IRS	Total: 453,383	Pregnant women: 10,524	Children < 5: 78,171
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 639 (295 female, 46.2% female)		

1.15.1 PROGRAM HIGHLIGHTS

- Trained 2,790 temporary workers, using PMI funds, to support IRS activities in Nkhotakota as well as in the three districts (Mangochi, Balaka, and Nkhata Bay) where IRS is supported by the Global Fund to Fight AIDS, Tuberculosis and Malaria.
- Provided two technical advisors who worked full-time to support the NMCP, World Vision International, and the Mangochi, Balaka, and Nkhata Bay DHOs with the planning, training, supervision, and close-out of IRS operations in Mangochi, Balaka, and Nkhata Bay.
- Hired 725 people as seasonal staff to support IRS; 47.2% (n=342) of whom were women.
- Worked with the NMCP, DHO, and the Environmental Affairs Department to ensure environmental compliance through inspections before, during, and after spraying in Nkhotakota District.
- Built capacity at national and district levels through trainings on IRS planning, supervision, implementation, monitoring and evaluation, and advocacy, to ensure high-quality spray.
- Conducted comprehensive longitudinal entomological monitoring activities through local partner Malaria Alert Center in 15 sentinel sites in six districts. Performed molecular lab analysis for species identification and detection of malaria parasite infection in vector mosquitoes. *Anopheles gambiae* s.l. (55.6%) and *An. funestus* (41.3%) were the dominant species identified. The overall *Plasmodium falciparum* infection rate of *An. funestus* s.l. was 3.5% and of *An. gambiae* s.l. was 1.1%.

- Conducted insecticide resistance monitoring, spray quality, and residual efficacy tests in selected sites. An. funestus s.l. and An. gambiae s.l. are fully susceptible to pirimiphos-methyl, chlorfenapyr, and clothianidin, and are highly resistant to deltamethrin, permethrin, and alpha-cypermethrin. Monthly cone assay tests confirmed that Actellic 300CS had two to four months' residual efficacy; the residual efficacy of SumiShield 50WG was 10 months. (That assessment was halted at 10 months due to the start of the 2021–2022 IRS campaign.) Despite the short residual efficacy of Actellic, preliminary analysis of HMIS data demonstrated that IRS with Actellic and SumiShield had a similar impact in reducing malaria case incidence.
- Strengthened the national Vector Control Technical Working Group (VCTWG). PMI VectorLink Malawi supported quarterly meetings that were conducted virtually amid the COVID-19 pandemic by providing support on Wi-Fi to NMCP staff and on data bundles to other VCTWG participants.

1.16 MALI

TABLE 9: PMI VECTORLINK MALI VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	June 7–July 13, 2021 (Djenné and Mopti) – 28 operational days June 28–August 10, 2021 (Bandiagara) – 29 operational days		
	Number of districts covered by PMI-supported IRS	3 (Bandiagara, Djenné, and Mopti)		
	Insecticide(s)	Fludora Fusion WP-SB (10,271 units), SumiShield 50WG (9,603 units), and Actellic 300CS (4,501 units)		
	IRS results	Structures sprayed: 61,791	Structures found: 63,907	Spray coverage: 96.7%
	Population protected by PMI-supported IRS	Total: 233,663	Pregnant women: 17,768	Children < 5: 45,249
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 238 (31 female, 13% female)		

1.16.1 PROGRAM HIGHLIGHTS

- Started the 2021 IRS campaign as scheduled on June 7, despite the delayed delivery of Fludora Fusion WP-SB, one out of the three intended insecticides, due to international supply chain disruptions related to the COVID-19 pandemic, as well as the labor strikes and the political situation in Mali in May 2021. Demonstrated adaptability and resilience, resulting in the achievement of the two-phased spray campaign.
- Successfully introduced the electronic scanning of insecticide in three pilot health areas.
- Conducted IRS quality assurance and monthly insecticide decay rate monitoring in 10 houses in each of the three IRS districts: all three insecticides yielded greater than 80% mortality from the week after spraying and every subsequent month in this reporting period on all wall types. Residual efficacy will continue to be monitored monthly until the mortality drops below 80% for two consecutive months.
- Conducted monthly entomological monitoring from July through September 2021 in the three IRS districts, Tominian (control district), and two sites in Sikasso Region: Bougouni and Selingue.
- Extended community-based surveillance using CDC-LT and PSC to all six sites in Mopti Region following the successful pilot in two sites in 2020. Six community mosquito collectors were trained on mosquito collection and morphological identification, and have conducted monthly surveillance in their communities since June 2021. This increased the number of trapping nights and decreased the security risk to the project team, resulting in enhanced data from areas that would otherwise be inaccessible to the project team. *An. gambiae* s.l. accounted for 99% of *Anopheles* collected.
- Tested 8 of 10 scheduled sites for insecticide resistance using WHO susceptibility tube tests. Resistance to pyrethroids was observed in most sites with implication of mixed function oxidases. Susceptibility to clothianidin and chlorfenapyr was recorded in all eight sites.

- Built the capacity of the NMCP and the PMI Data Specialist to develop and use integrated visualizations to support vector control decision making in Mali. Improved basic data management skills and dashboard development in Tableau through four three-hour remote training sessions. Due to COVID-19, the planned in-person intensive training has been postponed.
- Held a stakeholder meeting with the NMCP and partners to identify and collect key data sources in preparation for evaluating the impact of IG2 ITNs, then analyzed the data for inclusion in the interim report.

1.17 MOZAMBIQUE

TABLE 10: PMI VECTORLINK MOZAMBIQUE VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	October 20–November 20, 2020 35 operational days		
	Number of districts covered by PMI-supported IRS	5 districts: Maganja da Costa, Milange, Molumbo, Mopeia, and Morrumbala		
	Insecticide(s)	SumiShield 50WG (45,169 units) and Fludora Fusion WP-SB (120,183 units)		
	IRS results	Structures sprayed: 361,820	Structures found: 373,094	Spray coverage: 97.0 %
	Population protected by PMI-supported IRS	Total: 1,619,088:	Pregnant women: 85,856	Children < 5: 231,509
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 1,480 (346 female, 23.4% female)		

1.17.1 PROGRAM HIGHLIGHTS

- Supported the NMCP in the development of the IRS Manual by preparing the operations, environmental compliance supervision, and gender sections in the manual.
- Developed the 2021-2026 Mozambique Supplemental Environmental Assessment (SEA).
- Eight weeks prior to the start of the campaign, on July 30, 2020, the PMI mission informed VectorLink Mozambique that, despite a robust effort by the USAID Mozambique team and strong support from the overall project, the mission would not have the G2G agreement in place in time to allow a successful 2020 IRS campaign, due to changes in the structure of the provincial government. The project successfully completed these activities in time for the spray campaign.
- Supported the NMCP-led national TOT in Inhambane, in select sessions. The facilitation team included the PMI VectorLink Operations Manager, Regional Vector Control Manager, and Database Manager, to assist with logistics planning and distribution, design and construction of soak pits, construction of temporary training walls, and data collection.
- Provided financial and logistical support to 40 participants (31 males and 9 females) to attend the TOT training, held in Nampula City; participants were drawn from the eight IRS target districts and the province and included the district medical chief, representatives of the departments of community health and health education, malaria focal points, and district storekeepers. Training and training materials were based on the PMI VectorLink training curriculum.
- Supported entomology activities in Nampula Province, in two districts (Nampula City and Monapo) targeted for IRS, and in a non-intervention (control) district (Erati, which was replaced with Mogovolas). Nampula Provincial Health Directorate technicians performed activities under the supervision and guidance of the PMI VectorLink Nampula entomology coordinator. Activities conducted measured entomological indicators, namely malaria vector species composition, density, biting time and place, blood meal source and human blood index, infection, entomological inoculation rate, and seasonality. The vector sampling methods included PSC, Prokopack, and CDC light trap collections. Susceptibility tests were conducted in the three districts. Cone bioassays were also conducted to evaluate quality of spraying and monitor the decay rate of the insecticide after spraying in the two districts.

- Conducted mosquito collections; collections demonstrated highly diverse species composition of anophelines, which included the two main vectors *An. funestus* s.l. and *An. gambiae* s.l., collected indoors and outdoors, and whose densities were observed to generally decrease following the IRS campaign in October.
- Conducted cone wall bioassays to determine the quality of IRS in Nampula and Zambezia, suggest that spray teams demonstrated appreciable skills in the application of insecticide uniformly, resulting in 100% mortality for Fludora Fusion and SumiShield 50WG. The insecticide decay rate assessment showed that SumiShield 50WG and Fludora Fusion WP-SB lasted at least nine months.
- Performed insecticide susceptibility testing in Nampula and Zambezia; local vectors were fully susceptible to pirimiphos-methyl, chlorfenapyr, clothianidin, and bendiocarb, except in Maganja da Costa and Nampula Districts, where they were resistant to bendiocarb. Widespread vector resistance to deltamethrin, permethrin, and alpha-cypermethrin was noted. While PBO restored the vector's susceptibility to deltamethrin, lambda-cyhalothrin, alpha-cypermethrin, and permethrin at most of the sites in Zambezia, PBO did not fully restore the vector's susceptibility to pyrethroid insecticides in Nampula Province.

1.18 NIGER

1.18.1 PROGRAM HIGHLIGHTS

- Completed entomological monitoring in 15 sentinel sites selected by the NMCP between October 2020 and March 2021. The NMCP used the entomological data to update vector control tools with the introduction of IG2 and PBO nets in 2022 mass campaign and routine distribution.
- Conducted longitudinal vector surveillance in six sites (Agadez, Keita, Balleyara, Guidimouni, Gaya, and Niamey V) using HLC and insecticide resistance testing in 4 out of 15 sites planned in Year 4 using WHO test kits and CDC bottle assays.
- Supported the establishment of a susceptible *An. gambiae* Kisumu colony in Niger and trained dedicated Centre de Recherche Médical et Sanitaire (CERMES) staff to maintain laboratory colonies and ensure that all activities in the insectary follow standard protocols. As the only research institution within Niger's Ministry of Public Health, the CERMES conducted ITN cone bioassay and is now able to support the NMCP in vector control decision making.
- Supported the training of a local technician of Gaya on basic entomological methods as part of an effort to increase district-level capacity to conduct entomological monitoring activities.
- Promoted the use of the DHIS2-based VectorLink Collect database for improved entomological data monitoring, reporting, and decision making by relevant stakeholders.
- Conducted an entomological methods training for field technicians involved in the PMI VectorLink-supported entomological data collection from the CERMES and NMCP.
- Supported the adaptation of Maternal and Child Health cards to include ITN messaging and a table for capturing data on routine ITN distribution and printed 18,545 updated health cards for distribution to pregnant women during their antenatal care visits in the Dosso and Tahoua Regions.
- Coordinated with the NMCP and the PMI Impact Malaria project to organize and carry out biannual supervision of ITN continuous distribution in 95 priority health facilities in the two focus PMI regions (Dosso and Tahoua). The supervision activities carried out in November–December 2020 highlighted several weaknesses in ITN continuous distribution in certain districts, after which health facility managers were encouraged to put corrective measures in place to provide ITNs to children at their first immunization visits.
- Worked closely with the NMCP, Impact Malaria, and Breakthrough Action on reinforcement of SBC messaging by participating in an SBC material design workshop. Radio spots on ITN use were developed and translated into three languages, to be diffused in Year 5.

