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# PMI IRS COUNTRY PROGRAMS: COMPARATIVE COST ANALYSIS

## AUGUST 11, 2011 – DECEMBER 31, 2012

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**Prepared by:** Abt Associates Inc.

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

## AUGUST 11, 2011 – DECEMBER 31, 2012

Michele Abbott
Ben Johns

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# ACRONYMS

| | |
|---|---|
| **AIRS** | Africa Indoor Residual Spraying Project |
| **A&P** | Anemia and Parasitemia |
| **CDC** | Centers for Disease Control and Prevention |
| **CREC** | *Centre de Recherche Entomologique de Contonou* |
| **DDT** | Dichlorodiphenyltrichloroethane |
| **EC** | Environmental Compliance |
| **G&A** | General and Administrative |
| **IEC** | Information, Education and Communication |
| **IRS** | Indoor Residual Spraying |
| **IT** | Information Technology |
| **LGA** | Local Government Authority |
| **$M^2$** | Square meters |
| **M&E** | Monitoring and Evaluation |
| **MOH** | Ministry of Health |
| **MOU** | Memorandum of Understanding |
| **NMCP** | National Malaria Control Program |
| **PMI** | President's Malaria Initiative |
| **PNLP** | *Programme National de Lutte contre le Paludisme* |
| **PPE** | Personal Protective Equipment |
| **RTI** | Research Triangle Institute International |
| **SOP** | Spray Operators |
| **STTA** | Short-Term Technical Assistance |
| **UCAD** | *Université Cheikh Anta Diop* |
| **USAID** | United States Agency for International Development |

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# 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 reducing 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 14 countries in sub-Saharan Africa. In 2012, PMI supported the Ministries of Health (MOHs) and National Malaria Control Programs (NMCPs) through the AIRS project in the following countries: Angola, Benin, Ethiopia, Ghana, Liberia, Madagascar, Mali, Mozambique, Nigeria, Rwanda, Senegal, Zambia, and Zimbabwe. In addition, USAID supported IRS activities in Burkina Faso through the AIRS project, which is also included in this report. PMI also supports IRS in Kenya and Tanzania outside of the AIRS project, through bilateral programs, and thus their costs are not included in this analysis.

In 2012, during the first year of AIRS project implementation, PMI asked Abt Associates, the implementing partner managing AIRS, to provide a cost analysis on the total and unit costs of the country IRS programs. This builds directly on previous PMI-sponsored IRS analyses: *Indoor Residual Spraying (IRS) for Malaria Control IQC TO1: Analysis of 2008 Expenditures in Five IRS TO1 Countries*[1] and *An Economic Analysis of the Costs of Indoor Residual Spraying in 12 PMI Countries, 2008-2010*[2]. Section 2.3 provides a broad look at PMI IRS program costs per person protected from 2008 through 2012.

### Objective

The objective of this activity was to conduct an analysis of the expenses that were incurred during project implementation between August 2011 and December 2012 in 11 of the 14 countries, using a methodology that can be repeated on an annual basis. The analysis assessed the overall level of spending in each of these countries, by program activity and by cost category, as well as the unit costs. Thus, it is important to note that this is a costing analysis, not a full economic analysis.

Specifically, the analysis calculated total program costs, unit cost per structure sprayed, unit cost per 100 square meters ($m^2$) sprayed, and unit cost per person protected.

The three PMI countries supported by AIRS not included in this analysis are Madagascar, Zambia, and Zimbabwe. The spray round in Madagascar extended past the December 31, 2012 cutoff date used for this cost analysis. Thus, while the start-up costs are included in the report, operational expenditures incurred through December 31 do not present an accurate picture of the full cost of program implementation. Madagascar's first year expenditures will be included in the subsequent year's costing analysis. In Zimbabwe and Zambia, PMI's AIRS project is not leading implementation of spray operations. In Zambia, the MOH National Malaria Control Centre is implementing IRS for malaria control as part of

[1] 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

[2] 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

an integrated vector management strategy. AIRS is responsible for the procurement and environmental compliance components of IRS activities in 20 PMI-supported districts. In Zimbabwe, PMI provides technical support to the NMCP through the AIRS project, as the Government of Zimbabwe has implemented IRS campaigns since the 1940s. Because the government provided overall oversight and management of the spray operations, both financial expenditure data and M&E data are unavailable to the costing team.

### 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 some program management, and will be shared with PMI's government partners and other key stakeholders to inform them of the country-specific costs associated with implementing an IRS program. PMI also intends to share findings broadly with global partners and post the analysis on their publicly available website.

## 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 the AIRS implementing partners' internal financial tracking systems for the full project. Inventory disposition lists and procurement records were collected from country teams and PMI, in order to determine the cost value of any donated or inherited 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) start-up, capital, and recurrent costs, 2) full project costs (burdened) vs. actual costs to implement program (unburdened) with and without U.S. labor, 3) technical program activities, and 4) cost categories. It also provides information for a more detailed analysis of cost drivers, program efficiencies, and cost effectiveness. All costs are normalized to 2012 US dollars, adjusted for currency and inflation.
4. *Define services and units of measure* – Two indicators included in the cost analysis are cost per person protected and cost per structure sprayed. However, because the average structure size and population density varies across countries, this costing analysis also reports the unit cost per 100 $m^2$ sprayed, which is a standardized unit of measure comparable across countries, and adjusts for this 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 10.7 million people were protected, ranging from about 115,000 people in Burkina Faso to over 2.7 million people in Mozambique. This corresponds to about 2.7 million total structures sprayed, ranging from about 37,000 structures in Burkina Faso to 547,000 structures in Ethiopia, and a total of over 320 million total square meters of structures sprayed.

The average structure size varied widely across countries, ranging from 54.4 square meters ($m^2$) in Ghana, to 210.8 $m^2$ in Liberia. The average people per structure sprayed ranged from 2.65 people in Ghana, to 8.98 people in Liberia. Due to these variances, the unit cost per 100 $m^2$ sprayed provides a standardized measure, which is more informative for cross-country comparisons, as well as for program management and decision-making purposes.

**TABLE ES1: IRS COUNTRY PROGRAM OUTPUTS IN 2012**

| Country | # Structures Sprayed | # Population Protected | # 100 $m^2$ Sprayed | Average Size of Structure ($m^2$) | Average People/ Structure Sprayed | # 100 m2 sprayed/ SOP day |
|---|---|---|---|---|---|---|
| Ethiopia | 547,421 | 1,506,273 | 524,334 | 95.8 | 2.75 | 9.3 |
| Mozambique | 536,558 | 2,716,176 | 974,470 | 181.6 | 5.06 | 23.0 |
| Ghana | 355,278 | 941,240 | 193,220 | 54.4 | 2.65 | 9.5 |
| Senegal | 306,916 | 1,095,093 | 267,185 | 87.1 | 3.57 | 10.9 |
| Rwanda | 236,610 | 1,025,181 | 415,653 | 175.7 | 4.33 | 11.9 |
| Benin | 210,380 | 652,777 | 127,105 | 60.4 | 3.10 | 8.2 |
| Mali | 206,295 | 762,146 | 192,968 | 93.5 | 3.69 | 10.6 |
| Angola | 141,782 | 676,090 | 195,518 | 137.9 | 4.77 | 14.1 |
| Liberia | 96,901 | 869,707 | 204,228 | 210.8 | 8.98 | 32.0 |
| Nigeria | 58,704 | 346,115 | 72,943 | 124.3 | 5.90 | 9.9 |
| Burkina Faso | 36,870 | 115,638 | 48,413 | 131.3 | 3.14 | 13.1 |
| **Average** | **248,520** | **973,312** | **292,399** | **123.0** | **4.36** | **13.9** |
| **Total** | **2,733,715** | **10,706,436** | **3,216,035** | | | |

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: 2012 IRS PROGRAM UNIT COSTS**

| Program Size (# of structures sprayed) | Country | Cost per Structure Sprayed | Cost per Person Protected | Cost per Area Sprayed (100 $m^2$) | Type of Insecticide Used |
|---|---|---|---|---|---|
| **Large Programs** (230,000 – 550,000) | Ethiopia | $ 8.44 | $ 3.07 | $ 8.81 | Pyrethroid & Carbamate |
| | Mozambique | $ 9.90 | $ 1.96 | $ 5.45 | Pyrethroid |
| | Ghana | $ 15.84 | $ 5.98 | $ 29.13 | Pyrethroid & Organophosphate |
| | Senegal | $ 15.63 | $ 4.38 | $ 17.96 | Carbamate |
| | Rwanda | $ 15.96 | $ 4.78 | $ 11.78 | Pyrethroid |
| **Medium Programs** (90,000 – 230,000) | Benin | $ 16.97 | $ 5.47 | $ 28.08 | Carbamate |
| | Mali | $ 22.16 | $ 6.00 | $ 23.69 | Carbamate |
| | Angola | $ 21.77 | $ 4.56 | $ 15.78 | Pyrethroid |
| | Liberia | $ 38.72 | $ 4.31 | $ 18.37 | Pyrethroid & Carbamate |
| **Small Programs** (25,000 – 90,000) | Nigeria | $ 33.14 | $ 5.62 | $ 26.67 | Pyrethroid |
| | Burkina Faso | $ 36.08 | $ 11.50 | $ 27.48 | Carbamate |
| **Unweighted Average** | | **$ 21.33** | **$ 5.24** | **$ 19.38** | |

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 $5.24 across the countries, ranging from $1.96 in Mozambique to $11.50 in Burkina Faso. The average cost per structure sprayed was $21.33 across countries, ranging from $8.44 in Ethiopia to $38.72 in Liberia. The average cost per 100 $m^2$ sprayed was $19.38, ranging from $5.45 in Mozambique to $29.13 in Ghana (both of which are large programs).

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 100 $m^2$ sprayed has a greater variation within program size groups than the other unit costs, and the correlation between program scale and unit cost therefore weakens considerably within this unit cost analysis. The reasons why are discussed below in the cost driver analysis.

### Cost Drivers

Country program expenditures were divided into five cost categories: spray commodities, spray operations, full-time local labor, local administration, and US-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.

*Spray Commodities: 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. The type of insecticide class used in spray campaigns is causing the wide variation in country unit costs, and accounts for 81 percent of variation **within** the spray commodities portion of the total unit costs, but also accounts for 20 percent of the variation across the total country unit costs per area sprayed (100 $m^2$). On average, the portion of unit costs spent on insecticides is $1.72 for pyrethroids, $5.82 for carbamates, and $7.91 for organophosphates.

*Spray Operations: Program Scale and Country Context*

Spray operations, which includes costs associated with temporary labor of spray operators (SOPs), ground transportation, and warehousing costs, accounted for an average of 32 percent of the total unit cost per area sprayed. Additionally, the spray operations portion of the unit cost accounts for about 26 percent of the variation between country unit costs. Ghana, a large country program, was an outlier with the most expensive spray operations portion of the unit cost across all countries. This may be due in large part to the geography of the spray coverage area where structures are spread far apart, causing higher inputs of SOP and ground transportation costs. Mozambique had a low spray operations portion of the unit cost, and while the spray coverage area was almost double the next largest program (Ethiopia), each SOP was able to cover an average of 2,300 $m^2$ per day. Although temporary labor in Mozambique is the most inexpensive across countries, these findings may suggest efficiencies in program structure or implementation.

*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). Unlike spray commodities and spray operations, local labor unit cost tends to be lower for larger programs, and countries with large programs spend fewer labor hours per 100 $m^2$ sprayed than countries with smaller programs. This suggests that local labor is, to some extent, a fixed cost, but the correlation is not fully explanatory. It is clear that the price of labor in some countries (e.g., Senegal and Benin) is simply more expensive than in others (e.g., Ethiopia and Mozambique).

### Limitations

Limitations in available data influence the results. Part of the insecticide included in this report was procured externally, either inherited through a previous IRS program, or purchased directly by PMI or host governments. In Ethiopia and Rwanda in particular, government-procured insecticide cost information was not available, so this report estimates the full value using the average unit price per sachet of each insecticide class. Additional in-kind contributions by host governments may be provided (e.g., supervision), but this is generally unknown or not accurately tracked 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 (Ethiopia and Liberia completed two spray campaign rounds within 2012). 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 100 $m^2$ 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).

## CONCLUSIONS

### Unit of Measure

From a macro view, the number of people protected and number of structures sprayed are two important indicators of IRS programs. In addition, cost per person protected provides a very useful indicator for programmatic management and decision making at the country level. For example, if a country is interested in expanding IRS coverage, they can use the cost per person protected to calculate approximately how much money it would cost to protect more people. In 2012, IRS programs' cost per person protected ranged from $1.96 in Mozambique to $11.50 in Burkina Faso, with an unweighted average of $5.24.

When comparing unit costs across country programs, it is difficult to determine if differences are due to the average structure size or number of people per structure, among other external factors such as: different commodity or labor prices, different quantities of inputs, or the type of implementation model used. Since the average structure size and people living per structure varies across countries, the number of 100 $m^2$ sprayed removes factors outside the control of IRS programs, and provides a standardized measure as the best cross-country comparison to inform implementation management.

- Providing country unit costs per 100 $m^2$ sprayed and per person protected provide appropriate and informative analyses for programmatic and implementation management and decision-making by PMI as well as host governments.

### Program Scale

Broadly speaking, unit costs of large programs are less expensive than small programs, however…

- Even within each program size group, every country is different in terms of context and in the unit costs per 100 $m^2$ sprayed. Using the most standardized comparison unit cost available, there is no 'one-price-fits-all' for IRS across countries. For example, in the large program group, the cost per 100 $m^2$ in Mozambique and Ethiopia is $5.45 and $8.81 respectively; however Senegal and Ghana unit costs are $17.96 and $29.13, respectively.

*So what is driving the cost differences across countries?*

**Cost Drivers**

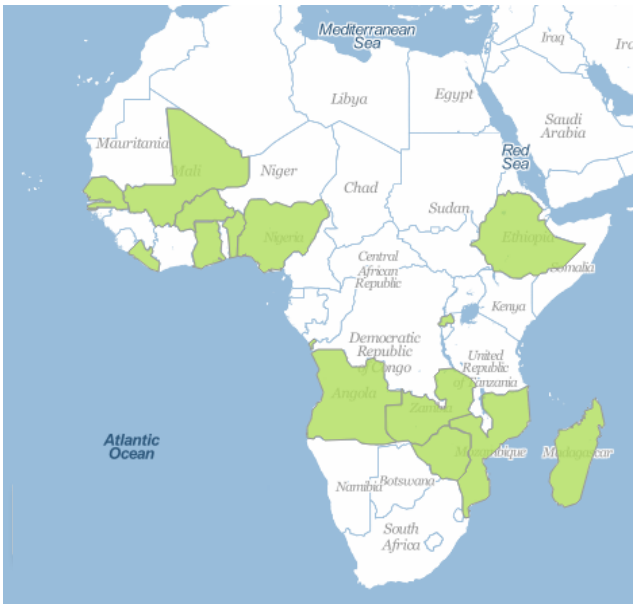
- The insecticide class used in spray campaigns is one of the most important cost drivers. On average, the portion of unit costs spent on insecticides is $1.72 for pyrethroids, $5.82 for carbamates, and $7.91 for organophosphates. An average of 24 percent of the unit cost was spent on spray commodities.
- The portion of the unit costs spent on both spray operations and full-time local staff labor is largely due to country context: geography of spray coverage area, number of spray rounds per year, and general cost of living (prices for labor, fuel, etc.). An average of 31 percent was spent on spray operations.
- Full-time local staff labor is responsible for an average of 23 percent of the total cost per 100 $m^2$ sprayed, compared to 7 percent spent on U.S.-based labor and STTA.
- Important quality assurance technical activities (i.e., entomology; information, education and communication; environmental compliance; and M&E) are not driving unit costs. These four activities are on average $2.28 per 100 $m^2$ sprayed, or make up about 12 percent of the total unit cost.
- Fixed capital costs and local administration expenses are small relative to overall program implementation costs, at an average of 14 percent of the total unit cost.

# 1. INTRODUCTION

## 1.1 BACKGROUND

In 2011, 153 million people were protected through multiple donors' Indoor Residual Spraying (IRS) programs, of which about half live in Africa.[3] The President's Malaria Initiative (PMI) in particular is a key component of the U.S. Government's Global Health Initiative, and has been implementing IRS programs since 2006. In May 2009, the PMI strategy was revised to achieve Africa-wide impact by halving the burden of malaria in 70 percent of at-risk populations in sub-Saharan Africa – or approximately 450 million people. With a goal of limiting exposure to malaria and reducing incidence and prevalence of malaria, PMI has provided program support to the Ministries of Health (MOHs) and National Malaria Control Programs (NMCPs) in sub-Saharan Africa since 2006. The current central PMI IRS implementation program is the Africa Indoor Residual Spraying (AIRS) project, which began August 11, 2011. As shown in Figure 1, during the first calendar year of program implementation (2012), the project has supported 13 PMI countries (Angola, Benin, Ethiopia, Ghana, Liberia, Madagascar, Mali, Mozambique, Nigeria, Rwanda, Senegal, Zambia, and Zimbabwe), as well as USAID-funded IRS in Burkina Faso.

**FIGURE 1: MAP OF PMI IRS IMPLEMENTATION UNDER AIRS PROJECT**




Following PMI guidance, AIRS project implements all aspects of the IRS process, including, but not limited to:

- Planning and forecasting IRS programming with government, community leaders, and other key stakeholders
- Procuring insecticides and spray equipment/materials
- Managing the supply chain of all IRS equipment and materials
- Working with local leaders and organizations to ensure community awareness and knowledge of IRS campaign objectives, benefits, and timelines; and working with communities to provide further buy-in and further sensitization regarding malaria control for neighboring communities
- Implementing IRS campaigns in targeted areas
- Ensuring environmental compliance (EC) of IRS campaigns, and materials used in the campaigns
- Monitoring and evaluating all program activities
- Completing entomological surveillance, and testing insecticide effectiveness

[3] Source: WHO, World Malaria Report 2012 Fact Sheet. http://www.who.int/malaria/en/

One of PMI's guiding principles of the AIRS project is to ensure sustainability by developing local knowledge and technical capacity, in order to empower country governments, the private sector, and communities with the ability and will to lead future efforts concerning IRS and malaria control. The project works closely with MOHs and NMCPs, health centers, and community leader, to encourage and empower governments and communities to be involved in future 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.

In 2012, PMI asked the AIRS project to provide a cost analysis on the total and unit costs of the IRS country programs incurred during the first year of the AIRS project implementation.

## 1.2 OBJECTIVE

This report presents the findings of a cost analysis of the expenses that were incurred during project implementation between August 2011 and December 2012 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 structure sprayed, unit cost per area sprayed (in units of 100 $m^2$), and unit cost per person protected are stratified using burdened and unburdened cost, and U.S.-based labor costs. This was requested in order for PMI to understand its total project costs (burdened) as well as the actual costs of implementing an IRS program in-country with and without US-based staff labor.

Additionally, the analysis separates "start-up" expenditure items (one-off costs specifically identified by the technical team of the current IRS project), 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 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 three PMI countries supported by AIRS not included in this analysis are Madagascar, Zambia, and Zimbabwe. The spray round in Madagascar extended past the December 31, 2012 cutoff date used for this cost analysis. Thus, while the start-up costs are included in the report, operational expenditures incurred through December 31 do not present an accurate picture of the full cost of program implementation. Madagascar's first year expenditures will be included in the subsequent year's costing analysis. In Zimbabwe and Zambia, PMI's AIRS project is not leading implementation of spray operations. In Zambia, the MOH National Malaria Control Centre is implementing IRS for malaria control as part of an integrated vector management strategy. AIRS is responsible for the procurement and environmental compliance components of IRS activities in 20 PMI-supported districts. In Zimbabwe, PMI provides technical support to the NMCP through the AIRS project, as the Government of Zimbabwe has implemented IRS campaigns since the 1940s. Because the government provided overall oversight and management of the spray operations, both financial expenditure data and M&E data are unavailable to the costing team.

## 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 some program management, and will be shared with PMI's government partners and other key stakeholders to inform them of the country-specific costs associated with implementing an IRS program. PMI also intends to share findings broadly with global partners and post the analysis on its publicly available website.

# 2. APPROACH

## 2.1 METHODOLOGY

There are three previously existing costing analyses of PMI IRS programs: one conducted by the Abt Associates-led IRS program in Uganda,[4] the other two by Research Triangle Institute International (RTI). The most recent RTI report is an economic analysis covering 12 countries from 2008 to 2010.[5,6] Links to these reports are included in the footnotes below. Overall, the methodology used in this report builds upon the previous one and is more inclusive in terms of program costs. Key differences in methodology and cost comparisons of IRS programs from 2008 through 2012 are detailed in Section 2.3.

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 to complete the costing analysis:

1. *Verify and finalize target audience and objectives of 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.
2. *Collect project expenditures and output measures* – Financial data were collected from Abt Associates' internal financial tracking systems for the full AIRS project, including the project's initial start-up and overarching project management. Project-wide start-up funding was not country-specific, but expenditures were allocated and assigned to specific countries. Inventory disposition lists and procurement records were collected from country teams and PMI to determine the value of any inherited 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 framework, depicted below in Figure 2, was developed in order 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) start-up, capital, and recurrent costs, 2) burden type, 3) technical programs activities, and 4) cost categories. These will all be explained in further detail below.

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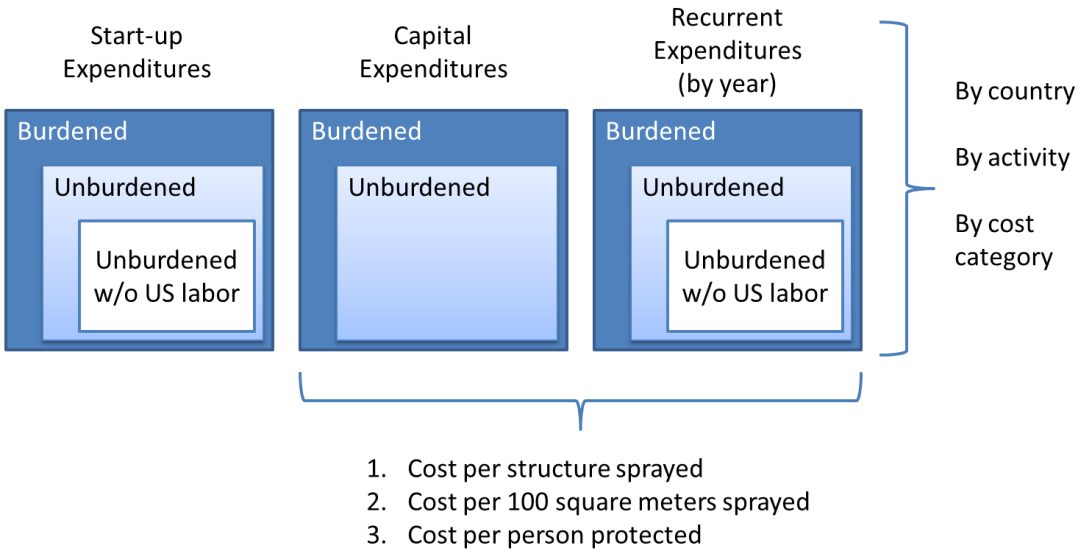
[4] Uganda Indoor Residual Spraying project. 2011. *Uganda Indoor Residual Spraying (IRS) Project Costing Exercise Report 2011*. Uganda Indoor Residual Spraying project, Abt Associates Inc.

[5] 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

[6] 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

**FIGURE 2: COSTING METHODOLOGY FRAMEWORK**




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

- *Start-up, capital, and recurrent costs:*
  - Start-up costs include 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. The costing team met with AIRS technical staff to determine the country-specific dates that mark the end of start-up operations and the beginning of program implementation. Labor and operational expenses incurred before this date are considered start-up 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.[7]
  - Recurrent costs include all operational expenditures incurred a) after the start date of program implementation, and b) on an annual basis.
- *Burdened versus Unburdened costs*: This analysis is conducted using burdened costs (explained below), and differentiates between the two types of costs to demonstrate to the reader and target audience the difference between the total (burdened) program costs vs. the cost for the actual IRS interventions with or without US labor (unburdened costs).

[7] Some expenditure items (listed as "Government Property," "Supplies," or "Materials") did not include enough identifying information to discern whether these expenditures were capital or recurrent costs. Following AIRS program assumptions, the costing 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.

- Burdened costs include all the unburdened costs with the addition of the expense to run program implementation through Abt Associates. Abt Associates' burden is generated by 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 or by U.S. expatriates (as opposed to in-country local staff), as well as expenses incurred under STTA.

- *Activity categories*:
  - AIRS program teams internally track financial expenditures by the following activities: Administration, Entomology, EC, Insecticide Purchase, IEC, Equipment and Supplies, M&E, Spray Planning, Spray Campaign Operations, and Post-Spray Operations.
- *Cost categories and expenditure items:*
  - In collaboration with the AIRS project staff, the costing team used an iterative process to determine what types of expenditure items should be assigned to which cost categories for the AIRS project. Table 1, below, 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 | Start-up Expenditures | Capital Expenditures | Recurrent Expenditures |
|---|---|---|---|
| **Spray Operations** | (None) | (None) | • Transportation and vehicle use for local staff and spray operators<br>• Warehousing<br>• Technical consultants and temporary labor, including spray operators<br>• Subcontracts for technical activities*<br>• Training, conferences, and seminars for technical activities<br>• Honoraria and misc. professional services |
| **Spray Operations Commodities** | (None) | • Spray pumps<br>• Reusable personal protective equipment (PPE)<br>• Unidentified govt. property > $500 | • Insecticide<br>• Disposable PPE<br>• Shipping of insecticides and equipment<br>• Unidentified govt. property < $500 |
| **Local Labor** | • Local and third country national staff labor before country-specific start date<br>• Local staff relocation | (None) | • Local and third country national staff labor after country-specific program start date<br>• Local staff allowances and bonuses |

| IRS Cost Category | Start-up Expenditures | Capital Expenditures | Recurrent Expenditures |
|---|---|---|---|
| **Local (in-country) Administration** | • Office start-up maintenance and renovation<br>• Rent and utilities before country-specific start date<br>• Admin consultants | • Vehicles (bought or inherited)<br>• Site office furniture, equipment, and supplies (bought or inherited)<br>• Unidentified govt. property > $500 | • Office rent, utilities, maintenance after country-specific start date<br>• Information Technology (IT) support<br>• Admin travel and transportation<br>• Postage and shipping for Remote Office Vouchers and admin items<br>• Training, conferences, and seminars on admin activities<br>• Unidentified govt. property < $500 |
| **U.S.-Based Labor and STTA** | • U.S.-based labor before country-specific start date<br>• STTA expenses<br>• Expat salaries and allowances | (None) | • U.S.-based labor after country-specific start date<br>• U.S.-based support services (communications, human resources, IT, etc.)<br>• STTA: airfare, lodging, per diem, and other travel expenses<br>• Home office management<br>• Network charges |

* 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.

4. *Define services and units of measure* – 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 across countries, this costing analysis also reports the unit cost per 100 square meters ($m^2$) sprayed, as a standardized measure. The number of square meters sprayed is a standardized unit of measure comparable across countries, and adjusts for this size difference in structures. As such, the unit cost will be more informative for program management and decision-making purposes. All costs are reported in 2012 US dollars.
5. *Cost analysis and report writing* – The costing team analyzed all cost data according to the costing objectives and methodology, as portrayed in Figure 2. All costs are reported in 2012 real US dollars. AIRS staff verified preliminary results and provided further country and program context, as necessary.

## 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.[8] Due to lack of available information on the full useful life of some items (i.e., how long they have been used previously, or how long they will continue to be used after the life of the project), capital items were depreciated across the three years of AIRS project implementation[9]. This assumption may inflate the costs presented here to some extent, since some of the items (i.e., vehicles, office

[8] 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.
[9] Therefore, each capital item total cost was divided by three (years) to find the 2012 value.

equipment) will have a useful life of greater than three years and/or have a salvage cost, while others do not (PPE, software licensing).

### 2.2.2 Valuation of Inherited Items

The inventory disposition lists for donated or inherited items lists each item, quantity, unit cost, and total value. In Liberia, Ethiopia, 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 its 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 Associate's 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 staff. Note that other overhead expenses list whether they are linked to U.S.-based or local staff.

### 2.2.4 Determining Expenditure Status

Assigning expenditure items to either start-up or recurrent costs is dependent on the individual program. Country-specific dates were decided upon to mark the period of start-up operations (from the beginning of start-up operations through the beginning of program implementation) and the period of program implementation, which runs through December 31, 2012. Table 2 lists these dates for each country. Expenditures incurred during the initial program preparation period are included in the program Start-Up Operations cost, and those incurred during the program implementation period are included in the Recurrent cost.

**TABLE 2: COUNTRY PROGRAM START DATES**

| Country | Start-up Operations Start Date | Program Implementation Start Date[10] |
|---|---|---|
| Angola | October 24, 2011 | April 1, 2012 |
| Benin | October 22, 2011 | January 10, 2012 |
| Burkina Faso | October 10, 2011 | January 1, 2012 |
| Ethiopia | November 7, 2011 | February 1, 2012 |
| Ghana | October 3, 2011 | February 10, 2012 |
| Liberia | October 24, 2011 | January 10, 2012 |
| Madagascar | February 12, 2012 | August 15, 2012 |
| Mali | October 9, 2011 | February 1, 2012 |
| Mozambique | February 12, 2012 | April 1, 2012 |
| Nigeria | October 14, 2011 | February 1, 2012 |
| Rwanda | November 28, 2011 | March 1, 2012 |
| Senegal | October 3, 2011 | January 1, 2012 |

[10] The AIRS project transition of country IRS programs from the previous implementer was organized in a graduated transition. Thus, country programs under AIRS were not necessarily engaged in start-up operations from the beginning of the project, and have varying program implementation start dates.

### 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 100 $m^2$ sprayed. 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 cheaper than in other countries (such as Angola).

The geography of the spray campaign coverage area will impact program costs as well. In campaign areas where structures are spread out, the campaign will require an increase in quantity of inputs (labor of spray operators and ground transportation), which can also result in an increased duration of the spray campaign. In a spray coverage area where structures are situated closer together, the spray campaign will tend to require fewer of these inputs and spraying can be concluded quicker as there is less time spent travelling between sites.

Any costs incurred within the first five months of project award, August 11, 2011 through December 31, 2011, were minimal, and are considered start-up costs. 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 as spray campaign rounds in Madagascar were not finalized within the 2012 calendar year. Additionally, AIRS programs in Ethiopia and Liberia completed two spray campaign rounds within the 2012 calendar year. The analysis carefully avoided double-counting.

In order to accurately cost all AIRS project expenditures, this costing analysis includes all insecticides inherited and/or purchased in the 2012 calendar year. However, if these insecticides are not used until 2013, the costs associated with them will need to be rolled over and included in the subsequent costing analyses as inherited items. In Ethiopia and Rwanda, the IRS program received pyrethroid insecticides purchased by the government. The cost of these insecticides is included, and the value was estimated by multiplying the total number of insecticide sachets by the average cost of a pyrethroid sachet in 2012.

## 2.3 PMI IRS PROGRAM COSTS: 2008 THROUGH 2012

As mentioned earlier, while this costing exercise uses a similar methodology as the previous IRS costing analysis done for PMI by the implementing partner RTI ('RTI report'), some key differences have been adopted due to the objectives of this report and the reality of the current IRS programs. Key differences between the AIRS methodology and the RTI methodology are as follows. This costing report:

- Removed the "Nairobi labor" cost category used in the RTI report. The IRS programs under RTI were implemented with a regional office based in Nairobi. Thus, in the unit costs below, US-based and Nairobi-based labor have been combined.
- Included all financial expenditures incurred under the AIRS project. The previous RTI report noted the exclusion of some program costs indirectly related to IRS implementation such as insectaries.
- Obtained inventory dispositions and procurement records, and included the cost of all inherited and externally procured items.

The following reports the costs per person protected where PMI has implemented IRS country programs from 2008 through 2012. Please note that the PMI IRS program in Liberia was not implemented in 2008. Unit costs were calculated using the data presented in the 2011 RTI Report, as well as additional financial information provided for this purpose by PMI and RTI.

Figure 3 (page 13) presents the unit cost per person protected throughout PMI-funded IRS programs. The unit costs have all been adjusted for currency and inflation and are reported in 2012 US dollars. Adjustments were made in two ways:

1. *Insecticide costs*: Insecticide costs were provided as the actual expenditures incurred in the year they were purchased. To adjust these costs to 2012 US dollars, the costing team determined the unit price per sachet in 2012 (on a country-by-country basis), and multiplied this by the quantity of sachets purchased in the previous years. Where country programs changed the insecticide type (i.e., switched from pyrethroid to carbamate insecticide) and the unit cost of a particular insecticide were not available for that country in 2012, the 2012 average unit price for that type of insecticide across all available country data was used to multiply by the total number of sachets. Note that there was no data available for DDT[11] prices in 2012, so these costs remain as they were incurred.
2. *All other expenditures*: All other expenditures were adjusted for inflation using the World Bank reported GDP deflator (annual percent).[12] The costs for IRS programs in 2008, 2009 and 2010, were provided by RTI, and had already been adjusted to 2010 US dollars. However, the GDP deflator reported by the World Bank for these years has been updated since RTI made the adjustments. This report assumed all costs provided were in (as accurately as possible) 2010 US dollars, and then adjusted these to 2012 US dollars. Historical exchange rates were taken from the International Monetary Fund's World Economic Outlook database.[13]

Table 3 and Figure 3 present the number of people protected by each IRS country program by year, which provides additional contextual information about each year of the countries' IRS programs. This demonstrates that as expected, comparing unit costs per person protected across country programs does show economies of scale.

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[11] DDT was used by the following country programs: Ethiopia in 2008 and 2009, and Mozambique in 2008 and 2009.
[12] World Bank database. Inflation, GDP deflator (annual percent). Access September 6, 2013. http://data.worldbank.org/indicator/NY.GDP.DEFL.KD.ZG
[13] International Monetary Fund, World Economic Outlook Database. Updated April 2013, Accessed September 9, 2013. http://www.imf.org/external/pubs/ft/weo/2013/01/weodata/index.aspx

**TABLE 3: COMPARISON OF IRS PROGRAM OUTPUTS (PEOPLE PROTECTED)**

| Country | Number of People Protected | | | | |
|---|---|---|---|---|---|
| | 2008 | 2009 | 2010 | 2011 | 2012 |
| Angola | 685,908 | 485,974 | 649,842 | 689,668 | 676,090 |
| Benin | 521,738 | 512,491 | 636,448 | 426,232 | 652,777 |
| Burkina Faso | - | - | 118,691 | 110,064 | 115,638 |
| Ethiopia | 1,000,526 | 1,539,163 | 4,064,389 | 2,919,450 | 1,506,273 |
| Ghana | 601,973 | 708,103 | 849,620 | 966,747 | 941,240 |
| Liberia | - | 163,149 | 420,537 | 834,671 | 869,707 |
| Mali | 420,580 | 497,122 | 440,815 | 697,512 | 762,146 |
| Mozambique | 1,457,142 | 2,263,409 | 2,945,721 | 2,825,648 | 2,716,176 |
| Rwanda | 885,957 | 1,329,340 | 1,365,949 | 1,571,625 | 1,025,181 |
| Senegal | 645,346 | 661,814 | 959,727 | 887,315 | 1,095,093 |

**FIGURE 3: NUMBER OF PEOPLE PROTECTED, BY COUNTRY AND YEAR**

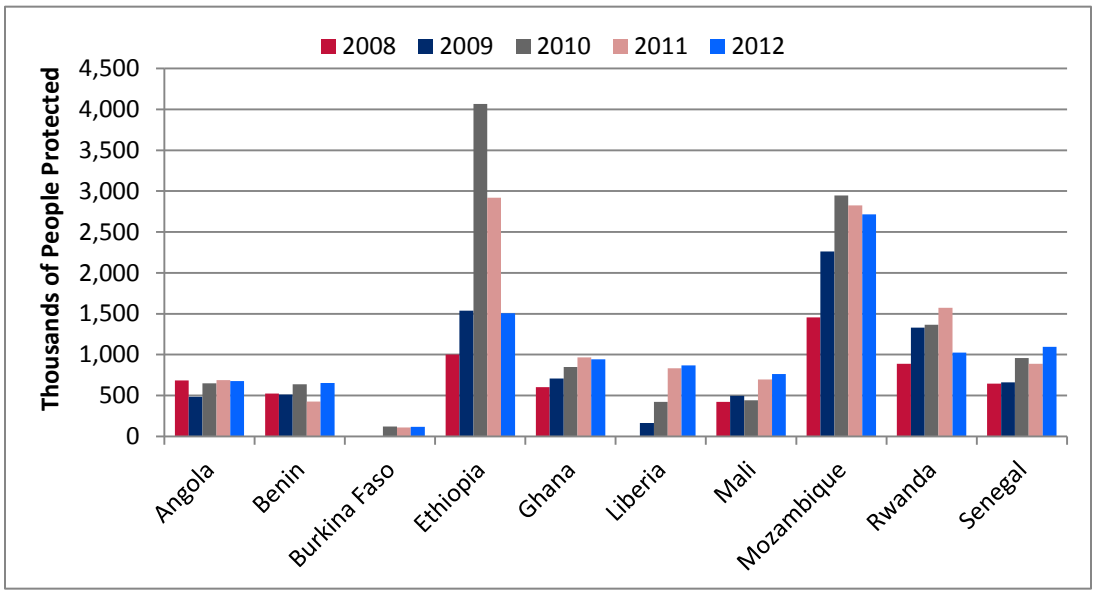
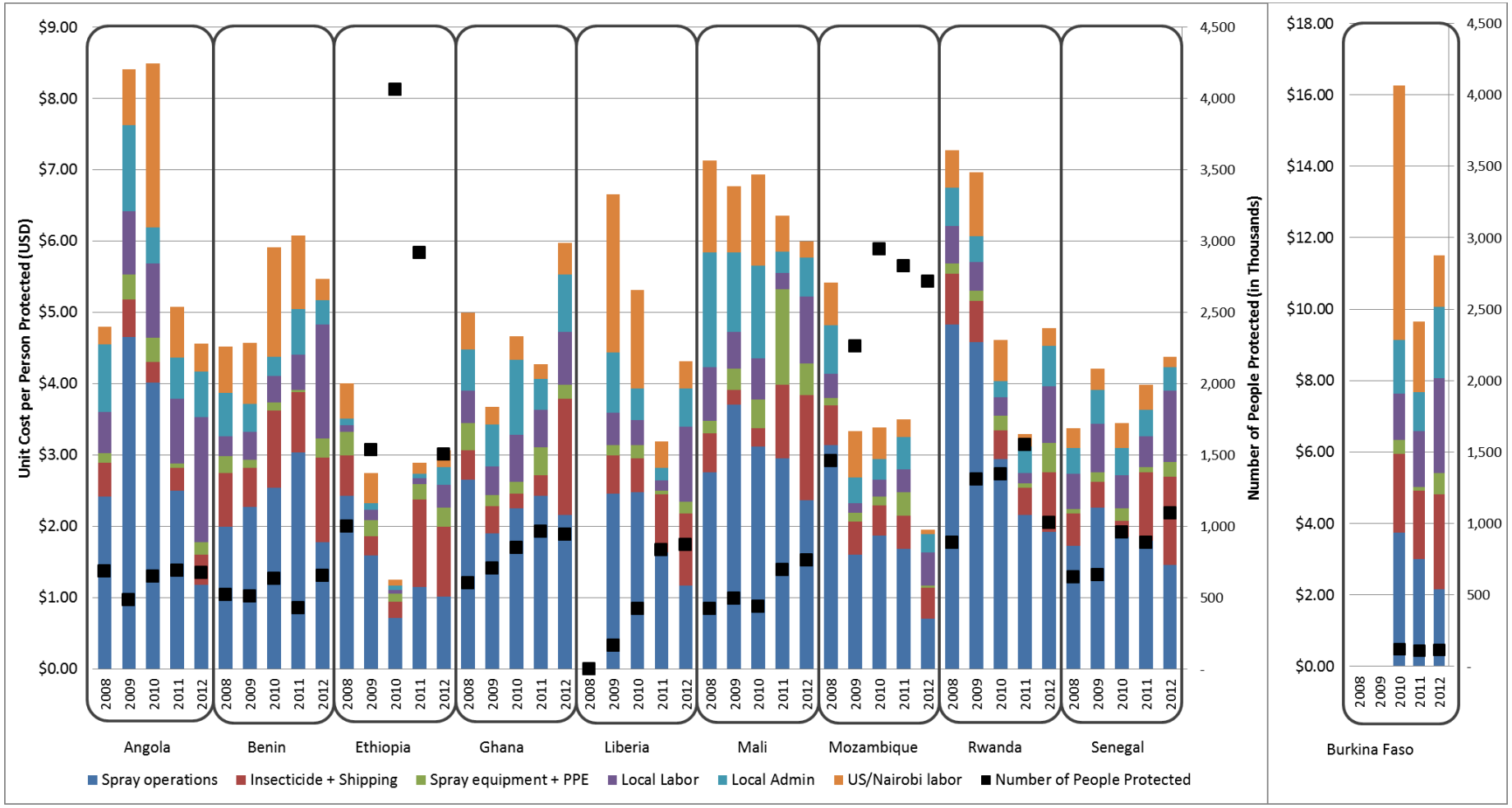



Figure 4, on the following page, presents the unit costs per person protected (y-axis on the left), as well as the number of people protected (y-axis on the right). In Ethiopia, the unit cost fluctuates drastically, but this is primarily due to program scale and the number of people protected each year. On the other hand, the unit costs in Mozambique have steadily decreased even though the program scale has been decreasing, which is counter-intuitive and may demonstrate efficiencies. In Benin, the unit cost and number of people protected have stayed fairly stable (compared to some of the fluctuation in other countries), but there is a distinct change between the portion of the unit cost spent on US and Nairobi based labor (orange) and local staff labor (purple) in the last year of implementation. In Senegal, unit costs have stayed steady, but there is a clear decrease in the portion of the unit cost spent on 'spray operations' and an increase in the portion spent on 'insecticides.'

**FIGURE 4: IRS PROGRAM COST PER PERSON PROTECTED & NUMBER OF PEOPLE PROTECTED (2008 – 2012)**




Burkina Faso is included on the farthest right side of Figure 4 and has a separate unit cost vertical axis, but the same number of people protected vertical axis. Burkina Faso received USAID-supported IRS from 2010 to 2012, and these programs covered a much smaller population than the other country IRS programs, an average of about 20 percent less than the next smallest program (Benin). Due to economies of scale, and the low number of people protected, Burkina Faso's unit costs were twice as expensive as the rest of the programs.

Table 4 below shows the range and average of unit costs per person protected in each year, excluding Burkina Faso. While the average unit cost per person protected has followed a downward trend over the past five years, there is still a significant amount of variation of unit costs between countries.

**TABLE 4: IRS UNIT COST PER PERSON PROTECTED**

| Year | Min | Max | Average |
|---|---|---|---|
| 2008 | $ 3.38 | $ 7.27 | $ 5.19 |
| 2009 | $ 2.75 | $ 8.41 | $ 5.26 |
| 2010 | $ 1.26 | $ 8.49 | $ 4.89 |
| 2011 | $ 2.89 | $ 6.35 | $ 4.30 |
| 2012 | $ 1.96 | $ 6.00 | $ 4.50 |

Table 5, below, provides the type of insecticide used in each country by year as additional contextual information on country programs. As insecticide resistance becomes increasingly problematic, country IRS programs are changing the type of insecticide being used and these insecticides are becoming increasingly expensive.

**TABLE 5: TYPES OF INSECTICIDE USED**

| Country | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Angola | Pyrethroid | Pyrethroid | Pyrethroid | Pyrethroid | Pyrethroid |
| Benin | Carbamate | Carbamate | Carbamate | Carbamate | Carbamate |
| Burkina Faso | - | - | Carbamate | Carbamate | Carbamate |
| Ethiopia | DDT | DDT | Pyrethroid | Pyrethroid & Carbamate | Pyrethroid & Carbamate |
| Ghana | Pyrethroid | Pyrethroid | Pyrethroid | Pyrethroid | Pyrethroid & Organophosphate |
| Liberia | - | Pyrethroid | Pyrethroid | Pyrethroid & Carbamate | Pyrethroid & Carbamate |
| Mali | Pyrethroid | Pyrethroid | Pyrethroid | Carbamate | Carbamate |
| Mozambique | DDT & Pyrethroid | DDT & Pyrethroid | Pyrethroid | Pyrethroid | Pyrethroid |
| Rwanda | Pyrethroid | Pyrethroid | Pyrethroid | Pyrethroid | Pyrethroid |
| Senegal | Pyrethroid | Pyrethroid | Pyrethroid | Pyrethroid & Carbamate | Carbamate |

# 3. Cross-Country Results

## 3.1 Background

Table CC1 presents the coverage provided by PMI's AIRS project spray campaigns in each country. The number of 100 $m^2$ sprayed was calculated by multiplying the total number of sachets used by the estimate of 250 $m^2$ coverage provided by each sachet, and divided by 100 $m^2$ in order to develop a more usable unit of measure. Note that in Ethiopia, total number of sachets was multiplied by 200 $m^2$ because the amount of insecticide per sachet is less than in other countries and thus it covers less surface area. Number of people per structure sprayed was calculated by dividing the total population protected by the number of structures sprayed, and ranged from about 2.7 in Ghana to about 9 in Liberia.

**TABLE CC1: PROJECT SPRAY COVERAGE IN 2012, BY COUNTRY**

| Country | # Structures Sprayed | # Population Protected | # 100 $m^2$ Sprayed | Average Size of Structure ($m^2$) | Average People/ Structure Sprayed |
|---|---|---|---|---|---|
| Ethiopia | 547,421 | 1,506,273 | 524,334 | 95.8 | 2.75 |
| Mozambique | 536,558 | 2,716,176 | 974,470 | 181.6 | 5.06 |
| Ghana | 355,278 | 941,240 | 193,220 | 54.4 | 2.65 |
| Senegal | 306,916 | 1,095,093 | 267,185 | 87.1 | 3.57 |
| Rwanda | 236,610 | 1,025,181 | 415,653 | 175.7 | 4.33 |
| Benin | 210,380 | 652,777 | 127,105 | 60.4 | 3.10 |
| Mali | 206,295 | 762,146 | 192,968 | 93.5 | 3.69 |
| Angola | 141,782 | 676,090 | 195,518 | 137.9 | 4.77 |
| Liberia | 96,901 | 869,707 | 204,228 | 210.8 | 8.98 |
| Nigeria | 58,704 | 346,115 | 72,943 | 124.3 | 5.90 |
| Burkina Faso | 36,870 | 115,638 | 48,413 | 131.3 | 3.14 |
| **Average** | **248,520** | **973,312** | **292,399** | **123.0** | **4.36** |

The average size of each structure sprayed was calculated by dividing the total number of square meters sprayed by the number of structures sprayed in each country. Average structure size provides additional contextual understanding of a country's spray campaign. Structure size varied widely between countries, from an average of 54.4 $m^2$ in Ghana to almost four times that, 210.8 $m^2$, in Liberia. The average size of structures sprayed across all 2012 IRS countries was 123 $m^2$ (not weighting for the different number of structures sprayed between countries). Since an average insecticide sachet covers 250 $m^2$ of structure, on average each sachet covered just over two structures.

PMI's AIRS project began on August 11, 2011. The cost of project start-up operations for country programs comprises all expenditure items incurred by country programs between the start of the project through the start date of program implementation, listed in Table CC2. All expenditures incurred after this date are considered capital or recurrent costs.

**TABLE CC2: IRS COUNTRY PROGRAM DATES**

| Country | Program Impementation Start Date | Spray Campaign Start Date | Length of Spray Campaign | # 100 $m^2$ Sprayed/ Day |
|---|---|---|---|---|
| Angola | April 1, 2012 | October 29, 2012 | 44 days | 4,444 |
| Benin | January 10, 2012 | May 14, 2012 | 35 days | 3,632 |
| Burkina Faso | January 1, 2012 | July 6, 2012 | 21 days | 2,305 |
| Ethiopia | February 1, 2012 | June 15, 2012<br>August 15, 2012 | 40 days<br>35 days | 6,991 |
| Ghana | February 10, 2012 | April 23, 2012 | 60 days | 3,220 |
| Liberia | January 10, 2012 | March 23, 2012<br>October 3, 2012 | 83 days<br>31 days | 1,791 |
| Mali | February 1, 2012 | July 23, 2012 | 45 days | 4,288 |
| Mozambique | April 1, 2012 | October 8, 2012 | 61 days | 15,975 |
| Nigeria | February 1, 2012 | April 4, 2012 | 32 days | 2,279 |
| Rwanda | March 1, 2012 | August 21, 2012<br>September 17, 2012 | 30 days | 13,855 |
| Senegal | January 1, 2012 | June 6, 2012 | 48 days | 5,566 |

Table CC2 also shows the number of days of active spraying in each campaign and the number of 100 square meters sprayed per day in the spray campaign. This will be discussed further under the unit cost analysis. In calendar year 2012, the AIRS programs in Ethiopia and Liberia included two spray rounds, while all other countries included only one spray round.

### 3.1.1 Defining 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.[14] For the purpose of this costing report, IRS country programs will be separated into three program sizes. This breakdown is summarized in Table CC3.

**TABLE CC3: COUNTRY PROGRAM SIZES**

| Program Size | # Structures Sprayed | # Square Meters Sprayed | # Population Protected |
|---|---|---|---|
| Large | 230,000 – 550,000 | 20,000,000 – 100,000,000 | 940,000 – 2,600,000 |
| Medium | 90,000 – 230,000 | 10,000,000 – 20,000,000 | 500,000 – 940,000 |
| Small | 25,000 – 90,000 | 2,500,000 – 10,000,000 | 100,000 – 500,000 |

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 $m^2$). However, for a more detailed analysis, countries will be grouped and presented according to program size, as specified above.

[14] 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.

**TABLE CC4: COUNTRY PROGRAM SIZE GROUPS**

| Small Programs | Medium Programs | Large Programs |
|---|---|---|
| Burkina Faso | Angola | Ethiopia |
| Nigeria | Benin | Mozambique |
| | Liberia | Rwanda |
| | Mali | Ghana |
| | | Senegal |

## 3.2 IRS Country Program Cost Results

This section presents the IRS country programs' total expenditures for both program start-up operations as well as the first year of program implementation (period of performance for start-up operations and program implementation varies by country). 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 (start-up, capital, or recurrent), and by burden type.

### 3.2.1 Project Start-up Expenditures

Costs incurred by country programs between August 11, 2011 and the country-specific start-up operations end date (listed above, in Table CC2), are considered start-up expenditures. Start-up operations consist of roughly the same activities in every country program.

**FIGURE CC1: START-UP EXPENDITURES**

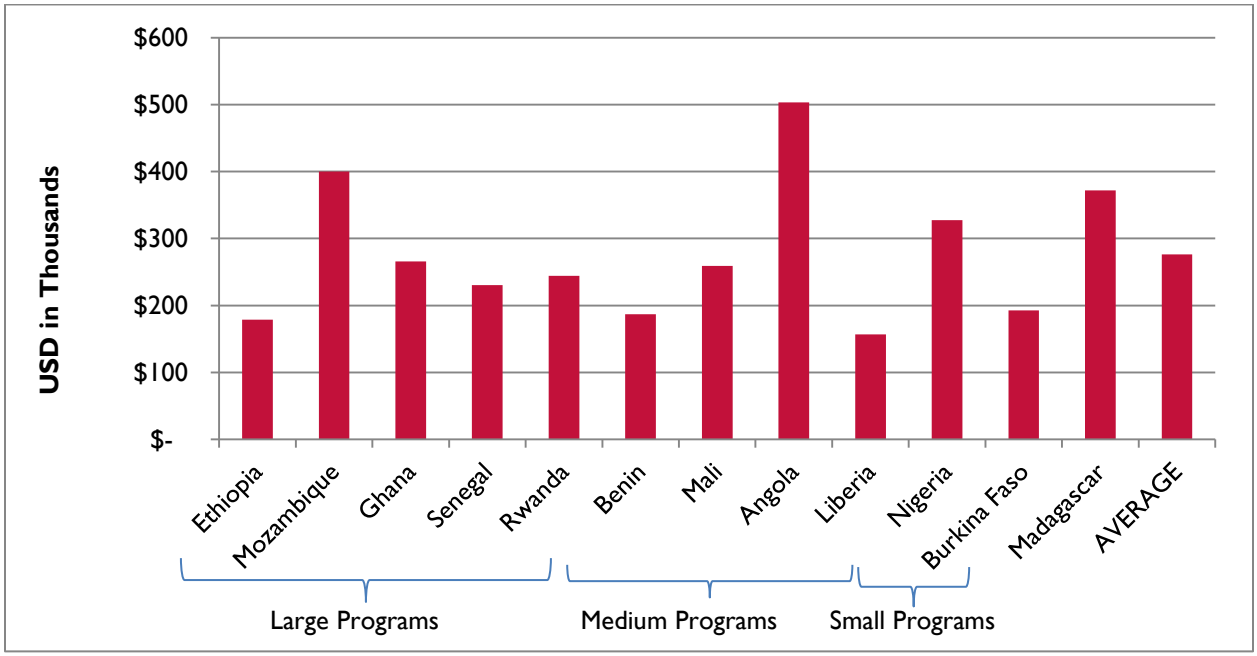



Figure CC1 above shows the total burdened expenditures spent by each country program on start-up operations. Countries are organized in order of the number of structures sprayed under the 2012 programs, from largest to smallest. As described in the Methodology section, start-up expenses include all expenses incurred under the period of preparation for program implementation. Program start-up operations included activities such as country scoping, information gathering, and hiring of local staff,

which usually required three short-term technical assistance trips by US-based staff. Start-up expenditures range from $156,588 in Liberia to $503,536 in Angola, with an average of $276,410 (about $264,000 for countries with large programs, $270,000 in countries with medium-sized programs, and $282,000 in the two small programs – showing little meaningful difference by program size). Liberia, which was the first AIRS country to begin the spray campaign due to peak malaria transmission season, experienced the shortest period of time for start-up operations, and also had the lowest start-up costs. This could possibly be explained by an early start of pre-spray work. Although the team continued start-up activities, they were done at the same time as spray preparation and, therefore, team billed the labor to various non-start-up cost categories. This accounted for the lower overall cost. The three most expensive start-up programs, Angola, Mozambique, and Madagascar, also had the latest spray campaign start dates, all occurring in October 2012 or later. Due to the late start date of program implementation, the start-up expenditures were accrued over a longer period of time than any of the other country program. The average length of start-up operations for all country programs was about 111 calendar days (or about 16 weeks). The majority of start-up expenditures are U.S.-based and local labor costs. The breakdown of these costs for each country is available in the country-specific chapters.

