



USAID
FROM THE AMERICAN PEOPLE

PRESIDENT'S MALARIA INITIATIVE



PMI IRS COUNTRY PROGRAMS: COMPARATIVE COST ANALYSIS YEARS 1 AND 2

Recommended Citation: Abbott, Michele, 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.

Contract: GHN-I-00-09-00013-00

Task Order: AID-OAA-TO-11-00039

Submitted to: United States Agency for International Development/PMI



Abt Associates Inc. | 4550 Montgomery Avenue | Suite 800 North
| Bethesda, Maryland 20814 | T. 301.347.5000 | F. 301.913.9061
| www.abtassociates.com

PMI IRS COUNTRY PROGRAMS:
COMPARATIVE COST ANALYSIS
YEARS 1 AND 2

CONTENTS

Acronyms	ix
Acknowledgments	xi
Executive Summary	I
1. Introduction	8
1.1 Background.....	8
1.2 Objective	9
1.3 Target Audience.....	10
2. Approach	11
2.1 Methodology	11
2.2 Assumptions and Limitations	15
3. Cross-Country Results	18
3.1 Background.....	18
3.2 Total Program Expenditures	19
3.3 Unit Cost Analysis	21
3.4 Cost Drivers	25
3.5 Conclusions	40
4. Year-on-Year Comparison	42
4.1 Changes in IRS Programs from Year 1 to Year 2.....	42
5. Angola	47
5.1 Background.....	47
5.2 Program Expenditures.....	48
5.3 Unit Cost Analysis	50
5.4 Comparison: Year 1 and Year 2.....	53
6. Benin	56
6.1 Background.....	56
6.2 Program Expenditures.....	57
6.3 Unit Cost Analysis	59
6.4 Comparison: Year 1 and Year 2.....	62
7. Ethiopia	65
7.1 Background.....	65
7.2 Program Expenditures.....	66
7.3 Unit Cost Analysis	69
7.4 Comparison: Year 1 and Year 2.....	71

8. Ghana	73
8.1 Background	73
8.2 Program Expenditures	74
8.3 Unit Cost Analysis	76
8.4 Comparison: Year 1 and Year 2	78
9. Liberia	80
9.1 Background	80
9.2 Program Expenditures	81
9.3 Unit Cost Analysis	83
9.4 Comparison: Year 1 and Year 2	85
10. Madagascar	88
10.1 Background	88
10.2 Year 1 Program Expenditures	89
10.3 Year 1: Unit Cost Analysis	91
10.4 Year 2: Program Expenditures	94
10.5 Year 2: Unit Cost Analysis	96
10.6 Comparison: Year 1 and Year 2	99
11. Mali	102
11.1 Background	102
11.2 Program Expenditures	103
11.3 Unit Cost Analysis	105
11.4 Comparison: Year 1 and Year 2	107
12. Mozambique	110
12.1 Background	110
12.2 Program Expenditures	111
12.3 Unit Cost Analysis	113
12.4 Comparison: Year 1 and Year 2	116
13. Nigeria	118
13.1 Background	118
13.2 Program Expenditures	119
13.1 Unit Cost Analysis	121
13.2 Comparison: Year 1 and Year 2	124
14. Rwanda	126
14.1 Background	126
14.2 Program Expenditures	127
14.3 Unit Cost Analysis	129
14.4 Comparison: Year 1 and Year 2	132
15. Senegal	134
15.1 Background	134
15.2 Program Expenditures	135

15.3 Unit Cost Analysis.....	137
15.4 Comparison: Year 1 and Year 2.....	139
References	143

LIST OF TABLES

Table ES1: AIRS Project Spray Coverage in Year 2, by Country	3
Table ES2: Year 2 IRS PMI Program Unit Costs	3
Table ES3: Summary of Insecticide versus Non-Insecticide Unit Costs	7
Table 1: Expenditure Items Included in IRS Cost Categories, Assumptions	13
Table 2: Country Program Start Dates	16
Table CC1: AIRS Project Spray Coverage in Year 2, by Country	18
Table CC2: IRS Program Sizes.....	19
Table CC3: Country IRS Program Size Groups	19
Table CC4: Year 2 IRS Program Unit Costs	22
Table CC5: Breakdown of Fixed and Variable Costs, as Percentage of Unit Cost per Area Sprayed	27
Table CC6: Class and Number of Insecticide Sachets Purchased and Used in Year 2 ...	29
Table CC7: Insecticide Portion of Cost per Area Sprayed (procured)	30
Table CC8: Cost of Insecticides Used per Area Sprayed	30
Table CC9: Temporary Spray Operators (SOPs) and Campaign Days	34
Table CC10: Total Full-Time Local Staff Members	38
Table CC11: Local Full-Time Labor Impact on Program Unit Costs	39
Table YR1: Year-on-Year Comparison of Program Size	42
Table YR2: Year-on-Year Comparison of Output Measures	42
Table YR3: Year-on-Year Comparison of Unit Costs.....	43
Table YR4: Insecticide versus Non-Insecticide Cost per Area Sprayed	44
Table YR5: Summary of Insecticide versus Non-Insecticide Unit Costs.....	45
Table AO1: Angola Quick Facts	47
Table AO2: Angola IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	48
Table AO3: Angola IRS Program Comparison of Output Measures	53
Table AO4: Angola IRS Program Comparison of Expenditures	54
Table AO5: Angola IRS Program Comparison of Unit Costs	54
Table BN1: Benin Quick Facts.....	57
Table BN2: Benin IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	57
Table BN3: Benin IRS Program Comparison of Output Measures	62
Table BN4: Benin IRS Program Comparison of Expenditures	63
Table BN5: Benin IRS Program Comparison of Unit Costs.....	63
Table ET1: Ethiopia Quick Facts	66
Table ET2: Ethiopia IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	67
Table ET3: Ethiopia IRS Program Comparison of Output Measures	71
Table ET4: Ethiopia IRS Program Comparison of Expenditures	72

Table ET5: Ethiopia IRS Program Comparison of Unit Costs	72
Table GH1: Ghana Quick Facts.....	73
Table GH2: Ghana IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	74
Table GH3: Ghana IRS Program Comparison of Output Measures	78
Table GH4: Ghana IRS Program Comparison of Expenditures	79
Table GH5: Ghana IRS Program Comparison of Unit Costs.....	79
Table LR1: Liberia Quick Facts*	80
Table LR2: Liberia IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	81
Table LR3: Liberia IRS Program Comparison of Output Measures	85
Table LR4: Liberia IRS Program Comparison of Expenditures	86
Table LR5: Liberia IRS Program Comparison of Unit Costs.....	86
Table MG1: Madagascar Quick Facts	89
Table MG2: Madagascar IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category	89
Table MG3: Madagascar IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category	94
Table MG4: Madagascar IRS Program Comparison of Output Measures	99
Table MG5: Madagascar IRS Program Comparison of Expenditures	100
Table MG6: Madagascar IRS Program Comparison of Unit Costs	101
Table ML1: Mali Quick Facts.....	102
Table ML2: Mali IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	103
Table ML3: Mali IRS Program Comparison of Output Measures	107
Table ML4: Mali IRS Program Comparison of Expenditures	108
Table ML5: Mali IRS Program Comparison of Unit Costs.....	108
Table MZ1: Mozambique Quick Facts	110
Table MZ2: Mozambique IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category	111
Table MZ3: Mozambique IRS Program Comparison of Output Measures	116
Table MZ4: Mozambique IRS Program Comparison of Expenditures	117
Table MZ5: Mozambique IRS Program Comparison of Unit Costs	117
Table NG1: Nigeria Quick Facts	118
Table NG2: Nigeria IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	119
Table NG3: Nigeria IRS Program Comparison of Output Measures	124
Table NG4: Nigeria IRS Program Comparison of Expenditures	125
Table NG5: Nigeria IRS Program Comparison of Unit Costs.....	125
Table RW1: Rwanda Quick Facts	126
Table RW2: Rwanda IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	127
Table RW3: Rwanda IRS Program Comparison of Output Measures	132
Table RW4: Rwanda IRS Program Comparison of Expenditures	133
Table RW5: Rwanda IRS Program Comparison of Unit Costs	133
Table SN1: Senegal Quick Facts.....	134
Table SN2: Senegal IRS Program Capital and Recurrent Expenditures, by Activity and Cost Category.....	135

Table SN3: Senegal IRS Program Comparison of Output Measures.....	139
Table SN4: Senegal IRS Program Comparison of Expenditures.....	140
Table SN5: Senegal IRS Program Comparison of Unit Costs	140

LIST OF FIGURES

Figure 1: Costing Methodology Framework.....	12
Figure CC1: Capital and Recurrent Expenditures, by Burden Type	20
Figure CC2: Capital and Recurrent Expenditures, by Cost Category	21
Figure CC3: Unit Costs per Person Protected, by Cost Category.....	23
Figure CC4: Unit Costs per Structure Sprayed, by Cost Category.....	24
Figure CC5: Unit Cost per Area Sprayed, by Cost Category	25
Figure CC6: Cost Category Percentage of Unit Cost per Area Sprayed.....	26
Figure CC7: Fixed Costs Portion of Cost per Area Sprayed.....	28
Figure CC8: Cost per Area Sprayed, Organized by Insecticide Class.....	31
Figure CC9: Cost per Person Protected, Organized by Insecticide Class.....	32
Figure CC10: Spray Operations Cost per Area Sprayed, Area Sprayed per Campaign Day, and Total Number of Structures Sprayed	33
Figure CC11: Spray Operations Coverage and Cost per Area Sprayed, Large Programs	35
Figure CC12: Spray Operations Coverage and Cost per Area Sprayed, Medium Programs	36
Figure CC13: Spray Operations Coverage and Cost per Area Sprayed, Small Programs	37
Figure CC14: Local Labor Portion of Cost per Area Sprayed	38
Figure CC15: Local Labor Price versus Quantity Analysis	39
Figure YR 1: Year-on-Year Comparison of Cost per Area Sprayed	44
Figure AO1: Angola IRS Program Activity Expenditures, by Cost Category.....	49
Figure AO2: Angola IRS Program Cost Category Expenditures, by Activity	50
Figure AO3: Angola IRS Unit Costs, by Activity	51
Figure AO4: Angola IRS Cost per Person Protected, by Cost Category and Burden.....	52
Figure AO5: Angola IRS Cost per Structure Sprayed, by Cost Category and Burden.....	53
Figure BN1: Benin IRS Program Activity Expenditures, by Cost Category	58
Figure BN2: Benin IRS Program Cost Category Expenditures, by Activity	59
Figure BN3: Benin IRS Unit Costs, by Activity.....	60
Figure BN4: Benin IRS Cost per Person Protected, by Cost Category and Burden	61
Figure BN5: Benin IRS Cost per Structure Sprayed, by Cost Category and Burden	62
Figure ET1: Ethiopia IRS Program Activity Expenditures, by Cost Category.....	68
Figure ET2: Ethiopia IRS Program Cost Category Expenditures, by Activity.....	68
Figure ET3: Ethiopia IRS Unit Costs, by Activity	69
Figure ET4: Ethiopia IRS Cost per Person Protected, by Cost Category and Burden	70
Figure ET5: Ethiopia IRS Cost per Structure Sprayed, by Cost Category and Burden.....	71
Figure GH1: Ghana IRS Program Activity Expenditures, by Cost Category	75
Figure GH2: Ghana IRS Program Cost Category Expenditures, by Activity	75
Figure GH3: Ghana IRS Unit Costs, by Activity	76
Figure GH4: Ghana IRS Cost per Person Protected, by Cost Category and Burden	77

Figure GH5: Ghana IRS Cost per Structure Sprayed, by Cost Category and Burden	78
Figure LR1: Liberia IRS Program Activity Expenditures, by Cost Category	82
Figure LR2: Liberia IRS Program Cost Category Expenditures, by Activity	82
Figure LR3: Liberia IRS Unit Costs, by Activity.....	83
Figure LR4: Liberia IRS Cost per Person Protected, by Cost Category and Burden	84
Figure LR5: Liberia IRS Cost per Structure Sprayed, by Cost Category and Burden	85
Figure MG1: Madagascar IRS Program Activity Expenditures, by Cost Category.....	90
Figure MG2: Madagascar IRS Program Cost Category Expenditures, by Activity.....	91
Figure MG3: Madagascar IRS Unit Costs, by Activity	92
Figure MG4: Madagascar IRS Cost per Person Protected, by Cost Category and Burden	93
Figure MG5: Madagascar IRS Cost per Structure Sprayed, by Cost Category and Burden	94
Figure MG6: Madagascar IRS Program Activity Expenditures, by Cost Category.....	95
Figure MG7: Madagascar IRS Program Cost Category Expenditures, by Activity.....	96
Figure MG8: Madagascar IRS Unit Costs, by Activity	97
Figure MG9: Madagascar IRS Cost per Person Protected, by Cost Category and Burden	98
Figure MG10: Madagascar IRS Cost per Structure Sprayed, by Cost Category and Burden	99
Figure ML1: Mali IRS Program Activity Expenditures, by Cost Category	104
Figure ML2: Mali IRS Program Cost Category Expenditures, by Activity	104
Figure ML3: Mali IRS Unit Costs, by Activity.....	105
Figure ML4: Mali IRS Cost per Person Protected, by Cost Category and Burden	106
Figure ML5: Mali IRS Cost per Structure Sprayed, by Cost Category and Burden	107
Figure MZ1: Mozambique IRS Program Activity Expenditures, by Cost Category.....	112
Figure MZ2: Mozambique IRS Program Cost Category Expenditures, by Activity.....	113
Figure MZ3: Mozambique IRS Unit Costs, by Activity	114
Figure MZ4: Mozambique IRS Cost per Person Protected, by Cost Category and Burden	115
Figure MZ5: Mozambique IRS Cost per Structure Sprayed, by Cost Category and Burden	116
Figure NG1: Nigeria IRS Program Activity Expenditures, by Cost Category	120
Figure NG2: Nigeria IRS Program Cost Category Expenditures, by Activity	121
Figure NG3: Nigeria IRS Unit Costs, by Activity.....	122
Figure NG4: Nigeria IRS Cost per Person Protected, by Cost Category and Burden	123
Figure NG5: Nigeria IRS Cost per Structure Sprayed, by Cost Category and Burden	124
Figure RW1: Rwanda IRS Program Activity Expenditures, by Cost Category.....	128
Figure RW2: Rwanda IRS Program Cost Category Expenditures, by Activity.....	129
Figure RW3: Rwanda IRS Unit Costs, by Activity	130
Figure RW4: Rwanda IRS Cost per Person Protected, by Cost Category and Burden	131
Figure RW5: Rwanda IRS Cost per Structure Sprayed, by Cost Category and Burden	132
Figure SN1: Senegal IRS Program Activity Expenditures, by Cost Category	136
Figure SN2: Senegal IRS Program Cost Category Expenditures, by Activity	136
Figure SN3: Senegal IRS Unit Costs, by Activity	137
Figure SN4: Senegal IRS Cost per Person Protected, by Cost Category and Burden.....	138
Figure SN5: Senegal IRS Cost per Structure Sprayed, by Cost Category and Burden.....	139

ACRONYMS

A&P	Anemia and Parasitemia
AIRS	Africa Indoor Residual Spraying
CREC	Entomological Research Center of Cotonou
DRC	Democratic Republic of Congo
EC	Environmental Compliance
G&A	General and Administrative
IEC	Information, Education and Communication
IRS	Indoor Residual Spraying
IT	Information Technology
LGA	Local Government Authority
M&E	Monitoring and Evaluation
MOH	Ministry of Health
NMCP	National Malaria Control Program
NMIMR	Noguchi Memorial Institute for Medical Research
PMI	President's Malaria Initiative
RTI	Research Triangle Institute
STTA	Short-term Technical Assistance
UCAD	Université Cheikh Anta Diop
USAID	United States Agency for International Development
WHO	World Health Organization

ACKNOWLEDGMENTS

The authors of this report would like to acknowledge the contribution of many AIRS staff without whom this activity could not have been completed. Specific thanks go to Nicole de Gier and Lena Kolyada for managing the activity, coordinating across all the AIRS country teams, and many other contributions throughout the process. Additional gratitude is owed to the other AIRS technical coordinators: Josh Rosenfeld, Mariandrea Chamorro, and Jane Coleman as well as many other AIRS M&E and Finance and Contract Administration staff who provided valuable input on preliminary results and comments on the draft report. Thank you to the AIRS senior management team, Brad Lucas, Project Director, Dereje Dengela, Technical Director, and Allan Were, Operations Director. The authors would like to thank the PMI Malaria Division Chief, Julie Wallace for her oversight and support, as well as PMI COR team members, Allison Belemvire, Christen Fornadel, and Kristen George who provided helpful input and feedback. A final word of thanks goes to Ben Johns for the technical quality assurance support that he provided on this activity.

EXECUTIVE SUMMARY

INTRODUCTION

Background

The President's Malaria Initiative (PMI) has been implementing IRS programs since 2006, with a goal of limiting exposure to malaria and thus reducing the incidence and prevalence of malaria. Most recently, the PMI-funded Africa Indoor Residual Spraying (AIRS) project, which began in August 2011, provides program support and manages implementation of Indoor Residual Spraying (IRS) activities. In 2013 (Project Year 2), AIRS provided support to IRS in 11 countries with full IRS operations and logistics support (Angola, Benin, Ethiopia, Ghana, Liberia, Madagascar, Mali, Mozambique, Nigeria, Rwanda, and Senegal). AIRS also provided technical assistance to local government-run IRS programs in Zambia and Zimbabwe, as well as enhanced entomological monitoring in Burundi and the Democratic Republic of the Congo (DRC). PMI has also supported IRS in Kenya, Uganda, Malawi and Tanzania under different mechanisms and thus their costs are not included in this analysis.

PMI requested the AIRS project to provide comparative cost analyses on the total and unit costs of the IRS country programs after each year of implementation. This is the second report, which provides Year 2 cost results and compares them with those of Year 1.

Overview

This report presents and compares the findings of a cost analysis of the expenses that were incurred during the first two years of IRS program implementation in 11 PMI countries, using a methodology that can be repeated on an annual basis. The purpose of the assessment is to evaluate the overall level of spending in each of these countries, by program activity and by cost category, as well as the unit costs. Specifically, the total program costs, unit cost per person protected, unit cost per structure sprayed, and unit cost per area sprayed (in units of 100 m²) are calculated using unburdened, burdened, and U.S.-based costs. PMI requested this cost breakdown to understand total project costs (fully burdened as delivered through an international implementing partner) as well as the actual costs of implementing an IRS program in-country with and without U.S.-based staff labor.

Conducted annually over the course of the three-year project, the analysis will provide cost comparisons for overall annual expenditure trends within and across countries. Costing data findings will support PMI and host countries in the decision-making process of planning and prioritizing future investments within a country. Findings may also help to inform local governments as to whether they would like to expand funding, management or implementation of IRS programs.

APPROACH

Through a collaborative and iterative process with PMI, project technical and operational staff, as well as monitoring and evaluation (M&E) and finance officers, the costing team established the following steps to complete the analysis of costs:

1. *Verify and finalize target audience and objectives of the costing analysis.*
2. *Collect project expenditures and output measures* – Financial data were collected from Abt Associates' internal financial tracking systems for the first two years of the full (11-country) AIRS project. Inventory disposition lists and procurement records were collected from country teams and PMI to determine the value of any inherited or donated resources. Information collected was augmented and verified through staff interviews. Program output data were collected from the AIRS M&E systems.
3. *Categorize all financial expenditures according to the methodology framework* – The costing framework used in this analysis comprises multi-dimensional categories: (1) capital and recurrent costs, (2) burden type, (3) technical program activities, and (4) cost categories. Categorizing expenditures on multiple levels provides information for a more detailed analysis of cost drivers, program efficiencies, and cost effectiveness. All costs are reported in 2013 U.S. dollars.
4. *Define services and units of measure* – Two common indicators included in the cost analysis are cost per person protected and cost per structure sprayed. However, because the average structure size and the number of people living per structure varies greatly by country, this costing analysis also reports the unit cost per area sprayed in terms of 100 square meters (m²), which is a standardized unit of measure and allows for the accurate comparisons of program costs across countries as it adjusts for the size difference in structures.
5. *Cost analysis and report writing* – The costing team analyzed all cost data according to the costing objectives and methodology.

RESULTS

Cross-Country Comparison

Project output data was collected and verified by AIRS M&E staff for the 11 countries included in the analysis. Table ES1 lists the process and outcome indicators for the 11 countries included in this analysis. In total, about 10.8 million people were protected, ranging from approximately 347,000 people in Nigeria to over 2.18 million people in Mozambique. This corresponds to about 2.8 million total structures sprayed, ranging from approximately 42,700 structures in Liberia to 635,500 structures in Ethiopia, and a total of over 322 million total square meters of structures sprayed.

The average structure size varied widely across countries, ranging from 54.7 square meters (m²) in Ghana, to 201.8 m² in Liberia. The average people per area sprayed (in terms of 100 m²) ranged from 2.2 people in Rwanda, to 8.0 people in Madagascar. Due to these variances, the unit cost per area sprayed (in terms of 100 m²) provides a standardized measure, which is informative for cross-country comparisons, as well as for program management and decision-making purposes.

TABLE ESI: AIRS PROJECT SPRAY COVERAGE IN YEAR 2, BY COUNTRY

Country	# of People Protected	# of Structures Sprayed	# Area Sprayed (100 m ²)	Avg. Size of Structure (m ²)	# People per Area Sprayed
Angola	419,353	98,136	107,140	109.2	3.9
Benin	694,729	228,951	125,605	54.9	5.5
Ethiopia	1,629,958	635,528	617,442	97.2	2.6
Ghana	534,060	197,655	108,210	54.7	4.9
Liberia	367,930	42,708	86,185	201.8	4.3
Madagascar	1,588,138	343,470	198,985	57.9	8.0
Mali	850,104	228,985	233,588	102.0	3.6
Mozambique	2,181,896	414,232	822,735	198.6	2.7
Nigeria	346,798	62,592	99,988	159.7	3.5
Rwanda*	1,479,342	345,862	662,425	191.5	2.2
Senegal	690,029	207,116	162,623	78.5	4.2
Average	980,212	255,021	293,175	118.4	4.1
Total	10,782,337	2,805,235	3,224,925		

* Rwanda had two rounds of spraying in 2013 and there is some overlap in structures sprayed, therefore, some numbers are double counted.

Table ES2 presents the results of the unit cost analysis. The countries have been grouped into three categories based on the size of the program in terms of number of structures sprayed.

TABLE ES2: YEAR 2 IRS PMI PROGRAM UNIT COSTS

Program Size (# structures sprayed)	Country	Cost per Person Protected	Cost per Structure Sprayed	Cost per Area Sprayed (100 m ²)	Insecticide Class Procured	Insecticide Sprayed
Large (230,001 - 640,000)	Ethiopia	\$ 4.48	\$ 11.49	\$ 11.83	Carbamates	Carbamates
	Mozambique	\$ 2.38	\$ 12.52	\$ 6.30	Pyrethroids	Pyrethroids
	Rwanda	\$ 4.46	\$ 19.08	\$ 9.96	Pyrethroids, Carbamates	Pyrethroids, Carbamates
	Madagascar	\$ 5.00	\$ 23.13	\$ 39.92	Organophosphates, Pyrethroids	Pyrethroids, Carbamates, Organophosphates
Medium (100,001 - 230,000)	Mali	\$ 7.00	\$ 25.99	\$ 25.48	Carbamates	Carbamates
	Benin	\$ 5.90	\$ 17.92	\$ 32.66	Organophosphates	Carbamates, Organophosphates
	Senegal	\$ 7.16	\$ 23.85	\$ 30.37	Carbamates	Carbamates
	Ghana	\$ 10.05	\$ 27.14	\$ 49.58	Organophosphates	Organophosphates
Small	Angola	\$ 10.83	\$ 46.29	\$ 42.40	Pyrethroids	Pyrethroids
	Nigeria	\$ 8.76	\$ 48.56	\$ 30.40	Pyrethroids	Pyrethroids

(40,000 - 100,000)	Liberia	\$ 8.82	\$ 75.95	\$ 37.64	Organophosphates	Organophosphates
--------------------	---------	---------	----------	----------	------------------	------------------

In general, countries with larger programs have lower unit costs, demonstrating a correlation between cost and program scale. However, there is still variation within each grouping of program size, which will be discussed in the report under the Cost Drivers section.

The average cost per person protected was \$6.80 across the countries, ranging from \$2.38 in Mozambique to \$10.83 in Angola. The average cost per structure sprayed was \$30.17 across countries, ranging from \$11.49 in Ethiopia to \$79.95 in Liberia. The average cost per area sprayed was \$28.78, ranging from \$6.30 in Mozambique to \$49.58 in Ghana.

As mentioned, the cost per structure sprayed and cost per person protected show a correlation between program size and unit cost. However, the cost per area sprayed has a greater variation within program size groups than the other unit costs. The correlation between program scale and unit cost therefore weakens considerably within this unit cost analysis. The reasons why are discussed in the cost driver analysis below.

Cost Drivers

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. The types of expenditures included in each cost category are detailed in Table 1 of the Methodology section. The three predominate cost drivers included Insecticide, Spray Operations, and Local Labor. Together, these three cost categories constituted an average of 81 percent of the cost per area sprayed.

Insecticide

To prevent and manage the increasing challenge of malaria vector resistance to insecticides, IRS programs are changing or rotating the class of insecticide used: from pyrethroid to carbamate to organophosphates. Insecticide constituted an average of 23 percent of the cost per area sprayed across country programs. On average, the portion of unit costs spent on insecticides is \$1.07 for pyrethroids, \$6.65 for carbamates, and \$11.68 for organophosphates.

Spray Operations

Spray operations, which includes costs associated with temporary labor of spray operators (SOPs), ground transportation, and warehousing costs, accounted for an average of 36 percent of the total unit cost per area sprayed, and is correlated with the scale of program size. Madagascar and Ghana were two outliers, being the most expensive unit costs by a large margin within their program size groups. Madagascar's geographical coverage area is more spread out than the other large countries and the program incurred about a third higher transportation costs than the other programs, contributing to the higher unit cost. Ghana's spray coverage (in terms of amount of 100 m² sprayed) was 38 percent less than the average of the other medium-sized programs, and thus, scale is still driving the unit cost to be more expensive.

Full-Time Local Labor

Local labor includes the country site office full-time staff members. It does not include temporary workers who are hired as spray operators (and discussed under the spray operations section). Implementation of an IRS program requires a certain minimum threshold of staff to operate effectively, so the number of staff members is not linked to program size. Unlike the number of staff members, however, the unit cost of local labor per area sprayed tends to be lower for larger programs and higher for smaller programs because this cost is shared across more square meters of area sprayed in larger programs. Thus, while local full-time staff labor is a major cost driver, it is also a step-variable cost. This means that the local labor portion of the cost per area sprayed is related to the size of the IRS program, but the number of staff hired is not directly related to the number of structures sprayed.

Year-on-Year Comparison

Angola, Ghana, Liberia, and Senegal, which all had decreased program sizes in Year 2, likewise saw decreases in all output measures. Madagascar and Mozambique remained large programs, but also saw decreases in all output measures. Rwanda grew by almost half, Ethiopia grew by around 15 percent, Benin and Mali grew by about 10 percent, and Nigeria remained a similar size as the previous year.

As calculated by cost per 100 square meters sprayed, the unit costs in all countries increased in Year 2 with the exception of Rwanda. Insecticide choice played a role in this increase, as well as the reduction in number of target structures in some countries. On average, across the countries, the cost per 100 square meters sprayed increased by 49 percent. If countries had operated at the same scale in Year 2 as in Year 1, the fixed costs would have been divided such that overall unit costs would have increased by 37 percent on average. Further, if insecticides had been procured at Year 1 prices, then unit costs would have increased by 38 percent on average; together program scale and insecticide costs account for about half of the increase in unit costs between the two years. Increases in operational costs, including SOPs salaries, cost of ground transport, etc. account for the remainder of the increase in costs. SOP salaries increased in Ethiopia (50%), Angola (33%), and Nigeria (25%). The number of local staff hired by the project also increased in Madagascar, Ghana, Senegal, and Angola. A few countries improved their infrastructure, such as made renovations to warehouses and offices, as was the case in Angola and Madagascar, or oversaw the creation of a mobile insectary, as was the case in Liberia. Some activities were carried out in Year 2 that were not implemented in Year 1. Some examples include enumeration in Senegal, Angola, and Liberia.

The correlation between program size and unit cost remains true, and also shows a trend of unit costs increasing more for smaller programs than for bigger programs. If small programs get smaller, the percent decrease in program size will be a larger portion of the original compared to large programs getting smaller. Likewise, if the expensive unit cost of a small program increases, it will increase even more than a large program's increase in unit costs because the denominator (area sprayed) is much smaller, causing more volatile changes in the unit cost than large programs.

Limitations

Limitations in available data influence the results. Part of the insecticide included in this report was procured externally, either purchased directly by PMI or host governments. In Mozambique, the cost of government-procured insecticide was not available, and thus was estimated. Additional in-kind contributions by host governments may be provided (e.g., supervision), 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 peak malarial transmission seasons. In addition, differences in country input prices may cause variations in unit costs that are not attributable to program efficiency or cost effectiveness. For example, labor costs in some countries (such as Ethiopia) are known to be generally cheaper than in other countries (such as Angola).

Country Chapters

This report includes a more detailed and specific chapter for each IRS country program covered in this analysis. The country chapters each include a background section with relevant country context, M&E data, total program expenditures, and unit costs per person protected, per structure sprayed, and per area sprayed. These chapters also include a more detailed analysis of unit costs by burden (total cost of AIRS project vs. implementation-only costs with and without US-based labor), and between program Year 1 and Year 2.

CONCLUSIONS

Unit of Measure

When comparing IRS to alternative malaria interventions, the number of people protected and number of structures sprayed are two important indicators. In addition, cost per person protected provides a very useful indicator for programmatic management and decision making within a country year-on-year. However, when comparing unit costs across country IRS programs, analysis using people protected and structures sprayed is confounded by variations in both the average structure size and number of people per structure. Additional external factors can include: variation in commodity or labor prices, different quantities of inputs, or the type of implementation model used. Using the area sprayed (in units of 100 m²) removes factors outside the control of IRS programs, and provides a standardized measure as the best cross-country comparison to inform implementation management.

Program Scale

Broadly speaking, unit costs of large programs are less expensive than small programs, demonstrating that the cost per area sprayed is linked to program scale. Using the most standardized comparison unit cost available, there is still no 'one-price-fits-all' for IRS across countries. Large-sized programs averaged a cost per area sprayed of \$17.00, medium programs averaged \$34.52, and small programs averaged \$36.81. However, this does not explain all cost differences.

There are some fixed costs for IRS programs which are not correlated to program scale, such as local administration and U.S.-based labor, which constitute an average of 10 percent and 6 percent of the cost per area sprayed, respectively.

Two of the important IRS program cost drivers, spray operations and local labor, constitute an average of 36 percent and 19 percent of the cost per area sprayed, respectively. Spray operations and local labor are both largely correlated with program scale. Any programs with outlier costs in these areas are due to specific country context: geography of spray coverage area, number of spray rounds per year, and general cost of living (prices for labor, fuel, etc.).

Insecticide

The insecticide class used in spray campaigns is the third major cost driver in IRS programs, and will continue to be increasingly important as the threat of insecticide resistance prompts IRS programs to switch to more expensive classes of insecticide. The insecticide portion of the cost per area sprayed constitutes an average of 23 percent of the total unit cost across country programs.

Table ES3 provides a final summary of averages of various groups of country programs. The summary averages demonstrate that the non-insecticide cost per area sprayed is dependent on the program scale (unit costs of smaller programs increased by more than larger programs) and that insecticide cost per area sprayed is dependent on the class of insecticide procured. It is noteworthy that the small programs had a much higher percent change in non-insecticide cost per area sprayed than the medium or large programs. It is evident that smaller programs are more adversely impacted by increased insecticide costs and reductions in the number of target structures because the fixed costs become a higher percentage of total cost of implementing IRS.

TABLE ES3: SUMMARY OF INSECTICIDE VERSUS NON-INSECTICIDE UNIT COSTS

Summary Averages	Insecticide cost per area sprayed (100 m ²)			Non-insecticide cost per area sprayed (100 m ²)		
	Year 1	Year 2	Percent Change	Year 1	Year 2	Percent Change
Avg. Large Programs				\$ 9.08	\$ 12.43	37%
Avg. Medium Programs				\$ 19.26	\$ 25.06	30%
Avg. Small Programs				\$ 18.17	\$ 32.56	79%*
Avg. Pyrethroids**	\$ 1.34	\$ 1.07	-20%			
Avg. Carbamates	\$ 5.83	\$ 6.65	14%			
Avg. Organophosphates	\$ 8.47	\$ 11.09	31%			

*If the small programs had sprayed as much area in Year 2 as in Year 1, non-insecticide cost per area sprayed would have increased 55%. This remaining 24% is due to increases in spray operations costs including increases in SOP salaries. Two of the three small programs (Angola and Liberia) decreased their number of target structures substantially and the third program (Nigeria) had increased administration costs and wages as explained in the Nigeria section. More information can be found in the country chapters.

**Excluding Mozambique, for which we have only the costs of insecticides used in Year 2, not the costs of insecticides procured.

I. INTRODUCTION

I.1 BACKGROUND

In 2012, 134 million people (4 percent of the global population at risk for malaria) were protected by indoor residual spraying (IRS) programs. Across Africa, the proportion of the population at risk that was protected by IRS decreased from 11 percent in 2010 to 8 percent in 2012. As the World Health Organization (WHO)'s World Malaria Report notes, "the decrease in the number of people protected by IRS in Africa appears to be partly due to increased use of more costly non-pyrethroid insecticides (in response to a threat of insecticide resistance) in a setting of limited IRS budget" (WHO 2013). The report also notes that current available international and domestic funding is less than half of what is required to reach universal IRS coverage.

A key component of the U.S. Government's Global Health Initiative is the President's Malaria Initiative (PMI), whose goal is to limit exposure to malaria and thus reduce the incidence and prevalence of malaria. PMI has provided IRS program support to Ministries of Health (MOHs) and National Malaria Control Programs (NMCPs) in sub-Saharan Africa since 2006. In May 2009, the PMI strategy was updated to achieve Africa-wide impact by halving the burden of malaria in 70 percent of at-risk populations in sub-Saharan Africa. The current central PMI IRS implementation program is the Africa Indoor Residual Spraying (AIRS) project, which began on August 11, 2011. By the end of its second calendar year of implementation (2013), AIRS was providing 11¹ PMI countries with full IRS operations and logistics support (Angola, Benin, Ethiopia, Ghana, Liberia, Madagascar, Mali, Mozambique, Nigeria, Rwanda, and Senegal). AIRS was also providing technical assistance to local government-run IRS programs in Zambia and Zimbabwe, as well as enhanced entomological monitoring in Burundi and the Democratic Republic of the Congo (DRC).

In accordance with PMI guidance, the AIRS project implements all aspects of the IRS process, including the following:

- 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;

¹ USAID only sprayed in Burkina Faso through 2012. The Government of Burkina Faso reprioritized their donor funding to other health interventions.

- 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 (EC) of IRS campaigns, and materials used in the campaigns;
- Monitoring and evaluating all program activities; and
- Completing entomological surveillance, and testing insecticide effectiveness.

PMI also seeks to ensure sustainability of IRS and other malaria control approaches. It therefore expects the AIRS project to empower country governments, private sectors, and communities by developing local knowledge and technical capacity needed to lead future IRS efforts. To this end, the project works closely with MOHs and NMCPs, health centers, and community leaders to encourage and enable their involvement in malaria control planning and implementation. Additionally, in some countries, the project partners with local organizations that complete entomological surveillance and information, education, and communication (IEC) activities.

PMI requested the AIRS project to provide comparative cost analyses on the total and unit costs of the IRS country programs. AIRS completed the first of these analyses last year, which included project start-up costs (Abbott et al. 2014). This report builds upon those Year 1 findings by reporting on Year 2 costs and comparing them with those of Year 1.

1.2 OBJECTIVE

This report presents and compares the findings of a cost analysis of the expenses that were incurred during the first two years of IRS program implementation in 11 PMI countries, using a methodology that can be repeated on an annual basis. The purpose of the assessment is to evaluate the overall level of spending in each of these countries, by program activity and by cost category, as well as the unit costs.

Specifically, the total program costs, unit cost per person protected, unit cost per structure sprayed, and unit cost per area sprayed (in units of 100 m²) are stratified using unburdened, burdened, and U.S.-based costs. PMI requested such a breakout so that it could understand its total project costs (fully burdened as delivered through an international implementing partner) as well as the actual costs of implementing an IRS program in-country with and without U.S.-based staff labor.

Additionally, 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 scenarios are defined in detail in the methodology section.

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

Costing data findings will also support PMI and host countries in the decision-making process of planning and prioritizing future investments within a country. Findings may also help local governments decide whether they would like to expand funding or management of IRS programs, and eventually to conduct full IRS activities themselves.

The four PMI countries supported by AIRS not included in this analysis are Burundi, the DRC, Zambia, and Zimbabwe. In Burundi and the DRC, the AIRS project is providing only enhanced entomological monitoring activities. In Zimbabwe and Zambia, PMI's AIRS project was not leading implementation of spray operations in 2013. In Zambia, the MOH National Malaria Control Centre was implementing IRS for malaria control as part of an integrated vector management strategy. AIRS was responsible for the procurement and environmental compliance components of IRS activities in 20 PMI-supported districts. In Zimbabwe, PMI provided technical support to the NMCP through the AIRS project, as the Government of Zimbabwe has implemented IRS campaigns since the 1940s.

1.3 TARGET AUDIENCE

The results and findings of the cost analysis will be used by PMI and USAID to make informed decisions at PMI headquarters and in their field offices about how and at what funding level to invest in IRS in the future. The findings will also be used by AIRS 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.

2. APPROACH

2.1 METHODOLOGY

Prior to this cost analysis, four cost analyses had been done of PMI IRS programs: one was conducted by the Abt Associates-led IRS program in Uganda (Uganda Indoor Residual Spraying Project 2011), two by Research Triangle Institute International (RTI) (Sine and Doherty 2010, Sine et al. 2011), and the aforementioned AIRS project's comparative cost analysis of Year 1 (Abbott et al. 2014). The 2011 RTI report covered the costs of implementing IRS in 12 countries from 2008 to 2010. The methodology used in the current cost analysis builds upon the RTI report; like the AIRS cost analysis for project Year 1, it is more inclusive in terms of program costs. The analyses presented in this report use the same methods as the AIRS cost analysis for project Year 1.

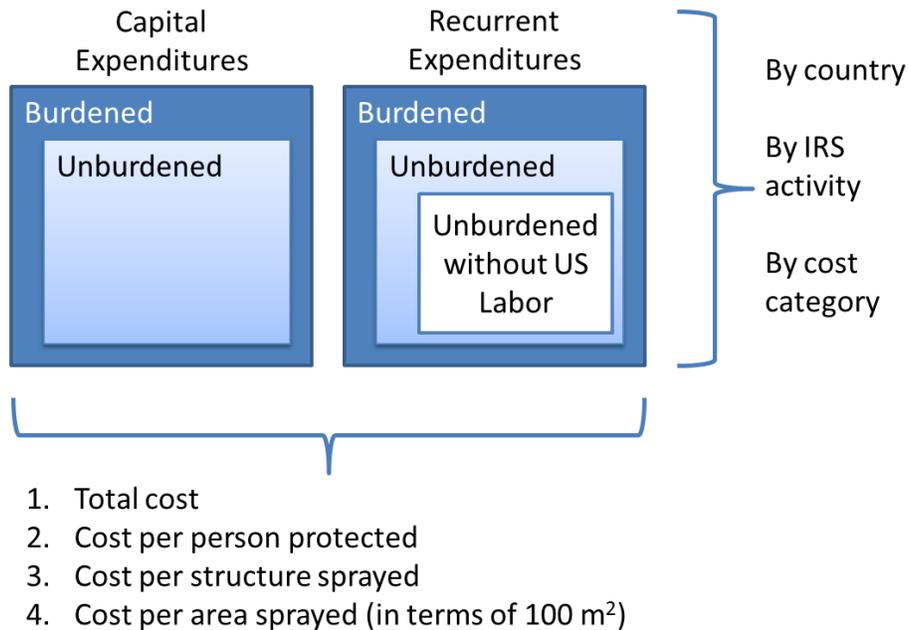
Through a collaborative and iterative process with PMI, project technical and operational staff, and monitoring and evaluation (M&E) and finance officers, the costing team established the following steps for the costing analysis.

The costing team met with PMI and AIRS programmatic staff to verify that the correct questions were being asked in order to generate an analysis that would provide the maximum relevant information for the target audience.

Financial data were collected from Abt Associates' internal financial tracking systems for the first two years of the full (11-country) AIRS project. Inventory disposition lists and procurement records were collected from country teams and PMI to determine the value of any inherited or donated resources. Information collected was augmented and verified through staff interviews. Program output data were collected from the AIRS M&E systems.

The framework, depicted below in Figure 1, was developed to illustrate the multi-dimensional categories assigned to expenditures. Categorizing expenditures on multiple levels provides information for a more detailed analysis of cost drivers, program efficiencies, and cost effectiveness. The framework covers four pools of categories: (1) capital and recurrent costs, (2) burden type, (3) technical program activities, and (4) cost categories.

FIGURE 1: COSTING METHODOLOGY FRAMEWORK



Note: A detailed explanation of the above Costing Methodology Framework is given below.

Capital and Recurrent Costs

Capital costs are one-time expenditures of equipment, materials, and supplies that will be used in multiple years of program implementation. These expenditures are linearly depreciated across the life of the project using basic accounting methods. A useful life of three years was assumed to match the project's performance period. The program technical coordinator for each country verified the list of equipment and supply items as capital expenditures.²

Recurrent costs include all operational expenditures incurred a) after the start date of program implementation, and b) on an annual basis.

An analysis of the project start-up costs were included in the previous cost analysis, and are not included here. Start-up costs included all expenses incurred during the initial period of preparation. Start-up operations include activities such as country scoping, office set-up, and hiring. These costs occur only once during the life of the IRS country program under PMI's AIRS project.

Burdened versus Unburdened Costs

² Some expenditure items ("Government Property," "Supplies," or "Materials") were not descriptive enough to allow the costing team to determine whether they were capital or recurrent costs. Following AIRS program assumptions, the team considers expenses less than \$500 to be recurrent costs, and expenses greater than \$500 to be capital costs. The AIRS program team's rationale is that \$500 is the dollar amount at which items begin to be recorded and tracked as government property, as well as recorded for disposition lists.

This analysis is conducted using burdened (total program) costs, but it also shows unburdened costs (of the actual IRS interventions with or without U.S. labor).

Burdened costs include all unburdened costs as well as the cost of running program implementation through an international implementing partner, in this case, Abt Associates. Abt's burden is based on a percentage of raw costs, and includes standard overhead, fringe benefits, general and administrative (G&A) expenses, handling charges, and the project fee.

Unburdened costs are the raw cost of program expenditures and the base salary of staff.

Unburdened costs without U.S.-based labor are the same raw costs less any expenditures incurred under the 'U.S.-Based Labor and STTA (short-term technical assistance)' cost category, which includes labor charged by AIRS project staff based in the United States as opposed to in-country local staff, as well as expenses incurred under STTA.

Technical IRS Activities

AIRS program teams internally track financial expenditures by the following IRS activities: Administration, Entomology, EC, IEC, Insecticide purchase, Equipment and Supplies, M&E, Spray Planning, Spray Campaign Operations, and Post-Spray Operations.

Cost Categories

In collaboration with the AIRS project staff, the costing team used an iterative process to determine which types of expenditure items should be assigned to which cost categories. Table 1 provides examples of the types of expenditure items in each cost category.

TABLE 1: EXPENDITURE ITEMS INCLUDED IN IRS COST CATEGORIES, ASSUMPTIONS

IRS Cost Category	Capital Expenditures	Recurrent Expenditures
Spray Operations	(None)	<ul style="list-style-type: none"> • Transportation and vehicle use for local staff and spray operators • Warehousing • Technical consultants and temporary labor, including spray operators • Subcontracts for technical activities* • Training, conferences, and seminars for technical activities • Honoraria and misc. professional services
Spray Commodities	<ul style="list-style-type: none"> • Spray pumps • Reusable personal protective equipment • Unidentified govt. property > \$500 	<ul style="list-style-type: none"> • Insecticide • Disposable personal protective equipment • Shipping of insecticides and equipment • Unidentified govt. property < \$500

IRS Cost Category	Capital Expenditures	Recurrent Expenditures
Local Labor	(None)	<ul style="list-style-type: none"> Local and third country national staff labor and overhead Local staff allowances and bonuses
Local (in-country) Administration	<ul style="list-style-type: none"> Vehicles (bought or inherited) Site office furniture, equipment, and supplies (bought or inherited) Unidentified govt. property > \$500 	<ul style="list-style-type: none"> Office rent, utilities, maintenance Information Technology (IT) support Admin travel and transportation Postage and shipping for Remote Office Vouchers and admin items Training, conferences, and seminars on admin activities Unidentified govt. property < \$500
U.S.-based Labor and STTA	(None)	<ul style="list-style-type: none"> U.S.-based labor and overhead U.S.-based support services (communications, human resources, IT, etc.) STTA: airfare, lodging, per diem, and other travel expenses Home office management Network charges Local staff Chief of Party travel to the U.S. for Chief of Party conference

* Technical activities include Entomology, IEC, EC, M&E, Spray Planning, Spray Campaign Operations, and any Post-Spray Campaign Operations. These are all included in the activity categories.

