
**PMI | Africa IRS (AIRS) Project**

Indoor Residual Spraying (IRS 2) Task Order Six

# PMI/ETHIOPIA INDOOR RESIDUAL SPRAYING SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT AMENDMENT 1 2015-2020

NATIONWIDE

CARBAMATES, ORGANOPHOSPHATES, PYRETHROIDS AND CHLORFENAPYR

FINAL

JUNE 2015

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# PMI/ETHIOPIA
# INDOOR RESIDUAL SPRAYING
# SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT AMENDMENT 1
# 2015-2020

## NATIONWIDE
## CARBAMATES, ORGANOPHOSPHATES, PYRETHROIDS AND CHLORFENAPYR

## FINAL

## JUNE 2015

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# ACRONYMS

| | |
|---|---|
| **AIRS** | Africa Indoor Residual Spraying |
| **BEO** | Bureau Environmental Officer |
| **BMP** | Best Management Practices Manual |
| **CB IRS** | Community-based IRS |
| **CFR** | U.S. Code of Federal Regulations |
| **CS** | capsule suspension |
| **CSA** | Central Statistical Agency |
| **DB IRS** | District-based IRS |
| **DDT** | dichlorodiphenyltrichloroethane |
| **DHO** | District Health Office |
| **DHS** | Demographic and Health Survey |
| **EC** | emulsifiable concentrate |
| **EMMP** | Environmental Mitigation and Monitoring Plan |
| **EOSR** | End-of-spray Report |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **FMHACA** | Food, Medicine and Health Care Administration and Control Authority |
| **FMOH** | Federal Ministry of Health |
| **GFATM** | Global Fund for AIDS, Malaria and Tuberculosis |
| **GHI** | Global Health Initiative |
| **GoE** | Government of Ethiopia |
| **HEW** | Health Extension Worker |
| **HSDP** | Health Sector Development Plan |
| **IEC** | Information, Education, and Communication |
| **IPM** | Integrated Pest Management |
| **ITN** | insecticide-treated net |
| **IVM** | Integrated Vector Management |
| **LLIN** | long-lasting insecticidal net |
| **M&E** | Monitoring and Evaluation |
| **MARD** | Ministry of Agriculture and Rural Development |
| **MCST** | Malaria Control Support Team |
| **MFP** | Malaria Focal Person |
| **MIS** | Malaria Indicator Survey |
| **MOP** | Malaria Operational Plan |
| **MPR** | Malaria Program Review |
| **MSDS** | material safety data sheet |
| **MSP** | mobile soak pit |
| **NGO** | nongovernmental organization |
| **NSP** | National Strategic Plan for Malaria |
| **OPs** | organophosphates |
| **ORHB** | Oromia Regional Health Bureau |
| **PEA** | Programmatic Environmental Assessment |

| | |
|---|---|
| **PMI** | President's Malaria Initiative |
| **PPE** | personal protective equipment |
| **RBM** | Roll Back Malaria |
| **SBCC** | social behavior change communication |
| **SEA** | Supplemental Environmental Assessment |
| **SOP** | Spray Operator |
| **SUFI** | Scaling up for Impact |
| **TOT** | Training of Trainers |
| **UNEP** | United Nations Environment Program |
| **USAID** | U.S. Agency for International Development |
| **USEPA** | U.S. Environmental Protection Agency |
| **WHO** | World Health Organization |
| **WHOPES** | WHO Pesticide Evaluation Scheme |

# 1. SUMMARY OF FINDINGS

## 1.1 PURPOSE OF THIS DOCUMENT

Supplemental Environmental Assessments (SEAs) must be developed to describe in-country impacts of interventions and describe country-specific activities to minimize those impacts. In 2013, an SEA was prepared for the 2013-2017 PMI IRS activities for Oromia Regional State. However, in 2015, PMI decided to potentially expand their support to other regional states of Ethiopia. This amended SEA (2015-2020) is nationwide in scope, allowing for implementation of regional or national level technical assistance and support as needed, in addition to implementation of IRS. This document also addresses changes in the IRS program and updates the information that was provided in previous SEAs.

## 1.2 MALARIA BURDEN IN ETHIOPIA

Three-quarters of the landmass of Ethiopia is estimated to be suitable for malaria transmission and around sixty percent of the population resides in areas where malaria could be transmitted. Malaria transmission in Ethiopia mainly occurs up to 2000 meters in elevation, but can also occasionally affect areas up to 2300 meters. In most parts of the country peak periods of malaria incidence occur from September to December following the main rainy seasons (June-September) and from March to May during and after the small rainy seasons (February-March). Due to the unstable and seasonal pattern of malaria transmission, the protective immunity of the population is generally low, and all age groups are at risk of infection and disease. In Ethiopia, most malaria cases are observed in persons over five years of age, although children under five and pregnant women are most vulnerable to the severe effects of the disease.

## 1.3 PMI SUPPORT IN ETHIOPIA

The U.S. Government (USG) announced Ethiopia as a PMI focus country in 2007, supported by $20 million PMI funding beginning in fiscal year (FY) 2008. PMI support was initially targeted to malaria control activities in the Oromia Regional State, which has about one-third of Ethiopia's malaria burden, population, and land area. Since 2011, PMI has expanded its support in a number of areas beyond Oromia, providing technical assistance to national structures, and technical and programmatic support and commodities to other Regional States.

## 1.4 ADVERSE HEALTH AND ENVIRONMENTAL IMPACTS FROM IRS AND MITIGATION MEASURES

Based on U.S. Agency for International Development's (USAID) experience with implementation of IRS in 17 other sub-Saharan African countries under the PMI, the most likely potential adverse health impact of the IRS intervention is unintentional pesticide exposure, leading to acute but mostly transitory health impacts on beneficiaries and spray operators (SOPs). Exposure treatment for carbamates, pyrethroids, chlorfenapyr and OP pesticides are detailed in Annexes C and D.

All of the World Health Organization Pesticide Evaluation Scheme (WHOPES)-recommended IRS insecticides except for malathion are hazardous to aquatic life, therefore the highest risk to the environment is likely to be contamination to water resources, with subsequent die-off of fish and other aquatic life. Potential negative environmental and health impacts are discussed in detail in Chapter 7, Potential Health and Environmental Consequences. Mitigation measures for potential health and environmental impacts are detailed in Chapter 8, the Safer Use Action Plan and the EMMP in Annex A of this SEA.

## 1.5 APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED:

The United States Agency for International Development's Global Health Bureau has determined that the proposed indoor residual spraying effort for the President's Malaria Initiative in Ethiopia, as described in this Supplemental Environmental Assessment 2015-2020, responds to the needs of the community and country as it relates to managing malaria in Ethiopia, as well as conforms to the environmental compliance requirements established in US 22 CFR 216.

This document does not mandate the execution of the proposed IRS, rather, documents the environmental planning and impact analysis executed by the IRS team in preparation for the proposed action. The design and standards of operation of the IRS program are established to avoid and reduce any potential impact. USAID has concluded that the proposed action, when executed as described in the Supplemental Environmental Assessment and the umbrella Programmatic Environmental Assessment (2012), is consistent with USAID's goal of reducing malaria incidence in Ethiopia while minimizing negative impact to environmental and human health.

The proposed actions recommended for approval in this 2015 SEA are:

1. The continuation of IRS implementation using pyrethroids, carbamates, organophosphates, and/or chlorfenapyr (when approved by WHOPES), where appropriate, based on pesticide resistance patterns throughout the country, and,
2. This SEA will extend coverage to all geographical areas in Ethiopia where IRS may be implemented or where national or regional level support may be provided by PMI as decided by the National Malaria Control Program and PMI for the 5-year period from 2015 to 2020.
3. This SEA authorizes small, closely supervised studies or hut trials to study new IRS insecticides, such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES evaluation and country-level required documentation has been submitted.

Due to the need to protect the population from malaria, and given the successful record of PMI in implementing IRS in Ethiopia without significant environmental consequences, it is proposed to allow IRS using the strict protocols and procedures contained in the 2015 PMI Best Management Practices (BMP) manual, and observing all precautions and prescriptions in this SEA.

The updated Environmental Mitigation and Monitoring Plan (EMMP) for Ethiopia (Annex A) provides detailed guidance on the performance of all activities associated with IRS. Through the use of this and other guidance, PMI has maintained an excellent record of success in executing IRS without substantial environmental or human health impact.

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# 2. PURPOSE OF THIS DOCUMENT

Under the U.S. Code of Federal Regulations (22 CFR §216), malaria vector control activities supported or planned by USAID must undergo environmental examination. To assist USAID missions in planning malaria vector control interventions, USAID in 2012 prepared the Management Programs for Malaria Vector Control: Programmatic Environmental Assessment (PEA) that provides a broad view of the human health and environmental impacts that could result from implementation of malaria vector control interventions. However, the PEA cannot account for inter-country and inter-regional variation regarding issues such as the capacity to manage pesticides used for vector control and the environment likely to be impacted. For this reason, Supplemental Environmental Assessments (SEAs) must be developed to describe in-country impacts of interventions and describe country-specific activities to minimize those impacts.

Whenever an in-country malaria vector control activity involves "assistance for the procurement or use, or both, of pesticides," SEAs supplementing the PEA must address the pesticide procedures found in 22 CFR 216.3(b). The pesticide procedures list 12 factors to address in SEAs and are described in the Pesticide Procedures section of this document.

In sum, the SEA should be looked upon as the overall representation of the country with regard to IRS. The SEA should address the human health and environmental impacts that may occur as a result of USAID support of malaria vector control activities.

The purpose of the PMI program is to save lives and reduce illness and suffering. The purpose of the SEA is to optimize these goals by ensuring malaria control programs use only safe and efficacious pesticides and use them in the way that will minimize inadvertent poisonings and intoxications; by ensuring the natural resources on which people depend for their daily food production and nutrition are not damaged; by ensuring that long term development is promoted by avoiding disruption of agricultural exports due to misuse of malaria pesticides on agricultural crops; and, by participating in international environmental agreements such as the Stockholm Convention on Persistent Organic Pollutants, among others.

An initial SEA for the Ethiopia IRS program was prepared and approved in March 2008 and provided an assessment of two of the WHO-recommended IRS insecticides for use in the Ethiopia Malaria Control Program, DDT and Malathion. Based on the results of the 2008 entomological study, which showed a high degree of vector resistance to DDT, an SEA Amendment was prepared in November of 2009 that provided an assessment of WHO-recommended pyrethroids, OPs and carbamates, in order to offer flexibility in pesticide choice based on future entomological studies and Federal Ministry of Health (FMOH) pesticide selection decisions.

In June of 2011 an SEA was prepared in response to the expiration of the 2009 SEA Amendment, which was valid for three years. The 2011 SEA was never officially approved by the USAID/GH BEO, and instead a Letter Report was prepared to meet the needs of the ongoing PMI IRS spray campaign. In August, 2013, a comprehensive 2013-2017 SEA was prepared to address changes in the IRS program and update

the information that was provided in previous SEAs. It also covered the use of three classes of WHO-recommended pesticides - pyrethroids, carbamates, and OPs - for IRS activities in the Oromia region. Based on PMI's interest to potentially expand support into all Ethiopian regions, this 2015 SEA amendment covers all regions in Ethiopia.This SEA authorizes the use of carbamates, organophosphates and pyrethroids and chlorfenapyr. This document also provides an opportunity to address changes in the IRS program and update information provided in the 2013 SEA.

Upon approval of this SEA, in subsequent years, a Letter Report will be submitted to USAID that will discuss the pertinent points of the IRS program for that particular year's spray campaign. According to PMI policy, for the first use of organophosphates the Letter Report must be signed by the Africa Bureau and Global Health Bureau Environmental Officers. However, organophosphates will be used for the first time in 2015, and the preparation of this SEA update renders the preparation of a Letter Report unnecessary for 2015.

# 3. BACKGROUND

## 3.1 BACKGROUND TO THE PROPOSED ACTION

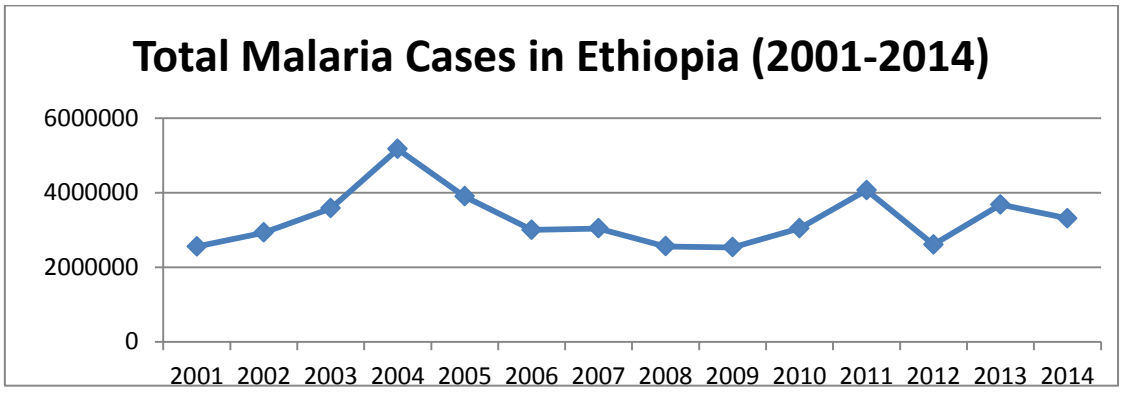
The PMI was launched in June 2005 as a 5-year, $1.2 billion inter-agency initiative to rapidly scale up malaria prevention and treatment interventions and to reduce malaria-related mortality by 50% in 15 high-burden countries in sub-Saharan Africa. The USG announced Ethiopia as a PMI focus country in 2007, supported by $20 million PMI funding beginning in FY 2008. PMI support was initially targeted to malaria control activities in the Oromia Regional State, which has about one-third of Ethiopia's malaria burden, population, and land area. With both GFATM and PMI support and that of other donors, the FMOH has been able to dramatically scale-up its efforts in malaria prevention and control. Since 2011, PMI annual budgets for Ethiopia increased, up to $44 million annually, to allow more support for malaria activities beyond the borders of Oromia Regional State.

PMI intends to support the updated National Strategic Plan (NSP) 2014-2020, which indicates the FMOH aims to provide universal LLIN coverage to all persons at malaria risk (60% of the population or 50.6 million persons), and to selectively provide IRS coverage according to annual parasite incidence (API). Case management, malaria surveillance, and social behavior change communication (SBCC) services are to be provided to all 84.2 million Ethiopians.

## 3.2 MALARIA BURDEN IN ETHIOPIA

Malaria transmission peaks bi-annually from September to December and April to May coinciding with major harvesting season with serious consequences for the subsistence economy of Ethiopia's countryside, and for the nation in general. Three-quarters of the landmass of Ethiopia is estimated to be suitable for malaria transmission; and around sixty percent of the population resides in areas where malaria could be transmitted. Malaria transmission in Ethiopia mainly occurs up to 2000 meters in elevation but can also occasionally affect areas up to the 2300 meters.

**Figure 1: Number of Malaria Cases per year**




Source: FMOH

The annual number of malaria cases varies from year to year. Even though the reporting coverage of the health facilities is about 83%, the data obtained from the national Public Health Emergency Management (PHEM) unit shows an average 4.1 million malaria cases in the last four years.

In recent years, Ethiopia has made significant strides in expanding coverage of key malaria prevention and control interventions throughout the country. The results of the scaling-up of anti-malarial interventions have been greatly encouraging since the number of cases has remained stable even though more people are being tested. For IRS specifically, the percentage of households sprayed nationwide more than doubled from 2007 to 2011 (20% and 46.6% respectively). The Administrative report[1] indicates that IRS coverage of the targeted households is further increased to 67% in 2012 and 83.9% in 2013.

## 3.3 HISTORY OF MALARIA CONTROL IN ETHIOPIA

In the 1950's Ethiopia attempted to implement malaria control activity as a pilot control project. The national eradication campaign was later launched in the 1960s as part of the WHO-supported global malaria eradication efforts, under the Malaria Eradication Services. The campaign subsequently evolved into a malaria control program in the early 1970s, which led to the establishment of the National Organization for the Control of Malaria and Other Vector-borne Diseases in 1985. Since June 1993, under the general policy of decentralization and democratization of the administration based on the federal system of administration in the country, malaria control became an integral part of the basic health service. The responsibility of managing malaria prevention and control activities has been vested to Regional Health Bureaus.[2]

Cognizant of the health and socio-economic problems the disease causes, the FMOH, Regional Health Bureaus and partners have been working jointly to strengthen malaria prevention and control activities in the country. To support implementation of the malaria prevention and control strategies, the FMOH developed several guiding documents. The 2014-2020 National Malaria Strategic Plan was published and disseminated in June 2014 in order to guide all national malaria interventions.

The goals of the National Strategic Plan include the following:

- By 2020, to achieve near zero malaria deaths (no more than one confirmed malaria death per 100,000 population at risk) in Ethiopia.
- By 2020, to reduce malaria cases by 75% from baseline of 2013.
- By 2020, to eliminate malaria in selected low transmission areas.

The strategy provides a detailed account on the status and direction of the major malaria prevention and control strategies, objectives and interventions that include community empowerment and mobilization, early diagnosis and treatment, selective vector control, surveillance and epidemic control, as well as cross cutting strategies that include monitoring and evaluation, and program management.

**2014 PMI-Funded IRS Activities**

The President's Malaria Initiative (PMI) has been supporting indoor residual spraying (IRS) in Ethiopia since 2008. In 2014, the key objectives of the IRS program were to contribute to the reduction of malaria-associated morbidity and mortality by:

[1] Ethiopia National Malaria Strategic plan 2014-2020

- Implementing IRS in 36 districts of the Oromia region;
- Providing technical and logistic support to IRS in 24 PMI-graduated districts in the Oromia region, and;
- Building capacity of the national malaria program.

In six districts, the responsibility for training SOPs and for planning and implementing the spraying was decentralized to the village level and specifically to health extension workers (HEWs). HEWs were also put in charge of ensuring environmental compliance during spray operations. This model is referred to as community-based IRS (CB IRS). The district and PMI provided supportive supervision in both models. PMI also provided technical and logistic support to 24 districts that graduated from PMI support in 2011.

Two pre-season environmental compliance assessments (PSECA) were made of all 36 project districts using the checklists installed in smart phones. The first-round PSECA was performed well ahead of the TOT, which, especially by utilizing and organizing the data uploaded from the smart phones, allowed the district staff to be told of any EC gaps they needed to address. Areas that required the contribution of AIRS project office were also identified.

**Table 1: 2014 IRS Results**

| | |
|---|---|
| Number of districts covered by PMI-supported IRS | 36 districts in the Oromia region |
| Number of structures found by SOPs | 670,303 |
| Number of structures sprayed by PMI-supported IRS | 667,236 |
| 2014 spray coverage | 99.5% |
| Population protected by PMI-supported IRS | Total population – 1,647,099<br>Children under 5 – 230,862<br>Pregnant women – 23,919 |
| Dates of PMI-supported IRS campaign | Aug 13–Sep 25, 2014 |
| Length of campaign (total days) | 44 days |
| Number of people trained with U.S. Government funds to deliver IRS | 2,886 |

**Soak Pits/Effluent Disposal**

To ensure safe disposal of effluent waste, AIRS Ethiopia prepared 181 (74 district size and 107 community size) soak pits (Figure 2). For efficiency in an effort of such scale, the project used polyethylene plastic sheets as ground cover for the washing/rinsing areas of the soak pits. The project carried out maintenance activities in all the 181 soak pits (74 districts size and 107 community size) from last year.

The AIRS Ethiopia project team made the general observation that the quality of spray operations and IRS infrastructure in 2014 has improved tremendously from previous IRS campaigns. During the inspections, the team witnessed many IRS best practices being used properly and regularly. The districts have openly embraced the practices and performed most very well. Among further improvements needed, the team noted that the excellent recording and tracking of insecticide should be applied to other IRS materials in the district stores. The stock management, although good, would be better if all records were updated regularly. Overall, spray actors used PPE appropriately. This year, Squad Leaders used helmets and face shields to observe spraying techniques inside houses. The inspection report with specific findings and recommendations is in Annex C. It is followed by the tables (C-1 through C-6) reporting on a summary of each of the four main supervisory checklists which were completed by various supervisors during the campaign. Each of these issues will be addressed to the best extent possible during the 2015 spray campaign.

Problems found repeatedly included poor network coverage, poor roads preventing access to spray sites, rooms not ready when SOPs arrived, disorganized temporary stores, and crowding of SOPs at district soak pits at the end of spray operations.

### 3.3.1 Ethiopian Environmental Regulations

The Federal Ministry of Environment and Forest of Ethiopia is responsible for implementing environmental policies. The goal of the Environmental Policy states: "The overall policy goal is to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs." The document includes policies for the Control of Hazardous Materials and Pollution from Industrial Wastes, Atmospheric Pollution and Climate Change and Environmental Impact Assessments.

Environmental Standards for Industrial Pollution Control in Ethiopia includes specific limit values for emissions to the atmosphere, emissions to water and noise for various industrial sectors including the manufacture and formulation of chemical products including pesticides.

Environmental Pollution Control Proclamation includes management of hazardous wastes. The generation, keeping, storage, transportation and treatment or disposal of hazardous wastes is subject to a permit from the Authority, or relevant regional environmental agency. Solid Waste Management Proclamation includes policies for the transportation and disposal of solid wastes.

### 3.3.2 Pesticide Regulations and Control

The Ministry of Agriculture and Rural Development's (MARD's) Crop Protection Department is responsible for the registration, control and management of agricultural pesticides in the country. MARD has strict pesticide registration requirements. The Pesticide Registration and Control Proclamation includes registration requirements; packaging, labeling, advertising, transport and disposal of pesticides; and safety measures. The MARD does not currently have the funding or staff to enforce the pesticide policies. However, the FMOH is not required to meet the insecticide registration requirements of the MARD, and uses non-registered pesticides in the health program.

### 3.3.3 International Conventions

The following are the Multilateral Environmental Agreements to which Ethiopia is a party:

- Convention on Biological Diversity
- Cartagena Protocol on Biosafety to the Convention on Biological Diversity
- Convention to Combat Desertification
- International Treaty on plant genetic resources for food and agriculture
- Vienna Convention for the Protection of the Ozone Layer
- Montreal Protocol on Ozone Depleting Substances
- UN Framework Convention on Climate Change (UNFCCC)
- Kyoto Protocol to the UNFCCC

- Stockholm Convention on Persistent Organic Substances
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
- Basel Convention on the Trans boundary Movement of Hazardous Wastes and their Disposal
- Basel Ban Amendment
- Protocol on Liability and Compensation for Damages Resulting from Trans boundary Movements of Hazardous Wastes and Their Disposal
- Bamako Convention on the ban of Import into Africa and the Control of Trans boundary Movement and Management of Hazardous Wastes within Africa
- Convention on International Trade in Endangered Species of Wild Fauna and Flora.

## 3.4 ETHIOPIA MALARIA CONTROL ACTIVITIES

### 3.4.1 VECTOR CONTROL ACTIVITIES

The two major malaria prevention services implemented in Ethiopia are targeted IRS with insecticides and distribution of LLINs. Other vector-control activities, mainly larval control through environmental management and chemical larviciding, are also practiced in areas where such interventions are appropriate and expected to have significant impact. The objective of the Ethiopian vector control program is to maintain universal coverage with LLINs and/or IRS. There will be an overlap of these interventions in high transmission strata to bring down malaria burden in line with recommendation of the WHO.

### 3.4.2 ENTOMOLOGICAL MONITORING

PMI conducts annual entomological studies in Ethiopia to determine the effectiveness of the IRS insecticides and spray activities, and potential resistance issues. In 2014, PMI completed a number of entomological monitoring activities in collaboration with the Oromia Regional Health Bureau (ORHB), the FMOH, and Jimma and Mekelle universities. The university experts participated in entomological activities that included insecticide resistance monitoring, vector behavior, density assessment and insecticide decay rate studies. Findings on the entomological indicators collected follows.

**Determination of Quality of Spraying and Persistence**
PMI conducted cone bioassay tests for quality check and decay rate in four sites; two DB IRS and two CB IRS districts. One CB IRS district and one DB IRS district were selected for the bioassay test.

The PMI team performed the tests in 12 houses per site purposefully selected to represent houses sprayed by different spray operators (SOPs) and wall types (mud, dug, painted). A total of 48 houses were sampled from the four sites. This is a change from last year, when the test was done with susceptible and wild mosquitoes in the same house and only five houses per site were sampled. This year's bioassay increased the sample size and sampled different types of walls.

The tests were carried out using known susceptible mosquito colonies reared in the Adama Malaria Reference Training Center insectary and wild mosquitoes reared from larvae or pupae (2–3-day-old sugar-fed adult *An. gambiae* s.l.).

Mortality of the exposed mosquitoes was 100 percent in 43 of the 48 houses sampled for quality check and cone bioassay tests conducted 1–5 days after spray. There was no difference between wild and susceptible mosquitoes and CB and DB IRS districts. Five houses gave less than 100 percent mortality. Further investigations showed that these five houses have mud walls. Though the wall type may have affected the bioavailability of the insecticide, the PMI implementing partner organized retraining of the teams and squads in the two districts and strengthened the supervision activities by assigning the technical manager of the project to these areas during the entire spray campaign.

**Table 2: Results of Wall Bioassay for Quality Check and Decay Rate**

| District | Site | Type of Colony | Percent Mortality (N) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1-5 days after spray (T0) | | | One month after spray (T1) | | |
| | | | Dung | Mud | Painted | Dung | Mud | Painted |
| Kersa | Siba (CB IRS) | Wild | - | 100 (120) | 100 (60) | - | 75.8 (60) | 98.3 (60) |
| | | Susceptible | - | 100 (120) | 100 (60) | - | 97.5 (60) | 100 (60) |
| Bako-Tibe | Denbi Dima (CB IRS) | Wild | 100 (90) | 71.2 (90)<br>100 (90)* | 100 (90) | 100 (88) | 33.7 (89) | 100 (90) |
| | | Susceptible | 100 (90) | 98.9 (90)<br>100 (90)* | 100 (90) | 100 (86) | 74.7 (91) | 100 (80) |
| Seka Chekorsa | Bore Tika (DB IRS) | Wild | - | 100 (120) | 100 (60) | - | 87.5 (60) | 93.3 (60) |
| | | Susceptible | - | 100 (120) | 100 (60) | - | 100 (60) | 100 (60) |
| Gobu-Seyo | Gambela-Tere (DB IRS) | Wild | 100 (90) | 100 (90) | 100 (90) | 100 (60) | 27.1 (60) | 100 (60) |
| | | Susceptible | 100 (90) | 64.5 (90)<br>100 (90)* | 100 (90) | 100 (81) | 46.3 (80) | 100 6) |

**Test repeated after re-spraying.*

**Insecticides Susceptibility**

As part of the spray campaign, the project conducted comprehensive tests on spray quality and insecticide resistance using wild and susceptible mosquitoes. These entomological results include the following:

- PMI tested susceptibility of the main vector to 11 WHO-recommended insecticides for IRS in five of the eight sentinel sites. The vector is susceptible to pirimiphos-methyl, fenitrothion, and propoxur in all tested sites. The vector is susceptible to bendiocarb in two sites; resistant in one site, and possibly resistant in one other site. An. gambiae s.l. is resistant to DDT and most of the pyrethroid-class insecticides in all sites.

**Table 3: 2014 Insecticide Resistance Results in Five Fixed Sites**

| No. | Insecticide | % mortality (dead/exposed) | | | | |
|---|---|---|---|---|---|---|
| | | Region: Oromia District: Chewaka Site: Chewaka | Region: Oromia Dsitrict: Omonada Site: Osso Billi | Region: Afar District: Amibara Site: Sedi | Region: Gambela District: Lare Site: Kurgeng | Region: Oromia District: Zwai Dugda Site: Burka |
| 1 | DDT | 6 (6/100) (R) | 6.8 (6/88) (R) | 18.8 (19/101) (R) | 12.5 (11/88) (R) | 6.2 (6/97) (R) |
| 2 | Lambda-cyhalothrin | 11.2 (11/97) (R) | 39 (39/100) (R | 46.2 (43/92) (R) | 14.7 (13/88) (R) | 4.3 (4/94) (R) |
| 3 | Deltamethrin | 45.5 (42/97) (R) | 42 (42/100) (R) | 45.4 (45/99) (R) | 18.1 (15/83) (R) | 21 (21/196) (R) |
| 4 | Fenitrothion | 100 (100/100) (S) | 100 (100/100) (S) | 100 (102/102) (S) | 100 (88/88) (S) | 100 (106/106) (S) |
| 5 | Malathion | 93.7 (87/93) (POR) | 73 (73/100) (R) | 100 (101/101) (S) | 95.5 (84/88) (POR) | 93 (91/98) (POR) |
| 6 | Pirimiphos-methyl | 100 (100/100) (S) | 100 (100/100) (S) | 100 (99/99) (S) | 100 (100/100) (S) | 100 (103/103) (S) |
| 7 | Propoxur | 100 (100/100) (S) | 100 (100/100) (S) | 100 (102/102) (S) | 100 (88/88) (S) | 100 (101/101) (S) |
| 8 | Bendiocarb | 100 (100/100) (S) | 86.4 (76/88) (R) | 100 (105/105) (S) | 92 (80/88) (POR) | 100 (101/101) (S) |
| 9 | Permethrin | 31.3 (25/80) (R) | 16(16/100) (R) | 19.1 (18/94) (R) | 28.4(25/88) (R) | 3(3/101) (R) |
| 10 | Etofenprox | 24(23/95) (R) | 55 (55/100) (R) | 86.6(87/100) (R) | 11.4 (10/88) (R) | 28.7 29/101) (R) |
| 11 | Alpha-cypermethrin | 32.2(31/96) (R) | 35 (35/100) (R) | 72.5(75/103) (R) | 14.7 (13/88) (R) | 5 (5/100) (R) |

*S-Susceptible* *R-Resistant* *POR- Possibility of Resistance*

**Insecticide Resistance Management Strategy**

Considering the rapidly spreading insecticide resistance by the vector in the country and the very limited choices of insecticides, it is critical that the country identifies procedures and approaches for rational use of insecticides, including the finalization and implementation of the insecticide resistance management (IRM) strategy. The IRM strategy includes the following:

- Platform and partnership for continuous monitoring of insecticide resistance need to be established;
- Inter-sectorial collaboration and partnership for wise use of pesticides need to be strengthened;
- All obsolete insecticides need to be safely disposed;
- Local production/processing of insecticides will be encouraged

### 3.4.3 DDT

Based on PMI insecticide susceptibility study results published in 2010 and direction from the FMOH, the use of DDT was discontinued and deltamethrin was used for spraying activities in 2010.