Start-up expenditures are not included in any of the following analyses.

### 3.2.2 Program Implementation Expenditures

The two figures below include all capital and recurrent country expenditures from the start of program implementation through December 31, 2012; however, this period may cover less than a year.

**FIGURE CC2: CAPITAL AND RECURRENT EXPENDITURES, BY BURDEN TYPE**

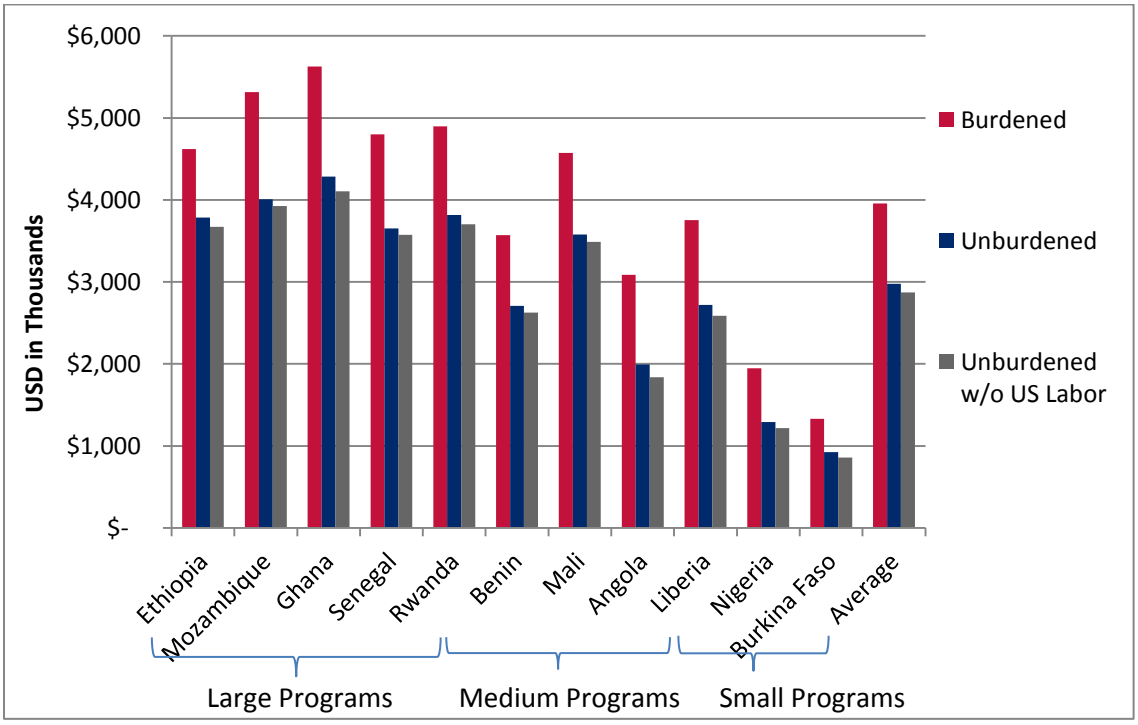



Figure CC2 shows the program total costs burdened, unburdened, and unburdened without U.S. labor. The definition of the types of burden is included in the Methodology section. The fully burdened bar (red) includes all the expenditures and overhead, burden, and G&A costs associated with running a global program through an international implementing partner, Abt Associates. The small difference

between the unburdened cost bar (blue) and the unburdened cost without U.S.-based labor (gray) represents the totality of expenditures spent on U.S. labor and all STTA.

The average total program implementation expenditures for large programs is about $4.86 million, for medium-sized programs is about $3.77 million, and for the two small programs is about $1.64 million. Further analysis of the burden rates is provided under each country chapter of this report.

**FIGURE CC3: CAPITAL AND RECURRENT EXPENDITURES, BY COST CATEGORY**

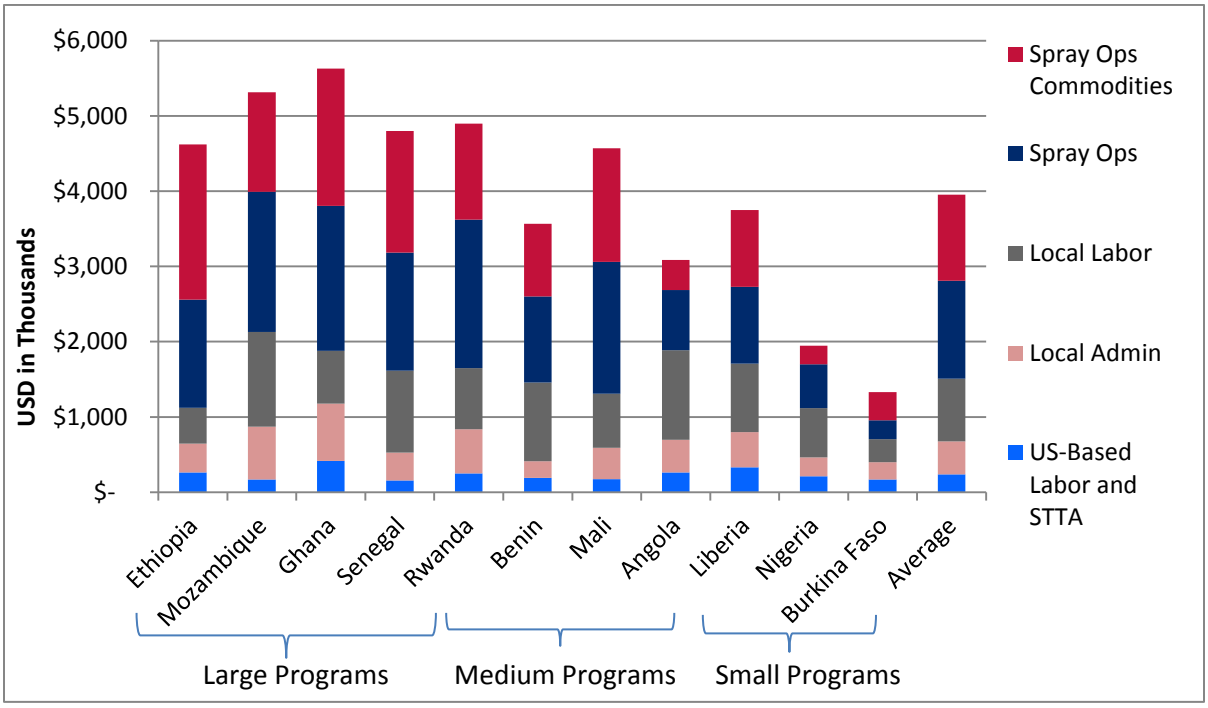



Figure CC3 above includes all capital and recurrent costs of country IRS programs, fully burdened, and broken down by cost category. Countries are arranged in order of the number of structures sprayed during 2012 spray campaigns, largest to smallest. The types of expenditure items included in each cost category are fully detailed in the Methodology section. The above figure begins to show that the local administration and U.S.-based labor and STTA cost categories remain fairly consistent across all country programs, with the exception of Ghana, at an average of $651,185. An average of 60 percent of total project expenditures are spent directly on spray operations and commodities.

Ghana is an outlier on U.S.-based labor and local administration costs, because it is over two standard deviations above the mean. The program incurred expenditures about $525,000 more than the average for these two cost categories. These fixed costs are discussed in more detail under the cost drivers analysis section.

## 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 100 $m^2$ sprayed as shown in Table CC5.

The ultimate objective of IRS programs is to protect people, but the unit cost per person protected incorporates living density as well as structure size. The differences between the rankings of countries based on the unit cost per person protected and the unit cost per structure sprayed are due largely to the density of people per structure. Unit cost per structure sprayed is the usual metric for IRS programs, but this conceals the fact that structures can be of varying sizes. Thus, unit cost per 100 $m^2$ sprayed is also included in this report, and serves as the basis for understanding differences in costs between countries. Rank differences between area sprayed and the number of structures sprayed and ultimately people protected are in specific 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 CC5: 2012 IRS PROGRAM UNIT COSTS**

| Category | Country | Cost per Structure Sprayed | Cost per Person Protected | Cost per Area Sprayed (100 $m^2$) |
|---|---|---|---|---|
| Large Programs | Ethiopia | $ 8.44 | $ 3.07 | $ 8.81 |
| | Mozambique | $ 9.90 | $ 1.96 | $ 5.45 |
| | Ghana | $ 15.84 | $ 5.98 | $ 29.13 |
| | Senegal | $ 15.63 | $ 4.38 | $ 17.96 |
| | Rwanda | $ 15.96 | $ 4.78 | $ 11.78 |
| Medium Programs | Benin | $ 16.97 | $ 5.47 | $ 28.08 |
| | Mali | $ 22.16 | $ 6.00 | $ 23.69 |
| | Angola | $ 21.77 | $ 4.56 | $ 15.78 |
| | Liberia | $ 38.72 | $ 4.31 | $ 18.37 |
| Small Programs | Nigeria | $ 33.14 | $ 5.62 | $ 26.67 |
| | Burkina Faso | $ 36.08 | $ 11.50 | $ 27.48 |
| **Unweighted Average*** | | **$ 21.33** | **$ 5.24** | **$ 19.38** |

* Average of country unit costs, not weighted by the size of the program in each country.

**FIGURE CC4: IRS COUNTRY UNIT COSTS PER PERSON PROTECTED, BY COST CATEGORY**

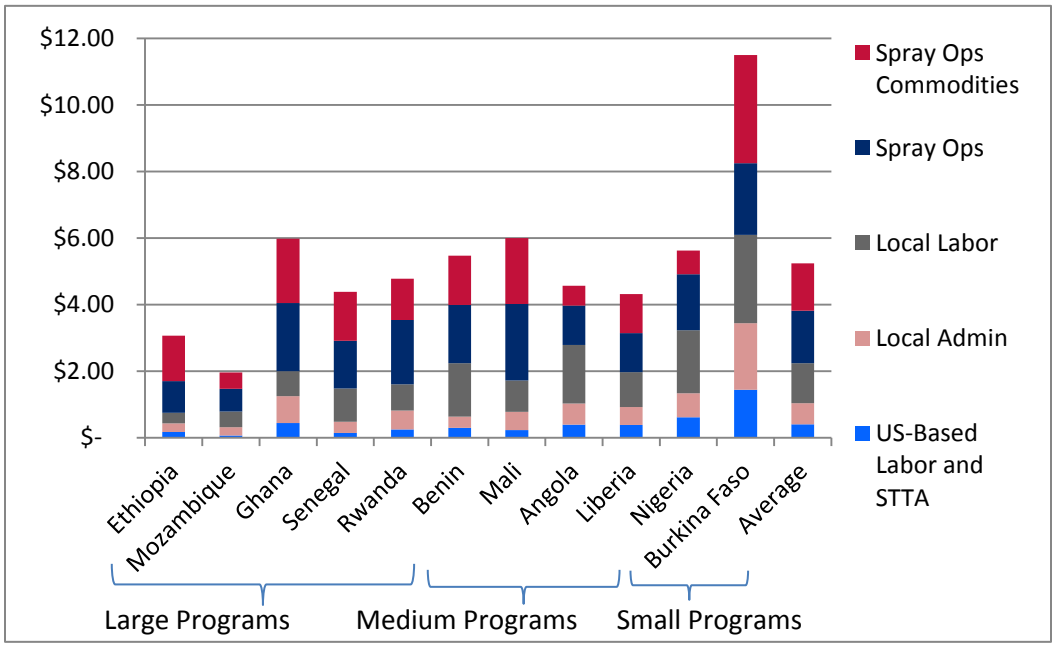



Figure CC4 shows the country programs' unit costs per person protected. These amounts are fully burdened, and itemized by cost category. Countries are ordered by number of structures sprayed, from largest to smallest. The last column on the right is an average. Eight of the 11 countries have a similar unit cost per person protected of between $4.00 and $6.00, close to the overall unweighted average of $5.24. Burkina Faso, a small IRS program, reached limited population coverage of 115,638 people, which is only 33 percent of the population protected in Nigeria, the next largest country in program size. As will be discussed in further detail under the cost drivers section below, the higher unit costs per person protected in Burkina Faso are largely due to program scale and a high percentage of fixed costs.

**FIGURE CC5: COUNTRY PROGRAM UNIT COSTS PER STRUCTURE SPRAYED, BY COST CATEGORY**

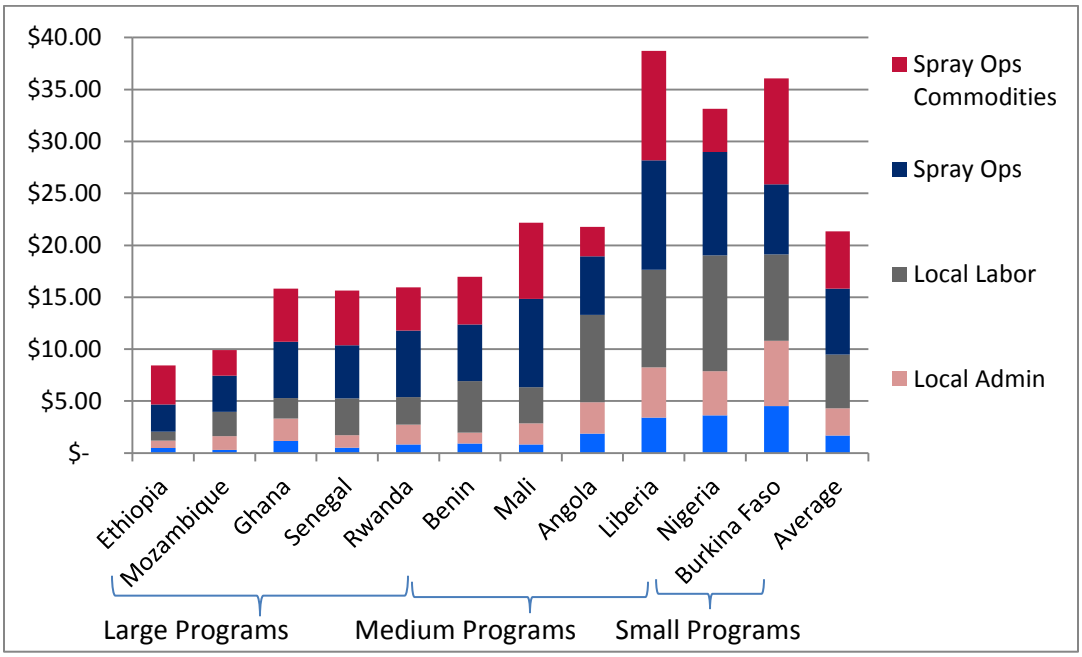



Figure CC5 shows country programs' unit costs per structure sprayed. The unit costs above are fully burdened, and itemized by cost category. The countries are in order of number of structures sprayed, from largest to smallest. Generally, if program size is defined by the number of structures sprayed, this figure shows a 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 $21.33. All of the countries with large programs plus Benin (a medium-sized program) have a unit cost below average.

As stated earlier, the average size of a structure in one country may vary greatly from one country to another, meaning even if fewer structures were sprayed, the same amount of square meters may have been covered. For example, in Figure CC5, the unit costs per structure sprayed for Liberia is the highest, and Ghana is below average. However, in Figure CC6, the unit cost per 100 $m^2$ sprayed for Ghana is one of the highest, and Liberia is around average. This is because in Ghana, the average size of a structure is 54.4 $m^2$, and in Liberia the average is 210.8 $m^2$. Therefore, as noted above, this report presents the total number of square meters sprayed as the default metric to help understand differences in costs between countries, because it is the metric that allows comparisons across countries without being influenced by non-cost variables (size of structures, people protected per structure).

**FIGURE CC6: PROGRAM UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY**

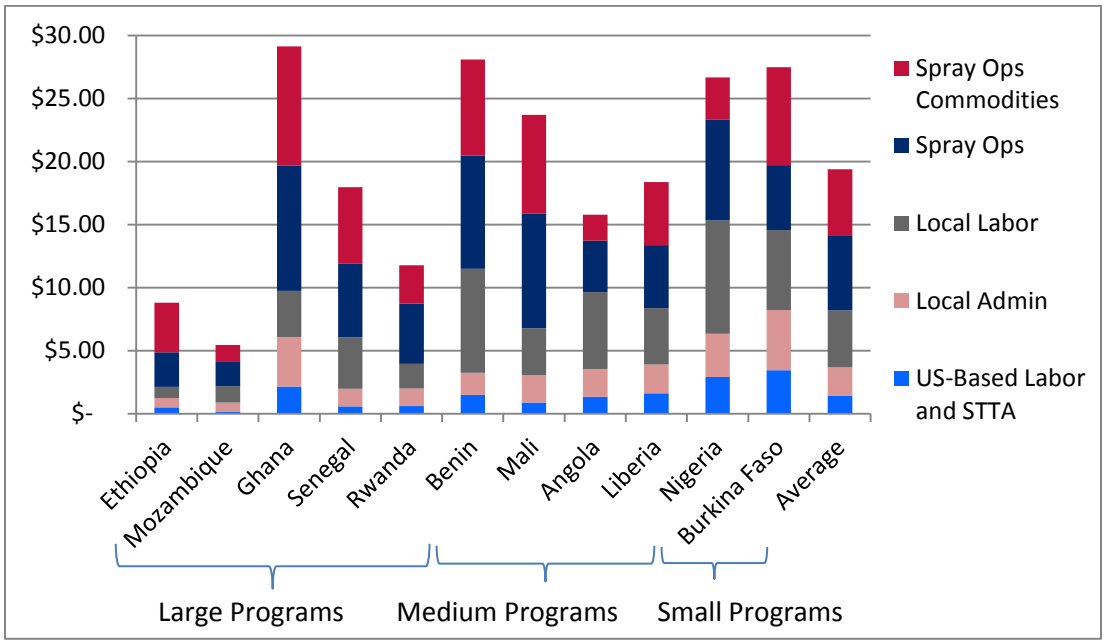



Figure CC6 shows country IRS programs' unit costs per area (100 m²) sprayed. The unit costs above are fully burdened, and itemized by cost category. The countries are in order of number of structures sprayed, from largest to smallest. This figure shows that the unit cost per area sprayed has a greater variation (range: $5.63 to $29.13) 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' unit 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 CC7: COST CATEGORY PERCENTAGE OF TOTAL UNIT COST PER 100 M² SPRAYED**

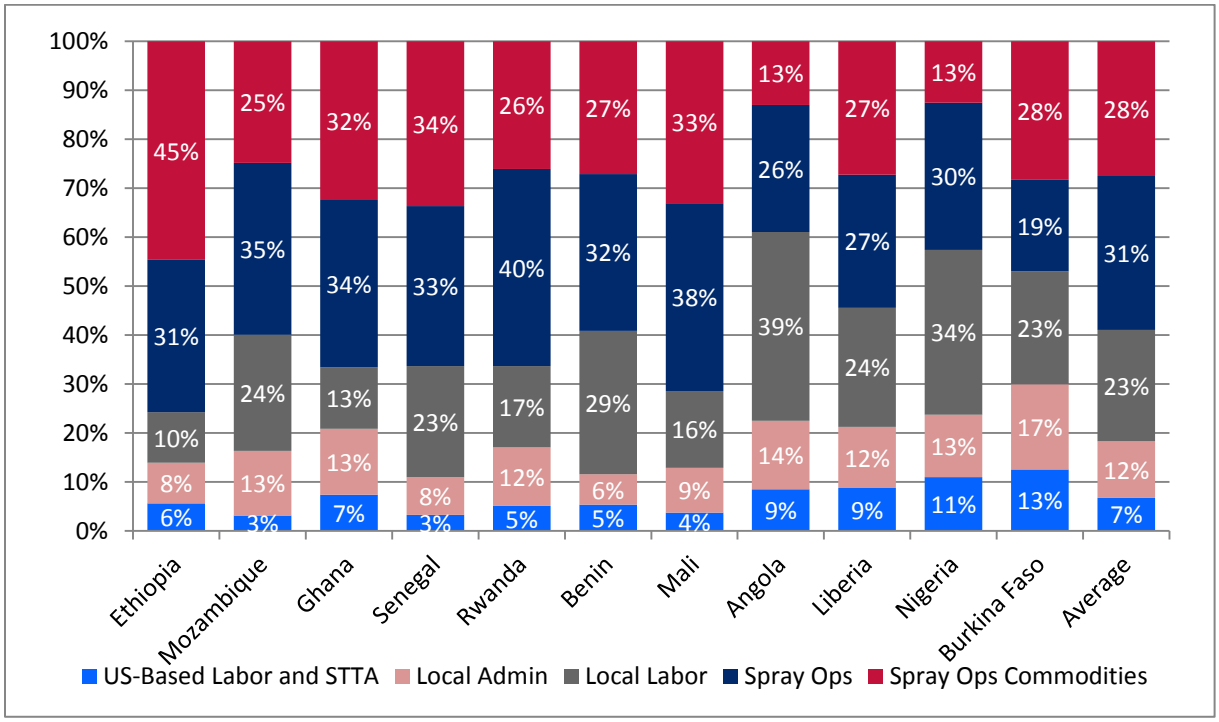



Figure CC7 shows the percentage of each cost category out of the total unit cost per area sprayed. This is the first step in determining what cost categories are driving costs. For example, in Ethiopia, spray commodities account for 45 percent of the total unit cost, while in Rwanda, they constitute only 26 percent of total costs and spray operations make up 40 percent of the unit cost. The next step, which will be assessed later in this section, is to determine *why* these categories are different across countries.

**TABLE CC6: FIXED AND VARIABLE COST PERCENT OF UNIT COST PER 100 M² SPRAYED**

| Country | Fixed Costs | | | | Variable Costs | | | | Unit Cost per 100 Sq M. Sprayed |
|---|---|---|---|---|---|---|---|---|---|
| | Capital Costs | US-based Labor and STTA | Local Admin | Total Fixed Cost % | Local Labor | Spray Ops | Spray Ops Commodities | Total Variable Cost % | |
| Ethiopia | 6% | 8% | 6% | 20% | 10% | 29% | 41% | 80% | $ 8.81 |
| Mozambique | 3% | 3% | 11% | 18% | 24% | 35% | 24% | 82% | $ 5.45 |
| Ghana | 4% | 7% | 12% | 23% | 13% | 34% | 31% | 77% | $ 29.13 |
| Senegal | 4% | 3% | 6% | 13% | 23% | 33% | 31% | 87% | $ 17.96 |
| Rwanda | 8% | 5% | 9% | 22% | 17% | 40% | 21% | 78% | $ 11.78 |
| Benin | 5% | 5% | 4% | 14% | 29% | 32% | 24% | 86% | $ 28.08 |
| Mali | 6% | 4% | 6% | 16% | 16% | 38% | 30% | 84% | $ 23.69 |
| Angola | 6% | 9% | 11% | 26% | 39% | 26% | 10% | 74% | $ 15.78 |
| Liberia | 3% | 9% | 11% | 23% | 24% | 27% | 26% | 77% | $ 18.37 |
| Nigeria | 5% | 11% | 10% | 26% | 34% | 30% | 10% | 74% | $ 26.67 |
| Burkina Faso | 7% | 13% | 15% | 35% | 23% | 18% | 24% | 65% | $ 27.48 |
| **Average** | **5%** | **7%** | **9%** | **22%** | **23%** | **31%** | **24%** | **78%** | **$ 19.38** |

Note: Numbers are rounded to the nearest whole number and therefore may not visibly add up to 100 percent.

Table CC6 provides the same breakdown of the cost categories as Figure CC7; however, it also separates out the capital expenditures as a distinct category, and differentiates fixed costs from variable costs. Fixed costs include capital expenditures, U.S.-based labor, and local administrative costs. These costs are fixed costs because the total costs 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. Therefore, in the individual country chapters, these costs will usually be discussed together. The three categories that have variable costs are local staff labor, spray operations, and spray commodities. Across country programs, fixed costs make up an average of 22 percent of the unit costs per 100 square meters sprayed (range: 13 percent to 35 percent), while variable costs make up an average of 78 percent (range: 65 percent to 87 percent). Burkina Faso spends the largest percentage of its unit cost on US-based labor and local administration expenses, but this is again due to the small size of the program.

The following sub-sections provide a more in-depth cost driver analysis of the following components: fixed costs, spray commodities, 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 22 percent (range: 13 percent to 35 percent) of the total unit cost, while the average of the variable costs is 78 percent (range: 65 percent to 87 percent) of the total unit cost per 100 square meters sprayed.

**FIGURE CC8: FIXED COST PORTION OF UNIT COSTS PER 100 M² SPRAYED**

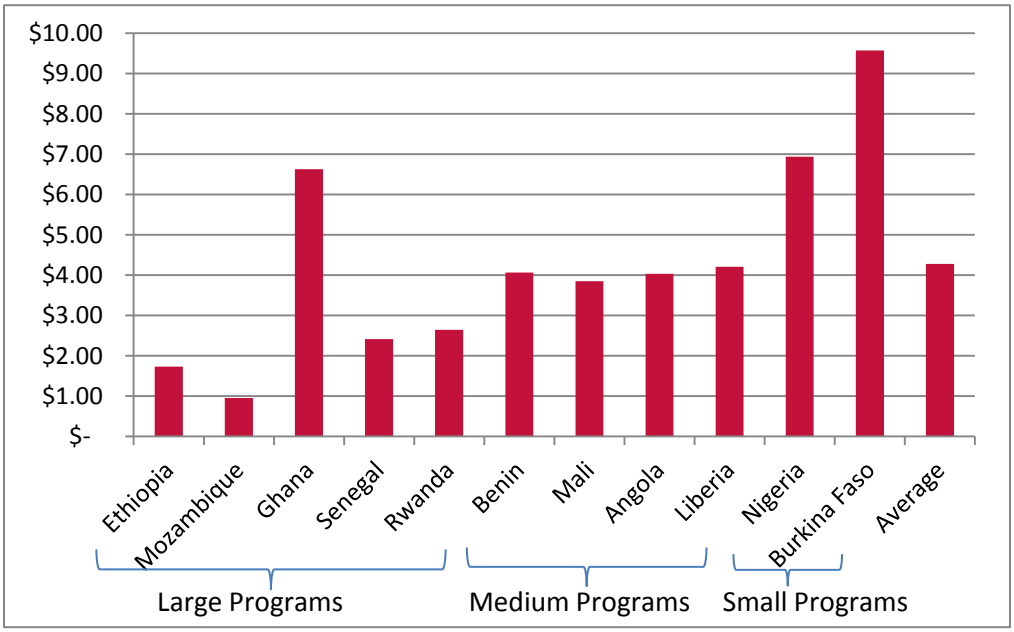



Figure CC8 shows the fixed unit cost per 100 square meters sprayed. This includes capital expenditures, U.S.-based labor and STTA, and local administration costs. This figure portrays the countries in order of their program size based on number of structures sprayed. With the exception of Ghana, the fixed costs are correlated to the size of the country program, ranging from $0.96 in Mozambique to $9.57 in Burkina Faso. The average fixed cost of the large programs is $2.87 ($1.93 excluding Ghana), for medium programs is $4.04, and for the small programs is $8.25.

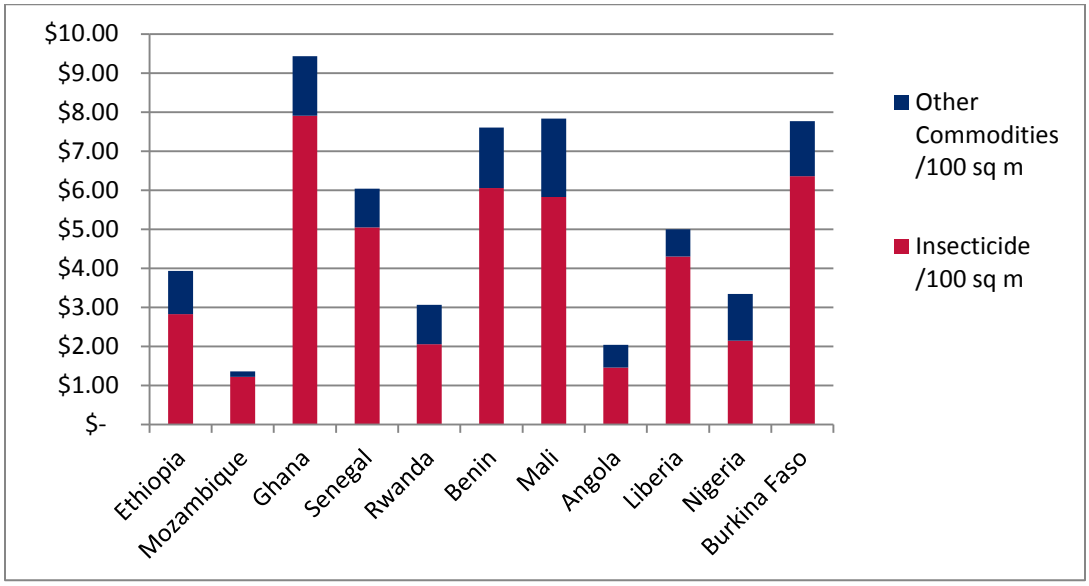
In Ghana, the average size of a structure is 54.4 square meters, so while Ghana is the third largest program in terms of structures sprayed, the number of square meters sprayed falls within the medium-sized program group (with the number of square meters sprayed similar to Mali). As was mentioned previously in regard to Figure CC3, Ghana's total expenditures in fixed costs were much higher than any other country program. The geographical coverage of Ghana's spray campaigns is extensive, and about $1.01 out of the $6.08 above was spent on ground transportation alone. Likewise, Ghana's local administration (excluding capital costs) makes up $3.38 of the unit cost, which is at least $2.30 higher than any other large program.

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

### 3.4.2 Spray Commodities: Insecticide Prices

Spray commodities, one of the five cost categories analyzed in this report, includes insecticide, spray equipment, and PPE. Figure CC9 focuses only on the spray commodities portion of the cost per area sprayed, and provides an additional breakdown between insecticides and all other commodities. This figure shows that it is the insecticide that is causing the wide variation in commodity costs (insecticide accounts for 81 percent of variation **within** the commodities portion of the unit costs, and accounts for 20 percent of the variation in the total unit cost per area sprayed).[15]

**FIGURE CC9: SPRAY COMMODITIES PORTION OF UNIT COST PER 100 M² SPRAYED**




As shown in Figure CC9, spray commodities range from $1.36 (Mozambique) to $9.43 (Ghana) per 100 m² sprayed. Additionally, spray commodities have been broken down between insecticides (red bar), and other recurrent commodities (blue bar), such as PPE.

[15] This indicates that the average of differences between the unit costs of a particular country and the overall mean unit costs across countries would decrease by 20 percent if all countries used the same insecticide.

**TABLE CC7: COUNTRY PROGRAM INSECTICIDE SOURCES**

| Country | Procured Insecticide | Inherited Insecticide Included |
|---|---|---|
| Ethiopia | | X* |
| Mozambique | X | X |
| Ghana | X | X |
| Senegal | X | X |
| Rwanda | | X* |
| Benin | X | X |
| Mali | X | |
| Angola | X | X |
| Liberia | X | X |
| Nigeria | | X |
| Burkina Faso | X | |

* Ethiopia and Rwanda programs received insecticide purchased by the local government. Value of insecticide was estimated by multiplying the number of sachets by the average 2012 price per sachet type.

Table CC7 shows the source of insecticides used in each country. If the insecticide was procured, it was bought directly by AIRS and includes freight, insurance, shipping, etc. If the insecticide was inherited from RTI (the previous implementing partner) or PMI, the full value of the insecticides was made available by the organization that made the procurement. If the insecticide was inherited and procured by the country government, then the number of sachets was multiplied by the average cost per sachet in 2012 to estimate a total value.

As previously shown in Table CC6, the following countries had a high percentage of spray commodities, which primarily include insecticide and PPE, driving their unit cost: Ethiopia (41 percent), Ghana (31 percent), Senegal (31 percent), and Mali (30 percent). Of these countries, Senegal and Mali procured carbamate insecticide, Ethiopia used both carbamate and pyrethroid insecticides, and Ghana was the only country program to procure organophosphate insecticide, though the program also used inherited pyrethroids.

**TABLE CC8: INSECTICIDE PORTION OF UNIT COST PER 100 $M^2$ SPRAYED, BY PRIMARY INSECTICIDE CLASS USED**

| Pyrethroid ($) | | Carbamate ($) | | Organophosphate ($) | |
|---|---|---|---|---|---|
| Angola | 1.46 | Senegal | 5.05 | Ghana* | 7.91 |
| Mozambique | 1.22 | Burkina Faso | 6.36 | | |
| Nigeria | 2.15 | Benin | 6.05 | | |
| Rwanda | 2.06 | Mali | 5.82 | | |
| **AVERAGE** | **1.72** | | **5.82** | | **7.91** |

*Ghana was the only country program to use organophosphates in 2012. While about 60 percent of insecticide sachets used were pyrethroids, they only made up 9 percent of the cost of insecticides,This accounts for the fact that the above cost per area sprayed for organophosphates is only slightly more expensive than the average for carbamates.

Table CC8 shows the average amount of the unit cost spent by countries on insecticide, organized by the primary insecticide class used in the country program. With the exception of Ghana, this does not

include the countries where multiple insecticide classes were used in 2012. Liberia inherited pyrethroids and procured carbamates, and Ethiopia inherited both pyrethroids and carbamates; because both of these countries used a mixed selection of insecticides, they were left out of Figures CC10 through CC13. A portion of the pyrethroids used in Rwanda were provided by the local government, so the value is estimated based on the 2012 average price of pyrethroids across countries. There is a general correlation of the type of insecticide procured affecting the cost per 100 $m^2$ sprayed. However, while the unit costs of country programs using pyrethroid insecticide are generally less expensive than unit costs of country programs using carbamates and organophosphates, there is still some variation within insecticide classes.

The following tables show the cost per 100 $m^2$ sprayed, and group countries by program size (Figure CC10) in terms of number of structures sprayed, which is the main format for this report, as well as by insecticide class (Figure CC11). These tables exclude Liberia and Ethiopia as these country programs used multiple insecticide classes in multiple spray rounds. Ghana both procured organophosphate insecticide, as well as inherited a portion of pyrethroid sachets (the value of which has been included in this report). However, even though the program used two types of insecticide, Ghana was the only country in 2012 to use organophophates, and thus has still been included as a comparison. All other country programs used one class of insecticide.

**FIGURE CC10: COST PER 100 M² SPRAYED, GROUPED BY PROGRAM SIZE**

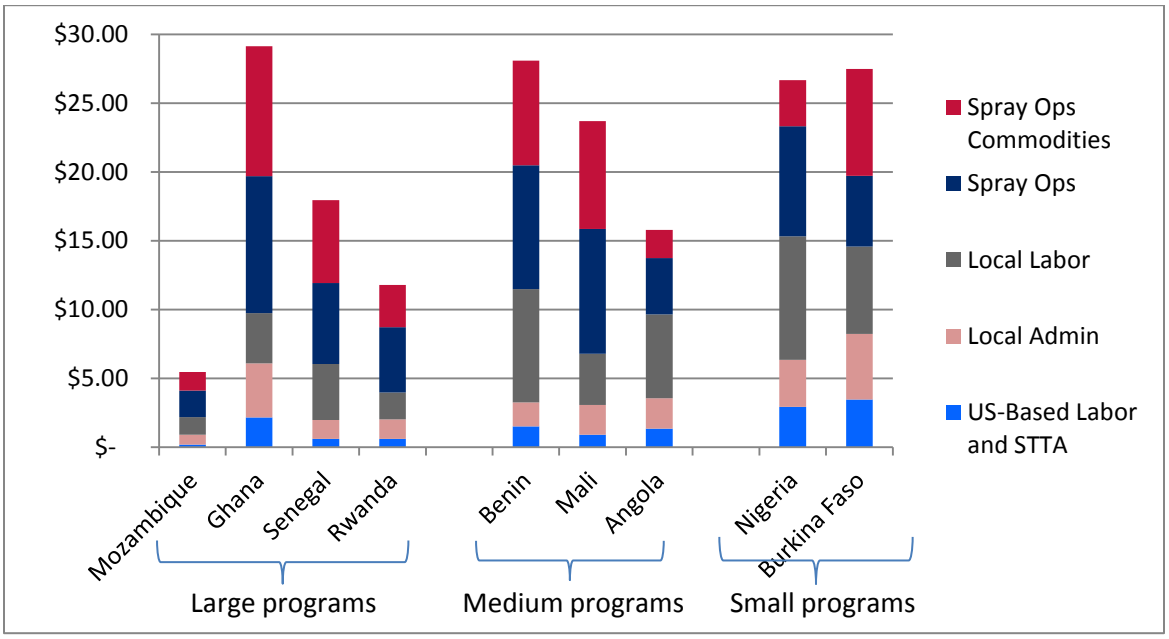
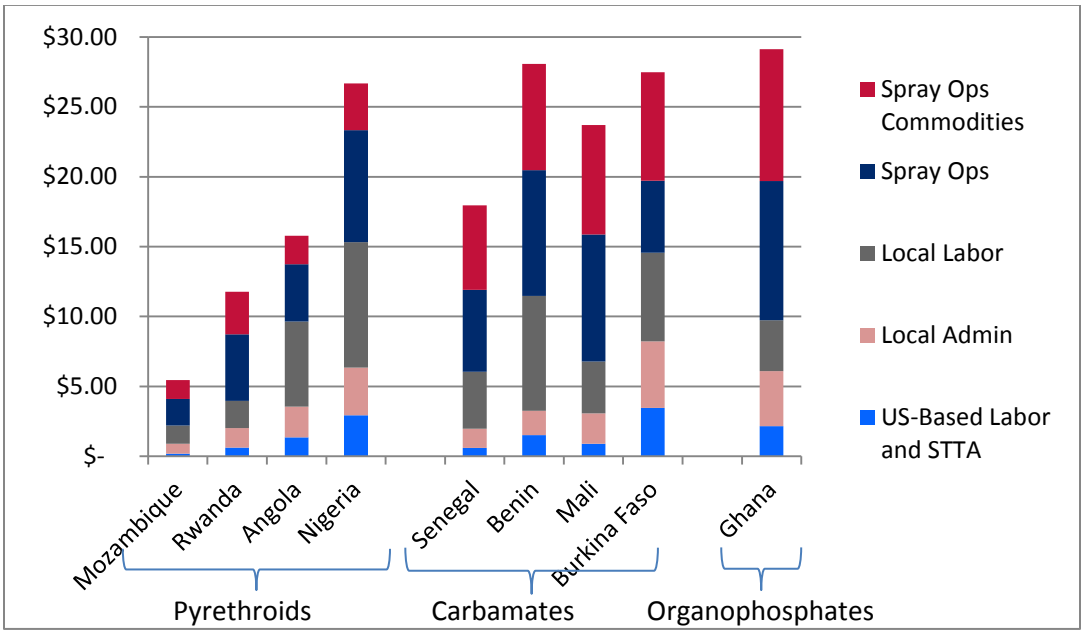


**FIGURE CC11: COST PER 100 M² SPRAYED, GROUPED BY INSECTICIDE CLASS**




In Figure CC11 above, country programs are still ordered in program size from largest to smallest within each insecticide class. The red portion at the top of each bar is the spray commodities (insecticide, as well as PPEs and other spray equipment). In conclusion, it is clear that the size of the commodities portion is dependent upon which class of insecticide the country program used.

However, within the pyrethroid group, it is apparent that the countries' unit costs are still correlated with the size of the country program. 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. Ghana is the outlier in the large program grouping, which is discussed further in Sections 3.4.3 and 3.4.4. Since the spray commodities 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.

The following two figures group countries first by program size (Figure CC12), and by insecticide class (Figure CC13), but this time present the cost per person protected rather than per area sprayed.

**FIGURE CC12: COST PER PERSON PROTECTED, GROUPED BY PROGRAM SIZE**

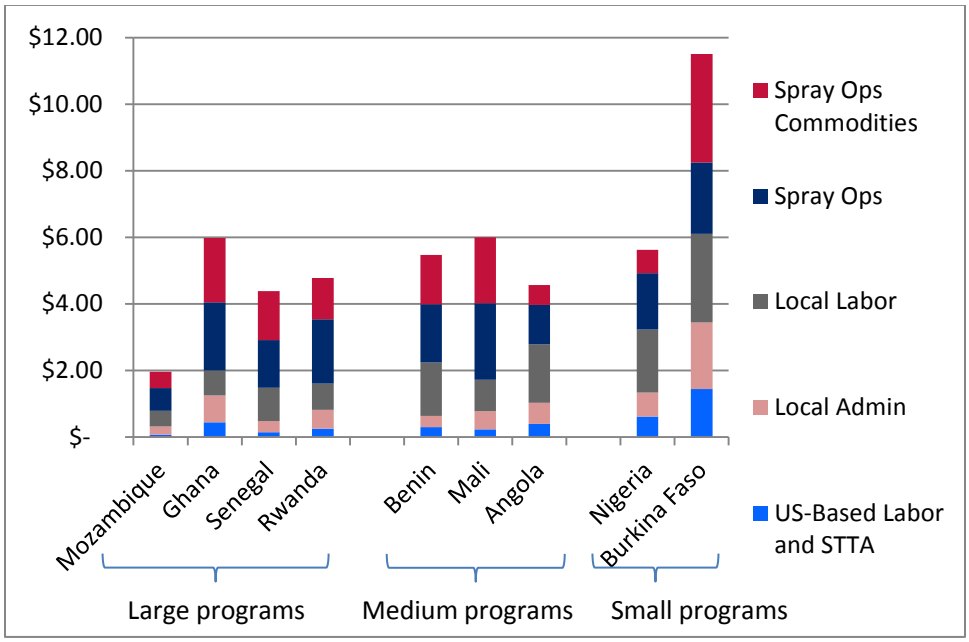
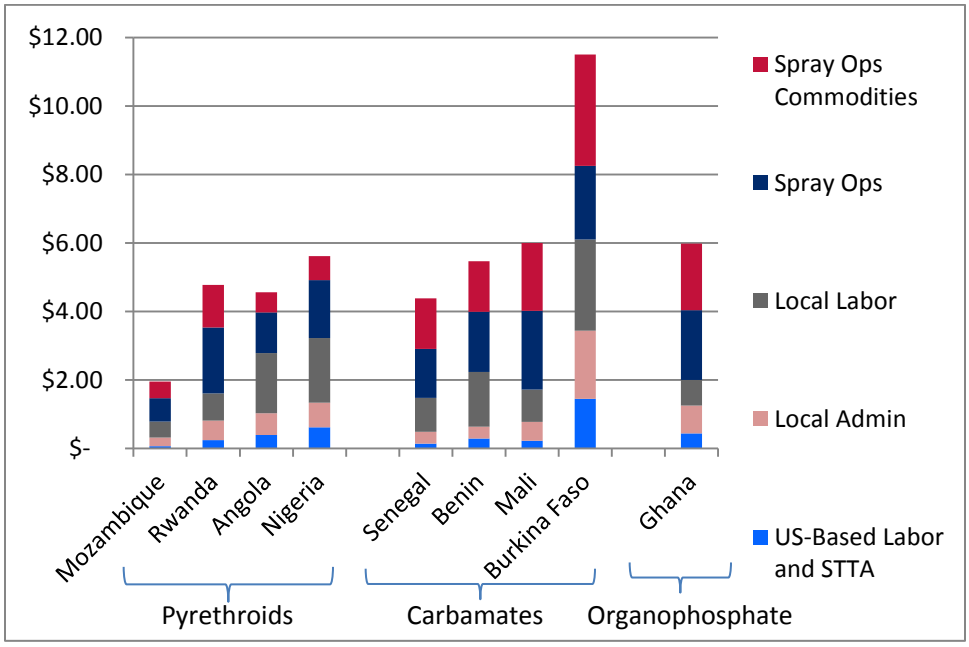



**FIGURE CC13: COST PER PERSON PROTECTED, GROUPED BY INSECTICIDE CLASS**




In Figure CC13, the red portion of the bar (spray commodities, including insecticide) is still correlated by insecticide class, however, the difference between insecticide classes is less apparent than under the cost per area sprayed.

### 3.4.3 Spray Operations: Program Scale and Country Context

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,[16] accounted for an average of 32 percent of the total unit cost. Additionally, the spray operations portion of the unit cost per area sprayed accounts for 25.6 percent of the variation (deviance from the mean) between country unit costs.

**FIGURE CC14: SPRAY OPERATIONS PORTION OF UNIT COST PER 100 M² SPRAYED**

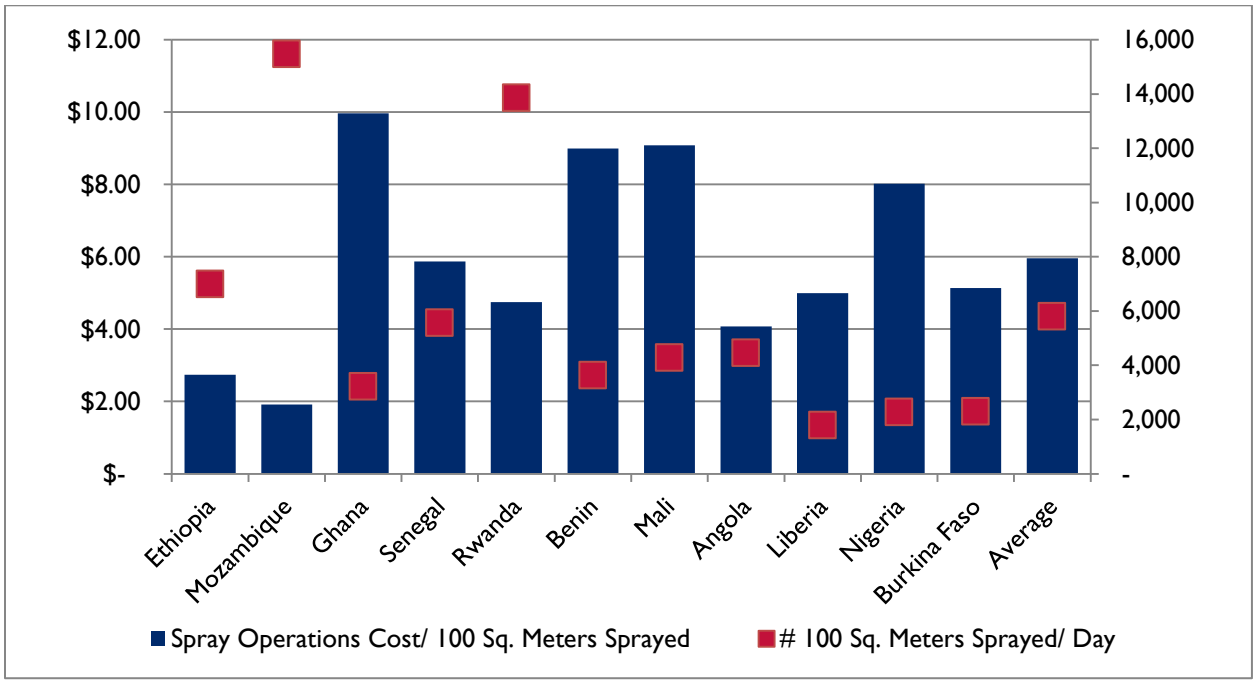



Figure CC14 shows both the spray operations portion of the unit costs per 100 square meters sprayed (blue bar), as well as the number of 100 square meters sprayed per day of the spray campaign (red dots). The unit cost of spray operations ranges from $1.91 in Mozambique to $9.96 in Ghana, with an average of $5.96. The number of square meters sprayed per campaign day (listed above in Table CC2) ranges from 179,100 in Liberia to 1,553,700 in Mozambique. The longer a spray campaign is, the higher the quantity of inputs such as temporary spray operators' labor and ground transportation expenses. While some countries are able to cover the most spray area per campaign day, such as Mozambique and Rwanda, and have lower spray operations unit costs, this indicator does not provide a consistent trend across all country programs. Thus, spray operations cost is not driven by the length of the spray campaign itself, but rather the campaigns' direct inputs.

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

**TABLE CC9: TEMPORARY SPRAY OPERATORS (SOPS)**

| Country | Total # SOPs | Total # SOP days | Avg # days/ SOP | Avg Daily Wage of SOP | Total # Campaign Days | Total # 100 $m^2$ sprayed | # 100 $m^2$ sprayed/ SOP day |
|---|---|---|---|---|---|---|---|
| Ethiopia | 1,533 | 56,521 | 36.9 | $ 4.00 | 75 | 524,334 | 9.3 |
| Mozambique | 960 | 42,304 | 44.1 | $ 3.76 | 61 | 974,470 | 23.0 |
| Ghana | 466 | 20,445 | 43.9 | $ 5.50 | 60 | 193,220 | 9.5 |
| Senegal | 692 | 24,592 | 35.5 | $ 12.00 | 48 | 267,185 | 10.9 |
| Rwanda | 1,369 | 34,991 | 25.6 | $ 9.20 | 30 | 415,653 | 11.9 |
| Benin | 495 | 15,488 | 31.3 | $ 6.00 | 35 | 127,105 | 8.2 |
| Mali | 625 | 18,204 | 29.1 | $ 6.00 | 45 | 192,968 | 10.6 |
| Angola | 532 | 13,859 | 26.1 | $ 15.00 | 44 | 195,518 | 14.1 |
| Liberia | 302 | 6,376 | 21.1 | $ 10.00 | 114 | 204,228 | 32.0 |
| Nigeria | 250 | 7,393 | 29.6 | $ 12.50 | 32 | 72,943 | 9.9 |
| Burkina Faso | 176 | 3,696 | 21.0 | $ 5.25 | 21 | 48,413 | 13.1 |

Table CC9 provides a detailed breakdown of the number of SOPs working in each country spray campaign, as well as the total number of SOP days and the average daily wage. As seen in the right-hand column, five of eleven country programs sprayed between 900 to 1,100 square meters per SOP day, which is roughly four insecticide sachets' worth. There is no noticeable correlation or trend between the number of SOPs or number of SOP days and the number of square meters sprayed in one SOP day. However, there are two clear outliers: Mozambique and Liberia. Liberia's high number of square meters sprayed per SOP working day is likely due to the country having the largest average size of structures in the spray coverage area. Mozambique is likely due to a mix of densely situated structures and a generally larger structure size than the cross-country average.

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

**FIGURE CC15: SPRAY OPERATIONS PORTION OF UNIT COSTS PER 100 M² SPRAYED, LARGE PROGRAMS**

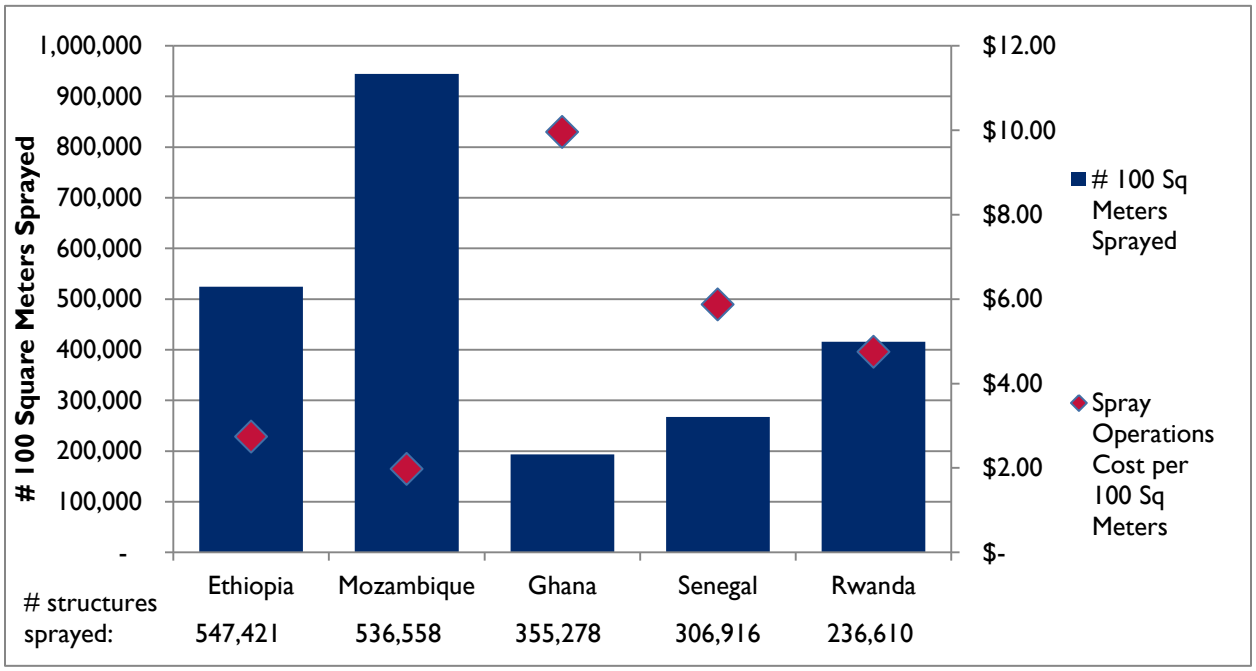



Figure CC15 shows that within the large programs, there is enough difference across the country unit costs that program scale does not account for all variation. The Ethiopia spray operations unit cost ($2.74) is more expensive than Mozambique ($1.91) even though it is the larger program in terms of number of structures sprayed, because the Mozambique program covers almost twice as many square meters as Ethiopia does. The unit cost in Ethiopia is still close to Mozambique because it has a low cost of doing business (local labor, rent, etc.).