Based on the M&E reporting mechanisms of the AIRS project, as well as the previously existing costing analyses, two indicators included in the cost analysis are cost per person protected and cost per structure sprayed. However, because the average structure size and people living per structure varies greatly by country, this costing analysis also reports the unit cost per area sprayed in terms of 100 square meters (m²). This standardized unit of measure allows for the most accurate comparisons of program costs across countries as it adjusts for the size difference in structures. As such, it makes unit costs more informative for program management and decision-making purposes. All costs are reported in 2013 U.S. dollars.

The costing team analyzed all cost data according to the costing objectives and methodology illustrated above in Figure 1. AIRS staff verified preliminary results and provided further country and program context, as necessary. An initial comparison of costs across countries, for Years 1 and 2, is provided in terms of cost per area sprayed. Following this, country-specific chapters provide cost results from Year 2 programs and compare results from Years 1 and 2 in terms of costs per person protected and per structure sprayed.

In order to compare the costs of Years 1 and 2, expenditures from Year 1 were adjusted to 2013 real U.S. dollars. This was calculated by converting Year 1 expenditures to the local currency using a 2012 exchange rate, multiplying by World Bank deflator for 2013, and reconverting to U.S. dollars using the 2013 exchange rate. Portions of the Year 1 programs that took place in 2013 were not adjusted.

2.2 ASSUMPTIONS AND LIMITATIONS

2.2.1 DEPRECIATION OF CAPITAL COSTS

Capital costs include both items purchased under the AIRS project and items inherited from previous programs.³ Due to lack of available information on the full useful life of some items (i.e., how long the item has been used, or how long it will continue to be used after the life of the project), capital items were depreciated across the three years of AIRS project implementation.⁴ This assumption may inflate the costs presented here to some extent because some of the items (i.e., vehicles, office equipment) will have a useful life of greater than three years and/or have a salvage cost.

2.2.2 VALUATION OF INHERITED ITEMS

The inventory disposition lists for donated or inherited items lists each item, and its quantity, unit cost, and total value. In Ethiopia, Liberia, and Mozambique, the cost value attributed to each capital item included in the disposition inventory had already been decreased by project staff under the previous PMI IRS project, in order to reflect the item's previous use and current value. For disposition lists that may not have accounted for a decreased valuation, no adjustments were made by this costing team.

2.2.3 ASSIGNING BURDEN COSTS

In Abt Associates' internal financial tracking system, fringe benefits and G&A expenditures are listed as individual line items and are not directly linked to direct labor expenditures. Thus, we cannot precisely distinguish these expenses between U.S.-based and local staff. The costing team assigned fringe and G&A expenses to the appropriate cost categories based on the proportionate direct labor expenses of U.S.-based and in-country local staff. Note that other overhead expenses list whether they are linked to U.S.-based or local staff. Non-labor burden provided a direct link to the relevant expenditure item.

2.2.4 PROGRAM DATES

This comparative costing analysis covers Years 1 and 2 of AIRS project implementation. However, the dates of each program year (the period of program implementation)

³ The cost of capital items will need to be added to the future costing analyses of the AIRS project, as they will no longer show up in the Abt Associates internal financial tracking system.

⁴ Therefore, each capital item total cost was divided by three (years) to find the correct cost value for each year.

vary by country (see Table 2) – in Year 1, program start dates were staggered to allow for efficient project start-up and smooth initial operations. The majority of countries operate within the calendar year dates.

The first full calendar year of AIRS project implementation ran from January 1, 2012, through December 31, 2012. However, the spray campaign rounds were timed to each country's rainy season, which corresponds with peak malaria transmission. This complicates the costing analysis. For example, spray campaign rounds in Madagascar were not finalized in the 2012 calendar year, and so they could not be included in the previous costing analysis. Thus, the results of both program years in Madagascar are included in this report. Additionally, IRS programs in Ethiopia and Liberia completed two spray campaign rounds in the first year of implementation, and Rwanda completed two spray campaign rounds in the second year of implementation. The analysis carefully avoided double-counting.

TABLE 2: COUNTRY PROGRAM START DATES

Country	Year 1 Program Dates	Year 2 Program Dates
Angola	April 1, 2012 – March 31, 2013	April 1, 2013 – March 31, 2014
Benin	January 10, 2012 – December 31, 2012	January 1, 2013 – December 31, 2013
Burkina Faso	January 1, 2012 – December 31, 2012	n/a*
Ethiopia	February 1, 2012 – December 31, 2012	January 1, 2013 – December 31, 2013
Ghana	February 10, 2012 – December 31, 2012	January 1, 2013 – December 31, 2013
Liberia	January 10, 2012 – December 31, 2012	January 1, 2013 – December 31, 2013
Madagascar	August 15, 2012 – April 30, 2013	May 1, 2013 – April 30, 2014
Mali	February 1, 2012 – December 31, 2012	January 1, 2013 – December 31, 2013
Mozambique	April 1, 2012 – March 31, 2013	April 1, 2013 – March 31, 2014
Nigeria	February 1, 2012 – December 31, 2012	January 1, 2013 – December 31, 2013
Rwanda	March 1, 2012 – December 31, 2012	January 1, 2013 – December 31, 2013
Senegal	January 1, 2012 – December 31, 2012	January 1, 2013 – December 31, 2013

* USAID only sprayed in Burkina Faso through 2012. The Government of Burkina Faso reprioritized their donor funding to other health interventions.

2.2.5 COUNTRY CONTEXT

When comparing unit costs across countries, it is important to note that variations between countries, unrelated to the IRS program structure or implementation, can account for differences in cost. For example, cross-country differences in the average size of structures sprayed or the average number of people living per structure sprayed will cause country unit costs to represent different levels of coverage. To account for this, the costing team introduced an additional unit of measure of cost per area sprayed (100 m²). Standardizing project coverage by square meters sprayed, rather

than structure sprayed or people protected, provides for a more accurate comparison of unit costs across countries, which is helpful for program management and decision-making purposes.

Differences in country input prices can cause variations in unit costs that are not attributable to program efficiency or cost effectiveness. For example, labor costs in some countries (such as Ethiopia) are known to be generally lower than in other countries (such as Angola).

The geography of the spray campaign coverage area has an impact on program costs as well. In areas where structures are dispersed, a campaign requires a greater number of inputs (labor of spray operators and ground transportation); longer travel times between sites can also extend the duration of the spray campaign. In areas where structures are in close proximity, a campaign tends to require fewer inputs and less time.

This analysis includes the cost of all insecticides purchased in each implementation year. However, in some cases the insecticide sachets purchased in a particular year are not all used, and the extra sachets are then used in the following year or, in one case, transferred to another country*. The analyses reported here present the costs of insecticides procured with the exception of Mozambique (discussed below). In addition, some IRS programs receive insecticide from external organizations. In the first year, the Ethiopia IRS programs received pyrethroid insecticides purchased by the government and Rwanda received pyrethroids from the previous implementer, RTI. The procurement bills of these insecticides were provided to the costing team, so the real value has been included. However, in the second year, Mozambique received insecticide from the MOH, but the cost was not available for inclusion in this report. We include an estimated cost based on the procurement costs for project Year 1; lacking data on how many sachets were procured, the costs presented here for Mozambique reflect the estimated costs of insecticide used.

* Liberia transferred insecticide to Madagascar when it was determined that they would not spray again in the near future. The cost of these transferred insecticides are reported in the costs for Madagascar and have been subtracted out of the costs for Liberia.

3. CROSS-COUNTRY RESULTS

3.1 BACKGROUND

Output Measures

Table CC1 presents the coverage provided by PMI's AIRS project spray campaigns in each country. The area sprayed (number of 100 m² sprayed) was calculated by multiplying the total number of sachets used by the estimate of 250 m² coverage provided by each sachet, and divided by 100 m² in order to develop a more usable unit of measure. Note that in Ethiopia, total number of sachets was multiplied by 200 m² because the program uses an 8L spray tank (and smaller (100gr) sachets), which holds less insecticide than in other countries, and thus covers less surface area. 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 2.3 in Rwanda to 8.0 in Madagascar. Note that one sachet of pyrethroid or carbamate is equivalent to one bottle of organophosphate.

TABLE CCI: AIRS PROJECT SPRAY COVERAGE IN YEAR 2, BY COUNTRY

Country	# of People Protected	# of Structures Sprayed	# Area Sprayed (100 m ²)	Avg. Size of Structure	# People per Area sprayed
Angola	419,353	98,136	107,140	109.2	3.9
Benin	694,729	228,951	125,605	54.9	5.5
Ethiopia	1,629,958	635,528	617,442	97.2	2.6
Ghana	534,060	197,655	108,210	54.7	4.9
Liberia	367,930	42,708	86,185	201.8	4.3
Madagascar	1,588,138	343,470	198,985	57.9	8.0
Mali	850,104	228,985	233,588	102.0	3.6
Mozambique	2,181,896	414,232	822,735	198.6	2.7
Nigeria	346,798	62,592	99,988	159.7	3.5
Rwanda	1,479,342	345,862	662,425	191.5	2.2
Senegal	690,029	207,116	162,623	78.5	4.2

The average structure size and number of people per area sprayed both provide additional contextual understanding of a country program's spray campaign. Structure size varied widely between countries, ranging from 54.7 m² in Ghana to 201.8 m² in Liberia, almost four times as large. The average size of structures sprayed across all Year

2 countries was 118.7 m² (not weighting for the different number of structures sprayed between countries). Since an average insecticide sachet covers 250 m² of structure, on average each sachet covered just over two structures.

The average size of a structure may differ in program Years 1 and 2. This is because the average structure size is calculated based on the number of insecticide sachets used and the number of structures sprayed. Variations in the average size may be due to changes in spray technique efficiencies or spray operations moved to an area with larger structures.

Program Size

PMI, project staff and the general IRS community define “program size” using a combination of both the total number of structures sprayed and total number of population protected.⁵ For the purpose of this costing report, IRS country programs will be separated into three program sizes. This breakdown is summarized in Table CC2.

TABLE CC2: IRS PROGRAM SIZES

Program Size	# Structures Sprayed	# Population Protected	# Square Meters Sprayed
Large	230,001 – 640,000	860,001 – 2,200,000	17,000,001 – 85,000,000
Medium	100,001 – 230,000	450,001 – 860,000	11,000,001 – 17,000,000
Small	40,000 – 100,000	300,000 – 450,000	8,000,000 – 11,000,000

In order to use a standardized unit cost for comparisons across countries, this report will most often reference the unit cost per area sprayed (in 100 m²). However, for a more detailed analysis, countries will be grouped and presented according to program size, as specified above. Country programs are listed by size in Table CC3 below.

TABLE CC3: COUNTRY IRS PROGRAM SIZE GROUPS

Small	Medium	Large
Angola	Benin	Ethiopia
Liberia	Ghana	Madagascar
Nigeria	Mali	Mozambique
	Senegal	Rwanda

3.2 TOTAL PROGRAM EXPENDITURES

This section presents the IRS country programs’ total expenditures for the second year of program implementation. As described in the Methodology section of this report, the data have been categorized in the following ways: by cost category, by program activity, by expenditure status (capital or recurrent), and by burden type. The two

⁵ In the 2011 RTI IRS Costing Report, “large programs” were those where more than 150,000 structures were sprayed per implementation year; “small programs” sprayed fewer than 150,000 structures.

figures below show the total program expenditures in Year 2 for each country. Expenditures are organized first by burden type, and then by cost category.

FIGURE CC1: CAPITAL AND RECURRENT EXPENDITURES, BY BURDEN TYPE

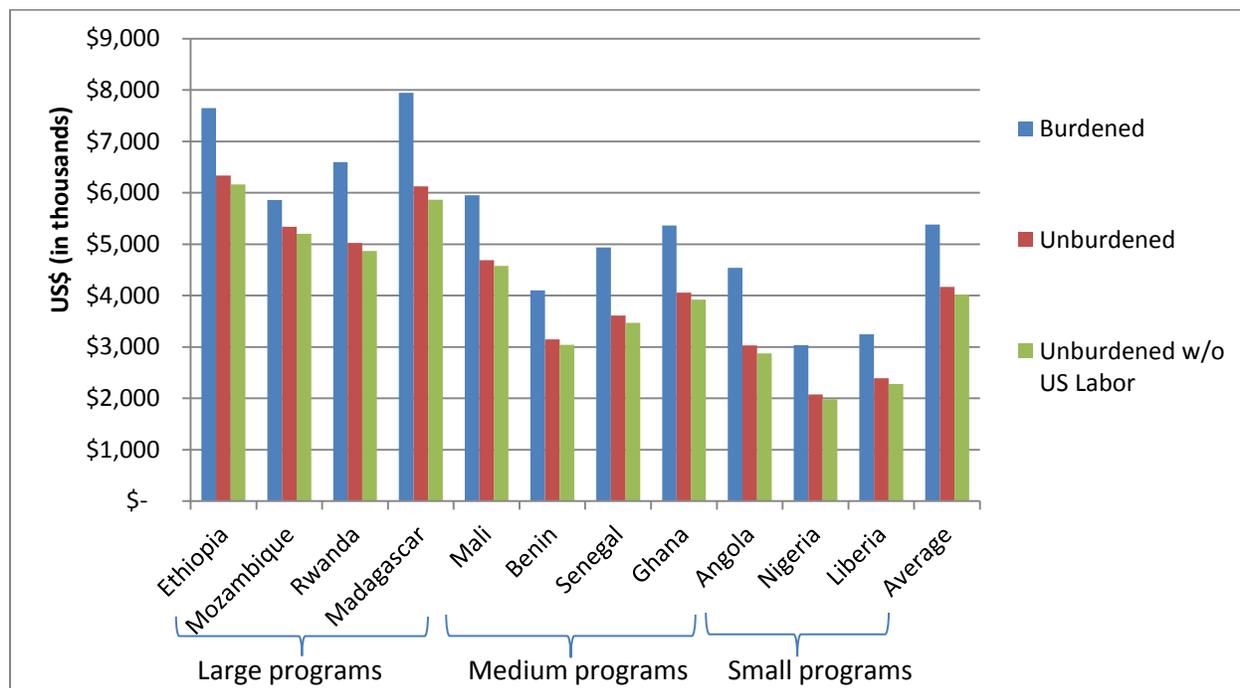
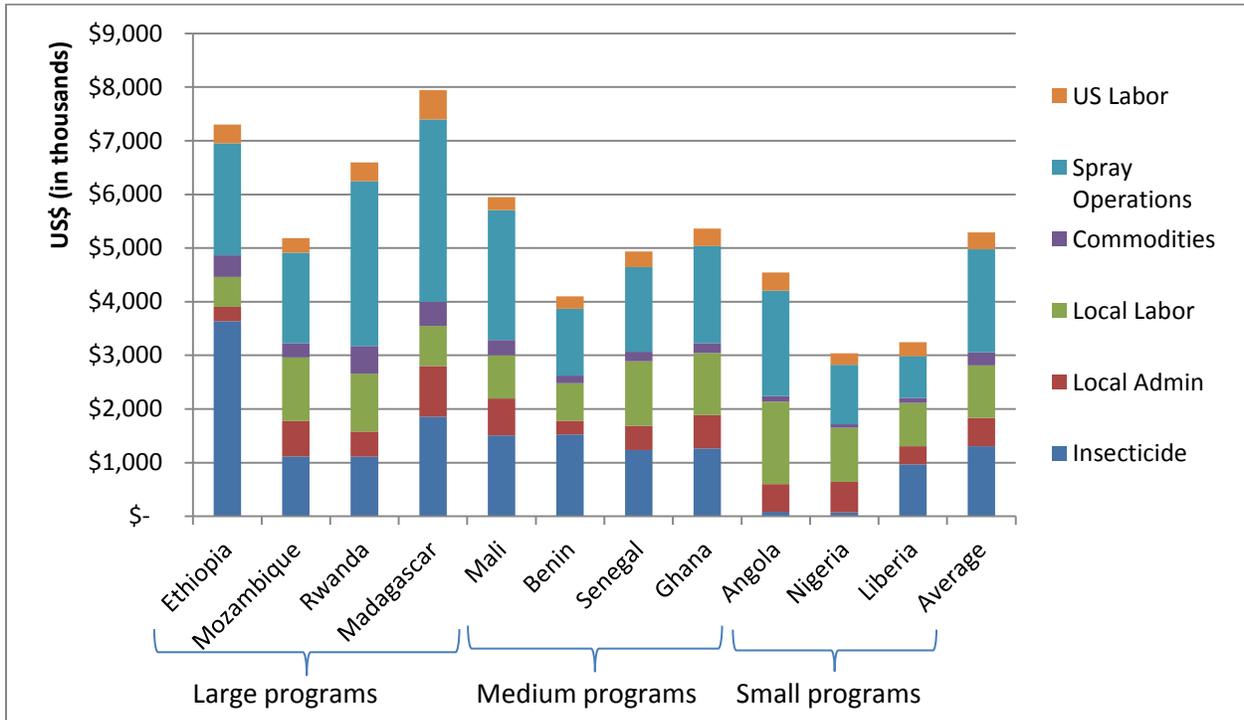


Figure CC1 shows the program total costs burdened, unburdened, and unburdened without U.S. labor. The definition of the types of burden is included in the Methodology section. The fully burdened bar (blue) includes all the expenditures and overhead, burden, and G&A costs associated with running the global AIRS project through an international implementing partner, Abt Associates. The small difference between the unburdened cost bar (red) and the unburdened cost without U.S.-based labor (green) represents the totality of expenditures spent on U.S. labor and all STTA.

The average total program implementation expenditures for large programs is about \$6.76 million, for medium-sized programs is about \$5.09 million, and for the small programs is about \$3.61 million. Further analysis of the burden rates is provided under each country chapter of this report.

Figure CC2 below includes all capital and recurrent costs of country IRS programs, fully burdened, and broken down by cost category. Countries are arranged in order of the number of structures sprayed during Year 2 spray campaigns, largest to smallest. The types of expenditure items included in each cost category are fully detailed in the Methodology section.

FIGURE CC2: CAPITAL AND RECURRENT EXPENDITURES, BY COST CATEGORY



The above figure begins to show that the U.S.-based labor and STTA cost category remains consistent across all country programs at an annual average of about \$312,000. Local administration, while more variable than the U.S.-based labor cost category, is also considered a fixed cost and averaged about \$526,000 across countries. These fixed costs are discussed in more detail under the cost drivers analysis section. An average of two-thirds of total project expenditures (66 percent) are spent directly on spray operations, insecticide, and other commodities.

Insecticide used for the Year 2 spray campaign in Mozambique was purchased by an external organization and donated to the AIRS Mozambique project by the MoH. We estimated the cost of insecticides in Mozambique by using the unit costs of procurement and shipment from Year 1 and applying those to the total amount of insecticide used.

3.3 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 CC4, are calculated using total program expenditures and the output measures provided in Table CC1.

The most important objective of IRS programs is to protect people; however the unit cost per person protected is confounded by the variability of living density and structure size when it is compared across different countries. The differences between the unit costs of country programs based on the number of people protected and the number of structures sprayed are due largely to the density of people per structure. In

addition, the unit cost per structure sprayed is a common metric for IRS programs, but conceals the fact that structures can be of varying sizes. Thus, a unit cost per area sprayed (with a unit of 100 m²) is also included in this report and serves as the foundation for understanding differences in costs between countries. A country program may be inexpensive in terms of cost per person protected compared to other country programs, but if the density of people living per structure is larger than other country programs, then the cost per area sprayed may look comparatively more expensive than other programs. Thus, the number of structures sprayed and ultimately people protected are specific to varying country contexts (i.e., size of structures and density of people living in a structure) and not inherently controllable by an IRS program.

All of the following unit costs in this section are fully burdened. The country-specific chapters provide a detailed breakdown in unit cost by burdened, unburdened, and unburdened without U.S.-based labor, as well as unit costs itemized by cost category and program activity.

TABLE CC4: YEAR 2 IRS PROGRAM UNIT COSTS

Program Size	Country	Cost per Person Protected	Cost per Structure Sprayed	Cost per Area Sprayed
Large	Ethiopia	\$ 4.48	\$ 11.49	\$ 11.83
	Mozambique	\$ 2.38	\$ 12.52	\$ 6.30
	Rwanda	\$ 4.46	\$ 19.08	\$ 9.96
	Madagascar	\$ 5.00	\$ 23.13	\$ 39.92
Medium	Mali	\$ 7.00	\$ 25.99	\$ 25.48
	Benin	\$ 5.90	\$ 17.92	\$ 32.66
	Senegal	\$ 7.16	\$ 23.85	\$ 30.37
	Ghana	\$ 10.05	\$ 27.14	\$ 49.58
Small	Angola	\$ 10.83	\$ 46.29	\$ 42.40
	Nigeria	\$ 8.76	\$ 48.56	\$ 30.40
	Liberia	\$ 8.82	\$ 75.95	\$ 37.64
Average (unweighted)		\$ 6.80	\$ 30.17	\$ 28.78

The following figures show each of the country IRS programs' unit costs: per person protected, per structure sprayed, and per area sprayed. These costs are fully burdened, and itemized by cost category. Countries are ordered by number of structures sprayed, from largest to smallest.

FIGURE CC3: UNIT COSTS PER PERSON PROTECTED, BY COST CATEGORY

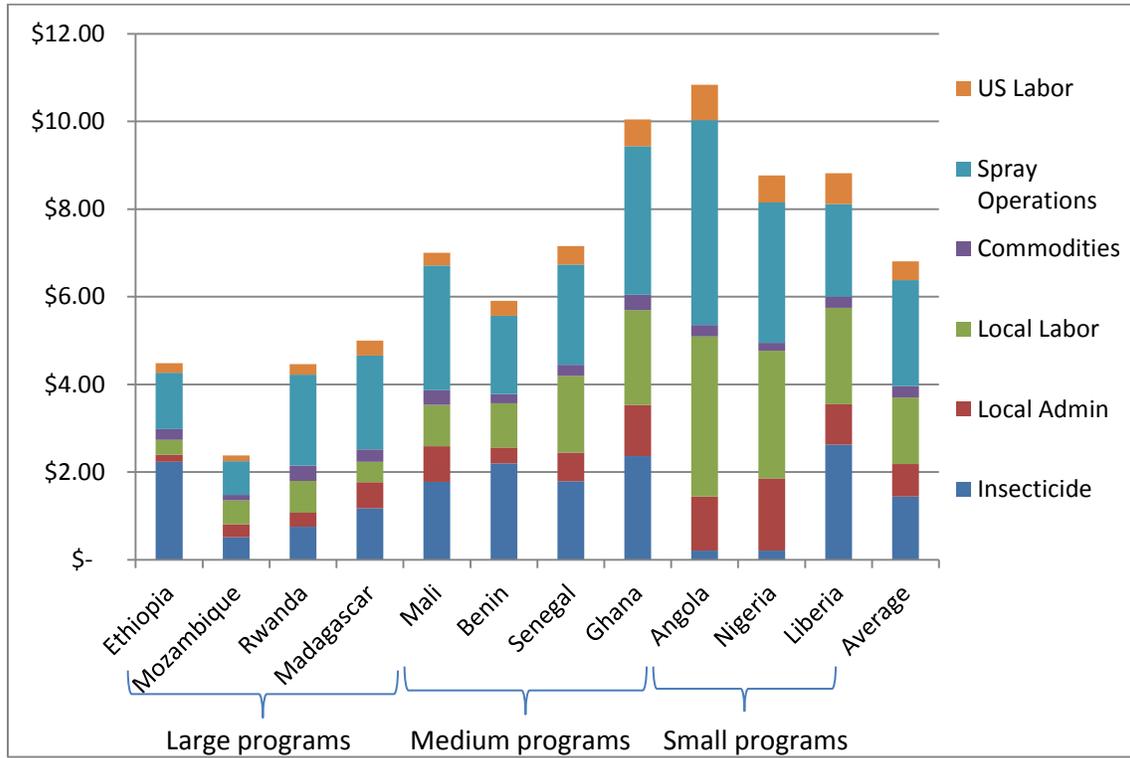


Figure CC3 above shows the cost per person protected, broken down by cost category. The overall unweighted average is \$6.80. The average cost per person protected by program size is \$4.08 for large programs, \$7.53 for medium programs, and \$9.47 for small programs. As will be discussed in further detail under the cost drivers section, the higher unit costs per person protected in the smaller programs are largely due to program scale and a high percentage of fixed costs.

FIGURE CC4: UNIT COSTS PER STRUCTURE SPRAYED, BY COST CATEGORY

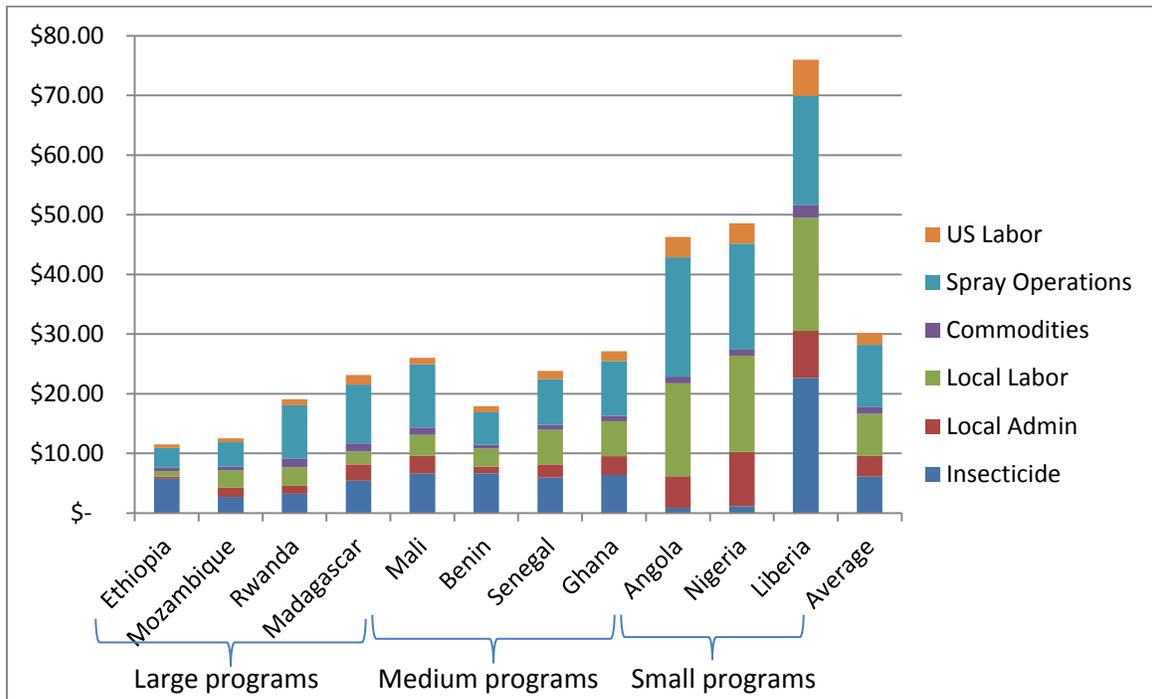


Figure CC4 shows country programs' unit costs per structure sprayed. The unit costs above are fully burdened, and itemized by cost category. Generally, since program size is defined by the number of structures sprayed, this figure is the clearest demonstration of the correlation between program size and unit cost; the larger the program, the smaller the unit cost. The average cost across countries (not weighted by the number of structures sprayed in each country) was \$30.17. The average cost per structure sprayed for large programs is \$16.55, for medium programs is \$23.72, and for small programs is \$56.93.

As stated earlier, the average size of a structure may vary greatly from one country to another, which means that even if fewer structures were sprayed, the same amount of square meters may have been covered. For example, in Figure CC4, the unit costs per structure sprayed for Liberia is the highest, and Ghana is below average. However, in Figure CC5 below, the unit cost per area sprayed for Ghana is the most expensive, and Liberia has dropped to third expensive (\$11.94 less per area sprayed than Ghana). This is because in Ghana the average size of a structure is 54.7 m², and in Liberia the average is 201.8 m². Therefore, presenting the cost per area sprayed (in terms of 100 m²) in comparing costs across countries provides a standardized unit of measure that is not influenced by non-cost variables, which allows this report to draw more accurate cost comparisons between countries than is possible using cost per person protected or cost per structure sprayed.

FIGURE CC5: UNIT COST PER AREA SPRAYED, BY COST CATEGORY

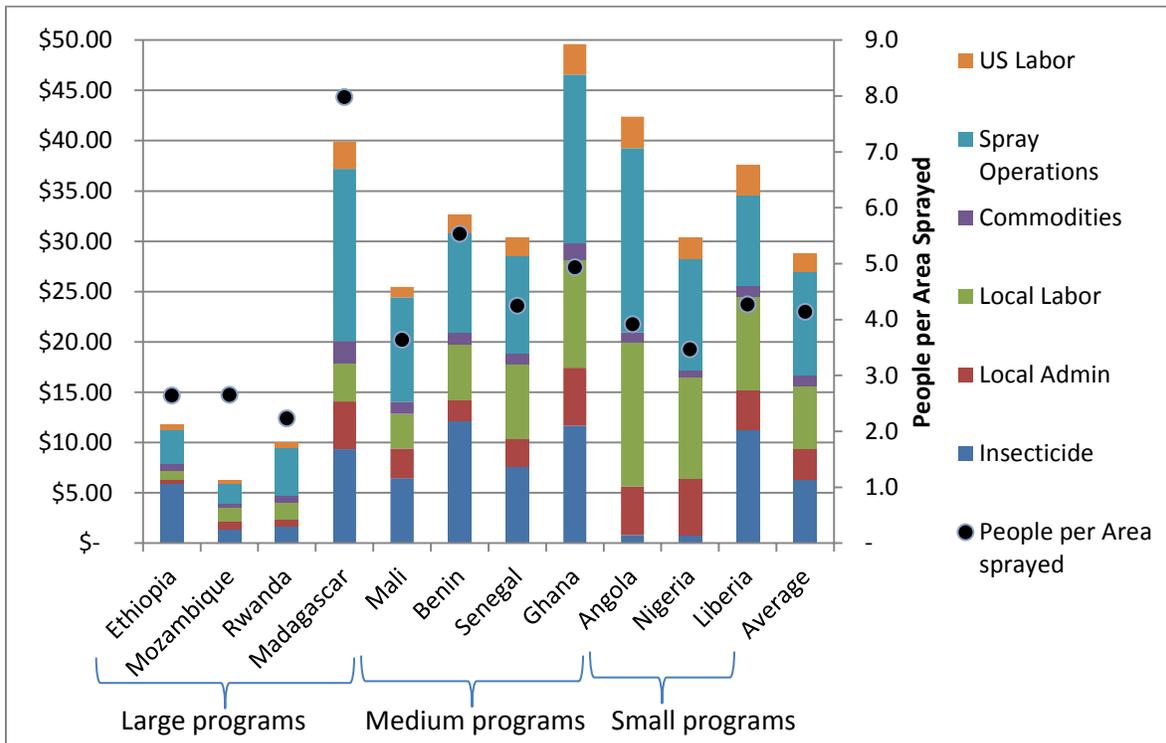


Figure CC5, above, shows the unit costs per area sprayed (in terms of 100 m²) broken down by cost category, and also includes black dots for the number of people per area sprayed (in terms of 100 m²) to provide context. The unit costs above are fully burdened, and itemized by cost category. The countries are in order of number of structures sprayed, from largest to smallest. The unweighted average of all countries is \$28.78 per area sprayed. Madagascar's cost per area sprayed is significantly larger than the other large-sized country programs, but each unit of area sprayed protects about 8 people, compared to an average of 2.5 people for the other countries. Ghana's cost per area sprayed is also high and is a result of expensive insecticide, spray operations, and local labor. One possible driver for these high spray operations costs is the great distances between districts and between structures.

This figure shows that the cost per area sprayed has a greater variation (range: \$6.30 in Mozambique to \$49.58 in Ghana) than the other unit costs, and does not correlate as closely with program size. In the following section, the unit cost per area sprayed will be used to demonstrate and analyze the cost drivers that help to determine why some countries are more expensive than others.

3.4 COST DRIVERS

This section focuses on the country IRS programs' costs per area (100 m²) sprayed, in order to assess the unit cost drivers. A cost driver is the activity, or unit of an activity, that is responsible for significant differences in costs between one country and another. Therefore, this section will walk through each cost category to determine where the

variation in cost is coming from, and why. This section will also compare country unit costs by program size: large, medium, and small.

Figure CC6 provides the percentage of each cost category out of the total unit cost per area sprayed. This is the first step in determining what cost categories are driving costs.

FIGURE CC6: COST CATEGORY PERCENTAGE OF UNIT COST PER AREA SPRAYED

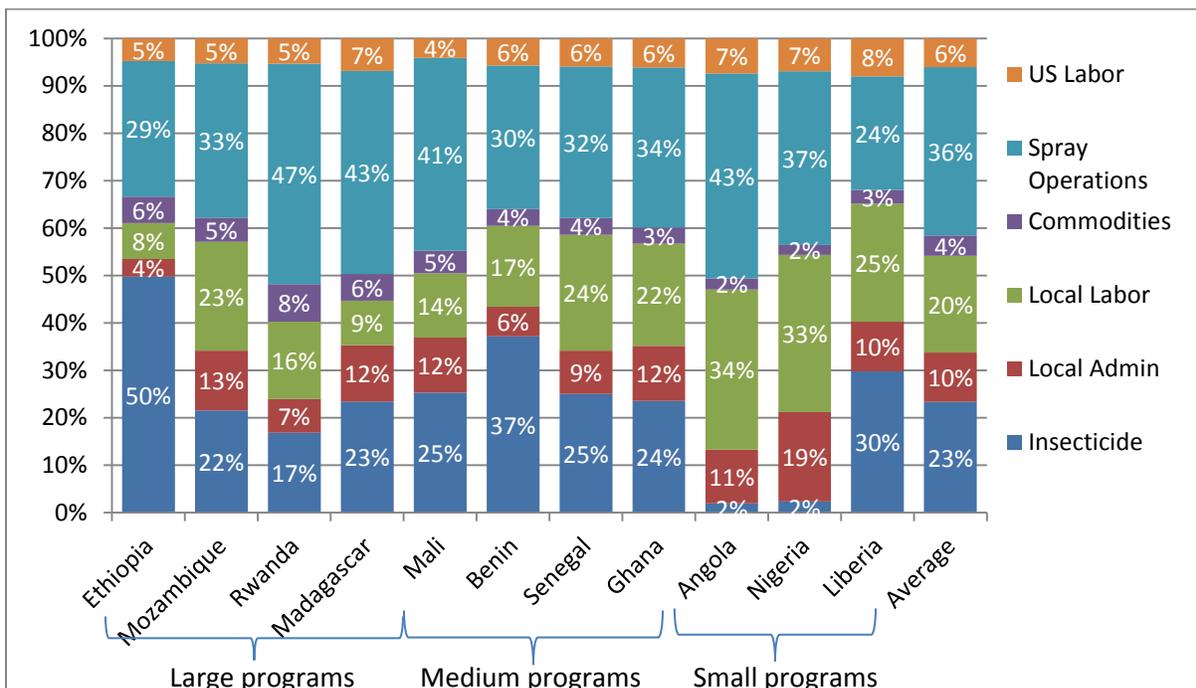


Figure CC6, above, shows that on average, the largest cost category is spray operations, which accounts for an average of 36 percent of the unit costs. Insecticides and local labor follow as the next largest cost drivers, making up an average of 23 and 20 percent of costs, respectively. However, there is still variability in the cost drivers between countries. For example, local labor accounts for 34 percent of the cost per area sprayed in Angola, but only 9 percent in Madagascar. The next step, which will be assessed later in this section, is to determine why these categories are different across countries.

In addition, the following country-specific chapters provide a more detailed analysis of the unique cost drivers in each country, and what the unique causes are.

TABLE CC5: 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	
Ethiopia	3%	3%	5%	3%	14%	29%	50%	8%	86%	\$ 11.83
Mozambique	11%	4%	5%	4%	23%	33%	21%	23%	77%	\$ 6.55
Rwanda	5%	6%	5%	4%	20%	46%	17%	16%	80%	\$ 9.96
Madagascar	10%	7%	7%	1%	24%	43%	23%	9%	76%	\$ 39.92
Mali	9%	6%	4%	2%	21%	40%	25%	14%	79%	\$ 25.48
Benin	4%	5%	6%	1%	15%	30%	37%	17%	85%	\$ 32.66
Senegal	7%	5%	6%	1%	19%	32%	25%	24%	81%	\$ 30.37
Ghana	9%	5%	6%	1%	21%	34%	24%	22%	79%	\$ 49.58
Angola	9%	5%	7%	0%	22%	43%	2%	34%	78%	\$ 42.40
Nigeria	17%	3%	7%	1%	28%	37%	2%	33%	72%	\$ 30.40
Liberia	9%	4%	8%	1%	21%	24%	30%	25%	79%	\$ 37.64
Average	8%	5%	6%	2%	21%	35%	23%	20%	79%	\$ 28.80

Table CC5 provides the same breakdown of the cost categories as Figure CC6 with the addition of capital expenditures separated as a distinct category, and differentiates fixed costs from variable costs. Fixed costs include capital expenditures, U.S.-based labor, durable commodities, and local administrative costs. These costs are fixed costs because the total expenditures are found to be relatively fixed across countries relative to total project expenditures, and are not expected to fluctuate significantly each implementation year. In addition, the total value of these costs is not as clearly or significantly correlated to program size or spray coverage as the variable costs shown above. The three categories that have variable costs are local staff labor, spray operations, and insecticides. Across country programs, fixed costs make up an average of 21 percent of the unit costs per area sprayed (range: 14 percent to 28 percent), while variable costs make up an average of 79 percent (range: 72 percent to 86 percent).

Nigeria spends the largest percentage on fixed costs, as explained in the specific Nigeria chapter, mainly due to an increase in the number of trips by the project staff to the field and the capital in Year 2. The cost for IT services increased significantly because the team employed an SMS messaging platform to send out reminders to workers during the spray campaign.

The following sub-sections provide a more in-depth cost driver analysis of the following components: fixed costs, insecticides, spray operations, and local labor.

3.4.1 FIXED COSTS: U.S.-BASED LABOR AND LOCAL ADMINISTRATION

On average, the fixed costs of country programs is about 21 percent (range: 15 percent to 28 percent) of the total unit cost, while the average of the variable costs is 79 percent (range: 72 percent to 85 percent) of the total unit cost per 100 square meters sprayed.

FIGURE CC7: FIXED COSTS PORTION OF COST PER AREA SPRAYED

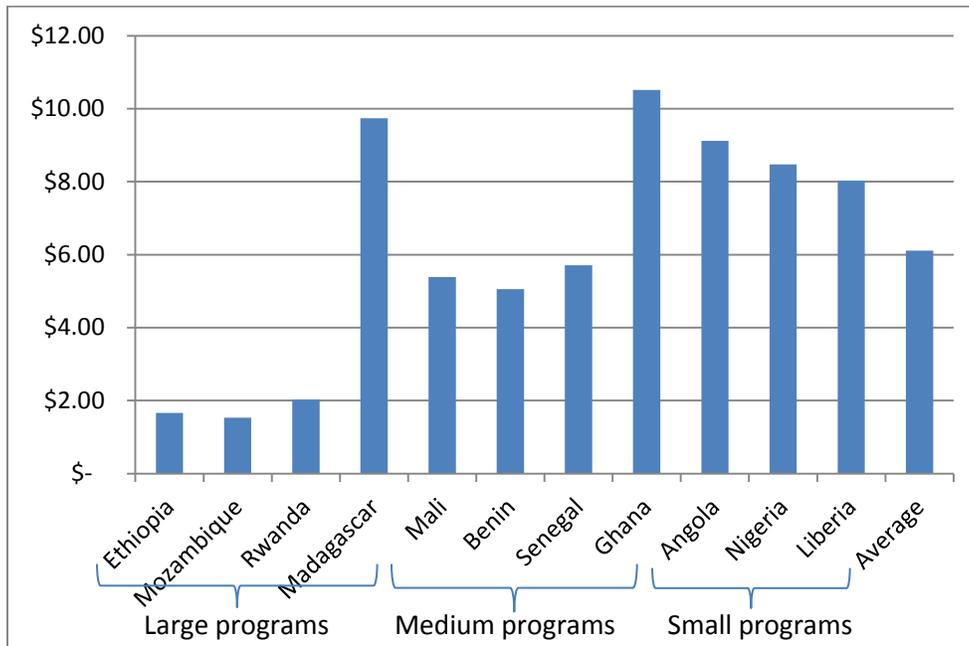


Figure CC7 shows the fixed unit cost per area sprayed (in terms of 100 m²). This includes capital expenditures, commodities (PPE and other spray equipment), U.S.-based labor and STTA, and local administration costs. This figure portrays the countries in order of their program size based on number of structures sprayed. With the exception of Madagascar, the fixed costs are roughly correlated to the size of the country program, ranging from \$1.54 in Mozambique to \$10.51 in Ghana. The average fixed cost of the large programs is \$3.74 (\$1.74 excluding Madagascar), for medium programs is \$6.67, and for the small programs is \$8.54.

The two most expensive fixed costs per area sprayed are in Ghana and Madagascar, and the fixed cost of both of these programs are outliers within their size groups. The IRS program in Ghana has the most expensive fixed costs per area sprayed, however, as shown in Table CC5, this only makes up 21 percent of Ghana's total unit cost, which is about average. Thus, the expensive fixed cost per area sprayed is a function of Ghana's expensive cost per area sprayed overall. In Ghana, the average size of a structure is 54.7 m², so while Ghana's program sprayed a similar number of structures to Mali, the area sprayed is similar to Angola, and falls within the size range of small programs. In Madagascar, fixed costs make up 24 percent of the total unit cost, which is close to the average (21 percent). In addition, the geographical coverage of the program's spray campaigns is extensive, and about a third (32 percent) of the local administration costs are comprised of travel costs (airfare, per diem, and ground transportation).

The following three sections will focus on insecticide, spray operations, and local labor as three major cost drivers.

3.4.2 INSECTICIDE: THE COST OF RESISTANCE

As mentioned in the Introduction, PMI, WHO, and other international donors are concerned about the threat of pyrethroid insecticide resistance, and the accompanying need for IRS programs to switch to more expensive classes of insecticide. The impact of using more expensive classes of insecticide is seen clearly throughout PMI's AIRS project.

The number and class of insecticide sachets purchased under the AIRS country programs does not always perfectly reflect the number and class of insecticide sachets used during the same year's spray campaign. For example, IRS programs in Year 2 may use leftover sachets from the previous year, may use a mix of insecticide classes, or may have some remaining insecticide at the end of the spray campaign. Table CC6 below lists the number and class of insecticide sachets purchased and used in Year 2 of the country IRS programs.

TABLE CC6: CLASS AND NUMBER OF INSECTICIDE SACHETS PURCHASED AND USED IN YEAR 2

Country	Type of Insecticide Purchased	Number of sachets/ bottles purchased	Type of insecticide(s) used	Number of sachets/ bottles used
Angola	Pyrethroid	32,000	Pyrethroid	42,856
Benin	Organophosphates	39,000	Carbamates; Organophosphates (Actellic EC)	Carbamates: 29,062 Organophosphates: 21,180 Total: 50,242
Ethiopia	Carbamates	400,080	Carbamates	308,721
Ghana	Organophosphates	41,166	Organophosphates	43,284
Liberia	Organophosphates	43,700	Organophosphates	34,474
Madagascar	Organophosphates	50,425	Pyrethroid, Carbamates, Organophosphates	Pyrethroids: 14,431 Carbamates: 33,490 Organophosphates: 31,673 Total: 79,594
Mali	Carbamates	103,800	Carbamates	93,435
Mozambique	n/a ¹		Pyrethroids	329,094
Nigeria	Pyrethroids	40,000	Pyrethroids	39,995
Rwanda	Pyrethroids	85,440	Pyrethroids, Carbamates	Pyrethroids: 196,407 Carbamates: 68,563 264,970
Senegal	Carbamates	92,700	Carbamates	65,049

¹In Mozambique, pyrethroid insecticide sachets were provided by the MoH, and the total number of sachets of the insecticide purchased was not made available to the project. Thus, it is not included here.

In Benin and Madagascar, the only class of insecticide purchased was organophosphates, however, the amount purchased was not enough to cover the full amount required for the program's Year 2 coverage. If all insecticides were purchased

in Year 2, the costs given below would be even higher; the cost per insecticide used is presented in table CC8. Expenditures included in the insecticide cost category include insecticide sachets, shipping, freight, insurance, and import taxes, where necessary.