- Conducted analysis and reporting for the 24-month round of Olyset ITN durability monitoring in Gazaoua (in the Maradi Region) and Madaoua (Tahoua Region) and completed training and data collection for the 36-month round.
- Provided technical assistance to the NMCP and CERMES entomological technicians for the review and interpretation of entomological data to inform strategic and cost-efficient deployments of vector control interventions and to improve integrated vector control decision making.

1.19 NIGERIA

1.19.1 PROGRAM HIGHLIGHTS

- Conducted monthly vector surveillance and insecticide resistance monitoring across five sites (Akwa Ibom, Ebonyi, Oyo, Plateau, and Sokoto) and insecticide resistance monitoring only in 10 additional sites (Bauchi, Bayelsa, Benue, Bonny Island, Cross River, Enugu, Federal Capital Territory, Kebbi, Nasarawa, and Zamfara) with routine supervision from staff and the Nigerian Institute of Medical Research.
- Assisted Global Fund-supported sentinel sites through the procurement and distribution of entomology materials for surveillance and insecticide resistance activities.
- Started baseline routine vector surveillance and insecticide resistance data collection to support monitoring of the epidemiological and entomological impact of IG2 and PBO ITNs to be distributed in Kebbi and Sokoto, respectively. Conducted refresher trainings for two principal investigators, two co-principal investigators, two data entry personnel/storekeepers, and 48 Entomology Technicians from the two states prior to beginning expanded data collection.
- Completed a Health Management Information System data quality assessment in Kebbi and Sokoto to determine the suitability of this data for the evaluation of the IG2 and PBO ITN campaigns through PMI VectorLink core partner PATH. Based on these findings, PMI VectorLink then developed an evaluation plan.
- From October 2020 to February 2021, VectorLink Nigeria continued expanded entomological monitoring in Ebonyi State to support the ongoing impact evaluation led by PATH of PBO ITNs distributed in the status in November 2019. Baseline dashboards showing trends in entomological and epidemiological indicators in Ebonyi were then updated with the latest data, and an interim report on the impact of PBO ITNs one year after distribution was completed. The results suggest a promising impact of PBO ITNs on indoor and outdoor human biting rates and indoor resting densities, but no clear indication of impact on malaria case incidence.
- Supported the development of a draft national vector surveillance and insecticide resistance implementation guide, containing practical guidance as well as harmonized protocols and procedures for implementation of entomological activities by the NMEP and its partners. The guide will be reviewed and validated by key stakeholders in Year 5.
- Developed protocol for streamlined durability monitoring of IG2 ITNs planned for distribution in November 2021 in Kebbi State, with training and field implementation to begin in Year 5.
- Facilitated supplemental molecular analysis by the University of Witwatersrand on samples collected by VectorLink in Akwa Ibom that were identified as *An. hargreavesi*. Results indicated the samples belonged to the *An. marshalli* complex (of which *An. hargreavesi* is a member) but were otherwise inconclusive. In Year 5, the team plans to collect and send fresh samples to South Africa for additional identification and sequencing.

1.20 RWANDA

TABLE 11: PMI VECTORLINK RWANDA VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	August 23–September 17, 2021 20 operational days		
	Number of districts covered by PMI-supported IRS	3 (Kirehe, including Mahama Refugee Camp, Nyagatare, and Ngoma)		
	Insecticide(s)	Actellic 300CS (232,705 units)		
	IRS results*	Structures sprayed: 346,277	Structures found: 347,963	Spray coverage: 99.5%
	Population protected by PMI-supported IRS	Total: 1,340,280	Pregnant women: 19,507	Children < 5: 186,521
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 3,080 (1,555 female, 50.5% female)		

* Rwanda conducted one spray campaign in Nyagatare, Ngoma, and Kirehe Districts during this reporting period. The results for the Rwanda 2021 campaign are pending final End of Spray Report submission and approval.

1.20.1 PROGRAM HIGHLIGHTS

- Conducted IRS in three districts and one refugee camp, protecting 1,340,280 people from malaria. The campaign exceeded its targeted number of structures. The campaign included new COVID-19 mitigation measures.
- Redoubled messaging and enhanced supervision on underreporting of non-sprayed structures following reports of this issue.
- Underwent evaluation by the Cadmus group for environmental compliance during the IRS campaign.
- Conducted comprehensive entomological monitoring in three IRS districts (Kirehe, Ngoma, and Nyagatare) in collaboration with the MOPDD. PMI VectorLink Rwanda also performed enzyme-linked immunosorbent assay tests to assess parasite infection rate and blood meal source in a sample of mosquitoes, and PCR for identification of vectors to the species level.
- Conducted bioassays in collaboration with the MOPDD to monitor the residual efficacy of Fludora Fusion WP-SB in three IRS districts (Kirehe, Ngoma, and Nyagatare) up to July 2021. In August 2021, VectorLink Rwanda began monitoring Actellic 300CS. Tests confirmed that the residual efficacy of Fludora Fusion WP-SB was more than 11 months.
- Conducted analysis for the baseline round of durability monitoring and supported the MOPDD with reporting. Completed training, data collection, household survey data analysis, and reporting for the 12-month round. The activity monitors PermaNet 3.0 ITNs in Kicukiro, Yahe ITNs in Ruhango, IG2 ITNs in Karongi, and Olyset ITNs in Bulera. For the 12-month round, remote TOT was conducted on May 11–13, followed by in-person fieldworker training on May 17–21 and data collection from May 24–July 3. Laboratory analysis and final reporting are in progress.
- Provided capacity building of entomology technicians, accountants, and heads of health centers from 12 sentinel sites of the MOPDD on entomology techniques, data management, and proper reporting of technical and financial components.

1.21 SENEGAL

TABLE 12: PMI VECTORLINK SENEGAL VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	May 31–June 29, 2021 20 operational days in Koungheul, Koumpentoum, and Kedougou Districts 21 operational days in Makacoulibantang District
	Number of districts covered by PMI-supported IRS	4 (Kedougou, Makacoulibantang, Koumpentoum, and Koungheul)
	Insecticide(s)	SumiShield 50WG (34,381 units) and Fludora Fusion WP-SB (11,966 units)

ITN	**IRS results**	Structures sprayed: 141,717	Structures found: 145,870	Spray coverage: 97.2%
	Population protected by PMI-supported IRS	Total: 556,620	Pregnant women: 13,445	Children < 5: 99,323
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 915 (227 female, 24.8% female)		
	ITN distribution channel(s) and dates of distribution	Public sector through health facilities, and community through community-based organizations October 1, 2020–September 20, 2021		
	Number of districts included in distribution	14 regions (Dakar, Kaffrine, Kaolack, Fatick, Ziguinchor, Sedhiou, Diourbel, Thies, Kolda, Tambacounda, Kedougou, Saint Louis, Matam, Louga)		
	Number of ITNs distributed	Distributed by PMI VectorLink: 10,015	Distributed by partners with PMI VectorLink support: 1,483,300	
	Type and brand of ITNs distributed	ITN types distributed: Pyrethroid-only (1,483,300), PBO (10,015)	ITN brands distributed: Olyset	

1.21.1 Program Highlights

- Organized National IRS Planning Workshop on March 3, 2021 and completed advocacy visits from March 16 through March 19, 2021.
- Completed the procurement of IRS commodities, training of actors, and hiring of seasonal workers in preparation for the campaign. Communication activities were primarily carried out by the NMCP.
- Implemented an M&E system based on two mobile phone applications, one for spray performance data and the other for supervision-related data, allowing real-time data review and increasing data quality.
- Completed procurement of equipment for the University of Cheikh Anta Diop laboratories, and established a new insectary space.
- Conducted cone bioassays to assess the quality of IRS in two sprayed villages in each IRS district within two to four days of receiving IRS. The results of bioassays indicated that the structures were adequately sprayed in both districts, with 100% mortality recorded between one and four days on both wall types.
- Conducted entomological monitoring in 31 sites across 19 districts of the country through PSCs, HLCs, and insecticide susceptibility testing. Six *Anopheles* species were collected during the monitoring; *An. gambiae* s.l. was the predominant vector collected in all sites except in Ndoffane, where the prevalent species was *An. funestus* s.l. Both *An. gambiae* s.l. and *An. funestus* s.l. bite more outdoors than indoors. *An. gambiae*, *An. arabiensis*, *An. coluzzii,* and *An. melas* were the species of the *An. gambiae* complex collected, with *An. arabiensis* as the predominant species in the country except in the Sudano-Guinean zone, where *An. gambiae* was predominant.
- Supported the NMCP's nationwide continuous distribution of ITNs through technical assistance and distribution to regions and select districts.
- Organized joint supervision with the NMCP visit to monitor the routine ITN distribution program; visited 11 regions, 53 DHOs, and 243 health facilities.
- Distributed PBO ITN to households s across seven health posts in Tambacounda District from October 14 to November 23, 2020, with support from PMI and the NMCP, as part of a PMI core-funded mass drug administration (MDA) operational research study.

1.22 SIERRA LEONE

TABLE 13: PMI VECTORLINK SIERRA LEONE VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	May 8–June 9, 2021 22 operational days		
	Number of districts covered by PMI-supported IRS	2 (Bo and Bombali)		
	Insecticide(s)	SumiShield 50WG (48,889 units)		
	IRS results	Structures sprayed: 150,895	Structures found: 160,919	Spray coverage: 93.8%
	Population protected by PMI-supported IRS	Total: 672,696	Pregnant women: 26,604	Children < 5: 111,103
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 1,223 (313 female, 25.6% female)		

1.22.1 PROGRAM HIGHLIGHTS

- Collaborated with the NMCP and District Health Management Teams in Bo and Bombali to conduct the first-ever IRS campaign in Sierra Leone in May 2021.
- Conducted vector bionomic monitoring at 10 routine sentinel sites in five districts. *An. gambiae* s.l. was the main vector in Sierra Leone, followed by *An. funestus* s.l. *Anopheles funestus* s.l. were collected mainly in Bo and Bombali.
- Conducted insecticide resistance monitoring in 10 sentinel sites representing all regions in Sierra Leone; results indicated susceptibility of *An. gambiae* s.l. to clothianidin, pirimiphos-methyl, and chlorfenapyr. *An. gambiae* s.l. was resistant to permethrin, deltamethrin, and alpha-cypermethrin, with high resistance intensity. Pre-exposure to PBO restored susceptibility partially, indicating that mono-oxygenases are involved in conferring resistance in Sierra Leone.
- Conducted spray quality assessment in selected sites from Bo and Bombali Districts that had been sprayed with SumiShield 50WG in May 2021. Results showed that mortality of *An. gambiae* s.s. Kisumu strain in cone bioassays on walls was 100% within the standard five days post-exposure holding time.
- Continued monitoring the residual efficacy of SumiShield 50WG monthly; results show mortality of exposed mosquitoes is above the 80% threshold for four months. Monitoring will continue.
- Developed the 2021-2026 Sierra Leone Supplemental Environmental Assessment (SEA).
- Finalized the protocol to evaluate the co-deployment of IRS and PBO ITNs and received approval from Abt Associates, the PATH Research Determination Committee, and the Government of Sierra Leone Office of the Sierra Leone Ethics and Scientific Review Committee.
- Completed training, data collection, household survey, data analysis, and reporting for the baseline round of net durability monitoring. Completed training, data collection, and household survey analysis for the 12-month round. The activity monitors PermaNet 3.0 ITNs distributed in Bo, and Olyset Plus ITNs in Moyamba. Bioassays, chemical residue analysis, and final reporting are in progress for both the baseline and 12-month rounds.

