PMI IRS COUNTRY PROGRAMS: 2014 COMPARATIVE COST ANALYSIS

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Abt Associates Inc. 1 4550 Montgomery Avenue 1 Suite 800 North
1 Bethesda, Maryland 20814 1 T. 301.347.5000 1 F. 301.913.9061
1 www.abtassociates.com

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ACRONYMS

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

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EXECUTIVE SUMMARY

The President's Malaria Initiative (PMI) began implementing indoor residual spraying (IRS) programs in 2006, with a goal of reducing the incidence and prevalence of malaria. The PMI-funded Africa Indoor Residual Spraying (AIRS) Project has provided program support and implementation of IRS activities since August 2011. This report presents the cost analysis of the expenses incurred during 2014, the third year of PMI AIRS Project implementation and compares these costs to IRS costs from the first two years of the PMI AIRS Project.

The aim of the assessment is to:

1. Evaluate the overall level of IRS spending in each of the PMI AIRS countries, by program activity and by cost category;
2. Calculate and compare the unit costs of IRS in each country, including the cost per person protected, cost per structure sprayed, and cost per area sprayed (in units of 100 m^2);
3. Provide cost comparisons for overall annual expenditure trends within countries over the first three years of the analysis.

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

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

1. *Collected project expenditures and output measures.* Financial data were collected from Abt Associates' internal financial tracking systems for the first three years of the PMI AIRS Project, including inventory disposition lists to determine the value of any inherited or donated resources. Information collected was augmented and verified through staff interviews. Program output and operational data were collected from the AIRS M&E systems.
2. *Categorized all financial expenditures according to the methodology framework*. The costing framework used in this analysis includes: (1) capital and recurrent costs, (2) technical program activities, and (3) cost categories. All capital costs are annualized for this report. All costs are reported in 2014 U.S. dollars; costs from previous years are adjusted for inflation.

Costs in 2014

Project output data, listed in Table ES 1, was collected and verified by AIRS M&E staff for the eleven countries with PMI-funded IRS campaigns in 2014. In total, about 11.8 million people

were protected, ranging from approximately 58,370 people in Angola to over 2.3 million people in Mozambique. This corresponds to about 3.1 million total structures sprayed, ranging from 14,649 structures in Angola to 667,236 structures in Ethiopia, a total of over 3.3 million total square meters of structures sprayed, and a total of over 1.6 million sachets or bottles of insecticide used.

The average structure size varied widely across countries, ranging from 54.8 square meters (m^2) in Ghana, to 376.8 m^2 in Angola. The average people per 100 m^2 sprayed ranged from 1.1 people in Angola, to 7.1 people in Benin and Zambia.

TABLE ES1: AIRS PROJECT SPRAY COVERAGE IN 2014, BY COUNTRY

Country	# of People Protected	# of Structures Sprayed	Area Sprayed (100 m^2)	Avg. Size of Structure (m^2)	# People per Area Sprayed
Angola	58,370	14,649	55,200	376.8	1.1
Benin	789,883	254,072	110,505	43.5	7.1
Ethiopia	1,647,099	667,236	624,764	93.6	2.6
Ghana	570,572	205,230	112,370	54.8	5.1
Madagascar	1,307,384	274,533	229,240	83.5	5.7
Mali	836,568	228,123	224,868	98.6	3.7
Mozambique	2,327,815	445,118	892,018	200.4	2.6
Rwanda*	1,217,837	297,005	482,958	162.6	2.5
Senegal	708,999	204,159	150,465	73.7	4.7
Zambia	2,000,824	409,544	281,508	68.7	7.1
Zimbabwe	334,746	147,949	167,600	113.3	2.0
Average	**1,072,736**	**286,147**	**302,863**	**124.5**	**4.0**
Total	**11,800,097**	**3,147,618**	**3,331,495**		

* Rwanda had two rounds of spraying in 2014 and there is some overlap in structures sprayed, therefore, some numbers are double counted.

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

TABLE ES2: 2014 PMI IRS PROGRAM UNIT COSTS

Program Size (# structures sprayed)	Country	Cost per Person Protected	Cost per Structure Sprayed	Cost per Area Sprayed (100 m^2)	Insecticide Class Procured	Insecticide Sprayed
Large (230,001 - 640,000)	Ethiopia	$ 5.33	$ 13.16	$ 14.05	Carbamates	Carbamates
	Mozambique	$ 2.46	$ 12.88	$ 6.43	Pyrethroids	Pyrethroids
	Zambia	$ 3.45	$ 16.87	$ 24.55	Organophosphates	Organophosphates
	Rwanda	$ 6.37	$ 26.13	$ 16.07	Carbamates	Carbamates

	Madagascar	$ 3.97	$ 18.88	$ 22.61	Pyrethroids, Organophosphates	Pyrethroids, Organophosphates, Carbamates
	Benin	$ 4.46	$ 13.88	$ 31.91	Organophosphates	Organophosphates
Medium (100,001 – 230,000)	Mali	$ 6.86	$ 25.15	$ 25.52	Organophosphates, Carbamates	Organophosphates, Carbamates
	Ghana	$ 7.30	$ 20.30	$ 37.08	Organophosphates	Organophosphates
	Senegal	$ 6.54	$ 22.71	$ 30.81	Organophosphates, Carbamates	Organophosphates, Carbamates
	Zimbabwe	$ 14.23	$ 32.19	$ 28.41	Organophosphates	Organophosphates
Small (40,000 - 100,000)	Angola	$ 54.57	$ 217.44	$ 57.70	None	Pyrethroids

The overall unweighted average cost per person protected is $10.50 ($6.10 if Angola is not included). The average cost per person protected by program size is $4.34 for large programs and $8.73 for medium programs. The unweighted average cost per structure sprayed across countries was $38.14 ($20.22 excluding Angola). The average cost per structure sprayed for large programs is $16.97 and for medium programs is $25.09. The unweighted average cost per 100 m^2 sprayed is $26.83 ($23.74 if Angola is excluded).

Cost Components in 2014

Country program expenditures were divided into six cost categories: insecticide, spray commodities, spray operations, full-time local labor, local administration, and U.S.-based labor and short-term technical assistance. The types of expenditures included in each cost category are detailed in Table 1 of the Methodology section. The three largest cost categories were insecticide (33 percent of all costs), spray operations (31 percent of all costs), and local labor (18 percent of all costs), constituting an average of 83 percent of all costs.

Insecticide

To prevent and manage the increasing challenge of insecticide resistance, IRS programs are changing or rotating the class of insecticide used. On average, the portion of insecticide cost per 100 m^2 sprayed is $0.60 for pyrethroids, $7.46 for carbamates, $6.47 for countries that used organophosphates with other classes of insecticides, and $10.66 for organophosphates. However, several countries used insecticides procured in previous years, indicating that more insecticide was used than was purchased. The estimated cost per 100 m^2 sprayed for the insecticides used is $0.90 for pyrethroids, $6.22 for carbamates, $8.02 for countries that used organophosphates with other classes of insecticides, and $10.66 for organophosphates.

Spray Operations

Spray operations include costs associated with temporary labor of spray operators (SOPs), ground transportation, warehousing costs, etc. Three (Ethiopia, Mozambique, and Zambia) of the four countries that sprayed the most area per day also had the lowest spray operations costs

per 100 m^2 sprayed. However, among countries that sprayed a similar amount of area per day, there is wide variation in the spray operations costs per 100 m^2 sprayed. Spray operations thus varied as a proportion of the total cost per 100 m^2 sprayed from 18 percent of costs in Zimbabwe to 50 percent of costs in Madagascar.

Full-Time Local Labor

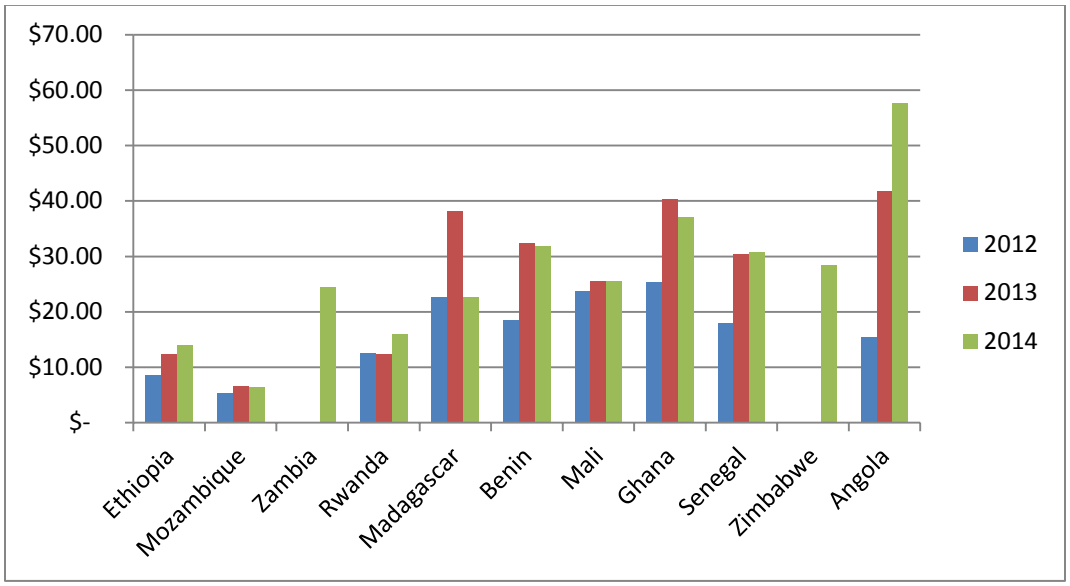
Local labor includes the country site office full-time staff members. The local labor portion of the unit costs per 100 m^2 sprayed ranged from $1.43 in Ethiopia to $25.24 in Angola, with an average of $6.33. The unit cost of local labor per area sprayed tends to be lower for larger programs and higher for smaller programs.

Year-on-Year Comparison

Four countries increased the number of structures sprayed in 2014 from 2013: Ethiopia (5 percent), Mozambique (7 percent), Ghana (4 percent), and Benin (11 percent), while Rwanda (-14 percent), Madagascar (-20 percent), Senegal (-1 percent), and Angola (-85 percent) all sprayed fewer structures. The number of structures sprayed in Mali was very close between the two years, while data from 2013 are not available for Zambia and Zimbabwe.

Figure ES 1 shows the unit costs for the countries included in this analysis for the years 2012 through 2014. It shows that cost per area sprayed in 2014 is generally slightly lower or about the same as in 2013. However, costs per 100 m^2 sprayed in 2012 were almost universally lower than both 2013 and 2014, with the exception of Madagascar (where 2014 cost per 100 m^2 sprayed returned to the same level as 2012 cost per 100 m^2 sprayed). The larger increases from 2012 to 2013 and 2014 are seen in Benin, Mali, Ghana, and Senegal – the countries that have switched partially or fully to organophosphates. Madagascar, which also used organophosphates for part of its spray area, saw a spike in 2013 because most of the organophosphates used in 2014 were purchased in 2013. The non-insecticide portion of the cost per 100 m^2 sprayed was less in 2014 than it was in 2013 in all countries except Ethiopia, Mozambique, Benin, and Angola.

FIGURE ES1: COST PER 100M² SPRAYED 2012 THROUGH 2014



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 costs, and unit costs per person protected, per structure sprayed, and per area sprayed. These chapters also include a more detailed analysis of unit costs between 2012, 2013, and 2014.

CONCLUSIONS

Limitations

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

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

As in past reports, we use the area sprayed as the unit for comparing costs across countries. This unit allows for a standardized metric to compare the relative efficiency of country programs that

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

Program Scale

Broadly speaking, we find, similar to previous years, that unit costs for large programs are lower than for small programs (although larger programs tend to cost more in total). Using the most standardized comparison unit cost available, there is no 'one-price-fits-all' for IRS across countries. Large-sized programs averaged a cost per 100 m^2 sprayed of $19.27, and medium programs averaged $30.46.

Insecticide

Insecticide makes up the second largest cost category across the IRS programs when looking at the cost per 100 m^2 sprayed; it is the largest cost category when assessing total expenditures. The cost of insecticide will be increasingly important as the threat of insecticide resistance prompts IRS programs to switch to more expensive classes of insecticide. The insecticide portion of the cost per area sprayed constitutes an average of 30 percent of the total unit cost across country programs.

INTRODUCTION

1.1 BACKGROUND

In 2013, 124 million people (4 percent of the global population at risk for malaria) were protected by indoor residual spraying (IRS) programs. Across Africa, the proportion of the population at risk that was protected by IRS decreased from 11 percent in 2010 to 7 percent in 2013 (WHO 2014). The World Health Organization (WHO)'s World Malaria Report 2013 noted, "the decrease in the number of people protected by IRS in Africa appears to be partly due to increased use of more costly non-pyrethroid insecticides (in response to a threat of insecticide resistance) in a setting of limited IRS budgets" (WHO 2013).

The President's Malaria Initiative (PMI) aims to reduce the incidence and prevalence of malaria. PMI has provided IRS program support to Ministries of Health (MOHs) and National Malaria Control Programs (NMCPs) in sub-Saharan Africa since 2006. In April 2015, PMI's 2015-2020 strategy was released with specific objectives to: 1) reduce malaria mortality by one-third from 2015 levels in PMI-supported countries, achieving a greater than 80 percent reduction from PMI's original 2000 baseline levels, 2) reduce malaria morbidity in PMI-supported countries by 40 percent from 2015 levels, and 3) assist at least five PMI-supported countries to meet the WHO criteria for national or sub-national pre-elimination. The Africa Indoor Residual Spraying (AIRS) Project, implemented from 2011-2014, along with its follow-on project the PMI AIRS Project, currently being implemented from 2014-2017, together constitute PMI's leading pan-African IRS initiative.

In its third calendar year of implementation (2014), AIRS provided 11 PMI-supported countries with full IRS operations and logistics support (Angola, Benin, Ethiopia, Ghana, Madagascar, Mali, Mozambique, Rwanda, Senegal, Zambia, and Zimbabwe).

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

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

campaigns;

- Monitoring and evaluating all program activities; and
- Completing entomological surveillance, and testing insecticide effectiveness.

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

PMI requested the Project to provide annual comparative cost analyses on the total and unit costs of the IRS country programs. This report builds upon the 2012 and 2013 findings by reporting on 2014 costs and comparing them with those of the previous two years.

1.2 Objective

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

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

Conducted annually over the course of the project, the analyses 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.

1.3 Target Audience

The results and findings of the cost analysis will be used by PMI 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 Project staff for program management, and may be shared with PMI's government partners and other key stakeholders to inform them of specific costs of implementing an IRS program in their respective countries. PMI also intends to share findings broadly with global partners and post the analysis on its publicly available website.

2. APPROACH

The methodology used for the analyses presented in this report is the same as used for the reports from 2012 and 2013 (Abbott 2013, Abbott 2014), with two exceptions.

First, the useful life of capital items was updated to reflect a longer timeframe for implementation, given that many of the items are still in use after the completion of 2014 activities. Thus, the useful life was changed to six years for most capital items. Items with shorter expected useful lives (boots, overalls, and other personal protective equipment) were not changed. The costs listed in this report for 2012 and 2013 have also had the capital costs updated to reflect this change; thus, the cost figures presented in this report will not be exactly the same as shown in previous reports.

Second, in the year-to-year comparisons, we did not apply inflation to insecticide costs. Insecticides are internationally available goods; when assessing the price of insecticides across the three years of the PMI AIRS Project, price changes do not appear to be correlated with the inflation rates in individual countries. Since insecticides constitute, in many countries, a substantial proportion of the overall costs of IRS, applying country-specific inflation rates to insecticides may make previous years look more expensive compared to 2014. This relatively higher cost after adjusting insecticides for inflation assumes that more was paid in 2014 for insecticides because the price was higher, while, in fact, the price of insecticides does not appear to have changed (or, if anything, the unit price of some insecticides may have slightly decreased over the three years). Therefore, in the analyses presented in this report, we do not adjust the expenditures for insecticide for inflation. We do adjust all other cost inputs for inflation, as described below and done in previous years' reports.

The remainder of this section describes the methods used.

2.1 METHODOLOGY

Prior to this cost analysis, five cost analyses have been done of PMI IRS programs: one was conducted by the Abt Associates-led IRS program in Uganda (Uganda Indoor Residual Spraying Project 2011), two by Research Triangle Institute International (RTI) (Sine and Doherty 2010, Sine et al. 2011), and the two aforementioned PMI AIRS Project's comparative cost analysis of 2012 and 2013 (Abbott 2013, Abbott 2014). The 2011 RTI report covered the costs of implementing IRS in 12 countries from 2008 to 2010, and the methodology used in the current cost analysis builds upon the RTI report.

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

2.1.1 Step One: Verify and finalize target audience and objectives of the costing analysis

The costing team met with AIRS programmatic staff to verify that the correct questions were being asked and to review changes to program implementation. Note that these analyses only include costs directly related to IRS implementation. For example, costs related to epidemiological monitoring are not included.

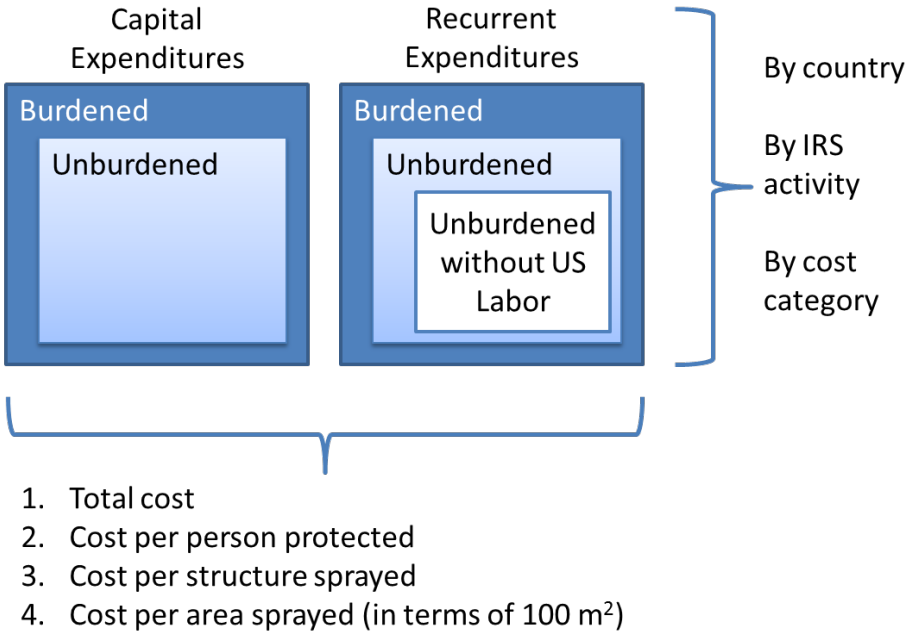
2.1.2 Step Two: Collect project expenditures and output measures

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

2.1.3 Step Three: Categorize all financial expenditures according to the methodology framework

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

FIGURE 1: COSTING METHODOLOGY FRAMEWORK



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

Capital and Recurrent Costs

Capital costs are expenditures for 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. The program technical coordinator for each country verified the list of equipment and supply items as capital expenditures.[1] Certain items, mostly personal protective equipment, were assumed to have a shorter useful life.

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

Technical IRS Activities

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

Cost Categories

Table 1 provides examples of the types of expenditure items in each cost category used in this report.

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

IRS Cost Category	Capital Expenditures	Recurrent Expenditures
Spray Operations	(None)	• Transportation and vehicle use for local staff and spray operators • Warehousing • Technical consultants and temporary labor, including spray operators • Subcontracts for technical activities* • Training, conferences, and seminars for technical activities • Honoraria and misc. professional services

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

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

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

2.1.4 Step Four: Define Services and Units of Measure

Based on the M&E reporting mechanisms of the PMI AIRS Project, as well as the previously existing costing analyses, two indicators included in the cost analysis are cost per person protected and cost per structure sprayed. However, because the average structure size and people living per structure varies greatly across countries, this costing analysis also reports the unit cost per area sprayed in terms of 100 square meters (m2). This standardized unit of measure allows for the most accurate comparisons of program costs across countries as it adjusts for the size difference in structures.

2.1.5 Step Five: Analyze Costs and Write Report

The costing team analyzed all cost data according to the costing objectives and methodology illustrated above in Figure 1. AIRS staff verified preliminary results and provided further country and program context, as necessary.

All costs are reported in 2014 U.S. dollars. In order to compare the costs of 2012 and 2013 to 2014 costs, expenditures from 2012 and 2013 were adjusted to 2014 real U.S. dollars. This was calculated by converting 2012 and 2013 expenditures to the local currency using the average exchange rate for that year, multiplying by International Monetary Fund GDP deflator for the appropriate year, and reconverting to U.S. dollars using the 2014 average exchange rate. As discussed at the beginning of this section, this method was not applied to the cost of insecticides.

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.[2] Due to lack of available information on the full useful life of some items (i.e., how long the item has been used or will continue to be used after the life of the project), capital items were depreciated across the six years of project implementation of two, three-year projects (the AIRS Project, 2011-2014, and the PMI AIRS Project, 2014-2017).[3] This assumption may inflate the costs presented here to some extent because some of the items (i.e., office equipment) will have a useful life of greater than six years and/or have a salvage cost.

2.2.2 Valuation of Inherited Items

The inventory disposition plans list donated or inherited items, and the item's quantity, unit cost, and total value[4]. In Ethiopia, Liberia, and Mozambique, the cost value attributed to each capital item included in the inventory disposition had already been decreased by project staff under the previous PMI IRS project, in order to reflect the item's previous use and current value. For disposition lists that may not have accounted for a decreased valuation, no adjustments were made by this costing team.

2.2.3 Program Dates

This comparative costing analysis covers 2012, 2013, and 2014 of IRS implementation. However, the dates of each program year (the period of program implementation) vary by country (see Table 2) – in 2012, program start dates were staggered to allow for efficient project start-up and smooth initial operations. The majority of countries operate within the calendar year dates.

The first full calendar year of 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.

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[2] The cost of capital items will need to be added to the future costing analyses of the PMI AIRS Project, as they will no longer show up in the Abt Associates internal financial tracking system. Capital costs from Year 1 and Year 2 are included in the Year 3 costs presented in this report.

[3] Therefore, each capital item total cost was divided by six (years) to find the correct cost value for each year.

[4] The exception is Zambia, for which only the total value of items on the disposition list was provided. We include these costs by assuming all the inherited items are capital items.

For example, spray campaign rounds in Madagascar were not finalized in the 2013 calendar year, and so they could not be included in the previous costing analysis. Thus, the results of both program years in Madagascar are included in this report. Additionally, IRS programs in Ethiopia and Liberia completed two spray campaign rounds in 2012, and Rwanda completed two spray campaign rounds in 2013 and 2014.

TABLE 2: COUNTRY PROGRAM START DATES

Country	2012 Program Dates	2013 Program Dates	2014 Program Dates
Angola	April 1, 2012 – March 31, 2013	April 1, 2013 – March 31, 2014	April 1, 2014 – March 31, 2015
Benin	Jan 10, 2012 – Dec 31, 2012	Jan 1, 2013 – Dec 31, 2013	Jan 1, 2014 – Dec 31, 2014
Burkina Faso	Jan 1, 2012 – Dec 31, 2012	n/a*	n/a*
Ethiopia	Feb 1, 2012 – Dec 31, 2012	Jan 1, 2013 – Dec 31, 2013	Jan 1, 2014 – Dec 31, 2014
Ghana	Feb 10, 2012 – Dec 31, 2012	Jan 1, 2013 – Dec 31, 2013	Jan 1, 2014 – Dec 31, 2014
Liberia	Jan 10, 2012 – Dec 31, 2012	Jan 1, 2013 – Dec 31, 2013	n/a*
Madagascar	Aug 15, 2012 – April 30, 2013	May 1, 2013 – April 30, 2014	May 1, 2014 – April 30, 2015
Mali	Feb 1, 2012 – Dec 31, 2012	Jan 1, 2013 – Dec 31, 2013	Jan 1, 2014 – Dec 31, 2014
Mozambique	April 1, 2012 – March 31, 2013	April 1, 2013 – March 31, 2014	April 1, 2014 – March 31, 2015
Nigeria	Feb 1, 2012 – Dec 31, 2012	Jan 1, 2013 – Dec 31, 2013	n/a*
Rwanda	March 1, 2012 – Dec 31, 2012	Jan 1, 2013 – Dec 31, 2013	Jan 1, 2014 – Dec 31, 2014
Senegal	Jan 1, 2012 – Dec 31, 2012	Jan 1, 2013 – Dec 31, 2013	Jan 1, 2014 – Dec 31, 2014
Zambia	n/a*	n/a*	March 1, 2014 – Feb 28, 2015
Zimbabwe	n/a*	n/a*	March 1, 2014 – Feb 28, 2015

* AIRS did not have IRS spray activities in these countries for these years.

2.2.4 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. A country program may be inexpensive in terms of cost per person protected as compared to other country programs, but if the density of people living per structure is larger than other country programs, then the cost per area sprayed may look comparatively more expensive than other programs. Thus, the number of structures sprayed and people protected are specific to varying country contexts (i.e., size of structures and density of people living in a structure) and not inherently controllable by an IRS program. To account for this, the costing team introduced an additional unit of measure of cost per area sprayed (100 m^2).

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

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

This analysis includes the cost of all insecticides purchased in each implementation year. However, in some cases the insecticide purchased in a particular year are not all used, and the extra insecticide is then used in the following year or, in some cases, transferred to another country*. The analyses reported here present the costs of insecticides procured and insecticides used. In addition, some IRS programs receive insecticide from external organizations. In 2012, the Ethiopia IRS program received pyrethroid insecticides purchased by the government and Rwanda received pyrethroids from the previous implementer, RTI. The procurement costs of these insecticides were provided to the costing team, so the real value has been included. However, in 2013, Mozambique received insecticide from the MOH, but the cost was not available for inclusion in the 2013 report. We included an estimated cost based on the procurement costs for 2012; lacking data on how many sachets were procured, the costs presented for Mozambique reflected the estimated costs of insecticide used. For 2014, costs for insecticides from Ethiopia were collected from PMI, and Angola only used insecticides left from 2013. The costs of Angola's 2014 pyrethroids are not included here because their acquisition costs were included in the previous year's cost study.

We also attempt to calculate the cost of the insecticides used. Note that an estimation is necessary in many cases, since the year of procurement is not always certain, and the unit cost of the insecticides may change from year to year. The costs of insecticides used are presented separately in Section 3.4.2.

* For example, Zambia transferred insecticides procured prior to this year to Rwanda.

3. Cross-Country Results

3.1 Background

Output Measures

Table CC1 presents the coverage provided by the AIRS project's spray campaigns in each country. The area sprayed (number of 100 m^2 sprayed) was calculated by multiplying the total number of sachets/bottles of insecticide used by the estimate of 250 m^2 coverage provided by each sachet/bottle, and dividing by 100 m^2 in order to develop a more usable unit of measure. Note that in Ethiopia and Rwanda, total number of sachets was multiplied by 200 m^2 because the programs use an 8L spray tank (and smaller (100gr) sachets), which holds less insecticide than in other countries, and thus covers less surface area. The average size of a structure in each country was calculated by the total area sprayed divided by the number of structures sprayed. The number of people per area sprayed was calculated by dividing the total population protected by the area sprayed in terms of 100 m^2, and ranged from 1.1 in Angola to 7.1 in Benin and Zambia. Note that one sachet of pyrethroid or carbamate is equivalent to one bottle of organophosphate.

TABLE CC1: AIRS PROJECT SPRAY COVERAGE IN 2014, BY COUNTRY

Country	# of People Protected	# of Structures Sprayed	Area Sprayed (100 m^2)	Avg. Size of Structure (m^2)	# People per Area Sprayed
Angola	58,370	14,649	55,200	376.8	1.1
Benin	789,883	254,072	110,505	43.5	7.1
Ethiopia	1,647,099	667,236	624,764	93.6	2.6
Ghana	570,572	205,230	112,370	54.8	5.1
Madagascar	1,307,384	274,533	229,240	83.5	5.7
Mali	836,568	228,123	224,868	98.6	3.7
Mozambique	2,327,815	445,118	892,018	200.4	2.6
Rwanda	1,217,837	297,005	482,958	162.6	2.5
Senegal	708,999	204,159	150,465	73.7	4.7
Zambia	2,000,824	409,544	281,508	68.7	7.1
Zimbabwe	334,746	147,949	167,600	113.3	2.0

The average structure size and number of people per area sprayed both provide additional contextual understanding of a country program's spray campaign. Structure size varied widely

between countries, ranging from 43.5 m^2 in Benin to 376.8 m^2 in Angola, over eight times as large. The average size of structures sprayed across all 2014 countries was 124.5 m^2 (not weighting for the different number of structures sprayed between countries). On average each sachet/bottle of insecticide covered about 2.8 structures.

The average size of structures may differ across the three years, even in countries that sprayed the same target areas across the years. The average structure size is calculated based on the number of insecticide sachets/bottles used and the number of structures sprayed. Thus, variations in the average size may be due to changes in spray technique efficiencies, changing the geographic target area for spray operations, or a combination of the two.

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. For the purpose of this costing report, IRS country programs are separated into three program sizes, using the same cut-off criteria as used in the 2013 report (based on the number of structures sprayed). This breakdown is summarized in Table CC2.

TABLE CC2: IRS PROGRAM SIZES

Program Size	# Structures Sprayed	Corresponding ranges within program size for following coverage variables:	
		# Population Protected	# Square Meters Sprayed
Large	230,001 – 667,000	789,001 – 2,400,000	11,000,001 – 90,000,000
Medium	100,001 – 230,000	334,001 – 837,000	11,000,001 – 61,000,000
Small	10,000 – 100,000	< 334,001	< 11,000,001

For a more detailed analysis, countries will be grouped and presented according to program size, as specified above. Country programs are listed by program size in Table CC3 below.

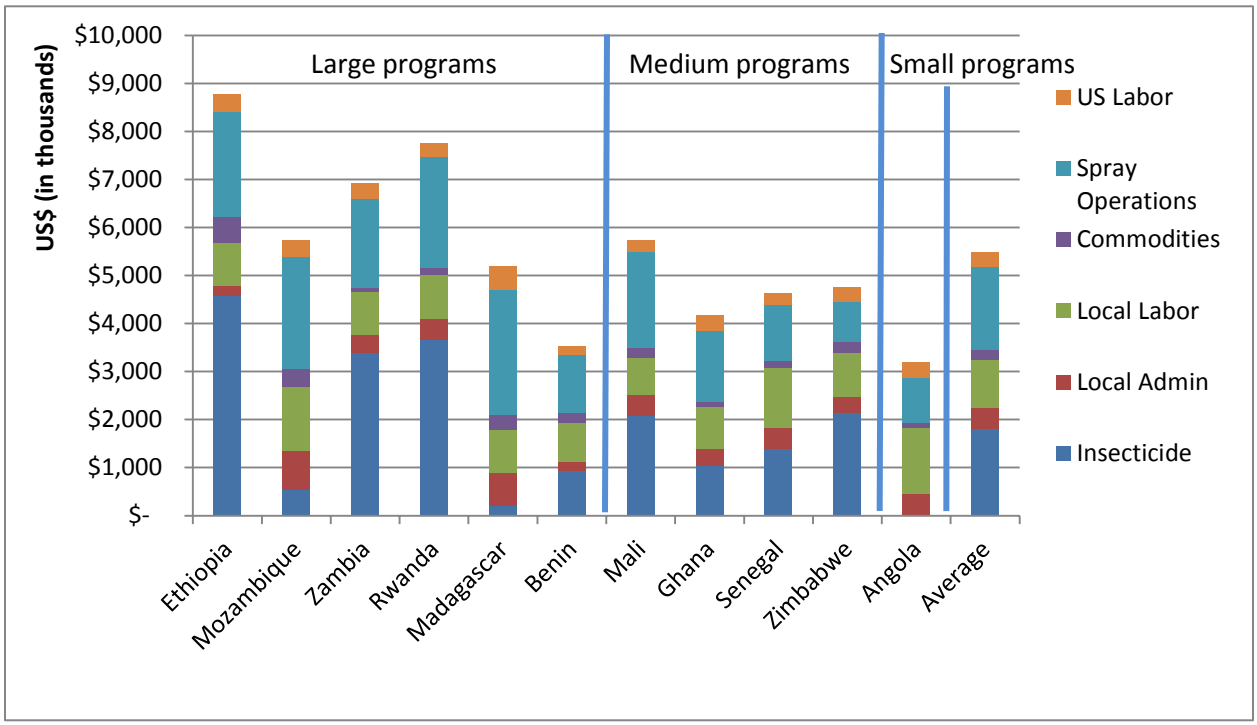
TABLE CC3: COUNTRY IRS PROGRAM SIZE GROUPS

Small	Medium	Large
Angola	Ghana	Benin
	Mali	Ethiopia
	Senegal	Madagascar
	Zimbabwe	Mozambique
		Rwanda
		Zambia

3.2 Total Program Expenditures

This section presents the IRS country programs' total expenditures for 2014. Figure CC1 below includes all capital and recurrent costs of country IRS programs broken down by cost category. Countries are arranged in order of the number of structures sprayed during 2014 spray campaigns, from largest to smallest.

