



U.S. PRESIDENT'S MALARIA INITIATIVE



PMI IRS COUNTRY PROGRAMS: 2019 COMPARATIVE COST ANALYSIS

Recommended Citation: Johns, Benjamin and Mignote Haile. May 2020. *PMI IRS Country Programs: 2019 Comparative Cost Analysis*. Rockville, MD. PMI VectorLink Project, Abt Associates Inc.

Contract: AID-OAA-I-17-00008

Task Order: AID-OAA-TO-17-00027

Submitted to: United States Agency for International Development/PMI



Abt Associates Inc. | 6130 Executive Boulevard
Rockville, Maryland 20852 | T. 301.347.5000 | F. 301.913.9061
www.abtassociates.com

PMI IRS COUNTRY PROGRAMS: 2019 COMPARATIVE COST ANALYSIS

CONTENTS

Contents	v
Acronyms	xi
Executive Summary	xiii
1. Introduction	1
2. Cross-Country Results	3
2.1 Background	3
2.2 Total Program Expenditures	3
2.3 Unit Cost Analysis	4
2.4 Cost Drivers	5
3. NgenIRS	9
4. Year-on-Year Comparison	13
5. Benin	15
5.1 Background	15
5.2 Program Expenditures	15
5.3 Unit Cost Analysis	16
5.4 Comparison between the Past Two Years	16
6. Burkina Faso	18
6.1 Background	18
6.2 Program Expenditures	18
6.3 Unit Cost Analysis	19
6.4 Comparison between the Past Two Years	19
7. Ethiopia	21
7.1 Background	21
7.2 Program Expenditures	21
7.3 Unit Cost Analysis	22
7.4 Comparison between the Past Two Years	22
8. Ghana	24
8.1 Background	24
8.2 Program Expenditures	24
8.3 Unit Cost Analysis	25

8.4 Comparison between the Past Two Years.....	25
9. Kenya	27
9.1 Background.....	27
9.2 Program Expenditures	27
9.3 Unit Cost Analysis.....	28
9.4 Comparison between the Past Two Years.....	28
10. Madagascar	31
10.1 Background.....	31
10.2Program Expenditures	31
10.3Unit Cost Analysis.....	32
10.4Comparison between the Past Two Years.....	32
11. Malawi	35
11.1 Background.....	35
11.2Program Expenditures	35
11.3Unit Cost Analysis.....	36
11.4Comparison between the Past Two Years.....	36
12. Mali	38
12.1 Background.....	38
12.2Program Expenditures	38
12.3Unit Cost Analysis.....	39
12.4Comparison between the Past Two Years.....	39
13. Mozambique	41
13.1 Background.....	41
13.2Program Expenditures	41
13.3Unit Cost Analysis.....	42
13.4Comparison between the Past Two Years.....	42
14. Rwanda.....	45
14.1 Background.....	45
14.2Program Expenditures	45
14.3Unit Cost Analysis.....	46
14.4Comparison between the Past Two Years.....	46
15. Tanzania.....	49
15.1 Background.....	49
15.2Program Expenditures	49
15.3Unit Cost Analysis.....	50

I5.4 Comparison between the Past Two Years	51
16. Uganda	53
16.1 Background	53
16.2 Program Expenditures	53
16.3 Unit Cost Analysis	55
16.4 Comparison between the Past Two Years	55
17. Zambia	57
17.1 Background	57
17.2 Program Expenditures	57
17.3 Unit Cost Analysis	59
17.4 Comparison between the Past Two Years	59
18. Zimbabwe	62
18.1 Background	62
18.2 Program Expenditures	62
18.3 Unit Cost Analysis	63
18.4 Comparison between the Past Two Years	63
References	65
Annex A: Year-on-Year Comparison of Output Measures	66
Annex B: Year-on-Year Comparison of Unit Costs	68
Annex C: Methodology	71

LIST OF TABLES

Table CC1: PMI VectorLink Project Spray Coverage in 2019, by Country.....	3
Table CC2: 2019 IRS Program Unit Costs	5
Table CC3: Breakdown of Fixed and Variable Costs, as Percentage of Unit Cost per Area Sprayed	6
Table CC4: Seasonal SOPs and Campaign Days.....	7
Table NG1: Effects of NgenIRS on Program Scale.....	10
Table YR1: Year-on-Year Comparison of Output Measures	13
Table YR2: Year-on-Year Comparison of Unit Costs.....	14
Table BN1: Benin Quick Facts	15
Table BN2: Benin IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	16
Table BN3: Benin Unit Costs	16
Table BN4: Benin IRS Program Comparison of Expenditures	16
Table BN5: Benin IRS Program Comparison of Output Measures and Unit Costs	17
Table BF1: Burkina Faso Quick Facts.....	18
Table BF2: Burkina Faso IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	19
Table BF3: Burkina Faso Unit Costs	19
Table BF4: Burkina FASO IRS Program Comparison of Expenditures.....	20
Table BF5: Burkina faso IRS Program Comparison of Output Measures and Unit Costs	20

Table ET1: Ethiopia Quick Facts.....	21
Table ET2: Ethiopia IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category .	22
Table ET3: Ethiopia Unit Costs.....	22
Table ET4: Ethiopia IRS Program Comparison of Expenditures	23
Table ET5: Ethiopia IRS Program Comparison of Output Measures and Unit Costs	23
Table GH1: Ghana Quick Facts.....	24
Table GH2: Ghana IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category....	25
Table GH3: Ghana Unit Costs	25
Table GH4: Ghana IRS Program Comparison of Expenditures	26
Table GH5: Ghana IRS Program Comparison of Output Measures and Unit Costs	26
Table KN1: Kenya Quick Facts.....	27
Table KN2: Kenya IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category....	28
Table KN3: Kenya Unit Costs	28
Table KN4: Kenya IRS Program Comparison of Expenditures	29
Table KN5: Kenya IRS Program Comparison of Output Measures and Unit Costs	29
Table MG1: Madagascar Quick Facts	31
Table MG2: Madagascar IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	32
Table MG3: Madagascar Unit Costs.....	32
Table MG4: Madagascar IRS Program Comparison of Expenditures.....	33
Table MG5: Madagascar IRS Program Comparison of Output Measures and Unit Costs.....	33
Table MW1: Malawi Quick Facts.....	35
Table MW2: Malawi IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category	36
Table MW3: Malawi Unit Costs.....	36
Table MW4: MalAWI IRS Program Comparison of Expenditures.....	37
Table MW5: MalAWI IRS Program Comparison of Output Measures and Unit Costs.....	37
Table ML1: Mali Quick Facts.....	38
Table ML2: Mali IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category	39
Table ML3: Mali Unit Costs.....	39
Table ML4: Mali IRS Program Comparison of Expenditures	40
Table ML5: Mali IRS Program Comparison of Output Measures and Unit Costs	40
Table MZ1: Mozambique Quick Facts	41
Table MZ2: Mozambique IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	42
Table MZ3: Mozambique Unit Costs	42
Table MZ4: Mozambique IRS Program Comparison of Expenditures.....	43
Table MZ5: Mozambique IRS Program Comparison of Output Measures and Unit Costs.....	43
Table RW1: Rwanda Quick Facts.....	45
Table RW2: Rwanda IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category	46
Table RW3: Rwanda Unit Costs.....	46
Table RW4: Rwanda IRS Program Comparison of Expenditures	47
Table RW5: Rwanda IRS Program Comparison of Output Measures and Unit Costs	47
Table TZ1: Tanzania Quick Facts.....	49
Table TZ2: Tanzania IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category	50
Table TZ3: Tanzania Unit Costs.....	50
Table TZ4: Tanzania IRS Program Comparison of Expenditures	51
Table TZ5: Tanzania IRS Program Comparison of Output Measures and Unit Costs	52
Table UG1: Uganda Quick Facts	53
Table UG2: Uganda IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category..	55
Table UG3: Uganda Unit Costs	55
Table UG4: Uganda IRS Program Comparison of Expenditures	56

Table UG5: Uganda IRS Program Comparison of Output Measures and Unit Costs	56
Table ZA1: Zambia Quick Facts.....	57
Table ZA2: Zambia IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category ..	59
Table ZA3: Zambia Unit Costs.....	59
Table ZA4: Zambia IRS Program Comparison of Expenditures	60
Table ZA5: Zambia IRS Program Comparison of Output Measures and Unit Costs	61
Table ZW1: Zimbabwe Quick Facts.....	62
Table ZW2: Zimbabwe IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category	63
Table ZW3: Zimbabwe Unit Costs	63
Table ZW4: Zimbabwe IRS Program Comparison of Expenditures	64
Table ZW5: Zimbabwe IRS Program Comparison of Output Measures and Unit Costs	64

LIST OF FIGURES

Figure ES1: Cost per 100m ² Sprayed 2012 through 2019	xv
Figure CC1: Capital and Recurrent Expenditures, by Cost Category.....	4

ACRONYMS

AIRS	Africa Indoor Residual Spraying
EC	Environmental Compliance
IEC	Information, Education and Communication
IRS	Indoor Residual Spraying
IT	Information Technology
M&E	Monitoring and Evaluation
NgenIRS	Next Generation IRS
NMCP	National Malaria Control Program
OP	Organophosphate
PMI	U.S. President's Malaria Initiative
PSDQA	Post-Spray Data Quality Audit
SOP	Spray Operator
STTA	Short-term Technical Assistance
TCN	Third country national
USAID	United States Agency for International Development
WHO	World Health Organization

EXECUTIVE SUMMARY

The U.S. President's Malaria Initiative (PMI) began implementing indoor residual spraying (IRS) programs in 2006, with a goal of reducing the incidence and prevalence of malaria. The Africa Indoor Residual Spraying (AIRS) Project, implemented from 2011 to 2014, the PMI AIRS Project, implemented from 2014 to 2018, and the PMI VectorLink Project, to be implemented from 2017 to 2022, together constitute PMI's pan-African IRS program. This report presents the cost analysis of the expenses incurred during 2019 and compares these costs to IRS costs from 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019.

The aim of the analysis is to:

1. Evaluate the overall level of IRS spending in each of the PMI VectorLink countries, by program activity and by cost category;
2. Calculate and compare the unit costs of IRS in each country, including the cost per person protected, cost per structure sprayed, and cost per area sprayed (per 100 m²);
3. Provide cost comparisons for overall annual expenditure trends within countries over the past eight years of PMI-supported IRS.

Costing data will support PMI and host countries in the decision-making process of planning and prioritizing future investments. Findings may also help to inform local governments in the planning, funding, management, or implementation of IRS programs.

Costs in 2019

Project output data (see Table CCI in the main report), were collected and verified by PMI VectorLink monitoring and evaluation (M&E) staff for the 14 countries with PMI-funded IRS campaigns that were implemented through the PMI VectorLink Project in 2019. In 2019, all of the countries sprayed under the auspices of the PMI VectorLink Project were also sprayed under the auspices of the project in 2018. Additionally, 2019 saw, for the first time, large-scale use of Fludora® Fusion, a new neonicotinoid insecticide using a mixture of clothianidin and deltamethrin, in six countries. In total, more than 20 million people were protected, ranging from approximately 307,209 people in Zimbabwe to more than 4.4 million people in Uganda. This corresponds to a total of about 5.47 million structures sprayed, ranging from 107,565 structures in Malawi to 1,291,569 structures in Uganda, with a total of more than 453 million square meters (m²) of structures sprayed, and more than 1.8 million units of insecticide used.

The average structure size varied across countries, ranging from 39.9 m² in Benin to 186.8 m² in Rwanda. The average people per structure sprayed ranged from 2.3 people in Zimbabwe to 4.7 people in Mali.

Table CC2 presents the results of the unit cost analysis. The overall unweighted average cost per person protected is \$6.19. The unweighted average cost per structure sprayed across countries is \$21.86. The unweighted average cost per 100 m² sprayed is \$26.31. On average costs increased by 6% per person protected, 5% per structure sprayed and 3% per area sprayed. This year's percent increase is slightly less than the increases reported in last year's report comparing 2017 and 2018 (Johns, Cico Sitruk. 2019). Largest increases in the cost per person protected and per structure sprayed were incurred in Burkina Faso, Madagascar, Malawi, and Zambia. In all four countries, fewer structures were sprayed and fewer people were protected in 2019 than in 2018. Costs decreased across the two years only for Madagascar (although not as much as the decrease in outputs), and increased by 2%, 7%, and

15% for Burkina Faso, Zambia, and Malawi, respectively, for the two years. The reasons for cost increases are discussed in the relevant country chapter.

Country program expenditures were divided into six cost categories: insecticide, spray commodities, spray operations, full-time local labor, local administration, and U.S.-based labor and short-term technical assistance. Details on the types of expenditures included in each cost category can be found in the 2014 report (Abbott and Johns 2014). The three largest cost categories were spray operations (33.7 percent of all costs), insecticide (32.1 percent of all costs), and local labor (18.9 percent of all costs), constituting an average of 84.7 percent of all costs. The lowest cost categories were U.S. labor and short-term technical assistance (STTA) (4.3 percent of all costs), non-insecticide commodities (3.8 percent of all costs) and local administration (7.2 percent of all costs).

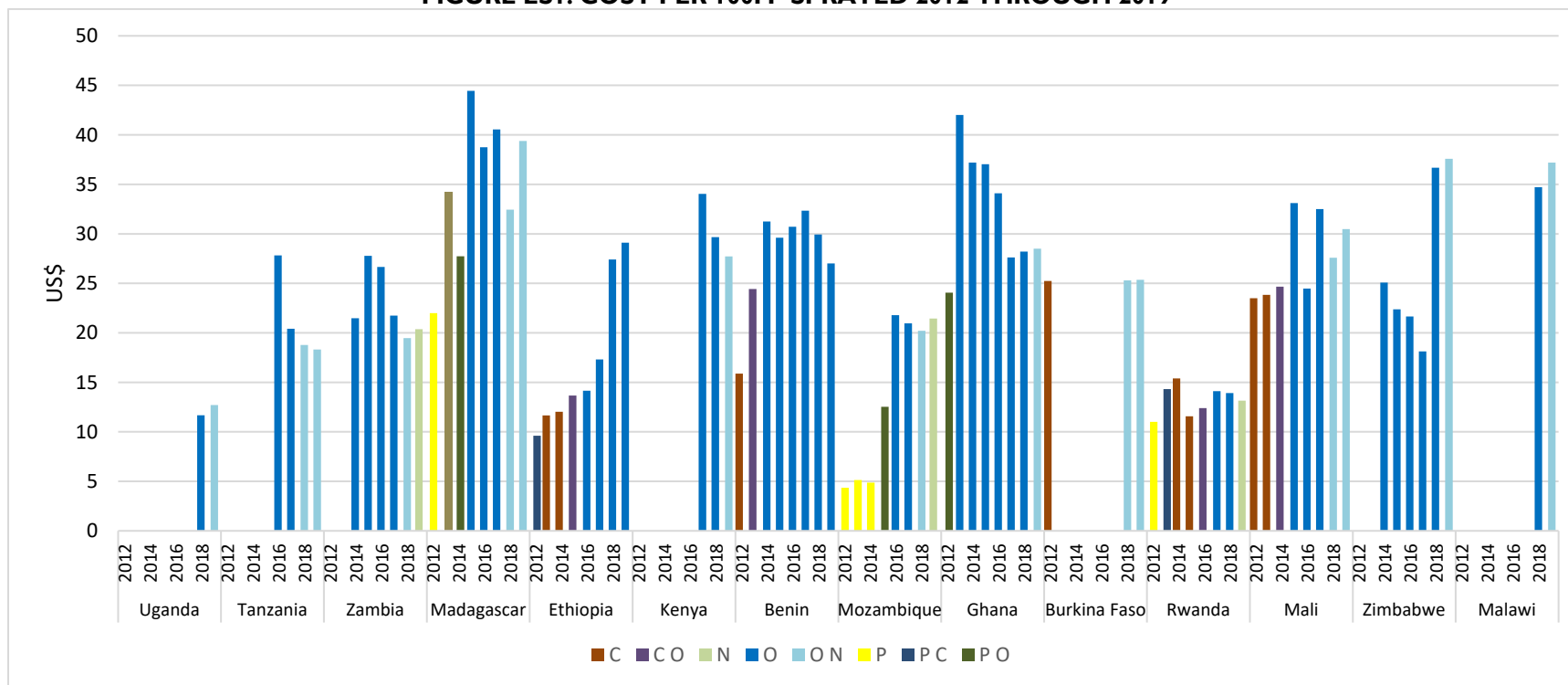
Next Generation IRS (NgenIRS) Project

Copayments from UNITAID's Next Generation IRS (NgenIRS) project kept the price of Actellic® 300CS in six countries at \$15 per bottle, SumiShield® 50WG in nine countries at \$15 per sachet (including insecticide procured by the Global Fund on behalf of the National Malaria Control Program (NMCP) in Mozambique), while Fludora® Fusion was used in four countries at \$14.50 per sachet without co-payment. All countries except for Benin, Ethiopia, and Rwanda used multiple insecticides in 2019. Note that costs presented in this report are the prices paid by PMI for the insecticide in NgenIRS-supported countries and do not consider the amount of the NgenIRS subsidy. Costs for insecticides procured by the government (Mozambique) and the Global Fund (Tanzania) are included.