1.23 TANZANIA

TABLE 14: PMI VECTORLINK TANZANIA VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	Phase 1: November 5–20, 2020 (14 operational days) Phase 2: November 23–December 21, 2020 (24 operational days) Phase 3: February 15–27, 2021 (12 operational days)		
	Number of districts covered by PMI-supported IRS	16: (Tanzania Mainland: Bukombe, Biharamulo, Kakonko, Kasulu, Kibondo, and Ukerewe; Zanzibar-Central, Micheweni, Mkoani, North A, North B, South, Urban, West A, West B, and Wete)		
	Insecticide(s)	Actellic 300CS (9,744 units), Fludora Fusion WP-SB (72,150 units), and SumiShield 50WG (83,619 units)		
	IRS results	Structures sprayed: 598,973	Structures found: 641,682	Spray coverage: 93.3%
	Population protected by PMI-supported IRS	Total: 2,285,089	Pregnant women: 82,057	Children < 5: 433,985
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 3,788 (1,725 female, 45.5% female)		
ITN	**ITN distribution channel(s) and dates of distribution**	School-based distribution: July, 2020–February 28,2021 Health facility distribution: October 1, 2020–February 28 , 2021 Hybrid facility-community distribution: October 1, 2020- February 28, 2021		
	Number of districts included in distribution	17 regions Mainland: Geita, Kagera, Katavi, Kigoma, Lindi, Mara, Morogoro, Mtwara, Pwani, Ruvuma, Simiyu, Shinyanga, and Tabora Zanzibar: North, Pemba North, Pemba South, South and Urban West		
	Number of ITNs distributed	3,592,269 School-Based Distribution: 2,253,149 Health Facility: 1,336,969 Health Facility-Community: 2,151		
	Type and brand of ITNs distributed	ITN types distributed: Pyrethroid-only (568,541), PBO (3,023,563), unknown (165)	ITN brands distributed: PermaNet 2.0 (210), PermaNet 3.0 (1,148,880), Olyset (568,331), OlysetPlus (1,874,683), unknown (165)	

1.23.1 PROGRAM HIGHLIGHTS

- Used mobile data collection for 527 Spray Operators (463 in Zanzibar, 40 in Biharamulo, and 24 in Ukerewe). The Zanzibar portion of the Year 4 campaign marked the first fully mobile IRS campaign using the DHIS2 Android capture application, demonstrating the evolution of the VectorLink Collect ecosystem and use of digital tools. This resulted in real-time data for better decision making during the spray campaign.
- Implemented IRS in line with PMI and global best practices to mitigate the risk of COVID-19. The project was able to complete all planned spray campaigns with no known cases, ensuring continuity of protection from malaria despite a global pandemic.
- Expanded the use of mobile soak pits to six sites (three in Ukerewe, one in Kakonko, and two in Pemba) to protect the environment and ensure IRS was done on all eligible islands.
- Piloted a 1:2 male to female ratio of applicants during Spray Operator recruitment. Due to low participation of women in prior years, the project encouraged qualified village women to apply, resulting in 42.1% of the seasonal workforce being female. With women overrepresented among initial applicants, the project nearly achieved a gender-balanced workforce.

- Took steps to mitigate adverse incidents involving stores management through ongoing supportive supervision, training, and adjusting the recruitment criteria to hire storekeepers better suited to perform the duties outlined in their job description.
- Supported the NMCP and the Zanzibar Malaria Elimination Program in distributing ITNs through four channels: health facilities, communities, mass campaigns, and schools. Distribution plans for ITNs equivalent to six months of stock were developed and approved by local governments, including for all 3,578 facilities in the 14 PMI-supported regions on the mainland.
- Distributed a total of 2,253,149 ITNs on the mainland through 4,065 primary schools in 39 councils in five PMI regions: Geita, Kagera, Kigoma, Mara, and Mwanza. To ensure a smooth distribution process, the project used a push short message service platform to inform all head teachers of the upcoming ITNs delivery to their schools. During the reporting period, 1,148,880 ITNs were distributed to health facilities on the mainland.
- Distributed a total of 190,240 ITNs through health facilities in Zanzibar during the reporting period, 2,151 of which were for the community channel.
- Leveraged technology as part of the ITN distribution. The team digitalized the supervision checklist used by supervisors to monitor quality of continuous distribution through health facilities on the mainland and in Zanzibar.
- Visited all 179 health facilities participating in the ITN distribution program in Zanzibar. Visits were conducted by a supervision team composed of the Zanzibar Malaria Elimination Program and PMI VectorLink. American Society of Tropical Medicine & Hygiene 2021 accepted a poster abstract reporting this data.
- Moved all meetings to virtual formats, minimized travel, and enforced physical distancing, wearing of masks, and handwashing during transport, distribution, and supervision, to ensure that distribution activities could continue in a safe manner amidst COVID-19.
- Closed out ITN activities in March 2021. The total number of ITNs distributed throughout the life of the project is 9,460,813 ITNs (5,363,533 through schools on mainland; 3,518,680 through health facilities on mainland; 244,501 through health facilities in Zanzibar; and 334,099 through the hybrid facility-community channel in Zanzibar).

1.24 UGANDA

TABLE 15: PMI VECTORLINK UGANDA VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	Phase 1: March 1–March 27, 2021 (24 operational days) Phase 2: April 26–May 22, 2021 (24 operational days)		
	Number of districts covered by PMI-supported IRS	14: 10 by PMI (Budaka, Bugiri, Butaleja, Butebo, Kibuku, Lira, Namutumba, Pallisa, Serere, Tororo) 4 by the United Kingdon Foreign, Commonwealth & Development Office (FCDO) (Amolatar, Dokolo, Kaberamaido, Kalaki)		
	Insecticide(s)	Fludora Fusion WP-SB (536,090 units)		
	IRS results	Structures sprayed: 1,294,515	Structures found: 1,387,270	Spray coverage : 93.3%
	Population protected by PMI-supported IRS	Total 4,466,905	Pregnant women: 127,711	Children <5 832,250
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 7,152 (1,484 female, 20.7% female)		

1.24.1 PROGRAM HIGHLIGHTS

- Conducted IRS in 14 districts using Fludora Fusion WP-SB with support of the Ministry of Health, district local government, subcounty leaders, and other stakeholders while strictly observing COVID-19 protocols. This campaign was successfully implemented in Uganda despite the ongoing COVID-19 pandemic, which resulted in travel restrictions and lockdowns.
- Bolstered supervision during the campaign and deployed additional district and local leaders to supervise IRS activities and mitigate misplacement of insecticide by the spray team members.
- Piloted mobile data collection in five operation sites in Bugiri District during the 2021 spray campaign as a step towards achieving real-time spray data collection on the project.
- Employed mass media including radio talk shows, radio announcements, and radio spots in consultation with the District Health Management Teams to sensitize communities on IRS and COVID-19 to promote intervention acceptance.
- Reviewed implementation status of action plans for strengthening ongoing malaria prevention and control interventions with district and subcounty leaders and other stakeholders during the malaria gains sustainability and exit meetings in districts supported by PMI and the Foreign, Commonwealth & Development Office.
- Conducted wall bioassays in seven districts (Bugiri, Butaleja, Dokolo, Kibuku, Lira, Serere, Tororo) within one week of IRS to assess the spray quality. The project recorded 100% mortality for susceptible *An. gambiae* s.s., which implies that the quality of spraying was satisfactory. Residual efficacy monitoring on surfaces sprayed with Fludora Fusion WP-SB is ongoing in four districts (Bugiri, Lira, Serere, Tororo).
- Conducted vector studies in four districts (Bugiri, Bugweri, Busia, and Tororo) to determine the preferred indoor resting sites of the major malaria vectors, *An. gambiae* s.l. and *An. funestus* s.l.
- Conducting longitudinal monitoring studies to assess the composition, density, and behavior of malaria vectors in six sentinel sites (Apac, Bugiri, Lira, Soroti, Tororo, and Otuke).
- Conducted assays in 2021 (September – October 2021) to assess the susceptibility status of *An. gambiae* s.l. and *An. funestus* s.l. to clothianidin, pirimiphos-methyl, deltamethrin, permethrin, alpha-cypermethrin, and chlorfenapyr in eight districts (Apac, Arua, Bugiri, Kanungu, Lira, Mityana, Moroto, and Tororo). Synergist assays with PBO for permethrin, deltamethrin, and alpha-cypermethrin and intensity assays for permethrin and deltamethrin are also being conducted.
- Engaged with Infectious Diseases Research Collaboration Uganda to transition the ITN durability monitoring activity begun under PMI MAPD to PMI VectorLink. Reviewed Infectious Diseases Research Collaboration-developed protocol and provided suggested revisions. Contracting and implementation for the 12-month round under PMI VectorLink are in progress in Year 5.

1.25 ZAMBIA

TABLE 16: PMI VECTORLINK ZAMBIA VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	September 29–November 18, 2020 35 operational days		
	Number of districts covered by PMI-supported IRS	15: Eastern Province (9 districts), Luapula Province (3 districts), Copperbelt Province (3 districts)		
	Insecticide(s)	SumiShield 50WG (91,426 units) and Fludora Fusion WP-SB (90,512 units)		
	IRS results	Structures sprayed: 648,914	Structures found: 672,581	Spray coverage: 96.5%
	Population protected by PMI-supported IRS	Total 2,776,336	Pregnant women: 73,959	Children < 5: 391,438
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 2,576 (1,096 female, 42.5% female)		
ITN	**ITN distribution channel(s) and dates of distribution**	Mass campaign November 1, 2020–April 1, 2021		
	Number of districts included in distribution	Eastern Province (14 districts), Luapula (12 districts), Muchinga (9 districts), and Northern (12 districts)		
	Number of ITNs distributed	Distributed by PMI VectorLink: 0	Distributed by partners with PMI VectorLink support: 2,101,403	
	Type and brand of ITNs distributed	ITN types distributed: Pyrethroid-only (1,619,376), PBO (482,027)	ITN brands distributed: Olyset (1,619,376) Olyset Plus (482,027)	

1.25.1 PROGRAM HIGHLIGHTS

- Increased the involvement of women in IRS operations to 43% of all spray team members and 35% of supervisory positions, compared to 33% and 25% during the 2019 campaign.
- Facilitated the customization and operationalization of Geo-Referenced Infrastructure and Demographic Data for Development maps, and data to inform IRS and ITN campaign planning in collaboration with PATH/MACEPA, Akros, the NMEP, and provincial/district stakeholders. The satellite-based Reveal tool was deployed during the campaign in Chadiza and Nchelenge Districts to optimize deployment of spray teams.
- Conducted environmental assessments in all 15 PMI-supported IRS districts and the necessary repairs based on the deficiencies identified. Established 17 new operations sites to reduce the number of spray operators per site and improve operational efficiency. Participated in a successful independent IRS field audit by ECOS.
- Conducted entomological surveillance following the 2020 IRS campaign; the residual efficacy of SumiShield 50WG and Fludora Fusion WP-SB was at least 10 months. The team also recorded 100% mortality of susceptible *An. gambiae* Kisumu strain on all wall surface types sprayed with the two insecticides, signifying a high-quality spray. *An. funestus* s.l. continued to be the predominant malaria vector at most sites. *An. funestus* s.l. and *An. gambiae* s.l. remain susceptible to clothianidin, chlorfenapyr, and pirimiphos-methyl.
- Provided technical assistance to the NMEP IRS campaign in environmental compliance training, monitoring and supervision of dichloro-diphenyl-trichloroethane use in Luapula, Muchinga, and Northern Provinces and of IRS in the seven urbanized Copperbelt districts, spray quality assessment in three dichloro-diphenyl-trichloroethane districts, and procurement of sprayers and personal protective equipment.
- Partnered with Mopani and Konkola Copper Mines in Copperbelt Province to strengthen their IRS monitoring, supervision, and environmental compliance protocols by sharing best practices and

providing training on tools for tracking insecticide use and storage. Contaminated solid waste from IRS in Luapula and Copperbelt Provinces was incinerated using the Mopani Copper Mine incinerator.