FIGURE CC1: CAPITAL AND RECURRENT EXPENDITURES, BY COST CATEGORY



The above figure shows that the U.S.-based labor and STTA cost category remains consistent across all country programs at an annual average of about $311,000. Local administration, while more variable than the U.S.-based labor cost category, is also considered a fixed cost and averaged about $423,000 across countries. These fixed costs are discussed in more detail in the cost drivers analysis section. An average of two-thirds of total project expenditures (68 percent) is spent directly on spray operations, insecticide, and other commodities.

The average total program implementation expenditures for large programs is about $6.32 million, for medium-sized programs is about $4.83 million, and for the small program is about $3.19 million.

3.3 Unit Cost Analysis

This section presents country IRS programs' capital and recurrent expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2). The unit

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

TABLE CC4: 2014 IRS PROGRAM UNIT COSTS

Program Size	Country	Cost per Person Protected	Cost per Structure Sprayed	Cost per Area Sprayed
Large	Ethiopia	$ 5.33	$ 13.16	$ 14.05
	Mozambique	$ 2.46	$ 12.88	$6.43
	Zambia	$ 3.45	$ 16.87	$24.55
	Rwanda	$ 6.37	$ 26.13	$16.07
	Madagascar	$ 3.97	$ 18.88	$22.61
	Benin	$ 4.46	$ 13.88	$31.91
Medium	Mali	$ 6.86	$ 25.15	$25.52
	Ghana	$ 7.30	$ 20.30	$37.08
	Senegal	$ 6.54	$ 22.71	$30.81
	Zimbabwe	$ 14.23	$ 32.19	$28.41
Small	Angola	$ 54.57	$ 217.44	$57.70
Average (unweighted)		$10.50	$ 38.14	$ 26.83

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

FIGURE CC2: UNIT COSTS PER PERSON PROTECTED, BY COST CATEGORY

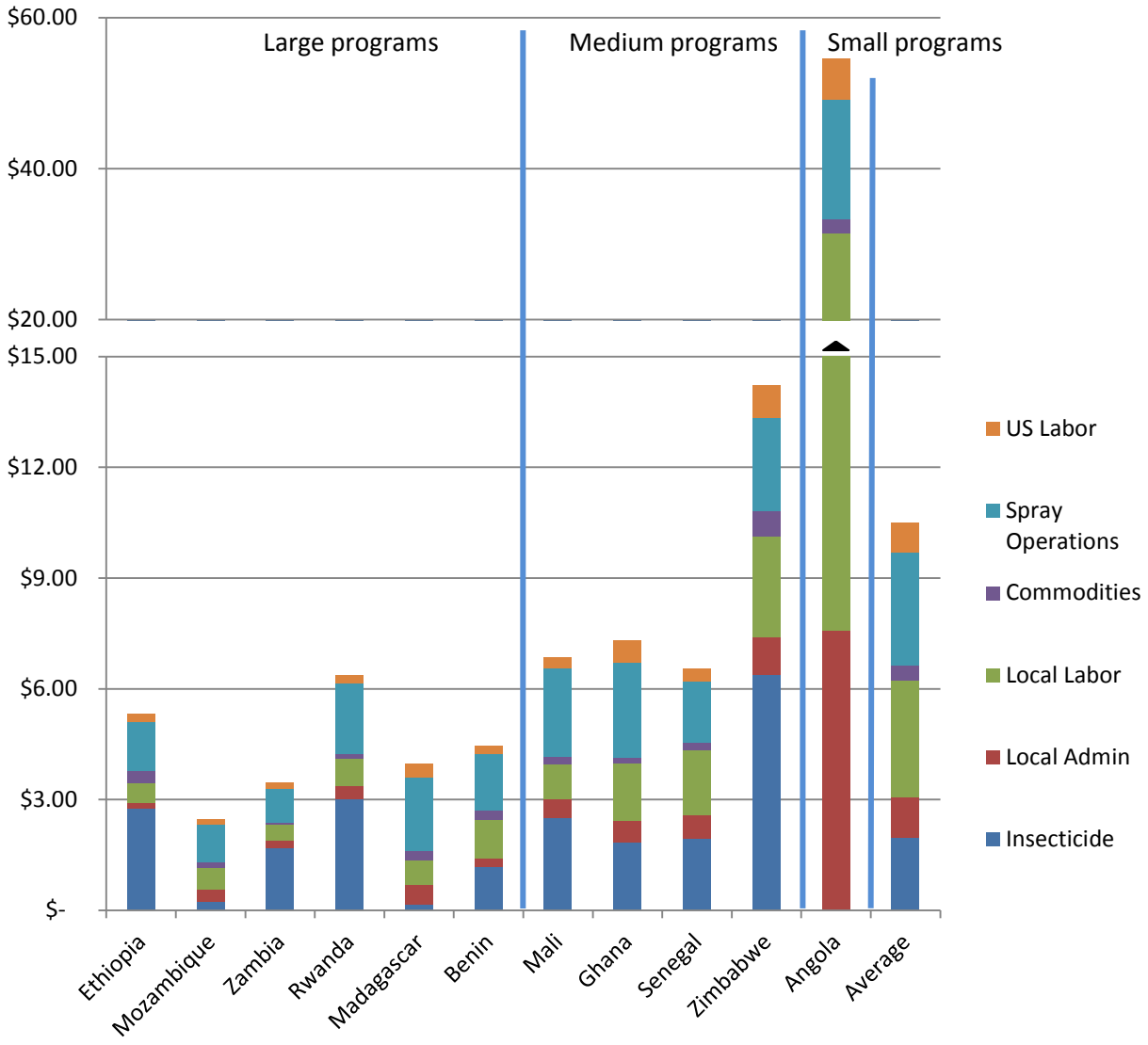


Figure CC2 shows cost per person protected, broken down by cost category. The overall unweighted average is $10.50 ($6.10 if excluding Angola). The average cost per person protected by program size is $4.34 for large programs, $8.73 for medium programs, and $54.57 for Angola. As observed in past studies, the size of the program is correlated with unit costs, with smaller programs tending to have higher unit costs. However, as explored in further sections, other factors in addition to program size also explain differences in unit costs across countries.

FIGURE CC3: UNIT COSTS PER STRUCTURE SPRAYED, BY COST CATEGORY

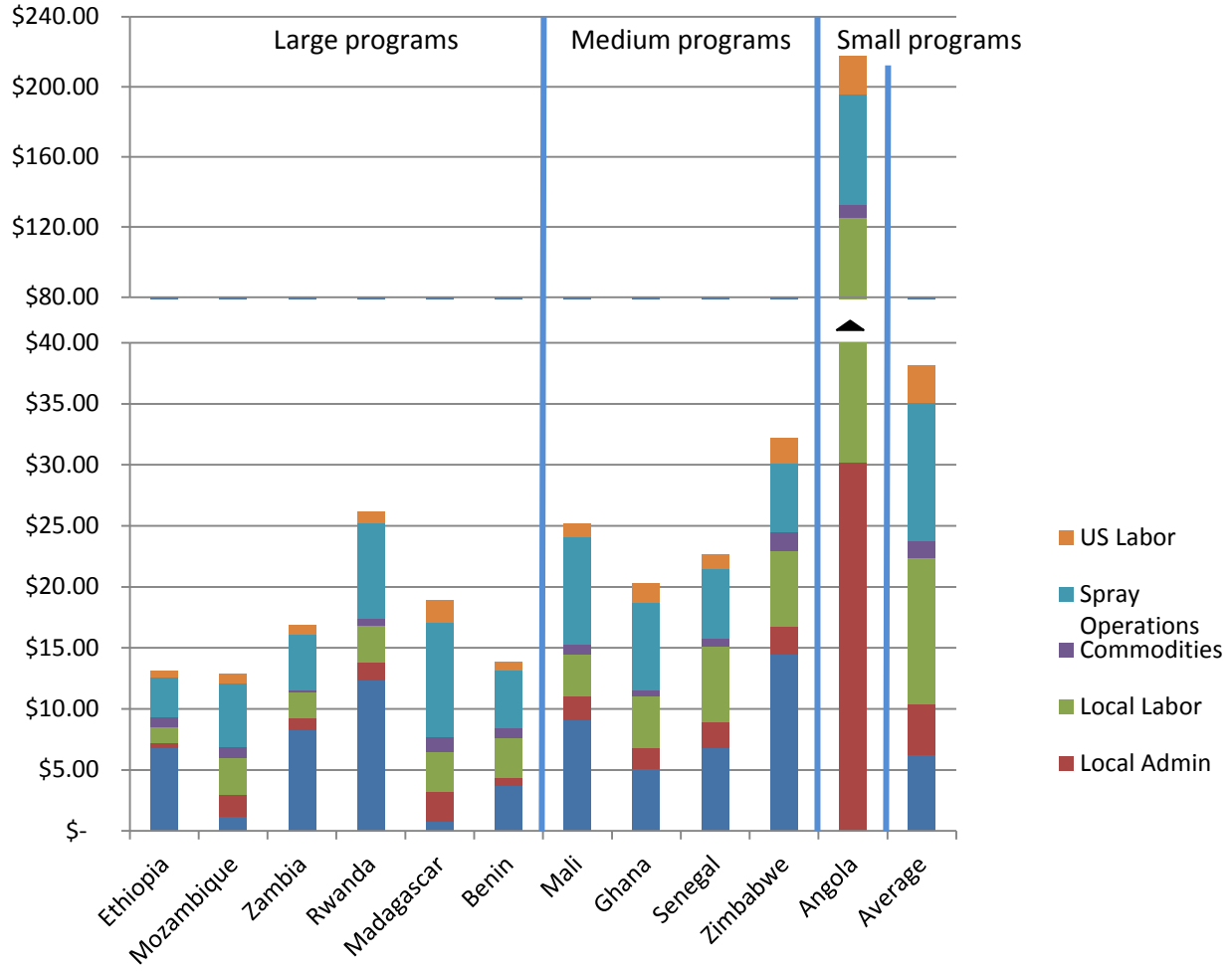


Figure CC3 shows country programs' unit costs per structure sprayed. The average cost across countries (not weighted by the number of structures sprayed in each country) was $38.14 ($20.22 excluding Angola). The average cost per structure sprayed for large programs is $16.97, for medium programs is $25.09, and for Angola is $217.44.

As stated earlier, the average size of a structure may vary greatly from one country to another, which means that even if fewer structures were sprayed, the same amount of square meters may have been covered. For example, in Figure CC3, the unit costs per structure sprayed for Zambia is lower than Rwanda. However, in Figure CC4, the unit cost per area sprayed for Zambia is higher than for Rwanda (Zambia incurred $8.49 more per area sprayed than Rwanda). This is because in Rwanda the average size of a structure is 162.6 m^2, and in Zambia the average is 68.7 m^2. Therefore, presenting the cost per area sprayed (in terms of 100 m^2) in comparing costs across countries provides a standardized unit of measure that is not influenced by non-cost variables.

FIGURE CC4: UNIT COST PER AREA SPRAYED, BY COST CATEGORY

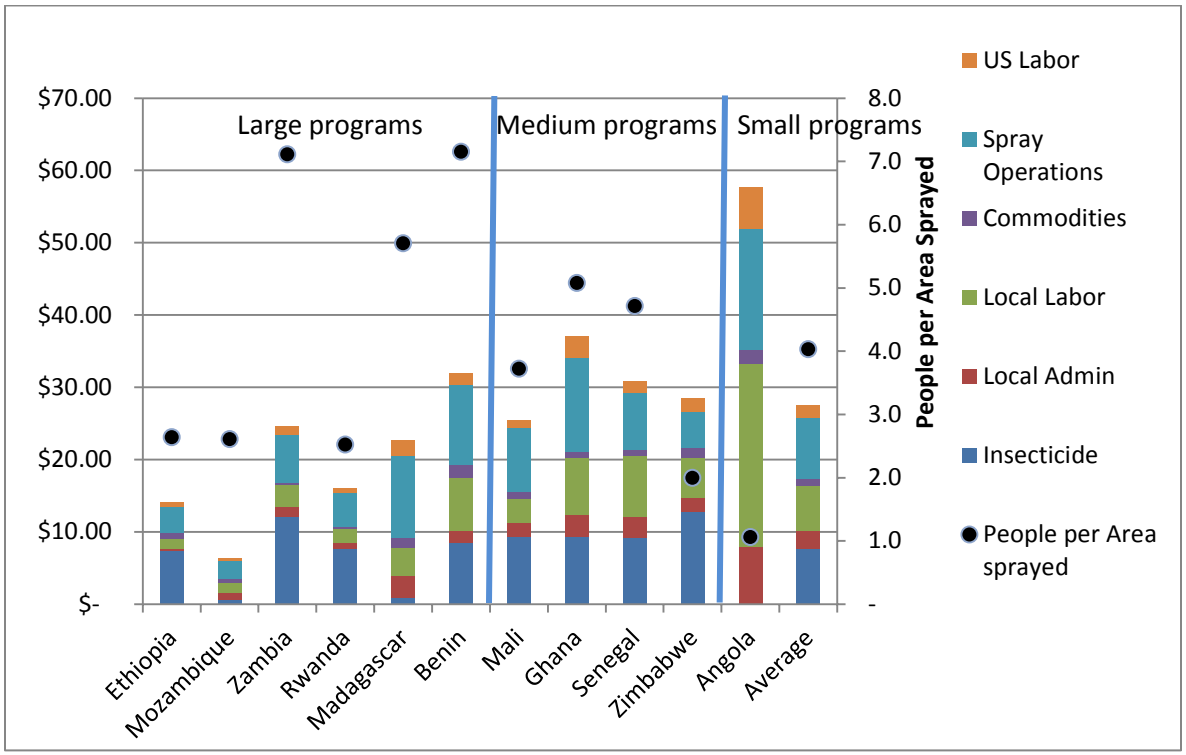


Figure CC4 shows the unit costs per area sprayed (in terms of 100 m^2) broken down by cost category, and also includes black dots for the number of people per area sprayed (in terms of 100 m^2) to provide context. The countries are in order of number of structures sprayed, from largest to smallest. The unweighted average of all countries is $26.83 per area sprayed ($23.74 if Angola is excluded). Among the large program countries, Zambia, Madagascar, and Benin had the highest cost per 100 m^2 sprayed, as well as higher numbers of people per area sprayed. Angola, for which cost per person protected and cost per structure sprayed were over three times higher than any other country, is only about 1.5 times more expensive than Ghana in terms of area sprayed. Angola also had the lowest number of people protected per area sprayed, which helps explain the comparatively higher unit costs in other areas relative to the cost per area sprayed. It should also be noted that no insecticide costs were incurred in Angola in this year because they used only insecticides left from last year.

3.4 Cost Drivers

This section focuses on the country IRS programs' costs per area (100 m^2) sprayed, in order to assess plausible explanations ("cost drivers") for differences in unit cost across the countries. A cost driver is the activity, or unit of an activity, that is responsible for significant differences in costs between one country and another. This section explores each cost category separately to assess and explain the variation in unit costs. This section will also continue to categorize countries by program size.

Table CC5 provides the percentage of each cost category out of the total unit cost per area sprayed. This is the first step in determining which cost categories constitute the largest percentage of costs, and which cost categories show the most variance across countries in terms of their percentage of the total costs.

Table CC5 shows that on average, the largest cost category is spray operations, which accounts for an average of 32 percent of the unit costs. Insecticides and local labor follow as the next largest cost categories, making up an average of 30 and 20 percent of costs, respectively. There is variability in the cost categories between countries. For example, local labor accounts for 23 percent of the cost per area sprayed in Benin, but 10 percent in Ethiopia. Insecticides constituted no costs in Angola, and 52 percent of costs in Ethiopia. Excluding Angola, which did not incur insecticide costs, insecticides constitute 32.5 percent of unit costs, and spray operations account for 32.0 percent of unit costs in those countries. The next step, which will be assessed later in this section, is to determine *why* these categories are different across countries.

TABLE CC5: BREAKDOWN OF FIXED AND VARIABLE COSTS, AS PERCENTAGE OF UNIT COST PER AREA SPRAYED

Country	Fixed Costs					Variable Costs				Total Unit Cost
	Local Admin	Capital Items	US Labor	Commodities	Total Fixed Costs	Spray Operations	Insecticide	Local Labor	Total Variable	
Ethiopia	2%	5%	4%	2%	13%	25%	52%	10%	87%	$ 14.05
Mozambique	12%	4%	6%	5%	27%	41%	9%	23%	73%	$ 6.43
Zambia	5%	0%	5%	1%	11%	27%	49%	13%	89%	$ 24.55
Rwanda	4%	3%	3%	1%	11%	30%	47%	12%	89%	$ 16.07
Madagascar	11%	7%	9%	1%	29%	50%	4%	17%	71%	$ 22.61
Benin	4%	4%	5%	3%	16%	34%	27%	23%	84%	$ 31.91
Mali	6%	3%	4%	2%	15%	35%	36%	14%	85%	$ 25.52
Ghana	8%	2%	8%	1%	19%	35%	25%	21%	81%	$ 37.08
Senegal	8%	3%	5%	1%	18%	25%	30%	27%	82%	$ 30.81
Zimbabwe	7%	2%	6%	3%	18%	18%	45%	19%	82%	$ 28.41
Angola	11%	6%	10%	0%	27%	29%	0%	44%	73%	$ 57.70
Average	7%	3%	6%	2%	19%	32%	30%	20%	81%	$ 26.83

Madagascar spends the largest percentage on fixed costs, and capital items represent the highest percentage of unit costs in Madagascar than in any other country. While fixed costs are highest in Madagascar, the relative weight of these costs is also influenced by the low insecticide costs; the four countries with the highest percentage of fixed costs also have the lowest percentage of insecticide costs.

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

3.4.1 Fixed Costs: U.S.-based Labor and Local Administration

On average, the fixed costs of country programs are about 19 percent (range: 11 percent to 29 percent) of the total unit cost, while the average of the variable costs is 81 percent (range: 71 percent to 89 percent) of the total unit cost per 100 m^2 sprayed.

FIGURE CC5: FIXED COSTS PORTION OF COST PER AREA SPRAYED

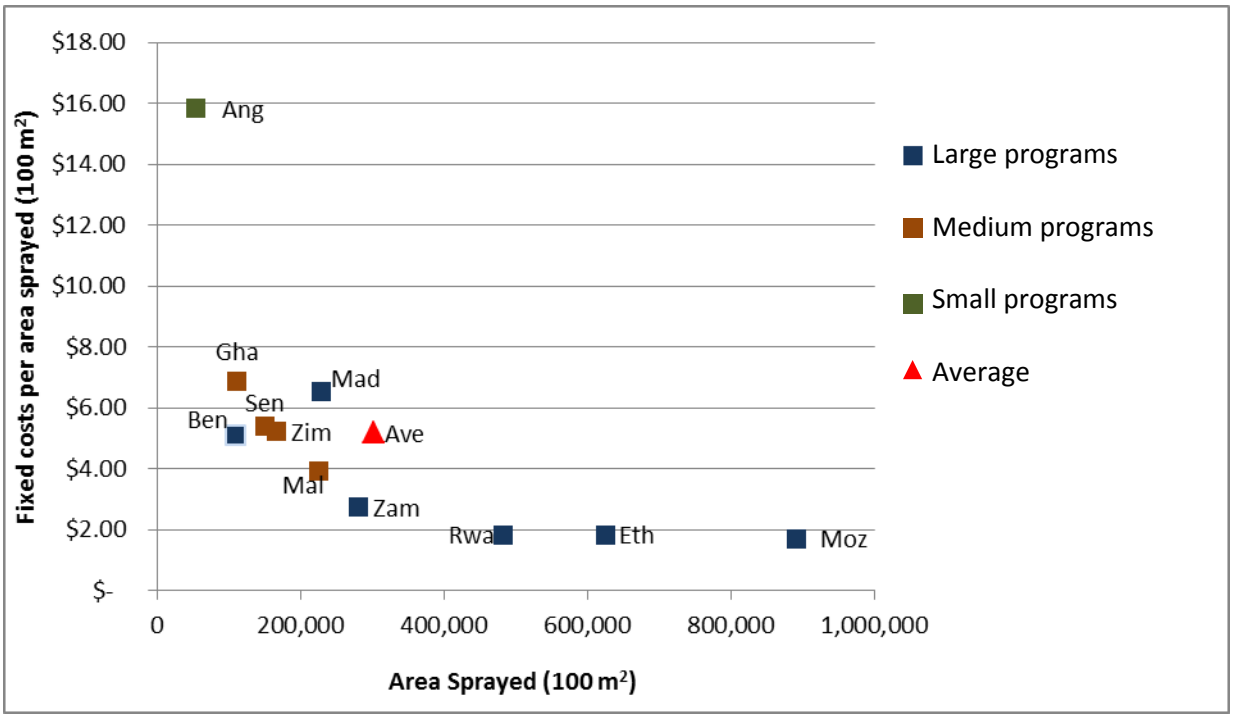


Figure CC5 shows the fixed unit cost per area sprayed (in terms of 100 m^2) on the y-axis. This includes capital expenditures, commodities (PPE and other spray equipment), U.S.-based labor and STTA, and local administration costs. The x-axis shows the total area sprayed. As expected, the fixed cost per area sprayed appears to be lower in countries that sprayed more area. The fixed costs per area sprayed range from $1.82 in Rwanda to $15.83 in Angola. The average fixed cost per 100 m^2 sprayed of the large programs is $3.29, and for medium programs is $5.36.

However, there is still substantial variation in the amount of fixed cost per 100 m^2 that is not directly correlated with the total area sprayed. For example, Mali and Madagascar both sprayed similar amounts of area (225 million m^2 and 229 million m^2, respectively), yet Mali's fixed cost per area sprayed was $3.93, compared to $6.54 for Madagascar. Madagascar spent about one dollar more per 100 m^2 sprayed for local administration, capital items, and US labor, but about $0.40 less per area sprayed for commodities. Madagascar also had two spray campaigns in different parts of the country, and had 37 local employees on its staff, compared to 18 local staff in Mali, which partly explains the difference in cost for local administration and the need for more equipment and capital items.

Excluding the small program in Angola, the two most expensive fixed costs per area sprayed are in Ghana and Madagascar, which was also the case in 2013. The IRS program in Ghana has the most expensive fixed costs per area sprayed (excluding Angola). However, as shown in Table CC5, this only makes up 19 percent of Ghana's total unit cost, which is about average. Thus, the expensive fixed cost per area sprayed is a function of Ghana's expensive cost per area sprayed overall. In Ghana, the average size of a structure is 54.8 m^2, so while Ghana's program sprayed a similar number of structures to Mali, the area sprayed is among the smallest.

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

3.4.2 Insecticide: The Cost of Resistance

As previously mentioned, the threat of insecticide resistance is forcing IRS programs to switch to more expensive classes of insecticide. The impact of using more expensive classes of insecticide is seen clearly in PMI AIRS Project: given fixed budgets, use of more expensive insecticides results in fewer people being protected by IRS, unless costs can be appropriated from other areas.

The amount and class of insecticide purchased under AIRS country programs does not always perfectly reflect the amount and class of insecticide used during the same year's spray campaign. For example, IRS programs in 2014 may use leftover insecticide from the previous year, may use a mix of insecticide classes, or may have some remaining insecticide at the end of the spray campaign. Table CC6 lists the number and class of insecticide sachets/bottles purchased and used in 2014 of the country IRS programs.

TABLE CC6: CLASS AND NUMBER OF INSECTICIDE SACHETS/BOTTLES PURCHASED AND USED IN 2014

Country	Number of sachets/ bottles purchased	Type of insecticide(s) used	Number of sachets/ bottles used
Angola	None	Pyrethroids	22,080
Benin	33,480	Organophosphates	44,202
Ethiopia	499,800	Carbamates	312,382
Ghana	40,428	Organophosphates	44,948
Madagascar	33,600	Pyrethroids	32,117
	5,196	Organophosphates	30,086
	None	Carbamates	29,493
Mali	75,648	Organophosphates	65,697
	5,260	Carbamates	24,250
Mozambique	bought 305,129; donation of 99,500	Pyrethroids	356,807
Rwanda	240,819 (including 7,313 from Zambia	Carbamates	241,479

	transfer)		
Senegal	48,467	Organophosphates	34,849
	9,746	Carbamates	25,337
Zambia	130,211	Organophosphates	112,603
Zimbabwe	80,429	Organophosphates	67,040

In Benin, Ghana, Zambia, and Zimbabwe the only class of insecticide purchased and used was organophosphates. Ghana and Benin used more insecticide than was purchased, while in Zambia and Zimbabwe, more insecticide was purchased than was used. Additionally, Madagascar, Mali, and Senegal used organophosphates in some areas. Angola and Mozambique were the only countries that exclusively purchased and used pyrethroids, which is the least expensive class of insecticides among the three types used. Madagascar also used pyrethroids for about 35 percent of its insecticides.

The estimated cost per insecticide used is presented in Table CC7; this is different from the cost for insecticide procured because it includes estimated costs for donated insecticides or insecticides procured in previous years. Estimation is necessary because while the unit acquisition price of insecticide remains relatively constant year-to-year, the total unit price of insecticide (including shipment, insurance, etc.) is not constant over the years. This variance was generated largely by the project's switch from air to sea freight, thereby reducing the year-to-year cost of IRS by improved procurement planning and program management. Whenever possible, the costs in Table CC7 reflect the purchase price in each country for 2014, even if some were purchased in previous years. When 2014 prices were not available because a country used an insecticide that it did not purchase in 2014, we use the purchase price from the previous year. Expenditures included in the insecticide cost category include insecticide sachets, shipping, freight, insurance, and import taxes, where necessary.

TABLE CC7: ESTIMATED COST OF INSECTICIDES USED PER AREA SPRAYED

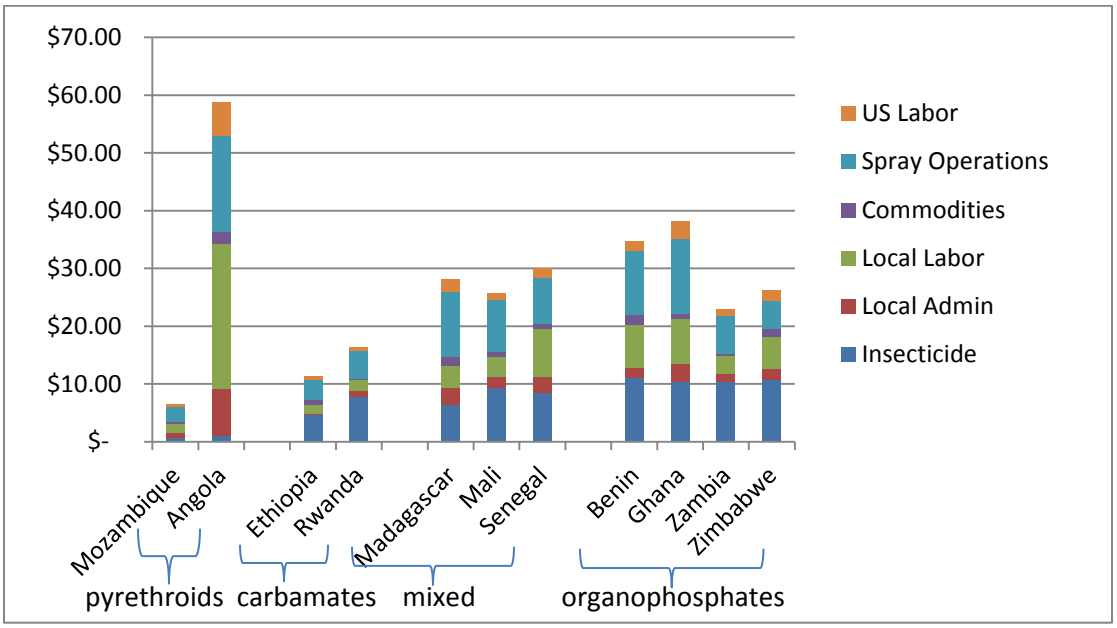
Pyrethroids		Carbamates		Mixed: OPs with others		Organophosphates	
Angola	$ 1.09	Ethiopia	$ 4.58	Madagascar	$ 6.36	Benin	$ 11.20
Mozambique	$ 0.71	Rwanda	$ 7.86	Mali	$ 9.35	Ghana	$ 10.39
				Senegal	$ 8.37	Zambia	$ 10.42
						Zimbabwe	$ 10.63
AVERAGE	**$ 0.90**		**$ 6.22**		**$ 8.02**		**$ 10.66**

In table CC7, there is a clear correlation between the insecticide class procured and the insecticide portion of the cost per area sprayed. The average cost of insecticides per 100 m^2 sprayed in organophosphate countries is over 11 times greater than the cost of insecticides per 100 m^2 sprayed in pyrethroid countries, and about twice as great as in Ethiopia and Rwanda, where carbamates were used.

In Figure CC6, country programs are organized by insecticide class, and from largest to smallest within each class, including the estimated cost of insecticide used (rather than the cost of insecticides procured as in Figure CC4). The blue portion at the bottom of each bar is the insecticide portion of the unit cost. The correlation between the insecticide class procured and the insecticide portion of the cost per area sprayed remains apparent, although somewhat diluted, when the cost per area sprayed includes all costs, as in Figure CC6. For example, the cost per 100 m^2 sprayed is roughly the same in Zimbabwe and Mali, despite carbamates constituting about 27 percent of insecticides used in Mali. When comparing between the two countries, Zimbabwe has higher insecticide costs per 100 m^2 sprayed, but higher costs for spray operations in Mali offset its lower insecticide costs. Insecticides represent 6 percent of all costs in pyrethroid countries, 44 percent of costs in carbamates countries (due to the low level of non-insecticide costs in Ethiopia and Rwanda), 29 percent of costs in countries that used both organophosphates and other insecticides, and 37 percent of costs in countries using only organophosphates.

On the other hand, the cost of insecticides per 100 m^2 sprayed in some countries is equal to or greater than the total costs per 100 m^2 sprayed in other countries. For example, the total cost per 100 m^2 sprayed in Ethiopia is $11.32, while the cost for organophosphates is $11.20 per 100 m^2 in Benin, and the total cost per 100 m^2 sprayed in Mozambique is $6.35, while the cost for insecticides is $9.35 per 100 m^2 in Mali.

FIGURE CC6: ESTIMATED COST PER AREA SPRAYED, ORGANIZED BY INSECTICIDE CLASS



In Figure CC7, it is less apparent that the countries' unit costs are correlated with the size of the country program, although the number of countries in each category is small.

FIGURE CC7: COST PER PERSON PROTECTED, ORGANIZED BY INSECTICIDE CLASS

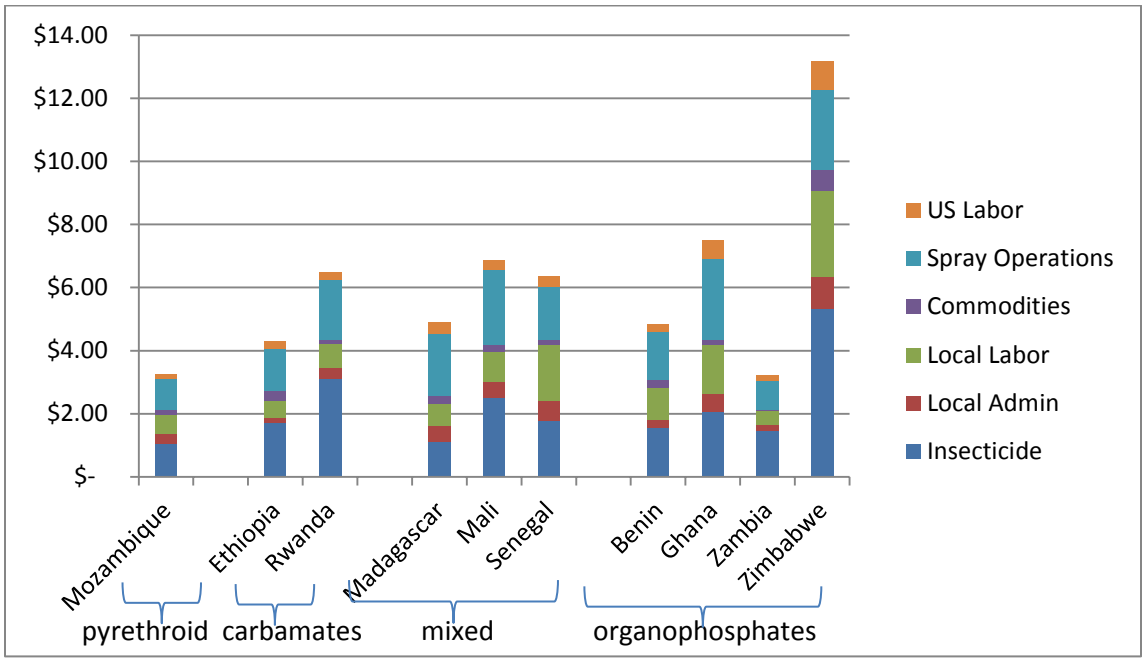


Figure CC7 shows the same data as Figure CC6 – the total cost including the estimated cost of insecticides used – but reflects the cost per person protected. Since the unit costs for Angola are over $54 per person protected, Angola has been excluded from this figure in order to present more details for the other 10 countries. The average cost for insecticides used was $0.65 for programs that purchased pyrethroids, $2.43 for carbamates, $1.80 for organophosphates mixed with other insecticide classes, and $2.60 for organophosphates only. Thus, the cost of insecticides used per person protected is not highly correlated with the type of insecticide used (except possibly for pyrethroids); the relative size of structures per person protected appears to mask the relationship between the cost of insecticides used and people protected.