Ghana shows up again as an outlier within the large programs with a spray operations cost of $9.96. In terms of spray operations, Ghana's geographical coverage area is important as the campaign sprays structures that are very spread out, requiring more labor hours of temporary spray operators and higher transportation costs.

**FIGURE CC16: SPRAY OPERATIONS PORTION OF UNIT COSTS PER 100 M² SPRAYED, MEDIUM PROGRAMS**

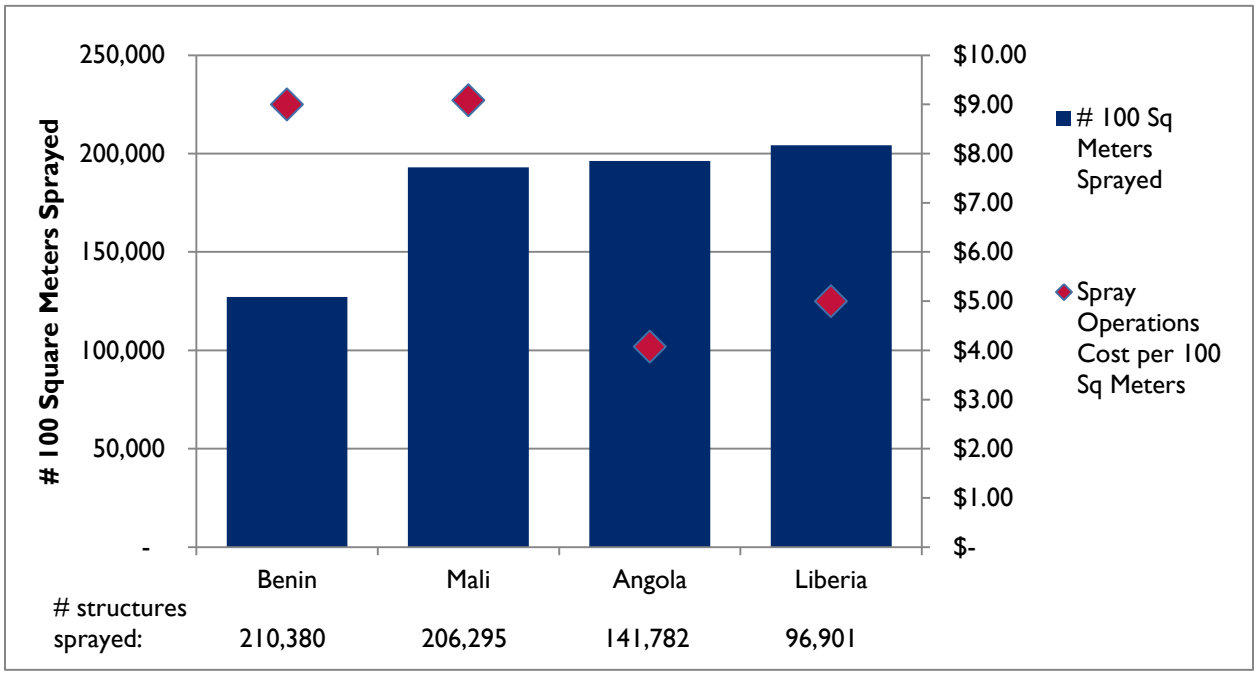
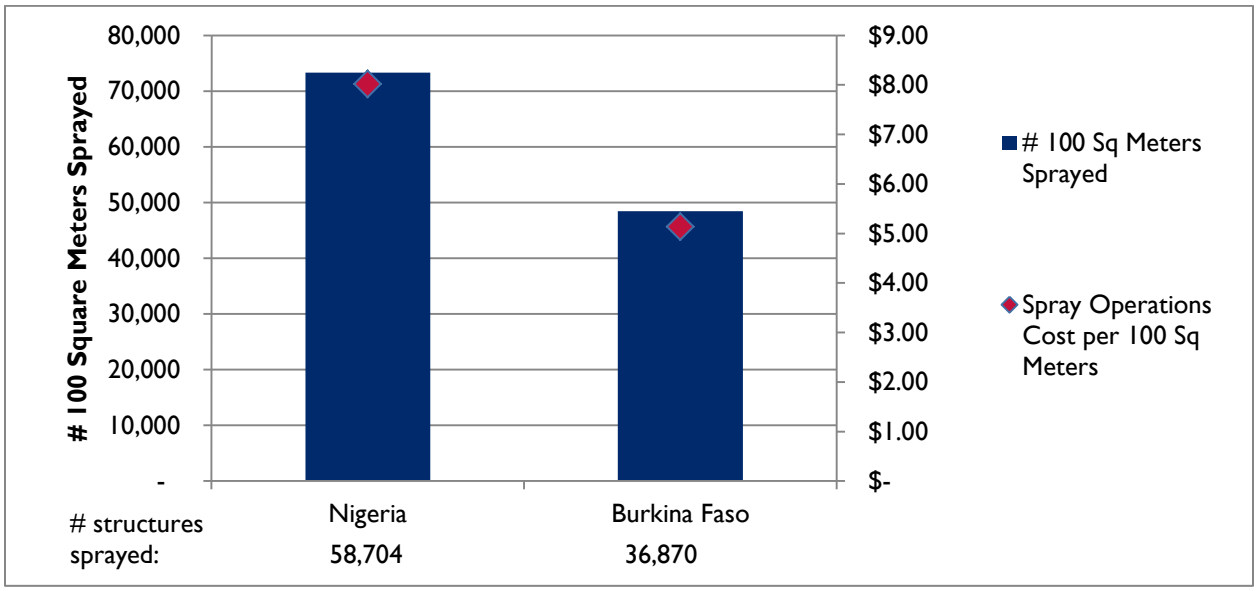



Figure CC16 shows that medium-sized program spray operations costs range from $4.07 in Angola to $9.08 in Mali. The geographical coverage of the spray campaigns in both Benin ($9.00) and Angola ($4.07) includes spray coverage areas of densely situated structures. Operation costs such as labor and rent also tend to be more expensive in these countries, but the close proximity of structures reduces sprayer labor hours and transportation costs. One would expect spray campaigns across similar spray coverage settings to likewise have a similar cost per square meter sprayed, however, the average structure size in Angola is twice as big as in Benin. In contrast, what raises the cost of spray operations (38 percent of the total unit cost) in the Mali spray campaign is that the spray area covers structures that are spread out, with dispersed population groups and structures necessitating more spray operator time and transportation.

**FIGURE CC17: SPRAY OPERATIONS PORTION OF UNIT COST PER 100 M² SPRAYED, SMALL PROGRAMS**




As Figure CC17 shows, the two small programs, Burkina Faso and Nigeria, have spray operations costs of $5.14 and $8.02, respectively. Because it is such as small program, it is interesting to note that the Burkina Faso spray operations unit cost is below the average of all the country programs, but this is in part due to the fact that spray operations accounts for only 18 percent of the total unit cost. While typically the small program scale would produce high unit costs, spray operations is directly related to IRS inputs such as SOPs and ground transport.

### 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, temporary labor is a variable cost directly related to the spray campaign and the number of structures sprayed. It is included in the Spray Operations cost category analyzed in Section 3.4.3. This section covers the full-time local staff labor separately. Table CC10 lists the number of full-time local staff members based in the field office.

**TABLE CC10: TOTAL FULL-TIME LOCAL STAFF MEMBERS**

| Country | # Local Staff | Country Program | # Local Staff |
|---|---|---|---|
| Angola | 20 | Mali | 14 |
| Benin | 14 | Mozambique | 28 |
| Burkina Faso | 11 | Nigeria | 18 |
| Ethiopia | 19 | Rwanda | 16 |
| Ghana | 25 | Senegal | 14 |
| Liberia | 15 | **Average** | **17.6** |

**FIGURE CC18: LOCAL LABOR PORTION OF UNIT COST PER 100 M² SPRAYED**

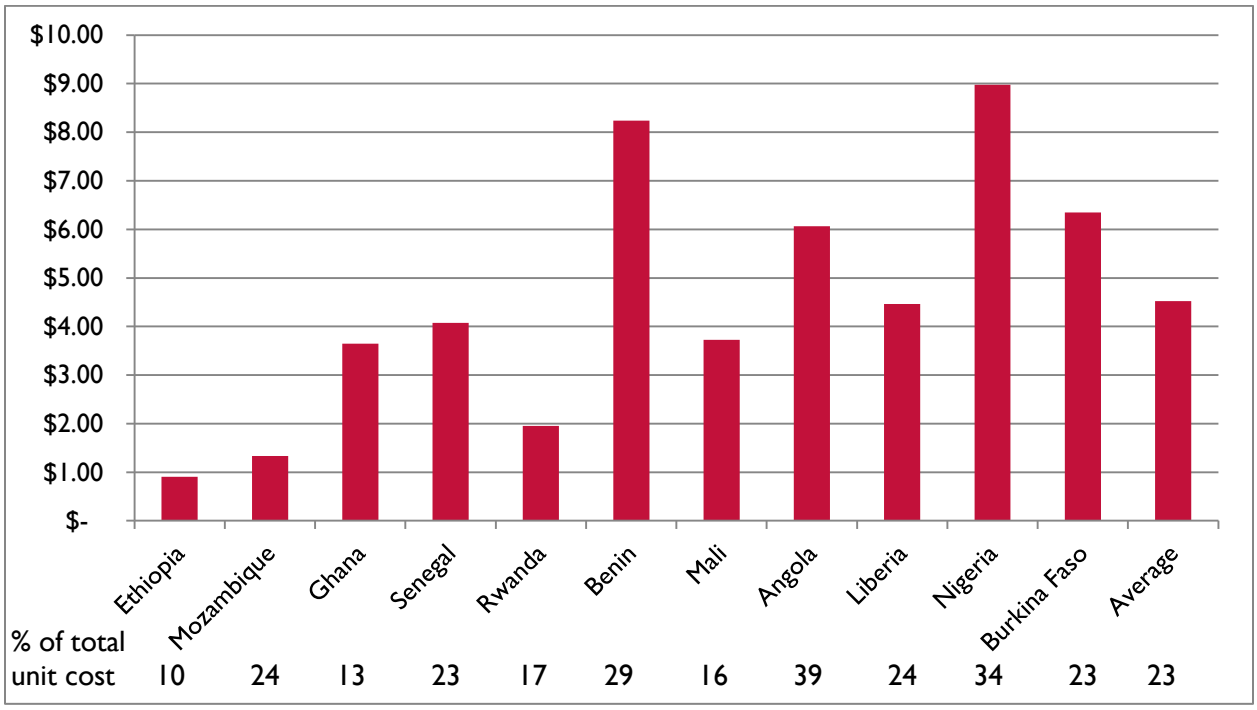



Figure CC18 shows the local labor portion of the unit costs per area sprayed (100 m²), ranging from $0.91 in Ethiopia to $8.97 in Nigeria, with an average of $4.52. The figure shows that unlike spray commodities and spray operations, local labor unit cost tends to be lower for larger programs, but the correlation is not fully explanatory. For example, Senegal has a higher local labor portion of the unit cost than does Mali. Table CC11 below helps explain this: while Mali spent about 0.12 labor hours per 100 m², Senegal spend about 0.09 hours. This would indicate that costs should be lower in Senegal. However, the cost per labor hour in Senegal is almost $44, while it is only $32 in Mali, so it is the cost of labor, as opposed to quantity of labor that is driving Senegal's local labor unit cost to be more expensive than Mali's.

**TABLE CC11: LOCAL LONG-TERM LABOR IMPACT ON PROGRAM UNIT COSTS**

| Country | Local Labor Total Hours | Local Labor Total Cost | Average Cost per Labor Hour | Labor Hours/ 100 Sq M sprayed | Labor Cost/ 100 Sq M sprayed | Local Labor % of Unit Cost |
|---|---|---|---|---|---|---|
| Ethiopia | 27,393 | $ 474,904 | $ 17.34 | 0.05 | $ 0.91 | 11% |
| Mozambique | 76,069 | $ 1,259,475 | $ 16.56 | 0.08 | $ 1.33 | 24% |
| Ghana | 42,926 | $ 704,729 | $ 16.42 | 0.22 | $ 3.65 | 13% |
| Senegal | 24,758 | $ 1,088,729 | $ 43.97 | 0.09 | $ 4.07 | 23% |
| Rwanda | 27,245 | $ 812,338 | $ 29.82 | 0.07 | $ 1.95 | 19% |
| Benin | 24,522 | $ 1,046,902 | $ 42.69 | 0.19 | $ 8.24 | 29% |
| Mali | 22,226 | $ 718,434 | $ 32.32 | 0.12 | $ 3.72 | 16% |
| Angola | 26,711 | $ 1,190,348 | $ 44.56 | 0.14 | $ 6.06 | 39% |
| Liberia | 32,747 | $ 911,183 | $ 27.82 | 0.16 | $ 4.46 | 24% |
| Nigeria | 21,605 | $ 654,613 | $ 30.30 | 0.30 | $ 8.93 | 34% |
| Burkina Faso | 15,956 | $ 307,271 | $ 19.26 | 0.33 | $ 6.35 | 23% |
| **AVERAGE** | | | **$ 29.19** | **0.16** | **4.52** | **23%** |

Table CC6 showed that the full-time local labor portions of the unit cost are highest for Angola (39 percent), Nigeria (34 percent), and Benin (29 percent). Table CC11, shows that these countries also have three out of the four most expensive local labor portions of unit costs.

**FIGURE CC19: LOCAL LABOR PRICE VS. QUANTITY ANALYSIS**

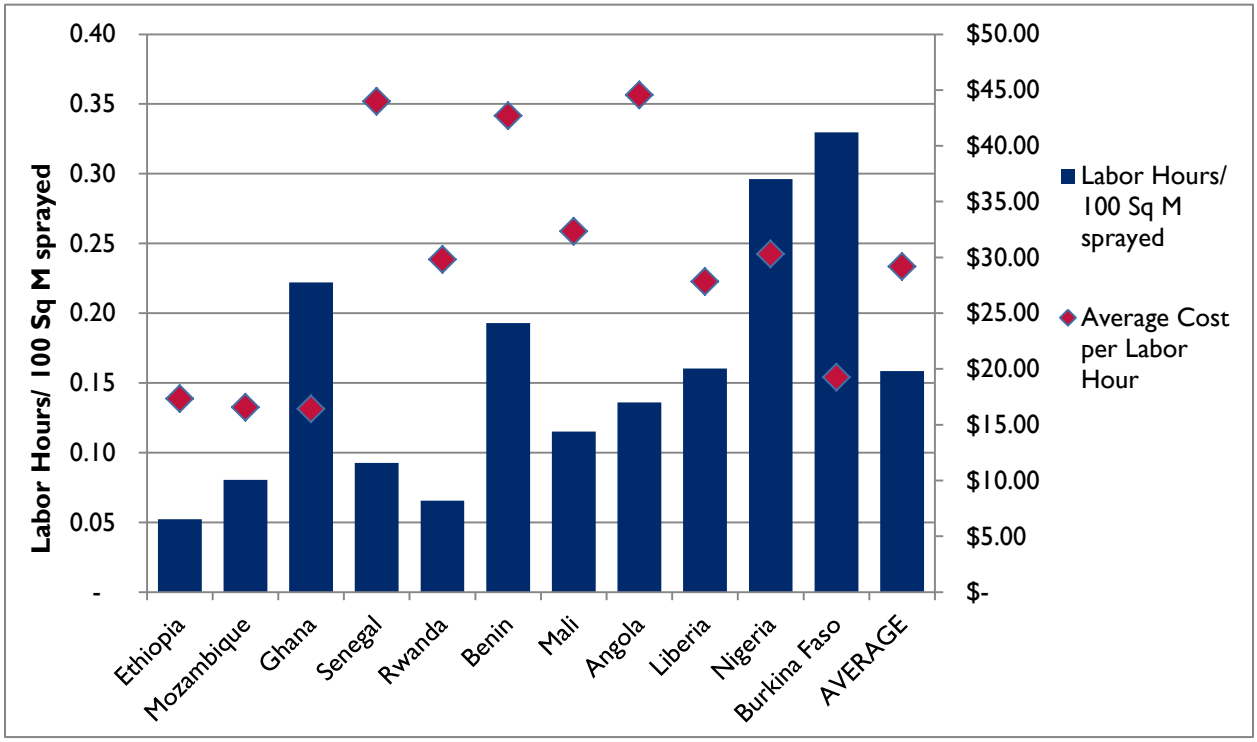



Figure CC19 presents an analysis of the local labor price versus quantity impact on country programs. The average cost per local labor hour is calculated by the total program cost of local labor divided by the total local labor hours worked. Labor hour per 100 $m^2$ sprayed is calculated by the total local labor hours worked divided by the number of 100 $m^2$ sprayed. The average cost per labor hour (dots) provides a representation of the variation in labor *prices* across countries, while the labor hours per 100 $m^2$ (bars) provides a representation of *quantity* of labor across countries.

Returning to Angola, Nigeria, and Benin, Figure CC19 begins to explain why the local labor unit costs are high relative to other countries. In Benin and Angola, average labor costs are two out of the three most expensive. Therefore, the price of labor is what drives this cost. In Nigeria, the average labor cost is similar to the overall average of all the countries, but the number of local labor hours per 100 square meters sprayed is above average. Therefore, even though the total number of square meters sprayed in a program is directly related to local labor hours, Nigeria is using the second highest quantity of labor of all countries studied. Also recall that since Nigeria is a small program, the high labor portion of the unit cost may also be due in part to program scale.

Table CC11 and Figure CC19 suggest that countries with large programs spend fewer labor hours per 100 $m^2$ sprayed than countries with smaller programs. The average number of hours spent in the large country programs was just about 0.1 hours (6 minutes) per 100 $m^2$ sprayed, while it was about 0.15 hours (9 minutes) in the medium program countries, and about 0.31 (19 minutes) in the countries with small programs. This suggests that local labor is, to some extent, a fixed cost.

## 3.5 CONCLUSIONS

### Unit of Measure

From a macro view, the number of people protected and number of structures sprayed are two important indicators of IRS programs. In addition, cost per person protected provides a very useful indicator for programmatic decision making and management at the country level. If a country has limited funds and needs to make a decision about IRS coverage, the cost per person protected can be a useful input. In 2012, IRS programs' cost per person protected ranged from $1.96 in Mozambique to $11.50 in Burkina Faso, with an unweighted average of $5.24.

When comparing unit costs across country programs, it is difficult to determine if differences are due to the average structure size or number of people per structure, among other external factors such as: different commodity or labor prices, different quantities of inputs, or the type of implementation model used. Since the average structure size and people living per structure varies across countries, the number of 100 $m^2$ sprayed removes factors outside the control of IRS programs, and provides a standardized measure as the best cross-country comparison to inform implementation management.

- Providing country unit costs per 100 $m^2$ sprayed and per person protected provide appropriate and informative analyses for programmatic and implementation management and decision-making by PMI as well as host governments.

### Program Scale

Broadly speaking, unit costs of large programs are less expensive than small programs, however…

- Even within each program size group, every country is different in terms of context as well as in the unit costs per 100 $m^2$ sprayed. Using the most standardized comparison unit cost available, there is no 'one-price-fits-all' for IRS across countries. For example, in the large program group, the cost per 100 $m^2$ in Mozambique and Ethiopia is $5.45 and $8.81, respectively; however Senegal and Ghana unit costs are $17.96 and $29.13, respectively.

*So what is driving the cost differences across countries?*

### Cost Drivers

- The type of insecticide class used in spray campaigns is one of the most important cost drivers. On average, the portion of unit costs spent on insecticides is $1.72 for pyrethroids, $5.82 for carbamates, and $7.91 for organophosphates. An average of 24 percent of the unit cost was spent on spray commodities.
- The portion of the unit costs spent on both spray operations and full-time local staff labor is largely due to country context: geography of spray coverage area, number of spray rounds per year, and general cost of living (prices for labor, fuel, etc.). An average of 31 percent of the unit cost was spent on spray operations.
- Full-time local staff labor is responsible for an average of 23 percent of the total cost per 100 $m^2$ sprayed, compared to 7 percent spent on U.S.-based labor and STTA.
- Important quality assurance technical activities (i.e., entomology; information, education and communication; environmental compliance; and M&E) are not driving unit costs. These four activities are on average $2.28 per 100 $m^2$ sprayed, or make up about 12 percent of the total unit cost.
- Fixed capital costs and local administration expenses are small relative to overall program implementation costs, at an average of 14 percent of the total unit cost.

# 4. ANGOLA

## 4.1 BACKGROUND

PMI began implementing IRS in southern Angola in 2006 and has continued through 2012. In 2012, IRS was implemented in the provinces of Huila, Huambo, 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 (SADC) initiative for malaria elimination in Namibia and reduce introduction of malaria cases from this area.

In August 2012, a Memorandum of Understanding (MOU), the Initiative Trans-Kunene for Malaria Control (TKMI), was signed between the Governments of Angola and Namibia. The MOU, 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.

**TABLE AO1: ANGOLA QUICK FACTS**

| | |
|---|---|
| # Local Staff | 20 |
| Spray Start Date | October 29, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 78,207 |
| # People Protected | 676,090 |
| # Structures Sprayed | 141,782 |
| # 100 Square Meters Sprayed | 195,518 |
| Average Size of Structure | 137.9 $m^2$* |

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

## 4.2 RESULTS

This section presents the Angola IRS program's total expenditures for both AIRS start-up operations (August 11, 2011 – March 31, 2012), as well as the first year of program implementation under the AIRS project (April 1, 2012–December 31, 2012). Since the spray campaign in Angola did not begin until October 29, 2012, there may be some minimal additional costs incurred in 2012 spray operations that would not have been included in the Abt Associates financial systems until as late as February 2013, and are not included in this costing report. 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE AO1: ANGOLA IRS TOTAL EXPENDITURES**

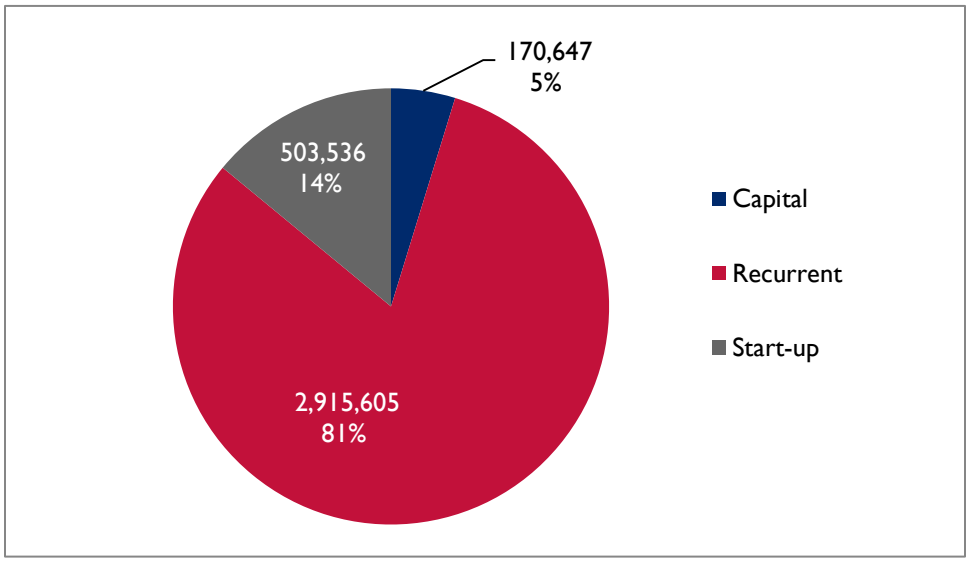



Figure AO1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 81 percent of total project expenditures are recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $137,500 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list.

**FIGURE AO2: ANGOLA IRS START-UP EXPENDITURES, BY BURDEN TYPE**

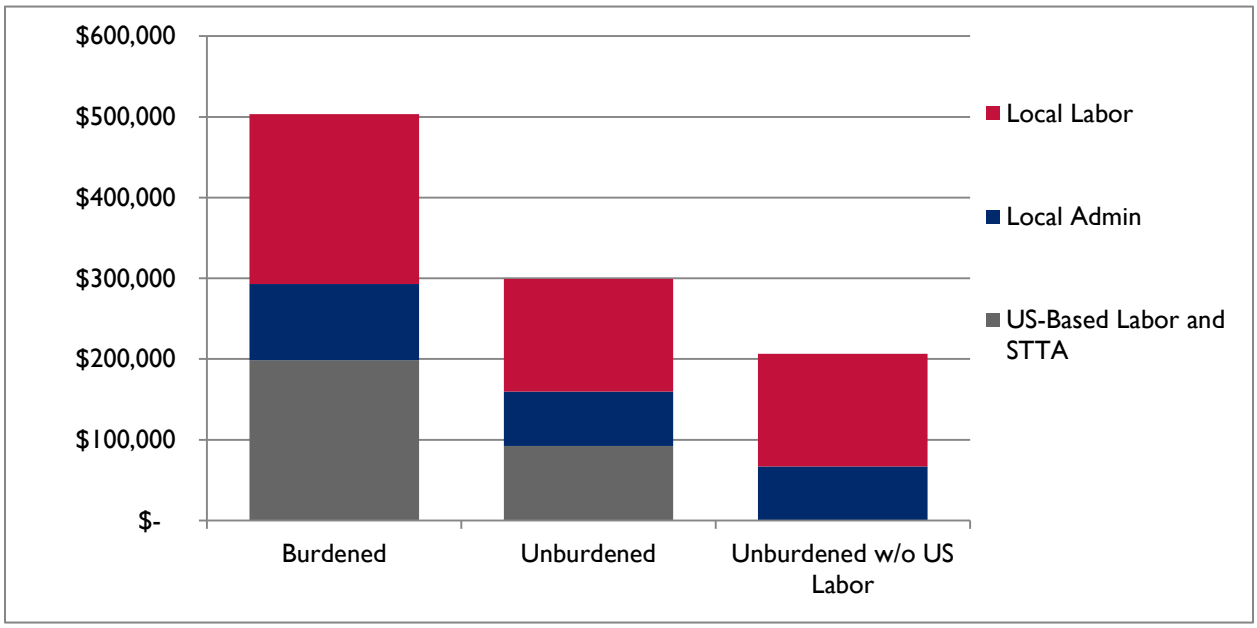



Figure AO2 displays the Angola IRS program start-up expenditures only, which include activities such as country scoping, technical information gathering, recruitment and hiring, and office set-up in all three

provinces. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. About 81 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. The total program start-up expenditures for Angola IRS were high; this may be due to the fact that the program had a late spray campaign date, which meant the start-up operations period lasted through March 30, 2013. As mentioned previously, start-up expenditures are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

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

| Activity | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 168,082 | 331,538 | 819,914 | | | $ 1,319,534 | 44.18% |
| Entomology | 6,359 | | 42,365 | 52,959 | | $ 101,683 | 3.40% |
| EC | 6,880 | | 14,676 | 15,059 | | $ 36,615 | 1.23% |
| Equipment Supplies | 195 | | | 6,581 | 109,787 | $ 116,563 | 3.90% |
| IEC | | | 1,732 | 154,723 | | $ 156,455 | 5.24% |
| Insecticide | | | | | 285,759 | $ 285,759 | 9.56% |
| M&E | 69,171 | | 90,058 | 68,879 | | $ 228,108 | 7.64% |
| Post-Spray Ops | | | 102 | 90 | | $ 192 | 0.01% |
| Spray Campaign | 10,305 | | 105,178 | 417,505 | | $ 532,988 | 17.84% |
| Spray Planning | 2,722 | | 116,323 | 89,885 | | $ 208,930 | 7.00% |
| **Grand Total** | **$ 263,714** | **$ 331,538** | **$1,190,348** | **$ 805,681** | **$ 395,546** | **$ 2,986,827** | **100%** |

Table AO2 displays the Angola IRS program total capital and recurrent expenditures, and excludes the start-up costs. 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 costs in the above table.

**FIGURE AO3: ANGOLA IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

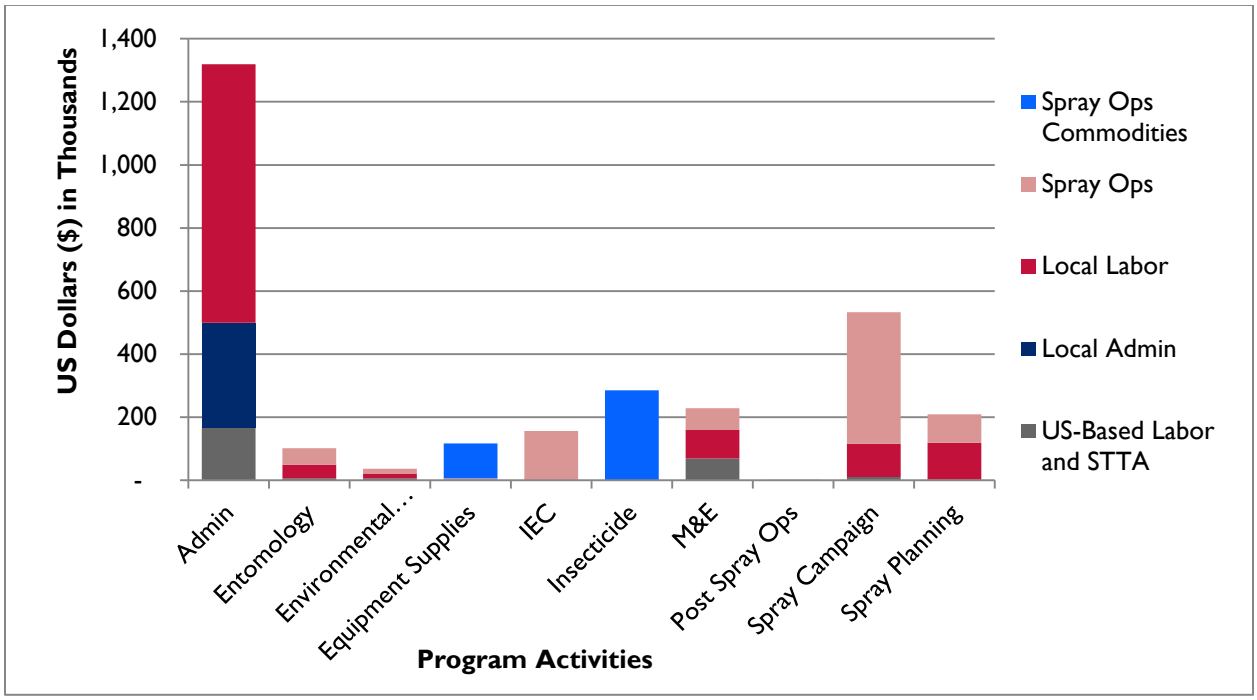



Figure AO3 shows fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Administration and implementation of the spray campaign are the two most expensive activities, followed by insecticide. The total cost for administration is the largest activity cost, but about 75 percent of this cost 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 AO4: ANGOLA IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

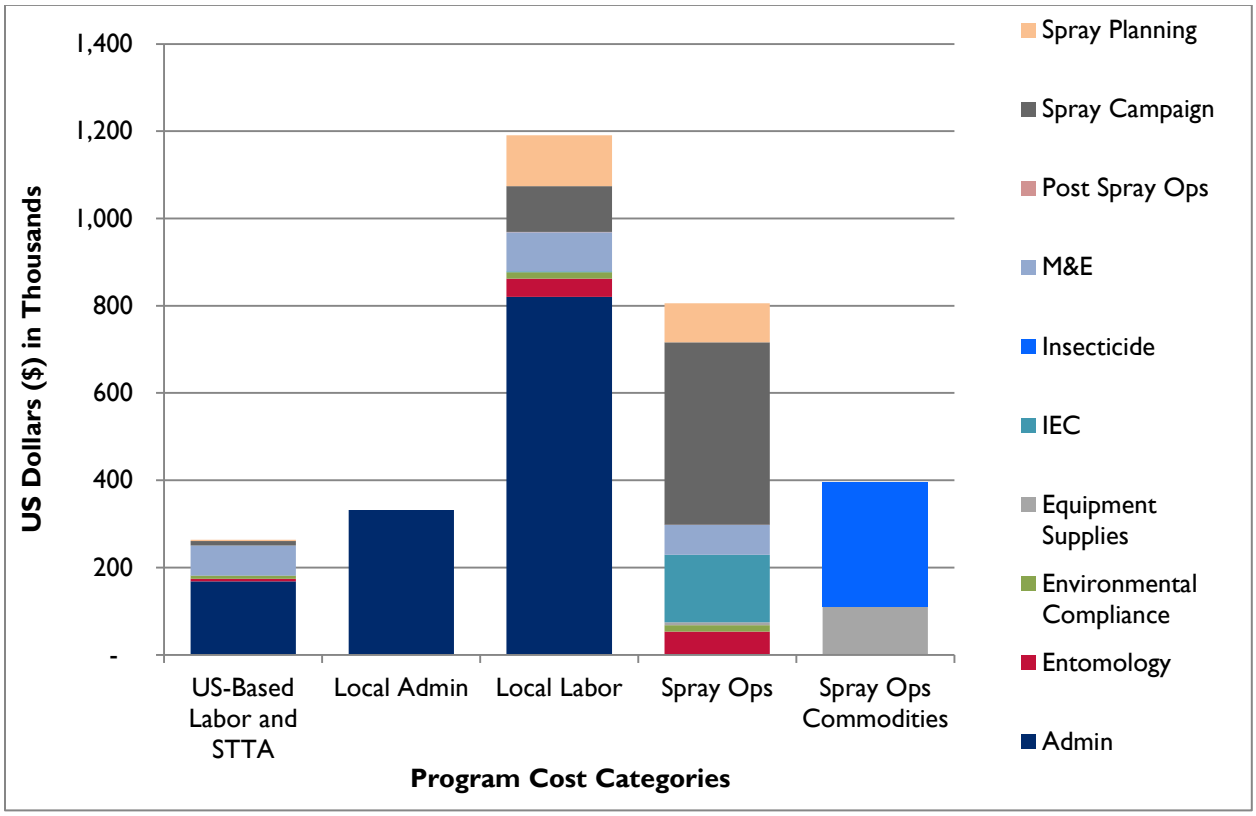



Figure AO4 contains the same information as Figure AO3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs and U.S.-based labor and STTA are minimal compared to expenditures related to local labor, technical operations, and commodities.

## 4.3 Unit Cost Analysis

This section presents Angola IRS capital and recurrent expenditures as unit costs: per structure sprayed, per 100 $m^2$ sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 $m^2$ was added as a more standardized unit to allow for cross-country comparison.

**FIGURE AO5: ANGOLA IRS UNIT COSTS, BY ACTIVITY**

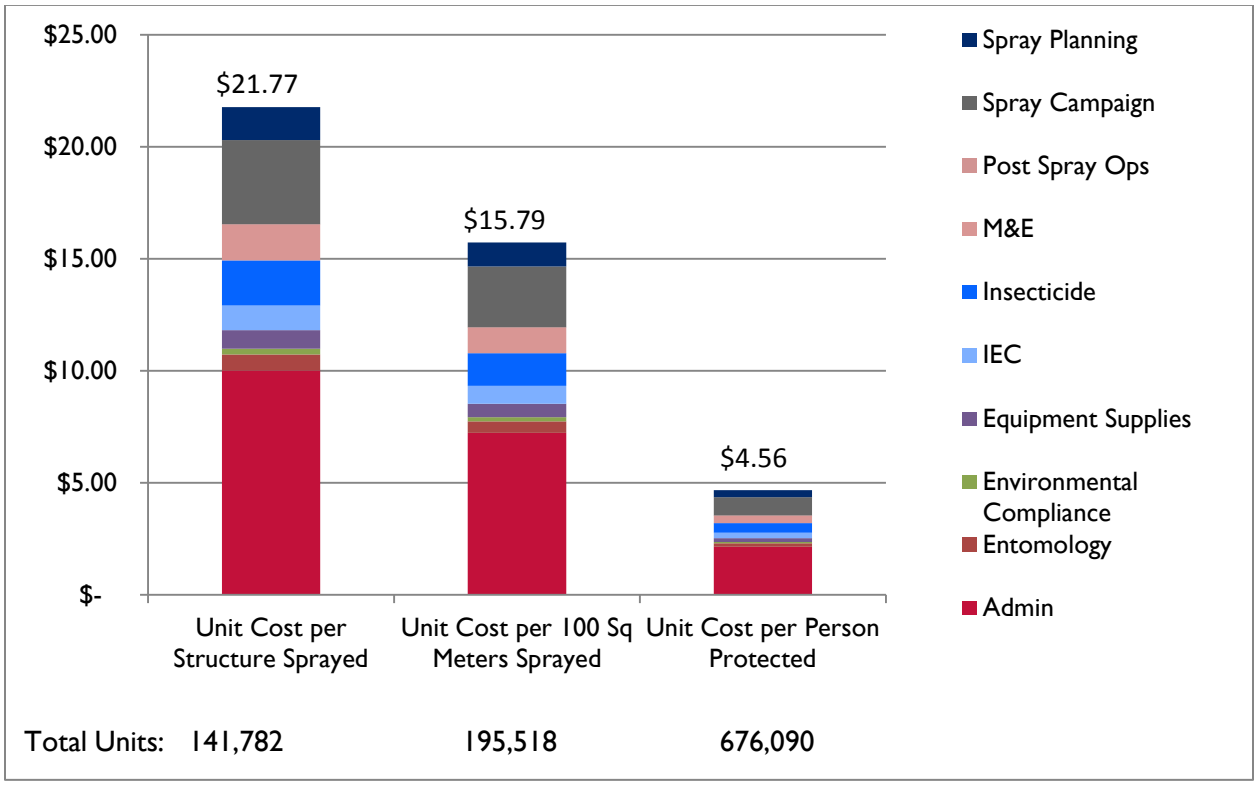
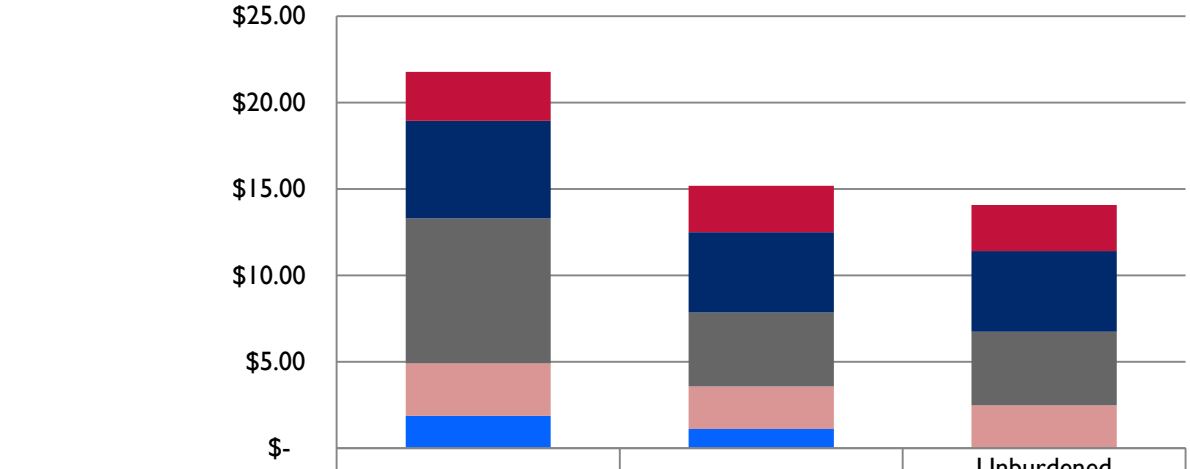



Figure AO5 illustrates the Angola program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, IEC, EC, and M&E, have only a minor impact on the unit cost. Administration is the largest cost driver, followed by the spray campaign and then insecticide. Keep in mind that Figure AO3 showed that over three-fourths of the costs under administration consisted of U.S.-based and local labor.

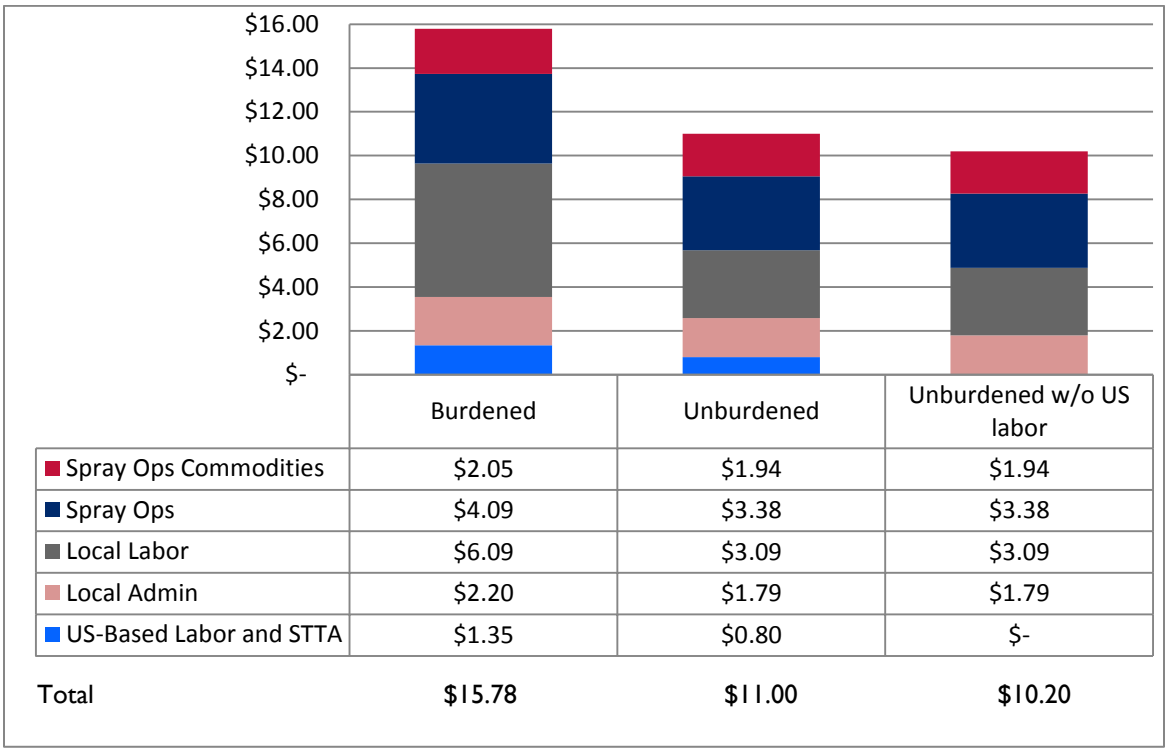
**FIGURE AO6: ANGOLA IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $2.83 | $2.67 | $2.67 |
| Spray Ops | $5.64 | $4.66 | $4.66 |
| Local Labor | $8.40 | $4.26 | $4.26 |
| Local Admin | $3.04 | $2.47 | $2.47 |
| US-Based Labor and STTA | $1.86 | $1.10 | $- |
| Total | $21.77 | $15.17 | $14.07 |

The Angola IRS program sprayed 141,782 structures during the 2012 spray campaign. Figure AO6 shows the unit costs per structure sprayed burdened ($21.77), unburdened ($15.17), and unburdened without U.S. labor ($14.07), itemized by cost category. In terms of cost categories, the largest cost driver is local labor, followed by spray operations and spray commodities. In contrast to the preceding figure, the local administration cost category excludes local staff labor expenses, and both local administration and U.S.-based labor make up about 22 percent of the total burdened unit cost. As outlined fully in the Methodology section, the unburdened unit cost excludes the implementing partner's overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration and STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is about 35 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for almost two thirds of the total "cost of burden."

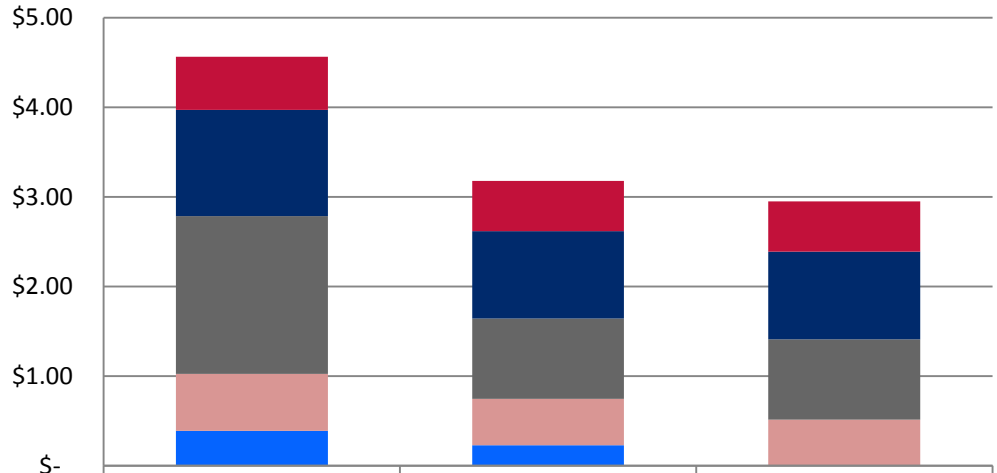
**FIGURE AO7: ANGOLA IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $2.05 | $1.94 | $1.94 |
| Spray Ops | $4.09 | $3.38 | $3.38 |
| Local Labor | $6.09 | $3.09 | $3.09 |
| Local Admin | $2.20 | $1.79 | $1.79 |
| US-Based Labor and STTA | $1.35 | $0.80 | $- |
| Total | $15.78 | $11.00 | $10.20 |

Figure AO7 shows the unit costs per 100 m² sprayed burdened ($15.78), unburdened ($11.00), and unburdened without U.S.-based labor ($10.20), itemized by cost category. The Angola spray campaign used 78,207 sachets of insecticide to cover 19,551,750 square meters of structure area. Thus, the average size of the structures sprayed in Angola was 137.9 m². This report looks at the unit cost of 100 m² sprayed, which covers about three-fourths of a structure in Angola. The Angola IRS program unit cost per 100 m² sprayed is one-fourth less expensive than the unit cost per structure sprayed. Using this unit of measure, per 100 m² sprayed, along with the contextual information of the average size of structures in Angola, allows for a more accurate comparison to other country program costs.

**FIGURE AO8: ANGOLA IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $0.59 | $0.56 | $0.56 |
| Spray Ops | $1.18 | $0.98 | $0.98 |
| Local Labor | $1.76 | $0.89 | $0.89 |
| Local Admin | $0.64 | $0.52 | $0.52 |
| US-Based Labor and STTA | $0.39 | $0.23 | $- |
| Total | $4.56 | $3.18 | $2.95 |

As noted in the Background section, the Angola 2012 IRS spray campaign protected 676,090 people from malaria transmission. Figure AO8 shows the unit costs per person protected burdened ($4.56), unburdened ($3.18), and unburdened without U.S.-based labor ($2.95), itemized by cost category. The categories driving the unit cost include local labor and spray operations. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of AIRS Angola program costs, as delivered through an international implementing partner, adds $1.61 to the unit cost per person protected.

# 5. BENIN

## 5.1 BACKGROUND

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 IRS program focus from Ouémé Region to Atacora Region in northern Benin, in an attempt to cover the entire transmission season to potentially increase cost-effectiveness. Since 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 using carbamates.

In 2012, PMI's AIRS project completed IRS in all of Atacora Region's nine districts: Boukoumbe, Cobli, Kerou, Kouande, Materi, Natitingou, Pehunco, Tangueita, and Toucountouna. This was the first IRS campaign in both Pehunco and Kerou districts. The campaign used the carbamate-class insecticide bendiocarb. 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. This impacted the cost of ground transportation.

The AIRS Benin team is composed of 14 full-time local staff, with an additional 800 temporary workers involved in the spray campaign. Additionally, the AIRS implementing partner's core team, based out of its home office in Bethesda, Maryland, provides overall project accountability, conducts international procurements, and provides technical assistance and best practices on an as needed basis. Entomological monitoring activities were completed through a subcontract to the local organization, Centre de Recherche Entomologique de Contonou (CREC), a research firm associated with the University of Benin. Beginning in 2013, PMI will directly subcontract CREC.

**TABLE BN1: BENIN QUICK FACTS**

| | |
|---|---|
| # Local Staff | 14 |
| Spray Start Date | May 14, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 50,842 |
| # People Protected | 652,777 |
| # Structures Sprayed | 210,380 |
| # 100 Square Meters Sprayed | 127,105 |
| Average Size of Structure | 60.4 sq. meters* |

* Reverse calculation using number of insecticide sachets used during campaign multiplied by the average of 250 $m^2$ estimated to be sprayed by one sachet and divided by the number of structures sprayed.

## 5.2 RESULTS

This section presents the Benin IRS program's total expenditures for both program start-up operations (August 11, 2011–January 9, 2012), as well as the first year of program implementation under the AIRS project (January 10, 2012–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE BN1: BENIN IRS TOTAL EXPENDITURES**

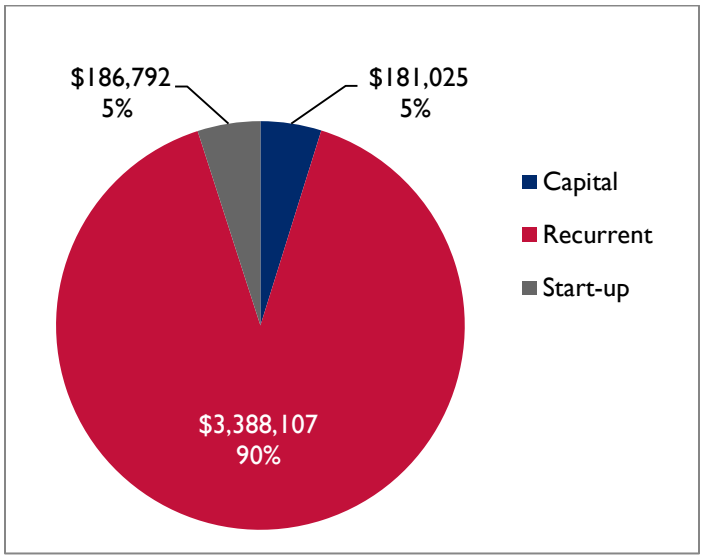



Figure BN1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and are analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 90 percent of total project expenditures are recurrent costs. The cost of the entomological monitoring activity ($202,456, as shown in Table BN2, later in this chapter) is currently included in the total recurrent expenditures, but it will not be included in next year's scope of work. Note that the capital expenses included here are depreciated across the three years of the project.[17] Out of the total program expenditures, about $461,000 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list.

[17] As noted by the technical program staff, some PPE capital items are only expected to have a useful life of two years, and are depreciated accordingly. For Benin, these items include coveralls, boots, and gloves.

**FIGURE BN2: BENIN IRS TOTAL START-UP EXPENDITURES, BY EXPENDITURE STATUS**

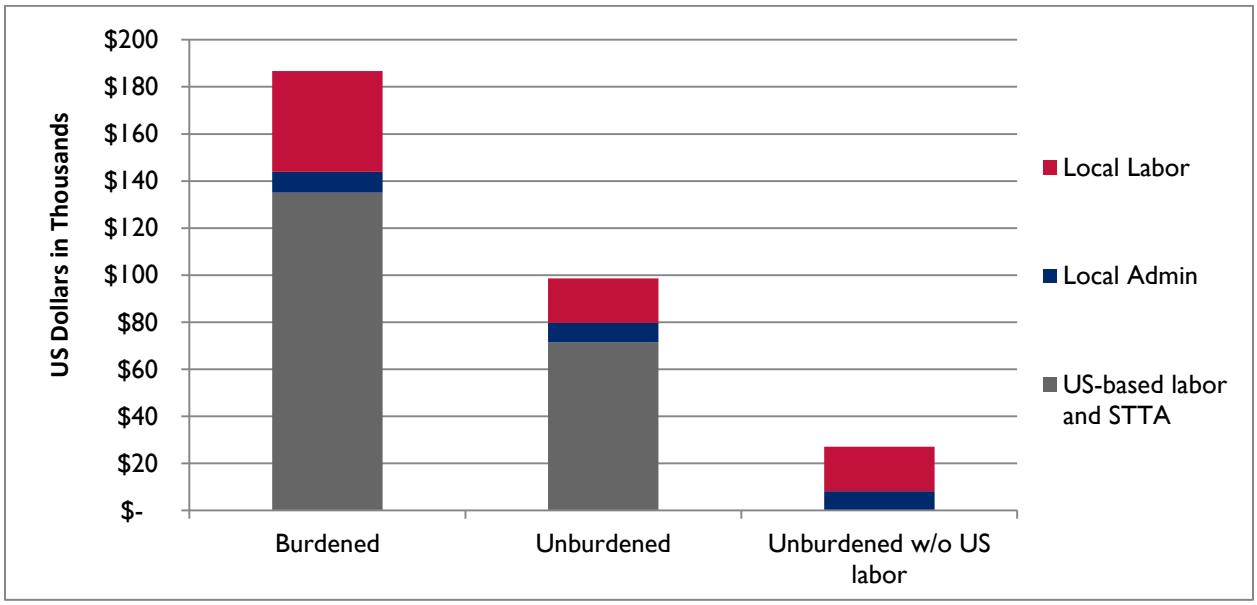



Figure BN2 looks at the Benin program start-up expenditures under the AIRS project only, which include activities such as country scoping, technical information gathering, and hiring. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. Over 95 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. As mentioned before, start-up expenditures are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

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

| Activity | U.S.-based labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 144,022 | 221,322 | 353,863 | | | $ 719,207 | 20.15% |
| Entomology | 6,534 | | 183,039 | 12,883 | | $ 202,456 | 5.67% |
| EC | 11,552 | | 75,228 | 19,658 | | $ 106,438 | 2.98% |
| Equipment Supplies | 107 | | 22,069 | 74,541 | 175,588 | $ 272,305 | 7.63% |
| IEC | | | 65 | 35,073 | | $ 35,138 | 0.98% |
| Insecticide | | | 1,047 | 2,551 | 769,333 | $ 772,931 | 21.66% |
| M&E | 27,764 | | 81,153 | 13,323 | | $ 122,240 | 3.43% |
| Spray Planning | | | 57,239 | 12,818 | | $ 70,057 | 1.96% |
| Spray Campaign | 256 | | 208,509 | 963,521 | 21,335 | $ 1,193,621 | 33.45% |
| Post-Spray Ops | 1,025 | | 64,689 | 9,024 | | $ 74,738 | 2.09% |
| **Grand Total** | **$ 191,260** | **$ 221,322** | **$ 1,046,901** | **$ 1,143,392** | **$ 966,256** | **$ 3,569,131** | **100%** |

Table BN2 displays the Benin IRS program total capital and recurrent expenditures, and excludes the start-up costs. 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 costs in the above table.