- Revised the interactive dashboards through core partner PATH to inform vector control product choice in Zambia, building on last year's success in integrating entomology data across partners; and facilitated the use of these dashboards during the country's Insecticide Resistance Monitoring and Management Plan Technical Advisory Committee meeting in January 2021.
- Developed programs to collect IRS and ITN campaign data within the National Malaria Elimination Center's DHIS2, provided training and support for data entry, developed interactive dashboards to visualize the combined coverage of both campaigns, and worked closely with the national vector control program staff to support data use. For the first time, the NMEP was able to view integrated visualizations showing combined coverage of IRS and ITNs based on health facility-level data.
- Supported the NMEP in drafting the end-term Malaria Program Review document, which will feed into the National Malaria Strategic Plan 2022–2026.
- Provided technical assistance to the NMEP at the national level for planning, coordinating, implementing, and monitoring of the 2020/2021 ITN mass campaign. That campaign aimed to distribute 2,072,000 ITNs procured by PMI (1.7 million standard ITNs for Luapula, Northern, and Muchinga Provinces, and 372,000 PBO ITNs for Eastern), and 4.8 million PBO ITNs across the remaining six provinces in the country. Assisted the NMEP to establish and operationalize national planning structures, produce the 2020 Net Mass Campaign Plan of Action, and implement COVID-19 mitigation measures. PMI VectorLink procured 20,000 face masks and 30,000 bottles of hand sanitizer for community-based volunteers during training, household registration, and distribution.
- Provided enhanced ITN campaign planning and implementation support at the provincial and district levels in four PMI focus provinces (Eastern, Luapula, Muchinga, and Northern). The team installed a Site Manager in each province to assist provincial and district health offices to monitor and supervise the campaign. PMI VectorLink also helped design, facilitate, and support cascade ITN campaign trainings at the national, provincial, and district levels, and provided monitoring and supervision support for all campaign stages, including training, household registration, door-to-door distribution, data collection, validation, and entry in DHIS2.
- Assisted the NMEP in establishing a national Continuous Distribution Task Team under the VCTWG to give strategic direction for effective implementation of continuous distribution activities. Facilitated the development of Terms of Reference and convening of Task Team meetings.
- Completed training and data collection for the baseline round of durability monitoring of Olyset Plus ITNs in Nyimba District and Veeralin ITNs in Serenje District distributed during the 2020–2021 mass campaign. Household survey data analysis, laboratory analysis, and reporting are in progress.
- Reinitiated the ITN Misuse Assessment put on hold in Year 4 due to COVID-19. Following approval from ERES Converge, the Zambian National Health Research Authority, and the PSI Research Ethics Board, the team completed remote TOT and in-person fieldworker training in nine selected sites in collaboration with the NMEP, Ministry of Fisheries, and the local research agency. Data collection began in September; fieldwork, analysis, and reporting will continue in Year 5.

1.26 ZIMBABWE

TABLE 17: PMI VECTORLINK ZIMBABWE VECTOR CONTROL AT A GLANCE

IRS	**Dates and length of PMI-supported IRS campaign**	November 2–December 14, 2020 36 operational days		
	Number of districts covered by PMI-supported IRS	2 (Mashonaland East Province: Mudzi and Mutoko)		
	Insecticide(s)	(Fludora Fusion WP-SB (52,728 units)		
	IRS results	Structures sprayed: 133,078	Structures found: 136,774	Spray coverage: 97.3%
	Population protected by PMI-supported IRS	Total: 315,403	Pregnant women: 4,620	Children < 5: 49,029
	Number of people trained with U.S. govt. funds to deliver IRS	Total: 319 (79 female, 24.8% female)		

1.26.1 PROGRAM HIGHLIGHTS

- Implemented a full package of IRS support in two districts in Mashonaland East Province, prioritizing the spray campaign in 18 wards in Mudzi and 28 wards in Mutoko.
- Worked with national, provincial, and district government stakeholders to conduct micro-planning meetings to most effectively review and plan for spray operations.
- Drafted and implemented mitigation measures to prevent COVID-19 during the campaign.
- Conducted gender integration training as part of all 2020 IRS trainings; 26.1% of IRS staff hired across all positions were women – the highest proportion of women since PMI started supporting IRS in Zimbabwe in 2014.
- Worked with volunteer community mobilizers in all wards to continuously engage communities to improve uptake of IRS, adequately prepare for IRS, and identify unsprayed households.
- Conducted cone bioassays to measure the quality of spraying and insecticide residual efficacy of Fludora Fusion at Kawere in Mutoko District and Dendera in Mudzi District. Mosquito mortality was still >80% at Day 5 post-exposure on four surface types (mud, brick, cement, painted cement) 10 months after spraying Fludora Fusion.
- Provided technical assistance in the national entomological assessment activities, including micro-planning (May 2021), training of data collectors (June 2021), and field collection in three districts (Mazowe, Shamva, and Centenary) in Mashonaland Central Province (June–July 2021).
- Emphasized and supervised accurate data collection and data management, through comprehensive trainings, data quality checks, and supervision at all levels during the 2020 IRS campaign.
- Conducted a data reconciliation exercise to address discrepancies in the number of mosquito samples captured in the VectorLink Collect database and the number of samples received and processed at Africa University laboratory.
- Initiated the provision of latrines, bathing rooms, soak pits, and upgraded storerooms at eight IRS campsites in Mashonaland East Province (Uzumba-Maramba-Pfungwe [UMP], Murehwa and Goromonzi) as part of the preparations for the 2021 IRS campaign, which will be led by the NMCP.
- Provided operational technical assistance to the NMCP in preparation for the 2021 IRS campaign which is being fully implemented by the Government of Zimbabwe starting in October 2021. Key areas of technical assistance before the start of the campaign include support in planning for spray operations, input in seasonal staff selection, and participating in select trainings
- Completed the construction of the insectary at Africa University which included the completion of the building, installation of utilities, and procurement of equipment and supplies to outfit the insectary.

2. CORE

2.1 COVID-19 ADAPTATIONS

PMI VectorLink continued to adapt project operations to sustain life-saving vector control activities during the COVID-19 pandemic. As necessary adjustments, project offices remained closed worldwide, staff shifted to telecommuting and virtual meetings, and travel reduced to a minimum both in country and internationally. As necessary conditions for any travel, staff were subject to mandatory PCR testing before and after to ensure safe conditions. Staff also began receiving COVID-19 vaccinations in many countries, with seven PMI VectorLink country programs achieving 100% vaccination rates among project staff.

In field settings, PMI VectorLink updated project standards developed at the outset of the pandemic to reflect the latest CDC and global guidance for COVID-19 prevention. Project standards included the mandatory use of face coverings, ensuring at least 2m (6ft) physical distancing, and encouraging vaccination for anyone participating in project activities. The project also adapted all training events, micro-planning meetings, and data entry activities to take place virtually whenever possible or outdoors or in well-ventilated spaces with necessary COVID-19 mitigation measures. Whenever cases presented during IRS, ITN, and other vector control field activities, PMI VectorLink implemented strict protocols for contact tracing, testing requirements, and quarantine and isolation mandates within the project's sphere of influence. All of PMI VectorLink's COVID-19 adaptations were included in the project's Operating Standards to Reduce the Risk of Transmission of COVID-19.

PMI VectorLink continued to show resilience with respect to overcoming supply chain barriers posed by the COVID-19 pandemic. The project's Procurement and Logistics Team worked closely with country teams to ensure adherence to stricter and longer lead times for all orders. Doing so ensured the on-time start of the 2021 spray campaigns that occurred during this reporting period with the exception of Mali. PMI VectorLink also continued to foster good working relationships with insecticide, personal protective equipment, and lab supply vendors to ensure timely delivery of supplies and prompt notices of longer lead times or logistics challenges.

2.2 VECTOR CONTROL OPERATIONS INNOVATIONS

Goizper IK Smart Light Pilot

PMI VectorLink implemented a pilot test with an updated version of the IK Smart Light during the 2021 spray campaign in Ghana. The observational study, led and partially funded by IVCC, was carried out with 150 spray operators working in six operations sites across three districts. Consistent with the findings from the Mozambique pilot conducted in 2019, there was no evidence to suggest that using the IK Smart Light significantly affected the daily output of spray operators. The findings suggested that spray operators who used the IK Smart Light's guidance system overall sprayed a slightly higher number of structures per unit of insecticide. However, the device scored poorly on durability, and spray teams spent a significant amount of time troubleshooting breakdowns.

Electronic Race to the Starting Line (RSL)

A revised and automated version of the Race to the Starting Line planning tool was rolled out across all spray countries. The automated prompts have enhanced the ability of country teams and head office backstops to keep activities on schedule, and to initiate follow-ups as needed.

Electronic Timesheet Pilot

Building off an electronic timesheet pilot implemented in Burkina Faso in 2020, PMI VectorLink expanded the use of electronic timesheets for the seasonal day laborers hired to conduct IRS campaigns in Benin, Mali, Senegal, and Rwanda. Implementing electronic timesheets during IRS reduced travel time to collect paper timesheets and the reconciliation time required for mobile money payments of thousands of seasonal workers. The electronic timesheets were implemented in each country using the existing phones or tablets

already purchased for mHealth applications at each site. Based on this pilot, PMI VectorLink intends to scale up use of electronic timesheets to all IRS countries in Year 5.

2.3 OPERATIONS RESEARCH

Experimental Hut Trial on Partial Wall Spraying of New Generation IRS Insecticides in Côte d'Ivoire

PMI VectorLink conducted an operational research study assessing the efficacy of SumiShield 50WG (neonicotinoid-based insecticide), Fludora Fusion 56.25WP-SB (mixture of neonicotinoid-deltamethrin insecticides), and Actellic 300CS (pirimiphos-methyl) when partially sprayed in experimental huts, against free-flying populations of *An. gambiae* s.l. in Tiassalé. The study evaluated two iterations of partial wall spraying – either the top or bottom half of the walls was sprayed along with the ceilings, and this was compared with full spraying and unsprayed huts. The intent was to determine whether partial spraying is a viable option to reduce the cost of IRS without compromising efficacy. All huts were sprayed in September 2020, and PMI VectorLink conducted a nine-month evaluation of sprayed surfaces. The experimental phase was completed in June 2021.

Mosquitoes entering and resting inside the huts were collected from the different locations in the huts such as the bottom half wall, top half wall, ceiling of inside of the hut, or veranda trap. Mortality was assessed at the time of collection and after a 24-hour holding period (Actellic) or up to 120 hours-(SumiShield and Fludora Fusion). In addition to the mortality of free-flying mosquitoes, the residual life of each insecticide was assessed using cone bioassays with both susceptible *An. gambiae* s.s. Kisumu strain and wild pyrethroid-resistant *An. gambiae* s.l. Tiassalé mosquitoes.