Insecticide costs are not included in the two other cost driver analyses in order to isolate the additional conclusions drawn in the following sections from any consideration of the costs of insecticides.

3.4.3 Spray Operations: Program Scale

Spray operations, which includes temporary labor of spray operators (SOPs), ground transportation, and warehousing costs,[5] accounted for an average of 30 percent of the average cost per 100 m^2 sprayed across the countries. Additionally, the spray operations portion of the unit cost per area sprayed accounts for 25.0 percent of the variation (deviance from the mean) between country unit costs, which is essentially the same as insecticides, which account for 25.3 percent of variation.

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

The spray operations portion of the cost per 100 m^2 sprayed is a function of total expenditures, number of campaign days (efficiency), and size of the program (number of structures sprayed), as demonstrated in Figure CC8.

FIGURE CC8: SPRAY OPERATIONS COST PER AREA SPRAYED, AREA SPRAYED PER CAMPAIGN DAY, AND TOTAL NUMBER OF STRUCTURES SPRAYED

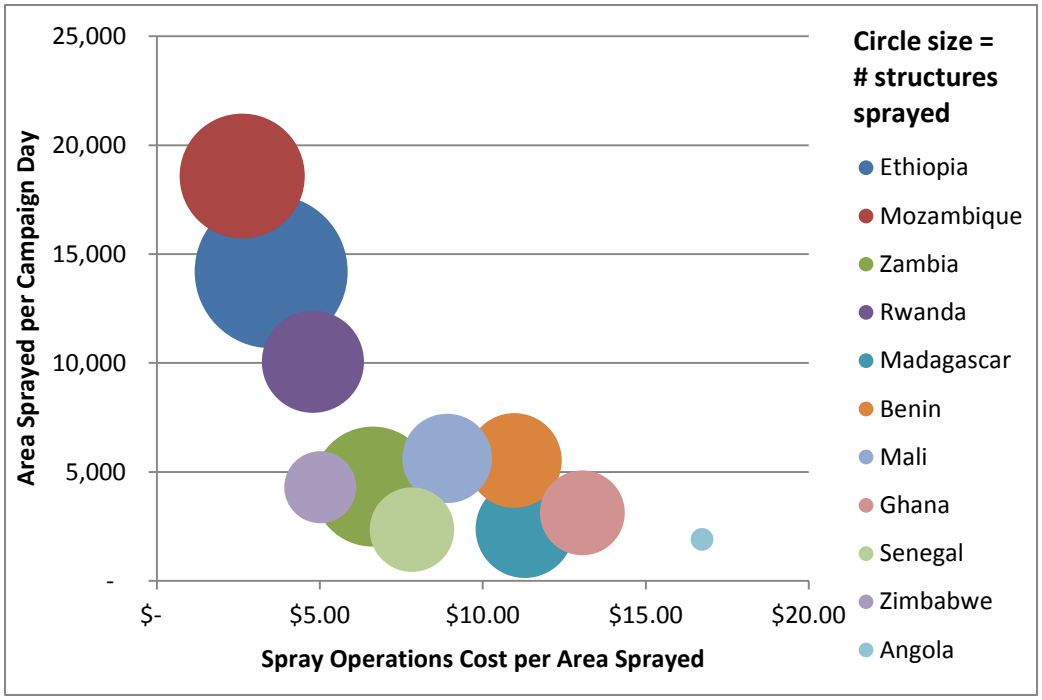


Figure CC8 shows the spread of country program spray operations, including the cost of spray operations per 100 m^2 sprayed (x-axis), the amount of area sprayed (in terms of 100 m^2) per campaign day (y-axis), and the program size in terms of number of structures sprayed (circle size). Ethiopia, Mozambique, and Rwanda sprayed the largest amount of area per campaign day, and consequently had the lowest spray operations cost per 100 m^2 sprayed. The other country programs sprayed under 5.65 million m^2 per day. The spray operation cost per 100 m^2 sprayed in these countries were varied (although separated from Ethiopia, Mozambique, and Rwanda), ranging from $5.01 in Zimbabwe to $16.73 in Angola, while the spray operation cost per 100 m^2 sprayed in Ethiopia, Mozambique, and Rwanda were all under $4.80.

Thus, while being able to spray large amounts during one campaign day likely provides cost efficiency, other factors also influence the cost per 100 m^2 sprayed. For example, Madagascar and Benin had relatively similar spray operations cost per 100 m^2 sprayed ($11.29 and $10.97, respectively), while in Madagascar 2.39 million m^2 were sprayed per day, and in Benin 5.53 million m^2 were sprayed per day. The data presented in Table CC9 helps to explain these differences. Benin used a comparatively larger number of SOPs over a shorter period of time than Madagascar. However, the area sprayed per SOP per day in Benin was just over half of that in Madagascar, offsetting the greater total area sprayed per day (SOPs in Benin also had higher daily wages than in Madagascar). While this explains the differences mathematically, the

underlying reasons for the lower area sprayed per SOP per day in Benin than Madagascar are not fully clear, but may be related to geography, housing sizes, etc.

TABLE CC8: SEASONAL SPRAY OPERATORS (SOPS) AND CAMPAIGN DAYS

Country	Total # SOPs	Total # SOP Days	Avg. # Days/ SOP	Avg. Daily wage of SOP	Total # Campaign days	Total Area Sprayed (# 100 m^2)	Area Sprayed/ SOP day	Area Sprayed/ Campaign Day
Ethiopia	2,054	39,481	31	$6.00	44	624,764	15.8	14,199
Mozambique	935	49,342	53	$3.95	48	892,018	18.1	18,584
Zambia	1,323	22,535	17	$6.25*	65	281,508	12.5	4,331
Rwanda	1,518	40,126	26	$8.80	48	482,958	12.0	10,062
Madagascar	559	19,483	35	$4.27	96	229,240	11.8	2,388
Benin	986	17,760	18	$6.00	20	110,505	6.2	5,525
Mali	582	16,239	28	$7.00	40	224,868	13.8	5,622
Ghana	425	13,183	27	$8.50	36	112,370	8.5	3,121
Senegal	554	15,045	27	$6.63	64	150,465	10.0	2,351
Zimbabwe	242	9,272	38	$15.00	39	167,600	18.1	4,297
Angola	130	1,939	15	$26.00	29	55,200	28.5	1,903
Average	**846**	**22,219**	**29**	**$8.95**	**48**	**302,863**	**14.1**	**6,580**

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

Table CC8 provides a detailed breakdown of the number of SOPs working in each country spray campaign, as well as the total and average numbers of SOP days, and the average daily wage. Also provided are the total number of campaign days, the total amount of area sprayed (in terms of 100 m^2), and the average amount of area sprayed per SOP day and per campaign day (both also in terms of 100 m^2). There is no noticeable correlation or trend between the number of SOPs or number of SOP days and the amount of area sprayed per SOP day. For example, the three programs spraying the largest area, Ethiopia, Mozambique, and Rwanda, used very different numbers of SOPs in the program spray campaigns, but clearly utilized the most SOP-days. However, the amount of area sprayed per SOP per day for these three countries is relatively close to the average amount sprayed per SOP per day in all countries.

Figure CC9 provides a comparison of efficiency in SOP productivity (measured by area sprayed per SOP per day) and the spray operations cost per 100 m^2 sprayed. The graph is sorted by the amount spent for spray operations per 100 m^2 sprayed, with countries spending less on the left and countries spending relatively more on the right. The red dots in Figure CC9 represent the average area sprayed per SOP per day for each country.

FIGURE CC9: SPRAY OPERATIONS EFFICIENCY AND COST PER AREA SPRAYED

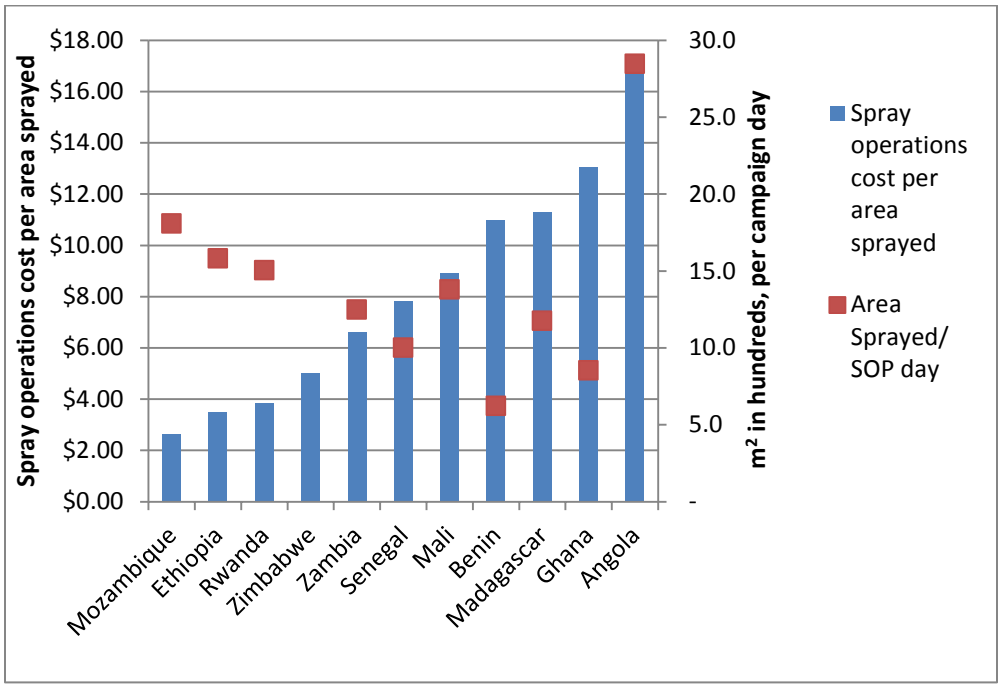


Figure CC9 suggests that countries with higher SOP productivity tend to have lower spray operations per 100 m^2 sprayed, although other factors are also involved. The countries with the lowest spray operations cost per 100 m^2 sprayed (Mozambique, Ethiopia, and Rwanda) had three of the four highest SOP efficiency. Mozambique and Ethiopia also had among the lowest daily wages for SOPs among the countries. The country with the highest area sprayed per SOP per day was Angola. In Angola, while productivity is high, the daily wage of SOPs is also much higher than in other countries. It should be noted that wages for SOPs reflect only, on average, 8% of spray operations costs – thus the decreased spray operations associated with greater area sprayed per SOP per day likely reflect overall efficiencies in spray operations.

Efficiency in operations is only partly amenable to changes; as noted above, geography, transportation infrastructure, housing density, etc. also affect the ability of SOPs to spray. For example, spray operations cost per 100 m^2 sprayed for Madagascar is almost three times greater than Rwanda's, while SOPs spray 78 percent as much area per day in Madagascar as Rwanda. Madagascar's geographical coverage area is more spread out than Rwanda's, and its program incurred over 50 percent higher transportation costs then the Rwanda program ($3.84 per 100 m^2 sprayed in Madagascar vs. $1.11 per 100 m^2 sprayed in Rwanda), as well as higher costs for lodging ($0.39 vs. $0.03) and per diems ($0.62 vs. $0.03).

Transportation, lodging and per diems account for 56 percent of the difference in the spray operations costs per 100 m^2 sprayed between the two countries, while recruitment and payment of SOPs and other seasonal labor account for 21 percent of the difference in the spray operations costs per 100 m^2 sprayed between the two countries – which is of a similar magnitude as the difference in the area sprayed per SOP per day (training, administration, and equipment make up the remainder of the difference).

3.4.4 Local Full-time Staff Labor

The last major cost driver of country unit costs per 100 m^2 sprayed is local labor. Local labor includes the country site office full-time staff members. It does not include seasonal workers who are hired during the spray campaign. Thus, while local full-time staff labor is a major cost driver, it is also a step-variable cost. This means that the local labor portion of the cost per area sprayed is related to the size of the IRS program, but the number of staff hired is not directly related to the number of structures sprayed because there is a minimum number of staff required to run even the smaller programs. Temporary labor of the spray operators, on the other hand, is included in the spray team cost category and is a variable cost directly related to the number of structures sprayed. Table CC9 lists the number of full-time local staff members based in the field office of each country.

TABLE CC9: TOTAL FULL-TIME LOCAL STAFF MEMBERS

Large Programs	# Local Staff	Medium Programs	# Local Staff	Small Programs	# Local Staff
Ethiopia	22	Mali	18	Angola	12
Mozambique	21	Ghana	22		
Zambia	27	Senegal	19		
Madagascar	37	Zimbabwe	10		
Rwanda	17				
Benin	13				

The average number of local full-time staff across all country programs is 19.8. The number of full-time staff is variable based on programmatic and operational needs specific to each country, and the program size in terms of number of structures sprayed.

FIGURE CC10: LOCAL LABOR PORTION OF COST PER AREA SPRAYED

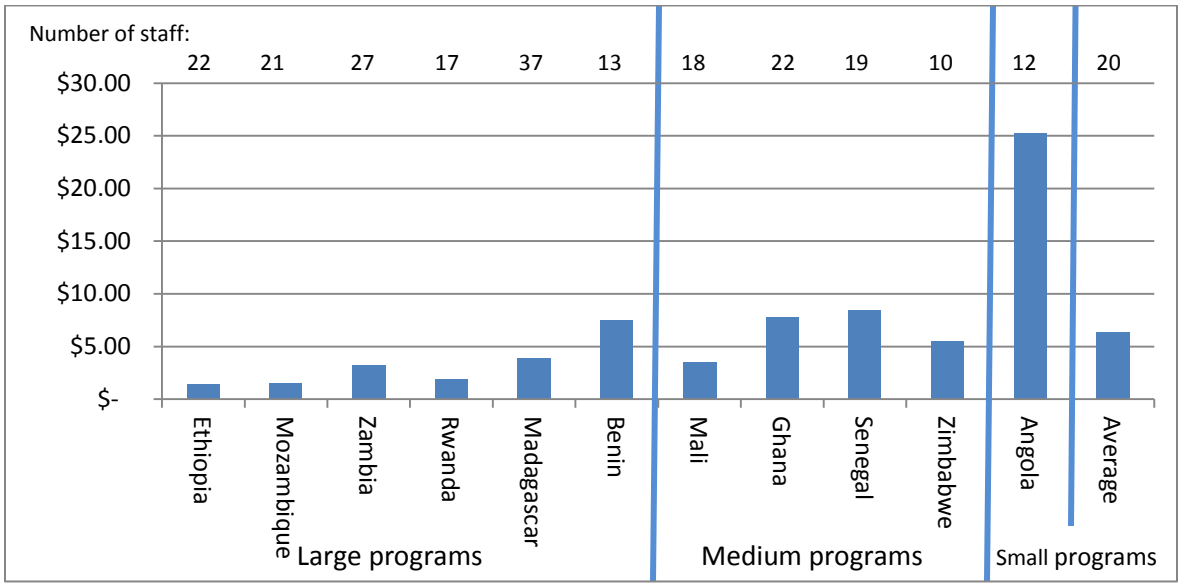


Figure CC10 shows the local labor portion of the unit costs per area sprayed (100 m^2), ranging from $1.43 in Ethiopia to $25.24 in Angola, with an average of $6.33. The figure shows that unlike the actual number of staff members, the unit cost of local labor per area sprayed tends to be lower for larger programs and higher for smaller programs.

TABLE CC10: LOCAL FULL-TIME LABOR IMPACT ON PROGRAM UNIT COSTS

Country	Total Local Labor Hours	Total Local Labor Cost	Avg. Cost per Labor Hour	Labor hours per Area sprayed	Local Labor Cost per Area Sprayed	Local Labor % per Area Sprayed
Ethiopia	38,111	895,303	23.49	0.06	1.43	10%
Mozambique	38,559	1,341,262	34.79	0.04	1.50	23%
Zambia	28,129	889,716	31.63	0.10	3.16	13%
Rwanda	33,170	916,556	27.63	0.07	1.90	12%
Madagascar	77,886	890,411	11.43	0.34	3.88	17%
Benin	24,106	821,588	34.08	0.22	7.43	23%
Mali	26,561	783,592	29.50	0.12	3.48	14%
Ghana	40,791	879,255	21.56	0.36	7.82	21%
Senegal	31,868	1,261,106	39.57	0.21	8.38	27%
Zimbabwe	16,595	911,163	54.91	0.10	5.44	19%
Angola	21,425	1,393,271	65.03	0.39	25.24	44%
Average	**34,291**	**$ 998,475**	**$ 33.97**	**0.18**	**$ 6.33**	**20%**

Table CC10 shows that the full-time local labor portions of the cost per area sprayed are highest for Angola (44 percent), Senegal, and Mozambique (27 and 23 percent, respectively). Angola, Ghana, and Madagascar have the highest number of local labor hours per 100 m^2 sprayed.

FIGURE CC11: LOCAL LABOR PRICE VERSUS QUANTITY ANALYSIS

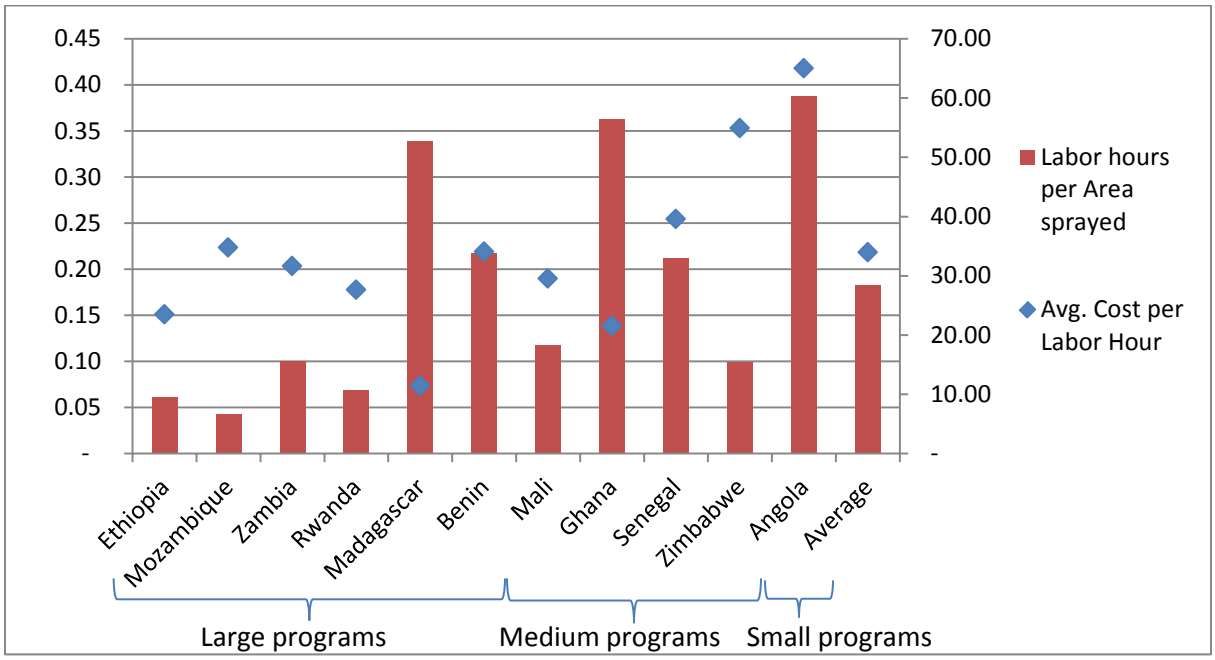


Figure CC11 presents an analysis of the local labor price versus quantity impact on country programs. The average cost per local labor hour is calculated by the total program expenditures of local labor divided by the total local labor hours worked. Labor hours per 100 m^2 sprayed is calculated by the total local labor hours worked divided by the amount of area sprayed. The average cost per labor hour (blue dots) provides a representation of the variation in labor prices across countries, while the labor hours per area sprayed in 100 m^2 (red bars) provides a representation of quantity of labor across countries.

Angola, which has both the highest number of local labor hours per 100 m^2 sprayed and highest hourly wages, has the highest local labor cost per 100 m^2 sprayed. Senegal has both higher than average local labor hours per 100 m^2 sprayed and hourly wages, and thus has higher than average local labor costs per 100 m^2 sprayed. This contrasts with Mali, where more structures and area were sprayed, but the country employed one less local labor staff (with salaries about $10 per hour lower than in Senegal). Thus, Mali achieved better efficiency than average in terms of labor hours and local labor costs per 100 m^2 sprayed.

Figure CC12 also suggests that countries with large programs spend fewer labor hours per area sprayed than countries with smaller programs. The average number of hours spent in the large country programs was about 8.2 minutes per 100 m^2 sprayed, while it was about 11.9 minutes in the medium program countries.

3.5 CONCLUSIONS

Unit of Measure

As in past reports, we use area sprayed as the unit for comparing costs across countries. However, the true area sprayed is not measured routinely in AIRS country programs. **Rather, we estimate the area sprayed based on the amount of insecticide used; thus, we are, in actuality, comparing the cost of programs per unit of insecticide used.** While this remains, in our opinion, the best metric available for comparing between countries, there still remains the possibility for differences in the efficiency of insecticide use between countries (due to differing spray equipment, etc.) that affect the comparisons. Further, the efficacy of use may change over time; for example, there may be higher efficiency in terms of flow rate when spray pumps are equipped with a control flow valve (CFV), such as those that come standard on Goizper pumps. Thus, some degree of inaccuracy in the comparisons is possible, and should be kept in mind when reading the results. For the country-specific chapters, we use the number of structures sprayed for comparison.

Program Scale

Broadly speaking, we find, similar to previous years, that unit costs for large programs are lower than for small programs (although larger programs tend to cost more in total). Using the most standardized comparison unit cost available, there is no 'one-price-fits-all' for IRS across countries. Large-sized programs averaged a cost per 100 m^2 sprayed of $19.27, and medium programs averaged $30.46.

There are some fixed costs for IRS programs which are not correlated to program scale, such as local administration and U.S.-based labor, which constitute an average of 9 percent ($177,400 to $797,000) and 7 percent ($177,100 to $490,000) of the cost per 100 m^2 sprayed, respectively.

Two of the important IRS program cost drivers, spray operations and local labor, constitute an average of 30 percent and 23 percent of the cost per area sprayed, respectively. Spray operations and local labor are both correlated with program scale (although there is a minimum level of local labor needed for any program). Programs with outlier costs in these areas are due to specific country context: geography of spray coverage area, number of spray rounds per year, and general cost of living (prices for labor, fuel, etc.).

Insecticide

The insecticides used in spray campaigns is the second largest cost category across the IRS programs when looking at the cost per 100 m^2 sprayed; it is the largest cost category when assessing total expenditures. The costs for insecticides will continue to be increasingly important as the threat of insecticide resistance prompts IRS programs to switch to more expensive classes of insecticide. The insecticide portion of the cost per area sprayed constitutes an average of 28 percent of the total unit cost across country programs.

4. Year-on-Year Comparison

4.1 Changes in IRS Programs from 2012 to 2014

As an IRS program matures, lessons are learned, efficiencies are realized, and needs change. This section provides an overview of the major changes in countries' IRS programs across the years, focusing on changes from 2013 to 2014.

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

Program Size	2012	2013	2014
Large	Ethiopia Mozambique Rwanda Madagascar Ghana Senegal	Ethiopia Mozambique Rwanda Madagascar	Ethiopia Mozambique Rwanda Zambia Madagascar Benin
Medium	Mali Benin Angola Liberia	Mali Benin Ghana Senegal	Mali Ghana Senegal Zimbabwe
Small	Nigeria Burkina Faso	Nigeria Angola Liberia	Angola

As discussed in Section 3.1, program size is based on the number of structures sprayed by an IRS program. In 2014, two new countries were added: Zambia as a large program and Zimbabwe as a medium program, and AIRS-supported IRS stopped in Nigeria and Liberia.

Table YR2 provides details on the changes in output measures for all country programs, and Table YR 3 shows the changes in unit costs across the three years. For more information, a comprehensive discussion of the changes in each country program is provided at the end of each individual country chapter.

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

	People Protected				Structures Sprayed				Area Sprayed (100 m^2)			
Country	**2012**	**2013**	**2014**	**Percent Change 2013-2014**	**2012**	**2013**	**2014**	**Percent Change 2013-2014**	**2012**	**2013**	**2014**	**Percent Change 2013-2014**
Ethiopia	1,506,273	1,629,958	1,647,099	1%	547,421	635,528	667,236	5%	524,334	617,442	624,764	1%
Mozambique	2,716,176	2,181,896	2,327,815	7%	536,558	414,232	445,118	7%	974,470	822,735	892,018	8%
Zambia			2,000,824				409,544				281,508	
Rwanda	1,025,181	1,479,342	1,217,837	-18%	236,610	345,862	297,005	-14%	332,522	529,940	482,958	-9%
Madagascar	1,781,990	1,588,138	1,307,384	-18%	371,391	343,470	274,533	-20%	221,418	198,985	229,240	15%
Benin	762,146	694,729	789,883	14%	206,295	228,951	254,072	11%	192,968	125,605	110,505	-12%
Avg. Large Programs	1,558,353	1,514,813	1,548,474	-3%	379,655	393,609	391,251	-2%	449,142	458,941	436,832	1%
Mali	762,146	850,104	836,568	-2%	206,295	228,985	228,123	0%	192,968	233,588	224,868	-4%
Ghana	941,240	534,060	570,572	7%	355,278	197,655	205,230	4%	193,220	108,210	112,370	4%
Senegal	1,095,093	690,029	708,999	3%	306,916	207,116	204,159	-1%	267,185	162,623	150,465	-7%
Zimbabwe			334,746				147,949				167,600	
Avg. Medium Programs	932,826	691,398	612,721	3%	289,496	211,252	196,365	1%	217,791	168,140	163,826	-2%
Angola	676,090	419,353	58,370	-86%	141,782	98,136	14,649	-85%	195,518	107,140	55,200	-48%
Avg. Small Programs	676,090	419,353	58,370	-86%	141,782	98,136	14,649	-85%	195,518	107,140	55,200	-48%

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

	People Protected				Structures Sprayed				Area Sprayed (100 m^2)			
Country	**2012**	**2013**	**2014**	**Percent Change 2013-2014**	**2012**	**2013**	**2014**	**Percent Change 2013-2014**	**2012**	**2013**	**2014**	**Percent Change 2013-2014**
Ethiopia	$ 2.97	$ 4.69	$ 5.33	14%	$ 8.18	$ 12.02	$ 13.16	9%	$ 8.54	$ 12.37	$ 14.05	14%
Mozambique	$ 1.92	$ 2.46	$ 2.46	0%	$ 9.69	$ 12.96	$ 12.88	-1%	$ 5.34	$ 6.52	$ 6.43	-1%
Zambia			$ 3.45				$ 16.87				$ 24.55	
Rwanda	$ 4.08	$ 4.44	$ 6.37	43%	$ 17.67	$ 19.00	$ 26.13	37%	$ 12.57	$ 12.40	$ 16.07	30%
Madagascar	$ 2.82	$ 4.79	$ 3.97	-17%	$ 13.54	$ 22.13	$ 18.88	-15%	$ 22.72	$ 38.20	$ 22.61	-41%
Benin	$ 4.70	$ 5.87	$ 4.46	-24%	$ 17.35	$ 17.80	$ 13.88	-22%	$ 18.55	$ 32.44	$ 31.91	-2%
Avg. Large Programs	*$ 3.30*	*$ 4.45*	*$ 4.34*	*3%*	*$ 13.29*	*$ 16.78*	*$ 16.97*	*2%*	*$ 13.54*	*$ 20.39*	*$ 19.27*	*0%*
Mali	$ 6.03	$ 6.99	$ 6.86	-2%	$ 22.28	$ 25.96	$ 25.15	-3%	$ 23.82	$ 25.45	$ 25.52	0%
Ghana	$ 5.21	$ 8.19	$ 7.30	-11%	$ 13.81	$ 22.14	$ 20.30	-8%	$ 25.40	$ 40.44	$ 37.08	-8%
Senegal	$ 4.38	$ 7.18	$ 6.54	-9%	$ 15.62	$ 23.94	$ 22.71	-5%	$ 17.95	$ 30.49	$ 30.81	1%
Zimbabwe			$ 14.23				$ 32.19				$ 28.41	
Avg. Medium Programs	*$ 5.21*	*$ 7.46*	*$ 8.64*	*-7%*	*$ 17.24*	*$ 24.01*	*$ 24.88*	*-6%*	*$ 22.39*	*$ 32.13*	*$ 30.28*	*-2%*
Angola	$ 4.47	$ 10.69	$ 54.57	410%	$ 21.32	$ 45.68	$217.44	376%	$ 15.46	$ 41.84	$ 57.70	38%
Avg. Small Programs	*$ 4.47*	*$ 10.69*	*$ 54.57*	*410%*	*$ 21.32*	*$ 45.68*	*$217.4*	*376%*	*$ 15.46*	*$ 41.84*	*$ 57.70*	*38%*

Table YR2 provides an overview of each country program's output measures for 2012, 2013, and 2014, as well as the percent change that occurred from 2013 to 2014. Ethiopia, Mozambique, Benin, Ghana and Senegal increased the number of people protected, with all of these countries except Senegal also increasing the number of structures sprayed. Mali's program protected fewer people but sprayed roughly the same number of structures. Madagascar changed part of the target geography for spray activities, and sprayed fewer structures. Ethiopia, Mozambique, Madagascar, and Ghana increased the area sprayed. Benin increased the number of structures sprayed while decreasing the amount of insecticide used.

In Table YR3, all country unit costs increased in 2013 compared to 2012 for all three unit costs presented with the exception of Rwanda, where the cost per area sprayed declined. In 2014, the cost per person protected fell as compared to 2013 in all countries, except Ethiopia, Rwanda, Angola, and Mozambique (where it was unchanged). Angola's 2014 program was much smaller than in previous years, spreading fixed costs over fewer people. Ethiopia procured more insecticides than were used; in 2013 it used about 77 percent of the insecticide procured, while in 2014 it used about 63 percent of the insecticide procured, and thus insecticide costs account for about 50 percent of the increase in cost per person protected. Increases in local labor and commodities explain the other 50 percent of the increase in the unit costs, as detailed in the Ethiopia chapter below.

The cost per structure sprayed decreased across countries, excluding Ethiopia, Angola and Rwanda, in similar patterns to the cost per person protected. The cost per 100 m^2 sprayed decreased in large-sized program countries on the same order of magnitude as well. In medium-sized campaign countries, cost per 100 m^2 sprayed decreased only in Ghana, while rising slightly in Mali and Senegal.

A detailed discussion of the changes in each country program is included in the individual country chapters. Figure YR1 below illustrates the cost per 100 m^2 sprayed in 2012, 2013, and 2014. It shows that while cost per area sprayed in 2014 is generally slightly lower or about the same as in 2013, cost per 100 m^2 sprayed in 2012 were almost universally lower, with the exception of Madagascar (where 2014 cost per 100 m^2 sprayed returned to the same level as 2012 cost per 100 m^2 sprayed). The larger increases from 2012 to Years 2 and 3 are seen in Benin, Mali, Ghana, and Senegal – the countries that have switched partially or fully to organophosphates. Madagascar, which also used organophosphates for part of its spray area, saw a spike in 2013 because most of the organophosphates used in 2014 were purchased in 2013.