In December 2010, the PMI IRS implementing partner conducted an inventory of obsolete pesticides stored in IRS districts (including both PMI and non PMI districts within Oromia region). The data collected included the following;

- Location of the obsolete pesticides and contaminated wastes (by district).
- Quantities of expired pesticides and contaminated wastes in each store.

- Quantities of contaminated wastes in each store.
- Type of expired pesticides in each store (commercial name, date of manufacture, name of manufacturer, date of expiry.
- Physical form of the pesticide (granules, liquid) including active ingredient.
- Condition and type of the packaging material of the expired pesticides (drums, sachets, boxes).
- The condition of the warehouse in terms of safeguarding the pesticides before a disposal option is identified (floor type, roof type).

In 2012, PMI requested an updated inventory of the DDT stock in the 60 PMI-supported IRS districts in Oromia. To conduct the survey, a protocol and checklist for the assessment was developed before staff was dispatched to the field. The survey was conducted in each of the 60 districts in 10 zones of Oromia region where the staff collected data and took photographs in order to characterize the amounts and storage conditions of these stocks. Specific locations for the stock were noted using GPS to better estimate the logistics that will be required to consolidate the pesticides at a central, secure storage location.

**Table 4: DDT Quantities stored throughout Ethiopia**

| | Region | Store Quantity | Total DDT, kg |
|---|---|---|---|
| 1 | Oromia | 190 | 286,747.50 |
| 2 | Gambela | 4 | 43,074 |
| 3 | Tigray | 30 | 28,953.67 |
| 4 | SNNPR | 68 | 203,231.50 |
| 5 | Harari | 1 | 5,440 |
| 6 | Dire-Dawa | 1 | 4,793 |
| 7 | Somali | 31 | 34,625.20 |
| 8 | Benshangul | 17 | 17,433.24 |
| 9 | Amhara | 102 | 287,861.60 |
| 10 | Afar | 16 | 16,349.60 |
| **Total** | **10** | **460** | **928,509.30** |

The amount in DDT located in the 60 PMI-supported IRS districts, including the graduated 24 districts, is provided in the table below.

**Table 5: Estimated Quantity of DDT Waste Found in Oromia PMI Districts, by zone**

| Zone | DDT 75% (Kg) | DDT 100% (Kg) | Total |
|---|---|---|---|
| East Wollega | 12,945.85 | 920.00 | 13,865.85 |
| Kellem Wollega | 37.80 | 0.00 | 37.80 |
| East Shoa | 6,997.80 | 406.60 | 7,404.40 |
| West Arsi | 7,083.40 | 107.00 | 7,190.40 |
| Arsi | 5,127.30 | 71.40 | 5,198.70 |
| West Hararge | 7,083.40 | 107.00 | 7,190.40 |
| Jimma | 17,892.80 | 506.40 | 18,399.20 |
| West Wollega | 10,929.80 | 0.00 | 10,929.80 |
| Illubabor | 3,941.00 | 96.00 | 4,037.00 |
| West Shoa | 4,686.80 | 384.90 | 5,071.70 |
| Total | 76,725.95 | 2,599.30 | 79,325.25 |

An implementation plan for the disposal of the DDT in PMI-supported districts was finalized and approved in December 2014 by the USAID Ethiopia Mission and relevant USAID environmental authorities. Veolia, a UK based company, has been identified to transport and dispose of the obsolete waste. The country where the DDT will be disposed of, and any trans-boundary countries, will be identified before activities may commence. DDT is categorized as a persistent organic pollutant (POP), therefore its management needs to be in accordance with the Stockholm Convention on Persistent Organic Pollutants. Other conventions that regulate DDT management and use include the Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and Their Disposal, and the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. All relevant international conventions will be adhered to during the implementation of the DDT removal activity.

# 4. DESCRIPTION OF PROPOSED AND ALTERNATIVE ACTIONS

This section describes the alternatives for malaria control that were considered in the preparation of this report, including those that were accepted or rejected. Alternatives considered include the following:

1. **Preferred action:** Establish annual IRS campaigns that spray pesticides of the pyrethroid, carbamate, organophosphate, and/or chlorfenapyr classes in high-risk districts and sectors identified by the evaluation of criteria such as transmission rate, vector susceptibility, and residual effect, appropriate home and wall structure, and ecological/human health impacts.
2. **No action alternative:** This action would discontinue PMI support for IRS activities in Ethiopia.
3. **Spraying in alternative geographic regions:** This alternative would use different criteria to select alternative districts and sectors to spray.
4. **Using alternative pesticides:** This alternative would consider pesticides other than those recommended by WHO.
5. **Alternative technologies:** This alternative would consider methods other than IRS to achieve the stated goals of reduction in malaria mortality and morbidity.

## 4.1 DESCRIPTION OF PROPOSED ACTIONS

The preferred action is to implement an IRS program in selected communities, choosing among the pyrethroid, carbamate, and organophosphate classes, as well as chlorfenapyr, considering current entomological, epidemiological, logistical, environmental, and economic conditions. The pesticide to be used will be determined by a process explained in Pesticide Procedures part b.

Small Studies or Hut Trials - To expand on PMI IRS Entomological Monitoring, PMI IRS program may conduct small studies or hut trials to study new IRS insecticides such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES evaluation and country-level required documentation has been submitted. . The guidelines for laboratory testing and small and large-scale field trials are provided in Guidelines for Testing Mosquito Adulticides for Indoor Residual Spraying and Treatment of Mosquito Nets (WHO 2006). The purpose of the proposed action is to measure the efficacy of chlorfenapyr (*and potentially other IRS insecticides as needed)* on key disease vectors.

In order to assess insecticidal bioefficacy, both susceptible and resistant strains of mosquitoes will be used. All tests will be performed at a controlled location. Mosquitoes will be exposed to insecticides in bottle assays and technicians will measure the amount of time needed to knock down and kill the mosquitoes.

The efficacy and residual life of the insecticide being studied as an indoor residual spray on relevant substrates will be compared with that of other WHO-recommended pesticides, at WHO recommended doses.

At specified intervals, data will be collected on blood feeding rates, death rates, and entry versus exit rates using window traps. Bioassays will be conducted to determine residual efficacy of all insecticides. In addition, the pH and sand/silt/clay content will be recorded for each wall surface; both have been known to impact the results of bioefficacy. [3]

## 4.2 No Project Alternative

Indoor Residual Spraying is one of the critical interventions in the control of the spread of malaria. A no project alternative will result in rising rates of infections, transmissions, mortality and morbidity due to the increased prevalence of infected vectors. Therefore, the no action alternative does not meet the overall goal of the Ethiopia National Malaria Control Program and President's Malaria Initiative, which is to reduce malaria mortality by 50% in up to 15 countries (total population: 175 million) in sub-Saharan Africa in five years.

## 4.3 Alternative IRS Geographical Sites Considered

In IRS implementation in Ethiopia, areas considered as highly malarious and those areas that fit within the NMCP strategic plan are considered, while lower risk areas are not considered for IRS as an intervention. Using different criteria for selecting geographical sites would reduce the effectiveness and impact of IRS, decreasing progress towards the goals of the Ethiopia National Malaria Control Program and the PMI program.

## 4.4 Use of Alternative Insecticide(s)

For IRS to be implemented, a pesticide approved by World Health Organization (WHO) under the World Health Organization Pesticide Evaluation Scheme (WHOPES) must be selected for use. WHOPES is the institution that analyses and recommends the pesticides that should be used in IRS based on their effectiveness, cost, and toxicity to human health and the environment.

To date WHOPES has approved the use of pesticides within the following four classes of pesticides: pyrethroids, carbamates, organochlorines and organophosphates. In addition, PMI may procure chlorfenapyr (which as of 2015 is undergoing Phase III WHOPES evaluation) once it is recommended by WHOPES. This proposed action for Ethiopia includes the use of organophosphates, carbamates, chlorfenapyr, and pyrethroid formulations. The proposed action excludes the use of DDT.

## 4.5 Alternative Technologies

A full range of known, available technologies is continually considered for use by the stakeholders in the malaria prevention and control efforts. It has been determined that IRS plays a significant part in malaria prevention in concert with those other technologies.4 The specific focus of this PMI effort and the role that PMI plays in Ethiopia includes IRS. If other, viable approaches were to arise that would replace or improve upon the role that IRS plays, the National Malaria Control Program, PMI and its partners would evaluate them and proceed accordingly.

[3] Abt/USAID PMI AIRS Project IRS2 Task Order four. Supplemental Environmental Assessment Addendum, Nigeria. 2014.

# 5. AFFECTED ENVIRONMENT

## 5.1 COUNTRY OVERVIEW

Ethiopia is the most populous landlocked country in the world and the second-most populated nation on the African continent, located in east central Africa. It is bordered by Eritrea to the north, Djibouti and Somalia to the east, Sudan and South Sudan to the west, and Kenya to the south. The country covers the latitude and longitude of 8°00 N and 38°00 E respectively. The total area of the country is around 1, 112,000 sq. km.

**Figure 2: Map of Ethiopia**


## 5.2 CLIMATE

Ethiopia is in the tropical zone lying between the Equator and the Tropic of Cancer. It has three different climate zones according to elevation.

*Kolla (Tropical zone)* - is below 1830 meters in elevation and has an average annual temperature of about 27 degree Celsius with annual rainfall about 510 millimeters. The Danakil Depression (Danakil Desert) is about 125 meters below sea level and the hottest region in Ethiopia where the temperature climbs up to 50 degree Celsius.

*Woina dega (Subtropical zone)* - includes the highlands areas of 1830 - 2440 meters in elevation has an average annual temperature of about 22 degree Celsius with annual rainfall between 510 and 1530 millimeters.

*Dega (Cool zone)* - is above 2440 meters in elevation with an average annual temperature of about 16 degree Celsius with annual rainfall between 1270 and 1280 millimeters.

**Ethiopian Seasons**

- *Kiremt or Meher (Summer)* - June, July and August are the summer season. Rainfall can be heavy during these three months.
- *Belg (Autumn)* - September, October and November are the spring season sometime known as the harvest season.
- *Bega (Winter)* - December, January and February are the dry season with frost in morning, especially in January.
- *Tseday (Spring)* - March, April and May are the autumn season with occasional showers. May is the hottest month in Ethiopia.

## 5.3 TOPOGRAPHY

Ethiopia contains a variety of distinct topographical zones. It is a country of geographical contrasts, varying from as much as 116 m below sea level in the Danakil depression to more than 4,600 m above in the mountainous regions. Ras Dashen, with an altitude of 4,620 m, is the fourth-highest peak in Africa. The most distinctive feature is the northern part of the Great Rift Valley, which runs through the entire length of the country in a northeast-southwest direction, at a general elevation of 1,500 to 3,000m. Immediately to the west is the High Plateau region; this rugged tableland is marked by mountain ranges. East of the Great Rift Valley is the Somali Plateau—arid and rocky semi-desert, extending to the Ogaden, which covers the entire southeastern section of the country. In the north, the Denakil Desert reaches to the Red Sea and the coastal foothills of Eritrea. The western boundary of Ethiopia follows roughly the western escarpment of the High Plateau, although in some regions the Sudan plains extend into Ethiopian territory. Also part of Ethiopia is Dahlak Archipelago in the Red Sea.

Ethiopia's largest lake, Lake Tana, is the source of the Blue Nile River. This river, which winds around in a great arc before merging with the White Nile in the Sudan, travels through great canyons, which reach depths of more than 1,200 m. Several rivers in the southwest also make up a system of tributaries to the White Nile.

## 5.4 SOILS

The wide ranges of topographic and climatic factors, parent material and land use have resulted in extreme variability of soils. According to the Ministry of Agriculture about 19 soil types are identified throughout the country. The big proportion of the country's landmass is covered by lithosols, nitosols, cambisols and regosols in order of their importance.

Research showed that potassium and nitrogen cation exchange capacity and organic matter contents of most Ethiopian highland soils are generally high by international standards, whereas their phosphorous content is low to very low. Compared to the African standard most soils in the highlands of Ethiopia are fertile. Contrary to most other African soils, the majority of Ethiopian highlands soils remain relatively fertile at depth. However, most highland soils are deficient in important nutrients and require fertilizer

to sustain crop yields. Research has indicated that Ethiopian soils are generally low in available nitrogen and phosphorous and cannot produce high crop yields unless these are supplied.

## 5.5 HYDROLOGY

There are 12 major river basins in Ethiopia. The total annual surface run off from these basins is about 110 billion $m^3$. Ethiopia has eight major natural lakes. Most of the natural lakes are situated in the rift valley. Many lakes have the potential to provide large sustainable yields of fish. The rift valley lakes are also sanctuaries for different species of birds.

The Hydrological Department under the Ministry of Water Resources is responsible for hydrological data collection, processing analysis and dissemination to users. The data collection activities are mainly engaged in surface water resources assessment which currently comprises collection of stream flow data, recording of suspended sediment sampling data and water quality. The hydrological network for both stream and lake consist of 560 gauging stations in 12 river basins of which 454 are at present operational throughout the country.

## 5.6 VEGETATION

Ethiopia was once heavily wooded with about 34 percent of its area and 57 percent of the land above 1,500 meters covered by dense forests, and a further 20 percent by wooded savannah. Massive deforestation has reduced these figures to 3.6 percent of the total area and 9 percent of the land above 1,500 meters. Widespread deforestation started, particularly in the highlands, at the end of the nineteenth century with the expansion of agriculture. The current deforestation rate is estimated to be 200,000 ha/year with most of the surviving forest in remnant patches in inaccessible and remote areas.

Ethiopia's natural vegetation is influenced by four biomes. The first is savanna, which, in wetter portions of the Western highlands, consists of montane tropical vegetation with dense, luxuriant forests and rich undergrowth. Drier sections of savanna found at lower elevations of the Western and Eastern Highlands contain tropical dry forests mixed with grassland. The second biome is mountain vegetation; it comprises montane and temperate grasslands and covers the higher altitudes of the Western and Eastern highlands. The third biome, tropical thickets and wooded steppe, is found in the Rift Valley and Eastern Lowlands. The fourth biome is desert steppe vegetation, which covers portions of the Denakil Plain.

Previously, the governmental organization that was responsible for managing the forests was under Ministry of Agriculture. Now, the Ministry of Environment and Forest is responsible for managing Ethiopia's forests.

## 5.7 AGRICULTURE

The poverty rate fell from 39% in 2005 to 32% in 2010, and the country was on track to achieve the UN Millennium Development Goals. The heavily agriculture-based Ethiopian economy was expected to grow at an average rate of about 7.5–10% in 2011. Even as the economy grew, however, high inflation and rising food and fuel prices eroded these gains.

The government's five-year economic strategy, the Growth and Transformation Plan, was released in late 2010. It continued to focus on agricultural development, though more attention was given to

industrial growth than in previous periods. Among the plans are large-scale commercial farms in parts of western Ethiopia, including several high-profile purchases made by foreign companies.

Ethiopian farmers have long recognized that altitude, climate, water availability, vegetation and other physical and biotic factors are interrelated to agricultural potential and production. The traditional classification, developed over thousands of years, divides the country into major and minor agro-ecological groups based primarily on altitude and rainfall. Each zone and sub zone is further characterized by variations in economic activity, population density and other socio- cultural attributes such as cropping and livestock rearing patterns.

The dominant agricultural enterprises in all agro-ecological zones are small-scale subsistence farms in the highlands and livestock rearing in the lowlands. Large enterprises (ex-state farms) were government holdings which are now being privatized. Current private investments are mainly in the agro-industrial sector, especially on cash crop and livestock production. Production systems in Ethiopia are as complex as the agro-ecological zones, and amplified further by the cultural diversity of the people.

In the higher part of the mountains, the proper Afroalpine zone ('Wurch'), plants are exposed to intense solar radiation causing a greater rise in the temperature to the leafy portion of the plant in contrast to their roots. This causes higher transpiration than absorption of water, so, even though moisture is not limiting plants have become adapted to moisture deficiency. The soil is often shallow, even though very rich in undecomposed organic matter. With the steepness of the terrain and the frequent heavy rains, the zone is vulnerable to erosion following human activity.

In the sub-afroalpine zone, the lower 'wurch' area, (3,200-3,700 meters) cropping is limited to barley, with two crops per year sometimes being possible with rainfall above 1,400 mm/annum; only one crop is possible in areas with 900 – 1,400 mm annual rainfall.

The most productive zones are between 3,200 and 1,500 meters highland, ('dega' ) and lowland ('Woina dega'). In this agro-ecological zone a wide range of crops are grown and many species of livestock are raised. Production systems consist of mixed cropping plus livestock, and the fields are mostly worked with draft animals. Rainfall is generally not limiting except in the far north and growing seasons are often very long ,with two crops per year in some areas. Due to high population, farming is dominated by smallholdings. Medium–scale private crop production is beginning as a result of the recent state farms privatization and the new investment policy.

In many agro-ecological zones at low altitudes 1,500-500 meters (kola-zone) growing seasons are short to very short, so only drought resistant crops can be grown, unless irrigation is possible.

## 5.8 LIVESTOCK

Ethiopia has the largest livestock populations in Africa. The country is a major repository of livestock resources and genetic diversity. Most local cattle are zebus; recognized breeds, including Boran, Fogera, Horro, Sheko (Gimira), Abigat (Adal), are indigenous to and synonymous with particular regions. The Fogera and Horro are known as milk producers, the first being reared round Lake Tana in Amhara State and the second in Eastern Welega in the west of Oromia State. The Boran, renowned as a beef breed is also "indigenous" to Kenya and Somalia where its tribal owners claim territory; it is found in the south and east of the country in the Southern Nation Nationalities and Peoples' Regional State (SNNPRS) and in Somali Regional State. Almost all sheep in Ethiopia are indigenous; several breeds have been identified but are less clearly differentiated than cattle. As to goats, until very recently, the situation was

very similar to that for sheep. The countryside community is known to have at least a two poultry per household for own consumption or for the market.

## 5.9 FISHERIES

There are 180 different species of fish in Ethiopia and 30 of those are native to the country. The total area of the lakes and reservoirs is approximately 7000 to 8000 $km^2$ and the important rivers stretch over 7000 km in the country. Fishing contribution for country's GDP is very low. Fish production potential of the country's estimated 51,000 tons. Fresh fish are consumed in the vicinity of the Great Rift Valley lakes. Outside these areas, the domestic market for fish is small. Fishery production is overexploited due to inappropriate fishing practice and poor management at the federal and regional levels.

## 5.10 DEMOGRAPHICS

The total population size of Ethiopia as of July 2014 is 87,952, 000 (Central Statistical Authority-Ethiopia); the World Bank and the UN report estimate more than 90 million. The population growth rate is about 2.6%. The estimated population density is about 79 persons per square kilometer. Around 80% of the total population resides in rural areas.
The Ethiopian economy has experienced strong and broad based growth over the past decade, averaging 10.9% per year in 2004/05 - 2012/13 compared to the regional average of 5.3%. Expansion of the services and agricultural sectors account for most of this growth, while manufacturing sector performance was relatively modest. Private consumption and public investment explain demand side growth with the latter assuming an increasingly important role in recent years.

## 5.11 HEALTH

Despite major strides to improve the health of the population, Ethiopia's population still faces a high rate of morbidity and mortality and the health status remains relatively poor. Vital health indicators from the DHS 2005 show a life expectancy of 54 years (53.4 years for male and 55.4 for female), and an Infant Mortality Rate of 77/1000. Under-five mortality rate has been reduced to 101/1000 in 2010v. Although the rates have declined in the past 15 years, these are still very high levels. The major health problems of the country are largely preventable communicable diseases and nutritional disorders. More than 90% of child deaths are due to pneumonia, diarrhea, malaria, neonatal problems, malnutrition and HIV/AIDS, and often as a combination of these conditions. In terms of women's health, the Maternal Mortality Rate has declined to 590/100,000, but this is still among the world's highest. The major causes of maternal death are obstructed/prolonged labor (13%), ruptured uterus (12%), severe preeclampsia/eclampsia (11%) and malaria (9%). Significantly, 6% of all maternal deaths were attributable to complications from abortion.

## 5.12 INFRASTRUCTURE

Ethiopia has prepared a five year Growth and Transformation Plan (GTP) which has an ambitiously extended goal. Based on this, there are many mega projects proposed which will significantly improve many years of infrastructure backlog.

So far, by the third year of the five year GTP (2013), 58,338 km of roads have been constructed. Due to improved access of road networks, the average time required to reach all weather roads declined from 3.7 hours in 2009/10 to 2.1 hours in 2012/13.

The railway system that will extend from Addis Ababa to different towns of the country, including Djibouti, and will cover more than 2,300 km, is 40% constructed.

The electric power, which currently is not more than 4000mega watt, is expected to double in three years.

Other country infrastructure, such as telecommunication and access to potable water, are improving.

## 5.13 REGIONAL STATES OF ETHIOPIA

Ethiopia is divided into nine regional states and two administrative cities. The regional states are divided into zones; and the zones are then divided into districts. Districts are subdivided in to the lowest administrative structures called “kebeles”, which comprise an average of 1000 households.

The nine regional states and the city administrations are listed below:

- Tigray Regional State
- Afar Regional State
- Amhara Regional State
- Oromia Regional State
- Somali Regional State
- Southern Nations Nationalities And Peoples Regional State
- Benishangul Gumuz Regional State
- Gambella Regional State
- Hareri Regional State
- Dire Dawa City Administration
- Addis Ababa City Administration

**Figure 3: Map of Regional States of Ethiopia**


## 5.13.1 TIGRAY REGIONAL STATE

The State of Tigray consists of four administrative zones, one special zone, 35 woredas and 74 towns. The capital city of the State of Tigray is Mekele. The State of Tigray is located at the northern tip of the country. The region shares common borders with Eritrea in the north, the State of Afar in the east, the State of Amhara in the south, and the Republic of the Sudan in the west. The region has an estimated area of 80,000 $km^2$. The population size of the region in 2014 is 5,200,000 of which around 70% resides in an area which malaria could endemically be transmitted.

**Major Economic Activities**

About 83% of the population is farmers. Teff, wheat, and barely are the main crops. Other agricultural products include beans, lentils, onions, and potatoes. Irrigation and terrace farming are used on the steep slopes. The region is also known for its export items of cotton, incense, sesame and minerals. 1.5 million hectares of land in the region is cultivable, of which one million hectares is being cultivated, while 420,877 hectares of land is terraced. Handicraft (gold smith, painting and wood sculptures) is another area of activity observed in the historic cities of the state.

**Topography and Climate**

Centuries of erosion, deforestation and overgrazing have left the region with dry and treeless plains, hills and plateau. Nevertheless, an amazing landscape of chains of mountains ranging from 3,250-3,500

meters, cliffs, ledges and precipice are natural attractions of the region. Two altitude extremes: the elevation of the region rises from 600 to 2,700 meters above sea level. The Tekeze Gorge, 550 meters and the "Kisad Gudo" peak at 3,935 meters are among Tigray's natural scenery which is classified into the central highland, the western lowland and eastern escarpments. The climate of the region is characterized as "Kolla" (semi-arid) 39%, "Woina dega" (warm temperate) 49%, and "Dega" (temperate) 12%. The average annual rainfall is between 450-980 mm.

**Rivers and Lakes**
Tekeze and Mereb are international rivers that pass through the state of Tigray with their sources in the Amhara and Eritrean Mountains, respectively. There are small rivers such as Geba, Worii, Berber, Arqoa and Teter, which are suitable for irrigation development. Tekeze is a promising source of hydroelectric power. Lake Ashenge is an interesting area for observing birds and for fishing.

**Livestock**
The State claims to have about 11.51 million domestic animals (1997 G.C.) of which 2.15 million are cattle, 5.63 million are sheep and goats and 392,000 are pack animals.

**Fauna**
Elephant, leopard, klipspringer and bush back are among the wild animals that are found in the state.

**Minerals**
Tigray is one of the richest areas in Ethiopia in mineral resources. Some of the explored metallic minerals of the state include gold, copper, iron ore, zinc, lead and nickel. Asbestos, Silica sand, Kaolin, graphite, gypsum gemstone, marble, granite slate, limestone and dolomite are among the non-metallic minerals.

### 5.13.2 AFAR REGIONAL STATE

The State of Afar consists of five administrative zones, 29 woredas and 28 towns. The rural area has 326 kebeles, while the urban part has 32 kebeles. Afar is the origin of human species, where a 4.4 million years old humanoid is recently discovered. The capital city of the state of Afar is Semera. Afar is located in the eastern part of Ethiopia. The region has common boundaries with the State of Eritrea in the north-east, with Tigray in the north-west, with Amhara in the south-west, with Oromia in the south, with the State of Somalia in the south-east and with the Republic of Djibouti in the east. The State of Afar has an estimated area of 270,000 $km^2$. The total population of the region is 1,704,768 and 97% of these population resides in malarious area.

**Major Economic Activities**
Ninety percent of the population leads a pastoral life by rearing camels, cattle, goats, sheep and donkeys. Agriculture, such as production of maize, beans, sorghum, papaya, banana, and orange, is also practiced. Cotton production is also typical to the region. Commerce, such as the mining of minerals (salt), is another regional occupation.

**Topography and Climate**
The state is found in the rift valley. Most of the region is flat. The altitude of the region ranges from 116 meters below sea level (where one of the highest temperature [50 degrees C] on earth has been recorded) to 1600 meters above sea level. The lowland areas of Afar are generally below 1600 meters above sea level. The highest peak, mount Mussa-Alle is just 2063 meters above sea level. The temperature of Afar varies from 25°C during the rainy season (September-March) to 48°C during the dry

season (March-September). The average annual rainfall registered for 11 years at Dubti station is 187.9mm.

**Rivers and Lakes**
The Awash River, and the Mille and Logia, which are tributaries of the Awash River, traverse the region. Abbe Bil, Afambo and Adebel lakes which are connected to the last section of the river Awash, are found in the region. They form an important habitat for river and lake Fauna.

**Minerals**
Salt, potash, sulfur, manganese, bentonite, aluminum, marble, gypsum and petroleum are possible major resources of the region. Tendaho geothermal energy is the most promising power source for electricity. The state has also a plausible source for solar energy.

### 5.13.3 AMHARA REGIONAL STATE

The State of Amhara consists of ten administrative zones, one special zone, 105 woredas, and 78 urban centers. Amharic is the working language of the state. The capital city of the State of the region is Bahir-Dar and the region is located in the north western and north central part of Ethiopia. The State shares common borders with the state of Tigray in the north, Afar in the east, Oromiya in the south, Benishangul/Gumuz in the south west, and the Republic of Sudan in the west. The State of Amhara covers an estimated area of 170,752 $km^2$. The total population of the region is 20,398, and 75% of these population resides in malarious areas.

**Major Economic Activities**
About 85% of the people are engaged in agriculture. The State is one of the major teff (staple food) producing areas in the country. Barley, wheat, oil seeds, sorghum, maize, wheat, oats, beans and peas are major crops produced in large quantities.

Cash crops such as cotton, sesame, sunflower, and sugarcane grow in the vast and virgin tract of the region's lowlands. The water resources from Lake Tana and all the rivers found in the region provide immense potential for irrigation development.

About 450,000 hectares of arable land is irrigable and suitable for horticultural development.

**Topography and Climate**
The State of Amhara is topographically divided into two main parts, namely the highlands and lowlands. The highlands are above 1500 meters above sea level and comprise the largest part of the northern and eastern parts of the region. The highlands are also characterized by chains of mountains and plateaus. Ras Dejen (4620 m), the highest peak in the country, Guna (4236 m), Choke (4184m) and Abune – Yousef (4190m) are among the mountain peaks that are located in the highland region of the State. The lowland part covers mainly the western and eastern parts with an altitude between 500-1500 meters above sea level. Areas beyond 2,300 meters fall within the "Dega" climatic Zone, and areas between the 1,500-2,300 meter contours fall within the "Woina Dega" climatic zone; and areas below 1,500 meter contour fall within the "Kolla" or hot climatic zones. The Dega, Woina Dega and Kolla constitute 25%, 44% and 31% of the total area of the region, respectively.

The annual mean temperature for most parts of the region lies between 15°C-21°C. The State receives the highest percentage (80%) of the total rainfall in the country. The highest rainfall occurs during the summer season, which starts in mid-June and ends in early September.

**Rivers and Lakes**
The State of Amhara is divided mainly by three river basins, namely the Abbay, Tekezze and Awash drainage basins. The Blue Nile (Abbay) river is the largest of all covering approximately 172,254 km. Its total length to its junction with the White Nile in Khartoum is 1,450 km, of which 800 km is within Ethiopia. The drainage basin of the Tekeze River is about 88,800 $km^2$. In addition, Anghereb, Millie, Kessem and Jema are among the major national rivers which are found in this region.
Tana, the largest lake in Ethiopia is located at the center of the region. It covers an area of 3,600 $km^2$. Besides, other crater lakes like Zengeni, Gudena Yetilba, Ardibo (75$km^2$) and Logia (35 $km^2$) are small lakes that are found in the region.