Of the 25,834 mosquitoes collected in the nine months post-spraying, 69% were *An. gambiae* s.l. Seventy-two percent of *An. gambiae* s.l. inside the huts were found resting on the bottom half of the walls, with only 11% on the top half and 14% on the ceilings. In the veranda, 58% were found resting on the bottom half, 37% on the top half, and only 5% on the ceilings. In month-by-month comparisons no significant difference was observed between fully sprayed huts and both iterations of partially sprayed huts for all three insecticides, with one exception: in the fifth month the Actellic fully sprayed treatment was superior to the "upper wall only + ceiling" partially sprayed treatment. For Actellic and Fludora Fusion WP-SB no significant difference in overall mortality was observed between any of the treatments. The mean mortality over the nine-month period was 88.5% for Actellic fully sprayed huts, 88.2% for Actellic lower wall + ceiling, and 80.8% for upper wall + ceiling. For Fludora Fusion WP-SB, an overall mean mortality of 86.3% was recorded for fully sprayed huts, 83.9% for lower wall + ceiling, and 80.9% for the upper wall + ceiling. For SumiShield 50WG, the fully sprayed treatment and the lower wall + ceiling treatment was superior to the upper wall + ceiling treatment. The overall mean mortality was 87.2% for fully sprayed huts, 85.8% for the lower wall + ceiling, and 77.1% for the upper wall + ceiling huts.

The residual efficacy, as determined by cone bioassays, of SumiShield 50WG and Fludora Fusion WP-SB was eight to nine months, whereas for Actellic it was six to seven months. No resistance to clothianidin or pirimiphos-methyl was found in *An. coluzzii,* the predominant species (99%) of the *An. gambiae* s.l. complex collected during the study.

Clustered Randomized Controlled Trial on the Impact of Partial Versus Full IRS on Malaria Burden

PMI VectorLink is planning a clustered randomized controlled trial to demonstrate the non-inferiority of partial IRS compared to full IRS, layered on existing pyrethroid-only ITN coverage, on malaria case burden. The primary comparison will be the difference in monthly malaria incidence in children in the 12 months following the intervention. Secondary outcomes include the impact of partial IRS on entomological indices; cost-effectiveness; and the community acceptance of partial IRS. A pre-RCT study of mosquito resting behavior in four Eastern Districts of Uganda was conducted in September 2021 and the full study protocol was submitted for review in October 2021. Low malaria case incidence, low mosquito density, a small effect size leading to large sample size requirements, and low frequency of ceilings in metal roof houses in Uganda led to reconsideration of the study location. Preparatory steps have been taken to shift the study to Mozambique where incidence rates are higher.

2.4 PMI VECTORLINK CORE ITN ACTIVITIES

Revisions to the ITN bioassay lab register

PMI VectorLink updated the 2020 list of laboratories in sub-Saharan Africa that have the infrastructure and human resource capacity to perform a range of tests, including tunnel tests and any other tests identified in the standard operating procedures, on various pyrethroid-susceptible and resistant mosquito strains. This included expanding the criteria that are recorded (e.g., WHO phase II experimental huts, Good Laboratory Practice status). This information was shared with the vector control community of practice to facilitate study planning, implementation, and country-supported capacity building.

Support Updating of Durabilitymonitoring.org Site and Review Supporting Study Materials

- Responsibility for the hosting and maintenance of www.durabilitymonitoring.org transitioned from Johns Hopkins University (under the previous VectorWorks contract) to PMI VectorLink.
- PMI VectorLink updated the "Tools" section on the website to disseminate Streamlined Durability Monitoring material and revised Full Durability Monitoring material, approved by PMI
- Ad hoc additional updates were also completed as they arose, including the uploading of approved final reports and links to publications from across the range of sites conducting durability monitoring.

ITN School-Based Distribution Exemplar

PMI VectorLink developed a school-based ITN Distribution Step-by-Step Exemplar. This is a consolidated, user-friendly step-by-step compendium to the 2016 Guide for National Malaria Control Programs and their partners. It explains the process, best practices, and tools needed to design and implement school-based distribution. It is available in English, French and Portuguese and is posted on the Alliance for Malaria Prevention's website, www.continuousdistribution.org and pmivectorlink.org.

Continuousdistribution.org Website

PMI VectorLink have been monitoring and updating the site with new tools and are carrying out quarterly reviews of the site's Google analytics.

Continuous Distribution Working Group

The Continuous Distribution Working Group (CDWG) was formalized in November 2020 and is co-chaired by PMI VectorLink's Senior Technical Advisor and the NMCP Manager from the Gambia. The CDWG has met three times to discuss continuous distribution issues, and held a well-attended meeting on community-based distribution on June 3, 2021. The CDWG will liaise with the Vector Control Working Group's Enhancing Impact of Core Interventions workstream to ensure harmonization and cross-fertilization of information and coordinate work plans for 2022.

Ghana COVID-19-Adapted School-Based Distribution Case Study

The VectorLink Ghana team developed a case study on the school-based distribution carried out towards the end of 2020 to add to the knowledge about net distribution during the pandemic. This was posted in English and French on the various websites mentioned previously.

2.5 MONITORING AND EVALUATION

The generation and use of high-quality data are critical priorities for PMI VectorLink. In Year 4, the project continued to enhance M&E approaches to improve quality and efficiency, including finalization of the roll-out of VectorLink Collect entomology programs, the expanded use of mobile data collection solutions, and enhanced analytics and visualization within VectorLink Collect to support data use. Several new initiatives were also launched during this reporting period, including a summary IRS data program in VectorLink Collect to facilitate data sharing with PMI's M-DIVE platform, final integration of legacy IRS and insecticide resistance datasets into VectorLink Collect to facilitate longitudinal analyses, and the design and launch of a core-funded pilot of mobile data collection for entomological data in Ghana. Significant advancements were also made in ensuring PMI VectorLink's data and digital efforts benefit the global malaria community, with ongoing collaborations with the WHO Global Malaria Team.

Robust Data Management and Analysis Using VectorLink Collect

VectorLink Collect, built on the DHIS2 platform, serves as the central, global database for PMI VectorLink. During this reporting period, VectorLink Collect was used in all 17 IRS countries for IRS data management and in 18 countries for entomological data management, as summarized in Table 18. In total, 22 PMI VectorLink countries are using VectorLink Collect programs to manage IRS and/or entomological data.

TABLE 18: USE OF VECTORLINK COLLECT FOR IRS AND ENTOMOLOGICAL DATA MANAGEMENT

VectorLink Collect Programs in Use by Country	IRS	Entomology
Angola	n/a	●
Benin	●	n/a
Burkina Faso	●	●
Cameroon	n/a	●
Colombia	n/a	●
Côte d'Ivoire	●	●
Democratic Republic of the Congo	n/a	●
Ethiopia	●	●
Ghana	●	●
Kenya	●	◊
Liberia	n/a	●
Madagascar	●	●
Malawi	●*	◊
Mali	●	●
Mozambique	●	◊
Niger	n/a	●
Nigeria	n/a	◊ (VLC planned for 2022)
Rwanda	●*	●
Senegal	●	●
Sierra Leone	●	●
Tanzania	●	n/a
Uganda	●	●
Zambia	●	●
Zimbabwe	●	●

* VectorLink Collect is also used for government-led IRS campaigns in Malawi and Rwanda.

◊ VectorLink Collect was not implemented for entomological data management in these countries due to considerations related to existing databases/systems and data management processes in each respective country.
N/A for IRS: PMI VectorLink does not conduct IRS in this country.
N/A for entomology: PMI VectorLink does not implement entomological data collection in this country.

During Year 4, PMI VectorLink prioritized several activities to enhance the VectorLink Collect system, to enable PMI VectorLink staff and selected stakeholders to use it appropriately and efficiently, and to support improved use of data for programmatic decision making. Highlights include:

- **Successfully implemented a significant DHIS2 software upgrade for VectorLink Collect ecosystem.** The VectorLink Collect system was successfully upgraded from DHIS2 version 2.31.10 to 2.35.1 in January 2021. The PMI VectorLink M&E Team and Abt Data Science, Surveys, and Enabling Technologies Team coordinated closely with BAO Systems to prepare for and implement this substantial upgrade, resulting in improved visualization functionalities and a new data entry application for the PMI VectorLink global user base.
- **Additional VectorLink Collect IRS deployment:** The project supported the deployment of VectorLink Collect for IRS data management in Sierra Leone, which sprayed for the first time in 2021.

- **Continued VectorLink Collect entomological deployment:** In Year 4, the M&E/entomology team continued to provide significant ongoing support to country teams in the nascent use of VectorLink Collect for entomological data management through five VectorLink Collect programs for vector bionomics (longitudinal monitoring), insecticide resistance monitoring, and insecticide residual life assessment. This included:
- Ongoing training, technical support, and process refinement for data entry, data cleaning and data quality review, and data analytics for PMI VectorLink teams in 17 countries for routine entomological data needs, as well as Colombia for evaluation-specific data management.
- Development of a new custom DHIS2 application for unique entomology data cleaning needs that is now being used routinely within the VectorLink Collect ecosystem.
- Development and roll-out of comprehensive standard entomological dashboards for each country. During this reporting period, 16 countries have prepared and submitted entomological deliverables using VectorLink Collect.
- **VectorLink Collect dashboard and visualization enhancements:** In Year 4, PMI VectorLink advanced several priorities for enhanced analytics and visualizations. With 22 PMI VectorLink countries using VectorLink Collect programs for IRS and/or entomological data, the project continues to make development adjustments to enhance the team's ability to use VectorLink Collect to present integrated results more effectively. These include:
    - Continued to work with a team of PMI beta testers to develop standardized analytics and dashboards for the entomology data. The agreed standard entomology dashboards are used in all 18 countries using VectorLink Collect for entomology.
    - Development and roll-out of enhanced standardized IRS Spray Progress dashboards, using new analytics features for streamlined results summaries, and a new "Live Campaign" dashboard for use in weekly updates with PMI.
    - Incorporation of updated shapefiles into VectorLink Collect to enable routine mapping. The PMI VectorLink M&E Team and Abt Data Science, Surveys, and Enabling Technologies Team conducted an extensive process during Year 4 to populate VectorLink Collect with updated shapefiles to faciliate mapping within the system.
    - With core partner PATH, developed three interactive case studies for Mali, Nigeria, and Zambia, which document PMI VectorLink's approach to supporting national malaria programs in using data and dashboards to guide national vector control decision making.
- **Collaboration with WHO:** In Year 4, PMI VectorLink continued to work closely with PMI and WHO to ensure harmonization and alignment between VectorLink Collect and the WHO DHIS2 entomological and vector control modules. More detail is provided above on collaborations related to the entomology laboratory program development. This partnership was more formally solidified this year with WHO acknowledgements in its metadata packages of PMI VectorLink contributions and engagement. Joint presentations by PMI VectorLink and WHO have been made on this collaboration through the Digital Solutions for Malaria Elimination Community of Practice in April 2021 and in the DHIS2 Symposium in September 2021. Finally, with PMI funding, PMI VectorLink supported ongoing enhancements to the WHO Metadata Sync Tool to optimize future interoperability efforts.
- **VectorLink Collect for entomological laboratory data.** In Year 4, PMI VectorLink continued discovery work on incorporating laboratory and molecular data into VectorLink Collect. During this reporting period, WHO shared progress on a new DHIS2 tracker module for laboratory data with the PMI VectorLink team, after which discovery shifted to testing the viability of using this module in the VectorLink Collect ecosystem. This discovery and alignment process is close to completion, and PMI VectorLink hopes to plan for a pilot of the laboratory program in Year 5.
- **Legacy data:** During this reporting period, PMI VectorLink finalized its compilation, cleaning, and organization of legacy data for sharing with the PMI Data Integration Team for PMI's M-DIVE platform, and for integrating into VectorLink Collect. This includes:

- **Legacy IRS data:** A new summary program was developed within VectorLink Collect, called the "End of Spray Results" program, to manage final IRS campaign results, in alignment with indicators prioritized for PMI's M-DIVE platform. The full IRS legacy data set from 2012–2018 was integrated into the End of Spray Results program in December 2020, and the program is now used to manage all final and approved IRS datasets at the district level.
- **Legacy entomological data:** PMI VectorLink has continued its efforts to compile and clean legacy entomological data for import into VectorLink Collect with a focus on legacy insecticide resistance data. The consolidated insecticide resistance dataset was cleaned and transformed to align with the approved insecticide resistance data program in VectorLink Collect. All legacy insecticide resistance and residual efficacy data from 2018–2020 was shared with PMI and integrated into VectorLink Collect in December 2020.