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

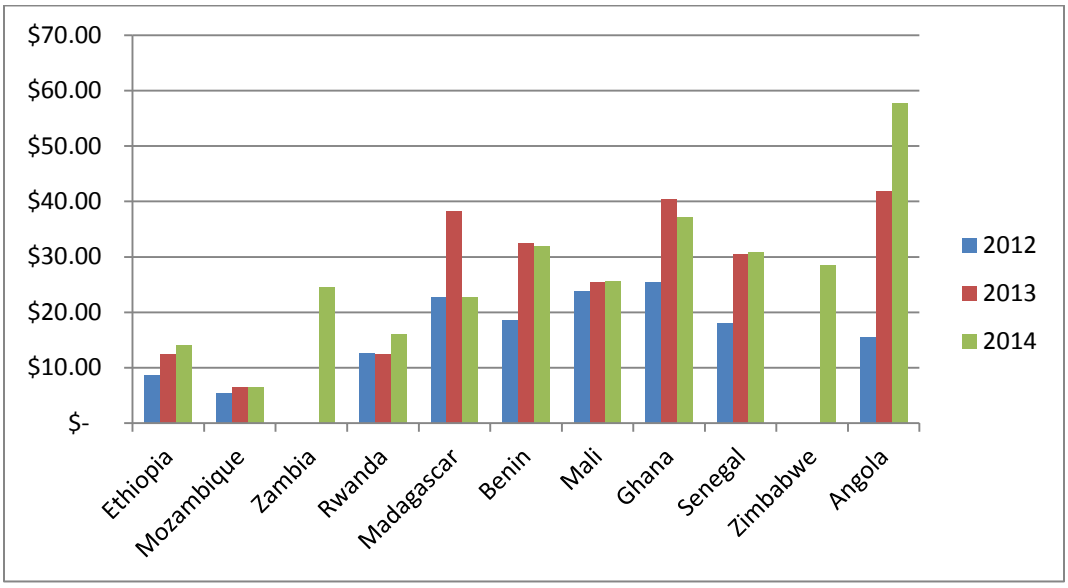


TABLE YR4: INSECTICIDE VERSUS NON-INSECTICIDE COST PER AREA SPRAYED

	Insecticide cost per 100 m^2 sprayed				Non-insecticide cost per 100 m^2 sprayed				Non-insecticide cost per structure sprayed			
Country	**2012**	**2013**	**2014**	**Percent Change 2013-2014**	**2012**	**2013**	**2014**	**Percent Change 2013-2014**	**2012**	**2013**	**2014**	**Percent Change 2013-2014**
Ethiopia	$ 2.27	$ 6.18	$ 7.32	18%	$ 6.27	$ 6.19	$ 6.73	9%	$ 6.01	$ 6.01	$ 6.30	5%
Mozambique	$ 1.22	$ 1.36	$ 0.60	-55%	$ 4.12	$ 5.17	$ 5.82	13%	$ 7.48	$ 10.26	$ 11.66	14%
Zambia			$ 12.05				$ 12.50				$ 8.59	
Rwanda	$ 0.54	$ 2.10	$ 7.60	262%	$ 12.03	$ 10.30	$ 8.47	-18%	$ 16.91	$ 15.79	$ 13.76	-13%
Madagascar	$ 7.05	$ 9.35	$ 0.91	-90%	$ 15.66	$ 28.85	$ 21.70	-25%	$ 9.34	$ 16.71	$ 18.12	8%
Benin	$ 4.01	$ 12.14	$ 8.48	-30%	$ 14.55	$ 20.30	$ 23.43	15%	$ 13.61	$ 11.14	$ 10.19	-9%
Mali	$ 5.82	$ 6.45	$ 9.28	44%	$ 17.99	$ 19.00	$ 16.24	-15%	$ 16.83	$ 19.38	$ 16.01	-17%
Ghana	$ 7.91	$ 11.67	$ 9.35	-20%	$ 17.49	$ 28.77	$ 27.73	-4%	$ 9.51	$ 15.75	$ 15.19	-4%
Senegal	$ 5.09	$ 7.60	$ 9.22	21%	$ 12.85	$ 22.89	$ 21.59	-6%	$ 11.19	$ 17.97	$ 15.91	-11%
Zimbabwe			$ 12.76				$ 15.66				$ 17.74	
Angola	$ 1.46	$ 0.82	$ -	-100%	$ 14.00	$ 41.02	$ 57.70	41%	$ 19.31	$ 44.79	$ 217.44	385%

Table YR4 provides the cost per 100 m^2 sprayed for each country for 2012, 2013, and 2014, but is separated into two portions: one for insecticide costs and one for non-insecticide costs.

For large programs, the non-insecticide cost per 100 m^2 sprayed increased for Ethiopia, Mozambique, and Benin, while they fell for Rwanda and Madagascar. The reasons for each country will be assessed in each country's chapter below. Thus, the lower overall cost per 100 m^2 sprayed in Mozambique and Benin is due to decreased cost of procuring (inclusive of shipment, insurance, etc.) insecticides. Mozambique, Madagascar, and Benin all used more insecticides than were procured. Among medium-sized countries, both Mali and Senegal procured more insecticide than was used, while Ghana used more than was procured. Additionally, Mali and Senegal used organophosphates for the first time. Thus, in Mali and Senegal, insecticide costs per 100 m^2 sprayed increased, while in Ghana the insecticide costs per 100 m^2 sprayed decreased from 2013 to 2014. However, in these countries the non-insecticide costs per 100 m^2 sprayed were lower in 2014 than in 2013. Again, the reasons for each country will be assessed in each country's chapter below, although we note the switch to organophosphates led to deliberate efforts to minimize costs in other areas by shortening the spray campaign, limiting mobilization of communities, etc. Since the decreases in the cost per 100 m^2 sprayed are greater than the change in the coverage, it is likely that these efforts had some effect.

Similar trends are observed when assessing the non-insecticide cost per structure sprayed, with some exceptions. First, while cost per area sprayed declined from 2013 to 2014 in Madagascar, the cost per structure sprayed increased; this may be related to the change in the target spray area. In Benin, the cost per area sprayed increased from 2013 to 2014, while the cost per structure sprayed declined.

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

	Insecticide cost per 100 m^2 sprayed				Non-insecticide cost per 100 m^2 sprayed				Non-insecticide cost per structure sprayed			
Averages*	**2012**	**2013**	**2014**	**Percent Change 2013-2014**	**2012**	**2013**	**2014**	**Percent Change 2013-2014**	**2012**	**2013**	**2014**	**Percent Change 2013-2014**
Avg. Large Programs					$10.53	$14.16	$14.42	2%	$ 10.67	$ 11.98	$ 11.57	-3%
Avg. Medium Programs					$16.11	$23.55	$21.85	-7%	$ 12.51	$ 17.70	$ 15.70	-11%
Avg. Small Programs (Angola)					$14.00	$41.02	$57.70	41%	$ 19.31	$ 44.79	$ 217.44	385%
Avg. Pyrethroids	$1.34	$1.09	$0.30	-72%	$9.06	$23.10	$31.76	38%	$ 13.39	$ 27.52	$ 114.55	316%
Avg. Carbamates	$1.41	$4.14	$7.46	80%	$9.15	$8.25	$7.60	-8%	$ 11.46	$ 10.90	$ 10.03	-8%
Avg. Mixed	$5.99	$7.80	$6.47	-17%	$15.50	$23.58	$19.84	-16%	$ 12.45	$ 18.02	$ 16.68	-7%
Avg. Organophosphates	$5.96	$11.91	$8.91	-25%	$16.02	$24.54	$25.58	4%	$ 11.56	$ 13.44	$ 12.69	-6%

*Zambia and Zimbabwe are excluded from these comparisons because data from 2012 and 2013 are not available for these countries.

Table YR5 provides a summary of average cost per 100 m^2 sprayed for various groups of country programs. For the non-insecticide portion of the cost per area sprayed, countries were grouped by program size, and the average unit cost was calculated (not weighted by the size of the program). Angola saw an increase in non-insecticide costs due to the reduction of its program. On average, non-insecticide costs for medium-sized programs decreased from 2013 to 2014, although they are still above levels observed in 2012. Non-insecticide costs in large program countries increased, on average, by 4 percent from 2013 to 2014. This does not hold true when assessing the non-insecticide cost per structure sprayed, which fell, on average, in countries with large programs between 2013 and 2014.

For the insecticide portion of the cost per area sprayed, country programs were grouped by insecticide class purchased, and the average unit cost was calculated. Cost per area sprayed increased for Ethiopia and Rwanda due to purchasing more insecticide than was used. Total insecticide costs declined for other types of insecticides because of the project's shift from air to sea freight and the consequential cost reductions. In part, this reflects a decline in the unit price of insecticides (inclusive of shipment, insurance, etc.), but it mostly reflects that many countries used more insecticides than they procured in 2014; the trend likely will not continue into the future since there will be less remaining insecticide from previous years for use. Non-insecticide costs for the organophosphate countries increased in Benin and decreased in Ghana (Zambia and Zimbabwe are not included in the calculations since there are not data from previous years); the increase in Benin outweighed the decrease in Ghana.

TABLE YR6: SUMMARY OF CHANGES IN SPRAY OPERATIONS COSTS AND STRUCTURES SPRAYED

Country	2012 to 2013		2013 to 2014	
	Change in spray operations cost	Change in number of structures sprayed	Change in spray operations cost	Change in number of structures sprayed
Ethiopia	36%	16%	-2%	5%
Mozambique	-3%	-23%	33%	7%
Rwanda	56%	46%	-24%	-14%
Madagascar	708%	-8%	-22%	-20%
Benin	4%	11%	-2%	11%
Mali	31%	11%	-17%	0%
Ghana	-13%	-44%	6%	4%
Senegal	-1%	-33%	-26%	-1%
Angola	142%	-31%	-52%	-85%

Table YR6 provides a summary of the changes in the costs, adjusted for inflation, for spray operations from 2012 to 2013 and from 2013 to 2014. Specific numbers are provided in each country chapter below. Additionally, Table YR6 provides the changes in the number of structures

sprayed over the two time periods. From 2013 to 2014, six of the nine countries included saw a lower change in the costs of spray operations than change in the number of structures sprayed. That is, three of these countries (Rwanda, Madagascar, and Senegal) saw the number of structures sprayed decrease, while the spray operations declined by a greater percentage than the decline in the number of structures. For three countries (Ethiopia, Benin, and Mali), the number of structures sprayed increased or stayed the same, while spray operations costs declined.

In Mozambique and Ghana, the number of structures sprayed increased, while spray operations costs increased by a greater percentage. Use of temporary agency services and training account for over 50 percent of the increase in spray operations costs between the two years in Ghana. While the Ghana team decreased the number of spray days and used vehicles more effectively in 2014, the program experienced difficulties with IRS acceptance in several districts, leading to an extension of spray campaign days and multiple additional meetings with locals at the national and community levels. Increased costs for per diems and ground transport account for 44 percent of the increase in spray operations costs in Mozambique. Angola saw the number of structures sprayed decline more than spray operations declined.

5. ANGOLA

5.1 BACKGROUND

2012

In 2012, AIRS implemented IRS in the provinces of Huambo, Huila, and Cunene. Historically, Huambo was the province with the second highest malaria mortality cases in the country, but in 2012, it became the province with the second fewest 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's request to support the Southern African Development Community initiative for malaria elimination in Namibia and reduce introduction of malaria cases from this area.

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.

2013

In 2013, AIRS Angola continued to spray in Huambo, Huila, and Cunene provinces with pyrethroids, based on susceptibility results from April 2013. The campaign had staggered start dates ranging from October 2 in Bailundo, Huambo Province to October 15 in Lubango, Huila Province. The campaign took place over 42 operational days. A total of 98,136 structures were sprayed.

2014

In the third year of the AIRS Angola program, spray operations were scaled back, as agreed between PMI and the Ministry of Health to stop IRS in Cunene and Huila Provinces, but continue to support IRS in Huambo Province in order to concentrate PMI's IRS efforts. In 2014 AIRS Angola only used pyrethroid insecticides remaining from 2013. The campaign took place in the Municipality of Bailundo, Huambo Province over 29 days, starting on October 7, 2014. The campaign sprayed 14,649 structures, protecting 58,370 people. After nine consecutive years of IRS (2005-2014), coverage of 1,083,595 structures and 5,407,696 people protected, PMI ceased its direct financing and implementation of IRS in Angola in favor of focusing on providing technical assistance to provinces or municipalities interested in financing and implementing IRS themselves.

Table AO1 summarizes the spray done in 2012 through 2014.

TABLE AO1: ANGOLA QUICK FACTS

	2012	2013	2014
# Local Staff	20	19	12

Spray Start Date	October 29, 2012	October 2, 2013	October 7, 2014
# Spray Rounds	1	1	1
# Sachets & Bottles Used	78,207	42,856	22,080
# People Protected	676,090	419,353	58,370
# Structures Sprayed	141,782	98,136	14,649
# 100 Square Meters Sprayed	195,518	107,140	55,200

5.2 PROGRAM EXPENDITURES

This section will present an overview of Angola IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		442,316	807,554			194,172	$ 1,444,042	45.3%
Entomology			130,036		396,834	10,808	$ 537,678	16.9%
Environmental Compliance			10,077		6,296	1,286	$ 17,658	0.6%
Equipment Supplies				107,529		28	$ 107,556	3.4%
IEC			7,725		24,015	2,204	$ 33,944	1.1%
Insecticide*							$ -	0.0%
M&E			118,677		14,283	91,448	$ 224,408	7.0%
Post Spray			107,621		69,232	6,226	$ 183,079	5.7%
Spray Campaign			85,791		310,353	5,289	$ 401,433	12.6%
Spray Planning			125,790		102,302	7,356	$ 235,448	7.4%
Grand Total	**$ -**	**$ 442,316**	**$ 1,393,271**	**$ 107,529**	**$ 923,316**	**$ 318,815**	**$ 3,185,246**	100.0%

*No insecticide was procured in 2014; insecticide from 2013 was used.

Table AO2 displays the Angola IRS program total capital and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS Project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the table.

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

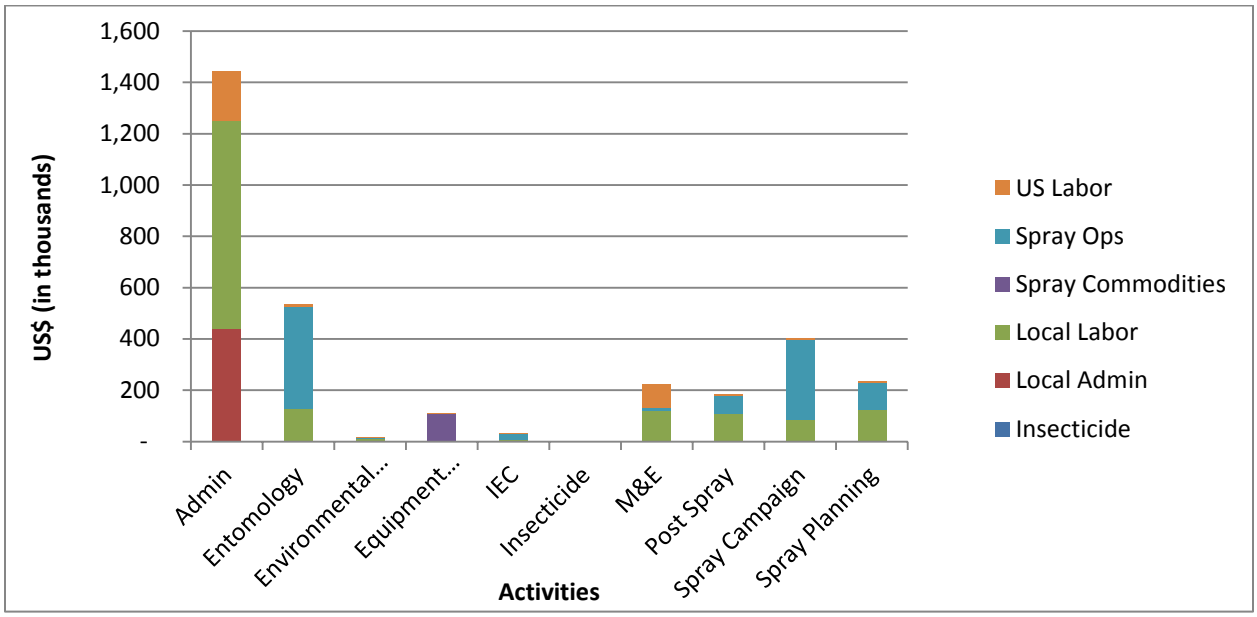


Figure AO1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Local administration represented the largest share of the total costs at 45.3 percent of costs. Entomology and spray campaign costs were the next two largest categories of costs, representing 16.6 and 12.6 percent of costs, respectively. AIRS did not procure insecticide during 2014; the insecticides used were procured in 2013. About 69.4 percent of the total cost for administration consists of labor, both local and U.S.-based.

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

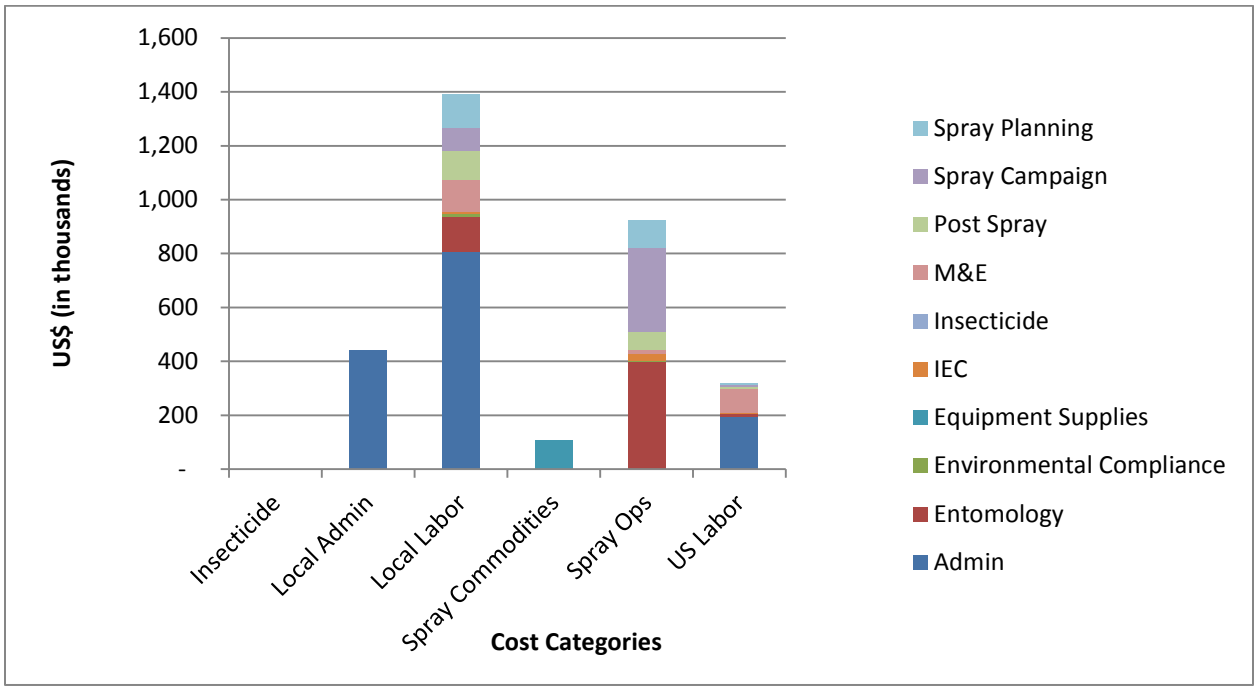


Figure AO2 contains the same information as Figure AO1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on local labor and spray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

5.3 Unit Cost Analysis

This section presents Angola IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE AO3: ANGOLA UNIT COSTS

		Insecticide costs		
		Procured		Used
	Person protected	$ 54.57	$	55.66
Cost per	Structure sprayed	$ 217.44	$	221.80
	100 m^2 sprayed	$ 57.70	$	58.86

The Angola 2014 IRS spray campaign protected 58,370 people from malaria transmission, sprayed 14,649 structures and covered an area of 55,200 m^2. Table AO3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $1.09 in the cost per person protected, $4.36 in the cost per structure sprayed, and $1.16 in the cost per area sprayed, compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 24 percent of the unit cost.

5.4 Comparison Across the Three Years

This section provides a comparison of the Angola IRS program for 2012 through 2014, as implemented by the AIRS Project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, 2012 and 2013 expenditures, excluding insecticides, have been adjusted to real 2014 U.S. dollars to allow for a more accurate comparison.

TABLE AO4: ANGOLA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	676,090	419,353	58,370	-86.1%
Structures Sprayed	141,782	98,136	14,649	-85.1%
Area Sprayed (100 m^2)	195,518	107,140	55,200	-48.5%

Table AO4 compares the year-on-year change in Angola IRS program output measures. In 2014, the program achieved lower coverage on all three indicators used in Table AO3 than in 2013 or 2012. Between 2013 and 2014, the number of people protected decreased 86.1 percent, the number of structures decreased 85.1 percent, while the area sprayed decreased by 48.5 percent.

TABLE AO5: ANGOLA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	285,759	87,577	-	-100%
Local Admin	396,554	491,882	442,316	-10.1%
Local Labor	1,192,003	1,521,898	1,393,271	-8.5%
Spray Operations	801,148	1,938,496	923,316	-52.4%
Commodities	83,483	108,450	107,529	-0.8%
U.S. Labor	264,081	334,588	318,815	-4.7%
TOTAL	**$ 3,023,028**	**$ 4,482,890**	**$ 3,185,246**	**-28.9%**

Table AO5, above, compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 28.9 percent from 2013 to 2014 (total expenditures in 2014 were similar to those in 2012), representing a decrease in the total annual cost of $1,297,644. Expenditures in all categories declined. Costs for insecticide dropped 100 percent from 2013 to 2014; when considering the cost for the insecticide used, costs in 2014 were about 48 percent lower in 2014 than in 2013 (22,080 sachets in 2014 vs. 42,856 sachets in 2013). The largest decline between the years in terms of total expenditures was for spray operations, which was $1,015,180 less in 2014 than in 2013 (constituting 78 percent of the total decline in costs between the two years).

TABLE AO6: ANGOLA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 4.47	$ 10.69	$ 54.57	410.5%
Per Structure Sprayed	$ 21.32	$ 45.68	$ 217.44	376.0%
Per Area Sprayed	$ 15.46	$ 41.84	$ 57.70	37.9%

Table AO6 shows the program unit costs across the three years. Because the program size decreased (for all measured in Table AO6) more than the total expenditures decreased from 2013 to 2014, the unit costs increased: by about 410 percent for cost per person protected, 376 percent for cost per structure sprayed, and about 38 percent for cost per area sprayed. These

sharp increases in unit costs are a reflection of lost economies of scale as a result of the sharply reduced number of structures sprayed.

TABLE AO7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	13,859	8,145	-41%	1,939	-76%
Number of other seasonal laborers	671	284	-58%	50	-82%
Number of structures sprayed	141,782	98,136	-31%	14,649	-85%
Structures sprayed per SOP per day	10.23	12.05	18%	7.55	-37%
Spray operations cost per SOP Day	218.13	237.99	9%	476.18	100%
Spray operations and commodities cost per structure sprayed	8.25	21.75	163%	70.37	224%
Spray operations and commodities cost per structure sprayed (without insecticide)	6.24	20.86	234%	70.37	237%

Table AO7 displays various measures of implementation efficiency across the three years. In 2014, the SOPs sprayed 37 percent fewer structures per day than they did in 2013. The cost of spray operations and commodities consequently increased by more than threefold per structure sprayed over the two years.

6. Benin

6.1 Background

2012

In Benin, IRS campaigns using carbamate insecticides were funded through PMI for four years prior to the start of the AIRS Project

In 2012 (2012), AIRS Benin completed IRS in all of Atacora Region's nine districts: Boukoumbé, Cobli, Kérou, Kouandé, Matéri, Natitingou, Péhunco, Tanguéita, and Toucountouna. This was the first IRS campaign in both Péhunco and Kérou. The campaign used a carbamate class of insecticide. The IRS campaign was completed in 35 days. The spray coverage area included one peri-urban area of about 70,000 people, with the other 580,000 people protected living in small villages. The need to travel to these villages is reflected in the cost of ground transportation. Entomological monitoring activities were subcontracted to the Entomological Research Center of Cotonou (CREC), a research firm associated with the University of Benin. Beginning in 2013, PMI directly subcontracted CREC for entomological monitoring activities.

2013

AIRS Benin carried out the 2013 IRS campaign over 32 in 2013. The IRS campaign again covered all nine districts in Atacora Department.

Organophosphate class (Actellic EC) insecticide was used in 2013 for the first time in Benin for an IRS campaign (the EC formulation was used since the CS one was not approved by WHOPES yet). Organophosphate was selected based on entomological surveillance data collected after the 2012 IRS campaign, which showed that the malaria vectors had become less susceptible to carbamates. For 2013's IRS campaign, 21,180 bottles of organophosphates were used in five districts (Cobly, Kouandé, Matéri, Tanguiéta, and Toucountouna) and 29,062 sachets of carbamates were used in four districts (Boukoumbé, Kérou, Natitingou, and Péhunco).

2014

In 2014, the Project continued in all nine districts in Atacora; organophosphate class (remaining Actellic EC for the central subdistricts and CS formulation in all villages) insecticide was used in all areas where IRS was implemented. The campaign was completed in 20 days, 12 days less than in 2013. The shorter length of campaign meant that more SOPs were hired – 988 SOPs were hired in 2014 compared with 493 in 2013 and 495 in 2012. In 2014, 44,202 bottles of Actellic EC and CS were used.

Table BN1 summarizes the spray done in 2012 through 2014.

TABLE BN1: BENIN QUICK FACTS

	2012	2013	2014
# Local Staff	13	13	13
Spray Start Date	May 14, 2012	May 20, 2013	May 4, 2014
# Spray Rounds	1	1	1
# Sachets & Bottles Used	50,842	50,242	44,202
# People Protected	652,777	694,729	789,883
# Structures Sprayed	210,380	228,951	254,072
# 100 Square Meters Sprayed	127,105	125,605	110,505

6.2 PROGRAM EXPENDITURES

This section will present an overview of Benin IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		177,413	405,431			106,967	**$ 689,811**	19.6%
Entomology			20,488		1,365	1,911	**$ 23,764**	0.7%
Environmental Compliance			84,772		40,536	10,947	**$ 136,256**	3.9%
Equipment Supplies			8,861	200,914		1,818	**$ 211,592**	6.0%
IEC			12,111			932	**$ 13,043**	0.4%
Insecticide	937,104						**$ 937,104**	26.6%
M&E			59,331		12,215	25,486	**$ 97,032**	2.8%
Post Spray			89,551			6,668	**$ 96,219**	2.7%
Spray Campaign			29,163		1,118,266	12,339	**$ 1,159,768**	32.9%
Spray Planning			111,881		39,551	10,111	**$ 161,542**	4.6%
Grand Total	**$ 937,104**	**$ 177,413**	**$ 821,588**	**$ 200,914**	**$ 1,211,934**	**$ 177,180**	**$ 3,526,131**	100.0%

Table BN2 displays the Benin IRS program total capital and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS Project's financial systems, and the top row lists IRS program cost categories. The following two figures illustrate the cost breakdown in the table.

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

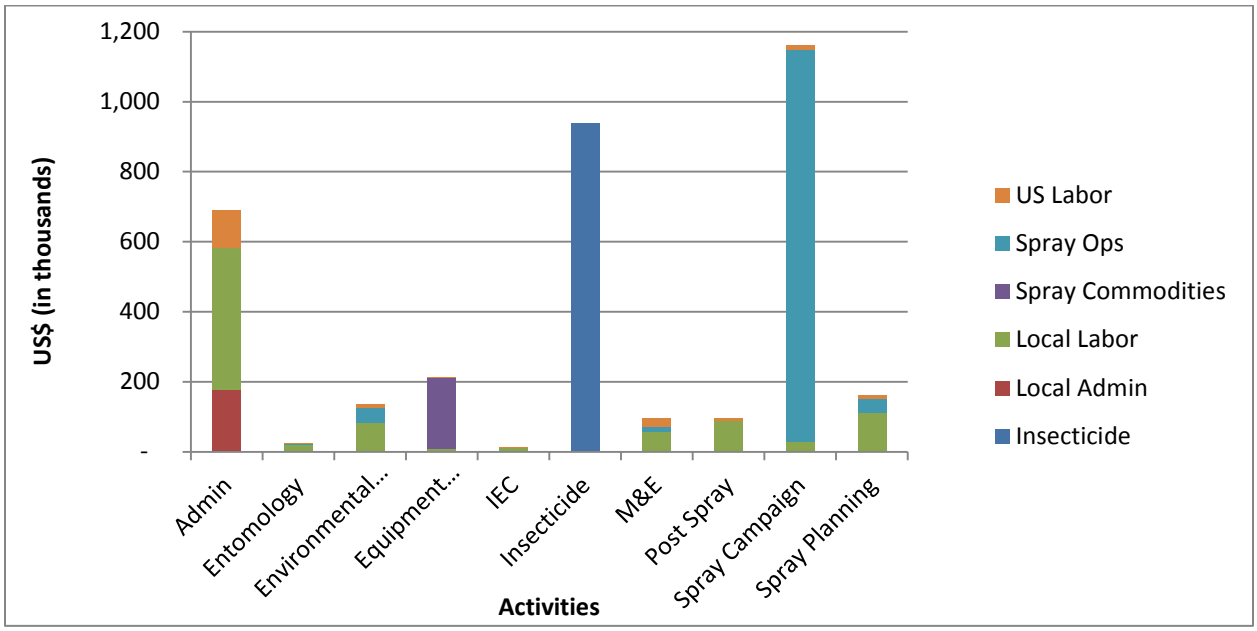


Figure BN1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). The spray campaign is the most expensive IRS activity (32.9 percent of expenditures), followed by the insecticides themselves (26.6 percent of expenditures) and local administrative activities (19.6 percent of expenditures). AIRS Benin procured 33,480 bottles of insecticide, or about 75 percent of the total amount used (since there was remaining stock from the previous year). About 74 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 (74 percent of US labor expenditures are in the two categories).

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

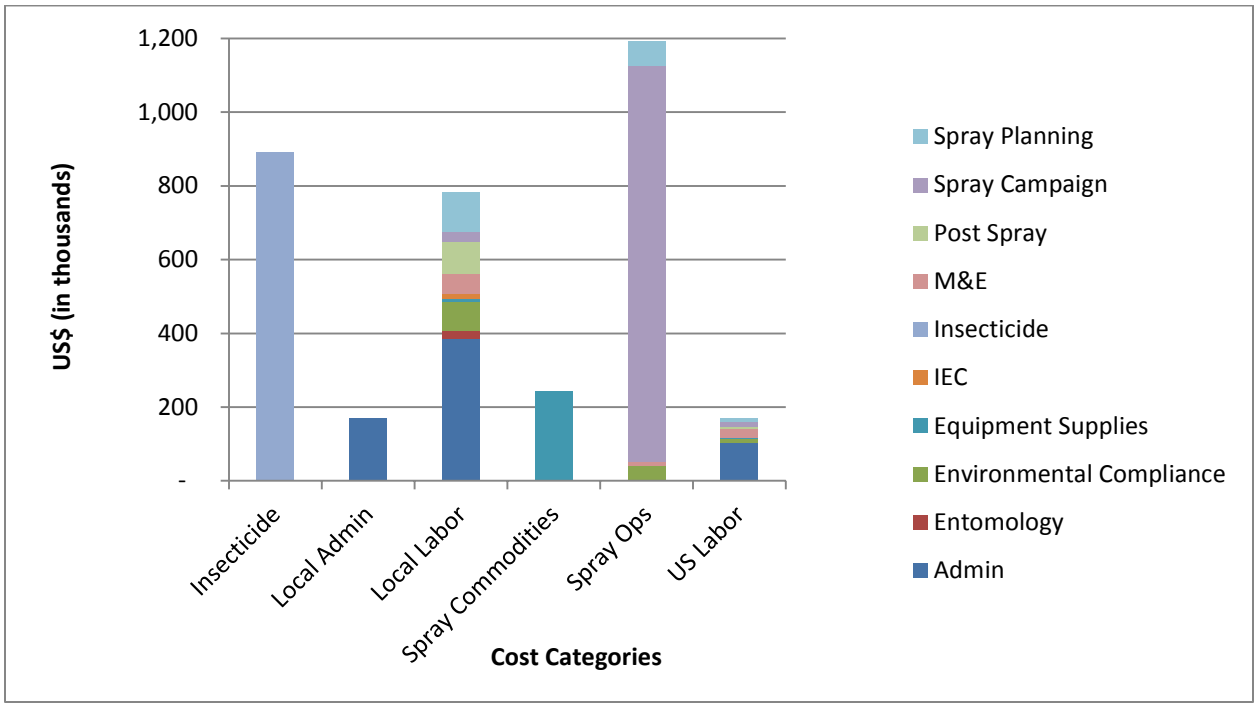


Figure BN2 contains the same information as Figure BN1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor,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

6.3 Unit Cost Analysis

This section presents Benin IRS as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE BN3: BENIN UNIT COSTS

		Insecticide costs			
		Procured		Used	
Cost per	Person protected	$	4.46	$	14.47
	Structure sprayed	$	13.88	$	45.00
	100 m^2 sprayed	$	31.91	$	103.46

In 2014, the Benin IRS campaign protected 789,883 people from malaria transmission, sprayed 254,072 structures and covered an area of 110,505 m^2. Table BN3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $10.01 in the cost per person protected, $31.12 in the cost per structure sprayed, and $71.55 in the cost per area sprayed,

compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 2.2 percent of the unit cost. Insecticide is the largest category of expenditures at 77.4 percent, followed by spray campaign cost at 10.1 percent and administration at 6 percent.

6.4 COMPARISON ACROSS THE THREE YEARS

This section provides a comparison of the AIRS Benin IRS program for 2012 through 2014, as implemented by the PMI AIRS Project. The comparison focuses on output measures, total expenditures, and unit costs.