TABLE CC7: INSECTICIDE PORTION OF COST PER AREA SPRAYED (PROCURED)

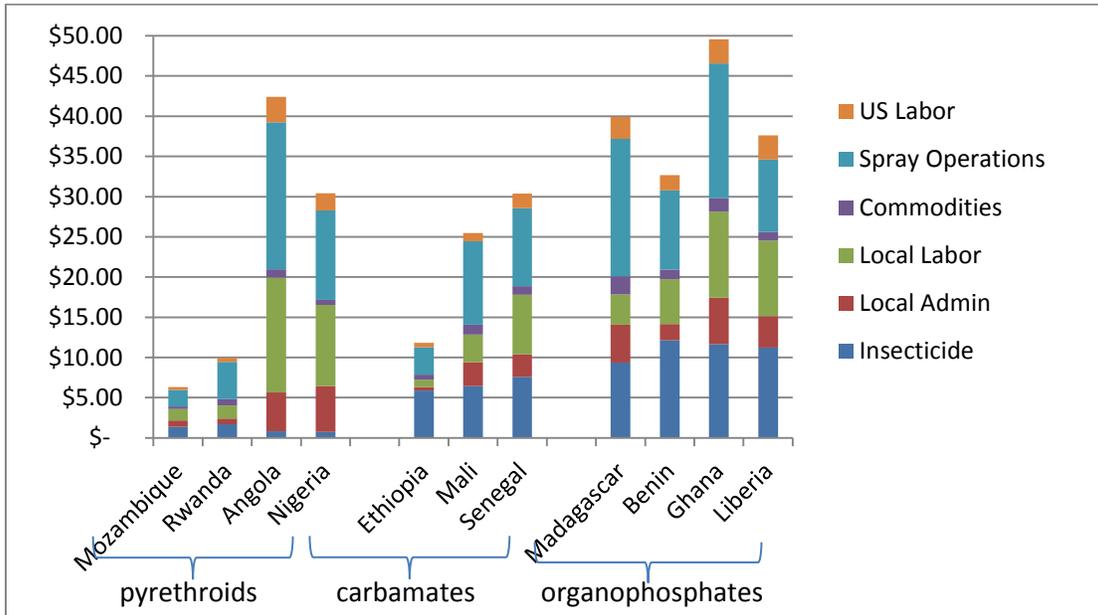
Pyrethroids		Carbamates		Organophosphates	
Rwanda	\$ 1.68	Ethiopia	\$ 5.89	Benin	\$ 12.14
Angola	\$ 0.82	Mali	\$ 6.45	Ghana	\$ 11.67
Nigeria	\$ 0.72	Senegal	\$ 7.60	Liberia	\$ 11.22
				Madagascar	\$ 9.35
AVERAGE	\$ 1.07		\$ 6.65		\$ 11.68

TABLE CC8: COST OF INSECTICIDES USED PER AREA SPRAYED

Pyrethroids		Carbamates		Organophosphates	
Rwanda	\$ 5.21	Ethiopia	\$ 4.54	Benin	\$ 15.65
Angola	\$ 1.09	Mali	\$ 5.81	Ghana	\$ 12.27
Nigeria	\$ 0.72	Senegal	\$ 5.33	Liberia	\$ 8.85
Mozambique	\$ 1.36			Madagascar	\$ 14.76
AVERAGE	\$ 2.34		\$ 5.23		\$ 12.25

Table CC7 shows the portion of the cost per area sprayed spent by countries on insecticide, organized by the insecticide class purchased in Year 2 of the country program. Although country programs may have used multiple classes of insecticide in the spray campaign, all countries purchased only one insecticide class. Mozambique is not included in this table since we only have the estimated costs of insecticides used; it is included in Table CC8. There is a clear correlation of the insecticide class procured affecting the insecticide portion of the cost per area sprayed. However, the correlation is diluted when the cost per area sprayed is viewed holistically, as in Figure CC8 below. This may be due to the fact that country programs that switched to organophosphates were provided with similar total budget levels but faced increased prices of insecticide, thus forcing reductions in the coverage of people protected or structures sprayed, or creating cost efficiencies in other areas such as local labor or spray operations.

FIGURE CC8: COST PER AREA SPRAYED, ORGANIZED BY INSECTICIDE CLASS



In Figure CC8 above, country programs are organized by insecticide class, but are still ordered by program size from largest to smallest within each class. The blue portion at the bottom of each bar is the insecticide portion of the unit cost. It is clear that the size of the insecticide portion of the cost per area sprayed is dependent upon which class of insecticide the country program purchased, with insecticides representing 11% of all costs in pyrethroid countries, 33% of costs in carbamates countries, and 28% of costs in organophosphates countries. However, within the pyrethroid group, it is apparent that the countries' unit costs are still correlated with the size of the country program. Angola and Nigeria both fall within the small-sized programs, and even though the insecticide portion of the unit cost is minimal (2 percent for each), the unit costs are still among the most expensive. For two out of three major cost drivers (spray operations and full-time local labor), the portion of the unit cost is correlated more closely by program size, rather than insecticide class: larger sized country programs tend to have smaller spray operations and local labor portions of the unit cost.

FIGURE CC9: COST PER PERSON PROTECTED, ORGANIZED BY INSECTICIDE CLASS

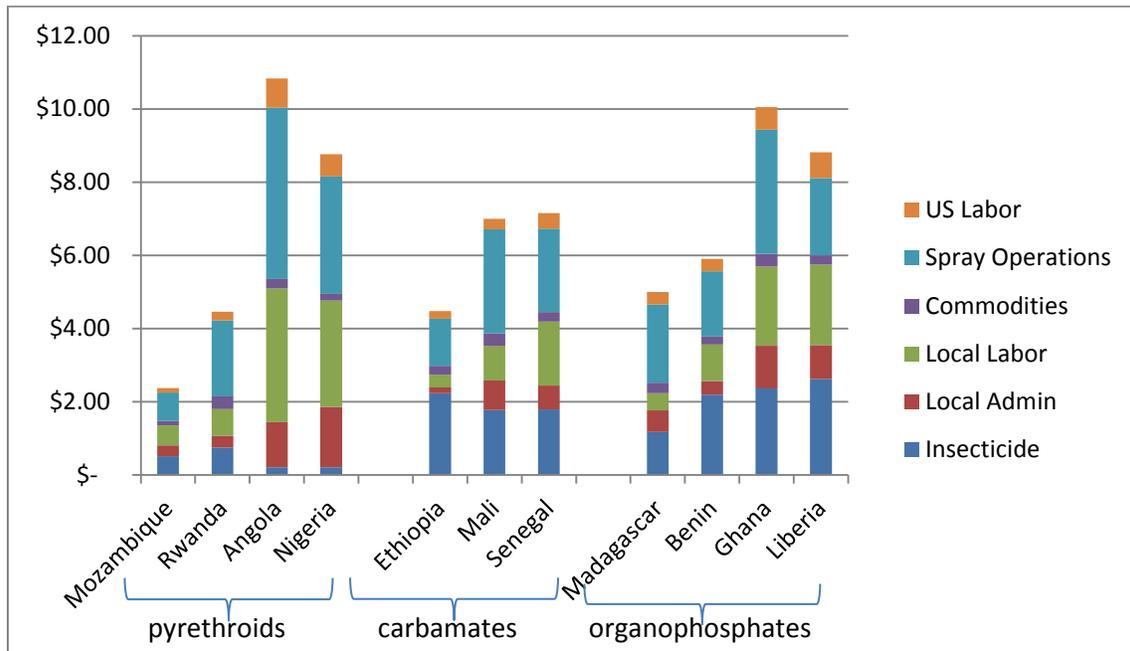


Figure CC9, above, shows the average portion of the cost per person protected spent on insecticide was \$0.42 for programs that purchased pyrethroids, \$1.93 for carbamates, and \$2.40 for organophosphates. The average difference in the insecticide portion of the unit cost between programs that purchased carbamates versus programs that purchased organophosphates is less in the cost per person protected (\$0.46, or a 24 percent increase) than it is in the cost per area sprayed (\$5.03, or a 76 percent increase). This is because the area sprayed unit of measure is directly dependent on the number of insecticide sachets used in each country IRS program. Thus, when comparing across countries, it is more helpful to use the cost per area sprayed in Figure CC8, than the cost per person protected in Figure CC9.

Insecticide costs are not included in the two other cost driver analyses; we have effectively controlled for the variation caused by insecticide class prices, and it does not skew additional conclusions drawn from the following sections.

3.4.3 SPRAY OPERATIONS: PROGRAM SCALE

The second variable cost driver of IRS programs is spray operations. Spray operations, which includes temporary labor of spray operators (SOPs), ground transportation, and warehousing costs,⁶ accounted for an average of 36 percent of the total unit cost. Additionally, the spray operations portion of the unit cost per area sprayed accounts for 28.2 percent of the variation (deviance from the mean) between country unit costs, compared with insecticides which account for 26.0 percent of variation.

⁶ For a full list of expenditure items included in the spray operations cost category, please refer to Table 1 in the Methodology section.

The spray operations portion of the cost per area sprayed is a function of total expenditures, number of campaign days (efficiency), and size of the program (number of structures sprayed), as demonstrated below in Figure CC10.

FIGURE CC10: SPRAY OPERATIONS COST PER AREA SPRAYED, AREA SPRAYED PER CAMPAIGN DAY, AND TOTAL NUMBER OF STRUCTURES SPRAYED

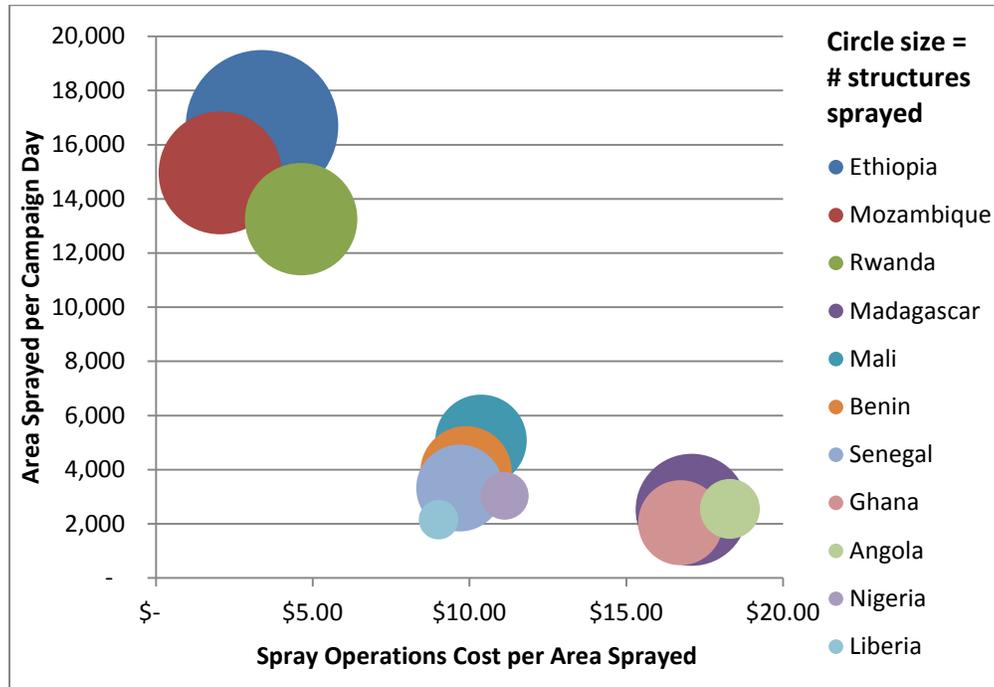


Figure CC10 shows the spread of country program spray operations, including the spray operations portion of the cost per area sprayed (x-axis), the amount of area sprayed (in terms of 100 m²) per campaign day (y-axis), and the program size in terms of number of structures sprayed (circle size). The three largest programs, Ethiopia, Mozambique, and Rwanda, also sprayed the largest amount of area per campaign day, and thus had the lowest spray operations cost per area sprayed. The three programs with the most expensive cost per area sprayed also sprayed the least amount of area per campaign day. The spray coverage area of both Madagascar and Ghana are geographically spread out, thus making it difficult to spray large swaths of area in each day of the campaign. This increases the number of days temporary SOPs are paid, as well as the ground transportation costs to SOPs to each operational site. Angola is a very expensive country to operate in, driving up unit costs.

TABLE CC9: TEMPORARY SPRAY OPERATORS (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
Ethiopia	1,492	54,160	36	\$ 6.00	37	617,442	11.4	16,688
Mozambique	849	13,075	15	\$ 3.95	55	822,735	62.9	14,959
Rwanda	2,273	104,787	46	\$ 9.19	50	662,425	6.3	13,249
Madagascar	642	19,260	30	\$ 6.33	79	198,985	10.3	2,519
Mali	550	6,600	12	\$ 5.83	46	233,588	35.4	5,078
Benin	493	10,452	21	\$ 6.00	32	125,605	12.0	3,925
Senegal	551	6,171	11	\$ 6.38	49	162,623	26.4	3,319
Ghana	490	4,508	9	\$ 5.50	53	108,210	24.0	2,042
Angola	586	8,145	14	\$ 20.00	42	107,140	13.2	2,551
Nigeria	250	1,900	8	\$ 15.89	33	99,988	52.6	3,030
Liberia	280	1,960	7	\$ 10.00	40	86,185	44.0	2,155
Average	769	21,002	19	\$ 8.64	47	293,175	27.1	6,319

Table CC9 provides a detailed breakdown of the number of SOPs working in each country spray campaign, as well as the total and average numbers of SOP days, and the average daily wage. Also provided are 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, the three largest programs, Ethiopia, Mozambique, and Rwanda, which sprayed similarly large amounts of area per each campaign day, used very different numbers of SOPs in the program spray campaigns. One possible explanation for this variation is that Rwanda sprays twice and therefore has a greater total number of spray days in a year.

The following figures provide a comparison of countries within each group of program size, and show that factors due to country and programmatic context cause variation in unit costs of spray operations.

FIGURE CC11: SPRAY OPERATIONS COVERAGE AND COST PER AREA SPRAYED, LARGE PROGRAMS

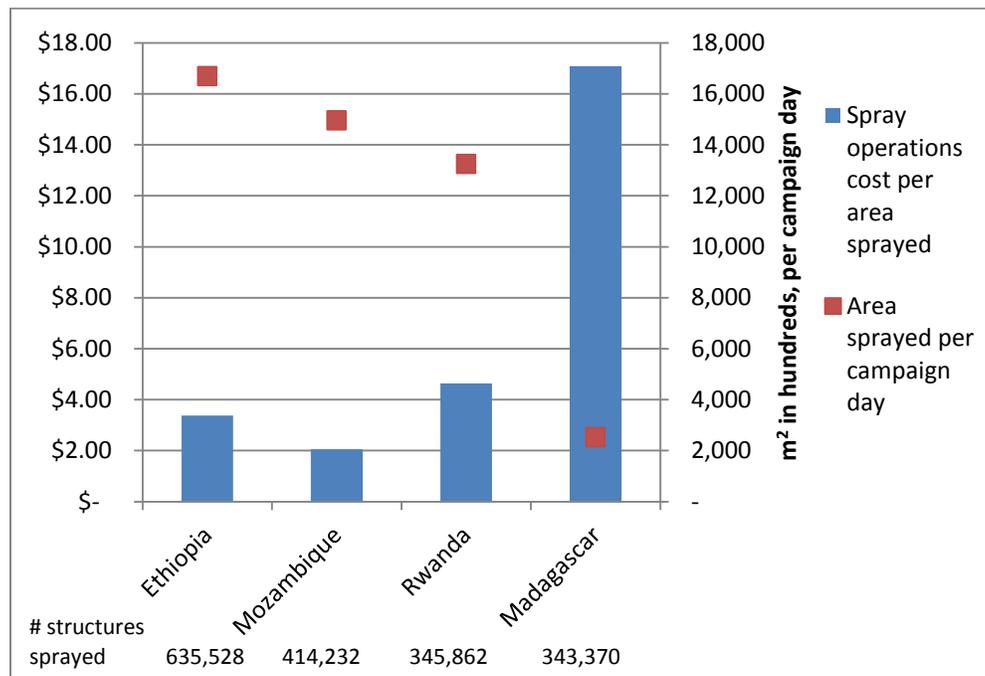


Figure CC11 shows bars for the spray operations portion of the cost per area sprayed (in terms of 100 m²) on the left-hand y-axis, and dots for the area sprayed (again, in terms of 100 m²) on the right-hand y-axis. The number of structures sprayed is included underneath each country. On average, the spray operations cost per area sprayed is \$6.79 for the large programs (\$3.35 excluding Madagascar), and the average amount of area sprayed per campaign day is 11,853 (in terms of 100 m²). The cost difference between Ethiopia and Mozambique is largely due to the efficiencies of the SOPs. As shown in Table CC9, the average daily wage of SOPs in Mozambique was about \$2.00 less than in Ethiopia, but moreover, Mozambique incurred about 22 percent of the SOP days as Ethiopia, while still spraying about 90 percent of the area in terms of 100 m². The Mozambique campaign was not short compared to other campaigns as it took 55 operational days to complete. However, as part of increasing efficiencies in Mozambique, the AIRS Mozambique team slightly increased the target number of structures sprayed per operator per day, which means that spray operators were spraying more each day. Madagascar is the clear outlier of the group, spraying only about 250,000 m² per campaign day compared to an average of 1,487,000 m² per campaign day for the other three large programs. Madagascar's geographical coverage area is more spread out than the other large countries, and its program incurred about a third higher transportation costs than the other programs, as well as double the costs for lodging and per diems. In comparison, Rwanda is a small country, the districts are close together, and the structures are fairly close together which makes operations more efficient. On the other hand, Rwanda has two spray campaigns in a year which increases the total number of spray days.

FIGURE CC12: SPRAY OPERATIONS COVERAGE AND COST PER AREA SPRAYED, MEDIUM PROGRAMS

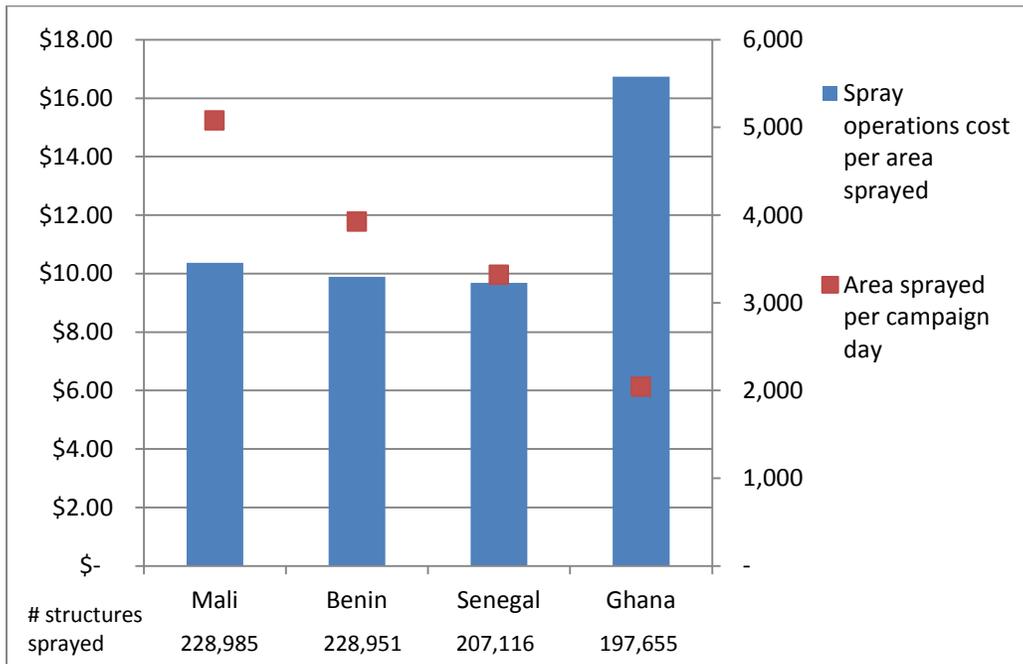


Figure CC12 shows that medium-sized program spray operations costs range from \$9.68 in Senegal to \$16.73 in Ghana. On average, the spray operations cost per area sprayed is \$11.67 for the medium programs (\$9.98 excluding Ghana), and the average amount of area sprayed per campaign day is 3,591 (in terms of 100 m²).

Ghana is an outlier within the medium programs with a spray operations cost of \$16.73. In terms of total expenditures for spray operations, the Ghana program incurred about the average for the medium programs. However, since the program's coverage in terms of area sprayed was significantly lower than the other medium-sized programs (about 38 percent less than the average of the other three programs), the unit cost is therefore more expensive. In addition, the Ghana program's geographical area covers structures that are very spread out, incurring a higher than average number of campaign days.

FIGURE CC13: SPRAY OPERATIONS COVERAGE AND COST PER AREA SPRAYED, SMALL PROGRAMS

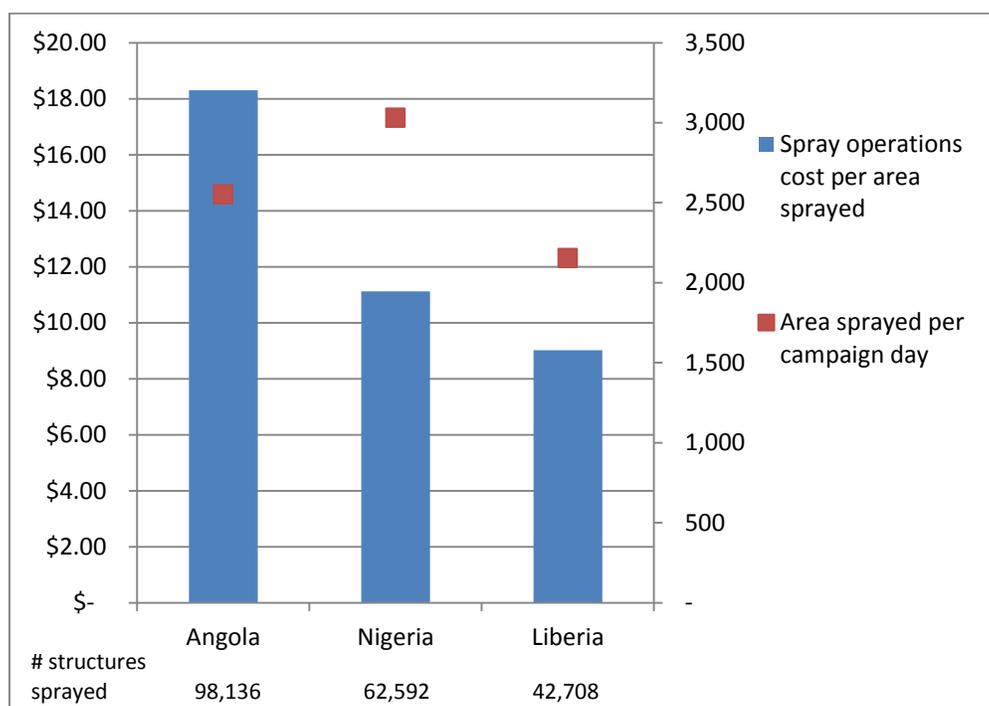


Figure CC13 shows that on average, the spray operations cost per area sprayed is \$12.81 for the small programs, and the average amount of area sprayed per campaign day is 2,579 (in terms of 100 m²). For the three small-sized programs, the spray operations cost per area sprayed is opposite of the expected trend; Angola's larger program has a higher unit cost and Liberia's smallest program has a lower unit cost. The cost driver for this unexpected trend is the daily wages of temporary SOPs, as listed in Table CC9. The average daily wage of a SOP in Angola is \$20.00, in Nigeria is \$15.89, and in Liberia is \$10.00. Likewise, Angola incurred total temporary labor expenditures that were 3.4 times higher than in Liberia, and 1.2 times higher than in Nigeria. In addition, the Liberia program's spray operations incurred one fourth less the ground transportation expenditures than the other two programs.

Overall, the above breakdown of programs by size has shown that the spray operations cost per area sprayed is generally correlated with program scale (with averages of \$6.88 for large programs, \$11.67 for medium programs, and \$12.81 for small programs), but that variability within each program size group is due to individual program factors and country context.

3.4.4 LOCAL FULL-TIME STAFF LABOR

The last major cost driver of country unit costs per area sprayed (100 m²) is local labor. Local labor includes the country site office full-time staff members. It does not include temporary workers who are hired as spray operators. Thus, while local full-time staff labor is a major cost driver, it is also a step-variable cost. This means that the local labor portion of the cost per area sprayed is related to the size of the IRS program, but the number of staff hired is not directly related to the number of structures sprayed, as will

be demonstrated below. Temporary labor of the spray operators, on the other hand, is included in the spray operations cost category and is a variable cost directly related to the number of structures sprayed. Table CC10 lists the number of full-time local staff members based in the field office.

TABLE CC10: TOTAL FULL-TIME LOCAL STAFF MEMBERS

Large Programs	# Local Staff	Medium Programs	# Local Staff	Small Programs	# Local Staff
Ethiopia	21	Mali	18	Angola	19
Mozambique	23	Benin	14	Nigeria	21
Rwanda	19	Senegal	16	Liberia	18
Madagascar	34	Ghana	26		

The average number of local full-time staff across all country programs is 20.8, and the number of full-time staff is variable based on programmatic and operational needs specific to each country, and the program size in terms of number of structures sprayed.

FIGURE CC14: LOCAL LABOR PORTION OF COST PER AREA SPRAYED

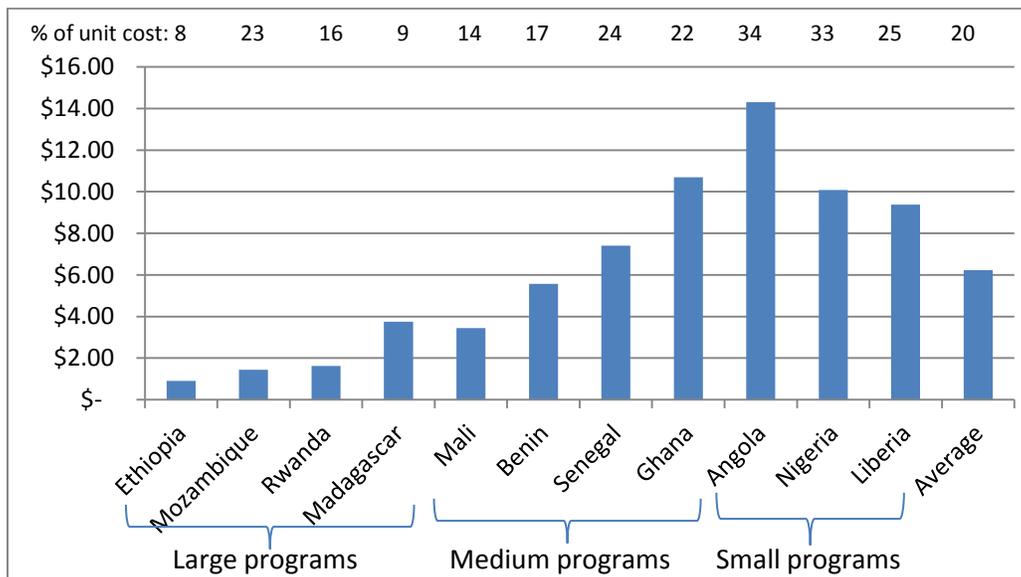


Figure CC14 shows the local labor portion of the unit costs per area sprayed (100 m²), ranging from \$0.90 in Ethiopia to \$14.30 in Angola, with an average of \$6.23. The figure shows that unlike the actual number of staff members, the unit cost of local labor per area sprayed tends to be lower for larger programs and higher for smaller programs.

TABLE CC11: LOCAL FULL-TIME LABOR IMPACT ON PROGRAM UNIT COSTS

Country	Total Local Labor Hours	Total Local Labor Cost	Avg. Cost per Labor Hour	Labor hours per Area sprayed	Local Labor Cost per Area Sprayed	Local Labor % per Area Sprayed
Ethiopia	38,163	555,222	14.55	0.06	0.90	8%
Mozambique	41,984	1,186,286	28.26	0.05	1.44	23%
Rwanda	36,930	1,077,600	29.18	0.06	1.63	16%
Madagascar	63,377	746,187	11.77	0.32	3.75	9%
Mali	25,089	803,522	32.03	0.11	3.44	14%
Benin	23,424	699,316	29.85	0.19	5.57	17%
Senegal	32,691	1,203,780	36.82	0.20	7.40	24%
Ghana	49,257	1,156,605	23.48	0.46	10.69	22%
Angola	32,851	1,531,931	46.63	0.31	14.30	34%
Nigeria	36,742	1,008,124	27.44	0.37	10.08	33%
Liberia	27,920	807,872	28.94	0.32	9.37	25%
Average	37,130	\$ 979,677	\$ 28.09	0.22	\$ 6.23	20%

Table CC11 demonstrates that the full-time local labor portions of the cost per area sprayed are highest for Angola (34 percent), Nigeria (31 percent), and Liberia (25 percent). All three are small-sized programs, so program scale is responsible for the large percent of unit costs spent on local labor, but Angola and Nigeria also have high labor prices. The implementation of an IRS program requires a certain minimum threshold of staff to operate effectively, but this cost is shared across less m² of area sprayed than many of the other programs. In addition, the cost of labor in Angola is extremely high (\$46.63 average cost per labor hour, about \$10.00 more than the next most expensive labor hour in Senegal).

FIGURE CC15: LOCAL LABOR PRICE VERSUS QUANTITY ANALYSIS

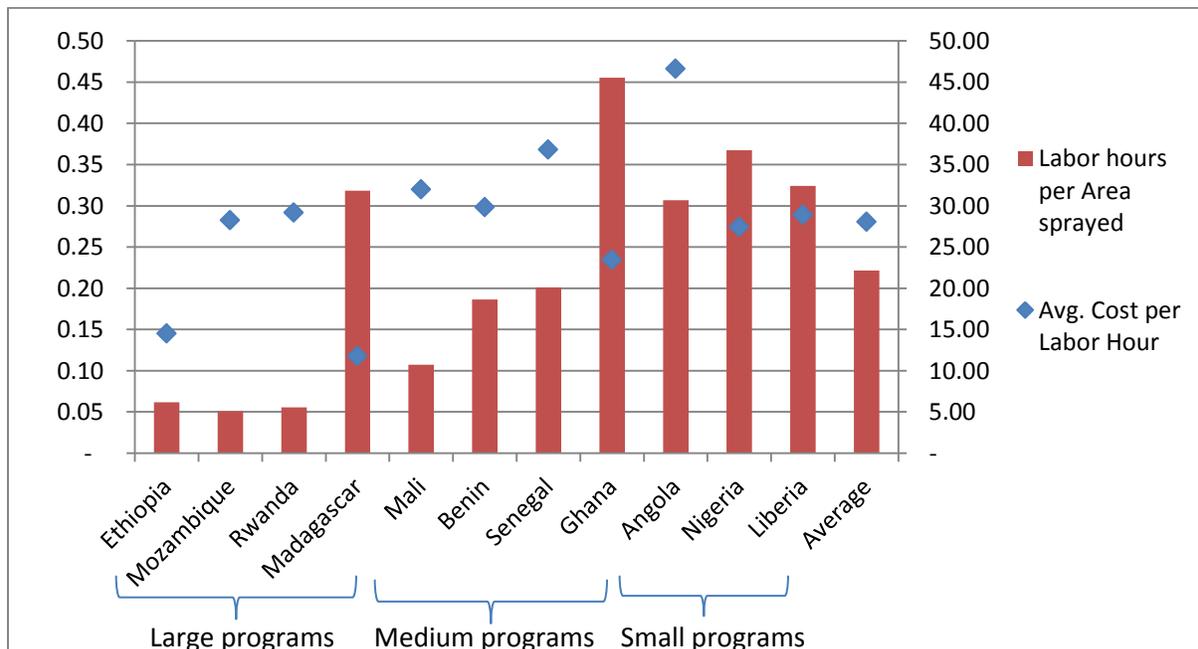


Figure CC15 presents an analysis of the local labor price versus quantity impact on country programs. The average cost per local labor hour is calculated by the total program expenditures of local labor divided by the total local labor hours worked. Labor hour per area sprayed (in terms of 100 m²) is calculated by the total local labor hours worked divided by the amount of area sprayed. The average cost per labor hour (blue dots) provides a representation of the variation in labor prices across countries, while the labor hours per area sprayed in 100 m² (red bars) provides a representation of quantity of labor across countries.

Angola, Ghana, and Nigeria were shown to have the three highest local labor costs per area sprayed, at \$14.30, \$10.69, and \$10.08, respectively. Figure CC15 begins to explain why the local labor unit costs are high relative to other countries. Angola and Nigeria have similar labor hours per area sprayed, but the average cost per labor hour in Angola is \$19.19 more expensive than in Nigeria. Thus, the price of labor is what drives Angola's unit cost. In Nigeria, the average labor cost per hour is similar to the overall average of all the countries, but the number of local labor hours per area sprayed is the second highest, which means Nigeria is using the second highest quantity of labor across countries programs, relative to its size in terms of area sprayed. The cost per labor hour in Ghana is below average, however, the labor hours per area sprayed is the highest, which means Ghana is incurring more labor hours than other programs relative to size of area sprayed.

Figure CC19 also suggests that countries with large programs spend fewer labor hours per area sprayed than countries with smaller programs. The average number of hours spent in the large country programs was just about 0.12 hours (about 7 minutes) per area, while it was about 0.24 hours (14 minutes) in the medium program countries, and about 0.33 (20 minutes) in the countries with small programs.

3.5 CONCLUSIONS

Unit of Measure

When comparing IRS to alternative malaria interventions, the number of people protected and number of structures sprayed are two important indicators. In addition, cost per person protected provides a very useful indicator for programmatic management and decision making within a country year-on-year. However, when comparing unit costs across country IRS programs, analysis using people protected and structures sprayed is confounded by variations in both the average structure size and number of people per structure. Additional external factors can include: variation in commodity or labor prices, different quantities of inputs, or the type of implementation model used. Using the area sprayed (in units of 100 m²) removes factors outside the control of IRS programs, and provides a standardized measure as the best cross-country comparison to inform implementation management.

Program Scale

Broadly speaking, unit costs of large programs are less expensive than small programs, demonstrating that the cost per area sprayed is linked to program scale. Using the most standardized comparison unit cost available, there is still no 'one-price-fits-all' for IRS across countries. Large-sized programs averaged a cost per area sprayed of \$17.00,

medium programs averaged \$34.52, and small programs averaged \$36.81. However, this does not explain all cost differences.

There are some fixed costs for IRS programs which are not correlated to program scale, such as local administration and U.S.-based labor, which constitute an average of 10 percent (\$254,000 to \$943,000) and 6 percent (\$212,000 to \$545,000) of the cost per area sprayed, respectively.

Two of the important IRS program cost drivers, spray operations and local labor, constitute an average of 36 percent and 20 percent of the cost per area sprayed, respectively. Spray operations and local labor are both largely correlated with program scale. Any programs with outlier costs in these areas are due to specific country context: geography of spray coverage area, number of spray rounds per year, and general cost of living (prices for labor, fuel, etc.).

Insecticide

The insecticide class used in spray campaigns is the third major cost driver in IRS programs, and will continue to be increasingly important as the threat of insecticide resistance prompts IRS programs to switch to more expensive classes of insecticide. The insecticide portion of the cost per area sprayed constitutes an average of 23 percent of the total unit cost across country programs.

4. YEAR-ON-YEAR COMPARISON

4.1 CHANGES IN IRS PROGRAMS FROM YEAR 1 TO YEAR 2

As an IRS program matures, lessons are learned, efficiencies are realized, and needs change. This section provides an overview of the major changes in countries' IRS programs between Year 1 and Year 2.

TABLE YR1: YEAR-ON-YEAR COMPARISON OF PROGRAM SIZE

Program Size	Year 1	Year 2
Large	Ethiopia Mozambique Rwanda Madagascar Ghana Senegal	Ethiopia Mozambique Rwanda Madagascar
Medium	Mali Benin Angola Liberia	Mali Benin Ghana Senegal
Small	Nigeria Burkina Faso	Nigeria Angola Liberia

As discussed in Section 3.1, program size is based on the number of structures sprayed by an IRS program. From Year 1 to Year 2, the AIRS project had two programs change from large to medium (Ghana and Senegal), and two programs change from medium to small (Angola and Liberia), and one small program was dropped altogether (Burkina Faso). Table YR2 will provide the detailed changes in output measures for all country programs, and Table YR 3 will demonstrate how these changes affected unit costs. For more information, a comprehensive discussion of the changes in each country program is provided at the end of each individual country chapter.

TABLE YR2: YEAR-ON-YEAR COMPARISON OF OUTPUT MEASURES

Country	People Protected			Structures Sprayed			Area Sprayed (100 m ²)		
	Year 1	Year 2	Percent Change	Year 1	Year 2	Percent Change	Year 1	Year 2	Percent Change
Ethiopia	1,506,273	1,629,958	8%	547,421	635,528	16%	524,334	617,442	18%
Mozambique	2,716,176	2,181,896	-20%	536,558	414,232	-23%	974,470	822,735	-16%
Rwanda	1,025,181	1,479,342	44%	236,610	345,862	46%	415,653	662,425	59%
Madagascar	1,781,990	1,588,138	-11%	371,391	343,470	-8%	221,418	198,985	-10%

Avg. Large Programs	1,757,405	1,719,834	5%	422,995	434,773	8%	533,969	575,397	13%
Mali	762,146	850,104	12%	206,295	228,985	11%	192,968	233,588	21%
Benin	652,777	694,729	6%	210,380	228,951	9%	127,105	125,605	-1%
Senegal	1,095,093	690,029	-37%	306,916	207,116	-33%	267,185	162,623	-39%
Ghana	941,240	534,060	-43%	355,278	197,655	-44%	193,220	108,210	-44%
Avg. Medium Programs	862,814	692,231	-16%	269,717	215,677	-14%	195,119	157,506	-16%
Angola	676,090	419,353	-38%	141,782	98,136	-31%	195,518	107,140	-45%
Nigeria	346,115	346,798	0%	58,704	62,592	7%	72,943	99,988	37%
Liberia	869,707	367,930	-58%	96,901	42,708	-56%	204,228	86,185	-58%
Avg. Small Programs	630,637	378,027	-32%	99,129	67,812	-27%	157,563	97,771	-22%

Table YR2 provides an overview of each country program's output measures for Year 1 and Year 2, as well as the percent change that occurred in Year 2. Averages are also provided for each program size group. Angola, Ghana, Liberia, and Senegal, which all dropped from one program size to a lower one, saw decreases in all output measures. Madagascar and Mozambique also saw decreases in all output measures. In terms of structures sprayed, Rwanda grew by almost half, Ethiopia grew by 16 percent, and Benin and Mali grew by about 10 percent. Nigeria remained a similar size as the previous year.

TABLE YR3: YEAR-ON-YEAR COMPARISON OF UNIT COSTS

Country	Cost per Person Protected			Cost per Structure Sprayed			Cost per Area Sprayed (100 m ²)		
	Year 1	Year 2	Percent Change	Year 1	Year 2	Percent Change	Year 1	Year 2	Percent Change
Ethiopia ⁷	\$ 3.00	\$ 4.48	49%	\$ 8.25	\$ 11.49	39%	\$ 8.61	\$ 11.83	37%
Mozambique	\$ 1.95	\$ 2.38	22%	\$ 9.86	\$ 12.52	27%	\$ 5.43	\$ 6.30	16%
Rwanda	\$ 4.12	\$ 4.46	8%	\$ 17.84	\$ 19.08	7%	\$ 10.15	\$ 9.96	-2%
Madagascar	\$ 2.90	\$ 5.00	73%	\$ 13.90	\$ 23.13	66%	\$ 23.31	\$ 39.92	71%
Avg. Large Programs	\$ 2.99	\$ 4.08	38%	\$ 12.46	\$ 16.55	35%	\$ 11.88	\$ 17.00	31%
Mali	\$ 6.22	\$ 7.00	13%	\$ 22.96	\$ 25.99	13%	\$ 24.55	\$ 25.48	4%
Benin	\$ 5.70	\$ 5.90	4%	\$ 17.69	\$ 17.92	1%	\$ 29.28	\$ 32.66	12%
Senegal	\$ 4.38	\$ 7.16	63%	\$ 15.63	\$ 23.85	53%	\$ 17.96	\$ 30.37	69%
Ghana	\$ 6.41	\$ 10.05	57%	\$ 16.97	\$ 27.14	60%	\$ 31.20	\$ 49.58	59%
Avg. Medium Programs	\$ 5.68	\$ 7.53	34%	\$ 18.31	\$ 23.72	32%	\$ 25.75	\$ 34.52	36%

⁷ In Ethiopia, an estimate of \$273,000 in ground transportation expenses in Year 1 were allocated to unbillable account until the project corrected the paperwork and received the CO approval, which happened during the Year 2. Therefore, this amount was never included in the Year 1 or 2 expenses. Current version of the report provides revised data with the above-mentioned amount included in the expenses for Year 1.

Angola	\$ 4.56	\$ 10.83	137%	\$ 21.77	\$ 46.29	113%	\$ 15.79	\$ 42.40	169%
Nigeria	\$ 5.96	\$ 8.76	47%	\$ 35.12	\$ 48.56	38%	\$ 28.27	\$ 30.40	8%
Liberia	\$ 4.35	\$ 8.82	102%	\$ 39.09	\$ 75.95	94%	\$ 18.55	\$ 37.64	103%
Avg. Small Programs	\$ 4.96	\$ 9.47	96%	\$ 31.99	\$ 56.93	82%	\$ 20.87	\$ 36.81	93%

Table YR3 provides the all unit costs in Year 1 and Year 2, as well as the percent change in Year 2. All country unit costs increased in Year 2 for all three unit costs presented with the exception of Rwanda, where the cost per area sprayed declined. On average across the countries, cost per area sprayed increased by 49 percent. If countries had operated at the same scale in year 2 as in year 1, the fixed costs would have been divided such that overall unit costs would have increased by 37 percent on average. Further, if insecticides had been procured at Year 1 prices, then unit costs would have increased by 38 percent on average; together program scale and insecticide costs account for about half of the increase in unit costs between the two years. Increases in operational costs, including SOPs salaries, cost of ground transport, increased local staff, etc., account for the remainder of the increase in costs. In Ethiopia, seasonal worker's wage increased on average by 50 percent in Year 2.

A detailed discussion of the changes in each country program is included in the individual country chapters. Figure YR1 below illustrates the change in cost per area sprayed between Year 1 and Year 2.

FIGURE YR 1: YEAR-ON-YEAR COMPARISON OF COST PER AREA SPRAYED

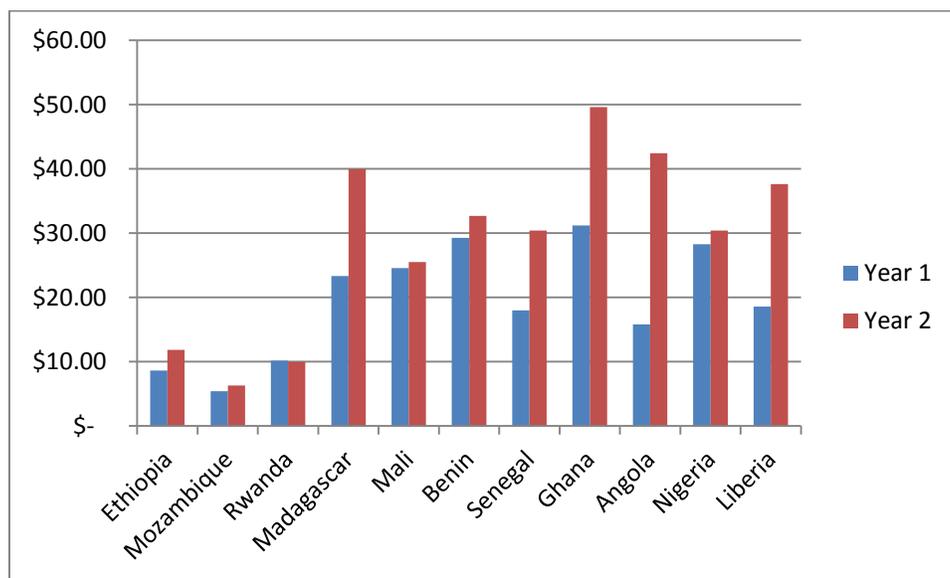


TABLE YR4: INSECTICIDE VERSUS NON-INSECTICIDE COST PER AREA SPRAYED

Country	Insecticide cost per area sprayed (100 m ²)			Non-insecticide cost per area sprayed (100 m ²)		
	Year 1	Year 2	Percent Change	Year 1	Year 2	Percent Change

Ethiopia	\$ 2.25	\$ 5.89	161%	\$ 6.36	\$ 5.94	-7%
Mozambique	\$ 1.21	\$ -	-100%	\$ 4.22	\$ 4.95	17%
Rwanda	\$ 0.43	\$ 1.68	290%	\$ 9.72	\$ 8.28	-15%
Madagascar	\$ 7.30	\$ 9.35	28%	\$ 16.01	\$ 30.57	91%
Mali	\$ 6.05	\$ 6.45	7%	\$ 18.50	\$ 19.03	3%
Benin	\$ 6.34	\$ 12.14	92%	\$ 22.94	\$ 20.51	-11%
Senegal	\$ 5.09	\$ 7.60	49%	\$ 12.87	\$ 22.77	77%
Ghana	\$ 8.47	\$ 11.67	38%	\$ 22.73	\$ 37.91	67%
Angola	\$ 1.46	\$ 0.82	-44%	\$ 14.32	\$ 41.58	190%
Nigeria	\$ 2.27	\$ 0.72	-68%	\$ 25.99	\$ 29.67	14%
Liberia	\$ 4.34	\$ 11.22	158%	\$ 14.20	\$ 26.42	86%

Table YR4 provides the cost per area sprayed for each country, but it is separated into two portions: one for insecticide costs and one for non-insecticide costs. This breakdown illustrates that some of the larger programs' increase in unit cost was caused by insecticide expenditures. This is especially true in Rwanda, but also in Ethiopia, which had seen a 37 percent increase in the cost per area sprayed (Table YR3), with an 18 percent increase in the total amount of area sprayed (Table YR2). The reason for this increase in Ethiopia is an almost 50% wage increase for all seasonal workers. It also should be noted, as stated in the Year 1 cost study, that Year 1 calculations did not include the cost of government-donated pyrethroid that the project sprayed in 19 out of 36 districts. If information on the pyrethroid was available to the project, the total insecticide cost for Year 1 used in the analysis would be higher. Table YR4 shows that the disproportionate increase was due to insecticide.