The rivers and lakes of the region have immense potential for hydroelectric power generation, irrigation and fishery development.

**Livestock**
The estimated livestock population of the region is 9.1 million cattle, 8.4 million sheep and goats, 1.6 million equines, and 8.5 million poultry. About 40% of the total livestock population for Ethiopia is found in this region. The huge livestock potential of this region gives ample opportunity for meat and milk production, food processing as well as leather and wool production.

**Fauna**
Walia ibex, Semien fox, Gelada-baboon, Grey Duiker, Klipspringer, hyenas and crocodiles are among the twenty-one species (three endemic) that are found in the region, especially at the Semien mountain national park. Wild fowls, Francolins, pelicans, cranes, ibises, and storks are among the birds that are found in the region.

**Minerals**
The Sate of Amhara has mineral resources such as coal, shell, limestone, lignite, gypsum, gemstone, silica, sulfur and bentonite. Hot springs and mineral water are also found in the region.

### 5.13.4 OROMIA REGIONAL STATE

The State of Oromia sprawls over the largest part of the country and at present consists of 18 administrative zones and more than 200 woredas. Of the 18 zones, Bale and Borena account for 45.7% of the State's total area but only about 14% of the state's population. The Council of the State of Oromia is the highest body of its administration. The capital city of the State of Oromiya is Finfine (Addis Ababa). The region borders Afar, Amhara and the State of Benshangul-Gumuz in the north, Kenya in the south, The State of Somali in the east, the Republic of the Sudan and the State of Southern Nations, Nationalities and Peoples' and the state of Gambella in the south. The estimated area of the State of Oromia is about 353,690 $km^2$, and accounts for almost 32% of the country. The total population of the region account 33,960,077 and 60% of this population is at risk of malaria transmission.

**Major Economic Activities**
Over 90% of the people of Oromia live in the rural area, and agriculture has remained the source of livelihood for the overwhelming majority of the people. The main agricultural crops include maize, teff, wheat, barley, peas, bean and various types of oil seeds. Coffee is the main cash crop in the region. Oromia accounts for 51.2% of the crop production, 45.1% of the area under temporary crops and 44% of the total livestock population of Ethiopia.

**Topography and Climate**

Oromia is a region of great physiographic diversity. Its landscape includes high and rugged mountain ranges, undulating plateaus, panoramic gorges and deep incised river valleys, and rolling plains. The landscape rises from less than 500 meters above sea level to high ranges that culminate in Mt. Batu (4607 m), the highest peak of the region. Oromia is endowed with varied relief features, which accentuate varied and amiable climatic conditions and other rich natural resource.

Oromia is a remnant part of the high and extensive Afro-Arabian plateau formed from continued uplift, rifting and subsequent volcanic piles. High relief of over 1500m is dominant. The climatic types prevailing in the region may be grouped into three major categories: the dry climate, tropical rainy climate and temperate rainy climate. The dry climate results in sparse vegetation with annual mean temperature of 27°C to 39°C, and mean annual rainfall of less than 450 mm. The hot semi-arid climate mean annual temperature varies between 18°C and 27°C. It has a mean annual rainfall of 410-820 mm with noticeable variability from year to year. Highlands of Oromiya experience temperate climate of moderate temperature, (mean temperature of the coolest month is less than 18 C) and ample precipitation (1200-2000mm).

**Rivers and Lakes**
Awash, Wabe-Shebele, Genale, Gibe, Baro, Dedessa and Guder are major rivers in the region. River Awash, which is the longest river inside Ethiopia, is a source of great agro-industrial and hydroelectric power. The crater lakes Green lake (true to its name), Bishoftu, Kuriftu, Bishoftu-Gudo, Hora-Kilole, Horsa Arsedi, and the rift-valley lakes Ziway, Abiyata, Shala, and Langano are found in this region. They have immense potential for recreation and fishery development.

**Fauna**
There are around 800 bird species and more than 100 wild animals in the region. Endemic wild animals such as the mountain Nyala, the Semien Red Fox and Menelik Bushbuck inhabit the Bale Mountains National Park.
The Awash National Park, the oldest and most developed game reserve of its kind in Ethiopia, consists mostly of the east African plain games except Giraffe and Buffalo. It is home to the oryx, kudu, caracal, aardvark, colobus monkey, green monkeys, baboons, leopard, klipspringer, hippo, Seemering's gazelle, Grevy's zebra, and cheetah.

The Awash National Park is also a natural sanctuary of numerous bird-species, some of which include Limburger, Wattle Crane, Angur Buzzard, Verreaux Eagle and long eared owls. Water fowls, shore birds and the colorful ruddy shelled duck as well as the endemic blue-winged goose are common in the marshy areas of the park.

**Minerals**
The explored mineral deposits of the region include: gold, platinum, nickel, iron-ore, soda ash, diatomite, limestone, feldspar, silica sand, dolomite, kaolin, granite and other non-metallic construction materials.

Gold mines at Adola and Laga Dambi (Borena zone) Nejo and Birbir river Valley (Wollega), and platinum at Yubdo (Wellega) are being exploited. Mining activities that are already underway include: gold (Borena and West Wellega), soda ash in the Rift Valley, limestone, gypsum and clay soil (Muger), tantalum (at Kenticha) ornamental and construction minerals (in Hararghe and Wellega) and ceramic in Borena.

Oromia has high potential for hydropower development. Untouched energy in geothermal, natural coal, and solar are found in the region. At present, the greatest percentage of the hydroelectric power of Ethiopia comes from Koka, Fincha, Melka-Wakena and Sor power stations of the region.
The total installed capacity of Integrated Circial System hydro electricity generating stations in the region amounts to 367,120 kW of which 360,200 (98.1%) and 6920 (1.9%) are hydro and thermal respectively. On the other hand, the total installed capacity of self-contained system (SCS) in 1993/94 is 12,759 kW of which 5,510 (43.2%) and 7,249 (56.8%) are hydro and thermal respectively. Gilgel Gibe another hydroelectric power source is under construction. Generally, most of the rivers in the state have immense hydroelectric power potential.

### 5.13.5 Somali Regional State

The State of Somali has a very large area size ranking second next to Oromia. At present the state comprises nine administrative zones and 49 woredas. Jijiga is the capital city of the State. The State is located in the eastern and south eastern part of Ethiopia. The State has common boundaries with Afar and the Republic of Djibouti in the north, Kenya in the south, the State of Oromia in the west, and Somalia in the east and in the South. The State of Somali has an estimated area of about 250,000 $km^2$. The total population of the region is 5,570,000. Based on the degree of availability of breeding site in the area, almost all the region is suitable for endemic malaria transmission.

**Major Economic Activities**
Although most of the people of the state of Somali mainly earn their livelihood from livestock, they practice crop production as well. The major crops cultivated in the region are sorghum and maize. Wheat and barley are also harvested in a smaller amount each year. Commercial activity is another occupation that is significantly exercised in the region.

**Topography and Climate**
The majority of the region has an altitude of 900 meters above sea level and in some areas the altitude reaches 1600 meters. Of the total area size of the State approximately 80% is flat & 7% mountainous. Regarding climate, 80% of the region is classified as "Kolla" (lowlands), 5% highland ("Dega"), and 15% of the area fall under temperate ("Woyna Dega") category. The maximum temperature reaches 32-40°C. In the temperate ("Woyna Dega") areas the temperature is within 20-28°C. The mean annual rainfall of the State is estimated to be 300-500 mm.

**Rivers and Lakes**
The State has three big rivers, namely Wabeshebele, Genale and Weybe, which could be utilized for irrigation.

**Livestock**
The region claims to have about 11.15 million domestic animals (1997 G.C.) of which 2.15 million are cattle. 5.63 million are sheep and goats and 392,000 pack animals.

**Fauna**
There is a large presence of wild animals in all seven zones of the region, especially in Fiq, Afdem, Liben and Jigjiga.

**Livestock**
The state of Somali is known for its livestock resources from which most of the Somali people earn their livelihood. The region is estimated to have about 15.2 million domestic animals out of which sheep

constitute for 53% (nearly 8 million in number). Goats and cattle are the second and third most important domestic animals in the State accounting for 20% (3.1 million in number) and 15% (2.3 million in number), respectively. Camels are actually the most important animals in the day to day life of the pastoralist Somali people, and they constitute for about 9% (1.3 million in number).

### 5.13.6 SOUTHERN NATIONS NATIONALITIES AND PEOPLES REGION

The State of Southern Nations, Nationalities and Peoples' comprise 10% of the total area of the country that is administratively divided in to nine zones, 72 woredas and 5 special woredas. The capital city of the State is Awassa. The State lies in the southern part of the country. It has common borders with Kenya in the south, the Republic of the Sudan in the southwest, the State of Gambella Peoples' in the northwest, and the State of Oromiya in the north and east. According to the CSA (Central Statistics Authority) annual statistical report, the State has an estimated area of about 112,323.19 $km^2$. The total population of the region is now 18,900,000 and of this about 11,000,000 is at risk of malaria. Coffee is the most important cash crop. Other major crops of the region include maize, teff, enset, potato, and wheat.

**Topography and Climate**

The State has an undulating land feature dissected by the Omo river basin into western and eastern parts. The elevation ranges from 376 to 4, 207 meters above sea level. The lowest area and highest peaks in the State are recorded near Lake Rudolf in South Omo and at Mount Goge in North Omo, respectively. About 56 % of the total area of the State is found below 1,500 meters elevation, which is categorized largely as hottest low land ("Kolla"). The rest 44% is found in the temperate climatic zone. The mean annual rainfall of the State ranges from 500 - 2,200 mm. Its intensity, duration and amount increases from South to Northeast and Northwest. The mean annual temperature of the State in general ranges from 15°C to 30°C.

**Rivers and Lakes**

Many perennial and seasonal rivers are found in this State. These include, Omo, Gojeb, Mago, Segen, Woito, Akobo, Dima, Wabi, Wolga, Bilate, and Genale. River Omo is among the largest.
Among the known Rift Valley lakes are Awassa, Abaya, Chamo, Chew Bahir and Rudolf.

**Fauna**

There are 23 kinds of wild animals and 300 species of birds. Some of the wild animals found in this State are elephant, lion, Giraffe, leopard, zebra, monkey, Lesser kudu, Water Buck, crocodile, rhinoceros, warthogs, and buffalo.

**Natural Resources and Minerals**

The State is rich in natural resources. These include, water, mineral, fauna and flora. Some of the minerals of the region include gold, coal, mineral water, clay, diatomite, scoria, limestone, mica, nickel, iron-ore, and asbestos. The water resource can be utilized for fishery, irrigation and hydroelectric development. There are seven preserved forest locations. Forests and bushes cover around 18% of the state.

### 5.13.7 BENISHANGUL GUMUZ REGIONAL STATE

Benishangul Gumuz has an estimated area of 51,000 $km^2$ and is located in the north-western part of Ethiopia. It shares common borders with the State of Amhara in the east, the Sudan in the north-east, and the State of Oromia in the south. It is divided into three administrative zones, 19 Woredas (two of

them special Woredas), and 33 Kebeles (the smallest administrative units). Metekel is the largest zone with an area of 26,272 km$^2$ followed by Assosa (14,166 km$^2$), and Kamashi (8,850 km$^2$).

### 5.13.8 Gambella Regional State

Gambella is one of the nine regions of Ethiopia. Its capital is Gambella. It is situated in the western tip of Ethiopia bordering with Sudan in the west, south and north. Its size is 25,802.01 km$^2$ with estimated population of around 700,000 inhabitants. The main nationalities of the region are: Anyuak, Nur, Mezhenger, Komo and Opo. Moreover, the other ethnic groups predominantly from high land of Ethiopia live in the region. Lying between the Baro and Akobo Rivers, the western part of Gambella includes the Baro salient. Located in Gambela is Gambella National Park, which covers approximately 5061 km$^2$ or 19.6% of the Region's territory. Malaria is relatively stable in the region compared to all other regional states in Ethiopia. Coffee is one of the agricultural products of the region. Cattle production is also one of the income generating options for the region. Gambella is believed to have major oil resources.

### 5.13.9 Harari Regional State

Harari is one of the most popular historical towns in the Eastern part of Ethiopia. The State has no administrative zones but has nine districts. The capital city of the State is Harar and the region is located in the Eastern part of Ethiopia, surrounded by the State of Oromia. The State's size is estimated at 340 km$^2$ and the estimated population at the end of 2014 is found to be 225,136 among which about 60% resides in malaria prone area.

**Major Economic Activities**

The State's population is engaged predominantly in farming, civil service and commerce. Sorghum, maize, chat, coffee, orange, mango are among major agricultural products.

An exotic variety of goods is offered for sale, and colorful cloths and jewelry worn by the people create a wild array of color. The Harari people excel in artisan crafts, such as weaving silver and cooper filigree, tanning, cutlery and blade production and sandal making.

**Topography and Climate**

Harari lies 51 kilometers to the south east of Dire Dawa. It is located in the eastern wall of the Great Rift Valley looking over the vast Danakil desert to the north, the cattle rich savannahs to the south and fertile lands of the Harar Mountains to the east. It lies between two rivers, tributaries of the Erer, on the southern edge of a vast plateau. The surrounding mountains divide the Great Rift Valley from the plains of the Ogaden. The climate of the State is one of the most pleasant in the country. Temperature is even between 17.1°C-20.2°C throughout the year. The coolest season (18.7°C) which is between June-September, coincides with heavy rains accompanied by storms and strong electrical discharges. The average annual intensity of precipitation is about 750-1,000 mm. The mean amount of rainfall over three years as registered 10 years ago was 1,509 mm.

### 5.13.10 Dire Dawa City Administration

The Dire Dawa administrative council consists of the city of Dire Dawa and the surrounding rural areas. The council has no administrative zones but six operational districts. The city is located in the eastern part of the country enclosed by the State of Somalia and the State of Oromia. It is found at a distance of 515 kilometers from Addis Ababa. The administration has an estimated area of 128,802 hectares. The 2014 population of the administrative city was estimated to be 440,000.

**Topography and Climate**
Dire Dawa is a grouped in the Kolla and semi-kolla climatic zone. The northeastern part of Dire Dawa is relatively sparsely populated lowland exhibiting agro-pastoral and pastoral system, and the southeastern part of the administration comprises of the escarpment with mixed farming system. Dire Dawa lies between 1000 to 2000 meters above sea level. The average monthly temperature is 24.8 degree Celsius. The average annual rainfall amounts to 604 mm.

### 5.13.11 Addis Ababa City Administration

Addis Ababa lies 9°1'48"N latitude and 38°44'24"E longitude. The city is located at the heart of the country, at an altitude ranging from 2,100 meters at Akaki in the south to 3,000 meters at Entoto Hill in the north. This makes Addis Ababa the third highest city in the world, after La Paz and Quito in Latin America. The city occupies a total area of 540 $km^2$.

Addis Ababa has a sub-tropical highland climate. The city has a complex mix of highland climate zones, with average temperature differences of up to 12.2°C, depending on elevation and prevailing wind patterns. The high elevation moderates temperatures year-round, and the city's position near the equator means that temperatures are very constant from month to month. The months from June to mid-September is the main rainy season during which days and nights are cool by local standards. Average annual rainfall is 1,184mm, of which about 80% falls between June and September, the months of July and August being the wettest. The hottest and driest months are usually April and May. The short rains fall during March to mid-April, characterized by relatively cool nights and warm days.

Addis Ababa is the largest as well as the dominant political, economic, cultural and historical city of the country established in 1887 by emperor Menilik II. It has the status of both a city and a state. It is the capital of federal government and a chartered city. It is where the African Union and its predecessor, the OAU are based. It also hosts the headquarters of the United Nations Economic Commission for Africa (UNECA) and numerous other continental and international organizations. It is the largest city in Ethiopia. The city is divided into ten sub-cities, which are the second administrative units next to city administration. A total of about four million people reside in the city.

## 5.14 PROTECTED AREAS

### 5.14.1 National Parks

**Awash National Park** is located 211 km east of Addis Ababa and covers 827 $km^2$. The park takes its name from the Awash River which marks its southern boundary. The rivers last gesture is the salt lake, Lake Abbe, on the Ethiopia-Djiboutian border.

The park offers quite good wildlife and outstanding birdlife viewing. It also contains an interesting range of volcanic landscapes. The Beisa oryx and Sommering gazelles inhabit the open areas, Greater and Lesser Kudus can be found the bushed areas, the endemic Swayne's Hartbeest graze in the grass plains, the tiny salt Dik-Dik stay under the dry acacia bushes, Defarsa waterbuck are located along the bushy river area and the two monkey species – the Anubis and Hamadryas - can be seen near the river. The Colobus and Grivet monkeys can be found along the riverside and drier areas respectively. Leopards, lions, Black-Backed and Golden jackals, caracals, servals and wildcats are also seen in the park, though very rarely.

In 2002, 462 bird species were recorded. Of these, six are endemic, namely the Banded Barbet, Golden-Backed Woodpecker, White-Winged Cliff Chat, White-Tailed Starling, Thick-Billed Raven and Wattled

Ibis. There are several buzzard species in the park and secretary birds in the grass plains. The camping grounds near the bank of the Awash River and the Filwoha Hot Spring area are the best sites to spot many species of birds, such as Emerald-Spotted Wood Dove, Green Wood-Hoopoes, Red and Yellow Barbets, Carmine Bea Eaters.

One of the main features of the park area is the Fentale Volcano. The dark scar from the last lava flow (1820) can be seen on the southern flank of the Volcano. The other park feature is the turquoise-blue pools of the natural hot springs in the extreme north of the park, where you can spot waterbucks and hamadryas baboons, and sometimes hear lions at night.

**Bale Mountains National Park** covers 2400 $km^2$ covering wide range of habitats and ranging in altitude from 1500 to 4377 meters and lies in southeastern of Ethiopia.

The spectacular Harenna escarpment running from east to west divides the area into two major parts. To the north is a high altitude plateau area known as the Sanetti Plateau (4000m) formed of ancient volcanic rocks and dissected by many rivers and streams that have cut deep gorges into the edges. In some places this has resulted in scenic waterfalls and alpine lakes.

The vegetation in the park varies according to altitude and can be divided into three main zones. Around Dinsho, in the north, there are grass riverine plains, bordered by bands of bushes, particularly sagebrush and St. John's Wort. Wild flowers, such as giant lobelia, geraniums, 'red-hot pokers' and alcheilla form carpets of color. Higher up the mountains heather appears either as small bushes or as mature trees.
The second zone, the Sanetti Plateau, is home to typical Afro-Alpine plants, some coping with the extreme temperatures by either remaining very small or becoming large. The best example of the latter is the curious looking Giant Lobelia, whose stems stand high against the skyline. Wild flowers are many and various, the dominant plant being the helichrysum, or 'everlasting' flowers that can be seen in many forms. The third habitat, which is the southern part of the park, is heavily forested – the moist, tropical Harenna Forest, is home to tree species such as Haenia, Celtis and Podocarpus. The wildlife of Bale includes many endemic species. The park was originally established to protect the two endemic mammals: the Mountain Nyala and the Semien Fox or Jackal.

**Gambela National Park**:
Located in the Gambela Region, its 5061 $km^2$ of territory is encroached upon by cotton plantations and refugee camps.

The general topography of the Park is flat, with some areas of higher ground where deciduous woodland and savanna occur; these higher areas are often rocky with large termite mounds. About 66% of the area is considered shrubland, 15% is forest, while 17% has been modified by man. Gambela National Park also supports extensive areas of wet grassland and swamps where the native grasses grow over three meters in height.

The Gambela Park was established primarily to protect two species of endangered wetland antelopes: the White-eared Kob and the Nile Lechwe. Other wildlife reported as living here include populations of elephant, African Buffalo, lion, roan antelope, tiang, Lelwel Hartebeest, olive baboon, and guereza monkey. Several birds only found in this area include the shoebill stork, the Long-tailed Paradise Whydah and the Red-throated and Green Bee-eaters.

**Mago National Park** was established in 1979, making it the newest of Ethiopia's several National Parks. Its highest point is Mount Mago (2528 meters). Located in the Southern Nations, Nationalities, and Peoples Region about 782 km south of Addis Ababa and north of a large 90° bend in the Omo River. The park is divided by the Mago River, a tributary of the Omo, into two parts. To the west is the Tama Wildlife Reserve, with the Tama River defining the boundary between the two. To the south is the Murle Controlled Hunting Area, distinguished by Lake Dipa, which stretches along the left side of the lower Omo. The park office is 115 km north of Omorate and 26 km southwest of Jinka.

The major environments in and around the Park are the rivers and riverine forest, the wetlands along the lower Mago and around Lake Dipa, the various grasslands on the more level areas, and scrub on the sides of the hills. Open grassland comprises about 9% of the park's area. The largest trees are found in the riverine forest beside the Omo, Mago and Neri.

Indigenous bird life include the extremely uncommon *Turdoides tenebrosus* especially at Lake Dipa, *Estrilda troglodytes* in the rank grass along streams and swamp edges*, Phoeniculus damarensis, Porphyrio alleni, Butorides striatus* also at Lake Dipa, and in riverine contexts *Pluvianus aegypticus, Scotopelia peli* and *Cossypha niveicapilla*.

**Nechisar National Park (also spelled as Nech Sar)** is located in the Southern Nations, Nationalities, and Peoples Region (SNNPR) immediately to the east of Arba Minch. Its 514 $km^2$ of territory include the "Bridge of God" (an isthmus between Lakes Abaya and Chamo), and the Nechisar (English: white grass) plains east of the lakes. Park elevations range between 1108 and 1650 meters above sea level. Nechisar National Park was established in 1974.

Approximately 15% of the park consists of lakes including Lake Abaya in the north and Lake Chamo in the south. Part of the habitat consists of the groundwater forest and shoreline of the lakes, but there are dry grassy plains, and most of the park is covered in thick bushland and the wooded valleys and foothills of the Amaro Mountains. The altitude ranges from 1,108 meters above sea level at the shore of Lake Chamo to 1,650 meters on Mount Tabala in the north-east, renowned for its hot springs. The forest between the two lakes and by the Kulfo River is dominated by *Ficus sycamorus*, which can grow up to 30 m tall. The freshwater swamps at the mouth of the Kulfo River and in Lake Chamo are dominated by *Typha angustifolia*, tall waterside grasses and the small leguminous trees, such as *Aeschynomene elaphroxylon* and *Sesbania sesban*. Taller trees found in the park include *Dichrostachys cinerea, Acacia tortilis, Balanites aegyptiaca* and less common *Acacia nilotica*. The southern part of the park is dominated by edaphic grassland and a calcareous black clay soil underneath with *Dobera glabra, Acacia tortilis* and the grass *Chrysopogon aucheri* forming much of the landscape.

Both Lake Abaya and Chamo have substantial fish populations, notably Nile perch, which forms the basis of the local fishing industry. Crocodiles inhabit both lakes and there is a crocodile farm near Lake Abaya. At Chamo crocodiles are exploited for their skins.

**Abijatta-Shalla National Park**: is located in the Oromia Region 200 km south of Addis Ababa to the east of the Ziway–Shashamane highway, it contains 887 $km^2$ including the Rift Valley lakes of Abijatta and Shalla. The two lakes are separated by three kilometers of hilly land. The altitude of the park ranges from 1540 to 2075 meters, the highest peak being Mount Fike, which is situated between the two lakes. Besides the two lakes, the primary attraction of this national park are a number of hot springs on the northeast corner of Lake Abijatta, and large numbers of flamingoes on the lake.

**Kafta Sheraro National Park:** is located in the western Tigray region, in the districts (woredas) of Kafta Humera and Tahtay Adiyabo. The park borders with Eritrea's Gash-Setit to the north and is traversed by the Tekezé River. Vegetation communities in the park include *Acacia-Commiphora, Combretum-Terminalia*, dry evergreen montane woodlands and riparian types. A total of 167 mammal species, 95 bird species and 9 reptile species have been recorded at the site. The park is home to a transboundary African elephant population of about 100 individuals, which it shares with Eritrea's Gash-Setit, and which constitutes the northernmost elephant population in Eastern Africa. Kafta-Sheraro is also an important wintering site for demoiselle cranes. Other notable wildlife species include lion, leopard, caracal, aardvark, greater kudu, roan antelope, red-fronted gazelle and ostrich.

**Maze National Park**: is located in the Southern Nations, Nationalities, and People's Region of Ethiopia. It is 210 $km^2$ in size. Elevations within the park range between 1000 and 1200 meters above sea level. Maze was founded in 2005. Maze is noted for its population of the endangered Swayne's hartebeest (*Alcelaphus buselaphus swaynei*), and is said to be second only to Senkelle Swayne's Hartebeest Sanctuary in importance for that subspecies.

**Omo National Park** is a very remote park located in the Southern Nations, Nationalities, and Peoples Region on the west bank of the Omo River. The lower reaches of the Omo river were declared a UNESCO World Heritage Site in 1980, after the discovery (in the Omo Kibish Formation) of the earliest known fossil fragments of Homo sapiens, which have been dated circa 195,000 years old.

The Omo National Park covers 4,068 $km^2$ of wilderness bordered by the Omo River, is home to an amazing range of wildlife. 306 species of birds have been identified here, while large herds of Eland, some Buffalo, Elephants, Giraffe, Cheetah, Lion, Leopard, Burchell's Zebra, are quite common. Physical features that characterized the park include belts of forest along the Omo and Mui rivers, hot springs, extensive wilderness. The grass plains are relieved by hands of hills to the north and south of the centrally located park headquarters. Temperatures are high, ranging from 14C to 41C, and the rainfall averages 500 mm a year, falling between March and April, and September and October. Vegetation coverage comprises Savannah, riverine forest, deciduous woodland, acacia bush.

The park's wildlife includes large herds of eland and buffalo, elephant, giraffe, cheetah, lion, leopard and Burchell's zebra. Lesser kudu, lelwel hartebeest, topi and oryx are all found here, in addition to deBrazza's and colobus monkeys and Anubis baboon. A total of fifty-seven species of mammal are found in the park. It also contains three hundred and six species of birds; of these one is endemic.

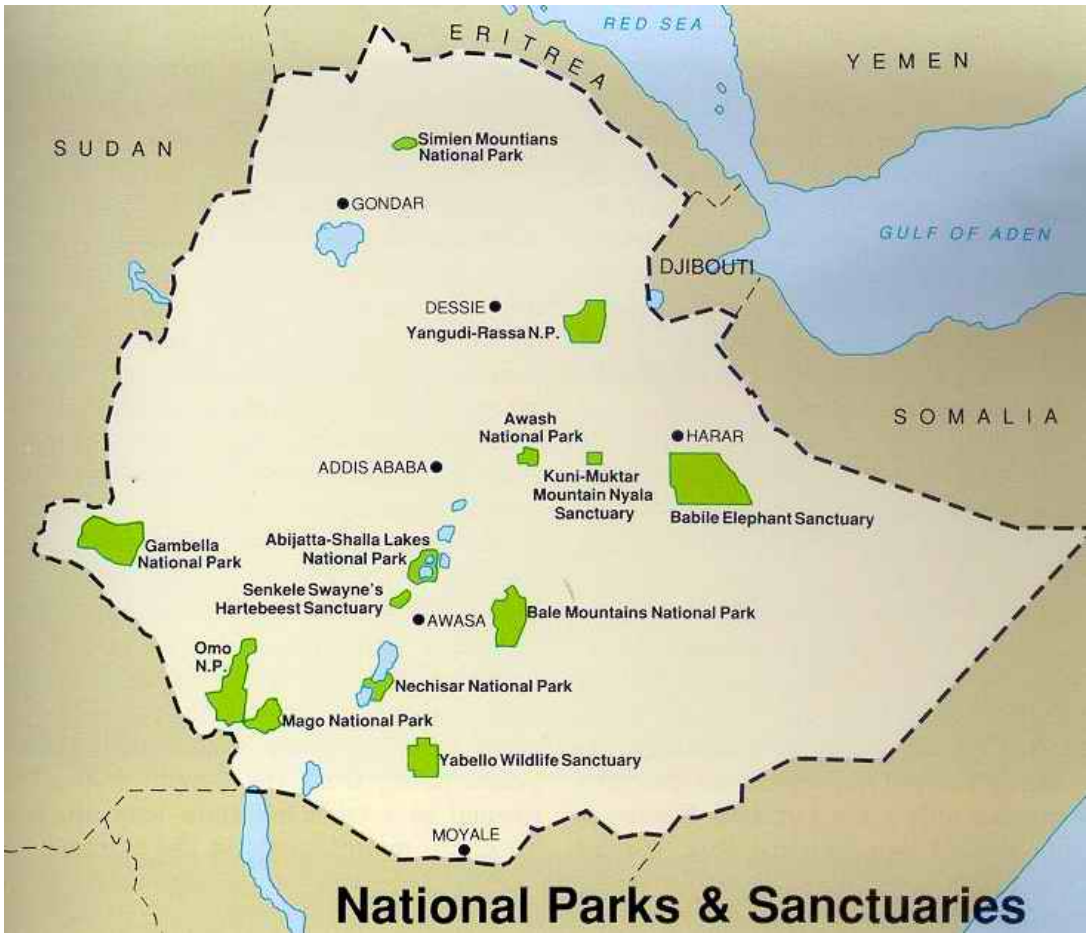
**Simien Mountains National Park** is located in the Semien (North) Gondar Zone of the Amhara Region, its territory covers the Simien Mountains and includes Ras Dashan, the highest point in Ethiopia. It is home to a number of wild species, including the Ethiopian wolf and the walia ibex, a wild goat found nowhere else in the world. The gelada baboon and the caracal, a cat, also occur within the Simien Mountains. More than 50 species of birds inhabit the park, including the impressive bearded vulture, or lammergeier, with its 3m wingspan. The park was established in 1969. The Park has been declared a World Heritage Site by UNESCO.