TABLE BN4: BENIN IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	762,146	694,729	789,883	13.7%
Structures Sprayed	206,295	228,951	254,072	11.0%
Area Sprayed (100 m^2)	192,968	125,605	110,505	-12.0%

Table BN4, above, compares the year-on-year change in Benin IRS program output measures. Overall, in 2014, the program sprayed more structures and protected more people than in either 2012 or 2013, growing for both metrics by over 10 percent from 2013 to 2014. As shown in Table BN1 in the Background, the average size of the structures sprayed in 2014 was 43.5 m^2 compared to 54.9 m^2 in the previous year, and the decrease in average size of a structure explains why the area sprayed dropped from 2013 to 2014 while the number of structures sprayed increased slightly. An alternative explanation could be the method used to calculate area sprayed. That is, the calculation assumes 250 m^2 per bottle or sachet..

TABLE BN5: BENIN IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	772,932	1,525,209	937,104	-39%
Local Admin	189,632	252,405	177,413	-29.7%
Local Labor	1,082,097	694,245	821,588	18.3%
Spray Operations	1,180,374	1,233,131	1,211,934	-1.7%
Commodities	157,323	137,803	200,914	45.8%
U.S. Labor	197,889	232,426	177,180	-23.8%
TOTAL	**$ 3,580,246**	**$ 4,075,221**	**$ 3,526,131**	**-13.5%**

Table BN5, above, compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 13.5 percent from 2013 to 2014 (total expenditures in 2014 were also less than in 2012), while spraying more structures and protecting more people. However, when looking at the change in expenditures by cost category, reduced costs for insecticides are, in total, about three-quarters of the reduction in the total costs between the years. The main reasons the cost of insecticide decreased include:

(i) While four districts used the less expensive carbamates in 2013, in 2014 only about 75 percent of the insecticides used were paid for in 2014 (the remainder was left in stock from 2013; similarly in 2013 some carbamate insecticide was used that was procured in 2012);

(ii) The program in 2014 used about 12 percent fewer bottles/sachets of insecticide; and

(iii) The procurement price per bottle (inclusive of shipment, insurance, etc.) of organophosphates was lower in 2014 than in 2013.

The main reason the cost of insecticide increased from 2012 to 2013 was the change from all districts spraying carbamate insecticides to five districts spraying Actellic EC.

The shorter timeframe used for the spray campaign in 2014 appears to have saved money, with the costs for spray operations decreasing by almost $21,000 (about 1.7 percent less than 2013 spray operation costs). However, the costs for commodities increased by over $63,000 between 2013 and 2014, offsetting the savings in spray operations. Increased expenditures for SOP personal equipment (gloves, boots, etc.) constituted the majority (about 60 percent) of the increase in the cost of commodities, followed by the purchase of spray pumps.

Local labor costs increased by about $127,000, but a decrease in administration costs of about $75,000 partly balanced the increased labor costs. In addition to the overall program growing slightly, the cost increases in local labor and spray commodities were not large enough to offset the total decreased insecticide costs, so the overall program expenditures decreased by 13.5%.

TABLE BN6: BENIN IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 4.70	$ 5.87	$ 4.46	-23.9%
Per Structure Sprayed	$ 17.35	$ 17.80	$ 13.88	-22.0%
Per Area Sprayed	$ 18.55	$ 32.44	$ 31.91	-1.7%

Table BN6 shows the program unit costs across the three years. Because the program size increased (in terms of structures sprayed and people protected) while the total expenditures decreased from 2013 to 2014, the unit costs also decreased. For the cost per person protected

and per structure sprayed, costs decreased by about 24 percent from 2013 to 2014; both unit cost numbers in 2014 are the lowest amongst the years presented. As noted previously, the area spayed went down from 2013 to 2014; this lower volume was offset by lower total costs, so that the cost per 100 m^2 sprayed in 2014 was about 1.7 percent lower than in 2013. However, this decrease was due to lower costs for insecticide procurement; non-insecticide costs increased 15% from 2013 to 2014. The increase in non-insecticide costs is mainly due to a 66% increase in the cost of commodities from $1.10 per 100 m^2 sprayed in 2013 to $1.82 per 100 m^2 sprayed in 2014 (due largely to procurement of new or replacement personal protective equipment). Local administrative and US labor unit costs per 100 m^2 sprayed decreased by 20% and 13%, respectively.

TABLE BN7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	17,325	15,776	-9%	17,760	13%
Number of other seasonal laborers	330	311	-6%	411	32%
Number of structures sprayed	206,295	228,951	11%	254,072	11%
Structures sprayed per SOP per day	11.9	14.5	22%	14.3	-1%
Spray operations cost per SOP Day	206.65	78.17	-62%	68.24	-13%
Spray operations and commodities cost per structure sprayed	10.23	12.65	24%	9.25	-27%
Spray operations and commodities cost per structure sprayed (without insecticide)	6.48	5.99	-8%	5.56	-7%

Table BN7 displays various measures of implementation efficiency across the three years. As mentioned above, of particular note is the change in the implementation model from 2013 to 2014 to hire more SOPs but for a shorter period of time. While from 2012 to 2013 the number of SOP-days used for the campaign decreased by 9 percent, the number of structures sprayed increased by 11 percent, resulting in more structures sprayed per operator per day (11.9 structures per SOP per day in 2012 vs. 14.5 structures per SOP per day in 2013). In 2014 more total SOP days were employed, spraying more structures, than in 2013, resulting in about 14.3 structures sprayed per operator per day. However, the spray operation cost per SOP per day decreased by about 13 percent from 2013 to 2014, reflecting the fact that total spray operation costs declined over the two years, but there were more SOP-days utilized in 2014. Similarly, 2014 utilized more seasonal labor (excluding SOPs) than the other years, but again for a shortened period of time (indicating the person-days of employment for other seasonal labor fell from 2013 to 2014). As noted above, the commodities cost incurred in 2014 offset the lower operations costs, but not enough to prevent total expenditures from decreasing from 2013 to 2014. As shown in the last row of Table BN7, spray operations and commodities costs (excluding insecticides) per structure sprayed decreased year-on-year over the three years. From 2013 to

2014, the decrease in spray operation costs were enough to compensate for the combination of increased commodity costs, so operations and commodity costs per structure sprayed decreased over the two years by 7 percent.

7. Ethiopia

7.1 Background

2012

In 2012, AIRS Ethiopia's spray campaign covered 36 districts in Oromia Region in two rounds of spraying. The spray campaign was completed in 19 districts using deltamethrin from the pyrethroid class of insecticides and in 17 additional districts using bendiocarb, an insecticide from the carbamate class. In addition, PMI provided 24 districts that graduated from PMI support in 2011 with boots and personal protective equipment. The Government of Ethiopia supplied pyrethroid insecticides and warehousing space to use in the first spray round. Carbamate insecticides were procured directly by PMI.

2013

AIRS Ethiopia conducted only one round of spraying, using carbamate insecticides, in 2013. As in 2012, carbamate insecticides were procured directly by PMI. AIRS completed operations in the same 36 districts as in the previous year over a total of 37 days between August 15 and September 27, 2013. In 30 districts, the district health office, with technical and logistic support from the AIRS project, was responsible for implementing all planning, training, and spraying activities and ensuring environmental compliance. In six other districts, the responsibility for training spray operators and for planning and implementing the spray operation was decentralized to the village level and specifically to health extension workers.

AIRS also provided technical and logistics support to non-PMI districts including training on environmental compliance, and supplying PPE, spray pumps, and 72,000 sachets of carbamate insecticide. These costs are excluded from the 2013 expenditures used for the analysis.

2014

In 2014, AIRS Ethiopia continued to implement one round of spraying using carbamates in 36 districts. PMI directly procured 499,800 sachets of bendiocarb insecticide; the costs have been included here in order to have a complete depiction of the IRS program. In total, 62.5 percent, or 312,382 sachets, of purchased insecticide were used in the 44 operational days of the campaign. "Community-based IRS," in which health extension workers assume responsibility for overseeing spray operations and training, was continued in the same six districts where it was implemented in 2013.

Table ET1 summarizes the spray done in 2012 through 2014.

TABLE ET1: ETHIOPIA QUICK FACTS

	2012	2013	2014
# Local Staff	19	21	22
Spray Start Date	June 15, 2012 August 15, 2012	August 15, 2013	August 13, 2014
# Spray Rounds	2	1	1
# Sachets & Bottles Used	262,167	308,721	312,382
# People Protected	1,506,273	1,629,958	1,647,099
# Structures Sprayed	547,421	635,528	667,236
# 100 Square Meters Sprayed*	524,334	617,442	624,764

* Reverse calculation using number of insecticide sachets/bottles used during campaign multiplied by the average of 200 m^2 estimated to be sprayed by one sachet and divided by the number of structures sprayed.

7.2 PROGRAM EXPENDITURES

This section will present an overview of Ethiopia IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		210,154	533,363			195,181	**$ 938,698**	10.7%
Entomology			104,421		182,316	10,315	**$ 297,051**	3.4%
Environmental Compliance			102,628		85,586	70,898	**$ 259,113**	3.0%
Equipment Supplies				544,720		32	**$ 544,753**	6.2%
IEC							**$ 0**	0.0%
Insecticide*	4,574,686						**$ 4,574,686**	52.1%
M&E			50,152		35,980	70,770	**$ 156,902**	1.8%
Post Spray					20,834		**$ 20,834**	0.2%
Spray Campaign			66,805		1,569,089	8,930	**$ 1,644,824**	18.7%
Spray Planning			37,934		293,854	11,741	**$ 343,530**	3.9%
Grand Total	**$ 4,574,686**	**$ 210,154**	**$ 895,303**	**$ 544,720**	**$ 2,187,660**	**$ 367,867**	**$ 8,780,391**	100%

*Includes cost of insecticides procured through PMI but not as part of the PMI AIRS project.

Table ET2 displays the Ethiopia IRS program total capital and recurrent expenditures from 2014.The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these

designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the table.

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

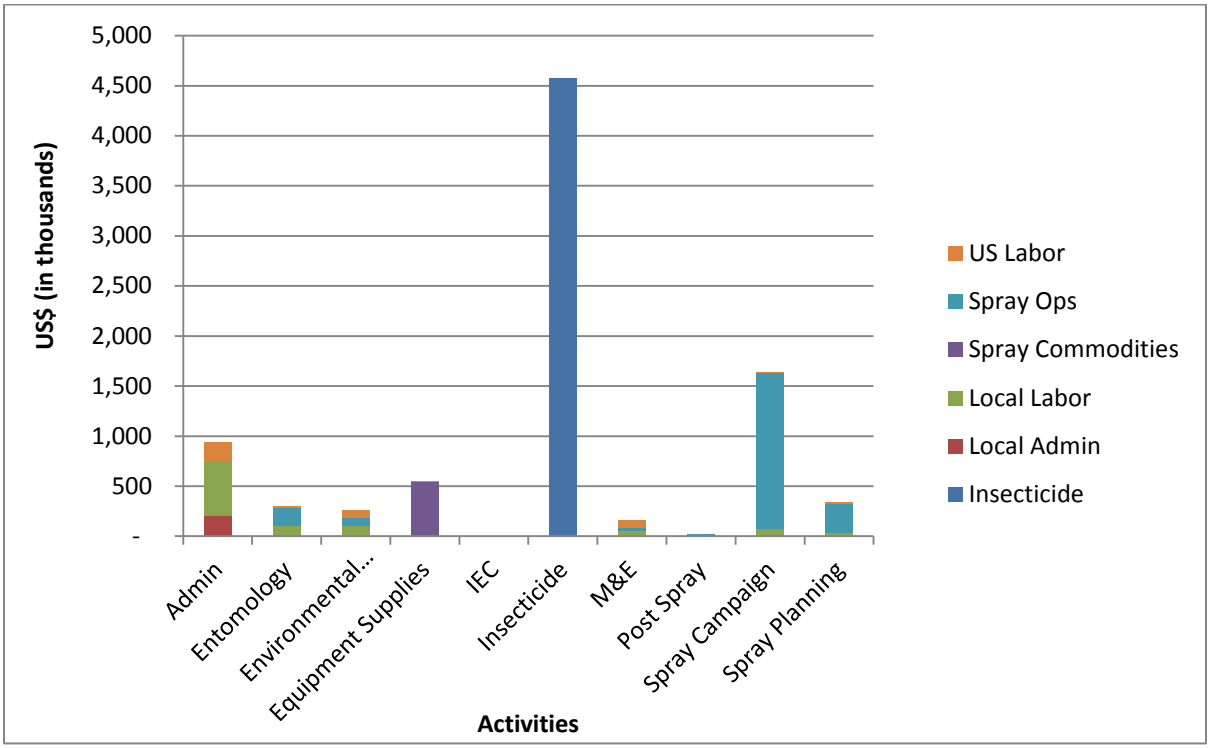


Figure ET1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticides represented the majority of the total costs at 52.1 percent of costs. Spray campaign costs and administration were the next two largest categories of costs, representing 18.7 and 10.7 percent of costs, respectively. AIRS procured 499,800 sachets of carbamate. About 78 percent of the total cost for administration consists of labor, both local and U.S.-based.

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

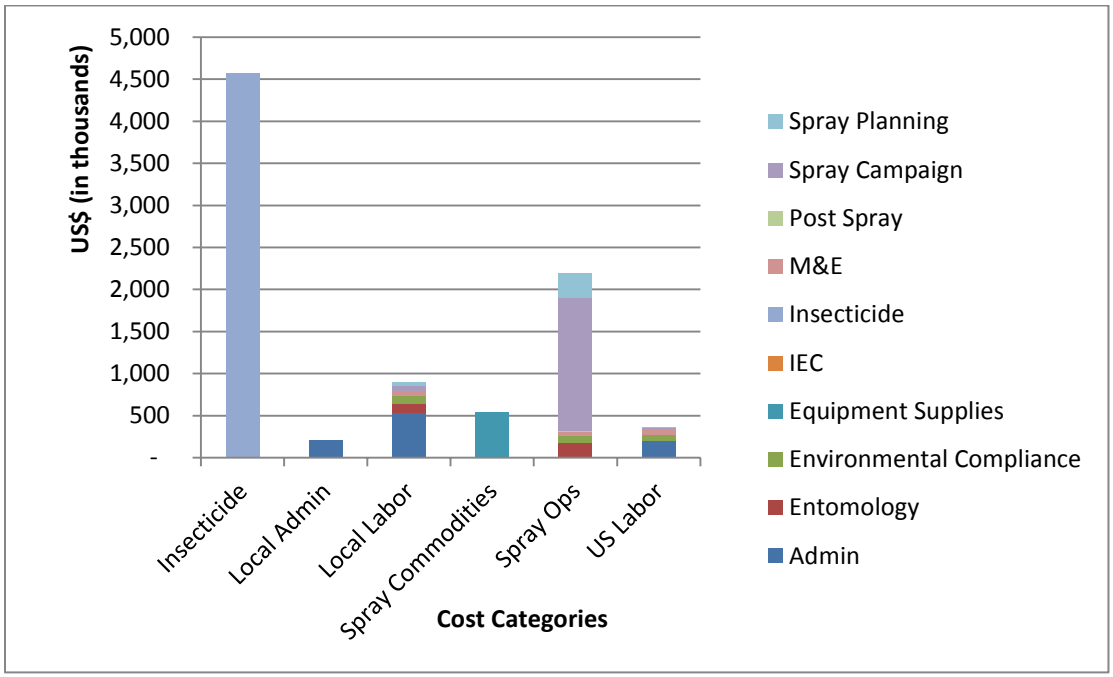


Figure ET2 contains the same information as Figure ET1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor,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

7.3 Unit Cost Analysis

This section presents Ethiopia IRS as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE ET3: ETHIOPIA UNIT COSTS

		Insecticide costs	
		Procured	**Used**
Cost per	**Person protected**	$ 5.33	$ 7.13
	Structure sprayed	$ 13.16	$ 17.60
	100 m^2 sprayed	$ 14.05	$ 18.80

The Ethiopia 2014 IRS spray campaign protected 1,647,099 people from malaria transmission, sprayed 667,236 structures and covered an area of 624,764 m^2. Table ET3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $1.80 in the cost per person protected, $4.44 in the cost per structure sprayed, and $4.74 in the cost per area sprayed, compared to using the cost of insecticides procured. When calculating the total unit cost using

the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 6.1 percent of the unit cost. Insecticide is the largest category of expenditures at 64.2 percent, followed by spray campaign costs at 14 percent.

7.4 COMPARISON ACROSS THE THREE YEARS

This section provides a comparison of the Ethiopia IRS program for 2012 through 2014, as implemented by the PMI-funded AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, 2012 and 2013 expenditures, excluding insecticides, have been adjusted to real 2014 U.S. dollars to allow for a more accurate comparison.

TABLE ET4: ETHIOPIA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	1,506,273	1,629,958	1,647,099	1.1%
Structures Sprayed	547,421	635,528	667,236	5.0%
Area Sprayed (100 m^2)	524,334	617,442	624,764	1.2%

Table ET4 compares the year-on-year change in Ethiopia IRS program output measures. In 2014, the program achieved higher coverage on all three indicators used in Table ET4 than in 2013 or 2012. Between 2013 and 2014, the number of people protected increased 1.1 percent, the number of structures increased 5.0 percent, while the area sprayed increased by 1.2 percent.

TABLE ET5: ETHIOPIA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	1,191,856	3,818,143	4,574,686	19.8%
Local Admin	318,434	262,220	210,154	-19.9%
Local Labor	475,468	592,788	895,303	51.0%
Spray Operations	1,639,829	2,227,102	2,187,660	-1.8%
Commodities	505,022	371,641	544,720	46.6%
U.S. Labor	349,091	368,580	367,867	-0.2%
TOTAL	**$ 4,479,700**	**$ 7,640,474**	**$ 8,780,391**	**14.9%**

Table ET5 compares the year-on-year change in total program capital and recurrent expenditure. The total program cost increased by 14.9 percent from 2013 to 2014 (total

expenditures in 2014 were also more than in 2012), representing an increase in the total annual cost of about $1,140,000. In terms of the total increase between 2013 and 2014, insecticides represented the majority of the increase ($757,011). As noted in the introduction, only about 62.5 percent of the insecticide purchased was used; the cost of insecticide used in 2014 was about $2,859,535.

When the insecticide is excluded from the year-on-year comparison, costs were 10 percent greater in 2014 than in 2013. Costs decreased for spray operations by about $39,000 between the years, but this was offset by an increase in the cost of commodities of about $173,000. Costs also decreased for local administration and U.S. labor between 2013 and 2014, but the cost of local labor increased by more than the local administration and U.S. labor together decreased. This local labor cost increase was created by salary increases provided to local staff in compliance with two new FSN scales that were released and implemented in 2014: one in June and the other in September. Increased expenditures for PPE constituted about 80 percent of increased costs for commodities between 2013 and 2014; increased costs for spray pumps constituted the remainder of the increased costs for commodities between the two years. Further analysis of the spray pump cost data suggests that the increase is likely just a more accurate accounting of capital equipment in use. Increased expenditures for PPE might possibly be attributed to a significant increase in quantities of laundry and cleansing soaps purchased in 2014, when each seasonal worker received a new bar of soap every day. Going forward, this strategy has been revised to drastically reduce the dispersed soap quantities.

TABLE ET6: ETHIOPIA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 2.97	$ 4.69	$ 5.33	14%
Per Structure Sprayed	$ 8.18	$ 12.02	$ 13.16	9%
Per Area Sprayed	$ 8.54	$ 12.37	$ 14.05	14%

Table ET6 shows the program unit costs across the three years. Because the program size increased (for all measured in Table ET6) less than the increase for the total expenditures from 2013 to 2014, the unit costs increased: by about 14 percent for cost per person protected and area sprayed and about 9 percent for cost per structure sprayed. 2014 unit costs were the highest among all three years of the program.

TABLE ET7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	56,521	54,160	-4%	39,481	-27%
Number of other seasonal laborers	727	1,192	64%	985	-17%
Number of structures sprayed	547,421	635,528	16%	667,236	5%
Structures sprayed per SOP per day	9.7	11.7	21%	16.9	44%
Spray operations cost per SOP Day	29.01	41.12	42%	55.41	35%
Spray operations and commodities cost per structure sprayed	6.10	10.10	66%	10.95	8%
Spray operations and commodities cost per structure sprayed (without insecticide)	3.92	4.09	4%	4.10	0.1%

Table ET7 displays various measures of implementation efficiency across the three years. While from 2012 to 2013 the number of SOP-days used for the campaign decreased by about 4 percent, the number of structures sprayed increased 16 percent, resulting in more structures sprayed per SOP per day in 2013 (9.7 structures per SOP per day in 2013 vs. 11.7 structures per SOP per day in 2012). In 2014, the trend continued, with fewer SOP days employed but more structures sprayed than in 2013, resulting in about 16.9 structures sprayed per SOP per day (44 percent more than in 2013). However, while spray operations costs fell overall between 2013 and 2014, they did not fall as much as the decrease in the number of SOP days. The spray operations cost per SOP per day increased by about 35 percent from 2013 to 2014. As noted above, commodity costs increased from 2013 to 2014, and the spray operations and commodities cost per structure sprayed from 2013 to 2014 was about the same (increasing by 0.1 percent). When insecticides are included in the costs, cost per area sprayed increased by 8 percent from 2013 to 2014.

8. GHANA

8.1 BACKGROUND

2012

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

2013

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

2014

AIRS continued to spray the same four districts in 2014 (2014) with Actellic CS. The spray campaign ran from April 14-May 30, 2014, encompassing 36 operational days, compared with 60 and 53 days in 2012 and 2013, respectively. The shorter length of the campaign was accomplished by hiring more SOPs – 425 SOPs were hired in 2014 compared with 290 in 2013 and 375 in 2012. In 2014, 44,948 bottles of Actellic CS were used.

Table GH1 summarizes the spray campaigns in 2012 through 2014.

TABLE GH1: GHANA QUICK FACTS

	2012	2013	2014
# Local Staff	25	23	22
Spray Start Date	April 23, 2012	April 29, 2013	April 14, 2014
# Spray Rounds	1	1	1
# Sachets & Bottles Used	77,288	43,284	44,948
# People Protected	941,240	534,060	570,572
# Structures Sprayed	355,278	197,655	205,230
# 100 Square Meters Sprayed	193,220	108,210	112,370

8.2 Program Expenditures

This section will present an overview of Ghana IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		341,162	543,251			154,312	**$ 1,038,725**	24.9%
Entomology			89,532		282,734	16,482	**$ 388,748**	9.3%
Environmental Compliance			27,363		20,484	15,069	**$ 62,917**	1.5%
Equipment Supplies				87,092		41	**$ 87,133**	2.1%
IEC			25,735		65,716	3,805	**$ 95,256**	2.3%
Insecticide	1,050,235						**$ 1,050,235**	25.2%
M&E			49,215		31,769	94,894	**$ 175,878**	4.2%
Post Spray					174,231	532	**$ 174,763**	4.2%
Spray Campaign			139,284	7,813	890,136	27,585	**$ 1,064,818**	25.6%
Spray Planning			4,875		2,147	21,300	**$ 28,322**	0.7%
Grand Total	**$ 1,050,235**	**$ 341,162**	**$ 879,255**	**$ 94,905**	**$ 1,467,217**	**$ 334,020**	**$ 4,166,793**	100.0%

Table GH2 displays the Ghana IRS program total capital and recurrent expenditures from 2014. 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. Figures GH1 and GH2 illustrate the cost breakdown in the table.

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

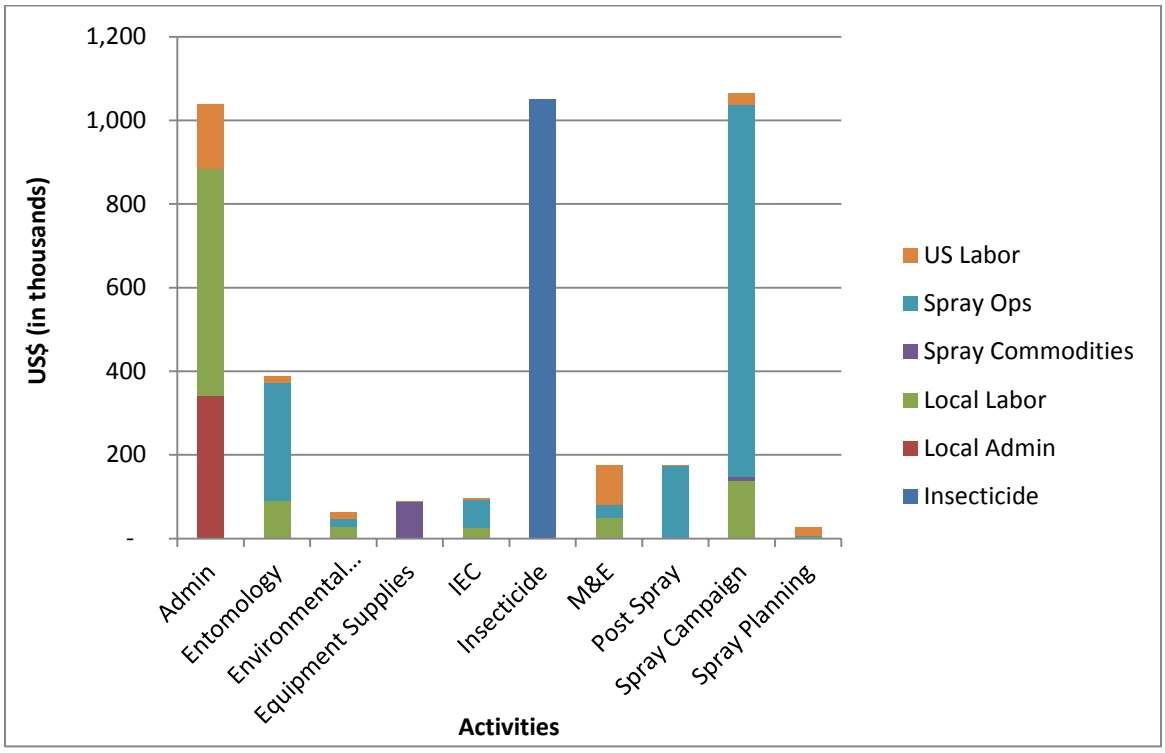


Figure GH1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Costs for spray campaign, insecticides, and administration constitute over 75 percent of costs, with each representing a roughly equal proportion of the total costs (25.6, 25.2 and 24.9 percent of costs, respectively). AIRS procured 40,428 bottles of Actellic CS, and used 44,948 bottles; about 11 percent more bottles were used than were purchased (8,267 bottles remained from the previous year). About 67 percent of the total cost for administration consists of labor, both local and U.S.-based.

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

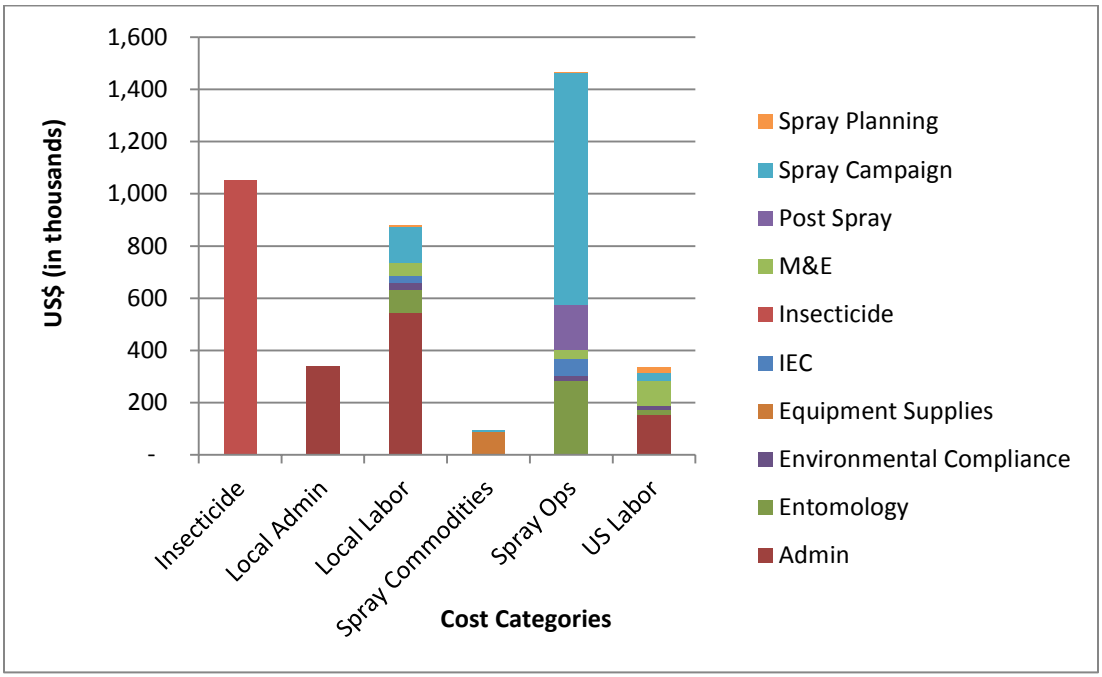


Figure GH2 contains the same information as Figure GH1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor,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

8.3 Unit Cost Analysis

This section presents Ghana IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE GH3: GHANA UNIT COSTS

		Insecticide costs			
		Procured		Used	
Cost per	Person protected	$	7.30	$	15.85
	Structure sprayed	$	20.30	$	44.07
	100 m^2 sprayed	$	37.08	$	80.50

The Ghana 2014 IRS spray campaign protected 570,572 people from malaria transmission, sprayed 205,230 structures and covered an area of 112,370 m^2. Table GH3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $8.55 in the cost per person protected, $23.77 in the cost per structure sprayed, and $43.42 in the cost per area sprayed, compared to using the cost of insecticides procured. When calculating the total unit cost using

the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 3.7 percent of the unit cost. Insecticide is the largest category of expenditures at 65.5 percent, followed by spray campaign cost at 11.8 percent and administration at 11.5 percent.

8.4 COMPARISON ACROSS THE THREE YEARS

This section provides a comparison of the Ghana IRS program for 2012 through 2014, as implemented by the AIRS project. The comparison focuses on output measures, total expenditures, and unit costs. As noted in the Methodology section, 2012 and 2013 expenditures, excluding insecticides, have been adjusted to real 2014 U.S. dollars to allow for a more accurate comparison.

TABLE GH4: GHANA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	941,240	534,060	570,572	6.8%
Structures Sprayed	355,278	197,655	205,230	3.8%
Area Sprayed (100 m^2)	193,220	108,210	112,370	3.8%

Table GH4 compares the year-on-year change in Ghana IRS program output measures. In 2014, the program achieved higher coverage on all three indicators used in Table GH4 than in 2013 (but remained lower than in 2012 when more districts were included in the program). Between 2013 and 2014, the number of people protected grew 6.8 percent, while the number of structures and area sprayed each increased by 3.8 percent.

TABLE GH5: GHANA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	1,527,912	1,262,861	1,050,235	-16.8%
Local Admin	576,374	464,862	341,162	-26.6%
Local Labor	535,189	883,282	879,255	-0.5%
Spray Operations	1,461,753	1,381,304	1,467,217	6.2%
Commodities	224,066	136,516	94,905	-30.5%
U.S. Labor	316,280	247,474	334,020	35.0%
TOTAL	**$ 4,641,573**	**$ 4,376,298**	**$ 4,166,793**	**-4.8%**

Table GH5 compares the year-on-year change in total program capital and recurrent expenditures. It should be noted that while Ghana is experiencing inflation rates over 14 percent per year, this inflation has been more than mediated by changes in the exchange rate (one dollar in 2014 would buy about 33 percent more Ghanaian Cedis than in 2013). This means that costs for 2012 and 2013 in Table GH4 are lower than the nominal amount spent in each of those years; for 2013 the deflationary effect of currency exchange results in a reduction in nominal costs of about 25 percent to produce real costs (the maximum 1-year adjustment for other countries in these analyses is under 4 percent). In situations of high inflation and currency instability, the ability to adjust costs across years is likely to contain at least some inaccuracy, which should be borne in mind for the discussions below.

The total program cost decreased by 4.8 percent from 2013 to 2014 (total expenditures in 2014 were also less than in 2012), representing a decrease in the total annual cost of about $209,000. Reductions in costs from 2013 to 2014 were attained for insecticides, local administration, local labor, and commodities; the total savings in these four categories amount to $378,000 (insecticides and local administration account for about 90 percent of the decrease in costs). Cost increased for the same period for spray operations and US labor; the total increase in costs for these two categories was about $168,000 (with spray operations accounting for over 50 percent of cost increases). U.S. labor costs increased by $10,000 between 2013 and 2014, when inflation is not applied to these costs.