Expanded Use of Digital Tools and Mobile Data Collection

During this reporting period, PMI VectorLink continued to build on the important opportunities the VectorLink Collect system offers for expanding the use of mobile data collection for IRS campaigns.

PMI VectorLink successfully implemented mobile data collection in several countries during this reporting period. This year, seven countries successfully implemented full mobile data collection for IRS campaigns, including Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, Senegal, and Zanzibar. Several countries implemented a hybrid data collection approach, using a blend of paper-based and mobile solutions: Kenya, mainland Tanzania, Uganda, and Zambia. Ghana and Zanzibar's shift to full mobile data collection and Uganda's first pilot of mobile data collection for IRS data capture during their respective 2021 IRS campaigns were all successful. PMI VectorLink developed an mobile data collection video and podcast to share experiences and lessons learned from our mobile data collection implementations.

During this reporting period, PMI VectorLink also completed a core deliverable, **Summary of Mobile Data Collection Approaches,** to summarize key approaches and lessons learned in mobile data collection over the life of the project, and to present a landscaping of mobile data collection tools compatible with VectorLink Collect that would be appropriate to pilot for mobile data collection for entomology. This landscaping guided a subsequent series of development sprints to test functionalities of selected tools for entomology data needs. PMI VectorLink selected the DHIS2 Android capture application, and designed and launched a **comprehensive pilot of mobile data collection for all five entomology programs in Ghana**. In the design of this pilot, the M&E Team incorporated factors related to sustainability, development, maintenance, maturity, and customizability. The team conducted extensive workflow mapping of entomology data streams to define implications in the shift from paper to mobile, while ensuring that browser-based data entry in 17 countries remained uncompromised. This core-funded pilot is still ongoing and has been implemented in phases, as follows:

- Phase 1: Launched in June 2021 for the non-hourly mosquito collection data (Collection, Identification and Dissection program) and the cone bioassay data
    - Collection, Identification and Dissection: Six intervention sites and two control sites, with three teams of data collectors, and field laboratory assistants
    - Cone Bioassay: Six sentinel sites, with three teams of data collectors
- Phase 2: Launched in August 2021 for two insecticide resistance programs, WHO Tube program and CDC Bottle program
    - WHO Tube: Four sentinel sites with three laboratory technicians
    - CDC Bottle: Four sentinel sites with three laboratory technicians
- Phase 3: Currently in the final stages of testing for the HLC program
    - The mobile program for HLC was tested by the home office M&E Team and PMI VectorLink Ghana Teams in September 2021, in preparation for field piloting in October 2021.

The pilot has been successful to date, with very few challenges observed. Field teams have provided positive feedback on the efficiency and ease of use of the mobile programs. PMI VectorLink will synthesize final

pilot findings and recommendations by December 2021 to inform scale-up and expansion to other countries.

Complementary M&E Training Resources: With 23 PMI VectorLink countries now using VectorLink Collect for IRS and/or entomology data management, the project continues to streamline and improve efforts for data generation and use across the project, including overall system troubleshooting and support approaches. During this reporting period, the M&E Team continued to develop and update internal resources to support country teams in the use of VectorLink Collect, as well as hosting refresher and training sessions to review new or updated system functionalities.

Exploration of Complementary Vector Control Coverage Indicators

During this reporting period, PMI VectorLink explored the feasibility of using complementary measurement approaches to estimating coverage of PMI VectorLink-supported IRS interventions. In the context of stalled progress in decreasing malaria burden, malaria stakeholders need accurate information for intervention targeting, as well as standardized indicators to measure implementation quality and intervention coverage. In the global malaria community, there are varied perspectives on how to measure coverage of vector control interventions, including IRS and ITNs. Coverage indicators answer important implementation and impact-related questions. Given the mechanisms of protection from malaria offered by vector control interventions, at the individual and community level, it is critical to ensure that estimates of coverage are as accurate as possible.

A comprehensive working paper was submitted in July 2021 that included a summary of IRS coverage indicators in use across global partners, building on the recent work and supported by additional literature review. The project conducted a simple landscaping exercise to review IRS coverage indicators in use by NMCPs in project-supported countries. The team presented a review of data collection methodologies for the range of coverage indicators, including an analysis of commonly available population data sources.

Vector Control Integrated Data Analytics and Visualization Best Practice Guide

With efforts coordinated by PATH, PMI VectorLink revised the Vector Control Integrated Data Analytics and Visualization Best Practices Guide. The guide, designed to support national decision-makers and partners, was developed based on PMI VectorLink's experiences in using existing data sources for the planning, implementation, and evaluation of malaria vector control interventions. It provides indicator definitions, along with how to use and interpret the indicators, data sources, and examples of visualizations created under the project.

2.6 GENDER

Across PMI VectorLink, innovative approaches led by field-based staff advanced the project's gender mainstreaming and female empowerment goals, and the project continues to disseminate results to inform the global dialogue. Despite the added challenges of the COVID-19 pandemic, the project continues to prioritize women's equal participation in vector control activities. The network of field-based gender focal points stays in touch via WhatsApp to share ideas and discuss challenges. Many teams marked International Women's Day and International Day of the Girl with posts on social media. A few other achievements in Year 4 included:

- Welcoming and orientation of new gender focal points in Senegal and Colombia.
- Highlighting female entomologists from across the project and its partners for World Mosquito Day.
- A case study in the Malaria No More report, "Achieving a Double Dividend: The Case for Investing in a Gendered Approach to the Fight Against Malaria," featured previously published data from PMI VectorLink and the AIRS project.
- An analysis of hiring trends among permanent and seasonal staff across the first three years of the project showed that the project continued progress towards gender-balanced hiring, despite the challenges of the COVID-19 pandemic.
- Staff from multiple project countries participated in the first Women in Malaria virtual conference in March 2021.

- The project gender advisor gave a guest lecture on gender mainstreaming in IRS to a Harvard T.H. Chan School of Public Health graduate class, "Eradicating Malaria and Neglected Tropical Diseases."

2.7 Environmental Compliance and Safety

In Year 4, PMI VectorLink's Environmental Compliance and Safety Team submitted SEAs for Mali and Sierra Leone. The SEA for Mozambique was approved in March 2021. Pre-Spray Letter Reports were prepared for Benin, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Rwanda, Senegal, Tanzania, Uganda, Zambia, and Zimbabwe.

Along with other members of the PMI VectorLink Team, the Environmental Compliance and Safety Team updated and implemented standards to mitigate COVID-19 transmission during all phases of IRS implementation. The team also led the design and delivery of the third virtual regional environmental compliance workshop series with 29 government representatives from the Francophone and Lusophone countries, as well as 35 PMI VectorLink staff (not including Environmental Compliance Officers (ECOs)). The training was highly rated by participants in terms both of content and level of interaction despite the virtual platform.

Other Environmental Compliance Accomplishments in Year 4 included:

- Produced and delivered environmental compliance workshop for government representatives and ECOs for all spray countries.
- Updated and upheld standards for COVID-19 transmission mitigation during all phases of IRS.
- Instituted monthly virtual meetings of all PMI VectorLink ECOs.
- Provided intensive training to ECOs on completion of Environmental Mitigation and Monitoring Reports.
- Developed an incident tracker and filing system to record incidents, assess patterns, and recommend correction actions.
- Coordinated with Vector Control Operations to roll out serialization of insecticide sachets and bottles across all PMI VectorLink countries.
- Rolled out bar code insecticide serialization to all sites in Ghana, Senegal, Benin, Rwanda, Zimbabwe, Malawi, and Mozambique. Piloted systems at three sites in Mali, two sites in Côte d'Ivoire, four district stores in Ethiopia, and 20 sites in Uganda.
- Provided virtual support to all campaigns for the execution of IRS.
- Provided in-country support to Sierra Leone and Senegal for IRS implementation.
- Rolled out strategies for reducing congestion in end-of-day wash areas, including staggered spray team arrivals, twinning of wash areas, and use of auxiliary wash areas using mobile soak pits.
- Hired and trained new ECOs in Burkina Faso and Sierra Leone.
- Researched and developed a Pesticide Evaluation Report and Safer Use Action Plan and an Environmental Mitigation and Monitoring Plan for global USAID larviciding activities.
- Provided technical guidance in the preparation of larviciding protocols in Madagascar and Ethiopia and prepared Supplemental Initial Environmental Examinations for each country.

2.8 Conferences

The **American Society of Tropical Medicine and Hygiene 2020 Conference** was held virtually on November 15–19, 2020. Nine abstracts were accepted out of which seven were poster presentations and two were oral presentations. Nine home office PMI VectorLink staff participated (including two from PSI and one from PATH) and more than 20 staff from the field.

Several members of the PMI VectorLink M&E Team participated in the virtual **Global Digital Health Forum** in early December 2020.

The PMI VectorLink Project participated in the Vector Control Working Group's meeting, held virtually in March and April 2021. Fourteen project staff participated in the meetings. The project's Director of Vector Control, in his capacity as co-chair, co-hosted the Enhancing Impact of Core Interventions I work stream session. PMI VectorLink made two presentations. The first, by Sarah Burnett, was titled "Experience working directly with countries to support country-led national decision making processes using their available data sources." The second, by Stephen Poyer, was titled "Streamlined ITN durability monitoring."

On April 27–30, 2021, project team members participated in the Global Digital Development Summit. PMI VectorLink M&E Specialist Jillian Berkowitz and PMI VectorLink Tanzania M&E Manager Grace Murage co-presented on "Digital solutions for informed malaria prevention and decision making amid the COVID-19 pandemic in Zanzibar."

PMI VectorLink participated in the **DHIS2 Annual Conference**, on June 21–25, 2021, as well as the **DHIS2 Symposium**, on September 28–29, 2021. Both conferences were held virtually. M&E Specialist Marianne Parrish co-presented, with the Lucía Fernández Montoya of the WHO Global Malaria Program, a session entitled "Global Alignment Across DHIS2-based Systems for Integrated Vector Control Data Use" to highlight the project's important ongoing collaboration with WHO on data alignment and interoperability efforts.

2.9 COMMUNICATIONS

During this reporting period, the PMI VectorLink Project produced nine success stories, three photo stories, three case studies, three malaria fighter profiles, and one podcast. The project also produced three videos, two of which were locally-produced (Kenya, Rwanda). Forty-two Fist Bump Friday posts were sent out to project staff. The project also successfully published nine peer-reviewed journal articles[2] during the reporting period.