**FIGURE BN3: BENIN IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

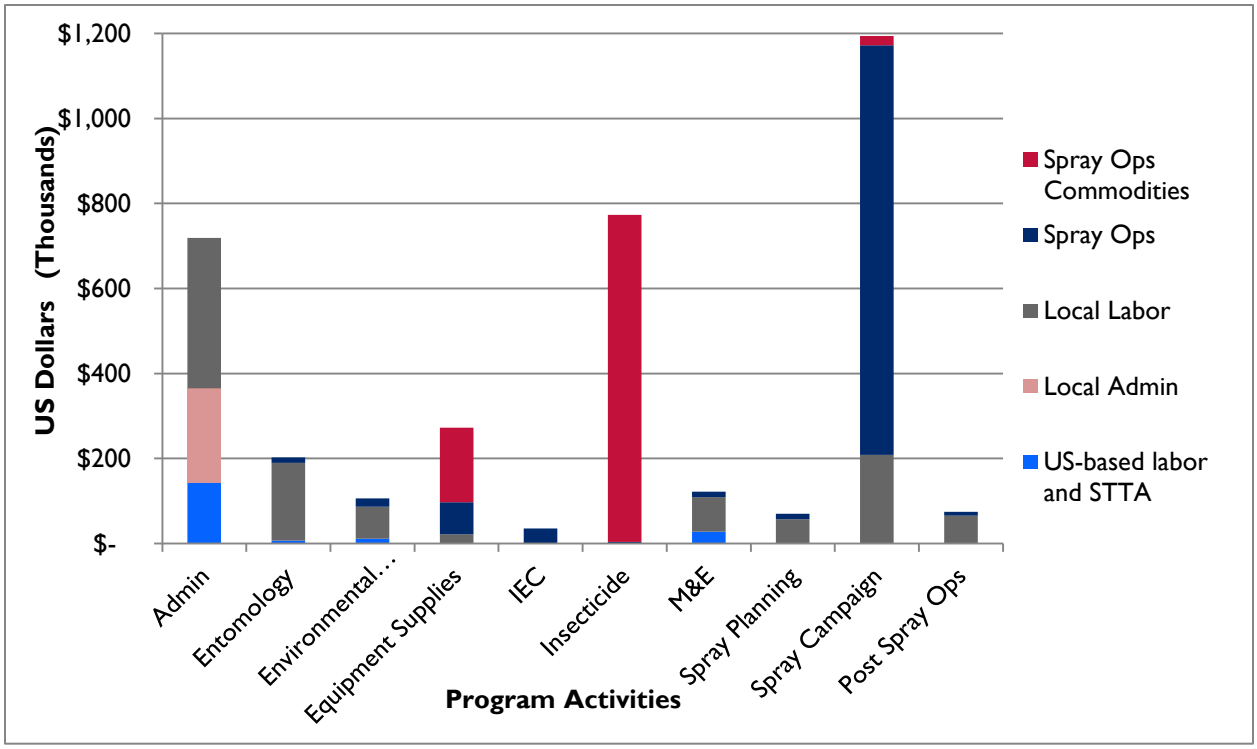



Figure BN3 shows fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The cost of insecticides and implementation of the spray campaign are the two most expensive activities. The total cost for administration is the third largest activity cost, but over two-thirds of this cost 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 and M&E program activities, while 'Local Labor' is spread more evenly across a majority of activities.

**FIGURE BN4: BENIN IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

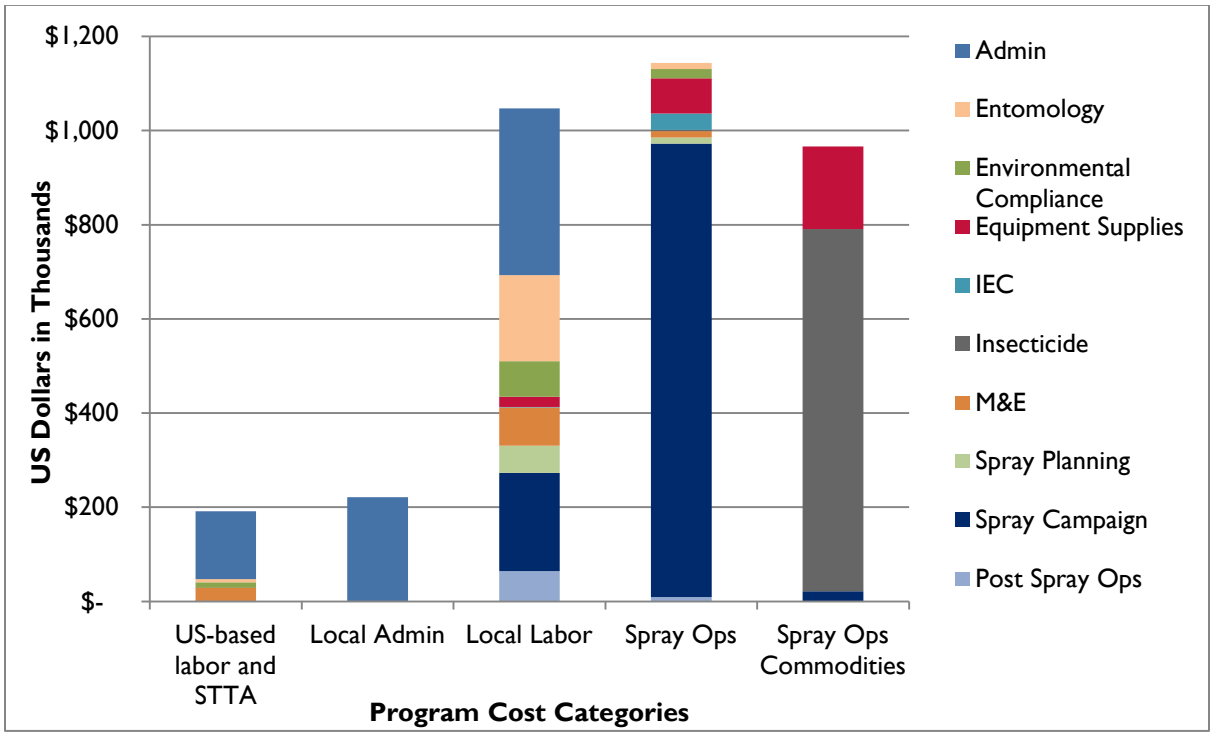



Figure BN4 contains the same information as Figure BN3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs and U.S.-based labor and STTA are minimal compared to expenditures related to local labor, technical operations, and commodities.

## 5.3 Unit Cost Analysis

This section presents Benin IRS program capital and recurrent expenditures as unit costs: per structure sprayed, per 100 $m^2$ sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 $m^2$ was added as a more standardized unit to allow for cross-country comparison.

**FIGURE BN5: BENIN IRS PROGRAM UNIT COSTS, BY ACTIVITY**

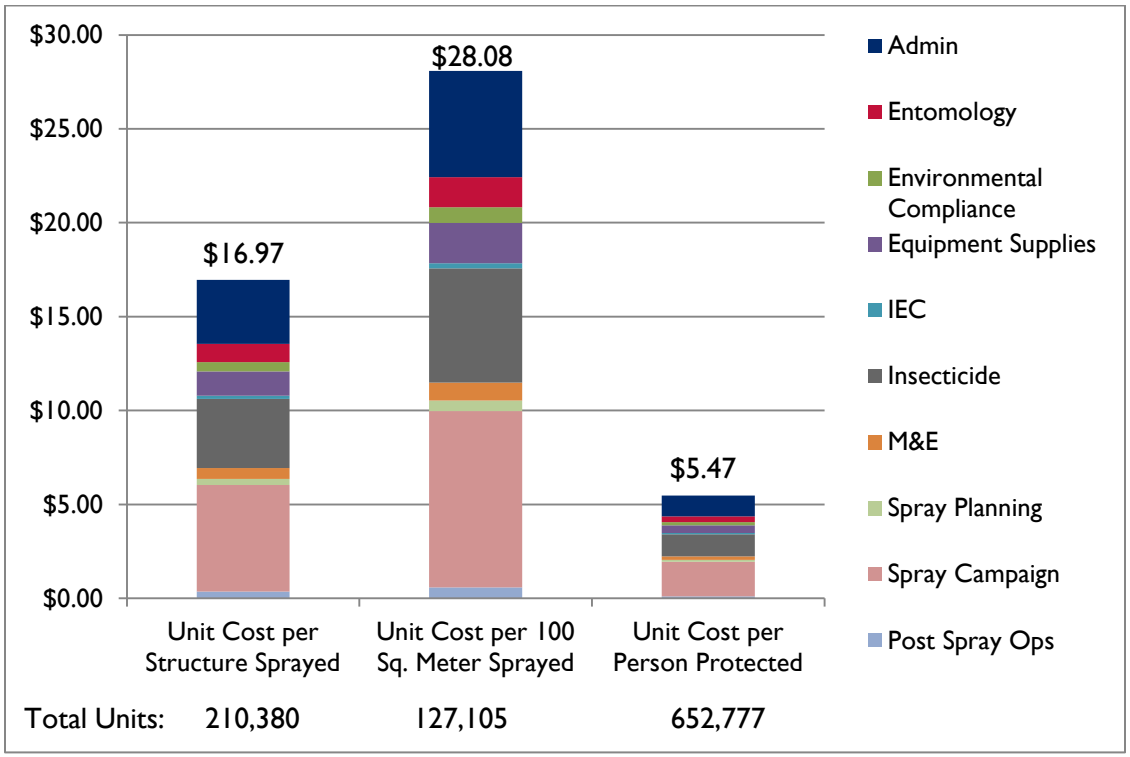
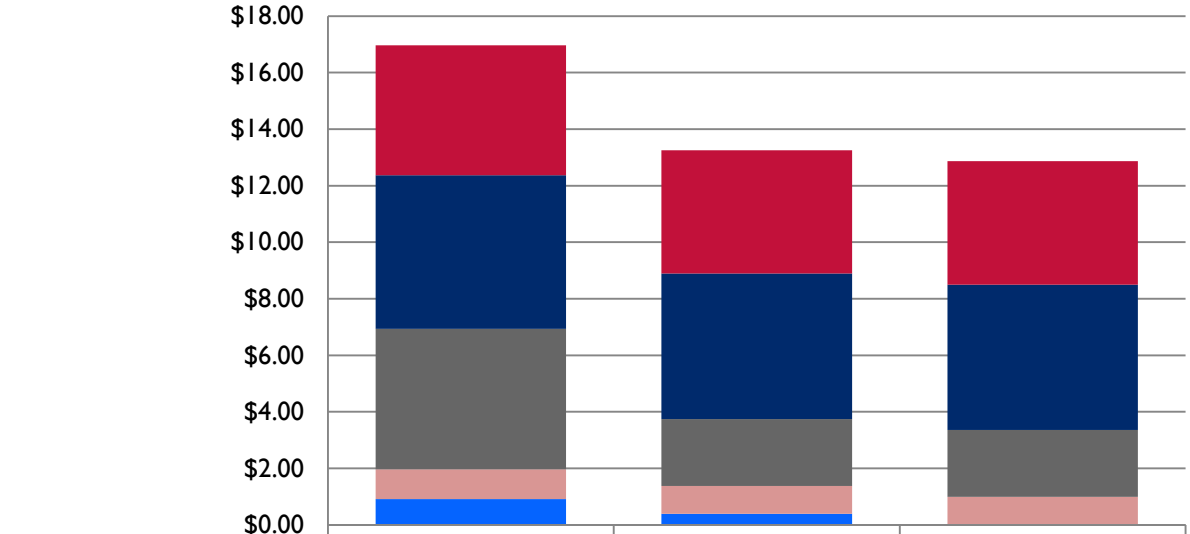



Figure BN5 illustrates the Benin IRS program fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, IEC, EC, and M&E, have only a minor impact on the unit cost. Instead, the spray campaign is the largest cost driver, followed closely by insecticide and administration. Keep in mind that Figure BN3 showed that over two-thirds of the costs under administration consisted of labor.

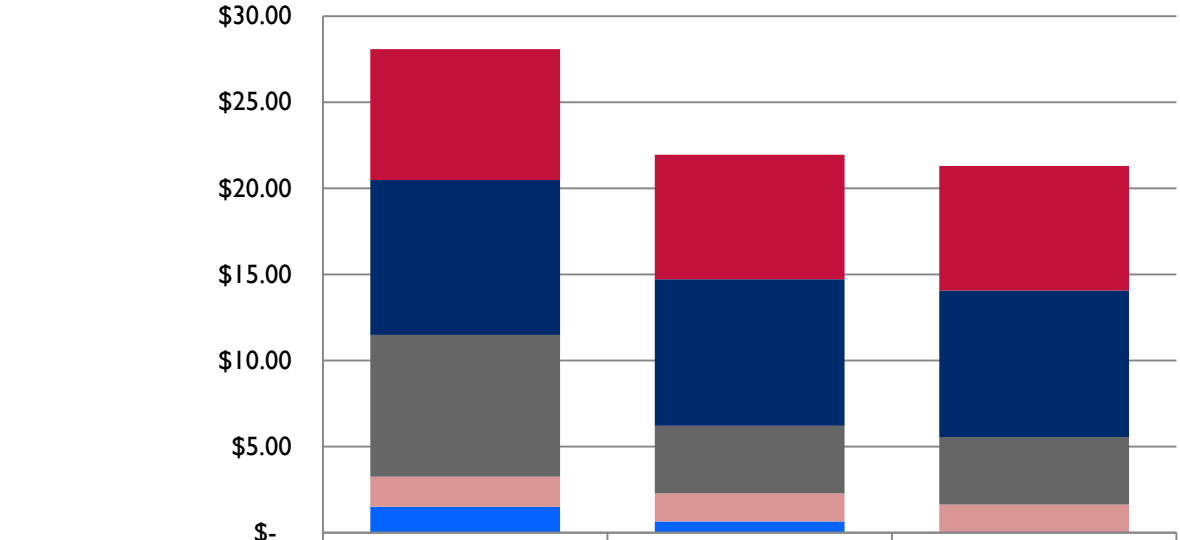
**FIGURE BN6: BENIN IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $4.59 | $4.37 | $4.37 |
| Spray Ops | $5.43 | $5.14 | $5.14 |
| Local Labor | $4.98 | $2.36 | $2.36 |
| Local Admin | $1.05 | $0.99 | $0.99 |
| US-based labor and STTA | $0.91 | $0.39 | $- |
| Total | $16.97 | $13.25 | $12.86 |

The Benin IRS program sprayed 210,380 structures during the 2012 spray campaign. Figure BN6 shows the unit costs per structure sprayed burdened ($16.97), unburdened ($13.25), and unburdened without U.S. labor ($12.86), itemized by cost category. In terms of cost categories, the largest cost driver is spray operations, followed by local labor and spray commodities. In contrast to the preceding figure, the local administration cost category excludes local staff labor expenses, and both local administration and U.S.-based labor make up less than 12 percent of the total burdened unit cost. The unburdened unit cost excludes implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $4.11 or 24 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for over two thirds of the total "cost of burden."

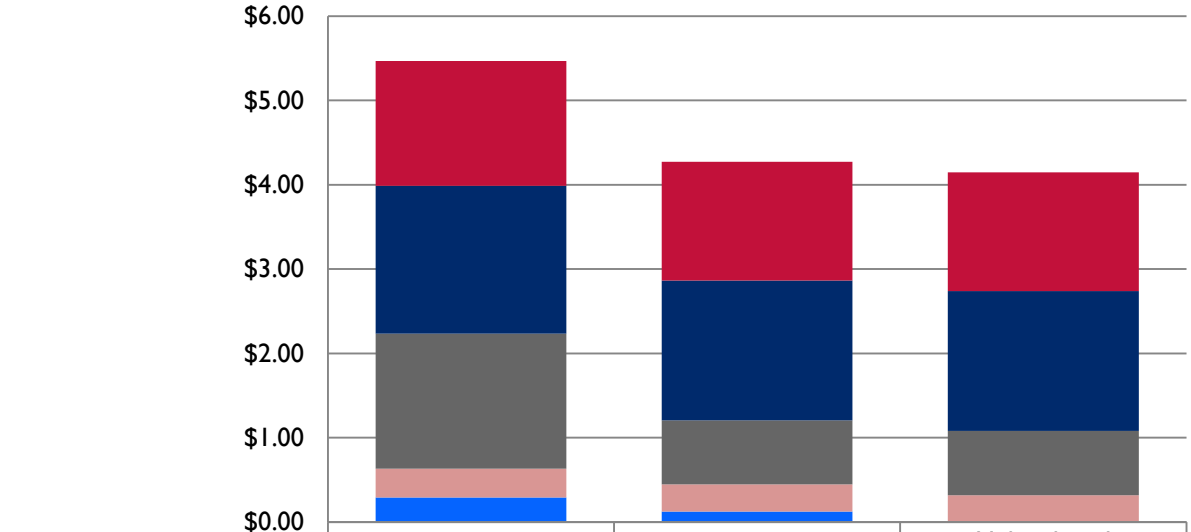
**FIGURE BN7: BENIN IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $7.60 | $7.23 | $7.23 |
| Spray Ops | $9.00 | $8.51 | $8.51 |
| Local Labor | $8.24 | $3.91 | $3.91 |
| Local Admin | $1.74 | $1.64 | $1.64 |
| US-based labor and STTA | $1.50 | $0.65 | $- |
| Total | $28.08 | $21.94 | $21.29 |

Figure BN7 shows the unit costs per 100 m² sprayed burdened ($28.08), unburdened ($21.94), and unburdened without U.S.-based labor ($21.29), itemized by cost category. The Benin spray campaign used 50,842 sachets of insecticide to cover 12,710,500 m² of structure area. Thus, the average size of the structures sprayed in Benin was 60.4 m². This report looks at the unit cost of 100 m² sprayed, which covers about one and two-thirds of a structure in Benin. The Benin unit cost per 100 m² sprayed is almost twice as much as the unit cost per structure sprayed. Using the unit of measure per 100 m² sprayed, however, along with the contextual information of the average size of structures in Benin, allows for a more accurate comparison to other country program costs.

**FIGURE BN8: BENIN IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $1.48 | $1.41 | $1.41 |
| Spray Ops | $1.75 | $1.66 | $1.66 |
| Local Labor | $1.60 | $0.76 | $0.76 |
| Local Admin | $0.34 | $0.32 | $0.32 |
| US-based labor and STTA | $0.29 | $0.13 | $- |
| Total | $5.47 | $4.27 | $4.15 |

As noted in the Background section, the Benin 2012 IRS spray campaign protected 652,777 people from malaria transmission. Figure BN8 shows the unit costs per person protected burdened ($5.47), unburdened ($4.27), and unburdened without U.S.-based labor ($4.15), itemized by cost category. The categories driving the unit cost include spray operations (largest), local labor, and spray commodities. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of Benin IRS program costs, as delivered through an implementing partner, adds $1.32 to the unit cost per person protected.

# 6. BURKINA FASO

## 6.1 BACKGROUND

Although Burkina Faso is not a PMI focus country, it still benefits from USAID support to malaria programs, including IRS. In late 2009, USAID assisted the Programme National de Lutte contre le Paludisme (PNLP) to identify a suitable target area for the first IRS implementation. The location chosen was Diébougou district, located in Bougouriba Province in the Sud-Ouest region in the south-westernmost zone of the country. Based on assessments of vector susceptibility completed in 2009, Burkina Faso chose carbamates to begin their spray operations. IRS was introduced in 2010 with funding from USAID, and continued through 2011 through the incumbent implementing entity. During the 2010 spray round, 34,284 structures were found, of which 33,897 were sprayed (98.9 percent coverage rate), protecting 118,691 persons including 24,587 children under five years old and 2,317 pregnant women. The 2011 spray round targets were essentially the same as the previous year, resulting in 34,067 structures found, of which 33,832 were sprayed (99.31 percent coverage rate), protecting 110,064 persons including 23,403 children under five years old and 1,967 pregnant women.

Through USAID funding, the AIRS Burkina Faso program conducted its third spray campaign in Diebougou district over 21 operational days, from July 6 through August 4, 2012. Based on assessments of vector susceptibility, the 2012 spray campaign used carbamate insecticide once again. The AIRS Burkina Faso program closed out on December 31, 2012 due to a change in PNLP priorities with respect to malaria prevention and control. Expenditures related to close-out were minimal. Most local staff had left by the end of December 2012, so severance was only paid for about four staff members, and it was minimal as they had only been hired for one year.

**TABLE BF1: BURKINA FASO QUICK FACTS**

| | |
|---|---|
| # Local Staff | 11 |
| Spray Start Date | July 6, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 19,365 |
| # People Protected | 115,638 |
| # Structures Sprayed | 36,870 |
| # 100 Square Meters Sprayed | 48,413 |
| Average Size of Structure | 82 sq. meters* |

* 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.

## 6.2 RESULTS

This section presents the Burkina Faso IRS program's total expenditures for both program start-up operations (August 11, 2011–December 31, 2011) and the first year of program implementation under the AIRS project (January 1, 2012–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE BF1: BURKINA FASO IRS TOTAL EXPENDITURES**

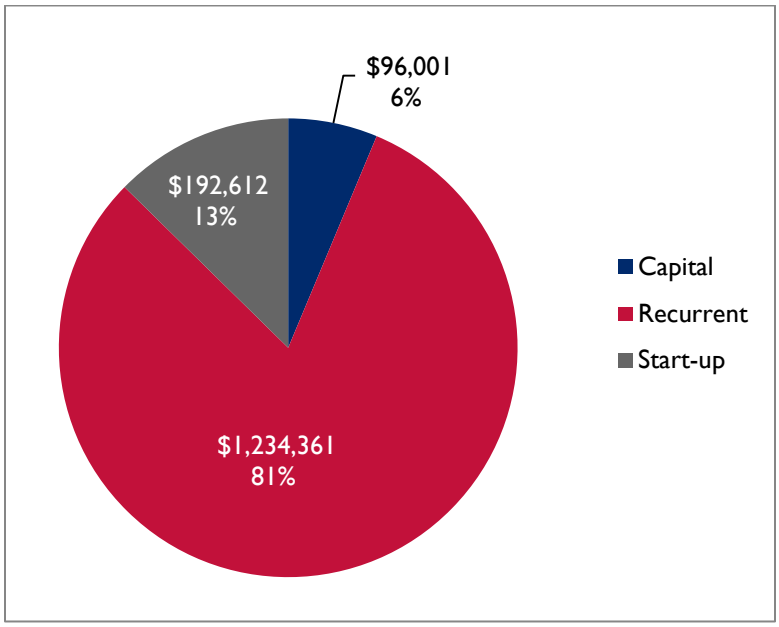



Figure BF1 shows the fully burdened cost of IRS program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 81 percent of total project expenditures are on recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $27,100 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list.

**FIGURE BF2: BURKINA FASO IRS START-UP EXPENDITURES, BY BURDEN TYPE**

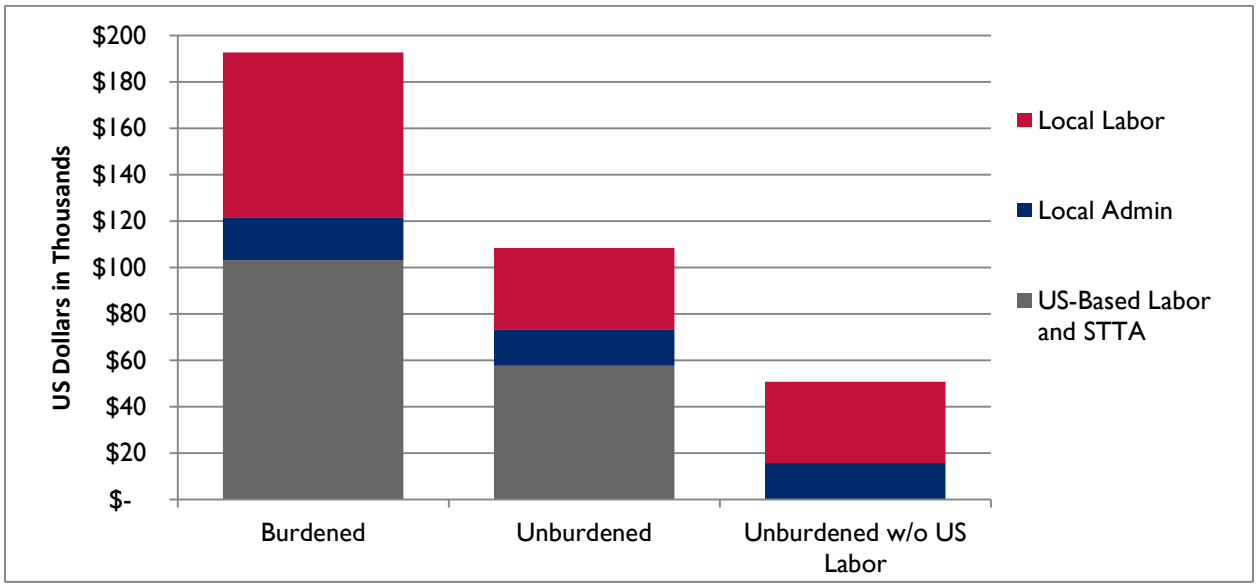



Figure BF2 shows the AIRS Burkina Faso program start-up expenditures only. These were on activities such as country scoping, technical information gathering, recruitment, hiring, and office set-up. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. Over 90 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. As mentioned before, start-up expenditures are treated as a one-time cost to the project, and therefore are not included in the program implementation analysis that follows.

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

| Activity | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 114,819 | 231,040 | 190,912 | | | $ 536,771 | 40.35% |
| Entomology | 5,342 | | | 58,594 | | $ 63,936 | 4.81% |
| EC | 10,325 | | 46,800 | 19,259 | | $ 76,384 | 5.74% |
| Equipment/ Supplies | 597 | | 18,988 | 6,353 | 68,523 | $ 94,461 | 7.10% |
| IEC | - | - | - | - | - | - | - |
| Insecticide | | | | 2,698 | 307,704 | $ 310,402 | 23.32% |
| M&E | 13,433 | | 22,568 | | | $ 36,001 | 2.71% |
| Post-Spray Ops | | | 2,796 | 1,320 | | $ 4,116 | 3.12% |
| Spray Campaign | 22,574 | | 25,207 | 119,026 | | $ 166,807 | 12.54% |
| Spray Planning | | | | 41,485 | | $ 41,485 | 0.31% |
| **Grand Total** | **$ 167,090** | **$ 231,040** | **$ 307,271** | **$ 248,735** | **$ 376,227** | **$ 1,330,363** | **100%** |

Table BF2 displays the Burkina Faso IRS program's total capital and recurrent expenditures and excludes the start-up costs. 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 costs in the above table.

**FIGURE BF3: BURKINA FASO IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

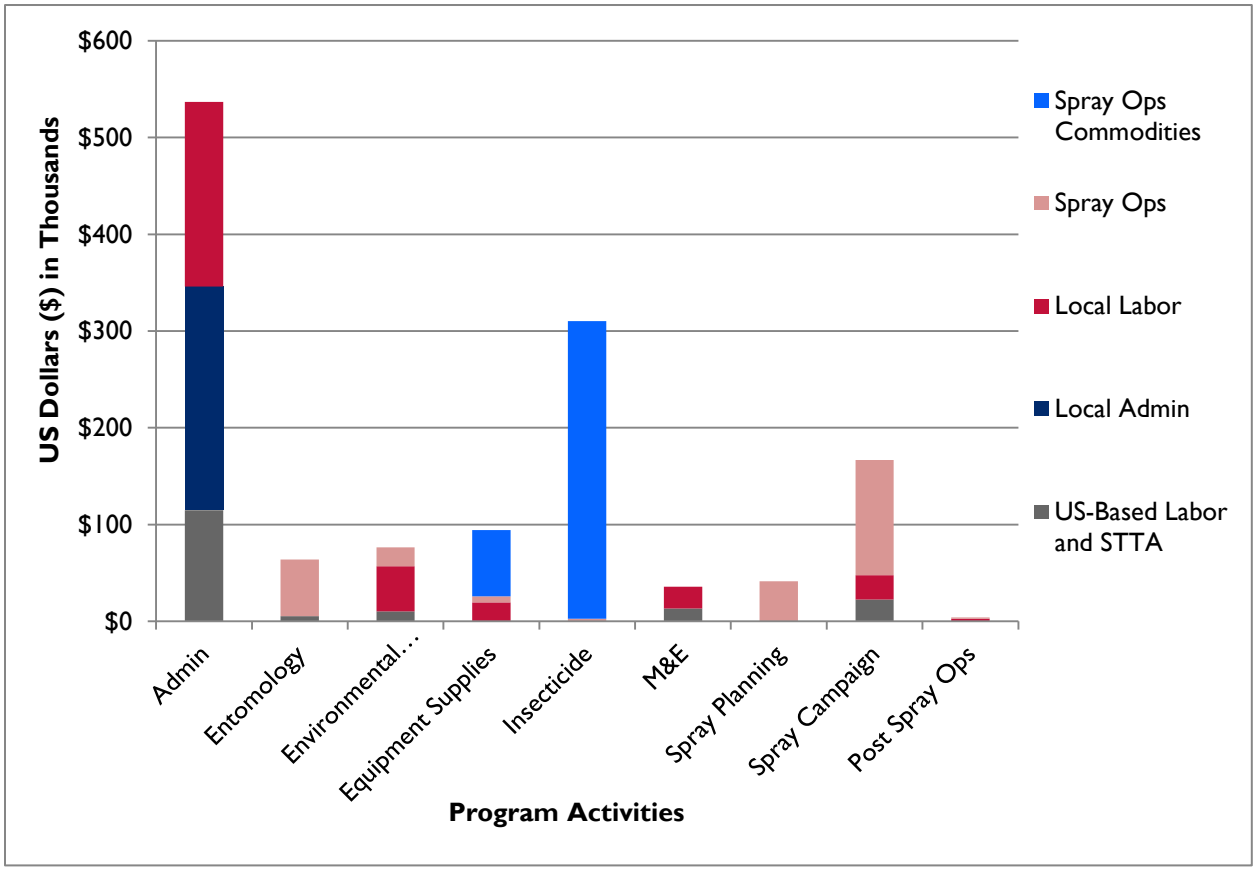



Figure BF3 shows fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Administration and insecticide are the two most expensive activities. About 57 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, while 'Local Labor' is spread more evenly across a majority of activities. The cost of the spray campaign is low compared to other activities because it was a very small program implemented in one district. However, the actual insecticide (carbamates) cost remains high.

**FIGURE BF4: BURKINA FASO IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

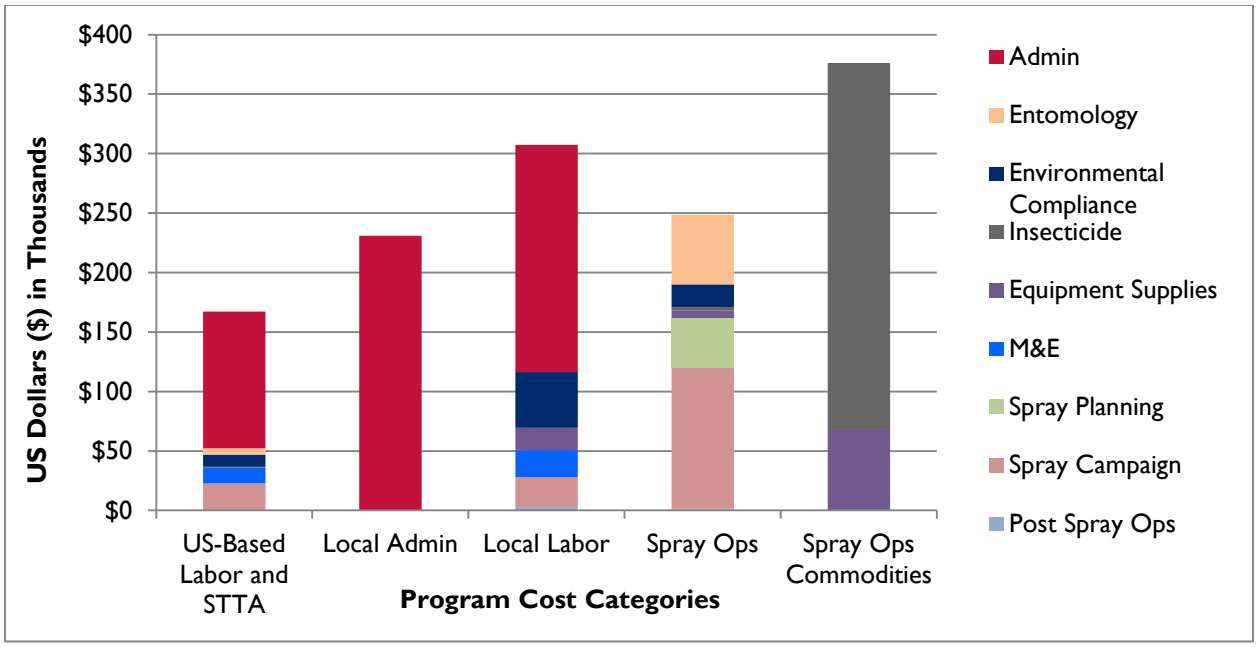



Figure BF4 contains the same information as Figure BF3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates again that the majority of the program costs were incurred under spray commodities and local labor, rather than the spray operations.

## 6.3 Unit Cost Analysis

This section presents Burkina Faso IRS program capital and recurrent expenditures as unit costs: per structure sprayed, per 100 m² sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 m² was added as a more standardized unit to allow for cross-country comparison.

**FIGURE BF5: BURKINA FASO IRS UNIT COSTS, BY ACTIVITY**

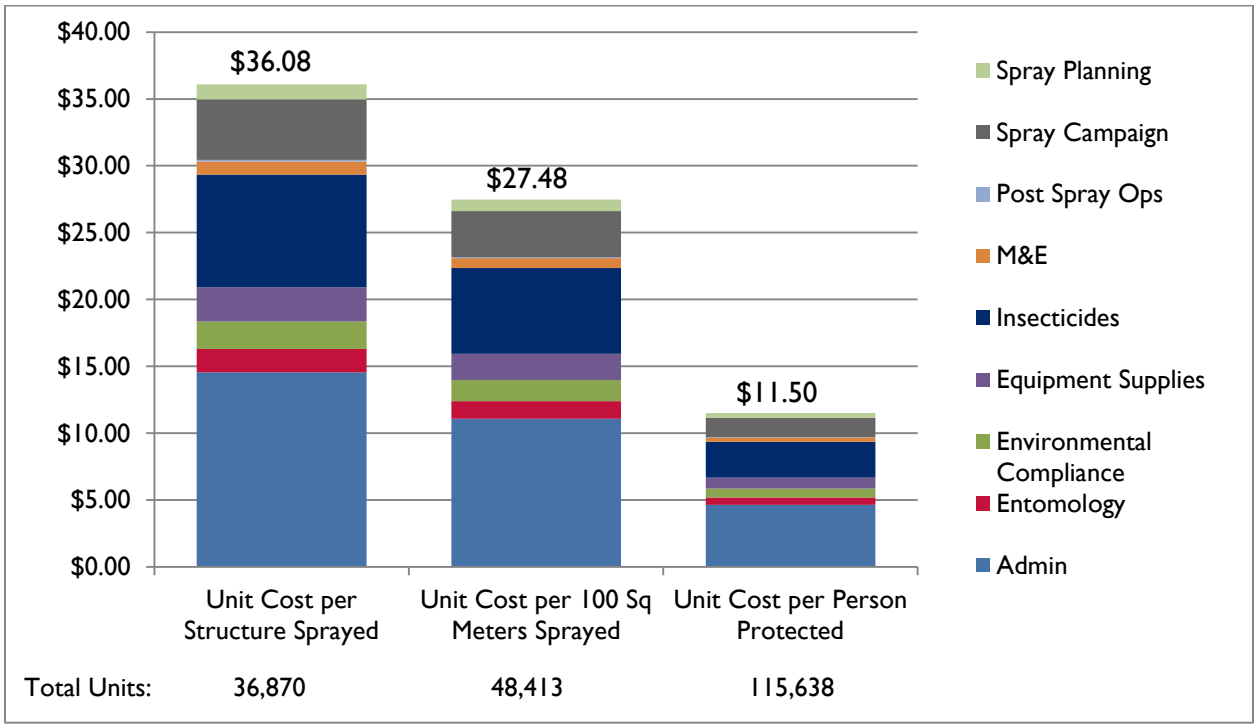
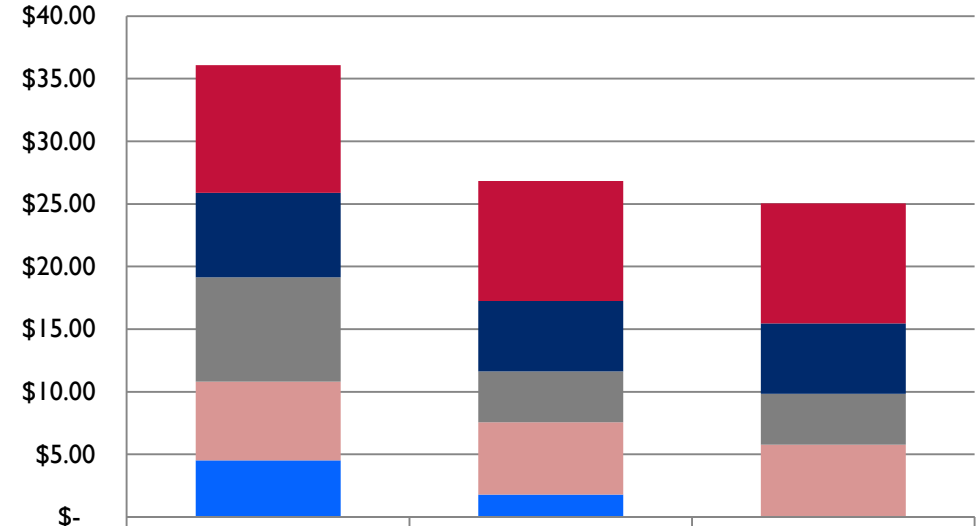



Figure BF5 illustrates the Burkina Faso IRS program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, EC, and M&E, have only a minor impact on the unit cost. Administration is the largest cost driver, followed closely by insecticide, and then the spray campaign. Keep in mind that Figure BF3 above showed over half of the costs under administration as consisting of labor.

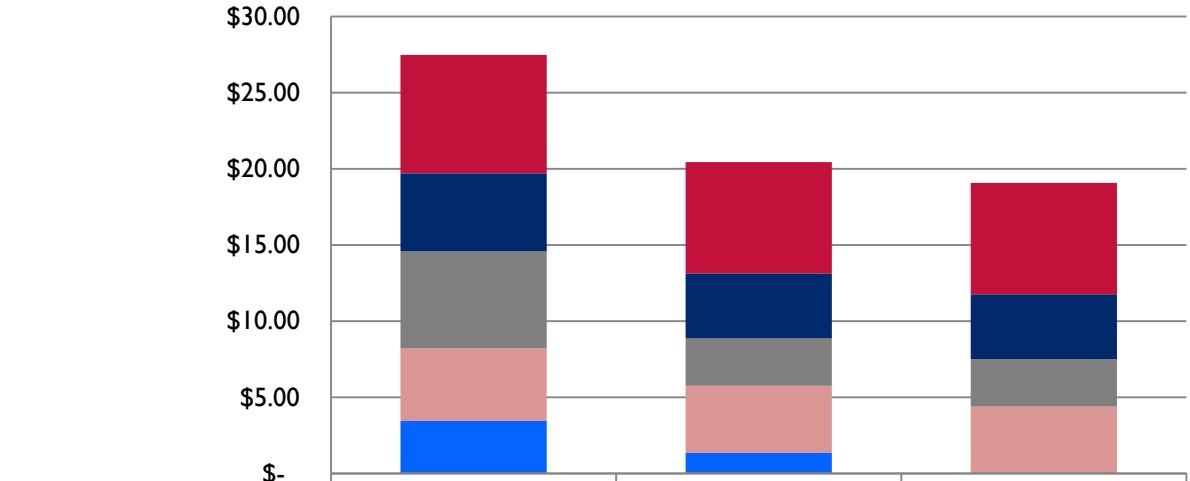
**FIGURE BF6: BURKINA FASO IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $10.20 | $9.58 | $9.58 |
| Spray Ops | $6.75 | $5.61 | $5.61 |
| Local Labor | $8.33 | $4.07 | $4.07 |
| Local Admin | $6.27 | $5.77 | $5.77 |
| US-Based Labor and STTA | $4.53 | $1.79 | $- |
| Total | $36.08 | $26.82 | $25.04 |

The Burkina Faso IRS program sprayed 36,870 structures during the 2012 spray campaign. Figure BF6 shows the unit costs per structure sprayed burdened ($36.08), unburdened ($26.82), and unburdened without U.S. labor ($25.04), itemized by cost category. In terms of cost categories, the largest cost driver is spray commodities, followed by local labor and spray operations. In contrast to the preceding figure, the local administration cost category excludes local staff labor expenses. Together, local administration and U.S.-based labor make up about 30 percent of the total burdened unit cost. The unburdened unit cost excludes implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $11.04, or about 30 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for about half of the total "cost of burden."

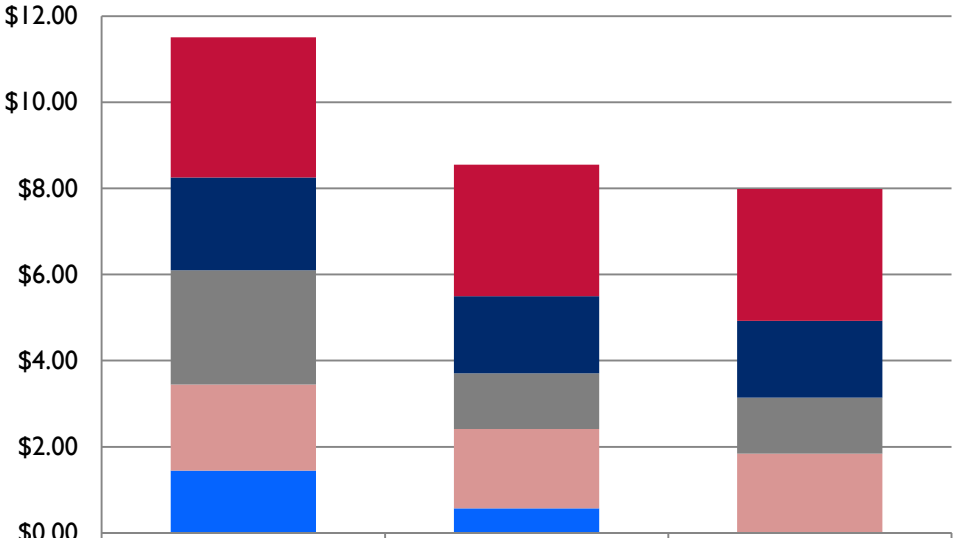
**FIGURE BF7: BURKINA FASO IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $7.77 | $7.30 | $7.30 |
| Spray Ops | $5.14 | $4.27 | $4.27 |
| Local Labor | $6.35 | $3.10 | $3.10 |
| Local Admin | $4.77 | $4.40 | $4.40 |
| US-Based Labor and STTA | $3.45 | $1.36 | $- |
| Total | $27.48 | $20.43 | $19.07 |

Figure BF7 shows the unit costs per 100 m² sprayed burdened ($27.48), unburdened ($20.43), and unburdened without U.S.-based labor ($19.07), itemized by cost category. The Burkina Faso spray campaign used 19,365 sachets of insecticide to cover 4,841,250 m² of structure area. Thus, the average size of the structures sprayed in Burkina Faso was 82 m². This report looks at the unit cost of 100 m² sprayed, which covers just over 1.2 structures in Burkina Faso. The Burkina Faso unit cost per 100 m² sprayed is three-fourths the unit cost per structure sprayed. Using the unit of measure per 100 m² sprayed, however, along with the contextual information of the average size of structures in Burkina Faso allows for a more accurate comparison to other country program costs.

**FIGURE BF8: BURKINA FASO IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | 3.25 | 3.05 | 3.05 |
| Spray Ops | 2.15 | 1.79 | 1.79 |
| Local Labor | 2.66 | 1.30 | 1.30 |
| Local Admin | 2.00 | 1.84 | 1.84 |
| US-Based Labor and STTA | 1.44 | 0.57 | - |
| Total | $11.50 | $8.55 | $7.98 |

As noted in the Background section, the Burkina Faso 2012 IRS spray campaign protected 115,638 people from malaria transmission. Figure BF8 shows the unit costs per person protected burdened ($11.50), unburdened ($8.55), and unburdened without U.S.-based labor ($7.98), itemized by cost category. The categories driving the unit cost include spray commodities, local labor, and spray operations. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of Burkina Faso IRS program costs, as delivered through an implementing partner, adds $3.52 to the unit cost per person protected.

# 7. ETHIOPIA

## 7.1 BACKGROUND

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 World Health Organization. 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 spread to other states. In 2012, PMI's Ethiopia spray campaign covered 36 districts in Oromia Region in two rounds of spraying. PMI completed the first round in 19 districts from June 15 through August 2 using deltamethrin from the pyrethroid class of insecticides and sprayed 17 more districts from August 15 through October 7 using bendiocarb, an insecticide from the carbamate class, lasting 40 and 35 operational days, respectively.

In addition, this year the PMI provided 24 districts that graduated from PMI support in 2011 with 1,025 pairs of boots and PPE for 1,000 spray operators (cost of about $60,000). In collaboration with the Federal MOH, PMI provided training for over 80 health workers from the Oromia region, including representatives from 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 has been 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.

**TABLE ET1: ETHIOPIA QUICK FACTS**

| | |
|---|---|
| # Local Staff | 19 |
| Spray Start Date(s) | June 15, 2012<br>August 15, 2012 |
| # Spray Rounds | 2 |
| # Sachets Used | 262,167 |
| # People Protected | 1,506,273 |
| # Structures Sprayed | 547,421 |
| # 100 Square Meters Sprayed | 524,334 |
| Average Size of Structure | 95.8 sq. meters* |

* Reverse calculation using number of insecticide sachets used during campaign multiplied by the average of 200 $m^2$ estimated to be sprayed by one sachet in an 8L spray tank and divided by the number of structures sprayed.

## 7.2 RESULTS

This section presents the Ethiopia IRS program's total expenditures for both program start-up operations (August 11, 2011–January 31, 2012), as well as the first year of program implementation under the AIRS project (February 1–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE ET1: ETHIOPIA IRS TOTAL EXPENDITURES**

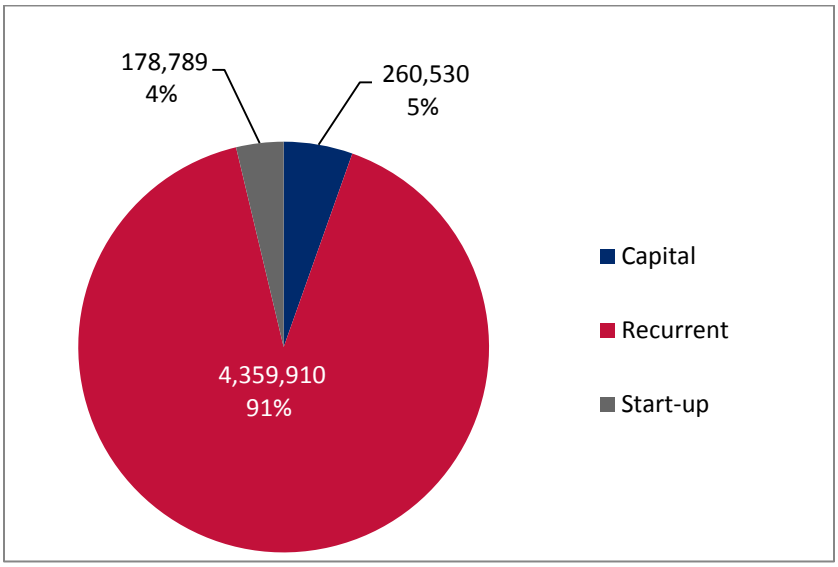



Figure ET1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 91 percent of total project expenditures are recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Included within the total program expenditures above is $1,191,856 of carbamate insecticide procured by PMI, and $270,395 of other capital and recurrent costs inherited from the previous IRS program. The prices of these items, respectively, were supplied through PMI's procurement records and the inventory disposition list. In addition, an estimated $291,109 of pyrethroid insecticide procured by the local government is included within total expenditures. This value was estimated by multiplying the 117,842 pyrethroid sachets procured by the 2012 average price per pyrethroid sachet, which was approximately $2.47.

**FIGURE ET2: ETHIOPIA TOTAL START-UP EXPENDITURES, BY EXPENDITURE STATUS**

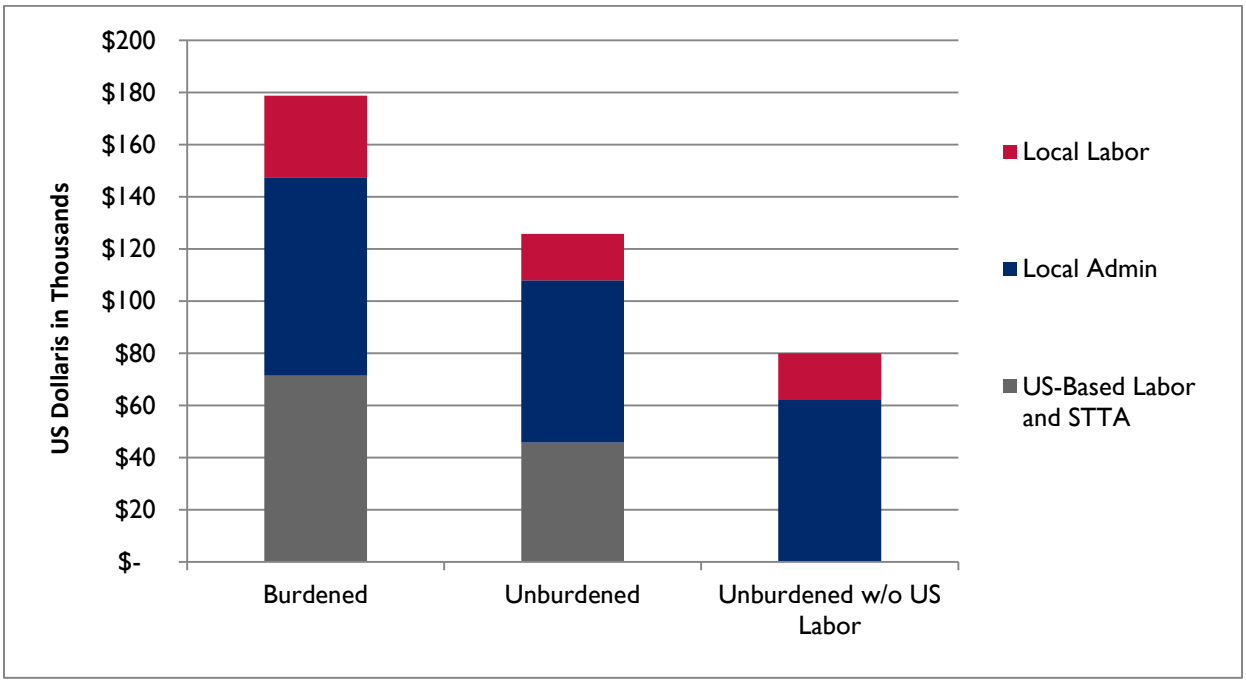



Figure ET2 looks at the AIRS Ethiopia program start-up expenditures only, which include activities such as country scoping, technical information gathering, and hiring. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. Over 57 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. As mentioned before, start-up expenditures are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

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

| Activities | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 148,020 | 381,551 | 219,013 | | | $ 748,584 | 16.2% |
| Entomology | 13,802 | | 85,126 | 53,767 | 1,167 | $ 153,862 | 3.3% |
| EC | 127,037 | | 20,255 | 27,014 | | $ 174,306 | 3.8% |
| Equipment Supplies | 284 | | 175 | 25,039 | 402,755 | $ 428,254 | 9.3% |
| IEC | | | | 320 | | $ 320 | 0.0% |
| Insecticides | | | | | 1,482,965 | $ 1,482,965 | 32.1% |
| M&E | 54,231 | | 40,046 | 26,253 | | $ 120,530 | 2.6% |
| Post-Spray Ops | | | 2,798 | 2,095 | | $ 4,893 | 0.1% |
| Spray Campaign | 5,136 | 1,738 | 69,944 | 1,118,369 | 176,108 | $ 1,371,295 | 29.7% |
| Spray Planning | 166 | | 37,547 | 97,717 | | $ 135,430 | 2.9% |
| **Grand Total** | **$ 348,676** | **$383,289** | **$474,904** | **$1,350,574** | **$ 2,062,995** | **$ 4,620,440** | **100%** |

Table ET2 displays the Ethiopia IRS program total capital and recurrent expenditures and excludes the start-up costs. 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 costs in the above table.