The cost of insecticides decreased 20.8 percent from 2013 to 2014, despite more Actellic CS being used in 2014 than in 2013. As mentioned previously, the cost of insecticides purchased represents about 90 percent of the cost of insecticides that were used. When considering the cost of insecticides used between 2013 and 2014, cost decreased by about 12 percent; the reduced cost of insecticide was due entirely to lower procurement cost (including shipment, insurance, etc.) per bottle in 2014 as compared to 2013 (since the amount of insecticide used in 2014 was more than the amount used in 2013).

Despite fewer operational days in 2014 compared with 2013, the costs for spray operations increased by almost $86,000 (about 6 percent more than 2013 spray operation costs). Use of temporary agency services for seasonal workers and training account for over 50 percent of the increase in spray operation costs between the two years. While the Ghana team decreased the number of spray days and used vehicles more effectively in 2014, the program experienced difficulties with IRS acceptance in several districts, leading to an extension of spray campaign days and multiple additional meetings with locals at the national and community levels.

TABLE GH6: GHANA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 4.93	$ 8.19	$ 7.30	-10.9%
Per Structure Sprayed	$ 13.06	$ 22.14	$ 20.30	-8.3%
Per Area Sprayed	$ 24.02	$ 40.44	$ 37.08	-8.3%

Table GH6 shows the program unit costs across the three years. Because the program size increased (for all measured in Table GH5), while the total expenditures decreased from 2013 to 2014, the unit costs decreased: by about 10.9 percent for cost per person protected and 8.3 percent for cost per structure and area sprayed. 2014 unit costs were still higher than 2012 unit costs, despite lower total costs because of the higher levels of coverage achieved in 2012 than in 2014. 2012 also included some use of less expensive pyrethroid class insecticides.

TABLE GH7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	20,445	11,008	-46%	13,183	20%
Number of other seasonal laborers	526	179	-66%	118	-34%
Number of structures sprayed	355,278	197,655	-44%	205,230	4%
Structures sprayed per SOP per day	17.4	18.0	3%	15.6	-13%
Spray operations cost per SOP Day	77.60	125.48	62%	111.30	-11%
Spray operations and commodities cost per structure sprayed	9.45	14.07	49%	12.73	-10%
Spray operations and commodities cost per structure sprayed (without insecticide)	5.15	7.68	49%	7.61	-1%

Table GH7 displays various measures of implementation efficiency across the 3 years. While from 2012 to 2013 the number of SOP-days used for the campaign decreased by 46 percent, the number of structures sprayed decreased by 44 percent, resulting in more structures sprayed per SOP per day in 2013 (17.4 structures per SOP per day in 2012 vs. 18.0 structures per SOP per day in 2013). The decrease in the number of SOP days used for spray operations and the decrease in the number of structures were largely due to the reduction in the number of targeted districts from nine to four as well as a reduction in the number of spray days from 60 days to 53 days. Between 2013 and 2014, the number of days of spray operations was reduced further from 45 days to 36 days. More spray operators were hired (425 in 2014 compared to 390 in 2013). In 2014, more total SOP-days were employed and more structures sprayed than in 2013, resulting in about 15.6 structures sprayed per SOP per day (13 percent less than in 2013). However, the spray operations cost per SOP per day also decreased by about 11 percent from 2013 to 2014, indicating that the overall increase in spray operations costs was not proportionately as great as the increase in the number of SOP-days. The decrease in spray operations and commodity costs per SOP per day did offset the lower number of structures sprayed per SOP per day, so spray operation and commodity costs per structure sprayed decreased by about 1 percent from 2013 to 2014, as shown in the last row of Table GH7. From 2013 to 2014, the decrease in insecticide costs lowered the cost per structure sprayed; when insecticides are included in the cost per structure sprayed, the cost decreased from 2013 to 2014 by 10 percent.

9. MADAGASCAR

9.1 BACKGROUND

2012

In June 2012, AIRS became the lead implementer of IRS in Madagascar. Overall, 371,391 structures (87,087 in the Central Highlands; 284,310 in southern Madagascar) were sprayed by AIRS Madagascar during the 2012 (2012–2013) IRS campaign, with 1,781,990 persons protected (522,292 persons in the Central Highlands, and 1,259,698 persons in southern Madagascar).

Per the Madagascar National Malaria Strategic Plan, IRS programming transitioned to focalized spraying in select communes of the Central Highlands. IRS in the other seven districts in southern Madagascar continued to follow blanket spraying, with the IRS campaign covering as many eligible structures as possible throughout the entire district.

AIRS Madagascar procured primarily carbamate insecticides for the 2012–2013 IRS campaign; however, pyrethroid insecticides were procured and used in communes located in Ambositra and Ambohimahasoa districts in the Central Highlands, an area that is not targeted for long-lasting insecticide-treated net (LLIN) distribution.

2013

In 2013 (2013–2014), AIRS Madagascar continued focalized spraying in 40 communes in the Central Highlands; however, there were several communes not sprayed in 2012, due to shifts in malaria incidence rates, and decisions by the NMCP on which communes should be sprayed. AIRS Madagascar continued with blanket spraying in six districts in southern Madagascar. Insecurity in the district limited AIRS Madagascar to spraying one *fokontany* (sub-commune) in Amboasary District. Overall, 343,470 structures were sprayed during 2013 (82,091 structures in the Central Highlands; 261,379 structures in southern Madagascar), with 1,588,138 persons protected (481,301 persons in the Central Highlands; 1,106,837 persons in southern Madagascar).

AIRS Madagascar procured carbamate, pyrethroid, and organophosphate class insecticides for 2013. Carbamates were used in all spray areas in the Central Highlands, except for communes in Ambositra and Ambohimahasoa districts, which continued to be sprayed with pyrethroids. In southern Madagascar, all districts were sprayed with organophosphates.

2014

In 2014 of operations, AIRS Madagascar stopped spraying in southern Madagascar and began spraying in the East Coast, where malaria transmission is high and perennial, and where the combination of LLINs and IRS is expected to have more impact than each strategy alone.

The spray campaign in the East Coast lasted for 59 operational days, while the one in the Central Highlands lasted for 37 operational days. The campaign in the Central Highlands continued

focalized spraying in 40 communes. The campaign in the East Coast provided blanket coverage in three districts (Brickaville, Toamasina II, and Fenerive Est), but some communes could not be reached due to difficult accessibility. Overall, 274,533 structures were sprayed during 2014 (125,125 structures in the Central Highlands; 149,408 structures in East Coast), with 1,307,384 persons protected (749,965 persons in the Central Highlands; 557,419 persons in East Coast).

AIRS Madagascar procured pyrethroid and organophosphate class insecticides for 2014, in addition to using insecticides remaining from 2013, including pyrethroids, organophosphates, and carbamates:

- Pyrethroids were used in Faratsiho, Ambohimasoa, and Ambositra districts in Central Highlands;
- Organophosphates were used in three districts in East Coast: Brickaville, Fenerive Est and Tamatave II; and
- Carbamates were used in three districts (Fandrina, Manadrina, and Fianarantsoa) in Central Highlands.

Table MG1 summarizes the spray done in 2012 through 2014.

TABLE MG1: MADAGASCAR QUICK FACTS

	2012	2013	2014
# Local Staff	15	34	37
Spray Start Date			
Central Highlands	Nov 26, 2012	Nov 18, 2013	Nov 3, 2014
Southern Madagascar	February 4, 2013	January 20, 2014	
East Coast			Sept 8, 2014
# Spray Rounds	1	1	1
# Sachets & Bottles Used	88,567	79,594	91,696
# People Protected	1,781,990	1,588,138	1,307,384
# Structures Sprayed	371,391	343,470	274,533
# 100 Square Meters Sprayed	221,418	196,615	229,240

9.2 PROGRAM EXPENDITURES

This section will present an overview of Madagascar IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		678,722	484,050			249,525	$ 1,412,298	27.2%
Entomology			130,622		347,859	72,366	$ 550,847	10.6%
Environmental Compliance			20,519		65,086	38,175	$ 123,780	2.4%
Equipment Supplies				328,356		64	$ 328,420	6.3%
IEC					32,270		$ 32,270	0.6%
Insecticide	209,255						$ 209,255	4.0%
M&E			73,019		205,210	71,110	$ 349,339	6.7%
Post Spray			49,653		53,527	19,034	$ 122,214	2.4%
Spray Campaign			51,370		1,342,009	14,884	$ 1,408,263	27.2%
Spray Planning			81,177		541,468	24,831	$ 647,477	12.5%
Grand Total	**$ 209,255**	**$ 678,722**	**$ 890,411**	**$ 328,356**	**$ 2,587,431**	**$ 489,989**	**$ 5,184,164**	100.0%

Table MG2 displays the Madagascar IRS program total capital and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS Project's financial systems, and the top row lists IRS program cost categories. The following two figures illustrate the cost breakdown in the table.

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

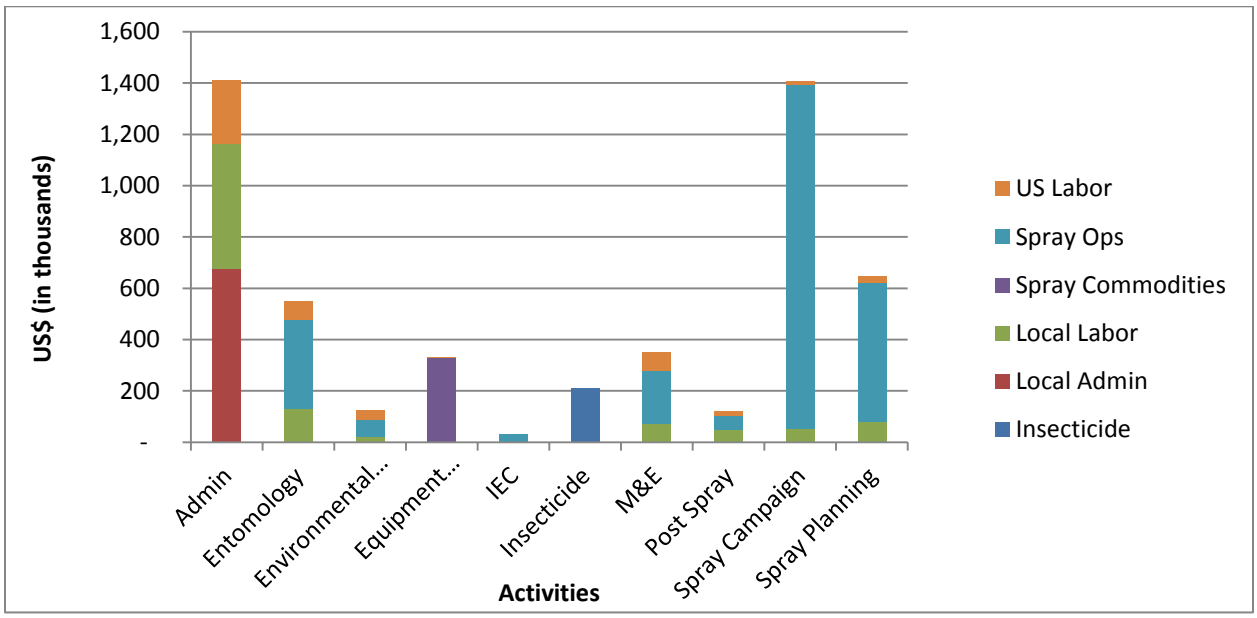


Figure MG1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Local administration and spray campaign costs are the two most expensive IRS activities (both constituting 27.7 percent of expenditures, respectively), followed by spray planning (12.5 percent of expenditures). AIRS Madagascar procured 33,600 sachets of pyrethroids, 5,196 bottles of Actellic CS, but used 32,117 pyrethroid sachets, 30,086 organophosphate bottles, and 29,493 carbamate sachets. About 52 percent of the total cost for administration consists of labor, both local and U.S.-based.

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

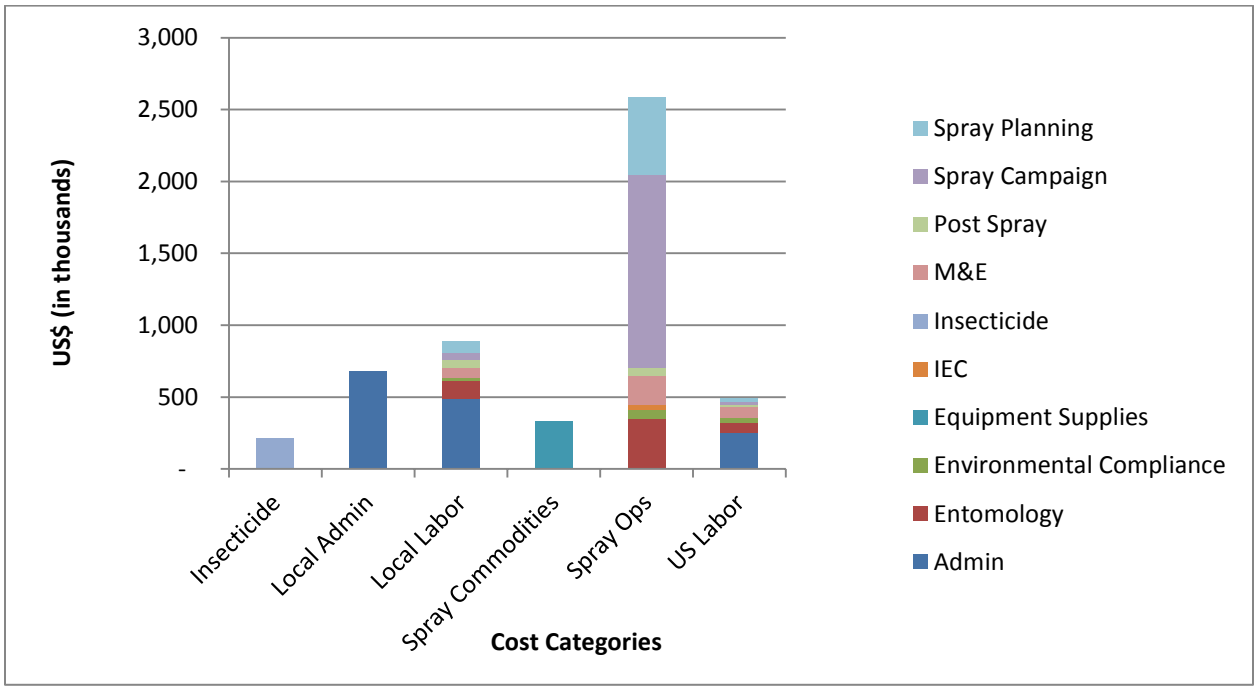


Figure MG2 contains the same information as Figure MG1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor,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

9.3 Unit Cost Analysis

This section presents Madagascar IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE MG3: MADAGASCAR UNIT COSTS

	Insecticide costs	
	Procured	**Used**
Person protected	$ 3.97	$ 10.16
Cost per Structure sprayed	$ 18.88	$ 48.41
100 m^2 sprayed	$ 22.61	$ 57.97

The Madagascar 2014 IRS spray campaign protected 1,307,384 people from malaria transmission, sprayed 274,533 structures and covered an area of 229,240 m^2. Table MG3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $6.20 in the cost per person protected, $29.52 in the cost per structure sprayed, and $35.36 in the cost per area sprayed, compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 7.7 percent of the unit cost. Insecticide is the largest category of expenditures at 62.6 percent, followed by spray campaign cost and administration at 10.6 percent each.

9.4 COMPARISON ACROSS THE THREE YEARS

This section provides a comparison of the AIRS Madagascar IRS program for 2012 through 2014, as implemented by the project. The comparison focuses on output measures, total expenditures, and unit costs.

TABLE MG4: MADAGASCAR IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	1,781,990	1,588,138	1,307,384	-17.7%
Structures Sprayed	371,391	343,470	274,533	-20.1%
Area Sprayed (100 m^2)	221,418	198,985	229,240	15.2%

Table MG4 compares the year-on-year change in Madagascar IRS program output measures. Overall, in 2014, the program sprayed fewer structures and protected fewer people than in either 2012 or 2013. On the other hand, in 2014, the largest area was sprayed across the three years, and the area sprayed increased 15.2 percent from 2013 to 2014. This may reflect the different geographic areas targeted in the two years.

TABLE MG5: MADAGASCAR IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	1,561,387	1,860,387	209,255	-88.8%
Local Admin	447,383	861,510	678,722	-21.2%
Local Labor	317,558	723,411	890,411	23.1%
Spray Operations	407,873	3,296,325	2,587,431	-21.5%
Commodities	1,874,330	331,172	328,356	-0.9%

U.S. Labor	421,003	528,076	489,989	-7.2%
TOTAL	**$ 5,029,534**	**$ 7,600,880**	**$5,184,164**	**-31.8%**

Table MG5, above, compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 31.8 percent from 2013 to 2014. The category of expenditures with any increase in net from 2013 to 2014 was local labor, where costs increased by about $167,000. Insecticides decreased the most between 2013 and 2014, in terms of both net and percentage decrease, with costs for insecticide decreasing by about $1,651,000 (over 88 percent of 2013 costs). However, 2014 also used insecticide from 2013; in terms of the cost of insecticide used, costs for insecticides decreased only by about 4 percent. The second largest decrease in costs between 2013 and 2014 was the spray operations category, for which costs declined over $708,000 representing 27 percent of the overall decrease in costs. Cost decreases can be attributed to (1) IEC materials were not printed in 2014; remaining insecticide stock from 2013 was used in the South, (2) use of mobile soak pits, and (3) better control on vehicle use.

TABLE MG6: MADAGASCAR IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 2.82	$ 4.90	$ 3.97	-17.1%
Per Structure Sprayed	$ 13.54	$ 22.66	$ 18.88	-14.7%
Per Area Sprayed	$ 22.72	$ 39.11	$ 22.61	-40.8%

Table MG6 shows the program unit costs across the three years. Because the program size increased (in terms of structures sprayed and people protected) while the total expenditures decreased from 2013 to 2014, the unit costs also decreased. For the cost per person protected and per structure sprayed, costs decreased by over 16 percent from 2013 to 2014. As noted previously, the area spayed went down from 2013 to 2014; this lower volume was offset by lower total costs, so that the cost per 100 m^2 sprayed in 2014 was about 42 percent lower than in 2013.

TABLE MG7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	42,304	19,260	-54%	19,483	1%
Number of other seasonal laborers	2,419	1,599	-34%	2,799	75%
Number of structures sprayed	371,391	343,470	-8%	274,533	-20%

Structures sprayed per SOP per day	8.78	17.83	103%	14.09	-21%
Spray operations cost per SOP Day	118.89	171.15	44%	132.80	-22%
Spray operations and commodities cost per structure sprayed	10.35	15.98	54%	11.38	-29%
Spray operations and commodities cost per structure sprayed (without insecticide)	6.15	10.56	72%	10.62	1%

Table MG7 displays various measures of implementation efficiency across the three years. It should be noted that the geographic areas sprayed changed, especially in 2014 and thus there may be changes in access and structure size that affected the efficiency measures across the years. From 2012 to 2013, the number of SOP-days used for the campaign decreased by 54 percent and the number of structures sprayed decreased by 8 percent, resulting in more structures sprayed per SOP per day in 2013 than in 2012 (8.8 structures per SOP per day in 2012 vs. 17.8 structures per SOP per day in 2013). In 2014, however, the 1 percent increase in total SOP days compared to 2013 was accompanied by fewer structures sprayed, resulting in about 14.1 structures sprayed per operator per day (21 percent less than in 2013). However, the spray operation cost per SOP per day decreased by about 22 percent from 2013 to 2014, reflecting the fact that total spray operation costs declined over the two years, but there were more SOP-days utilized in 2014. Thus, spray operations costs per SOP per day decreased from 2013 to 2014 (by 22 percent). The cost of commodities decreased in total from 2013 to 2014, but less than proportionally to the increase in SOP days. Thus, commodity costs per SOP per day increased and offset savings in operations. When including the cost of insecticides along with spray operations and commodity cost, the cost per structure sprayed decreased 29 percent between 2013 and 2014, although, as noted above, the majority of savings on insecticide costs where due to the use of insecticides purchased in 2013 during the 2014 campaign, rather than differences in usage.

10. MALI

10.1 BACKGROUND

2012

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

Due to the political situation in Mali during 2012, field work was suspended for a two-month period. Therefore, total costs spent may not accurately reflect the total spending in a normal year, as the program spent about $700,000 less than was budgeted for the year. In addition, Mali's AIRS program was unable to collaborate with its previously established government partners for entomological monitoring. Faced with a one-month timeline, AIRS created an innovative, cost-effective solution: the "insectary-in-a-box."[6]

2013

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

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

2014

AIRS continued to cover three districts in 2014: Baroueli, Bla, and Koulikoro. Organophosphate class (Actellic CS) insecticide was introduced in Baroueli and Bla, while use of carbamates continued in Koulikoro. In 2014, 65,697 bottles of Actellic CS and 24,250 sachets of carbamates were used. The campaign was completed in 40 days over the period July 15 to August 25, 2014, in Bla and Baroueli, and August 11 to September 19, 2014, in Koulikoro, representing six fewer campaign days than in 2013.

[6] 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/

Table ML1 summarizes the spray done in 2012 through 2014.

TABLE ML1: MALI QUICK FACTS

	2012	2013	2014
# Local Staff	14	18	18
Spray Start Date	July 23, 2012	August 1, 2013	July 15, 2014 (Bla and Baroueli); August 11, 2014 (Koulikoro)
# Spray Rounds	1	1	1
# Sachets & Bottles Used	77,187	93,435	89,947
# People Protected	762,146	850,104	836,568
# Structures Sprayed	206,295	228,985	228,123
# 100 Square Meters Sprayed	192,968	233,588	224,868

10.2 Program Expenditures

This section will present an overview of Mali IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		426,724	539,013			165,676	**$ 1,131,413**	19.7%
Entomology			58,997		55,064	20,519	**$ 134,580**	2.3%
Environmental Compliance			41,366		55,975	28,411	**$ 125,751**	2.2%
Equipment Supplies			1,210	193,470		34	**$ 194,714**	3.4%
IEC			3,462		339,482	250	**$ 343,194**	6.0%
Insecticide	2,087,116		3,013			125	**$ 2,090,254**	36.4%
M&E			55,221		5,082	22,965	**$ 83,268**	1.5%
Post Spray			6,819		149,500	726	**$ 157,045**	2.7%
Spray Campaign			34,086		1,273,705	1,780	**$ 1,309,571**	22.8%
Spray Planning			40,404		124,310	3,862	**$ 168,576**	2.9%
Grand Total	**$ 2,087,116**	**$ 426,724**	**$ 783,592**	**$ 193,470**	**$ 2,003,116**	**$ 244,349**	**$ 5,738,367**	100.0%

Table ML2 displays the Mali IRS program total capital and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS project financial systems, and

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

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

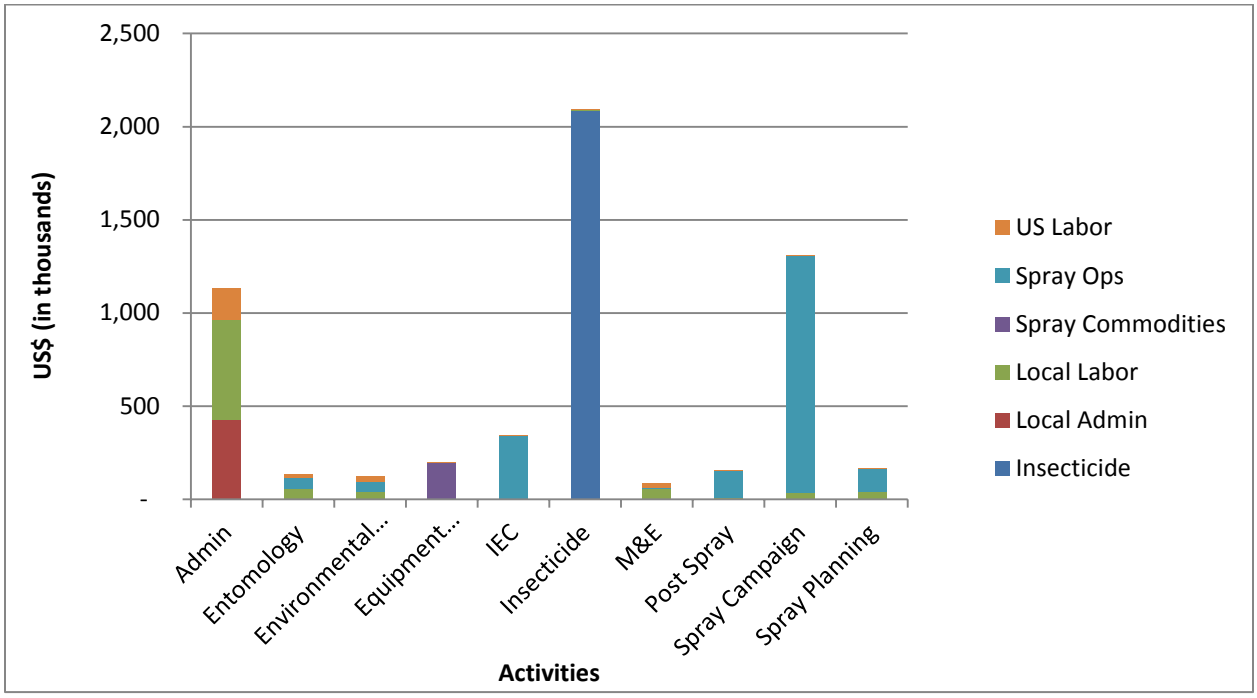


Figure ML1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticide is the most expensive IRS activity (36.4 percent of expenditures), followed by the spray campaign activities (22.8 percent of expenditures) and administrative activities (19.7 percent of expenditures). AIRS procured 75,648 bottles of Actellic CS and 5,260 sachets of carbamates. The campaign used about 87 percent of the Actellic CS purchased, while the carbamate purchase represents only about 22 percent of carbamates used, since there were carbamate sachets remaining from previous years. About 62 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, EC, and M&E program activities (89 percent of US labor expenditures are in the two categories).

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

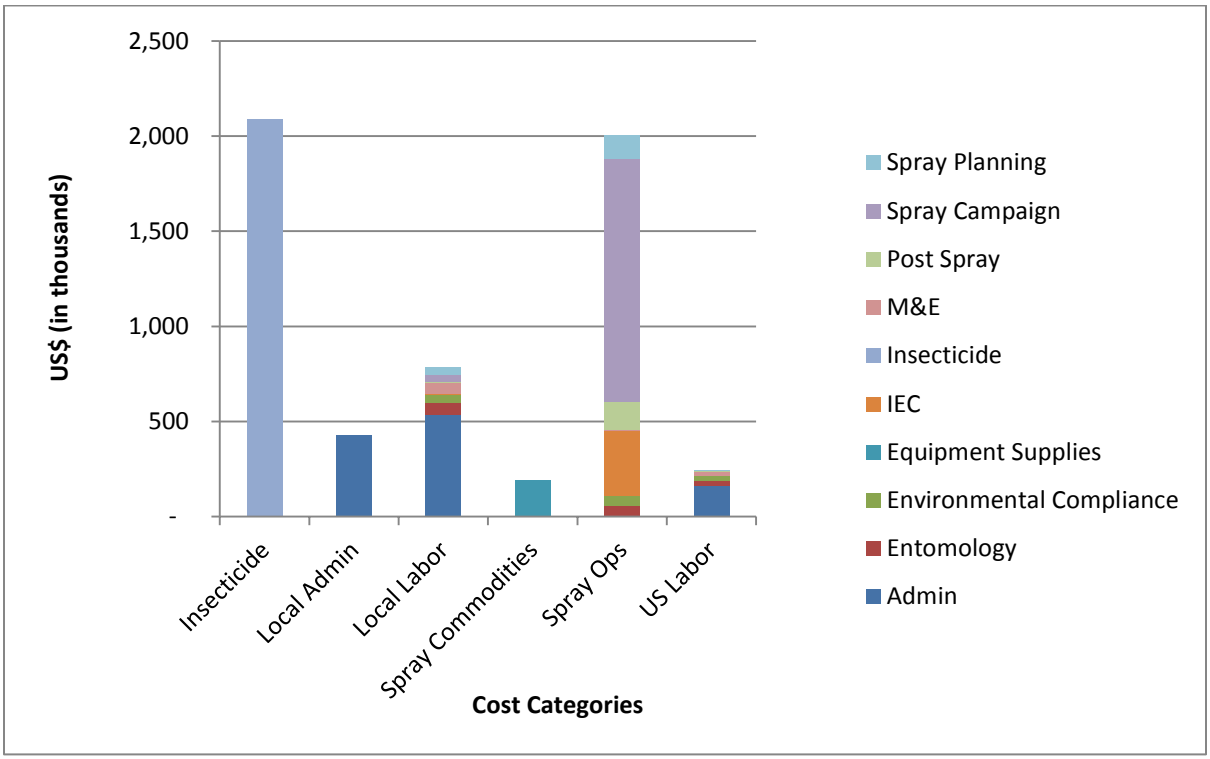


Figure ML2 contains the same information as Figure ML1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor,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

10.3 Unit Cost Analysis

This section presents Mali IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE ML3: MALI UNIT COSTS

		Insecticide costs		
		Procured		Used
	Person protected	$ 6.86	$	13.71
Cost per	Structure sprayed	$ 25.15	$	50.27
	100 m^2 sprayed	$ 25.52	$	51.00

The Mali Year 2014 IRS spray campaign protected 836,568 people from malaria transmission, sprayed 228,123 structures and covered an area of 224,868 m^2. Table ML3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $6.85 in the cost per person protected, $25.12 in the cost per structure sprayed, and $25.48 in the cost per area sprayed,

compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 3 percent of the unit cost. Insecticide is the largest category of expenditures at 68.2 percent, followed by spray campaign cost at 11.4 percent.

10.4 COMPARISON ACROSS THE THREE YEARS

This section provides a comparison of the Mali IRS program for 2012 through 2014, as implemented by the AIRS project. The comparison focuses on output measures, total expenditures, and unit costs

TABLE ML4: MALI IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	762,146	850,104	836,568	-1.6%
Structures Sprayed	206,295	228,985	228,123	-0.4%
Area Sprayed (100 m^2)	192,968	233,588	224,868	-3.7%

Table ML4 compares the year-on-year change in Mali IRS program output measures. Overall, in 2014, the program sprayed less structures and protected fewer people than in 2013 (but more than in 2012). The difference in the number of people protected and structures sprayed from 2013 to 2014 constitutes less than a 2 percent decrease. As shown in Table ML1 in the Background, the average size of the structures sprayed in 2014 was 98.6 m^2 compared to 102.0 m^2 in the previous year.

TABLE ML5: MALI IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	1,123,697	1,507,226	2,087,116	38%
Local Admin	368,421	692,204	426,724	-38%
Local Labor	754,356	809,567	783,592	-3%
Spray Operations	1,840,580	2,413,411	2,003,116	-17%
Commodities	328,557	276,152	193,470	-30%
U.S. Labor	180,502	245,727	244,349	-1%
TOTAL	**$ 4,596,112**	**$ 5,944,286**	**$ 5,738,367**	**-3.5%**

Table ML5, above, compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 3.5 percent from 2013 to 2014 (total expenditures in 2014 were higher than in 2012, when activities were ceased for a period of time

due to political strife). Costs declined in all categories, except insecticide, by a greater percentage than would be implied by the fewer number of structures sprayed (0.4 percent decline). Reductions in the total expenditures for spray operations (over $410,000) represent the largest area of savings (17 percent less than the spray operations costs in 2013). Administrative costs declined by over $265,000, representing about 38 percent of the decline in costs from 2013 to 2014.

The lower cost of spray operations in 2014 compared to 2013 was by itself not enough to compensate for the increased expenditures on insecticides (which increased by about $580,000). The cost of the insecticides used (as opposed to purchased) increased by $725,000 between 2013 and 2014, which is still less than the amount of reductions in costs in other categories.

TABLE ML6: MALI IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 6.03	$ 6.99	$ 6.86	-1.9%
Per Structure Sprayed	$ 22.28	$ 25.96	$ 25.15	-3.1%
Per Area Sprayed	$ 23.82	$ 25.45	$ 25.52	0.3%

Table ML6 shows the program unit costs across the three years. While the program size decreased from 2013 to 2014, the decrease in the total expenditures was greater, meaning that the unit costs were lower in 2014 than in 2013 per person protected and structure sprayed. For the cost per person protected and per structure sprayed, unit costs decreased by more than 1.5 percent from 2013 to 2014; (2012 had the lowest unit costs amongst the years presented). As noted previously, the area spayed decreased about 3.7 percent from 2013 to 2014; this lower volume was not fully offset by lower total costs, so that the cost per 100 m^2 sprayed in 2014 was about 0.3 percent higher than in 2013.