The Vector LearningXchange hosted three webinars: ITN School-based Distribution from Start Up to Full Scale Operations, Focusing on the Invasive *An. stephensi*, and Advancing Progress in Malaria Control. The webinars can be found here: https://www.vectorlearningxchange.com/webinars/.

The communications were posted on the project and PMI websites, promoted through the project Twitter account, and distributed via the PMI VectorLink quarterly e-letter.

The project distributed four e-letters this reporting period, in October 2020, and January, May, and September 2021, and seven e-alerts (November 2020 for the webinar, April 2021 for World Malaria Day, June 2021 for the ITN School-Based Distribution webinar and a time change announcement, August 2021 for World Mosquito Day, September 2021 and October 2021 for a Data in Decision making webinar), to reach nearly 4,000 global health professionals.

2.10 INSECTICIDE FORECASTING

In keeping with the Next Generation Indoor Residual Spray Project-negotiated two-year price-cap agreements with the three main insecticide manufacturers (Bayer, Sumitomo, and Syngenta), PMI committed to submitting consolidated insecticide forecasts.. Rather than conducting regional forecasting workshops, in the summer and early fall of 2021, PMI VectorLink country teams organized country-specific meetings between August and September 2021 with their respective vector control steering committees dedicated specifically to forecasting insecticide needs for 2022.

2.11 RISK AND FEASIBILITY ASSESSMENT: DETERMINATION OF AN APPROPRIATE RESPONSE TO THE SPREAD OF *ANOPHELES STEPHENSI* IN AFRICA

PMI VectorLink subcontracted the Imperial College in London to assess the potential impact of *An. stephensi* establishment on malaria transmission in Ethiopia, accounting for pre-existing transmission and

[2] https://pmivectorlink.org/resources/reports-and-publications/

control interventions through a mechanistic model of malaria transmission. Additionally, different illustrative scenarios were investigated, exploring the impact of different vector control interventions. While there is substantial uncertainty in what will happen if *An. stephensi* becomes fully established in Ethiopia and other areas across Africa, the estimates provided in this study highlight the need to rapidly implement surveillance and evaluate effective vector control interventions in response to this developing threat. Details are found at https://www.medrxiv.org/content/10.1101/2021.08.19.21262272v1

ANNEX A:
M&E RESULTS SUMMARY

TABLE A.1: PMI VECTORLINK SUMMARY VECTOR CONTROL RESULTS AND POPULATION PROTECTED

Country	IRS Structures Sprayed	IRS Structures Found	IRS Spray Coverage	Population Protected by IRS	Population Protected by IRS: Pregnant Women	Population Protected by IRS: Children <5	ITNs Distributed by VectorLink	Population Protected by ITNs (Estimate**)
Benin	280,237	299,800	93.5%	927,007	40,470	107,330	n/a	n/a
Burkina Faso	175,523	189,425	92.7%	586,249	31,218	120,019	n/a	n/a
Côte d'Ivoire	60,496	62,551	96.7%	201,178	5,008	32,068	3,074,527	6,149,054
Ethiopia	604,921	637,138	94.9%	1,618,765	50,137	221,612	n/a	n/a
Ghana	329,838	364,469	90.5%	928,692	20,118	156,671	n/a	n/a
Kenya	497,564	510,797	97.4%	2,083,177	50,494	244,948	n/a	n/a
Madagascar	197,787	203,028	97.4%	833,483	32,504	138,031	n/a	n/a
Malawi	114,196	125,521	91.0%	453,383	10,524	78,171	n/a	n/a
Mali	61,791	63,907	96.7%	233,663	17,768	45,249	n/a	n/a
Mozambique	361,820	373,094	97.0%	1,619,088	85,856	231,509	n/a	n/a
Rwanda*	346,277	347,963	99.5%	1,340,280	19,507	186,521	n/a	n/a
Senegal	141,717	145,870	97.2%	556,620	13,445	99,323	10,015	20,030
Sierra Leone	150,895	160,919	93.8%	672,696	26,604	111,103	n/a	n/a
Tanzania	598,973	641,682	93.3%	2,285,089	82,057	433,985	3,592,269	7,184,538
Uganda	1,294,515	1,387,270	93.3%	4,466,905	127,711	832,250	n/a	n/a
Zambia	648,914	672,581	96.5%	2,776,336	73,959	391,438	n/a	n/a
Zimbabwe	133,078	136,774	97.3%	315,403	4,620	49,029	n/a	n/a
Total	5,998,542	6,322,789	94.9%	21,898,014	692,000	3,479,257	6,676,811	13,353,622

* In this table and the figures below, an asterisk indicates that final IRS results are still under review by PMI and the End of Spray Report is not yet final.
** Note: This table only estimates population protected by ITNs for ITNs distributed by PMI VectorLink using a factor of 2.0 per ITN distributed. A summary of ITNs distributed by partners with PMI VectorLink support is provided in Table A.2 below.

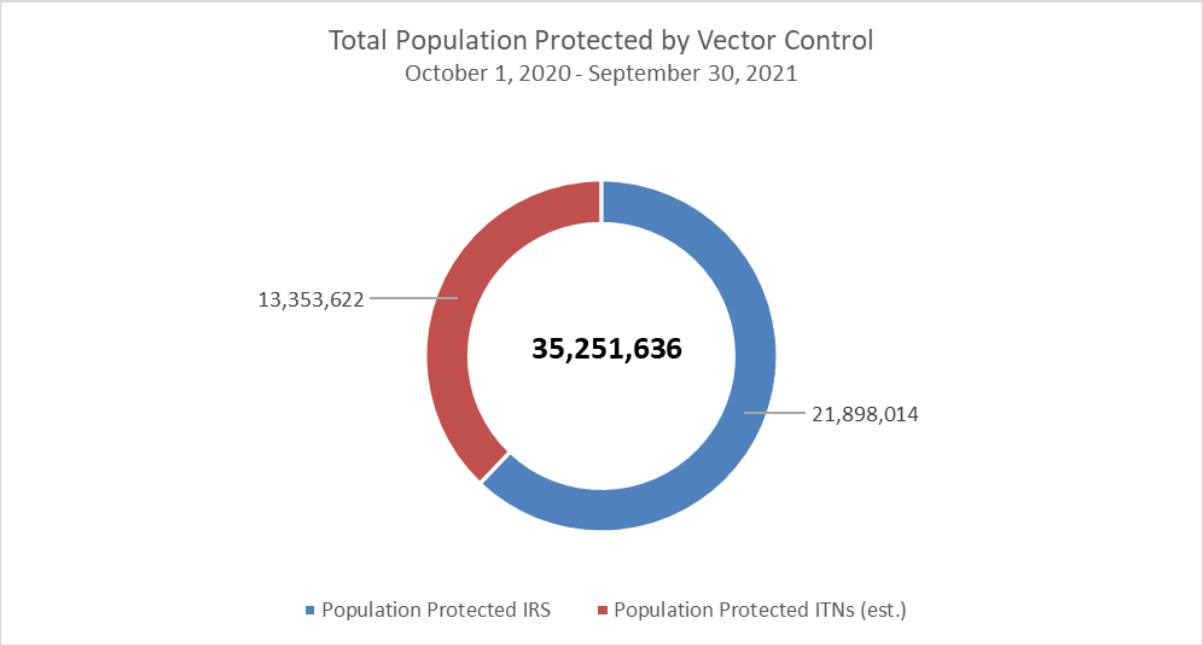
TABLE A.2: PMI VECTORLINK VECTOR CONTROL DETAILS

VectorLink Country	IRS			ITN		
	IRS Structures Sprayed	IRS Personnel Trained with PMI Funds	IRS Insecticide Used	ITNs Distributed by PMI VectorLink	ITNs Distributed by Partners with VectorLink Support	Type of ITNs Distributed
Benin	280,237	1,850	SumiShield 50WG	n/a	n/a	n/a
Burkina Faso	175,523	1,798	SumiShield 50WG, Fludora Fusion WP-SB, Actellic 300CS	n/a	n/a	n/a
Côte d'Ivoire	60,496	268	SumiShield 50WG, Fludora Fusion WP-SB	3,074,527	n/a	PBO: PermaNet 3.0
Ethiopia	604,921	3,430	Actellic 300CS, SumiShield 50WG, Fludora Fusion WP-SB	n/a	n/a	n/a
Ghana	329,838	920	SumiShield 50WG, Fludora Fusion WP-SB	n/a	9,809,536	Standard pyrethroid-only: MAGNet, Yorkool, DuraNet PBO: PermaNet 3.0 Dual active ingredient: IG2
Kenya	497,564	2,462	Actellic 300CS, Fludora Fusion WP-SB	n/a	n/a	n/a
Madagascar	197,787	948	Actellic 300CS, Fludora Fusion WP-SB, SumiShield 50WG	n/a	n/a	n/a
Malawi	114,196	639	Actellic 300CS, SumiShield 50WG	n/a	n/a	n/a
Mali	61,791	238	Actellic 300CS, Fludora Fusion WP-SB, SumiShield 50WG	n/a	n/a	n/a
Mozambique	361,820	1,480	Fludora Fusion WP-SB, SumiShield	n/a	n/a	n/a
Rwanda*	346,277	3,080	Actellic 300CS	n/a	88,400	PBO: PermaNet 3.0
Senegal	141,717	915	Fludora Fusion WP-SB, SumiShield 50WG	10,015	1,483,300	Standard pyrethroid-only: Olyset PBO: PermaNet 3.0
Sierra Leone	150,895	1,223	SumiShield 50WG	n/a	n/a	n/a
Tanzania	598,973	3,788	Actellic 300CS, Fludora Fusion WP-SB, SumiShield 50WG	3,592,269	n/a	Standard pyrethroid-only: PermaNet 2.0, Olyset PBO: PermaNet 3.0, Olyset Plus
Uganda	1,294,515	7,152	Fludora Fusion WP-SB	n/a	n/a	n/a

VectorLink Country	IRS			ITN		
	IRS Structures Sprayed	IRS Personnel Trained with PMI Funds	IRS Insecticide Used	ITNs Distributed by PMI VectorLink	ITNs Distributed by Partners with VectorLink Support	Type of ITNs Distributed
Zambia	648,914	2,576	Fludora Fusion WP-SB, SumiShield 50WG	n/a	2,101,403	Standard pyrethroid-only: Olyset PBO: Olyset Plus
Zimbabwe	133,078	319	Fludora Fusion WP-SB	n/a	n/a	n/a
Total	5,998,542	33,086	--	6,666,796	11,391,251	--

* The End of Spray Report is still under review by PMI for these countries.

FIGURE A.1.



Note: This figure estimates the population protected by ITNs only in countries where ITNs were distributed directly by PMI VectorLink (in Côte D'Ivoire, Senegal and Tanzania), using a factor of 2.0 per ITN distributed.

FIGURE A.2.