Year-on-Year Comparison

Figure ESI shows the unit costs for the countries included in this analysis for the years 2012 through 2019, as well as the type of insecticide used. Countries are arranged in order of the number of structures sprayed during 2019 spray campaigns, from largest to smallest.

FIGURE ESI: COST PER 100M² SPRAYED 2012 THROUGH 2019



P: pyrethroid; C: carbamate; O: organophosphate; N: neonicotinoid

Country Chapters

This report includes a specific chapter for each IRS country program covered in the analysis. The country chapters each include a background section with relevant country context, M&E data, total program costs, and unit costs per person protected, per structure sprayed, and per area sprayed. These chapters also include an analysis of unit costs between 2018 and 2019.

CONCLUSIONS

Program Scale

Broadly speaking, we find, similar to previous years, that unit costs for larger programs are lower than for smaller programs (although larger programs tend to cost more in total). This analysis uses the most standardized comparison unit cost available as there is no 'one-price-fits-all' for IRS across countries.

Spray Operations

Spray operations make up the largest cost category across the IRS programs when looking at the cost per 100 m² sprayed and in terms of total expenditures. The spray operations portion of the cost per area sprayed constitutes an average of 33.7percent of the total unit cost across country programs.

I. INTRODUCTION

PMI aims to reduce the incidence and prevalence of malaria. PMI has implemented IRS programs in collaboration with ministries of health and NMCPs in sub-Saharan Africa since 2006. In April 2015, PMI's 2015-2020 strategy was released which outlined the following objectives: (1) reduce malaria mortality by one-third from 2015 levels in PMI-supported countries, achieving a greater than 80 percent reduction from PMI's original 2000 baseline levels, (2) reduce malaria morbidity in PMI-supported countries by 40 percent from 2015 levels, and (3) assist at least five PMI-supported countries to meet the World Health Organization (WHO) criteria for national or sub-national pre-elimination. The AIRS Project, implemented from 2011 to 2014, the PMI AIRS Project, implemented from 2014 to 2018, and the PMI VectorLink Project, to be implemented from 2017 to 2022, together constitute PMI's leading pan-African IRS program.

In 2019, the PMI VectorLink Project provided 14 PMI countries with full IRS operations and logistics support (Benin, Burkina Faso, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Rwanda, Tanzania, Uganda, Zambia, and Zimbabwe).

The PMI VectorLink Project implements all aspects of the IRS process, including:

- Planning and forecasting IRS programming with government, community leaders, and other key stakeholders;
- Procuring insecticides and spray equipment/materials;
- Managing the supply chain of all IRS equipment and materials;
- Working with local leaders and organizations to ensure community awareness and knowledge of IRS campaign objectives, benefits, and timelines, and working with communities to provide further buy-in and further sensitization regarding malaria control for neighboring communities;
- Implementing IRS campaigns in targeted areas;
- Ensuring environmental compliance of IRS campaigns, and materials used in the campaigns;
- Conducting monitoring and evaluation (M&E) of all program activities; and
- Completing entomological surveillance and testing insecticide effectiveness in 12 of the 14 spray countries (the exception being Benin, where entomological surveillance is conducted by the Center for Entomological Research of Cotonou (CREC) through a direct funding mechanism from PMI). Further, in Tanzania, entomological monitoring work is conducted under a separate bilateral agreement under RTI.

PMI asked the project to provide annual comparative cost analyses on the total and unit costs of the IRS country programs. This report builds upon the 2012, 2013, 2014, 2015, 2016, 2017, and 2018 findings by reporting on 2019 costs and comparing them with those of the previous years. Expenditures on long-lasting insecticide-treated nets are included descriptively in individual country chapters when appropriate, but, due to limited scope of activities, are not fully analyzed and are not included in costs related to IRS.

2. CROSS-COUNTRY RESULTS

2.1 BACKGROUND

2.1.1 OUTPUT MEASURES

Table CCI presents the coverage provided by the PMI VectorLink Project's spray campaigns in each country. The area sprayed (number of 100 m² sprayed) was calculated by multiplying the total number of units of insecticide used by 250 m² (the estimate of coverage provided by each bottle or sachet) and dividing by 100 m² in order to develop a more comparable unit of measure. The average size of a structure in each country was calculated by the total area sprayed divided by the number of structures sprayed. The number of people per area sprayed was calculated by dividing the total population protected by the area sprayed in terms of 100 m², and ranged from 2.2 in Rwanda to 9.7 in Madagascar.

TABLE CCI: PMI VECTORLINK PROJECT SPRAY COVERAGE IN 2019, BY COUNTRY

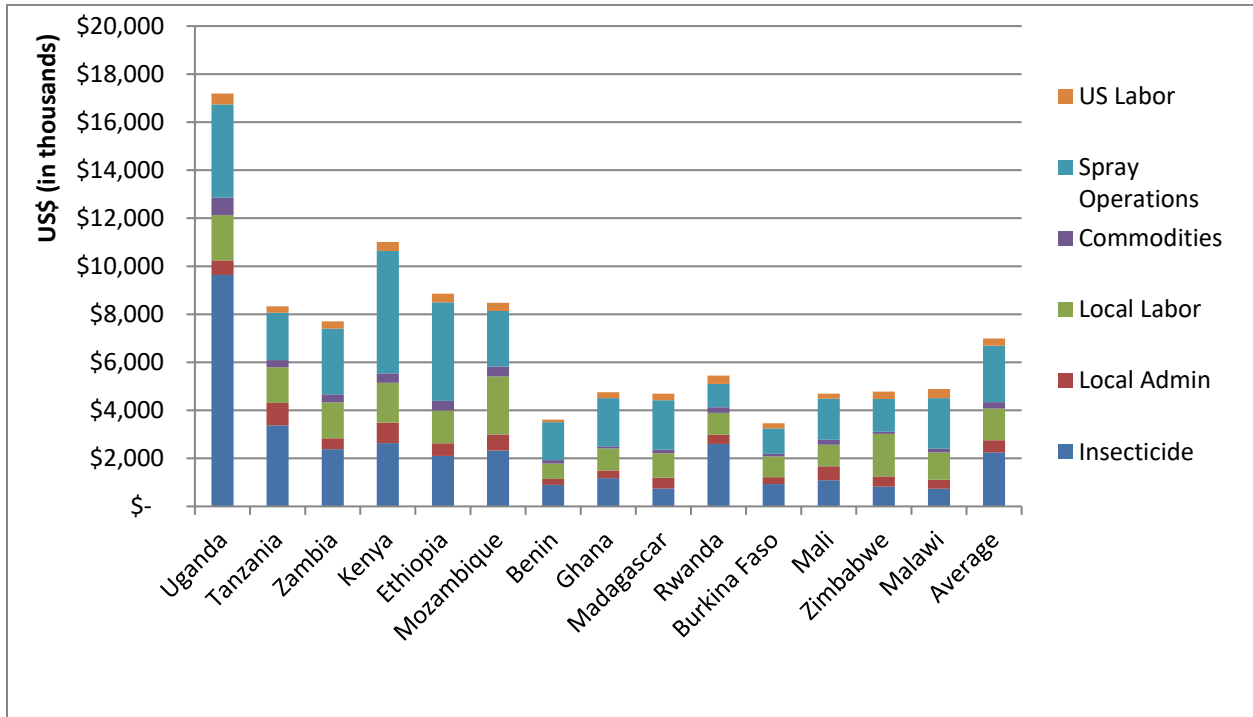
Country	# of People Protected	# of Structures Sprayed	Area Sprayed (100 m ²)	Avg. Size of Structure (m ²)	# People per Area Sprayed
Benin	1,077,411	335,207	133,760	39.9	8.1
Burkina Faso	587,248	201,901	136,423	67.6	4.3
Ethiopia	1,334,868	487,746	304,420	62.4	4.4
Ghana	875,481	298,385	166,833	55.9	5.2
Kenya	2,011,860	507,777	397,193	78.2	5.1
Madagascar	1,150,922	267,874	119,158	44.5	9.7
Malawi	441,375	107,565	131,373	122.1	3.4
Mali	690,793	148,198	154,043	103.9	4.5
Mozambique	1,484,191	338,330	395,325	116.8	3.8
Rwanda	915,034	221,712	414,260	186.8	2.2
Tanzania	2,404,010	595,923	454,843	76.3	5.3
Uganda	4,479,157	1,291,569	1,352,893	104.7	3.3
Zambia	2,273,188	536,983	378,248	70.4	6.0
Zimbabwe	307,209	131,191	127,213	97.0	2.4

The average structure size and number of people per area sprayed provide additional contextual understanding of a country program's spray campaign. Structure size varied widely between countries, ranging from 39.9 m² in Benin to 186.8 m² in Rwanda. The average size of structures sprayed across all 2019 countries was 81.4 m² (not weighting for the different number of structures sprayed between countries). On average each unit of insecticide covered about 4.2 structures.

2.2 TOTAL PROGRAM EXPENDITURES

This section presents the IRS country programs' total expenditures for 2019. Figure CCI includes all capital and recurrent costs of country IRS programs broken down by cost category. Countries are arranged in order of the number of structures sprayed during 2019 spray campaigns, from largest to smallest.

FIGURE CCI: CAPITAL AND RECURRENT EXPENDITURES, BY COST CATEGORY



Note: Costs of insecticides are reflective of the lower price paid through the NgenIRS project for project countries and include insecticides provided by other donors (such as the Global Fund) or the government.

Certain IRS costs are fixed and fairly consistent across country programs regardless of the number of structures sprayed. This includes the U.S.-based labor and STTA cost category which remain consistent across all country programs at an annual average of about \$298,000. Another category is local administration (rent, utilities, third country national (TCN) allowances). While more variable than the U.S.-based labor cost category, local administration is also considered a fixed cost and averages about \$507,000 across countries. These fixed costs are discussed in more detail in the cost-drivers analysis section. An average of 84.7 percent of total project expenditures is spent directly on the variable costs of spray operations, insecticide, and local labor.

The average total program implementation expenditures across all countries and cost categories are about \$7.0 million.

2.3 UNIT COST ANALYSIS

This section presents country IRS programs' capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). The unit costs, shown in Table CC2, are calculated using total program expenditures and the output measures provided in Table CCI (see preceding section). Countries are arranged in order of the number of structures sprayed, most to least.

TABLE CC2: 2019 IRS PROGRAM UNIT COSTS

Country	Cost per Person Protected	Cost per Structure Sprayed	Cost per Area Sprayed
Uganda	\$3.84	\$13.31	\$12.71
Tanzania	\$3.46	\$13.98	\$18.31
Zambia	\$3.39	\$14.35	\$20.37
Kenya	\$5.47	\$21.68	\$27.72
Ethiopia	\$6.64	\$18.17	\$29.10
Mozambique	\$5.71	\$25.05	\$21.44
Benin	\$3.35	\$10.78	\$27.01
Ghana	\$5.43	\$15.93	\$28.50
Madagascar	\$4.08	\$17.52	\$39.39
Rwanda	\$5.95	\$24.56	\$13.14
Burkina Faso	\$5.89	\$17.14	\$25.36
Mali	\$6.80	\$31.68	\$30.48
Zimbabwe	\$15.56	\$36.44	\$37.58
Malawi	\$11.07	\$45.43	\$37.20
Average (unweighted)	\$6.19	\$21.86	\$26.31

The average cost per structure sprayed across countries (not weighted by the number of structures sprayed in each country) was \$21.86. The cost per structure sprayed was generally lower for larger programs than for smaller ones.

2.4 COST DRIVERS

This section focuses on the country IRS programs' costs per area (100 m²) sprayed, in order to determine differences in cost drivers by unit cost across the countries. A cost driver is the activity, or unit of an activity, that is responsible for significant differences in costs between one country and another. This section explores selected cost categories separately to assess and explain the variation in unit costs. The section will also continue to categorize countries by program size.

2.4.1 VARIABLE AND CAPITAL COSTS

Table CC3 provides the percentage of each cost category out of the total unit cost per area sprayed. This is the first step in determining which cost categories constitute the largest percentage of costs, and which cost categories show the most variance across countries in terms of their percentage of the total costs.

Table CC3 shows that on average, variable costs (spray operations, insecticide, and local labor) constitute 87 percent of total costs across the countries, ranging from 81 percent of total costs in Mali to 89 percent of costs in Uganda and Ghana. Therefore, fixed costs (capital items, local administration, U.S. labor, and commodities) were 13 percent of costs on average. Capital items constitute 4 percent of total costs; commodities were 1 percent of costs (down from 2 percent last year).

TABLE CC3: BREAKDOWN OF FIXED AND VARIABLE COSTS, AS PERCENTAGE OF UNIT COST PER AREA SPRAYED

Country	Fixed Costs					Variable Costs				Total Unit Cost
	Local Admin	Capital Items	US Labor	Commodities	Total Fixed Costs	Spray Operations	Insecticide	Local Labor	Total Variable Costs	
Uganda	3%	2%	3%	3%	11%	22%	56%	11%	89%	\$ 12.71
Tanzania	10%	4%	1%	1%	17%	24%	41%	18%	83%	\$ 17.93
Zambia	6%	4%	1%	2%	12%	36%	32%	20%	88%	\$ 19.79
Kenya	7%	2%	1%	3%	13%	47%	25%	15%	87%	\$ 27.06
Ethiopia	6%	6%	1%	0%	13%	47%	25%	16%	87%	\$ 28.20
Mozambique	6%	4%	1%	3%	15%	27%	28%	29%	85%	\$ 20.84
Benin	5%	6%	0%	0%	12%	44%	26%	18%	88%	\$ 26.28
Ghana	6%	4%	1%	0%	11%	43%	26%	20%	89%	\$ 27.21
Madagascar	9%	4%	1%	1%	15%	46%	17%	23%	85%	\$ 37.30
Rwanda	6%	6%	2%	1%	15%	18%	50%	17%	85%	\$ 12.58
Burkina Faso	8%	3%	1%	2%	13%	32%	28%	26%	87%	\$ 23.96
Mali	11%	7%	1%	1%	19%	37%	24%	20%	81%	\$ 29.29
Zimbabwe	9%	2%	1%	1%	12%	30%	18%	39%	88%	\$ 35.38
Malawi	7%	2%	1%	3%	12%	46%	16%	25%	88%	\$ 34.58
Average	7%	4%	1%	1%	13%	38%	26%	22%	87%	\$ 25.22

The following sub-section provides a more in-depth cost driver analysis of spray operations.

2.4.2 SPRAY OPERATIONS: PROGRAM SCALE

Table CC4 provides a detailed breakdown of the number of spray operators (SOPs) who worked in each country spray campaign, as well as the total and average numbers of SOP days, and the average daily wage. It also shows the total number of campaign days, the total amount of area sprayed (in terms of 100 m²), and the average amount of area sprayed per SOP day and per campaign day (both also in terms of 100 m²). There is no noticeable correlation or trend between the number of SOPs or number of SOP days and the amount of area sprayed per SOP day. For example, Uganda and Tanzania sprayed the most area among the countries, even though their SOPs sprayed an above-average area per day in Uganda and a below-average area per day in Tanzania. Benin, Madagascar, Kenya, Zambia, and Burkina Faso had the lowest area sprayed per SOP per day; Benin, and Madagascar also had the smallest structure size on average. A possible explanation for differences in area sprayed per SOP per day is differences in the density of structures; however, data are not available to test this explanation. Variation in the daily productivity of SOPs (along with the daily wages of SOPs) is a direct contributor to variation in the spray operations cost per area sprayed, and helps to explain differences in cost per area sprayed between countries.