**FIGURE ET3: ETHIOPIA IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

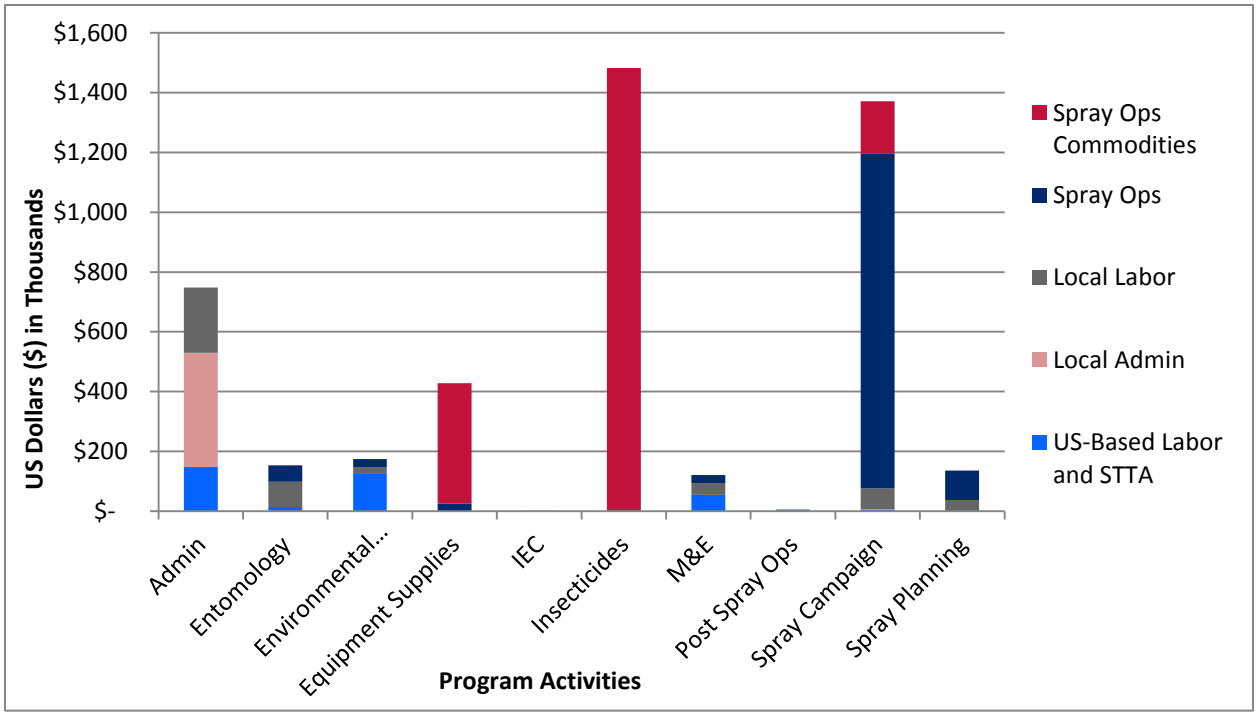



Figure ET3 includes fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The cost of insecticides and implementation of the spray campaign are the two most expensive program activity costs. The total cost for administration is the third largest activity cost, but about half of this cost consists of labor, both local and U.S.-based.

**FIGURE ET4: ETHIOPIA PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY**

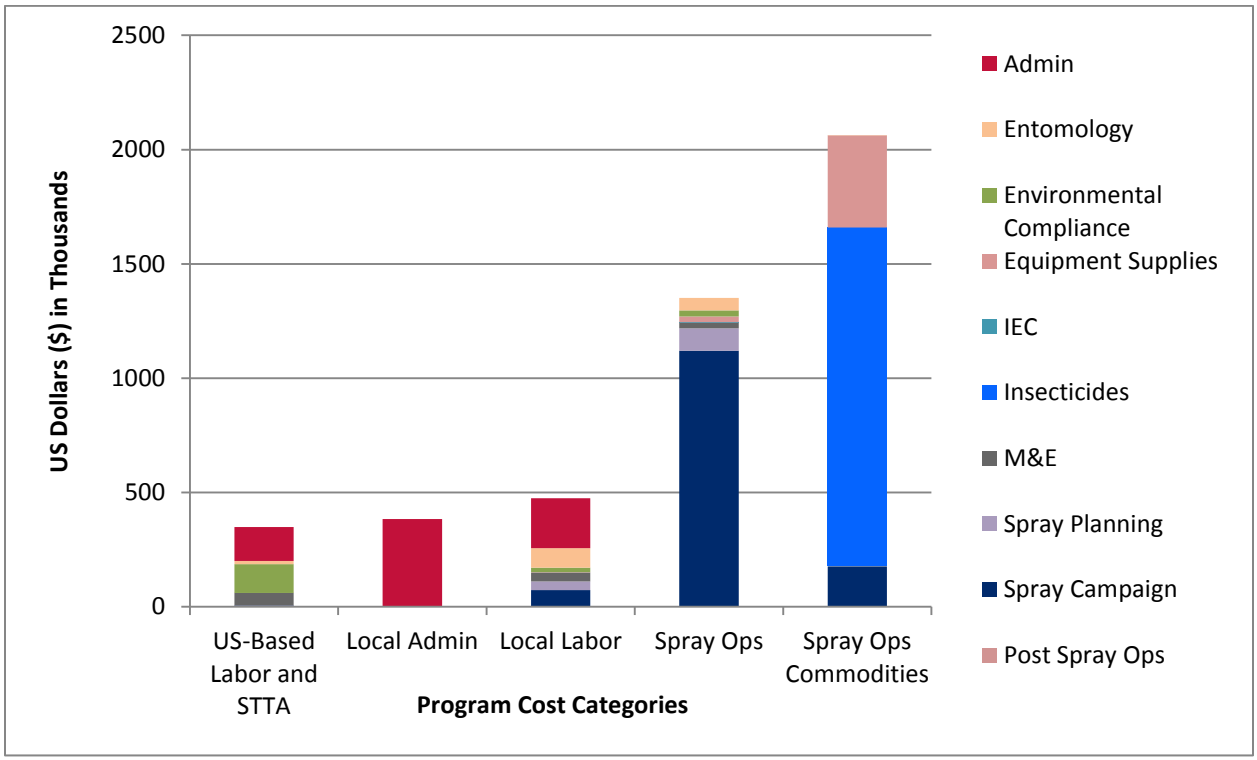



Figure ET4 contains the same information as Figure ET3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs and U.S.-based labor and STTA are minimal compared to expenditures related to technical operations, and commodities.

## 7.3 Unit Cost Analysis

This section presents Ethiopia IRS program capital and recurrent expenditures as unit costs: per structure sprayed, per 100 $m^2$ sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 $m^2$ was added as a more standardized unit to allow for cross-country comparison.

**FIGURE ET5: ETHIOPIA PROGRAM UNIT COSTS, BY ACTIVITY**

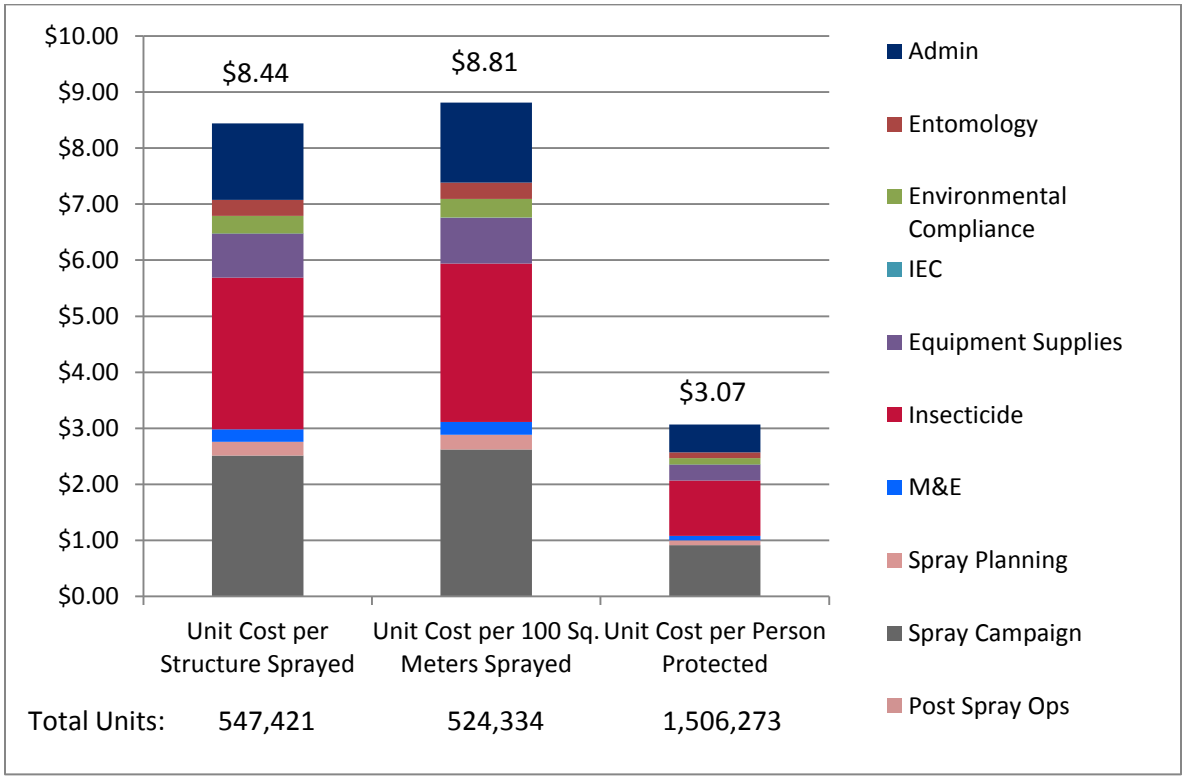
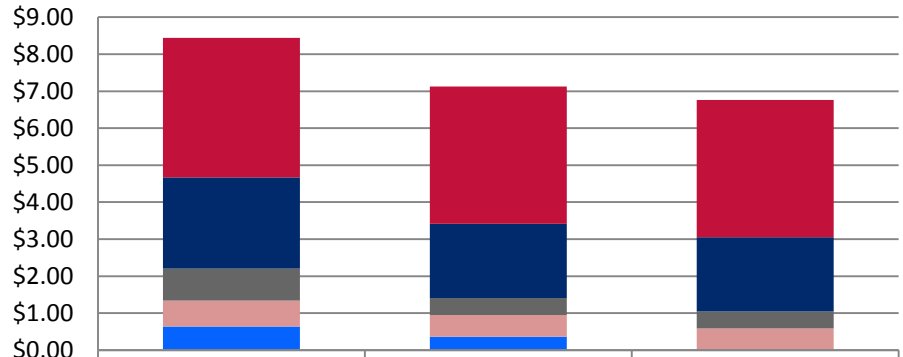



Figure ET5 illustrates the Ethiopia IRS program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, EC, and M&E, have only a minor impact on the unit cost. In contrast, the spray campaign is the largest cost driver, followed closely by insecticide and administration. Keep in mind that Figure ET3 showed that about half of the costs under the administration activity were for labor (from both local and US-based staff).

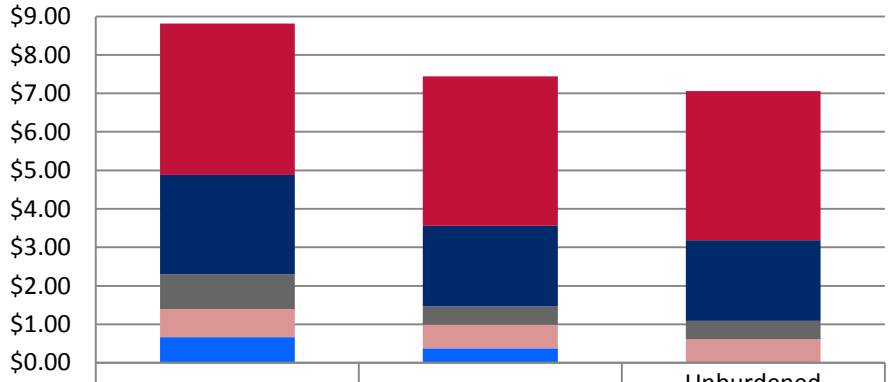
**FIGURE ET6: ETHIOPIA IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | 3.77 | 3.71 | 3.71 |
| Spray Ops | 2.47 | 2.01 | 2.01 |
| Local Labor | 0.87 | 0.45 | 0.45 |
| Local Admin | 0.70 | 0.59 | 0.59 |
| US-Based Labor and STTA | 0.64 | 0.36 | - |
| Total | $8.45 | $7.12 | $6.76 |

The Ethiopia IRS program sprayed 547,421 structures during the 2012 campaign. Figure ET6 shows the unit costs per structure sprayed burdened ($8.45), unburdened ($7.12), and unburdened without U.S. labor ($6.76), itemized by cost category. In terms of cost categories, the largest cost driver is spray commodities, followed by spray operations. In contrast to the preceding figure, the local administration cost category excludes local staff labor expenses, and both local administration and U.S.-based labor make up about 16 percent of the total burdened unit cost. The unburdened unit cost excludes the implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as for STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $1.69, or about 20 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for about one third of the total "cost of burden."

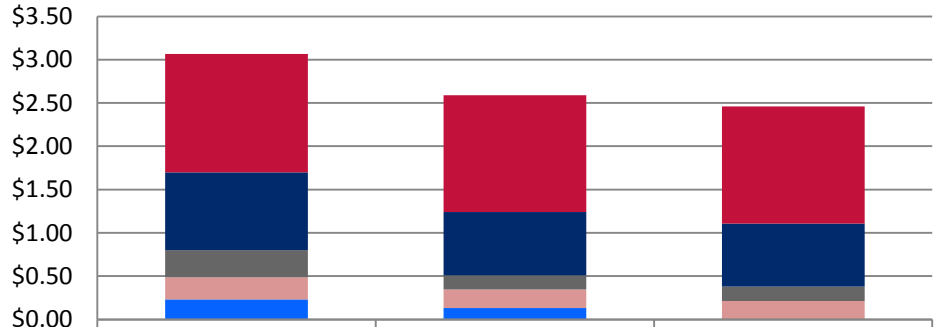
**FIGURE ET7: ETHIOPIA IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | 3.93 | 3.88 | 3.88 |
| Spray Ops | 2.58 | 2.10 | 2.10 |
| Local Labor | 0.91 | 0.47 | 0.47 |
| Local Admin | 0.73 | 0.62 | 0.62 |
| US-Based Labor and STTA | 0.66 | 0.38 | - |
| Total | $8.81 | $7.45 | $7.07 |

Figure ET7 shows the IRS unit costs per 100 m² sprayed burdened ($8.81), unburdened ($7.45), and unburdened without U.S.-based labor ($7.07), itemized by cost category. The Ethiopia spray campaign used 262,167 sachets of insecticide to cover 52,433,400 square meters of structure area. The average size of the structures sprayed in Ethiopia was 95.8 m² if it is calculated by multiplying total number of sachets by the average of 200 m² (an estimate size to be sprayed by one sachet) and divided by total number of structures sprayed. This report looks at the unit cost of 100 m² sprayed, which covers almost exactly one structure in Ethiopia. The Ethiopia unit cost per 100 m² sprayed is, therefore, also very similar to the unit cost per structure sprayed. Using the unit of measure per 100 m² sprayed, however, along with the contextual information of average size of structure sprayed, allows for a more accurate comparison to other country program costs.

**FIGURE ET8: ETHIOPIA UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | 1.37 | 1.35 | 1.35 |
| Spray Ops | 0.90 | 0.73 | 0.73 |
| Local Labor | 0.32 | 0.17 | 0.17 |
| Local Admin | 0.25 | 0.21 | 0.21 |
| US-Based Labor and STTA | 0.23 | 0.13 | - |
| Total | $3.07 | $2.59 | $2.46 |

As noted in the Background section, the Ethiopia 2012 spray campaign protected 1,506,273 people from malaria transmission. Figure ET8 shows the unit costs per person protected burdened ($3.07), unburdened ($2.59), and unburdened without U.S.-based labor ($2.46), itemized by cost category. The categories driving the unit cost include spray commodities, followed by spray operations. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of Ethiopia IRS program costs, as delivered by the implementing partner, adds $0.61 to the unit cost per person protected.

# 8. GHANA

## 8.1 BACKGROUND

In Ghana, IRS campaigns have been funded through PMI for five years. The IRS spray campaign in 2012 covered nine districts: Bunkpurugu Yunyoo, Chereponi, East Mamprusi, Gushegu, Karaga, Saboba, Savelugu-Nanton, Tolon-Kumbungu, and West Mamprusi. The spray campaign was implemented for 60 days, over a period from April 23, 2012 through July 31, 2012. 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 supports an anemia and parasitemia (A&P) operational research study funded and implemented by PMI. As part of this study, PMI's AIRS project provides logistical support during the surveys and the team also conducts IRS in one half of a district during a second round of spraying in the fall. The estimated total cost for work provided under the A&P research study is $344,540. Additionally, the Ghana IRS program executed a sub-contract with the Noguchi Memorial Institute for Medical Research (about $66,000) to carry out the entomological monitoring activities in the first year of implementation.

**TABLE GH1: GHANA QUICK FACTS**

| | |
|---|---|
| # Local Staff | 25 |
| Spray Start Date | April 23, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 77,288 |
| # People Protected | 941,240 |
| # Structures Sprayed | 355,278 |
| # 100 Square Meters Sprayed | 193,220 |
| Average Size of Structure | 54.4 sq. meters* |

* 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 RESULTS

This section presents the Ghana IRS program's total expenditures for both program start-up operations (August 11, 2011–February 9, 2012) and the first year of program implementation under the AIRS project (February 10, 2012–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE GH1: GHANA IRS TOTAL EXPENDITURES**

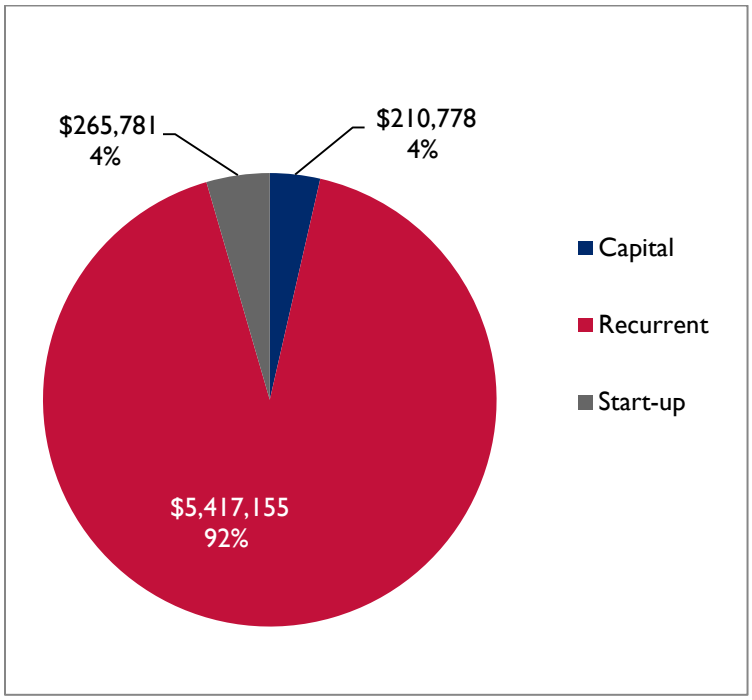



Figure GH1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 92 percent of total project expenditures are recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $316,500 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list.

**FIGURE GH2: GHANA IRS START-UP EXPENDITURES, BY BURDEN TYPE**

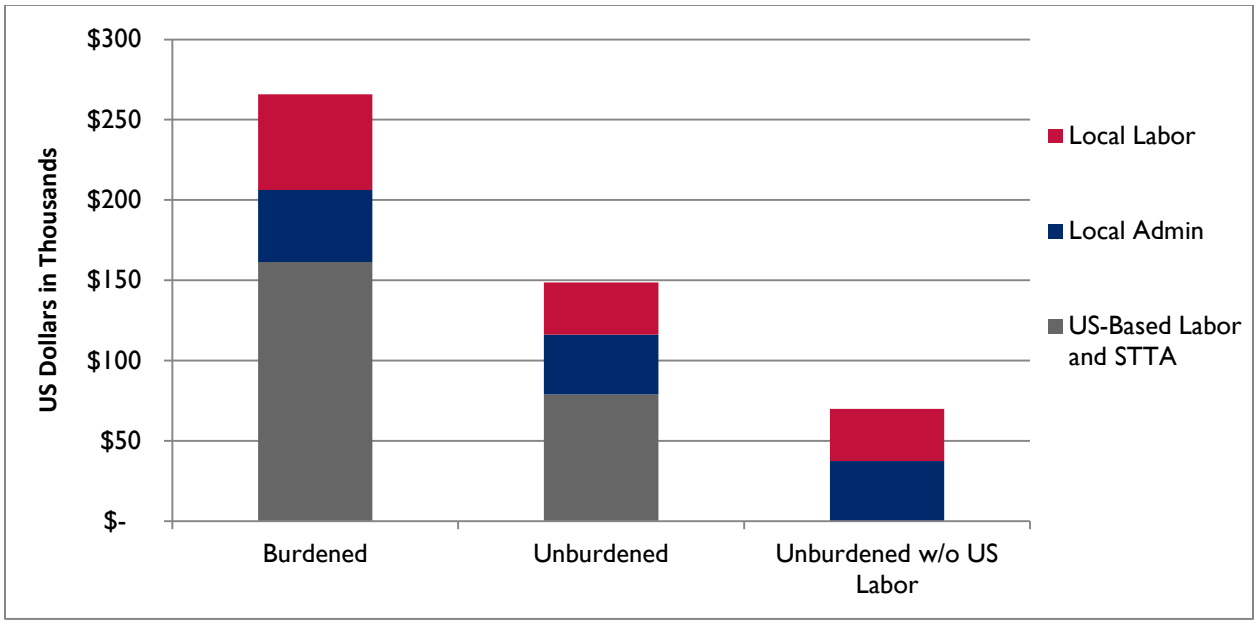



Figure GH2 displays the Ghana IRS program start-up expenditures only, which include activities such as country scoping, technical information gathering, and local hiring. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. Over 83 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. As mentioned before, start-up expenditures are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

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

| Activity | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 357,394 | 758,960 | 398,412 | | 9,012 | $ 1,523,778 | 27.08% |
| Entomology | 6,473 | | 26,665 | 335,774 | 40,194 | $ 409,106 | 7.27% |
| EC | 10,907 | | 18,084 | 6,252 | | $ 35,243 | 0.62% |
| Equipment Supplies | 313 | | | | 183,486 | $ 183,799 | 3.27% |
| IEC | | | 27,324 | 53,412 | | $ 80,736 | 1.43% |
| Insecticide | | | | | 1,527,912 | $ 1,527,912 | 27.15% |
| M&E | 38,157 | | 30,974 | 4,280 | | $ 73,411 | 1.30% |
| Post-Spray Ops | 1,028 | | 717 | | | $ 1,745 | 0.03% |
| Spray Campaign | 2,201 | | 202,555 | 1,386,205 | 62,354 | $ 1,653,315 | 29.38% |
| Spray Planning | | | | 138,891 | | $ 138,891 | 2.47% |
| **Grand Total** | **$ 416,473** | **$ 758,960** | **$ 704,731** | **$1,924,814** | **$ 1,822,958** | **$ 5,627,936** | **100%** |

Table GH2 displays the Ghana IRS total capital and recurrent expenditures, and excludes the start-up costs. 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 costs in the above table.

**FIGURE GH3: GHANA IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

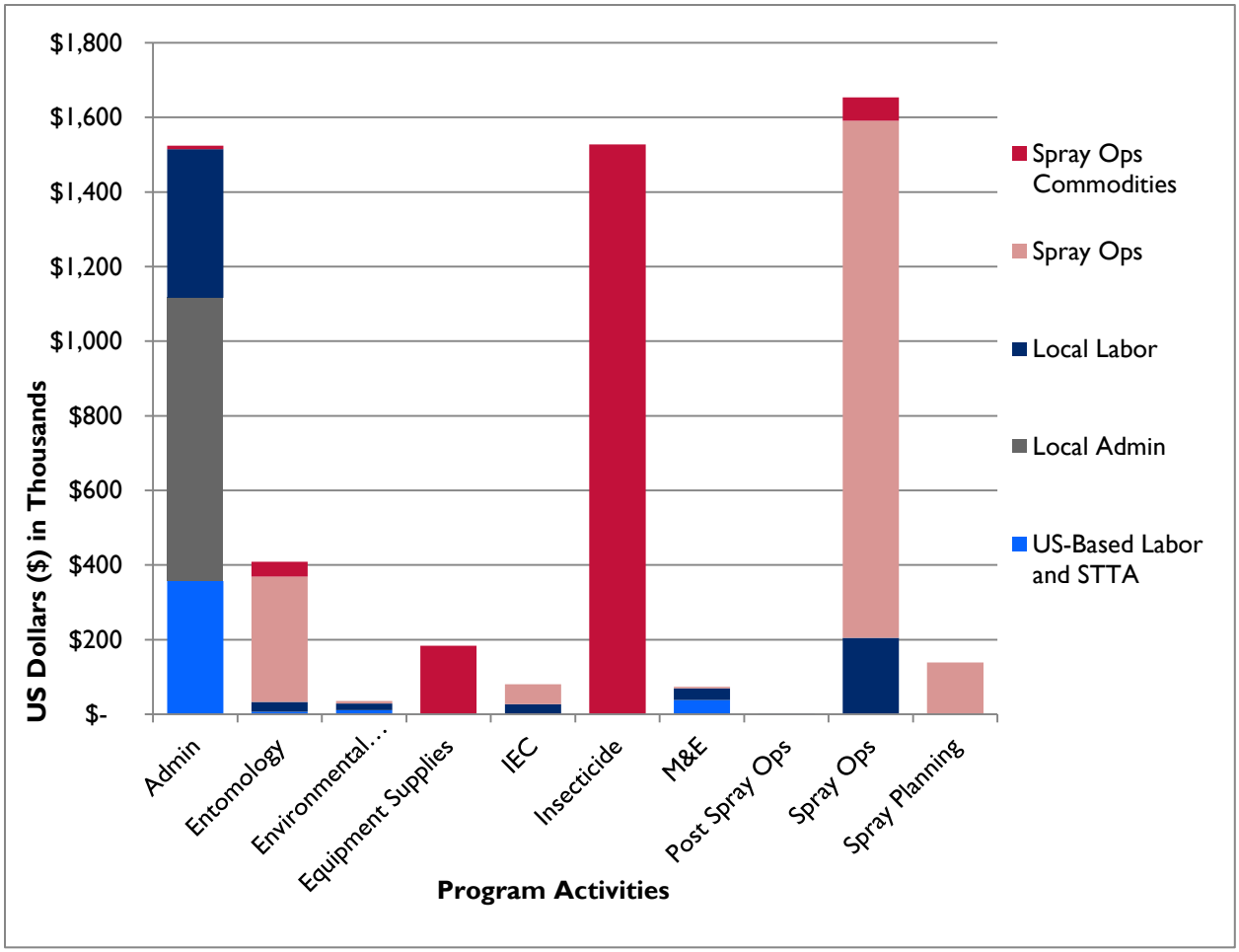



Figure GH3 shows fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The cost of insecticide and implementation of the spray campaign are the two most expensive activities. The total cost for administration is the third largest activity cost, but half of this cost 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, while 'Local Labor' is spread more evenly across a majority of activities.

**FIGURE GH4: GHANA IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

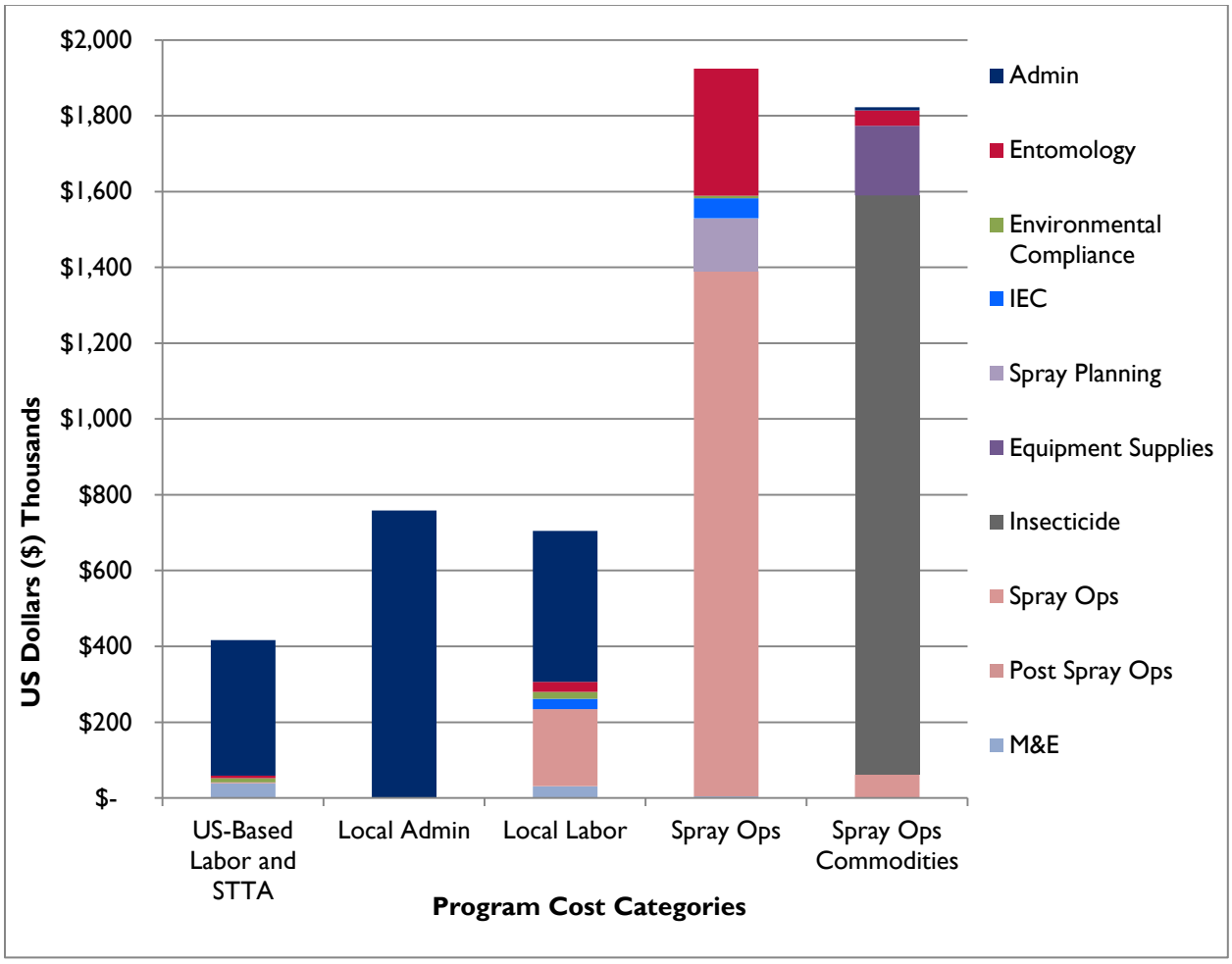



Figure GH4 contains the same information as Figure GH3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs and U.S.-based labor and STTA, as well as local staff labor, are minimal compared to expenditures related to technical spray operations and commodities.

## 8.3 Unit Cost Analysis

This section presents Ghana IRS capital and recurrent expenditures as unit costs: per structure sprayed, per 100 m² sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 m² was added as a more standardized unit to allow for cross-country comparison.

**FIGURE GH5: GHANA IRS UNIT COSTS, BY ACTIVITY**

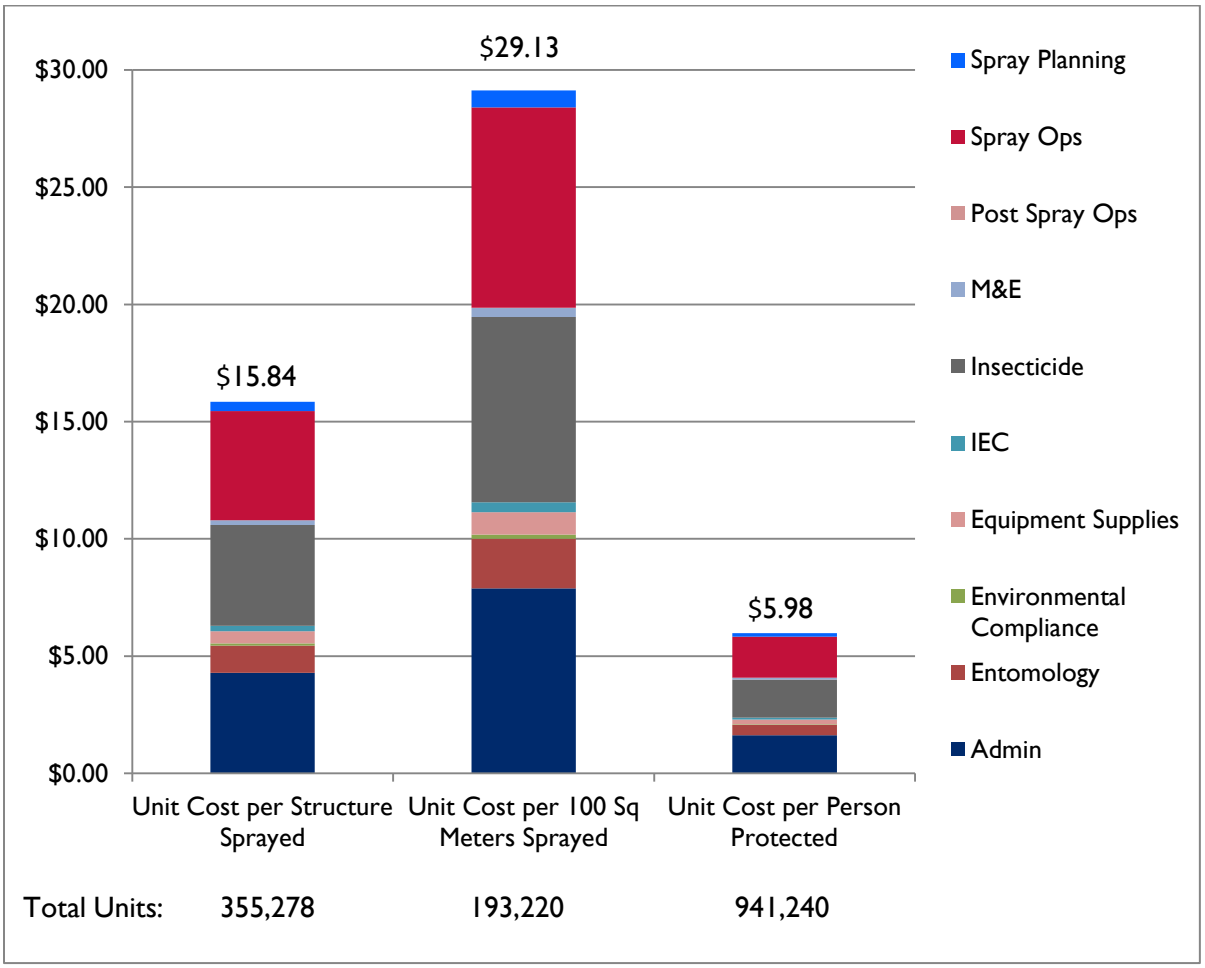
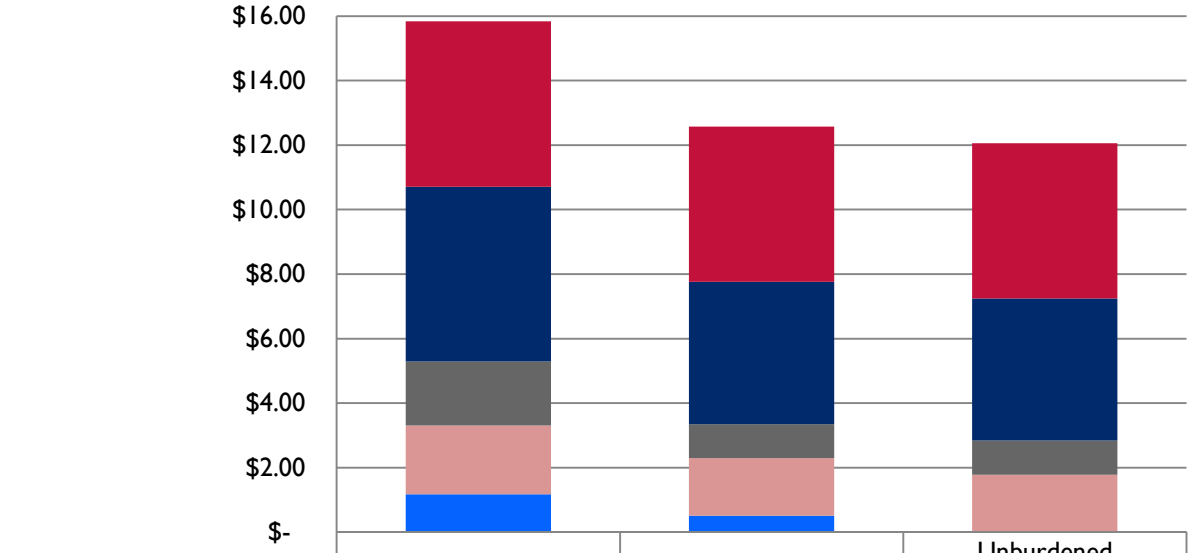



Figure GH5 illustrates the Ghana IRS program's fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, IEC, EC, and M&E, have only a minor impact on the unit cost. In contrast, the spray campaign is the largest cost driver, followed closely by insecticide and administration. Keep in mind that Figure GH3 showed that about half of the costs under the administration activity consisted of labor.

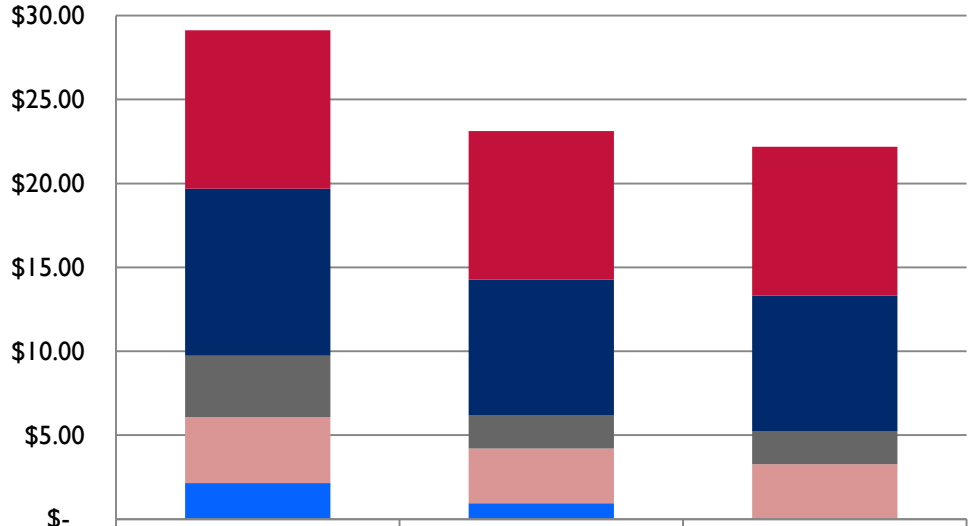
**FIGURE GH6: GHANA IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $5.13 | $4.82 | $4.82 |
| Spray Ops | $5.42 | $4.41 | $4.41 |
| Local Labor | $1.98 | $1.06 | $1.06 |
| Local Admin | $2.14 | $1.78 | $1.78 |
| US-Based Labor and STTA | $1.17 | $0.51 | $- |
| Total | $15.84 | $12.58 | $12.06 |

The Ghana IRS program sprayed 355,278 structures during the 2012 spray campaign. Figure GH6 shows the unit costs per structure sprayed burdened ($15.84), unburdened ($12.58), and unburdened without U.S. labor ($12.06), itemized by cost category. In terms of cost categories, the largest cost driver is spray operations, followed by spray commodities. Both local administration and U.S.-based labor make up about 21 percent of the total burdened unit cost. The unburdened unit cost excludes implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $3.78, or 24 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor and spray operations, which each account for about 30 percent of the total "cost of burden."

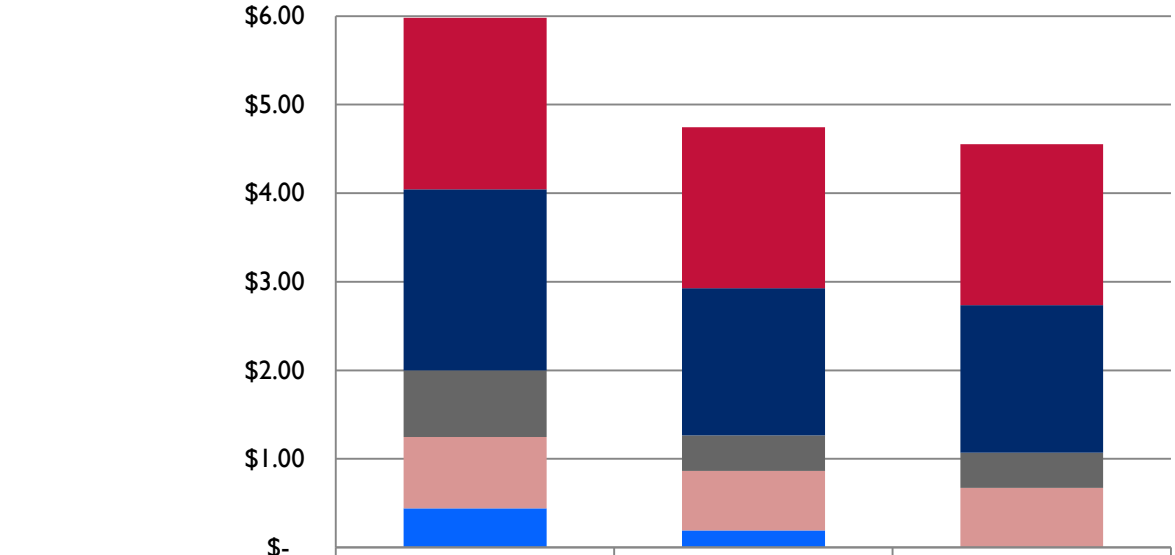
**FIGURE GH7: GHANA IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $9.43 | $8.86 | $8.86 |
| Spray Ops | $9.96 | $8.10 | $8.10 |
| Local Labor | $3.65 | $1.95 | $1.95 |
| Local Admin | $3.93 | $3.27 | $3.27 |
| US-Based Labor and STTA | $2.16 | $0.94 | $- |
| Total | $29.13 | $23.12 | $22.18 |

Figure GH7 shows the unit costs per 100 m² sprayed burdened ($29.13), unburdened ($23.12), and unburdened without U.S.-based labor ($22.18), itemized by cost category. The Ghana spray campaign used 77,288 sachets of insecticide to cover 19,322,000 m² of structure area. Thus, the average size of the structures sprayed in Ghana was 54.4 m². This report looks at the unit cost of 100 m² sprayed, which covers about two structures in Ghana. The Ghana unit cost per 100 m² sprayed is almost twice as much as the unit cost per structure sprayed. Using the unit of measure per 100 m², however, along with the contextual information of the average size of structures in Ghana allows for a more accurate comparison to other country program costs.

**FIGURE GH8: GHANA IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $1.94 | $1.82 | $1.82 |
| Spray Ops | $2.04 | $1.66 | $1.66 |
| Local Labor | $0.75 | $0.40 | $0.40 |
| Local Admin | $0.81 | $0.67 | $0.67 |
| US-Based Labor and STTA | $0.44 | $0.19 | $- |
| Total | $5.98 | $4.75 | $4.55 |

As noted in the Background section, the Ghana IRS spray campaign in 2012 protected 941,240 people from malaria transmission. Figure GH8 shows the unit costs per person protected burdened ($5.98), unburdened ($4.75), and unburdened without U.S.-based labor ($4.55), itemized by cost category. The categories driving the unit cost include spray operations and spray commodities. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of Ghana IRS program costs, as delivered by the implementing partner, adds $1.43 to the unit cost per person protected.

# 9. LIBERIA

## 9.1 BACKGROUND

In Liberia, IRS campaigns were funded through PMI for three years prior to the start of the AIRS project. In 2012, 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 spray campaign used two classes of insecticides, both of which had to be imported, thus increasing the cost of the procurement. In 12 districts, a long-lasting pyrethroid was applied and 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 cycle took 83 operational days. The second spray round took 31 operational days. The private sector spray campaign included providing support to spray the premises of 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.

**TABLE LR1: LIBERIA QUICK FACTS***

| | |
|---|---|
| # Local Staff | 15 |
| Spray Rounds | 2 |
| Spray Date(s) | March 23, 2012<br>October 3, 2012 |
| # Sachets Used | 81,691 |
| # People Protected | 869,707 |
| # Structures Sprayed | 96,901 |
| # 100 Square Meters Sprayed | 204,228 |
| Average Size of Structure | 210.8 $m^2$** |

*This does not include any information on the private sector spray campaign
** Reverse calculation using number of insecticide sachets used during spray campaign multiplied by the average of 250 $m^2$ estimated to be sprayed by one sachet and divided by the number of structures sprayed.

## 9.2 RESULTS

This section presents the Liberia IRS program's total expenditures for both program start-up activities (August 11, 2011–January 9, 2012) and the first year of implementation under the AIRS project (January 10, 2012–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE LR1: LIBERIA IRS TOTAL EXPENDITURES**

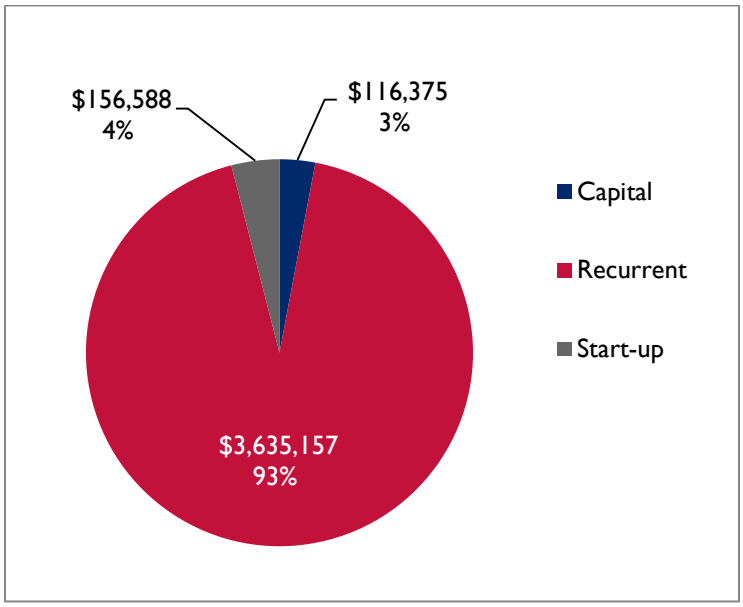



Figure LR1 shows the fully burdened cost of program expenditures, incurred between August 11, 2011 and December 31, 2012, and broken out by expenditure status. Start-up expenditures are a one-time project cost and are analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 93 percent of total project expenditures are recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $201,400 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list.

**FIGURE LR2: LIBERIA IRS TOTAL START-UP EXPENDITURES, BY BURDEN TYPE**

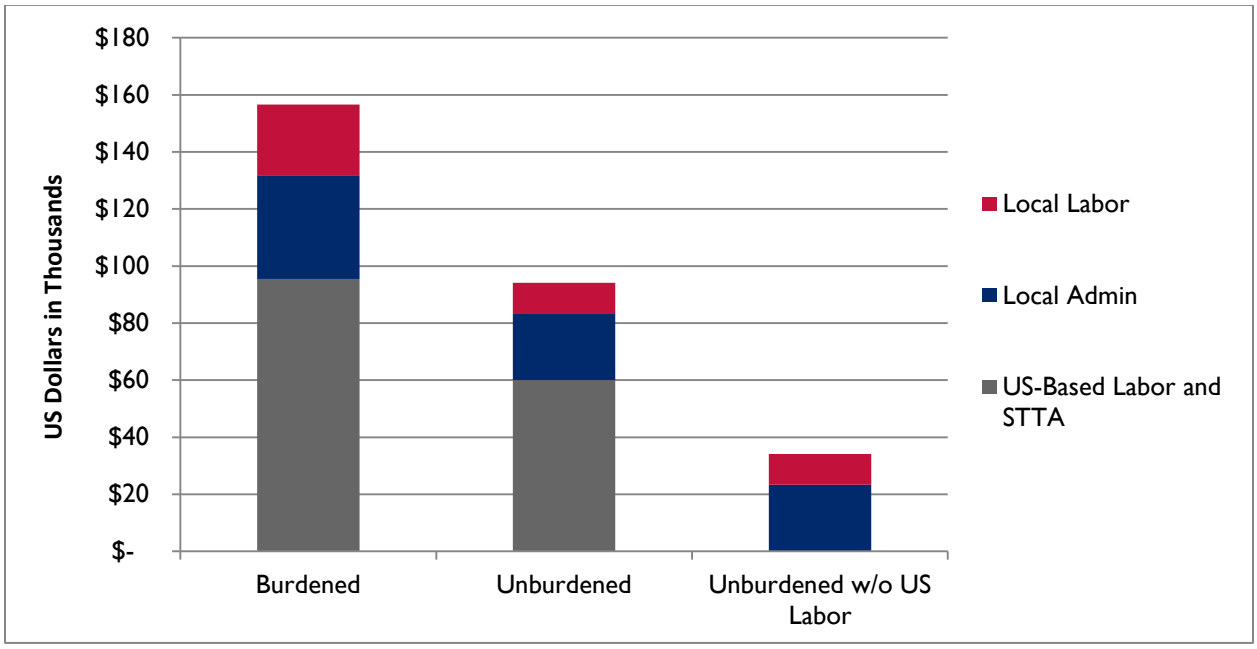



Figure LR2 covers the Liberia IRS program start-up expenditures only, which include activities such as country scoping, technical information gathering, and hiring. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. Over 77 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. As mentioned before, start-up expenditures are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

**TABLE LR2: LIBERIA IRS CAPITAL AND RECURRENT TOTAL EXPENDITURES, BY ACTIVITY AND COST CATEGORY**

| Activity | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 272,884 | 468,276 | 380,678 | 3,297 | | $ 1,125,135 | 29.99% |
| Entomology | 3,193 | | 86,659 | 22,260 | | $ 112,112 | 2.99% |
| EC | 23,820 | | 28,214 | 30,074 | | $ 82,108 | 2.19% |
| Equipment Supplies | 930 | | 107,848 | 192,900 | 143,216 | $ 444,894 | 11.86% |
| IEC | | | 21,630 | 10,004 | | $ 31,634 | 0.84% |
| Insecticides | | | | | 878,196 | $ 878,196 | 23.42% |
| M&E | 21,463 | | 126,622 | 9,252 | | $ 157,337 | 4.19% |
| Post-Spray Ops | | | 27,540 | | | $ 27,540 | 0.73% |
| Spray Campaign | 7,034 | 594 | 71,105 | 742,533 | | $ 821,266 | 21.89% |
| Spray Planning | | | 60,888 | 10,424 | | $ 71,312 | 1.90% |
| **Grand Total** | **$ 329,324** | **$ 468,870** | **$ 911,184** | **$1,020,744** | **$ 1,021,412** | **$ 3,751,534** | **100%** |

Table LR2 displays the Liberia IRS program total capital and recurrent expenditures and excludes the start-up costs. These expenditures are fully burdened. The first column lists the program activities as tracked through 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 costs in the above table.

**FIGURE LR3: LIBERIA IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

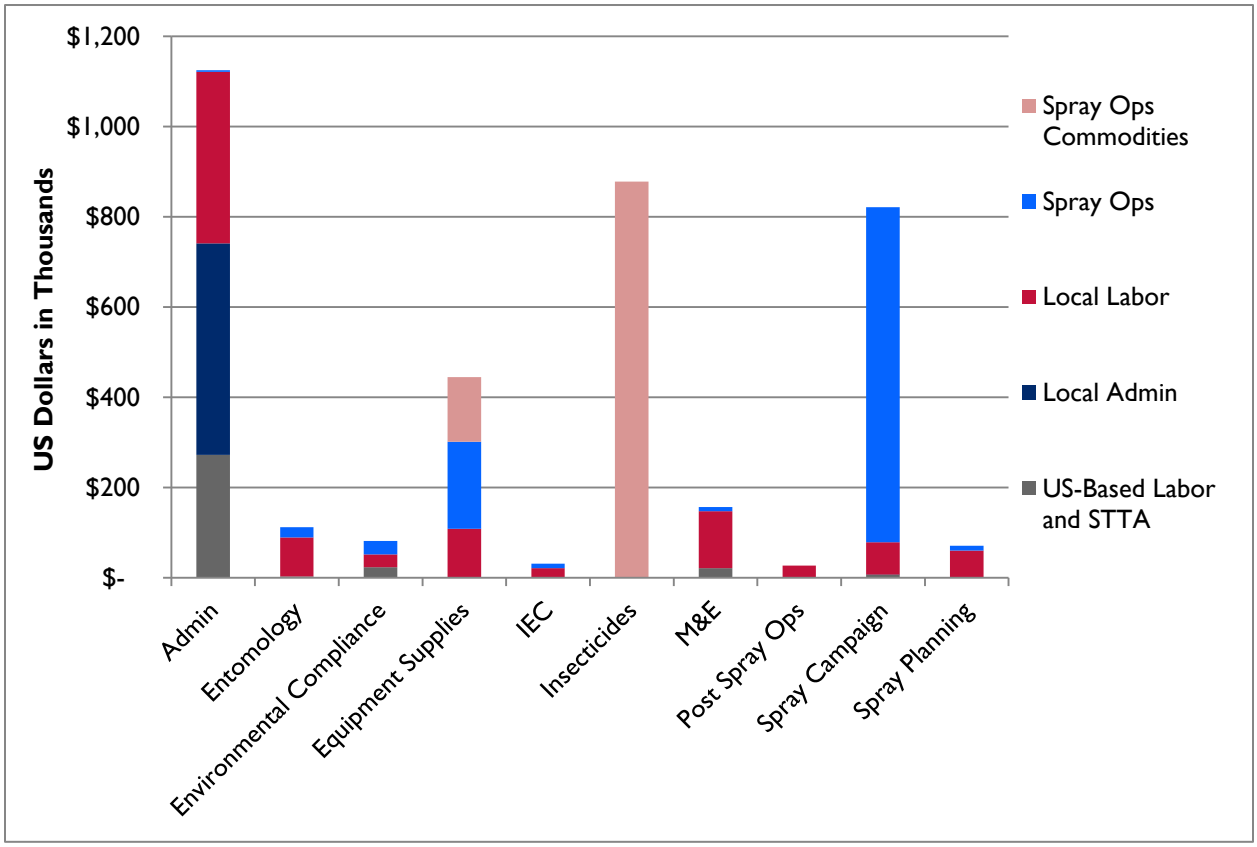



Figure LR3 includes fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The total cost for administration is the largest activity cost, but over two-thirds of this cost consists of labor, both local and U.S.-based. Insecticide and spray campaign are the next two most expensive activities. The total cost of insecticides used by the Liberia IRS program in 2012 is included in this report. Note that the 'U.S.-based Labor and STTA' expenditures are incurred under the administrative, EC, and M&E program activities, while 'Local Labor' is spread more evenly across a majority of activities.