TABLE YR5: SUMMARY OF INSECTICIDE VERSUS NON-INSECTICIDE UNIT COSTS

Averages	Insecticide cost per area sprayed (100 m ²)			Non-insecticide cost per area sprayed (100 m ²)		
	Year 1	Year 2	Percent Change	Year 1	Year 2	Percent Change
Avg. Large Programs				\$ 9.08	\$ 12.43	37%
Avg. Medium Programs				\$ 19.26	\$ 25.06	30%
Avg. Small Programs				\$ 18.17	\$ 32.56	79%*
Avg. Pyrethroids**	\$ 1.34	\$ 1.07	-20%			
Avg. Carbamates	\$ 5.83	\$ 6.65	14%			
Avg. Organophosphates	\$ 8.47	\$ 11.09	31%			

*If the small programs had sprayed as much area in Year 2 as in Year 1, non-insecticide cost per area sprayed would have increased 55%. This remaining 24% is due to increases in spray operations costs including increases in SOP salaries.

**Excluding Mozambique, for which we have only the costs of insecticides used in Year 2, not the costs of insecticides procured.

Table YR5 provides a summary of averages for various groups of country programs. For the non-insecticide portion of the cost per area sprayed, countries were grouped by program size, and the average unit cost was calculated. Small-scale programs saw a larger increase in non-insecticide costs than large- and medium-sized programs. For the insecticide portion of the cost per area sprayed, country programs were grouped by insecticide class purchased, and the average unit cost was calculated. This demonstrates that insecticide is becoming more expensive (except for pyrethroids), and that programs changing insecticide classes in response to the threat of insecticide resistance can expect significantly increased costs.

Table YR5 is useful for international donors, implementing partners, and even country governments, that are planning to implement IRS programs and need to know how much budget to set aside.

5. ANGOLA

5.1 BACKGROUND

Year 1

PMI began implementing IRS in southern Angola in 2006 and has continued through 2013. In 2012, IRS was implemented in the provinces of Huambo, Huila, and Cunene. Historically, Huambo was the second most malarious province in the country, but in 2012, it became the province with the second fewest malaria mortality cases. Huila reports the most cases of malaria among the southern provinces. Cunene, on the border with Namibia, was added as an IRS target province in 2010 in response to the NMCP request to support the Southern African Development Community initiative for malaria elimination in Namibia and reduce introduction of malaria cases from this area.

In August 2012, a Memorandum of Understanding, the Initiative Trans-Kunene for Malaria Control, was signed between the Governments of Angola and Namibia. The memorandum, which is supported by USAID Angola, calls for synchronized IRS along the border between Namibia and Angola. Pyrethroids have been the insecticide of choice since the start of PMI-funded IRS for Angola in 2006. In 2012, Abt Associates conducted the sixth annual spray campaign in Huambo, the eighth in Huila, and the fifth in Cunene. Pyrethroid insecticides were used based on susceptibility results, and the spray campaign took place over a total of 44 operational days between October 29 and December 18, 2012.

Year 2

In 2013, AIRS Angola continued to spray in Huambo, Huila, and Cunene provinces with pyrethroids, based on susceptibility results from April 2013. The campaign had staggered start dates ranging from October 2 in Bailundo, Huambo Province to October 15 in Lubango, Huila Province. The campaign took place over 42 operational days. A total of 101,000 structures were targeted for spray, including 25,000 in Huambo, 60,000 in Huila, and 16,000 in Cunene. Spray operators reported 106,515 found structures and sprayed 98,136 of them, resulting in a 92.1 percent spray coverage rate.

TABLE AOI: ANGOLA QUICK FACTS

	Year 1	Year 2
# Local Staff	20	19
Spray Start Date	October 29, 2012	October 2, 2013
# Spray Rounds	1	1
# Sachets Used	78,207	42,856
# People Protected	676,090	419,353
# Structures Sprayed	141,782	98,136

# 100 Square Meters Sprayed	195,518	107,140
Average Size of Structure	137.9 m ² *	109.2 m ²

* Reverse calculation using number of insecticide sachets used during campaign and number of structures sprayed.

5.2 PROGRAM EXPENDITURES

This section will present an overview of Angola IRS program expenditures in Year 2. Costs are organized by activity and cost category.

TABLE AO2: ANGOLA IRS PROGRAM CAPITAL AND RECURRENT EXPENDITURES, BY ACTIVITY AND COST CATEGORY

IRS Activity	U.S. Labor & STTA	Local Admin	Local Labor	Spray Operations	Spray Commodities	Insecticide	Grand Total	% of Total
Administration	162,589	516,178	729,251				\$ 1,408,018	31.0%
Entomology	5,902		68,094	98,880			\$ 172,875	3.8%
Environmental Compliance	2,819		49,032	25,493			\$ 77,344	1.7%
Equipment Supplies					109,165		\$ 109,165	2.4%
IEC			11,295	54,842			\$ 66,137	1.5%
Insecticide						87,577	\$ 87,577	1.9%
M&E	137,211		196,664	221,622			\$ 555,496	12.2%
Post Spray	2,059		197,850	100,963			\$ 300,872	6.6%
Spray Campaign	4,254		93,712	1,260,369			\$ 1,358,334	29.9%
Spray Planning	21,961		186,033	199,027			\$ 407,021	9.0%
Grand Total	\$ 336,794	\$ 516,178	\$ 1,531,931	\$ 1,961,195	\$ 109,165	\$ 87,577	\$ 4,542,840	100%

Table AO2 displays the Angola IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE AO1: ANGOLA IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

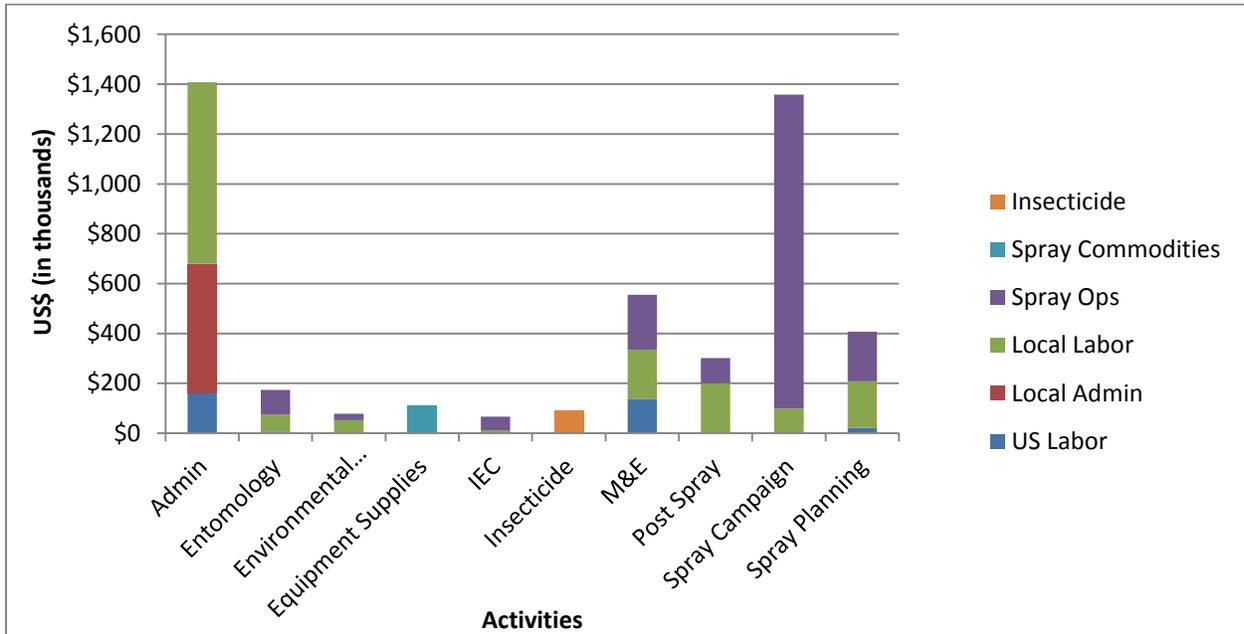


Figure AO1 shows the total burdened capital and recurrent costs but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Administration and implementation of the spray campaign are the two most expensive activities, followed by M&E. The total cost for administration is the largest activity cost, and over 60 percent of this cost consists of labor, both local and U.S.-based. Local labor costs increased in Year 2 because AIRS Angola recruited staff for positions that were vacant during the first year (e.g Database Manager, M&E Manager, Surveillance Coordinator, and Procurement Assistant). Note that the 'U.S.-based Labor and STTA' expenditures are largely incurred under the administrative and M&E program activities. The M&E expenditures for the Angola IRS program are higher than other country programs due to the development of a mobile data collection pilot for Angola IRS M&E activities.

FIGURE AO2: ANGOLA IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

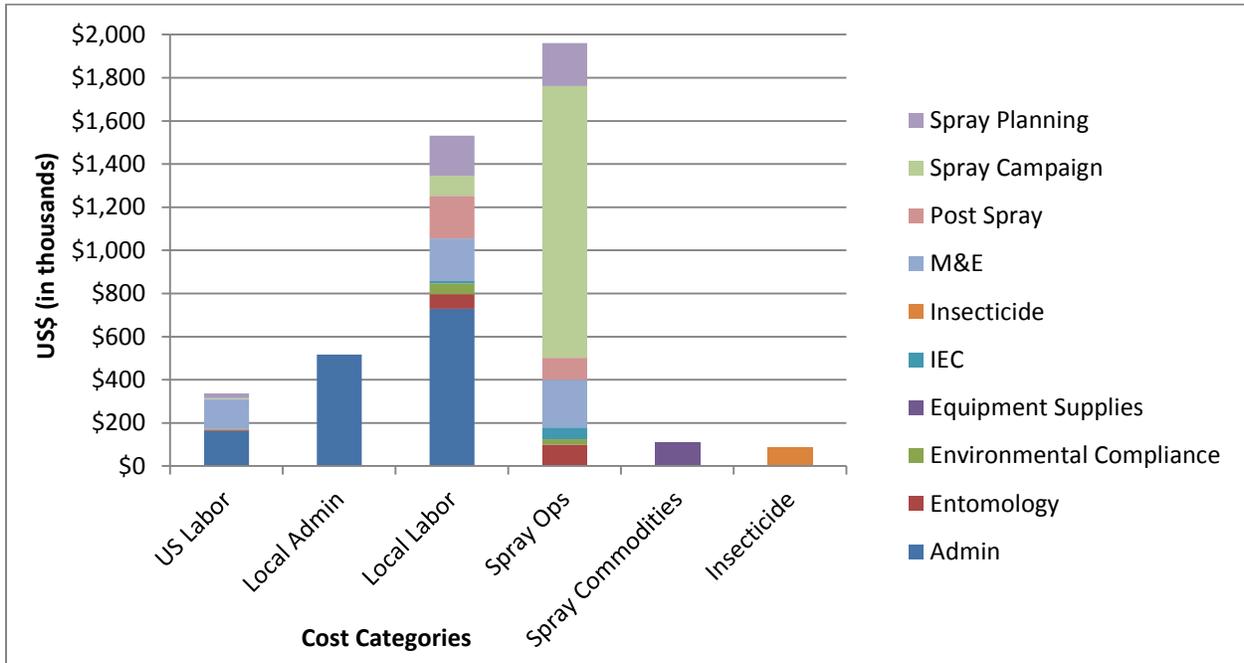


Figure AO2 contains the same information as Figure AO1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that commodities, insecticide, local administrative costs, and U.S.-based labor and STTA are minimal compared to expenditures related to local labor and technical spray operations.

5.3 UNIT COST ANALYSIS

This section presents Angola IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE AO3: ANGOLA IRS UNIT COSTS, BY ACTIVITY

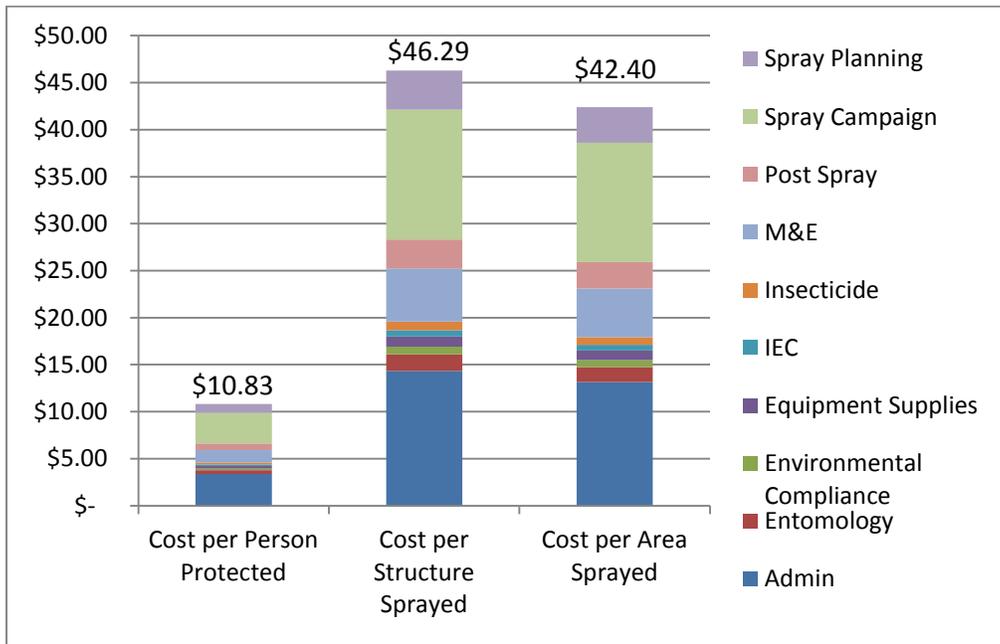
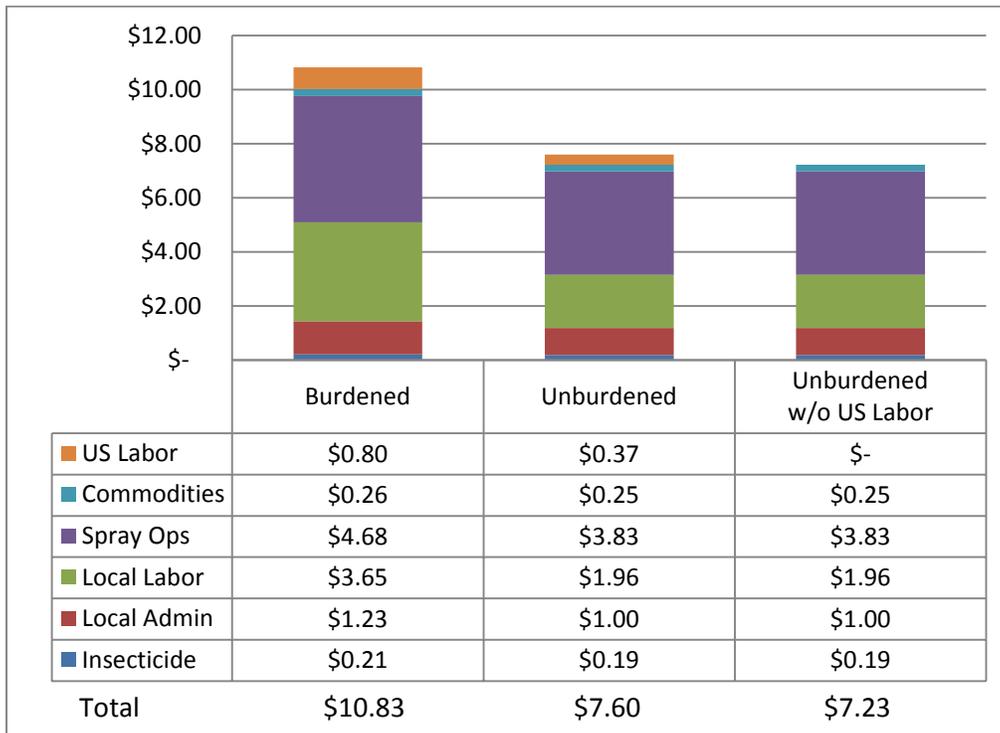


Figure AO3 illustrates the Angola program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, and IEC, make up 7 percent of the unit cost. Administration is the largest cost driver at 31 percent, followed closely by the spray campaign at 29.9 percent. Keep in mind that over 60 percent of the administration activity consisted of U.S.-based and local labor, shown in Figure AO1.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures of the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA.

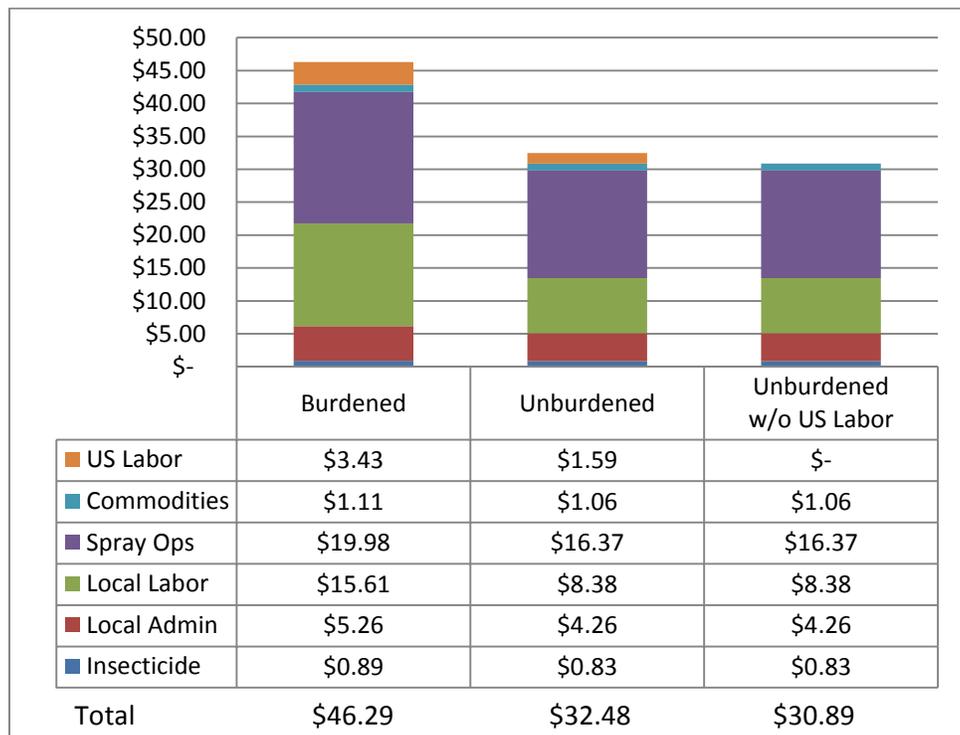
FIGURE AO4: ANGOLA IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Angola Year 2 IRS spray campaign protected 419,353 people from malaria transmission. Figure AO4 shows the unit costs per person protected burdened (\$10.83), unburdened (\$7.60), and unburdened without U.S.-based labor (\$7.23), itemized by cost category. The categories driving the unit cost include spray operations and local labor, which together constitute 76.9 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 11.4 percent and 7.4 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Angola program costs, as delivered through an international implementing partner, adds \$3.60 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 33.3 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by local staff labor, which accounts for over half of the total “cost of burden.”

FIGURE AO5: ANGOLA IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Angola IRS program sprayed 98,136 structures during the Year 2 spray campaign. Figure AO5 shows the unit costs per structure sprayed burdened (\$46.29), unburdened (\$32.48), and unburdened without U.S. labor (\$30.89), itemized by cost category. The burdened portion of AIRS Angola program costs, as delivered through an international implementing partner, adds \$15.40, or 33.3 percent, to the unit cost per structure sprayed.

5.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Angola IRS program between Year 1 and Year 2. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE AO3: ANGOLA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	Year 1	Year 2	Percent Change
People Protected	676,090	419,353	-38.0%
Structures Sprayed	141,782	98,136	-30.8%
Area Sprayed (# 100 m ²)	195,518	107,140	-45.2%

Table AO3, above, compares the year-on-year change in Angola IRS program output measures. Overall, the size of the program decreased, with the number of people protected dropping by 38.0 percent, and the number of structures sprayed dropping by 30.8 percent. As shown in Table AO1 in the Background, the average size of the

structures sprayed in Year 2 was 109.2 m² compared to 137.9 m² in the previous year, which is why the measure of area sprayed dropped more than the number of structures sprayed.

TABLE AO4: ANGOLA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Categories	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 289,794	\$ 87,577	-69.8%
Local Admin	\$ 437,047	\$ 516,178	-18.1%
Local Labor	\$ 1,207,156	\$ 1,531,931	26.9%
Spray Ops	\$ 811,332	\$ 1,961,195	141.7%
Commodities	\$ 117,062	\$ 109,165	-6.7%
U.S. Labor	\$ 267,438	\$ 336,794	25.9%
TOTAL	\$ 3,129,830	\$ 4,542,840	45.1%

Table AO4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost increased by 45 percent, but a more nuanced breakdown of change in expenditures is provided by cost category. For example, insecticide expenditures decreased by almost 70 percent, while spray operations increased by 141 percent. The cost of insecticide decreased in part because the program used more insecticide in Year 1 (as noted in Table AO1 'Area Sprayed'), and also because about 10,000 of the sachets used in Year 2 were left over from the previous year, meaning the cost of these sachets was borne in Year 1.

With respect to local labor, as mentioned earlier, in Year 2 AIRS Angola recruited staff for positions that were vacant during the first year thereby increasing costs. The bulk of the additional spray operations expenditures were incurred under the M&E, spray planning, and spray campaign activities. Salaries of the SOPs increased by 33 percent in Year 2 due to increased level of responsibility conducting both mobilization activities, which they had not one in Year 1, and spray activities. The area sprayed per day decreased by about 8 percent meaning that spray operators were less productive in their spraying overall. Together, these two factors indicate an increase in SOP cost per area sprayed of about 44 percent. Also related to SOP productivity is the fact that despite spraying 31% less structures, the campaign length only reduced by 2% meaning that the program did not see substantial decreases in transportation costs among other spray campaign costs. Some additional factors contributing to higher spray operations costs in Year 2 include: (1) enumeration activities in Bailundo, Huambo Province, which was a new IRS target area, (2) building a new operational site in Bailundo, (3) building a new insectary and (4) the design and implementation of a data collection smartphone pilot.

TABLE AO5: ANGOLA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Cost	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 4.63	\$ 10.83	134.0%
Per Structure Sprayed	\$ 20.07	\$ 46.29	109.7%

Per Area Sprayed (100 m2)	\$ 16.01	\$ 42.40	164.9%
---------------------------	----------	----------	--------

Table AO5 compares the year-on-year change in program unit costs. Although the program size decreased in Year 2 (across all three output measures) and the total expenditures also decreased, the decrease was not proportional, so the program unit costs increased in Year 2. This is primarily due to the increase in total spray operations expenditures, as discussed above, as well as increases in local labor and administration expenditures.

6. BENIN

6.1 BACKGROUND

Year 1

In Benin, IRS campaigns using carbamate insecticides were funded through PMI for four years prior to the start of the AIRS project. From 2007 to 2010, PMI-supported IRS campaigns were carried out in the Ouémé Region in southern Benin. Beginning in 2011, PMI shifted the IRS program focus from Ouémé Region to Atacora Department in northern Benin, in an attempt to cover the entire transmission season. Because northern Benin experiences a shorter malaria transmission season, only one IRS round per year is needed in Atacora, as compared to Ouémé, which experiences year-round malaria transmission and required two IRS campaigns annually with a carbamate insecticide.

In 2012 (Year 1), the AIRS project completed IRS in all of Atacora Region's nine districts: Boukoubé, Cobli, Kerou, Kouande, Materi, Natitingou, Pehunco, Tangueita, and Toucountouna. This was the first IRS campaign in both Pehunco and Kerou. The campaign used bendiocarb, which is a member of the carbamate class of insecticide. The IRS campaign was completed in 35 days (May 14 through June 22). The spray coverage area included one large city of about 70,000 people, with the other 580,000 people covered living in small villages. The need to travel to these villages raised the cost of ground transportation. Entomological monitoring activities were subcontracted to the Entomological Research Center of Cotonou (CREC), a research firm associated with the University of Benin. Beginning in 2013, PMI will directly subcontract CREC.

Year 2

PMI's AIRS Benin project carried out the Year 2 IRS campaign over 32 days between May 20 and June 26, 2013. The IRS campaign covered all nine communes in Atacora Department. AIRS Benin conducted the IRS campaign by working closely with PMI/Benin, as well as with the following government stakeholders: the NMCP; the MOH; the Ministry of Agriculture, Livestock and Fisheries; the Ministry of Environment, Habitat and Urbanization; the Benin Environmental Agency; the National Directorate of Agriculture; the Department Administrative Authorities of Atacora; and the Department Directorate of Health for Atacora.

Organophosphate class (Actellic EC) insecticide was used in Year 2 for the first time in Benin for an IRS campaign. Organophosphate selection was done based on entomological surveillance data collected after the Year 1 IRS campaign, which showed that the malaria vectors had become less susceptible to carbamates. 21,180 bottles of organophosphates were used in five districts (Cobly, Kouandé, Matéri, Tanguiéta, and Toucountouna) and 29,062 sachets of carbamates were used in four districts (Boukoubé, Kérou, Natitingou, and Pehunco).

PMI/Benin subcontracted CREC to collect entomological surveillance data to evaluate the quality and effectiveness of the Year 2 IRS campaign. CREC noted that the quality

of the IRS was good 24 hours after spraying in all districts; there were 100 percent mortality rates for mosquitoes coming into contact with walls treated with carbamates and with organophosphates.

Table BN1 summarizes the spray done in Years 1 and 2.

TABLE BNI: BENIN QUICK FACTS

	Year 1	Year 2
# Local Staff	13	13
Spray Start Date	May 14, 2012	May 20, 2013
# Spray Rounds	1	1
# Sachets Used	50,842	50,242
# People Protected	652,777	694,729
# Structures Sprayed	210,380	228,951
# 100 Square Meters Sprayed	127,105	125,605
Average Size of Structure	60.4 m ² *	54.9 m ²

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

6.2 PROGRAM EXPENDITURES

This section will present an overview of Benin IRS program expenditures in Year 2. Costs are organized by activity and cost category.

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		254,249	316,685			150,898	\$ 721,832	17.6%
Entomology			19,285		103,707	332	\$ 123,325	3.0%
Environmental Compliance			72,370		52,368	23,889	\$ 148,627	3.6%
Equipment Supplies				146,644			\$ 146,644	3.6%
IEC			4,253				\$ 4,253	0.1%
Insecticide	1,525,209				233		\$ 1,525,443	37.2%
M&E			52,720		1,419	49,477	\$ 103,616	2.5%
Post Spray			67,557			1,034	\$ 68,591	1.7%
Spray Campaign			35,713		1,079,326	1,922	\$1,116,960	27.2%
Spray Planning			130,733		5,084	6,572	\$ 142,389	3.5%

Grand Total	\$1,525,209	\$ 254,249	\$ 699,316	\$ 146,644	\$ 1,242,138	\$ 234,124	\$ 4,101,680	100.0%
--------------------	--------------------	-------------------	-------------------	-------------------	---------------------	-------------------	---------------------	---------------

Table BN2 displays the Benin IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the table.

FIGURE BN1: BENIN IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

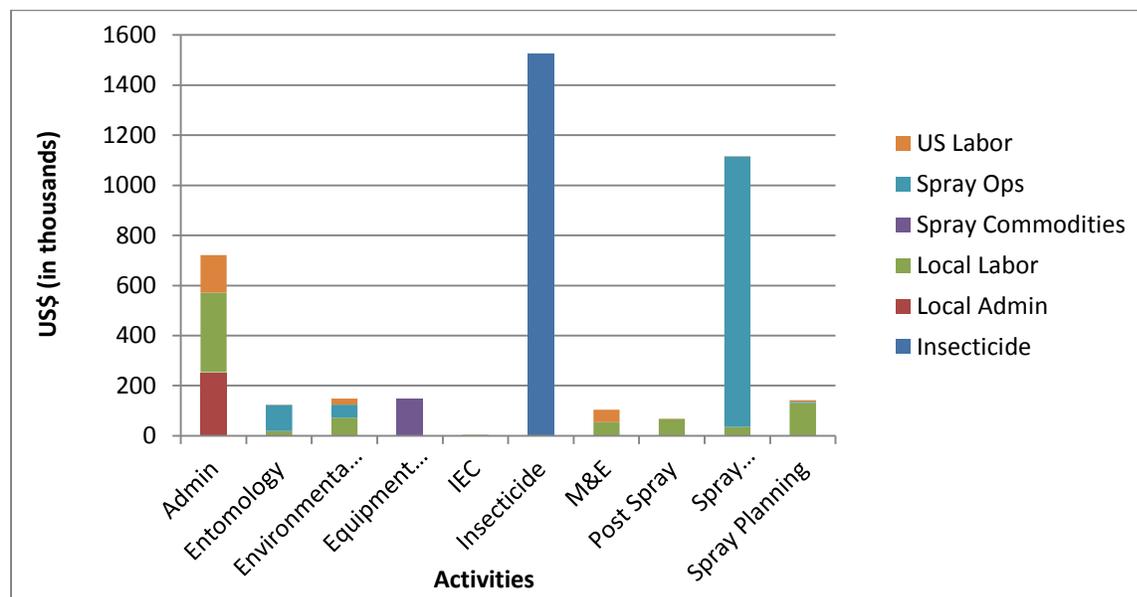


Figure BN1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticide is the most expensive IRS activity (37.2 percent of expenditures), followed by the administrative and spray campaign activities. About 65 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.

FIGURE BN2: BENIN IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

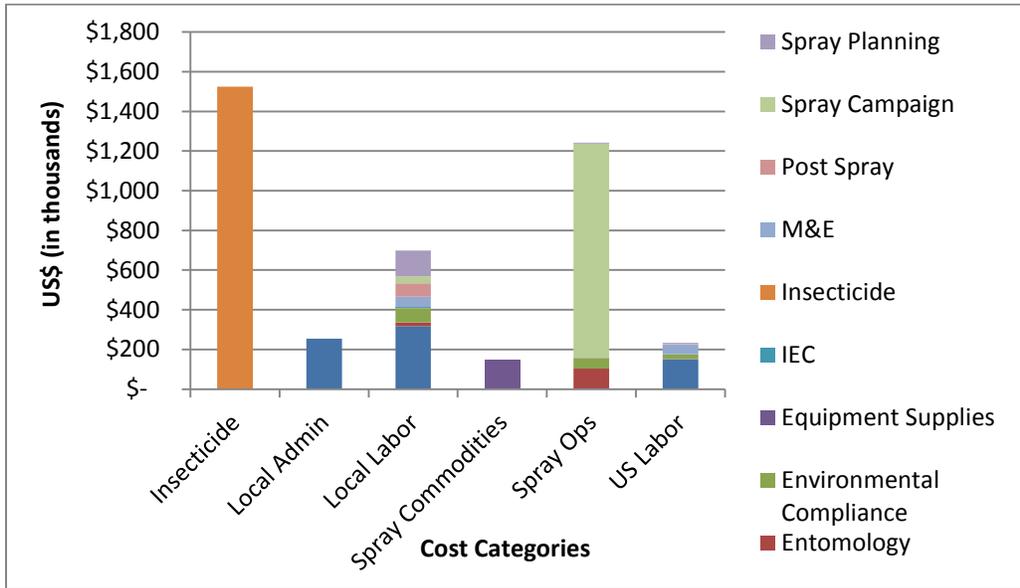


Figure BN2 contains the same information as Figure BN1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, and spray operations.

6.3 UNIT COST ANALYSIS

This section presents Benin IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE BN3: BENIN IRS UNIT COSTS, BY ACTIVITY

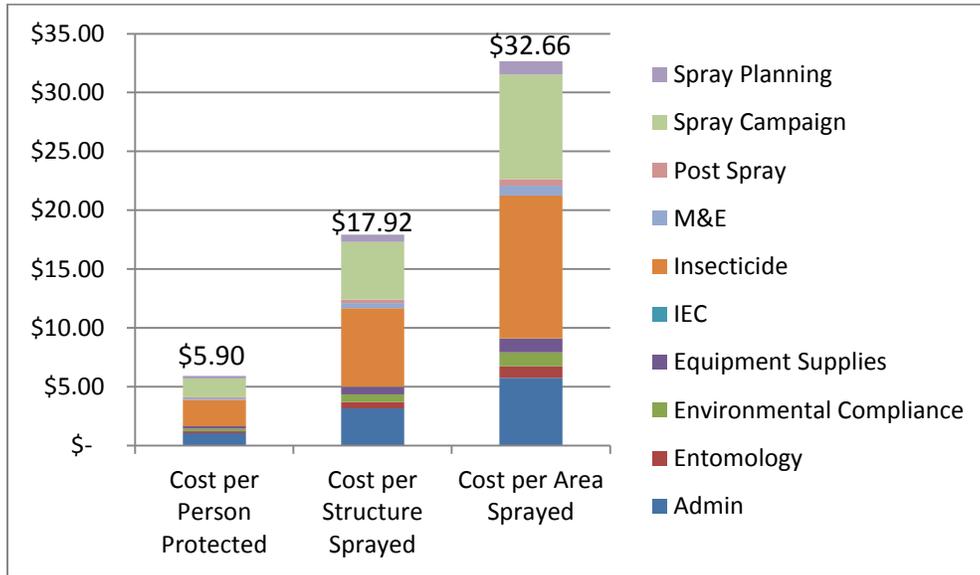
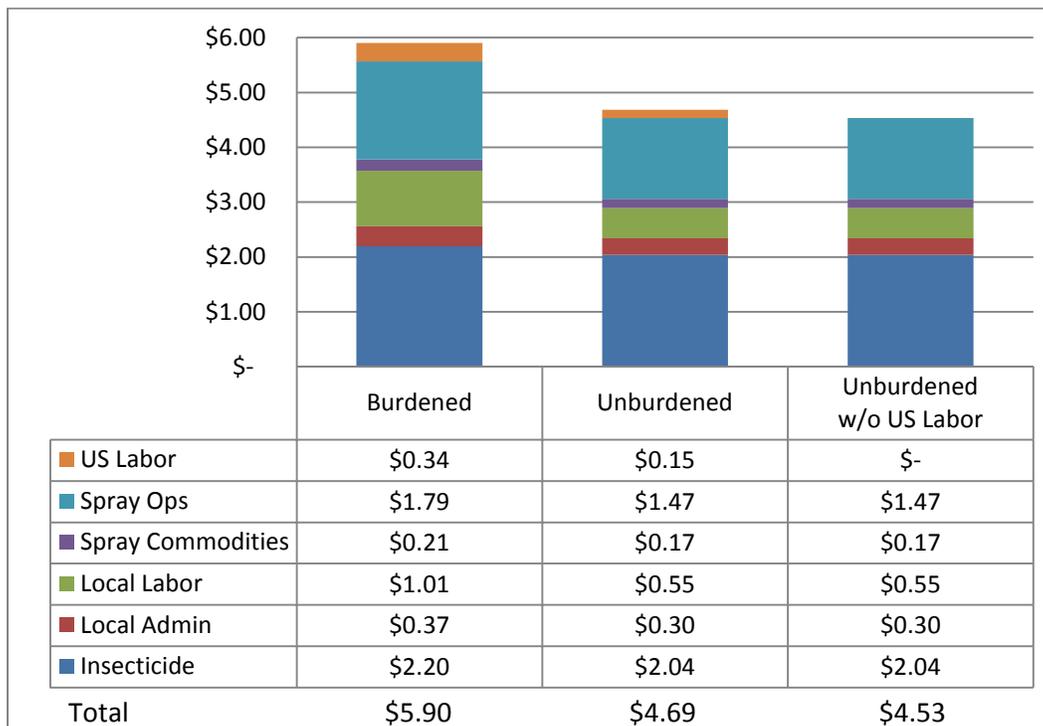


Figure BN3 illustrates the Benin program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, and IEC, make up 6.7 percent of the unit cost. Insecticide is the largest cost driver at 37.2 percent, followed closely by the spray campaign at 27.2 percent. Administration makes up 17.2 percent of the total unit costs; keep in mind that Figure BN1 showed that about 65 percent of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

FIGURE BN4: BENIN IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Benin Year 2 IRS spray campaign protected 694,729 people from malaria transmission. Figure BN4 shows the unit costs per person protected burdened (\$5.90), unburdened (\$4.69), and unburdened without U.S.-based labor (\$4.53), itemized by cost category. The categories driving the unit cost include spray operations and insecticide, which together constitute 67.5 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 6.2 percent and 5.7 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Benin program costs, as delivered through an international implementing partner, adds \$1.37 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 23.2 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by local and U.S.-based staff labor, which together account for about 57 percent of the total “cost of burden.”

FIGURE BN5: BENIN IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Benin IRS program sprayed 228,951 structures during the Year 2 spray campaign. Figure BN5 shows the unit costs per structure sprayed burdened (\$17.92), unburdened (\$14.22), and unburdened without U.S. labor (\$13.75), itemized by cost category. The burdened portion of AIRS Benin program costs, as delivered through an international implementing partner, adds \$4.17 to the unit cost per structure sprayed.

6.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Benin IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE BN3: BENIN IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	Year 1	Year 2	Percent Change
People Protected	652,777	694,729	6.4%
Structures Sprayed	210,380	228,951	8.8%
Area Sprayed (100 m ²)	127,105	125,605	-1.2%

Table BN3, above, compares the year-on-year change in Benin IRS program output measures. Overall, the size of the program grew slightly, with the number of people protected increasing by 6.4 percent, and the number of structures sprayed increasing by 8.8 percent. As shown in Table BN1 in the Background, the average size of the structures sprayed in Year 2 was 54.9 m² compared to 60.4 m² in the previous year, and the slight decrease in average size of a structure is why the area sprayed dropped slightly while the number of structures sprayed increased slightly.

TABLE BN4: BENIN IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 805,864	\$ 1,525,209	89.3%
Local Admin	\$ 230,752	\$ 254,249	10.2%
Local Labor	\$ 1,091,508	\$ 699,316	-35.9%
Spray Operations	\$ 1,192,108	\$ 1,242,138	4.2%
Commodities	\$ 201,562	\$ 146,644	-27.2%
U.S. Labor	\$ 199,410	\$ 234,124	17.4%
TOTAL	\$ 3,721,203	\$ 4,101,680	10.2%

Table BN4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost increased by 10.2 percent, but a more nuanced breakdown of change in expenditures is provided by cost category. For example, insecticide expenditures increased by almost 90 percent, while local labor decreased by almost 36 percent. The main reason the cost of insecticide increased is because 21,180 bottles of organophosphates (Actellic EC) were procured in Year 2 which were much more expensive compared to Year 1, when only carbamates were used. In addition to the overall program growing slightly, the cost savings in local labor and spray commodities were not quite large enough to offset the increased insecticide costs, so the overall program expenditures increased.

TABLE BN5: BENIN IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 5.70	\$ 5.90	3.6%
Per Structure Sprayed	\$ 17.69	\$ 17.92	1.3%
Per Area Sprayed	\$ 29.28	\$ 32.66	11.5%

Table BN5 compares the year-on-year change in program unit costs. Because both the program size and the total expenditures increased slightly in Year 2, the unit costs also increased slightly. As noted previously, this is primarily due to the increase in insecticide costs incurred by procuring organophosphates. As insecticide and spray operations are the two largest cost drivers, increases in both of these total costs with only a minimal increase in program size is responsible for the slight increase in the unit costs.

7. ETHIOPIA

7.1 BACKGROUND

Year 1

In Ethiopia, malaria is generally seasonal, with transmission peaking for two to five months per year during and/or following the rainy season. As a result, one round of IRS, just before the peak of the transmission period (September–November), is considered enough to protect people during the malaria season. IRS in Ethiopia was launched in 1959 as part of the Global Malaria Eradication Program spearheaded by the WHO. After the program ended in 1969, the Ethiopian government continued to independently fund spraying campaigns through 2004.

PMI support for IRS in Ethiopia began in 2008. Initially, PMI's focus was Oromia Regional State, which comprises one-third of the country's territory and population. Recently, IRS-related trainings and workshops, as well as entomological monitoring activities, have been expanded to other states. In Year 1, the PMI AIRS project's Ethiopia spray campaign covered 36 districts in Oromia Region in two rounds of spraying. The spray campaign was completed in 19 districts from using deltamethrin from the pyrethroid class of insecticides and in 17 additional districts using bendiocarb, an insecticide from the carbamate class.

In addition, PMI provided 24 districts that graduated from PMI support in 2011 with 1,025 pairs of boots and personal protective equipment for 1,000 spray operators (at a cost of about \$60,000). In collaboration with the Federal MOH, PMI provided training to over 80 health workers from the Oromia Region, including representatives from the 24 graduated districts, on the use and safety of carbamate insecticides (cost of about \$3,600). The Government of Ethiopia supplied pyrethroid insecticides and warehousing space to use in the first spray round. The cost value for the warehouse was unobtainable, but the value of insecticide was estimated and is included in this report. PMI used carbamate insecticides to cover 17 districts in the second round. These were procured directly by PMI, and the cost value is included in this report. As part of the EC work, URS Corporation, a U.S.-based engineering firm, provided support with an assessment of DDT insecticide waste disposal opportunities in country, and Envirocare Company, a waste management firm based in Kenya, provided support with training on and installation of two incinerators.

Year 2

In Year 2, PMI's IRS program conducted only one round of spraying using carbamate insecticides. As in Year 1, these carbamate insecticides were procured directly by PMI. PMI's IRS program completed operations in the same 36 districts as in the previous year over a total of 37 days between August 15 and September 27, 2013. In 30 districts, the

district health office, with technical and logistic support from the PMI's IRS program, was responsible for implementing all planning, training, spraying and ensuring environmental compliance activities. In six other districts, the responsibility for training spray operators and for planning and implementing the spray operation was decentralized to the village level and specifically to health extension workers. The health extension workers were also put in charge of ensuring environmental compliance during spray operations.

The IRS program also provided technical and logistics support to the non-PMI districts and 24 districts that graduated from PMI support in 2011. This support included the training of 55 district, zonal, and regional health staff regarding environmental compliance (about \$9,000), and supplying 600 boxes (72,000 sachets) of carbamate insecticide. In addition, the Ethiopia IRS program provided personal protective equipment and spray pumps to these districts for a total of about \$389,000. Also, as part of PMI support to build national entomological capacity, the project donated to Jimma University equipment and materials in the amount \$60,000. The project also conducted an IRS impact assessment study (\$23,500) and worked with the Integrated Vector Control Consortium to introduce their Disease Data Management System to the project with a potential roll out to the national partners (\$37,000). These costs are excluded from the Year 2 expenditures used for the analysis.

TABLE ETI: ETHIOPIA QUICK FACTS

	Year 1	Year 2
# Local Staff	19	21
Spray Start Date(s)	June 15, 2012 August 15, 2012	August 15, 2013
# Spray Rounds	2	1
# Sachets Used	262,167	308,721
# People Protected	1,506,273	1,629,958
# Structures Sprayed	547,421	635,528
# 100 Square Meters Sprayed	524,334	617,442
Average Size of Structure	95.8 m ² *	97.2 m ²

* Reverse calculation using number of insecticide sachets used during campaign multiplied by the average of 200 m² estimated to be sprayed by one sachet in an 8L spray tank and divided by the number of structures sprayed.

7.2 PROGRAM EXPENDITURES

This section will present an overview of Ethiopia IRS program expenditures in Year 2. Costs are organized by activity and cost category.

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
Administration		267,526	305,087			188,891	761,504	10.4%
Entomology			87,795		131,789	5,712	225,296	3.1%
Environmental Compliance			27,354		105,320	55,099	187,774	2.6%
Equipment Supplies				405,080	180	683	405,943	5.6%
IEC					-		-	0.0%
Insecticide	3,636,327						3,636,327	49.8%
M&E			45,365		64,998	80,567	190,929	2.6%
Post Spray			3,764		6,115		9,880	0.1%
Spray Campaign			46,660		1,499,974	3,791	1,550,426	21.2%
Spray Planning			39,197		278,689	17,138	335,024	4.6%
Grand Total	\$ 3,636,327	\$ 267,526	\$ 555,222	\$ 405,080	\$ 2,087,066	\$ 351,881	\$ 7,303,101	100%

Table ET2 displays the Ethiopia IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE ET1: ETHIOPIA IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

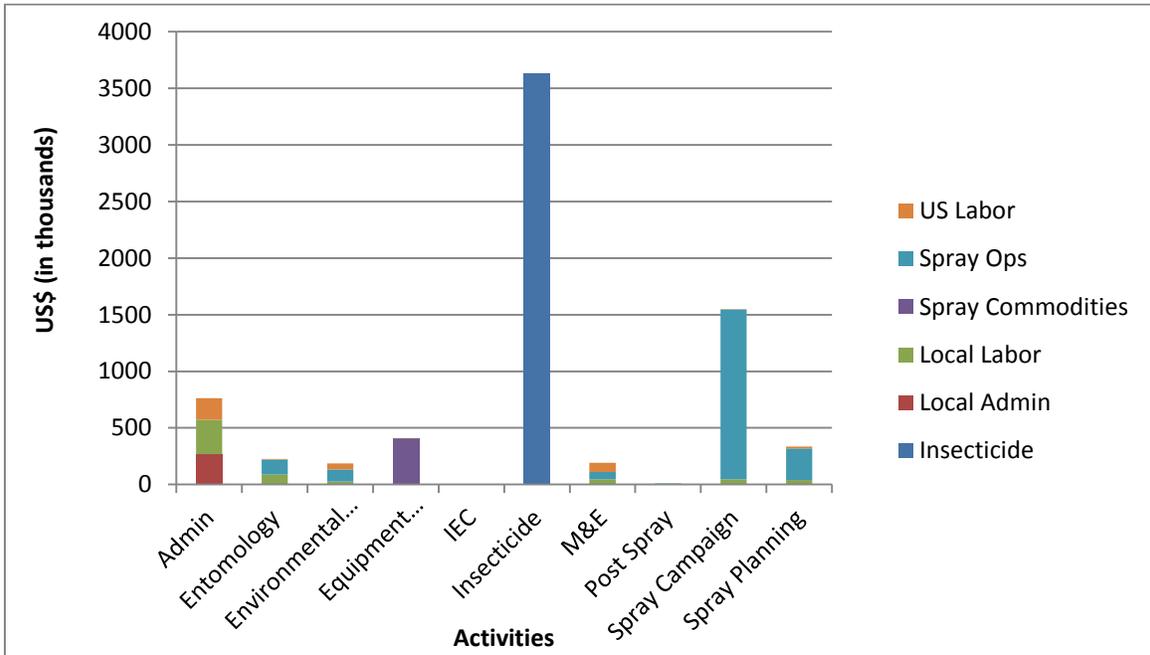


Figure ET1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticide represents almost half of total program expenditures, at 49.8 percent. The report is using the cost for procured insecticide. Implementation of the spray campaign is the next most expensive activity, followed by equipment/supplies and local administration.

