



Integrated Vector Management Programs for Malaria Vector Control

**Programmatic Environmental
Assessment**

January 2007

This publication was produced for review by the United States Agency for International Development. It was prepared by RTI International with contributions from International Resources Group.

Table 21. IRS Recommendations

Potential Negative Activities/Impacts	Recommended Mitigation Actions
Daily Operations	
Occupational exposure to insecticide from daily indoor residual spraying (IRS) operations	<p>Training of spray operators, team leaders, and supervisors according to best practices, including recognition of insecticide-poisoning symptoms.</p> <hr/> <p>Procurement and proper use of personal protective equipment (PPE) by spray operators, team leaders, and supervisors (cotton overalls, face mask, broad-rimmed hat, rubber gloves, gum boots)</p> <hr/> <p>Training of health workers in insecticide-poisoning treatment</p> <hr/> <p>Procurement and distribution of treatment medicines for insecticide exposure</p> <hr/> <p>Daily on-site personal washing (after spraying)</p> <hr/> <p>Reprimand of spray operators who do not follow proper procedure in all aspects of operations (handling, spraying, hygiene, cleanup)</p> <hr/> <p>Hire of commercial laundry or local wash persons (can be spray operators) for proper washing of overalls.</p> <hr/> <p>Frequent washing of overalls (after spraying)</p> <hr/> <p>Procurement and wearing of PPE by wash person (chemical apron, rubber boots, rubber gloves) if a wash person is hired to clean spray operator PPE</p> <hr/> <p>Procurement and distribution of barrels for progressive rinse, and wash-tubs for overall washing and personal hygiene</p> <hr/> <p>Progressive rinse of sprayers and PPE</p> <hr/> <p>Development and implementation of a human health monitoring plan to determine pesticide impacts on spray operators and residents, particularly when using organophosphates.</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>
Fetal exposure to insecticide from daily IRS operations (female spray operators)	<p>When dichloro-diphenyl-trichloroethane (DDT) is used, institute prohibitions of hiring women of child-bearing age as spray operators.</p> <hr/> <p>Ensure that pregnant or breast-feeding women are not hired as spray operators</p>

Potential Negative Activities/Impacts	Recommended Mitigation Actions
	<p>Distribution of condoms to women spray operators</p> <hr/> <p>Pregnancy tests 1 month into spray campaign</p>
<p>Community and environmental exposure to insecticide from daily IRS operations</p>	<p>Prohibition of spraying in homes where sick persons or pregnant women are living and cannot move outside the home <i>and</i> stay outside the home during and 1 hour after spraying</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p> <hr/> <p>Prohibition of spraying in protected areas/sensitive ecosystems (e.g., uncultivated wetlands), and spraying with care in residential areas where beekeeping occurs</p> <hr/> <p>Prohibition of spraying in homes where food and utensils have not been removed from the house, and where furniture has not been removed from the house or moved to the middle of the room and covered with a cloth by the spray operator</p> <hr/> <p>Information, education, and communication (IEC) campaign, citing importance of removing all food and utensils from house prior to spraying, moving furniture to the center of the room or outside, staying out of the house during and 1 hour after spraying, not allowing children or animals in the house until floor residue is swept outside, educating about potential impacts of insecticide on domestic animals (e.g., chickens eating insects killed by carbamates)</p> <hr/> <p>Procurement of seat covers or sheets for covering cloth vehicle seats</p> <hr/> <p>Covering of cloth interior seats of program vehicles with seat cover or cloth to prevent seat contamination</p> <hr/> <p>Use of gloves for washing interior and exterior of program vehicle</p> <hr/> <p>Wiping of contaminated bed of truck with damp cloth prior to exterior washing of program vehicles</p> <hr/> <p>End-of-program cleaning/decontamination of interior and exterior of vehicle, according to the United Nations Food and Agriculture Organization's (UNFAO) <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>End-of-campaign washing of seat covers and wiping of seats/bed of program vehicle with damp cloths</p> <hr/> <p>Prior to spraying, covering furniture that cannot be moved with cloths provided by the Ministry of Health (MOH), District Health Office, or U.S. Agency for International Development (USAID) program.</p>