**Yangudi Rassa National Park** is located in the Afar Region, its 4730 $km^2$ of territory include Mount Yangudi near the southern border and the surrounding Rassa Plains, with altitudes from 400 to 1459 meters above sea level. Sandy semi-desert and wooded grassland cover the majority of the park's area. This Park lies between the territory of the Afars and the Issas, and while violence have been frequent between them, most of the park happens to be in an area where they avoid each other. As a result,

most of the active protection of the Park is focused on managing their conflict.

This national park was proposed in 1977 in specific to protect the African Wild Ass, but the steps needed to officially establish this park have not been completed as of 2002. Recently, the Wild Ass went extinct in Yagundi Rassa. However, there is a small population in the adjacent Mile-Serdo Wild Ass Reserve (8,766 km²). The park headquarters are in Gewane. Large animals native to the park include Beisa Oryx, Soemmering's gazelle, gerenuk and Grevy's zebra. Bird species of interest include *Phoenicopterus minor*, *Petronia brachydactyla* and *Ardeotis arabs*. The Awash - Asseb highway crosses the Yangudi Rassa National Park, as does the Awash River.

**Figure 4: Map of Ethiopia's Protected Areas**




## 5.14.2 RESERVES/SANCTUARIES

**Babile Elephant Sanctuary:** The 698,200ha Babile Elephant Sanctuary is located 560km east of Addis Ababa and 25km south of the city of Harar. In part it encompasses a plateau, as well as the lowlands of the valleys of the Erer, Daketa, Fafen, Gobele and Borale Rivers; all being tributaries of the Shabelle River. Elevations range from 1000 meters above sea level in the south to 1750 meters above sea level. in the north. The Sanctuary was originally set aside to protect a supposed elephant sub-species*, Loxodonta africana oleansie,* but recent DNA tests showed that it is the regular African Elephant. Nonetheless, it is the most Northeastern population Elephant populations and with about 400 animals the largest and most visible herd of the about 1000 animals remaining in Ethiopia, and the population has been slowly increasing over the last decade.

Other mammals living in the park are the Black-maned lion, Leopard, Cheetah, the Hamadryas Baboon, Papio hamadryas, Menelik's bushbuck, Soemmerring's Gazelle, and greater and lesser kudu. The bird list of 227 species includes the endemic Salvadori's serine. Of the reptiles, noteworthy are enormous tortoises and other animals.

**Senkelle Hartebeest Sanctuary:** is located 48km west of Hawassa and is 340 kms south of Addis Ababa and covers an area of 54 $km^2$. The sanctuary was originally established in 1976 to protect the endemic and endangered antelope species called Swayne's hartebeests. The sanctuary is located in between Oromia and SNNPRS and managed by the Ethiopian Wildlife Conservation Authority. The open acacia woodland of the reserve is quite scenic and some of the animals are easily spotted, especially the Swayne's hartebeests, the population of which is currently estimated at between 600 and 800. The sanctuary harbor other wild animals including Bohor, reedbucks, greater kudus, orbis antelopes, spotted hyenas, serval and civet cats, caracals, warthogs, common jackals as well as 91 species of birds.

# 6. PESTICIDE PROCEDURES

Regulation 22 CFR 216.3(b) mandates the consideration of twelve factors when a project includes "assistance for the procurement or use, or both, of pesticides". This section addresses each of those twelve factors for the Malaria Control Program in Ethiopia.

## 6.1 USEPA REGISTRATION STATUS OF THE PROPOSED PESTICIDE

Pesticides registered for IRS in Ethiopia and the United States, and recommended by WHO, will be preferred for use in this IRS project. However, some of the pesticides on the WHOPES list are not registered with the U.S. Environmental Protection Agency (USEPA), for economic reasons rather than health and safety or technical ones. Because this is an economic issue rather than a technical one, and because there is widespread use of these chemicals around the world, with a good database attesting to the safety of the chemicals, USAID and USEPA has chosen to allow the use of all WHO-recommended pesticides under the Africa IRS program. Currently, chlorfenapyr SC is under review by WHOPES and is currently registered by the USEPA for some agricultural uses, but has not yet been registered for public health use.

The agricultural pesticide regulating body in Ethiopia is the MARD's Crop Protection Department. Currently, only deltamethrin, lambda-cyhalothrin and alpha-cypermethrin are registered by the MARD for use in IRS. However, the FMOH is not required to register health pesticides with MARD, therefore country registration is not a limiting factor in deciding which pesticides may be used in the program. Of the WHOPES-recommended pesticides for IRS, pyrethroids, carbamates and organophosphates are included in this SEA. This document also includes chlorfenapyr, which is currently under WHOPES review for IRS and is registered for similar use by USEPA. DDT (organochlorine) is not included due to resistance issues. Pyrethroids (specifically deltamethrin) have also shown resistance, but are included as a potential option. All applicable Ethiopian laws and regulations regarding the public health use of the WHOPES-recommended pesticides will be followed.

## 6.2 BASIS FOR SELECTION OF THE PESTICIDE

Insecticide selection for any PMI supported program is subject to international procurement requirements of the US Federal laws. Requests to purchase public health insecticides used in IRS must be initiated at class level, rather than for a particular insecticide (compound). The insecticide class to be used in IRS is selected for each campaign based on a number of considerations.

The FMOH is working on the development of IRM (Insecticide Resistance Management) guidelines, which will provide strategies for selecting appropriate IVM and insecticides. Currently, the Ministry has a database that brings together different findings of all partners that work in malaria control, mainly WHO country office, Ethiopia Public Health Institute (EPHI), PMI, Addis Ababa University Institute of Pathobiology and Jimma University.

**Primary Criteria for choosing pesticides:**

a) **Recommendation by the World Health Organization Pesticide Evaluation Scheme:** Only insecticides recommended by WHO can be used in IRS. Organophosphates, carbamates, pyrethroids and organochlorines are WHOPES recommended classes of pesticides for use in IRS and thus any can be chosen for use based on entomological data and host country registration status. Chlorfenapyr belongs to the pyrroles class of chemicals, which are not included in the WHOPES-recommended classes for IRS; however, it is currently under consideration.

**Table 6: WHOPES Recommended Pesticides with Effective Duration, March 2, 2015**

| *Insecticide compounds and formulations*[1] | *Class group* [2] | *Dosage (g a.i./m²)* | *Mode of action* | *Duration of effective action (months)* |
|---|---|---|---|---|
| ***DDT WP*** | OC | 1-2 | contact | >6 |
| ***Malathion WP*** | OP | 2 | contact | 2–3 |
| ***Fenitrothion WP*** | OP | 2 | contact & airborne | 3–6 |
| ***Pirimiphos-methyl WP & EC*** | OP | 1-2 | contact & airborne | 2–3 |
| ***Pirimiphos-methyl CS*** | OP | 1 | contact & airborne | 4–6 |
| ***Bendiocarb WP*** | C | 0.1–0.4 | contact & airborne | 2–6 |
| ***Propoxur WP*** | C | 1–2 | contact & airborne | 3–6 |
| ***Alpha-cypermethrin WP & SC*** | PY | 0.02–0.03 | contact | 4–6 |
| ***Alpha-cypermethrin WG-SB*** | PY | 0.02–0.03 | contact | up to 4 |
| ***Bifenthrin WP*** | PY | 0.025–0.05 | contact | 3–6 |
| ***Cyfluthrin WP*** | PY | 0.02–0.05 | contact | 3–6 |
| ***Deltamethrin SC-PE*** | PY | 0.02–0.025 | contact | 6 |
| ***Deltamethrin WP, WG, WG-SB*** | PY | 0.02–0.025 | contact | 3–6 |
| ***Etofenprox WP*** | PY | 0.1–0.3 | contact | 3–6 |
| ***Lambda-cyhalothrin WP, CS*** | PY | 0.02–0.03 | contact | 3–6 |

(1) CS = capsule suspension; EC = emulsifiable concentrate; SC = suspension concentrate; SC-PE = polymer enhanced suspension concentrate; WG = water dispersible granules; WG-SB = water dispersible granules packaged in water soluble bags; WP = wettable powder.
(2) OC = organochlorines; OP = organophosphates; C = carbamates; PY = pyrethroids.

Note: Chlorfenapyr is still undergoing testing so is not included in this table.

b) **Registration for use in the country:** The FMOH is not required to conform to the pesticide registration requirements developed by the MARD, therefore the insecticides identified by the FMOH for use in health programs may or may not be registered for use by the MARD.

c) **Residual effect for a period longer than, or at least equal to, the average duration of the malaria transmission season in the area:** According to WHO, all pyrethroids, carbamates, and OPs are expected to have duration of 3 to 6 months in terms of effectiveness; however, the duration of effectiveness varies under different climatic conditions. In most of the country, the peak periods of malaria incidence occurs from September to December, following the main rainy seasons (June-September), and from March to May, during and after the small rainy seasons (February-March). Three pyrethroids, known as longer-lasting pyrethroids, can last up to eleven months based on various field trials. From this perspective, and for economic reasons,

pyrethroids are normally the most effective choice of insecticide. The results of a study conducted on 15 sprayed houses in Adama area showed that the residual life of two insecticides (pirimiphos methyl and deltamethrin) was more than six months. Due to resistance to pyrethroids it is currently not the best choice in Ethiopia and carbamates and organophosphates will be used instead. Even though the decay rate of bendiocarb is faster; as a result the protective period of the insecticide becomes shorter to minimize the cost implication of two round spraying, FMOH is suggesting just undergoing the spraying in one round being supported by other vector control methods such as larviciding. The organophosphate Actellic 300 (pirimiphos-methyl) capsule suspension (CS) formulation is expected to have an effective duration of 4 to 6 months (in some countries it has shown to have a duration of up to 9 months) and will be sprayed in selected districts.

d) **Pesticide must be appropriate for use on the wall surfaces of the selected location:** The majority of the structures in the targeted regions are made of thatch/wood covered with a mud plaster. Some homes may be only thatch, while others may have a commercial plaster surface. Structures made of corrugated metal are not sprayed as the pesticides do not adhere sufficiently to the surface to be effective. In Ethiopia ceilings and eaves are also sprayed. These are usually constructed out of thatch. Corrugated metal roofing is not sprayed.

**Local vector susceptibility to the insecticide:** One of the major concerns when implementing an IRS campaign is to prevent resistance to insecticide among vectors. Resistance to insecticide develops when a hereditary feature is selected in an insect population that reduces the population's sensitivity to a given insecticide. Entomological monitoring activities will be implemented in collaboration with the ORHB, FMOH and Jimma and Addis Ababa Universities. As part of the 2014 spray campaign, the project conducted comprehensive tests on spray quality and insecticide resistance using wild and susceptible mosquitoes. These entomological results include the following:

- Mortality of wild and susceptible mosquitoes was 100 percent in 43 of the 48 houses sampled one to five days after spraying in four districts (two CB and two DB IRS districts).
- PMI tested susceptibility of the main vector to 11 WHO-recommended insecticides for IRS in four of the eight sentinel sites. The vector is susceptible to pirimiphos-methyl, fenitrothion, and propoxur in all tested sites. The vector is susceptible to bendiocarb in two sites; resistant in one site, and possibly resistant in one other site. An. gambiae s.l. is resistant to DDT and most of the pyrethroid-class insecticides in all sites.

Chlorfenapyr has a unique mode of action and is believed to be highly improbable that mosquitoes can develop resistance to it. It is also not cross-resistant to DDT, pyrethroids, carbamates, or organophosphates.

Cognizant of the challenge of insecticide resistance in Ethiopia, the FMOH in collaboration with the partners is developing a separate insecticide management strategy which has the following seven key points (as depicted on the 2014-2020 NSP).

Notes on insecticide resistance management (IRM) in Ethiopia:

1. IRS will be targeted to areas where malaria burden is high and in highland fringe areas with epidemics risk only.
2. Rotation spray of two or preferably more insecticide classes with different modes of action at different spray cycles should be adopted as an insecticide management strategy.
3. Combinations of interventions: two or more insecticide based vector control interventions are used in areas of overlap such as treated nets and IRS.
4. Resistance management strategies will be considered in a broader context of integrated vector management.
5. Regular monitoring of insecticide resistance based on WHO standards will be conducted in selected sentinel sites throughout the country to develop or revise strategy for insecticide resistance management. The monitoring of insecticide resistance has three benefits:
    a. To provide baseline data for programme planning and choice of insecticide.
    b. To detect insecticide resistance at an early stage so that resistance management can be introduced.
    c. To monitor the level of resistance over time and compare data with the baseline and evaluate the effect of interventions on resistance.
6. Quality control based on WHO standards for quality of inputs and operations for vector control will be institutionalized, maintained and continuously updated.
7. Procedures for safe handling and disposal of public health insecticides including insecticide contaminated materials will be institutionalized in accordance with the Ethiopia's Environment and Forest Ministry and WHO global regulations.

e) **Ecological impact:** The 2012 PEA for Integrated Vector Management (IVM) assessed the toxicity of IRS insecticides to non-target organisms, including mammals, birds, fish, bees, and 'other aquatic' organisms. In summary, pyrethroids and carbamates are similar in toxicity to non-target organisms as shown in Table 8. Apart from propoxur, the rest of the insecticides are all highly toxic to fish and other aquatic organisms. Similarly all the insecticides from the recommended classes are highly toxic to bees, apart from pirimiphos methyl. In mammals, all the insecticides recommended by WHO for IRS carry low-to medium toxicity, with the exception of lambda cyhalothrin and propoxur, which are categorized as highly toxic to mammals. In avi-fauna, only propoxur is categorized as highly toxic with the rest categorized as low/medium in toxicity.

**Table 7: Pesticide Toxicity**

| IRS Insecticide | Mammal | Bird | Fish | Other Aquatic | Bee | Persistence | Bioaccumulate |
|---|---|---|---|---|---|---|---|
| Alpha-cypermethrin (P) | | | | | | | |
| Bendiocarb ( C) | | | | | | | |
| Bifenthrin (P) | | | | | | | |
| Cyfluthrin (P) | | | | | | | |
| DDT (OC) | | | | | | | |
| Deltamethrin (P) | | | | | | | |
| Etofenprox (P) | | | | | | | |
| Fenitrothion (OP) | | | | | | | |
| Lambda-cyhalothrin (P) | | | | | | | |
| Malathion (OP) | | | | | | | |
| Pirimiphos-methyl (OP) | | | | | | | |
| Propoxur ( C) | | | | | | | |
| Clorfenapyr | | | | | | | |

Source: IVM PEA

| Key |
|---|
| High Toxicity |
| Medium to High Toxicity |
| Medium Toxicity |
| Low to Medium Toxicity |
| Low Toxicity |
| Data Not Found |

f) **<u>Human health impact:</u>** The 2012 PEA for IVM also assessed cancer and non-cancer risks associated with all WHOPES-recommended insecticides by process (e.g., mixing insecticide, spraying, residing in sprayed house, etc.) and pathway (e.g. inhalation, dermal, ingestion, etc.), and cancer risks by process and pathway where available (mainly for DDT and select pyrethroids). In general, pyrethroids and carbamates pose less non-cancer risks than OPs when risks are assessed via any pathway. If OPs are used, then decisions on insecticide type should be informed in part by the human health toxicity and risk associated with each compound and formulation. For malathion and fenitrothion, it will be necessary to monitor the level of acetyl cholinesterase in any worker who may have been exposed to contamination. Occupational exposures to OP insecticides are measurable using blood cholinesterases and urinary excretion of chemical biomarkers. The results of a biomonitoring pilot conducted in2015 will contribute to a needs assessment and guidelines for PMI spray operations.

**Secondary Selection Criteria:**

Once the FMOH and PMI approve the analysis of these factors, then the criteria is updated to include international procurement language in which the criteria is clearly stipulated and then tendered out in accordance with international open competitive procurement rules. Once there are responses to the call for bids, the resulting proposals are subjected to secondary criteria including:

- Appropriate packaging for safety and standard delivery tools
- Unit cost of insecticide
- Timely delivery of the insecticide to the preferred point of delivery
- Local representation of supplier in host country
- Technical assistance with training and troubleshooting by supplier

Beginning in 2015, the PMI IRS implementing partner will procure the insecticides for the IRS country program.

## 6.3 Extent to Which the Proposed Pesticide Use Is Part of an Integrated Pest Management Program

Integrated Pest Management (IPM) is defined[5] as:

> "…an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties [agricultural products]. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials [pesticides] are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment."

IPM is often used in an agricultural context, but similar in nature is the concept of IVM. The major characteristics of IVM include:

- Methods based on knowledge of factors influencing local vector biology, disease transmission, and morbidity;
- Use of a range of interventions, often in combination and synergistically;
- Collaboration within the health sector and with other public and private sectors that impact vectors;
- A public health regulatory and legislative framework.

USAID strategy has been that IRS will be implemented as a component of IVM for malaria control, along with LLINs. The FMOH Malaria Control Guidelines include environmental management and larviciding. Environmental management for vector control has been implemented in urban and semi-urban areas, refugee camps, development projects, water harvesting ponds, and irrigation scheme areas. In areas where breeding sites are few, accessible, and manageable, communities are encouraged to participate in environmental management activities under the direction of HEWs. Larvicides can be used to address collected water that cannot be managed through environmental control measures. Similar to environmental control measures, the success of larvicides depends on the identification of all mosquito breeding sites and their distribution in the entire target area, followed by sustained weekly spraying of chemicals. Larvicide control measures should be applied in conjunction with environmental control measures. The most common water-soluble chemical used to kill mosquito larvae in Ethiopia is temephos (Abate®). The application of temephos must be carried out on larvae-positive sites through the guidance of HEWs in areas where breeding sites are easily identifiable. PMI does not support the

[5] (http://www.ipm.ucdavis.edu/IPMPROJECT/about.html

implementation of larviciding or environmental management, which are both outside the scope of this SEA.

## 6.4 Proposed Methods of Application

IRS involves spraying a liquid insecticide with long lasting residual activity on the indoor wall surfaces where mosquitoes usually rest. The pesticide then dries up and leaves a crystalline deposit on the sprayed surface. A lethal dose of the insecticide is absorbed when the mosquito rests on the surface, and the mosquito is killed.
Pesticide will only be applied using pressurized spray equipment approved for the pesticide in use, by trained SOPs wearing full PPE (face mask, gloves, overalls, hard hats with face shields, boots, neck protection and goggles). Experienced program operators will train SOPs in the correct spray procedures per PMI BMPs. These procedures have been proven to be effective for providing long-lasting effectiveness toward controlling the malaria vector mosquito.

The following IRS equipment will be used:

**Spray Nozzles**

The program in Ethiopia will procure 8002E nozzles for the spray pumps, which are the standard size recommended by WHO for mud walls.

**Spray pumps**

The SOPs who implement IRS use HUDSON X-PERT or Goizper backpack compression sprayers to apply a measured amount of insecticide on the interior walls of houses and structures. A water-soluble insecticide is added to the sprayer containing a pre-measured amount of water, the sprayer is pressurized, and the material is then applied to the interior walls of targeted house (structure). After the day's spraying is complete, SOPs must clean the sprayer following the manufacturer's recommendations to ensure their proper operation and calibration.

## 6.5 Acute and Long-Term Toxicological Hazards and Measures to Minimize Them

The two broad categories of hazard are exposure to humans and domestic animals, and release into the environment causing environmental damage. These may occur at any point, from the production or importation of the pesticide through transportation, storage, distribution, pesticide preparation, spray application, cleanup, and final disposal. Post-spray activity may cause exposure as well through improper behavior of beneficiaries regarding sprayed surfaces and cleanup and disposal of residue and any insects killed with the insecticides from the household after spraying. Hazards are discussed in Chapter 8, Potential Health and Environmental Consequences, and addressed in the Chapter 9, the Safer Use Action Plan, as well as the EMMP in Annex A. The acute and long-term toxicological hazards of pyrethroids, chlorfenapyr, carbamates and OP-based pesticides are detailed in Annex E: Pesticide Profiles of the PMI IVM PEA.

Major hazards include exposure during handling (transporting or spraying), environmental release through vehicular accidents during transportation, and widespread airborne release of pesticide combustion byproducts in the event of a fire at the storage facility or in transport. Although the PMI BMP manual is the operative document, the *Pesticide Storage and Stock Control* by FAO provides detailed guidance on proper storage management practices, as well as remedial measures in case of spillage and incidents brought on by natural disasters including flooding. These guidelines therefore

provide a sound basis for minimizing the risk of human, animal, or environmental exposure. It is not incumbent on the PMI Ethiopia implementing partner to observe all recommendations from the FAO manual.

Exposure treatment for pyrethroids, chlorfenapyr, carbamates, and OP-based pesticides are detailed in Annexes C and D. Training for supervisors, spray team leaders, SOPs, washpersons, storeroom managers, and health officials include recognition of the symptoms of poisoning, incident response elevation protocol, and, for the medical professionals, the treatment protocols for each pesticide.

## 6.6 THE EFFECTIVENESS OF THE REQUESTED PESTICIDE FOR THE PROPOSED USE

Pesticides are selected for IRS based on efficacy in the intended use, and other extrinsic variables. Selection criteria have been expounded in Section 7.2 of this Pesticide Procedures section.

Once the program is established, it is necessary to monitor vector resistance prior to the initiation of spray activities, to ensure that acceptable kill levels will be achieved. A resistance monitoring program has been established and is operating, and the results from this ongoing program will be a primary determinant of the choice of pesticide and other supplementary actions.

Pesticide efficacy is also affected by vector behavior, insecticide quality, and the residual action of the pesticide. The probability of vector-pesticide contact depends on whether the targeted vector feeds indoors (endophagic) and rests indoors (endophilic), as this increases the likelihood of the vector resting on the sprayed wall. The efficacy of the pesticide to kill may be either compromised if the vector exits after feeding without resting on the wall, or absent if the vector feeds outdoors (exophagic) and rests outdoors (exophilic). Overall human landing catch collection results showed that vector biting was consistently lower indoors than outdoors, indicating a tendency of exophagic habits. This is characteristic of *Anopheles arabiensis*, which is the dominant vector in Ethiopia. To further elaborate on these findings, the data indicates that the vector has both options but it prefers biting people sitting outdoors than those sitting indoors. However, because people spend more time indoors during the mosquito's preferred biting time (night time), a mosquito more often has to go inside to bite, which means people can still be protected by IRS.

Knowledge of vector susceptibility is critical to planning and evaluating the effectiveness of the IRS program. It enables timely forward planning to: (i) manage the development of the resistance and (ii) evaluate new or alternative insecticides for possible future introduction should a change of pesticide be required. Resistance testing is done to: (i) establish a baseline susceptibility of the local vectors for future reference, (ii) monitor changes that occur as time progresses, (iii) identify the mechanisms of resistance and cross-resistance to inform the resistance management strategy that will be adopted, and (iv) evaluate the susceptibility of the local vectors to potential alternative insecticides, should there be a need to change pesticide. The operational criterion for vector resistance is having 20% or more survival rate in the number of mosquitos tested using standardized methods of the WHO.[6]

Vector resistance may differ in origin, intensity, type, and significance for vector/disease control in a given population. The evaluation of the significance of resistance to vector control should therefore consider the biochemical and genetic characteristics of the resistance, as well as the eco-epidemiology

[6] WHO (1998). *Test procedures for insecticide resistance monitoring in malaria vectors, bio-efficacy and persistence of insecticides on treated surfaces.* World Health Organization, Geneva, WHO/CDS/CPC/MAL/98.12

of the disease and operational characteristics.[7, 8] Resistance also tends to be highly focal (i.e., limited to a definite area). It is therefore important to ascertain the spatial distribution of the observed resistance to better inform the resistance management strategy to be employed and the geographical extent to which it will apply (e.g., what geographical area a possible change in pesticides for IRS will cover).

Irrespective of the pesticides used for IRS, national capacity is being strengthened to enable systematic evaluation of the mechanisms for resistance development and the gene frequencies among the local malaria vector populations. There is also a need to evaluate other pesticides and non-chemical alternatives to facilitate the evolution of a full-fledged IVM for malaria.

The residual efficacy of the pesticide being used for IRS is crucial to evaluating the implication of vector resistance. Generally, a positive correlation between observed vector resistance and a decline in pesticide efficacy is an important criterion in determining the need for a change of the pesticide in a local area. It is important that wall bioassays be carried out at specified intervals after the IRS operation in order to determine the period and level of residual activity in a given locality and the sprayed surface. The third major factor affecting the effectiveness of the pesticides is their quality (strength and other factors). If the active ingredient, for example, is not up to the recommended specification and concentration, it may lead to under-dosage of deposited pesticide, which then contributes to intervention failure. Storage of pesticide for too long a time, or in extremely hot warehouses can lead to breakdown of the active ingredient. Poor pesticide quality may present additional risks to the pesticide handlers and SOPs who may be exposed. For this reason, samples of the pesticide should be taken prior to use, and analyzed for the concentration of the active ingredient.

## 6.7 Compatibility of the Proposed Pesticide with Target and Non-Target Ecosystems

The WHOPES recommended pesticides are compatible with the target environment (walls, ceilings, eaves, etc.) in that they dry on these surfaces, and are not released to any great extent. The dried pesticide remains on the sprayed surfaces, and performs as designed, killing vector mosquitos that rest on those surfaces. In fact, there is a high potential for a positive impact on the target environment because of corollary reduction of other household pests.

The proposed pesticides are incompatible with the non-target ecosystems (humans, animals, and the environment), in that if they are released to the non-target environment in large quantities, they would have negative effects on humans, as well as land and water based flora and fauna.

The IRS implementation process is carefully designed to ensure that pesticides are deliberately and carefully applied via strict protocols to the interior surfaces of dwellings, and do not come in significant contact with humans, animals, or the environment. IRS implementation protocols minimize and responsibly manage IRS liquid wastes, through the next-day reuse of mixed but unused pesticides drained from operators' spray tanks at the end of the day, and the triple rinsing process. At the end of the spray season, contaminated solid wastes are incinerated in approved incinerators that comply with PMI specifications that destroy the pesticide and prevent environmental contamination. The EMMP in

[7] WHO (1986) Resistance of vectors and reservoirs of disease to pesticides: tenth report of the WHO Expert Committee on Vector Biology and Control. World Health Organization, Geneva.

[8] Brogdon, W.G. and McAllister, J.C. (1998). Insecticide Resistance and Vector Control *Emerging Infectious Diseases* 4(4): 605-613.

Annex A details the steps and measures that will be taken to prevent negative impacts on the non-target ecosystems.

## 6.8 The Conditions under Which the Pesticide Is To Be Used

Chapter 6: Affected Environment of this SEA discusses in detail the environmental background conditions that exist in Ethiopia relative to the implementation of IRS. Ethiopia in general and Oromia in particular exhibit the environmental conditions that promote malaria transmission. In Ethiopia, altitude and climate (rainfall and temperature) are the most important determinants of malaria transmission. There are four major eco-epidemiological strata of malaria in the country:

- Malaria free highland areas above 2,500 meter altitude,
- Highland fringe areas between 1,500 – 2,500 meter (which are affected by frequent epidemics),
- Lowland areas below 1,500 meters (with seasonal pattern of transmission) and,
- Stable malaria areas (characterized by all year round transmission)

In general, pyrethroids, chlorfenapyr, carbamates, and OPs have the potential to cause harm to bees, birds, fish, and other aquatic organisms. Due to the established toxicity of the WHO pesticides to bees, as well as the potential for contamination of edible honey, structures with attached or free-standing bee-hives within 30 m will not receive IRS. Prior to spraying, IEC and reconnaissance personnel will work to identify areas where bee-keeping or natural bee habitats are established, and explain to the households that bee-hives should be temporarily moved before spraying to a safe location at least 30 m from any habitation.

Oromia contains a rich network of rivers and water bodies, and established National Parks. The PMI IRS implementing partner will consult with the EPA regarding the application of pesticides near ecologically sensitive areas, such as wetlands, lakeshores, river edges, protected areas and National Parks, and follow their policies and guidelines. At a minimum, no IRS activities will take place within 30 meters of any sensitive sites.

The PMI IRS implementing partner will identify households within sensitive areas, and train sprayers to also identify houses that should not be sprayed. In addition to spraying precautions, pesticide storage areas may be curbed or bermed if necessary to contain any spills and provide an extra layer of protection down gradient of natural or developed resources.

Strict supervisory control will be established to prevent contamination of Ethiopia's economic resources, such as agricultural, aquacultural, horticultural, or apiary production, due to authorized or unauthorized outdoor spraying, or disposal of wastes.

## 6.9 The Availability and Effectiveness of Other Pesticides or Non-Chemical Control Methods

This IRS program has been limited to using those pesticides that WHO currently recommends, comprising fourteen compounds and formulations from four classes (WHO 2013) each with a specific dosage regime, duration of effectiveness, and safety rating.[9] A relatively new pesticide, chlorfenapyr, which is a pyrrole class, will also be considered for the IRS program, if and when it is recommended by

[9] Najera JA, Zaim M (2002). Malaria vector control – Decision-making criteria and procedures for judicious use of insecticides. WHO, Geneva, WHO/CDS/ WHOPES/2002.5. (Document available at: www.who.int/ctd/whopes/docs/JudiciousUseRev.pdf)

WHOPES. Of these, all but DDT have been evaluated for effectiveness within the program, and continued monitoring for resistance and susceptibility will be employed to allow up-to-date decisions prior to each spray campaign. The goal of this SEA is to broaden the options for pesticide use to combat periodic resistance development. Due primarily to monitoring that has confirmed vector resistance, DDT will not be considered for PMI-sponsored IRS at this time. Although monitoring has also shown resistance to pyrethroids, it will continue to be considered as an option for an IRS insecticide rotation program.