TABLE CC4: SEASONAL SOPs AND CAMPAIGN DAYS

Country	Total # SOPs	Total # SOP Days	Avg. # Days/SOP	Avg. Daily Wage of SOP	Total # Campaign Days	Total Area Sprayed (# 100 m ²)	Area Sprayed/SOP Day	Area Sprayed/Campaign Day
Uganda	5,528	132,672*	24	\$3.17	74	1,352,893	10.2	18,282
Tanzania	2,323	54,858*	24	\$8.66	47	454,843	8.3	9,678
Zambia	1,468	46,976	32	\$3.82 ⁺	42	378,248	8.1	9,006
Kenya	2,033	55,356	27	\$6.86	54	397,193	7.2	7,355
Ethiopia	1,361	28,357	21	\$7.00	64	304,420	10.7	4,757
Mozambique	1,000	35,000	35	\$2.39	35	395,325	11.3	11,295
Benin	1,278	26,838	21	\$7.00	21	133,760	5.0	6,370
Ghana	637	19,110	30	\$7.33	30	166,833	8.7	5,561
Madagascar	830	19,920	24	\$5.50	24	119,158	6.0	4,965
Rwanda	1,205	24,100	20	\$6.10	20	414,260	17.2	20,713
Burkina Faso	547	16,410	30	\$5.96	30	136,423	8.3	4,547
Mali	616	18,480	30	\$5.36	30	154,043	8.3	5,135
Zimbabwe	239	8,604	36	\$15.00	36	127,213	14.8	3,534
Malawi	390	12,480	32	\$10.16	32	131,373	10.5	4,105
Average	1,390	35,654	28	6.34	39	333,284	9.6	8,236

*The campaign was split into different times and in different geographic locations, so SOPs were recruited separately in different locations; thus, the average number of days per SOP is less than the total number of campaign days because most/all of the SOPs did not work the full campaign.

⁺SOPs are not paid; figure represents allowance given to SOPs for meals.

3. NGENIRS

In 2019, the PMI VectorLink Project benefited from the NgenIRS project, a UNITAID-funded partnership between the Innovative Vector Control Consortium, PMI and its IRS implementing partner Abt Associates Inc., Global Fund, PATH/Malaria Control and Elimination Partnership in Africa, and NMCPs. Its objective is to accelerate and expand access and affordability of new, third generation formulations of IRS insecticides for malaria vector control to mitigate insecticide resistance. The goal of the NgenIRS project is sustainable and rational deployment of effective malaria vector control tools in insecticide resistance management programs to save lives and improve health. Through the NgenIRS project, eight PMI VectorLink Project countries were able to procure Actellic 300CS insecticide at a price of \$15.00 per bottle instead of the market price of \$23.50 per bottle in 2019. A further nine countries benefited from co-payments for SumiShield 50WG insecticide, at a price of \$15.00 per sachet. Five countries procured Fludora® Fusion at a price of \$14.50 per sachet, which did not have a co-payment. Insecticide usage and costs for the three years of the NgenIRS project are depicted in Table NGI.

TABLE NGI: EFFECTS OF NGENIRS ON PROGRAM SCALE

Countries Receiving NgenIRS Copayment	Number of Insecticide Bottles Used				Total Cost of Insecticide (to the PMI VectorLink Project)				Number of Structures Sprayed				Number of People Protected				Insecticide Cost per Structure Sprayed				Comments
	2017	2018	2019	2019 – 2017	2017	2018	2019	2019 – 2017	2017	2018	2019	2019 – 2017	2017	2018	2019	2019 – 2017	2017	2018	2019	2019 – 2017	
Benin	58,765	62,841	53,504	(5,261)	1,017,823	1,060,118	898,601	(119,221)	384,761	400,997	335,207	(49,554)	1,227,536	1,321,758	1,077,411	(150,125)	\$2.65	\$2.64	\$2.68	0.04	
Burkina Faso		53,525	54,569	1,044		872,354	926,449	54,096		258,766	201,901	(56,865)		766,374	587,248	(179,126)		\$3.37	\$4.59	1.22	3 insecticides used in 2019
Ethiopia	250,918	114,897	121,768	(129,150)	4,339,305	1,975,237	2,103,827	(2,235,478)	738,810	472,569	487,746	(251,064)	1,877,154	1,264,189	1,334,868	(542,286)	\$5.87	\$4.18	\$4.31	(1.56)	
Ghana	65,895	65,544	66,733	838	1,145,787	1,028,897	1,173,748	27,961	302,648	298,701	298,385	(4,263)	840,438	836,376	875,481	35,043	\$3.79	\$3.44	\$3.93	0.15	
Kenya	70,553	162,468	158,877	88,324	1,206,372	2,899,824	2,636,023	1,429,651	212,029	440,969	507,777	295,748	906,388	1,833,860	2,011,860	1,105,472	\$5.69	\$6.58	\$5.19	(0.50)	
Madagascar	75,944	88,224	47,663	(28,281)	1,314,331	1,481,633	743,700	(570,630)	487,636	548,789	267,874	(219,762)	2,008,963	2,232,097	1,150,922	(858,041)	\$2.70	\$2.70	\$2.78	0.08	
Malawi		47,743	52,549	4,806		824,537	738,773	(85,764)		112,264	107,565	(4,699)		501,324	441,375	(59,949)		\$7.34	\$6.87	(0.48)	
Mali	80,269	76,985	61,617	(18,652)	1,468,859	1,388,739	1,090,705	(378,154)	227,646	160,723	148,198	(79,448)	823,201	665,581	690,793	(132,408)	\$6.45	\$8.64	\$7.36	0.91	
Mozambique	205,223	184,827	158,130	(47,093)	3,078,345	2,772,405	2,330,278	(748,067)	381,463	387,413	338,330	(43,133)	1,711,518	1,663,078	1,484,191	(227,327)	\$8.07	\$7.16	\$6.89	(1.18)	NMCP procured in 2019
Rwanda	82,408	63,551	65,704	(16,704)	3,191,487	2,781,842	2,604,218	(587,269)	231,258	214,802	221,712	(9,546)	919,735	894,098	915,034	(4,701)	\$13.80	\$12.95	\$11.75	(2.05)	
Tanzania	211,118	234,930	181,937	(29,181)	3,742,699	4,222,167	3,376,560	(366,139)	664,622	744,597	595,923	(68,699)	2,568,522	2,840,927	2,404,010	(164,512)	\$5.63	\$5.67	\$5.67	0.03	Global Fund procured Actellic 300CS in 2019 without co-payment

Uganda		554,568	541,157	(13,411)		8,871,598	9,638,259	766,661		1,292,309	1,291,569	(740)		4,436,156	4,479,157	43,001		\$6.86	\$7.46	0.60	
Zambia	168,771	147,983	151,299	(17,472)	2,970,959	2,561,377	2,381,016	(589,943)	634,371	579,490	536,983	(97,388)	3,005,676	2,818,176	2,273,188	(732,488)	\$4.68	\$4.42	\$4.43	(0.25)	
Zimbabwe	99,148	42,270	50,885	(48,263)	1,747,064	719,396	821,394	(925,670)	209,055	112,805	131,191	(77,864)	517,374	276,343	307,209	(210,165)	\$8.36	\$6.38	\$6.26	(2.10)	

*All countries benefited from the NgenIRS co-payment of Actellic and SumiShield in 2017 (if there was spraying under PMI VectorLink) 2018 and 2019.

4. YEAR-ON-YEAR COMPARISON

This section provides an overview of the major changes in countries' IRS programs across the years, focusing on changes from 2018 to 2019.

Table YR1 provides details on the changes in output measures for all country programs between 2018 and 2019. A complete table of output measures for all country programs for the period 2012-2019 is included in Annex A. Table YR2 shows the changes in unit costs between 2018 and 2019. A complete table of unit costs for all country programs for the period 2012-2019 is included in Annex B. For more information, a comprehensive discussion of the changes in each country program is provided at the end of each individual country chapter.

TABLE YR1: YEAR-ON-YEAR COMPARISON OF OUTPUT MEASURES

Country	People Protected			Structures Sprayed			Area Sprayed (100 m ²)		
	2018	2019	Percent Change 2018-2019	2018	2019	Percent Change 2018-2019	2018	2019	Percent Change 2018-2019
Uganda	4,436,156	4,479,157	1%	1,292,309	1,291,569	0%	1,386,420	1,352,893	-2%
Tanzania	2,840,927	2,404,010	-15%	744,597	595,923	-20%	587,325	454,843	-23%
Zambia	2,818,176	2,273,188	-19%	579,490	536,983	-7%	369,958	378,248	2%
Kenya	1,833,860	2,011,860	10%	440,969	507,777	15%	406,170	397,193	-2%
Ethiopia	1,264,189	1,334,868	6%	472,569	487,746	3%	287,243	304,420	6%
Mozambique	1,663,078	1,484,191	-11%	387,413	338,330	-13%	462,068	395,325	-14%
Benin	1,321,758	1,077,411	-18%	400,997	335,207	-16%	157,103	133,760	-15%
Ghana	836,376	875,481	5%	298,701	298,385	0%	163,860	166,833	2%
Madagascar	2,232,097	1,150,922	-48%	548,789	267,874	-51%	220,560	119,158	-46%
Rwanda	894,098	915,034	2%	214,802	221,712	3%	408,878	414,260	1%
Burkina Faso	766,374	587,248	-23%	258,766	201,901	-22%	133,813	136,423	2%
Mali	665,581	690,793	4%	160,723	148,198	-8%	192,463	154,043	-20%
Zimbabwe	276,343	307,209	11%	112,805	131,191	16%	105,675	127,213	20%
Malawi	501,324	441,375	-12%	112,264	107,565	-4%	119,358	131,373	10%
Average	1,596,453	1,430,911	-10%	430,371	390,740	-9%	357,206	333,284	-7%

NA: Data are not available

As Table YR1 shows, seven countries (Uganda, Kenya, Ethiopia, Ghana, Rwanda, Mali, and Zimbabwe) increased the number of people protected, of which four (Kenya, Ethiopia, Rwanda, and Zimbabwe) also increased the number of structures sprayed from 2018 to 2019. Zambia, Ethiopia, Ghana, Rwanda, Burkina Faso, Zimbabwe, and Malawi also used more units of insecticide (the basis for calculating the area sprayed) between 2018 and 2019.

Unit costs decreased from 2018 to 2019 in Tanzania, Kenya, Benin, and Rwanda (Table YR2). Unit costs increased in Uganda, Zambia, Ethiopia, Mozambique, Madagascar, Burkina Faso, Zimbabwe, and Malawi, and were mixed in Ghana and Mali.

TABLE YR2: YEAR-ON-YEAR COMPARISON OF UNIT COSTS

Country	Person Protected			Structure Sprayed			Area Sprayed (100 m ²)		
	2018	2019	Percent Change 2018-2019	2018	2019	Percent Change 2018-2019	2018	2019	Percent Change 2018-2019
Uganda	\$3.65	\$3.84	5%	\$12.53	\$13.31	6%	\$11.68	\$12.71	9%
Tanzania	\$3.88	\$3.46	-11%	\$14.81	\$13.98	-6%	\$18.77	\$18.31	-2%
Zambia	\$2.55	\$3.39	33%	\$12.42	\$14.35	15%	\$19.46	\$20.37	5%
Kenya	\$6.57	\$5.47	-17%	\$27.33	\$21.68	-21%	\$29.67	\$27.72	-7%
Ethiopia	\$6.23	\$6.64	7%	\$16.66	\$18.17	9%	\$27.41	\$29.10	6%
Mozambique	\$5.61	\$5.71	2%	\$24.10	\$25.05	4%	\$20.21	\$21.44	6%
Benin	\$3.56	\$3.35	-6%	\$11.73	\$10.78	-8%	\$29.93	\$27.01	-10%
Ghana	\$5.53	\$5.43	-2%	\$15.47	\$15.93	3%	\$28.20	\$28.50	1%
Madagascar	\$3.21	\$4.08	27%	\$13.04	\$17.52	34%	\$32.45	\$39.39	21%
Rwanda	\$6.36	\$5.95	-6%	\$26.48	\$24.56	-7%	\$13.91	\$13.14	-6%
Burkina Faso	\$4.42	\$5.89	33%	\$13.08	\$17.14	31%	\$25.30	\$25.36	0%
Mali	\$7.98	\$6.80	-15%	\$33.04	\$31.68	-4%	\$27.59	\$30.48	10%
Zimbabwe	\$10.24	\$15.56	11%	\$25.09	\$36.44	6%	\$26.78	\$37.58	2%
Malawi	\$8.27	\$11.07	34%	\$36.91	\$45.43	23%	\$34.71	\$37.20	7%
Average	\$5.58	\$6.19	6%	\$20.19	\$21.86	5%	\$24.72	\$26.31	3%

A detailed discussion of the changes in each country program is included in the individual country chapters. Note that inflation in Zimbabwe was very high during this period, making year-on-year comparisons of costs difficult to interpret.

5. BENIN

5.1 BACKGROUND

TABLE BNI: BENIN QUICK FACTS

	2019
Program Dates	Jan 1, 2019– Dec 31, 2019
Number of Districts	6
# Local Staff	16
Spray Start Date	May 6, 2019
Insecticides Used	Organophosphates
# Units of Insecticide Used	53,504
# People Protected	1,077,411
# Structures Sprayed	335,207.00
# 100 Square Meters Sprayed*	133,760

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

5.2 PROGRAM EXPENDITURES

This section will present an overview of Benin IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table BN2 displays the Benin IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

The spray campaign is the most expensive IRS activity (32.8 percent of expenditures), followed by insecticide (24.9 percent of expenditures), and administration (21.0 percent of expenditures). PMI VectorLink Benin procured 50,856 units of Actellic CS300 insecticide, and used 53,504 (the cost of insecticide used is reflected in Table BN2). About 67.7 percent of the total cost for administration consists of labor, both local and U.S.-based. Note that the 'U.S.-based Labor and STTA' expenditures are largely incurred under the administrative and M&E program activities (90 percent of U.S. labor expenditures are in the two categories). Local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray operations.

TABLE BN2: BENIN IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		245,929	433,019			81,326	\$760,274	21.0%
Entomology					49	1,374	\$1,424	0.0%
Environmental Compliance			27,823		37,851	8,792	\$74,466	2.1%
Equipment Supplies				144,534			\$144,534	4.0%
IEC*							\$-	0.0%
Insecticide	898,601						\$898,601	24.9%
M&E			55,906		40,148	15,967	\$112,021	3.1%
Post Spray			19,011		18,282	-	\$37,293	1.0%
Spray Campaign			12,027		1,173,012	-	\$1,185,039	32.8%
Spray Planning			91,389		307,461	467	\$399,318	11.1%
Grand Total	\$898,601	\$245,929	\$639,176	\$144,534	\$1,576,804	\$107,926	\$3,612,970	100.0%

Note: IEC: information, education and communication.

* IEC did take place through town criers, mass media communication (radio spots), village leaders recruited within their own communities for a very short period of time, and printing pamphlets and leaflets. These costs were bundled with other printing or seasonal labor costs and are included in spray planning or spray campaign costs.

5.3 UNIT COST ANALYSIS

This section presents Benin IRS as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE BN3: BENIN UNIT COSTS

	Unit Cost
Person protected	\$ 3.35
Structure sprayed	\$ 10.78
100 m ² sprayed	\$ 27.01

5.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the PMI VectorLink Benin IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table BN4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 23.2 percent from 2018 to 2019, reflecting spray campaigns in six districts in 2019 (versus 8 districts in 2018). U.S. labor accounted for the largest decrease in costs in relative terms (36 percent or about \$60,244), followed by spray operations costs, which decreased by 33 percent (roughly \$791,235). The costs of insecticides used also decreased 15 percent (roughly \$161,517) from 2018 to 2019 reflecting lower usage.