Potential Negative Activities/Impacts	Recommended Mitigation Actions
	Reprimand of spray operators who do not follow proper procedure in all aspects of operations (handling, spraying, hygiene, cleanup)
	Frequent washing of cloths used to cover furniture
	Training of spray operators, team leaders, and supervisors according to best practices
	Procurement and distribution of barrels for progressive rinse and wash-tubs for overall washing and personal hygiene
	Progressive rinsing of sprayers and PPE
	Procurement and distribution of materials necessary for collection (in the case of using a commercial laundry for washing spray operator overalls) and decontamination of washtub rinse-water
	Daily collection of laundry rinse-water (from commercial laundry), decontamination of laundry rinse-water, and latrine disposal
	Analysis of decontaminated rinse-water to determine levels of active ingredient
	Storage of all insecticides, empty packaging, barrels, and tubs in storage facilities, reducing use of contaminated goods domestically
	Inscription of all program barrels and tubs as District Health Office property, and labeling with host-country-specific poison indicators, to deter sale and domestic use (e.g., storage of food or water for human or animal consumption) in the event of pilferage
	Secure storage of contaminated plastic sachets for recapture by the manufacturer or disposal at an internationally recognized hazardous waste incinerator
	Shredding or puncturing of plastic packaging materials, making them unusable (unless barrels used for progressive rinse)
	Local disposal of noncontaminated cardboard or paper packaging
	Transport of rinsed packaging materials to a landfill for disposal, or a power plant or cement kiln for reuse as fuel (if they are not recovered by the manufacturer and if host country environmental guidelines allow)
	Development and implementation of environmental and/or livestock monitoring plan to the extent "feasible" and "relevant"

Potential Negative Activities/Impacts	Recommended Mitigation Actions
	<p>Development and implementation of a human health monitoring plan to determine pesticide impacts on spray operators and residents, particularly when using organophosphates</p> <hr/> <p>Development of protocol for decision making when environmental monitoring indicates environmental or agricultural contamination as a result of IRS</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>
Special Circumstances	
<p>Pilferage of insecticide, consequential human and environmental exposure</p>	<p>Construction or renovation of central, permanent storage facilities according to UNFAO's <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>Construction or renovation of temporary storage facilities using main principles of UNFAO's <i>Pesticide Storage and Stock Control Manual</i> as a general guideline</p> <hr/> <p>Double-padlocking and guarding of all storage facilities</p> <hr/> <p>Supervision of spray operators</p> <hr/> <p>Development and implementation of environmental monitoring plan</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>
<p>Storehouse fire, inhalation of toxic fumes from insecticide fire</p>	<p>Construction or renovation of central, permanent storage facilities according to UNFAO's <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>Construction or renovation of temporary storage facilities using main principles of UNFAO's <i>Pesticide Storage and Stock Control Manual</i> as a general guideline</p> <hr/> <p>Procurement and distribution of emergency equipment to insecticide storage facilities</p> <hr/> <p>Training of storekeepers according to FAO guidelines</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>

Potential Negative Activities/Impacts	Recommended Mitigation Actions
Accidents and spillage during transport and storage, leading to human and environmental exposure	<p>Training of drivers for long-distance transport of insecticide and short-distance transport during the campaign period</p> <hr/> <p>Transport of centrally-stored insecticides according to UNFAO's <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>Construction or renovation of central, permanent storage facilities according to UNFAO's <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>Construction or renovation of temporary storage facilities using main principles of UNFAO's <i>Pesticide Storage and Stock Control Manual</i> as a general guideline</p> <hr/> <p>Emergency equipment located in storage facilities</p> <hr/> <p>Storekeeper training for all insecticide storage facilities, both temporary and permanent</p> <hr/> <p>Training of health workers in insecticide-poisoning treatment</p> <hr/> <p>Procurement and distribution of treatment medicines for insecticide exposure</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>
Flooding of storehouse, leading to environmental contamination	Storage facility sites located on high ground, outside of floodplain
Insecticide Quality and Resistance	
Decreased effectiveness of insecticide, lessening impact on malaria incidence	<p>Selection of insecticide to minimize resistance and maximize residuality on surfaces sprayed</p> <hr/> <p>Laboratory testing of insecticide to ensure quality control</p> <hr/> <p>Entomological monitoring of resistance</p> <hr/> <p>IEC campaign, citing importance of not plastering or painting walls after the home has been sprayed</p> <hr/> <p>Data recording on agricultural insecticides for the purpose of knowing how they may contribute to resistance</p> <hr/> <p>Proper insecticide storage by renovation of storage facilities</p> <hr/> <p>Training of spray operators in proper application for specific wall types (e.g., uniform spray speed, constant and accurate spray distance)</p>