FIGURE ET2: ETHIOPIA IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

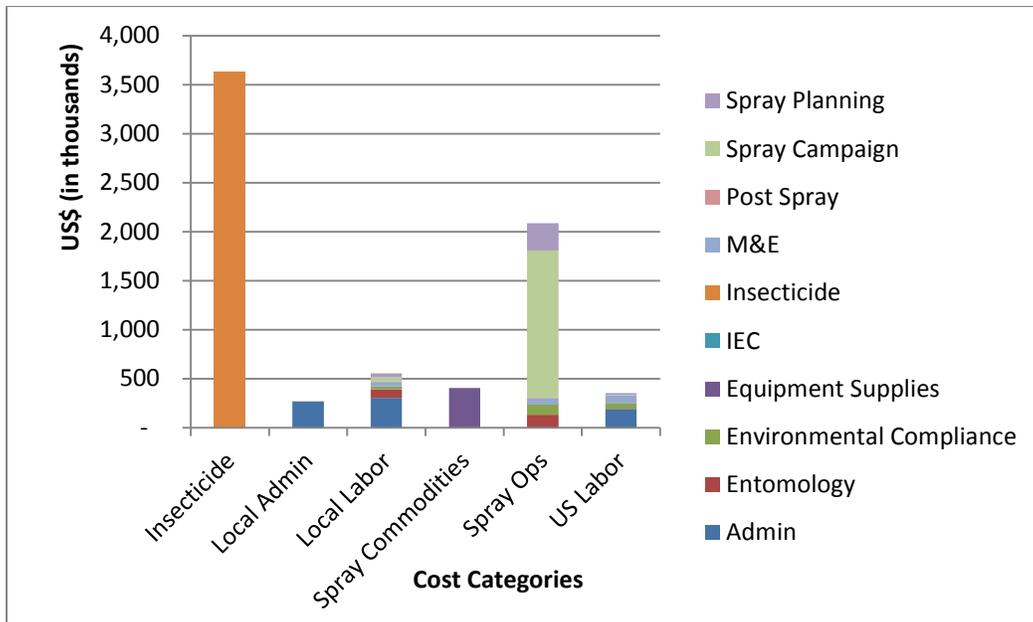


Figure ET2 contains the same information as Figure ET1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs, local labor, and U.S.-based labor and STTA are minimal compared to expenditures related to insecticide and technical spray operations.

7.3 UNIT COST ANALYSIS

This section presents Ethiopia IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE ET3: ETHIOPIA IRS UNIT COSTS, BY ACTIVITY

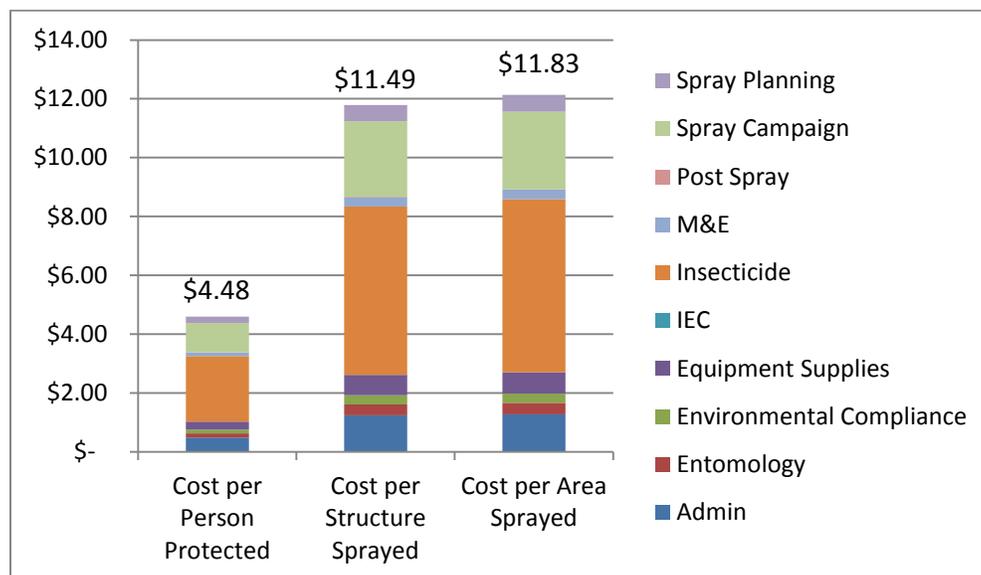
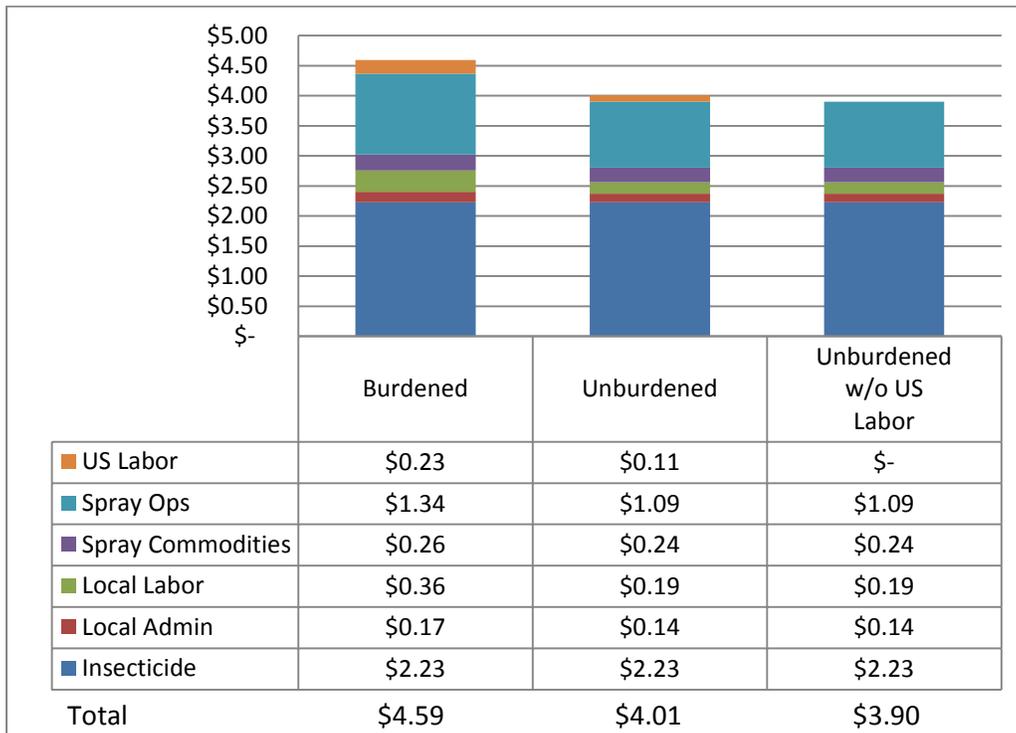


Figure ET3 illustrates the Ethiopia program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, and M&E, make up 8.3 percent of the unit cost. Insecticide is the largest cost driver at 49.8 percent, followed by the spray campaign at 21.2 percent.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

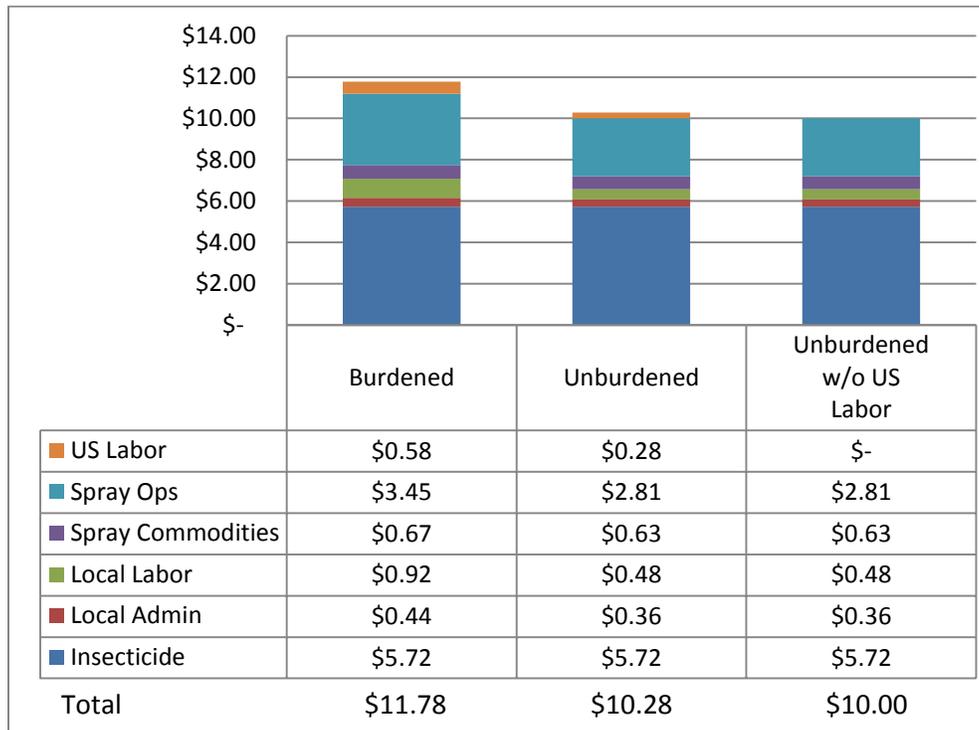
FIGURE ET4: ETHIOPIA IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Ethiopia Year 2 IRS spray campaign protected 1,629,958 people from malaria. Figure ET4 shows the unit costs per person protected burdened (\$4.59), unburdened (\$4.01), and unburdened without U.S.-based labor (\$3.90), itemized by cost category. The categories driving the unit cost include insecticide and spray operations, which together constitute 77.8 percent of the total burdened unit cost. In contrast to the administrative portion (activity) of the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 3.8 percent and 4.9 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Ethiopia program costs, as delivered through an international implementing partner, adds \$0.69 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 15.1 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by spray operations, which accounts for 36.1 percent of the total “cost of burden.”

FIGURE ET5: ETHIOPIA IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Ethiopia IRS program sprayed 635,528 structures during the Year 2 spray campaign. Figure ET5 shows the unit costs per structure sprayed burdened (\$11.78), unburdened (\$10.28), and unburdened without U.S. labor (\$10.00), itemized by cost category. The burdened portion of AIRS Ethiopia program costs, as delivered through an international implementing partner, adds \$1.78 to the unit cost per structure sprayed.

7.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Ethiopia IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE ET3: ETHIOPIA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	Year 1	Year 2	Percent Change
People Protected	1,506,273	1,629,958	8.2%
Structures Sprayed	547,421	635,528	16.1%
Area Sprayed (100 m ²)	524,334	617,442	17.8%

Table ET3, above, compares the year-on-year change in Ethiopia IRS program output measures. Overall, the size of the program grew, with the number of people protected increasing by 8.2 percent, and the number of structures sprayed increasing by 16.1

percent. As shown in Table ET1 in the Background, the average size of the structures sprayed in Year 2 stayed about the same, 95.8 m² compared to 97.2 m² in Year 1, which is why the percent increase in area sprayed is similar to that of the number of structures sprayed.

TABLE ET4: ETHIOPIA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 1,181,408	3,636,327	207.8%
Local Admin	\$ 336,415	267,526	-20.5%
Local Labor	\$ 470,740	555,222	17.9%
Spray Ops	\$ 1,623,523	2,087,066	28.6%
Commodities	\$ 557,471	405,080	-27.3%
U.S. Labor	\$ 345,620	351,881	1.8%
TOTAL	\$ 4,515,178	7,303,101	61.7%

Table ET4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost increased by 61.7 percent, but a more nuanced breakdown of change in expenditures is provided by cost category. For example, insecticide expenditures increased by 207.8 percent, while local administration decreased by 20.5 percent. The cost of insecticide increased in part because in Year 1 the program used a mix of pyrethroid and carbamate insecticides, whereas in Year 2 the program used all carbamate insecticide, which tends to be more expensive than pyrethroids. Expenditures for meetings, conferences and seminars under local administration categories have decreased significantly in Year 2.

Spray operations expenditures saw a large increase. Escalation in spray operations cost in Year 2 was mainly due to 50% rate increase for SOP salaries, and similar salary adjustments for team leaders and supervisors. In Year 1, the country program used the rates that RTI International set four years ago. Because the country program experienced problems with hiring people at those rates during Year 1, the rates were adjusted in Year 2.

TABLE ET5: ETHIOPIA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 3.00	\$ 4.48	49.5%
Per Structure Sprayed	\$ 8.25	\$ 11.49	39.3%
Per Area Sprayed	\$ 8.61	\$ 11.83	37.4%

Table ET5 compares the year-on-year change in program unit costs. Although the program size increased in Year 2, the total expenditures also increased by a disproportionate amount, which caused the program unit costs to increase in Year 2. As discussed above, this is primarily due to the large increase in expenditures on insecticide and spray operations.

8. GHANA

8.1 BACKGROUND

Year 1

Ghana began implementing IRS with the support of PMI in 2008, and the number of beneficiary districts was steadily scaled up to nine by 2011. The 2012 spray campaign was implemented for 60 days between April 23 and July 31, 2012 (Table GH1). The Ghana IRS program implemented the spray campaign with procured organophosphate insecticide in 3.5 districts and with inherited pyrethroid insecticide in the remaining 5.5 districts. In addition to the IRS campaign, AIRS Ghana supported an anemia and parasitemia (A&P) survey funded and implemented by PMI, by providing logistical support. The team also conducted IRS in one half of a district during a second round of spraying in the fall of 2012 as part of this survey. The estimated total cost for work provided under the A&P survey is \$344,540. Additionally, the Ghana IRS program executed a subcontract (in the amount of approximately \$66,000) with the Noguchi Memorial Institute for Medical Research (NMIMR) to carry out advanced entomological monitoring activities.

Year 2

In 2013, the number of target IRS districts was decreased from nine to four districts, Bunkpurugu Yunyoo, East Mamprusi, West Mamprusi, and Savelugu-Nanton. An organophosphate insecticide, Actellic CS, was used in all four districts. The number of spray days was reduced from 60 to 53 days. AIRS supported two A&P surveys in 2013, one in the spring and one in the fall, but it was not accompanied by additional spraying as was done in 2012. AIRS also worked with the Liverpool School of Tropical Medicine to complete a desk review scoping exercise in which the results were used for future IRS targeting. AIRS subcontracted with NMIMR again to conduct advanced entomological monitoring activities.

TABLE GHI: GHANA QUICK FACTS

	Year 1	Year 2
# Local Staff	25	26
Spray Start Date	April 23, 2012	April 29, 2013
# Spray Rounds	1	1
# Sachets/bottles Used	77,288	43,284
# People Protected	941,240	534,060
# Structures Sprayed	355,278	197,655
# 100 Square Meters Sprayed	193,220	108,210
Average Size of Structure	54.4 m ² *	54.7 m ²

* Reverse calculation using number of insecticide sachets used during campaign multiplied by the average of 250 square meters estimated to be sprayed by one sachet and divided by the number of structures sprayed.

8.2 PROGRAM EXPENDITURES

This section will present an overview of Ghana IRS program expenditures in Year 2. Costs are organized by activity and cost category.

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
Administration		623,186	823,701			191,449	\$1,638,336	30.5%
Entomology			65,219		562,691	2,327	\$ 630,237	11.7%
Environmental Compliance			27,004		19,281	13,987	\$ 60,272	1.1%
Equipment Supplies				167,893		284	\$ 168,177	3.1%
IEC			25,021		46,025		\$ 71,047	1.3%
Insecticide	1,262,861						\$1,262,861	23.5%
M&E			41,992		31,849	102,413	\$ 176,254	3.3%
Post Spray					67,914	2,926	\$ 70,840	1.3%
Spray Campaign			173,668	15,626	972,886	2,794	\$1,164,974	21.7%
Spray Planning					109,843	12,248	\$ 122,091	2.3%
Grand Total	\$ 1,262,861	\$ 623,186	\$1,156,605	\$ 183,519	\$ 1,810,489	\$ 328,429	\$5,365,088	100.0%

Table GH2 displays the Ghana IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE GH1: GHANA IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

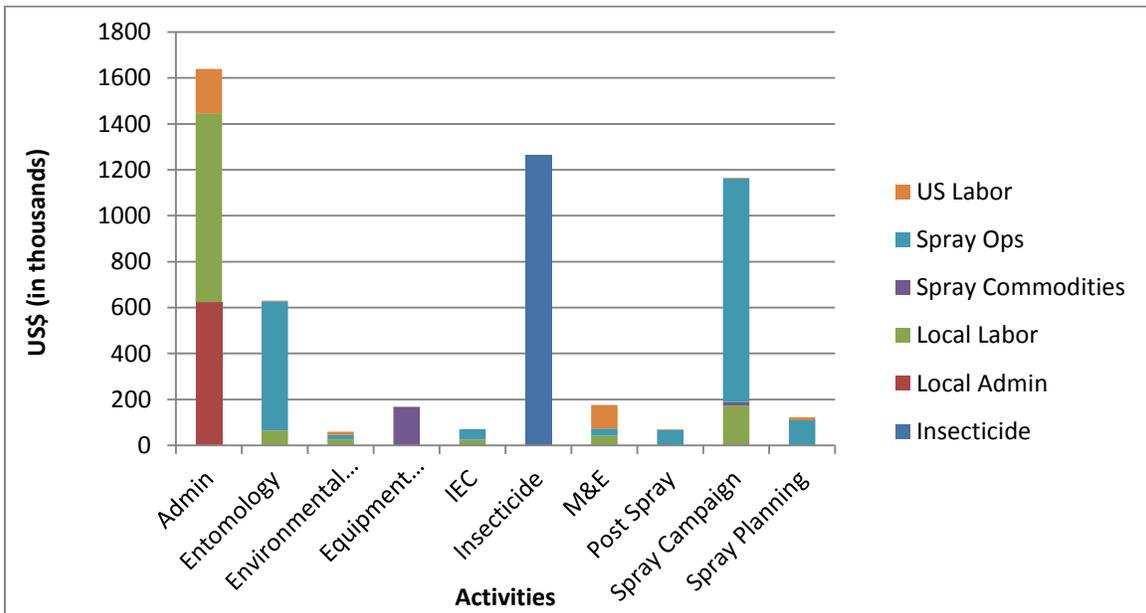


Figure GH1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Administration, insecticide, and implementation of the spray campaign are the most expensive activities. The total cost for administration is the largest activity cost, but the majority of this cost is incurred for labor, with 50.3 percent local labor and 11.7 percent U.S.-based staff labor. Note that the 'U.S.-based Labor and STTA' expenditures are largely incurred under the administrative and M&E program activities.

FIGURE GH2: GHANA IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

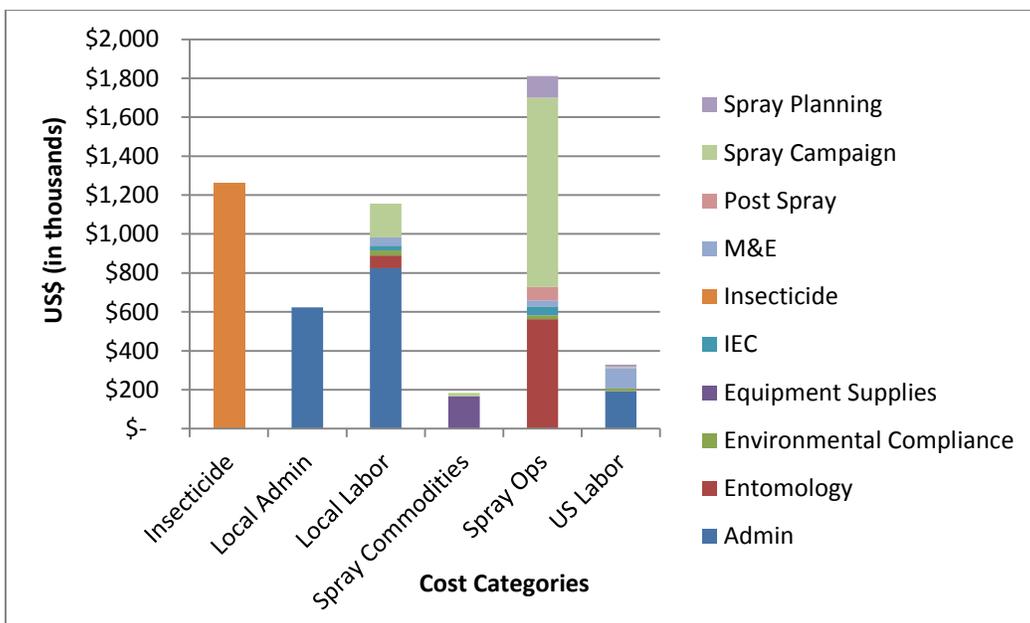


Figure GH2 contains the same information as Figure GH1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that commodities and U.S.-based labor and STTA are minimal compared to expenditures related to insecticide, local labor, and technical spray operations.

8.3 UNIT COST ANALYSIS

This section presents Ghana IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE GH3: GHANA IRS UNIT COSTS, BY ACTIVITY

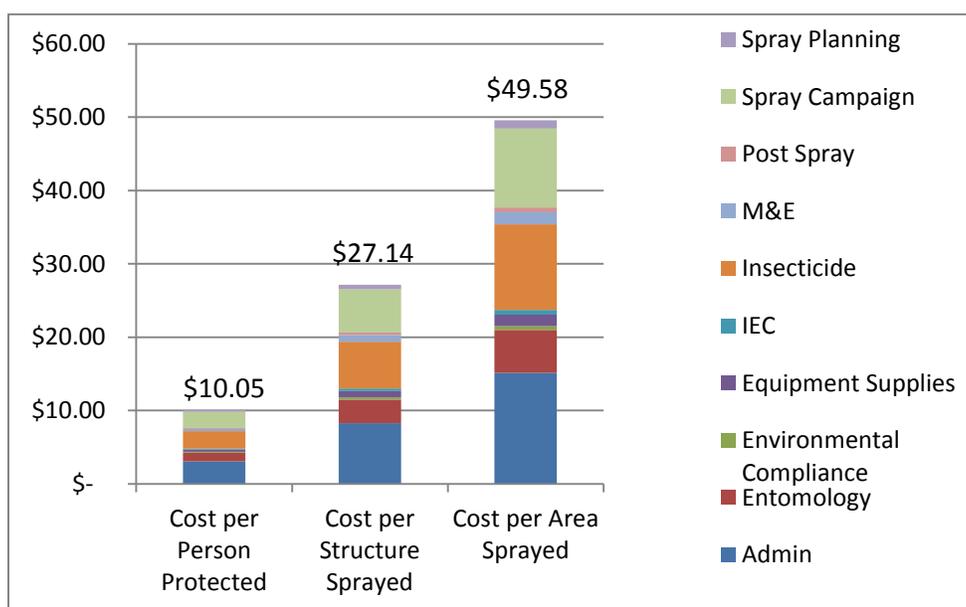
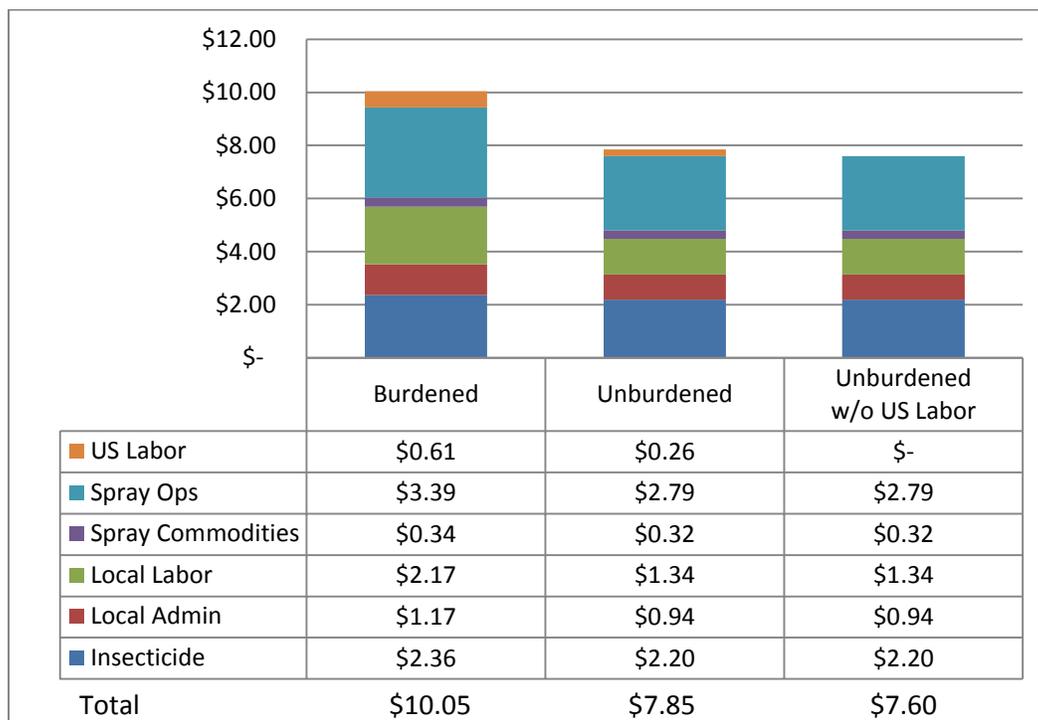


Figure GH3 illustrates the Ghana program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including EC, IEC, and M&E, together make up 5.7 percent of the unit cost. Administration is the largest cost driver at 30.5 percent, followed closely by the insecticide at 23.5 percent, and the spray campaign at 21.7 percent. Keep in mind that Figure GH1 showed that 62 percent of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the

unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

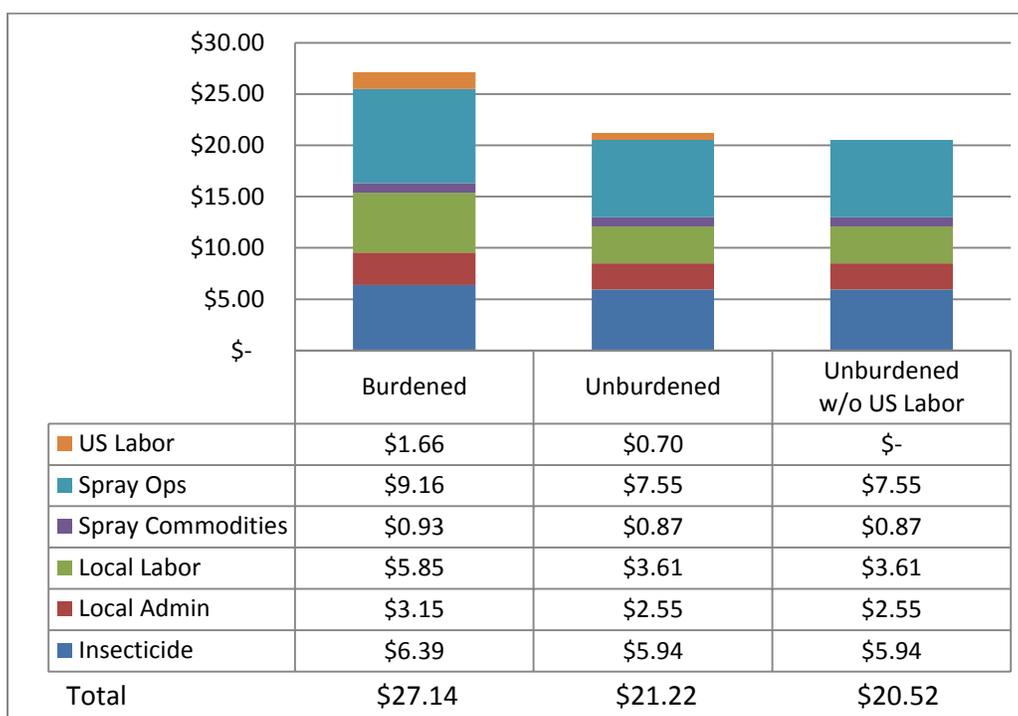
FIGURE GH4: GHANA IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Ghana Year 2 IRS spray campaign protected 534,060 people from malaria transmission. Figure GH4 shows the unit costs per person protected burdened (\$10.05), unburdened (\$7.85), and unburdened without U.S.-based labor (\$7.60), itemized by cost category. The categories driving the unit cost include spray operations and insecticide, which together constitute 57.3 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 11.6 percent and 56.1 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Ghana program costs, as delivered through an international implementing partner, adds \$2.45 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 24.4 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by local staff labor, which accounts for over a third of the total “cost of burden.”

FIGURE GH5: GHANA IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Ghana IRS program sprayed 197,655 structures during the Year 2 spray campaign. Figure GH5 shows the unit costs per structure sprayed burdened (\$27.14), unburdened (\$21.22), and unburdened without U.S. labor (\$20.52), itemized by cost category. The burdened portion of AIRS Ghana program costs, as delivered through an international implementing partner, adds \$6.58 to the unit cost per structure sprayed.

8.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Ghana IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE GH3: GHANA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	Year 1	Year 2	Percent Change
People Protected	941,240	534,060	-43.3%
Structures Sprayed	355,278	197,655	-44.4%
Area Sprayed (100 m ²)	193,220	108,210	-44.0%

Table GH3, above, compares the year-on-year change in Ghana IRS program output measures. Overall, the size of the program decreased consistently by almost half, with the number of people protected dropping by 43 percent, and the number of structures

sprayed dropping by 44 percent. As shown in Table GH1 in the Background, the average size of the structures sprayed in Year 2 was 54.7 m² compared to 54.4 m² in the previous year, which is why the percent change in measure of area sprayed is consistent with the change in number of structures sprayed.

TABLE GH4: GHANA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Categories	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 1,636,890	\$ 1,262,861	-22.8%
Local Admin	\$ 813,092	\$ 623,186	-23.4%
Local Labor	\$ 754,994	\$ 1,156,605	53.2%
Spray Ops	\$ 2,062,100	\$ 1,810,489	-12.2%
Commodities	\$ 316,090	\$ 183,519	-41.9%
U.S. Labor	\$ 446,177	\$ 328,429	-26.4%
TOTAL	\$ 6,029,344	\$ 5,365,088	-11.0%

Table GH4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost decreased by 11.0 percent. Local labor, the largest cost driver, increased by 53 percent. The increase was due to an expatriate Financial Director hired in response to the program's management challenges, and the addition of a Third Country National Chief of Party. Several local staff members were switched to full time employment contracts as well. Commodities decreased by about 42 percent. Insecticide, the next largest cost driver, decreased by about 23 percent. The reason the insecticide costs decreased is that the pyrethroid districts were not sprayed in Year 2, thus the total cost of insecticides decreased.

TABLE GH5: GHANA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 6.41	\$ 10.05	56.6%
Per Structure Sprayed	\$ 16.97	\$ 27.214	59.9%
Per Area Sprayed (100 m ²)	\$ 31.20	\$ 49.58	58.9%

Table GH5 compares the year-on-year change in program unit costs. Although the program size decreased in Year 2 (across all three output measures) and the total expenditures also decreased, the decrease was not proportional, so the program unit costs increased in Year 2. This is primarily due to the increase in total local labor expenditures, as discussed above, as well as the minor decrease in spray operations expenditures. The decrease in spray operations expenditures can be attributed to better management of the spray campaign as well as a reduction in the number of spray days. As spray operations and local labor are the two largest cost drivers, an

increase or only minimal decrease in these either of these cost categories demonstrates a noticeable adverse effect on the unit costs. Ghana program unit costs increase when the number of structures decreased because of the high fixed costs of implementing a spray campaign.

9. LIBERIA

9.1 BACKGROUND

Year 1

In Liberia, IRS campaigns were funded through PMI for three years prior to the start of the AIRS project. In 2012, Year 1 of the project, the Liberia IRS program implemented spray campaigns in 14 districts across five counties (Grand Bassa, Margibi, Montserrado, Bong, and Nimba) and provided support to a private sector spray campaign. The AIRS spray campaign used two classes of insecticides, pyrethroids and carbamates. In 12 districts, a long-lasting pyrethroid was applied; in the two remaining districts, a shorter-lasting carbamate was applied. Due to the short period of effectiveness of the carbamate, there were two spray cycles in those two districts. The first cycle, which was conducted in all of the 14 districts, was done in March and part of April, while the second spray cycle in two districts was done in October. The first spray campaign took 83 operational days and the second spray campaign lasted 31 operational days. AIRS provided technical and operational support to Arcelor Mittal Liberia, an iron ore mining company located in Yekepa, Nimba County, with a base in Buchanan, Grand Bassa County. The program incurred additional expenses of about \$50,000 in support of the private sector spray campaign through supervision and other technical assistance.

Year 2

Due to insecticide resistance to pyrethroids and carbamates, Liberia switched to an organophosphate insecticide (Actellic CS) in 2013, Year 2 of the project. The target area and number of targeted structures was reduced due to the increase in insecticide cost so the spray campaign was only conducted in Bong County, central Liberia. In consultation with local stakeholders, such as the NMCP, four old IRS districts were chosen for spraying, along with one new district, Jorquelleh. However, due to a shortfall in the number of targeted structures in Jorquelleh district, spray operations were extended to parts of two more new districts, Zota and Sanoyea, to ensure the IRS campaign covered more than the target number of 40,000 structures. Spraying was conducted for 33 days in March and April.

TABLE LRI: LIBERIA QUICK FACTS*

	Year 1	Year 2
# Local Staff	15	18
Spray Start Date(s)	March 23, 2012 October 3, 2012	March 19, 2013
# Spray Rounds	2	1
# Sachets Used	81,691	34,474
# People Protected	869,707	367,930
# Structures Sprayed	96,901	42,708
# 100 Square Meters Sprayed	204,228	86,185
Average Size of Structure	210.8 m ² *	201.8 m ²

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

9.2 PROGRAM EXPENDITURES

This section will present an overview of Liberia IRS program expenditures in Year 2. Costs are organized by activity and cost category.

TABLE LR2: LIBERIA 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		338,706	389,603			182,417	\$ 910,726	28.1%
Entomology			101,230		71,962	1,092	\$ 174,284	5.4%
Environmental Compliance			26,270		50,538	12,348	\$ 89,157	2.7%
Equipment Supplies			73,114	93,803	363,685	229	\$ 530,831	16.4%
IEC			24,498		33,930	7,978	\$ 66,405	2.0%
Insecticide	966,704						\$ 966,704	29.8%
M&E			58,594		21,671	43,394	\$ 123,659	3.8%
Post Spray			62,267		57,184		\$ 119,451	3.7%
Spray Campaign			50,019		177,943	5,819	\$ 233,781	7.2%
Spray Planning			22,278			6,432	\$ 28,709	0.9%
Grand Total	\$ 966,704	\$ 338,706	\$ 807,872	\$ 93,803	\$ 776,914	\$ 259,709	\$ 3,243,708	100.0%

Table LR2 displays the Liberia IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE LR1: LIBERIA IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

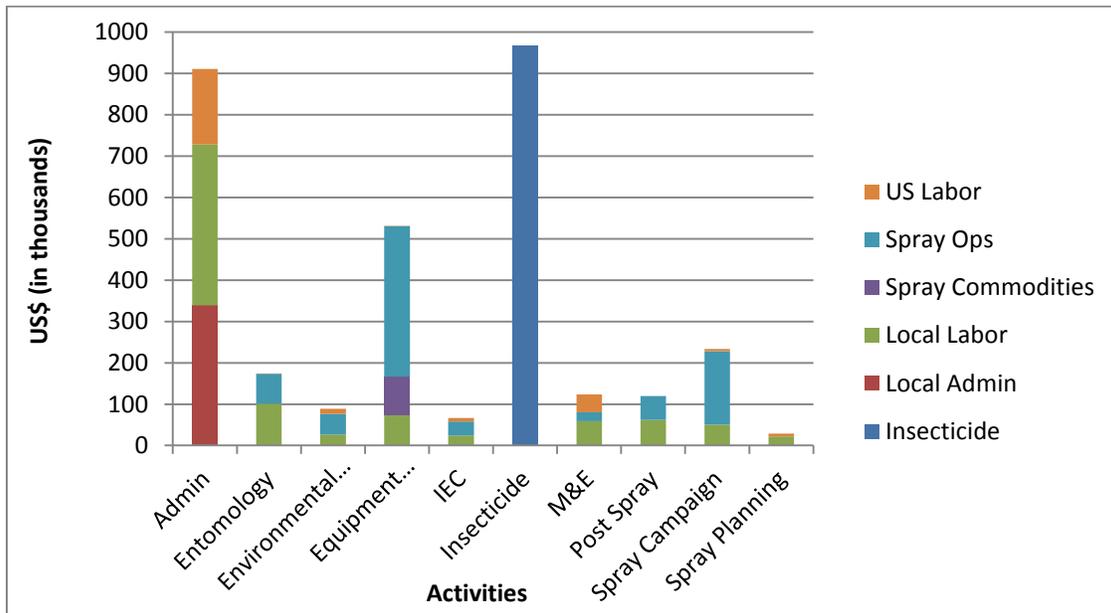


Figure LR1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticide is the most expensive IRS activity (29.8 percent of expenditures), followed closely by the administrative activity (28.1 percent). About 63 percent of the total cost for administration consists of labor, both local (about 43 percent) and U.S.-based (20 percent). Note that the 'U.S.-based Labor and STTA' expenditures are largely incurred under the administrative and M&E program activities.

FIGURE LR2: LIBERIA IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

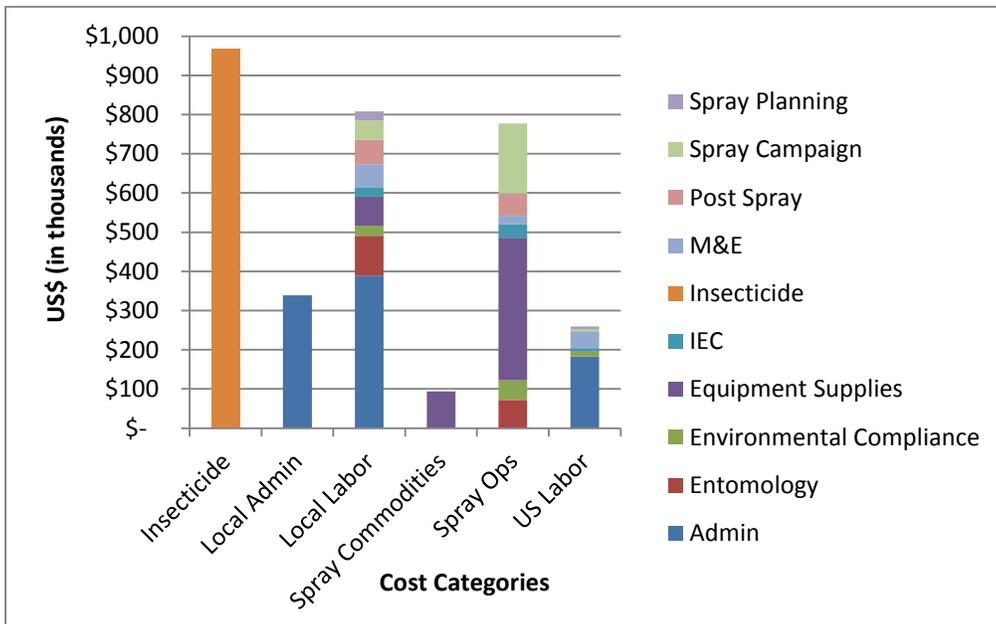


Figure LR2 contains the same information as Figure LR1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures related to insecticide, local labor, and technical spray operations.

9.3 UNIT COST ANALYSIS

This section presents Liberia IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE LR3: LIBERIA IRS UNIT COSTS, BY ACTIVITY

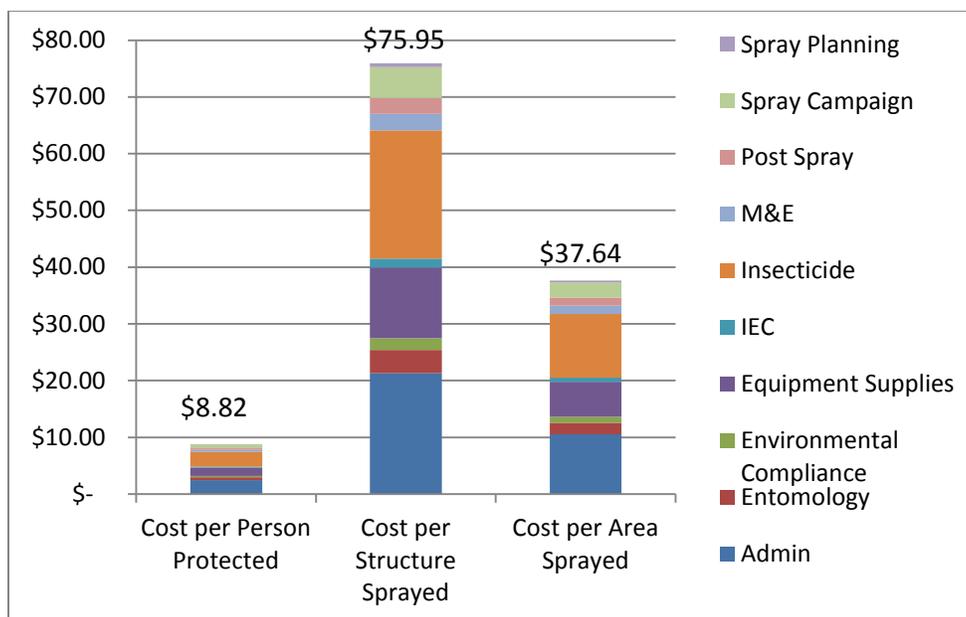
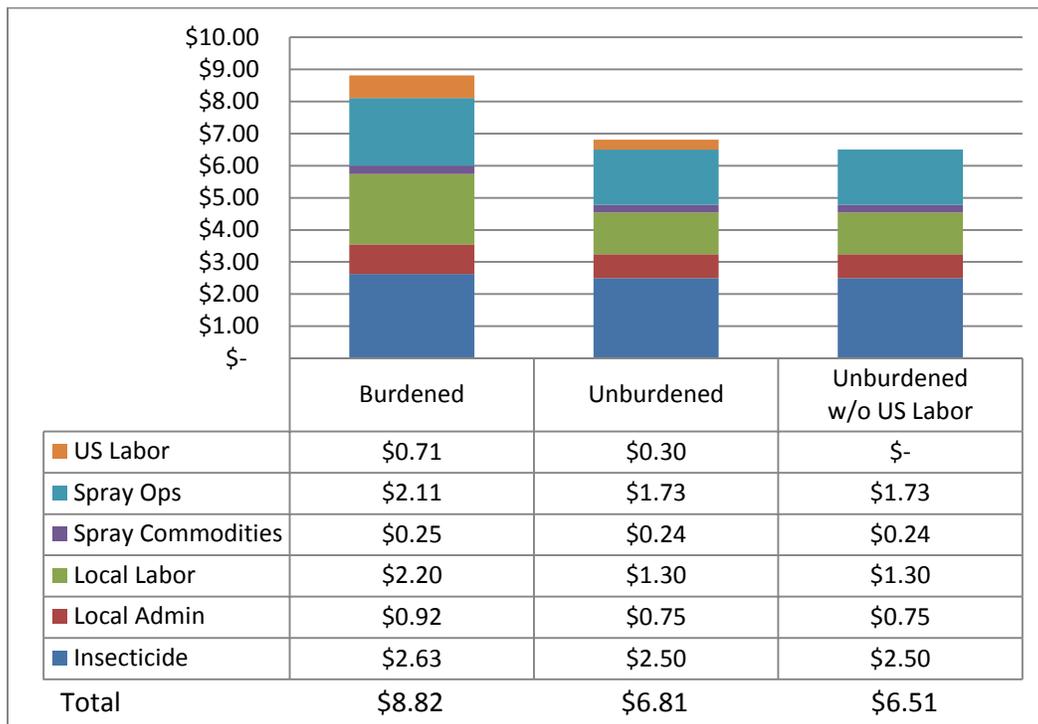


Figure LR3 illustrates the Liberia program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, and IEC, make up 10.2 percent of the unit cost. The program also constructed a mobile insectary with expenditures incurred under entomology. Insecticide is the largest cost driver at 29.8 percent, followed closely by administration at 28.1 percent. Administration makes up 17.2 percent of the total unit costs; keep in mind that Figure LR1 showed that about 63.0 percent of the costs under administration consisted of U.S.-based and local labor.