TABLE ML7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	18,204	17,646	-3%	16,293	-8%
Number of other seasonal laborers	247	303	23%	283	-7%
Number of structures sprayed	206,295	228,985	11%	228,123	0%
Structures sprayed per SOP per day	11.3	13.0	15%	14.0	8%
Spray operations cost per SOP Day	101.11	136.77	35%	122.94	-10%
Spray operations and commodities cost per structure sprayed	15.96	18.33	15%	18.78	2%

Spray operations and commodities cost per structure sprayed (without insecticide)	10.51	11.75	12%	9.63	-18%

Table ML7 displays various measures of implementation efficiency across the three years. As mentioned above, the spray campaign was six days shorter in 2014 than in 2013. Although more SOPs were hired, the shorter campaign offset this increase, resulting in about 8 percent fewer SOP-days in 2014 than in 2013. Since the number of structures sprayed remained similar in the two years, the number of structures sprayed per SOP per day increased by 8 percent from 2013 to 2014. With a decline in the total cost of spray operations, the spray operations cost per SOP per day decreased by 10 percent from 2013 to 2014. Thus, the cost of spray operations and commodities per structure was 18 percent lower in 2014 than in 2013. Further, in 2014 there were fewer non-SOP seasonal laborers hired (again for a shorter period of time), which also helped lower spray operational costs. As noted above, these cost savings in spray operations almost balanced the increased cost of insecticides; when including insecticide costs together with spray operation and commodities costs, the cost per structure sprayed increased 2 percent from 2013 to 2014.

11. MOZAMBIQUE

11.1 BACKGROUND

2012

Between 1995 and 2003, the NMCP carried out vector control with sporadic IRS interventions in Zambezia Province. In 2005, the NMCP resumed IRS in Zambezia in three districts, using DDT, and in 2006 expanded to cover five districts. This effort was strengthened in 2007 by PMI. Initially, IRS activities were implemented in densely populated areas using DDT or pyrethroids; from 2009 through 2011, pyrethroids were the sole class of insecticides purchased for IRS, although all remaining stocks of DDT were sprayed in 2009.

In 2012, 2012 of the AIRS project, six districts of Zambezia (Milange, Mocuba, Morrumbala, Namacurra, Nicodala, and Quelimane) were sprayed. The spray campaign used pyrethroid insecticide based on susceptibility testing. It began October 8 and ran through December 18, for a total of 61 operational days.

2013

In 2013, 2013, AIRS implemented the spray campaign in four of the six districts that were sprayed in 2012, namely, Milange, Mocuba, Morrumbala, and Quelimane. Namacurra and Nicoadala were dropped because of reduced funding and use of LLINs in that area. The country continued to use pyrethroids for the spray campaign. The insecticides were donated by the MOH (no additional insecticide was procured by AIRS for the 2013 campaign), and the cost of these insecticides was not provided (although estimated costs of procurement based on costs in other countries are reported in this report). A total of 329,094 sachets were used. The campaign was conducted over 55 operational days and covered 414,232 structures.

2014

In 2014, 2014, AIRS continued to use pyrethroids in five districts, namely Mopeia, Milange, Morrumbala, Mocuba and Quelimane. A total of 305,129 sachets of insecticide were procured by AIRS, and the campaign received a donation of 99,500 sachets from the NMCP via Global Fund procurement. The campaign lasted 48 operational days, spraying 445,118 structures and protecting 2,327,815 people.

Table MZ1 summarizes the spray done in 2012 through 2014.

TABLE MZ1: MOZAMBIQUE QUICK FACTS

	2012	2013	2014
# Local Staff	28	23	21
Spray Start Date	October 8, 2012	October 7, 2013	October 20, 2014

# Spray Rounds	1	1	1
# Sachets Used	389,788	329,094	356,807
# People Protected	2,716,176	2,181,896	2,327,815
# Structures Sprayed	536,558	414,232	445,118
# 100 Square Meters Sprayed	974,470	822,735	914,518

11.2 Program Expenditures

This section presents an overview of Mozambique IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		796,618	853,731			198,780	$ 1,850,254	32.3%
Entomology			73,792		303,639	8,520	$ 385,951	6.7%
Environmental Compliance			59,151		84,629	39,804	$ 183,584	3.2%
Equipment Supplies				375,005		194	$ 375,199	6.5%
IEC							$ -	0.0%
Insecticide	538,729						$ 542,324	9.5%
M&E			118,949		186,329	70,455	$ 375,733	6.6%
Post Spray							$ -	0.0%
Spray Campaign			9,446		567,225	342	$ 577,014	10.1%
Spray Planning			226,193		1,191,431	24,203	$ 1,441,828	25.2%
Grand Total	**$ 538,729**	**$ 796,618**	**$ 1,341,262**	**$ 375,005**	**$ 2,333,255**	**$ 342,299**	**$ 5,731,888**	100.0%

Table MZ2 displays the Mozambique IRS program total capital and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS project's financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the table.

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

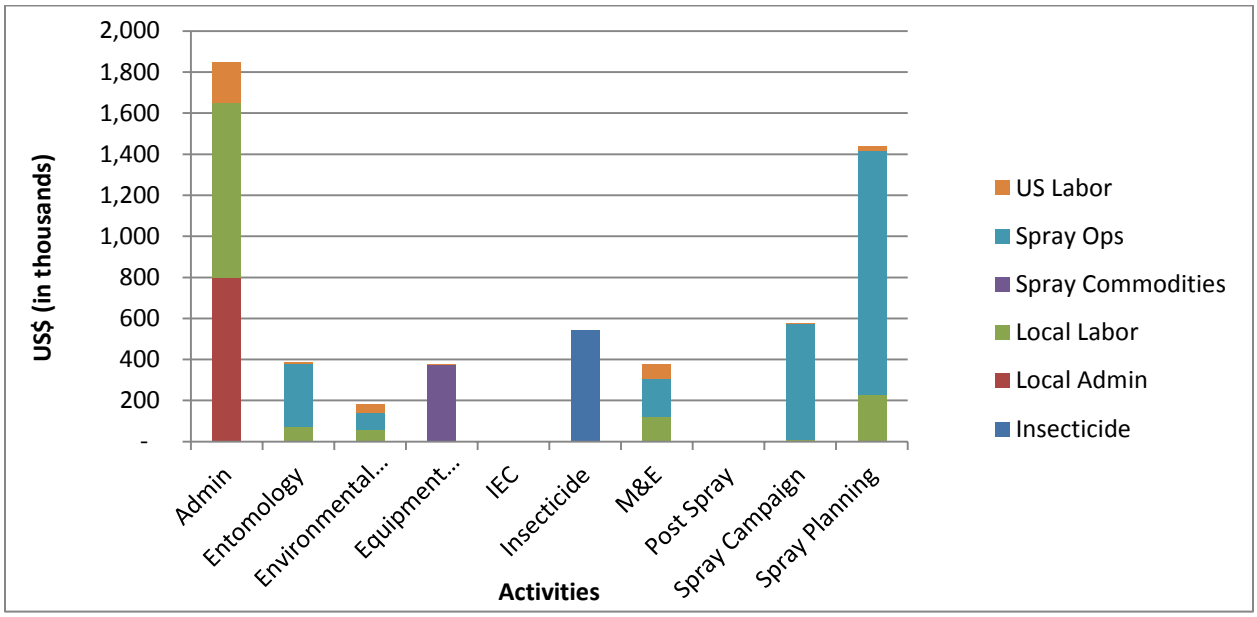


Figure MZ1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Local administration and spray planning are the two most expensive IRS activities (32.3 percent and 25.2 percent of expenditures, respectively), followed by the spray campaign (10.1 percent of expenditures). AIRS Mozambique procured 305,129 sachets of pyrethroids, while receiving another 99,500 sachets as donation; 356,807 sachets were used. About 57 percent of the total cost for administration consists of labor, both local and U.S.-based.

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

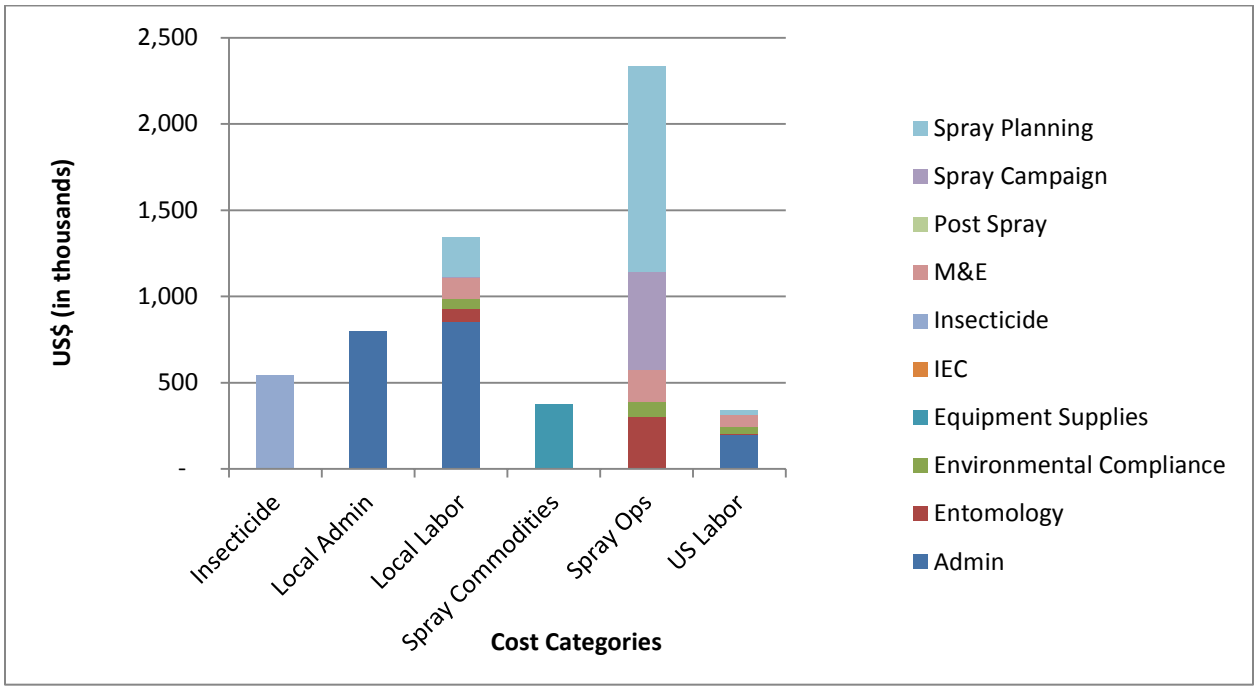


Figure MZ2 contains the same information as Figure MZ1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on local labor and spray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

11.3 Unit Cost Analysis

This section presents Mozambique IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE MZ3: MOZAMBIQUE UNIT COSTS

		Insecticide costs	
		Procured	Used
Cost per	Person protected	$ 2.46	$ 2.94
	Structure sprayed	$ 12.88	$ 15.38
	100 m^2 sprayed	$ 6.27	$ 7.48

The Mozambique 2014 IRS spray campaign protected 2,327,815 people from malaria transmission, sprayed 445,118 structures and covered an area of 914,518 m^2. Table MZ3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $0.48 in the cost per person protected, $2.50 in the cost per structure sprayed, and $1.22 in the cost per area sprayed, compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 13.8 percent of the unit cost. Administration is the largest category of expenditures at 27 percent, followed by insecticide at 24.2 percent and spray campaign cost at 8.4 percent.

11.4 COMPARISON ACROSS THE THREE YEARS

This section provides a comparison of the AIRS Mozambique IRS program for 2012 through 2014, as implemented by the AIRS Project.

TABLE MZ4: MOZAMBIQUE IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	2,716,176	2,181,896	2,327,815	6.7%
Structures Sprayed	536,558	414,232	445,118	7.5%
Area Sprayed (100 m^2)	974,470	822,735	914,518	11.2%

Table MZ4 compares the year-on-year change in Mozambique IRS program output measures. Overall, in 2014, the program sprayed more structures and area and protected more people than in 2013 (but not as many as in 2012, when two additional districts were covered by the program). Coverage increased 6.7% in terms of people protected from 2013 to 2014.

TABLE MZ5: MOZAMBIQUE IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	1,186,964	1,115,746*	542,324	-51%
Local Admin	682,072	686,569	797,744	16.2%
Local Labor	1,225,147	1,238,942	1,341,262	8.3%
Spray Operations	1,814,552	1,760,616	2,333,255	32.5%
Commodities	129,356	279,400	375,005	34.2%
U.S. Labor	163,767	285,115	342,299	20.1%
TOTAL	$ 5,201,858	$ 5,366,387	$ 5,731,888	6.8%

*Represents the estimated cost of insecticides used; AIRS did not procure insecticides in 2013.

Table MZ5, above, compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 6.8 percent from 2013 to 2014 (total expenditures in 2012 were less than in 2014). Note, however, that AIRS incurred no expenditures for insecticides in 2013; the number presented above reflects the estimated cost of insecticide used in 2013. Additionally, 2014 reflects the cost of procurement of insecticides, not the amount used. The estimated cost of the insecticides used in 2014 is $599,972, which is 46 percent less than the cost of insecticides used in 2013 (and, if this measure of insecticide cost is used, then total costs of the IRS program increased 0.6 percent from 2013 to 2014).

The categories of expenditures with any increase from 2013 to 2014 were local administration, local labor, spray operations, and U.S. labor. Among these categories, spray operations accounted for 68 percent of the increase in costs. Increased costs for per diems and ground transport accounted for 44 percent of the increase in spray operations costs.

TABLE MZ6: MOZAMBIQUE IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 1.92	$ 2.46	$ 2.46	0.1%
Per Structure Sprayed	$ 9.69	$ 12.96	$ 12.88	-0.6%
Per Area Sprayed	$ 5.34	$ 6.52	$ 6.27	-3.9%

Table MZ6 shows the program unit costs across the three years. Because the program size increased proportionately more than the total expenditures increased from 2013 to 2014, the unit costs decreased for structure sprayed and area sprayed. The decrease in costs per structure sprayed and per area sprayed is due to lower costs for insecticide procurement; non-insecticide costs per structure sprayed increased 13.6% and the non-insecticide cost per 100 m^2 sprayed increased 9.8%. The increase in non-insecticide costs is mainly due to an increase in the cost per 100 m^2 sprayed of commodities (with the largest increase in costs for IRS household cards). The cost per 100 m^2 of spray operations increased by 19% from $2.14 in 2013 to $2.55 in 2014 (see below), whereas the cost per 100 m^2 sprayed of commodities increased by 21%, from $0.34 in 2013 to $0.41 in 2014. For the cost per person protected, the cost was the same between 2013 and 2014.

TABLE MZ7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	42,304	36,811	-13%	49,342	34%
Number of other seasonal laborers	993	519	-48%	506	-3%

Number of structures sprayed	536,558	414,232	-23%	445,118	7%
Structures sprayed per SOP per day	12.7	11.3	-11%	9.02	-20%
Spray operations cost per SOP Day	123.0	47.8	-61%	47.29	-1%
Spray operations and commodities cost per structure sprayed	5.84	7.62	31%	7.30	-4%
Spray operations and commodities cost per structure sprayed (without insecticide)	3.62	4.92	36%	6.08	24%

Table MZ7 displays various measures of implementation efficiency across the three years. From 2012 to 2013, the number of SOP-days used for the campaign decreased by 13 percent, the number of structures sprayed decreased by 23 percent, resulting in fewer structures sprayed per operator per day in 2013 than in 2012 (12.7 structures per SOP per day in 2012 vs. 11.3 structures per SOP per day in 2013). In 2014, the increase in total SOP days compared to 2013 was proportionately more than the increase in number of structures sprayed, resulting in about 9.0 structures sprayed per operator per day (20 percent fewer than in 2013). The spray operation cost per SOP per day decreased by about 1 percent from 2013 to 2014, reflecting the number of SOP days increased more than the total spray operation costs over the two years. The decrease in spray operation cost per SOP-day was not enough to offset the decrease in the number of structures sprayed per SOP per day. Thus, spray operations and commodity cost per structure sprayed both increased from 2013 to 2014 (by 24 percent). When including the cost of insecticides along with spray operations and commodity cost, the cost per structure sprayed decreased 4 percent between 2013 and 2014; when considering the estimated cost of insecticide used (rather than procured) in 2014, then the spray operations, commodity, and insecticide cost per structure sprayed declined by 2 percent from 2013.

12. RWANDA

12.1 BACKGROUND

2012

In Rwanda, PMI funded IRS campaigns for five years prior to the start of the AIRS project. In 2012 or 2012 of the project, the Rwanda IRS program sprayed 236,610 structures located in three districts, Bugesera, Gisagara, and Nyagatare. The spray campaign took place over a total of 30 days, and a pyrethroid insecticide was used for spraying. Unfortunately, at the start of the 2012 Rwanda spray campaign, a spray operator passed away so the program halted operations immediately. The AIRS project was cleared one month later to continue spraying and finished spraying successfully. The delay in operations caused some increase in the costs of the program.

2013

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

2014

In 2014 of the project, 2014, two rounds of spraying were again implemented in the same three districts, Bugesera, Gisagara, and Nyagatare. The first round was conducted in February, and the second in September; each round had 24 operational days. In this year, AIRS Rwanda used only carbamate insecticides to spray 297,005 non-individual structures (173,086 structures in the September campaign; 123,919 structures in the February 2014 campaign, with some structures sprayed twice). In total, 233,506 sachets were purchased, with another 7,317 sachets transferred from Zambia, for a total of 240,823 sachets. The spraying utilized 241,479 sachets over the two rounds (including sachets left over from the previous year).

Table RW1 summarizes the spray done in 2012 through 2014.

TABLE RW1: RWANDA QUICK FACTS

	2012	2013	2014
# Local Staff	16	19	17
Spray Start Date	August 20, 2012	Feburary 11, 2013 September 2, 2013	February 10, 2014 September 8, 2014
# Spray Rounds	1	2	2
# Sachets & Bottles Used	172,620	265,189	241,483
# People Protected	1,025,181	1,479,342	1,217,837
# Structures Sprayed	236,610	345,862	297,005
# 100 Square Meters Sprayed	415,652	662,425	603,698

12.2 Program Expenditures

This section presents an overview of Rwanda IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		421,825	499,808			165,834	**$ 1,087,467**	14.0%
Entomology			147,734		313,773	9,631	**$ 471,138**	6.1%
Environmental Compliance			45,550		21,203	14,231	**$ 80,984**	1.0%
Equipment Supplies				164,323		32	**$ 164,355**	2.1%
IEC			5,899		11,079		**$ 16,979**	0.2%
Insecticide	3,671,599						**$ 3,671,599**	47.3%
M&E			83,920		4,745	56,593	**$ 145,258**	1.9%
Post Spray					11,884		**$ 11,884**	0.2%
Spray Campaign					1,629,760	3,193	**$ 1,632,953**	21.0%
Spray Planning			133,644		318,267	25,339	**$ 477,251**	6.2%
Grand Total	**$ 3,671,599**	**$ 421,825**	**$ 916,556**	**$ 164,323**	**$ 2,310,712**	**$ 274,852**	**$ 7,759,867**	100.0%

Table RW2 displays the Rwanda IRS program total capital and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS project financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the table.

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

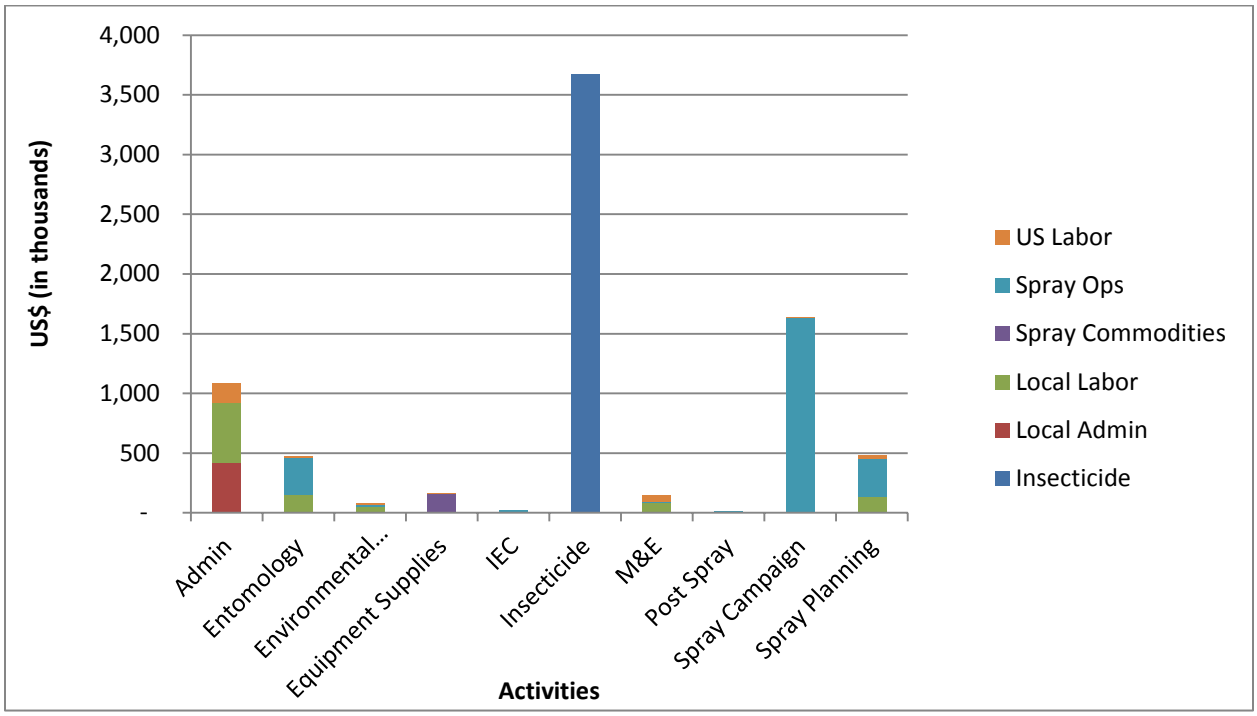


Figure RW1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticides represented a plurality of the total costs at 47.3 percent of costs. Spray campaign costs and administration were the next two largest categories of costs, representing 21.0 and 14.0 percent of costs, respectively. The Project procured 233,506 sachets of carbamate, received another 7,313 sachets from Zambia, and used 241,479 sachets. About 61 percent of the total cost for administration consists of labor, both local and U.S.-based.

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

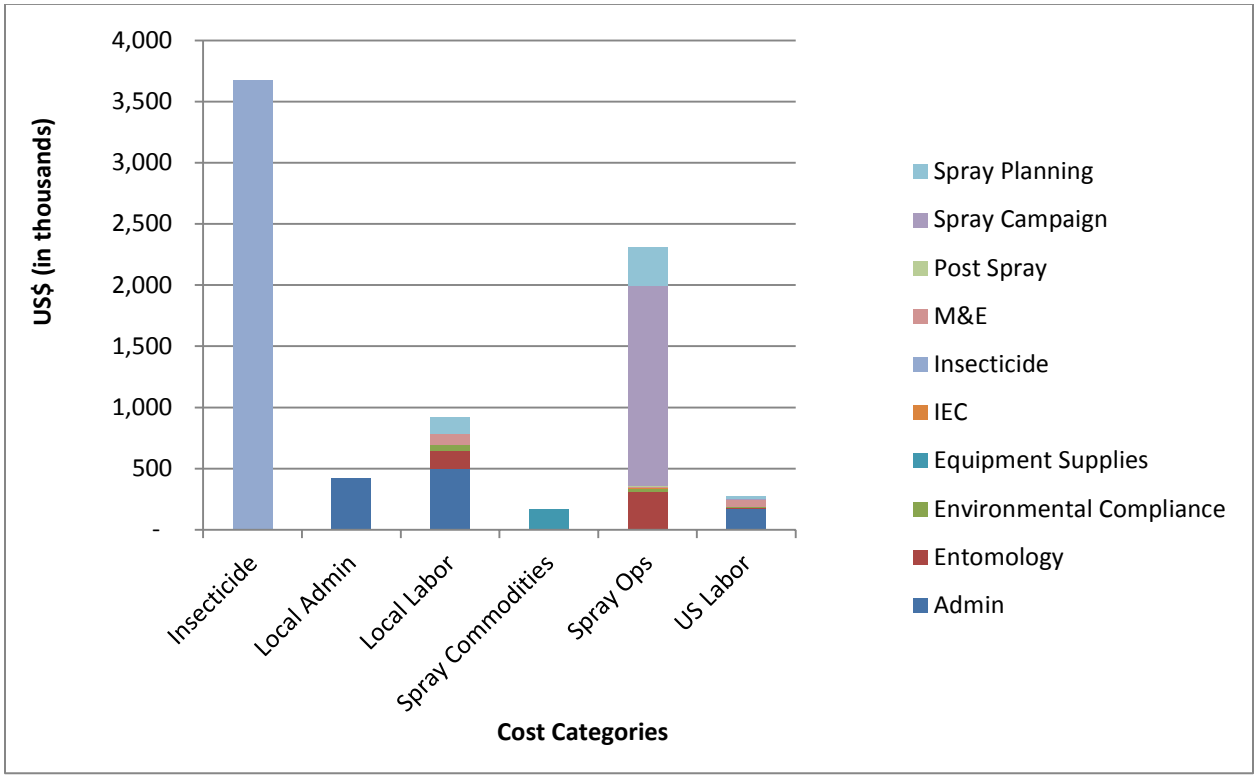


Figure RW2 contains the same information as Figure RW1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor,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

12.3 Unit Cost Analysis

This section presents Rwanda IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE RW3: RWANDA UNIT COSTS

		Insecticide costs			
		Procured		Used	
	Person protected	$	6.37	$	9.65
Cost per	**Structure sprayed**	$	26.13	$	39.55
	100 m^2 sprayed	$	16.07	$	24.32

The Rwanda 2014IRS spray campaign protected 1,217,837 people from malaria transmission, sprayed 297,005 structures and covered an area of 482,958 m^2. Table RW3 shows a comparison

of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $3.27 in the cost per person protected, $13.43 in the cost per structure sprayed, and $8.26 in the cost per area sprayed, compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 5.9 percent of the unit cost. Insecticide is the largest category of expenditures at 65.2 percent, followed by spray campaign cost at 13.9 percent and administration at 9.3 percent.

12.4 COMPARISON ACROSS THE THREE YEARS

This section provides a comparison of the Rwanda IRS program for 2012 through 2014, as implemented by the AIRS project. The comparison focuses on output measures, total expenditures, and unit costs.

TABLE RW4: RWANDA IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	1,025,181	1,479,342	1,217,837	-17.7%
Structures Sprayed	236,610	345,862	297,005	-14.1%
Area Sprayed (100 m^2)	332,522	529,940	482,958	-8.9%

Table RW4 compares the year-on-year change in AIRS Rwanda program output measures. In 2014, the program achieved lower coverage on all three indicators used in Table RW3 than in 2013 (and lower numbers of people protected and structures sprayed than in 2012, despite spraying more area). Between 2013 and 2014, the number of people protected decreased 17.7 percent, the number of structures decreased 14.1 percent, while the area sprayed decreased by 8.9 percent.

TABLE RW5: RWANDA IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	179,216	1,113,217	3,671,599	230%
Local Admin	580,242	465,741	421,825	-9%
Local Labor	804,254	1,072,665	916,556	-15%
Spray Operations	1,953,825	3,056,136	2,310,712	-24%
Commodities	414,278	515,585	164,323	-68%
U.S. Labor	248,211	349,455	274,852	-21%
TOTAL	**$ 4,180,026**	**$ 6,572,800**	**$ 7,759,867**	**18.1%**

Table RW5 compares the year-on-year change in total program capital and recurrent expenditures. The total program cost increased by 18.1 percent from 2013 to 2014 (total expenditures in 2014 were also more than in 2012), representing an increase in the total annual cost of about $1,187,067. Increases in costs from 2013 to 2014 were incurred solely for insecticides, for which costs increased by over $2.5 million. Costs decreased in other categories by over $1.3 million. Decreases in the cost of spray operations represented about 54 percent of the cost decrease from 2013 to 2014 in the non-insecticide costs (at over $745,000), while costs for commodities decreased by $351,000 from 2013 to 2014.

The costs of insecticides increased 214 percent from 2013 to 2014 due to a change from pyrethroid to carbamate insecticides in two out of three districts (the third district used carbamate insecticides in 2013). The figures in Table RW4 reflect the cost of insecticides procured, not the cost of insecticide used. In 2014, more insecticide was used than was paid for; about 3.3 percent of insecticide used was transferred from Zambia or procured in 2013.

While costs for spray operations in 2014 were almost $357,000 higher than in 2012 (18.2 percent more), 2012 had only one round of spraying, while 2014 had two rounds.

TABLE RW6: RWANDA IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 4.08	$ 4.44	$ 6.37	43.4%
Per Structure Sprayed	$ 17.67	$ 19.00	$ 26.13	37.5%
Per Area Sprayed	$ 12.57	$ 12.40	$ 16.07	29.5%

Table RW6 shows the program unit costs across the three years. Because the program size decreased (for all measured in Table RW5), while the total expenditures increased from 2013 to 2014, the unit costs increased: by about 43.8 percent for cost per person protected and 37.5 percent for cost per structure sprayed. 2014 unit costs were the highest among all three years of the program. Again, this was mainly explained by the switch from pyrethroids to carbamates.

TABLE RW7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	34,991	31,999	-9%	40,126	25%
Number of other seasonal laborers	4,696	3,556	-24%	2,442	-31%
Number of structures sprayed	236,610	345,862	46%	297,005	-14%

Structures sprayed per SOP per day	6.8	10.8	60%	7.4	-32%
Spray operations cost per SOP Day	55.84	95.51	71%	57.59	-40%
Spray operations and commodities cost per structure sprayed	10.77	13.55	26%	20.70	53%
Spray operations and commodities cost per structure sprayed (without insecticide)	10.01	10.33	3%	8.33	-19%

Table RW7 displays various measures of implementation efficiency across the 3 years. While from 2012 to 2013 the number of SOP-days used for the campaign decreased by about 9 percent, the number of structures sprayed increased by 46 percent, resulting in more structures sprayed per SOP per day in 2013 (6.8 structures per SOP per day in 2012 vs. 10.8 structures per SOP per day in 2013). In 2014, the number of SOP days increased by 25 percent and the structures sprayed decreased by 14 percent compared with 2013, resulting in about 7.4 structures sprayed per SOP per day (32 percent less than in 2013). The spray operation cost per SOP per day, however, decreased by about 40 percent from 2013 to 2014, indicating that the decrease in spray operation costs was proportionately greater than the decrease in the number of structures sprayed per SOP-day between the two years. When translated from cost per SOP per day to spray operations and commodity costs per structure sprayed, spray operation and commodity costs per structure sprayed decreased by about 19 percent from 2013 to 2014, as shown in the last row of Table RW6. The increase in insecticide costs in 2014 compared to 2013 offset the increased operational efficiency, and cost per structure sprayed for spray operations and commodities, including insecticide, increased by 53 percent from 2013 to 2014.

13. SENEGAL

13.1 BACKGROUND

2012

In 2012, 2012 of the AIRS project, the program sprayed six districts: Guinguinéo, Koungheul, Koumpentoum, Malem Hodar, Nioro, and Vélingara. The 2012 IRS campaign took place over a total of 48 operational days, and the project used carbamates, some of which were inherited from the previous implementing partner, the rest of which the project directly procured in 2012. Entomological monitoring activities were implemented by UCAD, and IEC activities were led by ChildFund Senegal.

2013

In 2013 of the project, 2013, the program sprayed in four of the six districts that had been sprayed in 2012, namely: Malem Hodar, Koumpentoum, Koungheul, and Vélingara. The 2013 spray campaign was conducted for 49 operational days, and used the carbamate class of insecticide. In the 2013, AIRS Senegal sprayed 207,116 structures, protecting 690,029 people.

2014

In 2014, AIRS continued to spray in Malem Hodar, Koumpentoum, Koungheul, and Vélingara. Two rounds of spraying were implemented – May 15 to June 18 in Koumpentoum and Vélingara, and July 15 to August 17, 2014, in Koungheul and Malem Hoddar, lasting 34 and 32 days, respectively (66 operational days in total). While the total number of operational days increased, each of the rounds was shorter than in 2013 (49 operational days) or 2012 (48 operational days). For the first time, organophosphate insecticides were used for the campaign in two districts (Koumpentoum and Vélingara) while the remaining supply of carbamates were used in the other two districts (Koungheul and Malem Hoddar). In total, 34,849 bottles of organophosphates and 25,337 sachets of carbamates were used to spray 204,159 structures, protecting 708,999 people.

Table SN1 summarizes the spray done in 2012 through 2014.

TABLE SN1: SENEGAL QUICK FACTS

	2012	2013	2014
# Local Staff	14	16	19
Spray Start Date	June 6, 2012	July 15, 2013	May 15, 2014
# Spray Rounds	1	1	2
# Sachets & Bottles Used	106,874	65,049	60,186

# People Protected	1,095,093	690,029	708,999
# Structures Sprayed	306,916	207,116	204,159
# 100 Square Meters Sprayed	267,185	162,623	150,465

* Reverse calculation using number of insecticide sachets/bottles 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.