Potential Negative Activities/Impacts	Recommended Mitigation Actions
	<p>Procurement and use of sprayers manufactured according to WHO specifications</p> <hr/> <p>Daily sprayer maintenance</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>
Future Activities	
Indirect support of malaria vector control operations that have not undergone environmental review through procurement of sprayers and storage facilities	Importance of an environmental assessment for any pesticides used in IRS will be discussed with MOH and Ministry of Environment staff and online resources for conducting assessments will be provided (http://www.encapafrica.org/)
Adaptive Management (potentially reducing pesticide use for malaria vector control)	<p>Development of a strong malaria surveillance system to target IRS interventions, reducing pesticide use</p> <hr/> <p>Study resting behavior of the target species, so “treatment may be confined to the ceiling or the lower or upper half of walls, or to include the undersides of furniture, outside eaves and porches” (WHO, 2006;23)</p> <hr/> <p>Pursuit of an integrated strategy involving environmental management and larviciding</p> <hr/> <p>Development of protocol/implementation of measures to mitigate mosquito resistance to insecticides (pesticide rotation or mosaicing)</p> <hr/> <p>Submission of Human Health and Environmental Evaluation Report to USAID Contractor, USAID Mission Environmental Officer (MEO), USAID Regional Environmental Officer (REO)</p>

IRS: Description of Some of the General Recommendations

Hygiene Regimen. WHO recommendations in *Pesticides and their Application for the Control of Pests of Public Health Importance* should be followed in every malaria control program utilizing pesticides. The box below details these recommendations.

Table 22. Larviciding Recommendations

Potential Negative Activities/Impacts	Recommended Mitigation Actions
Daily Operations	
Occupational exposure to larvicide from daily operations	Training of spray applicators and supervisors according to best practices.
	Procurement and proper use of personal protective equipment (PPE) by applicators (cotton overalls, face mask, rubber gloves)
	Training of health workers in pesticide-poisoning treatment
	Procurement and distribution of treatment medicines for pesticide exposure
	Reprimand of applicators who do not follow proper procedure in all aspects of operations (handling, application, hygiene, cleanup)
	Procurement and distribution of barrels for progressive rinse and wash-tubs for overall washing and personal hygiene
	Progressive rinse of sprayers and PPE
Development and implementation of a human health monitoring plan (to determine pesticide impacts on applicators and residents)	
Fetal exposure to larvicide from daily operations (female applicators)	Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)
	Women prohibited from conducting organophosphate application while pregnant or breastfeeding
Community and environmental exposure to larvicide from daily operations	Care should be taken in deciding when to spray, avoiding larviciding before major storm events
	Care should be taken in deciding where to spray, avoiding bodies of water used as drinking water sources for humans or livestock
	Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)

Potential Negative Activities/Impacts	Recommended Mitigation Actions
	<p>Reprimand of applicators who do not follow proper procedure in all aspects of operations (handling, application, hygiene, cleanup)</p> <hr/> <p>Training of applicators and supervisors according to best practices</p> <hr/> <p>Procurement and distribution of barrels for progressive rinse and wash-tubs for overall washing and personal hygiene</p> <hr/> <p>Progressive rinsing of sprayers and PPE</p> <hr/> <p>Storage of all insecticides, empty packaging, barrels, and tubs in storage facilities, reducing use of contaminated goods domestically</p> <hr/> <p>Inscription of ALL program barrels and tubs as District Health Office property, and labeling with poison stickers, to deter sale and domestic use in event of pilferage</p> <hr/> <p>Daily triple-rinsing of contaminated packaging</p> <hr/> <p>Shredding or puncturing of packaging materials, making them unusable (unless barrels used for progressive rinse)</p> <hr/> <p>Transport of rinsed packaging materials to landfill or, if appropriate for incineration, power plant or cement kiln</p> <hr/> <p>Development and implementation of environmental and/or livestock monitoring plan</p> <hr/> <p>Development and implementation of a human health monitoring plan (to determine pesticide impacts on spray operators and residents)</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>
Special Circumstances	
<p>Pilferage of larvicide, consequential human and environmental exposure</p>	<p>Construction or renovation of central, permanent storage facilities according to the United Nations Food and Agriculture Organization's (UNFAO's) <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>Construction or renovation of temporary storage facilities using main principles of UNFAO's <i>Pesticide Storage and Stock Control Manual</i> as a general guideline</p>