As noted in Table LR1, the average size of structures in the area sprayed is 201.8 m², which is larger than in most countries. Thus, the unit cost per structure sprayed is almost double the cost per area sprayed (in terms of 100 m²), and can be misleading if compared to countries with smaller structures.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

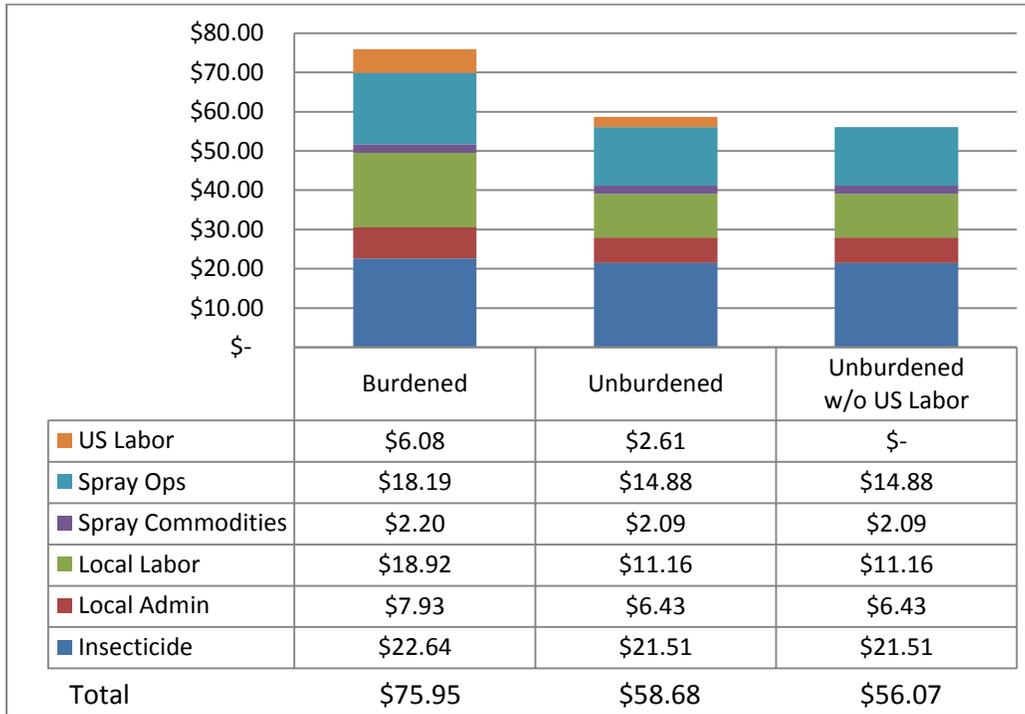
FIGURE LR4: LIBERIA IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Liberia Year 2 IRS spray campaign protected 367,930 people from malaria transmission. Figure LR4 shows the unit costs per person protected burdened (\$8.82), unburdened (\$6.81), and unburdened without U.S.-based labor (\$6.51), itemized by cost category. The categories driving the unit cost include insecticide and local labor, which together constitute 54.7 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 10.4 percent and 8.0 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Liberia program costs, as delivered through an international implementing partner, adds \$2.31 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 26.2 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by local and U.S.-based staff labor, which together account for about 69.6 percent of the total “cost of burden.”

FIGURE LR5: LIBERIA IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Liberia IRS program sprayed 42,708 structures during the Year 2 spray campaign. Figure LR5 shows the unit costs per structure sprayed burdened (\$75.95), unburdened (\$58.68), and unburdened without U.S. labor (\$56.07), itemized by cost category. The burdened portion of AIRS Liberia program costs, as delivered through an international implementing partner, adds \$19.88 to the unit cost per structure sprayed.

9.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Liberia IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE LR3: LIBERIA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	Year 1	Year 2	Percent Change
People Protected	869,707	367,930	-57.7%
Structures Sprayed	96,901	42,708	-55.9%
Area Sprayed (100 m ²)	204,228	86,185	-57.8%

Table LR3, above, compares the year-on-year change in Liberia IRS program output measures. Overall, the size of the program was cut to less than half the size of Year 1, with the number of people protected decreasing by almost 58 percent, and the number of structures sprayed decreasing by 56 percent. As shown in Table LR1 in the Background, the average size of the structures sprayed in Year 2 was 201.8 m² compared to 210.8 m² in the previous year, which is very similar and why the measure of area sprayed dropped a similar amount to the number of structures sprayed increased slightly.

TABLE LR4: LIBERIA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Categories	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 886,607	\$ 966,704	9.0%
Local Admin	\$ 473,360	\$ 338,706	-28.4%
Local Labor	\$ 919,910	\$ 807,872	-12.2%
Spray Operations	\$ 1,030,520	\$ 776,914	-24.6%
Commodities	\$ 144,588	\$ 93,803	-35.1%
U.S. Labor	\$ 332,477	\$ 259,709	-21.9%
TOTAL	\$ 3,787,463	\$ 3,243,708	-14.4%

Table LR4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost decreased by 14.4 percent, but a more variable and nuanced breakdown of change in expenditures is provided by cost category. For example, insecticide expenditures increased by 9.0 percent, while local administration expenditures decreased by almost 28.4 percent. The main reason the cost of insecticide increased even though the size of the program was halved is that the IRS program used organophosphates, the most expensive class of insecticides, in Year 2, while in Year 1, carbamates and pyrethroids were used. The cost savings in local labor, spray commodities, and commodities were due to the size of the program decreasing.

TABLE LR5: LIBERIA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 4.35	\$ 8.82	102.4%
Per Structure Sprayed	\$ 39.09	\$ 75.95	94.3%
Per Area Sprayed (100 m ²)	\$ 18.55	\$ 37.64	102.9%

Table LR5 compares the year-on-year change in program unit costs. Because the program size was cut by more than half, but the total expenditures only decreased by about 14 percent, the unit costs basically doubled. As noted previously, this is in part due to the change in insecticide from pyrethroids and carbamates to the more expensive organophosphates. To decrease Year 2 unit costs to a level similar to Year 1, expenditures for local labor and spray operations, two of the main cost drivers, would

have had to be cut even further than they were. Liberia program unit costs increased when the number of structures decreased because of the high fixed costs of implementing a spray campaign. A few other activities were implemented in Year 2 which were not implemented in Year 1. Those activities include enumeration of the number of structures in the new spray area and the creation of a mobile insectary.

10. MADAGASCAR

10.1 BACKGROUND

Year 1

PMI has supported IRS in Madagascar since 2008. In June 2012, the AIRS Madagascar program became the lead implementer for PMI's IRS work in Madagascar. Overall, 371,391 structures (87,087 in the Central Highlands; 284,310 in southern Madagascar) were sprayed by AIRS Madagascar during the Year 1 (2012–2013) IRS campaign, with 1,781,990 persons protected (522,292 persons in the Central Highlands, and 1,259,698 persons in southern Madagascar).

Per the Madagascar National Malaria Strategic Plan, IRS programming transitioned to focalized spraying in the Central Highlands and in four communes around Fort Dauphin (southern Madagascar). Focalized spraying consists of completing IRS in select communes (sub-districts) where malaria incident rates remain high (according to Malagasy health data). Other communes in Central Highland IRS districts, and the remaining communes in Fort Dauphin district with lower malaria incident rates were not sprayed. IRS in the other seven districts in southern Madagascar continued to follow generalized spraying, with the IRS campaign covering as many eligible structures as possible throughout the entire district.

AIRS Madagascar procured primarily carbamate insecticides for the 2012–2013 IRS campaign; however, pyrethroid insecticides were procured and used in communes located in Ambositra and Ambohimahasoia districts in the Central Highlands, an area that is not targeted for LLIN distribution.

Year 2

In Year 2 (2013–2014), AIRS Madagascar continued focalized spraying in 40 communes in the Central Highlands; however, there were several new communes, due to shifts in malaria incident rates, and decisions by the NMCP on which communes should be sprayed. AIRS Madagascar also continued with generalized spraying in six districts in southern Madagascar. AIRS Madagascar intended to spray an additional district in southern Madagascar, Amboasary district, but insecurity in the district limited AIRS Madagascar to spraying one *fokontany* (sub-commune) in the district. Overall, 343,470 structures were sprayed during Year 2 (82,091 structures in the Central Highlands; 261,379 structures in southern Madagascar), with 1,588,138 persons protected (481,301 persons in the Central Highlands; 1,106,837 persons in southern Madagascar).

AIRS Madagascar also recognized several IRS campaign operations inefficiencies from the Year 1 IRS campaign in both spray areas, and after making adjustments, was able to decrease the length of the IRS campaign in both spray areas by a total of 16 days. The adjustments that AIRS Madagascar made included: decreasing the number of soak pits and store rooms used; decreasing the number of seasonal staff hired while

increasing the number of days they worked during the IRS campaign; and increasing the number of full-time staff to provide more supervision and organization during the IRS campaign. Additionally, due to local labor law, AIRS Madagascar was required to hire several part-time entomology staff members as full-time employees.

AIRS Madagascar procured carbamate, pyrethroid, and organophosphate class insecticides for Year 2. Carbamates were used in all spray areas in the Central Highlands, except for communes in Ambositra and Ambohimahasoia districts, which continued to be sprayed with pyrethroids. In southern Madagascar, all districts were sprayed with organophosphates.

TABLE MGI: MADAGASCAR QUICK FACTS

	Year 1	Year 2
# Local Staff	15	34
Spray Start Date <i>Central Highlands</i>	November 26, 2012 – December 31, 2013	November 18, 2013 – December 24, 2013
<i>Southern Madagascar</i>	February 4, 2013 – April 29, 2013	January 20, 2014 – March 15, 2014
# Spray Rounds	1	1
# Sachets Used	88,567	79,594
# People Protected	1,781,990	1,588,138
# Structures Sprayed	371,391	343,470
# 100 Square Meters Sprayed	221,418	196,615
Average Size of Structure	59.6 m ²	57.2 m ²

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

Due to the dates of the spray campaigns, Madagascar was not included in the first AIRS project costing report. As such, the following sections will first detail the Madagascar IRS program's full costs from Year 1 before moving into Year 2 and comparing the two program years.

10.2 YEAR 1 PROGRAM EXPENDITURES

This section will present an overview of Madagascar IRS program expenditures in Year 1. Costs are organized by activity and cost category.

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		441,719	263,914			180,413	\$ 886,047	17.8%
Entomology					182,039	5,778	\$ 187,817	3.8%
Environmental			26,776		46,923	32,636	\$ 106,336	2.1%

Compliance								
Equipment Supplies				402,710	186	33	\$ 402,929	8.1%
IEC					341,693	14,962	\$ 356,655	7.2%
Insecticide	1,561,330			57			\$ 1,561,387	31.3%
M&E			17,756		18,117	168,275	\$ 204,148	4.1%
Post Spray					2,682		\$ 2,682	0.1%
Spray Campaign			4,102		1,104,454	7,624	\$ 1,116,180	22.4%
Spray Planning			990		154,510	5,953	\$ 161,453	3.2%
Grand Total	\$1,561,330	\$ 441,719	\$ 313,538	\$ 402,767	\$1,850,604	\$ 415,673	\$ 4,985,632	100.0%

Table MG2 displays the Madagascar IRS program total capital and recurrent expenditures from Year 1. This excludes start-up expenditures, which were reported in the previous AIRS project costing report. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE MG1: MADAGASCAR IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

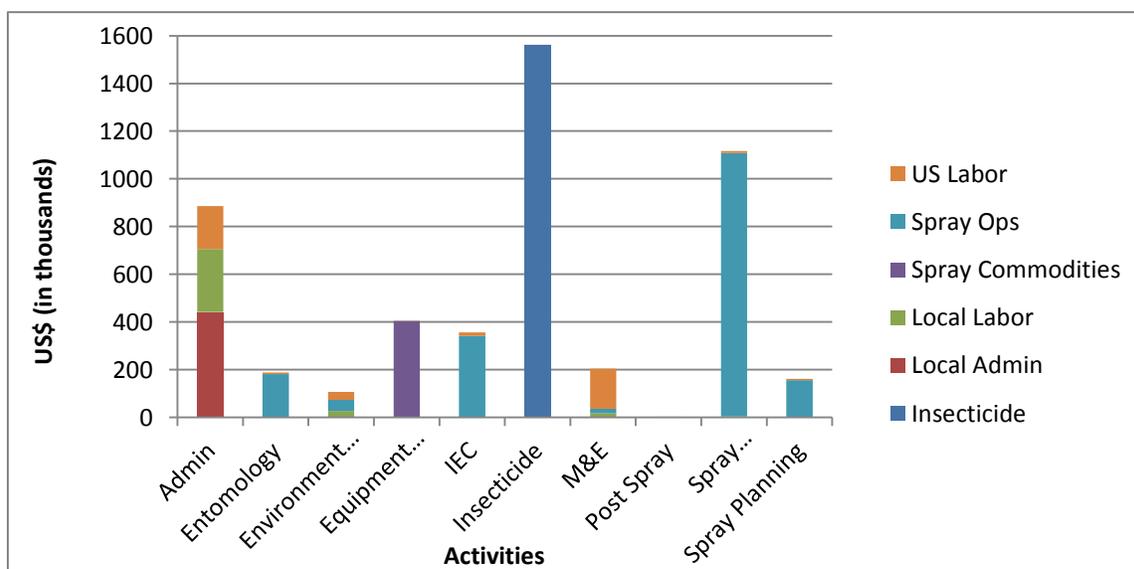


Figure MG1 shows the total burdened capital and recurrent costs, but provides a more detailed depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticide procurement is the most expensive IRS activity (31.3 percent of expenditures), followed by the spray campaign and administrative activities. About 50 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.

FIGURE MG2: MADAGASCAR IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

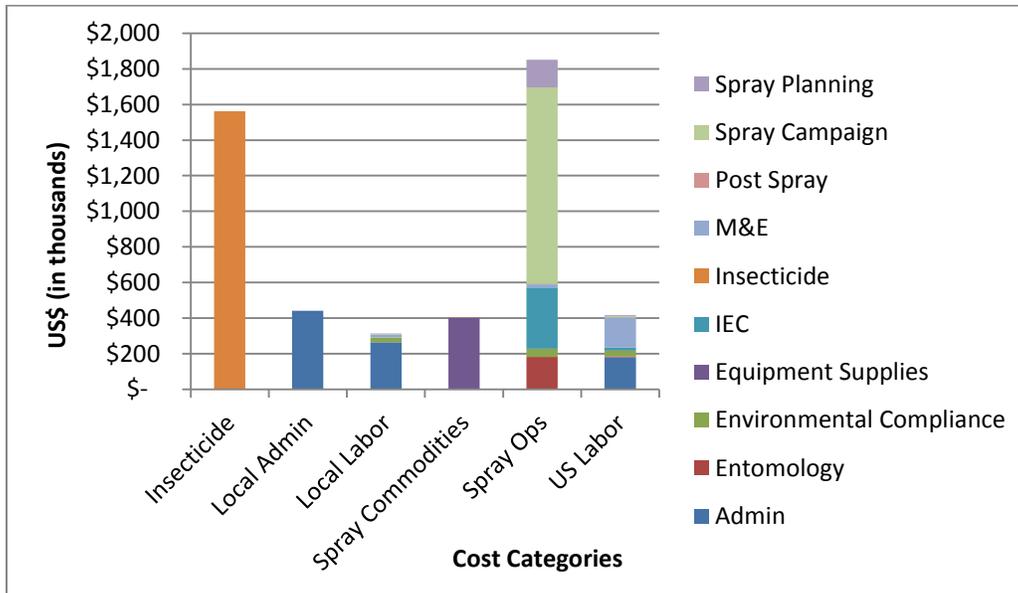


Figure MG2 contains the same information as Figure MG1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, local labor, and U.S.-based labor are minimal compared to expenditures related to local labor and technical spray operations.

10.3 YEAR 1: UNIT COST ANALYSIS

This section presents Madagascar IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE MG3: MADAGASCAR IRS UNIT COSTS, BY ACTIVITY

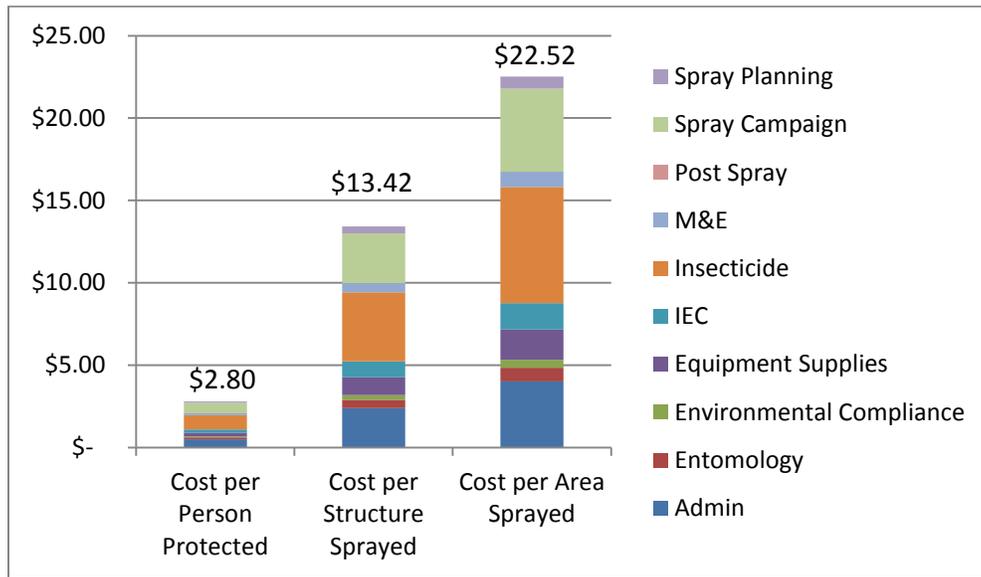
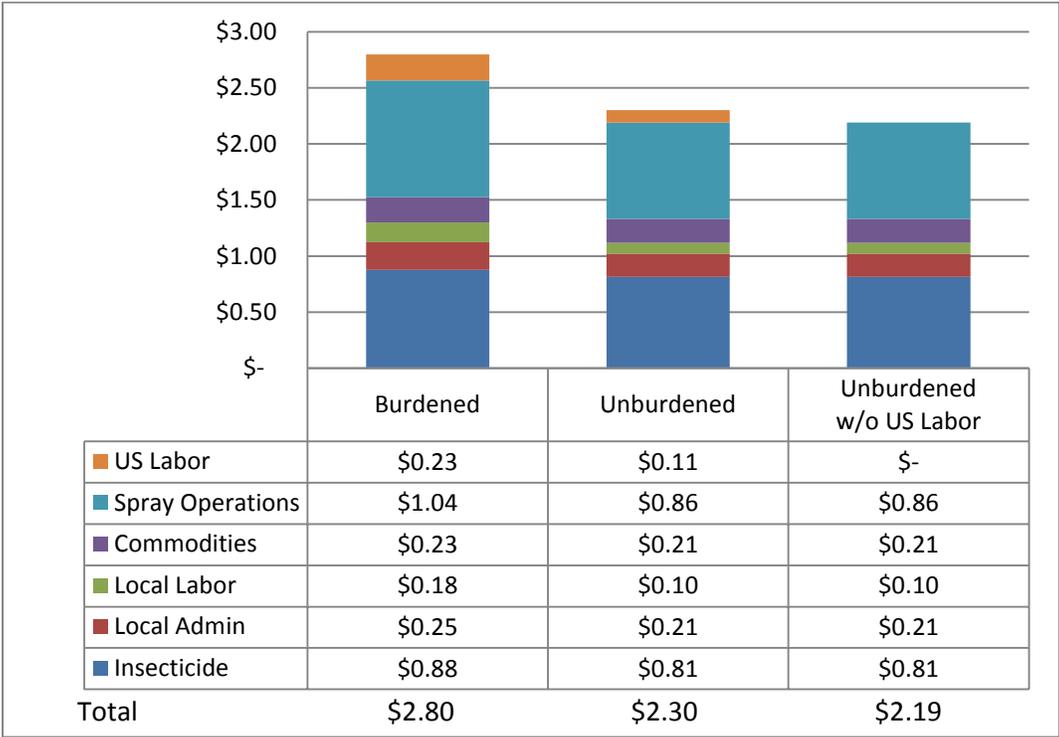


Figure MG3 illustrates the Madagascar program’s fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, and M&E, make up 10 percent of the unit cost. Insecticide is the largest cost driver at 31.3 percent, followed by the spray campaign at 22.4 percent. Administration makes up 17.8 percent of the total unit costs; keep in mind that Figure MG1 showed that about 50 percent of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner’s overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

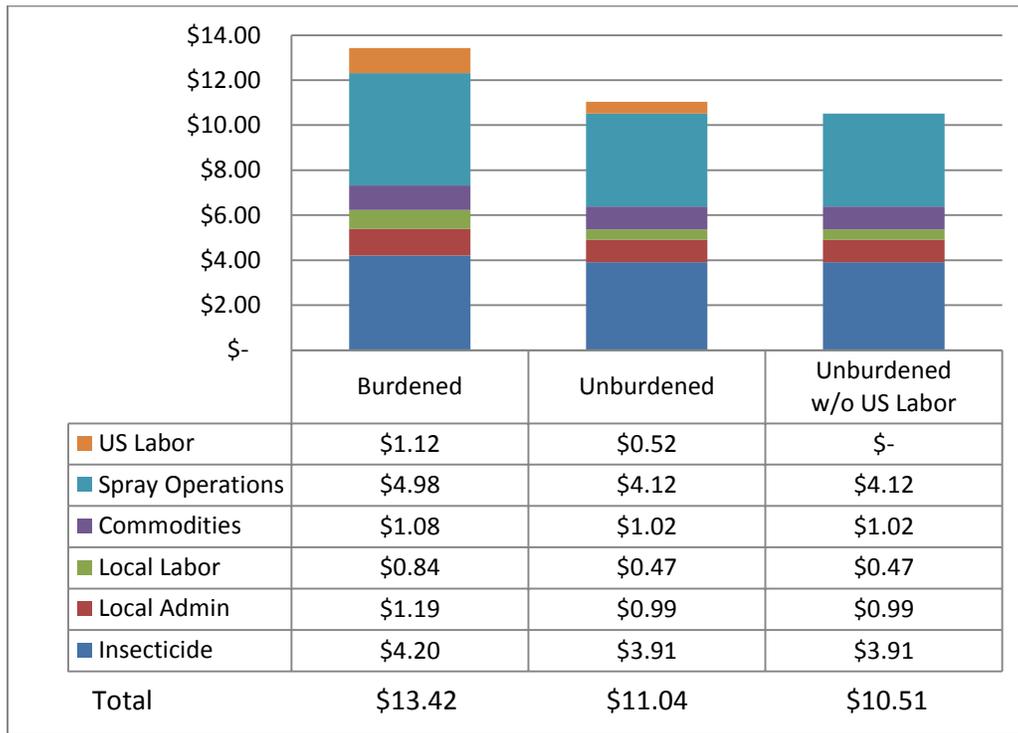
FIGURE MG4: MADAGASCAR IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Madagascar Year 1 IRS spray campaign protected 1,781,990 people from malaria transmission. Figure MG4 shows the unit costs per person protected burdened (\$2.80), unburdened (\$2.30), and unburdened without U.S.-based labor (\$2.19), itemized by cost category. The categories driving the unit cost include spray operations and insecticide, which together constitute 68.4 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 8.9 percent and 8.3 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Madagascar program costs, as delivered through an international implementing partner, adds \$0.61 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 21.7 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by spray operations and U.S.-based staff labor, which together account for about 68.1 percent of the total “cost of burden.”

FIGURE MG5: MADAGASCAR IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Madagascar IRS program sprayed 371,391 structures during the Year 1 spray campaign. Figure MG5 shows the unit costs per structure sprayed burdened (\$13.42), unburdened (\$11.04), and unburdened without U.S. labor (\$10.51), itemized by cost category. The burdened portion of AIRS Madagascar program costs, as delivered through an international implementing partner, adds \$2.91 to the unit cost per structure sprayed.

10.4 YEAR 2: PROGRAM EXPENDITURES

This section will present an overview of Madagascar IRS program expenditures in Year 2. Costs are organized by activity and cost category.

TABLE MG3: 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		943,365	493,446			295,879	\$ 1,732,690	21.8%
Entomology			79,203		220,093	9,728	\$ 309,023	3.9%
Environmental Compliance			24,279		114,533	90,864	\$ 229,676	2.9%
Equipment Supplies				449,363	408		\$ 449,771	5.7%
IEC					71,198		\$ 71,198	0.9%

Insecticide	1,860,387						\$ 1,860,387	23.4%
M&E			19,027		33,907	98,938	\$ 151,872	1.9%
Post Spray			28,693		23,458	5,663	\$ 57,813	0.7%
Spray Campaign			64,889		2,797,360	12,631	\$ 2,874,880	36.2%
Spray Planning			36,651		139,153	30,999	\$ 206,803	2.6%
Grand Total	\$1,860,387	\$ 943,365	\$ 746,187	\$ 449,363	\$ 3,400,108	\$ 544,702	\$ 7,944,113	100.0%

Table MG3 displays the Madagascar IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE MG6: MADAGASCAR IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

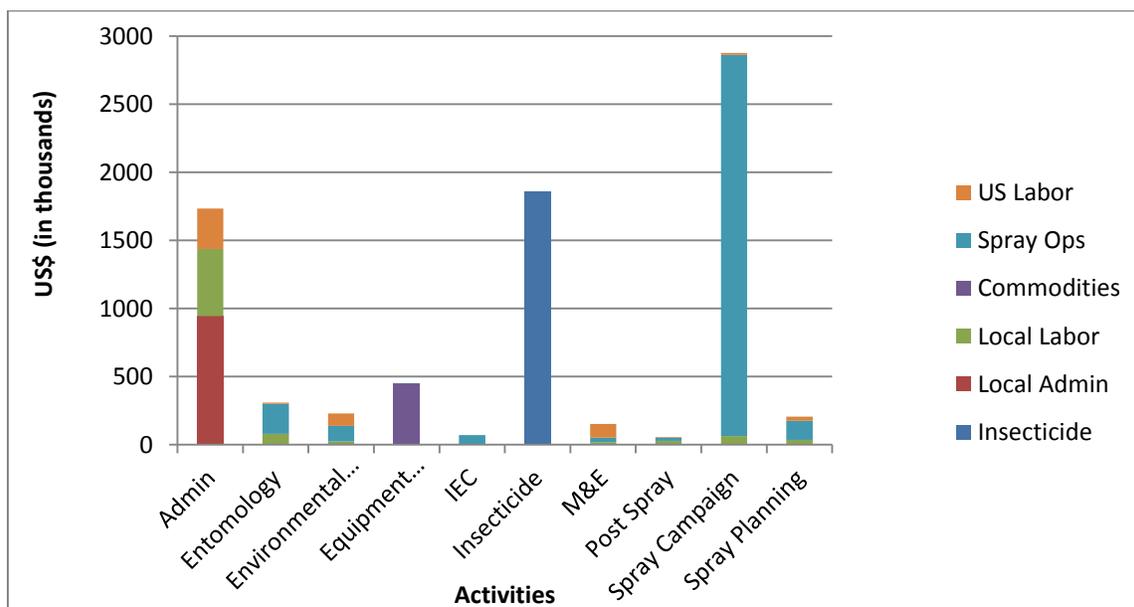


Figure MG6 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The spray campaign is the most expensive IRS activity (36.2 percent of expenditures), followed by the insecticide and administrative activities (23.4 percent and 21.8 percent, respectively). About 45.6 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.

FIGURE MG7: MADAGASCAR IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

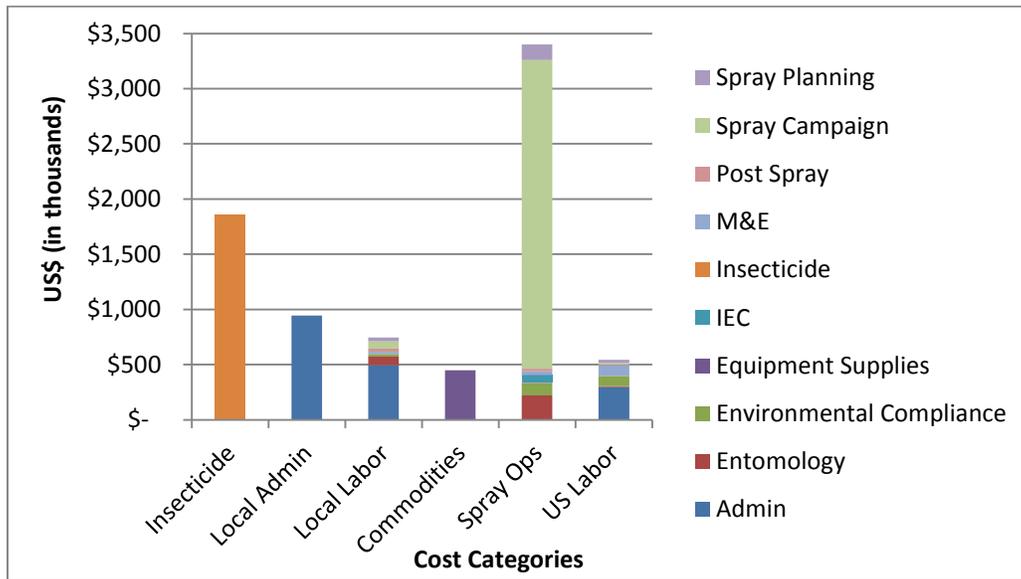


Figure MG7 contains the same information as Figure MG6, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the spray commodities and U.S.-based labor costs are minimal compared to expenditures related to spray operations and insecticide.

10.5 YEAR 2: UNIT COST ANALYSIS

This section presents Madagascar IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE MG8: MADAGASCAR IRS UNIT COSTS, BY ACTIVITY

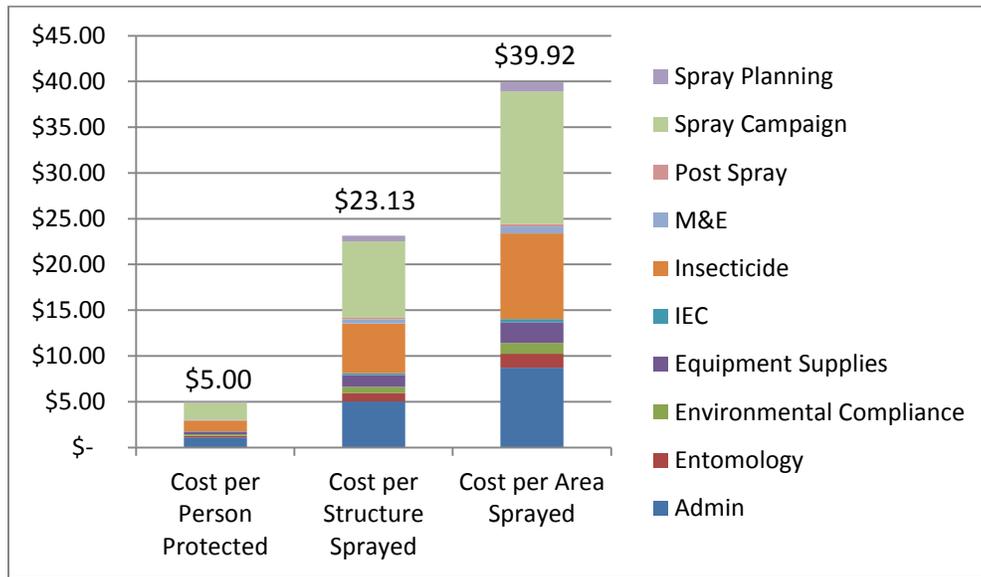
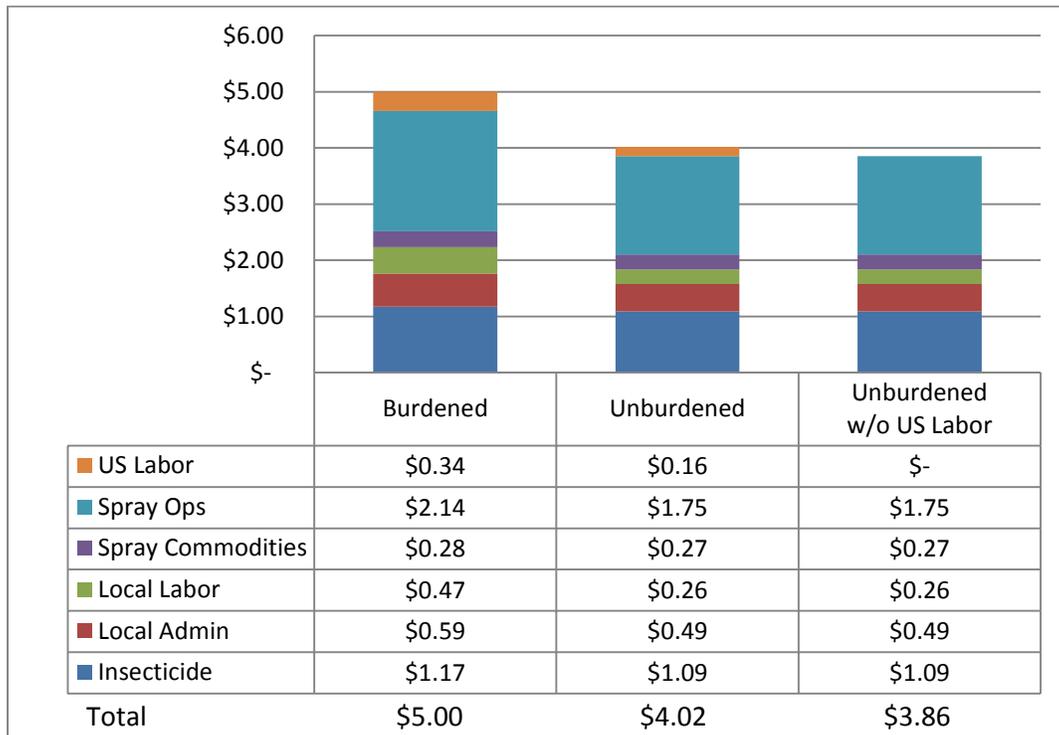


Figure MG8 illustrates the Madagascar program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, and M&E, make up 8.7 percent of the unit cost. Spray operations is the largest cost driver at 36.2 percent, followed by the insecticide at 23.4 percent. Administration makes up 21.8 percent of the total unit costs; keep in mind that Figure MG6 showed that about 45.6 percent of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

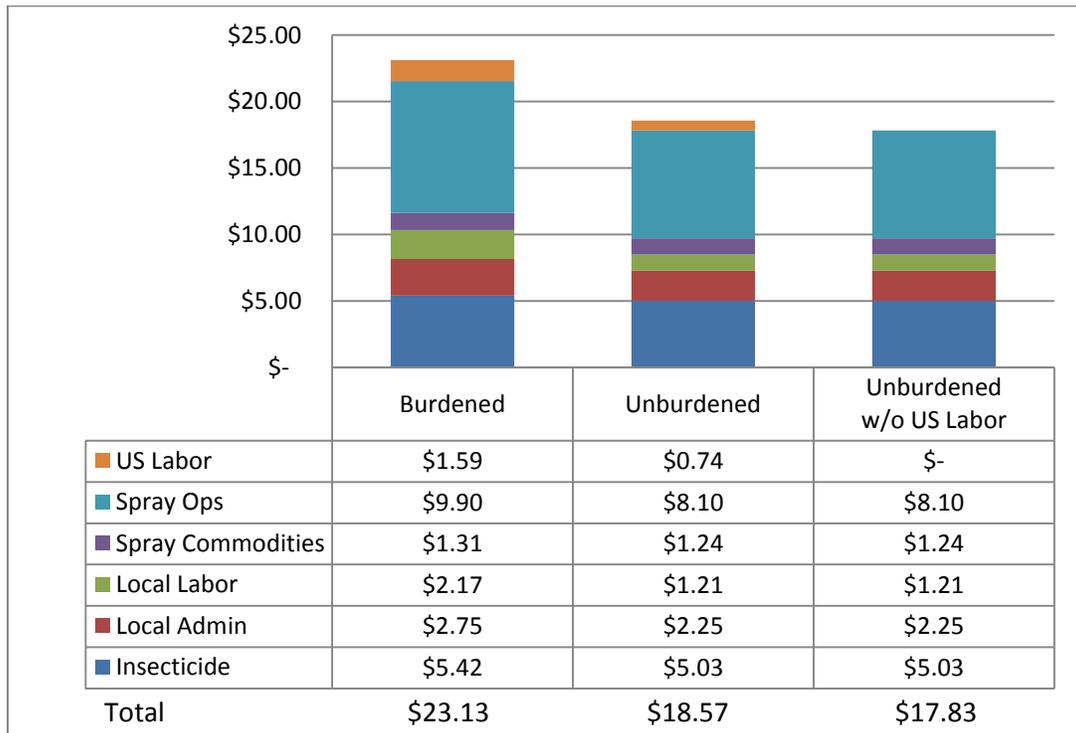
FIGURE MG9: MADAGASCAR IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Madagascar Year 2 IRS spray campaign protected 1,588,138 people from malaria transmission. Figure MG9 shows the unit costs per person protected burdened (\$5.00), unburdened (\$4.02), and unburdened without U.S.-based labor (\$3.86), itemized by cost category. The categories driving the unit cost include spray operations and insecticide, which together constitute 66.2 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 11.9 percent and 6.9 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Madagascar program costs, as delivered through an international implementing partner, adds \$1.14 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 22.9 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by spray operations and U.S.-based staff labor, which together account for about 63.8 percent of the total “cost of burden.”

FIGURE MG10: MADAGASCAR IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Madagascar IRS program sprayed 343,470 structures during the Year 2 spray campaign. Figure MG10 shows the unit costs per structure sprayed burdened (\$23.13), unburdened (\$18.57), and unburdened without U.S. labor (\$17.83), itemized by cost category. The burdened portion of AIRS Madagascar program costs, as delivered through an international implementing partner, adds \$5.30 to the unit cost per structure sprayed.

10.6 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Madagascar IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. Because Year 1 of the Madagascar program was implemented from June 2012 through the end of April 2013, only half of the Year 1 expenditures were adjusted to real 2013 U.S. dollars, in order to allow for a more accurate comparison.

TABLE MG4: MADAGASCAR IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	Year 1	Year 2	Percent Change
People Protected	1,781,990	1,588,138	-10.9%
Structures Sprayed	371,391	343,470	-7.5%
Area Sprayed (100 m ²)	221,418	198,985	-10.1%

Table MG4, above, compares the year-on-year change in Madagascar IRS program output measures. Overall, the size of the program shrank slightly, with the number of people protected decreasing by 10.9 percent, and the number of structures sprayed decreasing by 7.5 percent. As shown in Table MG1 in the Background, the average size of the structures sprayed in Year 2 was 57.2 m² compared to 59.6 m² in the previous year, and the slight decrease in average size of a structure is why the measure of area sprayed decreased by more than the number of structures sprayed.

TABLE MG5: MADAGASCAR IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 1,616,636	\$ 1,860,387	15.1%
Local Admin	\$ 457,366	\$ 943,365	106.3%
Local Labor	\$ 324,645	\$ 746,187	129.8%
Spray Ops	\$ 1,916,157	\$ 3,400,108	77.4%
Commodities	\$ 417,034	\$ 449,363	7.8%
U.S. Labor	\$ 430,397	\$ 544,702	26.6%
TOTAL	\$ 5,162,236	\$ 7,944,113	53.9%

Table MG5, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost increased by 53.9 percent, but a more variable and nuanced breakdown of change in expenditures is provided by cost category. For example, local labor expenditures increased by 129.8 percent, while commodities and insecticide changed less, increasing by 7.8 and 15.1 percent, respectively. The number of local staff employed by the project increased from 19 to 38 because some staff were converted from seasonal employees to full time project staff to increase their accountability to the project. AIRS Madagascar had substantial quantities of carbamates class of insecticide in stock from Year 1, and did not need to procure additional carbamates for Year 2. However, AIRS Madagascar did procure over 60,000 bottles of organophosphate, the most expensive class of insecticide. As mentioned in the Background section, significant programmatic changes were made in Year 2, including the hiring of more local staff, causing a large increase in local labor cost, as well as an increase in local administrative costs, for office rent and supplies.

However, the large cost driver is spray operations, which increased by 77.4 percent, and accounts for the majority of the additional expenditures. While expenditures incurred on consultants decreased from about \$98,000 in Year 1 to \$18,000 in Year 2, other spray operations expenditures increased significantly and a large part of this increase is because the spray campaign lasted longer than expected. Ground transportation costs increased from roughly \$272,000 to \$921,000. Due to the presidential election in late 2013, AIRS Madagascar found fewer rental vehicles available for the IRS campaign, and thus vehicle vendors charged substantially more. The project also repaired motorbikes which cost \$64,000. Other new costs for the Year 2 IRS campaign included rent for a second warehouse in southern Madagascar (to store

all 60,000 organophosphate bottles), more supervision and IRS campaign monitoring trips (by AIRS Madagascar full-time and seasonal staff), and more frequent and detailed IRS campaign planning trips (to improve efficiency and lessen issues from the Year 1 IRS campaign).

TABLE MG6: MADAGASCAR IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 2.90	\$ 5.00	72.7%
Per Structure Sprayed	\$ 13.90	\$ 23.13	66.4%
Per Area Sprayed (100 m ²)	\$ 23.31	\$ 39.92	71.2%

Table MG5 compares the year-on-year change in program unit costs. The program size decreased by roughly 10 percent, while the total expenditures increased by almost half in Year 2. Thus, the unit costs also increased by about 70 percent in Year 2. As noted previously, this is primarily due to the increase in spray operations costs incurred because of programmatic changes in Year 2. Insecticide costs also increased slightly. As insecticide and spray operations are the two largest cost drivers, increases in both of these total costs with a decrease in program size is responsible for the rise in the unit costs.

II. MALI

II.1 BACKGROUND

Year 1

In Mali, IRS campaigns have been funded through PMI for five years, and remain one of the key malaria control interventions. In 2012, the Year 1 Mali IRS spray campaign was implemented using 68 operational sites in three districts: Baroueli, Bla, and Koulikoro. The spray campaign used a carbamate insecticide and took place over 45 days between July 23 and September 6, 2012.

Due to the political situation in Mali during 2012, field work was suspended for a two-month period. Therefore, total costs spent may not accurately reflect the total spending in a normal year, as the program spent about \$700,000 less than was budgeted for the year. In addition, Mali's IRS program was unable to collaborate with its previously established government partners for entomological monitoring. Faced with a one-month timeline, the AIRS project created an innovative, cost-effective solution: the "insectary-in-a-box."⁸

Year 2

In 2013, the Year 2 Mali IRS spray campaign was again implemented using 68 operations sites in three districts: Baroueli, Bla, and Koulikoro. The spray campaign used a carbamate insecticide and took place over 46 days between August 1 and September 19, 2013.

In 2013, the political situation calmed, and USAID lifted the suspension on field work. IRS implementation activities in 2013 were carried out with the full participation of technical partners from the NMCP and National Directorate for Sanitation and Pollution Control at all levels. The Year 2 IRS campaign helped protect 850,104 people. Using the project "insectary-in-a-box," entomological monitoring demonstrated a nascent resistance to carbamates in Bla and Baroueli.

TABLE MLI: MALI QUICK FACTS

	Year 1	Year 2
# Local Staff	14	18
Spray Start Date	July 23, 2012	August 1, 2013
# Spray Rounds	1	1
# Sachets Used	77,187	93,435

⁸ In English: <http://www.africairs.net/2012/12/mali-pilots-insectary-in-a-box/>,
or French: <http://www.africairs.net/2012/12/le-mali-dirige-un-insectarium-en-boite/>

# People Protected	762,146	850,104
# Structures Sprayed	206,295	228,985
# 100 Square Meters Sprayed	192,968	233,588
Average Size of Structure	93.5 m ²	102.0 m ²

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

11.2 PROGRAM EXPENDITURES

This section will present an overview of Mali IRS program expenditures in Year 2. Costs are organized by activity and cost category.

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		691,478	413,317			162,006	\$ 1,266,801	21.3%
Entomology			90,234		231,047	8,449	\$ 329,730	5.5%
Environmental Compliance			77,425		95,302	19,000	\$ 191,727	3.2%
Equipment Supplies			6,333	283,775		702	\$ 290,811	4.9%
IEC			2,713		311,200		\$ 313,913	5.3%
Insecticide	1,507,226						\$ 1,507,226	25.3%
M&E			68,953		70,369	38,292	\$ 177,614	3.0%
Post Spray			5,473		39,999		\$ 45,472	0.8%
Spray Campaign			39,124		1,446,638	3,265	\$ 1,489,027	25.0%
Spray Planning			42,497		284,837	12,178	\$ 339,512	5.7%
Grand Total	\$1,507,226	\$ 691,478	\$ 746,069	\$ 283,775	\$ 2,479,392	\$ 243,893	\$ 5,951,833	100.0%

Table ML2 displays the Mali IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE ML1: MALI IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

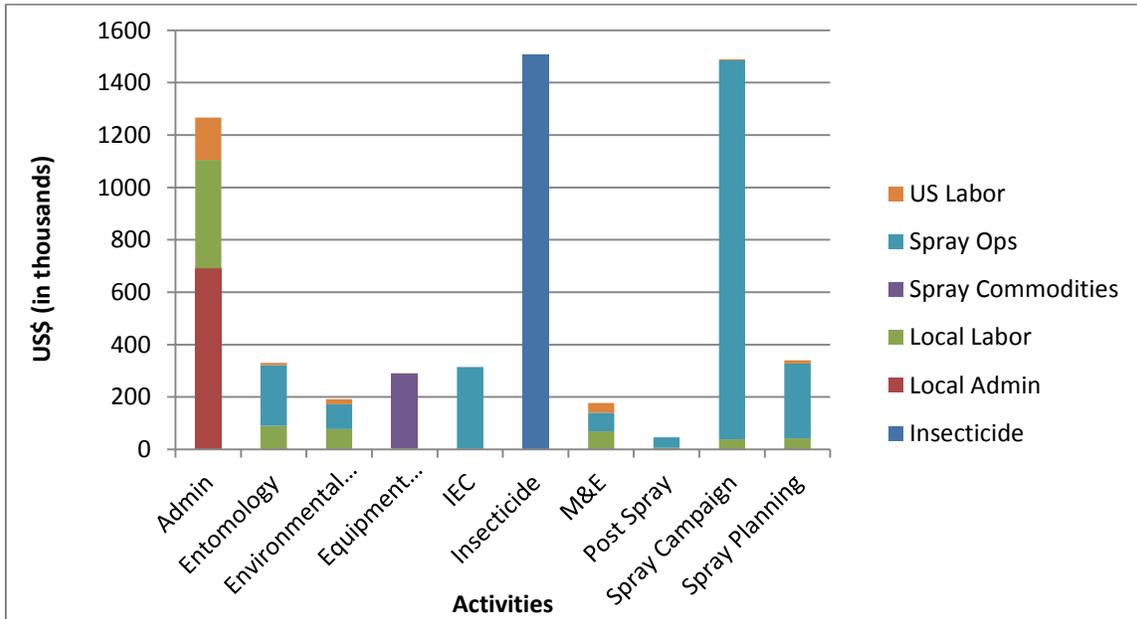


Figure ML1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticide is the most expensive IRS activity (25.3 percent of expenditures), followed closely by the spray campaign and administrative activities. About half (45 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.