**FIGURE LR4: LIBERIA IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

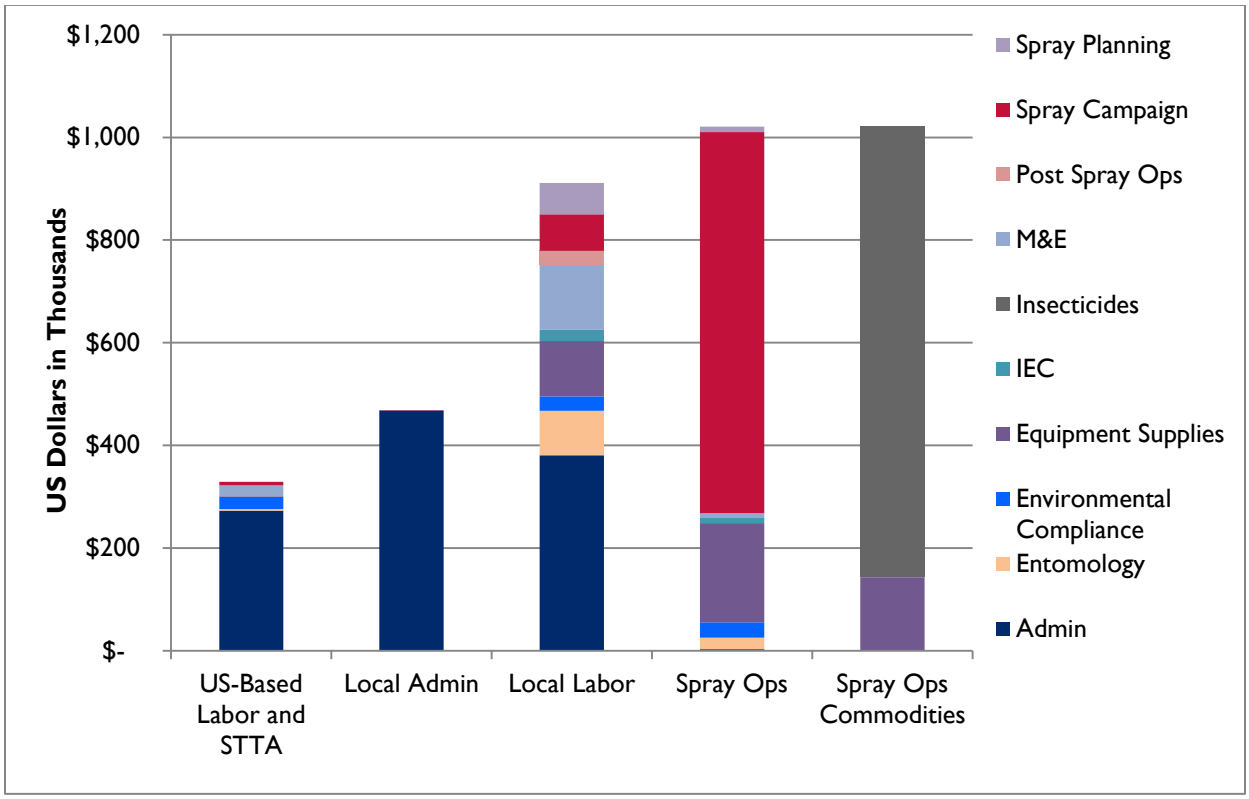



Figure LR4 contains the same information, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative and U.S.-based labor associated with oversight costs are minimal compared to the expenditures related to local labor and technical activities.

## 9.3 Unit Cost Analysis

This section presents Liberia IRS program capital and recurrent expenditures as unit costs: per structure sprayed, per 100 m² sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 m² was added as a more standardized unit to allow for cross-country comparison.

**FIGURE LR5: LIBERIA IRS UNIT COSTS, BY ACTIVITY**

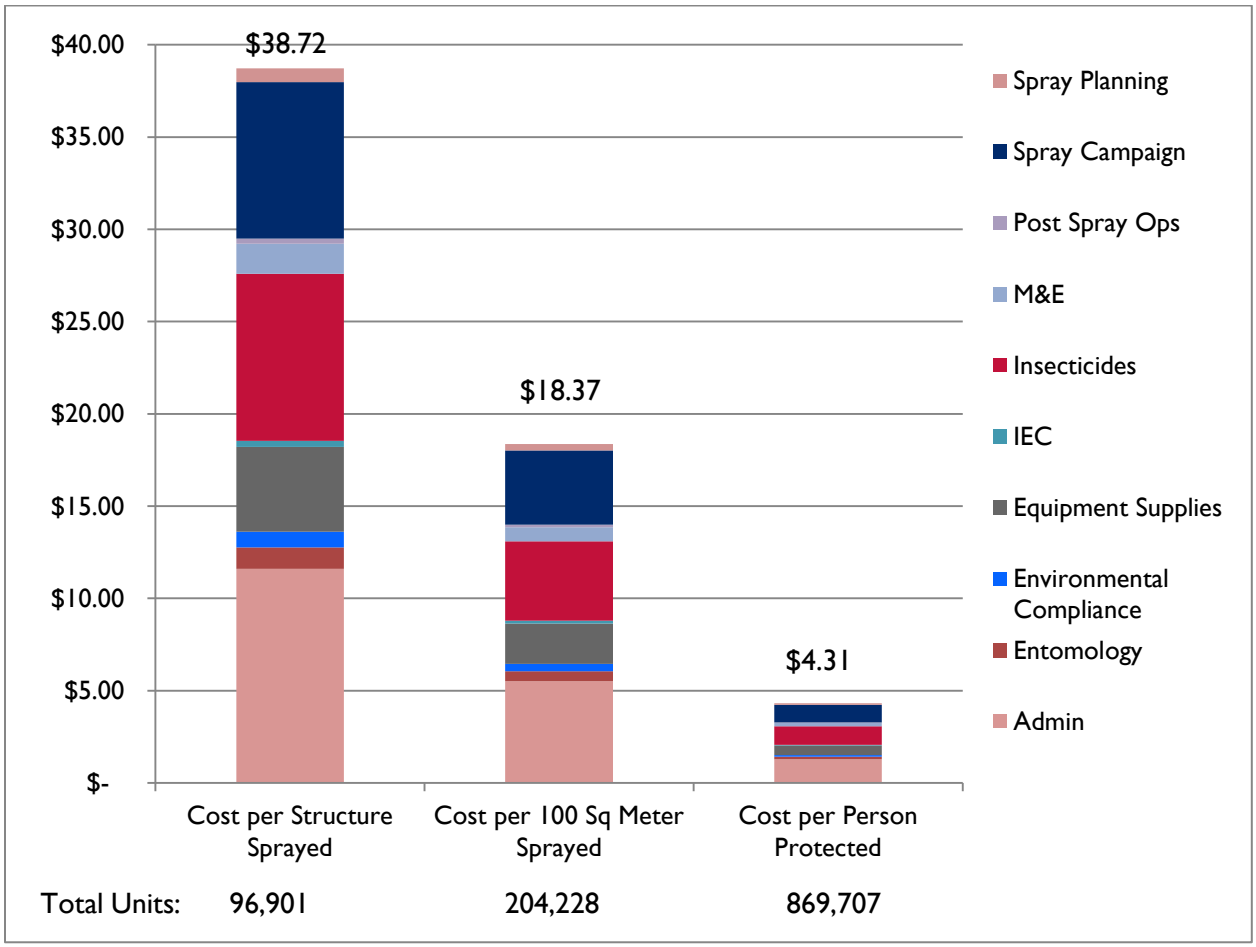
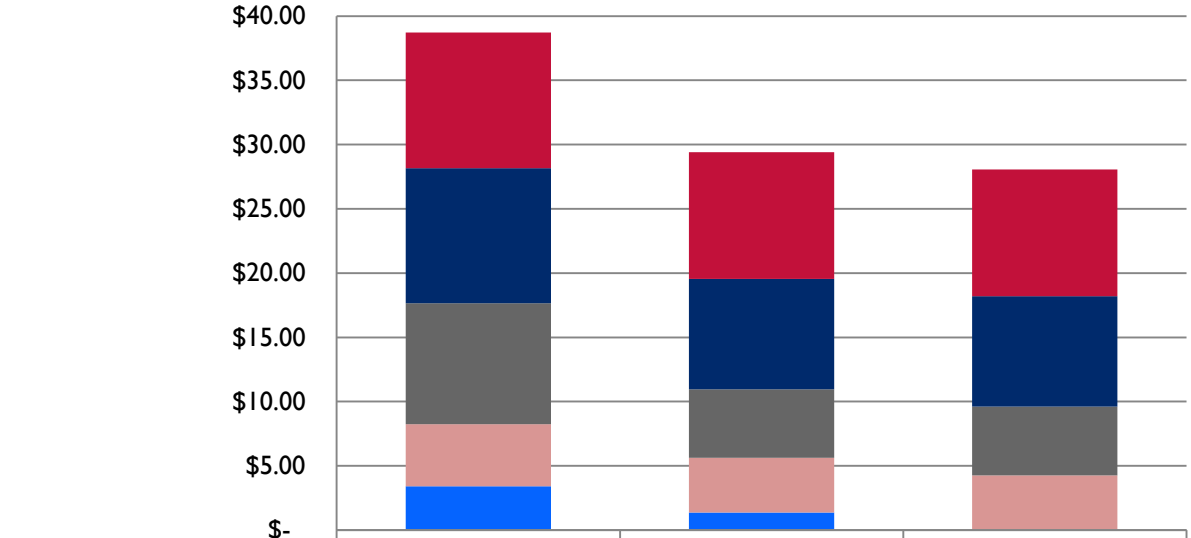



Figure LR5 illustrates the Liberia IRS fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, IEC, EC, and M&E, have a minor impact on the unit cost. On the other hand, administration, the spray campaign, and insecticide are the major cost drivers.

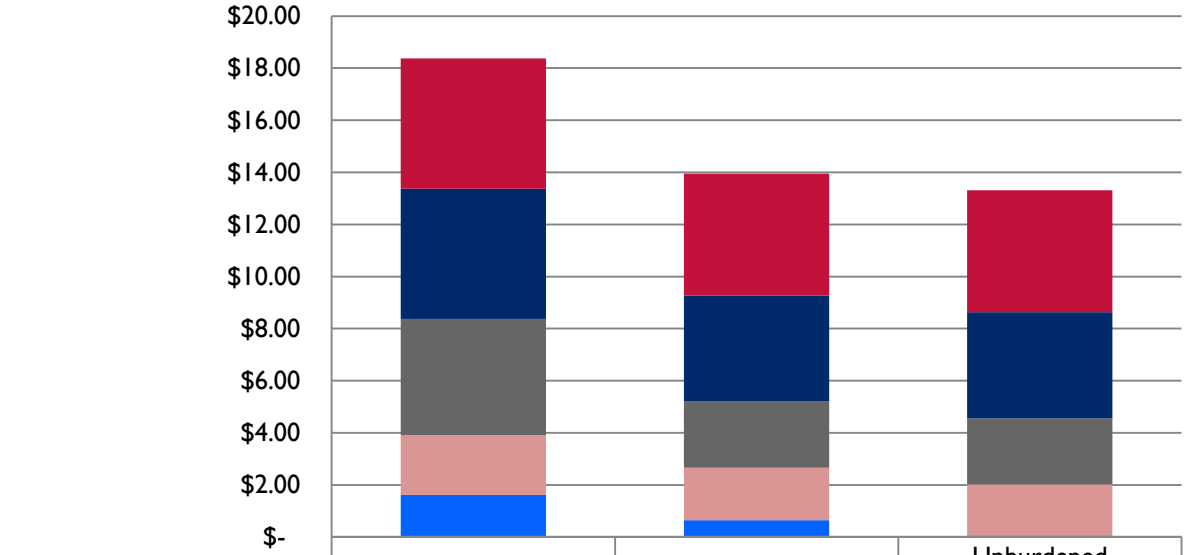
**FIGURE LR6: LIBERIA IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $10.54 | $9.87 | $9.87 |
| Spray Ops | $10.53 | $8.59 | $8.59 |
| Local Labor | $9.40 | $5.34 | $5.34 |
| Local Admin | $4.84 | $4.26 | $4.26 |
| US-Based Labor and STTA | $3.40 | $1.35 | $- |
| Total | $38.72 | $29.42 | $28.06 |

The Liberia IRS program sprayed 210,380 structures during the two spray campaign rounds completed in 2012. Figure LR6 shows the unit costs per structure sprayed burdened ($38.72), unburdened ($29.42), and unburdened without U.S. labor ($28.06), itemized by cost category. In terms of cost categories, the largest cost drivers are spray operations and spray commodities, followed closely by local labor. In contrast to the preceding figure, the local administration cost category excludes local staff labor expenses, and both local administration and U.S.-based labor make up about 21 percent of the total burdened unit cost. The unburdened unit cost excludes implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is about $10.66, or about 28 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for almost half of the total "cost of burden."

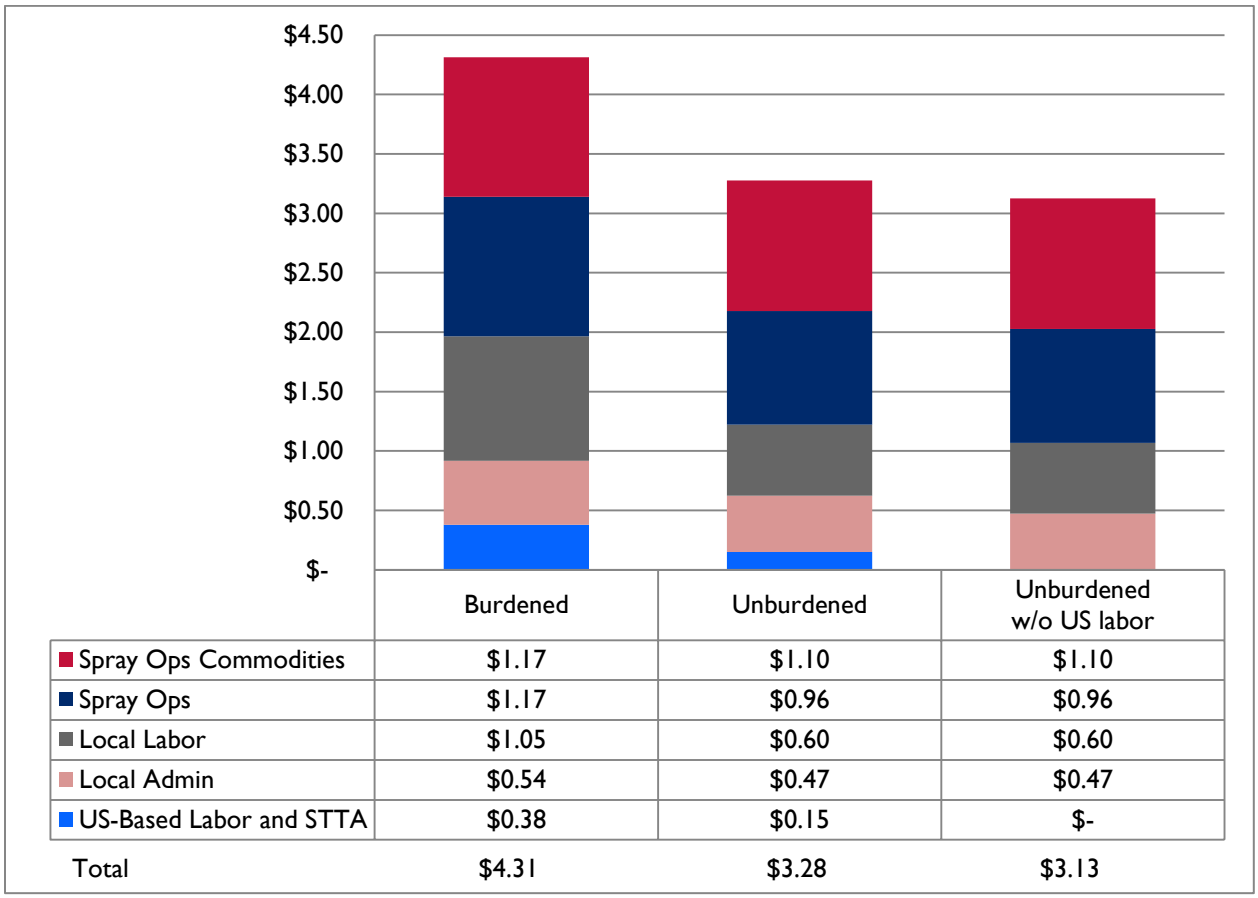
**FIGURE LR7: LIBERIA IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $5.00 | $4.68 | $4.68 |
| Spray Ops | $5.00 | $4.08 | $4.08 |
| Local Labor | $4.46 | $2.54 | $2.54 |
| Local Admin | $2.30 | $2.02 | $2.02 |
| US-Based Labor and STTA | $1.61 | $0.64 | $- |
| Total | $18.37 | $13.96 | $13.31 |

Figure LR7 shows the unit costs per 100 m² sprayed burdened ($18.37), unburdened ($13.96), and unburdened without U.S.-based labor ($13.31), itemized by cost category. The Liberia spray campaigns used 81,691 sachets of insecticide to cover 20,422,750 m² of structure area. Thus, the average size of the structures sprayed in Liberia was 210.8 m². This report looks at the unit cost of 100 m² sprayed, which covers less than half of a structure in Liberia. The Liberia IRS unit cost per 100 m² sprayed is about half as expensive as the unit cost per structure sprayed. Using this unit of measure, along with the contextual information of the average size of structures in Liberia, allows for a more accurate comparison to other country program costs.

**FIGURE LR8: LIBERIA IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $1.17 | $1.10 | $1.10 |
| Spray Ops | $1.17 | $0.96 | $0.96 |
| Local Labor | $1.05 | $0.60 | $0.60 |
| Local Admin | $0.54 | $0.47 | $0.47 |
| US-Based Labor and STTA | $0.38 | $0.15 | $- |
| Total | $4.31 | $3.28 | $3.13 |

As noted in the Background section, the Liberia IRS spray campaigns in 2012 protected 869,707 people from malaria transmission. Figure LR8 shows the unit costs per person protected burdened ($4.31), unburdened ($3.28), and unburdened without U.S.-based labor ($3.13), itemized by cost category. The categories driving the unit cost include spray operations and spray commodities, followed closely by local labor. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of the Liberia IRS program costs, as delivered by the implementing partner, adds $1.18 to the unit cost per person protected.

# 10. MADAGASCAR

## 10.1 BACKGROUND

PMI has supported IRS programming in Madagascar since 2008. In 2011, PMI supported IRS in 15 districts in the central highlands and southern Madagascar. The 2011 IRS campaign sprayed 502,697 eligible structures and protected 2,585,672.

In 2012, PMI's IRS program transitioned to targeted spraying in the central highlands and in four communes around Fort Dauphin (southern Madagascar). Therefore, the Madagascar program focused IRS in select communes (sub-districts) where malaria incidence remains high. Additionally, the program completed general "blanketed" IRS in seven districts within southern Madagascar, and thereby worked to provide IRS for as close to 100 percent of eligible structures in the districts, as possible. The Madagascar program procured both pyrethroid and carbamate insecticides for use in its spray campaigns.

IRS Madagascar transitioned into the AIRS project from the previous project throughout May and June of 2012, when the program began start-up operations. AIRS Madagascar completed IRS in the central highlands between November 20 and December 31, 2012. Although the first half of the IRS campaign in the central highlands was completed within the 2012 calendar year, the second half of the campaign in the south occurred in 2013. Thus, M&E data regarding number of structures sprayed, and population protected are not available for this costing report, and will be included in the next report. Table MG1 notes the targets for the IRS campaign in the central highlands.

**TABLE MG1: MADAGASCAR TARGETS***

| | |
|---|---|
| # Local Staff | 13 |
| Spray Start Date | November 20, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | N/A |
| # People Protected (Target) | 550,000 |
| # Structures Sprayed (Target) | 99,000 |
| # 100 Square Meters Sprayed | N/A |
| Average Size of Structure | N/A |

* Only includes preliminary target data for the part of the spray campaign in the Central Highlands. Additional data for the spray campaign in the South was not available at the time of this report.

This report only includes expenditures incurred before December 31, 2012. The cost of start-up operations is complete, and shown in Figure MG2. However, due to the spray campaign dates in Madagascar, which lasted into 2013, this costing report does not fully capture program implementation costs.

## 10.2 RESULTS

This section presents the total expenditure of Madagascar IRS since the beginning of the program's start under the AIRS project. This includes start-up operations for the program (May 1, 2012–August 14, 2012), and the first few months of program implementation (August 15, 2012–December 31, 2012). Note that AIRS Madagascar had a later initiation of start-up operations than many of the other country programs, as this was part of the planning for graduated transition from the previous IRS program to the AIRS project. Transition began in May of 2012, but the program was not fully transferred to the AIRS project until June 1, 2012. As described in the Methodology section of this report, the data have been categorized in the following ways: cost category; program activity; expenditure status (start-up, capital, or recurrent); and burden type.

**FIGURE MG1: MADAGASCAR IRS 2012 EXPENDITURES**

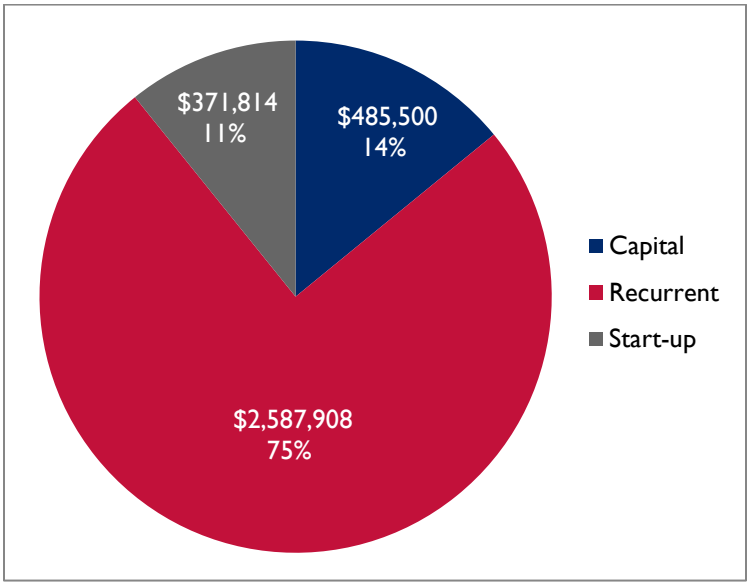



Figure MG1 shows the fully burdened cost of program expenditures incurred in the 2012 calendar year, broken out by expenditure status. Note that the recurrent expenses (red) are not an accurate representation of the full cost of an IRS program, but only cover one of two expected spray campaigns. Recurrent expenses only run through December 31, 2012, and are included here to provide information on the first half of the spray round. The Madagascar IRS start-up expenditures were a one-time project cost and are analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. Thus, both start-up and capital costs would comprise a lower percentage of total expenditures if the full program recurrent costs were included. Capital expenses included above were depreciated across the three years of the project. Included within total program expenditures above is $386,700 of capital and recurrent costs that were inherited; the value of these items used for the costing analysis was supplied through the inventory disposition list.

**FIGURE MG2: MADAGASCAR IRS START-UP EXPENDITURES, BY BURDEN TYPE**

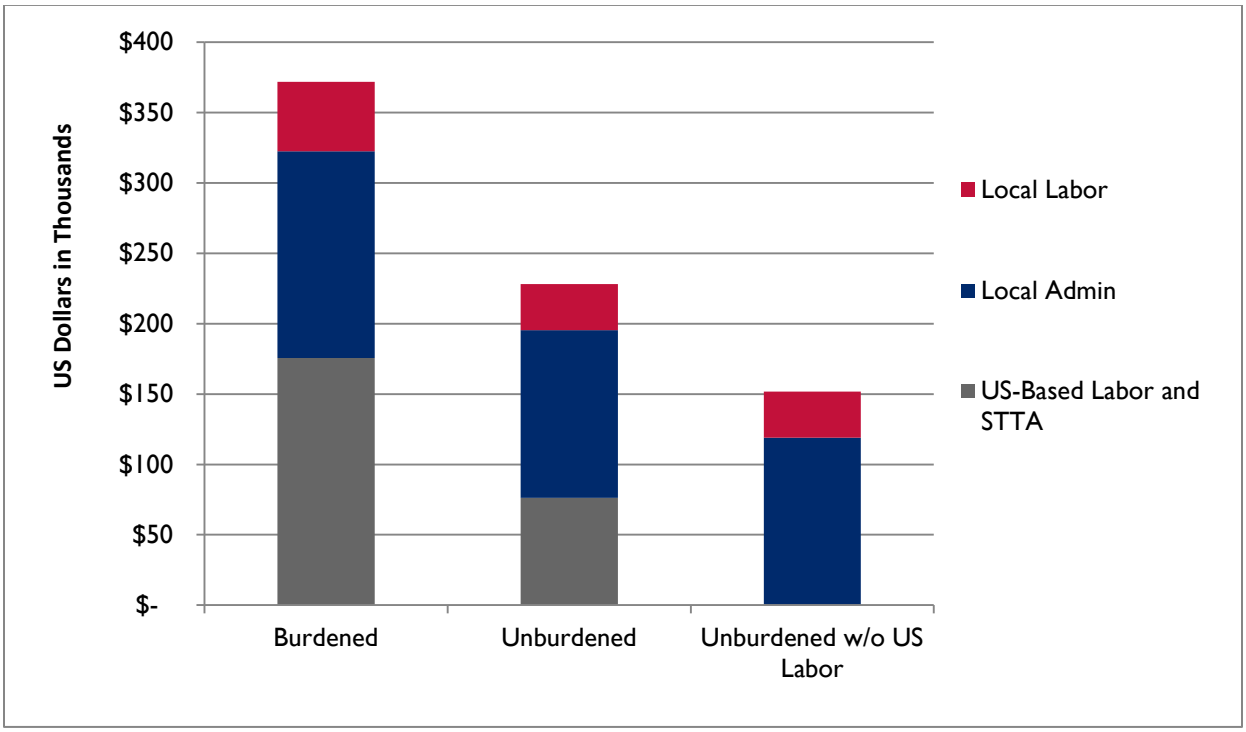



Figure MG2 displays expenditures related to start-up operations for Madagascar's IRS program. Start-up expenses include any operations that took place between May 1, 2012 and August 15, 2012. The figure separates total burdened ($371,814), unburdened ($228,053) and unburdened without U.S.-based labor costs ($151,718) by program cost categories. As noted in the Methodology section, total burdened start-up expenditures are treated as a one-time cost to the project.

# 11. MALI

## 11.1 BACKGROUND

In Mali, IRS campaigns have been funded through PMI for five years, and remain one of the key malaria control interventions. In 2012, the Mali IRS spray campaign was implemented using 68 operations sites in three districts: Baroueli, Bla, and Koulikoro. The spray campaign used a carbamate insecticide and took place over 45 days during the period from July 23, 2012 through 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."[18]

**TABLE ML1: MALI QUICK FACTS**

| | |
|---|---|
| # Local Staff | 14 |
| Spray Start Date | July 23, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 77,187 |
| # People Protected | 762,146 |
| # Structures Sprayed | 206,295 |
| # 100 Square Meters Sprayed | 192,968 |
| Average Size of Structure | 93.5 $m^2$ |

* 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.

[18] 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/

## 11.2 RESULTS

This section presents the Mali IRS program's total expenditures for both program start-up operations (August 11, 2011–January 31, 2012) and the first year of program implementation under the AIRS project (February 1, 2012–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE ML1: MALI IRS TOTAL EXPENDITURES**

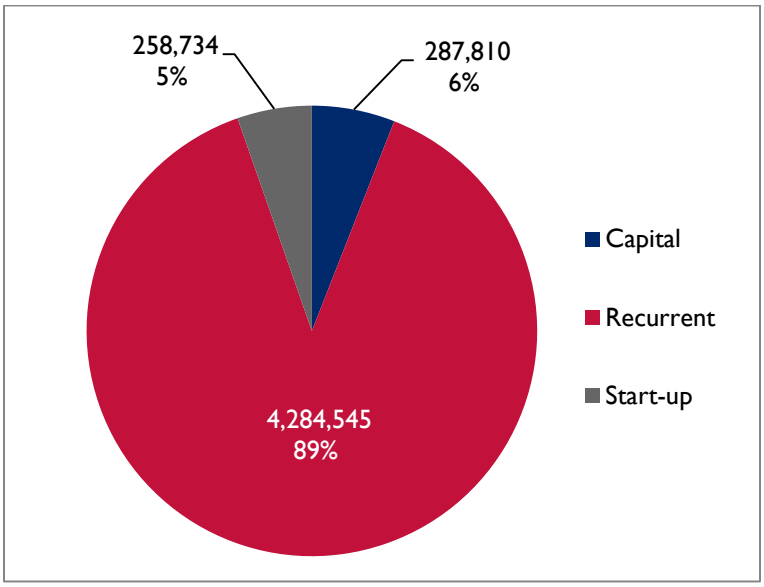



Figure ML1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 89 percent of total project expenditures are recurrent costs. As noted in the Background section, during the calendar year 2012, Mali's IRS program was about $700,000 under budget due to political strife causing a cessation of field programs for a two-month period. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $572,900 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list.

**FIGURE ML2: MALI IRS START-UP EXPENDITURES, BY BURDEN TYPE**

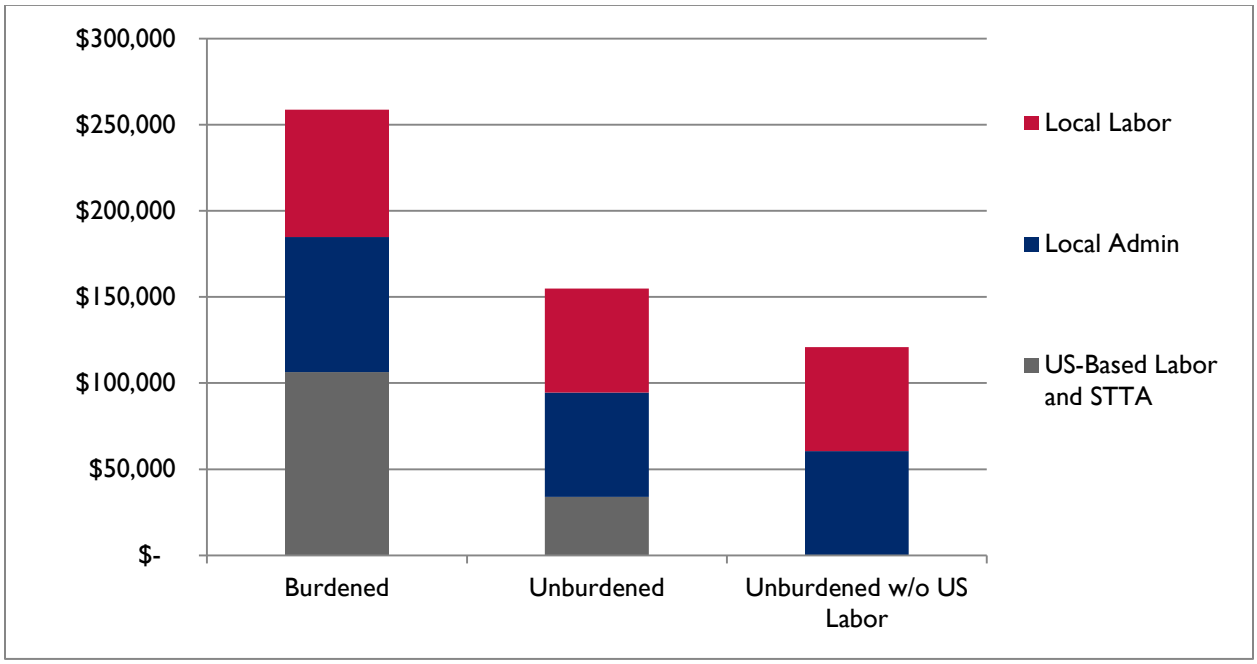



Figure ML2 displays the Mali IRS program start-up expenditures only, which include activities such as country scoping, technical information gathering, and hiring. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. About 70 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. As mentioned before, start-up expenditures are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

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

| Activities | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 109,850 | 418,053 | 400,243 | | | $ 928,146 | 20.30% |
| Entomology | 24,590 | | 82,192 | 60,596 | 38,893 | $ 206,271 | 4.51% |
| EC | 12,877 | | 70,135 | 34,935 | 12,415 | $ 130,362 | 2.85% |
| Equipment Supplies | 362 | | 7,698 | 1,244 | 335,430 | $ 344,734 | 7.54% |
| IEC | | | 6,448 | 189,118 | | $ 195,566 | 4.28% |
| Insecticide | | | 1,713 | 1,055 | 1,123,697 | $ 1,126,465 | 24.64% |
| M&E | 22,502 | | 117,768 | 6,040 | | $ 146,310 | 3.20% |
| Post-Spray Ops | | | 8,389 | 94,633 | | $ 103,022 | 2.25% |
| Spray Campaign | 1,726 | | 8,396 | 1,195,188 | 592 | $ 1,205,902 | 26.37% |
| Spray Planning | | | 15,452 | 170,126 | | $ 185,578 | 4.06% |
| **Grand Total** | **$ 171,907** | **$ 418,053** | **$ 718,434** | **$1,752,935** | **$ 1,511,027** | **$ 4,572,356** | **100%** |

Table ML2 displays the Mali IRS program total capital and recurrent expenditures, and excludes the start-up costs. 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 costs in the above table.

**FIGURE ML3: MALI IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

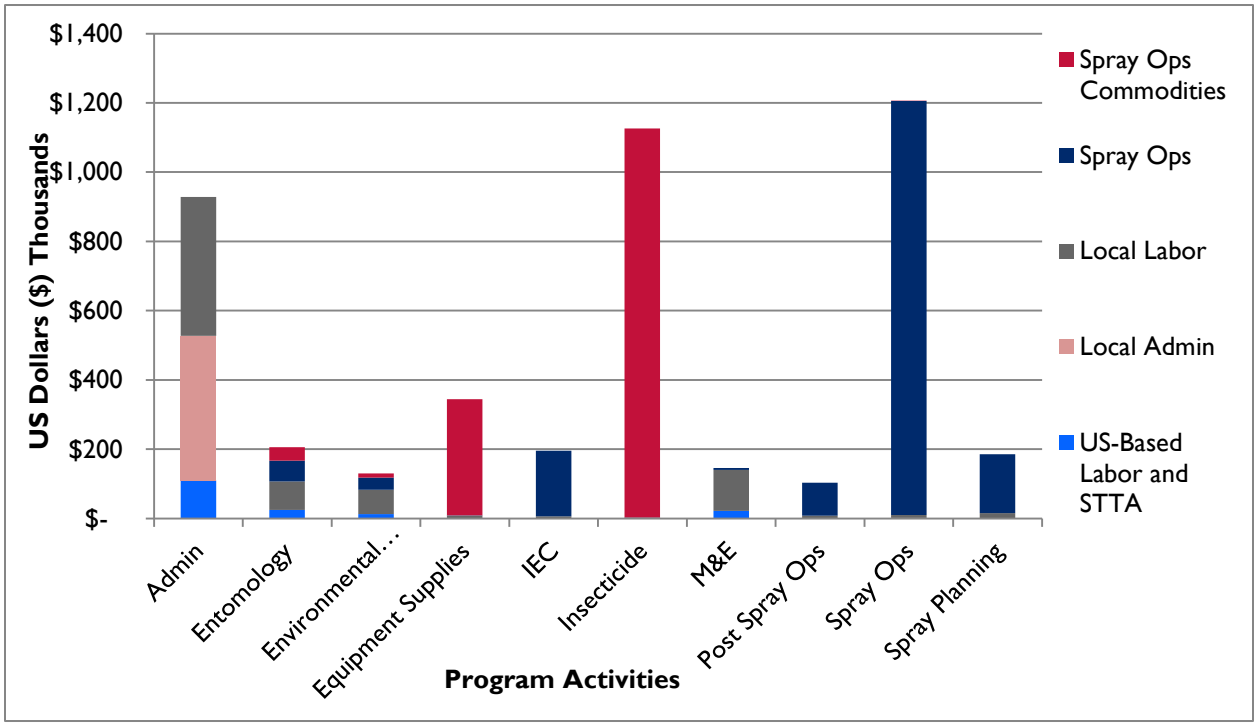



Figure ML3 contains fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The implementation of the spray campaign and the cost of insecticides are the two most expensive activities. The total cost for administration is the third largest activity cost, but over half of this cost 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, while 'Local Labor' is spread more evenly across a majority of activities.

**FIGURE ML4: MALI IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

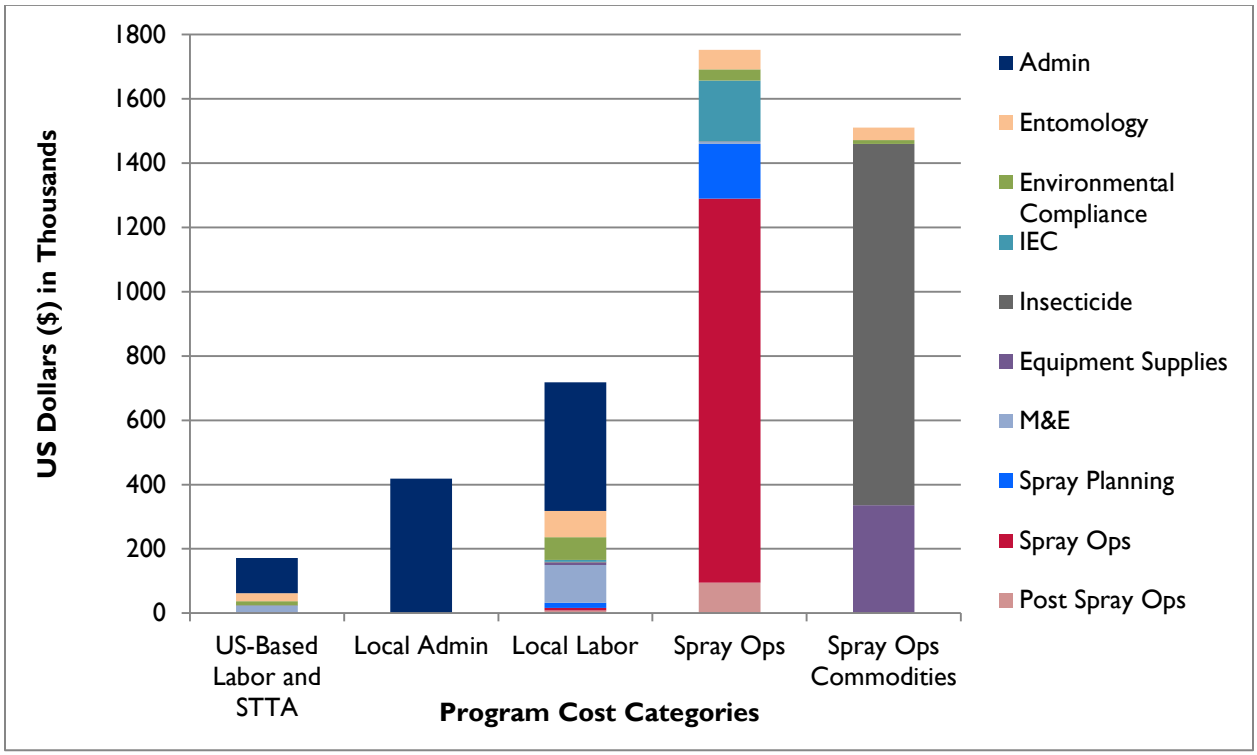



Figure ML4 contains the same information as Figure ML3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs and U.S.-based labor and STTA are minimal compared to expenditures related to local labor, technical operations, and commodities.

## 11.3 Unit Cost Analysis

This section presents Mali's IRS program capital and recurrent expenditures as unit costs: per structure sprayed, per 100 m² sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 m² was added as a more standardized unit to allow for cross-country comparison.

**FIGURE ML5: MALI IRS UNIT COSTS, BY ACTIVITY**

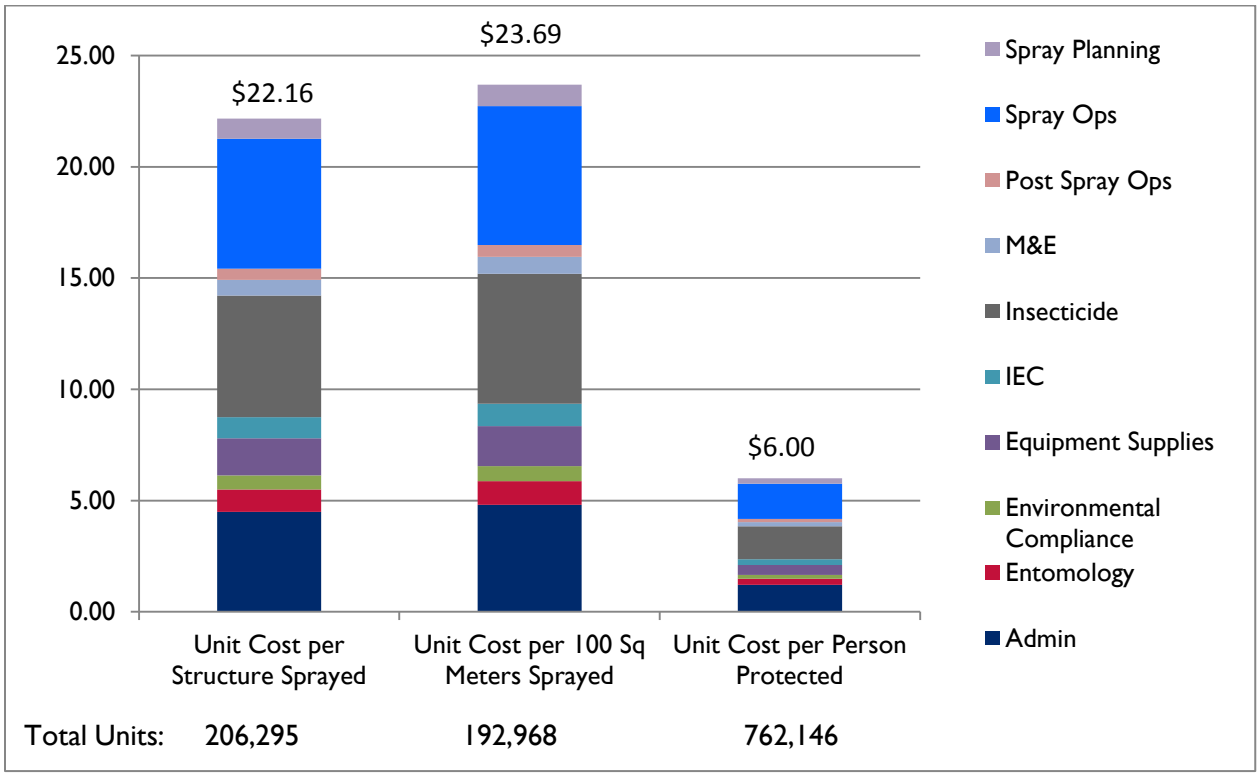
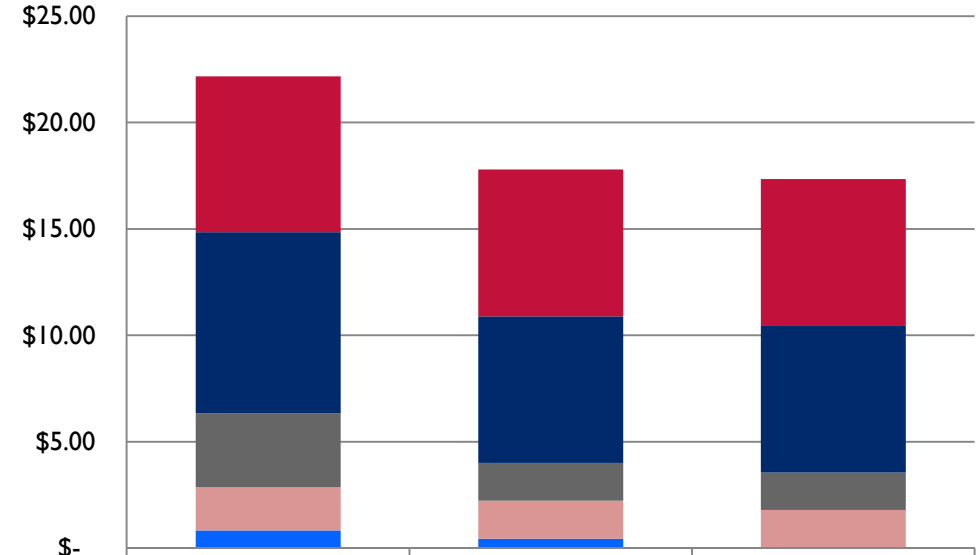



Figure ML5 illustrates the Mali IRS fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, IEC, EC, and M&E, have only a minor impact on the unit cost. Spray operations is the largest cost driver, followed closely by insecticide and administration. Keep in mind that Figure ML3 showed that over half of the costs under the administration activity consisted of labor.

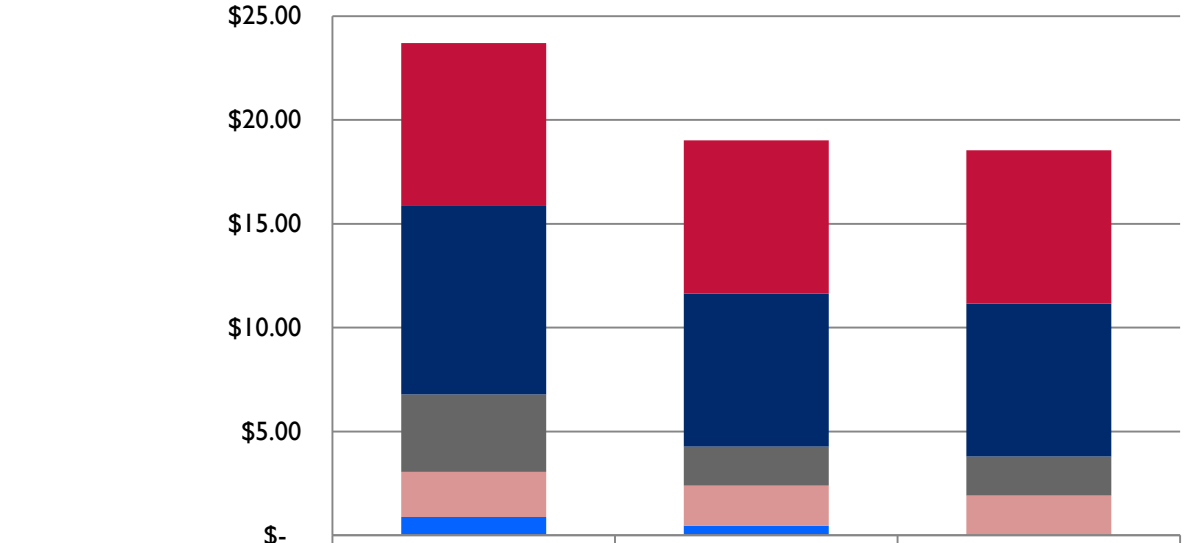
**FIGURE ML6: MALI IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $7.32 | $6.90 | $6.90 |
| Spray Ops | $8.50 | $6.89 | $6.89 |
| Local Labor | $3.48 | $1.76 | $1.76 |
| Local Admin | $2.03 | $1.79 | $1.79 |
| US-Based Labor and STTA | $0.83 | $0.45 | $- |
| Total | $22.16 | $17.79 | $17.35 |

The Mali IRS program sprayed 206,295 structures during the 2012 spray campaign. Figure ML6 shows the unit costs per structure sprayed burdened ($22.16), unburdened ($17.79), and unburdened without U.S. labor ($17.35), itemized by cost category. In terms of cost categories, the largest cost driver is spray operations, followed by spray commodities. In contrast to the preceding figure, the local administration cost category excludes local staff labor expenses, and both local administration and U.S.-based labor make up less than 13 percent of the total burdened unit cost. The unburdened unit cost excludes implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $4.81, or 22 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for over one third of the total "cost of burden."

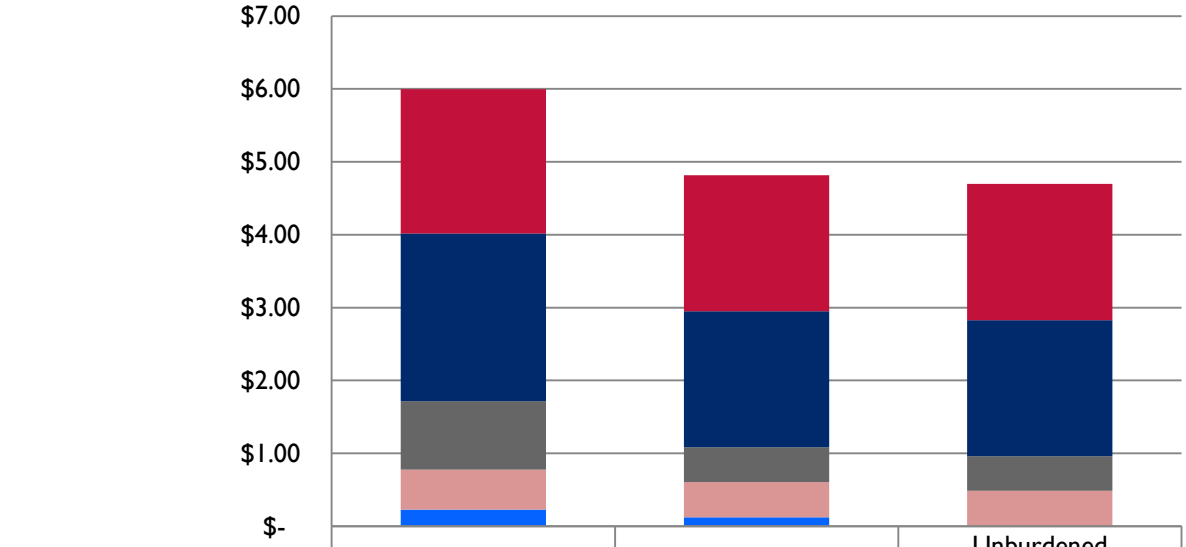
**FIGURE ML7: MALI IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $7.83 | $7.38 | $7.38 |
| Spray Ops | $9.08 | $7.37 | $7.37 |
| Local Labor | $3.72 | $1.88 | $1.88 |
| Local Admin | $2.17 | $1.92 | $1.92 |
| US-Based Labor and STTA | $0.89 | $0.48 | $- |
| Total | $23.69 | $19.02 | $18.55 |

Figure ML7 shows the unit costs per 100 m² sprayed burdened ($23.69), unburdened ($19.02), and unburdened without U.S.-based labor ($18.55), itemized by cost category. The Mali spray campaign used 77,187 sachets of insecticide to cover 19,296,750 m² of structure area. Thus, the average size of the structures sprayed in Mali was 93.5 m². This report looks at the unit cost of 100 m² sprayed, which covers just over one full structure in Mali. The Mali unit cost per 100 m² sprayed is about the same unit cost per structure sprayed. Using the unit of measure per 100 m², however, along with the contextual information of the average size of structures in Mali, allows for a more accurate comparison to other country program costs.

**FIGURE ML8: MALI IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $1.98 | $1.87 | $1.87 |
| Spray Ops | $2.30 | $1.87 | $1.87 |
| Local Labor | $0.94 | $0.48 | $0.48 |
| Local Admin | $0.55 | $0.49 | $0.49 |
| US-Based Labor and STTA | $0.23 | $0.12 | $- |
| Total | $6.00 | $4.82 | $4.70 |

As noted in the Background section, the IRS Mali 2012 spray campaign protected 762,146 people from malaria transmission. Figure ML8 shows the unit costs per person protected burdened ($6.00), unburdened ($4.82), and unburdened without U.S.-based labor ($4.70), itemized by cost category. The categories driving the unit cost include spray operations and spray commodities. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of Mali program costs, as delivered by the implementing partner, adds $1.30 to the unit cost per person protected.

# 12. MOZAMBIQUE

## 12.1 BACKGROUND

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, mainly lambda-cyhalothrin and deltamethrin, 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 lambda-cyhalothrin, 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, PMI implemented a spray campaign in six districts: Milange, Mocuba, Morrumbala, Namacurra, Nicodala, and Quelimane. The 2012 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.