Potential Negative Activities/Impacts	Recommended Mitigation Actions
	<p>Double-padlocking of all storage facilities</p> <hr/> <p>Supervision of applicators</p> <hr/> <p>Development and implementation of environmental monitoring plan</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>
<p>Storehouse fire, inhalation of toxic fumes from larvicide fire</p>	<p>Construction or renovation of central, permanent storage facilities according to UNFAO's <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>Construction or renovation of temporary storage facilities using main principles of UNFAO's <i>Pesticide Storage and Stock Control Manual</i> as a general guideline</p> <hr/> <p>Procurement and distribution of emergency equipment to larvicide storage facilities</p> <hr/> <p>Training of storekeepers</p> <hr/> <p>Development and implementation of environmental reporting system</p>
<p>Accidents and spillage during transport and storage, leading to human and environmental exposure</p>	<p>Training of drivers for long-distance transport of larvicide and short-distance transport during the campaign period</p> <hr/> <p>Transport of larvicides according to UNFAO's <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>Construction or renovation of central, permanent storage facilities according to UNFAO's <i>Pesticide Storage and Stock Control Manual</i></p> <hr/> <p>Construction or renovation of temporary storage facilities using main principles of UNFAO's <i>Pesticide Storage and Stock Control Manual</i> as a general guideline</p> <hr/> <p>Procurement and distribution of emergency equipment to larvicide storage facilities</p> <hr/> <p>Storekeeper training</p> <hr/> <p>Training of health workers in pesticide-poisoning treatment</p> <hr/> <p>Procurement and distribution of treatment medicines for pesticide exposure</p> <hr/> <p>Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)</p>

Potential Negative Activities/Impacts	Recommended Mitigation Actions
Flooding of storehouse, leading to environmental contamination	Storage facility sites located on high ground, outside of floodplain
Insecticide Quality and Resistance	
Decreased effectiveness of larvicide, lessening impact on malaria incidence	Prohibition of applying larvicidal agents where vector larvae are not present
	Whenever possible, use of “source reduction” (emptying, covering, or filling in breeding sites) instead of application of the larvicidal agent
	Selection of larvicidal agent to minimize vector resistance
	Laboratory testing of larvicidal agent to ensure quality control
	Entomological monitoring of resistance
	Data recording on agricultural pesticides for the purpose of knowing how they may contribute to resistance
	Construction or renovation of storage facilities according to UNFAO’s <i>Pesticide Storage and Stock Control Manual</i>
	Procurement and use of sprayers manufactured according to World Health Organization (WHO) specifications
	Daily sprayer maintenance
Development and implementation of environmental reporting system for Human Health and Environmental Evaluation Report (see Section 6.2)	
Future Activities	
Indirect support of malaria vector control operations that have not undergone environmental review through procurement of sprayers and storage facilities	Importance of an environmental assessment for any pesticides used in malaria vector control will be discussed with Ministry of Health (MOH) and Ministry of Environment staff and online resources for conducting assessments will be provided (http://www.encapafrika.org/)

Potential Negative Activities/Impacts	Recommended Mitigation Actions
Adaptive management (potentially reducing larvicide use for malaria vector control)	Development of a strong malaria surveillance system to target interventions, reducing pesticide use
	Pursuit of an integrated malaria vector control strategy
	Development of protocol/implementation of measures to mitigate mosquito resistance to larvicidal agents through rotation or mosaicing
	Submission of Human Health and Environmental Evaluation Report to USAID Contractor, USAID Mission Environmental Officer, USAID Regional Environmental Officer

Environmental Management Recommendations

The site location for an environmental management intervention should be chosen based on larval surveillance—if no vector larvae are present, no intervention should be conducted. When vector larvae are present in an area, the intervention chosen should be based on scientific information about the site, such as soil type and density, slope, species composition, endangered species habitat, and water flow and quality. Additionally, stakeholder and environmental water needs should be assessed and factored into decisions on specific interventions and intervention design.

Adverse environmental and human health impacts in environmental management are heterogeneous, varying according to the intervention chosen. Because the negative environmental impacts of environmental management are location specific, only general impacts and mitigation suggestions are described in this PEA. Table 23 breaks down the potential negative impacts by specific environmental management intervention and provides suggestions for mitigation.

It is important to note that the use of environmental management can decrease the need for pesticide-based interventions, which decreases the potential for harm to human health and the environment from pesticide use.