TABLE BN4: BENIN IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide (used)	\$1,060,118	\$898,601	-15%
Local Admin	\$284,528	\$245,929	-14%
Local Labor	\$667,341	\$639,176	-4%
Spray Operations	\$2,368,039	\$1,576,804	-33%

Commodities	\$153,785	\$144,534	-6%
U.S. Labor	\$168,170	\$107,926	-36%
TOTAL	\$4,701,982	\$3,612,970	-23.2%

Table BN5 compares the year-on-year change in Benin IRS program output measures and unit costs. Overall, in 2019, the program had lower coverage metrics than in 2018. The number of people protected decreased by 18.5 percent from 2018 to 2019, and the number of structures sprayed and area sprayed decreased by 16.4 percent and 14.9 percent, respectively. Because the decrease in program size was of a smaller magnitude than the decrease in total expenditures, unit costs decreased from 2018 to 2019. To further reduce spray operation costs, the Benin team worked to decrease vehicle rental by more closely coordinating the transport of personnel for supervision. They also downsized the launch ceremony, and local administration fixed costs were reduced by sharing office space and associated costs with another Abt project. The cost per person protected decreased by about 5.7 percent to \$3.35 per person protected, while costs per structure sprayed and area sprayed decreased on the order of 8.1 percent and 9.8 percent, respectively, from 2018 to 2019. This can be attributed to decreases in spray operation costs due to the smaller scale of the program in 2018.

TABLE BN5: BENIN IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	1,321,758	1,077,411	-18.5%
Structures Sprayed	400,997	335,207	-16.4%
Area Sprayed (100 m ²)	157,103	133,760	-14.9%
Unit Costs			
Per Person Protected	\$3.56	\$3.35	-5.7%
Per Structure Sprayed	\$11.73	\$10.78	-8.1%
Per Area Sprayed	\$29.93	\$27.01	-9.8%

6. BURKINA FASO

6.1 BACKGROUND

TABLE BF1: BURKINA FASO QUICK FACTS

	2019
Program Dates	Jan 1, 2019–Dec 31, 2019
Number of Districts	3
# Local Staff	18
Spray Start Date	Jun 6, 2019
Insecticides Used	Organophosphates and neonicotinoids
# Units of Insecticide Used	54,569 (15,358 O; 39,211 N)
# People Protected	587,248
# Structures Sprayed	201,901
# 100 Square Meters Sprayed*	136,423

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

6.2 PROGRAM EXPENDITURES

This section presents an overview of Burkina Faso IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table BF2 displays the Burkina Faso IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project’s financial systems, and the top row lists IRS program cost categories.

Administration is the most expensive IRS activity (28.7 percent of expenditures), followed by insecticide (26.8 percent of expenditures) and the spray campaign (11.8 percent of expenditures). PMI VectorLink procured 30,802 sachets of SumiShield and 6,110 sachets of Fludora® Fusion, and used about 33,885 sachets of SumiShield, 15,358 bottles of Actellic CS300 and 5,326 sachets of Fludora® Fusion (costs reflect the insecticides used). About 70.8 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray operations. An additional \$35,802 was spent on activities related to ITN durability monitoring, which is not included in table BF2.

TABLE BF2: BURKINA FASO IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		290,417	595,430			107,897	\$993,744	28.7%
Entomology			10,698		367,483	21,881	\$400,062	11.6%
Environmental Compliance			42,355		32,428	6,531	\$81,315	2.4%
Equipment Supplies				109,811			\$109,811	3.2%
IEC			31,708			5,200	\$36,908	1.1%
Insecticide	926,449						\$926,449	26.8%
M&E			29,669		64,130	47,383	\$141,183	4.1%
Post Spray			48,324		52,439	1,400	\$102,163	3.0%
Spray Campaign			28,482		377,807	1,827	\$408,115	11.8%
Spray Planning			77,696		161,350	21,265	\$260,311	7.5%
Grand Total	\$926,449	\$290,417	\$864,363	\$109,811	\$1,055,636	\$213,385	\$3,460,062	100.0%

Note: IEC: information, education and communication

6.3 UNIT COST ANALYSIS

This section presents Burkina Faso IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE BF3: BURKINA FASO UNIT COSTS

		Unit Costs
Cost per	Person protected	\$5.89
	Structure sprayed	\$17.14
	100 m ² sprayed	\$25.36

6.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the PMI VectorLink Burkina Faso IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table BF4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 2 percent from 2018 to 2019, largely reflecting increased cost for local labor for six additional full time staff, which included transitioning seasonal district coordinators to permanent staff. Local labor accounted for the largest increase in costs (13 percent or about \$98,131), followed by local administration (8 percent or about \$21,149) and insecticides (6% or about \$54,096).

TABLE BF4: BURKINA FASO IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide (used)	\$872,354	\$926,449	6%
Local Admin	\$269,268	\$290,417	8%
Local Labor	\$766,232	\$864,363	13%
Spray Operations	\$1,101,083	\$1,055,636	-4%
Commodities	\$145,021	\$109,811	-24%
U.S. Labor	\$231,361	\$213,385	-8%
TOTAL	\$3,385,319	\$3,460,062	2%

Table BF5 compares the year-on-year change in Burkina Faso IRS program output measures and unit costs. Overall, in 2019, number of people protected decreased by 23 percent from 2018 and the number of structures sprayed decreased by 22 percent, while the area sprayed increased by 2 percent. In 2019, the project removed portions of the original target within districts and reduced the number of operations sites due to security issues, thereby reducing spray operations costs and commodity purchases. Local administration costs increased due to increased communication costs for internet for the more than 600 tablets used to implement the mobile data collection pilot.

Given the decrease in total program cost was of a smaller magnitude than the decrease in people protected and structures sprayed, unit costs increased for both from 2018 to 2019 (33 percent and 31 percent increase, respectively). There was minimal change in the cost per area.

TABLE BF5: BURKINA FASO IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	766,374	587,248	-23%
Structures Sprayed	258,766	201,901	-22%
Area Sprayed (100 m ²)	133,813	136,423	2%
Unit Costs			
Per Person Protected	\$4.42	\$5.89	33%
Per Structure Sprayed	\$13.08	\$17.14	31%
Per Area Sprayed	\$25.30	\$25.36	0%

7. ETHIOPIA

7.1 BACKGROUND

TABLE ET1: ETHIOPIA QUICK FACTS

	2019
Program Dates	Jan 1, 2019–Dec 31, 2019
Number of Districts	44
# Local Staff	34
Spray Start Date	May 20, 2019
Insecticides Used	Organophosphates
# Units of Insecticide Used	121,768
# People Protected	1,334,868
# Structures Sprayed	487,746
# 100 Square Meters Sprayed*	304,420

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

7.2 PROGRAM EXPENDITURES

This section will present an overview of Ethiopia IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table ET2 displays the Ethiopia IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project’s financial systems, and the top row lists IRS program cost categories.

The spray campaign represented the majority of the total costs at 33.3 percent of costs. Insecticides and administration were the next two largest categories of costs, representing 23.7 and 14.9 percent of costs, respectively. PMI VectorLink procured 50,004 bottles of Actellic CS300 organophosphate, and used 121,768 bottles. 60.1 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray operations.

TABLE ET2: ETHIOPIA IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		525,455	682,815	-	-	108,638	\$1,316,908	14.9%
Entomology		-	158,782	-	613,265	135,505	\$907,552	10.2%
Environmental Compliance		-	107,806	-	56,197	35,387	\$199,390	2.3%
Equipment Supplies		-	-	401,462	-	-	\$401,462	4.5%
IEC		-	-	-	-	10,062	\$10,062	0.1%
Insecticide	2,103,827	-	-	-	-	-	\$2,103,827	23.7%
M&E		-	92,241	-	351,566	39,218	\$483,026	5.5%
Post Spray		-	8,067	-	66,597	-	\$74,665	0.8%
Spray Campaign		-	283,487	-	2,640,851	21,704	\$2,946,042	33.3%
Spray Planning		-	29,575	-	376,679	10,747	\$417,001	4.7%
Grand Total	\$2,103,827	\$525,455	\$1,362,774	\$401,462	\$4,105,156	\$361,261	\$8,859,935	100%

Note: IEC: information, education and communication

7.3 UNIT COST ANALYSIS

This section presents Ethiopia IRS as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE ET3: ETHIOPIA UNIT COSTS

		Unit Costs
Cost per	Person protected	\$6.64
	Structure sprayed	\$18.17
	100 m² sprayed	\$29.10

7.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Ethiopia IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table ET4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 12.5 percent from 2018 to 2019, representing an increase in the total annual cost of about \$987,664. Spray operations accounted for the largest increase in costs in relative and absolute terms (54.9 percent or about \$1,454,550). In 2018, VectorLink Ethiopia expanded IRS operations to add 26 new districts out of 44 overall. In 2019, using lessons learned in operating in remote, security-challenged areas, the project reinforced planning, training and supervision during implementation, including nearly doubling the number of squad leaders, introducing M&E assistants, and tripling the number of seasonal supervisors (to complement the government supervisors). We also introduced breakfast and conducted door-to-door mobilization for the first time. Additionally, the project experienced major security issues that resulted in an increased number of campaign days. Finally, the project conducted enumeration in Gambela and a Post-Spray Data Quality Audit (PSDQA). These operational changes accounted for the increase in spray operation costs.

The increase in spray operations was somewhat offset by a decrease in commodities costs because most equipment was retained by the graduated districts and the majority of costs associated with preparing sites was incurred previously.

TABLE ET4: ETHIOPIA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2017-2018
Insecticide	\$1,975,237	\$2,103,827	6.5%
Local Admin	\$480,766	\$525,455	9.3%
Local Labor	\$1,220,782	\$1,362,774	11.6%
Spray Operations	\$2,650,606	\$4,105,156	54.9%
Commodities	\$1,104,841	\$401,462	-63.7%
U.S. Labor	\$440,039	\$361,261	-17.9%
TOTAL	\$7,872,271	\$8,859,935	12.5%

Table ET5 compares the year-on-year change in Ethiopia IRS program output measures and unit costs. In 2019, the program protected more people, sprayed more structures and more area than in 2018.

Because both the number of people protected and total costs increased by 5.6 and 12.5 percent, respectively, from 2018 to 2019, the cost per person protected increased from \$6.23 to \$6.64 (6.6 percent) across the two years. The increases in total costs and number of structures sprayed from 2018 to 2019 also resulted in higher costs per structure sprayed (9.0 percent increase). The increases in area sprayed and total costs also resulted in a higher cost per area sprayed in 2019 than in 2018 (6.2 percent increase).

TABLE ET5: ETHIOPIA IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	1,264,189	1,334,868	5.6%
Structures Sprayed	472,569	487,746	3.2%
Area Sprayed (100 m ²)	287,243	304,420	6.0%
Unit Costs			
Per Person Protected	\$6.23	\$6.64	6.6%
Per Structure Sprayed	\$16.66	\$18.17	9.0%
Per Area Sprayed	\$27.41	\$29.10	6.2%

8. GHANA

8.1 BACKGROUND

TABLE GHI: GHANA QUICK FACTS

	2019
Program Dates	Jan 1, 2019– Dec 31, 2019
Number of Districts	8
# Local Staff	25
Spray Start Date	Apr 9, 2019
Insecticides Used	Organophosphates and neonicotinoids
# Units of Insecticide Used	66,733 (33,783 O; 32,950 N)
# People Protected	875,481
# Structures Sprayed ^{†**}	298,385
# 100 Square Meters Sprayed [*]	166,833

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

**Includes 1,458 structures sprayed in the partial spraying trial.

8.2 PROGRAM EXPENDITURES

This section will present an overview of Ghana IRS program expenditures. In addition to the initially planned spray campaign, VL Ghana conducted a six-operational day (May 16 through 26) partial spraying trial in three communities in Bunkpurugu-Nakpanduri, Gushegu, and Karaga. The objective of the field-based trial was to monitor the efficacy of IRS on reduced amounts of surfaces and assess potential cost savings and operational benefits of this approach. Partial spraying was conducted with Actellic® 300CS pirimiphos-methyl in three communities. To support the partial spray, the project conducted a one-day refresher training on partial spray techniques for the spray teams. Since the costs in this section include structures in the three areas that used partial IRS -- where cost savings have been considerable -- the overall cost averages in Ghana are slightly lower than what they would have been for full IRS. Costs are organized by activity and cost category.

Table GH2 displays the Ghana IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

Costs for insecticides, the spray campaign, and administration constitute almost 67 percent of costs (24.7, 21.7 and 20.5 percent of total costs, respectively). PMI VectorLink procured 26,832 bottles of Actellic CS300 and 38,292 sachets of SumiShield and used 33,783 bottles and 32,950 sachets, respectively; the cost for insecticide used is included in this analysis. 67 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray

operations. An additional \$157,528 was spent on activities related to ITN durability monitoring, which is not included in Table GH2.

TABLE GH2: GHANA IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		322,180	505,881			148,267	\$976,328	20.5%
Entomology			155,130		479,911	6,491	\$641,532	13.5%
Environmental Compliance			35,869		26,696	21,463	\$84,028	1.8%
Equipment Supplies				78,742			\$78,742	1.7%
IEC			21,299		223,262		\$244,561	5.1%
Insecticide*	1,173,748						\$1,173,748	24.7%
M&E			31,113		94,705	46,471	\$172,290	3.6%
Post Spray			95,631		87,773		\$183,404	3.9%
Spray Campaign			33,394	7,707	978,485	12,542	\$1,032,127	21.7%
Spray Planning			39,483		114,091	14,387	\$167,961	3.5%
Grand Total	\$1,173,748	\$322,180	\$917,799	\$86,448	\$2,004,923	\$249,621	\$4,754,720	100.0%

Note: IEC: information, education and communication

8.3 UNIT COST ANALYSIS

This section presents Ghana IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE GH3: GHANA UNIT COSTS

		Unit costs
Cost per	Person protected	\$5.43
	Structure sprayed	\$15.93
	100 m ² sprayed	\$28.50

8.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Ghana IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table GH4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 2.9 percent from 2018 to 2019, representing an increase in the total annual cost of about \$133,582. Costs increased for (1) insecticide by \$144,851, and (2) spray operations by \$177,703. The increased costs in spray operations mainly reflect preparation for expansion to a new district, for which the project procured insecticide and commodities and completed a number of pre-spray activities including IRS infrastructure, trainings and enumeration. Ghana did not expand IRS into the new area due to emerged ethnic conflict that posed safety and security risks to the project team and implementation. Cost in all other categories declined, although by less than \$100,000 for any individual category.

TABLE GH4: GHANA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$1,028,897	\$1,173,748	14.1%
Local Admin	\$337,233	\$322,180	-4.5%
Local Labor	\$991,786	\$917,799	-7.5%
Spray Operations	\$1,827,220	\$2,004,923	9.7%
Commodities	\$120,316	\$86,448	-28.1%
U.S. Labor	\$315,685	\$249,621	-20.9%
TOTAL	\$4,621,137	\$4,754,720	2.9%

Table GH5 compares the year-on-year change in Ghana IRS program output measures and unit costs. In 2019, the program protected more people and sprayed more area, 4.7 and 1.8 percent increases, respectively. The program sprayed fewer structures for the same time period (0.1 percent decrease).

Total program costs increased by 2.9 percent, while the number of people protected increased by 4.7 percent between 2018 and 2019. Thus, the cost per person protected decreased by 1.7 percent between the two years. Given the increase in total program cost was of a slightly higher magnitude than the increase in area sprayed, the unit cost per area sprayed increased in 2019 compared to 2018 (1.1 percent increase). The unit cost per structure sprayed also increased by 3 percent for this time period.

TABLE GH5: GHANA IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	836,376	875,481	4.7%
Structures Sprayed	298,701	298,385	-0.1%
Area Sprayed (100 m ²)	163,860	166,833	1.8%
Unit Costs			
Per Person Protected	\$5.53	\$5.43	-1.7%
Per Structure Sprayed	\$15.47	\$15.93	3.0%
Per Area Sprayed	\$28.20	\$28.50	1.1%

9. KENYA

9.1 BACKGROUND

TABLE KNI: KENYA QUICK FACTS

	2019
Program Dates	Oct 1, 2018–Sep 30, 2019*
Number of Sub-counties	14
# Local Staff	38
Spray Start Date	Jan 28, 2019
Insecticides Used	Organophosphates and neonicotinoids
# Units of Insecticide Used	158,877 (155,547 O; 3,330 N)
# People Protected	2,011,860
# Structures Sprayed	507,777
# 100 Square Meters Sprayed ⁺	397,193

*These dates were used for the costing analysis to be comparable with previous years' analyses so that all costs, year on year, are included in the report.