13.2 Program Expenditures

This section presents an overview of Senegal IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		439,194	813,415			163,888	**$ 1,416,497**	30.6%
Entomology			482		5	29	**$ 516**	0.0%
Environmental Compliance			79,105		33,931	8,483	**$ 121,519**	2.6%
Equipment Supplies				126,346		40	**$ 126,386**	2.7%
IEC			39,572		25,681	3,972	**$ 69,225**	1.5%
Insecticide	1,387,443						**$ 1,387,443**	29.9%
M&E			76,540		75,596	28,693	**$ 180,829**	3.9%
Post Spray			66,407		36,953	8,329	**$ 111,688**	2.4%
Spray Campaign			68,242		745,376	7,526	**$ 821,144**	17.7%
Spray Planning			117,343		260,094	23,127	**$ 400,564**	8.6%
Grand Total	**$ 1,387,443**	**$ 439,194**	**$ 1,261,106**	**$ 126,346**	**$ 1,177,635**	**$ 244,087**	**$ 4,635,811**	100.0%

Table SN2 displays the Senegal IRS program total capital and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS Project's financial systems, and the top row lists IRS program cost categories. The following two figures illustrate the cost breakdown in the table.

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

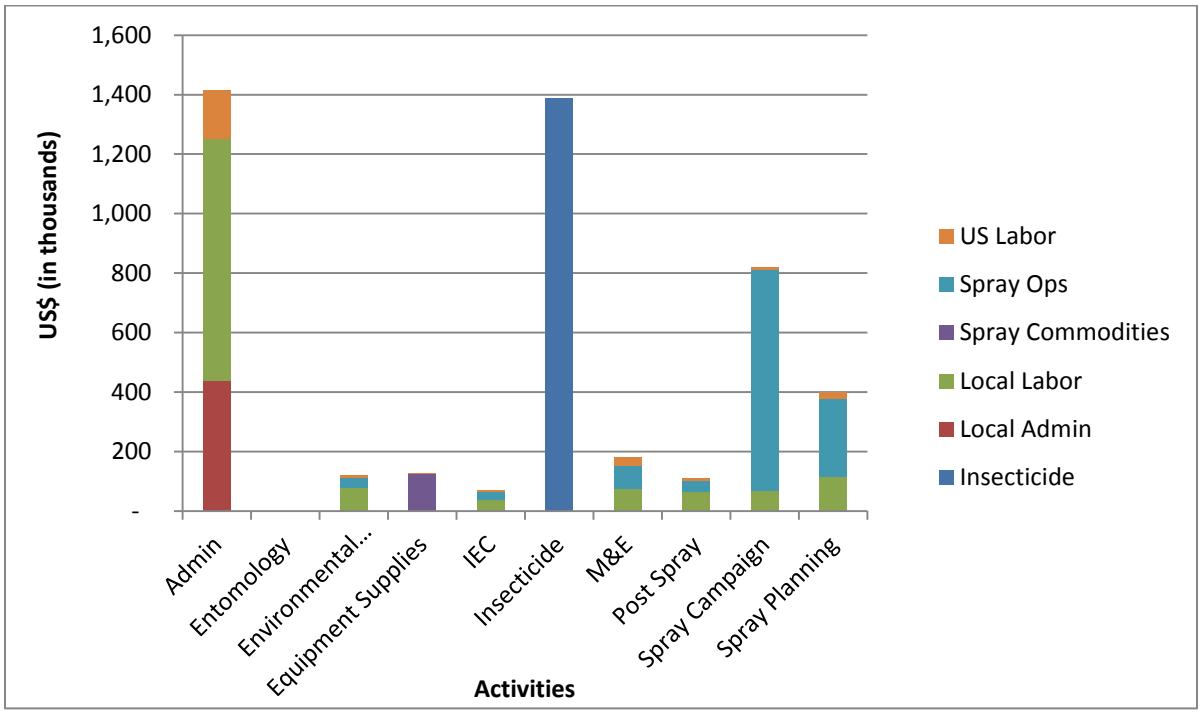


Figure SN1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Local administration is the most expensive IRS activity (30.6 percent of expenditures), followed by the insecticides (29.9 percent of expenditures) and spray campaign activities (17.7 percent of expenditures). AIRS procured 48,467 bottles of OP insecticide, and used about 72 percent of the amount purchased. Additionally, 9,746 sachets of carbamate were procured, although 25,337 sachets were used (the difference being stock left from previous campaigns). About 69 percent of the total cost for administration consists of labor, both local and U.S.-based.

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

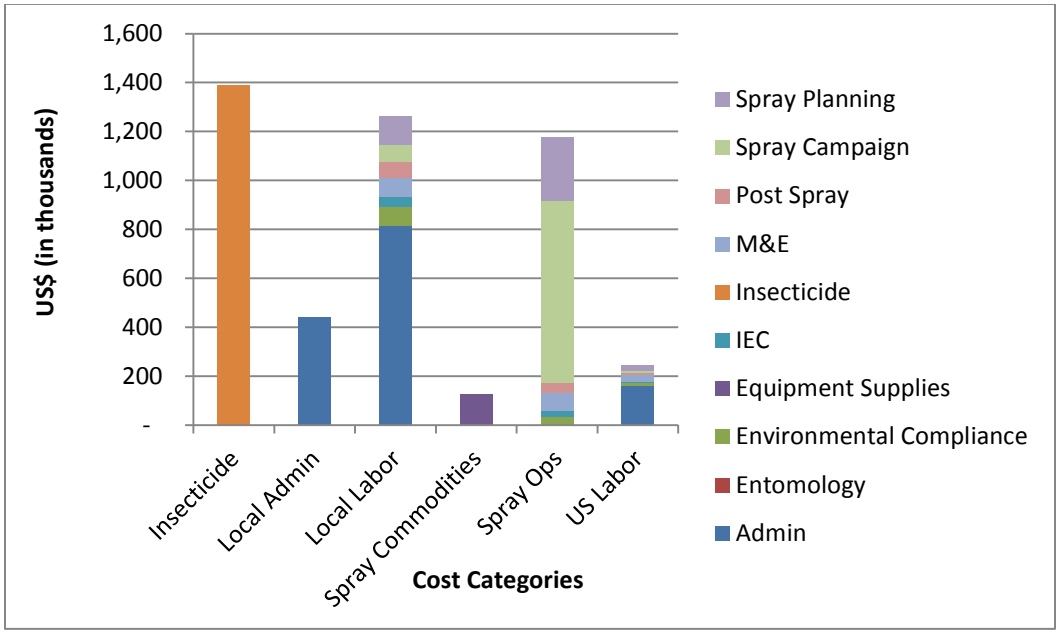


Figure SN2 contains the same information as Figure SN1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor,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

13.3 Unit Cost Analysis

This section presents Senegal IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE SN3: SENEGAL UNIT COSTS

		Insecticide costs	
		Procured	**Used**
	Person protected	$ 6.54	$ 12.95
Cost per	**Structure sprayed**	$ 22.71	$ 44.97
	100 m^2 sprayed	$ 30.81	$ 61.01

The Senegal 2014 IRS spray campaign protected 708,999 people from malaria transmission, sprayed 204,159 structures and covered an area of 150,465 m^2. Table SN3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $6.41 in the cost per person protected, $22.26 in the cost per structure sprayed, and $30.21 in the cost per area sprayed,

compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 3.3 percent of the unit cost. Insecticide is the largest category of expenditures at 64.6 percent. Administration, insecticides, and the spray campaign together account for 89 percent of costs.

13.4 COMPARISON ACROSS THE THREE YEARS

This section provides a comparison of the Senegal IRS program for 2012 through 2014, as implemented by the AIRS project. The comparison focuses on output measures, total expenditures, and unit costs.

TABLE SN4: SENEGAL IRS PROGRAM COMPARISON OF OUTPUT MEASURES

Output Measures	2012	2013	2014	Percentage Change (2013 to 2014)
People Protected	1,095,093	690,029	708,999	2.7%
Structures Sprayed	306,916	207,116	204,159	-1.4%
Area Sprayed (100 m^2)	267,185	162,623	150,465	-7.5%

Table SN4, above, compares the year-on-year change in Senegal IRS program output measures. In 2014, the program protected more people than in 2013, growing by 2.7 percent from 2013 to 2014. However, this greater number of people protected from 2013 to 2014 was done by spraying about 1.4 percent fewer structures. As shown in Table SN1 in the Background, the average size of the structures sprayed in 2014 was 73.7 m^2 compared to 78.5 m^2 in the previous year, and the decrease in average size of a structure and fewer structures sprayed means that the area sprayed dropped from 2013 to 2014 by 7.5 percent. Across the three years, the greatest degree of program coverage was achieved in 2012 for all three measures listed in Table SN3.

TABLE SN5: SENEGAL IRS PROGRAM COMPARISON OF EXPENDITURES

Cost Category	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Insecticide	1,360,208	1,235,219	1,387,443	12.3%
Local Admin	334,918	456,304	439,194	-3.7%
Local Labor	1,116,850	1,212,729	1,261,106	4.0%
Spray Operations	1,597,995	1,586,534	1,177,635	-25.8%
Commodities	223,858	175,267	126,346	-27.9%
U.S. Labor	160,977	291,558	244,087	-16.3%
TOTAL	**$ 4,794,806**	**$ 4,957,611**	**$ 4,635,811**	**-6.5%**

Table SN5, above, compares the year-on-year change in total program capital and recurrent expenditures. The total program cost decreased by 6.5 percent from 2013 to 2014 (total expenditures in 2014 were also less than in 2012), representing a decrease in the total annual cost of about $322,000. Reductions in costs were seen across all costs categories from 2013 to 2014 except for insecticides and local labor. Compared to 2012, 2014 had lower spray operations and commodities costs, which were great enough to offset increases in the costs in other areas.

The costs of insecticides increased 12.3 percent from 2013 to 2014, despite the switch to more expensive OP insecticides in some areas. As mentioned previously, about 72 percent of organophosphates purchased were sprayed during the 2014 IRS campaign. However, about 62 percent of the carbamates sprayed in 2014 were purchased in 2013, lowering the costs of carbamates in 2014 compared to actual usage. This is, then, reflected in higher insecticide costs in 2013 (i.e., more carbamate insecticide was purchased than was used in 2013). When considering the cost of insecticides used between 2013 and 2014, cost increased by over 40 percent.

Despite more operational days for the two campaigns in 2014 compared with 2013, the cost for spray operations decreased by almost $409,000 (about 26 percent less than 2013 spray operation costs; spray operation costs in 2014 were also lower than in 2012 by about $420,000).

TABLE SN6: SENEGAL IRS PROGRAM COMPARISON OF UNIT COSTS

Unit Costs	2012 (Adjusted)	2013 (Adjusted)	2014	Percentage Change (2013 to 2014)
Per Person Protected	$ 4.38	$ 7.18	$ 6.54	-9.0%
Per Structure Sprayed	$ 15.62	$ 23.94	$ 22.71	-5.1%
Per Area Sprayed	$ 17.95	$ 30.49	$ 30.81	1.1%

Table SN6 shows the program unit costs across the three years. Because the program size increased (in terms of people protected), while the total expenditures decreased from 2013 to 2014, the unit costs per person protected also decreased by about 9 percent. For the cost per structure sprayed, costs decreased by enough to offset lower coverage figures and the unit cost metrics declined between 2013 and 2014. 2014 unit costs were still higher than 2012 unit costs, despite lower total costs because of the higher levels of coverage achieved in 2012 than in 2014.

TABLE SN7: YEAR ON YEAR CHANGES IN EFFICIENCY MEASURES

Efficiency measure	2012	2013	% Change from 2012 to 2013	2014	% Change from 2013 to 2014
Number of SOP days	24,592	15,450	-37%	15,045	-3%
Number of other seasonal laborers	529	382	-28%	243	-36%
Number of structures sprayed	306,916	207,116	-33%	204,159	-1%
Structures sprayed per SOP per day	12.5	13.4	7%	13.6	1%
Spray operations cost per SOP Day	64.98	102.69	58%	78.27	-24%
Spray operations and commodities cost per structure sprayed	10.37	14.47	40%	13.18	-9%
Spray operations and commodities cost per structure sprayed (without insecticide)	5.94	8.51	43%	6.39	-25%

Table SN7 displays various measures of implementation efficiency across the three years. While from 2012 to 2013 the number of SOP-days used for the campaign decreased by 37 percent, the number of structures sprayed also decreased by 33 percent, resulting in more structures sprayed per SOP per day in 2013 (12.5 structures per SOP per day in 2012 vs.13.4 structures per SOP per day in 2013). In 2014, however, even fewer total SOP-days were employed, but fewer structures sprayed, resulting in about 13.6 structures sprayed per SOP per day. However, the spray operation cost per SOP per day decreased by about 24 percent from 2013 to 2014, reflecting the fact that total spray operation costs declined over the two years. Similarly, 2014 utilized fewer seasonal laborers (excluding SOPs) than the other years. While the two rounds of spraying increased the number of operational days, the decreased number of laborers was greater – 2014 had over 2,500 fewer days of non-SOP seasonal labor than in 2013. This was mostly due to the reduced number of IEC mobilizers hired by the project since NMCP received direct funding from PMI to lead IEC mobilization in 2014. As shown in the last row of Table SN7, spray operations and commodities costs (excluding insecticides) per structure sprayed increased from 2012 to 2013 by 43 percent, but decreased from 2013 to 2014 by 25 percent. From 2013 to 2014, the decrease in spray operation and commodity costs per area sprayed were sufficient to compensate for the increased insecticide costs; when insecticides are included in the cost per structure sprayed, cost per structure sprayed decreased from 2013 to 2014 by 9 percent. However, as noted above, the full cost of insecticides used in 2014 were not borne in that year and savings in spray operations might not be enough to compensate for continued or expanded use of organophosphates in the future.

14. ZAMBIA

14.1 BACKGROUND

2014

In 2012 and 2013, PMI supported IRS implementation in 20 districts in Eastern, Northern, and Muchinga provinces in Zambia under the Zambia Integrated Systems Strengthening Program. The government of Zambia conducted IRS in three other districts in the country. In 2014, the AIRS project assumed responsibility for implementing IRS in Zambia in 29 districts to include districts in Luapula and part of Central provinces with the other provinces being funded under the Department for International Development (DFID). However, following district boundary re-demarcation by the Government, the number of districts increased from 28 to 40. Spray operations occurred from October 13, 2014 through December 23, 2014, representing 65 operational days. Organophosphates (Actellic CS) were employed for spraying because of vector susceptibility and the duration of effectiveness. A total of 130,211 bottles of insecticide were procured, and 112,603 bottles were used. A total of 409,544 structures were sprayed, protecting 2,000,824 people.

It should be noted that the Zambia team experienced several challenges the first year that IRS was implemented under the AIRS project. Some of these challenges included the delay in shipment of insecticides, which subsequently delayed the spray campaign by several weeks, and inadequate staffing levels for the scale of the program. The challenges most likely decreased the team's efficiency.

Table ZA1 summarizes the spray done in 2014.

TABLE ZA1: ZAMBIA QUICK FACTS

	2014
# Local Staff	27
Spray Start Date	October 13, 2014
# Spray Rounds	1
# Bottles Used	112,603
# People Protected	2,000,824
# Structures Sprayed	409,544
# 100 Square Meters Sprayed	281,508

14.2 Program Expenditures

This section presents an overview of Zambia IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		378,315	595,078			242,751	$ 1,216,144	17.6%
Entomology			31,805		100,011	9,500	$ 141,316	2.0%
Environmental Compliance			31,827		198,796	9,065	$ 239,688	3.5%
Equipment Supplies			11,255	65,426		2,135	$ 78,815	1.1%
IEC							$ -	0.0%
Insecticide	3,392,635						$ 3,392,635	49.1%
M&E			71,631		21,460	30,594	$ 123,686	1.8%
Post Spray			15,554		94,234	1,281	$ 111,068	1.6%
Spray Campaign			106,400		946,692	20,467	$ 1,073,559	15.5%
Spray Planning			26,166		502,929	5,800	$ 534,894	7.7%
Grand Total	**$3,392,635**	**$ 378,315**	**$ 889,716**	**$ 65,426**	**$ 1,864,121**	**$ 321,594**	**$ 6,911,806**	100.0%

Table ZA2 displays the Zambia IRS program total capital (including disposition) and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS Project's financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the table.

FIGURE ZA1: ZAMBIA IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

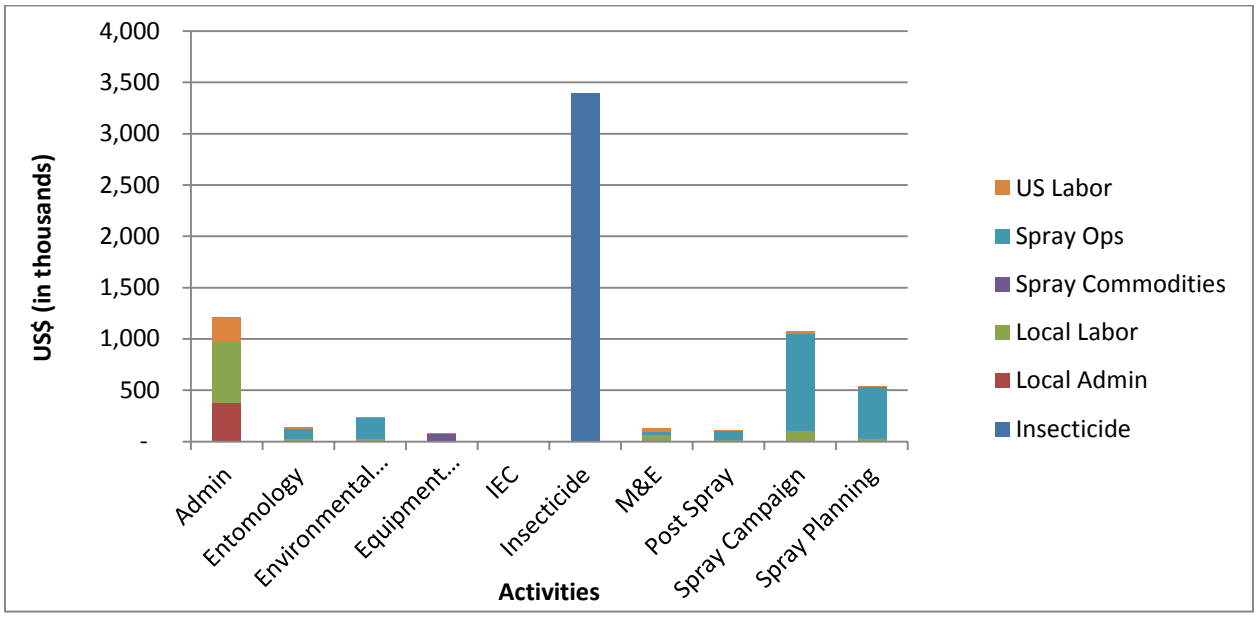


Figure ZA1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticides and administration are the two most expensive IRS activities (49.1 percent and 17.6 percent of expenditures, respectively), followed by the spray campaign (15.5 percent of expenditures). AIRS Zambia procured 130,211 bottles of organophosphate insecticide; 112,603 bottles were used. About 68.9 percent of the total cost for administration consists of labor, both local and U.S.-based.

FIGURE ZA2: ZAMBIA IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

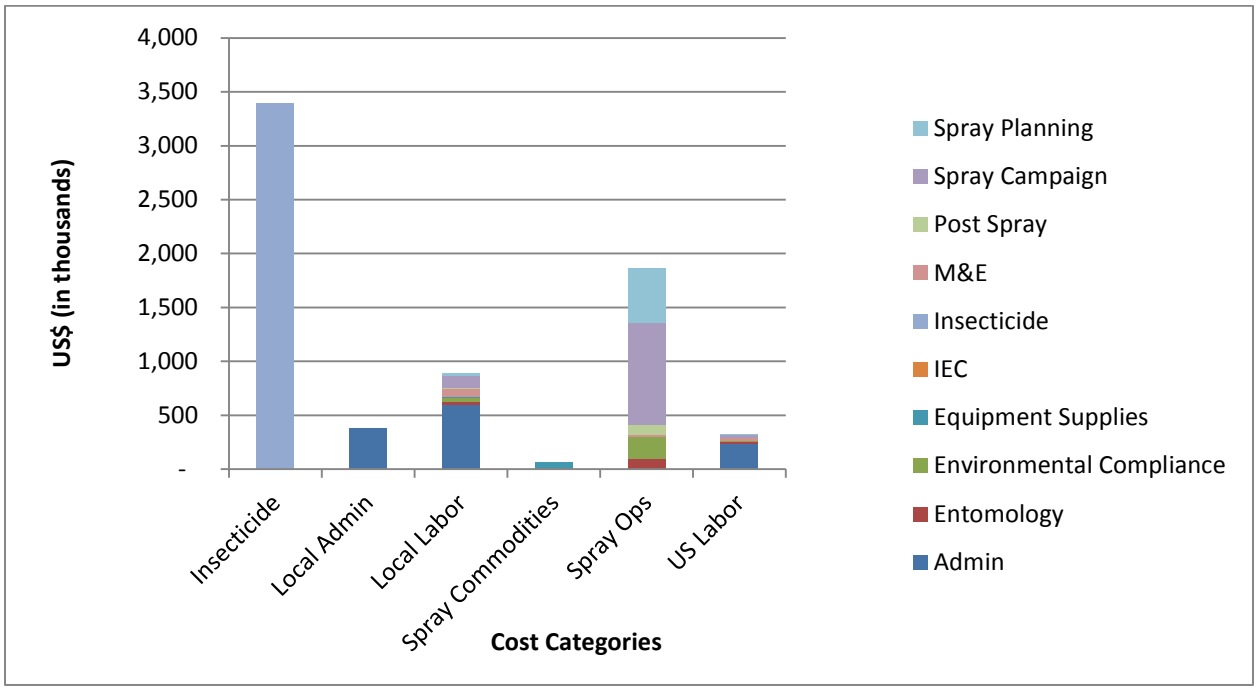


Figure ZA2 contains the same information as Figure ZA1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs were less than expenditures on insecticide, local labor, and spray operations.

14.3 Unit Cost Analysis

This section presents Zambia IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE ZA3: ZAMBIA UNIT COSTS

		Insecticide costs		
		Procured		Used
Person protected	$	3.45	$	12.18
Cost per Structure sprayed	$	16.88	$	59.51
100 m^2 sprayed	$	24.55	$	86.58

The Zambia 2014 IRS spray campaign protected 2,000,824 people from malaria transmission, sprayed 409,544 structures and covered an area of 281,508 m^2. Table ZA3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $8.73 in the cost per person protected, $42.63 in the cost per structure sprayed, and $62.02 in the cost per area sprayed, compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 2.1 percent of the unit cost. Insecticide is the largest category of expenditures at 85.6 percent, followed by administration at 9.4 percent and spray campaign costs at 4.4 percent.

15. ZIMBABWE

15.1 BACKGROUND

2012 and 2013

During the first two years of implementation, the project was directed by PMI to provide technical assistance to the Zimbabwean NMCP to improve the efficiency and effectiveness of Zimbabwe's national IRS program. AIRS Zimbabwe primarily focused on improving the environmental compliance/safety of IRS operations, assuring entomological surveillance data availability for future IRS campaign decision-making, assisting with the procurement of needed PPE for the safety of IRS campaign staff, and building the capacity of Zimbabwean malaria stakeholders on a variety of issues ranging from developing insectaries for rearing susceptible colonies of mosquitoes to completing IRS campaign monitoring.

2014

In 2014, AIRS assumed responsibility for direct implementation of IRS in Zimbabwe in the districts of Mutare, Chimanimani, Mutasa, and Nyanga in Manicaland Province. By leading the IRS campaign in these four districts, AIRS Zimbabwe aimed to provide new ideas and methods to the NMCP and other malaria stakeholders for improving the efficiency, safety, and effectiveness of IRS programming in other provinces. Spray operations took place in 39 operational days, using organophosphates. A total of 80,429 bottles of insecticide were procured, and 67,040 bottles used. A total of 147,949 structures were sprayed, protecting 334,746 people.

Table ZW1 summarizes the spray conducted in 2014.

TABLE ZW1: ZIMBABWE QUICK FACTS

	2014
# Local Staff	10
Spray Start Date	November 1, 2014
# Spray Rounds	1
# Bottles Used	67,040
# People Protected	334,746
# Structures Sprayed	147,949
# 100 Square Meters Sprayed	167,600

15.2 Program Expenditures

This section presents an overview of Zimbabwe IRS program expenditures in 2014. Costs are organized by activity and cost category.

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

IRS Activity	Insecticide	Local Admin	Local Labor	Spray Commodities	Spray Operations	U.S. Labor & STTA	Grand Total	% of Total
Admin		336,821	664,179			172,900	$ 1,173,900	24.7%
Entomology		2,049	177,503		152,276	11,145	$ 342,973	7.2%
Environmental Compliance		1,730	69,006		585,022	65,960	$ 721,719	15.2%
Equipment Supplies				228,793		32	$ 228,826	4.8%
IEC							$ -	0.0%
Insecticide	2,137,936						$ 2,137,936	44.9%
M&E					11	49,482	$ 49,493	1.0%
Post Spray					-	641	$ 641	0.0%
Spray Campaign			475		102,482	1,329	$ 104,286	2.2%
Spray Planning						2,439	$ 2,439	0.1%
Grand Total	**$ 2,137,936**	**$ 340,600**	**$ 911,163**	**$ 228,793**	**$ 839,790**	**$ 303,929**	**$ 4,762,212**	100.0%

Table ZW2 displays the Zimbabwe IRS program total capital (including requisition) and recurrent expenditures from 2014. The first column lists the program activities as tracked by the AIRS project's financial systems, and the top row lists IRS program cost categories. Further explanation of these designations is given in the Methodology section. The following two figures illustrate the cost breakdown in the table.

FIGURE ZW1: ZIMBABWE IRS PROGRAM ACTIVITY EXPENDITURES, BY COST CATEGORY

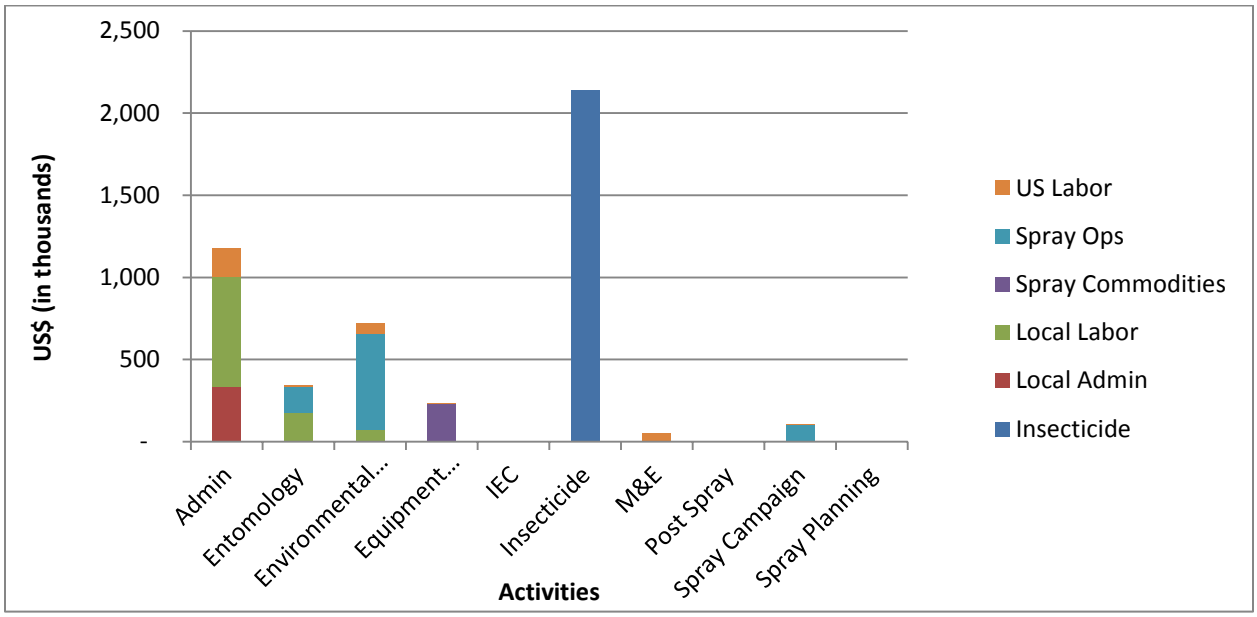


Figure ZW1 shows the total capital and recurrent costs, but provides a depiction of cost distribution across program activities (X-axis), as well as the make-up of the activities' costs by cost category (legend). Insecticides and local administration are the two most expensive IRS activities (44.9 percent and 24.7 percent of expenditures, respectively), followed by environmental compliance (15.2 percent of expenditures). AIRS Zimbabwe procured 80,429 bottles of organophosphate insecticide; 67,040 bottles were used. About 71.3 percent of the total cost for administration consists of labor, both local and U.S.-based.

FIGURE ZW2: ZIMBABWE IRS PROGRAM COST CATEGORY EXPENDITURES, BY ACTIVITY

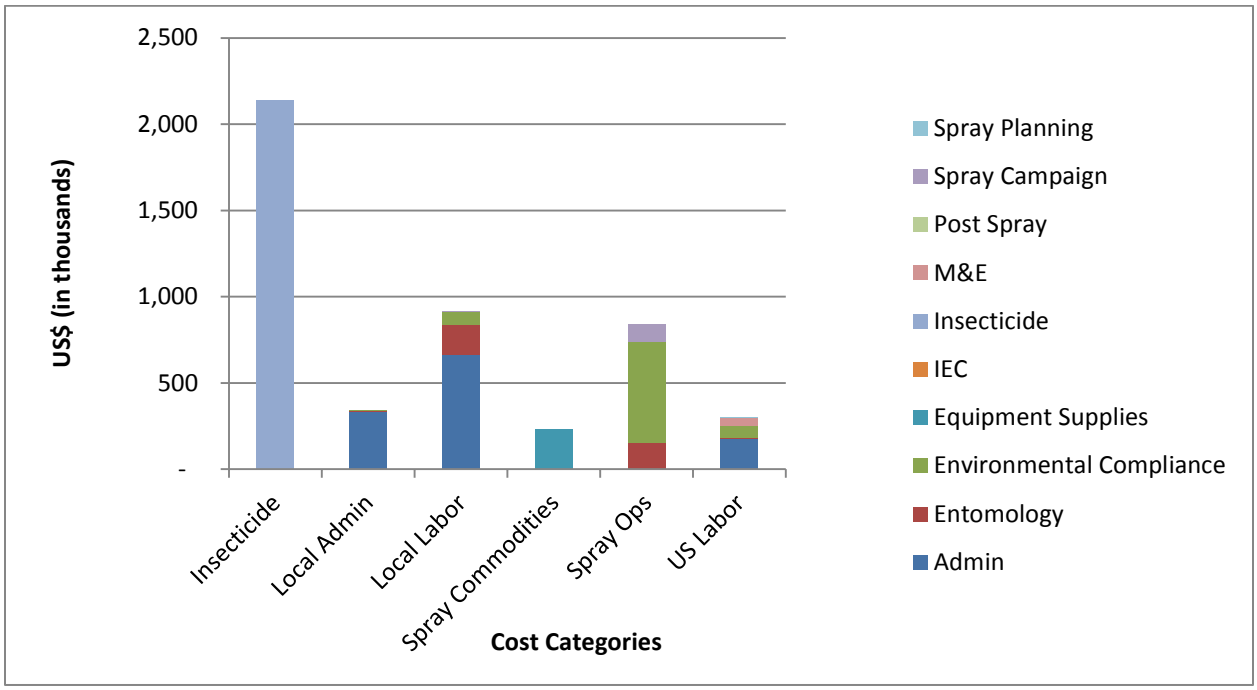


Figure ZW2 contains the same information as Figure ZW1, but switches the X-axis, which is now cost categories, with the legend items, now program activities. This illustrates that the local administration, U.S. labor, and commodities costs are minimal compared to expenditures on insecticide, local labor, and spray operations.

15.3 Unit Cost Analysis

This section presents Zimbabwe IRS expenditures as unit costs: per person protected, per structure sprayed, and per area sprayed (in terms of 100 m^2).

TABLE ZW3: ZIMBABWE UNIT COSTS

		Insecticide costs		
		Procured		Used
Person protected	$	14.23	$	18.47
Cost per Structure sprayed	$	32.19	$	41.79
100 m^2 sprayed	$	28.41	$	36.89

The Zimbabwe 2014 IRS spray campaign protected 2,000,824 people from malaria transmission, sprayed 409,544 structures and covered an area of 281,508 m^2. Table ZW3 shows a comparison of unit costs per person protected, per structure sprayed and per area sprayed when using the cost of insecticides procured versus estimating the cost of insecticides used.

Estimating the cost of insecticides used results in an increase of $4.25 in the cost per person protected, $9.61 in the cost per structure sprayed, and $8.48 in the cost per area sprayed, compared to using the cost of insecticides procured. When calculating the total unit cost using the estimated cost of insecticides used, entomology, environmental compliance, and M&E activities make up 18 percent of the unit cost. Insecticide is the largest category of expenditures at 57.6 percent, followed by administration at 19 percent and environmental compliance costs at 11.7 percent.

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