FIGURE ML2: MALI IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

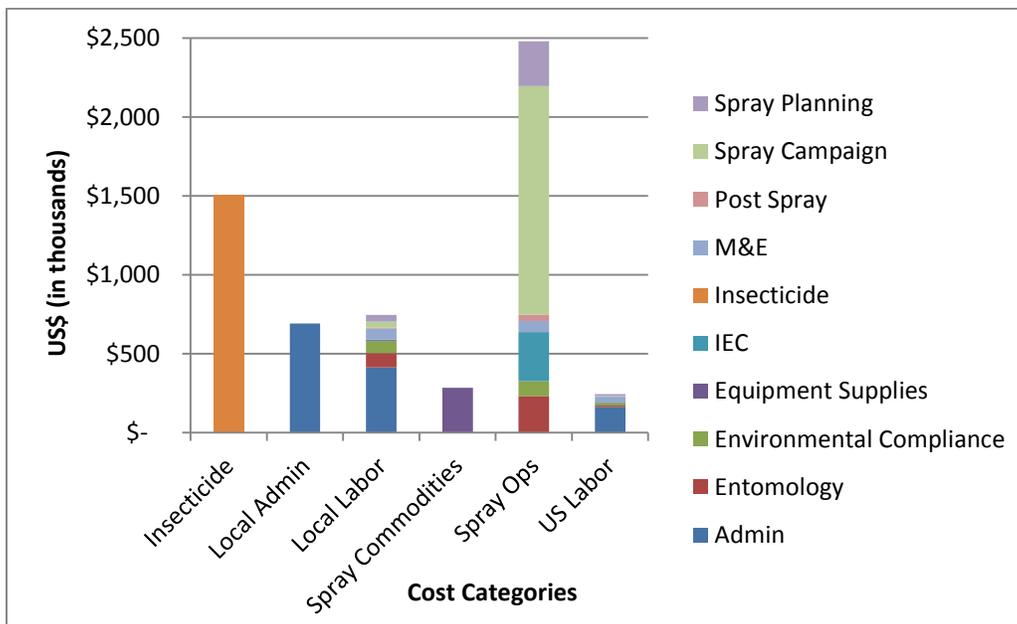


Figure ML2 contains the same information as Figure ML1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, and labor costs are minimal compared to expenditures related to insecticide and technical spray operations.

11.3 UNIT COST ANALYSIS

This section presents Mali IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE ML3: MALI IRS UNIT COSTS, BY ACTIVITY

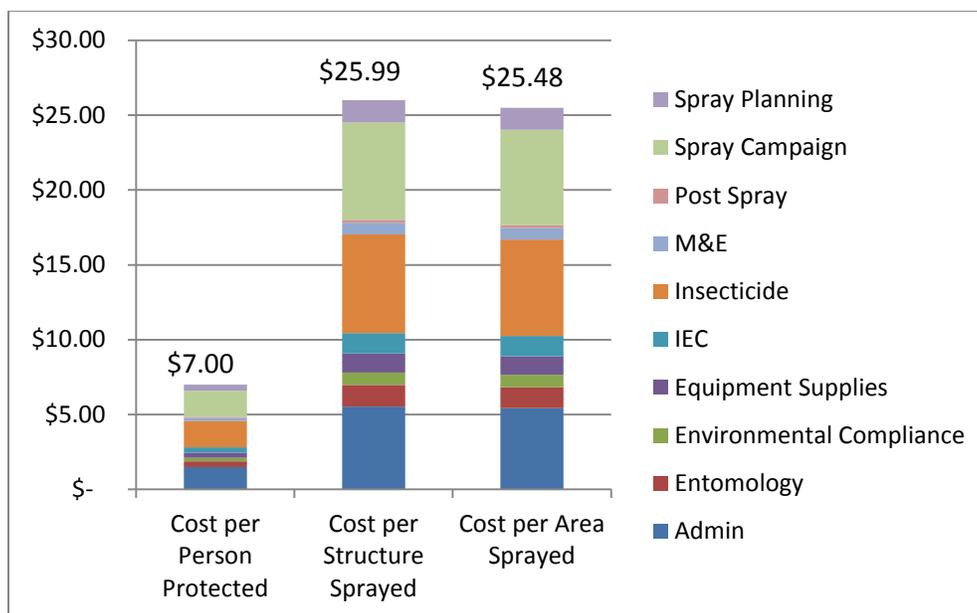


Figure ML3 illustrates the Mali program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, and M&E, make up 11.7 percent of the unit cost. Insecticide is the largest cost driver at 25.3 percent, followed closely by the spray campaign at 25.0 percent. Administration makes up 21.3 percent of the total unit costs; keep in mind that Figure ML1 showed that about half of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the

unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

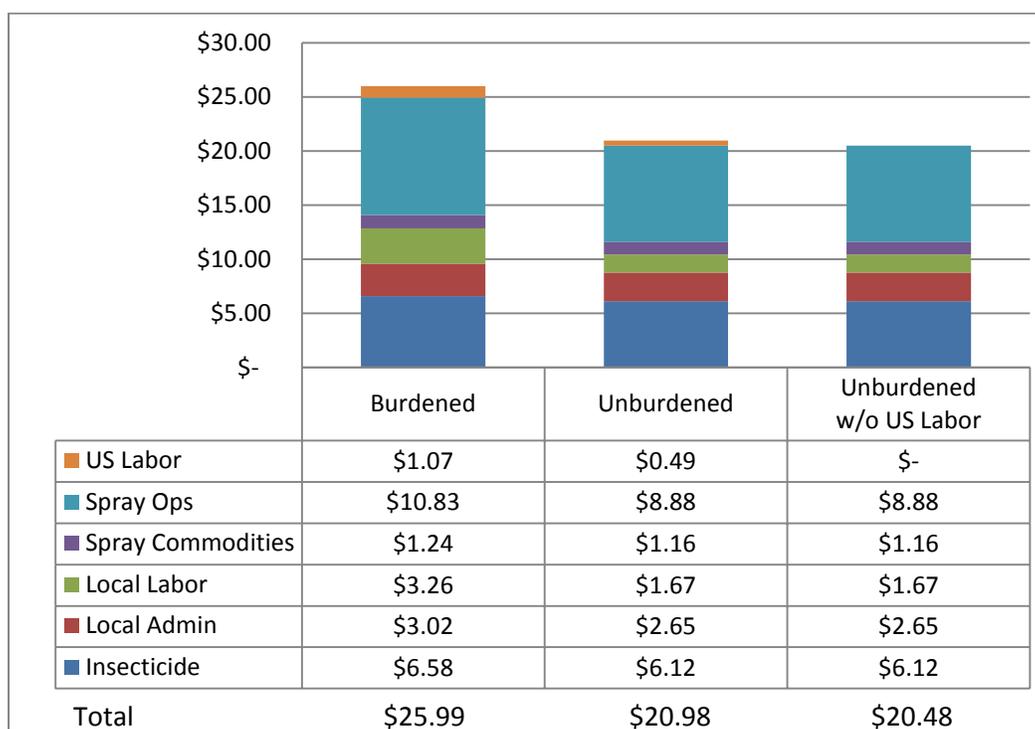
FIGURE ML4: MALI IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Mali Year 2 IRS spray campaign protected 850,104 people from malaria transmission. Figure ML4 shows the unit costs per person protected burdened (\$7.00), unburdened (\$5.65), and unburdened without U.S.-based labor (\$5.52), itemized by cost category. The categories driving the unit cost include spray operations and insecticide, which together constitute 67 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 11.6 percent and 4.1 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Mali program costs, as delivered through an international implementing partner, adds \$1.48 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 21.2 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by spray operations and local labor, which account for 35.4 percent and 28.7 percent, respectively, of the total “cost of burden.”

FIGURE ML5: MALI IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Mali IRS program sprayed 228,985 structures during the Year 2 spray campaign. Figure ML5 shows the unit costs per structure sprayed burdened (\$25.99), unburdened (\$20.98), and unburdened without U.S. labor (\$20.48), itemized by cost category. The burdened portion of AIRS Mali program costs, as delivered through an international implementing partner, adds \$5.51 to the unit cost per structure sprayed.

11.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Mali IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE ML3: MALI IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measure	Year 1	Year 2	Percent Change
People Protected	762,146	850,104	11.5%
Structures Sprayed	206,295	228,985	11.0%
Area Sprayed (100 m2)	192,968	233,588	21.1%

Table ML3, above, compares the year-on-year change in Mali IRS program output measures. Overall, the size of the program grew slightly, with the number of people protected increasing by 11.5 percent, and the number of structures sprayed increasing by 11.0 percent. As shown in Table ML1 in the Background, the average size of the structures sprayed in Year 2 was 102.0 m² compared to 93.5 m² in the previous year, and the slight increase in average size of a structure is why the measure of area sprayed increased more than the number of structures sprayed.

TABLE ML4: MALI IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 1,167,041	\$ 1,507,226	29.1%
Local Admin	\$ 433,112	\$ 691,478	59.7%
Local Labor	\$ 744,313	\$ 746,069	0.2%
Spray Operations	\$ 1,816,076	\$ 2,479,392	36.5%
Commodities	\$ 398,414	\$ 283,775	-28.8%
U.S. Labor	\$ 178,099	\$ 243,893	36.9%
TOTAL	\$ 4,737,053	\$ 5,951,833	25.6%

Table ML4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost increased by 25.6 percent, but a more nuanced and variable breakdown of change in expenditures is provided by cost category. For example, local administrative expenditures increased by almost 60 percent which could be a result of the local market increasing after the coup. Local labor remained the same, and spray commodities expenditures decreased by about 29 percent. Overall, the program expenditures in Year 2 increased by a higher percentage than the program size expanded. This is partially due to the political events that took place in Year 1, causing a suspension of field work and the program to underspend based on the work plan. The biggest impact of this change is seen in the local labor and spray operations expenditures.

TABLE ML5: MALI IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 6.22	\$ 7.00	12.6%
Per Structure Sprayed	\$ 22.96	\$ 25.99	13.2%
Per Area Sprayed (100 m ²)	\$ 24.55	\$ 25.48	3.8%

Table ML5 compares the year-on-year change in program unit costs. Because the program size increased slightly and the total expenditures increased by about 25 percent in Year 2, the unit costs also increased by about 13 percent in Year 2. Insecticide and spray operations are the two largest cost drivers, so increases in both of these total costs with only a minimal increase in program size is responsible for the slight increase in the unit costs.

12. MOZAMBIQUE

12.1 BACKGROUND

Year 1

The history of malaria control in Mozambique dates back to the early 1950s, when malaria was seen as a major threat to development in areas where the disease was endemic. The NMCP used DDT for IRS before a change in policy in 1993, when pyrethroids were introduced in the country. The Lubombo Spatial Development initiative began spraying in Maputo province in 2001 and PMI support for Zambezia province began in 2006. The rest of the country was covered by the MOH.

Between 1995 and 2003, the NMCP carried out vector control with sporadic IRS interventions in Zambezia province. In 2005, the NMCP resumed IRS in Zambezia in three districts, using DDT, and in 2006 expanded to cover five districts. This effort was strengthened in 2007 by PMI. Initially, IRS activities were implemented in densely populated areas using DDT or pyrethroids, the latter being applied only on western-style dwellings constructed in stone, brick, or cement. In 2009, pyrethroids were the sole class of insecticides purchased for IRS, although all remaining stocks of DDT were sprayed during that year. Pyrethroids were also used for the 2010 and 2011 spray campaigns.

In 2012, Year 1 of the AIRS project, PMI implemented a spray campaign in six districts: Milange, Mocuba, Morrumbala, Namacurra, Nicodala, and Quelimane. The spray campaign used pyrethroid insecticide based on susceptibility testing. It began October 8 and ran through December 18, for a total of 61 operational days.

Year 2

In Year 2, 2013, PMI implemented the spray campaign in four of the six districts that were sprayed in Year 1, namely, Milange, Mocuba, Morrumbala, and Quelimane. Namacurra and Nicoadala were dropped because of reduced funding and finding alternative malaria prevention methods through LLIN coverage in that area. The country continued to use pyrethroids for the spray campaign. The insecticides were donated by the MOH (no additional insecticide was procured by PMI for the Year 2 campaign), and the cost of these insecticides was not provided. A total of 329,094 sachets were used. The campaign was conducted over 55 operational days and sprayed 414, 232 structures.

TABLE MZI: MOZAMBIQUE QUICK FACTS

	Year 1	Year 2
# Local Staff	28	23
Spray Start Date	October 8, 2012	October 7, 2013
# Spray Rounds	1	1
# Sachets Used	389,788	329,094
# People Protected	2,716,176	2,181,896

# Structures Sprayed	536,558	414,232
# 100 Square Meters Sprayed	974,470	822,735
Average Size of Structure	181.6 m ² *	198.6 m ²

* Reverse calculation using number of insecticide sachets used during campaign multiplied by the average of 250 square meters estimated to be sprayed by one sachet and divided by the number of structures sprayed.

12.2 PROGRAM EXPENDITURES

This section will present an overview of Mozambique IRS program expenditures in Year 2. Costs are organized by activity and cost category.

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		657,389	738,525			187,626	\$1,583,540	38.9%
Entomology			98,970		81,112	4,953	\$185,035	4.5%
Environmental Compliance			39,955		18,470	14,350	\$72,775	1.8%
Equipment Supplies				267,525	89,216	135	\$356,876	8.8%
IEC			1,650				\$1,650	0.0%
Insecticide							-	0.0%
M&E			69,704		91,739	54,790	\$216,232	5.3%
Post Spray						253	\$253	0.0%
Spray Campaign			11,012		1,027,859	4,941	\$1,043,811	25.6%
Spray Planning			226,471		377,394	5,950	\$609,815	15.0%
Grand Total		\$657,389	\$1,175,695	\$267,525	\$1,678,308	\$272,998	\$ 4,051,916	100.0%

Table MZ2 displays the Mozambique IRS program total capital and recurrent expenditures from Year 2. We estimate a value of \$1,115,756 for the insecticides used, based on 2012 procurement and the amount of insecticides used. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE MZ1: MOZAMBIQUE IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

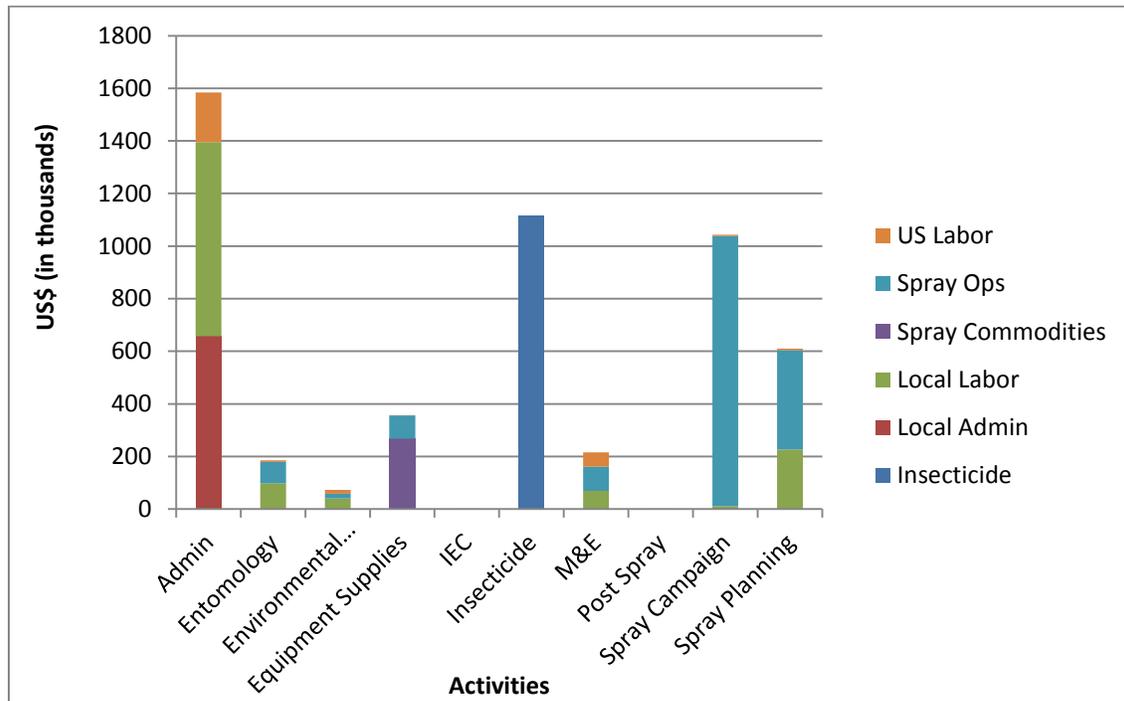


Figure MZ1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Administration is the most expensive IRS activity (38.9 percent of expenditures (excluding insecticides), followed by the spray campaign. About 58.5 percent of the total cost (excluding insecticides) 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.

FIGURE MZ2: MOZAMBIQUE IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

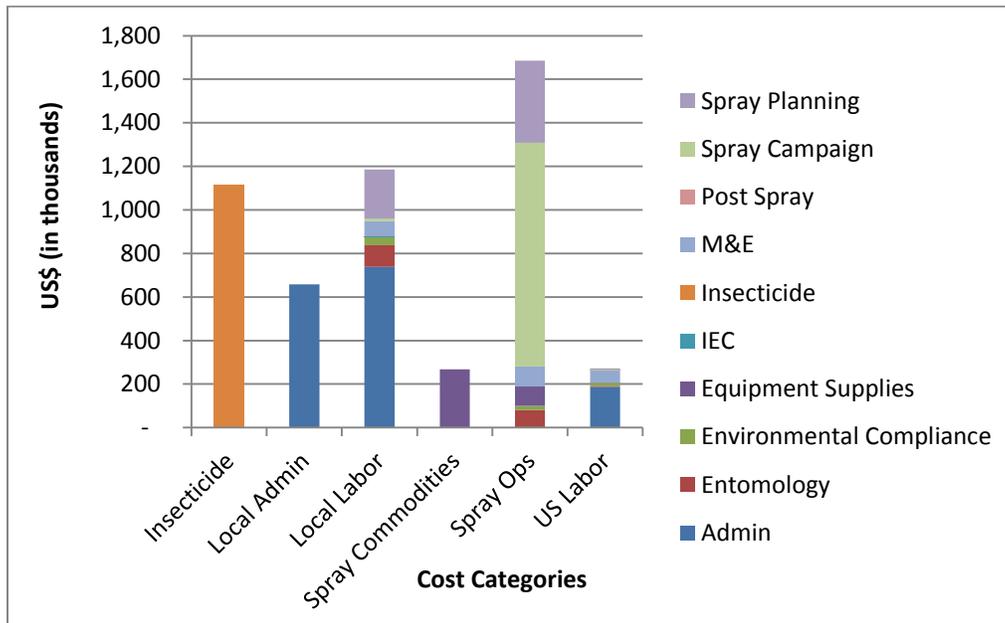


Figure MZ2 contains the same information as Figure MZ1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are less than expenditures related to local labor and technical spray operations.

12.3 UNIT COST ANALYSIS

This section presents Mozambique IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE MZ3: MOZAMBIQUE IRS UNIT COSTS, BY ACTIVITY

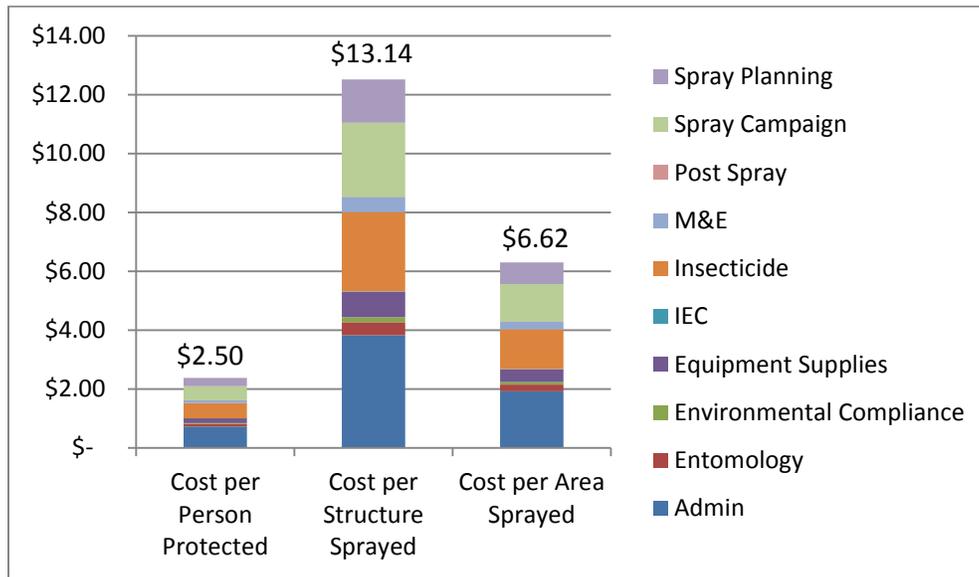
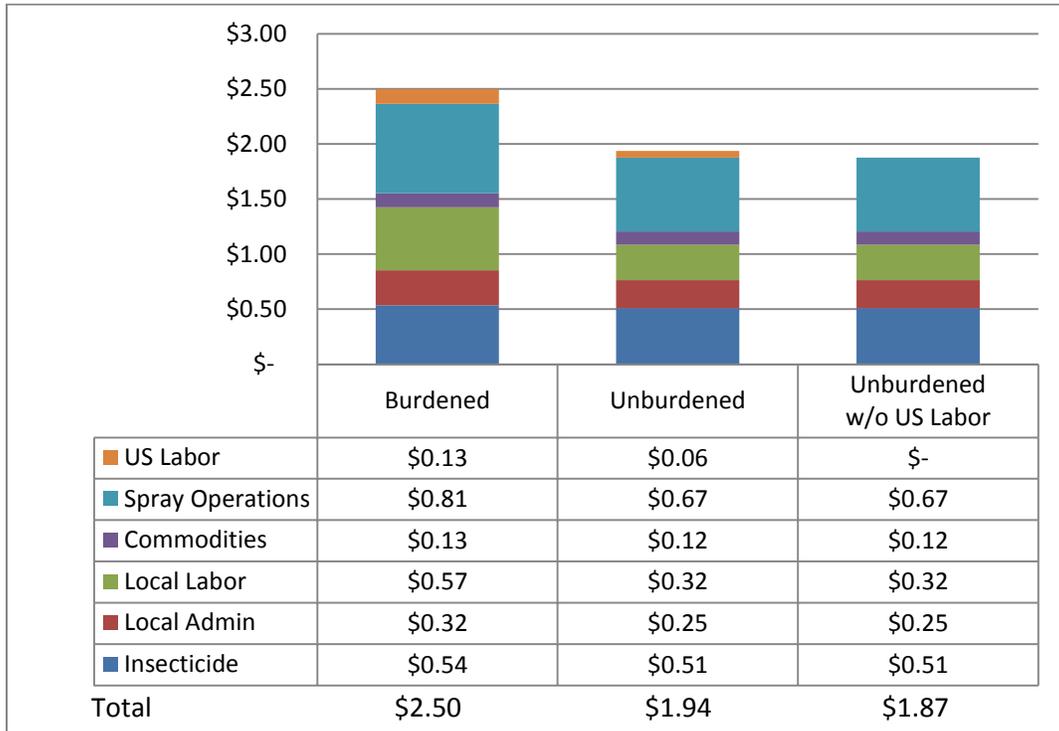


Figure MZ3 illustrates the Mozambique program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, IEC, and M&E, make up 9.2 percent of the unit cost. Administration is the largest cost driver at 31 percent, followed by the insecticides at 22 percent. Figure MZ1 showed that about 59 percent of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

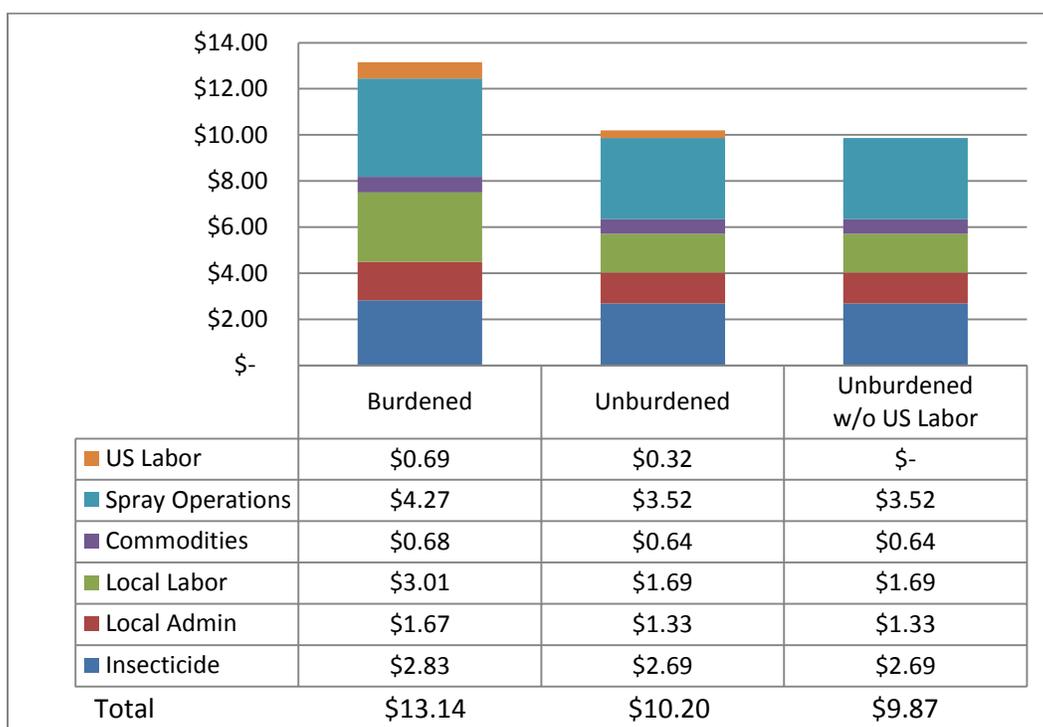
FIGURE MZ4: MOZAMBIQUE IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Mozambique Year 2 IRS spray campaign protected 2,181,896 people from malaria transmission. Figure MZ4 shows the unit costs per person protected burdened (\$2.50), unburdened (\$1.94), and unburdened without U.S.-based labor (\$1.87), itemized by cost category. The categories driving the unit cost include spray operations and local labor, which together constitute 55.4 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 12.7 percent and 5.3 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Mozambique program costs, as delivered through an international implementing partner, adds \$0.62 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 24.9 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by local labor and spray operations, which together account for about 63.2 percent of the total “cost of burden.”

FIGURE MZ5: MOZAMBIQUE IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Mozambique IRS program sprayed 414,232 structures during the Year 2 spray campaign. Figure MZ5 shows the unit costs per structure sprayed burdened (\$13.14), unburdened (\$10.20), and unburdened without U.S. labor (\$9.87), itemized by cost category. The burdened portion of AIRS Mozambique program costs, as delivered through an international implementing partner, adds \$3.27 to the unit cost per structure sprayed.

12.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Mozambique IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE MZ3: MOZAMBIQUE IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	Year 1	Year 2	Percent Change
People Protected	2,716,176	2,181,896	-19.7%
Structures Sprayed	536,558	414,232	-22.8%
Area Sprayed (100 m ²)	974,470	822,735	-15.6%

Table MZ3, above, compares the year-on-year change in Mozambique IRS program output measures. Overall, the size of the program shrank slightly, with the number of people protected decreasing by 19.7 percent, and the number of structures sprayed decreasing by 22.8 percent. As shown in Table MZ1 in the Background section, the average size of the structures sprayed in Year 2 was 198.6 m² compared to 181.6 m² in the previous year, and the increase in the average size of a structure sprayed is why the measure of area sprayed decreased less than the number of structures sprayed.

TABLE MZ4: MOZAMBIQUE IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 1,181,249	\$ 1,115,746	-5.5%
Local Admin	\$ 697,808	\$ 657,389	-5.8%
Local Labor	\$ 1,253,411	\$ 1,186,286	-5.4%
Spray Operations	\$ 1,856,414	\$ 1,685,789	-9.2%
Commodities	\$ 132,340	\$ 267,525	102.1%
U.S. Labor	\$ 167,545	\$ 272,998	62.9%
TOTAL	\$ 5,288,766	\$ 5,185,734	-1.9%

Table MZ4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost decreased by 1.9 percent, but a more variable and nuanced breakdown of change in expenditures is provided by cost category. For example, expenditures on commodities increased by 102.1 percent, while expenditures on spray operations, which are a much larger proportion of the total costs, decreased by 9.2 percent. A portion of the increase in expenditures on commodities was due to the purchase of household cards for about \$80,000, which was a new addition in Year 2. Local labor and spray operations expenditures decreased by less than the program size decreased. This is consistent with the premise that decreases in program size are not always proportional to decreases in expenditures.

TABLE MZ5: MOZAMBIQUE IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 1.95	\$ 2.38	22.1%
Per Structure Sprayed	\$ 9.86	\$ 12.52	27.0%
Per Area Sprayed (100 m ²)	\$ 5.43	\$ 6.30	16.1%

Table MZ5 compares the year-on-year change in program unit costs. Because the total program expenditures decreased by less than the program size in Year 2, the unit costs increased in Year 2.

13. NIGERIA

13.1 BACKGROUND

Year 1

Nigeria has embarked on IRS malaria control with pilot projects initiated in 2006 and 2007 by the NMCP with support from the World Bank. In 2011, PMI added Nigeria as a priority country and PMI began preparation for the first IRS campaign by training local specialists on entomology, completing a supplemental environmental assessment, and collecting data about local mosquito vectors and insecticide resistance. In 2012, Year 1 of PMI's AIRS project, the first IRS round was conducted in two local government authorities (LGAs), Doma and Nassarawa Eggon. The geographical scope included only two LGAs of a state with a total of 58,704 structures sprayed because the IRS program in Nigeria was designed as a demonstration model to show local stakeholders and potential donors how to establish and run an effective IRS campaign. Prior to PMI, no other local or international agency conducted IRS in the state. However, the local government showed good support for PMI's IRS program in 2012. Communities also showed a good level of acceptance even though it was their first exposure to IRS.

The spray campaign was implemented over 32 days in the period between April 4 and May 30, 2012. Data from the Mapping Malaria Risk in Africa Project indicate that the duration of the malaria transmission season for the project-focused areas in Nasarawa state is about seven months, between May and October/November. The IRS program used a pyrethroid class insecticide.

Year 2

In Year 2, 2013, PMI's IRS program continued spraying in the same two LGAs using a pyrethroid class insecticide. The spray campaign was implemented in 33 days from April 11 to May 18, 2013. It was the last campaign in Nigeria under the AIRS contract. During Year 2, the program conducted two national events: training for entomologists from all 36 states and an IRS Best Practices conference also organized for the representatives from all states and implementing partners. The expenses for the two activities are estimated at \$60,000 and excluded from the analysis. For the following year, PMI revised the scope of the AIRS Nigeria program to concentrate on vector control assistance by increasing entomological capacity and establishing vector surveillance statistics. These activities will help the National Malaria Elimination Program to guide malaria control and prevention planning and implementation interventions.

TABLE NG1: NIGERIA QUICK FACTS

	Year 1	Year 2
# Local Staff	18	21
Spray Start Date	April 4, 2012	April 11, 2013
# Spray Rounds	1	1
# Sachets Used	29,177	39,995

# People Protected	346,115	346,798
# Structures Sprayed	58,704	62,592
# 100 Square Meters Sprayed	72,943	99,988
Average Size of Structure	124.3 m ² *	159.7 m ²

* Reverse calculation using number of insecticide sachets used during the campaign multiplied by the average of 250 square meters estimated to be sprayed by one sachet and divided by the number of structures sprayed.

In Year 2, the project worked at 1.6 structure per sachet ratio whereas in Year 1, the ratio was 2 structures per sachet. Underdose of the insecticide is considered as one of the causes leading to the Year 1 results on residual efficacy and amount of insecticide used. Working from the lessons learned, in Year 2, the team observed that some of the SOPs kept the spray rhythm slightly slower and some of the SOPS allowed for 10 cm spray overlap vs. standard 5cm. These are most likely the reasons that led to the increased number of sachets used and therefore increased average size of structure in Year 2. The spray overlap issue was timely addressed though using the bulk SMS messaging.

13.2 PROGRAM EXPENDITURES

This section will present an overview of Nigeria IRS program expenditures in Year 2. Costs are organized by activity and cost category.

TABLE NG2: NIGERIA 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		571,895	580,767			130,618	\$1,283,280	42.2%
Entomology			136,106		297,157	4,057	\$437,320	14.4%
Environmental Compliance			54,823		20,053	29,181	\$104,058	3.4%
Equipment Supplies				47,503		431	\$47,933	1.6%
IEC			166		23,268		\$23,434	0.8%
Insecticide	72,296						\$72,296	2.4%
M&E			73,006		18,262	28,760	\$120,028	3.9%
Post Spray			65,491		11,234		\$76,725	2.5%
Spray Campaign			70,729	1,000	571,580	12,549	\$655,857	21.6%
Spray Planning			27,036	14,731	170,287	6,252	\$218,306	7.2%
Grand Total	\$72,296	\$571,895	\$1,008,124	\$63,234	\$1,111,841	\$211,847	\$3,039,238	100.0%

Table NG2 displays the Nigeria IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS

program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE NG1: NIGERIA IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

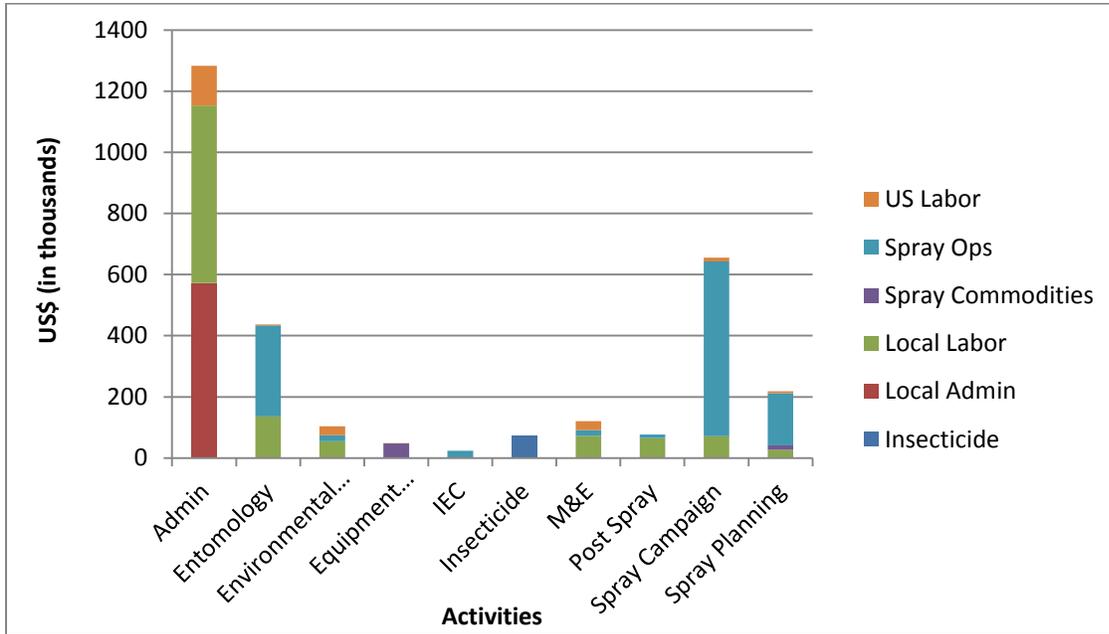


Figure NG1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Administration is the most expensive IRS activity (42.2 percent of expenditures), followed by the spray campaign and entomology activities. About 55 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, M&E, and environmental compliance program activities.

FIGURE NG2: NIGERIA IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

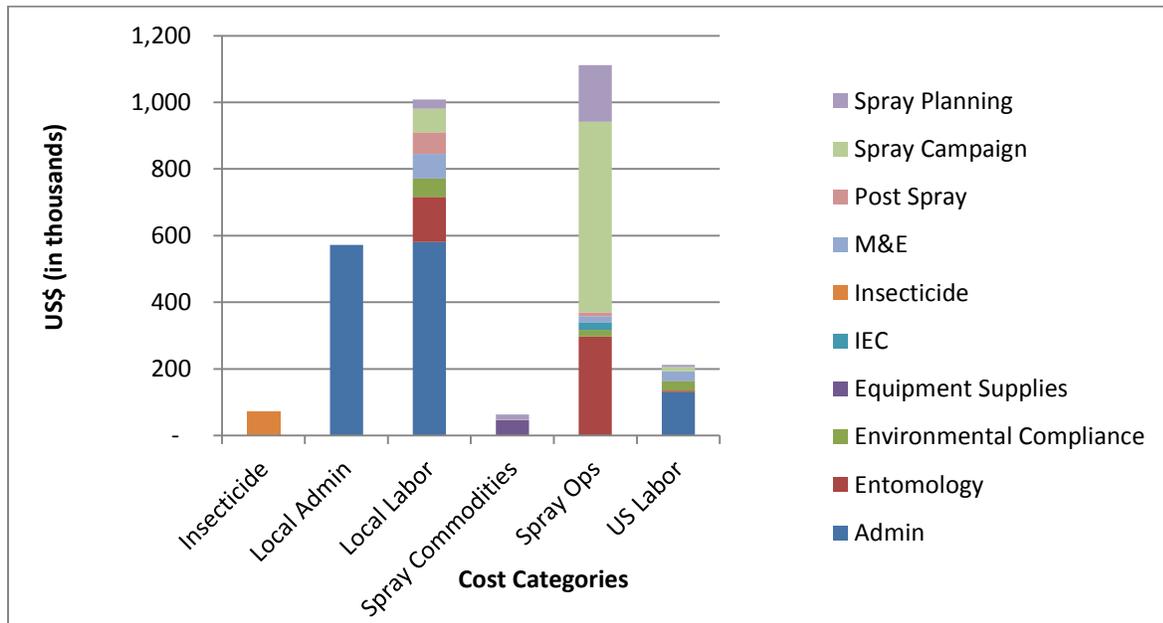


Figure NG2 contains the same information as Figure NG1, but switches the X-axis, which is now cost categories, with the legend items listing program activities. This illustrates that insecticide, commodities, and U.S.-based labor expenditures are minimal compared to local administration, local labor, and technical spray operations expenditures.

13.1 UNIT COST ANALYSIS

This section presents Nigeria IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE NG3: NIGERIA IRS UNIT COSTS, BY ACTIVITY

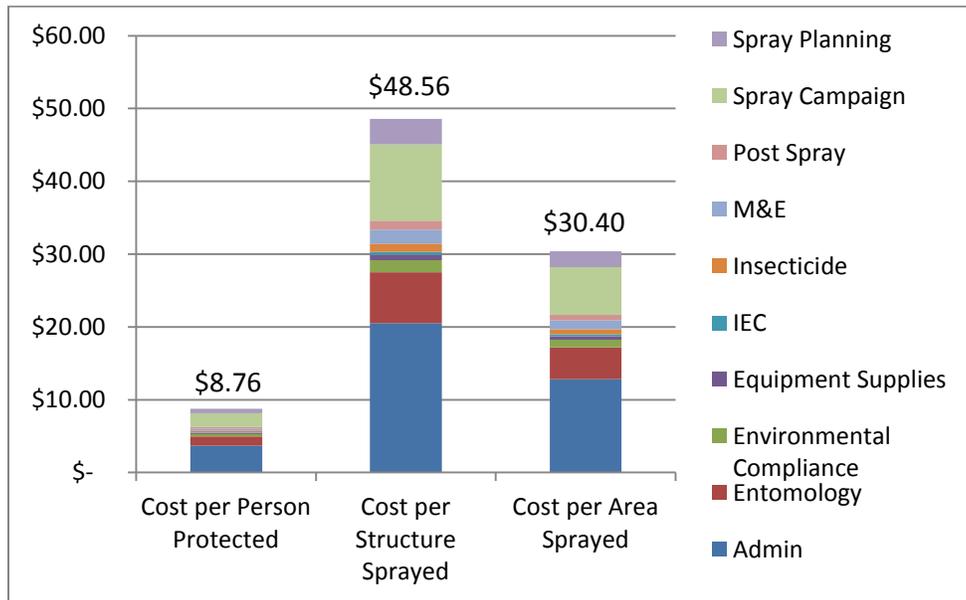
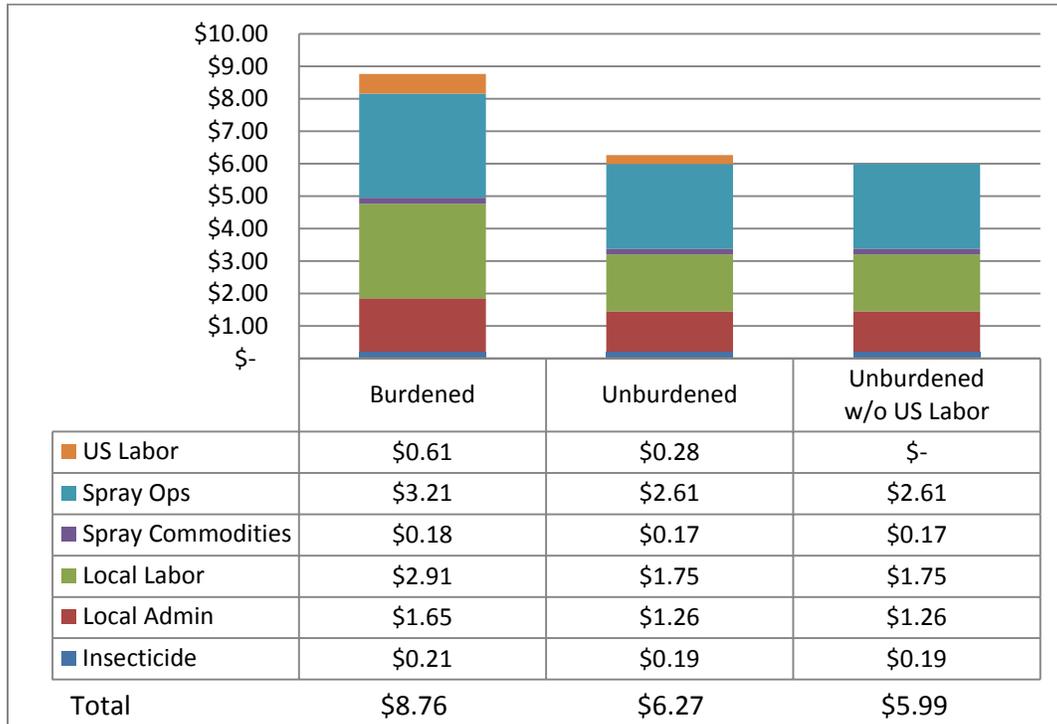


Figure NG3 illustrates the Nigeria program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including EC, IEC, and M&E, make up 8.1 percent of the unit cost. Administration is the largest cost driver at 42.2 percent, followed by the spray campaign at 21.6 percent. Keep in mind that Figure NG1 showed that about 55 percent of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

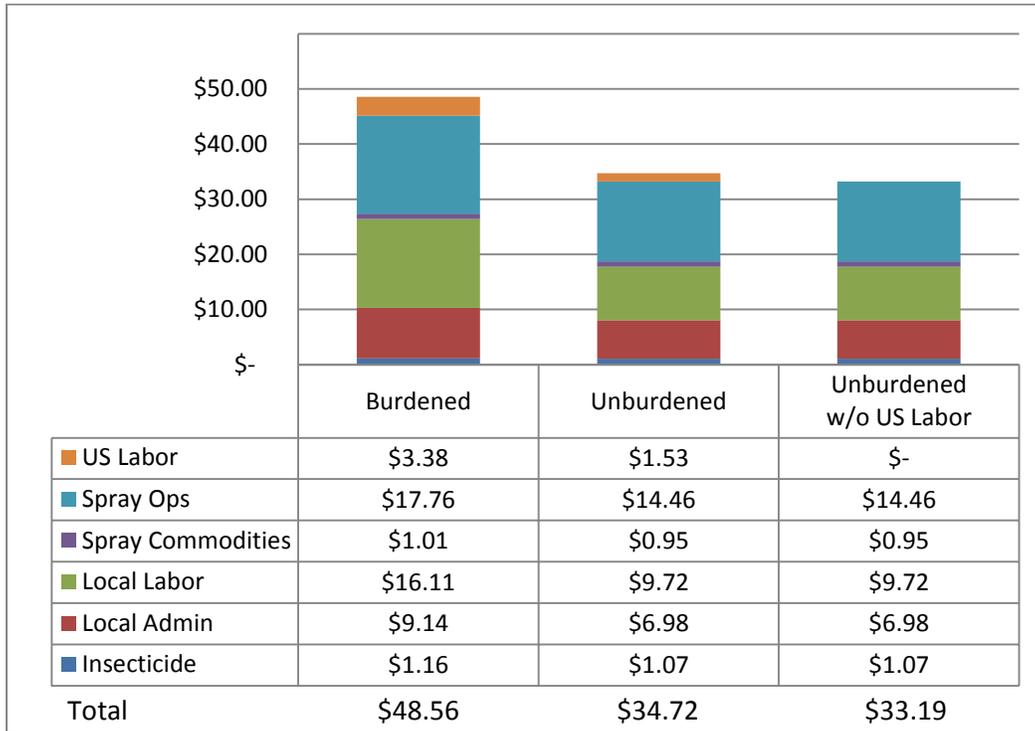
FIGURE NG4: NIGERIA IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Nigeria Year 2 IRS spray campaign protected 346,798 people from malaria transmission. Figure NG4 shows the unit costs per person protected burdened (\$8.76), unburdened (\$6.27), and unburdened without U.S.-based labor (\$5.99), itemized by cost category. The categories driving the unit cost include spray operations and local labor, which together constitute 69.8 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 18.8 percent and 7.0 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Nigeria program costs, as delivered through an international implementing partner, adds approximately \$2.77 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 31.6 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by local and U.S.-based staff labor, which together account for about 63.6 percent of the total “cost of burden.”