⁺ Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

9.2 PROGRAM EXPENDITURES

This section presents an overview of Kenya IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table KN2 displays the Kenya IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

The spray campaign is the most expensive IRS activity (26.9 percent of expenditures), followed by insecticide (23.9 percent of expenditures) and spray planning (17.3 percent of expenditures). PMI VectorLink procured 167,494 bottles of Actellic CS300 and 3,330 sachets of SumiShield, and used about 155,547 bottles and 3,330 sachets, respectively. Insecticide costs reflect total insecticides used. About 52 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray operations. An additional \$2,678 was spent on activities related to ITN durability monitoring, which are not included in Table KN2.

TABLE KN2: KENYA IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		853,612	717,860			205,897	\$1,777,369	16.1%
Entomology			196,850		395,632	31,384	\$623,865	5.7%
Environmental Compliance			31,330		21,432	21,806	\$74,568	0.7%
Equipment Supplies			148	392,691			\$392,840	3.6%
IEC			68,780		18,676	5,254	\$92,710	0.8%
Insecticide	2,636,023						\$2,636,023	23.9%
M&E			142,059		24,626	56,619	\$223,305	2.0%
Post Spray			119,322		204,630		\$323,952	2.9%
Spray Campaign			122,379		2,833,982	8,336	\$2,964,697	26.9%
Spray Planning			260,866		1,596,321	43,694	\$1,900,881	17.3%
Grand Total	\$2,636,023	\$853,612	\$1,659,594	\$392,691	\$5,095,299	\$372,989	\$11,010,208	100.0%

9.3 UNIT COST ANALYSIS

This section presents Kenya IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE KN3: KENYA UNIT COSTS

		Unit costs
	Person protected	\$5.47
Cost per	Structure sprayed	\$21.68
	100 m2 sprayed	\$27.72

9.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Kenya IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs. 2018 expenditures, excluding insecticides, have been adjusted to real 2019 U.S. dollars to allow for a more accurate comparison.

Table KN4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 8.6 percent from 2018 to 2019, representing a decrease in the total cost of about \$1,039,841. Costs decreased for all categories over this period, except for local labor. Local labor increased by 26.5% (about \$347,248) during this time period, primarily because 14 new staff, i.e. sub-county coordinators, were hired. The additional staffing was based on recommendation from prior spray campaigns for a need of another cadre of project staff (similar to district coordinators in other countries) to provide support and oversight at the sub-county level for effective operations.

TABLE KN4: KENYA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$2,899,824	\$2,636,023	-9.1%
Local Admin	\$954,959	\$853,612	-10.6%
Local Labor	\$1,312,347	\$1,659,594	26.5%
Spray Operations	\$5,905,701	\$5,095,299	-13.7%
Commodities	\$572,121	\$392,691	-31.4%
U.S. Labor	\$405,098	\$372,989	-7.9%
TOTAL	\$12,050,050	\$11,010,208	-8.6%

Table KN5 compares the year-on-year change in Kenya IRS program output measures and unit costs. In 2019, the program protected 9.7 percent more people and sprayed 15.2 percent more structures. Area sprayed decreased slightly by 2.2% in 2019.

Because the number of people protected increased by 9.7 percent from 2018 to 2019, but total costs decreased by 8.6 percent, the cost per person protected decreased from \$6.28 to \$5.47 (16.7 percent) across the two years. The decrease in total costs from 2018 to 2019 and the increase in the number of structures sprayed also resulted in decreased costs per structure sprayed in 2019 from 2018 (20.7 percent). The higher reduction in total costs compared to the smaller decrease in the area sprayed also resulted in a lower cost per area sprayed in 2019 than in 2018 (6.6 percent decrease).

TABLE KN5: KENYA IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	1,833,860	2,011,860	9.7%
Structures Sprayed	440,969	507,777	15.2%
Area Sprayed (100 m ²)	406,170	397,193	-2.2%
Unit Costs			
Per Person Protected	\$6.57	\$5.47	-16.7%
Per Structure Sprayed	\$27.33	\$21.68	-20.7%
Per Area Sprayed	\$29.67	\$27.72	-6.6%

10. MADAGASCAR

10.1 BACKGROUND

TABLE MGI: MADAGASCAR QUICK FACTS

	2019
Program Dates	Jan 1, 2019–Dec 31, 2019
Number of Districts	5
# Local Staff	35
Spray Start Date	Nov 4, 2019
Insecticides Used	Organophosphates and neonicotinoids
# Units of Insecticide Used	47,663 (30,667 O; 16,996 N)
# People Protected	1,150,922
# Structures Sprayed	267,874
# 100 Square Meters Sprayed*	119,158

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

10.2 PROGRAM EXPENDITURES

This section will present an overview of Madagascar IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table MG2 displays the Madagascar IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories. An additional \$77,056 was spent on activities related to ITN durability monitoring; this cost is not included in Table MG2.

TABLE MG2: MADAGASCAR IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		454,151	568,610			177,999	\$1,200,759	25.6%
Entomology			183,124		419,561	6,950	\$609,635	13.0%
Environmental Compliance			30,556		103,577	17,183	\$151,315	3.2%
Equipment Supplies				156,760			\$156,760	3.3%
IEC			29,840		109,221		\$139,061	3.0%
Insecticide	743,700						\$743,700	15.8%
M&E			40,325		110,876	61,982	\$213,182	4.5%
Post Spray			7,790		44,971		\$52,761	1.1%
Spray Campaign			13,104		906,121	2,607	\$921,833	19.6%
Spray Planning			135,203		363,168	5,686	\$504,057	10.7%
Grand Total	\$743,700	\$454,151	\$1,008,552	\$156,760	\$2,057,494	\$272,407	\$4,693,064	100.0%

Note: IEC: information, education and communication

Administration and the spray campaign were the two most expensive IRS activities (constituting 25.6 percent and 19.6 percent of expenditures, respectively), followed by insecticides (15.8 percent of expenditures). VectorLink Madagascar procured 10,140 sachets of Fludora® Fusion and 17,171 sachets of SumiShield, and used 30,667 Actellic bottles (from remaining stock from previous years' spray campaigns), 13,430 SumiShield sachets, and 3,566 Fludora® Fusion sachets. The costs of insecticides used are reflected here. About 62 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray operations.

10.3 UNIT COST ANALYSIS

This section presents Madagascar IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE MG3: MADAGASCAR UNIT COSTS

		Unit Costs
Cost per	Person protected	\$4.08
	Structure sprayed	\$17.52
	100 m ² sprayed	\$39.39

10.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the VectorLink Madagascar IRS program between 2018 and 2019, as implemented by the project. The comparison focuses on output measures, total expenditures, and unit costs. 2018 expenditures, excluding insecticides, have been adjusted to real 2019 U.S. dollars to allow for a more accurate comparison.

Table MG4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 34.4 percent from 2018 to 2019, largely due to an almost 69 percent decrease in commodities costs, a 34.2 decrease in spray operations costs and an almost 50 percent decrease in insecticide costs. All other costs also decreased for this time period.

TABLE MG4: MADAGASCAR IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$1,481,633	\$743,700	-49.8%
Local Admin	\$554,311	\$454,151	-18.1%
Local Labor	\$1,083,003	\$1,008,552	-6.9%
Spray Operations	\$3,126,841	\$2,057,494	-34.2%
Commodities	\$501,984	\$156,760	-68.8%
U.S. Labor	\$409,322	\$272,407	-33.4%
TOTAL	\$7,157,094	\$4,693,064	-34.4%

Table MG5 compares the year-on-year change in Madagascar IRS program output measures and unit costs. Overall, in 2019, the program coverage about half the number of people and structures than it did in 2018: the number of people protected decreased by 48.4 percent from 2018 to 2019, and the number of structures sprayed and area sprayed decreased by 51.2 percent and 46.0 percent, respectively.

TABLE MG5: MADAGASCAR IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	2,232,097	1,150,922	-48.4%
Structures Sprayed	548,789	267,874	-51.2%
Area Sprayed (100 m ²)	220,560	119,158	-46.0%
Unit Costs			
Per Person Protected	\$3.21	\$4.08	27.2%
Per Structure Sprayed	\$13.04	\$17.52	34.3%
Per Area Sprayed	\$32.45	\$39.39	21.4%

Total program costs decreased by 34.4 percent, while, comparatively, the number of structures sprayed decreased by 51.2 percent between 2018 and 2019. Thus, because coverage decreased more than costs, the cost per structure sprayed increased by 34.3 percent between the two years. The decrease in the number of people protected (48.4 percent) was larger than the decrease in the program costs between 2017 and 2018, indicating that the cost per person protected increased by 27.2 percent between the two years. The cost per area sprayed increased from \$32.83 in 2018 to \$39.39 in 2019, an increase of 21.4 percent.

II. MALAWI

II.1 BACKGROUND

TABLE MWI: MALAWI QUICK FACTS

	2019
Program Dates	Apr 1, 2019–Mar 31, 2020
Number of Districts	1
# Local Staff	18
Spray Start Date	Oct 17, 2019
Insecticides Used	Organophosphates and neonicotinoids
# Units of Insecticide Used	52,549 (42,767 O; 9,782 N)
# People Protected	441,375
# Structures Sprayed	107,565
# 100 Square Meters Sprayed*	131,373

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

II.2 PROGRAM EXPENDITURES

This section presents an overview of Malawi IRS program expenditures including technical assistance for government funded IRS in 2019. Costs are organized by activity and cost category.

Table MW2 displays the Malawi IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project’s financial systems, and the top row lists IRS program cost categories.

Administration is the most expensive IRS activity (24.1 percent of expenditures), followed by insecticide (15.1 percent of expenditures) and the spray campaign (14.5 percent of expenditures). Administration cost drivers in Malawi include site office labor for finance and administration staff, including one US expatriate and one third country national staff. PMI VectorLink procured 38,439 bottles of Actellic CS300, 10,213 sachets of SumiShield, and used 52,549 units of insecticide (42,767 bottles of Actellic CS300 and 9,782 sachets of SumiShield- costs reflect the insecticides used). About 49 percent of the total cost for administration consists of labor, both local and U.S.-based. Expenditures on insecticide, local labor, and spray operations are about 82 percent of costs, with local administration, U.S. labor, and commodities costs composing the remaining 18 percent of costs. An additional \$11,070 was spent on ITN durability monitoring which is not included in Table MW2.

TABLE MW2: MALAWI IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		341,672	655,663			181,371	\$1,178,705	24.1%
Entomology		21,014	100,993		871,069	12,021	\$1,005,098	20.6%
Environmental Compliance			41,643		46,276	52,921	\$140,840	2.9%
Equipment Supplies				155,741			\$155,741	3.2%
IEC			38,142		43,397		\$81,538	1.7%
Insecticide	738,773						\$738,773	15.1%
M&E		7,240	98,305		80,313	83,270	\$269,128	5.5%
Post Spray			25,241		61,637		\$86,877	1.8%
Spray Campaign			21,561		677,130	9,100	\$707,791	14.5%
Spray Planning			156,364		323,615	42,016	\$521,995	10.7%
Grand Total	\$738,773	\$369,926	\$1,137,912	\$155,741	\$2,103,436	\$380,699	\$4,886,487	100.0%

Note: IEC: information, education and communication

11.3 UNIT COST ANALYSIS

This section presents Malawi IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE MW3: MALAWI UNIT COSTS

		Unit Costs
	Person protected	\$11.07
Cost per	Structure sprayed	\$45.43
	100 m² sprayed	\$37.20

11.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Malawi IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table MW4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 17.9 percent (or about \$743,020) from 2018 to 2019. Costs increased for all categories during this time period except insecticides and local administration. Increases in spray operations costs increased by 34% (about \$536,000), largely because of an increase in subcontractor costs for entomological monitoring. Local labor also increased by \$316,230 as the number of staff increased from 16 to 18. Together, these two categories accounted for more than 92 percent of the increase in costs between the two years.

TABLE MW4: MALAWI IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$824,537	\$738,773	-10%
Local Admin	\$466,292	\$369,926	-21%
Local Labor	\$821,682	\$1,137,912	38%
Spray Operations	\$1,566,594	\$2,103,436	34%
Commodities	\$93,830	\$155,741	66%
U.S. Labor	\$370,532	\$380,699	3%
TOTAL	\$4,143,467	\$4,886,487	17.9%

Table MW5 compares the year-on-year change in Malawi IRS program output measures and unit costs. In 2019, the program protected 12 percent fewer people and sprayed 4.2 percent fewer structures. There was a 10.1 percent increase, however, in total area sprayed compared to 2018.

The increase in total costs resulted in increased unit costs per person protected and per structure sprayed in 2019 (34.0 percent and 23.1 percent increase, respectively) as compared to 2018. The magnitude of increase in total area sprayed in 2019 was lower than the increase in overall program costs, also resulting in increased cost per area sprayed (7.1 percent increase) compared to 2018.

TABLE MW5: MALAWI IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	501,324	441,375	-12.0%
Structures Sprayed	112,264	107,565	-4.2%
Area Sprayed (100 m ²)	119,358	131,373	10.1%
Unit Costs			
Per Person Protected	\$8.27	\$11.07	34.0%
Per Structure Sprayed	\$36.91	\$45.43	23.1%
Per Area Sprayed	\$34.71	\$37.20	7.1%

12. MALI

12.1 BACKGROUND

TABLE MLI: MALI QUICK FACTS

	2019
Program Dates	Jan 1, 2019–Dec 31, 2019
Number of Districts	3
# Local Staff	22
Spray Start Date	Jul 01, 2019
Insecticides Used	Organophosphates and neonicotinoids
# Units of Insecticide Used	61,617 (51,347 O; 10,270 N)
# People Protected	690,793
# Structures Sprayed	148,198
# 100 Square Meters Sprayed*	24,898

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

12.2 PROGRAM EXPENDITURES

This section will present an overview of Mali IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table ML2 displays the Mali IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

Administration is the most expensive IRS activity (29.7 percent of expenditures), followed by insecticide (23.2 percent of expenditures) and entomology (16.1 percent of expenditures). PMI VectorLink procured 60,993 bottles of Actellic CS300 and 10,583 sachets of SumiShield. PMI VectorLink used 51,347 bottles of Actellic CS300 and 10,270 sachets of SumiShield (costs reflect the amount of insecticide used).

TABLE ML2: MALI IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		575,876	687,503			131,693	\$1,395,072	29.7%
Entomology			112,814		614,551	29,960	\$757,325	16.1%
Environmental Compliance			29,622		117,881	10,218	\$157,721	3.4%
Equipment Supplies				205,230			\$205,230	4.4%
IEC					15,633		\$15,633	0.3%
Insecticide	1,090,705						\$1,090,705	23.2%
M&E			68,436		96,702	29,344	\$194,482	4.1%
Post Spray			1,576		30,132		\$31,708	0.7%
Spray Campaign			341		633,236	1,247	\$634,825	13.5%
Spray Planning			1,053		207,568	3,749	\$212,370	4.5%
Grand Total	\$1,090,705	\$575,876	\$901,345	\$205,230	\$1,715,703	\$206,210	\$4,695,069	100.0%

Note: IEC: information, education and communication

12.3 UNIT COST ANALYSIS

This section presents Mali IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE ML3: MALI UNIT COSTS

	Unit Costs
Person protected	\$5.47
Structure sprayed	\$25.51
100 m² sprayed	\$30.48

12.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Mali IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table ML4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 11.6 percent from 2018 to 2019. Costs decreased for all categories except local administration, which increased by about \$144,000 (33.5 percent), which accounts for shipping and moving costs for a new TCN COP and Technical Manager as well as changes in allowances. This increase is partially offset by local labor decreases due to gaps in employment for these two positions. Costs for insecticide decreased by almost \$300,000 (21.5 percent) and costs for spray operations decreased by almost \$235,000 (12.0 percent) between 2017 and 2018; together these two categories accounted for more than 70 percent of the decrease in costs between the two years. The decrease in spray operations costs is partly explained by shifting from covering four districts in 2018 to three districts in 2019 but also is a result of reductions in printing IEC materials and decreases in the unit cost of fuel.