Non-chemical control methods include behavior modification and use of untreated bed nets. While the IEC program includes certain types of behavior modification to avoid or reduce the probability of beneficiaries contracting malaria, untreated nets are not used, in favor of treated nets. Luring and trapping of vector mosquitos remains a possibility, but in general, luring is accomplished by the use of some type of chemical, which may or may not have toxicity characteristics. The PMI IRS implementing partner will remain alert to the possibilities for other non-chemical control methods, and will continuously evaluate the utility and practicality of these methods.

## 6.10 Host Country's Ability to Regulate or Control the Distribution, Storage, Use, and Disposal of the Requested Pesticide

The MARD, Crop Protection Department is responsible for regulating the registration, importation and use of agricultural pesticides. Due to limited funding and staff, MARD has a limited capacity to enforce the pesticide regulations. Health pesticides used by FMOH are not required to be registered by the MARD, and therefore are often not officially registered for use in Ethiopia.

Ethiopia's Environmental Protection Agency is the principal authority for the management of environmental issues. The EPA sets national environmental policy and enforces environmental regulations at the federal level, while the Regional States administer environmental regulations and policies at the regional level.

The quality of the pesticide used can have a large impact on the effectiveness of the IRS undertaking. There is no scientific testing facility in country to provide pesticide quality control functions. Pesticides manufactured at the Adami Tulu plant are sent to a certified laboratory in Belgium for quality testing. Pesticides that PMI imports for use in IRS are tested prior to delivery at WHO certified laboratories in South Africa or Germany.

Ethiopia has significant capacity to produce pesticides, and unfortunately has done so with little regard to demand or to disposal issues. Regulation and control have been lacking. PMI is currently involved in a project to collect scattered DDT stores from around the country, and to centrally store them. This situation is evidence of the lack of management capacity and control, and it is suspected that pilferage is occurring at these unmonitored storage locations.

## 6.11 Provisions for Training of Users and Applicators

The effectiveness of the IRS program depends on the availability of adequately trained spraying personnel, well-maintained equipment, and competent supervision, as well as end-user acceptability and compliance. USAID has developed guidelines for IRS operations ("PMI IRS Best Management Practices", "Spray Operators Pocket Guide", etc.), and WHO provides a training manual for Indoor

Residual Spraying[10]. Although PMI-produced documentation has precedence over other guidance, information from other sources may be useful and may be followed if the recommendations do not conflict with PMI sources. Other resources include the *WHO-UNEP Manual on Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning,*[11] the 2012 PEA and this SEA, all of which provide precise precautions and recommendations on many aspects of IRS operations.

PMI will support the training of SOPs and supervisors, and provide overall guidance and logistical support to the IRS operations in Ethiopia. The PMI IRS implementing partner will continue to provide technical support for environmental compliance, with a medium-term goal of building national capacity to progressively transfer responsibilities. Preparations will include the following:

- A TOT program in which potential supervisors[12] and team leaders are trained on all aspects of IRS operation in collaboration with the FMOH, ORHB and the DHOs. Areas of training shall include planning of IRS, household preparations, record keeping, community mobilization, rational/judicious use of insecticides including sprayer and PPE cleaning, personnel management, environmental aspects of IRS – including geographical reconnaissance, and data recording and analysis.
- The identification of temporary workers recruited from local areas and trained as SOPs and wash persons. New operators will receive five to seven days of training prior to the spray operations. Priority areas of training will include:
    - How to properly mix the wettable powder or liquid pesticides, and filling of the sprayer. If liquid pesticides are used, the sprayers will be trained to triple-rinse containers during the filling of the sprayer.
    - Correct spraying (maintaining 35-55 psi pressure, spray nozzle at 45 cm from the sprayable surface, swath overlap, etc.).
    - The correct use of protective materials and related safety precautions.
    - Support to households on safety issues.
    - Personal safety relating to the different pesticides used for IRS (carbamate and OP-based pesticides, as well as the pyrethroids, which are currently in use).
    - Environmental safety in relation to pesticides, including management of the empty pesticide sachets.
    - The use of daily spray cards and data entry.

## 6.12 PROVISIONS MADE FOR MONITORING THE USE AND EFFECTIVENESS OF THE PESTICIDE

Two kinds of measurements are needed to provide a complete understanding of the effectiveness of pesticide that is being used for IRS. The immediate (output) level relates to the efficacy of the pesticide, that is, the degree to which the pesticide is able to kill the targeted mosquito vectors, and involves direct entomological evaluations on pesticide contact bioassays and related pesticide resistance methodologies as recommended by WHO.[13] The second broad level of measuring the effectiveness of the pesticides relates to the general goal of reducing the local disease burden. This will require

[10] WHO. 2002. Manual for Indoor Residual Spraying: Application of Residual Sprays for Vector Control (WHO/CDS/WHOPES/GCDPP/2000.3).
[11] WHO. 2007. *WHO-UNEP Manual on Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning: A Resource Tool*. World Health Organization, Geneva. 332 Pages. (Document also accessible at. www.who.int/ipcs/en/a )
[12] These are usually health-related government staff within the targeted district (health assistants/educators/ inspectors, nursing assistants, and community development assistants).
[13] WHO (1998). Test procedures for insecticide resistance monitoring in malaria vectors, bio-efficacy and persistence of insecticides on treated surfaces WHO/HQ, Geneva, World Health Organization, WHO/CDS/CPC/MAL/98.12

specialized entomological and epidemiological skills and the assessment of the impact of vector control operations, and possibly the assignment of the contributory impact of the IRS operations. This latter measurement is usually done through a combination of methodologies such as measuring the changes in parasite inoculation rates, passive case detection at health centers, and periodic community fever and parasite surveys (active case detection).

Another key characteristic of pesticide effectiveness is the longevity of the treatment. This characteristic has important economic and health implications: the program must adjust its spray schedule to make sure that there is active pesticide on the walls of homes during critical breeding periods. Unfortunately, the guidance that is provided with regard to effective period for each pesticide is very broad (e.g. 3-6 months), and the effective period is probably subject to complex environmental factors such as heat, humidity, and substrate (wall) composition.

The PMI IRS implementing partner manages a number of entomological monitoring activities in collaboration with the ORHB, the FMOH, and Jimma and Addis Ababa Universities. The major activities include efficacy and residual life of different insecticides on sprayed walls, monitoring vector behavior and density, insecticide susceptibility tests, and other relevant entomological studies. Cone/wall bioassay tests have been undertaken to assess the residual life of a number of potential alternative insecticides, which include long-lasting (CS) formulation of pirimiphos methyl, deltamethrin, and propoxur. PMI IRS implementing partner is conducting cone bioassay tests to determine the residual efficacy of carbamates (propoxur and bendiocarb) at different pH levels of spray water and types of wall surface. Overall human landing catch collection results showed that vector biting was consistently lower indoors than outdoors, indicating a tendency of exophagic habits.

# 7. POTENTIAL HEALTH AND ENVIRONMENTAL CONSEQUENCES

This section addresses the potential direct and indirect impacts of the IRS program in Ethiopia, and also discusses mitigation and monitoring measures. The EMMP, in Annex A, presents the best management practices and mitigation measures identified for the project, responsibilities for the implementation of the Plan, and monitoring and reporting measures. This EMMP is the guiding document for IRS management team in Ethiopia, and will be used as the tool for ensuring environment compliance for the program. The EMMP Annual Reporting Form and Certification will be completed and submitted to the COR/AOR as part of the annual end-of-spray report (EOSR).

The EMMP in Annex A presents a program by which the PMI IRS implementing partner, FMOH, ORHB and DHOs will assure initial and ongoing compliance with environmental requirements and guidelines. The plan also includes descriptions of activities proposed for mitigating environmental and social impacts, indicators, methods and frequency of monitoring, and identifies responsible parties for monitoring.

## 7.1 POTENTIAL POSITIVE EFFECTS OF THE IRS PROGRAM

**Direct Positive Effects**

The direct positive impacts of the IRS program are generally the reduction in child and adult malaria morbidity and mortality that will result in a reduction in human suffering. In addition, economic losses due to absenteeism or inability to work will be reduced. Other positive impacts include reduced incidence of miscarriages, low birth-weight, adverse effects on malaria-induced fetal neurodevelopment, and reduced incidence of malaria-related childhood and maternal anemia, complications, and organ failure. There is also the benefit of elimination of other household insects, as well as vermin in some cases.

**Indirect Positive Effects**

The IRS program will also indirectly contribute in the enhancement of the local economy in the following indirect ways: SOPs, washers, mobilizers, supervisors will all receive a daily payment for their work. There will also be human and institutional capacity building in the form of training of a large number of people in IRS operations. A reduction in household pests may result in a reduction in other diseases carried by the pests.

## 7.2 POTENTIAL ADVERSE IMPACTS

Adverse impacts of IRS project are those unintended effects of the project that can compromise the well-being of the environment and/or human health.

**Direct Potential Adverse Effects**

Pesticides such as etofenprox, fenitrothion, pirimiphos-methyl, propoxur and chlorfenapyr have a moderate to high risk for human and environmental impacts and should be used with caution and with strict best management practices.

***Contamination of surface watercourses and underground water***
During IRS implementation, it is possible to accidently release insecticides into water bodies during the transportation and storage of pesticides, application of insecticides to walls, and clean-up of IRS equipment and PPE. It is also possible to have a deliberate release that will affect surface or groundwater through washing in areas other than the soak pit, or improper disposal of leftover pesticide.

A spill into surface water bodies is a key concern in IRS because it could lead to contamination of water routinely used for domestic purposes. Fish and other aquatic organisms that are vital to a healthy ecosystem could also be wiped out.

Contamination of underground water resources is possible through improper disposal of leftover pesticide on the ground, especially if there is a high water table. However, the impacts of this risk are likely to be insignificant because pyrethroids, OPs and carbamates degrade very quickly when exposed to sunlight and in the soil. If wash areas and soak pits are properly constructed in well-chosen areas, and used properly, liquid pesticide waste will be captured in the charcoal layer of the soak pit and held until broken down by natural processes.

***Impacts to Birds, Fishes, and other organisms from pesticides***
The degree of toxicity of the four WHO recommended pesticide classes to birdlife, aquatic life and insects especially bees including the degree of persistence and bio-accumulation is well-documented and very important to remember. See Table 8 for details.

***Impacts on Bees***
Bee keeping is done at a household level and the sale of honey provides some income to the residents. Spraying in areas near beehives can lead to the death of the bees, which are vulnerable to all WHO-recommended pesticides. In addition, spraying near hives can lead to contamination of edible honey. These risks must be mitigated at all times. The project will make conscientious efforts to identify locations where beehives are kept, and observe a 30 meter no-spray buffer zone around them.

***Indirect Adverse Effects***
When the PMI IRS program is discontinued, USAID may leave remaining IRS equipment in the hands of the DHOs and with the communities (community based programs). IRS equipment left to district health officials may include backpack compression sprayers, unexpired unused chemicals, and used, clean boots that are still in operable condition.

In general, if PMI supports the procurement of insecticide or disposition of unused insecticide to the GOE, this activity is required to be mentioned in the annual Letter Report, in addition to this SEA. This requires annual environmental compliance monitoring by USAID and/or the USAID implementing partner, requires that USAID and/or the USAID implementing partner provide environmental training to the GOE in the PMI IRS BMPs, and language must be inserted into the government-to-government agreement that PMI must provide technical assistance for insecticide selection to ensure quality/appropriateness of the product.

If PMI supports the procurement, loan, or disposition of spray pumps or personal protective equipment to the GOE these activities must be mentioned in the annual Letter Report, in addition to this SEA. These activities do not require environmental compliance monitoring, however, USAID and/or the USAID implementing partner must provide environmental training in the PMI IRS BMPs.

These requirements relate to the use of non-DDT insecticides by the GOE. The action of leaving behind IRS equipment may temporarily, and in a minor way increase the total pesticide load on the environment.

**Summary of Toxicity of pesticides to Avifauna, Aquatic life, Mammals and Insects by Class**

***Pyrethroids (alpha-cypermethrin, bifenthrin, cyfluthrin, deltamethrin, etofenprox, lambda-cyhalothrin):***

- All pyrethroids are highly toxic to bees and highly toxic to fish and other aquatic organisms except Deltamethrin, which has low toxicity to other aquatic organisms[14]

- Birds, if exposed, are most affected by bifenthrin (low to medium toxicity). All other pyrethroids have very low toxicity to birds.

- In the pyrethroid class, only lambda cyhalothrin is highly toxic to mammals. Alpha-cypermethrin and etofenprox have very low toxicity to mammals while bifenthrin, cyfluthrin and deltamethrin have low to medium toxicity.

- In terms of persistency in the environment, only cyfluthrin is considered persistent. The rest of the pyrethroids have low to medium persistence.

Bifenthrin does not accumulate in the environment. Potential for bio-accumulation in aquatic organisms for deltamethrin and cyfluthrin is relatively low while lambda-cyhalothrin is medium and alpha-cypermethrin is high.

***Carbamates (bendiocarb and propoxur)***

- Carbamates are highly toxic to bees, and have the potential to cause cholinesterase depression in humans. Care must be taken to avoid skin contact with carbamates, especially by SOPs. All spray personnel should be trained to recognize the symptoms of cholinesterase depression, and know the protocol for obtaining medical assistance.

- In addition to other aquatic organisms propoxur is also highly toxic to mammals and birds. Acute symptoms of propoxur poisoning in birds include eye tearing, salivation, muscle incoordination, diarrhea, and trembling. Depending on the type of bird, poisoning signs can appear within 5 minutes of exposure, with deaths occurring between 5 and 45 minutes, or overnight. On the other hand this insecticide has very low toxic properties on fish.

- Bendiocarb has low to medium toxicity on mammals and birds.

- In general both carbamates have low to medium indications for persistency in the environment and bioaccumulation in organisms

***OPs (malathion, fenitrothion, pirimiphos-methyl)***

- OPs have different characteristics and impacts on different organisms depending on the type of

[14] USAID's IVM PEA

insecticide. However, all three WHO-recommended OPs have the potential to cause cholinesterase depression in humans and other organisms, and *skin contact with these pesticides must be strictly avoided, especially by spray personnel*. All spray personnel should be trained to recognize the symptoms of cholinesterase depression, and know the protocol for obtaining medical assistance.

- Fenitrothion has low toxicity on mammals and fish and is not persistent in the environment. However it is highly toxic to bees, birds and other aquatic organisms, like crustaceans and aquatic insects and has a medium toxicity to aquatic worms. It has moderate to medium potential to bioaccumulate in organisms.

- Malathion is only highly toxic to bees. It has very low impacts on fish and other aquatic organisms, and has a very low potential to bioaccumulate in organisms or persist in the environment. Its toxicity on mammals and birds is low to medium.

- Pirimiphos-methyl is highly toxic to fish and other aquatic organisms and has a high potential to persist in the environment. It has low to medium toxic effects on mammals and bees. It does not bioaccumulate in organisms.

**Pyrrole (Chlorfenapyr)**

- Chlorfenapyr has a high to very high acute toxicity to birds. It also poses an acute poisoning hazard to aquatic organisms, and is very toxic to honeybees. Chlorfenapyr has low volatility and water solubility; is lipophilic; binds strongly to soil particles; and degrades slowly in soil (avg. half-life of 1 yr.), sediment (avg. half-life of 1.1 yr.), and water (avg. half- life of 0.8 yr.). Chlorfenapyr is rapidly metabolized and excreted by mammals, birds, and fish; hence, unlikely to bioaccumulate in individual organisms or biomagnify between trophic levels.

## 7.3 HUMAN EXPOSURE RISKS/IMPACTS

Exposure risks of all WHO recommended pesticides in relation to cancer and non-cancer endpoints, and with respect to exposure dosage, Hazard Quotient and the Life Time Average Daily Dose are presented in PEA 2012. The exposure risk for cancer and non-cancer endpoints is presented at different stages of the pesticide application including mixing, spraying, post spraying, dermal risk, etc.

**Inhalation exposure and risk during mixing**

- Of the proposed pesticides, only etofenprox (pyrethroid) propoxur (carbamate) have carcinogenic properties once threshold levels are exceeded.

**Dermal exposure and risk during mixing**

- From the WHOPES recommended list of insecticides to be used in IRS only etofenprox (pyrethroid) and propoxur (carbamate)) has been determined to be carcinogenic at dermal exposure levels of 8E-07 mg/kg-day for etofenprox and 4E-06 mg/kg-day for propoxur.

**Inhalation exposure and risk during spraying**

- Of the proposed pesticides, only etofenprox (pyrethroid) and propoxur (carbamate) have carcinogenic properties once threshold levels are exceeded.

**Dermal exposure and risk during spraying**

- Of the proposed pesticides, fenitrothion and pirimiphos-methyl have non-cancer risks due to dermal exposure.

**Fetal Exposure (Pregnancy Testing)**

- All female candidates for jobs which may involve pesticide or pesticide-contaminated waste will be tested for pregnancy before being recruited and every thirty days thereafter until operations end. Females found to be pregnant will be re-assigned to positions that do not have the potential for exposure to insecticides. Women who are breastfeeding cannot have any contact with pesticides, and are thus prohibited from spraying of pesticide, touching or moving pesticide stock, or washing contaminated items.

**Resident dermal exposure and ingestion risk after spraying**

- The only concerns are to adults when using cyfluthrin and etofenprox (pyrethroids) and propoxur (carbamate). The risk is however very low.

**Resident exposure and risk due to chronic ingestion after spraying**

- There are four insecticides with potential impact due to chronic ingestion by drinking insecticide-contaminated water. These are cyfluthrin, permethrin and etofenprox (pyrethroids) and propoxur (carbamate). Best management practices are recommended.

**Resident dermal exposure and risk due to bathing using contaminated groundwater**

- Cyfluthrin and etofenprox (pyrethroids) have potential impact for dermal exposure using contaminated groundwater. When best management practices are applied in IRS, this risk is significantly reduced.

**Resident exposure and risk due to reuse of pesticide containers**

- Only deltamethrin is registered to have potential for acute ingestion from using pesticide containers. However, residents will have no access to pesticide containers used in IRS. The pesticide containers are only available in IRS storage facilities which are securely double locked and must be disposed by incineration at high temperature.

**Worker exposure and risk due to inhalation during spillage**

- According to information presented in the PEA, etofenprox and propoxur have potential to impact workers through inhalation during spillage. The workers are trained on how to handle spillage and must be equipped with appropriate PPE.

**Worker and Resident Exposure Pathway**

During the IRS spraying process, spray personnel are at risk of un-intentional or deliberate exposure through accidents or poor and improper handling of the spray chemical. Worker exposure to the chemical could arise during the pre-spraying, spraying and post-spraying phase of the IRS operations. Beneficiaries can also be exposed during each of these phases, and additionally over the life of the pesticide on the wall.

a. Pre Spraying Exposure Pathway

   Preparing pesticide solutions during the IRS requires pouring the pesticide in the spray pump to ensure ample mix with the water. The process of mixing the pesticide can lead to exposures via inhalation, dermal contact, and incidental ingestion, mostly from releases of pesticide vapours, and solutions. Vapour releases can occur when liquid concentrated emulsions are diluted. Workers or residents can inhale the vapours or the particulates or be exposed through dermal contact. Spills

could also pose significant risk, especially for children who ingest the resulting residues that are left on surfaces such as food, floors, soil, as well as absorbing additional doses from eating plants and animals contaminated during the preparation for spraying.

b. Exposure during Spraying

Inhalation of aerosol vapours during spraying is the main process for worker exposure during IRS, however, dermal exposure through spills or absorption onto cotton overalls is also a significant risk. Especially in the case of OPs, the dermal hazard is significant, and can cause cholinesterase depression. Residents are mainly exposed through dermal contact with sprayed surfaces and incidental ingestion of insecticide after their houses have been sprayed, especially when food or drink are left in the house during spraying. Leaky equipment can also lead to insecticide exposure through dermal contact with the floors and incidental ingestion by children who may come in contact with the spills before they are cleaned up.

c. Exposure during Disposal (Including Progressive Rinsing)

Disposal is a key issue with IRS intervention that utilizes pesticides especially during the decontamination process and disposal of the liquid effluent that will arise from washing and progressive rinse. Both burying and dumping can lead to dermal exposure to residents who come in contact with the soil or water in which the pesticide was disposed. Ingestion exposure can occur from drinking contaminated surface water. Once the excess formulation gets into the soil, the pesticide can reach the groundwater, which may be used as a water supply via household wells. Residents may then be exposed to this contaminated water by ingestion or by dermal contact when it is used for cleaning or drinking purposes.

d. Occupant long-term exposure from residue

Residents of sprayed structures, especially crawling babies and children, will have a finite exposure risk due to physical contact with sprayed surfaces, as well as small amounts released from substrate walls, ceilings, and eaves, due to physical surface breakdown.

## 7.4 CUMULATIVE IMPACTS

The combined, incremental effects of human activity, referred to as cumulative impacts, pose a serious threat to the environment. Cumulative impacts develop over time, from one or more sources, and can result in the degradation of important resources.

The critical resources or ecosystems that can be affected by the IRS program over a period of time especially with regards to pesticide application include water supply, food supply, waste assimilation/disposal capacity, river, lake, and stream quality, agriculture, aquaculture, apiculture, human and animal health, biodiversity resources, environmental services, and others. Pesticide run-off and accumulation in the rivers, streams and other water bodies, can lead to the progressive contamination of the water resources and reduction of aquatic biodiversity. However, implementing the EMMPs provided in this SEA reduces the likelihood of releases, and the chances of a series of releases within the pesticides half-life are extremely unlikely, except in the case of willful malfeasance.

Continuous human exposure to pesticides over time can lead to health risks or complications, especially among SOPs and others in close contact with pesticides. This is particularly true in the case of OPs. However, the risk assessment performed in the PEA indicates minimal exposure with the use of proper technique and appropriate PPE, i.e. dust masks, helmet, face shield, gloves, overalls and boots that minimize exposure by dermal absorption or inhalation, and a great reduction in the potential for harm.

The sprayed pesticides solidify on the walls, ceilings, and eaves of the structures, and become largely immobile and significantly less harmful. Exposure to the occupants will be further reduced by the procedures and safety measures described in the EMMP.

Pyrethroids, OPs and carbamates degrade very quickly when exposed to light and to the external environment, thus the cumulative and residual adverse impacts of their use will be insignificant. The soak pits used for waste disposal are designed to break down influent pesticides wastes within about three months, while the pesticides are held by the charcoal used in pit construction.

The long-term use of any pesticide could lead to insecticide resistance. To minimize this cumulative impact, insecticide resistance is actively monitored. The proposed action is designed with the concept of vector monitoring, insecticide rotation and mosaicking which will reduce the future incidence of vector resistance.

## 7.5 CONCLUSION

OPs have the disadvantage of higher human health risk and higher cost, and some of them may require urine or blood biomonitoring. Chlorfenapyr is somewhat unknown and should be tested in hut trials before being included in an IRS program. Pyrethroids are the most cost effective and are considered less detrimental to human health and the environment, however, entomological studies show mosquito resistance, and therefore the government has decided to not use it in the current IRS program. It is important to note that all the insecticide classes, when used with all the compliance and mitigation measures, have acceptable risk to human health and the environment and therefore are considered part of the proposed action.

# 8. SAFER USE ACTION PLAN

## 8.1 IMPLEMENTATION CONDITIONS

During implementation, USAID/PMI/Ethiopia and its PMI IRS implementing partners will adhere to the conditions detailed in this SEA, which are summarized below, and in more detail in the Environmental Monitoring and Mitigation Plan (EMMP), Annex A of this report.

### 8.1.1 IMPLEMENTING PARTNER REQUIREMENTS

1. The prime contractor for the project ("the contractor", or "the PMI IRS implementing partner") or its designee will develop this SEA that specifies the conditions under which IRS may be implemented.
2. The PMI IRS implementing partner will follow the prescriptions of the EMMP contained herein, including monitoring and reporting to assure appropriate implementation and the sufficiency of environmental compliance measures.
3. The PMI IRS implementing partner shall integrate these environmental compliance measures into the project work plan and report on them in the normal basis of project reporting, including the EMMR Annual Reporting Form, which will be included in the end-of-spray report (EOSR). The PMI IRS team shall assure that this integration occurs.
4. The PMI IRS implementing partner will ensure that training is provided to all IRS staff and workers as prescribed by the EMMP and USAID's Automated Directives System (ADS) 204.5.4.
5. The PMI IRS implementing partner will notify PMI of any work plan activities outside the scope of the SEA, and the PMI unit will independently audit the work plan against the requirements of the SEA.
6. Any activities not addressed within the SEA must be addressed with an SEA amendment that must be approved by the Global Health and Africa Bureau Environmental Officers (BEO) before the activities in question can go forward.
7. PMI IRS team shall ensure that the PMI IRS implementing partner responsibilities with respect to environmental mitigation and monitoring will be incorporated into contracts, grants or any other sub-agreement and scopes of work.
8. For projects currently in implementation, PMI/Ethiopia, with the assistance of the Mission Environmental Officer (MEO) and/or the Regional Environmental Advisor (REA) as necessary, will discuss SEA conditions with the contractor; and where necessary, come to appropriate agreement regarding the process for implementing these conditions as a mid-project adjustment.
9. As devising and implementing environmental compliance approaches should be an integral part of work plan development, these procedures place this responsibility principally on prime contractors. PMI IRS team's primary role is thus to review and monitor, as with the execution of any other part of the work plan. Where such review and monitoring indicates unforeseen environmental impacts or that mitigation and control measures are insufficient, the PMI IRS unit will consult promptly with the REA, to revise and adapt the environmental mitigation measures as necessary.

### 8.1.2 POLICY, PLANNING AND INSTITUTIONAL REQUIREMENTS

- Prohibit IRS in sensitive ecosystems (i.e. within 30 meters of flood zones, wetlands, National Parks, National Reserves, rivers, dams, lakes, fish farms, beekeeping areas, etc.); IRS uses insecticides that could negatively impact such sites. In line with the established best practices for IRS, and relevant national and USAID policies, the PMI IRS implementing partner will establish and implement mitigation measures to assure adequate protection of these sensitive ecosystems.

- Develop and implement a vector resistance management plan. Appropriate measures will be undertaken to prevent/manage resistance and to ensure the continued effectiveness of insecticides used for IRS.

- Promote inter-sectoral collaboration frameworks and institutional arrangements to facilitate a comprehensive approach to vector control and associated pesticides management. Coordination between the Ministry of Health and major stakeholders will be strengthened. This will include collaboration with:

    - Federal Ministry of Health (FMOH) National Malaria Control Program (NMCP) is responsible for activities pertaining to the protection and improvement of public health and social welfare. NMCP and Regional Health Department have the mandate to plan, implement and coordinate malaria control activities in Ethiopia. The District Health Teams deal with all diseases including malaria at the district level.

    - The Ethiopian Ministry of Environment and Forest is the principle authority for implementing the Framework Environmental Act which provides a legal framework for the use and correct management of the environment and its components and to assure the sustainable development of Ethiopia.

    - Ministry of Agriculture and Rural Development (MARD), who is responsible for regulating the importation and use of pesticides. It issues permits for the importation of pesticides and implements international conventions governing such pesticides. The use of public health insecticides by the Ministry of Health are generally not regulated by MARD.

### 8.1.3 OPERATIONAL REQUIREMENTS

PMI and the PMI IRS implementing partner will work with FMOH and FMOEF to access relevant country level authorization and support needed for successful IRS implementation. The PMI IRS implementing partner will work closely with DMCP to coordinate and implement the IRS program at the field level. PMI will work with all government partners in the following areas:

- Quality assurance for commodity procurement and IRS operations, to minimize risks to human health and the environment. This will include ensuring legitimate procurement sources, verifiable chain of custody of commodities, and representative sampling and analysis of pesticide, as well as effective quality compliance inspections of IRS activities in the field.

- Ensure compliance with national regulations on pesticides and this SEA for registering, importing, transporting, labeling, handling, use, storage, and disposal of pesticides. If there is a conflict, this SEA's EMMP normally has precedence, as it is based on the USAID PMI IRS BMP

that was prepared specifically for PMI IRS programs and includes international regulations. USAID compliance requirements are usually stricter than country requirements; however, if country requirements are stricter, they must take precedence.

- Train relevant categories of workers involved in IRS operations (e.g. district program managers/coordinators, team leaders, SOPs, porters, storekeepers, pesticide transporters/drivers, washpersons, and guards) on best practices in accordance with national pesticides regulations and this SEA (which includes recommendations/guidelines of World Health Organization (WHO). Criteria for reprimanding or punishing non-observance of best practices by these workers will be established.

- Ensure use of appropriate PPE and best practices, including effective field supervision of spray operations, for adequate protection of SOPs and other handlers of pesticides or pesticide-contaminated waste.

- Train health workers in the management of insecticide poisoning. This will include pesticide-specific guidelines on poison treatment; designation of district hospitals or health centers within the target areas for appropriate treatment of insecticide poisoning; training of IRS workers to recognize early danger signs of poisoning and taking appropriate action.

- Enforce protection of fetuses and suckling children against exposure in spray operations. Exclude pregnant women and breast-feeding mothers from direct handling of pesticides (e.g. sprayers or washers). Before each spray season, and every thirty days thereafter during operations, pregnancy testing will be established for potential female handlers of pesticides.

- Work with health extension workers to carry out Information, Education, and Communication (IEC) activities for targeted communities and households to reduce exposure. Provide information on the timing of spraying in their village, removal of food, cooking and water utensils, covering of unmovable furniture with impermeable plastic prior to spraying; exclusion of spraying homes inhabited by pregnant women or sick individuals who are unable to leave the structure to be sprayed; preventing the reentry of sprayed rooms for at least two hours after spraying; sweeping of floor residues before reentry of children or animals and disposal cleaning wastes including dead insects in pits or latrines.