FIGURE NG5: NIGERIA IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Nigeria IRS program sprayed 62,592 structures during the Year 2 spray campaign. Figure NG5 shows the unit costs per structure sprayed burdened (\$48.56), unburdened (\$34.72), and unburdened without U.S. labor (\$33.19), itemized by cost category. The burdened portion of AIRS Nigeria program costs, as delivered through an international implementing partner, adds \$15.37 to the unit cost per structure sprayed.

13.2 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Nigeria IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE NG3: NIGERIA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measure	Year 1	Year 2	Percent Change
People Protected	346,115	346,798	0.2%
Structures Sprayed	58,704	62,592	6.6%
Area Sprayed (100 m ²)	72,943	99,988	37.1%

Table NG3, above, compares the year-on-year change in Nigeria IRS program output measures. Overall, the size of the program grew slightly, with the number of people protected increased by 0.2 percent, and the number of structures sprayed increased

by 6.6 percent. As shown in Table NG1 in the Background, the average size of the structures sprayed in Year 2 was 159.7 m² compared to 124.3 m² in the previous year, and the increase in average size of a structure accounts for the more dramatic increase in the measure of area sprayed compared to number of structures sprayed.

TABLE NG4: NIGERIA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 165,881	\$ 72,296	-56.4%
Local Admin	\$ 263,612	\$ 571,895	116.9%
Local Labor	\$ 693,686	\$ 1,008,124	45.3%
Spray Operations	\$ 620,002	\$ 1,111,841	79.3%
Commodities	\$ 92,302	\$ 63,234	-31.5%
U.S. Labor	\$ 226,251	\$ 211,847	-6.4%
TOTAL	\$ 2,061,734	\$ 3,039,238	47.4%

Table NG4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost increased by 47.4 percent, but a more variable and nuanced breakdown of change in expenditures is provided by cost category. For example, insecticide expenditures decreased by about 56 percent, while local administration expenditures increased by 117 percent. Local administration costs went up due in part to increased trips by all staff to the field for supervision and inspections before and after the spray campaign and frequent visits to Abuja by the senior management team to attend various meetings and events organized either by the country partners or PMI. However, the larger cost driver is the spray operations expenditures. In Year 2, the Nigeria IRS program hired about 100 more seasonal staff and had an average of 25 % wage increase for all seasonal personnel. The program also implemented an enhanced supervision strategy in cooperation with officers from the central NMCP, state health department, and environmental department, which included regularly scheduled field visits.

TABLE NG5: NIGERIA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 5.96	\$ 8.76	47.1%
Per Structure Sprayed	\$ 35.12	\$ 48.56	38.3%
Per Area Sprayed (100 m ²)	\$ 28.27	\$ 30.40	7.5%

Table NG5 compares the year-on-year change in program unit costs. As the program remained relatively the same in terms of size, while the total expenditures increased by about 56 percent in Year 2, the unit costs also increased in Year 2. As spray operations and local labor are the two largest cost drivers, increases in both of these total costs, combined with only a minimal increase in program size, are responsible for most of the increase in the unit costs.

14. RWANDA

14.1 BACKGROUND

Year 1

In Rwanda, PMI has funded IRS campaigns for five years prior to the start of the AIRS project. In Year 1 of the project, 2012, the Rwanda IRS program targeted 240,000 structures located in three districts, Bugesera, Gisagara, and Nyagatare. The spray campaign took place over a total of 30 days between August and October. The pyrethroid insecticide, deltamethrin, was used for spraying. Unfortunately, at the start of the 2012 Rwanda spray campaign, a spray operator passed away so the program halted operations immediately. The AIRS project was cleared one month later to continue spraying and finished spraying successfully. The delay in operations caused some increase in the costs of the program.

Year 2

In Year 2 of the project, 2013, two rounds of spraying were implemented in Rwanda in the same three districts, Bugesera, Gisagara, and Nyagatare. The first campaign was conducted in February and lasted 20 days. During this first round, 121,154 structures were sprayed in 20 sectors, using a pyrethroid. The second spray campaign was conducted in September and lasted 30 days. During this spray round, 224,708 structures were sprayed in 37 sectors. Pyrethroid insecticide left over from the previous year was used in Bugesera and Gisagara, while a newly procured carbamate (Ficam) was used in Nyagatare district. There was an overlap in the two rounds of spraying, in that some of the structures were sprayed twice. Thus, the total number of non-individual structures sprayed over the full Year 2 program was 345,862. The AIRS project's M&E system tracks the number of found structures and number of structures sprayed in each round, and does not track individual structures across spray campaigns.

TABLE RW1: RWANDA QUICK FACTS

	Year 1	Year 2
# Local Staff	16	19
Spray Start Dates	August 20, 2012- September 17, 2012	February 11, 2013 September 2, 2013
# Spray Rounds	1	2
# Sachets Used	166,261	264,970
# People Protected	1,025,181	1,479,342
# Structures Sprayed	236,610	345,862
# 100 Square Meters Sprayed	415,652	662,425
Average Size of Structure	175.7 m ² *	191.5 m ²

* Reverse calculation using number of insecticide sachets used during campaign multiplied by the average of 250 square meters estimated to be sprayed by one sachet and divided by the number of structures sprayed.

14.2 PROGRAM EXPENDITURES

This section will present an overview of Rwanda IRS program expenditures in Year 2. Costs are organized by activity and cost category.

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		467,883	516,284			198,481	\$1,182,649	17.9%
Entomology			237,765		243,602	1,023	\$ 482,390	7.3%
Environmental Compliance			74,967		13,695	56,462	\$ 145,125	2.2%
Equipment Supplies				517,957	2,880	431	\$ 521,268	7.9%
IEC			28,054		6,956		\$ 35,010	0.5%
Insecticide	1,113,217						\$1,113,217	16.9%
M&E			65,595		17,703	72,854	\$ 156,151	2.4%
Post Spray					47,226		\$ 47,226	0.7%
Spray Campaign					2,264,075	3,809	\$2,267,883	34.4%
Spray Planning			154,934		474,059	18,004	\$ 646,997	9.8%
Grand Total	\$1,113,217	\$ 467,883	\$ 1,077,600	\$ 517,957	\$3,070,196	\$ 351,063	\$6,597,917	100.0%

Table RW2 displays the Rwanda IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE RW1: RWANDA IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

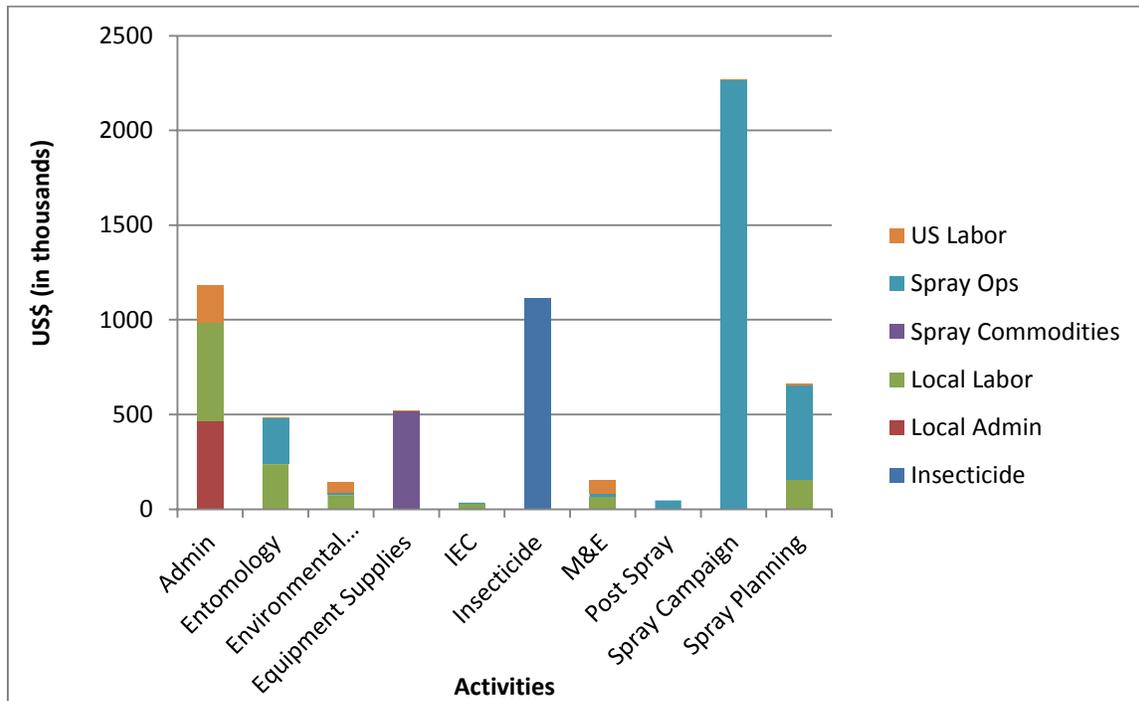


Figure RW1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Implementation of the spray campaign is the most expensive IRS activity (34.4 percent of expenditures), followed by the administrative activities and insecticide. Over 60 percent of the total cost for administration consists of labor, with 43.7 percent incurred from local labor and 16.8 percent from U.S.-based labor. Note that the 'U.S.-based Labor and STTA' expenditures are largely incurred under the administrative, environmental compliance, and M&E program activities.

FIGURE RW2: RWANDA IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

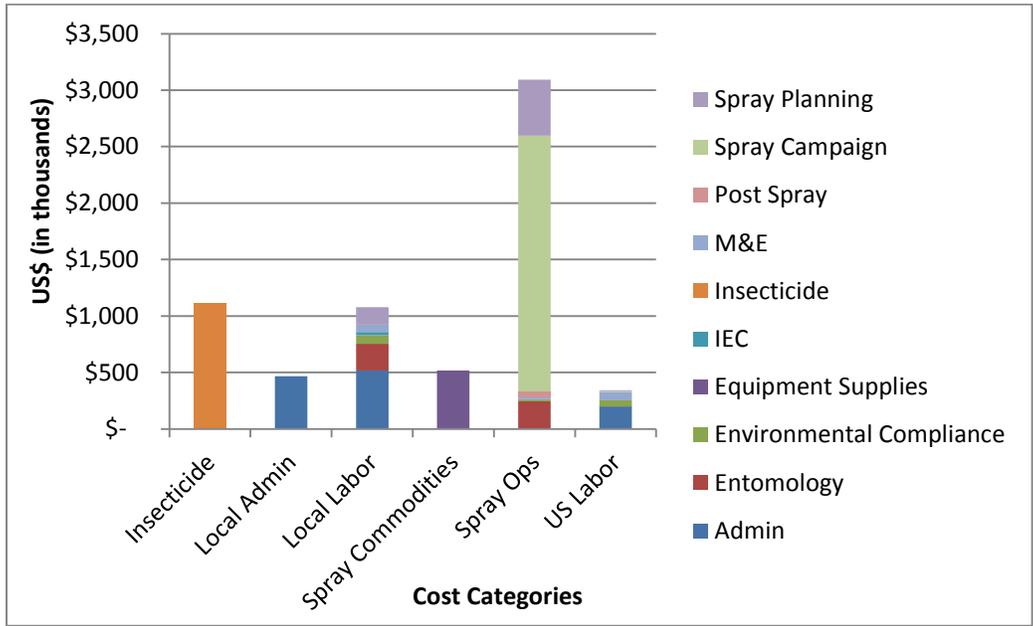


Figure RW2 contains the same information as Figure RW1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are less expensive compared to expenditures related to technical spray operations and other supporting costs such as insecticide and local labor.

14.3 UNIT COST ANALYSIS

This section presents Rwanda IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE RW3: RWANDA IRS UNIT COSTS, BY ACTIVITY

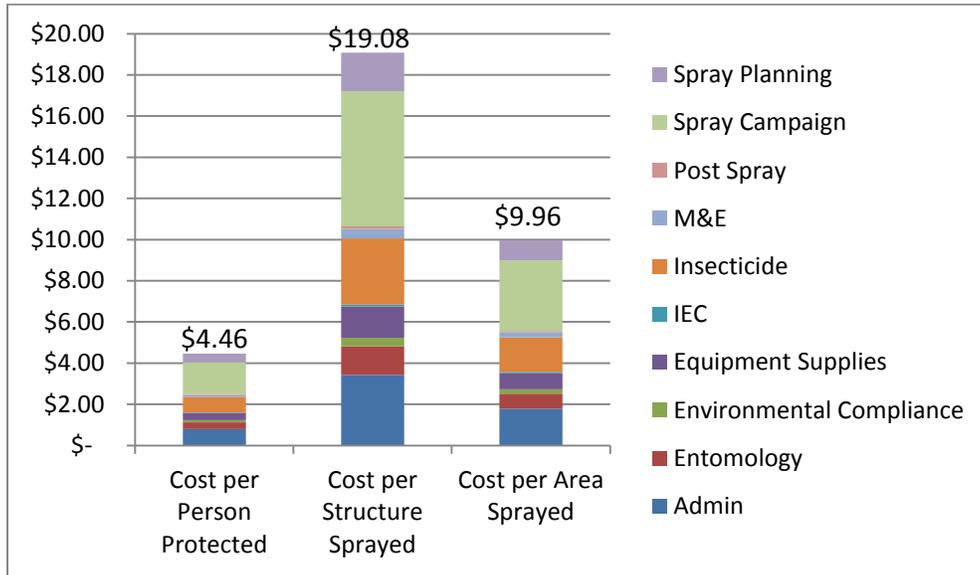
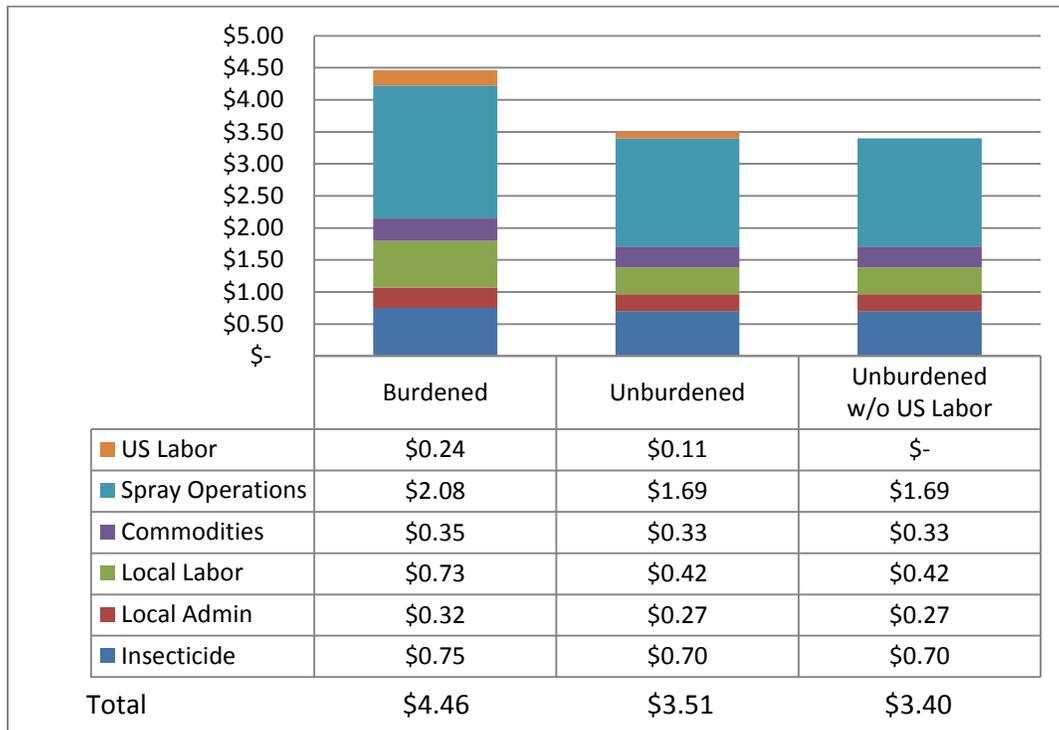


Figure RW3 illustrates the Rwanda program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including EC, IEC, and M&E, make up 5.1 percent of the unit cost. The spray campaign is the largest cost driver at 34.4 percent, followed by administration at 17.9 percent, and insecticide at 16.9 percent. Keep in mind that Figure RW1 showed that over 60 percent of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

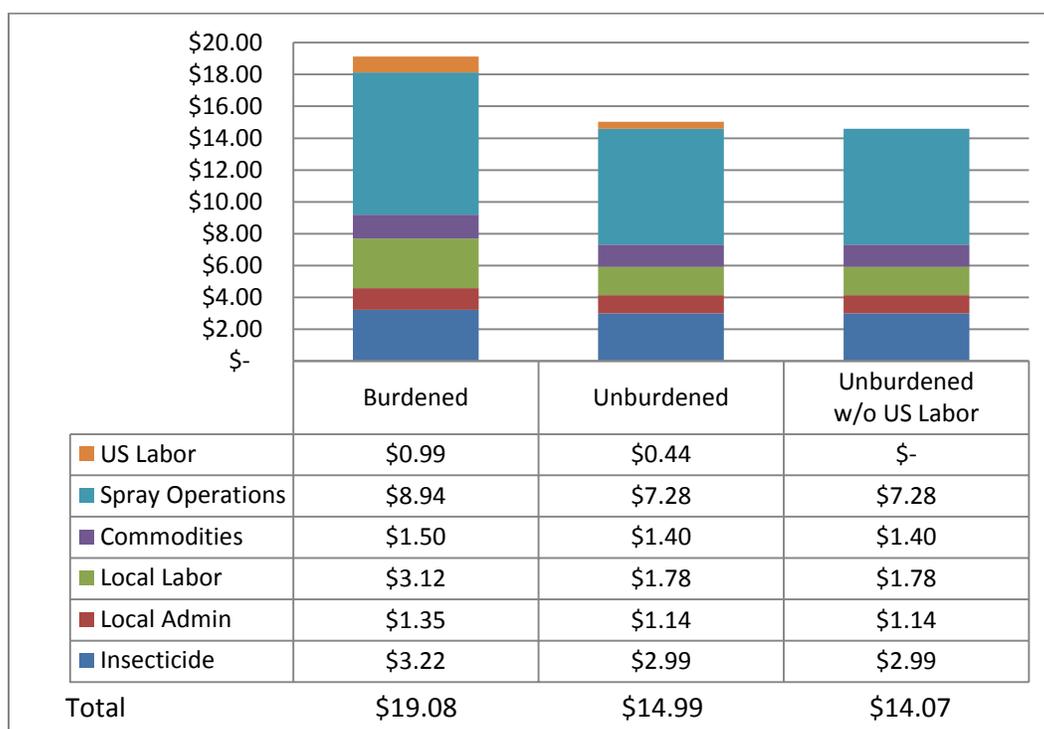
FIGURE RW4: RWANDA IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Rwanda Year 2 IRS spray campaign protected 1,479,342 people from malaria transmission. Figure RW4 shows the unit costs per person protected burdened (\$4.46), unburdened (\$3.51), and unburdened without U.S.-based labor (\$3.40), itemized by cost category. The category driving the unit cost is predominately the spray operations, which constitutes 46.5 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 7.1 percent and 5.3 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Rwanda program costs, as delivered through an international implementing partner, adds \$1.06 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 23.8 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by spray operations and local staff labor, which together account for about 66 percent of the total “cost of burden.”

FIGURE RW5: RWANDA IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Rwanda IRS program sprayed 345,862 structures during the Year 2 spray campaign. Figure RW5 shows the unit costs per structure sprayed burdened (\$19.08), unburdened (\$14.99), and unburdened without U.S. labor (\$14.07), itemized by cost category. The burdened portion of AIRS Rwanda program costs, as delivered through an international implementing partner, adds \$4.55 to the unit cost per structure sprayed.

14.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Rwanda IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE RW3: RWANDA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measure	YEAR 1	YEAR 2	Percent Change
People Protected	1,025,181	1,479,342	44.3%
Structures Sprayed	236,610	345,862	46.2%
Area Sprayed (100 m ²)	415,653	662,425	59.4%

Table RW3, above, compares the year-on-year change in Rwanda IRS program output measures. Overall, the size of the program grew by almost half, with the number of people protected increasing by 44.3 percent, and the number of structures sprayed

increasing by 46.2 percent. As shown in Table RW1 in the Background, the average size of the structures sprayed in Year 2 was 191.5 m² compared to 175.7 m² in the previous year, and the increase in average size of a structure is why the measure of area sprayed increased more than the number of structures sprayed increased in Year 2.

TABLE RW4: RWANDA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 178,963	\$ 1,113,217	522.0%
Local Admin	\$ 585,245	\$ 467,883	-20.1%
Local Labor	\$ 811,188	\$ 1,077,600	32.8%
Spray Operations	\$ 1,970,670	\$ 3,070,196	55.8%
Commodities	\$ 417,850	\$ 517,957	24.0%
U.S. Labor	\$ 250,351	\$ 351,063	40.2%
TOTAL	\$ 4,214,265	\$ 6,597,917	56.6%

Table RW4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost increased by almost 57 percent, but a more variable and nuanced breakdown of change in expenditures is provided by cost category. For example, insecticide expenditures increased by 522 percent, while local administration decreased by about 20 percent. The main reason the cost of insecticide increased is because in Year 1, the Rwanda IRS program used only pyrethroid-class insecticides. The insecticide was inherited from the previous PMI IRS project, and the estimated cost was provided by staff from the previous implementing partner and may not be accurate. In Year 2, the Rwanda IRS program purchased and sprayed with carbamate-class insecticides, which are more expensive. The overall IRS program grew by about half, so while spray operations expenditures increased close to proportionally, other cost savings in local administration and local labor were not quite large enough to offset the increase in insecticide costs.

TABLE RW5: RWANDA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 4.11	\$ 4.46	8.5%
Per Structure Sprayed	\$ 17.81	\$ 19.08	7.1%
Per Area Sprayed (100 m ²)	\$ 10.14	\$ 9.96	-1.8%

Table RW5 compares the year-on-year change in program unit costs. Since both the program size and the total expenditures increased by about half in Year 2, the unit costs this year remained similar to Year 1 levels. With such a large increase in expenditures for insecticide, this means that efficiencies were achieved in the other cost categories. For example, if insecticide costs had only increased by 100 percent (to about \$350,000) then the unit costs per person protected and per structure sprayed would have both decreased by about 4 percent and 5 percent, respectively, in Year 2, showing a better reflection of program cost effectiveness.

15. SENEGAL

15.1 BACKGROUND

Year 1

PMI has been supporting IRS campaigns in Senegal since 2007 in the districts of Nioro, Richard Toll, and Vélingara, each of which represents one of the country's three ecological zones. In 2010, the NMCP identified an additional three districts (Guinguinéo, Koumpentoum, and Malem Hodar) as having high malaria morbidity and mortality rates. In 2011, the Senegal IRS Steering Committee decided to stop spraying in Richard Toll due to low malaria prevalence and growing resistance to pyrethroid and carbamate insecticides.

In 2012, Year 1 of the PMI-funded AIRS project, the program sprayed six districts: Guinguinéo, Kougheul, Koumpentoum, Malem Hodar, Nioro, and Vélingara. Kougheul had never been sprayed previously, but it was selected in November 2011 by the Senegal IRS Steering Committee, which comprises representatives of the NMCP, PMI, the *Université Cheikh Anta Diop* (UCAD), and the National Hygiene Service, due to its high malaria prevalence rates and proximity to some of the existing IRS target districts. The spray campaign took place over a total of 48 operational days, between June 6 and September 3, 2012. PMI used carbamate insecticides, some of which were inherited from the previous implementing partner, the rest of which were directly procured in 2012. Entomological monitoring activities were implemented by UCAD, and IEC activities were led by ChildFund Senegal.

Year 2

In Year 2 of the project, 2013, the program sprayed in four of the six districts that had been sprayed in 2012 including: Malem Hodar, Koumpentoum, Kougheul, and Vélingara. The IRS Steering Committee decided to discontinue spraying in the districts of Nioro and Guinguineo due to the low burden of the disease. The Year 2 spray campaign was conducted for 49 operational days, from July 15 to September 3, and used the carbamates class of insecticide. In the 2013 work plan, AIRS Senegal set a target of 204,585 structures to be sprayed, which would cover approximately 667,000 residents. However, after undergoing an enumeration exercise, the target was adjusted to 221,655 structures.

TABLE SNI: SENEGAL QUICK FACTS

	Year 1	Year 2
# Local Staff	14	16
Spray Start Date	June 6, 2012	July 15, 2013
# Spray Rounds	1	1
# Sachets Used	106,874	65,049
# People Protected	1,095,093	690,029

# Structures Sprayed	306,916	207,116
# 100 Square Meters Sprayed	267,185	162,623
Average Size of Structure	87.0 m ² *	78.5 m ²

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

15.2 PROGRAM EXPENDITURES

This section will present an overview of Senegal IRS program expenditures in Year 2. Costs are organized by activity and cost category.

TABLE SN2: SENEGAL 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		452,937	659,778			177,212	\$ 1,289,928	26.1%
Entomology			2,078		3,029		\$ 5,107	0.1%
Environmental Compliance			88,178		68,187	21,977	\$ 178,342	3.6%
Equipment Supplies			328	177,554			\$ 177,882	3.6%
IEC			41,959		196,831		\$ 238,789	4.8%
Insecticide	1,235,219						\$ 1,235,219	25.0%
M&E			117,827		158,802	37,975	\$ 314,605	6.4%
Post Spray			86,272		77,969	1,049	\$ 165,291	3.3%
Spray Campaign			80,983		769,488	35,246	\$ 885,717	17.9%
Spray Planning			126,377		330,521	20,986	\$ 447,883	9.1%
Grand Total	\$1,235,219	\$ 452,937	\$1,203,780	\$ 177,554	\$ 1,574,827	\$ 294,446	\$ 4,938,764	100.0%

Table SN2 displays the Senegal IRS program total capital and recurrent expenditures from Year 2. These expenditures are fully burdened. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the above table.

FIGURE SN1: SENEGAL IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

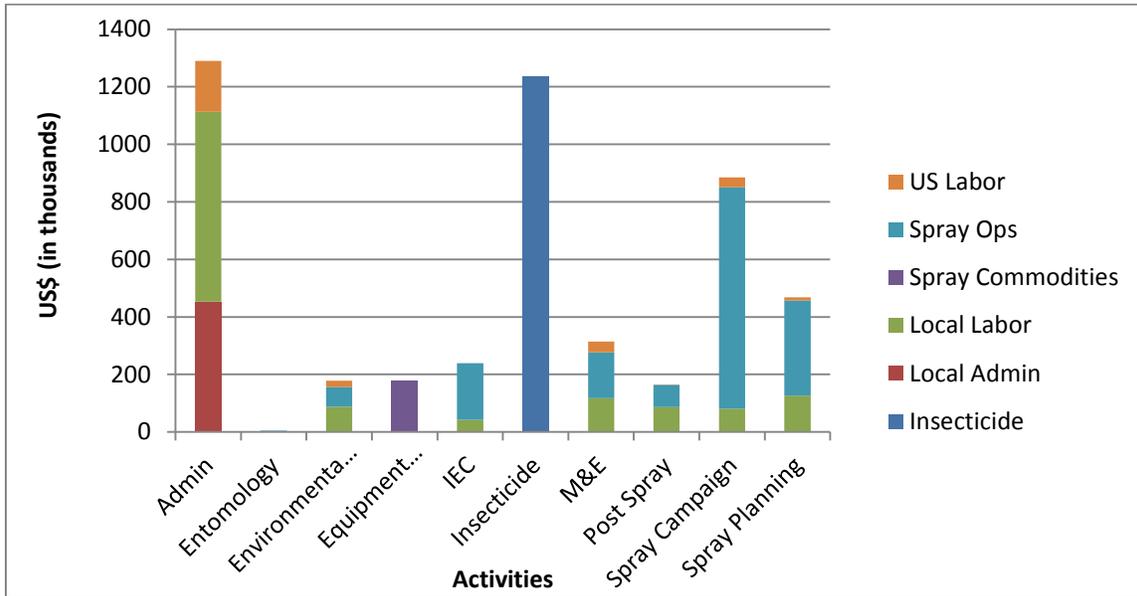


Figure SN1 shows the total burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Administration is the most expensive IRS activity (26 percent of expenditures), followed by insecticide and spray campaign activities (25.0 percent and 17.9 percent, respectively). About 65 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 administration, M&E, and spray campaign program activities.

FIGURE SN2: SENEGAL IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

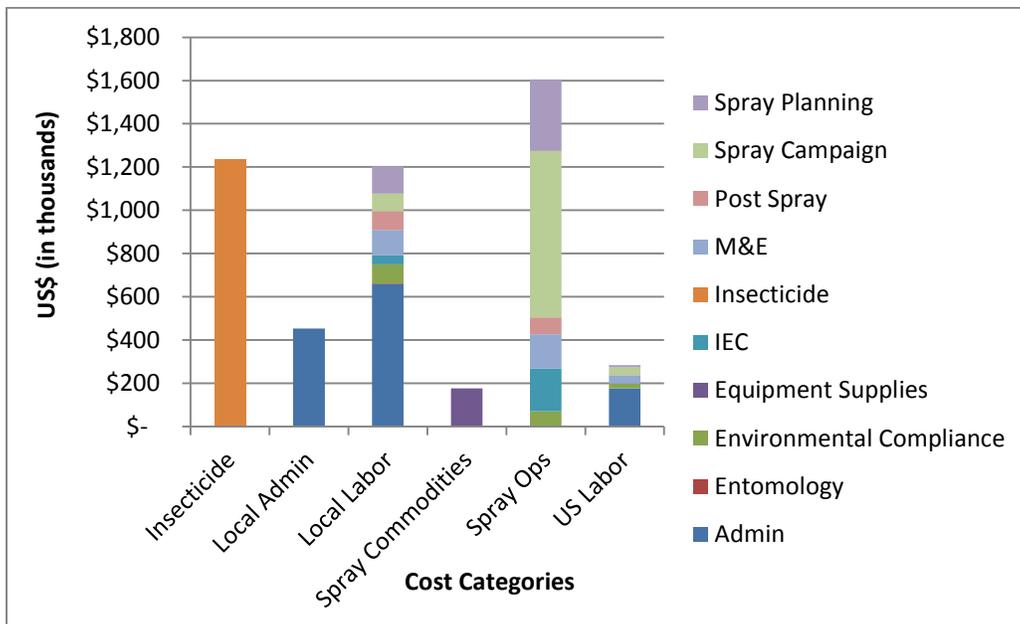


Figure SN2 contains the same information as Figure SN1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures related to local labor and technical spray operations.

15.3 UNIT COST ANALYSIS

This section presents Senegal IRS capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m²). Unit costs per person and per structure are more relevant for analysis at the country level, and the unit cost per area sprayed is primarily used in the cross-country analysis as a standardized unit to allow for consistent comparisons. This section will also introduce and discuss the breakdown of burdened costs.

FIGURE SN3: SENEGAL IRS UNIT COSTS, BY ACTIVITY

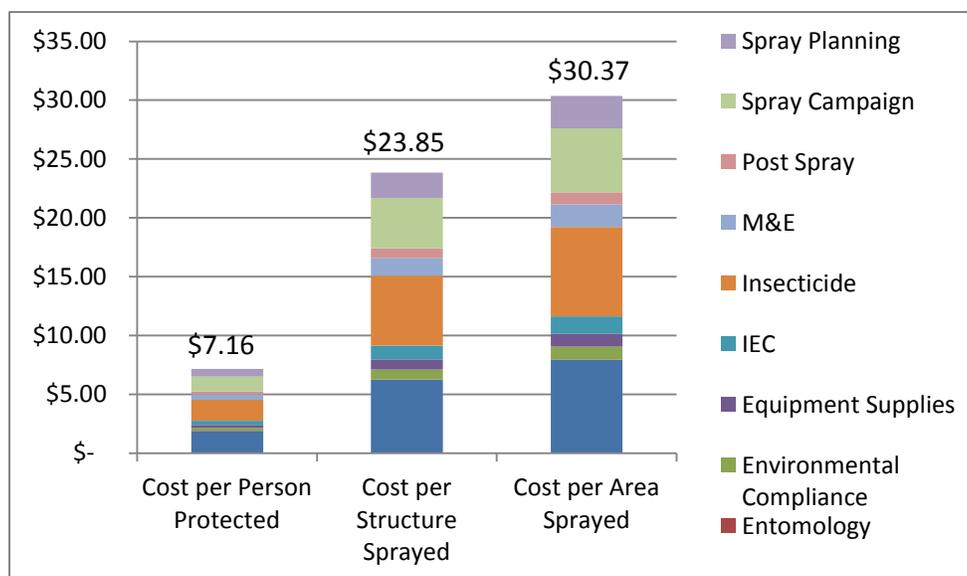
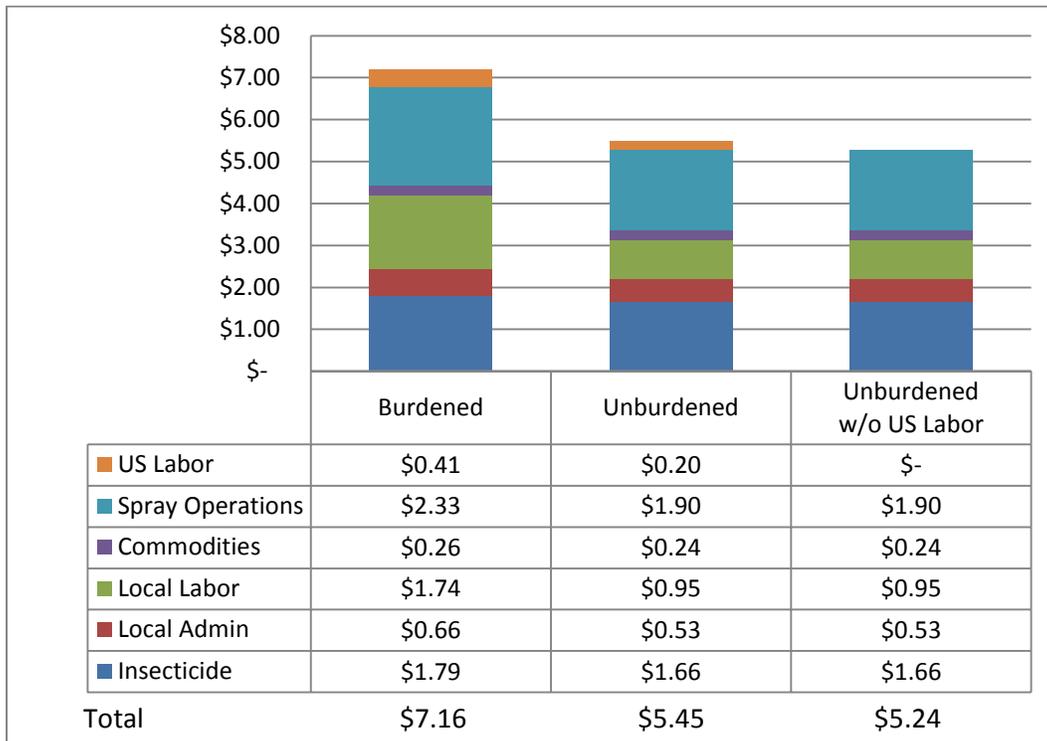


Figure SN3 illustrates the Senegal IRS program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. This figure shows that the activities supporting the quality and effectiveness of the spray program, including entomology, EC, and M&E, make up 10 percent of the unit cost. Local administration is the largest cost driver at 26 percent, followed closely by insecticide and spray campaign at about 25 and 18 percent, respectively. Keep in mind that Figure SN1 showed that about 65 percent of the costs under administration consisted of U.S.-based and local labor.

The following two figures show cost per person protected and cost per structure sprayed broken down by burden type. As discussed in the Methodology section, the burdened cost includes all expenditures by the IRS program, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs, and the unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, and STTA trips.

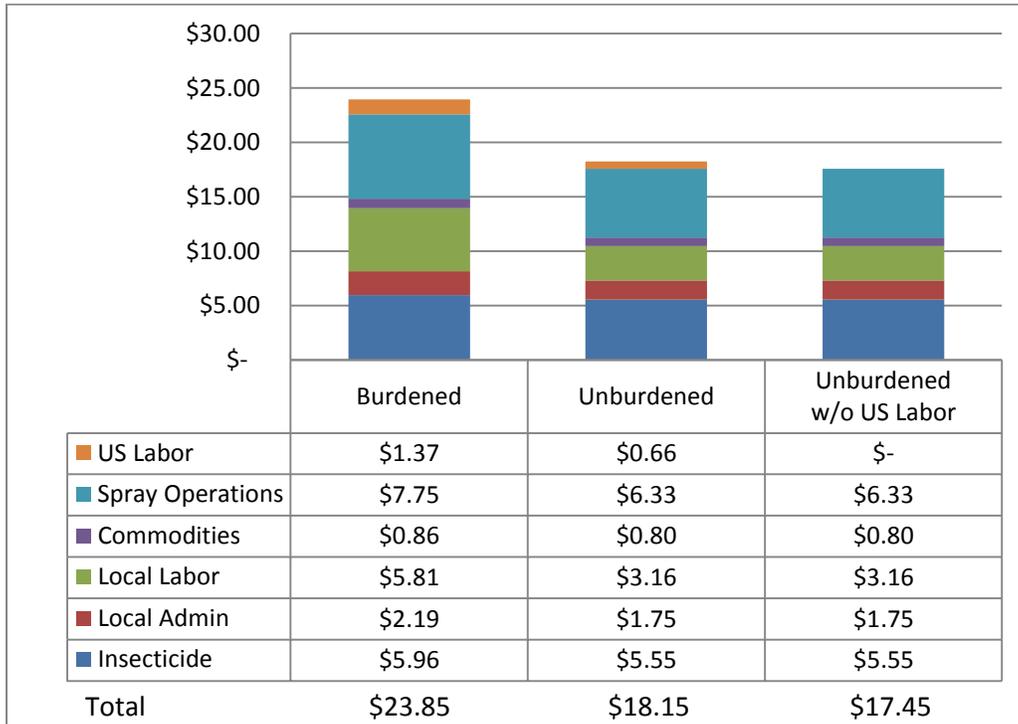
FIGURE SN4: SENEGAL IRS COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN



As noted in the Background section, the Senegal Year 2 IRS spray campaign protected 690,029 people from malaria transmission. Figure SN4 shows the unit costs per person protected burdened (\$7.16), unburdened (\$5.45), and unburdened without U.S.-based labor (\$5.24), itemized by cost category. The categories driving the unit cost include spray operations, insecticide, and local labor which together constitute 81.3 percent of the total burdened unit cost. In contrast to the administrative activity in the preceding figure, the local administration cost category excludes labor expenses, and the local administration and U.S.-based labor constitute 9.2 percent and 6.0 percent of the total burdened unit cost, respectively.

The burdened portion of AIRS Senegal program costs, as delivered through an international implementing partner, adds \$1.92 to the unit cost per person protected. The difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is 26.8 percent of the total unit cost. The difference between the burdened and unburdened unit costs, which can be called the “cost of burden,” is largely driven by local staff labor and spray operations, which together account for about 63.6 percent of the total “cost of burden.”

FIGURE SN5: SENEGAL IRS COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN



The Senegal IRS program sprayed 207,116 structures during the Year 2 spray campaign. Figure SN5 shows the unit costs per structure sprayed burdened (\$23.85), unburdened (\$18.15), and unburdened without U.S. labor (\$17.45), itemized by cost category. The burdened portion of AIRS Senegal program costs, as delivered through an international implementing partner, adds \$6.39 to the unit cost per structure sprayed.

15.4 COMPARISON: YEAR 1 AND YEAR 2

This section provides a comparison of the Senegal IRS program between Year 1 and Year 2, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, Year 1 expenditures have been adjusted to real 2013 U.S. dollars to allow for a more accurate comparison.

TABLE SN3: SENEGAL IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	Year 1	Year 2	Percent Change
People Protected	1,095,093	690,029	-37.0%
Structures Sprayed	306,916	207,116	-32.5%
Area Sprayed (100 m ²)	267,185	162,623	-39.1%

Table SN3, above, compares the year-on-year change in Senegal IRS program output measures. Overall, the size of the program shrank by about a third, with the number of

people protected decreasing by 37 percent, and the number of structures sprayed decreasing by 32.5 percent. As shown in Table SN1 in the Background, the average size of the structures sprayed in Year 2 was 78.5 m² compared to 87.0 m² in the previous year, and the slight decrease in average size of a structure is why the measure of area sprayed decreased more than the number of structures sprayed.

TABLE SN4: SENEGAL IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	Year 1 (Adjusted)	Year 2	Percent Change
Insecticide	\$ 1,410,553	\$ 1,235,219	-12.4%
Local Admin	\$ 384,210	\$ 452,937	17.9%
Local Labor	\$ 1,129,026	\$ 1,203,780	6.6%
Spray Operations	\$ 1,626,507	\$ 1,574,827	-3.2%
Commodities	\$ 262,967	\$ 177,554	-32.5%
U.S. Labor	\$ 162,732	\$ 294,446	80.9%
TOTAL	\$ 4,975,995	\$ 4,958,922	-0.7%

Table SN4, above, compares the year-on-year change in total program capital and recurrent expenditures, fully burdened. The total program cost decreased by 0.7 percent, but a more variable and nuanced breakdown of change in expenditures is provided by cost category. For example, look at two of the major cost drivers: insecticide expenditures decreased by 12.4 percent due to left-over stock and reduced spray area, while local labor increased by 6.6 percent due to hiring District Coordinators full time. Local administration increased in Year 2 mainly due to increased rent and utilities expenditures. U.S. labor increased primarily around environmental compliance and the spray campaign activities with STTA trips by the Project Director, Operations Director, Environmental Compliance Manager, and M&E Specialist. Spray Operations costs decreased by 3.2% despite reducing the scope from six districts to four. This is mainly due to the addition of IEC/BCC activity which was previously done by ChildFund Senegal in Year 1. In Year 2, AIRS Senegal also increased supervision (and accompanying transportation costs) which contributed to the minimal difference in operations costs between both years. Lastly, Year 2 costs also include structure enumeration activities which had not been conducted in Year 3.

TABLE SN5: SENEGAL IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	Year 1 (Adjusted)	Year 2	Percent Change
Per Person Protected	\$ 4.54	\$ 7.16	57.5%
Per Structure Sprayed	\$ 16.21	\$ 23.85	47.1%
Per Area Sprayed (100 m ²)	\$ 18.62	\$ 30.37	63.1%

Table SN5 compares the year-on-year change in program unit costs. Because the program size decreased by about a third and the total expenditures remained the

same in Year 2, the unit costs increased by about half in Year 2. Since two of the largest cost drivers, spray operations and local labor, had levels of expenditures that remained constant while program size decreased, these costs become a larger burden on the project per unit.

REFERENCES

- Abbott, Michele, and Ben Johns. January 2014. AIRS Ethiopia Monitoring and Evaluation Report for Community-Based IRS Operations. Bethesda, MD: PMI | Africa IRS (AIRS) Project Indoor Residual Spraying (IRS 2) Task Order Four, Abt Associates Inc. <http://www.africaairs.net/wp-content/uploads/2012/08/AIRS-Ethiopia-Community-based-IRS-pilot.pdf>
- Sine, Jeffrey, Rajeev Colaco, and Hannah Frawley. 2011. *An Economic Analysis of the Costs of Indoor Residual Spraying in 12 PMI Countries, 2008-2010*. Prepared by RTI International for PMI/USAID. http://www.pmi.gov/technical/irs/IRS_economic_analysis.pdf.
- Sine, Jeffrey, and Amy Doherty. 2010. *Indoor Residual Spraying (IRS) for Malaria Control IQC TO1: Analysis of 2008 Expenditures in Five IRS TO1 Countries*. Prepared by RTI International for PMI/USAID. http://www.fightingmalaria.gov/resources/reports/irs_iqc08.pdf
- Uganda Indoor Residual Spraying Project. 2011. *Uganda Indoor Residual Spraying (IRS) Project Costing Exercise Report 2011*. Bethesda, MD, USA: Uganda Indoor Residual Spraying project, Abt Associates.
- World Health Organization. 2013. *World Malaria Report 2013*. Geneva, Switzerland: WHO. http://www.who.int/malaria/publications/world_malaria_report_2013/en/