TABLE ML4: MALI IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$1,388,739	\$1,090,705	-21.5%
Local Admin	\$431,451	\$575,876	33.5%
Local Labor	\$1,077,218	\$901,345	-16.3%
Spray Operations	\$1,950,472	\$1,715,703	-12.0%
Commodities	\$215,923	\$205,230	-5.0%
U.S. Labor	\$246,727	\$206,210	-16.4%
TOTAL	\$5,310,531	\$4,695,069	-11.6%

Table ML5 compares the year-on-year change in Mali IRS program output measures and unit costs. In 2019, the program protected 3.8 percent more people, and sprayed 7.8 percent fewer structures and 20.0 percent less area than in 2018. This indicates that the unit costs per person protected and per structure sprayed were lower in 2019 than in 2018 by 14.8 percent and 4.1 percent, respectively. However, the total 100 m² sprayed in 2018 was greater than in 2019, and this decrease was larger than the decrease in overall program costs, indicating that the cost per area sprayed increased by 10.5 percent. This might be explained by an increase in acceptance or that non-sleeping rooms might have been converted to sleeping rooms to accommodate the internal displacement and migration of the population from the north.

TABLE ML5: MALI IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	665,581	690,793	3.8%
Structures Sprayed	160,723	148,198	-7.8%
Area Sprayed (100 m ²)	192,463	154,043	-20.0%
Unit Costs			
Per Person Protected	\$7.98	\$6.80	-14.8%
Per Structure Sprayed	\$33.04	\$31.68	-4.1%
Per Area Sprayed	\$27.59	\$30.48	10.5%

13. MOZAMBIQUE

13.1 BACKGROUND

TABLE MZI: MOZAMBIQUE QUICK FACTS

	2019
Program Dates	April 1, 2019– Mar 31, 2020*
Number of Districts	5
# Local Staff	32
Spray Start Date	October 28, 2019
Insecticides Used	Neonicotinoids
# Units of Insecticide Used	158,130
# People Protected	1,484,191
# Structures Sprayed	338,330
# 100 Square Meters Sprayed*	395,325

* These dates were used for the costing analysis to be comparable with previous years' analyses so that all costs, year on year, are included in the report; spray program dates were from Mar 1, 2019, to Feb 29, 2020.

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

13.2 PROGRAM EXPENDITURES

This section presents an overview of Mozambique IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table MZ2 displays the Mozambique IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

Insecticides and administration are the two most expensive IRS activities (27.5 percent and 19.2 percent of expenditures, respectively), followed by spray campaign (17.3 percent of expenditures). The NMCP through the Global Fund procured 204,412 sachets of Fludora® Fusion and 56,184 sachets of SumiShield, and PMI VectorLink Mozambique used 102,053 and 56,077 sachets of Fludora® Fusion and SumiShield, respectively. Costs reflect the insecticides used. About 59 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs make up less than 17 percent of total costs.

TABLE MZ2: MOZAMBIQUE IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		662,267	753,353			215,220	\$1,630,840	19.2%
Entomology			502,351		768,530	35,965	\$1,306,846	15.4%
Environmental Compliance			97,977		42,904	43,243	\$184,124	2.2%
Equipment Supplies				413,225			\$413,225	4.9%
IEC					20,368		\$20,368	0.2%
Insecticide*	2,330,278						\$2,330,278	27.5%
M&E			132,567		58,624	37,014	\$228,205	2.7%
Post Spray			46,750		42,097		\$88,847	1.0%
Spray Campaign			88,608		1,376,602	625	\$1,465,836	17.3%
Spray Planning			800,655		2,413	3,793	\$806,861	9.5%
Grand Total	\$2,330,278	\$662,267	\$2,422,260	\$413,225	\$2,311,540	\$335,860	\$8,475,430	100.0%

*Includes estimated cost of insecticides procured by the NMCP based on the unit price of \$15 for SumiShield 50WG and a base unit price of \$14.50 for Fludora® Fusion. Note: IEC: information, education and communication

13.3 UNIT COST ANALYSIS

This section presents Mozambique IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE MZ3: MOZAMBIQUE UNIT COSTS

		Unit Costs
Cost per	Person protected	\$5.71
	Structure sprayed	\$25.05
	100 m ² sprayed	\$21.44

13.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the PMI VectorLink Mozambique IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project.

Table MZ4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 5.0 percent from 2018 to 2019. The only cost category to increase in cost was local labor (35.2 percent increase from 2018). This increase was driven by (a) third country national technical manager labor and allowances, (b) two new staff (a driver and an insectary technician) and (c) the end of an operational research study titled “Cost-effectiveness evaluation of vector control strategies in Mozambique,” in October 2019. This was a collaborative study with NMCP, PMI, Innovative Vector Control Consortium, PATH and Manhiça Health Research Centre (Centro de Investigação em Saúde de Manhiça). From November 2019 – February 2020, entomology labor spent on Mopiea entomology activities is included in the PMI VectorLink Project. Local administration accounts for the largest relative decrease in costs, a 33.5 percent decrease (a \$334,095 decrease). Costs decreased between 2018 and 2019 by 22 percent, 14 percent, and 2.7 percent for spray operations, US labor, and commodities, respectively, with spray operations decreasing by more than \$650,000.

TABLE MZ4: MOZAMBIQUE IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$2,772,405	\$2,330,278	-15.9%
Local Admin	\$996,362	\$662,267	-33.5%
Local Labor	\$1,791,177	\$2,422,260	35.2%
Spray Operations	\$2,963,339	\$2,311,540	-22.0%
Commodities	\$424,481	\$413,225	-2.7%
U.S. Labor	\$390,349	\$335,860	-14.0%
TOTAL	\$9,338,113	\$8,475,430	-9.2%

Table MZ5 compares the year-on-year change in Mozambique IRS program output measures and unit costs. Overall, in 2019, the program protected fewer people and sprayed fewer structures and less area than in 2018. This decrease was because IRS was conducted in five districts in 2019 compared to six in 2018. Because the decrease in total program costs was of a smaller magnitude than the decrease in people protected, structures sprayed, and area sprayed, unit costs increased for all three metrics from 2018 to 2019 (1.7 percent, 3.9 percent, 6.1 percent, respectively).

TABLE MZ5: MOZAMBIQUE IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	1,663,078	1,484,191	-10.8%
Structures Sprayed	387,413	338,330	-12.7%
Area Sprayed (100 m ²)	462,068	395,325	-14.4%
Unit Costs			
Per Person Protected	\$5.61	\$5.71	1.7%
Per Structure Sprayed	\$24.10	\$25.05	3.9%
Per Area Sprayed	\$20.21	\$21.44	6.1%

14. RWANDA

14.1 BACKGROUND

TABLE RW1: RWANDA QUICK FACTS

	2019
Program Dates*	Mar 1, 2019–Feb 28, 2020
Number of Districts	2 + Mahama Refugee Camp
# Local Staff	14
Spray Start Date	Sep 2, 2019
Insecticides Used	Neonicotinoids
# Units of Insecticide Used	165,704
# People Protected [#]	915,034
# Structures Sprayed [#]	221,712
# 100 Square Meters Sprayed ^{#+}	414,260

* This year Rwanda sprayed a new district (Ngoma) in January/February 2020, which is outside the dates considered for the costing (Jan-Dec 2019) but within the work plan years listed. The costing dates are used for consistency with previous reports.

[#]Numbers include spraying of the Mahama Refugee Camp

⁺Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

14.2 PROGRAM EXPENDITURES

This section presents an overview of Rwanda IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table RW2 displays the Rwanda IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

Insecticides represented 47.8 percent of costs. Administration and spray campaign costs were the next two most expensive activities, representing 18.5 and 11.4 percent of costs, respectively. The project procured 239,590 sachets of Fludora® Fusion, and used 165,704 sachets. The costs below reflect the cost of insecticide used. It is important to note that the remaining amount of insecticide sachets were procured to spray a third IRS district in February 2020 but not included in this cost report. About 63 percent of the total cost for administration consisted of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs were minimal compared to expenditures on insecticide, local labor, and spray operations. About \$28,436 was also spent on ITN durability monitoring, which is not included in Table RW2.

TABLE RW2: RWANDA IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		377,071	365,875			264,097	\$1,007,043	18.5%
Entomology			307,528		51,525	8,927	\$367,979	6.8%
Environmental Compliance			58,615		20,790	9,768	\$89,174	1.6%
Equipment Supplies				235,430			\$235,430	4.3%
IEC							\$-	0.0%
Insecticide	2,604,218						\$2,604,218	47.8%
M&E			51,556		38,935	37,503	\$127,993	2.4%
Post Spray			320		38,862	1,896	\$41,078	0.8%
Spray Campaign			2,334		617,407	2,010	\$621,750	11.4%
Spray Planning			123,787		207,250	19,608	\$350,646	6.4%
Grand Total	\$2,604,218	\$377,071	\$910,015	\$235,430	\$974,770	\$343,809	\$5,445,311	100.0%

Note: IEC: information, education and communication

14.3 UNIT COST ANALYSIS

This section presents Rwanda IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE RW3: RWANDA UNIT COSTS

		Unit Costs
Person protected		\$5.95
Cost per Structure sprayed		\$24.56
100 m² sprayed		\$13.14

14.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Rwanda IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table RW4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 4.3 percent from 2018 to 2019, representing a decrease in the total annual cost of almost \$243,000. Insecticide costs decreased by 6 percent (about \$177,000), while spray operations costs decreased by 26 percent (about \$336,000) despite spraying more structures in 2019 than in 2018. Spray operation costs were decreased by a new mobilization strategy that saved costs, the walk-to-work strategy and reducing training length for SOPs in two districts. Costs also decreased for local administration by 2 percent. Costs increased for local labor by about \$132,000 (reflecting a scale increase in June 2019 that increased all site office staff salaries) and for US labor by about \$136,000 (largely for two STTA trips, increased M&E support for the VectorLink Collect rollout, and long-term technical assistance for a temporary COP in November and December). The costs for commodities also increased by about 5 percent.

TABLE RW4: RWANDA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$2,781,842	\$2,604,218	-6%
Local Admin	\$385,337	\$377,071	-2%
Local Labor	\$778,506	\$910,015	17%
Spray Operations	\$1,310,732	\$974,770	-26%
Commodities	\$223,761	\$235,430	5%
U.S. Labor	\$208,001	\$343,809	65%
TOTAL	\$5,688,179	\$5,445,311	-4.3%

Table RW5 compares the year-on-year change in VectorLink Rwanda program output measures and unit costs. In 2019, the program achieved higher coverage on all three indicators used in Table RW5 than in 2018. Between 2018 and 2019, the number of people protected increased 2.3 percent, the number of structures sprayed increased 3.0 percent, and the area sprayed increased by 1.2 percent. Given the decrease in total expenditures, the unit costs decreased by 6.4 percent for cost per person protected and 7.2 percent for cost per structure sprayed. The cost per area sprayed decreased by 5.5 percent.

TABLE RW5: RWANDA IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	894,098	915,034	2.3%
Structures Sprayed	214,802	221,712	3.0%
Area Sprayed (100 m ²)	408,878	414,260	1.2%
Unit Costs			
Per Person Protected	\$6.36	\$5.95	-6.4%
Per Structure Sprayed	\$26.48	\$24.56	-7.2%
Per Area Sprayed	\$13.91	\$13.14	-5.5%

15. TANZANIA

15.1 BACKGROUND

TABLE TZI: TANZANIA QUICK FACTS

	2019
Program Dates*	Oct 1, 2018–Sep 30, 2019
Number of Districts	17
# Local Staff	34
Spray Start Date <i>Mainland (Kagera/Geita)</i>	Oct 23, 2018 - Nov 24, 2018
<i>Zanzibar</i>	Feb 23, 2019 – Mar 17, 2019
Insecticides Used	Organophosphates and neonicotinoids
# Units of Insecticide Used	181,937 (27,193 O; 154,744 N)
# People Protected	2,404,010
# Structures Sprayed	595,923
# 100 Square Meters Sprayed ⁺	454,843

*These dates were used for the costing analysis to be comparable with previous years' analyses so that all costs, year on year, are included in the report.

⁺ Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

15.2 PROGRAM EXPENDITURES

This section presents an overview of Tanzania IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table TZ2 displays the Tanzania IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

TABLE TZ2: TANZANIA IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		929,582	1,060,307			192,462	\$2,182,350	26.2%
Entomology			567		36,504	1,107	\$38,177	0.5%
Environmental Compliance			56,737		105,926	25,680	\$188,342	2.3%
Equipment Supplies				302,574			\$302,574	3.6%
IEC							\$-	0.0%
Insecticide	3,376,560						\$3,376,560	40.5%
M&E			78,904		126,565	40,045	\$245,514	2.9%
Post Spray			187,609		68,579		\$256,188	3.1%
Spray Campaign			57,596		1,632,513	4,597	\$1,694,706	20.3%
Spray Planning			44,904		104	394	\$45,402	0.5%
Grand Total	\$3,376,560	\$929,582	\$1,486,624	\$302,574	\$1,970,190	\$264,285	\$8,329,814	100.0%

Note: IEC: information, education and communication

Insecticide is the most expensive IRS activity (40.5 percent of expenditures), followed by the spray administration (26.2 percent of expenditures) and spray campaign activities (20.3 percent of expenditures). PMI VectorLink procured 161,374 sachets of SumiShield insecticide and the Global Fund procured 10,603 bottles of Actellic CS300. PMI VectorLink used about 27,193 bottles of Actellic CS300 and 154,744 sachets of SumiShield (costs reflect the insecticides used). About 57 percent of the total cost for administration consists of labor, both local and U.S.-based. U.S. labor and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray operations. An additional \$34,953 was also spent on the start of the ITN school-based distribution campaign, which is not included in Table TZ2.

15.3 UNIT COST ANALYSIS

This section presents Tanzania IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE TZ3: TANZANIA UNIT COSTS

		Unit Costs
	Person protected	\$3.46
Cost per	Structure sprayed	\$13.98
	100 m² sprayed	\$18.31

15.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Tanzania IRS program between 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table TZ4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 24.5 percent from 2018 to 2019, representing a decrease in the total annual cost of about \$2,700,000 largely due to decreases in costs for insecticides and spray operations.

The costs of insecticides used decreased 20.0 percent (almost \$846,000) from 2018 to 2019 reflecting lower usage, UNITAID subsidies for SumiShield, and the Global Fund assistance in procuring bottles of organophosphate for Zanzibar (note that the cost of insecticides used, including those procured by the Global Fund, are included here). Spray operations and U.S. labor costs also decreased by 50.2 percent and 32.0 percent, respectively, from 2018 to 2019. Increases were seen in the costs of local administration (about 38.9 percent), while costs for local labor (about less than 0.1 percent), and commodities (-0.2 percent) remained roughly the same.

TABLE TZ4: TANZANIA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$4,222,167	\$3,376,560	-20.0%
Local Admin	\$669,073	\$929,582	38.9%
Local Labor	\$1,486,983	\$1,486,624	0.0%
Spray Operations	\$3,955,916	\$1,970,190	-50.2%
Commodities	\$303,308	\$302,574	-0.2%
U.S. Labor	\$388,621	\$264,285	-32.0%
TOTAL	\$11,026,068	\$8,329,814	-24.5%

Table TZ5 compares the year-on-year change in Tanzania IRS program output measures and unit costs. In 2019, the program had lower coverage metrics than in 2018. The number of people protected decreased by 15.4 percent from 2018 to 2019, and the number of structures sprayed and area sprayed decreased by 20.0 percent and 22.6 percent, respectively. Because the decrease in program size was of a smaller magnitude than the decrease in total expenditures, unit costs decreased from 2018 to 2019. The cost per person protected decreased by about 10.7 percent to \$3.46 per person protected, while costs per structure sprayed and area sprayed decreased on the order of 5.6 percent and 2.4 percent, respectively, from 2018 to 2019. This can be attributed largely to decreases in spray operation costs. As a percentage, spray operation costs decreased more than the number of structures sprayed because one campaign round was removed on the mainland which in turn reduced distribution costs, supervision travel and the number of hired field staff. Additionally, the shift from using organophosphates bottles to neonicotinoids sachets further reduced distribution costs. In Zanzibar, Global Fund directly paid 116 spray operators in three sites in the 2019 spray campaign.