- Establish strict practices to reduce environmental contamination from pesticides used in this program. This will include comprehensive pesticide chain of custody, auditing of pesticide stocks and pesticide usage, as well as enforcing best practices related to the handling, washing and disposal of containers; progressive use of waste/wash water and ablution blocks, and training on proper maintenance of spray pumps to prevent leakages.

- Establish best practice for the transport of SOPs. This includes providing trucks with benches for transport of SOPs, and ensuring that insecticides are not transported in the same compartment as SOPs. Contract specific insurance for covering SOPs during spray operation. Strengthen training of drivers to limit risk of traffic accidents.

- Provide IRS Training of Trainers (TOT) and training of SOPs on potential negative impacts of environmental contamination and the appropriate PMI IRS BMPs to avoid or minimize these impacts.

- Provide training support, as necessary, to strengthen the supervisory capacity of malaria actors at different level

#### 8.1.3.1 SUPERVISORY STRUCTURE

IRS supervision and monitoring in project districts of Ethiopia is strict and requires the completion of Environmental Checklist before project technical staff will be deployed to each spray zone (each zone includes 5-7 districts). The Chief of Party (COP) oversees all activities and conducts planned and unannounced site inspections. Also, government health structures at regional and federal level will conduct supervisory visits during the spray activities. The zonal malaria focal persons will continuously supervise spray operations from start to finish. The standard checklist and timeline prepared by the project specifies the proper best management practices and provides guidance for the district health office heads, malaria focal persons, team leaders, IEC coordinators and Environmental Compliance focal persons to supervise all activities during spray operations.

The districts are divided into geographical bases to facilitate operation and implementation. Base teams develop their operational plans with support from the district coordinators and Health Supervisors. Each team designates a team leader, four squad leaders, 16 SOPs, four porters and one driver. The teams meet at the beginning and end of each day to discuss operations and share challenges experienced in the field.

The District Malaria Focal Person (DMFP) ensures the quality of the spray operations and administrative duties. He/she also works in collaboration with the Health Supervisor to manage the planning and coordination of IRS activities. The DMFP supervises all logistical operations such as store keeping and transportation. And he/she ensures all risk preventions and environmental compliance measures are fully implemented. An operational spray plan (progress calendar), produced during the micro-planning and validated by the health team at the district level, indicating all communities to be sprayed during the spray operations will be maintained by the DMFP. The District malaria focal persons will compile daily spray progress and plot on the daily performance sheet and transfer the weekly status to the higher level.

The supervisors of different levels evaluate the work of the spray teams and IEC activities in the field. He/she also inspects structures that have been sprayed to check quality of spraying and that proper protocols have been fully followed. They will monitor the effectiveness on beneficiary populations of IEC campaigns by visiting sprayed houses to discuss beneficiary impressions, and visiting unsprayed houses to discuss with heads of families why spraying is important. Regarding spray technique and SOP discipline, monitoring will involve visiting the sprayed compounds and interviewing beneficiaries to ensure that SOPs respect household members, spray all eligible rooms, record the essential data in the relevant form, mix and apply insecticides at the right dosage, and pass the relevant health information to the household. Base Supervisors will provide oversight to ensure the goal of day-to-day achievement of environmental compliance. At the end of each day, team leaders at each operational site will meet with the District Malaria Focal Person to discuss the day's events, challenges faced, and recommendations for resolving problems.

The Team Leaders oversees SOPs to ensure spraying occurs according to best practices. They will also ensure sprayer equipment and PPE are properly cleaned daily, as well as review data collection for accuracy. They are also responsible for tracking insecticide sachets.

The Environmental Compliance Officer will visit each base during the spray operations and complete

the Environmental Compliance Checklists. The Environmental Compliance Checklists are simplified versions of those found in the PMI IRS BMP Manual for use in the field. The checklists ensure that all best management practices are being implemented and are effective, or that immediate action is taken to correct non-compliances. The use of the smartphone installed checklist to supervise activities will be continuing with better simplicity and better performance.

The PMI IRS implementing partner will maintain records of program performance reports which will be able to demonstrate adherence to PMI IRS BMP, quality of training and supervision, procurement activities, and environmental compliance. Such reports include the pre- and mid-spray environmental compliance report (checklist), reports on core IRS indicators and end-of-spray evaluation reports.

Good supervision will also require observing each spray team during implementation to ensure best practices for insecticide storage and solid waste management. Since the reports of the operators are the basis for all reporting and data collection, supervisors will ensure that they are completed accurately and promptly at the end of the spraying day.

#### 8.1.3.2 Insecticide Selection

The insecticide selection and the timing of the spray cycle are dictated by FMOH and are based on the results of annual entomological studies. The insecticide for the project areas will be procured by the PMI IRS implementing partner in collaboration with its headquarters.

#### 8.1.3.3 Quantification of Pesticide Requirements

The PMI IRS implementing partner will conduct logistics assessment for planning and procurement of materials (insecticides, pumps, PPE, etc.) for all districts that receive full project support and also partially supported graduated districts.

#### 8.1.3.4 Pesticide Quality Assurance

The procurement and use of pesticides that do not meet the necessary quality assurance standards can compromise the overall spray quality and desired vector action while at the same time could expose the residents and SOPs to hazards related to altered toxicological characteristics. All pesticides procured by PMI will be tested prior to shipment for the concentration of the active ingredient and other characteristics.

#### 8.1.3.5 Qualification of Warehouses (Storage Facilities)

During the logistics assessments, the need for rehabilitation of principal warehouses at district level to meet PMI IRS BMP requirements for pesticide storage will be assessed. Existing storage facilities that meet PMI IRS BMP requirements will be re-evaluated between spray campaigns.

The procured pesticides are categorized as hazardous and toxic and can potentially cause adverse impacts to human health, animals, and the natural environment if not properly stored according to the PMI IRS BMP manual (2015)). Before insecticides are procured or transported to the spray areas, suitable warehouse(s) must be assessed to ensure that they meet EMMP standards in this SEA. The standards include among others:

- Spacious enough to store insecticides in bulk and to store other materials separately
- Located as far as feasible from; flood plains, wetlands, markets, schools and residential areas
- Well ventilated and allowing for air circulation

- Built of concrete or other solid material
- Adequate roofing that is not susceptible to leaks
- Adequately secured with double-locked doors and barred windows
- At least 2 exits for emergency purposes
- Fire extinguisher

During the logistical needs assessment, the PMI IRS implementing partner will identify appropriate warehouses at the districts level that meet the above-mentioned requirements. PMI cannot provide funds for the construction of new buildings, but can assist in the modification or renovation of existing facilities.

All facilities used for storage, distribution, and transportation of insecticide products should comply with relevant requirements of the Ethiopia MARD Pesticide Regulation, and any other relevant Ethiopia standards on pesticides use and management. To that end, the following section and the EMMP describe the program requirements for storage, distribution, and transportation.

#### 8.1.3.6 Qualification of Liquid Waste Disposal Facilities (Wash areas and Soak Pits)

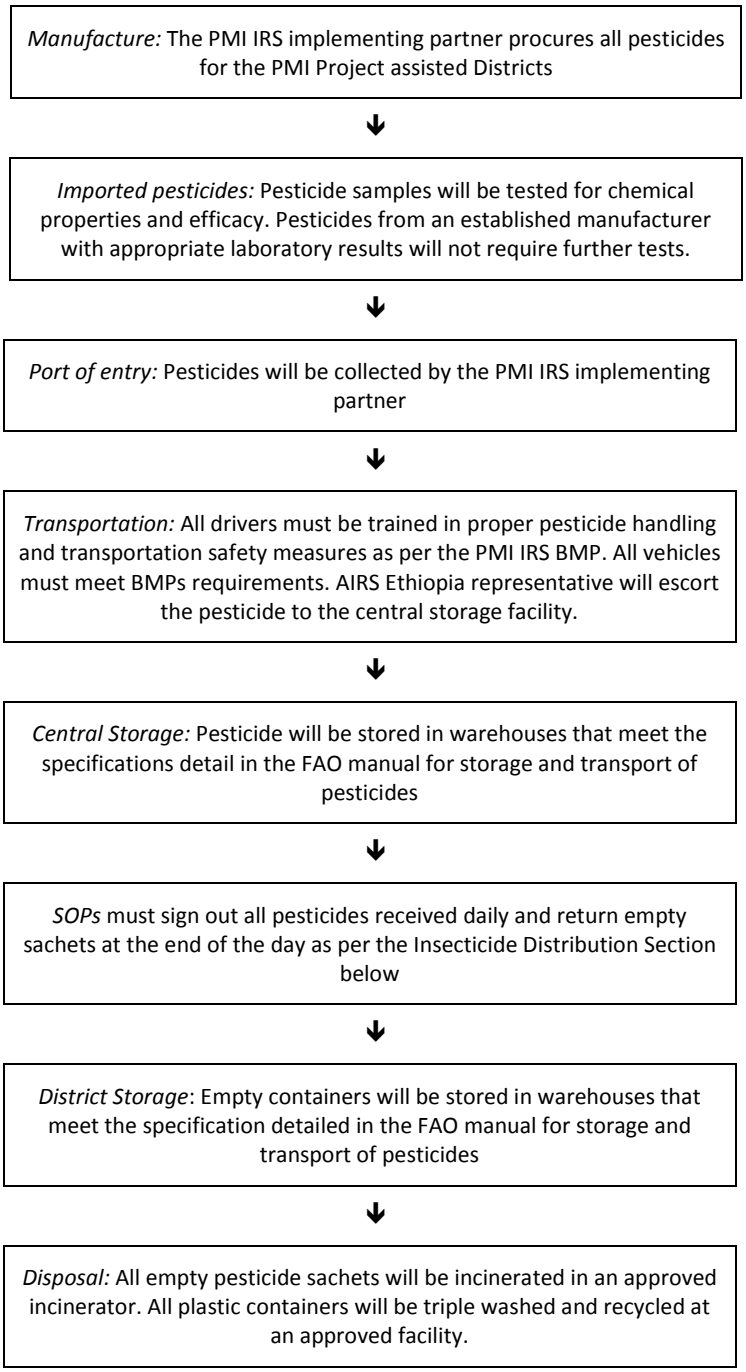
Site considerations for locating IRS cleaning and waste facilities (progressive rinse, soak pits, tanks, and wash areas) include soil type, topography, vertical distance to ground water, and proximity to schools, lakes, streams, and other sensitive areas. Ideally, disposal facilities should be located adjacent to the storage facilities, where they can be more easily protected and monitored. However, the setting or the function of buildings provided for storage do not always lend themselves to siting a wash area, so it may need to be placed some distance away. Due to access limitations and distance of some spray sites, it may be more feasible to locate a small facility in an appropriate area near the spray site.

- Soak pits must be located at least 30 meters from any sensitive areas such as water supplies, habitat, schools, etc. They should be located on relatively high ground to increase the vertical distance to groundwater. The general area should be level, but the wash area must slope gently toward the soak pit or toward the collection point that is piped to the soak pit.
- Soil characteristics affect how pesticides move through the soil, and how they break down by environmental or micro-biological degradation. Clay soils have a high capacity to absorb many pesticides, while sandy soils have a much lower capacity to absorb. Where possible, locate facilities on fine textured soils with good absorptive properties. Hard packed clay or rocky soils are not appropriate.
- Pesticides may move in water runoff as compounds dissolve in water or attach to soil particles. Facilities should be located on high, level ground to minimize exposure to runoff. Avoid steep slopes or natural runoff flow lines. Where feasible, construct curbs or berms to divert runoff away from the soak pit, and to contain any spills. In very rainy areas or seasons, it may be necessary to cover the soak pit and wash area when not in use with a tarpaulin, to prevent flooding of the soak pit and subsequent runoff of pesticide-contaminated water.

#### 8.1.3.7 Supply Chain and Disposal Options

The PMI IRS implementing partner will work with the relevant authorities and will employ the pesticide chain management as shown in Figure 7, in its Ethiopia IRS programs to ensure control. The chain of custody procedures are based on PMI IRS BMPs (and as previously mentioned, these BMPs include WHO, FAO and other international guidelines).

**Figure 5: Pesticide Chain of Custody and Management**




#### 8.1.3.8 PERSONAL PROTECTIVE EQUIPMENT

In accordance with PMI IRS BMP, all persons working on IRS must be adequately protected against potential harm due to exposure from pesticides. All persons with potential direct contact or exposure to pesticides during handling, transportation, storage, use and cleaning of pesticides or pesticide contaminated materials must wear appropriate personal protective clothing in accordance with the safety instructions on the pesticide label or material safety data sheet (MSDS).

Each team leader, SOP, and washer for both the district based and community based implementation models will be provided with the following safety equipment to be used during the spraying, in accordance with the PMI IRS BMPs specifications:

- Broad-brimmed hat/helmet
- Face shield or goggles (face shield preferable)
- Dust mask or filtered mask
- Two or more cotton overalls per SOP (appropriately sized)
- Nitrile rubber, neoprene, or butyl rubber gloves, without inside lining, and long enough to cover the forearm
- Rubber boots
- Cloth to protect the neck.
- Flashlights

For SOPs, safety precautions will depend on the proper use of PPE, and personal hygiene, including washing and daily changing of spray clothes. A schedule for carrying out and supervising personal hygiene, regular washing of protective clothes and cleaning of equipment will be organized along the following lines:

- Spraying staff will be provided with at least two uniforms to allow for frequent changes.
- Washing facilities with sufficient water and soap will be made available in the field at appropriate locations.
- All working clothes must be removed at the end of each day's operations and a shower or bath taken in circumstances where a full-body shower or bath is not feasible, face/neck and hands must be washed with soap and water.
- Working clothes will be washed daily by the wash-person hired by the project.
- Particular attention will be paid to washing gloves, helmets, face-shields, and boots, and to avoiding contamination of the inside of these items.
- SOPs will wash before eating, drinking or smoking at the end of the daily spray operation.
- Eating, drinking and smoking during work will be strictly forbidden at all times during operations. If SOPs need to drink water in the course of the operation, they must receive assistance from the homeowner, such that they do not need to handle water containers with gloves or other PPE that has been exposed to pesticides during spray or mixing activities. Because in the field there are no proper disposal facilities for water contaminated by washing gloves and hands, it is recommended that homeowners assist the operator if hydration is needed.

#### 8.1.3.9 PESTICIDE TRANSPORT

After the procurement of the insecticides for use during the current IRS campaign, insecticides will be transported to the district warehouses by road. During transportation, there is a risk of vehicle accidents and consequently insecticide spillage. The transport must comply with environment management regulation, statutory instrument 12 of 2007 section 14, regarding hazardous substances, pesticides and other toxic substances and the guidelines of NEMA on transport of pesticides.

Prior to long-distance transport of the insecticide from the customs warehouse/central storage facility of the supplier, drivers will be informed about general issues surrounding the insecticide and how to handle emergency situations (e.g. road accidents). Training for long-distance transport will include the following information:

- Purpose of the insecticide.
- Toxicity of the insecticide.
- Security issues, including implications of the insecticide getting into the public.
- Hazardous places along the routes to be taken, and mitigation measures.
- Steps to take in case of an accident or emergency (according to FAO standards).
- Combustibility and toxicity of the combustion byproducts of insecticide

Drivers hired specifically for the spray campaign period will receive:

- Training in operator transportation best practices and vehicle requirements from PMI IRS BMP #2, Worker and Resident Health and Safety.
- Training provided to SOPs (with the exception of sprayer operation and spray practice).
- Handling an accident or emergency (according to FAO standards).
- Handling vehicle contamination.

The vehicles to transport insecticides must be in good condition and preferably a lockable box truck. If the pesticides are to be left unattended for any period of time, including lunch breaks or overnight stops, a lockable box truck is essential. Figure 8 in the previous section on Emergency Response provides a list of key responses to mitigate the impact of the insecticide spills.

Because vehicles used for insecticides transportation can be used for the transport of other goods, including food, it is important to ensure that vehicles are decontaminated. The drivers will be responsible for cleaning and decontaminating the interior of the vehicle and exterior bed at the end of the spray campaign. Drivers will be provided with gloves, overalls, and rubber boots to wear for cleaning the vehicle. All cloths used in wiping down the interior and bed of the vehicle will be washed with soap.

**igure 6: Emergency Response to Insecticide Spills**

1. Control, contain and clean up the spill
2. Protective clothing should be donned prior to attempting to clean the spills.
3. It is imperative to avoid fire as a result of the accident and a fire extinguisher should be deployed just in case. The engine should be shut off and smoking in the area strictly prohibited.
4. Onlookers and bystanders should be cautioned against approaching the accident site.
5. If the crew has come in contact with the pesticides, they should remove contaminated clothing immediately and wash the pesticide off their skin.
6. For major spills send for help immediately; drivers should have cell phones and an emergency number for use in such cases.
7. People should be kept away and the spill covered with earth, sand, etc.; no attempt should be made to wash away the spill with water or other substances.
8. Vehicles that are used for transporting large quantities of pesticides should be equipped with a bucket of sand, sawdust or soil, a shovel, and fire extinguisher.

#### 8.1.3.10 HEALTH AND SAFETY IN THE WAREHOUSE

The following measures are required in all warehouses in order to reduce cases of pilferage, exposure through leakages and theft, and to ensure the health and safety of those accessing these facilities:

- Guarded 24 hrs. /day.
- Warehouse must be double-padlocked.
- All the storage facilities must have thermometers installed for temperature recording.
- Soap and clean water for washing must be available at all times.
- Trained storekeepers must be present and wear appropriate PPE when in the pesticide area of storage.
- Pallets are available for proper storage of insecticides.
- Pesticide stacking position and height in the warehouses must not be above 2 meters in height.
- Fire extinguishers must be available in the storage facilities and all workers trained on how to use them.
- Hazard warning notices must be placed in the outside of the store in pictorial form (skull and crossbones).
- First-aid kits must be available in all the central warehouses and secondary stores.

#### 8.1.3.11 INSECTICIDE DISTRIBUTION AND MANAGEMENT PROCESS AT DISTRICT AND COMMUNITY LEVELS

PMI Ethiopia uses, standard requisition, tracking, and monitoring forms to be used for inventory, and record and track all the insecticides distributed and returned. These forms will be used in the program at all levels, and the store managers will receive training on how to use these forms. The steps below highlight the insecticide distribution process proposed including recording and tracking methods:

- Upon reception of the pesticide at the central warehouse (the import company is responsible to deliver the pesticide to a determined location) lot numbers and quantities of insecticide are registered on shelf inventory card by the PMI AIRS- Ethiopia storekeeper. All copies are kept at the warehouse.
- District requisitions are approved at the PMI AIRS- Ethiopia program office, where copies are maintained.
- Requisition then proceeds to district warehouses where distribution takes place. All pesticide inventories are signed for based on sachet numbers. Insecticides are distributed on a “first-in, first-out” system, so the insecticide that arrived first is distributed first. This avoids accumulation of expired stock.
- All sachets are counted and stamped with the relevant stamp and registered on a stock card. Boxes are then resealed with the correct original quantity of sachets inside until the sachets are issued.
- Every morning before the spray operations begin, store managers distribute only enough sachets for the day’s work to the team operators. The team operator must sign for all pesticides received daily in a logbook.

- At the end of the day, empty and full sachets are returned and numbers checked against what was signed out. Returned empty and full sachets are logged into the logbook by the storekeeper or supervisor.
- Supervisor and team leaders examine SOPs' performance by comparing number of structures sprayed to sachets used to determine whether there is an over or under application.
- Storekeeper must submit the following to the program office for data entry on a daily basis: 1) insecticide stock balances; 2) sign-in/sign-out results; and 3) structures sprayed per SOP.
- The next day, all previously signed for but unused sachets are reissued and signed for by the relevant SOP.
- At the end of each day and at the end of the spray round, stock remaining must equal the stock at start of the day minus the number of sachets distributed. Number of sachets distributed should be equal to number of sachets used if there is no returned full sachet.

#### 8.1.3.12 PROCUREMENT OF OTHER IRS EQUIPMENT

The following IRS equipment will be procured alongside with the insecticides and PPEs including:

- Spray Nozzles. The program in Ethiopia will procure 8002E nozzles for the spray pumps, which are the standard size recommended by WHO for mud and brick walls.
- Spray pumps. SOPs use Hudson X-PERT compression sprayers with shoulder-suspended tanks to apply a measured amount of insecticide on the interior walls of houses and structures. A water-soluble insecticide is added to the sprayer containing a pre-measured amount of water, the sprayer is pressurized, and the material is then applied to the interior walls of targeted house (Structure). After the day's spraying is complete, SOPs must clean the sprayer following the manufacturer's recommendations to ensure their proper operation and calibration.

#### 8.1.3.13 TRAINING

The objective of the trainings is to build the capacity of the host government at the national and district levels to implement, monitor and evaluate a well-organized IRS program.
Training in IRS implementation will be a key element of the PMI IRS program. The planning process for trainings will be carried out in coordination with NMCP. The recruitment and training of SOPs are key elements in this process, and require vigorous involvement of government structure to ensure that when these activities are transferred to NMCP, there will be sufficient local capacity to continue IRS activities.

***Driver***s
Drivers that will transport insecticide will be trained on methods and protocol for safe driving, handling insecticides, and what to do in an emergency situation when transporting insecticides. Drivers will also be trained on insecticide-related security issues, handling vehicle contamination, methods for cleaning vehicles after transporting insecticide, and handling insecticide run-off.

***TOT Training for IRS supervisors:***
Participants include representatives from RHBs, ZHDs, DHO and former trainers from past spray campaigns. Key topics that will be covered include the following:

- Malaria epidemiology
- IRS

- Storage of IRS commodities
- Environmental and Safety issues concerning IRS campaigns
- IEC
- Spray pump use and maintenance
- Spray technique
- Data management and quality (correct use of forms)
- Basic entomological information
- Supervision, performance monitoring and auditing of spray activities

Graduates of the TOT training for supervisors then conduct the SOP training with the support of the PMI AIRS Ethiopia. The training has both theoretical and practical sessions.

***Training for District Staff on Environmental Compliance***
Participants will include district health staff identified by the District Coordinator and the Environmental Compliance Officer (ECO). District health staff will be trained on measures taken during IRS operations to meet environmental compliance rules and regulations, based on the EMMP (Annex A). This will include best practices in Environmental Compliance, including pre- and post-spray season inspections/reporting.

The individuals recruited for IRS campaigns will receive intensive training on the use, operation, calibration and repair of the spray pumps, including practical exercises during a 5-day period prior to the beginning of the spraying campaign. They will also receive training to understand proper hygiene, to recognize the signs and symptoms of poisoning, and to understand the referral procedure for any incidents involving poisoning. This training is conducted in accordance with PMI IRS BMP (which includes WHO IRS guidelines).

***Training SOPs, team leaders and base supervisors:***
Participants include SOPs, team leaders and base supervisors identified by the district health office. PMI AIRS- Ethiopia staff will supervise the trainings sessions.

The training includes:

- Insecticide application technique
- Handling a spray pump
- Communication strategies in the field
- Spray operation organization
- Completing Daily SOP forms for accuracy
- Team Leader protocols for checking SOP data (physical and mathematical checks)
- Use of PPE to prevent toxic exposure, environmental compliance and avoidance of spraying in environmentally- sensitive areas.

Following the training, a post-training exam is given, and only candidates that receive high scores will qualify as SOPs. The district malaria focal person will identify outstanding trainees and designate them as team leaders to supervise a number of operators.

SOPs will undergo medical exams to determine their physical capability for providing appropriate application of the insecticide. All female workers will be subjected to a mandatory pregnancy test before training and recruitment as SOPs or washers. Pregnancy tests will then be conducted every month during IRS operations.

***Storekeepers***
Training for all storekeepers includes IRS logistics and supply chain management, insecticide storage and security, inventory tracking (stock card use), spill control and management, and IRS waste storage and management. Following the training, an exam will be given, and only those who achieve a high enough score will qualify as storekeepers for the IRS spray campaign.

***Pump technicians***
Technicians for each project districts will be trained on technical maintenance and repair of the spray pumps and progressive rinsing systems.

***Washers***
District malaria focal person who attended the TOT training will lead training for washers, on how to wash coveralls and other PPE to prevent contamination.

***Data Clerks and District Data Manager***
Data clerks will be trained in IRS data entry; using the IRS database; and methods for reviewing data and assuring data accuracy and quality. The M&E manager and Coordinator will complete the trainings.

***TOT for IEC Coordinators***
Participants will include district IEC Coordinators. Training will include modules on communicating homeowner responsibilities for spray and post-spray activities, such as moving and/or covering belongings and respecting the two hour exclusion time after spray.
The main purpose of mobilization is to remind beneficiaries about the positive benefits of IRS in controlling and preventing malaria and malaria-related deaths, and to remind them of their roles and behaviors before, during, and after spray operations. Once the risks and benefits of IRS have been explained, households have the option of declining to participate.

***Health Workers in Poison Management***
Participants include health facility staff identified by the district health office. The Chief Medical Officers will conduct the trainings. Health facility staff will be trained and prepared for handling insecticide poisonings, skin irritations, and other potential IRS spray campaign injuries. General poison control guidance will be provided. When new pesticides will be used, additional training specific to the symptoms and treatment for that chemical will be provided. Acute exposure can occur through dermal contact, which could lead to absorption into the blood stream as well as skin and eye irritation, inhalation or ingestion. District hospitals or health centers will be designated as focal places to handle insecticide poisoning issues and will be provided with antidotes for the pesticides in use.

### 8.1.4 EMERGENCY RESPONSE

All pesticide transport vehicles and storerooms will be equipped with phones, spill kits, first aid kits, emergency response procedures and first aid procedures. Storerooms will be equipped with fire extinguishers. All spray team leaders; site and spray supervisors, storekeepers and district coordinators, (or anyone with similar responsibilities) will be trained in these procedures and responses, as well as recognizing and responding to symptoms of pesticide intoxication.

The following table provides guidance for response to cases of pesticide intoxication or spills.

Table 8: Treatment Medicines for WHO-recommended Pesticides

| Pesticide Class | Treatment Medicine(s) |
|---|---|
| Organochlorine (DDT): | Activated Charcoal (priority)<br>Diazepam or Lorazepam (for seizure)<br>Phenobarbital<br>Cholestryamine resin |
| Organophosphates: | Atropine sulfate or Glycopyrolate (priority treatment)<br>Furosemide (less critical)<br>Diazepam or Lorezapam (for seizure) |
| Carbamates: | Cholestryamine Atropine (priority)<br>Furosemide (less critical)<br>Diazepam (for seizure) |
| Pyrethroids | Promethazine<br>Panadol<br>Diazepam<br>Lorezapam<br>Calamine cream<br>Vitamin E<br>Hydrocortisone-<br>cream<br>Salbutamol<br>Activated charcoal |
| Chlorfenapyr | Activated<br>charcoal<br>Benzodiazepine (seizures) |

### 8.1.5 ACCIDENTAL WAREHOUSE FIRES

Combustion of IRS pesticides will result in the generation of toxic fumes. Inhalation of these fumes is a significant health risk, and should be avoided. The risk of fire can be minimized, however, by following PMI IRS BMPs for storage, including prohibiting lighted materials in the warehouse and in the vicinity of pesticides, providing proper ventilation, etc.

Information on the combustion byproducts of pyrethroids can be found in the 2012 PEA and fire-fighting instructions from MSDSs).

**Table 9: Combustion Byproducts and Firefighting**

| Pesticide | Combustion Byproduct | Extinguishing Instructions |
|---|---|---|
| Alpha-cypermethrine | Open burning of lambda-cyhalothrin creates nitrogen oxides, hydrogen chloride, and hydrogen fluoride (WHO, 1997) | Extinguishing media: For small fires use water spray, alcohol-resistant foam, dry chemical or carbon dioxide. For large fires, use Alcohol-resistant foam, Water spray<br>Extinguishing media, which must not be used for safety reasons: Do not use solid water stream as it may scatter and spread fire.<br>Specific hazards during firefighting: As the product contains combustible organic components, fire will produce dense black smoke containing hazardous products of combustion. Exposure to decomposition products may be a hazard to health.<br>Special protective equipment for firefighters: Wear full protective clothing and self- contained breathing apparatus.<br>Further information: Do not allow run-off from fire-fighting to enter drains or watercourses. Cool closed containers exposed to fire with water spray. |
| Bendiocarb | Fine dust may form explosive mixtures in air. The product is not flammable, but when heated above 125° C will evolve toxic fumes of methyl isocyanate. Water is the preferred extinguishing medium as it decomposes any methyl isocyanate. | Water fog or fine spray, carbon dioxide, dry chemical, foam.<br>Fire fighters should wear full protective gear, including self-contained breathing apparatus (AS/NZS 1715/1716). Keep unnecessary people away and move all other personnel to windward side of fire. Bund area with sand or earth to prevent contamination of drains or waterways. Dispose of fire control water or other extinguishing agent and spillage safely later. |
| Delta-methrine | Combustion and/or pyrolysis of deltamethrin can lead potentially to the production of compounds such as formaldehyde, acrolein, hydrogen cyanide, and hydrogen bromide (UK PID, 2006) | Suitable extinguishing media: Water spray jet, carbon dioxide (CO2), dry powder, foam.<br>Extinguishing media which should Product itself is non-combustible not be used for safety reasons: Fire extinguishing measures to suit surroundings. |
| Bifenthrin | Not available | Suitable extinguishing media: Carbon dioxide (CO2), Foam; Powders<br>Not suitable extinguishing media: Water (the product is hazardous for the environment - do not dilute it)<br>Specific fire-fighting methods: Isolate fire area. Evacuate downwind. Contain the extinguishing fluids by bunding (the product is hazardous for the environment). Do not attempt to fight the fire without suitable protective equipment. Do not breathe fumes<br>Protection of fire-fighters: Self-contained breathing apparatus and complete protective clothing |
| Cyfluthrin | Combustion and/or pyrolysis of cyfluthrin can lead potentially to the production of compounds such as formaldehyde, acrolein, hydrogen cyanide, hydrogen chloride, and hydrogen fluoride (UK PID, 2006) | Not available to-date. |

### 8.1.6 PREVENTION OF RESIDENTIAL EXPOSURE

PMI AIRS- Ethiopia will carry out an IEC campaign primarily at the district level of the government health structure, to sensitize the residents to IRS activities in accordance with WHO guidelines and the Ethiopian National Malaria Strategy Plan 2014-2020 and PMI Malaria Operational Plans. The IEC campaign, as well as IRS Project supervisors and Health Workers who will also instruct residents on best practices prior to spraying, will focus on the following residential safety elements during an IRS campaign:

- Remove all mats or rugs, furniture, cooking implements and foodstuffs prior to spraying; if furniture cannot be removed, then move it to the center of the room and covered with impermeable material.
- All residents must stay outside the home during spraying and for two hours after spraying.
- Move all animals outside the home during spraying, and keep them outside for two hours after spraying.
- After two hours, open all windows and doors and air the house out for ½ hour.
- Sweep up any insects killed from the spraying and dispose of in latrine pits.
- Sweep floors free of any residual insecticide that may remain from the spraying and dispose of in pits or latrines.
- Do not re-plaster or paint over the walls after spraying.
- Continue to use bed-nets for protection against malaria.
- If skin itches after re-entry into the home, wash with soap and water; for eye irritation, flush eyes with water; for respiratory irritation, leave the home for fresh air; for ingestion or if symptoms persist, contact program staff or go to nearest health facility which has the appropriate medical intervention.
- If spraying during the rainy season, the teams should follow the following Contingency Plans which will minimize exposure of household effects.