Table 23. Environmental Management Recommendations

Environmental Management Interventions	Potential Negative Impacts	Mitigation Measures
Environmental Modification		
Filling of breeding sites	Increased or decreased habitat and forage for animal species	Prohibit intervention in sensitive habitats, forest reserves, national parks, wildlife reserves, and endangered species habitats
Lining of water sources and canals	Increased flooding	Assess the impact of increased water flow on other water resources
Impoundment construction	Altered upstream and downstream water availability	Conduct impoundment planning at the water basin level
	Increased or decreased habitat and forage for animal species	Determine water needs (maximum use level) for stakeholders and the environment; assess impacts on water sources prior to intervention, work with stakeholders for appropriate solutions
	Increased or decreased plant and animal biodiversity	Prohibit intervention in sensitive habitats, forest reserves, national parks, wildlife reserves, and endangered species habitats
	Altered ecosystem composition	Design landscape that resembles the natural ecosystem to help conserve water and soil and provide habitat for wildlife
	Integrate buffer strips into intervention design to decrease adverse effects of water runoff and soil erosion	
Biological drainage	Reduced water availability	Use environmental information in activity design
	Reduced or enhanced water quality	Determine water needs (maximum use level) for stakeholders and the environment; assess impacts on water sources prior to intervention, work with stakeholders for appropriate solutions
	Increased or decreased habitat and forage for animal species	Prohibit intervention in sensitive habitats, forest reserves, national parks, wildlife reserves, and endangered species habitats
	Increased or decreased plant and animal biodiversity	Design landscape that resembles the natural ecosystem to help conserve water and soil and provide habitat for wildlife
	Altered ecosystem composition	Use native species when introducing vegetation

Environmental Management Interventions	Potential Negative Impacts	Mitigation Measures
Physical drainage	Reduced water availability	Use environmental information in activity design
	Reduced water quality	Determine water needs (maximum use level) for stakeholders and the environment; assess impacts on water sources prior to intervention, work with stakeholders for appropriate solutions
	Increased flooding	Prohibit intervention in sensitive habitats, forest reserves, national parks, wildlife reserves, and endangered species habitats
	Siltation and sedimentation of water bodies, including dams and retention ponds	Design landscape that resembles the natural ecosystem to help conserve water and soil and provide habitat for wildlife
	Change in conditions for transport and hydropower production	Integrate buffer strips into intervention design to decrease adverse effects of water runoff and soil erosion
	Decreased agricultural productivity of soil	Select alternative site
	Increased or decreased habitat and forage for animal species	
	Increased or decreased plant and animal biodiversity Altered ecosystem composition	
Environmental Manipulation		
Deepening/narrowing of existing drains	No significant impacts	Not applicable
Synchronized cropping/intermittent irrigation	No significant impacts	Not applicable
Saltwater flooding	Reduced water availability	Determine water needs (maximum use level) for stakeholders and the environment; assess impacts on water sources prior to intervention, work with stakeholders for appropriate solutions
	Decreased habitat for freshwater aquatic and terrestrial species	Prohibit interventions in sensitive habitats, forest reserves, national parks, wildlife reserves, and endangered species habitats

Environmental Management Interventions	Potential Negative Impacts	Mitigation Measures
		Design landscape that resembles the natural ecosystem to help conserve water and soil and provide habitat for wildlife
Introduction of larvivorious fish	Altered ecosystem composition on a small or large scale (invasive species problems)	Use indigenous larvivorious fish whenever possible
	Increased or decreased biodiversity	Prohibit intervention in sensitive habitats, forest reserves, national parks, wildlife reserves, and endangered species habitats
		Establish a license program for the use of larvivorious fish
Manipulation of vegetation	Reduced water availability	Determine water needs (maximum use level) for stakeholders and the environment; assess impacts on water sources prior to intervention, work with stakeholders for appropriate solutions
	Reduced water quality	Prohibit intervention in sensitive habitats, forest reserves, national parks, wildlife reserves, and endangered species habitats
	Increased flooding	Use native species when introducing vegetation
	Siltation and sedimentation of water bodies, including dams and retention ponds	Design landscape that resembles the natural ecosystem to help conserve water and soil and provide habitat for wildlife
	Change in conditions for transport and hydropower production	Integrate buffer strips into intervention design to decrease adverse effects of water runoff and soil erosion
	Decreased agricultural productivity of soil	Select alternative site
	Increased or decreased habitat and forage for animal species	
	Increased or decreased plant and animal biodiversity	
	Altered ecosystem composition	

6.2 Evaluation and Adaptive Management

Evaluation is a program management tool that links monitoring data to mitigation actions. Evaluation should be used to change or improve mitigation actions taken during