TABLE TZ5: TANZANIA IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	2,840,927	2,404,010	-15.4%
Structures Sprayed	744,597	595,923	-20.0%
Area Sprayed (100 m ²)	587,325	454,843	-22.6%
Unit Costs			
Per Person Protected	\$3.88	\$3.46	-10.7%
Per Structure Sprayed	\$14.81	\$13.98	-5.6%
Per Area Sprayed	\$18.77	\$18.31	-2.4%

16. UGANDA

16.1 BACKGROUND

TABLE UG1: UGANDA QUICK FACTS

	2019
Program Dates	Jan 1, 2018 – Dec 31, 2019
Number of Districts	15
# Local Staff	52
Spray Start Date <i>Phase 1:</i> Budaka, Bugiri, Butaleja, Butebo, Dokolo, Namutumba, Pallisa, and Tororo	March 18, 2019
<i>Phase 2:</i> Alebtong, Amolatar, Dokolo, Kaberamaido, Lira, Otuke, and Serere	May 27, 2019
Insecticides Used	Neonicotinoids and organophosphates
# Units of Insecticide Used	541,157 (449,604 O; 91,553 N)
# People Protected	4,479,157
# Structures Sprayed	1,291,569
# 100 Square Meters Sprayed*	1,352,893

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

16.2 PROGRAM EXPENDITURES

This section presents an overview of Uganda IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table UG2 displays the Uganda IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

TABLE UG2: UGANDA IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin	-	607,478	904,494	-	-	223,014	\$1,734,986	10.1%
Entomology	-	-	239,680	-	246,590	80,491	\$566,760	3.3%
Environmental Compliance	-	-	83,072	-	358,620	65,590	\$507,282	3.0%
Equipment Supplies	-	-	-	727,276	-	-	\$727,276	4.2%
IEC	-	-	23,072	-	386,541	-	\$409,613	2.4%
Insecticide	9,638,259	-	-	-	-	-	\$9,638,259	56.1%
M&E	-	-	88,522	-	170,236	50,402	\$309,160	1.8%
Post Spray	-	-	160,728	-	167,003	-	\$327,731	1.9%
Spray Campaign	-	-	139,740	-	1,721,535	21,351	\$1,882,626	10.9%
Spray Planning	-	-	243,540	-	830,022	17,801	\$1,091,363	6.3%
Grand Total	\$9,638,259	\$607,478	\$1,882,848	\$727,276	\$3,880,546	\$458,649	\$17,195,057	100.0%

Insecticide is the most expensive IRS activity (56.1 percent of expenditures), followed by the spray campaign (10.9 percent of expenditures) and administration (10.1 percent of expenditures). PMI VectorLink procured 488,651 bottles of Actellic CS300 and 119,715 sachets of SumiShield, and used 449,604 bottles of Actellic CS300 and 91,553 sachets of SumiShield (costs reflect the insecticides used). About 65 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray operations.

16.3 UNIT COST ANALYSIS

This section presents Uganda IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE UG3: UGANDA UNIT COSTS

		Unit Costs
	Person protected	\$3.84
Cost per	Structure sprayed	\$13.31
	100 m² sprayed	\$12.71

16.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Uganda IRS program for 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table UG4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 6 percent from 2018 to 2019, representing an increase in the total annual cost of about \$1,008,000.

TABLE UG4: UGANDA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$8,871,598	\$9,638,259	9%
Local Admin	\$491,379	\$607,478	24%
Local Labor	\$1,852,441	\$1,882,848	2%
Spray Operations	\$3,756,053	\$3,880,546	3%
Commodities	\$382,778	\$727,276	90%
U.S. Labor	\$832,659	\$458,649	-45%
TOTAL	\$16,186,907	\$17,195,057	6%

Costs increased in all categories except for US labor, which decreased in the second year of PMI VectorLink project implementation. The largest cost increase from 2018 to 2019 in relative costs was for commodities and local administration at 90 percent and 24 percent, respectively. The largest absolute increase in costs was for insecticide, which increased by more than \$760,000, accounting for more than half of the overall increase in costs between 2018 and 2019. Local labor and spray operations also increased by 2 percent and 3 percent, respectively. The project procured new spray pumps, four vehicles, coveralls and boots for the 2019 spray campaign which increased the overall commodity cost. Other expenditures incurred in 2019 include cost for the environmental and social impact assessment conducted to pave way for approval for use of SumiShield. The project also introduced the use of vehicles to transport spray operators occasioned by increase in distance to target villages as a result of the reduction in the number of operation sites.

Table UG5 compares the year-on-year change in Uganda IRS program output measures and unit costs. In 2019, the program protected about the same number of people, sprayed about the same number of structures, and sprayed a similar amount of area compared to 2018, with differences in 2019 all less than 3 percent (in either direction) compared to 2018. However, there was a 5 percent to 9 percent increase in the unit costs across the two years, reflecting the increase in overall costs.

TABLE UG5: UGANDA IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	4,436,156	4,479,157	1%
Structures Sprayed	1,292,309	1,291,569	0%
Area Sprayed (100 m ²)	1,386,420	1,352,893	-2%
Unit Costs			
Per Person Protected	\$3.65	\$3.84	5%
Per Structure Sprayed	\$12.53	\$13.31	6%
Per Area Sprayed	\$11.68	\$12.71	9%

17. ZAMBIA

17.1 BACKGROUND

TABLE ZA1: ZAMBIA QUICK FACTS

	2019
Program Dates	Apr 1, 2019 - Mar 30, 2020
Number of Districts	20
# Local Staff	44
Spray Start Date	Oct 02, 2019
Insecticides Used	Neonicotinoids
# Units of Insecticide Used	151,299
# People Protected	2,273,188
# Structures Sprayed	536,983
# 100 Square Meters Sprayed*	378,248

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

17.2 PROGRAM EXPENDITURES

This section presents an overview of Zambia IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table ZA2 displays the Zambia IRS program total capital and recurrent expenditures from 2019. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

Insecticides and administration are the two most expensive IRS activities (30.9 percent and 18.8 percent of expenditures, respectively), followed by the spray campaign (15.6 percent of expenditures). PMI VectorLink Zambia procured 120,149 sachets of SumiShield and 53,950 sachets of Fludora® Fusion; 104,764 sachets of SumiShield and 46,535 sachets of Fludora® Fusion were used. About 68.8 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs were less than expenditures on insecticide, local labor, and spray operations. An additional \$14,937 was spent on ITN durability monitoring, which is not reflected in Table ZA2 or elsewhere in this report.

TABLE ZA2: ZAMBIA IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		451,391	821,348			174,065	\$1,446,805	18.8%
Entomology			162,248		275,940	31,728	\$469,916	6.1%
Environmental Compliance			37,516		373,693	52,318	\$463,527	6.0%
Equipment Supplies				332,903			\$332,903	4.3%
IEC			20,197		88,164	305	\$108,665	1.4%
Insecticide	2,381,016						\$2,381,016	30.9%
M&E			59,982		531,632	34,154	\$625,768	8.1%
Post Spray			75,300		51,379	1,074	\$127,754	1.7%
Spray Campaign			99,209		1,096,462	4,316	\$1,199,988	15.6%
Spray Planning			223,114		320,579	4,761	\$548,454	7.1%
Grand Total	\$2,381,016	\$451,391	\$1,498,914	\$332,903	\$2,737,849	\$302,722	\$7,704,794	100.0%

17.3 UNIT COST ANALYSIS

This section presents Zambia IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE ZA3: ZAMBIA UNIT COSTS

Unit Costs	
Person protected	\$3.39
Cost per Structure sprayed	\$14.35
100 m ² sprayed	\$20.37

17.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Zambia IRS program for 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs.

Table ZA4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 7.0 percent from 2018 to 2019, representing an increase in the total annual cost of almost \$505,000.

TABLE ZA4: ZAMBIA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Adjusted)	2019	Percentage Change 2018-2019
Insecticide	\$2,561,377	\$2,381,016	-7%
Local Admin	\$388,140	\$451,391	16%
Local Labor	\$1,355,089	\$1,498,914	11%
Spray Operations	\$2,294,407	\$2,737,849	19%
Commodities	\$246,315	\$332,903	35%
U.S. Labor	\$354,615	\$302,722	-15%
TOTAL	\$7,199,942	\$7,704,794	7.0%

The largest cost decrease in relative costs was for US Labor and in absolute terms was for insecticide, which decreased by about \$180,000 from 2018 to 2019 (a 7 percent decrease between the two years). The largest relative increase in costs was for commodities at a 35 percent increase between the two years, but reflecting less than \$87,000. The largest absolute increase in costs between 2018 and 2019 was for spray operations, which increased by about \$443,000 and accounted for a more than 60% cost increase between the two years. Local labor, commodities, and local administration costs also increased by 11 percent, 35 percent, and 16 percent, respectively, over the same time period.

In 2018, the project conducted the IRS campaign in Northern, Luapula, Muchinga, and Eastern Provinces with existing infrastructure. In 2019, the project shifted its focus to Copperbelt and Eastern Province, plus one district (Nchelenge) in Luapula Province. The project had not conducted IRS in Copperbelt before, therefore, an investment was required to establish operations sites and conduct other local arrangements. In addition, the project piloted community-based IRS in Petauke District, which required investing in additional sites and sub-sites. Finally, to adhere to environmental compliance guidelines, the project also refurbished new operation sites to reduce the number of spray teams working at each site. This helped to improve operational efficiency by reducing the distance that spray teams needed to travel to the communities, but this increased costs between 2018 and 2019, comprising the largest component of the increase in spray operations costs between the two years.

Table ZA5 compares the year-on-year change in Zambia IRS program output measures and unit costs. In 2019, when the project sprayed in nine fewer districts than in 2018, the program protected fewer people and sprayed fewer structures by 19 percent and 7 percent, respectively, compared to 2018. However, there was a 2 percent increase in the area sprayed. Unit costs increased across the two years by almost 5 percent to more than 32 percent, depending on what metric is used.

TABLE ZA5: ZAMBIA IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018	2019	Percentage Change 2018-2019
Output Measures			
People Protected	2,818,176	2,273,188	-19.3%
Structures Sprayed	579,490	536,983	-7.3%
Area Sprayed (100 m ²)	369,958	378,248	2.2%
Unit Costs			
Per Person Protected	\$2.55	\$3.39	32.7%
Per Structure Sprayed	\$12.42	\$14.35	15.5%
Per Area Sprayed	\$19.46	\$20.37	4.7%

18. ZIMBABWE

18.1 BACKGROUND

TABLE ZW1: ZIMBABWE QUICK FACTS

	2019
Program Dates	Mar 1, 2019 - Feb 29, 2020
Number of Districts	2
# Local Staff	18
Spray Start Date	Nov 4, 2018
Insecticides Used	Neonicotinoids and organophosphates
# Units of Insecticide Used	50,885 (30,428 N; 20,457 O)
# People Protected	307,209
# Structures Sprayed	131,191
# 100 Square Meters Sprayed*	127,213

* Reverse calculation using number of insecticide units used during campaign multiplied by the average of 250 m² estimated to be sprayed by one unit and divided by the number of structures sprayed.

18.2 PROGRAM EXPENDITURES

This section presents an overview of Zimbabwe IRS program expenditures in 2019. Costs are organized by activity and cost category.

Table ZW2 displays the Zimbabwe IRS program total capital and recurrent expenditures from 2018. The first column lists the program activities as tracked by the PMI VectorLink Project's financial systems, and the top row lists IRS program cost categories.

Administration and the spray campaign are the two most expensive IRS activities (33.9 percent and 19.8 percent of expenditures, respectively), followed by insecticide (17.3 percent of expenditures). VectorLink Zimbabwe procured 47,970 sachets of Fludora® Fusion; 30,428 sachets were used along with 20,457 bottles of Actellic CS300 (Table ZW2 reflects the cost of insecticide used). About 74 percent of the total cost for administration consists of labor, both local and U.S.-based. Local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor and spray operations. An additional \$36,107 was spent on ITN durability monitoring, which is not reflected in Table ZW2 or elsewhere in this report.

TABLE ZW2: ZIMBABWE IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		424,630	1,034,931			160,016	\$1,619,577	33.9%
Entomology		2,115	384,711		329,636	53,327	\$769,788	16.1%
Environmental Compliance		1,785	123,021		46,098	29,575	\$200,479	4.2%
Equipment Supplies				81,192			\$81,192	1.7%
IEC					2,050		\$2,050	0.0%
Insecticide	821,394						\$821,394	17.2%
M&E			99,026		14,124	56,102	\$169,252	3.5%
Post Spray						881	\$881	0.0%
Spray Campaign			132,012		812,013	3,445	\$947,470	19.8%
Spray Planning			987		161,668	5,522	\$168,177	3.5%
Grand Total	\$821,394	\$428,529	\$1,774,689	\$81,192	\$1,365,588	\$308,868	\$4,780,259	100.0%

18.3 UNIT COST ANALYSIS

This section presents Zimbabwe IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²).

TABLE ZW3: ZIMBABWE UNIT COSTS

	Unit Costs
Person protected	\$15.56
Structure sprayed	\$36.44
100 m² sprayed	\$37.58

18.4 COMPARISON BETWEEN THE PAST TWO YEARS

This section provides a comparison of the Zimbabwe IRS program for 2018 and 2019, as implemented by the PMI VectorLink Project. The comparison focuses on output measures, total expenditures, and unit costs. Zimbabwe experienced unstable macroeconomic conditions in 2018/19, including high inflation and a currency devaluation in February 2019. This makes cost comparison between 2018 and 2019 tentative. Due to the devaluation, we have included 2018 costs both in nominal (as incurred in 2018) and inflation-adjusted terms, using the US dollar inflation rate to proxy past inflation.

Table ZW4 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 23.3 percent from 2018 to 2019 (21.6% in nominal terms), representing an increase in the total annual cost of over \$904,000 (\$848,000 in nominal terms). Costs for commodities decreased by about 30 percent between the two years. Costs of local administration and local labor saw the largest increase in relative terms (by 60.0 and 20.1 percent, respectively, and 57.2 percent and 35.2 percent, respectively, in nominal terms) between 2018 and 2019. The project hired 4 additional staff in 2019, including one TCN, which contributed to increased local labor and local

administration. Under spray operations, the project invested in renovations for borehole repairs, solar systems and storeroom repairs. Further, in some campsites the project hired water bowsers to augment water supplies. Costs for insecticides (which are not adjusted for inflation) increased by 14.2 percent between 2018 and 2019.

TABLE ZW4: ZIMBABWE IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2018 (Nominal)	2018 (Adjusted*)	2019	Percentage Change (Nominal) 2018-2019	Percentage Change (Adjusted) 2018-2019
Insecticide	\$719,396	\$719,396	\$821,394	14.2%	14.2%
Local Admin	\$272,571	\$267,808	\$428,529	57.2%	60.0%
Local Labor	\$1,503,693	\$1,477,419	\$1,774,689	18.0%	20.1%
Spray Operations	\$1,009,720	\$992,077	\$1,365,588	35.2%	37.6%
Commodities	\$117,327	\$115,277	\$81,192	-30.8%	-29.6%
U.S. Labor	\$309,539	\$304,130	\$308,868	-0.2%	1.6%
TOTAL	\$3,932,247	\$3,876,109	\$4,780,259	21.6%	23.3%

*Adjusted for US inflation; over the two year the majority of transactions occurred in US dollars.

Table ZW5 compares the year-on-year change in Zimbabwe IRS program output measures and unit costs. In 2019, the program had higher output metrics across the three categories considered, with increases of 11.2 percent in the number of people protected, 16.3 percent in the number of structures sprayed, and 20.4 percent in the area sprayed, compared to 2018. However, the increase in program size was not as large as the increase in total expenditures (adjusted or nominal). Unit costs increased from 2018 to 2019 by between 2.4 percent and 10.9 percent (adjusted; 1 percent to 9.5 percent in nominal terms) across the three output metrics. The nominal comparison indicates that the cost per area sprayed was very similar between the two years.

TABLE ZW5: ZIMBABWE IRS PROGRAM COMPARISON OF OUTPUT MEASURES AND UNIT COSTS

	2018 (Nominal)	2018 (Adjusted)	2019	Percentage Change 2018-2019 (Nominal)	Percentage Change 2018-2019 (Adjusted)
Output Measures					
People Protected		276,343	307,209		11.2%
Structures Sprayed		112,805	131,191		16.3%
Area Sprayed (100 m ²)		105,675	127,213		20.4%
Unit Costs					
Per Person Protected	\$14.23	\$14.03	\$15.56	9.4%	10.9%
Per Structure Sprayed	\$34.86	\$34.36	\$36.44	4.5%	6.0%
Per Area Sprayed	\$37.21	\$36.68	\$37.58	1.0%	2.4%

REFERENCES

Abbott, Michele, and Ben Johns. April 2013. *PMI IRS Country Programs: Comparative Cost Analysis, August 11, 2011 – December 31, 2012*. Bethesda, MD: Africa Indoor Residual Spraying (AIRS) Project, Abt Associates Inc.