Contingency Plan during the rainy season:

- Each SOP must be given adequate covering material (3m by 3m minimum), which should be used to cover household effects not removed from the homes.
- Adopt a system of moving household effects to the center of the room and covering them with impermeable material before spraying.
- Materials can also be moved into structures that are not targeted to be sprayed, e.g., an isolated kitchen or other domestic animal shelter.
- Move the household effects to one room which will not be sprayed on that particular day, but the next day.
- The spray teams should pay close attention to any signs of potential rain so that they prepare the communities accordingly

Contingency Plan when it rains in the mid of spraying:

- Stop the spraying activities. After the rains stop and the weather is considered good, spraying can continue.

- Cover the household effects with an impermeable material. These materials should have already been procured by the program and given to each operator.

## 8.2 PREVENTING ENVIRONMENTAL CONTAMINATION

While in the field, spray personnel must follow all BMPs to avoid contamination of the environment and non-targeted areas. These procedures include careful preparation of the pesticide to avoid spillage, closing windows and doors to avoid pesticide drift to the outside, spraying only in designated areas of dwellings, and never disposing of pesticide into the environment.

At the end of the day, the following procedures must be followed when SOPs clean their pumps, their PPE, and their bodies.

### 8.2.1 TRIPLE RINSE AND REUSE OF LEFTOVER PESTICIDE

USAID's PMI IRS BMP Manual recommends that at the end of each day any remaining pesticide, as well as the water used to rinse out spray pumps must be re-used at the beginning of the next day's work, in order to save water, reduce the chemical load on the soak pits, and reduce the potential for pollution from leftover pesticide or contaminated rinse-water. This re-used, contaminated material should be considered as make-up water rather than pesticide, as it has degraded overnight with exposure to air and sunlight, and so it must be mixed with new insecticide accordingly.

The best practice for spray pump cleaning is called "progressive rinse." As shown in Figure 11, seven barrels/drums/containers of approximately 200-litres each or 20-liter buckets for community based IRS organization (depending on the number of operators using the area) are placed in a line. Every other container is filled with water (e.g. the first container is empty, the second is filled with water, the third is empty, fourth is filled with water, fifth is empty, sixth is filled with water and the seventh container is empty). During the end-of-day cleanup, the remnants of the insecticide prepared in the field and remaining in the pump are emptied into the first container. This will be a limited volume, which should be much less than half of this container, as most sprayer pumps should be returned empty from the field. It is important to train operators to manage this goal of minimizing leftover at the end of the day. The SOP will then add two liters of water from the second container to the spray pump, close, pressurize, and shake the spray pump to rinse it. The pump is then depressurized by directing the spray into the third barrel, followed by opening it up and emptying any remaining contents into the third barrel.

The SOP will repeat those steps with the fourth and fifth containers, then with the sixth and seventh containers. The following morning during mobilization, the spray pumps are filled with liquid from containers in the same sequential order: container one, then container three, then container five, and finally seven.

### 8.2.2 PESTICIDE TREATMENT AND DISPOSAL FACILITIES

SOPs must completely wash their pumps, most of their PPE, and themselves after triple-rinsing their pumps. Overalls are washed separately by wash-persons provided with protective gear. In order to minimize possible ground contamination from washing spray equipment and PPE, wash operations are conducted on an impervious (plastic or concrete) wash area that continuously slopes to a soak pit. A soak pit is an in-ground filter that contains a layer of charcoal that adsorbs the insecticide from wash water.

**Wash Areas**
In order to minimize possible ground contamination from washing spray equipment and PPE, all staging areas are required to have an impervious wash area that continuously slopes to the soak pit. This will ensure that all contaminated wash water drains to and is properly treated in the soak pit.

Wash-persons will be hired and provided with protective gear. Wash-persons will wash overalls at a central location in tubs used exclusively for overall washing. SOPs must completely wash themselves after each day's operations using washbasins or shower areas constructed near the soak pits. SOPs should never wash themselves, their overalls, or their PPE in any water bodies, or delay washing until they are home. Washing must be performed at designated sites, and all wash-water must be disposed of in a soak pit.

**Soak *Pits***
Soak pits are of two basic types, fixed, and mobile, as described below. The overall principle of the soak pit, also referred to as a bio-bed, is to adsorb the toxic chemicals in pesticide-contaminated wash water through a carbon filtration process, so that the water that finally exits the bottom of the soak pit has been purified and no longer contains pesticide in any significant concentration. Pesticide that is adsorbed onto the carbon medium breaks down into harmless components through environmental and microbiological processes. The type and size of the soak pit used will depend on the logistics of the target spray area and the number of SOPs that the soak pit will support.

The site for fixed soak pits is selected jointly with AIRS- Ethiopia's Operations Manager, Environmental Compliance Officer, District Coordinator, and the representative of the District Health Office. Sites for mobile soak pits can be chosen by village leaders and spray team leaders, with input from the ECO as necessary. All soak pits must be sited at least 30 meters from water bodies, bore holes, schools, and other sensitive receptors.

### 8.2.3 Fixed Soak Pits

Fixed soak pits receive wash water from cleaning the outside of pumps and the spray wand and nozzle after disassembly. They also receive wash waters from cleaning all operators' PPE. They do not receive concentrated pesticide from any source. Fixed soak pits are established in a site centrally located in the target spray area for easy access at the end of a spray day. For 30-35 operators, fixed soak pits are two meters length by one-meter width, excavated to a depth of one meter. The bottom of the pit is packed with sawdust, followed by cooking charcoal, stone aggregates and gravels as shown in Figure 9. The entire soak pit area is fenced, with a lockable access door to prevent unauthorized entry by children or animals. Soak pits are renovated by district health office with funding from PMI. New soak pits are constructed and inspected before spray operations commence. Existing soak pits are evaluated by the PMI AIRS- Ethiopia and the district malaria focal person annually and renovated as needed before spray operations begin.

The gravel and stone layers work to exclude large particulates such as leaves and sticks that may eventually clog the soak pit, and they also help to distribute the influent across the soak pit bed so that it is not concentrated in one spot. As the organic chemical contaminants (pesticides) flow through the coal layer, they are adsorbed onto and held by the charcoal, where they are later broken down by environmental forces, including bacterial action. The sawdust at the bottom helps to regulate the flow rate so that there is enough contact time between the contaminated water and the coal. Unless the soak pit becomes clogged with foreign matter and will not drain, the soak pit should remain effective for

three years, at which time it can be excavated so that the sawdust and coal can be replaced. As long as the foreign matter can be separated from the stone, the three stone layers can be reconstituted using the same material.

**Figure 7: Soak pit layers**

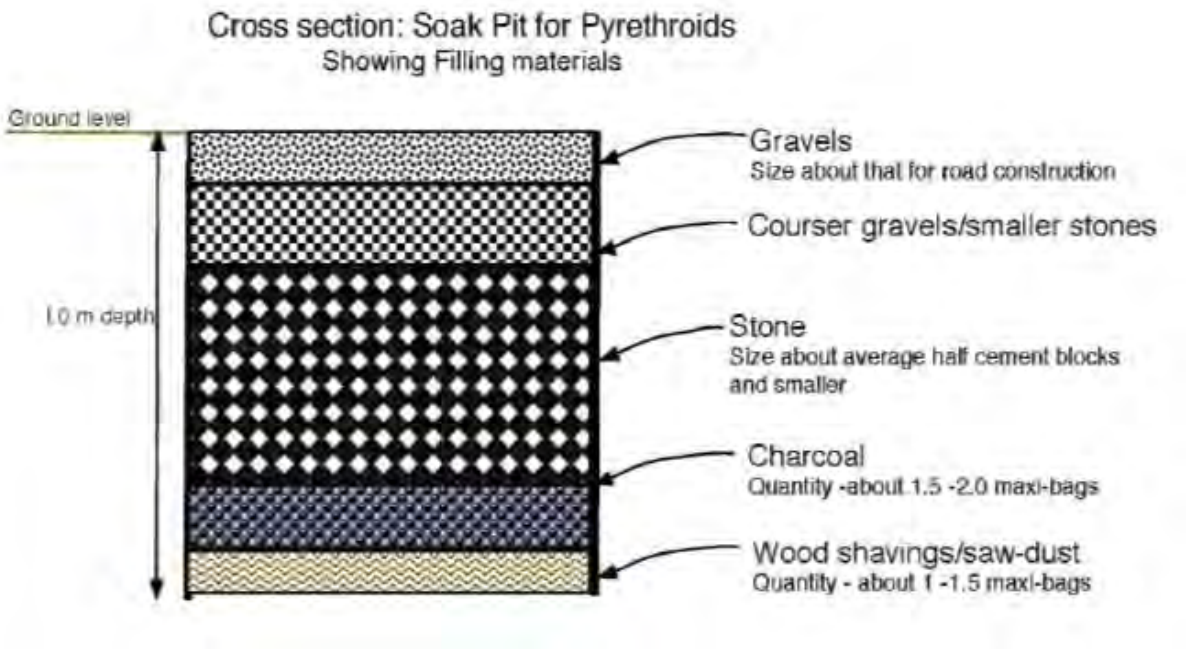


**Figure 8**: Wash area and soak pit schematic

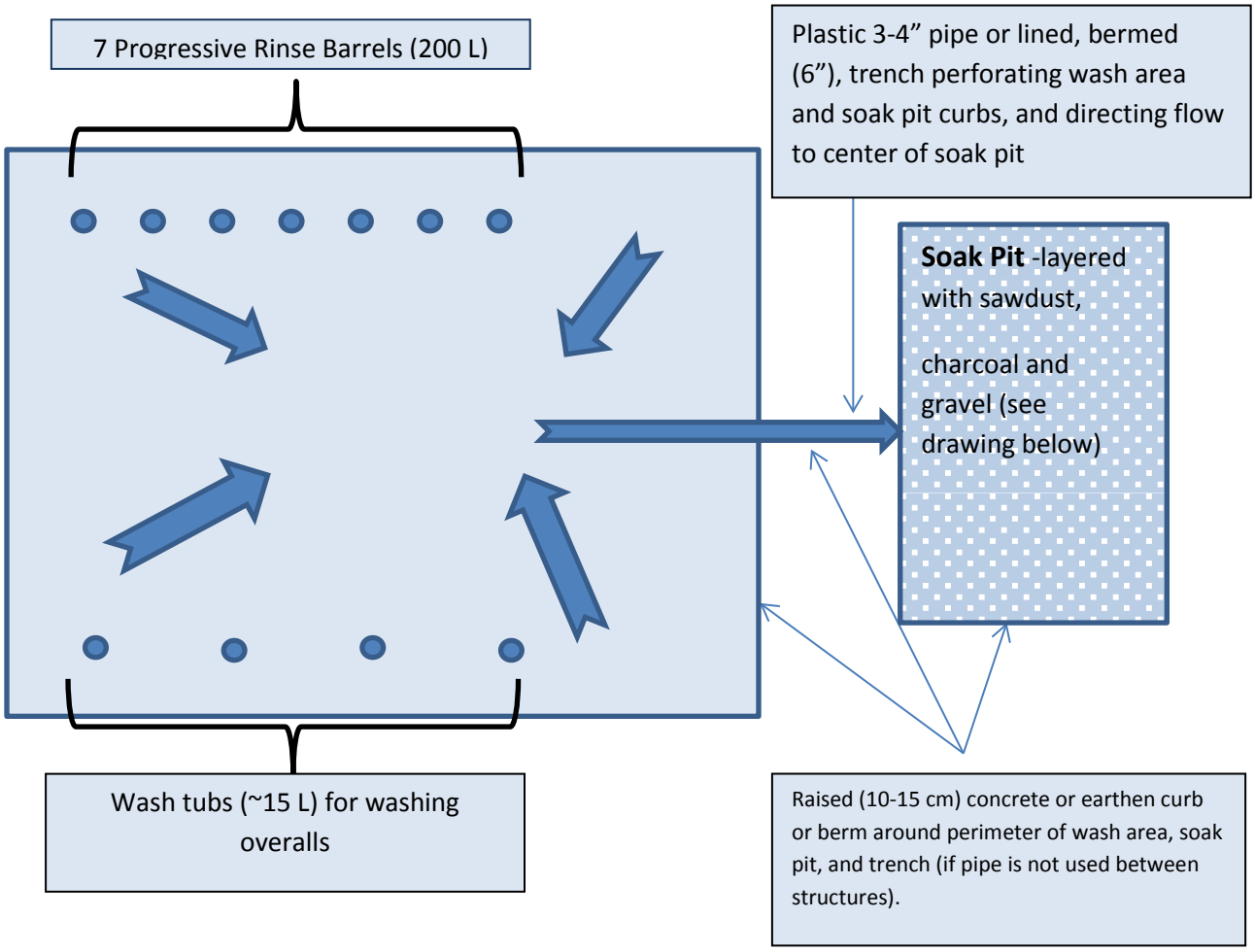
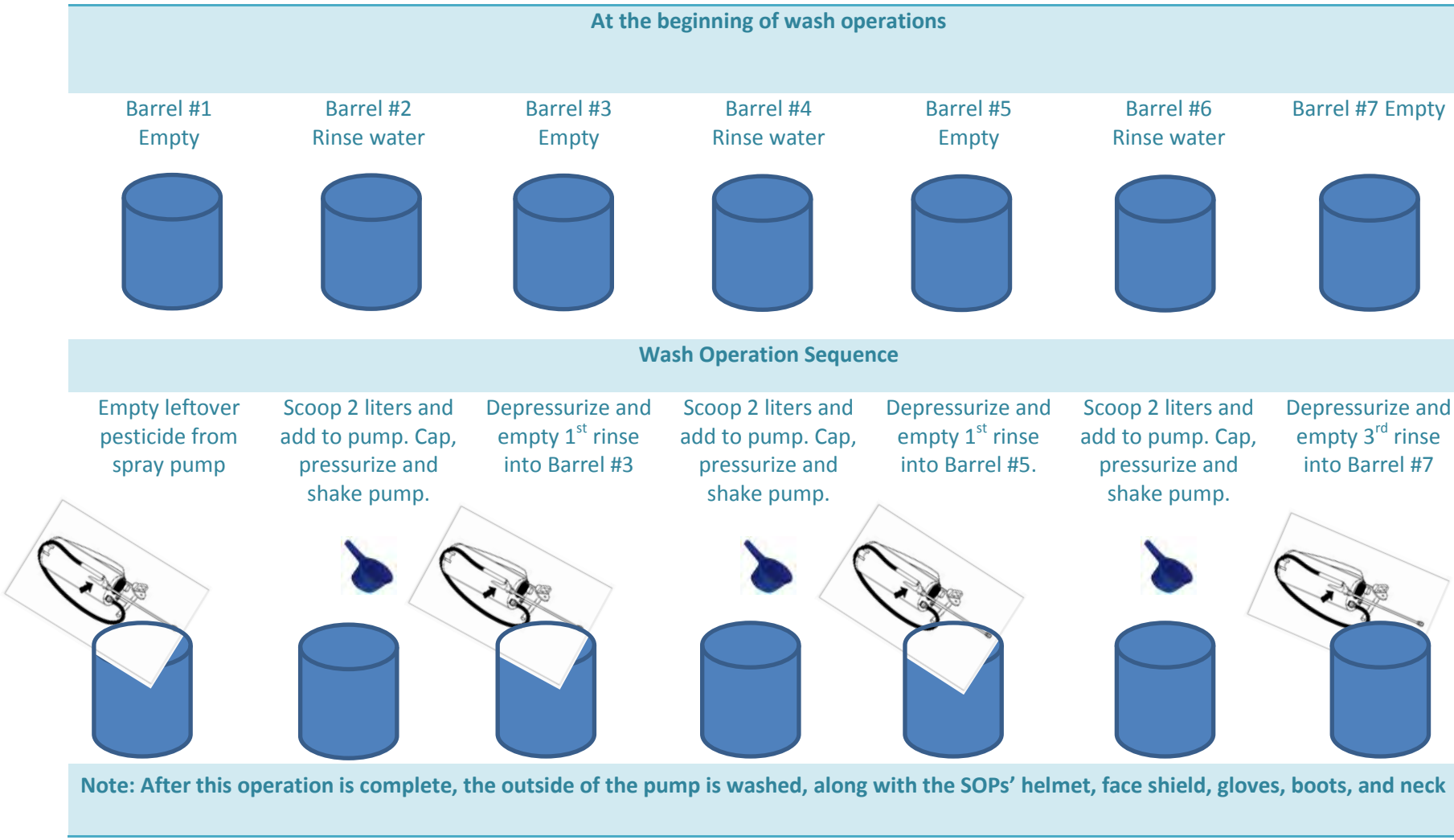


**Figure 9**: Triple rinse system for washing IRS pumps



### 8.2.4 Mobile Soak Pits

To reach certain targeted spray areas, operators must travel a great distance, and they may not be able to return at the end of the day to a centralized wash area for cleanup. Sometimes the operators will spend several days in the field, finding lodging and food in the villages where they finish their work for the day. The next day, they either continue to work at the same village, or travel on to the next targeted spray area. Working this way can reduce transportation requirements, shorten the working day, and result in greater productivity. However, operators need a different system for cleanup at the end of the day.

In this situation, the operators carry a MSP filter, wash barrels, and a tarpaulin with them, and construct a temporary wash facility at a suitable site within the village where they will stay. The mobile soak pit filter is a 20-25 L bucket layered as in the following figure, with highly adsorbent activated carbon that removes pesticide contamination from the wash water, so that the water that exits to the ground is purified.

The MSP can use a four-barrel rinse system to minimize the number of barrels that the spray team must carry, and reduce the necessary size of the wash area constructed. The four-barrel rinse system uses three barrels for rinse water, but only one barrel to receive both the leftover pesticide, and the water from all three rinses. This system simplifies the reuse of all leftover pesticide and rinse-water the following day, as the operators draw from only one barrel, instead of four.

**Figure 10**: Mobile soak pit filter layers

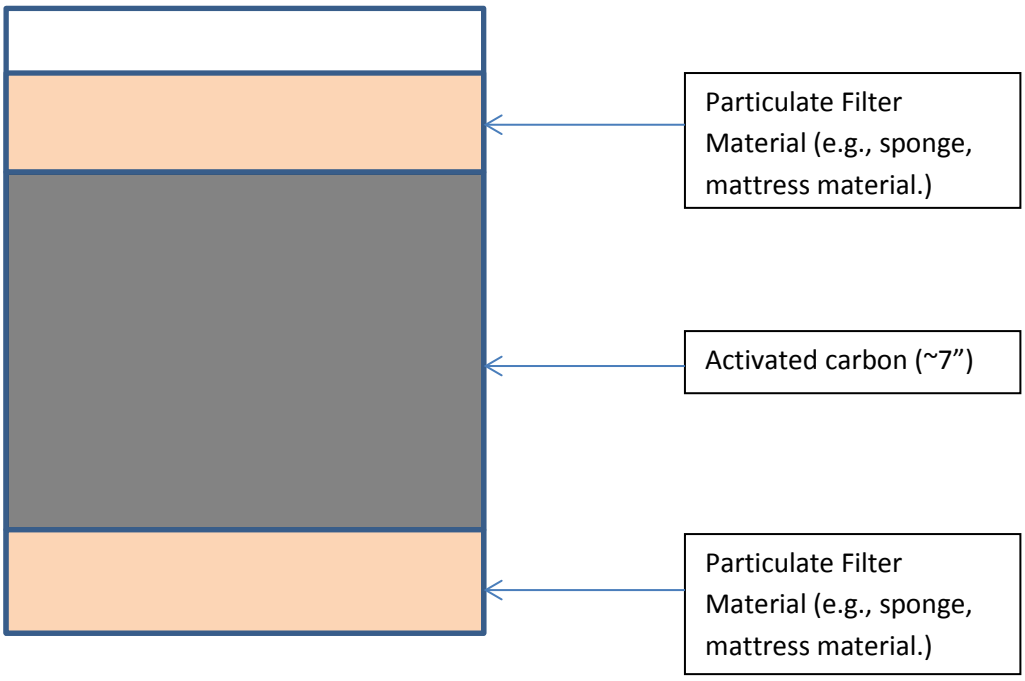
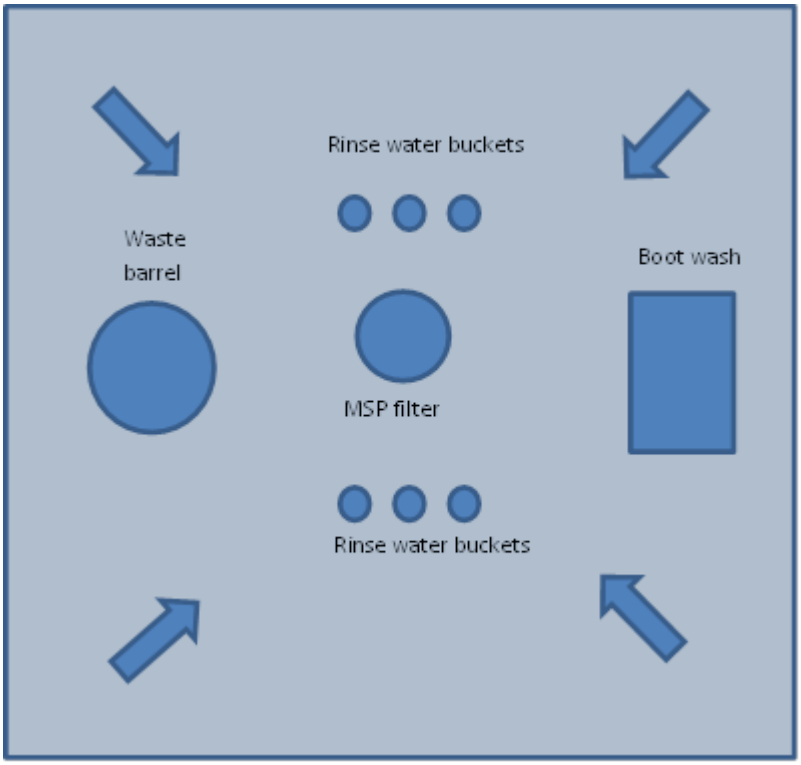


**Figure 11**: MSP wash area layout




This schematic shows a 4m x 4m (not to scale) wash area with a hole dug in the center of the area to receive the MSP filter, The area is sloped to the MSP filter at the center, and covered with a tarp.. An X is cut in the center of the tarp to allow rinse-water to distribute into the MSP. There is a rectangular boot wash at the entrance to the wash area, to collect mud from operators' boots so that it does not drain to and clog the MSP. There are two rows of rinse barrels so that two operators can wash up at one time. The large barrel on the left receives both leftover pesticide and all rinse-waters. An MSP can only receive rinse waters from washing the outside of the pumps, as well as operators' PPE, excluding overalls, which are transported to the nearest fixed soak pit and washed. The MSP is sized for 5 operators (1 team), and should not be used for more.

**Figure 12**: Preparing the site for the MSP installation (photo)

### 8.2.5 IRS Solid Wastes Disposal

IRS solid wastes contaminated with pyrethroids, chlorfenapyr, carbamates and Ops, which includes empty insecticide sachets, plastic containers, masks and torn gloves and boots, will be temporarily stored in the district warehouse. At the end of the spray campaign the empty sachets and used masks will be relocated to the central storage facility at Burayu site near Addis Ababa for the final disposal though incineration by the two USAID/ PM incinerators installed on the site.

Incineration is not recommended for polyvinyl chloride or other chlorinated wastes such as gloves and boots. Gloves and boots can be easily decontaminated with soap and water and disposed of as normal non-hazardous waste. It is also not recommended to incinerate non-contaminated wastes such as cardboard boxes, which can also be disposed of as normal non-hazardous wastes.

AIRS is currently in communication with a paper recycling plant that is interested in recycling IRS uncontaminated cardboard wastes. Other wastes such as plastic containers can be triple rinsed and recycled at an appropriate facility. AIRS is also currently in discussions with a company interested in recycling the triple rinsed insecticide bottles into sanitary vent pipes. An agreement will be signed once the company's legal registration status is confirmed and upon review of their recycling process for environmental due diligence.

Aaccording to WHO/FAO, incinerators recommended for disposal of non-DDT wastes must meet the following key requirements:

- The recommended combustion temperature is between 1,100°C and 1,300°C.
- A secondary combustion chamber is required, with a residence time of at least two seconds.
- The incinerator should have emission control, including particulate matter filters.
- The incinerator must meet all local, regional, and national regulations and bylaws.

Ash and slag produced by high-temperature incineration of pesticides are best incorporated into concrete and buried in a secure location In Ethiopia, as solid wastes are incinerated in a PMI-owned incinerator and the implementing partner has control over the ash and slag, this is the procedure that will be followed.

Due to resistance issues, DDT has not been used in the Ethiopia IRS program for the past five years. Though there still remains about 85 tons of expired DDT and contaminated wastes stored in Oromia Districts. VEOLIA, a UK based company, has been identified to transport and dispose of the remaining POP stock, and is working in collaboration with AIRS. A separate document, which describes the DDT waste disposal process was approved by PMI in December 2014. Initially, August 2015 was the expected disposal completion date, but due to unanticipated delays it is now expected to be completed in October or November 2015.

Due to the magnitude of the task and the national responsibility to handle the hazardous materials according to established international requirements, PMI AIRS will work hand in hand with various government agencies as outlined below.

i. The Federal Ministry of Health (FMOH) will provide overall guidance and facilitate the communication between Oromia Regional Health Bureau, Federal Ministry of Environment and Forest, and AIRS Ethiopia, in consultation with PMI.

ii. Federal Ministry of Environment and Forest will facilitate the permit process based on the relevant environmental international conventions and provide technical assistance.

iii. Oromia Regional Health Bureau will provide coordination support, inform district and zonal authorities about the activity, and make its staff available for training and collection of the waste at the district and zonal levels.

iv. District and zonal health offices will provide staff to be trained, and coordinate the collection process in their respective areas.

## 8.3 CONCLUSION

Using the new Best Management Practices and procedures, IRS can be performed safely and provide substantial benefits to the beneficiaries. The EMMR Annual Reporting Form in Annex B will be submitted to the USAID as part of the annual report.

# 9. EMMP IMPLEMENTATION

The District Environmental Health Officers, with the support from the PMI Implementing Partner, FMOH and ORHB, will be responsible for implementation of the EMMP. The staff in charge of implementation of EMMP will be trained to ensure effectiveness of the mitigation measures during spray operation. The District Environmental Health Officers will monitor environmental compliance during the IRS campaign.

The PMI Implementing Partner will work closely with District Environmental Health Officers throughout the spray campaign. The PMI Implementing Partner's Environmental Compliance Officer will conduct environmental compliance inspections during pre-spray activities, during mid-spray operations and at the completion of the spray campaign. These inspections will endeavor to ensure that all the mitigation measures in the EMMP are being implemented and propose measures for improvement for the next IRS campaign. These compliance inspections achieve the following objectives:

- Create a baseline of current compliance activities for the purpose of evaluating improvement in future IRS programs.
- Observe IRS activities in progress to determine and document whether the intervention is in full compliance with USAID requirements as included in the approved SEA.
- Determine, in consultation with FMOEF officials, the training and support required to improve and ensure future compliance with the SEA.
- Ensure adherence to relevant international rules and regulations, including USA regulations.
- Ensure accurate record keeping and daily collection of empty sachets.
- Ensure that progressive rinsing methods are used in all spray sites and ensure that leftover insecticide solution is re-used for spraying the next day to prevent environmental contamination.
- Ensure that SOPs, washers, team leaders and supervisors are knowledgeable of the correct way to handle and apply insecticides.
- Ensure that all persons in potential contact with pesticides use PPE at all times.

In addition, PMI has annually-programed funds to conduct an independent environment compliance audit to ensure that all the mitigation measures are implemented during the spray campaign.

# 10. PUBLIC CONSULTATIONS

During the preparation of this SEA, consultations with the various implementing governmental agencies including the FMOH, Federal Ministry of Agriculture, Federal Ministry of Environment and Forest, all Regional Health Bureaus (except Gambela and Addis Ababa), the Regional Culture and Tourism Bureaus and District Malaria Focal persons, were undertaken to ensure the information provided in this document was accurate and met the needs of the malaria control program. The SEA also sets out to meet the needs of the Ethiopian Ministry of Environment and Forest and their Environmental Impact Assessment requirements based on the Environmental Assessment Guidelines.