**TABLE MZ1: MOZAMBIQUE QUICK FACTS**

| | |
|---|---|
| # Local Staff | 28 |
| Spray Start Date | October 8, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 389,788 |
| # People Protected | 2,716,176 |
| # Structures Sprayed | 536,558 |
| # 100 Square Meters Sprayed | 974,470 |
| Average Size of Structure | 181.6 $m^2$ * |

* 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 RESULTS

This section presents the Mozambique IRS program's total expenditures for both program start-up operations (August 11, 2011–March 31, 2012), as well as the first year of program implementation under AIRS (April 1, 2012–December 31, 2012). Since the spray campaign in Mozambique did not begin until October 8, 2012, there may be some minimal additional costs incurred in 2012 spray operations that would not have been included in the AIRS project financial systems until as late as February 2013, and are not included in this costing report. 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE MZ1: MOZAMBIQUE IRS TOTAL EXPENDITURES,**

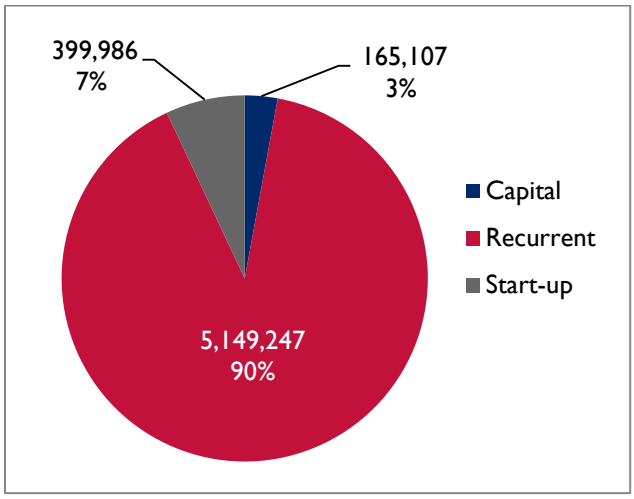



Figure MZ1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 90 percent of total project expenditures are recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $359,300 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list.

**FIGURE MZ2: MOZAMBIQUE IRS START-UP EXPENDITURES, BY BURDEN TYPE**

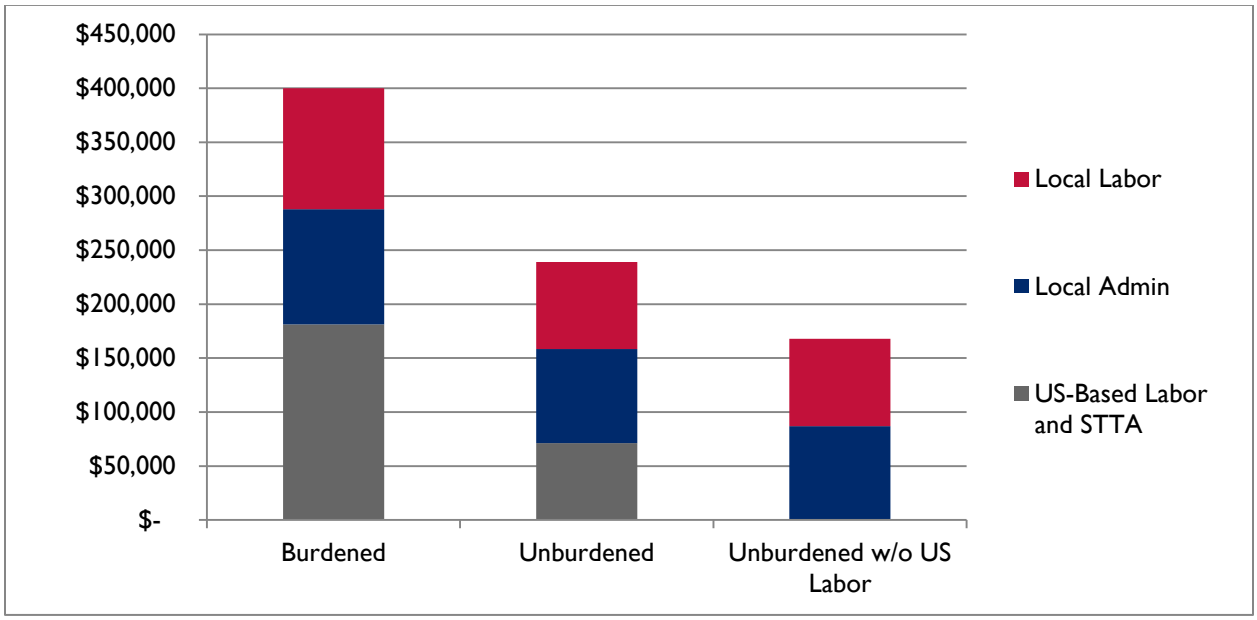



Figure MZ2 displays the Mozambique IRS program start-up expenditures only, which include activities such as country scoping, technical information gathering, recruitment, hiring, and office set-up in both Maputo and Quelimane. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. Almost three-fourths of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. The total program start-up expenditures for Mozambique were high, which may be due to the fact that the program had a late spray campaign date, which meant the start-up operations period lasted through March 31, 2012, for a total of over seven months. As mentioned before, start-up expenditures are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

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

| Activity | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 71,157 | 701,184 | 791,787 | | | $ 1,564,128 | 29.43% |
| Entomology | 1,741 | | 53,842 | 64,405 | 12,489 | $ 132,477 | 2.49% |
| EC | 17,960 | | 33,819 | 17,254 | | $ 69,033 | 1.30% |
| Equipment Supplies | | | 3,064 | 213,281 | 76,914 | $ 293,259 | 5.52% |
| IEC | | | 31,270 | 57,501 | | $ 88,771 | 1.66% |
| Insecticide | | | | | 1,186,964 | $ 1,186,964 | 22.34% |
| M&E | 45,330 | | 67,710 | 27,703 | | $ 140,743 | 2.65% |
| Post-Spray Ops | 9,892 | | | | | $ 9,892 | 0.19% |
| Spray Campaign | 8,374 | | 5,895 | 498,621 | | $ 512,890 | 9.65% |
| Spray Planning | 13,903 | | 272,088 | 986,630 | 43,578 | $ 1,316,199 | 24.77% |
| **Grand Total** | **$ 168,357** | **$ 701,184** | **$ 1,259,475** | **$ 1,865,395** | **$ 1,319,945** | **$ 5,314,356** | **100%** |

Table MZ2 displays the Mozambique IRS program total capital and recurrent expenditures, and excludes the start-up costs. These expenditures are fully burdened. The first column lists the program activities as tracked through 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. It is important to note that AIRS Mozambique had a late spray campaign start date, which may have caused some expenditures associated with the first year of program implementation to come in after December 31, 2012. The following two figures illustrate the costs in the above table.

**FIGURE MZ3: MOZAMBIQUE IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

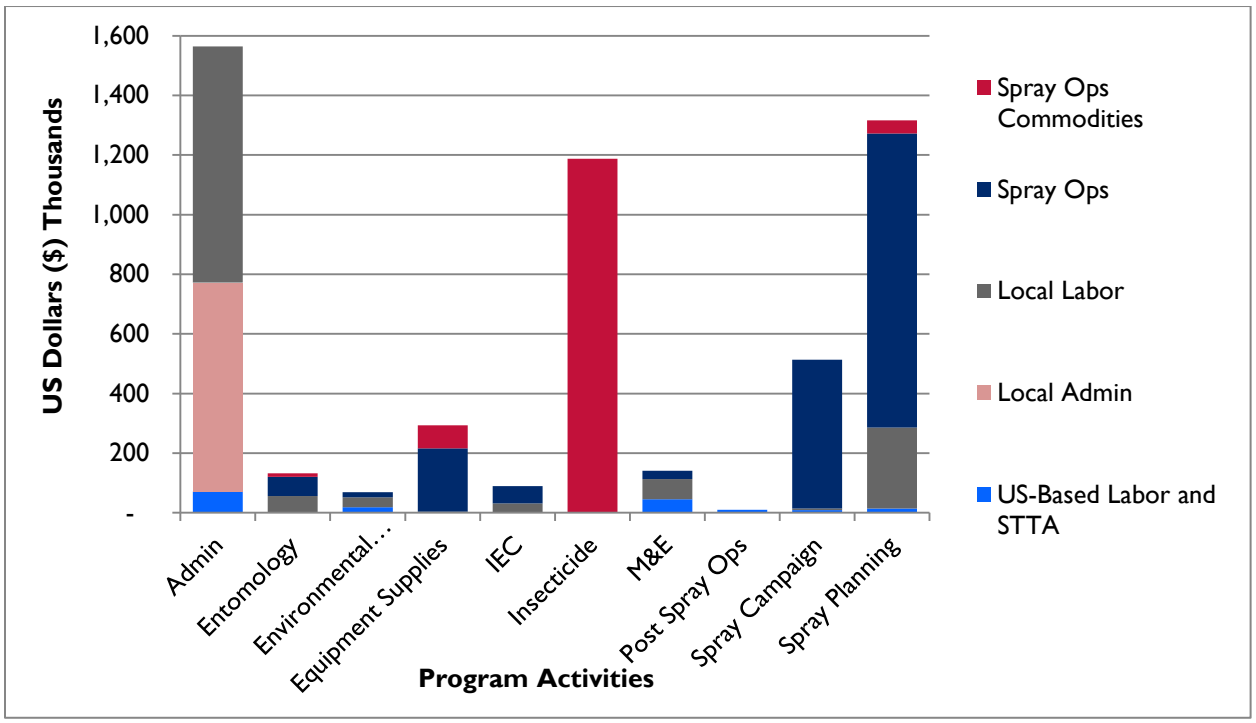



Figure MZ3 shows fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Administration and spray planning are the two most expensive activities, followed by insecticide. The total cost for administration is the largest activity cost, but about 55 percent of this cost 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, while local labor is slightly more spread out across activities. Additionally, expenditures associated with ground transportation and temporary labor of spray operators was captured under the 'spray planning' activity, compared to many IRS country programs that included this fully under the 'spray campaign' activity.

**FIGURE MZ4: MOZAMBIQUE IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

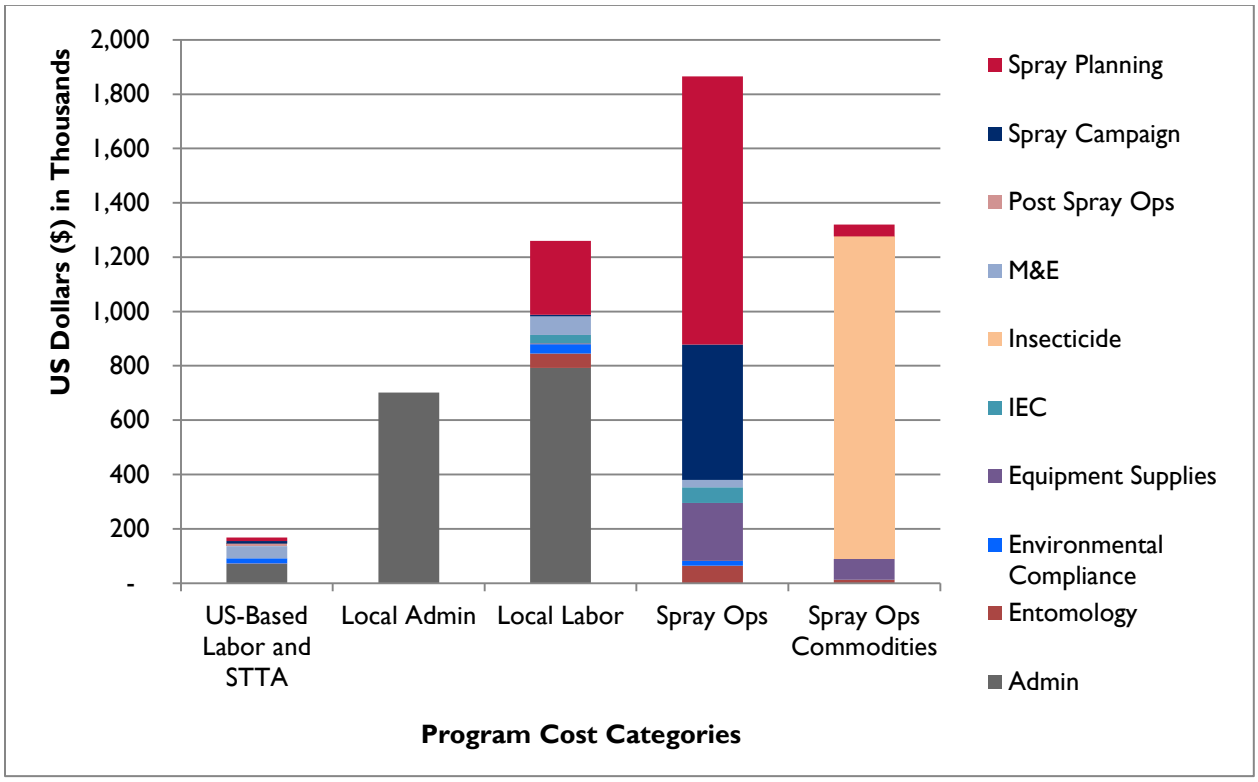



Figure MZ4 contains the same information as Figure MZ3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs and U.S.-based labor and STTA are minimal compared to expenditures related to local labor, technical operations, and commodities.

## 12.3 Unit Cost Analysis

This section presents the Mozambique IRS program's capital and recurrent expenditures as unit costs: per structure sprayed, per 100 m² sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 m² was added as a more standardized unit to allow for cross-country comparison.

**FIGURE MZ5: MOZAMBIQUE IRS UNIT COSTS, BY ACTIVITY**

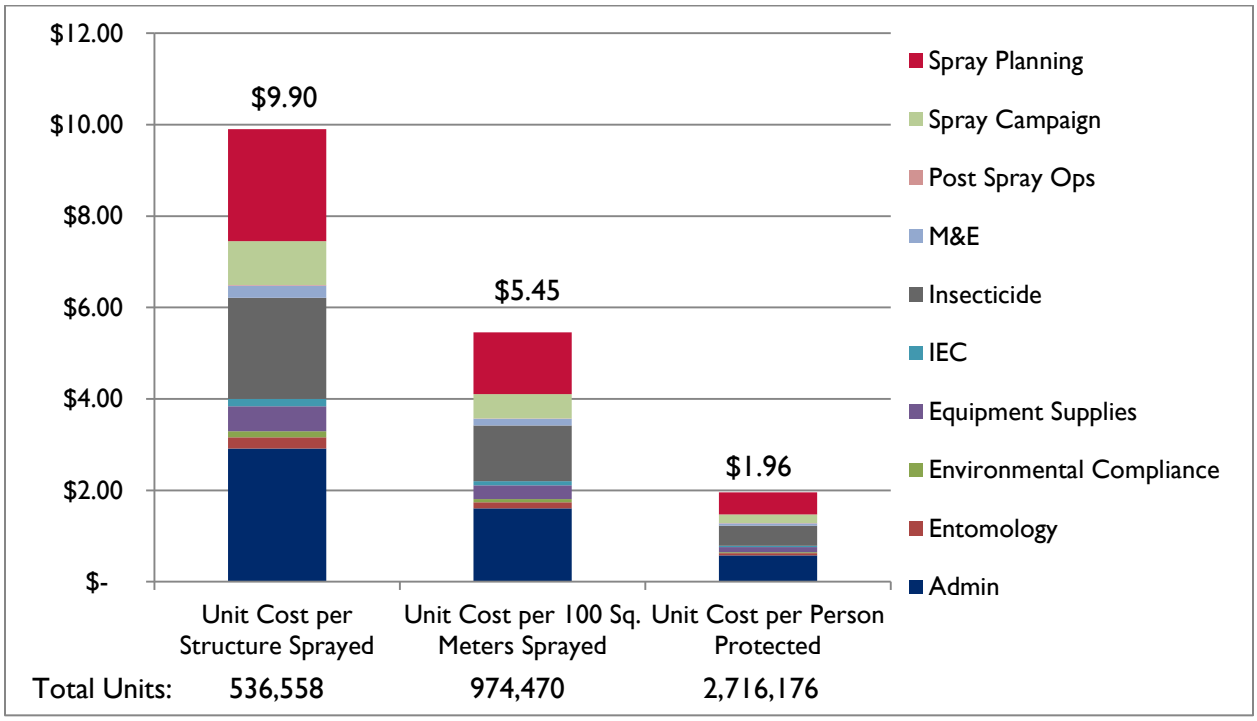
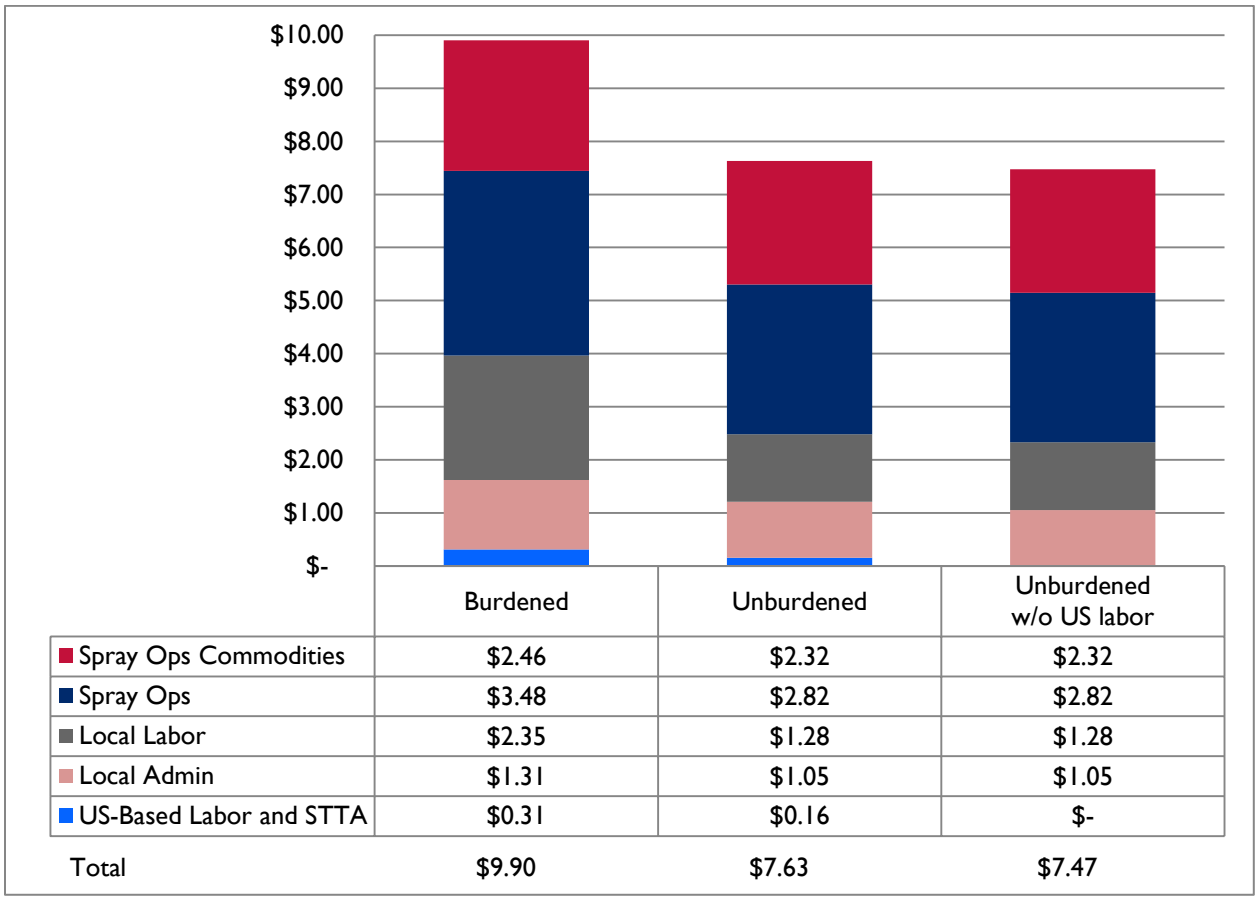



Figure MZ5 illustrates the Mozambique IRS fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, IEC, EC, and M&E, have only a minor impact on the unit cost. Administration is the largest cost driver, followed closely by spray planning and insecticide. Keep in mind that Figure MZ3 showed that over half of the costs incurred under administration consisted of labor.

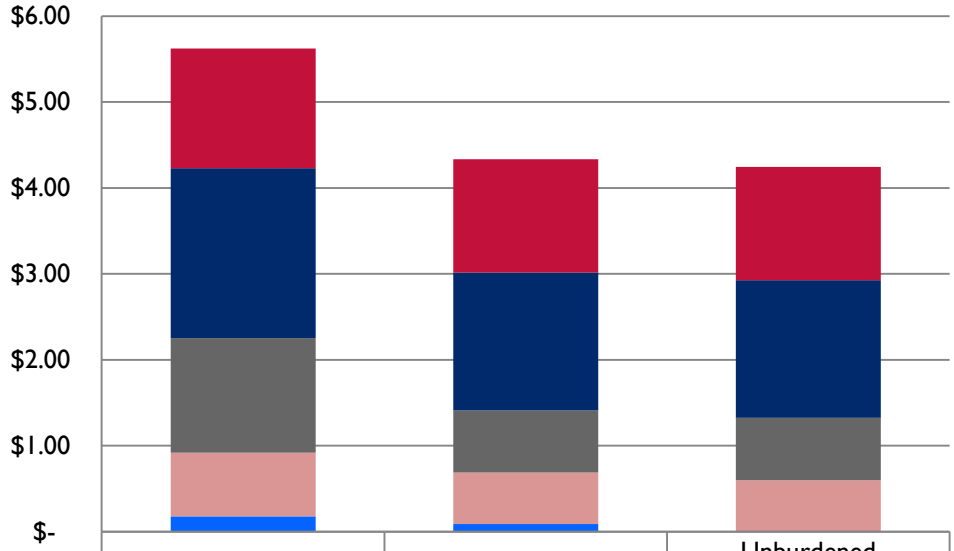
**FIGURE MZ6: MOZAMBIQUE IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $2.46 | $2.32 | $2.32 |
| Spray Ops | $3.48 | $2.82 | $2.82 |
| Local Labor | $2.35 | $1.28 | $1.28 |
| Local Admin | $1.31 | $1.05 | $1.05 |
| US-Based Labor and STTA | $0.31 | $0.16 | $- |
| Total | $9.90 | $7.63 | $7.47 |

The Mozambique program sprayed 536,558 structures during the 2012 spray campaign. Figure MZ6 shows the unit costs per structure sprayed burdened ($9.90), unburdened ($7.63), and unburdened without U.S. labor ($7.47), itemized by cost category. In terms of cost categories, the largest cost driver is spray operations, followed by spray commodities and local labor. In contrast to the preceding figure, the local administration cost category excludes labor expenses, and both local administration and U.S.-based labor make up 16.4 percent of the total burdened unit cost. The unburdened unit cost excludes Abt Associates overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $2.43, or less than 25 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for almost half of the total "cost of burden."

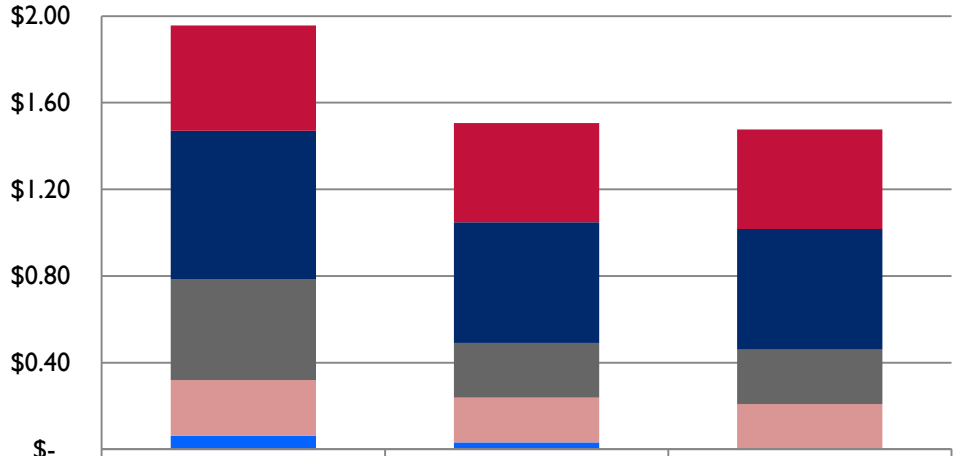
**FIGURE MZ7: MOZAMBIQUE IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $1.39 | $1.32 | $1.32 |
| Spray Ops | $1.98 | $1.60 | $1.60 |
| Local Labor | $1.33 | $0.73 | $0.73 |
| Local Admin | $0.74 | $0.60 | $0.60 |
| US-Based Labor and STTA | $0.18 | $0.09 | $- |
| Total | $5.45 | $4.20 | $4.11 |

Figure MZ7 shows the unit costs per 100 m² sprayed burdened ($5.45), unburdened ($4.20), and unburdened without U.S.-based labor ($4.11), itemized by cost category. The Mozambique spray campaign used 389,788 sachets of insecticide to cover 97,470,000 m² of structure area. Thus, the average size of the structures sprayed in Mozambique was 181.6 m². This report looks at the unit cost of 100 m² sprayed, which covers just over half of a structure in Mozambique. The Mozambique IRS unit cost per 100 m² sprayed is about half as much as the unit cost per structure sprayed. Using the unit of measure per 100 m², however, along with the contextual information of the average size of structures in Mozambique, allows for a more accurate comparison to other country program costs.

**FIGURE MZ8: MOZAMBIQUE IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $0.49 | $0.46 | $0.46 |
| Spray Ops | $0.69 | $0.56 | $0.56 |
| Local Labor | $0.46 | $0.25 | $0.25 |
| Local Admin | $0.26 | $0.21 | $0.21 |
| US-Based Labor and STTA | $0.06 | $0.03 | $- |
| Total | $1.96 | $1.51 | $1.48 |

As noted in the background section, the Mozambique 2012 spray campaign protected 2,716,176 people from malaria transmission. Figure MZ8 shows the unit costs per person protected burdened ($1.96), unburdened ($1.51), and unburdened without U.S.-based labor ($1.48), itemized by cost category. The categories driving the unit cost include spray operations and spray commodities. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of Mozambique IRS program costs, delivered by the implementing partner, adds $0.48 to the unit cost per person protected. The Mozambique IRS program unit costs, especially per person protected, are comparatively less expensive than other country program costs due primarily to the benefits of economies of scale. The number of people protected in Mozambique is 1.8 times higher than the next largest country program under the AIRS project (Ethiopia), and 23 times higher than the smallest AIRS program (Burkina Faso). This shows that while there are many other factors that impact program implementation costs, economies of scale do have an impact on lowering the unit costs.

# 13. NIGERIA

## 13.1 BACKGROUND

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. Under Task Order One, carried out by RTI, 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 the fall of 2011, the IRS program transitioned to the AIRS project and established an office in Lafia, the capital of Nasarawa State. This is where the project conducted the first IRS round in two local government authorities (LGAs), Doma and Nassarawa Eggon, in April and May 2012. 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. The geographical scope included only two local government areas (LGAs) of a state with a total of 58,704 structures sprayed. 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 is about seven months, between May and October/November. The IRS program used a pyrethroid class insecticide that was procured in two batches: one by RTI and one by Abt Associates.

**TABLE NG1: NIGERIA QUICK FACTS**

| | |
|---|---|
| # Local Staff | 18 |
| Spray Start Date | April 4, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 29,177 |
| # People Protected | 346,115 |
| # Structures Sprayed | 58,704 |
| # 100 Square Meters Sprayed | 72,943 |
| Average Size of Structure | 124.3 $m^2$* |

* 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.

## 13.2 RESULTS

This section presents the Nigeria IRS program's total expenditures for both program start-up operations (August 11, 2011–January 31, 2012), as well as the first year of program implementation (February 1, 2012–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE NG1: NIGERIA IRS TOTAL EXPENDITURES**

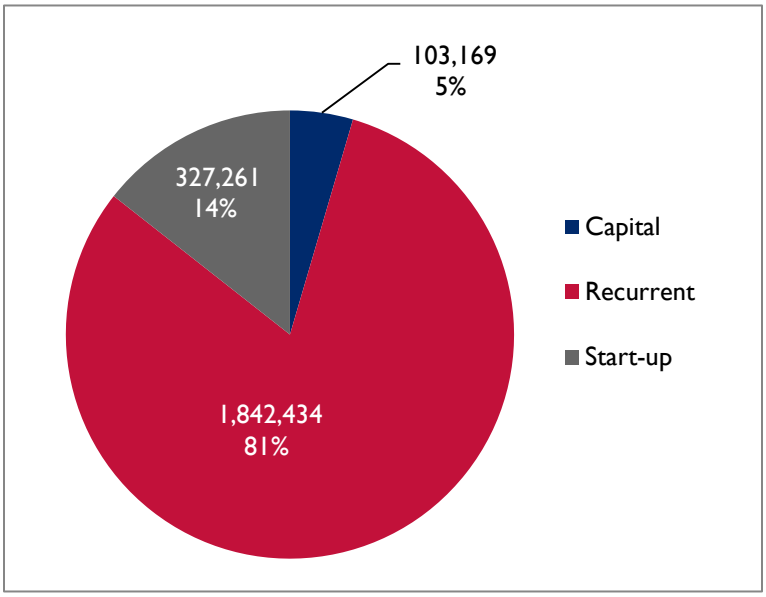



Figure NG1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 81 percent of total project expenditures are recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $44,100 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list. RTI procured a portion of pyrethroid insecticide for use by Nigeria's 2012 IRS program, the value of which was also provided and included in this report.

**FIGURE NG2: NIGERIA IRS START-UP EXPENDITURES, BY BURDEN TYPE**

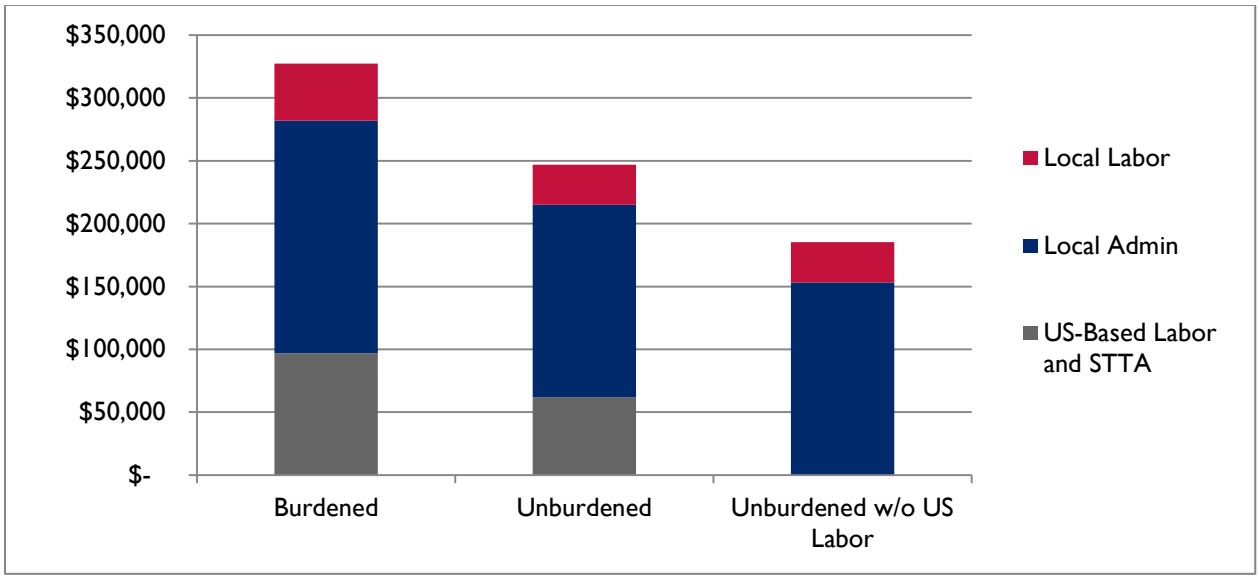



Figure NG2 displays the AIRS Nigeria program start-up expenditures only. They include activities such as country scoping, technical information gathering, and hiring. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. As mentioned before, total start-up expenditures ($327,261) are treated as a one-time cost to the project, and are, therefore, not included in the program implementation analysis that follows.

**TABLE NG2: NIGERIA IRS CAPITAL AND RECURRENT TOTAL EXPENDITURES, BY ACTIVITY AND COST CATEGORY**

| Activities | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Operations | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 138,002 | 248,764 | 312,582 | | | $ 699,348 | 35.95% |
| Entomology | 4,565 | | 46,867 | 26,627 | 2,077 | $ 80,136 | 4.12% |
| Environmental Compliance | 17,812 | | 39,959 | 5,231 | | $ 63,002 | 3.24% |
| Equipment Supplies | | | | | 43,005 | $ 43,005 | 2.21% |
| IEC | | | 23,898 | 10,592 | | $ 34,490 | 1.76% |
| Insecticide | | | | | 156,537 | $ 156,537 | 8.05% |
| M&E | 25,082 | | 45,785 | 12,355 | | $ 83,222 | 4.28% |
| Post-Spray Ops | | | 31,144 | 4,263 | | $ 35,407 | 1.82% |
| Spray Campaign | | | 60,452 | 398,562 | 6,927 | $ 465,941 | 23.95% |
| Spray Planning | 28,046 | | 93,928 | 127,450 | 35,093 | $ 284,517 | 14.62% |
| **Grand Total** | **$ 213,507** | **$ 248,764** | **$ 654,613** | **$ 585,079** | **$ 243,640** | **$ 1,945,605** | **100%** |

Table NG2 displays the Nigeria IRS program total capital and recurrent expenditures, and excludes the start-up costs. 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 costs in the above table.

**FIGURE NG3: NIGERIA IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

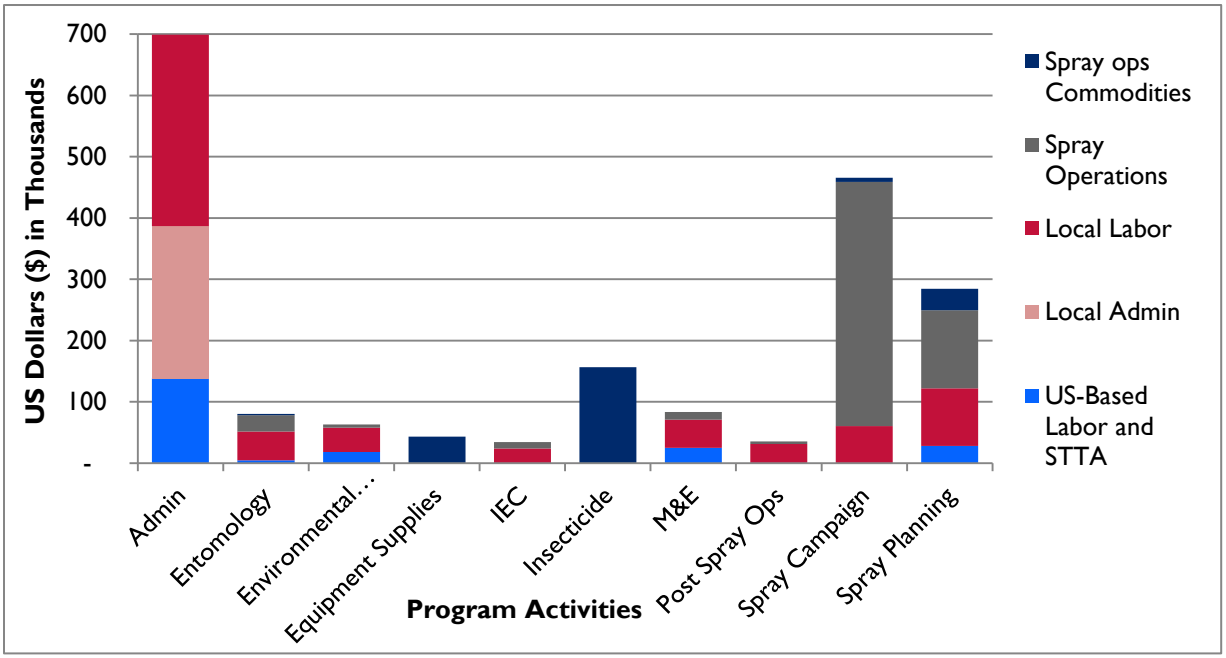



Figure NG3 shows fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The administration activity is the most expensive, but about two-thirds of its cost consists of labor, both local staff labor and U.S.-based. About half of the total local staff labor expenditures were captured under the Administrative activity, compared to other AIRS country programs where local labor was spread more evenly across all activities. Note that the 'U.S.-based Labor and STTA' expenditures are largely incurred under the administrative and M&E program activities, while 'Local Labor' is spread more evenly across a majority of activities. Spray planning and spray operations are the other high-cost items. The cost of insecticide is low in Nigeria compared to other country programs because the program used pyrethroid insecticide, as well as because of the small size of the spray campaign.

**FIGURE NG4: NIGERIA IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

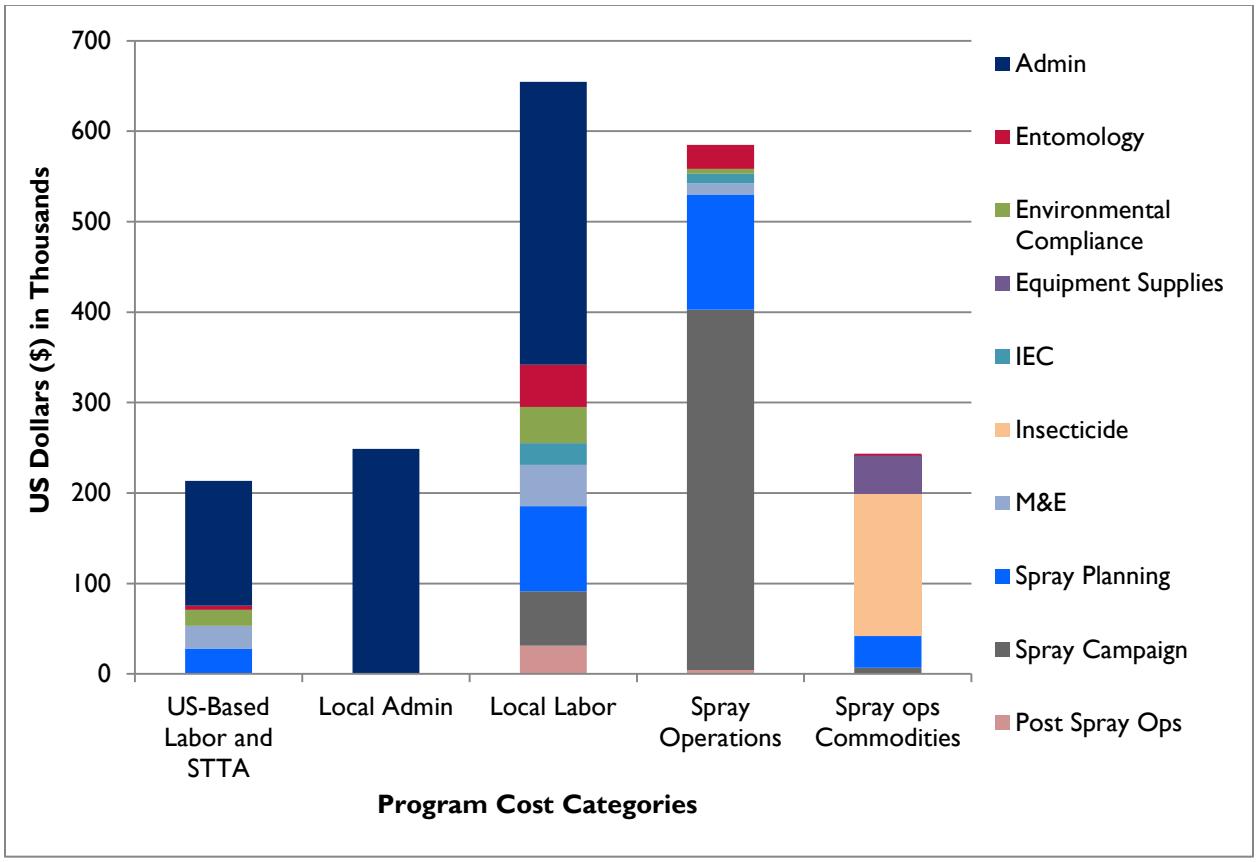



Figure NG4 contains the same information as Figure NG3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This shows that local administrative costs and U.S.-based labor and STTA are minimal compared to expenditures related to local labor and technical spray operations.

## 13.3 Unit Cost Analysis

This section presents the Nigeria IRS program's capital and recurrent expenditures as unit costs: per structure sprayed, per 100 m² sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 m² was added as a more standardized unit to allow for cross-country comparison.

**FIGURE NG5: NIGERIA IRS UNIT COSTS, BY ACTIVITY**

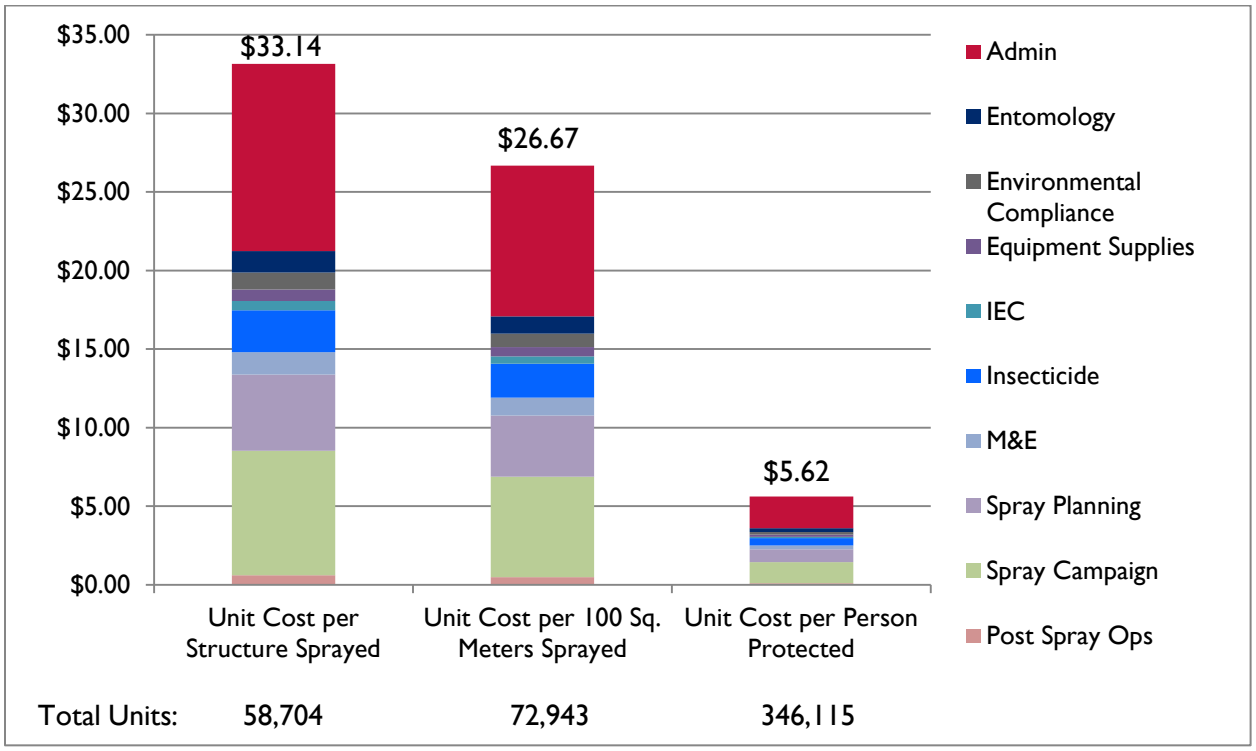
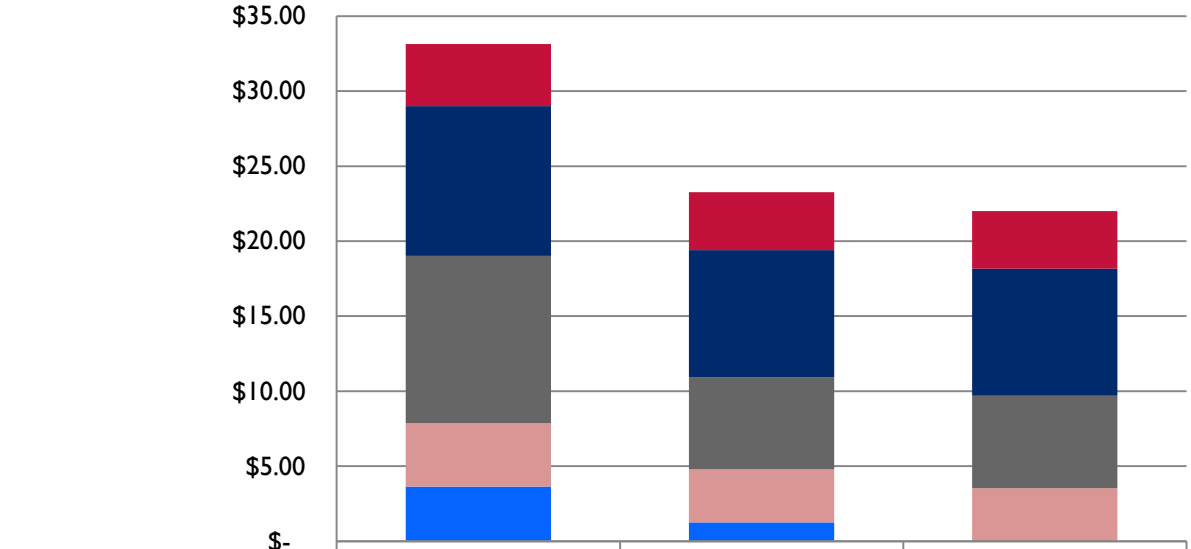



Figure NG5 illustrates the Nigeria IRS fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, IEC, EC, and M&E, have only a minor impact on the unit cost. Administration and spray operations are the largest cost drivers. Keep in mind that Figure NG3 showed that about two-thirds of the costs under the administration activity consisted of labor.

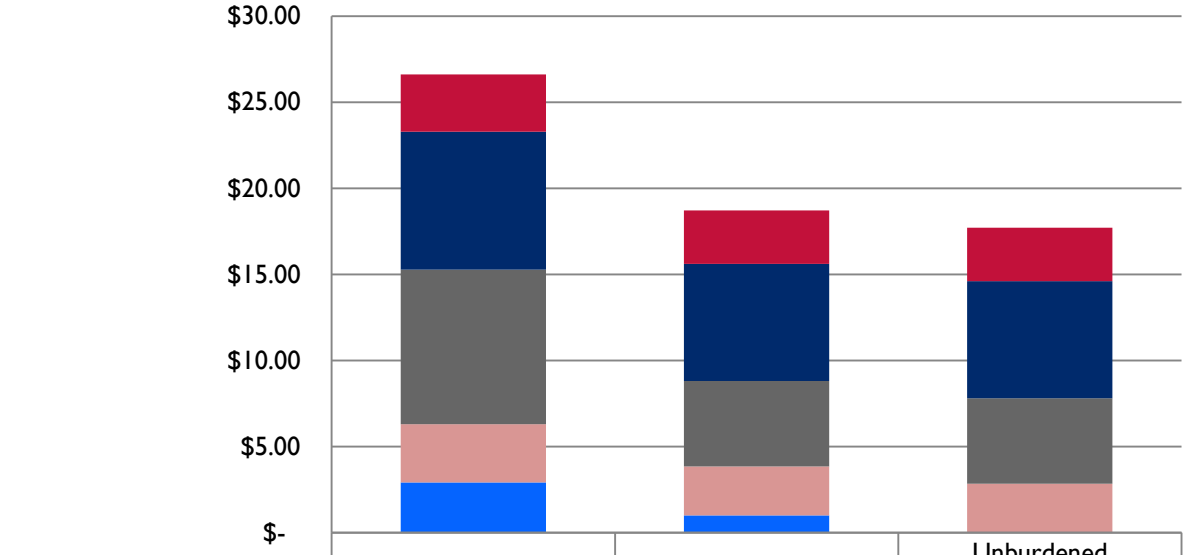
**FIGURE NG6: NIGERIA IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $4.15 | $3.85 | $3.85 |
| Spray Ops | $9.97 | $8.47 | $8.47 |
| Local Labor | $11.15 | $6.15 | $6.15 |
| Local Admin | $4.24 | $3.55 | $3.55 |
| US-Based Labor and STTA | $3.64 | $1.25 | $- |
| Total | $33.14 | $23.26 | $22.01 |

The Nigeria IRS program sprayed 58,704 structures during the 2012 spray campaign. Figure NG6 shows the unit costs per structure sprayed burdened ($33.14), unburdened, ($23.26), and unburdened without U.S. labor ($22.01), itemized by cost category. In terms of cost categories, the largest cost driver is local labor, followed by spray operations. In contrast to the preceding figure, the local administration cost category excludes labor expenses (both local staff and US-based staff), and both local administration and U.S.-based labor make up less than 24 percent of the total burdened unit cost. The unburdened unit cost excludes implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $11.13 or 34 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for half of the total "cost of burden."

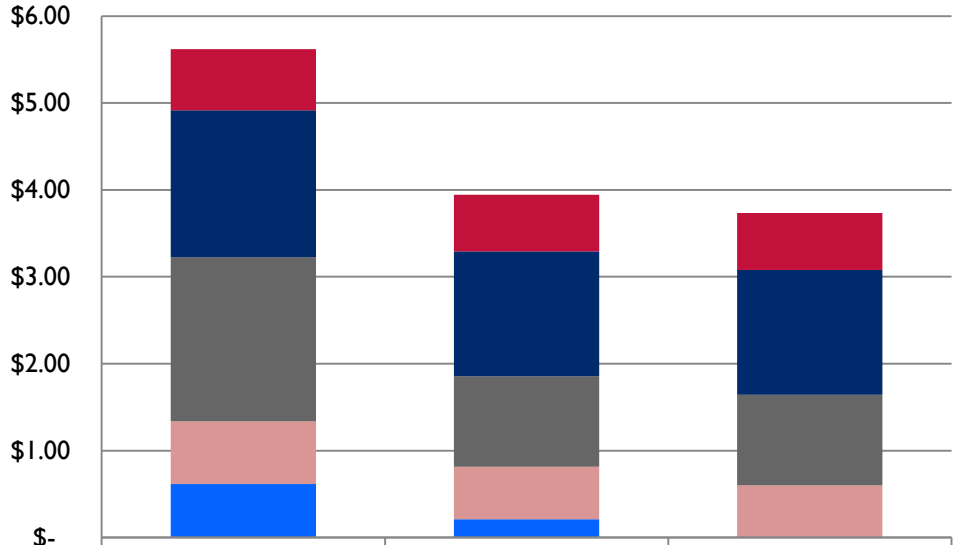
**FIGURE NG7: NIGERIA IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $3.31 | $3.10 | $3.10 |
| Spray Ops | $8.02 | $6.81 | $6.81 |
| Local Labor | $8.97 | $4.95 | $4.95 |
| Local Admin | $3.37 | $2.85 | $2.85 |
| US-Based Labor and STTA | $2.93 | $1.00 | $- |
| Total | $26.61 | $18.72 | $17.72 |

Figure NG7 shows the unit costs per 100 square meters sprayed burdened ($26.61), unburdened ($18.72), and unburdened without U.S.-based labor ($17.72), itemized by cost category. The Nigeria spray campaign used 29,177 sachets of insecticide to cover 7,294,250 m² of structure area. Thus, the average size of the structures sprayed in Nigeria was 124.3 m². This report looks at the unit cost of 100 m² sprayed, which covers about four-fifths of a structure in Nigeria. The Nigeria unit cost per 100 m² sprayed is about four-fifths as much as the unit cost per structure sprayed. Using the unit of measure per 100 m², however, along with the contextual information of the average size of structures in Nigeria, allows for a more accurate comparison to other country program costs.

**FIGURE NG8: NIGERIA IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $0.70 | $0.65 | $0.65 |
| Spray Ops | $1.69 | $1.44 | $1.44 |
| Local Labor | $1.89 | $1.04 | $1.04 |
| Local Admin | $0.72 | $0.60 | $0.60 |
| US-Based Labor and STTA | $0.62 | $0.21 | $- |
| Total | $5.62 | $3.95 | $3.73 |

As noted in the Background section, the Nigeria IRS spray campaign in 2012 protected 346,115 people from malaria transmission. Figure NG8 shows the unit costs per person protected burdened ($5.62), unburdened ($3.95), and unburdened without U.S.-based labor ($3.73), itemized by cost category. The categories driving the unit cost include local labor (largest) and spray operations. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of Nigeria IRS program costs, as delivered by the implementing partner, adds $1.89 to the unit cost per person protected.

# 14. RWANDA

## 14.1 BACKGROUND

In Rwanda, IRS campaigns were funded through PMI for five years prior to the start of the AIRS project. In 2012, the Rwanda IRS program targeted 240,000 structures located in three districts: Bugesera, Gisagara, and Nyagatare. The full spray campaign took place over a total of 30 days between August and October. The pyrethroid insecticide deltamethrin was procured by the country's government. Next year, in 2013, Rwanda will be implementing two spray campaign rounds in the same area using carbamate insecticide, which will increase the overall cost of the program.

Unfortunately, at the start of the 2012 Rwanda spray campaign, one of the spray operators passed away, and the program halted operations immediately. The AIRS project was cleared one month later to continue spraying, but the delay increased the costs of the program.