Abbott, Michele, and Ben Johns. December 2014. *PMI IRS Country Programs: Comparative Cost Analysis, Years 1 and 2*. Bethesda, MD. Africa Indoor Residual Spraying Project, Abt Associates Inc.

Cico, Altea, and Benjamin Johns. May 2018. *PMI IRS Country Programs: 2017 Comparative Cost Analysis*. Rockville, MD. PMI VectorLink Project, Abt Associates Inc.

Cico, Altea, and Benjamin Johns. September 2017. *PMI IRS Country Programs: 2016 Comparative Cost Analysis*. Bethesda, MD. Africa Indoor Residual Spraying Project, Abt Associates Inc.

Johns, Benjamin, and Altea Cico. June 2015. *PMI IRS Country Programs: 2014 Comparative Cost Analysis*. Bethesda, MD. Africa Indoor Residual Spraying Project, Abt Associates Inc. Available at <http://www.pmi.gov/docs/default-source/default-document-library/implementing-partner-reports/africa-indoor-residual-spraying-project-pmi-irs-country-programs-2014-comparative-cost-analysis.pdf?sfvrsn=4>.

Johns, Benjamin, and Altea Cico. August 2016. *PMI IRS Country Programs: 2015 Comparative Cost Analysis*. Bethesda, MD. Africa Indoor Residual Spraying Project, Abt Associates Inc.

Johns, Benjamin and Altea Cico Sitruk. May 2019. *PMI IRS Country Programs: 2018 Comparative Cost Analysis*. Rockville, MD. PMI VectorLink Project, Abt Associates Inc.

ANNEX A: YEAR-ON-YEAR COMPARISON OF OUTPUT MEASURES

Country	People Protected								Percent Change 2018-2019
	2012	2013	2014	2015	2016	2017	2018	2019	
Uganda							4,436,156	4,479,157	1%
Tanzania					2,042,561	2,568,522	2,840,927	2,404,010	-15%
Zambia			2,000,824	2,544,290	2,626,718	3,005,676	2,818,176	2,273,188	-19%
Kenya						906,388	1,833,860	2,011,860	10%
Ethiopia	1,506,273	1,629,958	1,647,099	1,655,997	1,688,745	1,877,154	1,264,189	1,334,868	6%
Mozambique	2,716,176	2,181,896	2,327,815	1,631,058	1,929,654	1,711,518	1,663,078	1,484,191	-11%
Benin	762,146	694,729	789,883	802,597	858,113	1,227,536	1,321,758	1,077,411	-18%
Ghana	941,240	534,060	570,572	553,954	570,871	840,438	836,376	875,481	5%
Madagascar	1,781,990	1,588,138	1,307,384	1,016,841	1,257,036	2,008,963	2,232,097	1,150,922	-48%
Rwanda	1,025,181	1,479,342	1,217,837	1,406,520	1,431,410	919,735	894,098	915,034	2%
Burkina Faso	115,638						766,374	587,248	-23%
Mali	762,146	850,104	836,568	494,205	788,922	823,201	665,581	690,793	4%
Zimbabwe			334,746	365,425	550,475	517,374	276,343	307,209	11%
Malawi							501,324	441,375	-12%
Average	686,485	639,873	788,052	747,921	981,750	1,171,893	1,596,453	1,430,911	-10%

Country	Structures Sprayed								
	2012	2013	2014	2015	2016	2017	2018	2019	Percent Change 2018-2019
Uganda							1,292,309	1,291,569	0%
Tanzania					515,217	664,622	744,597	595,923	-20%
Zambia			409,544	519,598	559,550	634,371	579,490	536,983	-7%
Kenya						212,029	440,969	507,777	15%
Ethiopia	547,421	635,528	667,236	704,945	715,541	738,810	472,569	487,746	3%
Mozambique	536,558	414,232	445,118	337,433	405,597	381,463	387,413	338,330	-13%
Benin	206,295	228,951	254,072	252,706	269,179	384,761	400,997	335,207	-16%
Ghana	355,278	197,655	205,230	205,935	211,283	302,648	298,701	298,385	0%
Madagascar	371,391	343,470	274,533	247,902	310,426	487,636	548,789	267,874	-51%
Rwanda	236,610	345,862	297,005	343,131	346,917	231,258	214,802	221,712	3%
Burkina Faso	36,870						258,766	201,901	-22%
Mali	206,295	228,985	228,123	133,527	228,672	227,646	160,723	148,198	-8%
Zimbabwe			147,949	162,127	229,377	209,055	112,805	131,191	16%
Malawi							112,264	107,565	-4%
Average	178,337	171,049	209,201	207,665	270,840	319,593	430,371	390,740	-9%

Country	Area Sprayed (100 m ²)								
	2012	2013	2014	2015	2016	2017	2018	2019	Percent Change 2018-2019
Uganda							1,386,420	1,352,893	-2%
Tanzania					437,933	549,095	587,325	454,843	-23%
Zambia			281,508	341,630	350,045	421,928	369,958	378,248	2%
Kenya						176,383	406,170	397,193	-2%
Ethiopia	524,334	617,442	624,764	641,994	677,990	627,295	287,243	304,420	6%
Mozambique	974,470	822,735	914,518	649,370	637,380	513,058	462,068	395,325	-14%
Benin	192,968	125,605	110,505	114,160	116,543	146,913	157,103	133,760	-15%
Ghana	193,220	108,210	112,370	113,285	117,833	164,738	163,860	166,833	2%
Madagascar	221,418	198,985	229,240	113,493	133,030	189,860	220,560	119,158	-46%
Rwanda	332,522	529,940	482,958	578,390	634,915	456,020	408,878	414,260	1%
Burkina Faso	48,413						133,813	136,423	2%
Mali	192,968	233,588	224,868	146,180	211,428	200,673	192,463	154,043	-20%
Zimbabwe			167,600	183,315	263,685	247,870	105,675	127,213	20%
Malawi							119,358	131,373	10%
Average	191,451	188,322	224,881	205,844	255,770	263,845	357,206	333,284	-7%

ANNEX B: YEAR-ON-YEAR COMPARISON OF UNIT COSTS

Country	Person Protected								Percent Change 2018-2019
	2012	2013	2014	2015	2016	2017	2018	2019	
Uganda							\$3.65	\$3.84	5%
Tanzania					\$5.96	\$4.36	\$3.88	\$3.46	-11%
Zambia			\$3.02	\$3.73	\$3.55	\$3.05	\$2.55	\$3.39	33%
Kenya						\$6.62	\$6.57	\$5.47	-17%
Ethiopia	\$3.35	\$4.42	\$4.56	\$5.30	\$5.68	\$5.79	\$6.23	\$6.64	7%
Mozambique	\$1.56	\$1.94	\$1.91	\$4.99	\$7.19	\$6.28	\$5.61	\$5.71	2%
Benin	\$4.02	\$4.42	\$4.37	\$4.21	\$4.17	\$3.87	\$3.56	\$3.35	-6%
Ghana	\$4.94	\$8.51	\$7.33	\$7.57	\$7.04	\$5.41	\$5.53	\$5.43	-2%
Madagascar	\$2.73	\$4.29	\$4.86	\$4.96	\$4.10	\$3.83	\$3.21	\$4.08	27%
Rwanda	\$3.57	\$5.13	\$6.10	\$4.76	\$5.50	\$7.00	\$6.36	\$5.95	-6%
Burkina Faso	\$10.56						\$4.42	\$5.89	33%
Mali	\$5.95	\$6.55	\$6.63	\$9.79	\$6.56	\$7.92	\$7.98	\$6.80	-15%
Zimbabwe*			\$12.56	\$11.22	\$10.37	\$8.68	\$14.03	\$15.56	11%
Malawi							\$8.27	\$11.07	34%
Average	\$4.59	\$5.04	\$5.71	\$6.28	\$6.01	\$5.71	\$5.85	\$6.19	6%

Country	Structure Sprayed								Percent Change 2018-2019
	2012	2013	2014	2015	2016	2017	2018	2019	
Uganda							\$12.53	\$13.31	6%
Tanzania					\$23.65	\$16.86	\$14.81	\$13.98	-6%
Zambia			\$14.77	\$18.27	\$16.68	\$14.46	\$12.42	\$14.35	15%
Kenya						\$28.32	\$27.33	\$21.68	-21%
Ethiopia	\$9.21	\$11.33	\$11.27	\$12.45	\$13.41	\$14.70	\$16.66	\$18.17	9%
Mozambique	\$7.90	\$10.20	\$9.99	\$24.10	\$34.23	\$28.19	\$24.10	\$25.05	4%
Benin	\$14.86	\$13.40	\$13.59	\$13.37	\$13.30	\$12.35	\$11.73	\$10.78	-8%
Ghana	\$13.08	\$23.00	\$20.37	\$20.37	\$19.02	\$15.03	\$15.47	\$15.93	3%
Madagascar	\$13.11	\$19.84	\$23.16	\$20.35	\$16.60	\$15.79	\$13.04	\$17.52	34%
Rwanda	\$15.48	\$21.94	\$25.02	\$19.51	\$22.70	\$27.83	\$26.48	\$24.56	-7%
Burkina Faso	\$33.13						\$13.08	\$17.14	31%
Mali	\$21.98	\$24.31	\$24.32	\$36.24	\$22.63	\$28.65	\$33.04	\$31.68	-4%
Zimbabwe*			\$28.41	\$25.30	\$24.89	\$21.49	\$34.36	\$36.44	6%
Malawi							\$36.91	\$45.43	23%
Average	\$16.09	\$17.72	\$18.99	\$21.11	\$20.71	\$20.33	\$20.85	\$21.86	5%

Country	Area Sprayed (100 m ²)								Percent Change 2018-2019
	2012	2013	2014	2015	2016	2017	2018	2019	
Uganda							\$11.68	\$12.71	9%
Tanzania					\$27.82	\$20.41	\$18.77	\$18.31	-2%
Zambia			\$21.48	\$27.78	\$26.66	\$21.74	\$19.46	\$20.37	5%
Kenya						\$34.04	\$29.67	\$27.72	-7%
Ethiopia	\$9.61	\$11.66	\$12.03	\$13.67	\$14.15	\$17.32	\$27.41	\$29.10	6%
Mozambique	\$4.35	\$5.13	\$4.86	\$12.52	\$21.78	\$20.96	\$20.21	\$21.44	6%
Benin	\$15.88	\$24.42	\$31.25	\$29.60	\$30.71	\$32.34	\$29.93	\$27.01	-10%
Ghana	\$24.05	\$42.01	\$37.20	\$37.03	\$34.10	\$27.62	\$28.20	\$28.50	1%
Madagascar	\$21.99	\$34.25	\$27.73	\$44.45	\$38.74	\$40.55	\$32.45	\$39.39	21%
Rwanda	\$11.02	\$14.32	\$15.39	\$11.58	\$12.40	\$14.11	\$13.91	\$13.14	-6%
Burkina Faso	\$25.23						\$25.30	\$25.36	0%
Mali	\$23.50	\$23.84	\$24.67	\$33.10	\$24.48	\$32.50	\$27.59	\$30.48	10%
Zimbabwe*			\$25.08	\$22.38	\$21.65	\$18.13	\$36.68	\$37.58	2%
Malawi							\$34.71	\$37.20	7%
Average	\$16.95	\$22.23	\$22.19	\$25.79	\$25.25	\$25.43	\$25.43	\$26.31	3%

*Adjusted for inflation based on US inflation rates

ANNEX C: METHODOLOGY

OBJECTIVE

This report presents and compares the findings of a cost analysis of the expenses that were incurred during the past seven years of IRS program implementation in 14 PMI countries, using a methodology that can be repeated on an annual basis. The purpose of the assessment is to evaluate the unit costs and the overall level of spending, by program activity and by cost category, in each of these countries.

The analysis separates capital expenditure items (used throughout full project implementation), and recurrent expenditure items (for each year of program implementation). The analysis also includes the cost of items inherited from previous IRS programs, as provided in each country's disposition inventory, as well as the cost of insecticides provided by local governments (where possible) in order to reflect the full cost of program implementation. These categories are defined in detail in the 2014 report (Abbott and Johns 2014).

Conducted annually over the course of the project, the analyses will provide cost comparisons for overall annual expenditure trends within and across countries.

TARGET AUDIENCE

The results and findings of the cost analysis will be used by PMI and host countries to make informed decisions about how and at what funding level to invest in IRS in the future. The findings will also be used by project staff for program management, and may be shared with PMI's government partners and other key stakeholders to inform them of specific costs of implementing an IRS program in their respective countries. PMI also intends to share findings broadly with global partners and post the analysis on its publicly available website.

APPROACH

Through a collaborative process with PMI, project technical, M&E, financial, and operational staff, the costing team:

1. *Collected project expenditures and output measures.* Financial data were collected from Abt Associates' internal financial tracking systems for the past seven years. Information collected was augmented and verified through staff interviews. Program output and operational data were collected from the VectorLink M&E systems.
2. *Categorized all financial expenditures according to the methodology framework.* The costing framework used in this analysis includes: (1) capital and recurrent costs, (2) technical program activities, and (3) cost categories. All capital costs are annualized for this report. All costs are reported in 2018 in U.S. dollars; costs from previous years are adjusted for inflation.

The methodology used for the analyses presented in this report is generally the same as used for the reports from 2012, 2013, 2014, 2015, 2017, 2018, and 2019 (Abbott and Johns 2013, Abbott and Johns 2014, Johns and Cico 2015, Johns and Cico 2016, Cico and Johns 2017, Cico and Johns 2018, Johns and Cico Sitruk 2019). In this report, all insecticide costs reflect the cost of the insecticide used, rather than the expenditures for insecticide procurement (as was done in the 2015 report, but not done in reports prior to 2015). Insecticide costs are estimated based on the unit cost of insecticides procured, with the unit costs incurred in procurement then applied to the amount of insecticide used.

In keeping with the methodology used in the 2014 report, the useful life of capital items reflects a six-year timeframe for implementation. Items with an expected useful life of less than six years (boots, overalls, and other personal protective equipment) were not changed. Further, in the year-to-year comparisons, we did not apply inflation to insecticide costs. Insecticides are internationally available goods; when assessing the price of insecticides across the past four years, price changes do not appear to be correlated with the inflation rates in individual countries. We do adjust all other cost inputs for inflation, as described below and done in previous years' reports.

For a detailed description of the methodology and assumptions used, as well as limitations, please refer to the 2014 report (Johns and Cico 2015).

This comparative costing analysis covers IRS implementation in 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019. However, the dates of each program year (the period of program implementation) vary by country. The specific program dates for each country program can be found in the respective country chapter.

LIMITATIONS

Limitations in available data influence the results. In-kind contributions by host governments may be provided (e.g., supervision or IEC material), but this is generally unknown and varies by government and spray campaign; therefore, they have not been included in this report.

Comparing unit costs across countries poses limitations in conclusive results as well. It is important to note that variations between countries, unrelated to the IRS program structure or implementation, can account for differences in cost. Country differences include geography and breadth of spray coverage areas, average size of structures, and number of malaria transmission seasons. In addition, differences in country input prices may cause variations in unit costs that are not attributable to program efficiency.

As in past reports, we use the area sprayed as the unit for comparing costs across countries. This unit allows for a standardized metric to compare the relative efficiency of country programs that is not influenced by differences in the size of structures or the number of people per structure across countries. However, the true area sprayed is not measured routinely in PMI VectorLink country programs. Rather, we estimate the area sprayed based on the amount of insecticide used. Thus, there still remains the possibility for differences in the efficiency of insecticide use between countries (due to differing spray equipment, etc.) that affect the comparisons. Further, the efficacy of use may change over time; for example, there may be higher efficiency in terms of flow rate when spray pumps are equipped with a control flow valve, such as those that come standard on Goizper pumps. Thus, some degree of inaccuracy in the comparisons is possible, and should be kept in mind when reading the results.