Health extension workers will use opportunistic occasions, such as public meetings and mobilization for different governmental and religious gatherings, for community outreach. District MFPs work in close contact with the Social Behavior Change Communication (SBCC) team leaders to inform the population about the spraying schedule. The HEWs carry out Information, Education, and Communication (IEC) activities for targeted communities and households to remind beneficiaries about the positive benefits of IRS in controlling and preventing malaria and malaria-related deaths, and to remind them of their roles and behaviors before, during, and after spray operations.

Overall, all stakeholders are actively involved in the management and implementation of the IRS program, and the program is well received in the field. FMOH determines what insecticides to be used, selecting from the WHO recommended pesticides list, and the regional Health Bureaus and district health offices determine eligible areas that should be targeted for indoor residual spraying.

During discussions with the regional health bureaus, zonal health departments and district health offices various gaps were identified that should be addressed. (Annex E). These gaps include the following:

- Except PMI districts which are still under the AIRS project and those graduated, no standard soak pit for the cleaning procedure of IRS was identified.
- Scarcity of PPE was reported at many of the sites.
- Micro-planning exercise to quantify the insecticide requirement is not completed in several districts; hence insecticide scarcity or excess of stock is often an issue.
- Almost all districts except those under the AIRS project do not undergo triple-rinsing to clean the spray pumps.
- Empty sachets are being burned at health center incinerators that do not meet BMP standards.
- Pregnancy tests for women SOPs are not done in many non-PMI project districts.
- Several districts are not prepared to handle incidental insecticide poisoning cases.

At the discretion of the PMI program, a draft version of the SEA will be distributed to the malaria control partners in Ethiopia for review.

# ANNEX A: ENVIRONMENTAL MITIGATION AND MONITORING PLAN

| Category of Activity | Describe specific environmental threats of your organization's activities | Description of Mitigation Measures | Who is responsible for monitoring | Monitoring Indicator | Monitoring Method | Frequency of Monitoring |
|---|---|---|---|---|---|---|
| Use of insecticides | 1. Occupational risks for workers involved in IRS campaigns (e.g., risks from insecticide exposure and vehicular accidents), especially women of child-bearing age | a. Inspect and certify vehicles used for pesticide or spray team transport prior to contract.<br><br>b. Train drivers<br><br>c. Provide cell phone, personal protective equipment (PPE) and spill kits during pesticide transportation.<br><br>d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact.<br><br>e. Health test all spray team members for duty fitness.<br><br>f. Procure, distribute, and train all workers with potential pesticide contact on the use of PPE.<br><br>g. Train operators on mixing pesticides and the proper use and maintenance of spray pumps.<br><br>h. Provide adequate facilities and supplies for end-of-day cleanup.<br><br>i. Enforce spray and clean-up procedures. | a-d. Environmental Compliance Officer (ECO).<br><br>e-g. Operations Manager (OM).<br><br>h. ECO<br><br>i. Chief of Party (COP), Technical Project Managers (TPM) and headquarters environmental staff. | a. Transport vehicles have a valid inspection certificate on-board.<br><br>b. Drivers have a certificate of training completion.<br><br>c. Transport vehicles are equipped with cell phone, spill kit, and PPE.<br><br>d. Storekeeper has records of pregnancy testing for all female team members.<br><br>e. Storekeeper has medical exam results for all team members.<br><br>f. SOPs wear complete PPE during spraying and clean-up.<br><br>g. Operators mix pesticide properly, and the pump does not leak.<br><br>h. All facilities are compliant, and materials required for clean-up are present.<br><br>i. Inspections are performed as scheduled, corrective action is taken as needed. | a-c. ECO inspection of vehicles in the field.<br><br>d-e. ECO inspection of health records at IRS operational sites.<br><br>f-h. ECO performs pre-spray inspections of inventories and training records, and mid-spray inspections of PPE use and SOP performance.<br><br>i. Monitoring of on-line database for submission of inspection reports. | a-c. 2 inspections per week.<br><br>d-e. One inspection per campaign, additional inspection if new hires or more than 30 spray days.<br><br>f-h. ECO pre-spray inspections 2/campaign, ECO mid-spray inspections 5 times/week.<br><br>i. Weekly |

| Category of Activity | Describe specific environmental threats of your organization's activities | Description of Mitigation Measures | Who is responsible for monitoring | Monitoring Indicator | Monitoring Method | Frequency of Monitoring |
|---|---|---|---|---|---|---|
| | 2. Safety risks for residents of sprayed houses (e.g., risks from inhalation and ingestion of insecticides) | a. IEC campaigns to inform homeowners of responsibilities and precautions.<br>b. Prohibit spraying houses that are not properly prepared.<br>c. Two-hour exclusion from house after spraying<br>d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside. | a-b. IEC officers, OM, ECO<br>c. ECO<br>d. SOPs (SO) and Team Leaders (TL) | a. Pre-spray IEC campaigns were executed. Homeowners know responsibilities.<br>b. All houses being sprayed are properly prepared.<br>c. Homeowners observe 2 hour exclusion.<br>d. Lack of incident reports, or incident reports with proper response noted. | a. OM- IEC work records,<br>ECO- mid-spray inspections.<br>b-d. ECO mid-spray inspections | a. Inspect work records 1/campaign,<br>b-d. ECO mid-spray inspections 3/wk. |
| | 3. Ecological risk to non-target species and water bodies from use of insecticides (during mixing and spraying) | a. Spray indoors only.<br>b. Train operators on proper spray technique.<br>c. Maintain pumps. | a-c. TL, District Coordinator (DC), OM, ECO | a. Operators spray only inside of houses.<br>b. Operators are trained and know and use proper spray techniques.<br>c. Pumps are maintained and operated to eliminate leaks and erratic spraying. | a. ECO mid-spray inspections.<br>b-c. Training records, ECO mid-spray inspections | a. ECO inspections 3/wk.<br>b. ECO inspection of training records 1/campaign.<br>b-c. ECO mid-spray inspections 5/wk. |

| Category of Activity | Describe specific environmental threats of your organization's activities | Description of Mitigation Measures | Who is responsible for monitoring | Monitoring Indicator | Monitoring Method | Frequency of Monitoring |
|---|---|---|---|---|---|---|
| | 4. Environmental risk from disposal of insecticide (both liquid and solid waste) | a. Choose sites for disposal of liquid wastes according to PMI BMPs.<br>b. Construct soak pits with charcoal to adsorb pesticide from rinse water.<br>c. Maintain soak pits as necessary during season.<br>d. Inspect and certify solid waste disposal sites before spray campaign.<br>e. Monitor waste storage and management during campaign.<br>f. Monitor disposal procedures post-campaign. | a-c. Abt OM, ECO, DC<br>d-f. Abt ECO | a. Operations sites meet PMI BMPs.<br>b. Soak pits are constructed according to the PMI BMP manual.<br>c. Soak pits perform properly throughout the spray season.<br>d. Disposal sites have the capacity and policies to properly dispose of wastes.<br>e. Wastes are stored and managed according to PMI BMPs.<br>f. Waste disposal has taken place as agreed and certificates of disposal received. | a-b. ECO Pre-spray inspections<br>c-f. ECO mid- and post-spray inspections and monitoring. | a.2/campaign<br>b.1/campaign<br>c. 5/week<br>d. 1/campaign<br>e. 3/week<br>f. Continuous during disposal |
| | 5. Risk of diversion of insecticides for unintended or uncontrolled use | a. Maintain records of all pesticide receipts, issuance, and return of empty sachets/bottles.<br>b. Reconcile number of houses sprayed vs. number of sachets/bottles used.<br>c. Examine houses sprayed to confirm spray application.<br>d. Perform physical inventory counts during the spray season. | a-d. Storekeepers, District coordinators, sector managers, logistics coordinator, OM, ECO | a-d. All pesticide management records are reconciled. | a-b, d. Inspection of pesticide management records. Storekeeper performance checklists.<br>c. ECO mid-spray inspections. | a-b, d. Daily monitoring by storekeeper or site supervisor. Weekly monitoring by District Coordinators<br>c. 1/campaign by country headquarters. 2/campaign by ECO<br>d. 2/campaign/ store-room |

# ANNEX B: EMMR FORM

**Please see Annual Environmental Mitigation and Monitoring Report (EMMR) Form next page**

**PMI IRS Ethiopia**

**ENVIRONMENTAL MITIGATION AND MONITORING REPORT (EMMR)**

**ANNUAL REPORTING FORM**

Implementing Organization:

Geographic location of USAID-funded activities:

Period covered by this Reporting Form

| Mitigation Measure | Status of Mitigation Measures | Outstanding issues relating to required conditions | Remarks |
|---|---|---|---|
| 1a. Pre-contract inspection and certification of vehicles used for pesticide or spray team transport. | | | |
| 1b. Driver training | | | |
| 1c. Cell phone, personal protective equipment (PPE) and spill kits on board during pesticide transportation. | | | |
| 1d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact. | | | |
| 1e. Health fitness testing for all operators | | | |

| Mitigation Measure | Status of Mitigation Measures | Outstanding issues relating to required conditions | Remarks |
|---|---|---|---|
| 1f. Procurement of, distribution to, and training on the use of PPE for all workers with potential pesticide contact. | | | |
| 1g. Training on mixing pesticides and the proper use and maintenance of spray pumps. | | | |
| 1h. Provision of adequate facilities and supplies for end-of-day cleanup, | | | |
| 1i. Enforce spray and clean-up procedures. | | | |
| 2a. IEC campaigns to inform homeowners of responsibilities and precautions. | | | |
| 2b. Prohibition of spraying houses that are not properly prepared. | | | |
| 2c. Two-hour exclusion from house after spraying | | | |
| 2d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside. | | | |

| Mitigation Measure | Status of Mitigation Measures | Outstanding issues relating to required conditions | Remarks |
|---|---|---|---|
| 3a. Indoor spraying only. | | | |
| 3b. Training on proper spray technique | | | |
| 3c. Maintenance of pumps | | | |
| 4a. Choose sites for disposal of liquid wastes according to PMI BMPs. | | | |
| 4b. Construct soak pits with charcoal to adsorb pesticide from rinse water. | | | |
| 4c. Maintain soak pits as necessary during season. | | | |
| 4d. Inspection and certification of solid waste disposal sites before spray campaign. | | | |
| 4e. Monitoring waste storage and management during campaign. | | | |
| 4f. Monitoring disposal procedures post-campaign. | | | |

| Mitigation Measure | Status of Mitigation Measures | Outstanding issues relating to required conditions | Remarks |
|---|---|---|---|
| 5a. Maintain records of all pesticide receipts, issuance, and return of empty sachets/bottles. | | | |
| 5b. Reconciliation of number of houses sprayed vs. number of sachets/bottles used. | | | |
| 5c. Visual examination of houses sprayed to confirm pesticide application. | | | |
| 5d. Perform physical inventory counts during the spray season. | | | |

# ANNEX C: GENERAL PRINCIPLES IN THE MANAGEMENT OF ACUTE POISONING

**Skin Decontamination**

Decontamination must proceed concurrently with whatever resuscitative and antidotal measures are necessary to preserve life. Shower patient with soap and water, and shampoo hair to remove chemicals from skin and hair. If there are any indications of weakness, ataxia, or other neurologic impairment, remove the victim's clothing, have the victim lie down, and give the victim a complete bath and shampoo using copious amounts of soap and water. Check for pesticide sequestered under fingernails or in skin folds and wash these areas.

Flush contaminating chemicals from eyes with copious amounts of clean water for 10-15 minutes. If eye irritation is present after decontamination, ophthalmologic consultation is appropriate.

Persons attending the victim should avoid direct contact with heavily contaminated clothing and vomitus. Contaminated clothing should be promptly removed, bagged, and laundered before returning to the patient. Shoes and other leather items cannot usually be decontaminated and should be discarded. Note that pesticides can contaminate the inside surfaces of gloves, boots, and headgear. Decontamination should especially be considered for emergency personnel (such as ambulance drivers) at the site of a spill or contamination. Wear rubber gloves while washing pesticide from skin and hair of patient. Latex and other surgical or precautionary gloves usually do not provide adequate protection from pesticide contamination.

**Airway Protection**

Ensure that a clear airway exists. Suction any oral secretions using a large bore suction device if necessary. Intubate the trachea if the patient has respiratory depression or if the patient appears obtunded or otherwise neurologically impaired. Administer oxygen as necessary to maintain adequate tissue oxygenation. In severe poisonings, mechanically supporting pulmonary ventilation for several days may be necessary.

**Note on Specific Pesticides:** There are several special considerations with regard to certain pesticides. In **OP** and **carbamate** poisoning, adequate tissue oxygenation is essential prior to administering atropine.

**Gastrointestinal Decontamination**

A joint position statement has recently been released by the American Academy of Clinical Toxicology and the European Association of Poisons Centres and Clinical Toxicologists on various methods of gastrointestinal decontamination. A summary of the position statement accompanies the description of each procedure.

I. **Gastric Lavage.** If the patient presents within 60 minutes of ingestion, lavage may be **considered**. Insert an orogastric tube and follow with fluid, usually normal saline. Aspirate back the fluid in an attempt to remove any toxicant. If the patient is neurologically impaired, airway protection with a cuffed endotracheal tube is indicated prior to gastric lavage. Lavage performed more than 60 minutes after ingestion has not proven to be beneficial and runs the risk of inducing bleeding, perforation, or scarring due to additional trauma to already traumatized tissues. It is almost always necessary first to control seizures before attempting gastric lavage or any other method

of GI decontamination. Studies of poison recovery have been performed mainly with solid material such as pills. There are no controlled studies of pesticide recovery by these methods. Reported recovery of material at 60 minutes in several studies was 8 percent to 32 percent. There is further evidence that lavage may propel the material into the small bowel, thus increasing absorption.

**Note on Specific Pesticides:** Lavage is contraindicated in hydrocarbon ingestion, a common vehicle in many pesticide formulations.

**Position Statement**: Gastric lavage should not be routinely used in the management of poisons. Lavage is indicated only when a patient has ingested a potentially life-threatening amount of poison and the procedure can be done within 60 minutes of ingestion. Even then, clinical benefit has not been confirmed in controlled studies.

**Activated Charcoal Adsorption**. Activated charcoal is an effective absorbent for many poisonings. Volunteer studies suggest that it will reduce the amount of poison absorbed if given within 60 minutes. There are insufficient data to support or exclude its use if time from ingestion is prolonged, although some poisons that are less soluble may be absorbed beyond 60 minutes. Clinical trials with charcoal have been done with poisons other than pesticides. There is some evidence that paraquat is well absorbed by activated charcoal. Charcoal has been anecdotally successful with other pesticides.

**DOSAGE OF ACTIVATED CHARCOAL:**

- Adults and children over 12 years: 25-100 g in 300-800 mL water.
- Children under 12 years: 25-50 g per dose.
- Infants and toddlers under 20 kg: 1 g per kg body weight.

Many activated charcoal formulations come premixed with sorbitol. Avoid giving more than one dose of sorbitol as a cathartic in infants and children due to the risk of rapid shifts of intravascular fluid. Encourage the victim to swallow the adsorbent even though spontaneous vomiting continues. Antiemetic therapy may help control vomiting in adults or older children. As an alternative, activated charcoal may be administered through an orogastric tube or diluted with water and administered slowly through a nasogastric tube. Repeated administration of charcoal or other absorbent every 2-4 hours may be beneficial in both children and adults, but use of a cathartic such as sorbitol should be avoided after the first dose. Repeated doses of activated charcoal should not be administered if the gut is atonic. The use of charcoal without airway protection is contraindicated in the neurologically impaired patient.

**Note on Specific Pesticides:** The use of charcoal without airway protection should be used with caution in poisons such as OPs, carbamates, and organochlorines if they are prepared in a hydrocarbon solution.

**Position Statement:** Single-dose activated charcoal should not be used routinely in the management of poisoned patients. Charcoal appears to be most effective within 60 minutes of ingestion and may be considered for use for this time period. Although it may be considered 60 minutes after ingestion, there is insufficient evidence to support or deny its use for this time period. Despite improved binding of poisons within 60 minutes, only one study suggests that there is improved clinical outcome. Activated charcoal is contraindicated in an unprotected airway, a GI tract not anatomically intact, and when charcoal therapy may increase the risk of **aspiration** of a hydrocarbon-based pesticide.

**Seizures:** Lorazepam is increasingly being recognized as the drug of choice for status epilepticus, although there are few reports of its use with certain pesticides. Emergency personnel must be prepared to assist ventilation with lorazepam and any other medication used to control seizures. See dosage provided below. For organochlorine compounds, use of lorazepam has not been reported in the literature. Diazepam is often used for this, and is still used in other pesticide poisonings.

**DOSAGE OF DIAZEPAM:**

- *Adults*: 5-10 mg IV and repeat every 5-10 minutes to maximum of 30 mg.
- *Children*: 0.2 to 0.5 mg/kg every 5 minutes to maximum of 10 mg in children over 5 years, and maximum of 5 mg in children under 5 years.

**DOSAGE OF LORAZEPAM:**

- Adults: 2-4 mg/dose given IV over 2-5 minutes. Repeat if necessary to a maximum of 8 mg in a 12 hour period.
- Adolescents: Same as adult dose, except maximum dose is 4 mg.
- Children under 12 years: 0.05-0.10 mg/kg IV over 2-5 minutes. Repeat if necessary .05 mg/kg 10-15 minutes after first dose, with a maximum dose of 4 mg.

Caution: Be prepared to assist pulmonary ventilation mechanically if respiration is depressed, to intubate the trachea if laryngospasm occurs, and to counteract hypotensive reactions.

Phenobarbital is an additional treatment option for seizure control. Dosage for **infants, children, and adults** is 15-20 mg/kg as an IV loading dose. An additional 5 mg/kg IV may be given every 15-30 minutes to a maximum of 30 mg/kg. The drug should be pushed no faster than 1 mg/kg/minute.
For seizure management, most patients respond well to usual management consisting of benzodiazepines, or phenytoin and phenobarbital.

# ANNEX D: SUMMARY OF ACUTE EXPOSURE SYMPTOMS AND TREATMENT OF WHO PESTICIDES

### Summary of Acute Exposure Symptoms and Treatment of WHO-recommended carbamates

| Carbamates | Human side effects | Treatment |
|---|---|---|
| Bendiocarb | Excessive sweating, headache, nausea, blurred vision, chest pain, vomiting, excessive salivation, and slurred speech. Severe intoxication causes narrowed pupils, muscle twitching, spasms, intestinal convulsions, diarrhea, and labored respiration. | The affected person should stop work immediately, remove any contaminated clothing and wash the affected skin with soap and clean water. The whole contaminated area (including the eyes, if necessary) should be flushed with large quantities of clean water. The patient should be kept at rest and immediate medical aid obtained. Administer Atropine. |
| Propoxur | Excessive sweating, headache, nausea, blurred vision, chest pain, vomiting, excessive salivation, and slurred speech. Severe intoxication causes narrowed pupils, muscle twitching, spasms, intestinal convulsions, diarrhea, and labored respiration. | The affected person should stop work immediately, remove any contaminated clothing and wash the affected skin with soap and clean water. The whole contaminated area (including the eyes, if necessary) should be flushed with large quantities of clean water. The patient should be kept at rest and immediate medical aid obtained. Administer Atropine. |

### Summary of Acute Exposure Symptoms and Treatment of WHO-recommended organophosphates

| Organo-phosphates | Human side effects | Treatment |
|---|---|---|
| Malathion | Malathion is an indirect cholinesterase inhibitor. The primary target of malathion is the nervous system; it causes neurological effects by inhibiting cholinesterase in the blood and brain. Exposure to high levels can result in difficulty breathing, vomiting, blurred vision, increased salivation and perspiration, headaches, and dizziness. Loss of consciousness and death may follow very high exposures to malathion. | Oral exposure to malathion should be treated with rapid gastric lavage unless the patient is vomiting. Dermal exposures should be treated by washing the affected area with soap and water. If the eyes have been exposed to malathion, flush them with saline or water. People exposed to malathion who exhibit respiratory inefficiency with peripheral symptoms should be treated via slow intravenous injection with 2–4 mg atropine sulfate and 1,000–2,000 mg pralidoxime chloride or 250 mg toxogonin (adult dose).<br><br>Exposure to high levels of malathion that result in respiratory distress, convulsions, and unconsciousness should be treated with atropine and a re-activator. Morphine, barbiturates, phenothiazine, tranquillizers, and central stimulants are all contraindicated. |
| Fenitrothion | Fenitrothion is the most toxic to man of the insecticides recommended for residual house spraying, and has a relatively low margin of safety.<br><br>Absorbed through the gastrointestinal tract as well as through intact skin and by inhalation. It is also a cholinesterase | Dermal exposure to fenitrothion should be treated by removing contaminated clothing, rinsing the skin with water, washing the exposed areas with soap and water, then seeking medical attention. If fenitrothion gets into the eyes, they should be rinsed with water for several minutes.<br><br>Contact lenses should be removed if possible and medical attention should be sought. Ingestion of fenitrothion should be treated by rinsing the mouth and inducing vomiting if the person is |

| Organo-phosphates | Human side effects | Treatment |
|---|---|---|
| | inhibitor. | conscious. Inhalation exposures require removal to fresh air and rest in a half-upright position. Artificial respiration should be administered if indicated and medical attention should be sought. |
| Pirimiphos-methyl | Pirimiphos-methyl is also a cholinesterase inhibitor. Early symptoms of poisoning may include excessive sweating, headache, weakness, giddiness, nausea, vomiting, stomach pains, blurred vision, constricted pupils, slurred speech, and muscle twitching.<br><br>Later there may be convulsions, coma, loss of reflexes, and loss of sphincter control. | OP poisoning is a medical emergency and requires immediate treatment. All supervisors and individual spraymen (in the case of dispersed operations) should be trained in first-aid and emergency treatment of OP intoxication.<br>The affected person should stop work immediately, remove any contaminated clothing, wash the affected skin with soap and clean water and flush the skin with large quantities of clean water. Care must be taken not to contaminate others, including medical or paramedical workers.<br><br>Automatic injectors loaded with atropine sulfate and obidoxime chloride can be made available in the field whenever relatively toxic OP insecticides are used in areas without easy access to medical care.<br><br>Atropine sulfate. Administer atropine sulfate intravenously or intramuscularly if intravenous injection is not possible.<br>Glycopyrolate has been studied as an alternative to atropine and found to have similar outcomes using continuous infusion. |

**Summary of Acute Exposure Symptoms and Treatment for WHO-recommended pyrethroids**

| Pyrethroids | Human side effects | Treatment |
|---|---|---|
| Bifenthrin | Acute exposure symptoms include skin and eye irritation, headache, dizziness, nausea, vomiting, diarrhea, excessive salivation, fatigue, irritability, abnormal sensations of the face and skin, and numbness.<br>No skin inflammation or irritation observed; however can cause a reversible tingling sensation.<br>Incoordination, irritability to sound and touch, tremors, salivation, diarrhea, and vomiting have been caused by high doses. | Depends on the symptoms of the exposed person. Casual exposures require decontamination and supportive care. Wash affected skin areas promptly with soap and warm water.<br>Medical attention should be sought if irritation or paresthesia occurs. Eye exposures should be treated by rinsing with copious amounts of water or saline. |

| Pyrethroids | Human side effects | Treatment |
|---|---|---|
| Deltamethrin | Acute exposure symptoms include skin and eye irritation, headache, dizziness, nausea, vomiting, diarrhea, excessive salivation, fatigue, irritability, abnormal sensations of the face and skin, and numbness. | If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water.<br>Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate.<br>Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed. |
| Lambda-Cyhalothrin | Skin exposure leads to transient skin sensations such as periorbital facial tingling and burning.<br>Can irritate the eyes, skin, and upper respiratory tract. Oral exposure can cause neurological effects, including tremors and convulsions.<br>Ingestion of liquid formulations may result in aspiration of the solvent into the lungs, resulting in chemical pneumonitis. | Dermal exposure should be treated by removing contaminated clothing and washing the exposed areas with soap and water. Eyes should be rinsed with water for several minutes. Vomiting should not be induced following ingestion. Inhalation exposures require removal to fresh air and rest. |
| Alpha-cypermethrin | Acute exposure symptoms include skin rashes, eye irritation, itching and burning sensation on exposed skin, and paraesthesia.<br>Acute inhalation exposures may cause upper and lower<br>Respiratory tract irritation. Ingestion of alpha-cypermethrin is also harmful | Dermal exposure should be treated by removing contaminated clothing and washing the exposed areas with soap and water. Eyes should be rinsed with water for several minutes. Vomiting should not be induced following ingestion. Inhalation exposures require removal to fresh air and rest. |
| Cyfluthrin | Acute occupational or accidental exposure results in burning, itching, and tingling of the skin. Reported systemic symptoms included dizziness, headache, anorexia, and fatigue. Vomiting occurs most commonly after ingestion of pyrethroids. Less commonly reported symptoms include tightness of the chest, paresthesia, palpitations, blurred vision, and increased sweating. In serious cases, coarse muscular fasciculations (twitching), convulsions, and coma. | If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water.<br>Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed. |

| Pyrethroids | Human side effects | Treatment |
|---|---|---|
| Etofenprox | Acute occupational or accidental exposure results in burning, itching, and tingling of the skin. Reported systemic symptoms included dizziness, headache, anorexia, and fatigue. Vomiting occurs most commonly after ingestion of pyrethroids. Less commonly reported symptoms include tightness of the chest, paresthesia, palpitations, blurred vision, and increased sweating. In serious cases, coarse muscular fasciculations (twitching), convulsions, and coma. | If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water.<br><br>Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed. |

**Summary of Acute Exposure Symptoms and Treatment for chlorfenapyr (currently under assessment by WHO)**

| Pyrrole | Human side effects | Treatment |
|---|---|---|
| Chlorfenapyr | As chlorfenapyr is a rather new product there are not many cases of poisonings where the symptoms were described. One incident involved someone who experienced an asthma attack after a nearby office was sprayed. The only symptoms reported were respiratory effects. This case was ranked as low severity. Another exhibited general fatigue, hyper-perspiration, nausea and vomiting. He was initially diagnosed as being dehydrated. And a third was hospitalized due to exogenous intoxication with chlorfenapyr with suicidal purposes, initially presenting diaphoresis, headache and cough. Symptomatic management was initiated, but after seven days she presented neurological and respiratory deterioration, causing her death. | As chlorfenapyr affects the central nervous system, it can be managed through supportive care and early treatment of seizure through benzodiazepine. No specific symptoms can be said for exposure by inhalation or ingestion. Possible generalized symptoms include nausea and vomiting. Prolonged contact of the skin with the concentrate may cause irritation. Eye contact may cause some discomfort if contact is prolonged. Evidence from prolonged animal studies indicates that repeated or prolonged exposure to high doses of chlorfenapyr can result in spongiform (encephalomyelopathy) and effects on the liver and kidney. |

# ANNEX E: IRS BMP GAPS IN NON PMI DISTRICTS

| S. N | Region | District Name | Micro planning for insecticide quantification? | Chemical allocated (Enough? Shortage? Excess?) | Soap for spray actors? Y/N | Any Chemical loss? Y/N | Empty Sachet Collected? | How is disposal made? | Soak pit dag? Y/N | Triple Rinsing? Y/N | Poison Mgt Y/N? | Pregnancy Test for female Participants Y/N? | Which Obsolete chemical is available in Your site? (DDT? /Delta? / Both?) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Tigray | Raya Azebo | Yes | Shortage | yes | no | yes | Incinerated | n | no | no | No female | Both |
| | | Raya Alamata | Yes | Shortage | yes | no | yes | Incinerated | yes but not standard | no | Yes | no | DDT |
| 2 | Afar | Dubti | Yes | Shortage | yes | no | yes | Incinerated | no | no | No | No female | No |
| 3 | Amhara | wereta | Yes | Shortage | yes | no | yes | Incinerated | no | no | Yes | No female | Both |
| | | Dangila | Yes | Shortage | yes | no | yes | Incinerated | no | no | Yes | no | Deltha |
| | | B/Dar Zuria | Yes | Shortage | yes | no | yes | Incinerated | no | no | Yes | no | DDT |
| | | Mechekel | Yes | Enough | yes | yes | yes | Incinerated | no | no | Yes | No female | DDT |
| 4 | Oromia | Haromaya | Yes | Enough | yes | yes | yes | Incinerated | no | no | no | no | DDT |
| | | Meiso | Yes | Shortage | yes | no | yes | just collected | sub-standard | no | yes | yes | DDT |
| | | Boset | Yes | Enough | yes | no | yes | just collected | yes | no | Yes | yes | No |
| 5 | Somali | Jijiga | No | Enough | no | no | yes | Incinerated | no | no | Yes | No female | DDT |
| 6 | Benishangul | Sherkol | No | Excess | yes | yes | yes | Incinerated | no | no | Yes | No female | Both |
| | | Menge | No | Shortage | yes | yes | yes | Incinerated | no | no | Yes | No female | DDT |
| 7 | SNNPR | Meskan | Yes | Shortage | yes | no | yes | Incinerated | no | no | Yes | no | Both |
| | | Damot Woide | Yes | Shortage | yes | no | yes | Incinerated | sub standard | no | Yes | no test | No |
| 8 | Gambela | Gambela | Yes | Enough | yes | no | yes | incinerated | no | no | no | no | DDT |
| 9 | Hareri | Hareri | No | Enough | yes | yes | yes | Incinerate | no | no | Yes | no test plan | Deltha |
| 10 | Dire Dawa City | Dire Dawa | Yes | Enough | Yes | Yes | Yes | Incinerate | No | No | No | No | Both |

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