**TABLE RW1: RWANDA QUICK FACTS**

| | |
|---|---|
| # Local Staff | 16 |
| Spray Start Dates | August 21, 2012-<br>September 17, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 166,261 |
| # People Protected | 652,777 |
| # Structures Sprayed | 236,610 |
| # 100 Square Meters Sprayed | 415,652 |
| Average Size of Structure | 175.7 sq. meters* |

* 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 RESULTS

This section presents the Rwanda IRS program's total expenditures for both program start-up operations (August 11, 2011–February 29, 2012), as well as the first year of program implementation under AIRS (March 1, 2012–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE RW1: RWANDA IRS TOTAL EXPENDITURES**

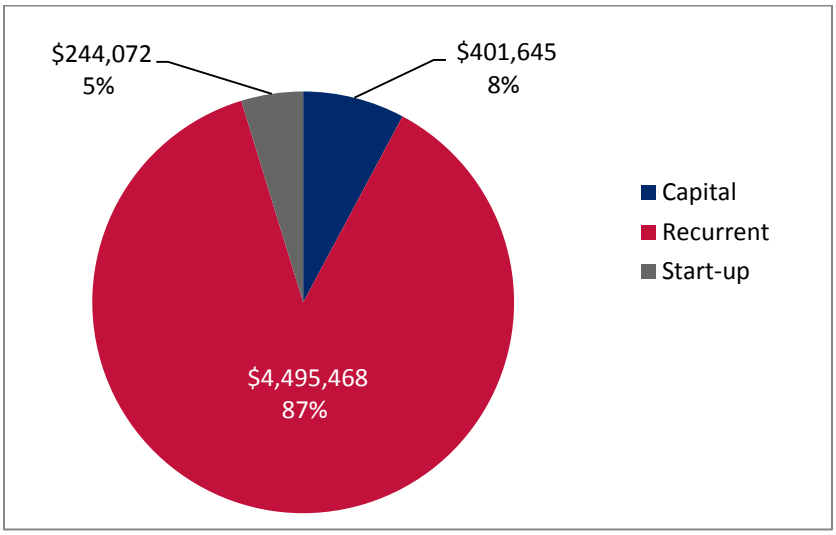



Figure RW1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 87 percent of total project expenditures are recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $1,284,368 of the capital and recurrent costs were inherited (about half of this cost consists of the insecticide procurement), and the price of these items was supplied through the inventory disposition list or estimated using the number of insecticide sachets.

**FIGURE RW2: RWANDA IRS START-UP EXPENDITURES, BY BURDEN TYPE**

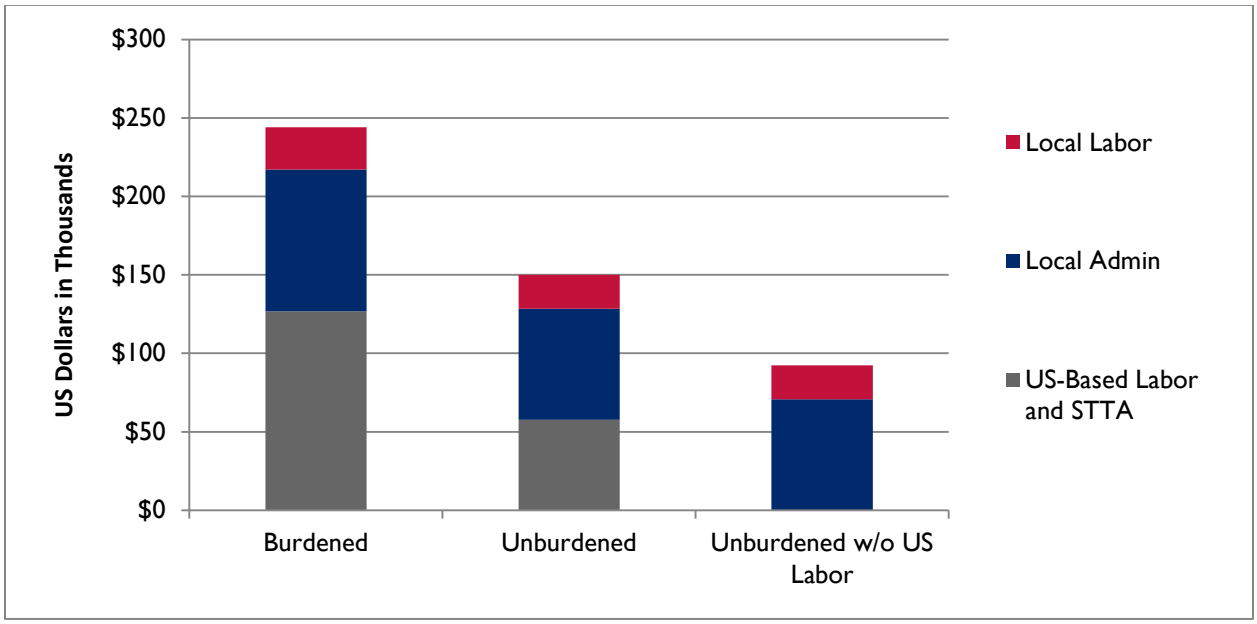



Figure RW2 displays the Rwanda IRS program start-up expenditures only, which include activities such as country scoping, technical information gathering, and hiring. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. About 63 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is a highly burdened portion of the total project costs, as is to be expected. As mentioned before, total start-up expenditures ($244,072) are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

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

| Activities | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 163,633 | 586,075 | 440,551 | | | $ 1,190,259 | 24.3% |
| Entomology | 5,748 | | 137,627 | 72,915 | | $ 216,290 | 4.4% |
| EC | 34,130 | | 34,577 | 38,697 | | $ 107,404 | 2.2% |
| Equipment Supplies | 160 | | 3,221 | 3,524 | 418,442 | $ 425,347 | 8.7% |
| IEC | | | 17,220 | 1,707 | | $ 18,927 | 0.4% |
| Insecticide | | | | | 856,088 | $ 856,088 | 17.4% |
| M&E | 44,964 | | 49,534 | 4,655 | | $ 99,153 | 2.0% |
| Post-Spray Ops | | | | 17,377 | | $ 17,377 | 0.4% |
| Spray Campaign | 516 | | | 1,506,120 | | $ 1,506,636 | 30.8% |
| Spray Planning | 1,554 | | 129,608 | 328,469 | | $ 459,631 | 9.4% |
| **Grand Total** | **$ 250,705** | **$ 586,075** | **$ 812,338** | **$ 1,973,464** | **$ 1,274,531** | **$ 4,897,113** | **100%** |

Table RW2 displays the Rwanda IRS program total capital and recurrent expenditures, and excludes the start-up costs. 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 costs in the above table.

**FIGURE RW3: RWANDA IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

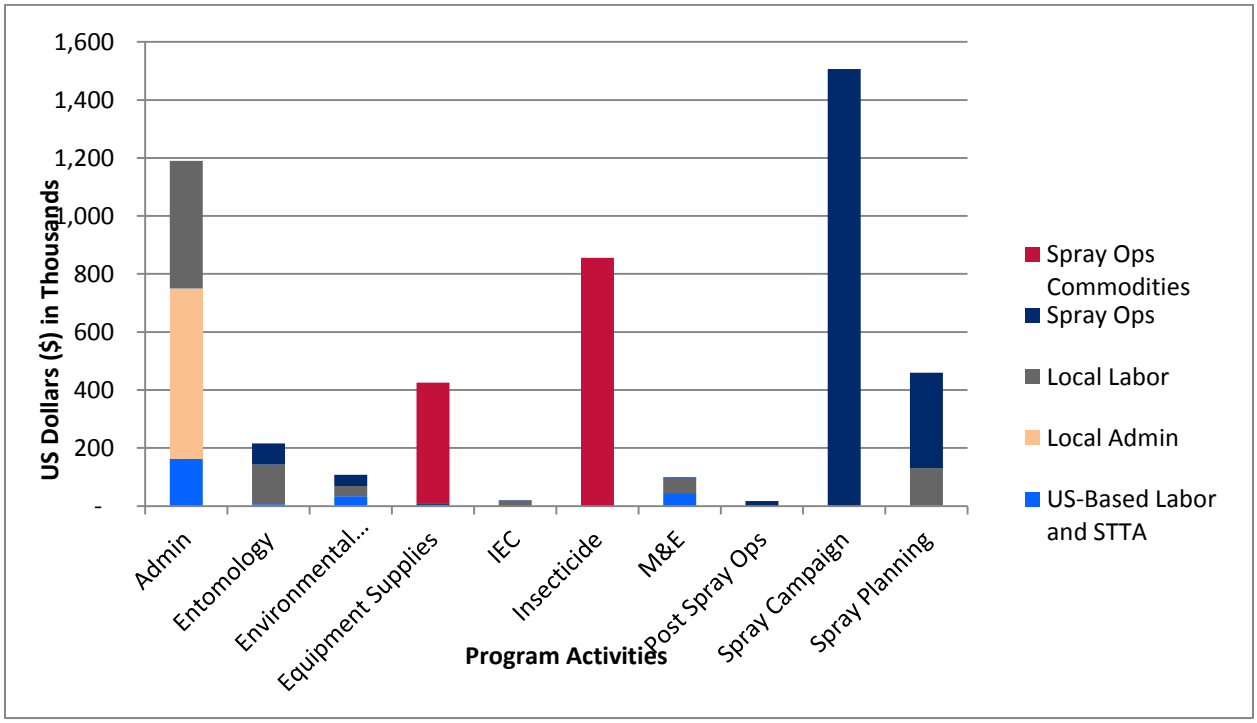



Figure RW3 shows fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The implementation of the spray campaign is the most expensive activity, followed by local administration as the second largest activity cost, half of which 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. Much of 'Local Labor' is also included in administration, but it is more evenly spread across a majority of activities than is U.S.-based labor.

**FIGURE RW4: RWANDA PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY**

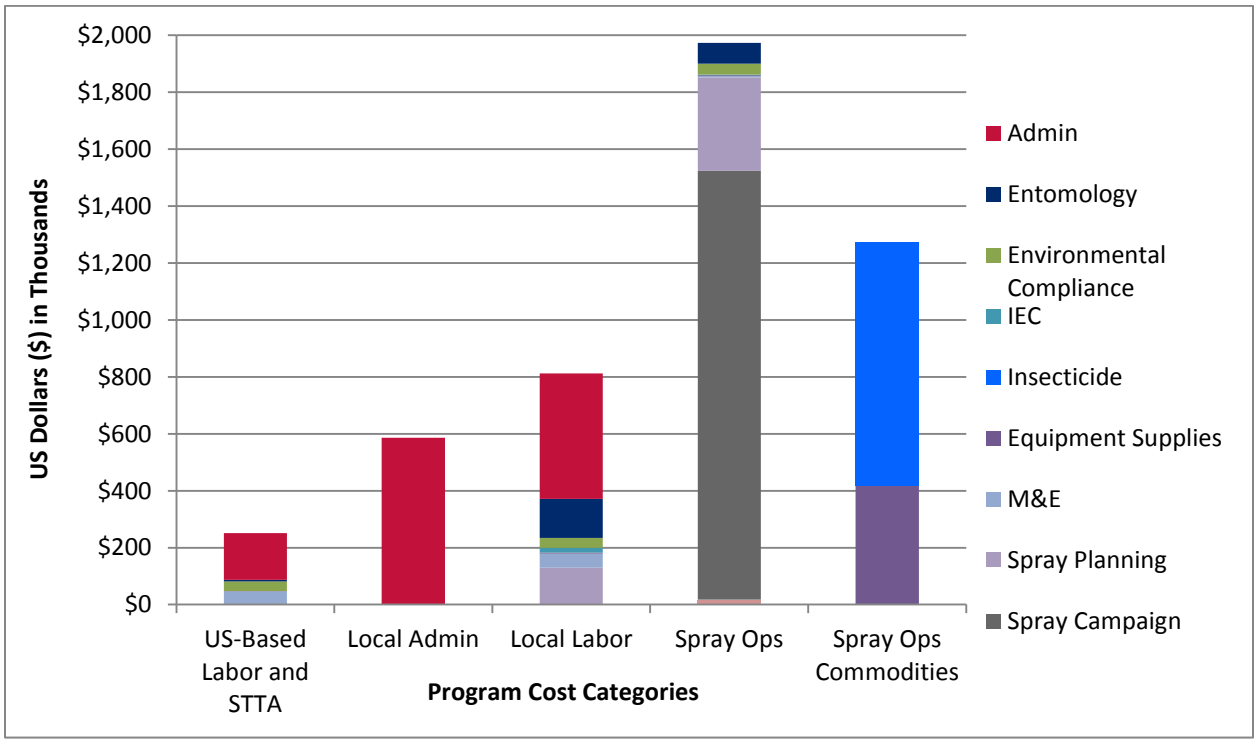



Figure RW4 contains the same information as Figure RW3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs and U.S.-based labor and STTA are minimal compared to expenditures related to the technical operations, and also, to lesser degree, local labor and spray commodities.

## 14.3 Unit Cost Analysis

This section presents Rwanda IRS program capital and recurrent expenditures as unit costs: per structure sprayed, per 100 $m^2$ sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 $m^2$ was added as a more standardized unit to allow for cross-country comparison.

**FIGURE RW5: RWANDA IRS UNIT COSTS, BY ACTIVITY**

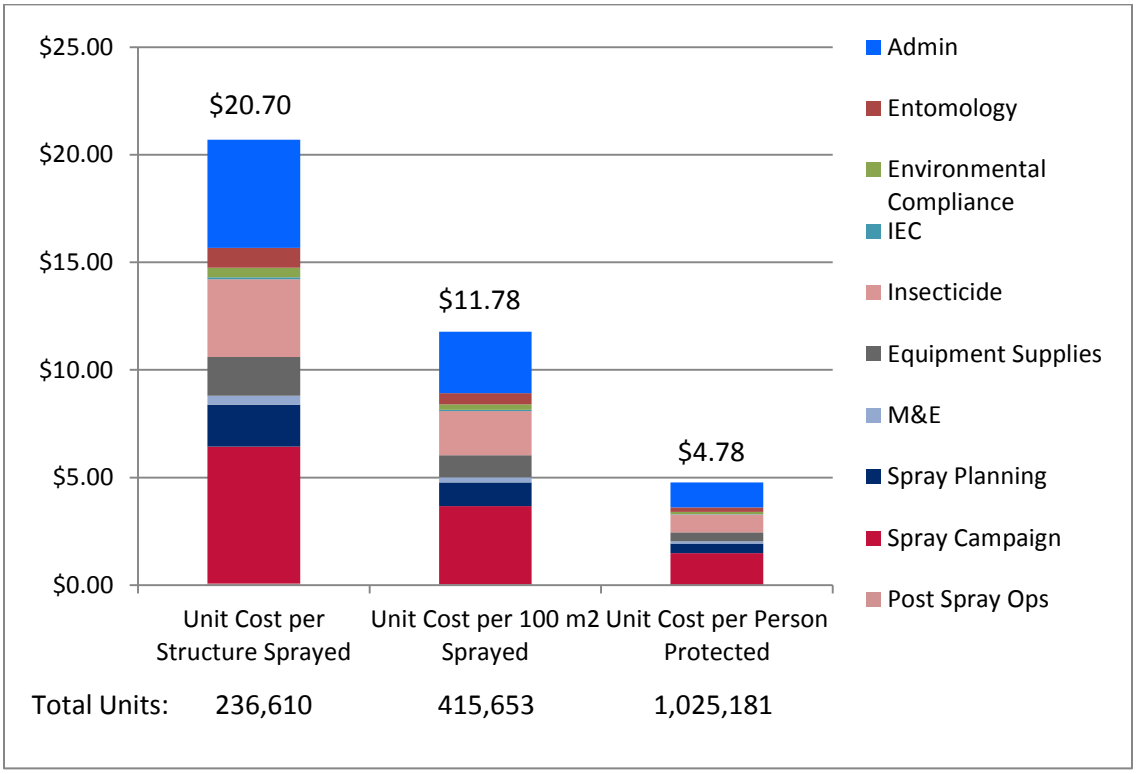
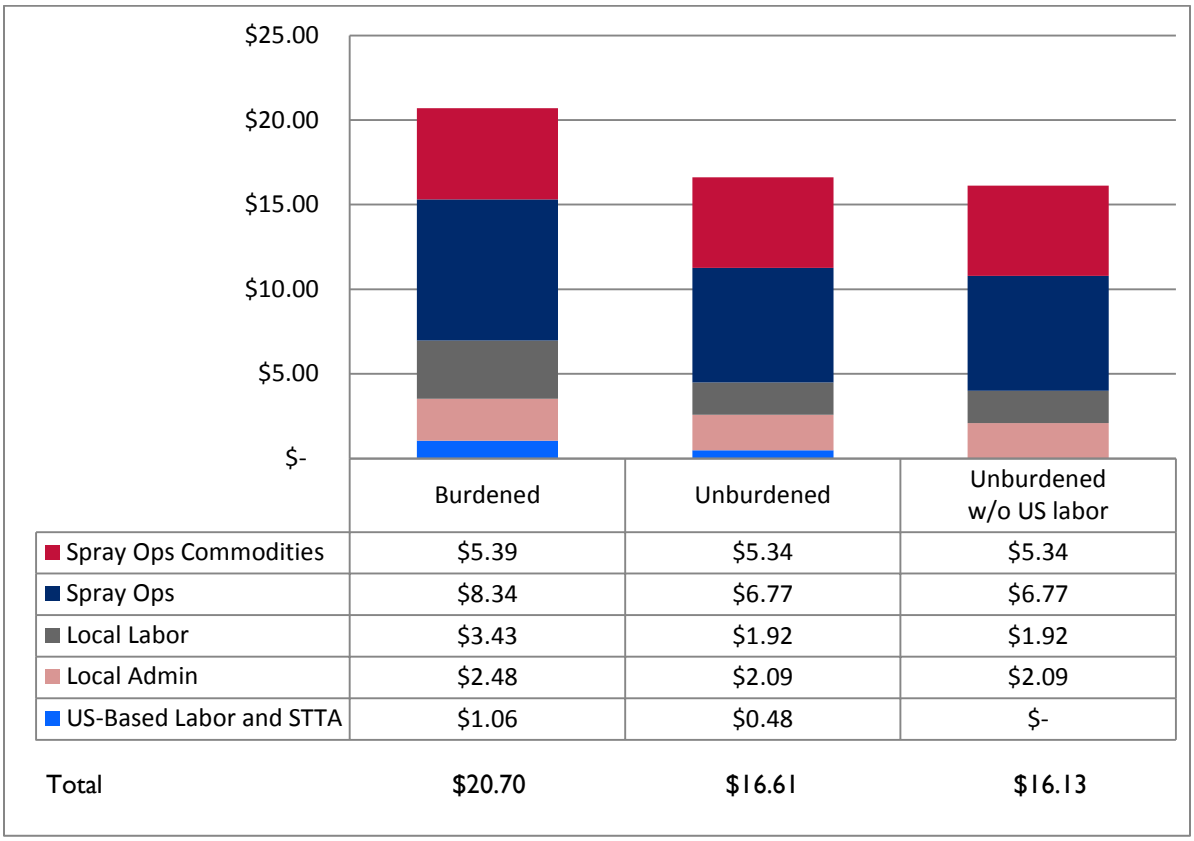



Figure RW5 illustrates the Rwanda IRS program fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. It shows that the activities supporting the quality and effectiveness of the spray program, such as entomology, IEC, EC and M&E, have only a minor impact on the unit cost. On the other hand, the spray campaign is the largest cost driver, followed closely by administration. Keep in mind that Figure RW3 showed that half of the costs under the administration activity consisted of labor.

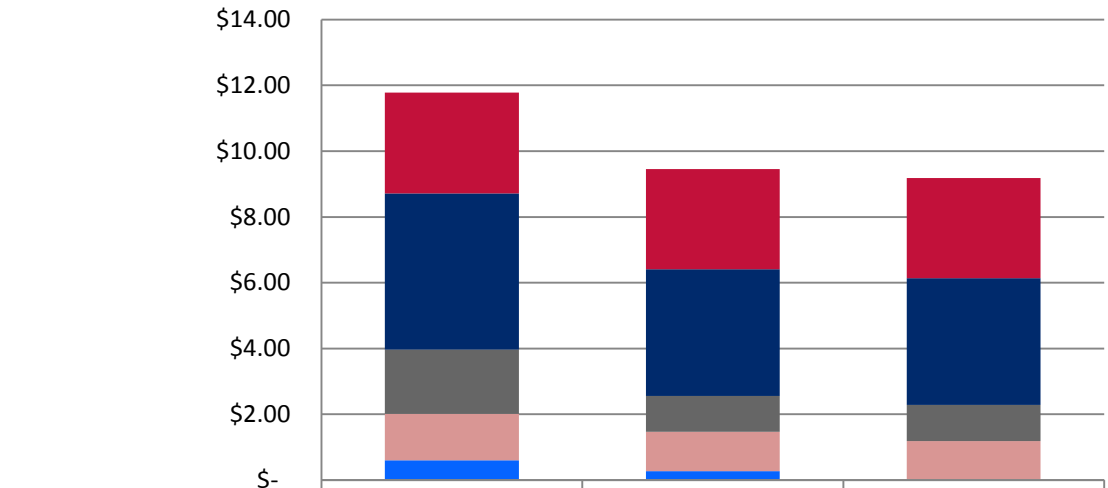
**FIGURE RW6: RWANDA IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $5.39 | $5.34 | $5.34 |
| Spray Ops | $8.34 | $6.77 | $6.77 |
| Local Labor | $3.43 | $1.92 | $1.92 |
| Local Admin | $2.48 | $2.09 | $2.09 |
| US-Based Labor and STTA | $1.06 | $0.48 | $- |
| Total | $20.70 | $16.61 | $16.13 |

The Rwanda program sprayed 236,610 structures during the 2012 spray campaign. Figure RW6 shows the unit costs per structure sprayed burdened ($20.70), unburdened ($16.61), and unburdened without U.S. labor ($16.13), itemized by cost category. In terms of cost categories, the largest cost driver is spray operations, followed by spray commodities and local labor. In contrast to the preceding figure, the local administration cost category excludes labor expenses (both local staff and US-based staff), and both local administration and U.S.-based labor make up less than 20 percent of the total burdened unit cost. The unburdened unit cost excludes implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management and administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $4.57, or about 22 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for one third of the total "cost of burden."

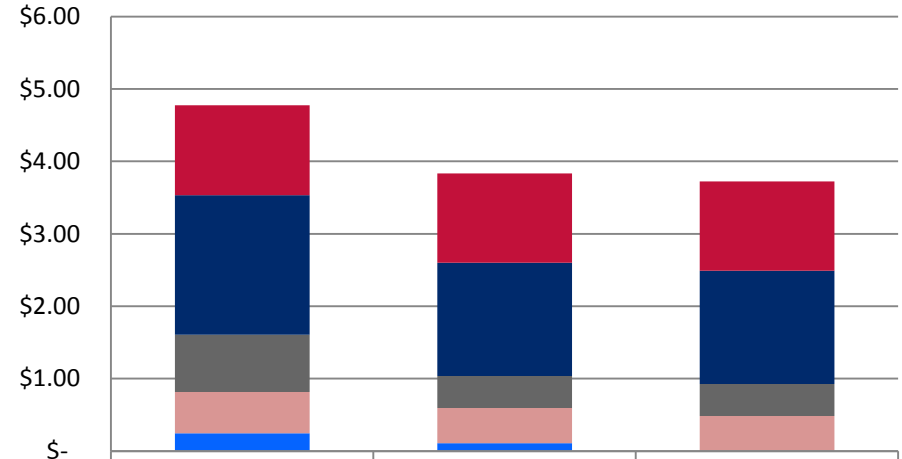
**FIGURE RW7: RWANDA IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $3.07 | $3.04 | $3.04 |
| Spray Ops | $4.75 | $3.86 | $3.86 |
| Local Labor | $1.95 | $1.09 | $1.09 |
| Local Admin | $1.41 | $1.19 | $1.19 |
| US-Based Labor and STTA | $0.60 | $0.28 | $- |
| Total | **$11.78** | **$9.46** | **$9.18** |

Figure RW7 shows the unit costs per 100 square meters sprayed burdened ($11.78), unburdened ($9.46), and unburdened without U.S.-based labor ($9.18), itemized by cost category. The Rwanda spray campaign used 166,261 sachets of insecticide to cover 41,565,250 m² of structure area. Thus, the average size of the structures sprayed in Rwanda was 175.7 m². This report looks at the unit cost of 100 m² sprayed, which covers just over half of a structure in Rwanda. The Rwanda unit cost per 100 m² sprayed is just over half as much as the unit cost per structure sprayed. Using the unit of measure per 100 m² sprayed, however, along with the contextual information of the average size of structures in Rwanda, allows for a more accurate comparison to other country program costs.

**FIGURE RW8: RWANDA IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $1.24 | $1.23 | $1.23 |
| Spray Ops | $1.92 | $1.56 | $1.56 |
| Local Labor | $0.79 | $0.44 | $0.44 |
| Local Admin | $0.57 | $0.48 | $0.48 |
| US-Based Labor and STTA | $0.24 | $0.11 | $- |
| Total | **$4.76** | **$3.81** | **$3.71** |

As noted in the Background section, the 2012 Rwanda spray campaign protected 1,025,181 people from malaria transmission. Figure RW8 shows the unit costs per person protected burdened ($4.78), unburdened ($3.83), and unburdened without U.S.-based labor ($3.72), itemized by cost category. The categories driving the unit cost include spray operations (largest), local labor, and spray commodities. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of AIRS Rwanda program costs, as delivered by the implementing partner, adds $1.05 to the unit cost per person protected.

# 15. SENEGAL

## 15.1 BACKGROUND

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 Richard Toll due to low malaria prevalence and growing resistance to pyrethroid and carbamate insecticides.

In 2012, the AIRS Senegal program sprayed six districts: Guinguinéo, Koungheul, Koumpentoum, Malem Hodar, Nioro, and Vélingara. Koungheul had never been sprayed previously, but it was selected in November 2011 by the Senegal IRS Steering Committee comprised of NMCP, PMI, UCAD, and National Hygiene Service representatives, 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 66 calendar days, 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 Université Cheikh Anta Diop (UCAD), and IEC activities were led by ChildFund Senegal.

**TABLE SN1: SENEGAL QUICK FACTS**

| | |
|---|---|
| # Local Staff | 14 |
| Spray Start Date | June 6, 2012 |
| # Spray Rounds | 1 |
| # Sachets Used | 106,874 |
| # People Protected | 1,095,093 |
| # Structures Sprayed | 306,916 |
| # 100 Square Meters Sprayed | 267,185 |
| Average Size of Structure | 87 $m^2$* |

* 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.

## 15.2 RESULTS

This section presents the Senegal IRS program's total expenditures for both program start-up operations (August 11, 2011–December 31, 2011), as well as the first year of program implementation under the AIRS project (January 1, 2012–December 31, 2012). 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 (start-up, capital, or recurrent), and by burden type.

**FIGURE SN1: SENEGAL IRS TOTAL EXPENDITURES**

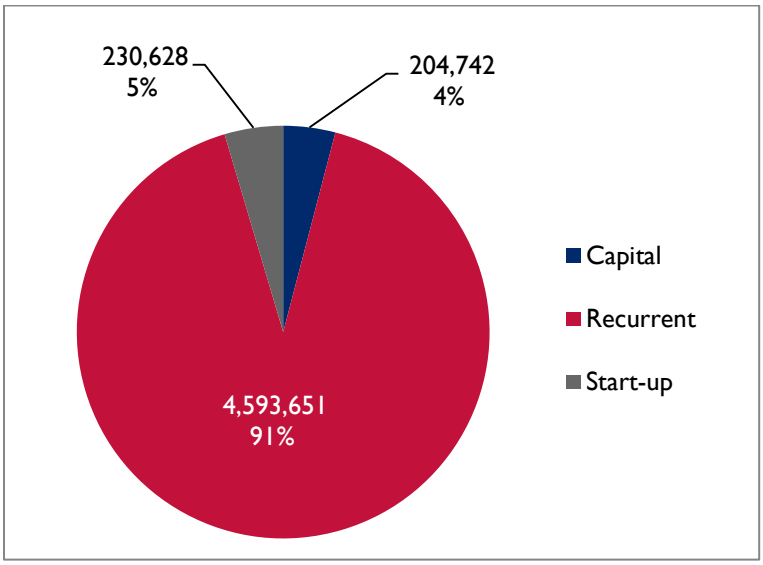



Figure SN1 shows the fully burdened cost of program expenditures, broken out by expenditure status. Start-up expenditures are a one-time project cost and will be analyzed separately from the program's implementation costs, which consist of the capital and recurrent expenditures. The figure illustrates that 91 percent of total project expenditures are recurrent costs. Note that the capital expenses included here are depreciated across the three years of the project. Out of the total program expenditures, about $293,400 of the capital and recurrent costs were inherited, and the price of these items was supplied through the inventory disposition list.

**FIGURE SN2: SENEGAL IRS START-UP EXPENDITURES, BY BURDEN TYPE**

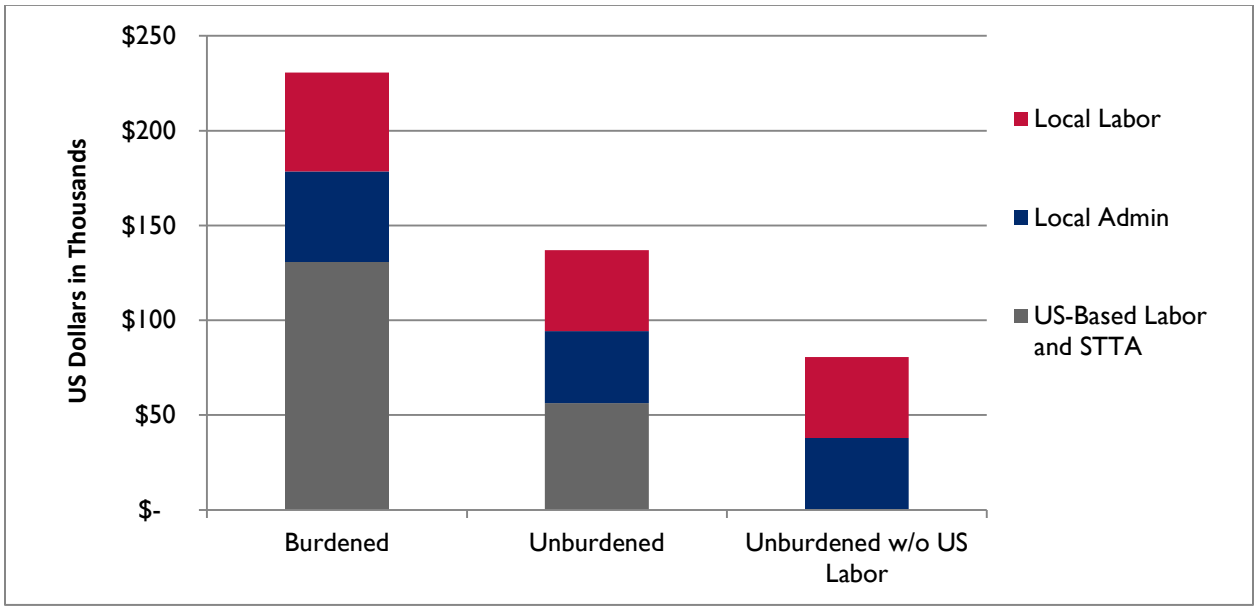



Figure SN2 displays the Senegal IRS program start-up expenditures only, which include activities such as country scoping, technical information gathering, recruitment and hiring, and office set-up. The figure separates burdened, unburdened, and unburdened without U.S.-based labor costs by program cost categories. About 80 percent of start-up expenditures are labor costs, both local and U.S.-based. As such, start-up is the most highly burdened portion of the total project costs. As mentioned before, start-up expenditures are treated as a one-time cost to the project, and are therefore not included in the program implementation analysis that follows.

**TABLE SN2: SENEGAL IRS CAPITAL AND RECURRENT TOTAL EXPENDITURES, BY ACTIVITY AND COST CATEGORY**

| Activity | U.S.-Based Labor and STTA | Local Admin | Local Labor | Spray Ops | Spray Ops Commodities | Grand Total | % of Total |
|---|---|---|---|---|---|---|---|
| Admin | 119,450 | 370,497 | 765,899 | | | $ 1,255,846 | 26.17% |
| Entomology | 338 | | 1,596 | 1,154 | | $ 3,088 | 0.06% |
| Environmental Compliance | 10,953 | | 51,187 | 13,314 | | $ 75,454 | 1.57% |
| Equipment Supplies | 799 | | 16,696 | | 232,656 | $ 250,151 | 5.21% |
| IEC | | | 27,586 | 1,836 | | $ 29,422 | 0.61% |
| Insecticide | | | | 10,695 | 1,349,513 | $ 1,360,208 | 28.35% |
| M&E | 20,179 | | 54,839 | 6,671 | | $ 81,689 | 1.71% |
| Post-Spray Ops | 2,151 | | 55,251 | 64,438 | | $ 121,840 | 2.54% |
| Spray Campaign | 3,052 | | 55,773 | 1,105,588 | 31,621 | $ 1,196,033 | 24.93% |
| Spray Planning | | | 59,902 | 364,760 | | $ 424,662 | 8.85% |
| **Grand Total** | **$ 156,922** | **$ 370,497** | **$1,088,729** | **$1,568,456** | **$ 1,613,790** | **$ 4,798,394** | **100%** |

Table SN2 displays the Senegal IRS program total capital and recurrent expenditures, and excludes the start-up costs. 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 costs in the above table.

**FIGURE SN3: SENEGAL IRS ACTIVITY EXPENDITURES, BY COST CATEGORY**

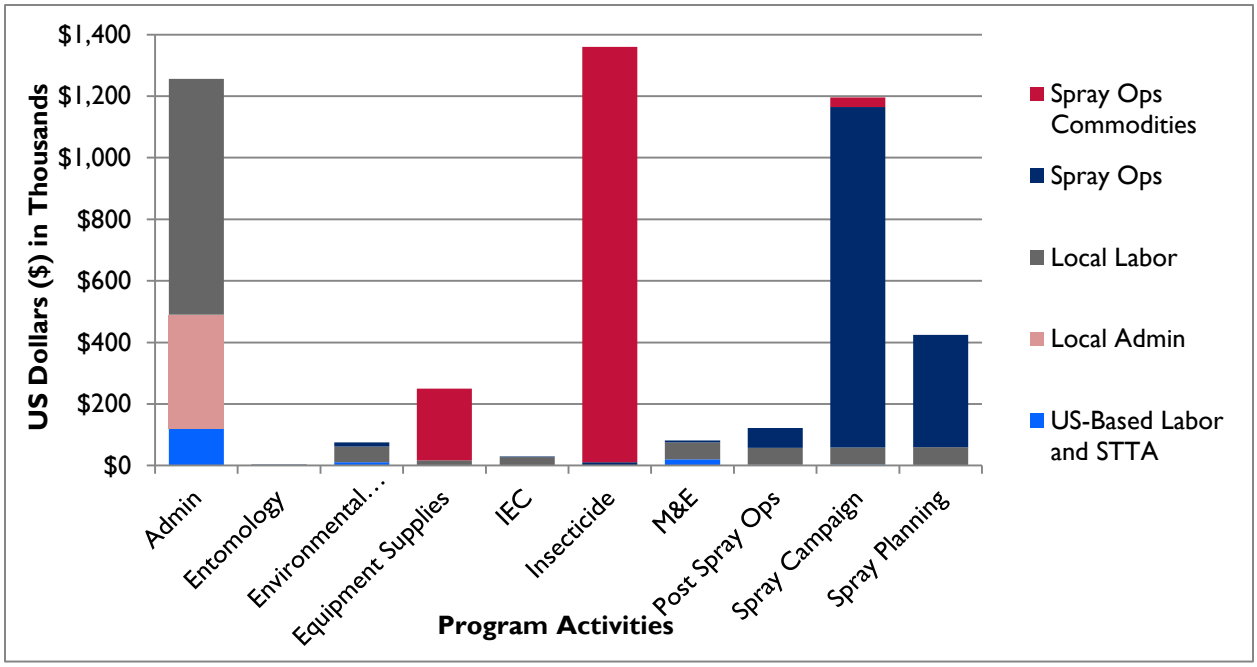



Figure SN3 shows fully burdened capital and recurrent costs, but provides a more nuanced depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticide, implementation of the spray campaign, and administration are the most expensive activities. The total cost for administration is the second largest activity cost, but over 70 percent of this cost consists of labor, both local and U.S.-based. Entomology does not show any costs, as these activities were all implemented by UCAD. IEC also shows low costs given that these activities were led by ChildFund Senegal. Note that the 'U.S.-based Labor and STTA' expenditures are largely incurred under the administrative and M&E program activities, while 'Local Labor' is spread more evenly across a majority of activities.

**FIGURE SN4: SENEGAL IRS COST CATEGORY EXPENDITURES, BY ACTIVITY**

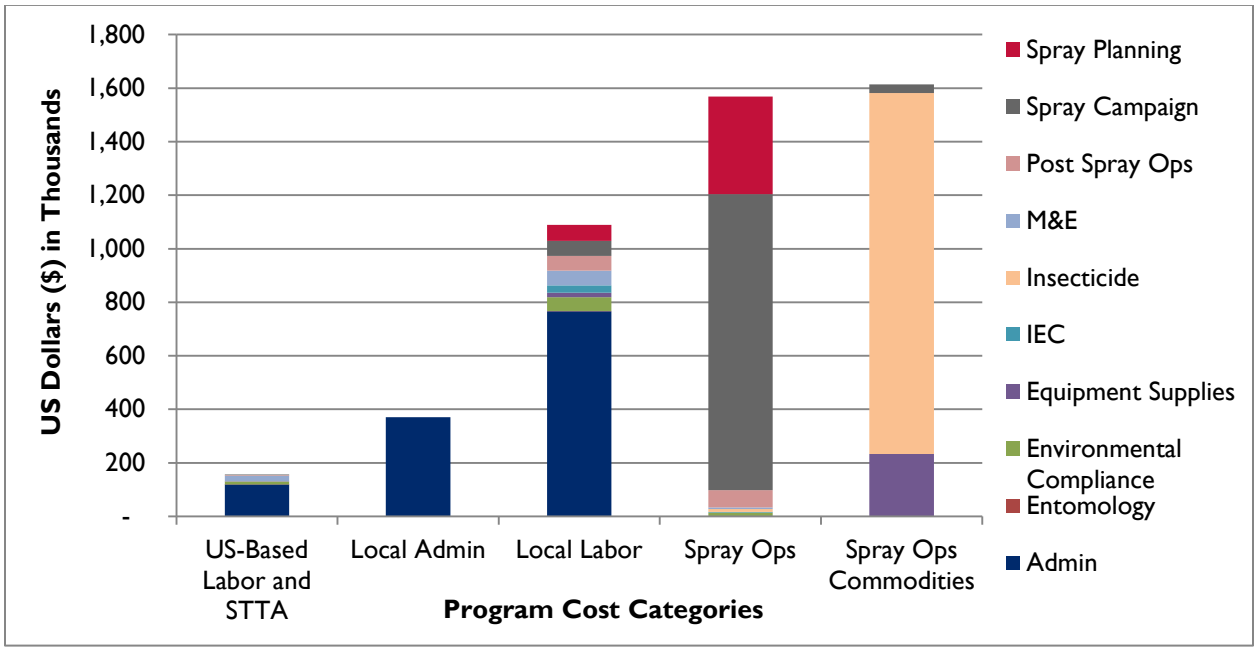



Figure SN4 contains the same information as Figure SN3, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that local administrative costs and U.S.-based labor and STTA are minimal compared to expenditures related to local labor, technical operations, and commodities.

## 15.3 Unit Cost Analysis

This section presents the Senegal IRS program capital and recurrent expenditures as unit costs: per structure sprayed, per 100 m² sprayed, and per person protected. While unit costs per structure and per person may be more relevant for analysis at the country level, the unit cost per 100 m² was added as a more standardized unit to allow for cross-country comparison.

**FIGURE SN5: SENEGAL IRS UNIT COSTS, BY ACTIVITY**

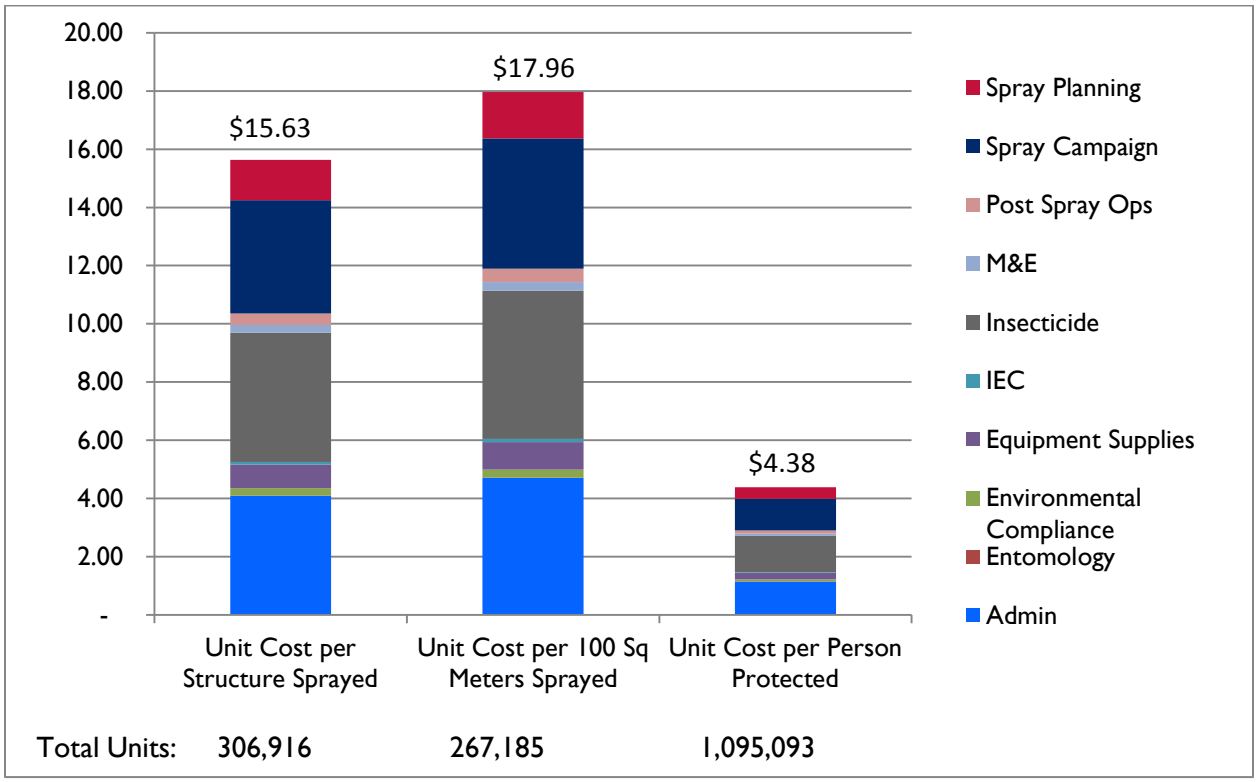
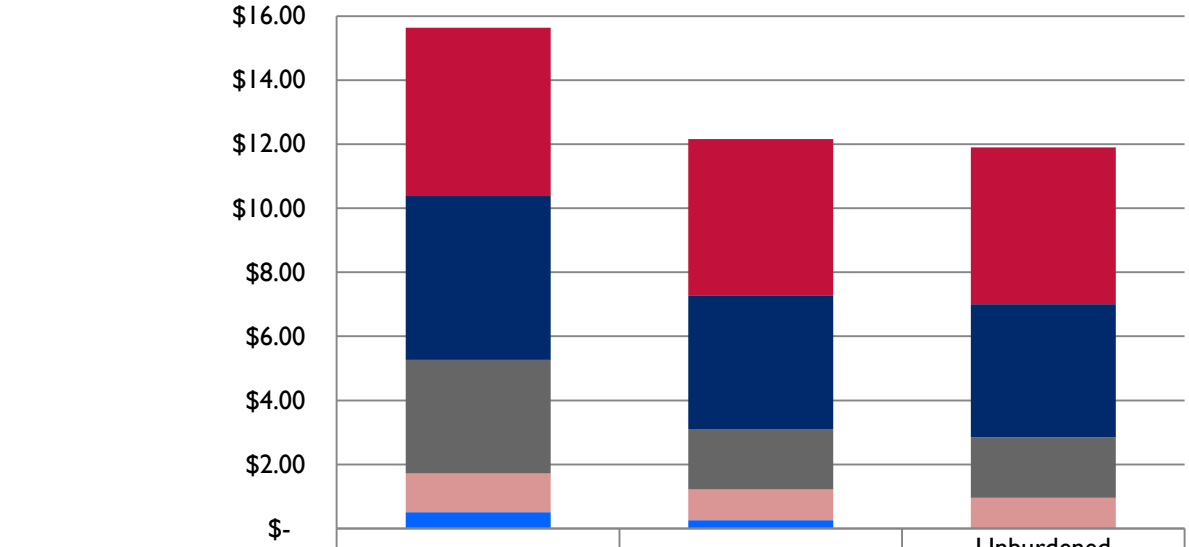



Figure SN5 illustrates the Senegal IRS fully burdened capital and recurrent expenditures in all three unit costs, broken down by program activity. Insecticide is the largest cost driver, followed closely by the spray campaign and administration. Peripheral activities that add to the quality of the program, such as M&E, have a minor impact on the unit cost. Keep in mind that Figure SN3 showed that over two-thirds of the costs under the administration activity consisted of labor.

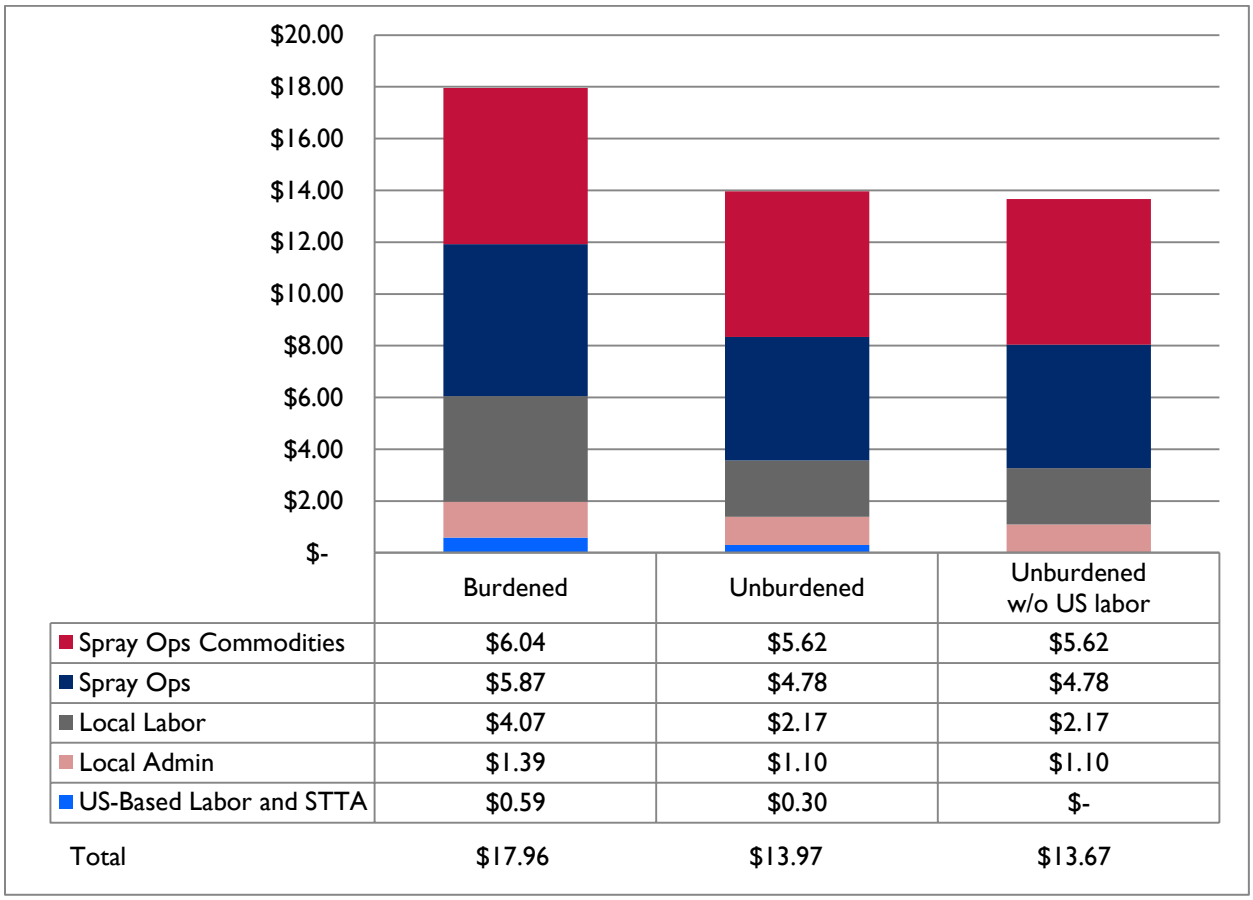
**FIGURE SN6: SENEGAL IRS UNIT COST PER STRUCTURE SPRAYED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $5.26 | $4.89 | $4.89 |
| Spray Ops | $5.11 | $4.16 | $4.16 |
| Local Labor | $3.55 | $1.89 | $1.89 |
| Local Admin | $1.21 | $0.96 | $0.96 |
| US-Based Labor and STTA | $0.51 | $0.26 | $- |
| Total | $15.63 | $12.16 | $11.90 |

The Senegal IRS program sprayed 306,916 structures during the 2012 spray campaign. Figure SN6 shows the unit costs per structure sprayed burdened ($15.63), unburdened ($12.16), and unburdened without U.S. labor ($11.90), itemized by cost category. In terms of cost categories, the largest cost driver is spray operations, followed by spray commodities and local labor. In contrast to the preceding figure, the local administration cost category excludes labor expenses (both local staff and US-based staff labor). Together, local administration and U.S.-based labor make up about 33 percent of the total burdened unit cost. The unburdened unit cost excludes implementing partner overhead and fringe benefits costs. The unburdened without U.S.-based labor unit cost also excludes all U.S.-based labor for management, administration, as well as STTA trips. The unit cost difference between the fully burdened unit cost and the unburdened without U.S.-based labor unit cost is $3.73, or 24 percent of the total unit cost. The difference between the burdened and unburdened unit costs, the "cost of burden," is largely driven by local staff labor, which accounts for almost half of the total "cost of burden."

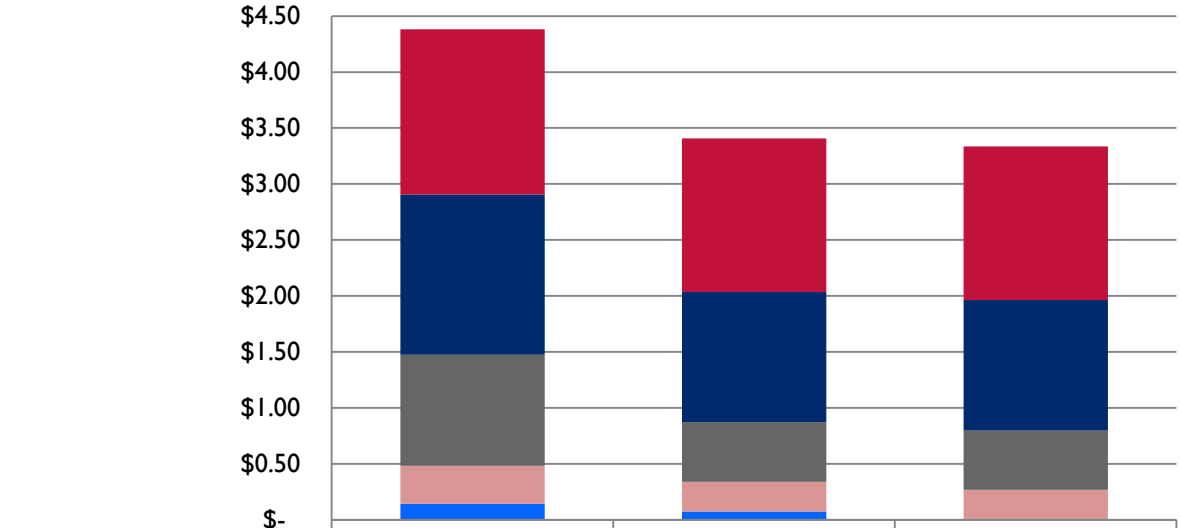
**FIGURE SN7: SENEGAL IRS UNIT COST PER 100 M² SPRAYED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $6.04 | $5.62 | $5.62 |
| Spray Ops | $5.87 | $4.78 | $4.78 |
| Local Labor | $4.07 | $2.17 | $2.17 |
| Local Admin | $1.39 | $1.10 | $1.10 |
| US-Based Labor and STTA | $0.59 | $0.30 | $- |
| Total | $17.96 | $13.97 | $13.67 |

Figure SN7 shows the unit costs per 100 m² sprayed burdened ($17.96), unburdened ($13.97), and unburdened without U.S.-based labor ($13.67), itemized by cost category. The Senegal spray campaign used 106,874 sachets of insecticide to cover 26,718,500 m² of structure area. Thus, the average size of the structures sprayed in Senegal was 87 m². This report looks at the unit cost of 100 m² sprayed, which covers just over one full structure in Senegal. The Senegal unit cost per 100 m² sprayed is $2.33 more expensive than the unit cost per structure sprayed. Using the unit of measure per 100 m², however, along with the contextual information of the average size of structures in Senegal, allows for a more accurate comparison to other country program costs.

**FIGURE SN8: SENEGAL IRS UNIT COST PER PERSON PROTECTED, BY COST CATEGORY AND BURDEN TYPE**




| | Burdened | Unburdened | Unburdened w/o US labor |
|---|---|---|---|
| Spray Ops Commodities | $1.47 | $1.37 | $1.37 |
| Spray Ops | $1.43 | $1.17 | $1.17 |
| Local Labor | $0.99 | $0.53 | $0.53 |
| Local Admin | $0.34 | $0.27 | $0.27 |
| US-Based Labor and STTA | $0.14 | $0.07 | $- |
| Total | $4.37 | $3.41 | $3.34 |

As noted in the Background section, the Senegal 2012 spray campaign protected 1,095,093 people from malaria transmission. Figure SN8 shows the unit costs per person protected burdened ($4.37), unburdened ($3.41), and unburdened without U.S.-based labor ($3.34), itemized by cost category. The categories driving the unit cost include spray commodities (largest), spray operations, and local labor. This unit cost is further broken out by burdened costs, unburdened costs, and unburdened costs without U.S. labor. Therefore, the burdened portion of IRS Senegal program costs, as delivered by the implementing partner, adds $1.03 to the unit cost per person protected.