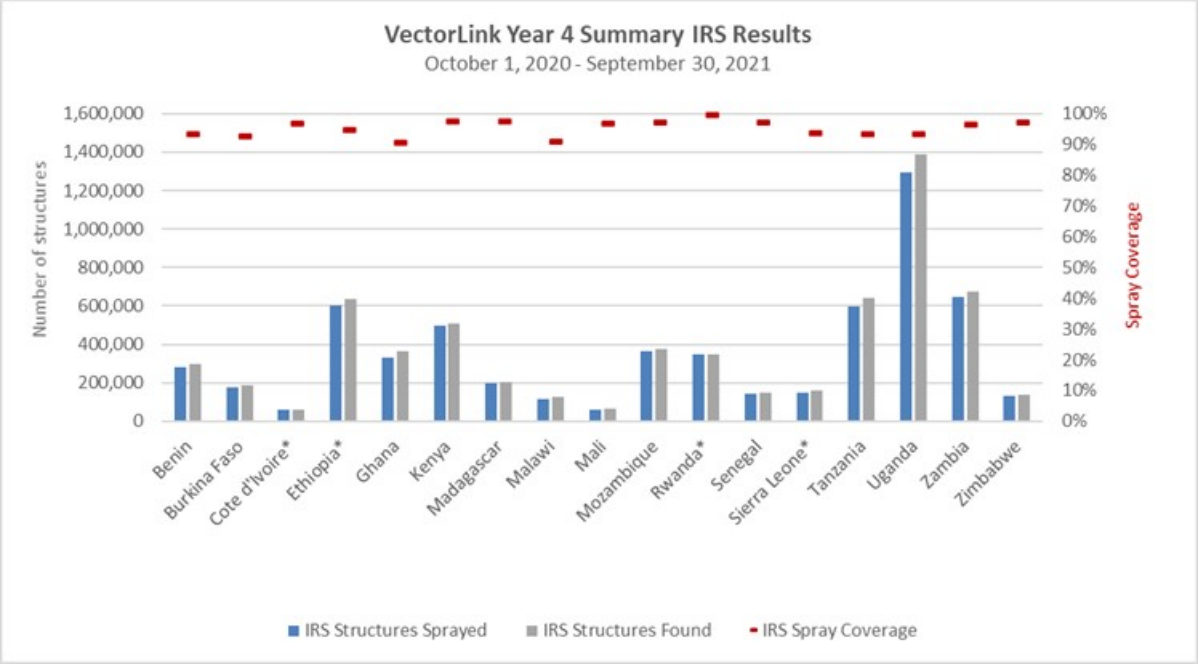


FIGURE A.3.

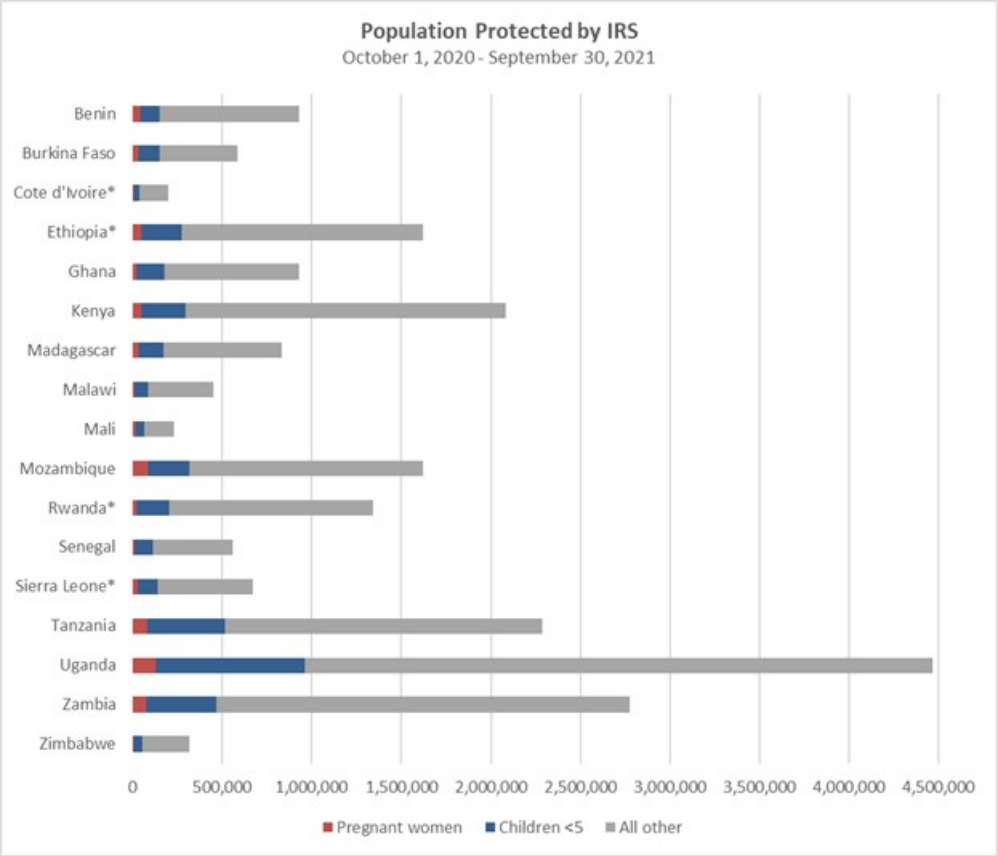
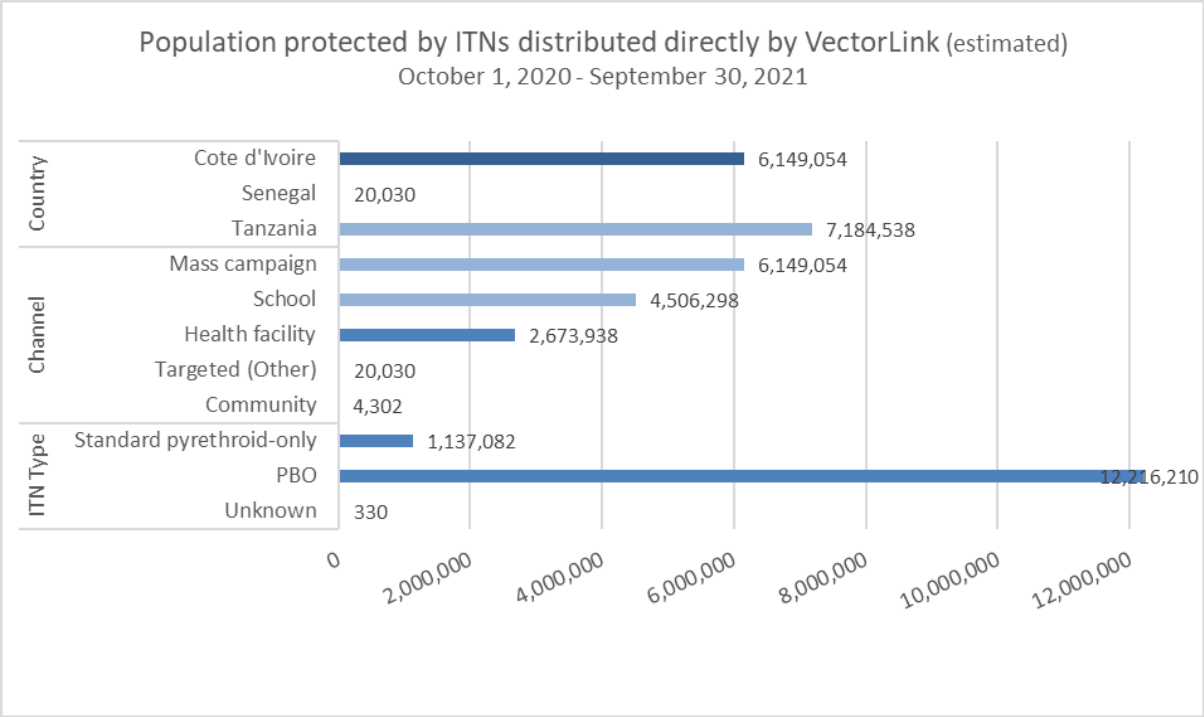


FIGURE A.4.



ANNEX B: COMMUNICATIONS

SUCCESS STORIES

- ITN Champions Aim to Increase Use of Nets – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- PMI VectorLink Mali's Collaboration with Local Leaders in IRS Ensures Communities in Bandiagara, Djenne and Mopti Districts are Protected from Malaria – The U.S. President's Malaria Initiative VectorLink Project
- Community Leaders Help to End Malaria – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- Responsible Waste – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- PMI VectorLink Study Helps Côte d'Ivoire Make Critical Decisions for the Distribution of New Generation ITNs (PBO-ITNs and Interceptor G2) – The U.S. President's Malaria Initiative VectorLink Project
- PMI VectorLink Adapts Durability Monitoring Assessment to COVID-19 Conditions – The U.S. President's Malaria Initiative VectorLink Project
- A Common Cause, PMI VectorLink's Collaboration with Communities, Civil Society, and Government Leads to Success
- Carrying on IRS in Zambia during COVID-19
- There's An App for That, Mobile Technology Improves School-Based Distribution of Insecticide-Treated Nets

PHOTO STORIES

- Women in Entomology – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- World Malaria Day 2021 – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- Celebrating International Women's Day – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)

MALARIA FIGHTERS

- PMI Malaria Fighter: Zeddy Bore – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- PMI VectorLink Malaria Fighter: Prince Owusu – The U.S. President's Malaria Initiative VectorLink Project
- PMI VectorLink Malaria Fighter Patricia Chirombo

CASE STUDIES

- Using data to mitigate the impact of insecticide resistance in Nigeria – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- Harnessing Data Visualization for Localized Vector Control Solutions in Zambia – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- Net gains for Mali: Using data to guide insecticide-treated net prioritization – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)

VIDEOS

- PMI Collaborates with Communities to Beat Malaria – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)
- PMI VectorLink Continues the Fight Against Malaria during COVID-19 Pandemic – The U.S. President's Malaria Initiative VectorLink Project
- Innovations in Mobile Data Collection – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org) (Including here as it was not included in the 2020 Annex)

PODCASTS

- Innovations in Mobile Data Collection

WEBINARS

- Advancing Progress in Malaria Control – Optimizing the Collection, Analysis and Use of Entomological Data for Vector Control
- ITN School-Based Distribution from Start-Up to Full-Scale Operations
- Focusing on *An. stephensi* in Ethiopia – The U.S. President's Malaria Initiative VectorLink Project (pmivectorlink.org)

PEER-REVIEWED JOURNAL ARTICLES & PUBLICATIONS

- Partial indoor residual spraying with pirimiphos-methyl as an effective and cost-saving measure for the control of *Anopheles gambiae* s.l. in northern Ghana, *Scientific Reports,* September 2021
- The potential impact of *Anopheles stephensi* establishment on the transmission of *Plasmodium falciparum* in Ethiopia and prospective control measures, *MedRxiv*, August 2021
- PMI VectorLink Cost Study 2020
- Determination of the discriminating concentration of chlorfenapyr (pyrrole) and Anopheles gambiae sensu lato susceptibility testing in preparation for distribution of Interceptor® G2 insecticide-treated nets (nih.gov), *Malaria Journal,* July 2021
- An update on the distribution, bionomics, and insecticide susceptibility of Anopheles stephensi in Ethiopia, 2018–2020 | Malaria Journal | Full Text (biomedcentral.com), *Malaria Journal*, June 2021
- Comparison of four outdoor mosquito trapping methods as potential replacements for human landing catches in western Kenya | Parasites & Vectors | Full Text (biomedcentral.com), *Parasites & Vectors*, June 2021
- Susceptibility of *Anopheles gambiae* from Côte d'Ivoire to insecticides used on insecticide-treated nets: evaluating the additional entomological impact of piperonyl butoxide and chlorfenapyr, *Malaria Journal*, December 2020
- Malaria vector species composition and entomological indices following indoor residual spraying in regions bordering Lake Victoria, Tanzania, October 2020, Malaria Journal